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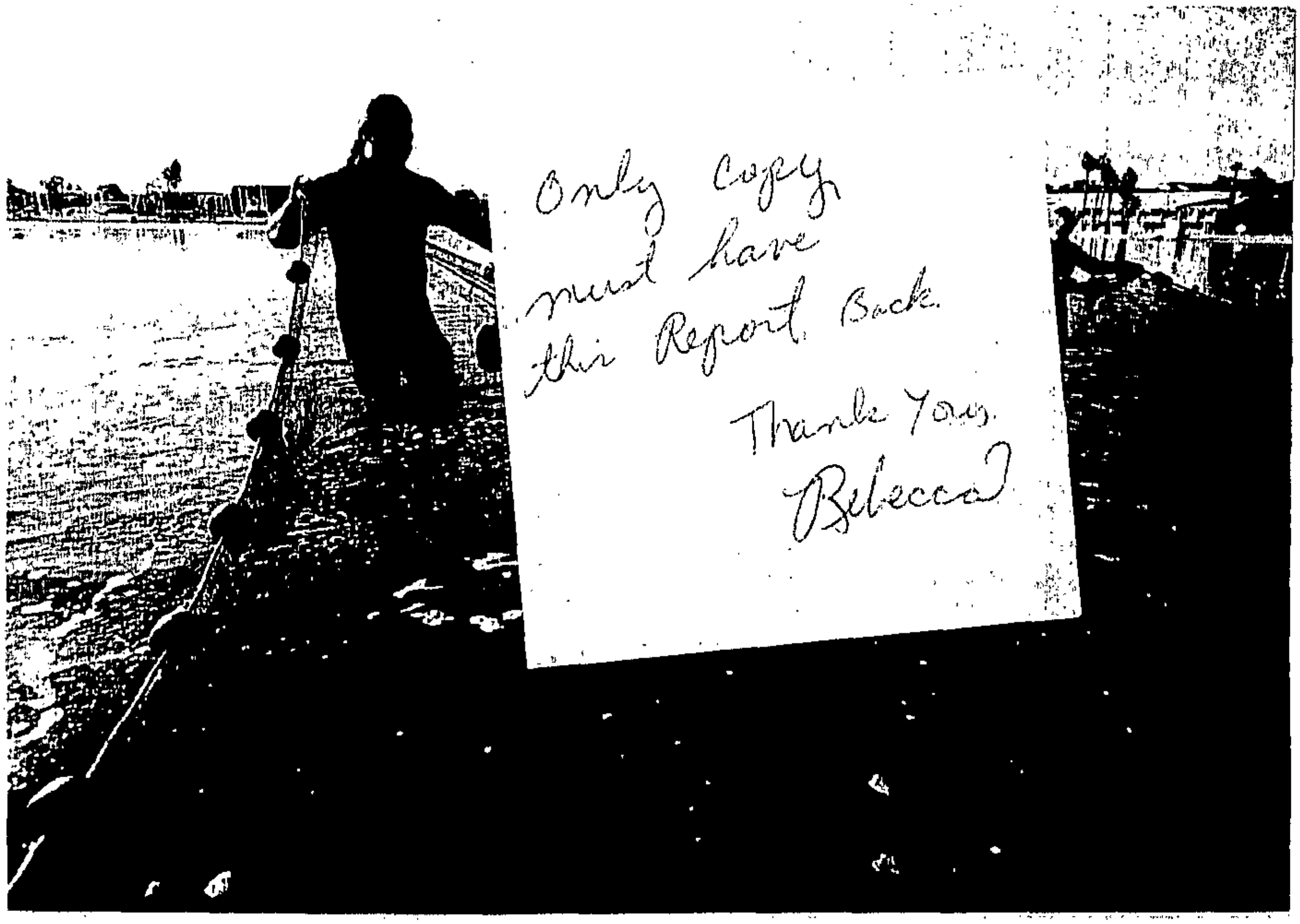
The Marine Environment of Marina del Rey Harbor
July 2000 - June 2001



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

By

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TOXICITY TESTING • OCEANOGRAPHIC RESEARCH

December 30, 2001

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

Dear Mr. Chesler:

The scientists and staff of Aquatic Bioassay are pleased to present this report of the 2000-2001 marine surveys of Marina del Rey Harbor.

This report contains the results of field and laboratory studies conducted from July 1, 2000 through June 30, 2001. The 2001-2001 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, 2000 to June 30, 2001. The program included monthly water quality and bacterial sampling; semiannual fish surveys including otter trawl, gill net, ichthyoplankton, beach seine, and diver-biologist transect sampling; and annual benthic sediment collection including physical, chemical, and biological characteristics.

Water Quality. Somewhat cooler water and low rainfall characterized this year's weather. Thus winter and spring rains had a smaller influence upon Harbor waters when compared to other, rainier years. Winter and spring precipitation lowered water clarity, salinity, and pH and increased ammonia, bacterial counts, and possibly biochemical oxygen demand (BOD) throughout the Harbor. The influence upon the phytoplankton community was generally limited to the summer. Red tides were noticed in July 2000 at Station 12 and in June 2001 at Stations 18, 10 and 8. As expected, seasonal temperature changes in the ocean impacted the Harbor, causing colder water in the winter and warmer water in the summer and fall.

Both the open ocean and Ballona Creek impact stations near the Harbor entrance. Open ocean influences included relatively low temperatures and high dissolved oxygen, salinity and pH. Ballona Creek caused decreased water clarity and high ammonia, BOD, and bacterial counts. Stations in the lower main channel, and even into Basins B and H, were most like the open ocean and were thus the most natural in the Harbor. High dissolved oxygen, salinity, pH and water clarity and low values of BOD characterized them. Stations further back in the Marina were warmer, more saline and moderate in dissolved oxygen and clarity.

Flows from Oxford Lagoon affected Basin E and brought reduced water clarity, dissolved oxygen, and salinity and elevated levels of BOD and bacteria. Basin D, which includes Mother's Beach, appeared less affected by surface runoff than in some past years.

Bacterial measurements were made monthly at 18 stations (648 measurements in the year). Total coliform limits were exceeded 20 times, fecal coliform limits 22 times, and enterococcus limits 41 times. The total violations (83) were down slightly from last year's numbers (84 exceedances). Among these 83 exceedances, 68 (82%) can be attributable to flows from either Ballona Creek or Oxford Lagoon. Most of the remainder were associated with moderate to heavy rainfall. With the exception of enterococcus in the fall, the frequency of exceedances was within the range of the past eight years.

Physical Characteristics of Benthic Sediments. Physical characteristics of Harbor sediments (median particle size and sorting) were influenced by energy of water flow that is influenced by Harbor configuration and rainfall intensity. The effect of current and wave action near the entrance and into the upper channel created sediments that were universally coarse and homogenous. A finer, more heterogeneous mix of sediments was found in the back Harbor areas. Sediments at the two stations in Oxford Lagoon had different characteristics from each other but were primarily sand to silt with a wide range of sediment types, suggesting that the flow regime in each of these areas is inconsistent.

Chemical Characteristics of Benthic Sediments. Oxford Lagoon did not appear to be a source of chlorinated hydrocarbons such as DDT and derivatives or other chlorinated pesticides into Basin E, although relatively high levels were found within the Lagoon itself. Ballona Creek was high in DDT derivatives, and Arochlor-1254 was found there at the highest concentration since 1994. DDT itself was found only at Station 4 in mid channel, which could suggests a possible fresh source of DDT. Among chlorinated hydrocarbons listed as toxic by NOAA, 11 of 15 Harbor stations exceeded at least one compound at levels "potentially" toxic to benthic organisms, and 6 out of 15 stations had chlorinated hydrocarbons at levels "probably" toxic to benthic organisms. The frequency of "potentially" toxic locations was lower this year, but frequency of "probably" toxic locations was higher. Despite this, most chlorinated compounds have continued to remain lower than historical values, and levels were much lower those of Los Angeles Harbor and are similar to those of reference samples collected offshore.

Heavy metals tended to be higher in the main channel and at Basins E and F, likely originating from the resident boat population itself. All stations, except Station 1, 3 and 12 near the Harbor entrance, exceeded at least one metal limit of "possible" toxicity, and 5 out of 15 exceeded at least one metal limit of "probable" toxicity. Metal concentrations in Marina del Rey sediments do not appear to have greatly increased or decreased since 1988. Levels of copper, lead, mercury, lead, silver and zinc in Marina del Rey were about two to three times higher than Los Angeles Harbor, although the rest of the metals were similar. The configuration of Los Angeles Harbor allows for better flushing and offshore movement of contaminated suspended materials since it has two entrances rather than the one like Marina del Rey Harbor. Tributyl tin continues to remain low but ubiquitous when compared to past surveys. Nonspecific organic compounds, including nutrients and carbonaceous organics, tended to be within the Harbor and away from the Harbor entrance.

Biological Comparisons of Benthic Sediments. When compared to Los Angeles Harbor, Marina del Rey infaunal abundances were higher possibly due to the protection from the enclosed design of the Harbor and perhaps due to differences in sampling methodology. Infaunal index and diversity values were lower than those of Los Angeles Harbor. Except for individuals, overall infaunal values were higher than past results with infaunal diversity the highest recorded since 1984.

The number of species was much higher this year (248) than last (168). Areas associated with Oxford Lagoon, Ballona Creek, the Administration Docks, and possibly Venice Canal tended to show some evidence of community disturbance. Infaunal community health did not appear to be strongly related to stations' benthic grain size patterns nor to any specific chemical compound, except perhaps chlorinated hydrocarbons. Nematode worms that are known to be characteristic of highly disturbed benthic sediments were found in low numbers this year. Despite some variable metals contamination, upper to mid channel stations appeared to be the healthiest in the 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. 160,884 total fish of all age groups, representing 47 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 slightly lower than past years for all strata of fish. Mid water gill net sampling caught eight fish of the same specie in the fall. The Marina continues to sustain an abundant and diverse assemblage of fish fauna and serves as a nursery for many species important to local sport and commercial fisheries, as well as the whole coastal environment.

2.INTRODUCTION

2.1. SCOPE AND PERIOD OF PERFORMANCE

This report covers the period of field and laboratory studies conducted from July 1, 2000 through June 30, 2001, supported by the County of Los Angeles, Department of Beaches and Harbors. The survey program consisted of monthly water column surveys; semiannual fish surveys including trawl, gill net, ichthyoplankton, beach seine, and diver transect enumerations; and annual benthic sediment surveys including the measurement of chemical and physical properties and benthic infaunal organisms.

2.2. HISTORY OF THE SURVEY PROJECT

Harbors Environmental Projects of the University of Southern California (HEP, USC) initiated baseline studies in Marina del Rey, the largest manmade marina in the world, in 1976, with partial funding from the Federal Sea Grant Program and the County. Survey techniques were examined and stations established for ecological evaluation of the marina. There was a hiatus until 1984, when surveys were resumed. Although there have been some lapses in periods covered due to funding constraints, the survey constitutes a unique, long term record of the ecology of the area (Soule and Oguri, 1991, 1980, 1985, 1986, 1981, 1988, 1990, 1994; Soule, Oguri and Jones, 1991, 1992a, 1992b, 1993; Soule, Oguri, and Pieper, 1996, 1997; and Aquatic Bioassay 1997,1998, 1999, 2000).

2.3. HISTORY OF THE STUDY SITE

Marina del Rey was developed in the early 1960s on degraded wetlands that formed part of the estuary of Ballona Creek Wetlands. The wetlands once extended through the communities of La Ballona, Port Ballona and what is now Venice on the north, to the Baldwin Hills and the San Diego Freeway on the east, and to the Westchester bluffs on the south. Present street drainage extends east to the USC area at Exposition Park, based on early drainage patterns. In earlier years, Ballona Wetlands joined wetlands leading to the Los Angeles River, to the north and east of the Baldwin Hills and Palos Verdes Peninsula. At one time creation of a navigable channel from Ballona Creek to Dominguez Channel and the Los Angeles River was considered. The San Pedro area and the little port of Ballona were competing sites for development of the large port, with railroad magnates engaging in political battles for control. Ultimately San Pedro was selected because it was more sheltered from southwest swells during storms. The history has been reviewed in previous reports, based in part on Bancroft (1884) and Beecher (1915).

Until Ballona Creek was channelized in the 1920s, a number of streams meandered through the wetlands, forming a large pond that drained into what are now Ballona Lagoon and Del Rey Lagoon, behind a barrier beach. The estuary opened into Santa Monica Bay, cutting the submerged Santa Monica Canyon at the margin of the alluvial shelf of the bay (Figure 2-1). In the mud flats, birds, mollusks, and crustaceans abounded, along with mosquitoes and midges in the standing freshwater pools. Urbanization overtook the wetlands, with development of oil and gas fields, truck farms, and industrial sites, which resulted in piecemeal dumping and filling. These activities deprived the wetlands of the normal cycles of renewal, including sedimentation and nutrient flow during heavy winter storms. 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 2-1. LOCATION OF MARINA DEL REY WITHIN SANTA MONICA BAY (FROM SOULE ET AL. 1997).

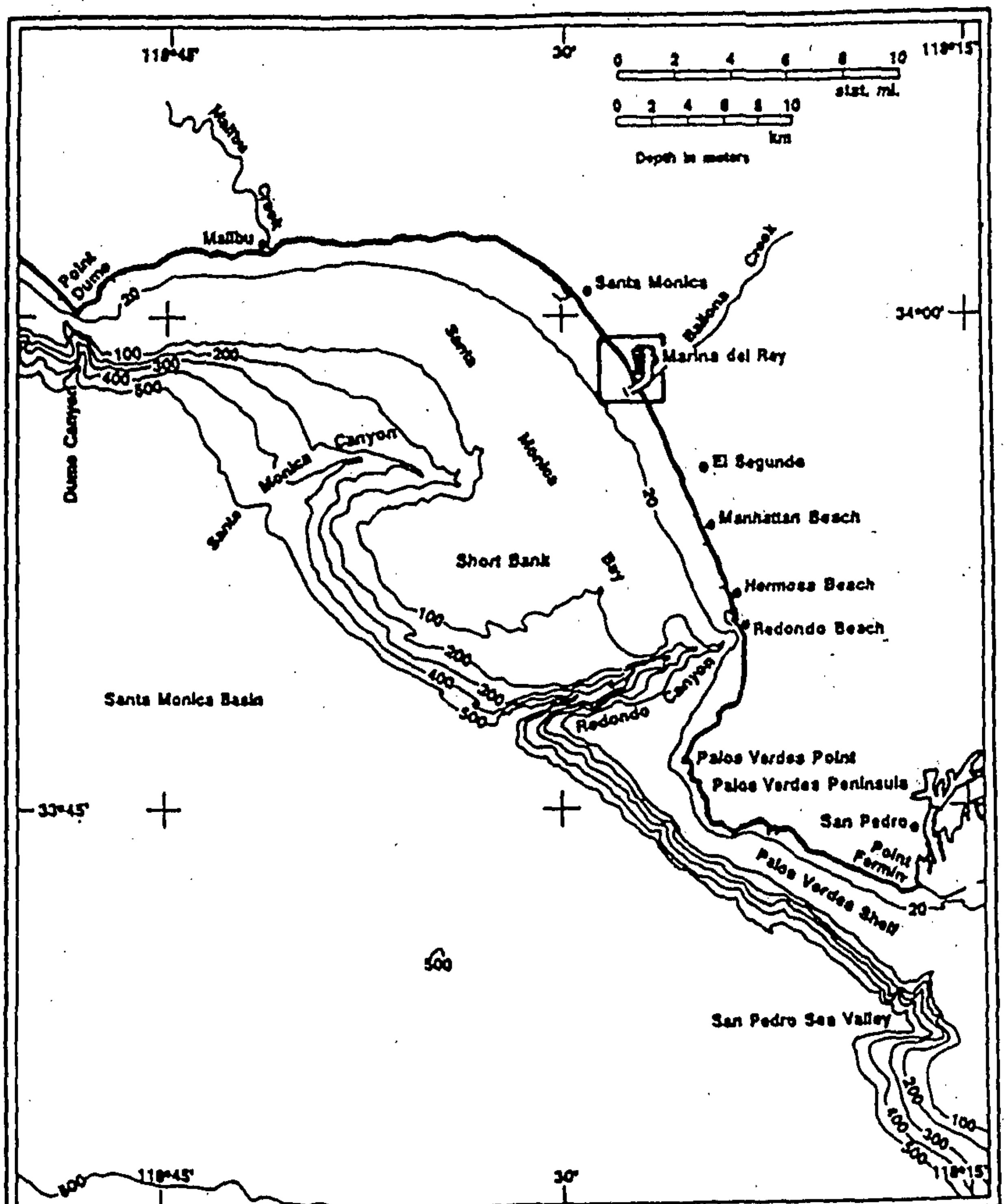
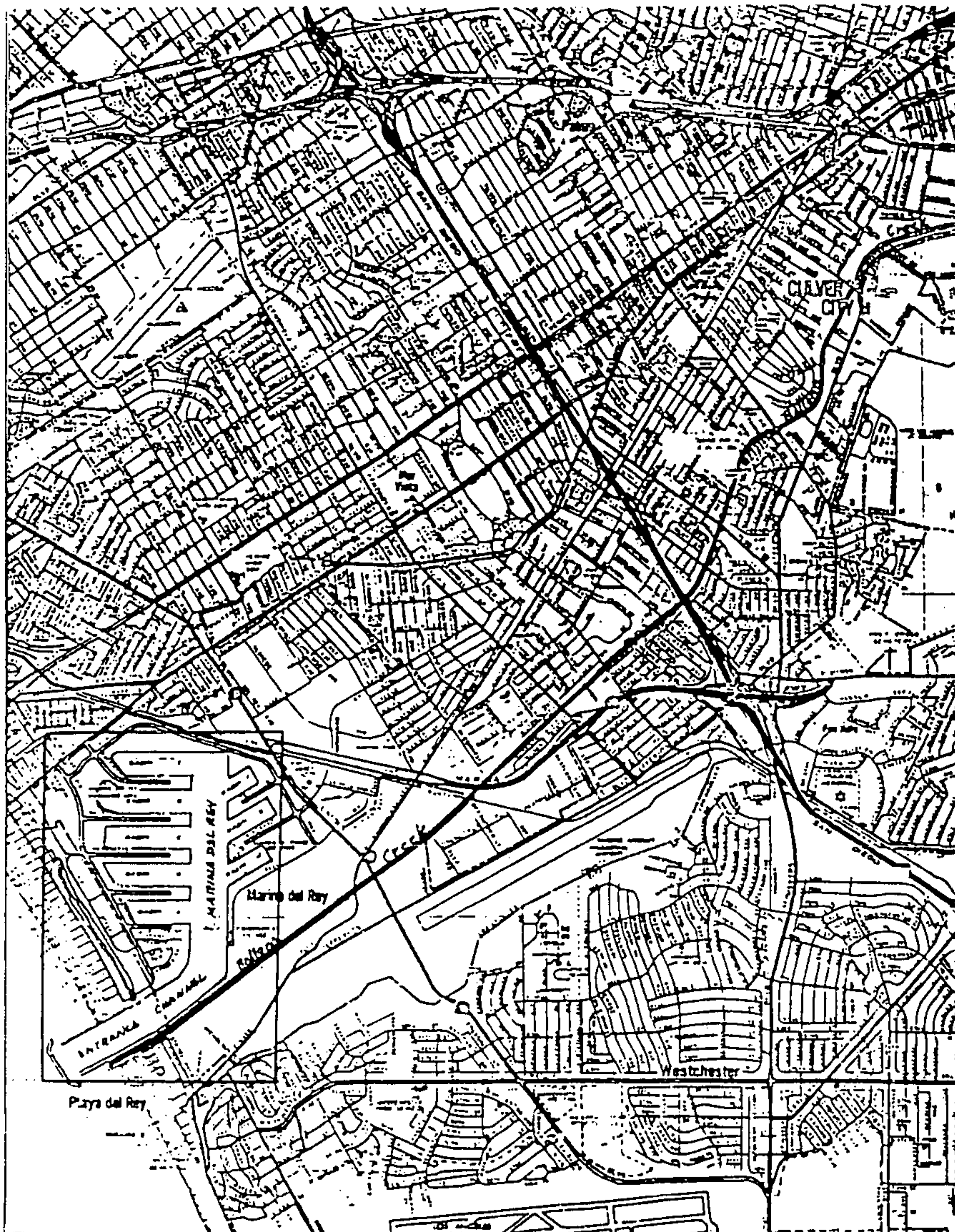


FIGURE 2-2. STUDY SITE MARINA DEL REY HARBOR (FROM SOULE ET AL. 1997).



Arsenic, copper, lead, mercury, nickel, silver 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 and have reappeared this year. Some terrestrial soils in areas to the north of the marina are known to contain high levels of PCBs that can enter drainage channels during grading or excavation. Pilot analyses of terrestrial soils surrounding Oxford Basin indicate that most areas are heavily contaminated with heavy metals, chlorinated pesticides, and polynuclear aromatic hydrocarbons.

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

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

About 111 species or larval taxa of fishes have been reported in the marina, more than for any other wetlands in the area. The fish species represent the remains of the wetlands fauna that has been largely shut off from the wetlands south of Ballona Creek. The rocky breakwater and jetties are important to species that would otherwise not find a habitat in the marina. The seagrass beds in sandy Basin D are very important to development of larval and juvenile fish, which also provide forage for larger fish.

Oxford Basin drainage is a significant source of pollutants in spite of the relatively low volume of runoff into the basin, as evidenced by the relatively high levels of coliforms, organic nitrogen and lead, for example. Ballona Creek is a significant source of contaminants, as indicated by levels of coliforms, volatile solids, chemical oxygen demand, oil and grease, sulfide, organic nitrogen, lead and silver. Levels of non-metals have been reduced, some by orders of magnitude, during the period of the surveys. Floating trash flushed from storm drains that accumulates at the breakwater and south jetty after rains often marks its flow pattern. Debris such as grass clippings and plastic food containers may move up into the main channel on the tides. The screen in Ballona Creek is not very effective at catching debris, it becomes filled and overflows, and is not deployed during rainstorms.

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

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

2.5. STATION LOCATIONS AND DESCRIPTIONS

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

MDR 1 is located midway between the breakwall and the southern jetty at the mouth of Ballona Creek Flood Control Channel. The area is subjected to discharges from the creek to severe impacts from storm water flow and deposition or erosion from storm wave action. The depth is irregular (2-6 meters). Depth during 2000 increased to about 7 meters due to dredging early in the year.

MDR 2 is located at the entrance to the Marina, midway between the two Marina jetties. The area is protected from most storm waves and swells. Tidal action, winds, and weak longshore currents influence it. Sediment and debris is carried tidally into the marina from the creek, and sand from the northern beach blows into the channel, covering jetty rocks, creating sandbars which reduce navigable areas. The areas nearby were dredged in February 1987, a "knockdown" was attempted in October 1992; and dredging also was done in October November 1994. The depth is 4-6 meters. Similar to MDR 1, dredging early in 2000 increased the depth to about 7 meters.

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

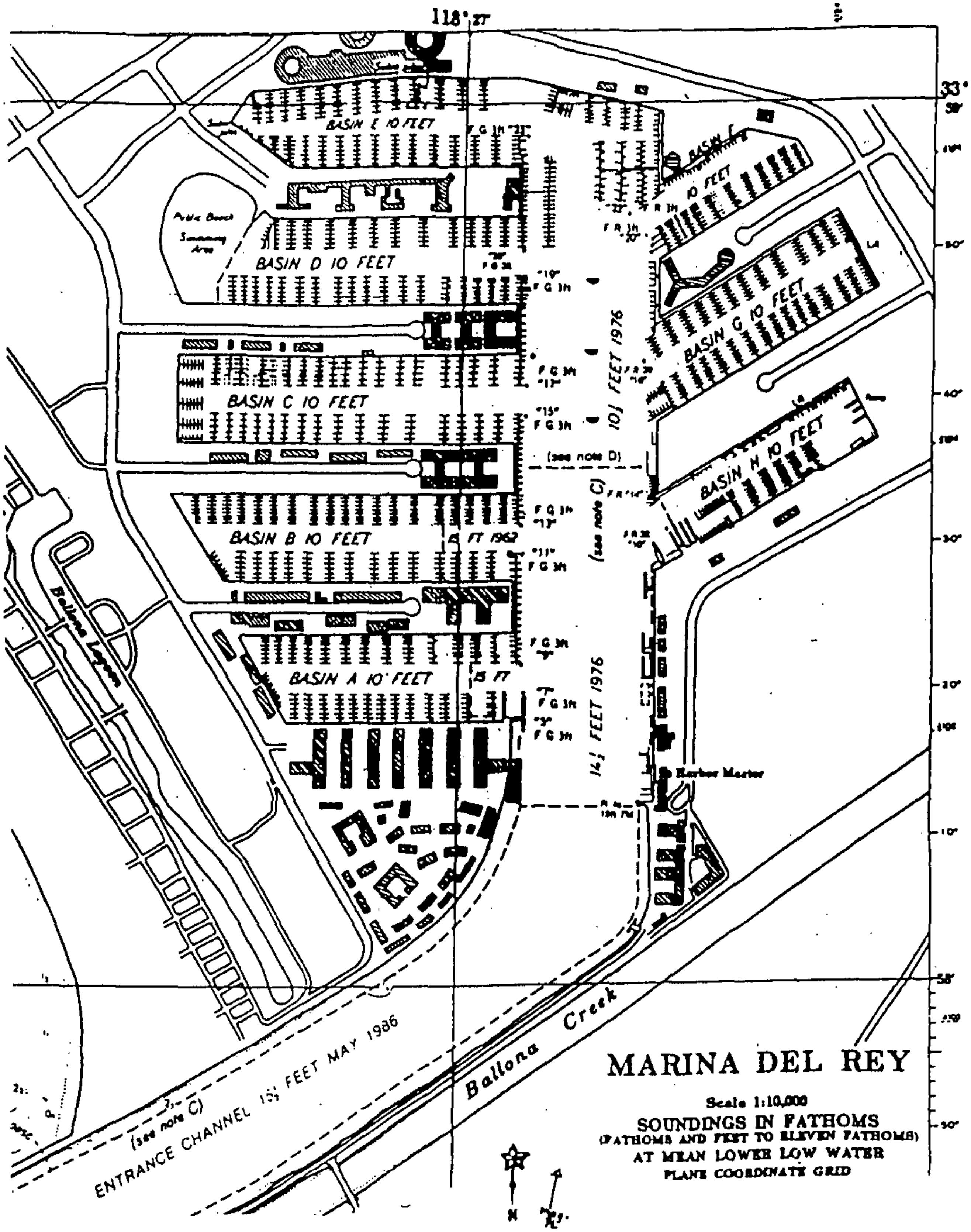
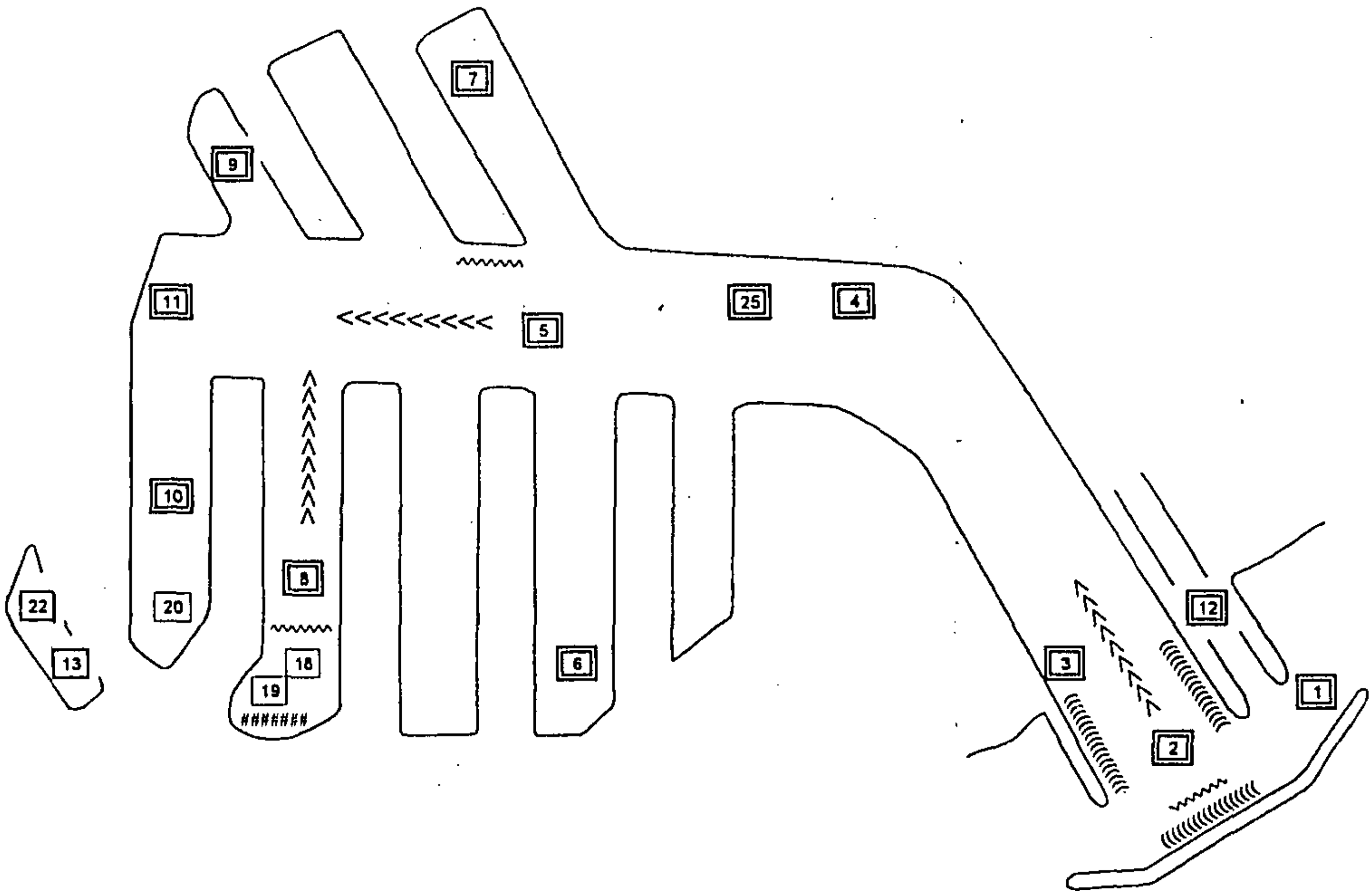


FIGURE 2-4. LOCATION OF MARINA DEL REY HARBOR SAMPLING STATIONS.



Water Quality Stations only

Water Quality and Sediment Chemistry Stations

Water Quality, Sediment Chemistry, and Benthic Infauna Stations

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

Midwater Fish by Gill Net

Reef Fish by Diver Transect

Inshore Fish by Beach Seine

MDR-3 is on the northwest side of the entrance channel, in front of the tide gate to the Venice Canal system. It is protected from all but severe storm waves but subjected to sediment and contaminated drainage from the lagoon. In the 1970s, mussel mounds are intermittently present in this area.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3. WATER QUALITY

3.1. BACKGROUND

3.1.1. General Weather and Oceanography

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

Superimposed upon annual trends are the sporadic occurrences of the El Nino Southern Oscillation (ENSO), an oceanographic anomaly whereby particularly warm, nutrient-poor water moves northward from the tropics and overwhelms the typical upwelling of colder nutrient-rich water. The El Nino Watch (Coast Watch, NMFS, and NOAA) program monitors sea surface temperatures off the West Coast of the United States and then compares them to long-term means. Coastal Watch data shows that in 1995-96, water temperatures were slightly higher with temperatures 2° C above normal for most months and 3° C above normal for February through May (Soule et. al. 1997). During 1996, temperatures remained high in the Southern California Bight (1° to 4° C above normal) from July through October but temperatures climbed again in 1997 with water temperatures averaging 5° C above normal in June. The 1997-98 survey year was characterized by a very strong ENSO anomaly. Surface water temperatures averaged from 2° (in April 1998) to 5° C (August through December 1997) above normal. During 1998-99, surface water temperatures were from 2° to 4° C above normal July to September but were from 0° to 3° C *below* normal for the remainder of the year (November through June). This trend continued through 1999-2000, average temperatures ranged from 2.5° below to 1.5°C above normal. During 2000-2001, surface temperatures deviated from normal in November and December, 1.0°C to 0.5°C below normal. Temperatures varied during February through June, the lowest in April, 2.0°C below and the highest, 0.5°C above normal, in 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 that, along with rainfall, can greatly affect water quality in Marina del Rey Harbor. Periodic phytoplankton blooms, including red tides, may be influenced by the above physical patterns, and can be exacerbated by anthropogenic inputs such as contaminated runoff and sewage effluents. In turn, blooms of red tide within enclosed bays and harbors can negatively impact resident fish and invertebrates (Daily, et. al. 1993).

3.1.2. Anthropogenic Inputs

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

3.1.3. Rainfall

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

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

The period of this report is from July 1, 2000 through June 30, 2001. The rainfall for this period (16 inches) was above normal (13 inches, SCCWRP 1973), but below what has been normal for the past 20 years (21 inches, Figure 3-1 as modified from Soule, et. al. 1997). As is characteristic of southern California, nearly all of the precipitation fell between October and April (Figure 3-2).

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

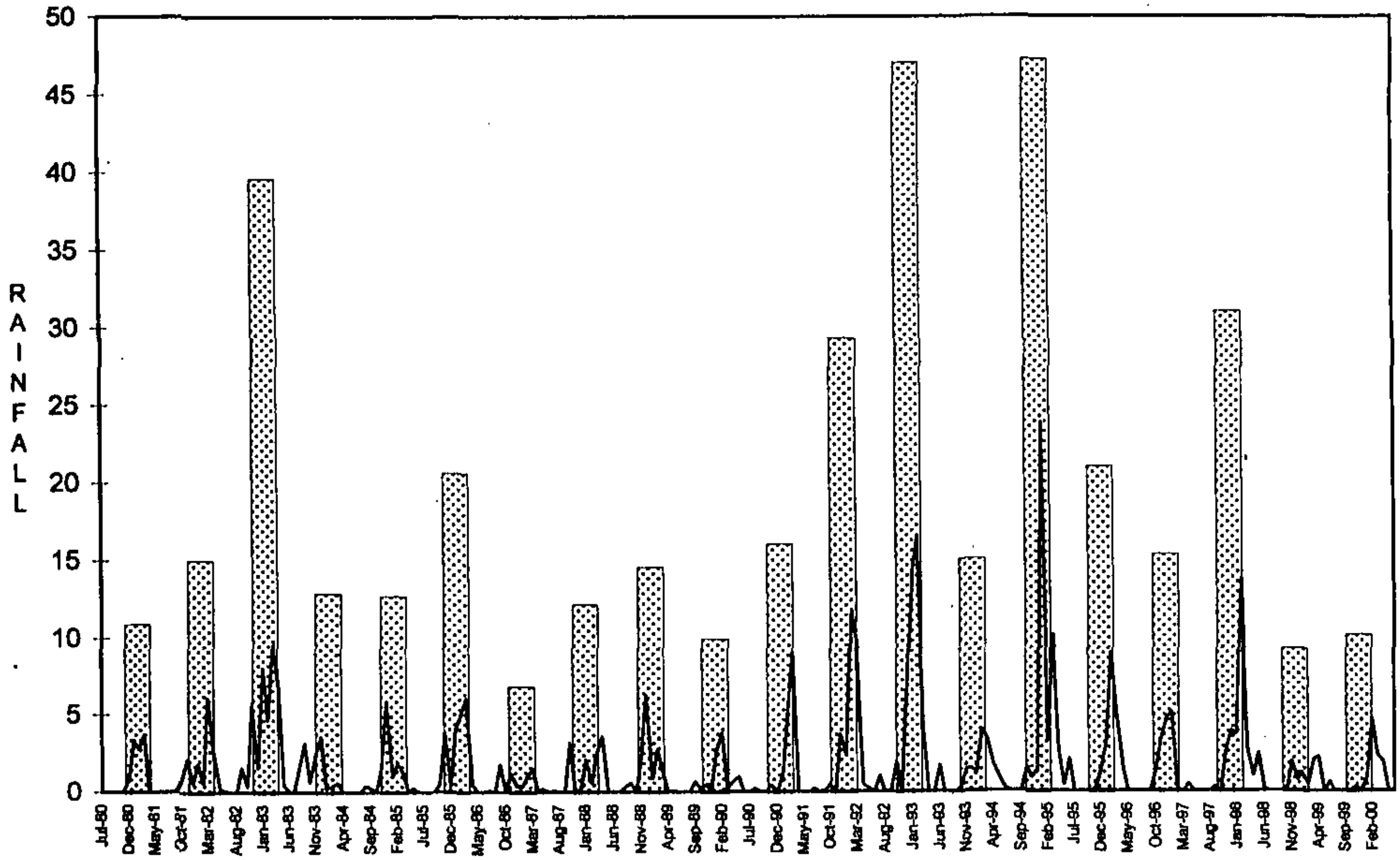


FIGURE 3-2. LOS ANGELES AIRPORT RAINFALL (INCHES).

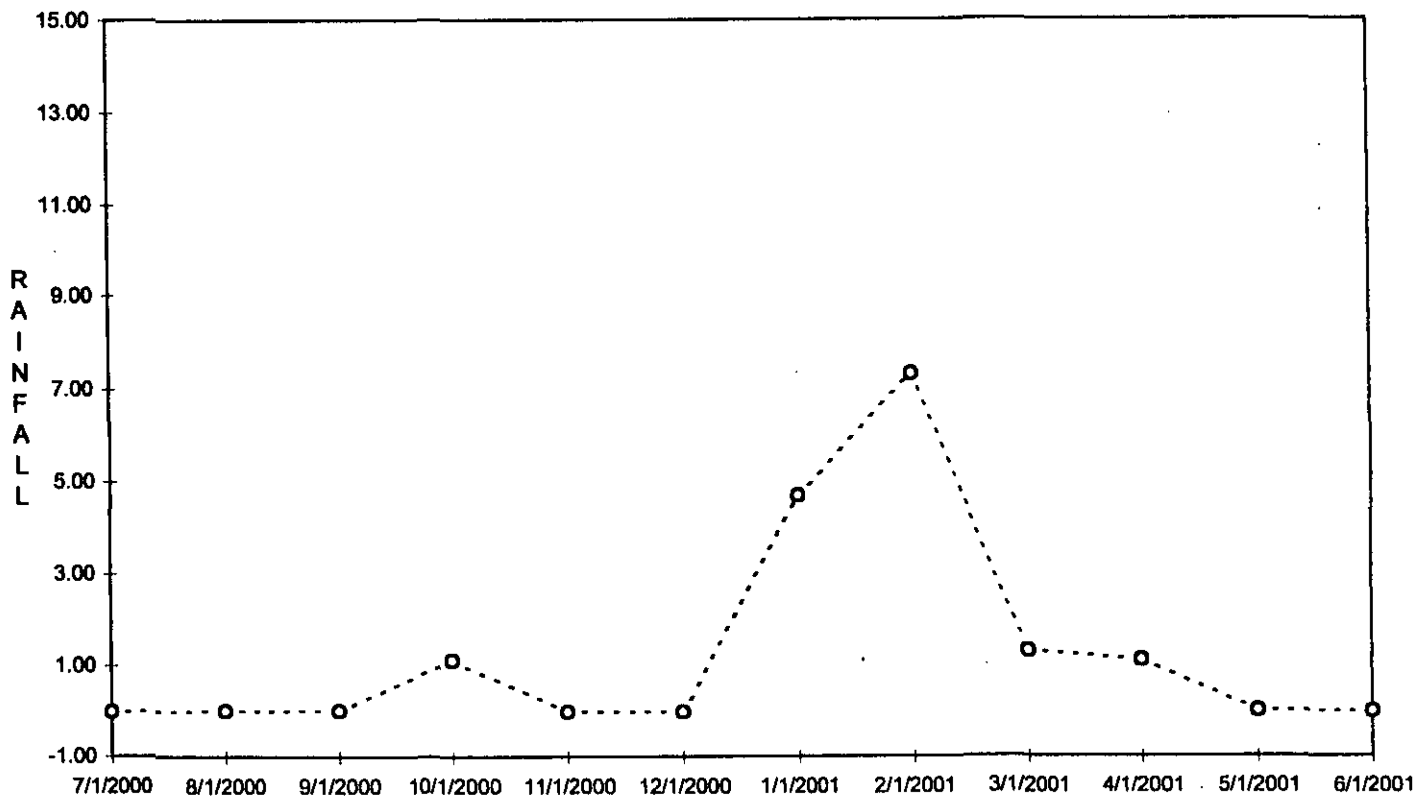


TABLE 3-1. DAILY LOS ANGELES AIRPORT RAINFALL (INCHES) WITH DATES OF WATER COLUMN SURVEYS.

DATE	PRECIP.
7/1/2000	0.00
7/2/2000	0.00
7/3/2000	0.00
7/4/2000	0.00
7/5/2000	0.00
7/6/2000	0.00
7/7/2000	0.00
7/8/2000	0.00
7/9/2000	0.00
7/10/2000	0.00
7/10/2000	*Survey*
7/11/2000	0.00
7/12/2000	0.00
7/13/2000	0.00
7/14/2000	0.00
7/15/2000	0.00
7/16/2000	0.00
7/17/2000	0.00
7/18/2000	0.00
7/19/2000	0.00
7/20/2000	0.00
7/21/2000	0.00
7/22/2000	0.00
7/23/2000	0.00
7/24/2000	0.00
7/25/2000	0.00
7/26/2000	0.00
7/27/2000	0.00
7/28/2000	0.00
7/29/2000	0.00
7/30/2000	0.00
7/31/2000	0.00
Sum =	**0.00**

DATE	PRECIP.
9/1/2000	0.00
9/2/2000	0.00
9/3/2000	0.00
9/4/2000	0.00
9/5/2000	0.00
9/6/2000	0.00
9/7/2000	0.00
9/8/2000	0.00
9/9/2000	0.00
9/10/2000	0.00
9/11/2000	0.00
9/12/2000	0.00
9/13/2000	0.00
9/14/2000	0.00
9/15/2000	0.00
9/16/2000	0.00
9/17/2000	0.00
9/18/2000	0.00
9/19/2000	0.00
9/20/2000	0.00
9/21/2000	0.00
9/21/2000	*Survey*
9/22/2000	**0.03**
9/23/2000	0.00
9/24/2000	0.00
9/25/2000	0.00
9/26/2000	0.00
9/27/2000	0.00
9/28/2000	0.00
9/29/2000	0.00
9/30/2000	0.00
Sum =	**0.03**

DATE	PRECIP.
11/1/2000	0.00
11/2/2000	0.00
11/3/2000	0.00
11/4/2000	0.00
11/5/2000	0.00
11/6/2000	0.00
11/7/2000	0.00
11/8/2000	0.00
11/9/2000	0.00
11/10/2000	0.00
11/10/2000	*Survey*
11/11/2000	0.00
11/12/2000	0.00
11/13/2000	0.00
11/14/2000	0.00
11/15/2000	0.00
11/16/2000	0.00
11/17/2000	0.00
11/18/2000	0.00
11/19/2000	0.00
11/20/2000	0.00
11/21/2000	0.00
11/22/2000	0.00
11/23/2000	0.00
11/24/2000	0.00
11/25/2000	0.00
11/26/2000	0.00
11/27/2000	0.00
11/28/2000	0.00
11/29/2000	0.00
11/30/2000	0.00
Sum =	**0.00**

DATE	PRECIP.
1/1/2001	0.00
1/2/2001	0.00
1/3/2001	0.00
1/4/2001	0.00
1/5/2001	**Trace**
1/5/2001	*Survey*
1/6/2001	**Trace**
1/7/2001	0.00
1/8/2001	**0.23**
1/9/2001	**Trace**
1/10/2001	**2.10**
1/11/2001	**0.94**
1/12/2001	**0.47**
1/13/2001	0.00
1/14/2001	0.00
1/15/2001	0.00
1/16/2001	0.00
1/17/2001	0.00
1/18/2001	0.00
1/19/2001	0.00
1/20/2001	0.00
1/21/2001	0.00
1/22/2001	0.00
1/23/2001	0.00
1/24/2001	**0.28**
1/25/2001	0.00
1/26/2001	**0.66**
1/27/2001	0.00
1/28/2001	0.00
1/29/2001	0.00
1/30/2001	0.00
1/31/2001	0.00
Sum =	**4.68**

DATE	PRECIP.
3/1/2001	0.00
3/2/2001	**Trace**
3/3/2001	0.00
3/4/2001	**0.07**
3/5/2001	**0.71**
3/6/2001	**0.47**
3/7/2001	**0.01**
3/7/2001	*Survey*
3/8/2001	0.00
3/9/2001	**0.02**
3/10/2001	0.00
3/11/2001	0.00
3/12/2001	0.00
3/13/2001	0.00
3/14/2001	0.00
3/15/2001	0.00
3/16/2001	0.00
3/17/2001	0.00
3/18/2001	0.00
3/19/2001	0.00
3/20/2001	**0.01**
3/21/2001	0.00
3/22/2001	0.00
3/23/2001	0.00
3/24/2001	0.00
3/25/2001	0.00
3/26/2001	0.00
3/27/2001	0.00
3/28/2001	0.00
3/29/2001	0.00
3/30/2001	0.00
3/31/2001	0.00
Sum =	**1.29**

DATE	PRECIP.
5/1/2001	0.00
5/2/2001	0.00
5/3/2001	0.00
5/4/2001	0.00
5/5/2001	0.00
5/6/2001	0.00
5/7/2001	0.00
5/8/2001	0.00
5/9/2001	0.00
5/10/2001	0.00
5/11/2001	0.00
5/12/2001	**0.01**
5/13/2001	0.00
5/14/2001	0.00
5/15/2001	0.00
5/16/2001	0.00
5/16/2001	*0.00*
5/17/2001	0.00
5/18/2001	0.00
5/19/2001	0.00
5/20/2001	0.00
5/21/2001	0.00
5/22/2001	0.00
5/23/2001	0.00
5/24/2001	0.00
5/25/2001	0.00
5/26/2001	**Trace**
5/27/2001	0.00
5/28/2001	0.00
5/29/2001	0.00
5/30/2001	0.00
5/31/2001	0.00
Sum =	**0.01**

DATE	PRECIP.
8/1/2000	0.00
8/2/2000	0.00
8/3/2000	0.00
8/4/2000	0.00
8/5/2000	0.00
8/6/2000	0.00
8/7/2000	0.00
8/8/2000	0.00
8/9/2000	0.00
8/10/2000	0.00
8/11/2000	0.00
8/12/2000	0.00
8/13/2000	0.00
8/14/2000	0.00
8/15/2000	0.00
8/16/2000	0.00
8/17/2000	0.00
8/18/2000	0.00
8/19/2000	0.00
8/20/2000	0.00
8/21/2000	0.00
8/22/2000	0.00
8/23/2000	0.00
8/24/2000	0.00
8/25/2000	0.00
8/25/2000	*Survey*
8/26/2000	0.00
8/27/2000	0.00
8/28/2000	0.00
8/29/2000	**0.03**
8/30/2000	0.00
8/31/2000	0.00
Sum =	**0.03**

DATE	PRECIP.
10/1/2000	0.00
10/2/2000	0.00
10/3/2000	0.00
10/4/2000	**0.03**
10/5/2000	0.00
10/6/2000	**0.03**
10/7/2000	0.00
10/8/2000	0.00
10/9/2000	0.00
10/10/2000	**Trace**
10/11/2000	**0.11**
10/12/2000	0.00
10/13/2000	0.00
10/14/2000	0.00
10/15/2000	0.00
10/16/2000	0.00
10/17/2000	0.00
10/18/2000	0.00
10/19/2000	0.00
10/20/2000	0.00
10/20/2000	*Survey*
10/21/2000	0.00
10/22/2000	0.00
10/23/2000	0.00
10/24/2000	0.00
10/25/2000	0.00
10/26/2000	**0.17**
10/27/2000	**0.19**
10/28/2000	0.00
10/29/2000	**0.59**
10/30/2000	0.00
10/31/2000	0.00
Sum =	**1.12**

DATE	PRECIP.
12/1/2000	0.00
12/2/2000	0.00
12/3/2000	0.00
12/4/2000	0.00
12/4/2000	*Survey*
12/5/2000	0.00
12/6/2000	**Trace**
12/7/2000	0.00
12/8/2000	**Trace**
12/9/2000	0.00
12/10/2000	0.00
12/11/2000	0.00
12/12/2000	0.00
12/13/2000	0.00
12/14/2000	0.00
12/15/2000	0.00
12/16/2000	0.00
12/17/2000	0.00
12/18/2000	0.00
12/19/2000	0.00
12/20/2000	0.00
12/21/2000	0.00
12/22/2000	0.00
12/23/2000	0.00
12/24/2000	0.00
12/25/2000	0.00
12/26/2000	0.00
12/27/2000	0.00
12/28/2000	0.00
12/29/2000	0.00
12/30/2000	0.00
12/31/2000	0.00
Sum =	**0.00**

DATE	PRECIP.
2/1/2001	0.00
2/2/2001	0.00
2/3/2001	0.00
2/4/2001	0.00
2/5/2001	0.00
2/6/2001	0.00
2/7/2001	**0.01**
2/8/2001	0.00
2/9/2001	**Trace**
2/10/2001	**0.33**
2/11/2001	**0.10**
2/12/2001	**2.00**
2/13/2001	**1.56**
2/14/2001	0.00
2/15/2001	0.00
2/15/2001	*Survey*
2/16/2001	0.00
2/17/2001	**Trace**
2/18/2001	**0.03**
2/19/2001	**0.24**
2/20/2001	0.00
2/21/2001	0.00
2/22/2001	0.00
2/23/2001	**0.17**
2/24/2001	**0.28**
2/25/2001	**1.86**
2/26/2001	**0.38**
2/27/2001	**0.25**
2/28/2001	**0.09**
Sum =	**7.30**

DATE	PRECIP.
4/1/2001	0.00
4/2/2001	0.00
4/3/2001	0.00
4/4/2001	0.00
4/5/2001	0.00
4/5/2001	*Survey*
4/6/2001	**0.01**
4/7/2001	**0.48**
4/8/2001	0.00
4/9/2001	0.00
4/10/2001	0.00
4/11/2001	0.00
4/12/2001	0.00
4/13/2001	0.00
4/14/2001	0.00
4/15/2001	0.00
4/16/2001	0.00
4/17/2001	0.00
4/18/2001	0.00
4/19/2001	0.00
4/20/2001	**0.54**
4/21/2001	**0.07**
4/22/2001	0.00
4/23/2001	0.00
4/24/2001	0.00
4/25/2001	0.00
4/26/2001	0.00
4/27/2001	0.00
4/28/2001	0.00
4/29/2001	0.00
4/30/2001	0.00
Sum =	**1.10**

DATE	PRECIP.
6/1/2001	0.00
6/1/2001	*Survey*
6/2/2001	**Trace**
6/3/2001	0.00
6/4/2001	0.00
6/5/2001	0.00
6/6/2001	0.00
6/7/2001	0.00
6/8/2001	0.00
6/9/2001	0.00
6/10/2001	0.00
6/11/2001	0.00
6/12/2001	0.00
6/13/2001	0.00
6/14/2001	0.00
6/15/2001	0.00
6/16/2001	0.00
6/17/2001	0.00
6/18/2001	0.00
6/19/2001	0.00
6/20/2001	0.00
6/21/2001	0.00
6/22/2001	0.00
6/23/2001	0.00
6/24/2001	0.00
6/25/2001	0.00
6/26/2001	0.00
6/27/2001	0.00
6/28/2001	0.00
6/29/2001	0.00
6/30/2001	0.00
Sum =	**0.00**

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, and precipitation and water column survey days are highlighted. Very little rainfall was recorded from July to October 11 (0.23 inches). The first serious rainfall of the season occurred between October 26 through 29 (0.95 inches) followed by storms on January 8 through 12 (3.74 inches) and January 24 through 26 (0.94 inches). Three storms occurred in February: February 7 through 13 (4.0 inches), February 17 through 19 (0.27 inches) and February 23 through 28 (3.03 inches). March had one storm, March 4 through 7 (1.26 inches) with some precipitation recorded on March 9 and 20 (0.03 inches). April had two small storm events on April 6 through 7 (0.49 inches) and April 20 through 21 (0.61 inches).

Rainfall during this sampling period (16 inches) was higher than the previous year (10 inches Figure 3-1). The wettest month of the sampling season was February (7.30 inches), followed by January (4.68 inches), March (1.29 inches), October (1.12 inches) and April (1.10 inches). Small amounts of rain were recorded in August (0.03 inches), September (0.03 inches) and May (0.01 inches) (see Figure 3-2). One water column sampling survey occurred immediately following trace precipitation (January 5, 2001) and immediately following a storm event (March 7, 2001).

3.2. MATERIALS AND METHODS

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

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

Water was distributed into sterile 125-ml polypropylene bottles for bacterial analysis, 250-ml polypropylene bottles containing sulfuric acid for ammonia analysis, and 300-ml glass, dark BOD bottles for biochemical oxygen demand analysis. At stations 1, 2, 5, 10, 12, 13, 19, 20, and 22; temperature and pH were measured directly at the surface using an NBS traceable standard mercury thermometer and hand-held, buffer-calibrated pH meter (respectively). Extra water samples were also collected at these stations and set for dissolved oxygen and chloride titration in the field. Extra samples and measurements backed up 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 (later converted to salinity) by the argentometric titration. Biochemical oxygen demand samples were immediately set and stored in a 20 °C incubator. Ammonia samples were placed in a laboratory refrigerator at 4 °C until analyzed. Ammonia was analyzed by ion-selective electrode calibrated against known standards. All water analyses were performed in accordance with either *Standard Methods for the Examination of Water and Wastewater* (American Public Health Association, 19th Edition) or *Methods for the Chemical Analysis of Water and Wastes* (US EPA, revised March 1983, EPA/600/4-79/020) modified to accommodate the analysis of seawater. Aquatic Bioassay is certified by both the State of California and the US EPA to perform these analyses.

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

3.3. RESULTS

3.3.1. Physical and Chemical Water Quality

3.3.1.1. **Temperature**

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

Vertical temperature patterns. Figure 3-3 depicts the minimum, average, and maximum temperatures for each station plotted against depth for 2000-2001. At most stations, temperatures declined slightly with depth. At stations 5, 10, 12, 18 and 20, temperatures increased slightly with depth suggesting that overlying water may be replaced more frequently than water at greater depths.

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 temperature during the beginning of the sampling season (July) was about 21 °C at most stations. Average temperature in August and September increased to about 23 °C, which were the highest temperatures during this sampling period. Beginning in October, average temperatures steadily declined until February (13 to 14 °C). Station 19 had a temperature of 8 °C in February. Temperatures then gradually climbed again through June (18 to 23 °C). This year, wider variability in temperature within months was recorded for stations near the Harbor entrance (1, 2, and 12), in the main channel (4, 5, 11, and 25) and at the head of Basins B, G, D and F (6, 7, 8 and 9). Ranges were widest in spring, summer and early fall, most likely due to temperature stratification.

Spatial temperature patterns. The horizontal spatial pattern of temperatures averaged over the year is presented as a three-dimensional graph in Figure 3-5. The spatial pattern of temperature was similar to those of past reports. Warmest stations (averages 18.2 to 18.6 °C) were those furthest back in the Harbor (Stations 7, 8, 9, 10, 11, 13, 18, 20, and 22). Station 19 at Mothers Beach and stations near the entrance (Stations 1 and 2) averaged coldest (16.9 to 17.0 °C). Average temperatures at other stations were moderate (17.4 to 17.9 °C). Station 19 at Mothers Beach averaged somewhat colder since it is very shallow at this station, and the measurements are usually made early in the morning. Otherwise, the overall pattern strongly indicates that horizontal mixing is the greatest at stations near the entrance, and that water residence time is much longer in the inner basins.

Temperature ranges compared with past years. Table 3-2 lists: 1) the individual seasonal temperature ranges from fall 1990 through summer 2000, 2) the overall seasonal ranges for the ten year period, and 3) the temperature values collected during 2000-2001. All 2000-2001 temperatures were within the overall seasonal ranges for the preceding ten years, except for the winter minimum, which was three degrees lower. Overall, this year's averages were similar to last years.

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

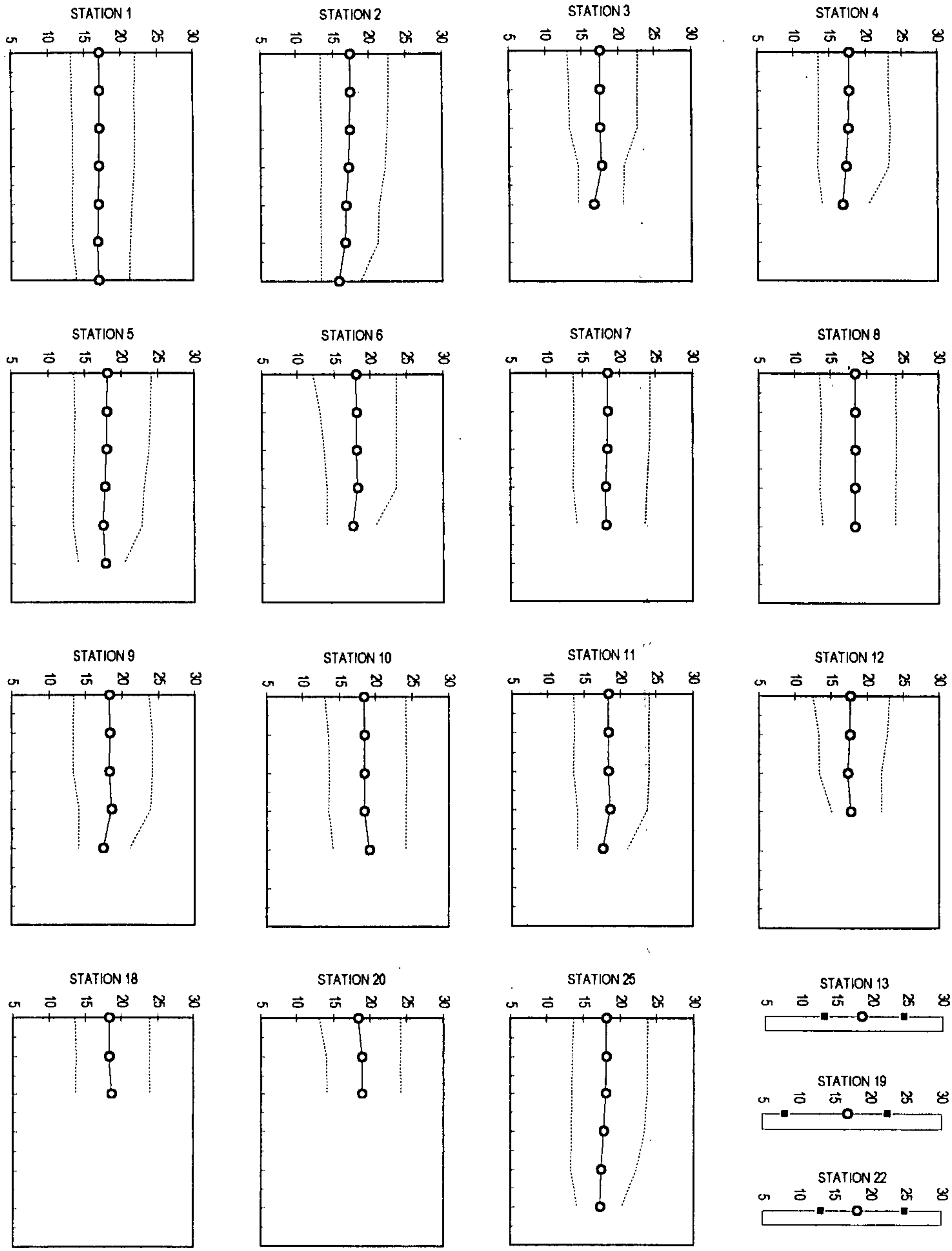


FIGURE 3-4. MINIMUM, AVERAGE, AND MAXIMUM TEMPERATURE (DEG C) VS. MONTH AT 18 WATER COLUMN STATIONS.

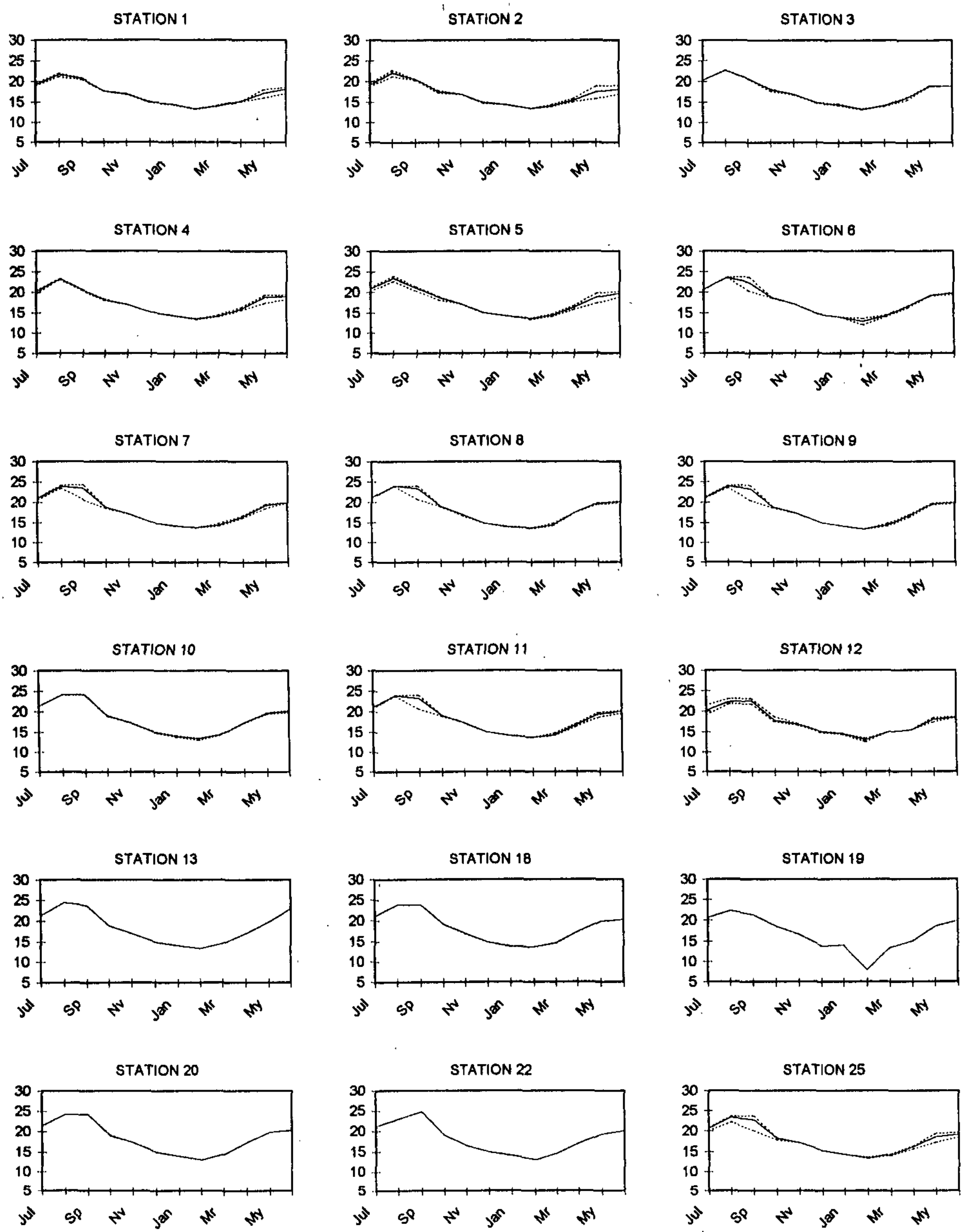


FIGURE 3-5. AVERAGE ANNUAL TEMPERATURE (DEG C) AT 18 WATER COLUMN STATIONS.

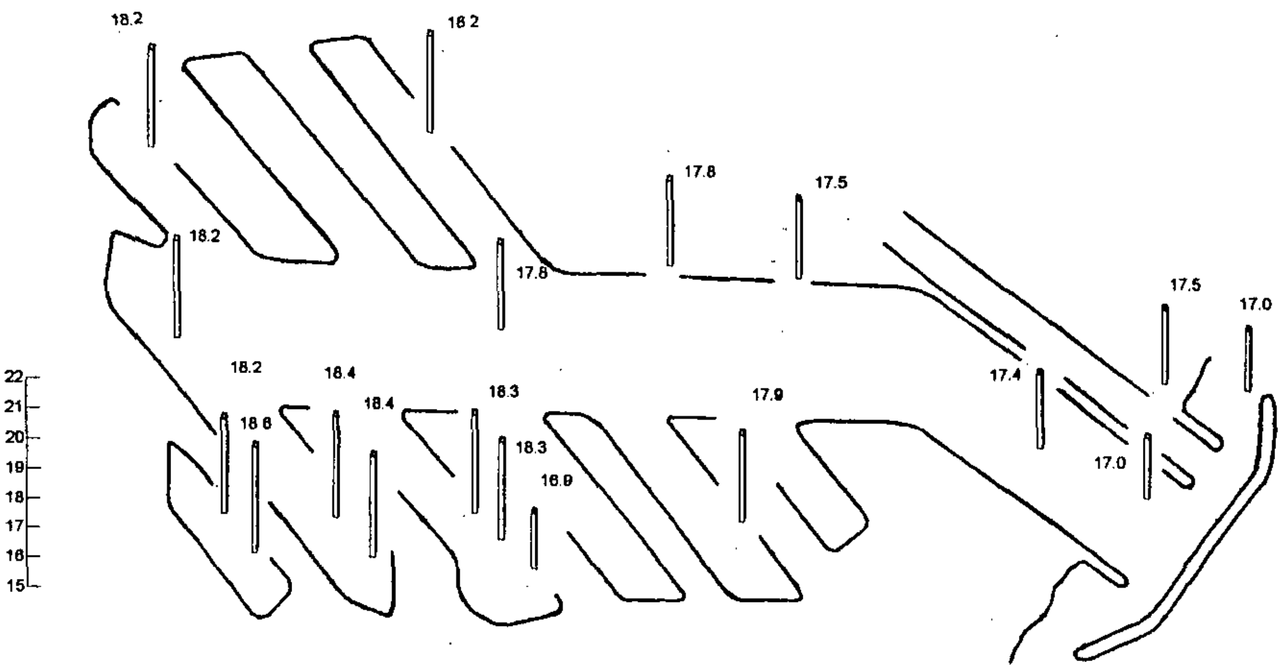


TABLE 3-2. SEASONAL TEMPERATURE RANGES (DEG C) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
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[1.]	18.4 - 26.6	13.1 - 15.3	14.8 - 21.2	18.0 - 24.6
1994-95	13.6 - 23.4	12.8 - 17.0	15.0 - 20.1	17.3 - 23.7
1995-96	17.3 - 24.7	13.8 - 17.3	13.9 - 22.6	18.0 - 26.9
1996-97	16.0 - 23.5	12.4 - 15.7	16.5 - 20.1	19.9 - 24.8
1997-98	15.0 - 24.9	11.1 - 17.4	14.5 - 20.7	17.7 - 28.8
1998-99	12.9 - 23.5	12.6 - 16.2	13.5 - 19.8	18.3 - 23.5
1999-00	15.9 - 20.2	11.9 - 15.6	12.8 - 19.8	18.3 - 24.5
Overall range	**12.9 - 26.6**	**11.0 - 17.4**	**12.8 - 22.7**	**16.8 - 28.8**
2000-01[2.]	16.5 - 24.8	8.0 - 15.2	13.5 - 19.9	17.0 - 23.0

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

[2.] One month only in the summer.

3.3.1.2. Salinity

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

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

Vertical salinity patterns. Very little difference among surface to bottom averages reflect the relatively low rainfall recorded for this year (Figure 3-6). Stations most influenced by runoff from Ballona Creek (Station 12) and Oxford Lagoon discharges (Station 22) had the widest salinity ranges in the Harbor. Stations 9 and 11 and to a lesser degree, 5 and 7, showed an increased salinity range at depth. Additionally, temperatures showed a similar decline at these stations. As a rule, 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 only very slight variability over the year. Similar to last year, stations associated with Ballona Creek (Stations 1 and 12) and Oxford Lagoon (Stations 13 and 22) were affected far more than the other stations. Stations 5, 22 and 9 experienced a slight to moderate decline in salinity during June 2001. All stations showed slight declines in salinity related to the March-April storms. Stations 2, 5, 13 and 22 showed slight declines in salinity related to the October storm. Stations 10 and 11 showed slight decreases in salinity in relatively dry December.

Spatial salinity patterns. With the exception of those stations influenced by Oxford Lagoon (13 and 22) and Ballona Creek discharges (12), all stations sampled within Marina del Rey Harbor had average year-long salinities of between 32.9 and 33.2 parts per thousand (Figure 3-8). Stations 13 and 22 in Oxford Lagoon (32.6 and 31.3 ppt, respectively) and Station 12 near Ballona Creek (29.7 ppt) were lower most likely due to municipal freshwater discharges and storm events.

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

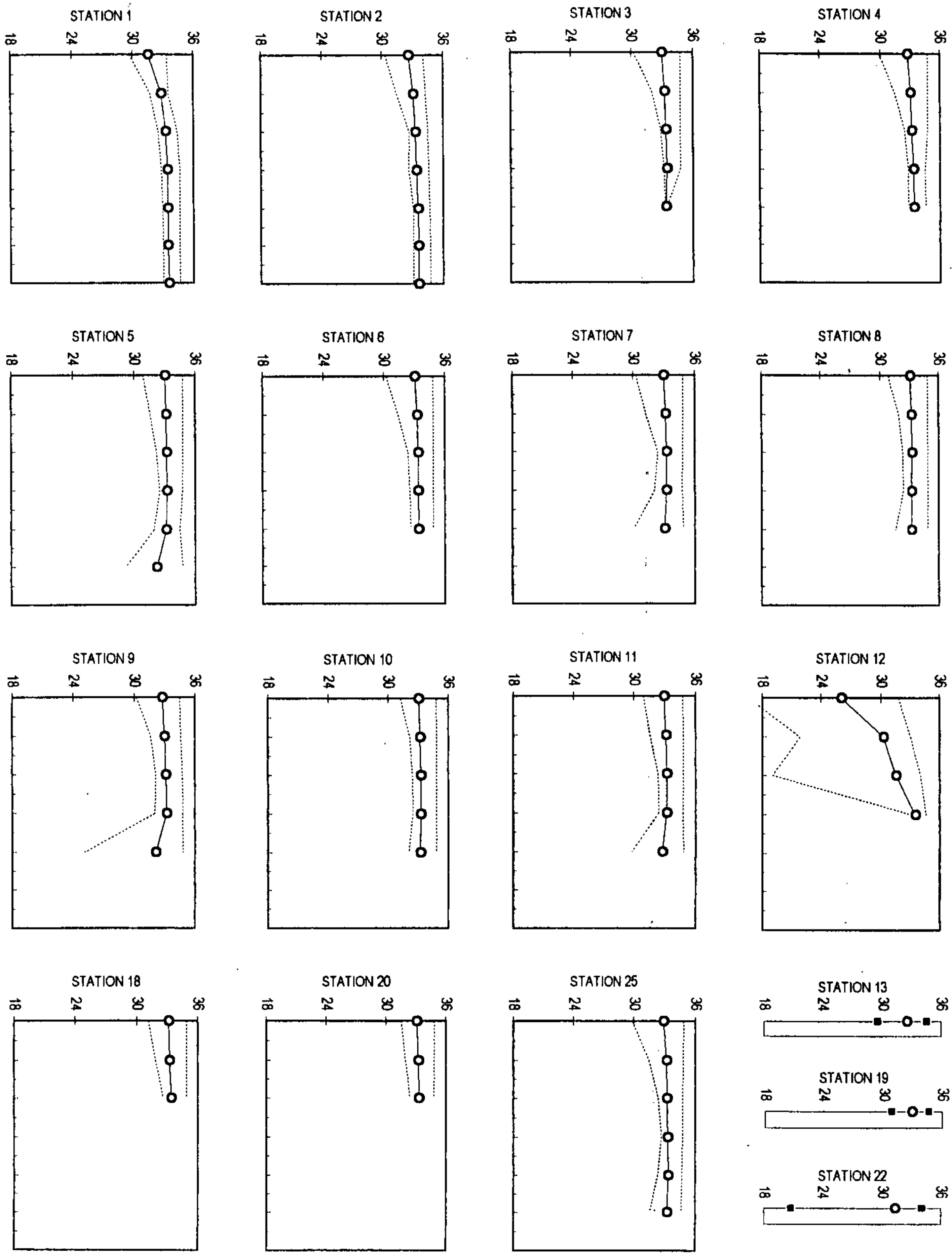


FIGURE 3-7. MINIMUM, AVERAGE, AND MAXIMUM SALINITY (PPT) VS. MONTH AT 18 WATER COLUMN STATIONS.

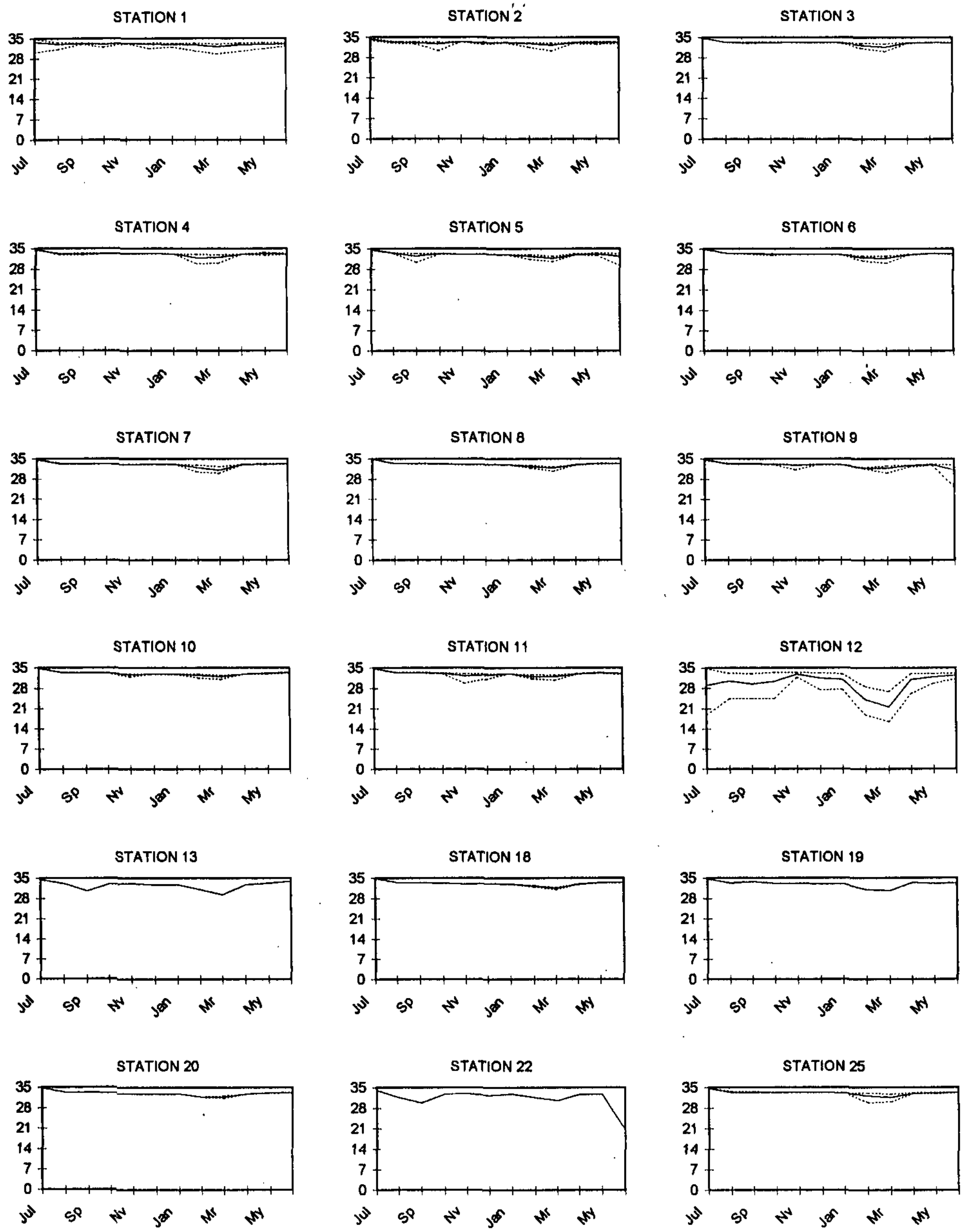


FIGURE 3-8. AVERAGE ANNUAL SALINITY (PPT) AT 18 WATER COLUMN STATIONS.

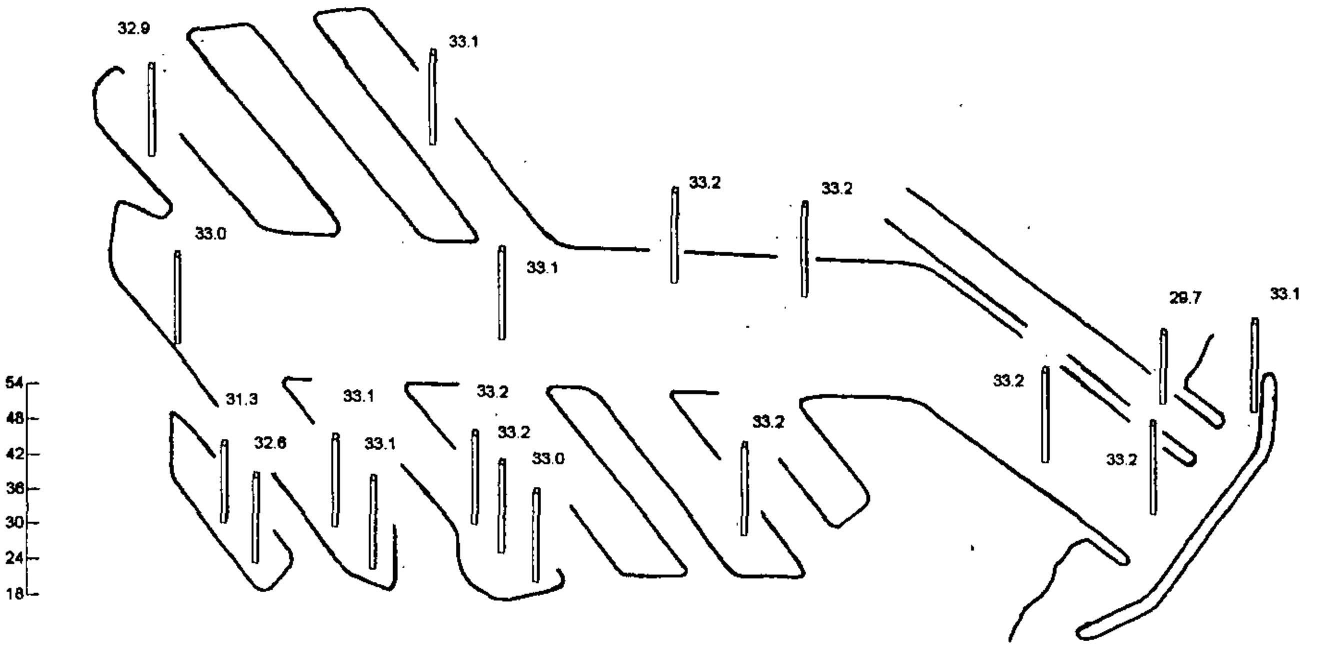


TABLE 3-3. SEASONAL SALINITY RANGES (PPT) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
1992-93	26.6 - 33.8	0.1 - 33.3	3.7 - 34.7	14.0 - 34.9
1993-94[1.]	28.1 - 34.5	16.4 - 33.9	19.1 - 34.5	33.1 - 34.6
1994-95	30.1 - 34.8	0.2 - 34.2	26.5 - 34.5	20.7 - 34.8
1995-96	21.1 - 34.8	1.4 - 34.4	11.1 - 34.5	18.7 - 34.0
1996-97	24.7 - 34.1	21.6 - 33.7	21.1 - 33.9	27.6 - 33.9
1997-98	5.0 - 33.8	1.2 - 33.4	11.6 - 33.5	19.4 - 33.8
1998-99	10.3 - 34.4	10.3 - 33.9	1.2 - 34.2	20.3 - 34.0
1999-00	20.3 - 33.9	25.9 - 33.5	19.9 - 34.1	19.0 - 35.2
Overall range	**5.0 - 34.8**	**0.1 - 34.4**	**1.2 - 34.7**	**14.0 - 35.2**
2000-01[2.]	24.6 - 33.8	19.1 - 33.5	16.6 - 33.8	20.7 - 33.9

[1.] Two months only in the fall.

[3.] *One month only in the summer.*

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

Salinity ranges compared with past years. Table 3-3 lists: 1) the individual seasonal salinity ranges from fall 1992 through summer 2000, 2) the overall seasonal ranges for the eight year period, and 3) the salinities collected during 2000-2001. All 2000-2001 salinities were well within, or close to, the overall seasonal ranges for the preceding eight 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. Perhaps the most important dissolved gas in seawater is oxygen. Animals require oxygen for respiration. Plants release oxygen as a by-product of photosynthesis and utilize it during respiration. The decomposition of organic matter in the ocean is dependent upon oxygen concentration. Consequently, the amount of oxygen dissolved in seawater depends not only on mixing but also upon the type and degree of biological activity. The amount of oxygen dissolved in the sea varies from zero to about 11 milligrams per liter. At the surface of the sea, the water is more or less saturated with oxygen because of the exchange across the surface and plant activity. In fact, when photosynthesis is at a maximum during a phytoplankton bloom, such as during a red tide event (see Section 3.1.1), it can become supersaturated (Anikouchine and Sternberg 1973). When these blooms die off, bacterial aerobic respiration during decomposition of these phytoplankton cells can rapidly deplete dissolved oxygen in the water.

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

Vertical dissolved oxygen patterns. Dissolved oxygen typically decreases with depth due to respiration of organisms as well as bacterial breakdown of organic material. However, if the water column is well mixed or particularly shallow, oxygen will be fairly constant with depth. Temperature and/or salinity can affect the density structure of the water column and create barriers to vertical mixing. Figure 3-9 depicts the minimum, average, and maximum dissolved oxygen values for each station plotted against depth for 2000-2001. For a few stations, oxygen values were actually slightly higher near the bottom. Since all stations are shallow, light can usually reach the bottom. Phytoplankton can then photosynthesize in all depths and, in fact, survive best a few meters below, rather than immediately at the surface (Anikouchine and Sternberg 1973). Thus, this elevation with depth is likely phytoplankton related. From surface to bottom, ranges were widest in Ballona Creek (Station 12), Oxford Lagoon (Station 22), and Station 25 in mid channel.

Dissolved oxygen patterns over the year. Overall, dissolved oxygen values varied in similar patterns with lowest values usually recorded in late summer and fall (Figure 3-10). Highest values were usually recorded in the spring. Stations 2, and 3 showed a drop in dissolved oxygen in September. These stations are close to the Harbor entrance. Stations farther away from the entrance did not experience as significant increases in dissolved oxygen concentrations in spring as did some other stations. As in the previous year, oxygen concentrations varied greatest in Ballona Creek (Station 12) and Oxford Lagoon (Stations 13 and 22).

Regulatory agencies consider dissolved oxygen values less than 5.0 mg/l as not acceptable for marine life. Actually, the 5.0 mg/l minimum is based on fish survival, while invertebrates can survive on much lower levels (Soule et. al. 1997). Values below 5.0 mg/l were most frequent at Basin E (Stations 10 and 20 - 4 and 5 times, respectively) and Oxford Lagoon (Stations 13 and 22 – 3 and 4 times, respectively). Values at Stations 8, 9, 11 and 25 were below 5.0 mg/l twice, and Stations 7 and 19 were below once during the year. Remaining stations were never below 5.0 mg/l. The lowest value recorded was 1.0 mg/l at Station 22 in August.

Spatial dissolved oxygen patterns. In general, dissolved oxygen tended to decline with distance from Harbor entrance, reflecting the reduced horizontal mixing with oceanic water within the interior basins (Figure 3-11). Lowest average values were in Oxford Lagoon (Stations 13 and 22 – 5.1 mg/l, each) and Basin E (Stations 10 and 20 – 5.6 and 5.2 mg/l, respectively). The highest oxygen averages in the Harbor were those nearest the entrance (Stations 1, 2 and 12 – 7.7, 7.6 and 7.4 mg/l, respectively). Remaining stations were moderate, averaging from 6.1 to 7.0 mg/l.

Dissolved oxygen ranges compared with past years. All 2000-2001 dissolved oxygen values were within the overall seasonal ranges for the preceding ten years (Table 3-4). When compared to 1999-00, values during all seasons tended to range higher.

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

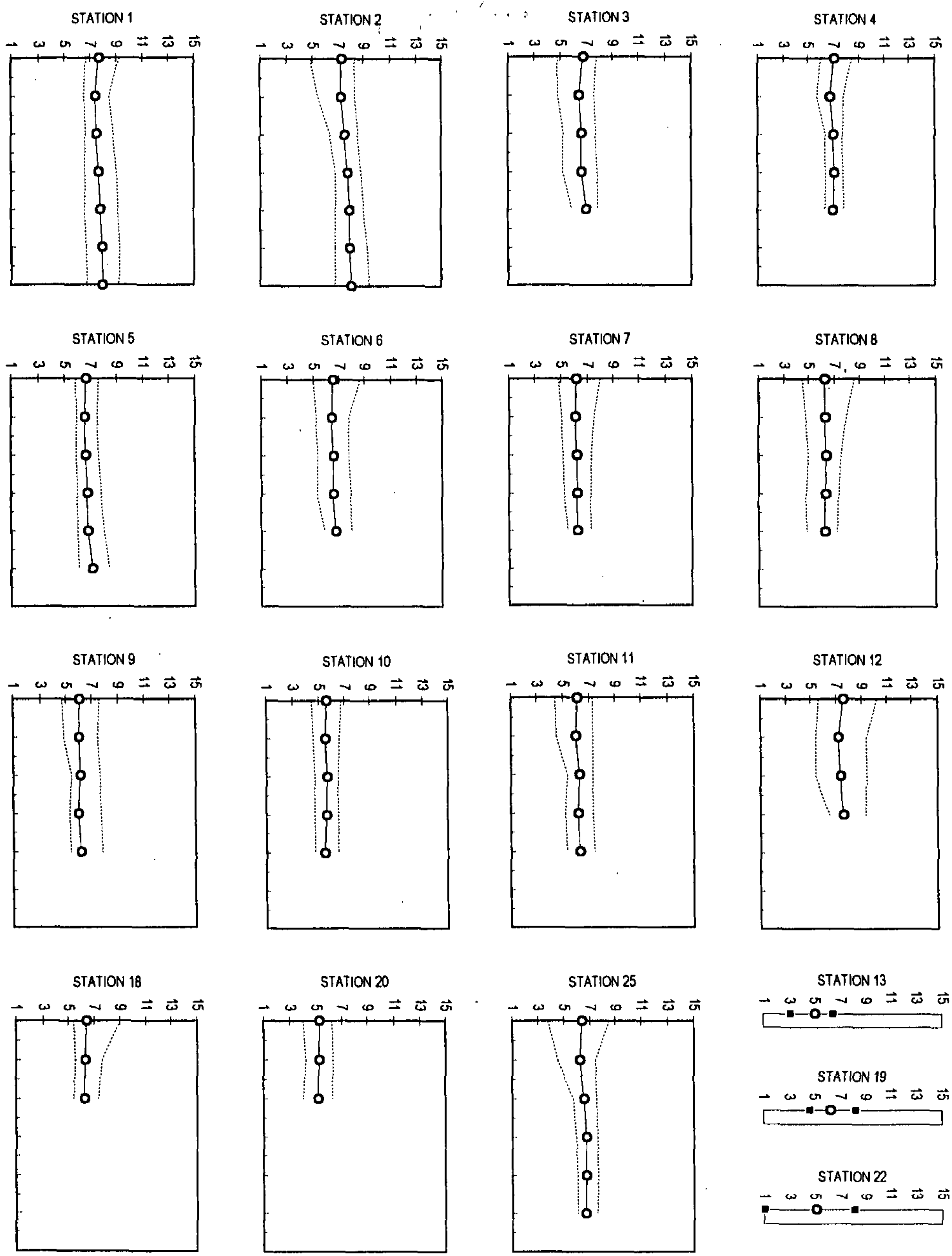


FIGURE 3-10. MINIMUM, AVERAGE, AND MAXIMUM DIS. OXYGEN (MG/L) VS. MONTH AT 18 WATER COLUMN STATIONS.

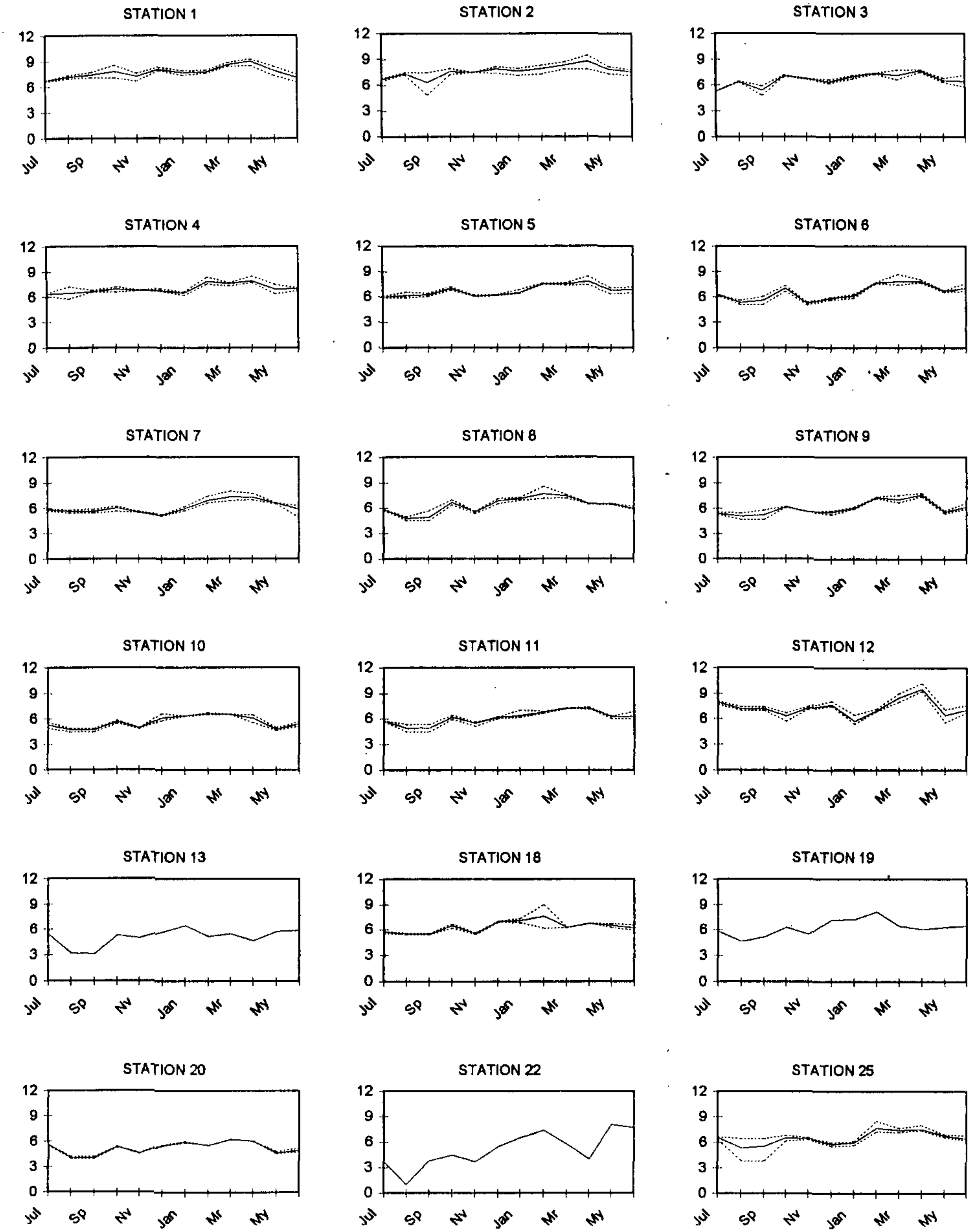


FIGURE 3-11. AVERAGE ANNUAL DISSOLVED OXYGEN (MG/L) AT 18 WATER COLUMN STATIONS.

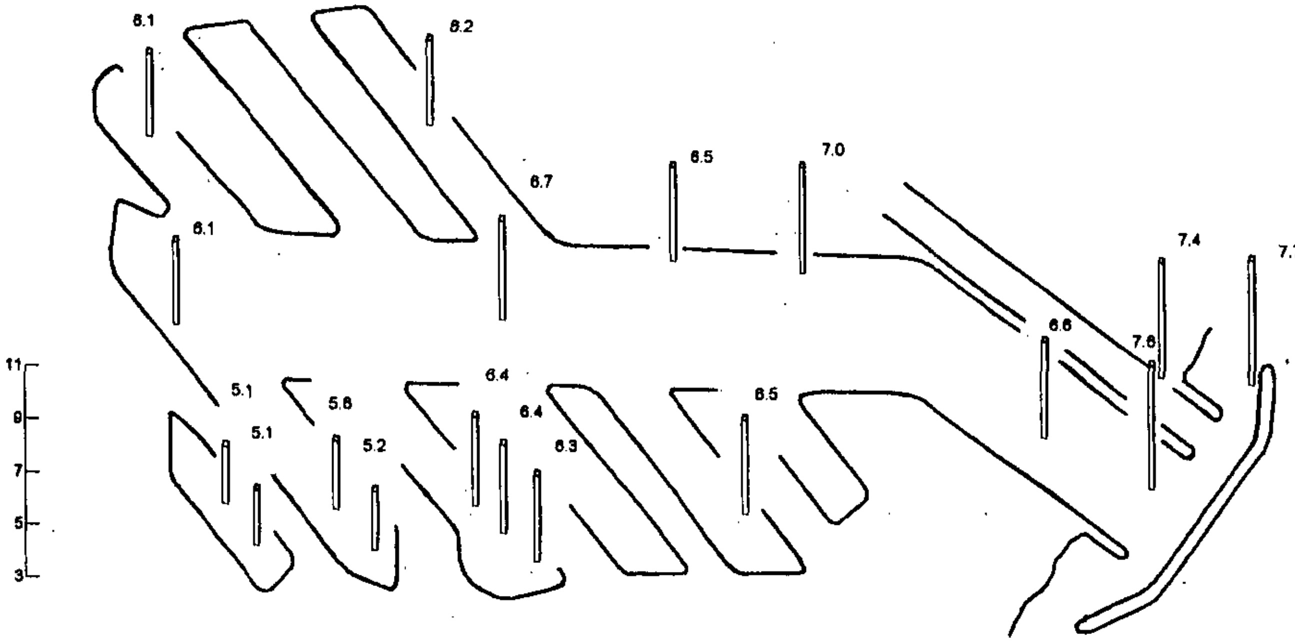


TABLE 3-4. SEASONAL DISSOLVED OXYGEN RANGES (MG/L) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
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[1]	—	—	—	2.5 - 8.1
1994-95	3.3 - 9.4	2.7 - 9.7	4.4 - 10.2	1.0 - 8.3
1995-96	1.9 - 8.1	4.6 - 12.1	4.6 - 9.2	2.2 - 9.1
1996-97	2.6 - 10.1	4.4 - 8.6	3.8 - 13.9	2.4 - 8.1
1997-98	3.0 - 7.2	3.8 - 10.0	5.2 - 10.6	1.2 - 9.6
1998-99	2.8 - 9.6	4.0 - 11.4	4.2 - 8.6	2.7 - 8.3
1999-00	2.7 - 8.3	4.3 - 9.1	2.0 - 7.7	1.0 - 8.1
Overall range	**1.9 - 12.0**	**2.0 - 13.1**	**1.4 - 13.9**	**1.0 - 11.0**
2000-01[2]	3.1 - 8.6	5.0 - 9.0	4.0 - 10.3	4.8 - 7.8

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

[2] One month only in the summer.

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 was very little change with depth, and at nearly all stations, minimum-maximum ranges were narrow. As in the last year, ranges at Station 22 in Oxford Lagoon and Station 12 in Ballona Creek were wider than other stations, indicating that a considerable amount of fresh water flows into these areas.

pH patterns over the year. Averages varied weakly at nearly all stations (Figure 3-13) with values tending to be lower during the rainy season. Most stations had a slight peak in pH during April and May. This could be due to the subtle relationship between phytoplankton photosynthesis and respiration. Similar to the past two years, the widest temporal pH ranges were within Oxford Lagoon (Stations 13 and 22), and Ballona Creek (Station 12). Stations within the Harbor, which can be impacted by Oxford Lagoon (e.g. 10 and 20, in Basin E), appeared unaffected this year. The variability observed at Oxford Lagoon and Ballona Creek can be accounted for by freshwater municipal drainage.

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

pH ranges compared with past years. All 2000-2001 pH values were within the overall seasonal ranges for the preceding eight years (Table 3-5).

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

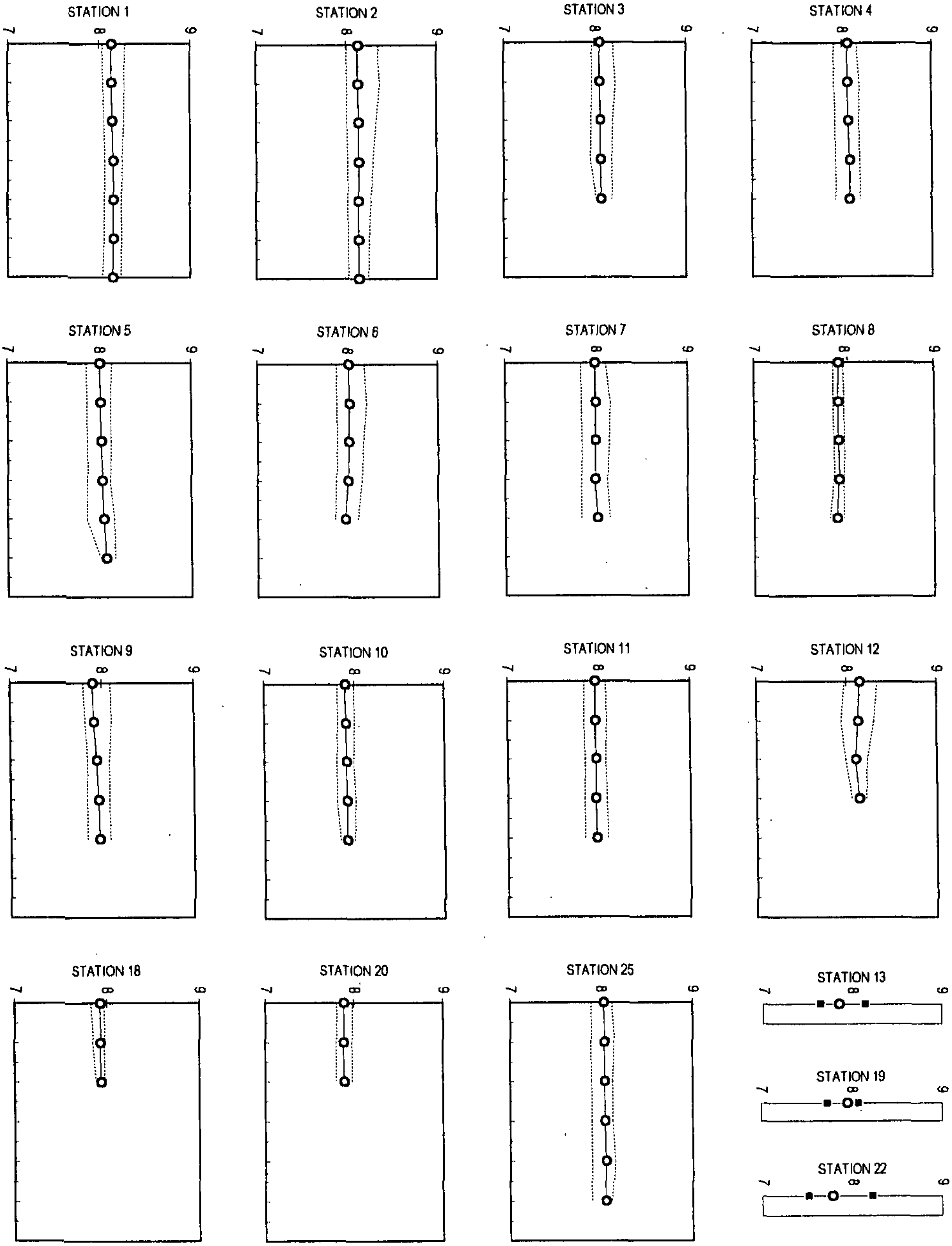


FIGURE 3-13. MINIMUM, AVERAGE, AND MAXIMUM PH (UNITS) VS. MONTH AT 18 WATER COLUMN STATIONS.

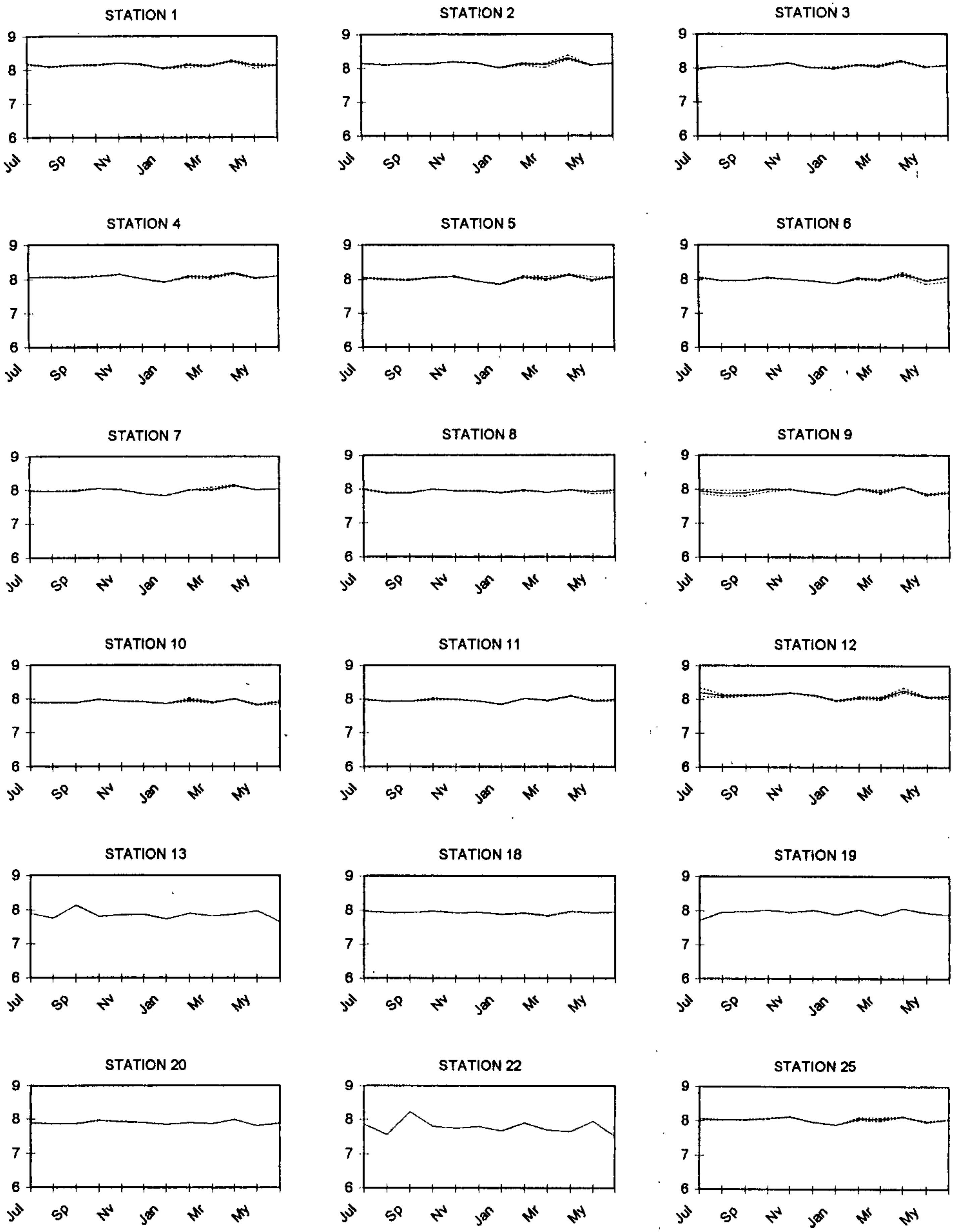


FIGURE 3-14. AVERAGE ANNUAL PH (UNITS) AT 18 WATER COLUMN STATIONS.

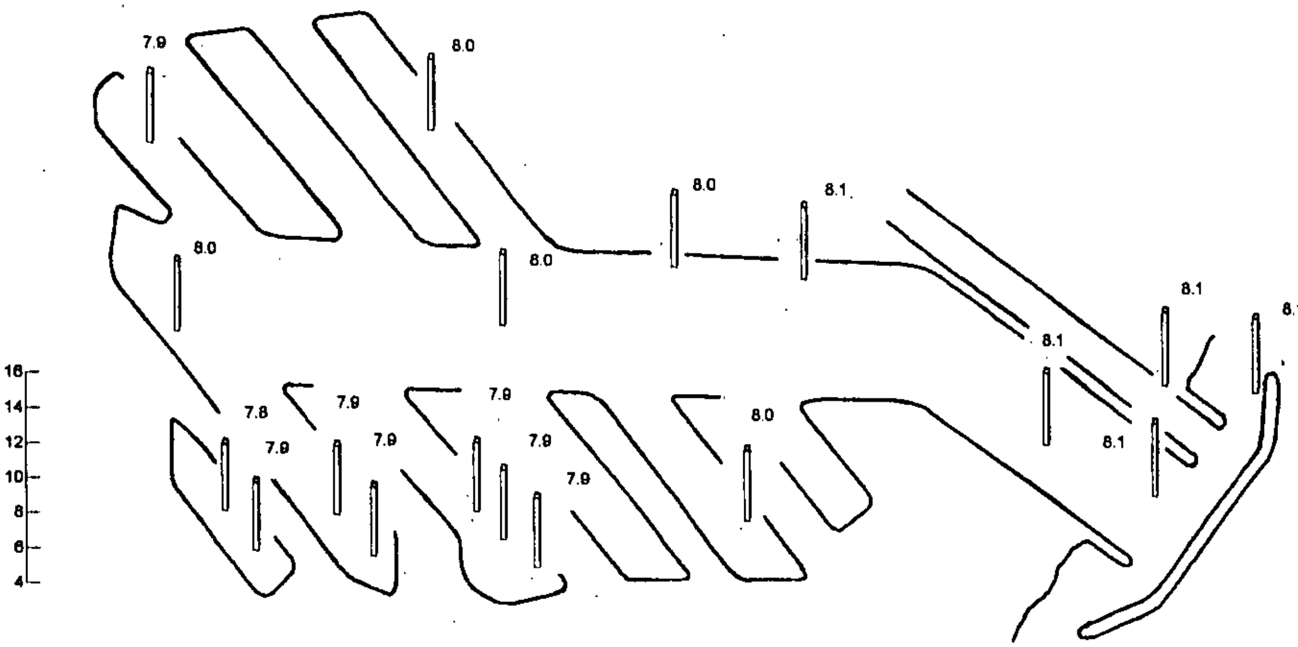


TABLE 3-5. SEASONAL PH RANGES (UNITS) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
1992-93	7.6 - 8.2	7.0 - 8.5	7.4 - 8.4	7.5 - 8.5
1993-94[1.]	7.9 - 8.6	7.2 - 8.1	7.8 - 8.7	7.3 - 8.7
1994-95	7.5 - 8.2	7.1 - 8.3	7.5 - 8.5	7.8 - 8.3
1995-96	7.5 - 8.3	7.2 - 8.2	7.4 - 8.3	7.3 - 8.4
1996-97	7.5 - 8.3	7.5 - 8.3	7.8 - 8.5	7.5 - 8.2
1997-98	7.7 - 8.3	6.8 - 8.2	7.7 - 8.6	7.1 - 8.7
1998-99	7.7 - 8.4	7.3 - 8.4	7.0 - 8.1	7.5 - 8.5
1999-00	7.8 - 8.4	7.6 - 8.0	7.6 - 8.3	7.6 - 8.3
Overall range	**7.5 - 8.6**	**6.8 - 8.5**	**7.0 - 8.7**	**7.1 - 8.7**
2000-01[2.]	7.8 - 8.2	7.7 - 8.2	7.7 - 8.4	7.5 - 8.2

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

[2.] One month only in the summer.

3.3.1.5. **Ammonia**

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

Ammonia concentration in the ocean is important for three reasons. First, since nitrogen is usually limiting in marine waters, its presence or absence can have a profound affect upon the primary producers in the ocean (i.e. usually phytoplankton) and thus the subsequent trophic levels that depend upon them (i.e. nearly all other living organisms in the sea). Secondly, too much ammonia can cause algal blooms that can be detrimental to other organisms, particularly in enclosed bays and estuaries such as Marina del Rey Harbor (see Section 3.3.1.3 for a discussion of the impacts of red tide algal blooms). Thirdly, ammonia is a by-product of the degradation of most forms of organic waste in the marine environment and can thus be used as a rough indicator of organic pollution. Surface runoff and drainage of nitrogen, including ammonia, is governed by the frequency, intensity, and duration of precipitation in the drainage basins. As a result, there can be relatively large fluctuations in these inputs from year to year, and lengthy periods within a year when they are absent (SCCWRP 1973). Marina del Rey is an estuary, which is a partially enclosed coastal ecosystem where seawater mixes with nutrient-rich freshwater that has drained from the land. The confined conditions tend to trap the nutrients, resulting in an extremely productive and important ecosystem, which is an important nursery area for many species of fish and invertebrates. In estuarine and coastal systems, ammonia input from natural recycling (breakdown of organic material) is often significantly increased by input from anthropogenic sources. These anthropogenic sources include ocean outfalls for treated sewage, rainwater runoff, and input from boats. Direct rainwater runoff into Marina del Rey is significantly augmented by runoff from the major flood control facilities, Oxford Basin and Ballona Creek. The ammonia concentrations in the marina are likely to be indicative of the breakdown of organic debris and/or waste, and terrestrial fertilizers, whether of human or animal origin. Localized events in the marina may add to the ammonia concentrations. These include the discharge of human wastes, bird droppings and wash-down products from nearby docks and walkways (Soule et. al. 1997).

Vertical ammonia patterns. No unifying vertical patterns of ammonia concentration were evident in Marina del Rey Harbor (Figure 3-15). Most stations remained relatively unchanged with depth. For all stations and all depths, ammonia minima were at or near the detection limit (0.01 mg/l) during at least one monthly survey. Maximum values were widest at Stations 2 and 11 for no apparent reason.

Ammonia patterns over the year. Ammonia averages did not vary widely over the year (Figure 3-16), with very small peaks appearing most commonly in November through February. Additionally, all samples showed a slight increase in ammonia levels in June. These peaks may be rainfall related, but the pattern is not clear since November and June had no rainfall. Patterns in Basin E (Stations 10 and 20) do not closely follow those of Oxford Lagoon (Stations 13 and 22).

Spatial ammonia patterns. Highest ammonia averages over the year were at the Harbor entrance (Stations 1 and 2, 0.08 and 0.09 mg/l, respectively). Stations 3, 4 and 19 had average concentrations of 0.06 mg/l. The lowest ammonia averages were recorded at Stations 18 and 25 (0.04 mg/l). All other stations were 0.05 mg/l (Figure 3-17).

Ammonia ranges compared with past years. All 2000-2001 ammonia values were well below values of the recent past (Table 3-6).

3.3.1.6. Biochemical Oxygen Demand (BOD)

A standardized test us used to determine the biochemical oxygen demand (BOD) 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 incubates for five days at 20 °C, and the dissolved oxygen is re-measured (APHA 1995). During the five-day period, naturally occurring bacteria reproduce and respire and consume whatever organic material available. In the process, they utilize the accessible oxygen the sealed container. Thus, the BOD is a measure of the amount of oxygen consumed by bacterial respiration over the period of five days. Although the BOD test utilizes bacteria, it is not a measure of bacterial density but rather an indirect measure of organic material in the water. The source of organic material may be natural, such as plankton or organic detritus from upwelled waters, or anthropogenic, such as wastewater effluents, stormwater drainage, or non-point runoff.

Vertical BOD patterns. Vertical BOD profiles (Figure 3-18) suggest that the water column is well mixed, and the BOD is fairly constant with depth. Minimum ranges were usually below 1.0 mg/l. Similar to the recent past, values at most stations this year were relatively low and consistent. Higher values tended to be associated with Ballona Creek (Station 12) and Oxford Lagoon (e.g. Stations 13 and 22). Stations 10, 11 and 20, influenced by Oxford Lagoon and Stations 3, 6 and 8 showed a wider range of values within the first 4 meters from the surface. Station 12, had a wide range of values deeper in the water. The source of the higher BOD is likely municipal, freshwater runoff.

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

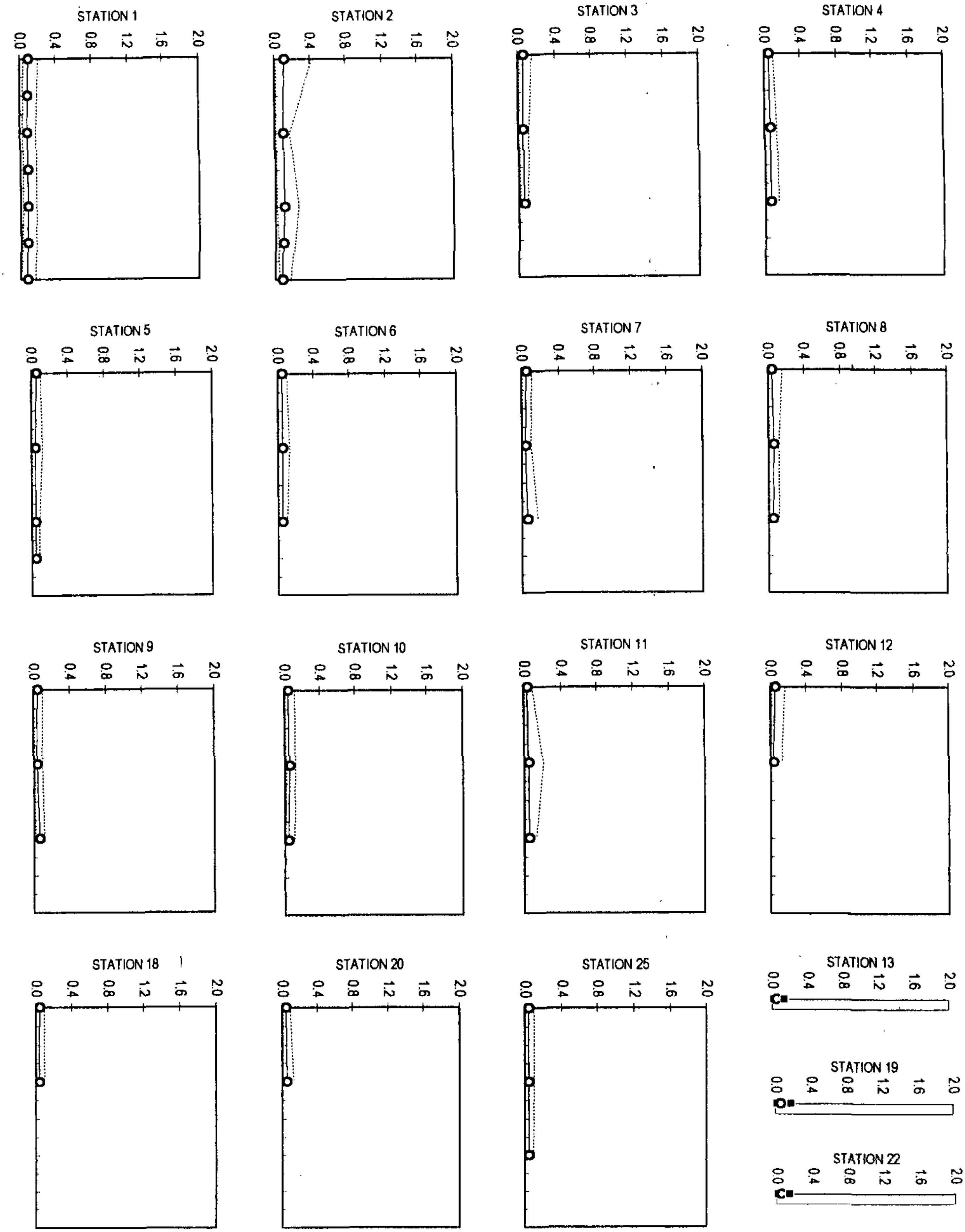


FIGURE 3-16. MINIMUM, AVERAGE, AND MAXIMUM AMMONIA (MG/L) VS. MONTH AT 18 WATER COLUMN STATIONS.

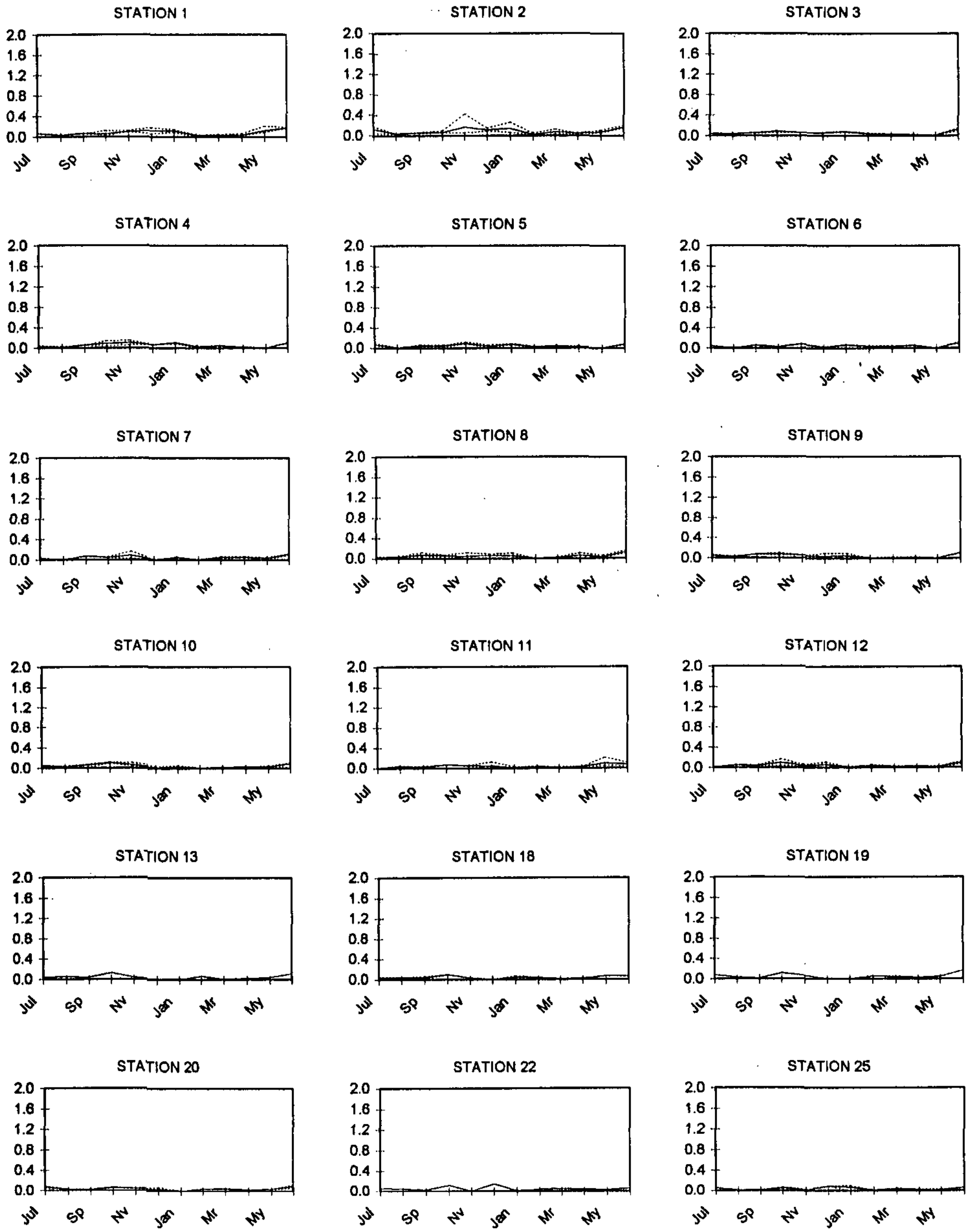


FIGURE 3-17. AVERAGE ANNUAL AMMONIA (MG/L) AT 18 WATER COLUMN STATIONS.

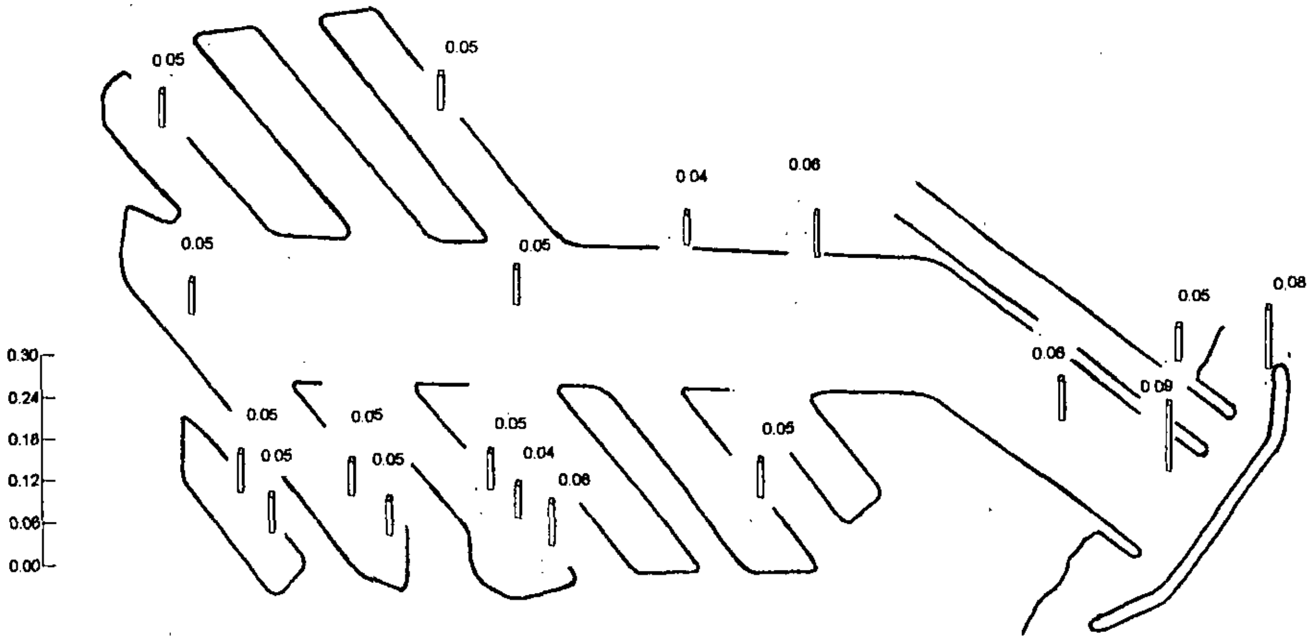


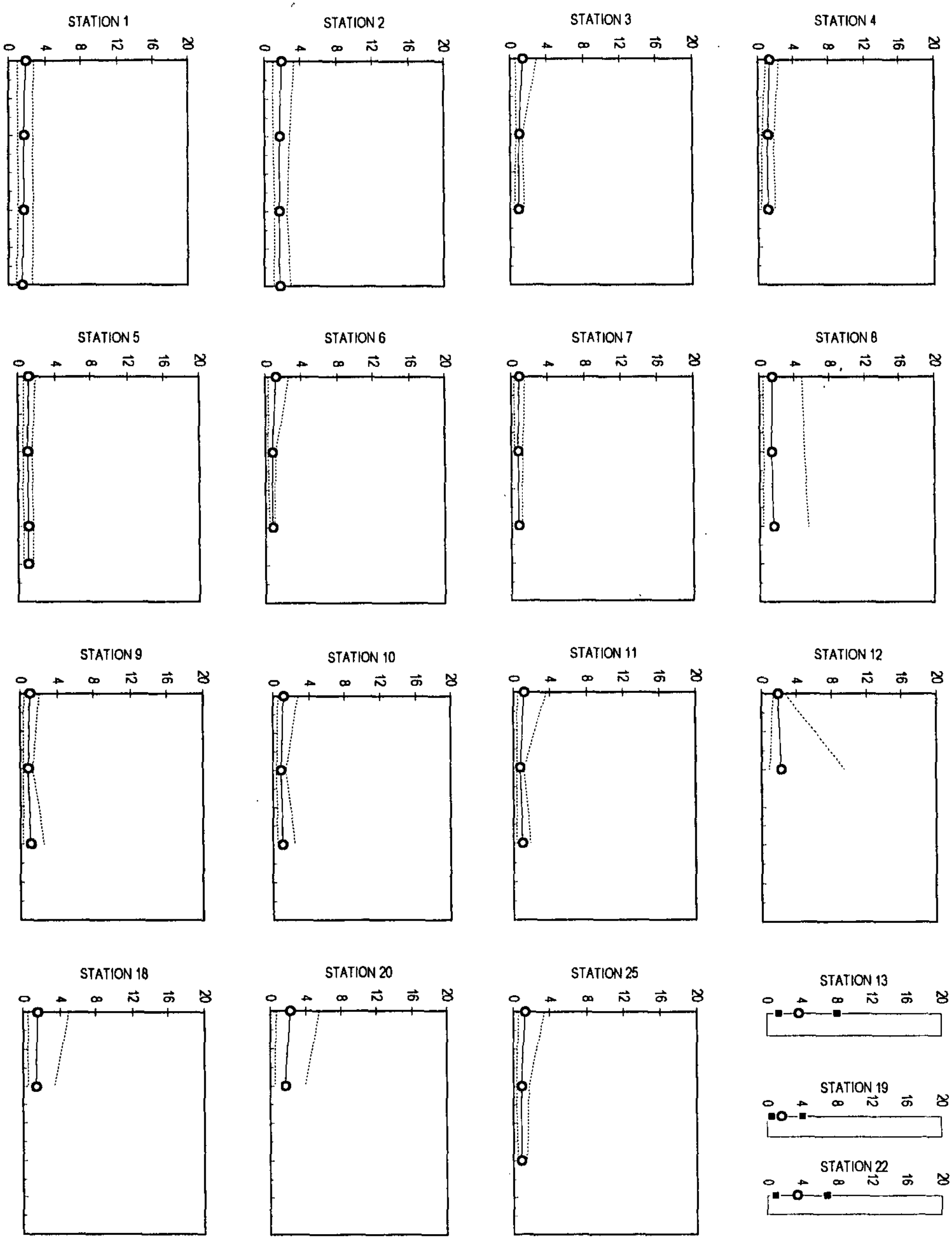
TABLE 3-6. SEASONAL AMMONIA RANGES (MG/L) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
1992-93	2.0 - 38.3	2.9 - 53.7	1.7 - 35.0	2.5 - 23.0
1993-94[1]	—	2.6 - 30.6	2.3 - 10.0	1.5 - 4.5
1994-95	1.5 - 6.0	0.2 - 5.0	0.9 - 4.1	1.0 - 12.7
1995-96	2.2 - 15.0	3.2 - 47.4	2.5 - 12.0	0.3 - 18.9
1996-97	0.3 - 18.2	0.3 - 27.7	0.3 - 22.6	0.3 - 105.8
1997-98	0.3 - 52.3	0.4 - 37.1	0.4 - 18.1	0.4 - 28.3
1998-99	0.4 - 45.5	0.4 - 43.6	0.4 - 22.9	0.01 - 3.5
1999-00	0.01 - 0.85	0.00 - 0.72	0.01 - 0.96	0.01 - 0.22
Overall range	**0.01 - 52.3**	**0.00 - 200.0**	**0.01 - 35.0**	**0.01 - 105.8**
2000-01[2]	0.01 - 0.42	0.00 - 0.26	0.01 - 0.21	0.04 - 0.20

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

[2] One month only in the summer.

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



BOD patterns over the year. For most stations, BOD values were low (below 5.0 mg/l) throughout the year (Figure 3-19). A slight red tide bloom was noticed at Station 12 in June 2000 although BOD was not greatly impacted. An increase in BOD that occurred at Stations 8 and 18 in June 2001 may have been related to the decay of red tide organisms. Although most stations showed a slight increase in BOD values in the spring, stations associated with Ballona Creek (1, 2 and 12) Mother's Beach (8, 18 and 19) and Oxford Lagoon (13, 20, and 22) were temporally independent of any naturally occurring patterns.

Spatial BOD patterns. Highest average BOD values were in Oxford Lagoon (Stations 13 and 22 – 3.7 and 3.5 mg/l, respectively), Basin E (Station 20 – 2.0 mg/l), and near Ballona Creek (Station 12 – 2.1 mg/l) (Figure 3-20). All other stations ranged from 0.8 to 1.8 mg/l).

BOD ranges compared with past years. BOD values for 2000-2001 were within the overall seasonal ranges for the preceding seven years (Table 3-7). Compared to 1999-2000, this year's ranges in the fall and spring were higher, winter and summer ranges were lower.

3.3.1.7. Light Transmissance

Water clarity in Marina del Rey Harbor is important for aesthetic and ecological reasons. Phytoplankton, as well as multicellular plants, depends on light for photosynthesis and therefore growth. Since nearly all higher-level ocean organisms depend on these plants for survival (except animals living in deep-ocean volcanic vents), the ability of light to penetrate into the ocean depths is clearly important. Water is least clear during spring upwelling and winter rain. In early summer, increased day length promotes plankton growth and reduces water clarity. Late summer and early fall typically have the greatest water clarity since shorter days and rain, which brings sediments into the marine environment, have yet to begin. Anthropogenic inputs including wastewater effluents, storm drain discharges and non-point runoff also greatly influence water quality locally. Surface transparency is measured using a weighted, white plastic, 30-cm diameter disk (a Secchi Disk) attached to a marked line. The depth at which the disk disappears in the water column is recorded. The depth to which light is available for photosynthesis is generally considered about 2.5 times the Secchi disk depth therefore; this provides an estimate of light available to plankton. Recent findings indicate net photosynthesis may occur at lower light levels (SCCWRP, 1973).

Light transmissance is measured using a transmissometer, 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.

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

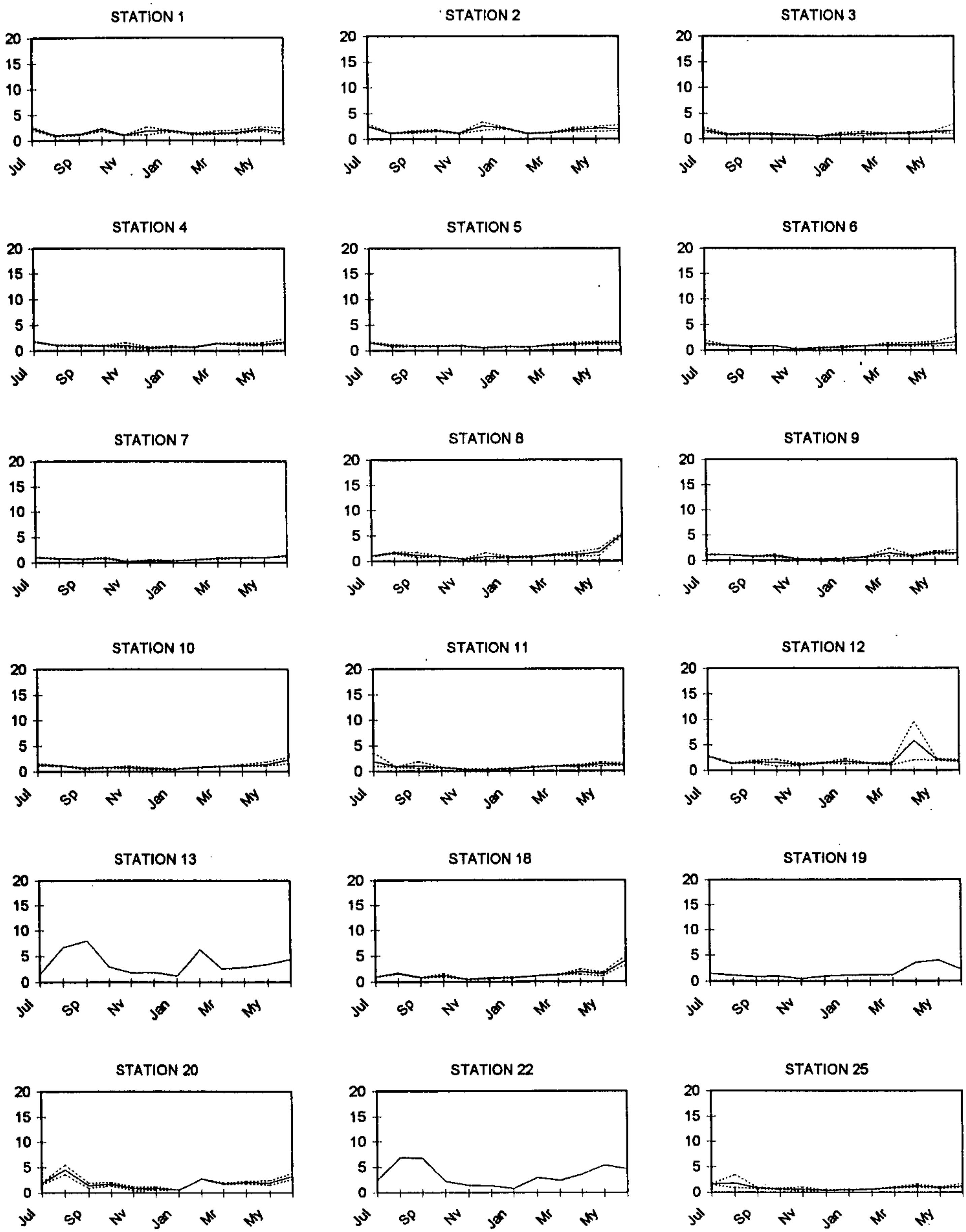


FIGURE 3-20. AVERAGE ANNUAL BOD (MG/L) AT 18 WATER COLUMN STATIONS.

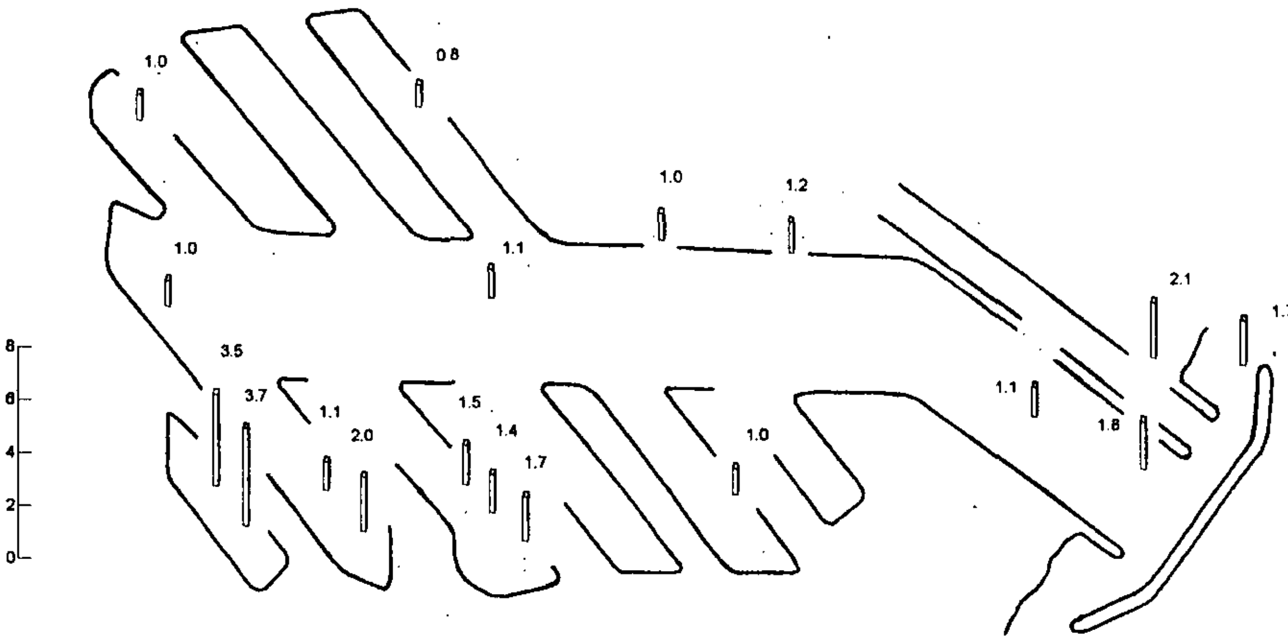


TABLE 3-7. SEASONAL BOD RANGES (MG/L) FOR ALL DEPTHS AND STATIONS.

Survey	Fall	Winter	Spring	Summer
1993-94[1.]	0.8 - 14.0	0.7 - 6.9	0.7 - 15.2	0.6 - 13.0
1994-95	0.6 - 5.2	0.5 - 10.3	0.6 - 13.0	0.9 - 11.2
1995-96	0.8 - 3.4	0.6 - 8.7	0.6 - 6.8	0.1 - 7.5
1996-97	0.1 - 7.8	0.4 - 6.8	1.0 - 13.0	0.8 - 15.2
1997-98	0.4 - 13.4	0.2 - 6.1	0.7 - 8.7	0.8 - 12.5
1998-99	0.0 - 19.3	0.3 - 8.7	0.4 - 7.6	0.5 - 8.4
1999-00	0.4 - 6.6	0.0 - 18.7	0.6 - 7.2	0.8 - 6.8
Overall range	**0.0 - 19.3**	**0.2 - 18.7**	**0.4 - 15.2**	**0.1 - 15.2**
2000-01[2.]	0.2 - 8.0	0.3 - 6.3	0.8 - 9.5	1.0 - 5.6

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

[2.] One month only in the summer.

Vertical light transmissance patterns. Profiles shown in Figure 3-21 suggest that, at most stations, the average transmissance is fairly constant with depth or declines slightly near the bottom. The exception was Station 12 in Ballona Creek where there was a large increase with depth. Stations with the widest ranges below the surface were Stations 6, 11 and 12 (widest from 0-6 m), Station 9 (2-4 m) and Station 25 (6-10 m). Stations 1 and 20 had increased ranges at the surface.

Light transmissance patterns over the year. Stations 2 and 3 did not show much variability in light transmissance over the year (Figure 3-22). Most stations showed a decrease in light transmissance from February to April, the most dramatic decreases appearing in Stations 1, 9, 10, 11, 12, 18, and 20. These stations are located at the Ballona Creek and Basins D, E and F. Low values during this time might be related to precipitation since most of the rain for this year fell in February (7.30 in), March (1.29 in) and April (1.10 in). Stations 5, 6, 7 and 8 had variable light transmissance values during the year. Stations 4 and 25 showed a slight decrease in transmissance with a wide range of values in June, 2001. Red tide activity was noted in the June, 2001 survey which could influence light transmissance around this time.

Spatial light transmissance patterns. Transmissance averages were fairly high throughout the Harbor (Figure 3-23) (Figure 3-23). Lowest averages were in Basin F (Station 9 – 79.7%) and Basin E (Station 10 – 79.7%). The highest averages were Stations 1, 2 and 3 (88.1%, 87.7% and 87.9%, respectively). Remaining stations were relatively high (82.0% to 86.8%).

Light transmissance ranges compared with past years. Transmissance values exceeded the overall seasonal ranges for the previous years only during the spring of 2000-2001 (Table 3-8). When compared to 1999-2000, ranges for most seasons were somewhat lower except in the spring and summer.

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 varied throughout the year (Figure 3-24). The highest peaks in surface transparency occurred in October near the Harbor entrance (Stations 1 and 2). Station 25 showed a marked decrease in November. Station 12 experienced very low surface transparency during February and March, probably due to rainfall in those months. Stations 5, 6, 18 and, to a lesser extent, 11 showed elevated surface transparency values during September. Surface transparency decreased to zero in May at Station 7.

Spatial surface transparency patterns. Surface transparency values averaged over the year are depicted in Figure 3-25. Highest values were in the Harbor entrance and main channel (Stations 1, 2, 3 and 4 – 3.1 to 3.6 m. Lowest averages were in Basin E (Stations 10 and 20 – 2.1 m and 2.0 m) and Basin F (Station 9 - 2.1 m). Values for other stations ranged from 2.3 m to 2.8 m.

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

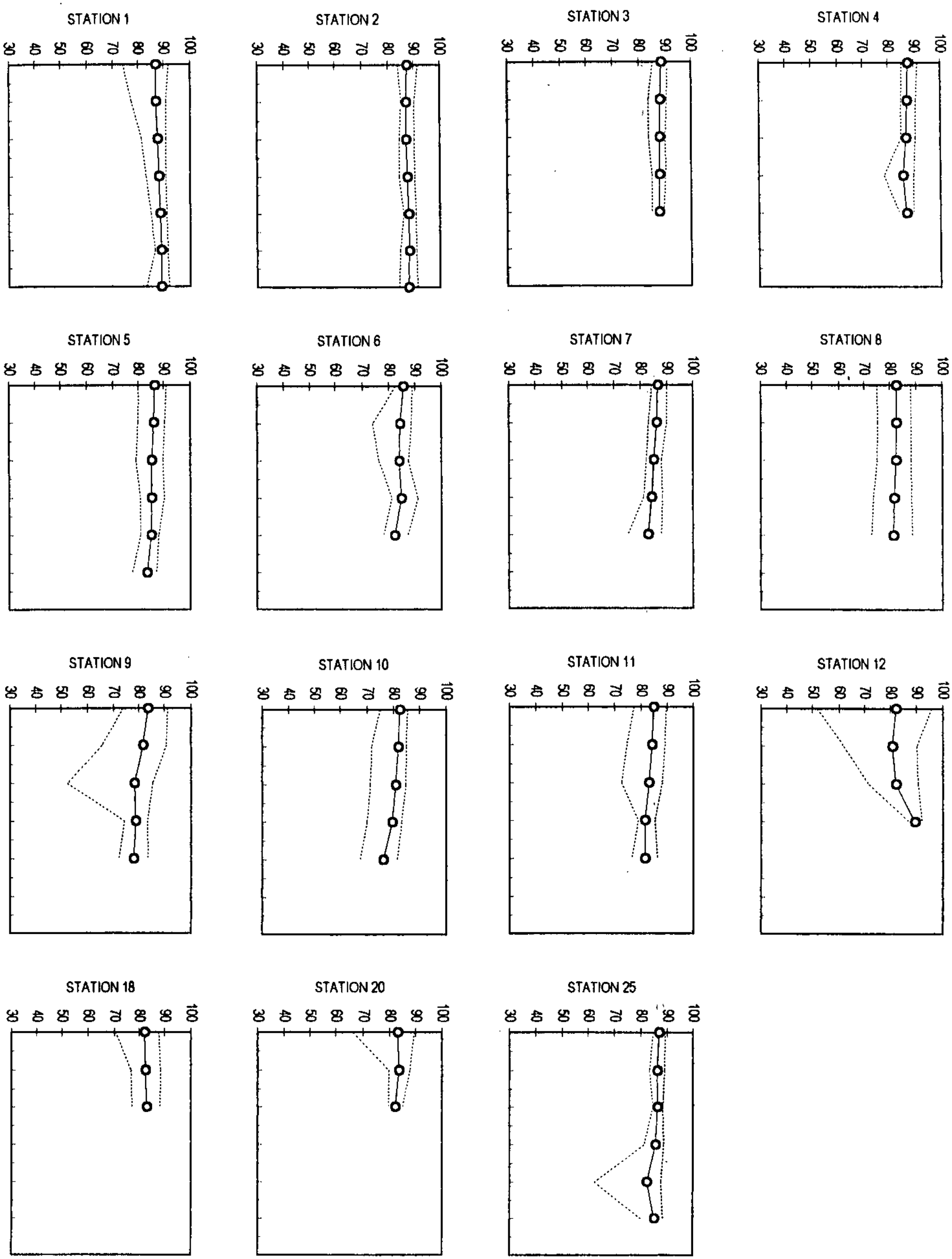


FIGURE 3-22. MINIMUM, AVERAGE, AND MAXIMUM TRANSMISSANCE (%) VS.MONTH AT 15 WATER COLUMN STATIONS

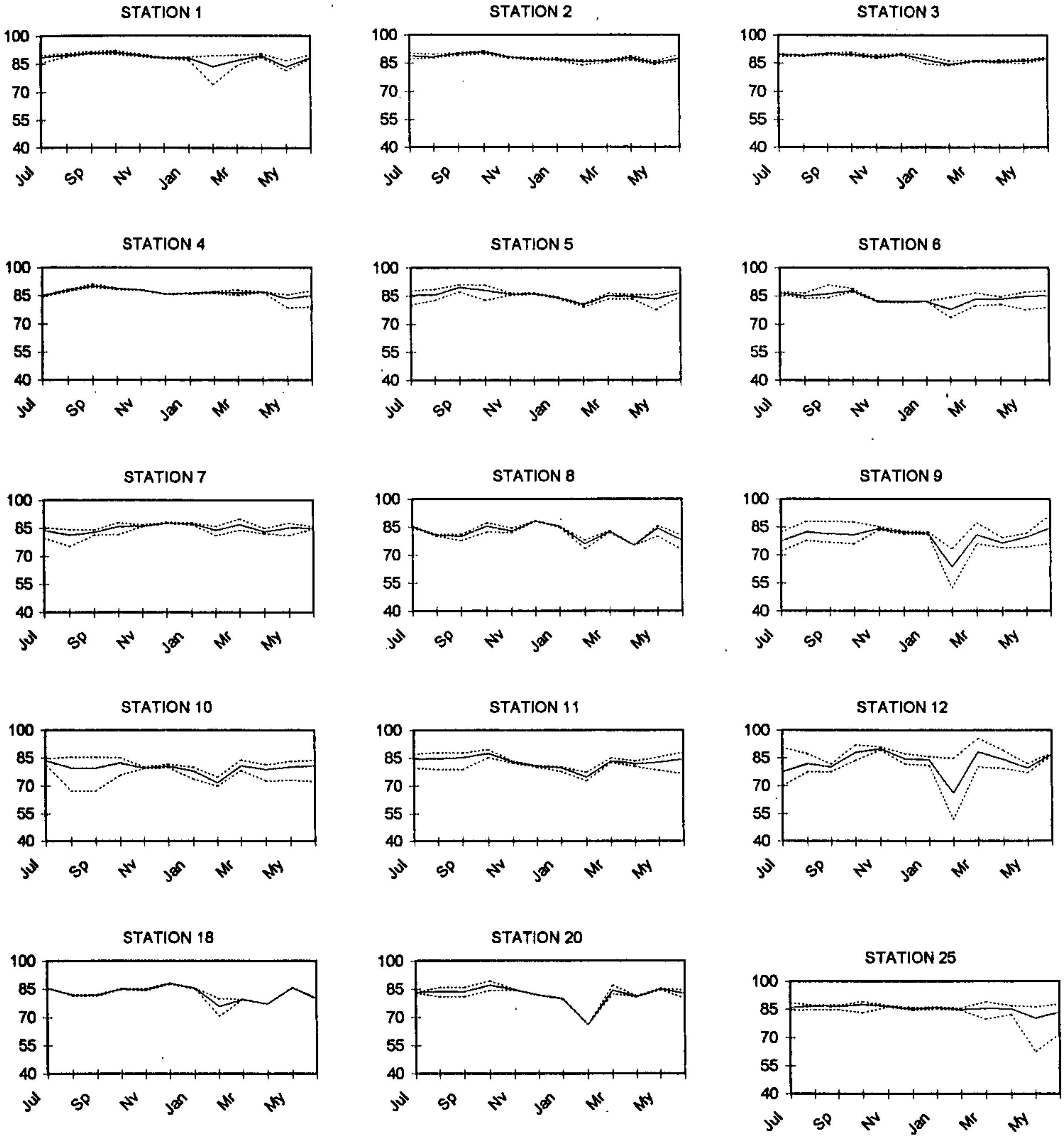


FIGURE 3-23. AVERAGE ANNUAL LIGHT TRANSMISSANCE (%) AT 15 WATER COLUMN STATIONS.

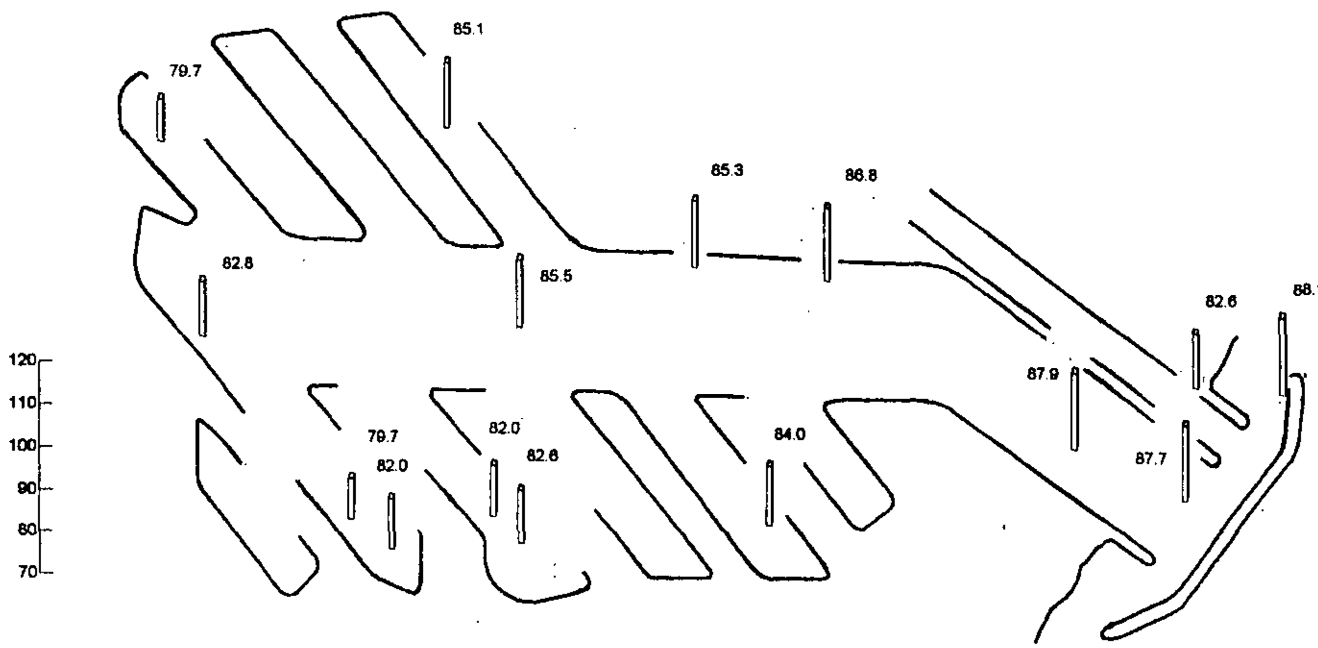


TABLE 3-8. SEASONAL LIGHT TRANSMISSANCE RANGES (%) FOR ALL DEPTHS AND STATIONS.

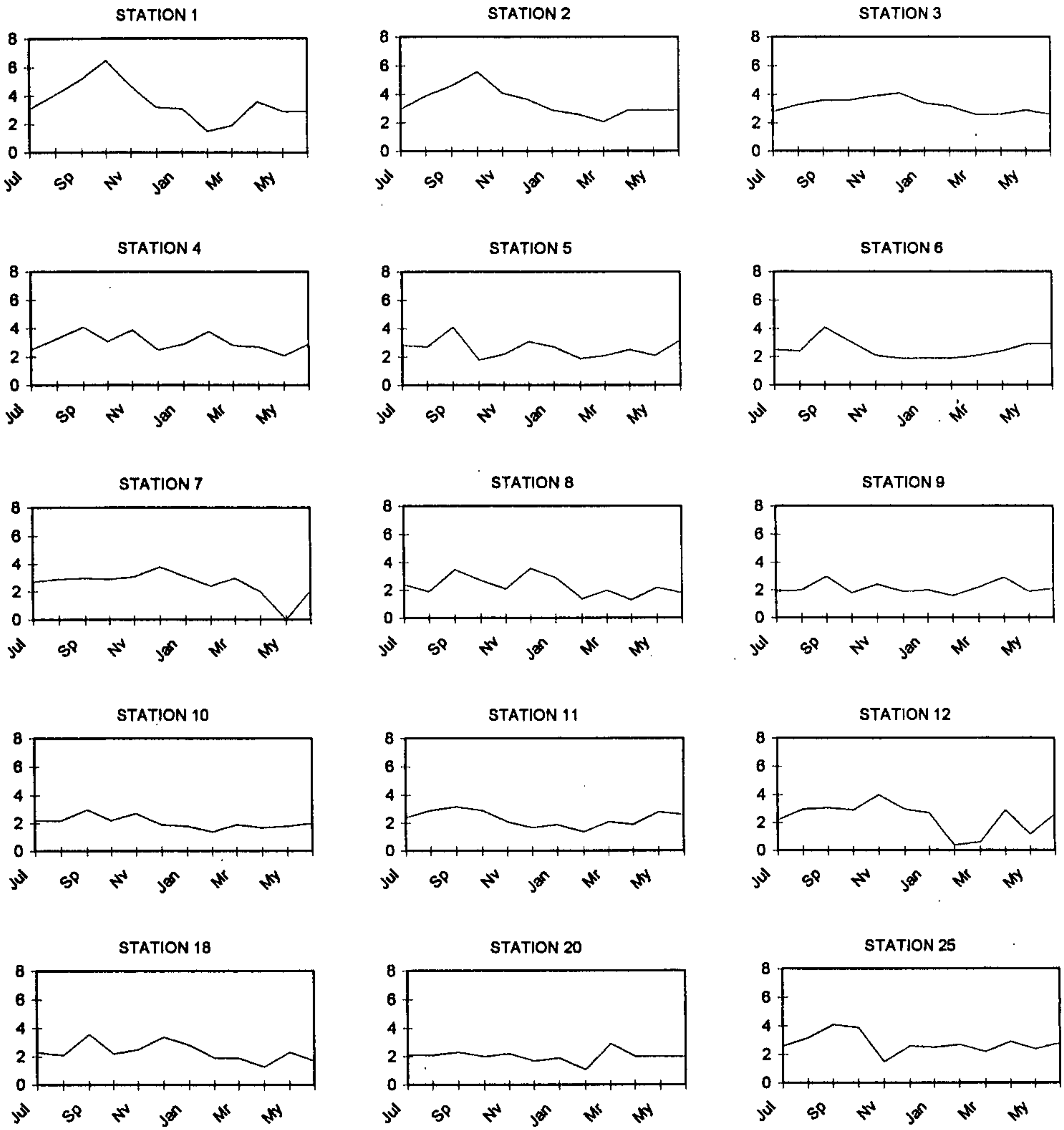
Survey	Fall	Winter	Spring	Summer
1992-93[1.]	50 - 91	0 - 85	31 - 85	41 - 90
1993-94[2.]	20 - 90	50 - 98	46 - 89	62 - 94
1994-95	53 - 96	5 - 93	41 - 88	41 - 88
1995-96	38 - 93	4 - 93	15 - 84	43 - 81
1996-97	71.4 - 93.3	57.2 - 92.0	33.8 - 89.8	74.9 - 93.8
1997-98	46.4 - 91.9	50.6 - 94.1	69.4 - 90.2	38.8 - 94.3
1998-99	74.5 - 94.7	54.7 - 94.4	62.3 - 93.1	65.2 - 92.1
1999-00	67.5 - 94.0	72.3 - 93.3	48.1 - 92.7	67.4 - 90.6
Overall range	**20 - 96**	**0 - 98**	**8 - 93.1**	**39 - 93.8**
2000-01[3.]	67.4 - 92.2	51.9 - 90.6	62.5 - 95.7	72.0 - 91.3

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

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

[3.] One month only in the summer.

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



Surface transparency ranges compared with past years. 2000-2001 surface transparency values were within the overall seasonal ranges for the preceding eight years except at Station 7 where surface transparency fell to zero in the spring (Table 3-9). Compared to 1999-2000, values were slightly lower except in the fall where values were slightly higher.

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 from particulates in the water and the true 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. Increases in phytoplankton numbers cause the water to appear blue green to green due to increased light scattering at longer wavelengths. If phytoplankton numbers get very high as in a "bloom", the water may take on the color of the particular algal species. A green algae bloom might color the water green or yellow-green to yellow-brown with a diatom bloom. Red tides, caused by a bloom of dinoflagellate, 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 affects water color directly and 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. Vial colors are compared to the seawater viewed above a white Secchi disk suspended beneath the water surface. Numbers 1-3 represent deep-sea blues, the clearest of oceanic waters. Numbers increase to the blue-greens (4-6), greens (7-9), yellow-greens (10-12), yellow-green-browns (13-15), yellow-browns (16-18), and brown-reds (19-20). 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; the same person should 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. Most stations had Forel-Ule values between 10 and 12 (yellow-green, Figure 3-26). The highest variation in Forel-Ule values occurred at Stations 1, 2, 3, and 12 all located at the mouth of the Harbor and influenced by Ballona Creek. Overall, color patterns did not consistently respond clearly to rainfall or other natural processes. High Forel-Ule values were recorded in December, February April and June. Station 12 had the highest (18 in February, 2001).

Spatial color patterns. Forel-Ule values averaged over the year are depicted in Figure 3-27. The highest average was in Ballona Creek (Station 12 – 13.3 units). Stations 1, 2 and 3, near the Harbor mouth had values of 12.8, 12.4 and 12.4, respectively. All other stations were moderate values (10.8 to 11.8 units).

FIGURE 3-25. AVERAGE ANNUAL SURFACE TRANSPARENCY (M) AT 15 WATER COLUMN STATIONS.

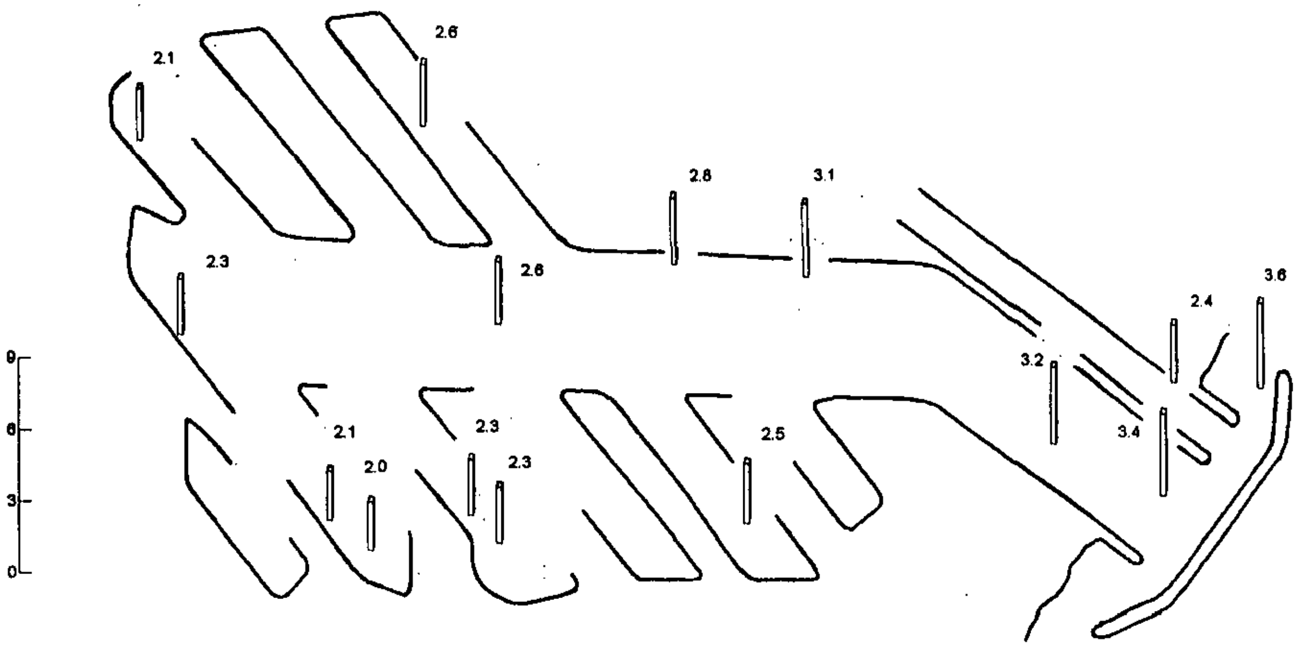


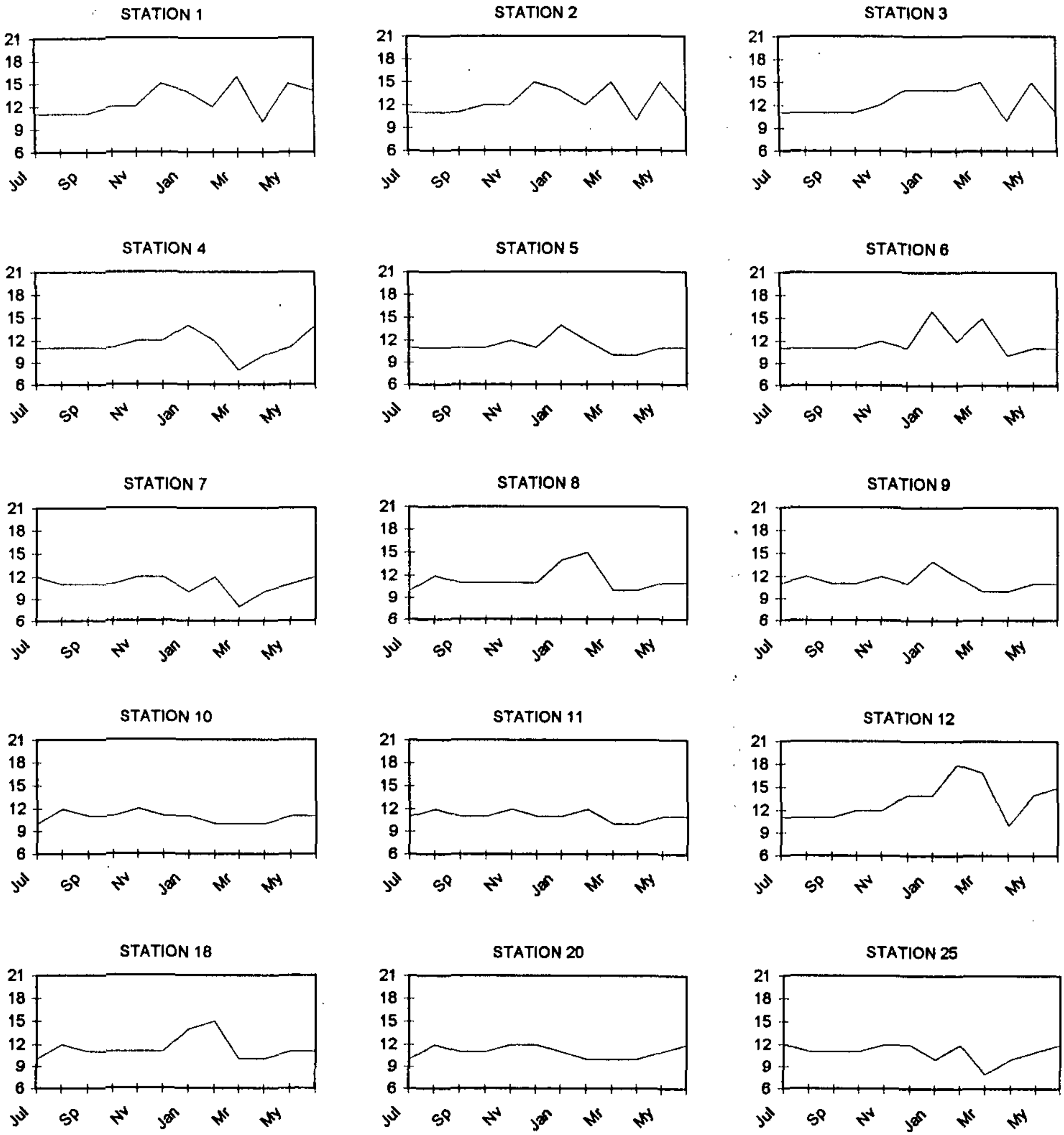
TABLE 3-9. SEASONAL SURFACE TRANSPARENCY RANGES (M) FOR ALL STATIONS.

Survey	Fall	Winter	Spring	Summer
1992-93	1.5 - 6.5	0.1 - 3.5	1.0 - 3.5	1.5 - 6.6
1993-94[1.]	1.5 - 4.5	2.0 - 7.0	1.0 - 4.0	1.5 - 4.5
1994-95	1.5 - 6.0	0.2 - 5.0	0.9 - 4.0	1.0 - 4.0
1995-96	1.5 - 6.5	0.1 - 3.5	0.3 - 4.4	1.3 - 2.0
1996-97	1.5 - 5.8	1.6 - 5.5	0.7 - 4.2	1.3 - 5.6
1997-98	0.4 - 4.3	0.9 - 5.8	1.8 - 4.5	1.4 - 5.6
1998-99	1.3 - 5.9	1.2 - 4.9	1.3 - 3.9	1.6 - 4.0
1999-00	1.5 - 4.2	2.0 - 4.5	0.4 - 3.9	1.9 - 4.1
Overall range	**0.4 - 6.5**	**0.1 - 7.0**	**0.3 - 4.5**	**1.0 - 6.6**
2000-01[2].	1.5 - 6.5	0.4 - 4.1	0.0 - 3.6	1.7 - 3.2

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

2. One month only in the summer.

FIGURE 3-28. AVERAGE FOREL-ULE COLOR (UNITS) VS. MONTH AT 15 WATER COLUMN STATIONS



Color ranges compared with past years. All 2000-2001 surface transparency values were within the overall seasonal ranges for the preceding eight years (Table 3-10). When compared to 1999-00, values tended to be higher in winter and summer, and lower in the fall.

3.3.2. Bacterial Water Quality

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

This study samples 14 marina sites, four stations in the adjacent stormwater channels, Ballona Creek and Oxford Lagoon on a monthly basis, providing independent documentation of bacterial contamination in the marina. Total coliforms, fecal coliforms and enterococcus measurements, 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 cost effective, rapid tests. Currently, it is 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.

FIGURE 3-27. AVERAGE ANNUAL FOREL-ULE COLOR AT 15 WATER COLUMN STATIONS.

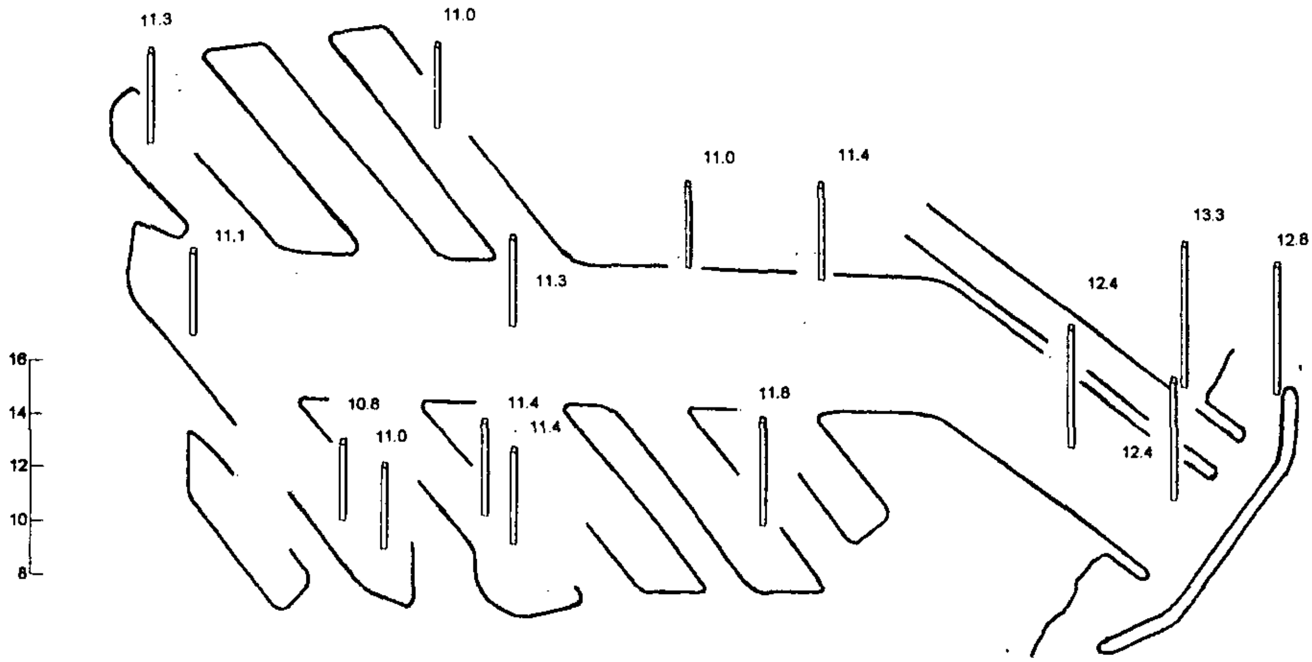


TABLE 3-10. SEASONAL FOREL-ULE COLOR RANGES FOR ALL STATIONS.

Survey	Fall	Winter	Spring	Summer
1992-93	3 - 12	4 - 18	7 - 16	5 - 15
1993-94[1.]	7 - 14	5 - 12	6 - 17	4 - 14
1994-95	4 - 14	4 - 17	5 - 17	4 - 14
1995-96	4 - 14	10 - 18	8 - 17	12 - 14
1996-97	9 - 12	9 - 12	10 - 17	10 - 17
1997-98	7 - 14	7 - 17	10 - 16	7 - 16
1998-99	8 - 16	9 - 16	10 - 15	10 - 15
1999-00	9 - 14	9 - 16	10 - 16	9 - 12
Overall range	**3 - 16**	**4 - 18**	**5 - 17**	**4 - 17**
2000-01[2.]	11 - 12	10 - 18	8 - 17	11 - 15

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

[3.] One month only in the summer.

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 216 measurements over the year, counts were in violation (greater than 10,000 MPN/100 ml) 20 times (Table 3-14). All of these were at stations associated with either Oxford Lagoon, including Basin E (Stations 13, 20, and 22) or Ballona Creek (Stations 1, 2 and 12). Limits were exceeded most often in February (five stations). February also had the highest rainfall (7.30 in.). During the rest of the year, total coliform exceedances ranged from zero to four stations per month.

Spatial total coliform patterns. Total coliform values averaged over the year are depicted in Figure 3-29. Oxford Lagoon had some of the highest averages (Stations 13 and 22 - 1275 and 6061 MPN/100 ml). The next highest averages occurred near Ballona Creek (Stations 1 and 12 – 1278 and 3320 MPN/100 ml), and Basin E (Stations 10 and 20 – 1095 and 929 MPN/100 ml). The remainder of the Harbor averaged much lower (82 to 324 MPN/100 ml).

Total coliform ranges compared with past years. Numbers of total coliform violations for 2000-2001 were within the overall seasonal ranges for the preceding eight years (Table 3-11). When compared to 1999-2000, violation frequency was higher in the winter and lower in the other seasons.

3.3.2.2. **Fecal Coliforms**

The fecal coliform test discriminates primarily between soil bacteria and those in human wastes, warm-blooded animals such as dogs, cats, birds, horses and barnyard animals, and some cold-blooded fish. Standards for fecal coliform provide that a minimum of not less than five samples in a 30-day period shall not exceed a geometric mean of 200 MPN/100 ml, nor shall more than 10 percent of the total samples during a 60-day period exceed 400 MPN/100 ml. 400 MPN has been historically used as the standard for single fecal coliform violations (Soule et. al. 1996, 1997).

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

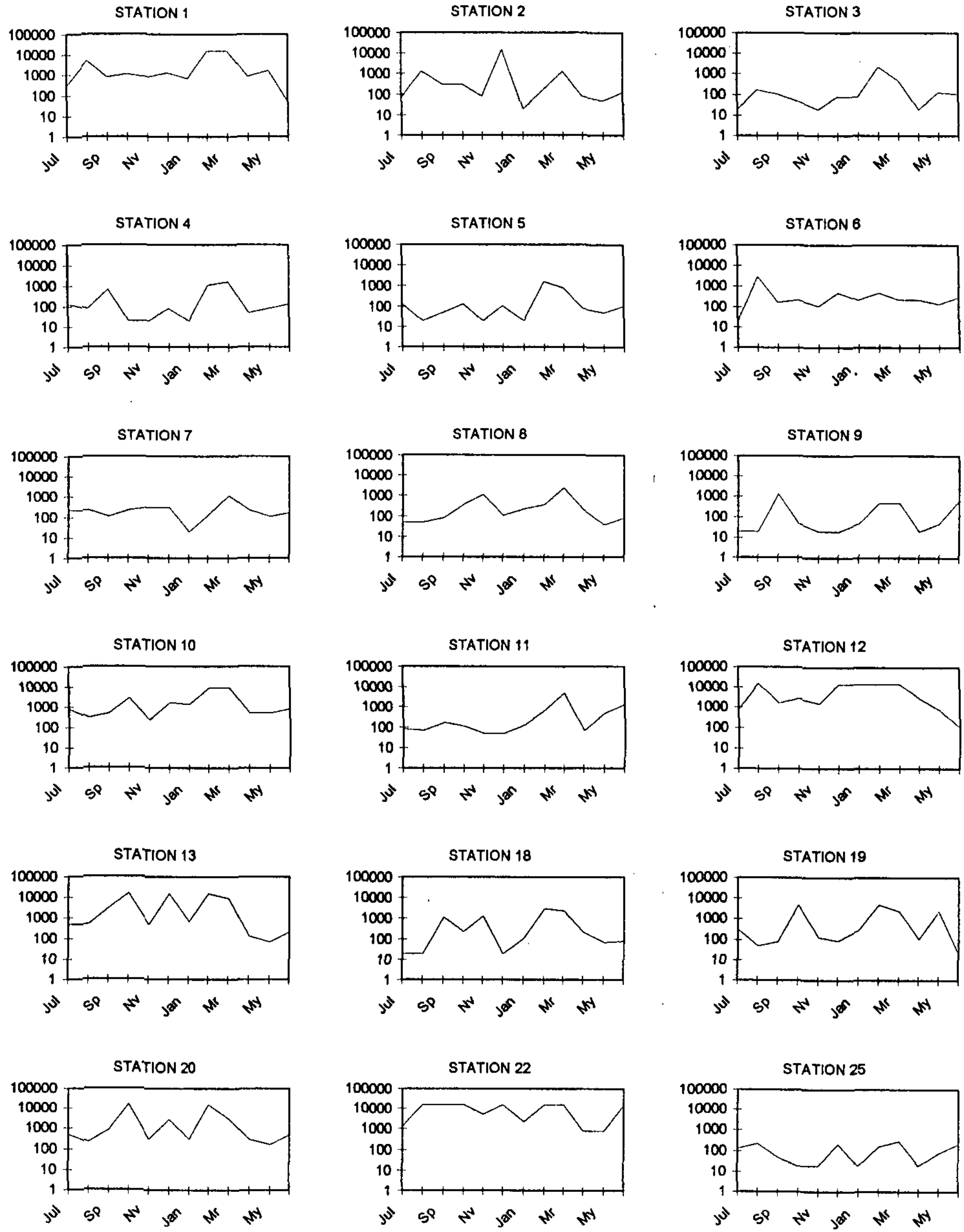


FIGURE 3-29. GEOMETRIC MEANS OF TOT. COLIFORM (MPN/100 ML) AT 18 WATER COLUMN STATIONS.

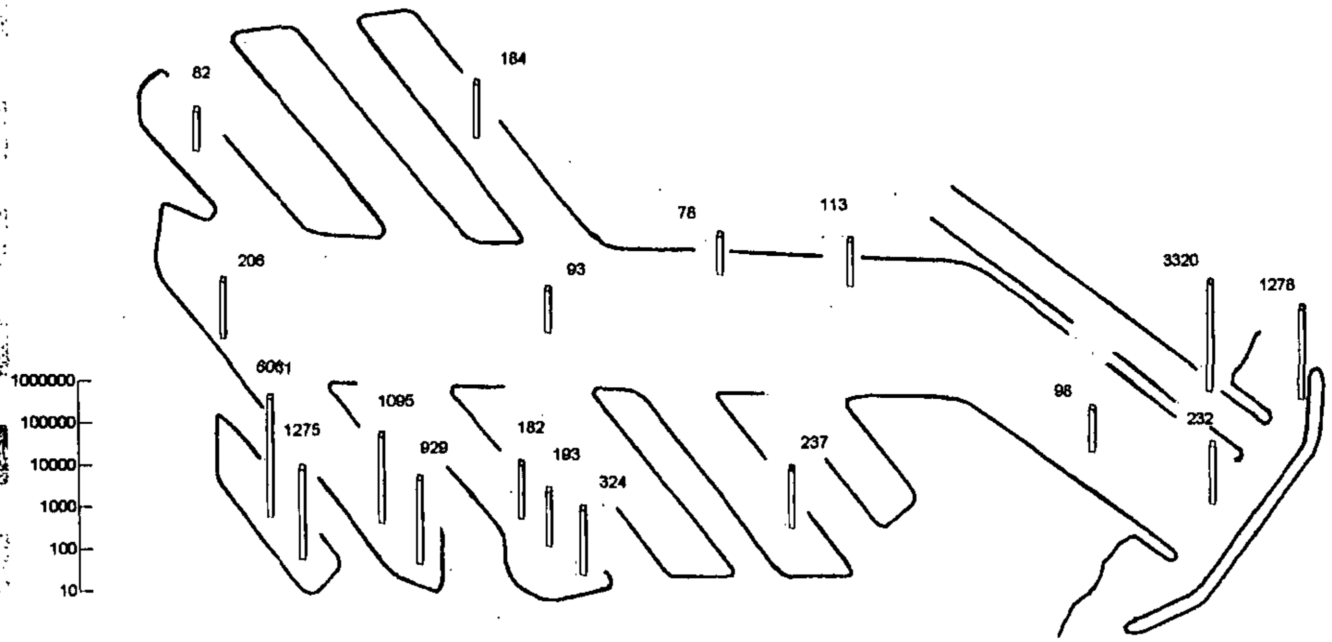


TABLE 3-11. FREQUENCY OF TOTAL COLIFORM VIOLATIONS (>10,000 MPN/100 ML) FOR ALL STATIONS.

Survey	Fall	Winter	Spring	Summer
1992-93	2	43	7	0
1993-94[1.]	—	6	4	0
1994-95	0	1	1	3
1995-96	2	6	5	0
1996-97	2	5	4	8
1997-98	5	8	3	7
1998-99	5	5	8	7
1999-00	7	9	5	3
Overall range	**0 - 7**	**1 - 43**	**1 - 13**	**0 - 8**
2000-01[2.]	4	10	3	1

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

[2.] One month only in the summer.

Fecal coliform patterns over the year. Fecal coliform counts ranged from <20 to ≥16,000 MPN/100 ml (Figure 3-30). Out of 216 measurements over the year, counts were in violation (greater than 400 MPN/100 ml) 22 times (Table 3-14). Nearly all (21) of these were at stations associated with either Oxford Lagoon, including Basin E (Stations 10, 13, 20, and 22), or Ballona Creek (Stations 1 and 12). The exceptions were exceedances in Basin D (Station 8) in March. The survey in March was conducted following major rainfall so was likely rainfall related. Limits were exceeded most frequently in February and March, two of the wettest months of the year. During the rest of the year, fecal coliform exceedances ranged from zero to three stations per month.

Spatial fecal coliform patterns. Fecal coliform values averaged over the year are depicted in Figure 3-31. Highest averages were around Ballona Creek (Stations 1 and 12 – 344 and 530 MPN/100 ml, respectively), Oxford Lagoon (Stations 13 and 22 – 104 and 207 MPN/100 ml) and Basin E (Stations 10 and 20 – 81 and 85 MPN/100 ml). Averages at the remaining stations were lower (24 to 78 MPN/100 ml).

Fecal coliform ranges compared with past years. Numbers of fecal coliform violations for 2000-2001 were within the overall seasonal ranges for the preceding eight years (Table 3-12). When compared to 1999-00, violations were less frequent in all 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).

Enterococcus patterns over the year. Enterococcus counts ranged from <2 to ≥1600 Colonies/100 ml (Figure 3-32). Out of 216 measurements, counts were in violation (greater than 104 Colonies/100 ml) 41 times (Table 3-14). Most of these (33) were at stations associated with either Oxford Lagoon, including Basin E (Stations 10, 13, 20, and 22), or Ballona Creek (Stations 1 and 12). The exceptions were exceedances in July (Basin D, Station 19), September (Basin D - Station 18, Basin F –Station 9, mid channel – Station 5), October (Basin H –Station 7, mid channel – Station 5), December (mid channel – Station 5) and March (mid channel – Station 25). Limits were exceeded most frequently (eight times) in October, seven times in March and six times in September and February. Exceedances in October, February and March may have been rainfall related. During the rest of the year, enterococcus exceedances ranged from zero to four stations per month.

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

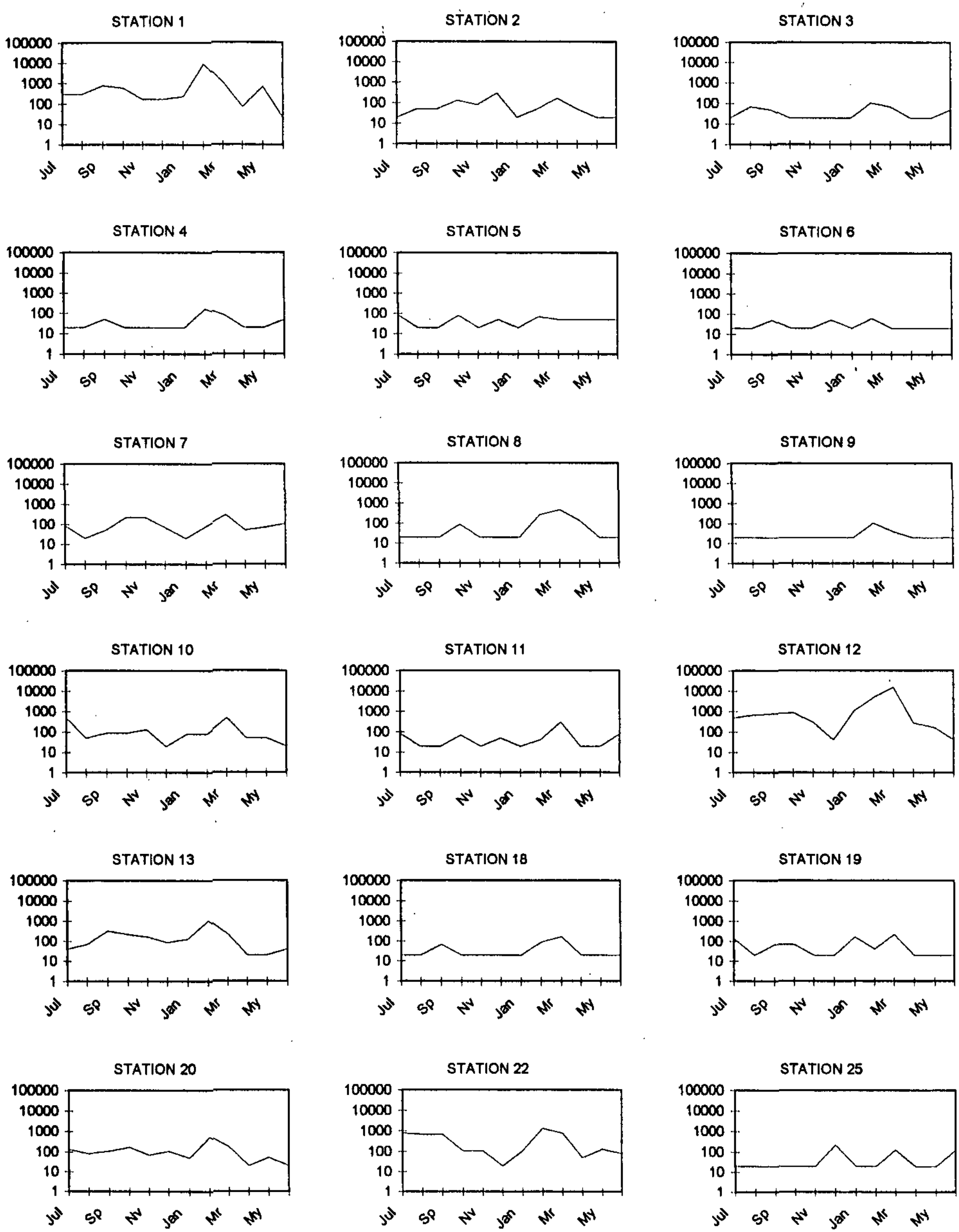


FIGURE 3-31. GEOMETRIC MEANS OF FEC. COLIFORM (MPN/100 ML) AT 18 WATER COLUMN STATIONS.

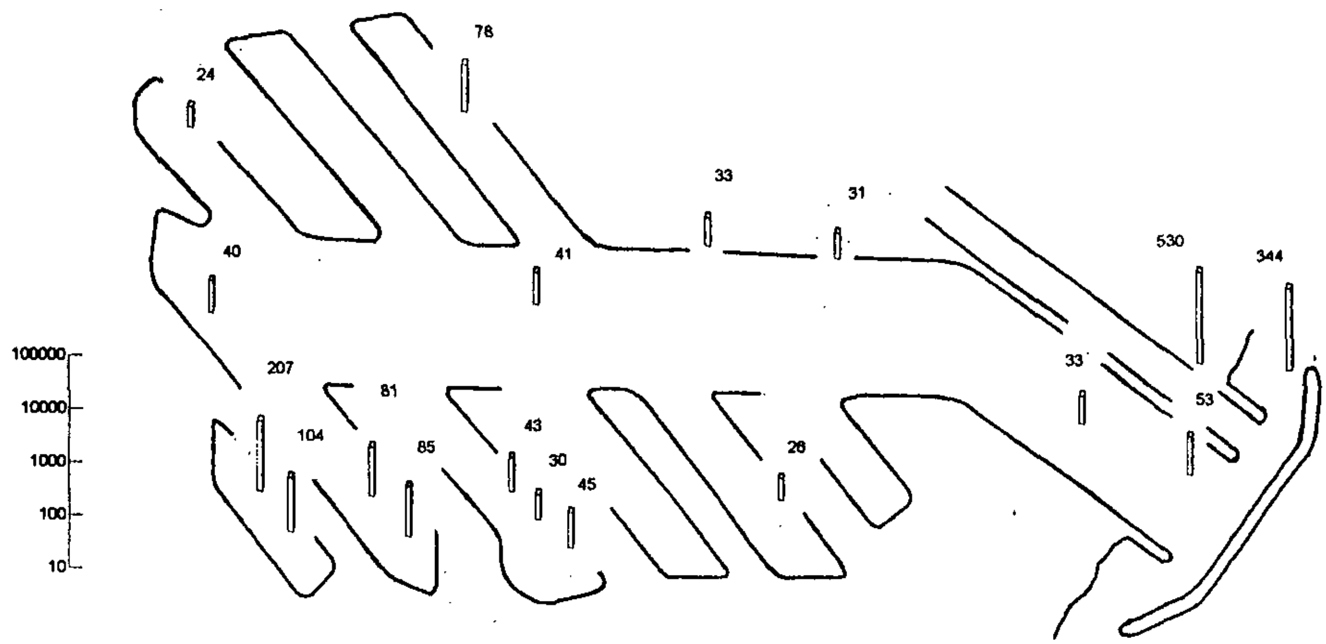


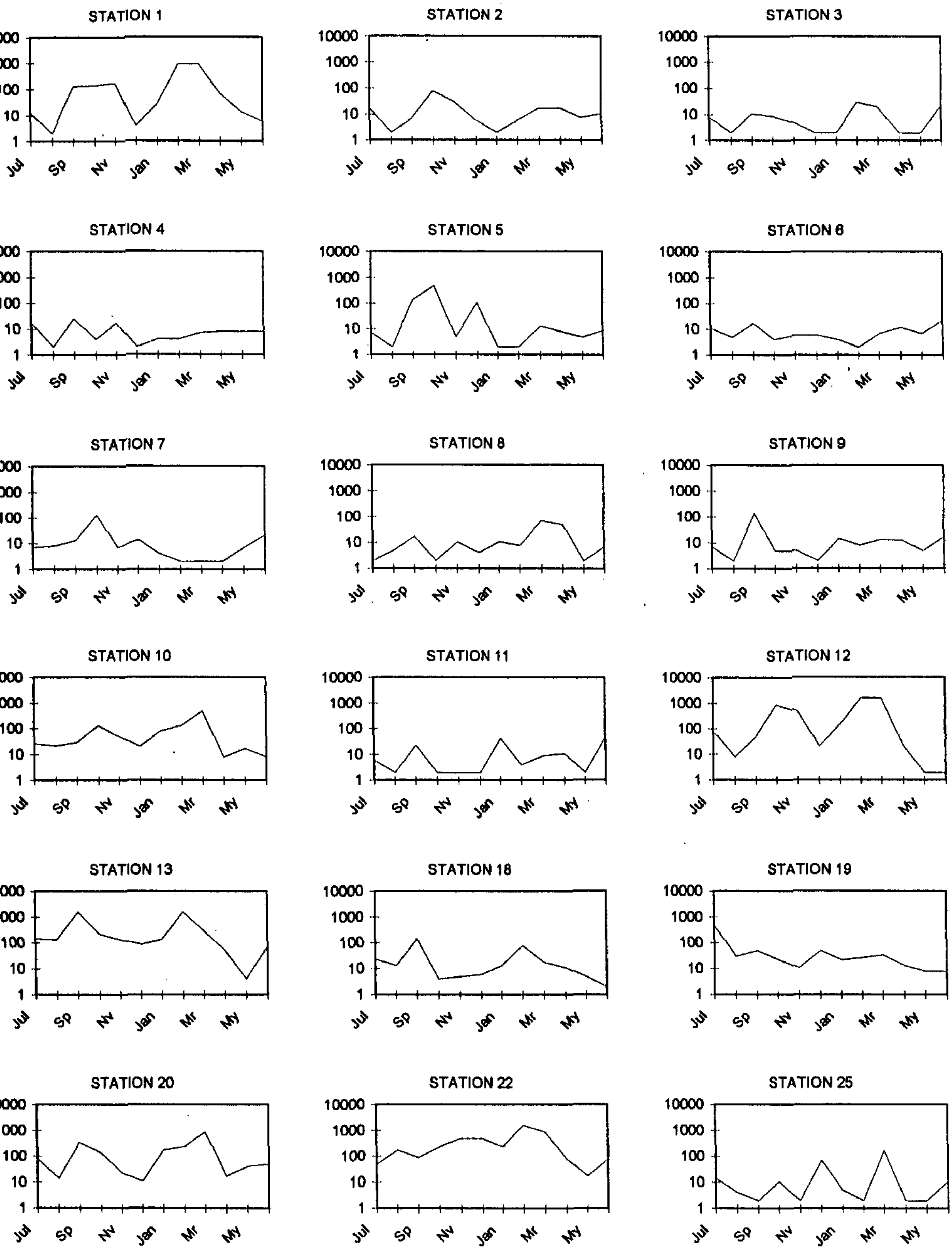
TABLE 3-12. FREQUENCY OF FECAL COLIFORM VIOLATIONS (>400 MPN/100 ML) FOR ALL STATIONS.

Survey	Fall	Winter	Spring	Summer
1992-93	8	46	13	0
1993-94[1.]	—	6	9	9
1994-95	2	27	5	2
1995-96	5	18	6	2
1996-97	5	6	3	6
1997-98	18	23	3	7
1998-99	6	12	11	10
1999-00	9	9	9	7
Overall range	**2 - 18**	**6 - 46**	**3 - 21**	**0 - 10**
2000-01[2.]	5	6	6	0

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

2. One month only in the summer.

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



Spatial enterococcus patterns. Enterococcus values averaged over the year are depicted in Figure 3-33. Similar to last year, highest averages were in Oxford Lagoon (Stations 13 and 22 – 143.3 and 186.1 Colonies/100 ml, respectively), Basin E (Stations 10 and 20 – 39.3 and 70.9 Colonies/100 ml), and near Ballona Creek (Stations 1 and 12 – 43.0 and 67.9 Colonies/100 ml). Remaining station counts averaged lower (5.9 to 27.1 Colonies/100 ml).

Enterococcus ranges compared with past years. Numbers of enterococcus violations for 2000-2001 were within the overall seasonal ranges for the preceding eight years (Table 3-13) except for in the fall when the maximum was higher. When compared to 1999-00, violations were more frequent except in the summer.

3.3.3. Station Groupings Based on Water Quality

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

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

Station 19. The water at this station in Basin D by Mother's Beach was slightly higher in ammonia and organic material. Relatively low salinity may suggest freshwater input. Bacteria concentrations were moderate at this station.

Stations 8, 9, 11 and 18. These stations are in the back Harbor of Basin D and Basin F in areas of low circulation and of limited exposure to tidal flushing. The water here tends to be warm, low in water clarity, ammonia and in fecal coliform but moderate in all remaining measurements.

Stations 3, 4, 5, 6, 7 and 25. These stations represent the middle and lower main channel plus Basin B and H. Water here tends to be more saline, clear and high in pH and dissolved oxygen. Organics were low and other measurements were moderate. These stations are the most natural in the Harbor.

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

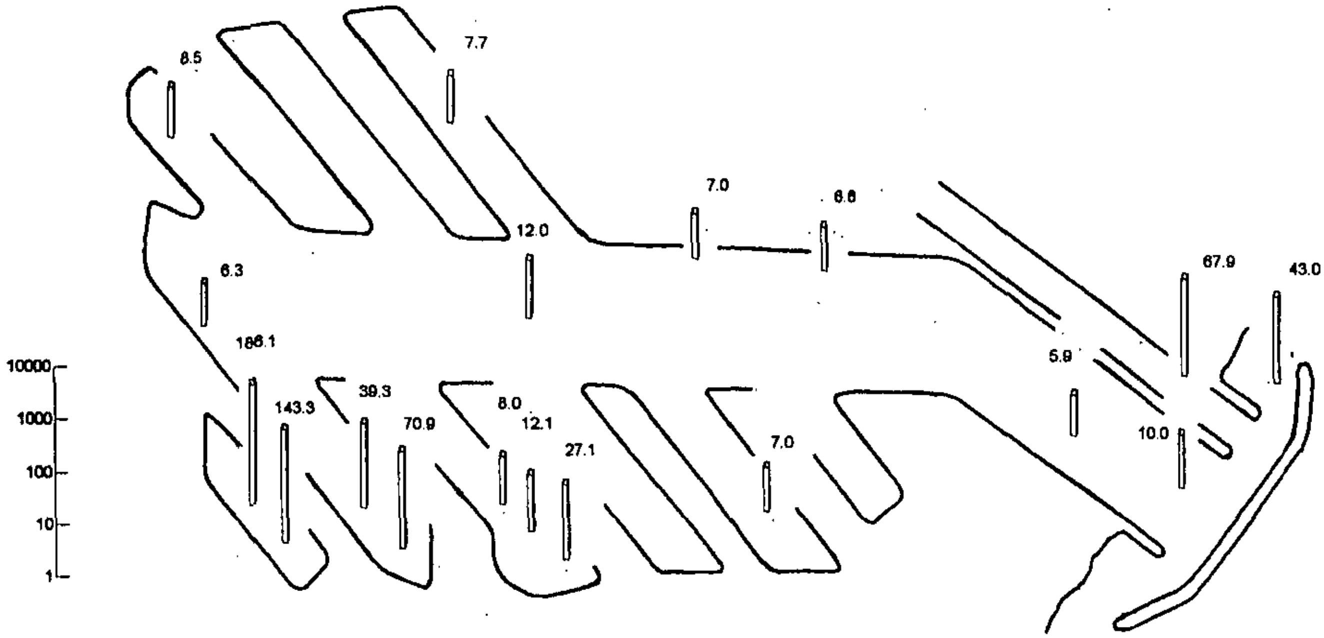


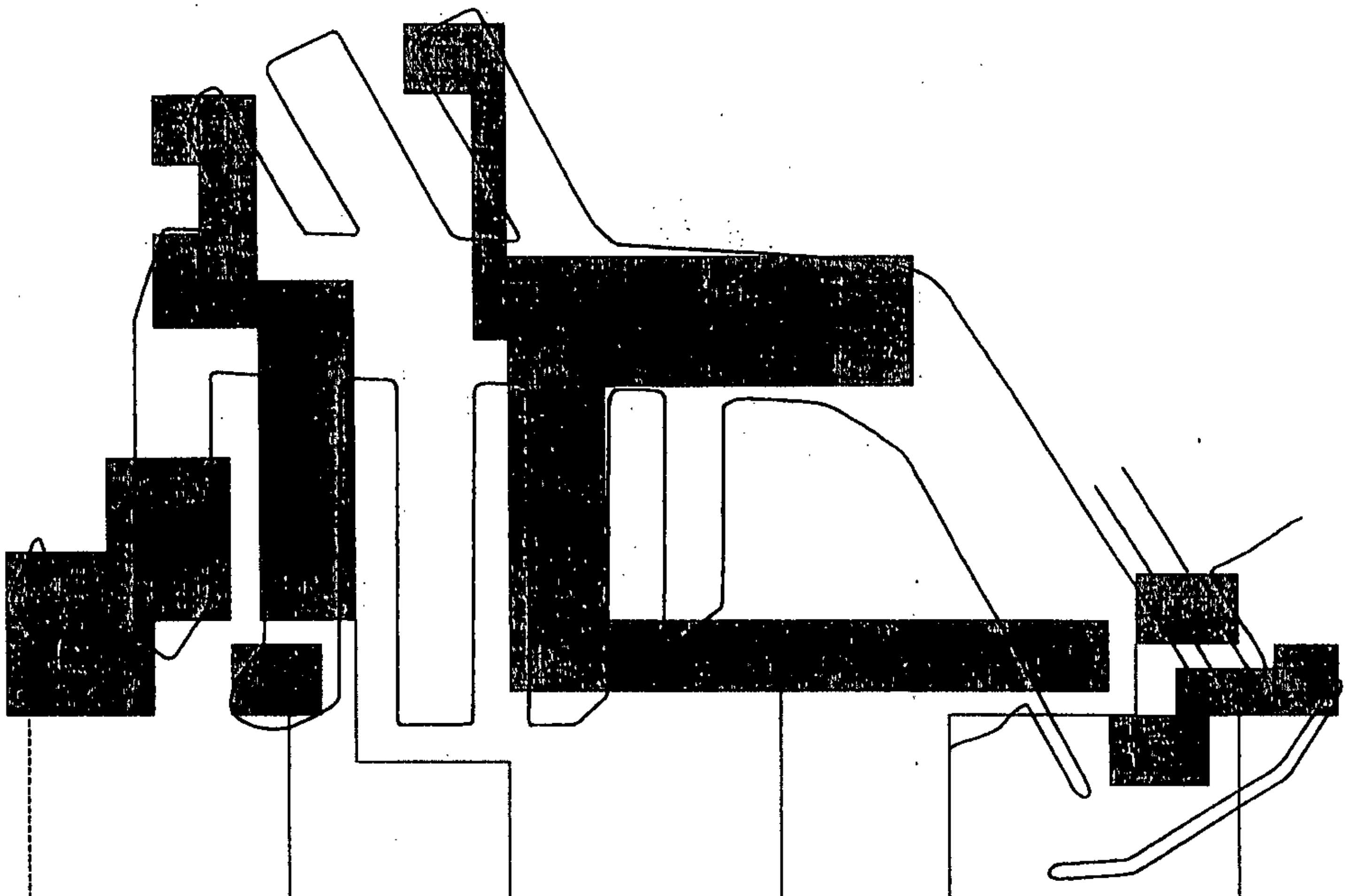
TABLE 3-13. FREQUENCY OF ENTEROCOCCUS VIOLATIONS (>104 MPN/100 ML) FOR ALL STATIONS.

Survey	Fall	Winter	Spring	Summer
1992-93	4	35	4	0
1993-94[1]	—	3	7	0
1994-95	0	0	0	2
1995-96	2	5	10	2
1996-97	2	8	1	1
1997-98	3	10	0	5
1998-99	10	14	9	3
1999-00	6	7	6	9
Overall range	**0 - 10**	**0 - 35**	**0 - 10**	**0 - 9**
2000-00[2]	18	12	7	0

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

[2] One month only in the summer.

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



Stations 10, 13, 20, 22

Relatively High in:
Temperature
Biochem. Oxygen Dem.
Total Coliform
Fecal Coliform
Enterococcus

Relatively Low in:
Salinity
Dissolved Oxygen
pH
Color
Surface Transparency

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

Station 19

Relatively High in:
Ammonia
Biochem. Oxygen Dem.

Relatively Low in:
Temperature
Salinity

Characteristics:
Typical of low circulation, back-harbor locations. Low salinity suggests freshwater influence.

Stations 8, 9, 11, 18

Relatively High in:
Temperature

Relatively Low in:
Light Transmissance
Surface Transparency
Ammonia
Fecal Coliform

Characteristics:
Fairly typical of back-harbor areas. Water is warm and relatively clear with low fecal coliform concentrations.

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

Relatively High in:
Dissolved Oxygen
Salinity
pH
Light Transmissance
Surface Transparency

Relatively Low in:
Biochem. Oxygen Dem.

Characteristics:
Typical of main channel water quality; clear, high in oxygen and pH, and low in oxygen demand.

Station 12

Relatively High in:
Dissolved Oxygen
pH
Color
Biochem. Oxygen Dem.
Total Coliform
Fecal Coliform
Enterococcus

Relatively Low in:
Temperature
Salinity
Ammonia

Characteristics:
Typical of Ballona Creek. Water is yellow-green-brown, cold and saline. Water is high in dissolved oxygen, pH, and oxygen demand. This area contributes organics and bacteria to the Harbor.

Stations 1, 2

Relatively High in:
Salinity
Dissolved Oxygen
pH
Light Transmissance
Color
Surface Transparency
Ammonia
Biochem. Oxygen Dem.
Total Coliform
Fecal Coliform
Enterococcus

Relatively Low in:
Temperature

Characteristics:
Highly influenced by Ballona Creek. High in bacteria, salinity, pH, dissolved oxygen and oxygen demand. Water is yellow green, clear and cold.

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

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

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

FECAL COLIFORM (>400 MPN/100 ML)

STATION	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	—	—	800	600	—	—	—	9,000	1,100	—	700	—
2	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	500	—	—	—
9	—	—	—	—	—	—	—	—	—	—	—	—
10	500	—	—	—	—	—	—	—	500	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—
12	500	700	800	900	—	—	1,100	5,000	16,000	—	—	—
13	—	—	—	—	—	—	—	1,100	—	—	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—
20	—	—	—	—	—	—	—	550	—	—	—	—
22	800	700	700	—	—	—	—	1,400	800	—	—	—
25	—	—	—	—	—	—	—	—	—	—	—	—

ENTEROCOCCUS (>104 COLONIES/100 ML)

STATION	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1	—	—	130	140	170	—	—	900	900	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	—
3	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	130	500	—	110	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	—	130	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—	—	—	—	—
9	—	—	140	—	—	—	—	—	—	—	—	—
10	—	—	—	130	—	—	—	130	500	—	—	—
11	—	—	—	—	—	—	—	—	—	—	—	—
12	—	—	—	900	500	—	140	1,600	≥ 1,600	—	—	—
13	140	130	1,600	220	130	—	130	1,600	300	—	—	—
18	—	—	140	—	—	—	—	—	—	—	—	—
19	500	—	—	—	—	—	—	—	—	—	—	—
20	—	—	350	130	—	—	170	240	900	—	—	—
22	—	170	—	240	500	500	240	1,600	900	—	—	—
25	—	—	—	—	—	—	—	—	170	—	—	—

Station 12. This station is in Ballona Creek. Water is yellow-green brown, cold, low in salinity and ammonia, high in pH, organics and all three types of bacteria but is well oxygenated. This area is also dominated by municipal drainage.

Stations 1 and 2. These stations are strongly influenced by both the flow from Ballona Creek and tidal flows from the open ocean. Ballona Creek influences include yellow to brown water and higher levels of BOD and all bacteria. The open ocean brings low temperature, clarity, high dissolved oxygen and pH.

3.4. DISCUSSION

As in past years, water quality in Marina del Rey Harbor this past survey was mostly impacted temporally by season and rainfall; and spatially impacted by proximity to Oxford Lagoon, Ballona Creek, and the Harbor entrance. Weather during 2000-2001 was similar to last year (Aquatic Bioassay 2000) and characterized by cooler water temperatures and relatively low rainfall. When rainfall did occur, however, numerous bacteriological, physical and chemical properties of the water column were affected. Winter and spring runoff lowered water clarity, salinity, and pH; and increased bacteria, ammonia and perhaps BOD. For all parameters, it should be noted that differences during the rainy seasons were very small. Slight red tide blooms were observed in June 2000 and strong blooms in July 2001. Temperature alone in the Harbor was more strongly affected by seasonal oceanographic trends than rainfall with characteristically low values in the winter and higher measurements in the summer and early fall.

Spatially, Harbor waters were strongly affected by tidal flow from the open ocean and drainage from Ballona Creek and particularly Oxford Lagoon. Both Ballona Creek and fresh tidal ocean water impact stations immediately adjacent to the entrance. Stations in the main channel, however, appeared to be mostly influenced by open ocean waters and were typically the most natural in the Harbor. Stations further from the entrance do not generally mix as well as channel stations; therefore, they are usually warmer and more saline, and lower in oxygen and pH.

Station 19 near Mother's Beach had moderate bacterial counts again this year. Stations surrounding Oxford Lagoon showed reduced salinity, dissolved oxygen, water clarity, and pH; and higher levels of ammonia, BOD, and bacteria. In addition, most measurements varied much more widely over the year. The open ocean and Ballona Creek effected Stations 1 and 2 this year, waters were more saline and clear but they were still high in bacteria, ammonia and nutrients as well as yellow to brown in color. Among 648 bacterial measurements, 83 violated standard water quality limitations. Among these, 68 (82%) could be attributable to drainage from either Ballona Creek or Oxford Lagoon. As we have stated in previous reports, the flows from these two areas directly impact the Harbor entrance, Basin E, and the upper end of the main channel. Half of the stations sampled during these surveys lie in these areas. Spatially, every variable we measured was influenced by these two sources of water, and their negative influence upon the water quality in the Marina overshadows all other impacts.

4. PHYSICAL CHARACTERISTICS OF BENTHIC SEDIMENTS

4.1. BACKGROUND

The benthos (bottom) of the marina is mostly composed of fine and very fine sediments, due in part to the historic nature of the Ballona wetlands that formed a large estuarine depositional area, and to the continuing influx and deposition of fine grained sediments carried into the marina through storm drains and tidal flux. During dry periods, the marina is a very low energy environment. Heavy rainfall and swiftly moving waters transport heavier, coarse materials to sea whereas fine grained sediments may be carried farther out into Santa Monica Bay in a plume. In dry weather, fine particles settle out in the low energy basins and in the main channel where flow from the basins meet. Extensive sediment build up in Basin E, adjacent to flow from Oxford Lagoon, broke up docks and moorings, but this was the only incident. 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. 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. Unfortunately, high levels of lead and results of toxicity tests preclude ocean disposal or use of this material for 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).

Some sand accumulation occurs due to winds from the northwest that brings sand from the beach north of the entrance channel. Littoral drift in spring and summer bring sand south 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, associated with storms with counter-current flow, and El Nino events. Rainstorms can carry sediments through Ballona Creek that are 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. Disturbances to the benthic community are quickly overcome, with temporary species composition changes. In 1987, 131,000 cubic yards were dredged from the tips of the jetty and Ballona Creek mouth. In 1992, 17,000 cubic yards were taken from the south side of the entrance. The ends of the breakwall and the Ballona Creek mouth had 57,000 cubic yards excavated 1994. The Harbor entrances and the outside of the northern jetty had 203,000 cubic yards removed in 1996. In 1998, 300,000 cubic yards were dredged from the north entrance, and in 1999-2000 – 530,000 cubic yards were removed from both entrances and the mouth of Ballona Creek. No dredge activity occurred in 2000-2001 surveys.

4.2. MATERIALS AND METHODS

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

Samples were collected on October 30, 2000 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 that have a very narrow distribution (very well sorted) to those which have a very wide distribution (extremely poorly sorted). This index is simply calculated as the 84^{th} percentile minus the 16^{th} percentile divided by two (Gray 1981). Well sorted sediments are homogeneous and are typical of high wave and current activity (high energy areas), whereas poorly sorted sediments are heterogeneous and are typical of low wave and current activity (low energy areas).

4.3. RESULTS

4.3.1. Particle Size Distribution

Figure 4-1 and Table 4-1 illustrate the overall particle size distributions from the fifteen sediment sampling stations. For both, results are presented for each size range as the percent of the whole. Two sediment characteristics can be inferred from the graphs. Position of the 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 3), then it is probable that the sediments will tend to be coarser overall.

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

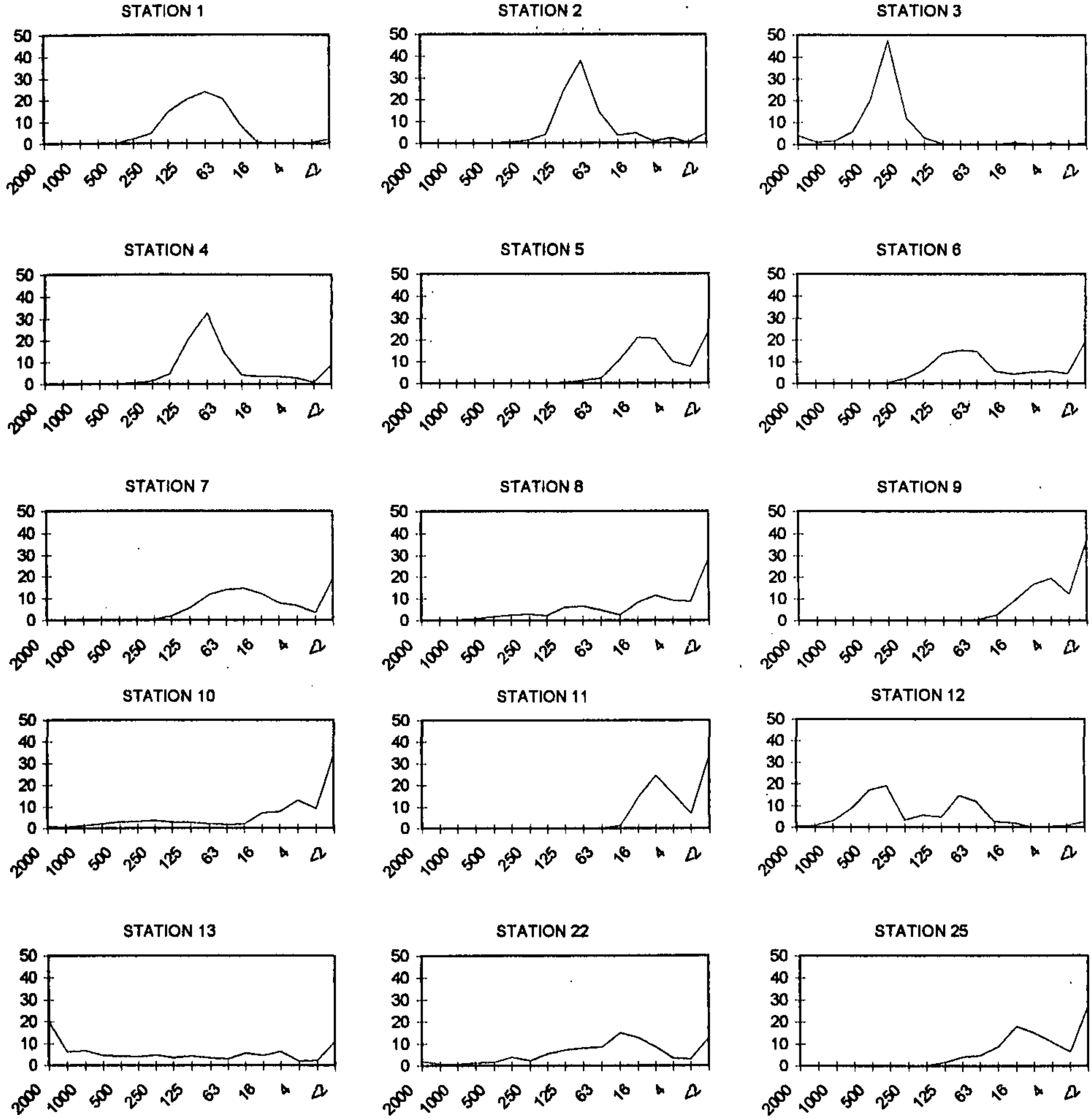


TABLE 4-1. PARTICLE SIZE DISTRIBUTIONS (PERCENTS) FROM 15 BENTHIC SEDIMENT STATIONS

	PARTICLE SIZE (MICRONS)																
	>2000	1414	1000	707	500	354	250	176	125	88	63	31	16	8	4	2	<2
STATION	granule	very course sand	very course sand	course sand	course sand	med sand	med sand	fine sand	fine sand	very fine sand	very fine sand	course silt	med silt	fine silt	very fine silt	clay	clay
1	0.1	0.1	0.2	0.2	0.2	2.4	4.7	14.4	20.3	23.9	20.7	8.8	0.7	0.1	0.1	0.7	2.3
2	0.0	0.1	0.1	0.2	0.4	0.6	1.5	4.0	24.2	38.2	14.1	3.6	4.7	0.8	2.4	0.5	4.7
3	4.3	1.2	1.7	5.7	20.6	47.8	11.8	3.2	0.5	0.2	0.1	0.1	1.1	0.1	0.8	0.1	0.9
4	0.2	0.1	0.2	0.3	0.5	0.6	1.5	4.6	20.4	32.8	14.5	4.2	3.6	3.6	2.9	1.0	9.1
5	0.0	0.0	0.0	0.1	0.1	0.2	0.1	0.3	0.6	1.3	2.3	10.8	21.2	20.8	9.9	7.7	24.6
6	0.0	0.1	0.0	0.1	0.2	0.5	2.4	6.3	13.9	15.5	15.0	5.8	4.6	5.3	5.8	4.7	19.9
7	0.0	0.0	0.0	0.1	0.1	0.4	0.4	2.0	5.8	11.9	14.1	14.8	12.2	8.0	6.7	3.5	19.9
8	0.0	0.3	0.5	1.0	1.8	2.6	3.0	2.5	6.2	6.7	4.8	2.7	8.6	11.7	9.3	9.0	29.3
9	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.3	0.6	2.6	9.6	16.8	19.6	12.4	37.7
10	0.9	0.7	1.4	2.2	3.2	3.4	3.8	3.0	2.9	2.2	1.9	1.9	7.5	7.9	13.2	9.4	34.4
11	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.4	0.4	0.3	1.6	14.6	24.6	16.0	7.1	34.5
12	1.0	1.0	3.1	8.6	17.2	19.2	3.6	5.7	4.8	14.8	12.1	2.6	2.2	0.1	0.4	0.8	2.8
13	20.2	6.5	6.9	4.8	4.5	4.2	5.0	3.8	4.5	3.5	3.1	5.8	4.8	6.4	2.1	2.5	11.5
22	2.1	0.8	1.0	1.3	1.7	4.0	2.4	5.6	7.3	8.4	8.7	15.1	13.1	8.7	3.6	3.2	13.1
25	0.1	0.0	0.1	0.1	0.1	0.1	0.3	0.4	1.8	4.3	4.8	8.9	18.1	15.2	10.9	6.8	28.0

TABLE 4-2. MEDIAN PARTICLE SIZES (MICRONS)[1] FROM 15 BENTHIC SEDIMENT STATIONS: OCTOBER 1990 TO OCTOBER 2000.

	STATION														
DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	22	25
Oct-90	100	<74	420	<74	<74	70	<74	<74	<74	<74	<74	430	>700	<74	<74
May-91	80	<74	<74	<74	<74	80	<74	<74	<74	<74	<74	300	450	<74	<74
Oct-91	<74	<74	<74	<74	<74	<74	<74	<74	<74	<74	<74	<74	160	<74	<74
Oct-92	300	110	<74	<74	<74	90	<74	<74	<74	<74	<74	330	220	<74	<74
Apr-94	340	90	370	<74	<74	80	<74	100	<74	<74	<74	200	>700	470	<74
Sep-94	90	90	360	<74	<74	<74	<74	<74	<74	<74	<74	100	700	210	<74
Oct-95	360	100	290	<74	<74	80	<74	<74	<74	<74	<74	430	260	160	<74
Oct-96	141	91	20	36	11	75	32	70	4	3	5	428	126	82	16
Oct-97	139	109	23	23	18	44	42	6	4	3	5	402	632	63	9
Sep-98	167	97	320	23	16	5	27	23	5	10	5	361	207	356	15
Oct-99	121	104	381	53	17	16	32	6	4	11	3	83	113	370	14
Oct-00	112	105	444	99	10	68	31	9	4	5	6	354	288	46	10

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

TABLE 4-3. SORTING INDEX VALUES[1] FROM 15 BENTHIC SEDIMENT STATIONS: OCTOBER 1996 TO OCTOBER 2000[2].

	STATION														
DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	22	25
Oct-96	0.88	1.40	3.16	2.88	2.44	3.11	2.84	3.44	2.28	3.01	2.32	0.62	5.20	4.47	2.88
Oct-97	0.77	0.87	3.80	2.87	2.62	3.19	2.89	3.66	2.14	3.41	2.36	1.48	2.72	3.29	2.93
Sep-98	1.01	1.48	2.96	2.86	2.87	3.29	3.08	3.53	2.65	4.89	2.69	2.70	3.96	3.56	2.98
Oct-99	0.58	0.87	0.62	2.79	2.68	3.52	3.33	3.44	2.18	4.13	1.92	2.28	3.58	2.99	2.51
Oct-00	0.82	0.75	0.52	1.73	2.40	3.47	3.11	3.79	2.30	4.35	2.47	1.57	4.18	2.92	2.91

[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.

If the peak is near the smaller micron sizes (Station 9), then it is probable that the sediments are mostly finer. Sediment medians, which range from 2000 to 63 microns, are defined as sand, sediments ranging from 63 to 4 are defined as silt, and sediments that are 4 or less are defined as clay (Wentworth Sediment Scale, see Gray 1981). Each category is also subdivided 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 3). Others, which have a wide range of sizes (Station 13), are considered to be heterogeneous or poorly sorted. The graphs in Figure 4-1 indicate that sediments near the Harbor entrance (1, 2 and 3) tended to be relatively coarse and homogeneous in composition. One Station within Oxford Lagoon (Station 13) also tended to be coarse but was relatively heterogeneous in composition. Most other stations in the Harbor tended to be finer and relatively heterogeneous.

4.3.1.1. Median Particle Size

Spatial particle size patterns. Median particle sizes are depicted in Figure 4-2 (note that the scale is logarithmic) and listed as the last line of Table 4-2. The lowest median particle sizes (4-10 microns – fine silt to clay) were at Station 5 in mid channel, Station 8 in Basin D, Station 9 in Basin F, Station 10 in Basin E, Station 11 at the end of the Harbor channel and Station 25 in mid channel. These stations are relatively far from the entrance and probably have very low current velocities. The largest median particle sizes were at Stations 1, 2, 3 and 4 nearer the Harbor entrance (99 to 444 microns), at Station 12 in Ballona Creek (354 microns), and Station 13 in Oxford Lagoon (288 microns) (all very fine sand to medium sand). These stations likely have the highest current velocities of the Harbor. Remaining stations had sediments, which were more moderate in median particle size (46 to 68 microns – very fine sand).

Particle size ranges compared with past years. Table 4-2 lists the median particle sizes per station from October 1990 through October 2000. In surveys previous to 1996, measurements were made only through the sand ranges. When values were in the range of silts or clays, less than 74 microns was reported. Largest changes in particle size were at Station 22 in Oxford Lagoon (a shift from medium sand to coarse silt), Stations 12 and 13 (a shift from very fine sand to medium sand) and Station 6, in Basin B (medium silt to very fine sand). These increased changes may be due to slightly higher rainfall this year compared to 1999. 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, 2, and 3 near the Harbor entrance (0.5 to 0.8 – moderately well sorted to well sorted) were the most homogeneous. Station 10 in Basin E and Station 13 in Oxford Lagoon (4.3 and 4.2, respectively – extremely poorly sorted) were the most heterogeneous.

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

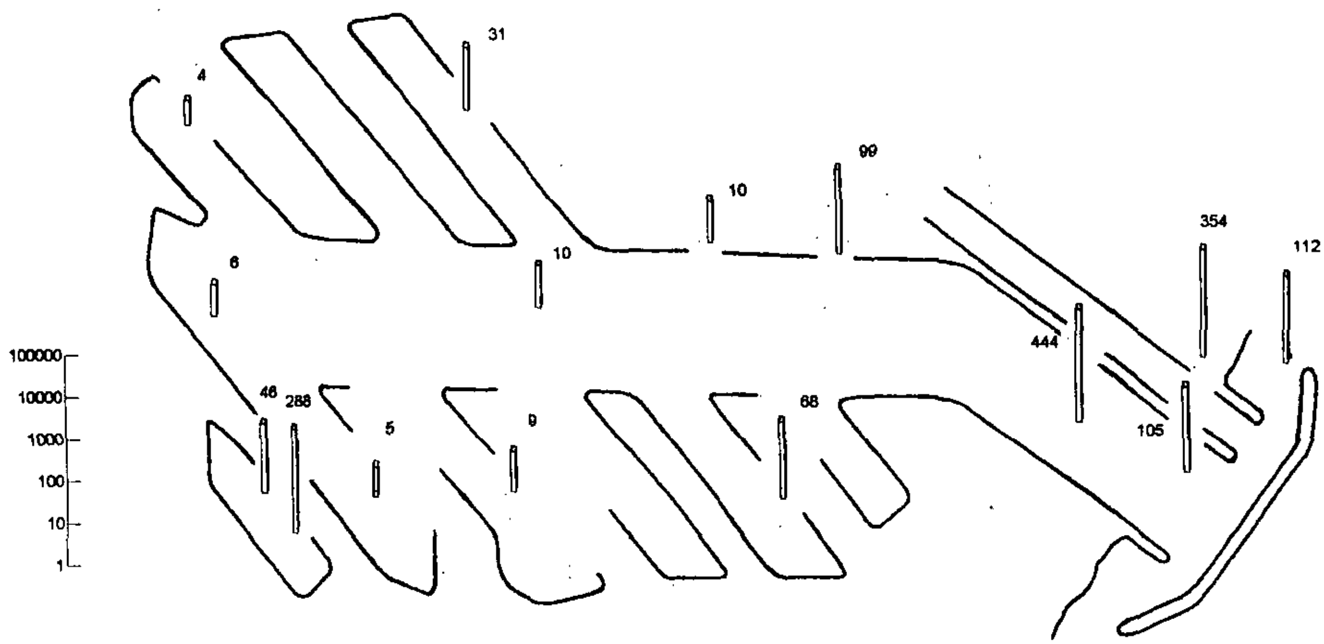
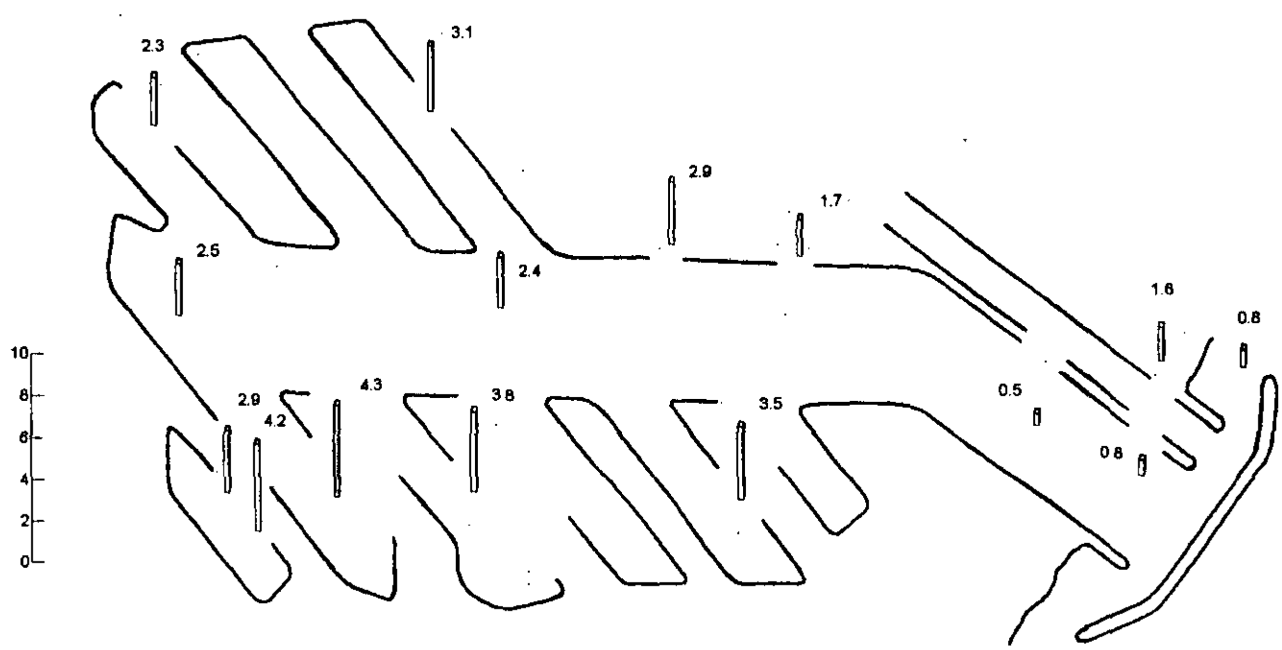


FIGURE 4-3. SORTING INDEX VALUES AT 15 BENTHIC SEDIMENT STATIONS.



The remaining stations were between 1.6 and 3.8 (poorly sorted to very poorly sorted). As a rough general rule, high-energy area sediments (i.e. Harbor entrance) tend to have larger median particle sizes and more homogeneous sediments than low energy areas (Harbor channels and basins). The exceptions to this are Station 13 in Oxford Lagoon, which had relatively large median particle size but was sorted very poorly. It is probable that this area has both periods of high velocity currents, as well as periods of relative quiescence.

Sorting index ranges compared with past years. Sorting indices could not be calculated for surveys previous to 1996 because the ranges measured were too narrow. Sorting index values this year (0.5 to 4.3) indicate that sediments tended to be slightly more homogeneous overall than during the past four years (0.8 to 5.2).

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

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

Station 13 (Oxford Lagoon). The median particle size was the second coarsest in the Harbor (medium sand). Additionally, the distribution was the second most heterogeneous (extremely poorly sorted). This area may have periods of both high and low water velocity.

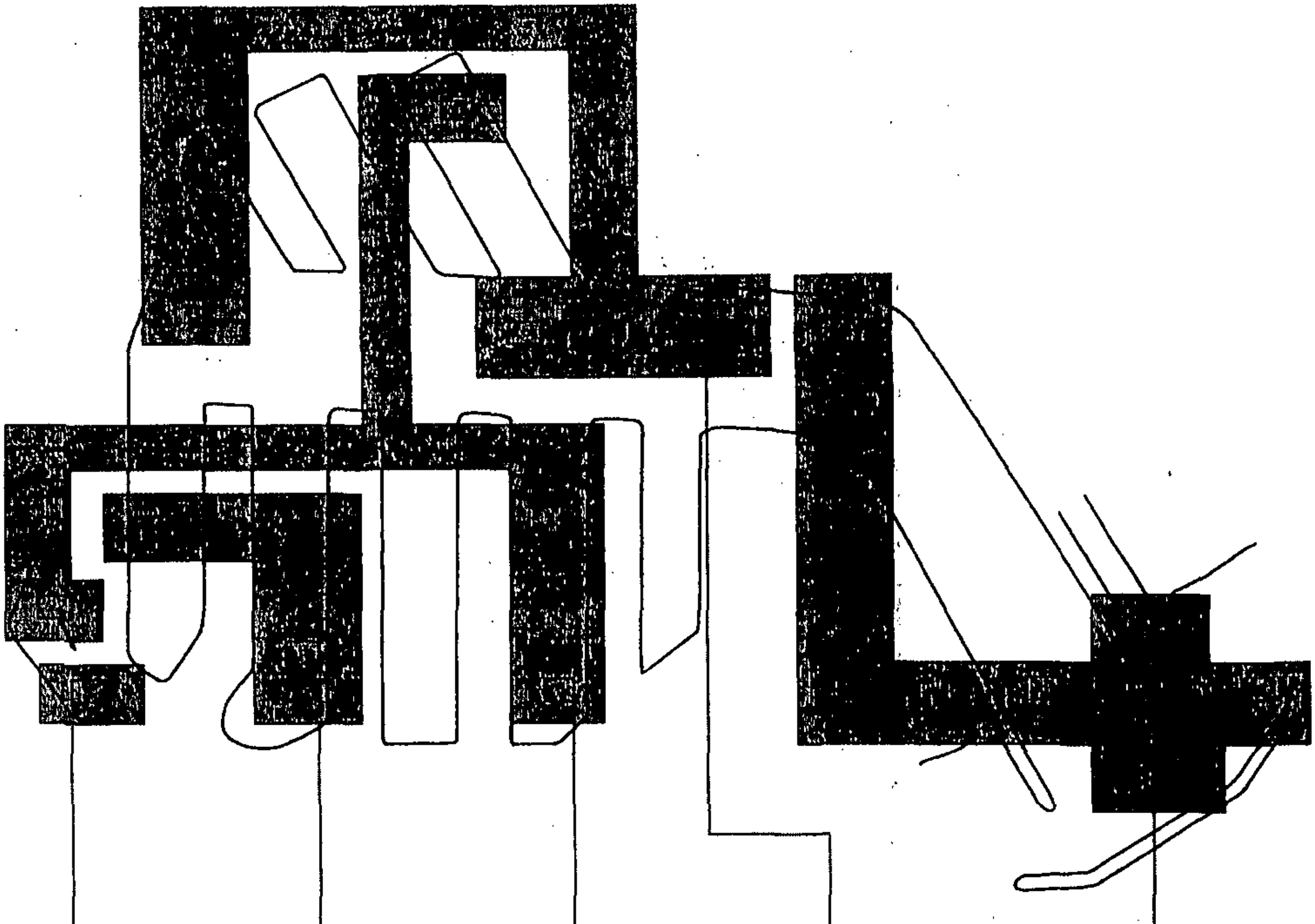
Stations 8 and 10 (Basins D and E). These sediments were also very heterogeneous (very poorly sorted to extremely poorly sorted), and the median particle size was fine (very fine silt to fine silt). These stations are located near the ends of Basins D and E and likely experience little disturbance so finer particles can accumulate.

Stations 6, 7 and 22 (Basins B and H and Oxford Lagoon). The grain size distribution at these stations was moderately heterogeneous compared to the other groups. The median particle size was also moderate. These stations likely have relatively low current velocities.

Stations 5, 9, 11 and 25 (upper, mid and back channel and Basin F). These sediments are among the finest in the Harbor (very fine silt to fine silt) and moderate in distribution (very poorly sorted). Current velocities at these stations are probably also moderate.

Stations 1, 2, 3, 4 and 12 (Ballona Creek, Harbor entrance and upper channel). Sediments here were the most homogeneous (poorly sorted), and the median grain size was the second coarsest in the Harbor (very fine sand to medium sand). This group of stations likely encounters nearly continuous strong water movement.

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



	Station 13	Stations 8, 10	Stations 6, 7, 22	Stations 5, 9, 11, 25	Stations 1, 2, 3, 4, 12
Median grain size:	Medium sand.	Very fine silt to fine silt.	Coarse silt to very fine sand.	Very fine silt to fine silt.	Fine sand to medium sand
Sorting:	Extremely poorly sorted.	Extremely poorly sorted.	Very poorly sorted.	Very poorly sorted.	Poorly sorted.
Characteristics:	This station contains the coarsest sediments in the Harbor. The grain size *distribution is the most* heterogeneous.	These stations contain some of the finest sediments in the Harbor. *The grain size distribution* is the second most heterogeneous.	These stations contain second finest sediments in the Harbor. The grain size *distribution is moderately* heterogeneous.	These stations contain finest sediments in the Harbor. The grain size *distribution is moderate.*	These stations contain the second coarsest sediments in the Harbor. *The grain size distribution* is the most homogeneous.

4.4. DISCUSSION

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

Based upon physical characteristics this year, Harbor sediments in most basins and the main channel are relatively fine (silt) but have a wide range of values. Areas with the narrowest ranges of sediments include those with the coarsest sediments (sand - Ballona Creek and the Harbor entrance). Usually both stations in Oxford Lagoon defy this concept. This year, only Station 13 had a coarse grain size (sand) and high heterogeneity. Station 22 had finer sediments and moderate heterogeneity. Station 22 might experience more dry weather flows than Station 13.

5. CHEMICAL CHARACTERISTICS OF BENTHIC SEDIMENTS

5.1. BACKGROUND

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

Ballona Creek Flood Control Channel is a notable source of visible debris: most especially fast food containers, plus plastic grocery sacks, milk bottles and beverage cans, motor oil containers, and garden debris tossed into storm drains or the channel. Often there is a collection of balls ranging from ping-pong and tennis to soccer and basketball sizes that attest to the route through storm drains. During dry weather low flow conditions; contaminated water and sediments accumulate in storm drains and channels, while during rainy seasons these contaminants are carried seaward. Part of the Ballona Creek flow is reflected off the breakwater, enters the marina, and move inward on rising tides. Station 12, in Ballona Creek; generally has a medium to high ranking with regard to contaminants (Soule and Pieper 1996).

Because the basins are very low energy environments (see Section 4), fine sediments settle out there, sometimes carrying heavy contaminant loads. The inner end of the main channel (Station 11) and adjacent Basins E and F (Stations 10 and 9) are particularly prone to contamination. Station 5, in mid-main channel, is also surprisingly contaminated, probably due to settling (shoaling) where flows from the basins meet in the main channel under low flow conditions. In very wet seasons, sediments from the basins may be carried farther due to heavy stormwater runoff, sometimes to the bend into the entrance channel, sometimes to the sandbar at the entrance. Flow from Ballona Creek and the Marina entrance channel meet where waves and tidal influx may slow the seaward progression of sediment-laden waters, resulting in deposition. Oxford Flood Control Basin is a sump for street drainage, from the community north and east of the marina, draining into Basin E through a tide gate. Severe flooding has occurred along Washington Street, flooding houses and floating cars, and a new pumping station was built in Oxford Basin in 1994-1995 to ameliorate that, but if the tide is high during a storm, drainage into the marina through the tide gate is inadequate to clear the streets. A new tide gate is planned (Soule and Pieper, 1996).

Soils in some adjacent industrial areas are known to have high levels of contamination, with erosion during storms carrying sediments into the basin and into the marina. During dry weather flow, runoff is not extreme and sediments tend to settle out in the basin. Rank growth of weeds and brush can add to the debris accumulation. Tidal flow also may result in deposition in Oxford basin when marina waters contain suspended sediments that may be deposited at slack tide. Station 13 tends not to be highly contaminated when velocity of flow is relatively high, which is further enhanced by the narrow tide gate; similarly, at Station 22 contamination varies depending on the amount and timing of rainfall during the previous or current rainfall season (Soule and Pieper, 1996).

5.2. MATERIALS AND METHODS

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

5.3. RESULTS

Table 5-1 lists all of the chemical constituents measured in the 15 benthic sediment stations. These compounds have been separated here into four main groups: 1) heavy metals, 2) chlorinated pesticides and polychlorinated biphenyls (PCB's), 3) simple organics, and 4) minerals and other compounds. Table 5-2 compares the ranges of the current survey with all surveys undertaken since October of 1988. 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 10^{th} percentile and median (50^{th}) percentile were identified. The lower 10^{th} percentile in the data was identified as an Effects Range-Low (ER-L) and the median was identified as an Effects Range-Median (ER-M). A third index was listed in the document as well, the Apparent Effects Threshold (AET). An AET concentration is the sediment concentration of a selected chemical above which statistically significant biological effects always occur, and, therefore, are always expected (PTI Environmental Services, 1988). AET values are somewhat similar in range to ER-M values, but individually may be higher or lower. In 1995, the list was revised (Morgan, et. al. 1995), and

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

	STATION															
COMPOUND	1	2	3	4	5	6	7	8	9	10	11	12	13	22	25	**MEAN**
Heavy Metals (ppm)																
Arsenic	<3	4.2	7.4	5.7	6.0	7.0	5.9	8.6	11.2	13.5	10.9	5.7	4.5	9.6	9.0	**7.28**
Cadmium	0.25	0.53	0.03	0.30	0.29	0.19	0.20	0.26	0.56	0.89	0.33	0.24	0.14	0.27	0.85	**0.355**
Chromium	12	19	6	21	32	27	25	34	38	33	44	16	16	24	46	**26.10**
Copper	7	20	8	62	164	182	151	307	167	147	420	24	41	32	223	**130.29**
Iron	8200	12900	4900	14300	21900	21600	21100	27800	28400	32000	37000	8800	13800	17100	28300	**19873**
Lead	46	64	18	67	105	61	63	76	105	88	103	43	113	26	155	**75.5**
Manganese	84	115	44	123	176	150	171	208	239	236	264	80	156	127	223	**159.7**
Mercury	0.045	0.110	0.028	0.170	0.440	0.680	0.330	0.690	1.650	0.650	0.590	0.059	0.069	0.043	0.410	**0.3976**
Nickel	7.0	12.4	4.0	11.2	16.6	14.9	14.3	17.8	22.6	19.2	29.5	8.2	11.6	18.1	20.6	**15.20**
Selenium	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	**0.00**
Silver	0.25	0.77	0.11	1.07	1.71	0.69	0.71	0.76	1.24	0.53	1.38	0.63	0.11	0.10	2.50	**0.8375**
Tributyl Tin	<0.002	<0.002	<0.002	0.002	<0.002	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	**0.001**
Zinc	53	108	29	134	219	194	190	320	245	252	390	80	256	97	340	**193.8**
Pesticides & PCB's (ppb)																
p,p' DDD	<0.5	5.0	<0.5	1.0	3.0	<0.7	1.0	<0.8	<1.0	2.0	1.0	5.5	3.0	<0.5	3.0	**1.63**
p,p' DDE	2.0	7.0	<0.5	5.0	9.0	2.0	4.0	<0.8	6.0	10.0	4.0	5.1	9.4	<0.5	14.0	**5.17**
p,p' DDT	<0.5	4.0	<0.5	<0.6	<0.9	<0.7	<0.7	<4.0	<5.0	<5.0	<5.0	<3.0	<4.0	<3.0	<4.0	**0.27**
All DDT & Derivatives	**2.0**	**16.0**	**0.0**	**6.0**	**12.0**	**2.0**	**5.0**	**0.0**	**6.0**	**12.0**	**5.0**	**10.6**	**12.4**	**0.0**	**17.0**	**7.07**
Delta BHC	<0.3	<0.3	<0.3	<0.3	<0.4	<0.3	<0.3	<0.4	<0.5	<0.4	<0.5	<0.3	<0.3	<0.3	<0.4	**0.00**
Alpha Chlordane	0.8	3.6	<0.3	<0.3	<0.4	<0.3	<0.3	<0.4	<0.5	<0.4	<0.5	3.5	2.0	<0.3	2.0	**0.79**
Gamma Chlordane	1.0	3.8	<0.3	<0.3	<0.4	<0.3	<0.3	<0.4	<0.5	<0.4	<0.5	4.6	2.0	<0.3	3.0	**0.96**
Dieldrin	<0.5	<0.6	<0.5	<0.6	<0.9	<0.7	<0.7	<0.8	<1.0	<0.9	<0.9	<0.5	<0.6	<0.5	<0.9	**0.00**
Endosulfan I	<0.3	<0.3	<0.3	<0.3	<0.4	<0.3	<0.3	<0.4	<0.5	<0.4	<0.5	<0.9	<0.3	<0.3	<0.4	**0.00**
Endrin Aldehyde	<0.5	<0.6	<0.5	<0.6	<0.9	<0.7	<0.7	<0.8	<1.0	<0.9	<0.9	<3.0	<0.6	<0.5	<0.9	**0.00**
Endrin Ketone	<0.5	<0.6	<0.5	<0.6	<0.9	<0.7	<0.7	<0.8	<1.0	<0.9	<0.9	<3.0	<0.6	<0.5	<0.9	**0.00**
All Non-DDT Pesticides	**1.8**	**7.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**8.1**	**4.0**	**0.0**	**5.0**	**1.75**
PCB's	**<10**	**<10**	**<10**	**<20**	**<20**	**<20**	**<20**	**<20**	**<30**	**<20**	**<20**	**110**	**<10**	**<10**	**<20**	**7.33**
Organic Content																
Tot. Organic Carbon (%)	0.300	1.600	0.190	1.300	1.500	0.690	0.880	0.980	2.300	1.400	1.400	0.810	1.100	0.720	3.100	**1.2180**
Volatile Solids (%)	2.3	3.1	2.0	3.1	2.0	2.7	4.4	5.0	6.2	5.7	5.8	2.4	5.4	2.9	5.2	**3.88**
Immed. Oxy. Dmd. (%)	0.01	ND	ND	ND	ND	ND	ND	ND	ND	3.11	2.37	1.08	1.48	1.22	ND	**0.618**
Chem. Oxygen Dmd. (%)	1.94	3.00	1.60	3.24	3.42	2.69	3.01	3.68	5.27	4.82	4.38	2.45	2.17	2.23	8.61	**3.501**
Oil and Grease (ppm)	136	177	73	282	80	120	190	63	<10	<10	<10	452	1510	94	463	**242.7**
Organic Nitrogen (ppm)	77	27	<16	<16	27	<16	183	<16	<16	<16	<16	<16	<16	<16	52	**24.4**
Ortho Phosphate (ppm)	34	54	3	20	52	20	35	22	38	18	33	37	25	38	33	**30.8**
Sulfides (ppm)	228	480	155	50	437	295	482	947	<1.0	1080	622	158	153	368	1130	**439.0**
Minerals, etc. (ppm)																
Moisture (%)	24.0	32.7	22.4	37.9	53.4	40.1	40.4	50.3	61.3	55.3	56.3	23.2	30.5	26.6	54.0	**40.55**
Spec. Cond. (mmhos/cm)	12600	18200	12000	8040	14200	11800	8320	10300	16100	13200	11000	12000	9280	8400	13300	**11916**
Alkalinity as CaCO3	237	713	219	370	365	317	336	362	336	1500	411	352	345	245	4240	**689.9**
Hardness as CaC03	1510	1770	1700	1130	1220	1840	1330	2210	1370	1970	1710	1210	1970	422	1350	**1514**
Total Dis. Solids (%)	10400	20400	12000	12900	22400	19700	13200	17300	27700	22700	25300	13200	16500	31900	11000	**18440**
Barium	23	33	58	34	67	43	61	65	107	105	105	29	49	59	74	**60.8**
Boron	4.4	12.0	3.5	12.4	14.1	15.1	13.2	15.8	17.9	16.1	16.3	7.7	13.1	7.5	19.6	**12.58**
Calcium	10000	11100	15000	15900	8200	6600	7500	7500	9200	8300	7100	6500	2560	1790	15100	**8823**
Chloride	5990	9240	5150	9350	19900	12800	12700	19200	27400	23700	22900	5310	10100	8230	20300	**14151**
Fluoride	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	**0.00**
Nitrogen	258	229	126	158	421	164	259	197	325	219	224	200	101	324	152	**223.8**
Nitrate	1.21	2.15	0.59	1.85	2.06	1.35	1.56	0.8	1.11	0.67	0.62	2.86	1.76	1.77	1.8	**1.48**
Potassium	1250	1890	490	2240	4700	3800	4500	5500	6300	7100	7800	1460	2630	3600	5400	**3911**
Sulfate	832	1210	724	1350	2920	1940	1880	2900	4080	3630	3250	739	1390	1200	3020	**2071**
Sodium	4400	7100	2590	7700	13200	10800	9900	13200	16200	14400	15900	4600	5900	5800	13600	**9686**

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

COMPOUND	October 1988[1]	October 1989[2]	October 1990[3]	May 1991	October 1991	October 1992	April 1994	September 1994	October 1995	October 1996	October 1997	October 1998	September 1999	**Overall Range**	October 2000
Metals (ppm)															
Arsenic	1.86 - 12.0	1.13 - 11.3	2.99 - 13.80	2.62 - 10.54	2.22 - 5.51	1.81 - 12.60	2.44 - 19.8	2.86 - 11.2	3.56 - 11.8	2.5 - 11.5	3.2 - 15.0	2.2 - 12.6	2.5 - 13.1	**1.13 - 19.8**	<3 - 13.5
Cadmium	0.19 - 1.10	<0.26 - 2.12	0.32 - 2.13	0.43 - 5.54	<0.63 - 3.0	0.13 - 2.22	<0.2 - 2.93	<2.8 - 1.14	<0.31 - 1.23	0.226 - 1.470	0.24 - 1.56	0.20 - 1.18	0.19 - 1.32	**0.13 - 5.54**	0.03 - 0.89
Chromium	7.2 - 70.5	4.68 - 65.2	6.78 - 69.80	16.5 - 67.8	12.5 - 57.9	8.73 - 72.6	5.74 - 67.5	11.9 - 81.7	15 - 83.3	17.0 - 81.1	17 - 70	14 - 86	12.5 - 84.0	**4.68 - 86**	5.9 - 46
Copper	6.8 - 342	8.19 - 333	10.4 - 399	24 - 348	13.8 - 455	5.50 - 322	6.55 - 339	25.3 - 402	29.4 - 380	10.6 - 346.0	9 - 390	8 - 320	7.8 - 450	**5.50 - 455**	6.9 - 420
Iron[5]	4.16 - 50.1	3.21 - 47.1	3.84 - 71.5	14.4 - 62.8	8.27 - 63.2	5.7 - 49.6	3.36 - 51.80	6.40 - 49.8	7.3 - 49.6	14.7 - 59.8	12 - 50	11.5 - 54.0	9 - 59	**3.21 - 71.5**	4.9 - 37
Lead	25.4 - 206	17.0 - 305	7.95 - 325	41.3 - 575	62.2 - 487	22.90 - 372	12.50 - 427	32.3 - 413	54.3 - 295	45.8 - 292.0	40 - 250	40 - 380	28.8 - 198	**7.95 - 575**	18 - 155
Manganese	36 - 276	27.5 - 283	30.3 - 273	147 - 315	86.3 - 263	63.1 - 279	26.20 - 292	52.2 - 328	74.6 - 315	117 - 366	125 - 330	115 - 340	64 - 360	**26.2 - 366**	44 - 264
Mercury	0.11 - 1.70	<0.12 - 0.92	<0.10 - 1.08	<0.07 - 1.2	<0.09 - 0.94	<0.10 - 2.8	<0.09 - 1.01	0.11 - 0.97	<0.09 - 0.92	0.064 - 0.903	0.08 - 1.40	0.03 - 0.81	0.04 - 0.96	**0.03 - 2.8**	0.03 - 1.65
Nickel	4.0 - 37.4	3.88 - 36.4	4.18 - 41.20	12 - 43.2	8.02 - 32.0	4.91 - 37.3	3.67 - 39.40	7.14 - 58.1	7.54 - 41.1	8.57 - 66.90	10 - 210	6.5 - 28.2	7.5 - 31.4	**3.67 - 210**	4.0-30
Selenium	—	—	—	—	—	—	—	<0.14 - 2.35	<0.47 - 0.99	0.30 - 1.80	0.4 - 2.4	<1 - 1.9	—	**<0.14 - 2.4**	<2
Silver	—	—	—	—	—	—	—	—	—	0.280 - 2.720	0.20 - 3.50	0.10 - 2.22	0.16 - 2.58	**0.10 - 3.50**	0.10 - 2.50
Tributyl Tin	<0.01 - 5.57	<0.1 - 0.4	<0.03 - 0.52	<0.01 - 0.44	<0.02 - 0.53	<0.003 - 2.2	<0.04 - 0.34	0.05 - 0.88	0.08 - 3.04	0.005 - 0.023	<0.002 - 0.014	<0.002 - 0.010	<0.002 - 0.01	**<0.002 - 5.57**	<0.002-0.004
Zinc	42.6 - 435	20.3 - 444	28 - 491	102 - 640	55.8 - 624	27.0 - 523	20.30 - 647	55.3 - 446	87.9 - 455	61.3 - 440.0	55 - 480	36 - 500	41 - 450	**20.3 - 647**	29 - 390
Chlor. Hyd. (ppb)[6]															
p,p' DDD	<4 - 66.7	2 - 40	4 - 100	<4 - 15	<4 - 23	<4 - 36	<4 - 40	8 - 47	<4 - 70	<0.5 - 6.6	<0.5 - 5.0	<0.5 - 18.0	<0.5 - 4.0	**<0.5 - 100**	<0.05 - 5.5
p,p' DDE	<4 - 189	<4 - 77	<4 - 104	3.5 - 110	3 - 67	<4 - 169	<4 - 94	11 - 63	<4 - 60	4.0 - 16.0	3.0 - 23.0	<0.05 - 2.0	1.0 - 9.5	**<0.05 - 189**	<0.5 - 14
p,p' DDT	<4 - 29.1	4 - 200	<4 - 29	<4 - 14	<4 - 48	<4 - 56	<4 - 86	<4 - 49	<4 - 60	<0.4 - 12.0	<1.0	<0.6 - 12.0	<0.5 - 5.0	**<0.4 - 200**	<0.5 - 4.0
Alpha-Chlordane	—	—	—	—	—	—	—	—	—	<0.1 - 6.6	<0.5	<0.3 - 8.3	<0.3 - 3.9	**<0.1 - 6.6**	0.8 - 3.6
Gamma-Chlordane	—	—	—	—	—	—	—	—	—	<0.2 - 7.7	<0.3 - 8.1	<0.4 - 11.0	<0.3 - 6.2	**<0.2 - 11.0**	1.0 - 4.6
Chlordane[7]	13.5 - 283	<20 - 630	10 - 410	<20 - 360	31 - 436	<20 - 270	<20 - 167	<20 - 109	<20 - 380	<0.1 - 14.3	<0.3 - 8.1	<0.3 - 19.3	<0.3 - 9.8	**<0.1 - 630**	0.8 - 8.1
Dieldrin	<1.0	<1.0 - 30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.5 - 2.0	<0.5 - 2.0	**<0.5 - 30**	<0.5 - <1.0
Endrin Aldehyde	<2	<2	<2	<2	<2	<2	<2	<2	<2	<0.6 - 2.0	<0.5 - 9.0	<0.6 - 6.6	<0.5 - 2.0	**<0.5 - 9.0**	<0.5 - <3.0
Heptachlor Epoxide	<1	<1	<1	<1	<1	<1	<1	<1	<1	<0.2 - 2.0	<0.3 - 1.0	<0.2 - 3.9	<0.4	**<0.2 - 3.9**	<0.3 - <0.5
Heptachlor	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 0.3	<0.4	**<0.2 - 0.3**	<0.3 - <0.5
Aldrin	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 0.6	<0.4	**<0.2 - 0.6**	<0.3 - <0.5
Methoxychlor	—	—	—	—	—	—	—	—	—	—	—	<2.0 - 6.5	<4	**<2.0 - 6.5**	<3 - <50
Endosulfan I	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 2.0	<0.3 - 3.0	**<0.2 - 3.0**	<0.3 - <0.9
Endosulfan II	—	—	—	—	—	—	—	—	—	—	—	<0.5 - 3.0	<0.7	**<0.5 - 3.0**	<0.5 - <3.0
Endosulfan Sulfate	—	—	—	—	—	—	—	—	—	—	—	<0.5 - 2.0	<0.7	**<0.5 - 2.0**	<0.5 - <1.0
Endrin Ketone	—	—	—	—	—	—	—	—	—	—	—	<0.5 - 4.0	<0.5 - 1.0	**<0.5 - 4.0**	<0.5 - <3.0
Alpha-BHC	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 0.4	<0.4	**<0.2 - 0.4**	<0.3 - <0.5
Delta-BHC	—	—	—	—	—	—	—	—	—	—	—	—	<0.3 - 0.4	**<0.3 - 0.4**	<0.3 - <0.5
Gamma-BHC	—	—	—	—	—	—	—	—	—	—	—	<0.2 - 1.0	<0.4	**<0.2 - 1.0**	<0.3 - <0.5
Tot. Non-DDT Pest.	—	—	—	—	—	—	—	—	—	0.5 - 15.2	<0.9 - 13.6	2.0 - 31.7	<0.3 - 14.7	**<0.3 - 31.7**	<0.3 - 8.2
Arochlor 1254	—	<50 - 330	<50 - 153	—	—	—	<50 - 110	<50 - 231	<50 - 90	<10 - 100	<20	<10 - <20	<10 - <20	**<10 - 330**	<10 - 110
Arochlor 1260	<50	<50 - 200	<50 - 172	<50 - 300	<50	<50 - 90	<50	<50	<50	<20	<20	<10 - <20	<10 - <20	**<10 - 300**	<10 - <30
Organics (ppm)															
Tot. Org. Carbon (%)	0.51 - 4.17	0.28 - 8.07	0.52 - 4.71	1.18 - 4.58	0.88 - 6.45	0.46 - 5.43	0.50 - 4.9	1.2 - 4.7	0.6 - 3.3	0.46 - 3.9	0.23 - 2.31	0.41 - 1.14	0.33 - 2.4	**0.23 - 8.07**	0.19 - 3.1
Volatile Solids (%)	0.88 - 7.19	0.84 - 13.91	1.3 - 11.78	2.96 - 11.45	2.22 - 16.12	1.13 - 13.58	1.20 - 12.2	2.94 - 11.72	1.47 - 8.26	0.8 - 11.0	0.6 - 4.0	0.7 - 3.7	1.3 - 7.5	**0.6 - 16.12**	2.0 - 6.2
Immed. Ox. Dmd.(%)	0.002 - 0.03	0.001 - 0.05	0.001 - 0.04	0.002 - 0.04	0.003 - 0.06	<0.001 - 0.04	<0.001 - 0.03	0.003 - 0.05	0.001 - 0.04	0.13 - 1.3	1.3 - 2.0	0.016 - 0.68	0.07 - 4.0	**<0.001 - 4.0**	ND - 3.1
Chem. Ox. Dmd.(%)	0.83 - 8.76	0.244 - 21.56	0.677 - 15.31	3.44 - 12.0	1.55 - 18.63	0.314 - 16.50	0.268 - 15.40	0.86 - 17.1	2.04 - 7.98	0.73 - 8.0	0.49 - 4.12	0.43 - 6.72	0.37 - 6.4	**0.24 - 21.56**	1.6 - 8.6
Oil and Grease	*500 - 3500*	*390 - 11070*	*360 - 4860*	*1280 - 7300*	*1080 - 8700*	*227 - 4160*	*508 - 9200*	*800 - 6760*	*520 - 2840*	30 - 350	40 - 360	3 - 140	<30 - 1500	**3 - 11070**	<10-1510
Organic Nitrogen	135 - 1840	380 - 4770	235 - 4125	1060 - 3125	334 - 4910	105 - 4010	110 - 3180	452 - 2960	692 - 1940	120 - 1400	120 - 1499	37 - 768	<300 - 1900	**37 - 4910**	<16-183
Ortho Phosphate	<1 - 3100	1900 - 13300	1.51 - 179	3.24 - 101.1	<1 - 43.5	0.53 - 15.1	290 - 1640	280 - 2220	288 - 1260	14 - 225	1.5 - 28.8	<10 - <20	—	**<1 - 13300**	3.4 - 54
Sulfides	0.2 - 12.1	<0.1 - 40.7	<0.2 - 3.22	0.13 - 14.44	<0.1 - 6.33	0.4 - 13.8	0.60 - 1350	1.5 - 2310	1.0 - 1322	75 - 580	130 - 850	<3 - 620	210 - 1800	**<0.1 - 2310**	<1.0 - 1130

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

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

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

	MARINA DEL REY (2000)		LOS ANGELES HARBOR (1995)		SCCWRP (1977)		SCCWRP (1985)
COMPOUND	AVERAGE	RANGE	AVERAGE	RANGE	AVERAGE	RANGE	AVERAGE
Metals (ppm)							
ARSENIC	7.28	<3.0 - 13.5	5.25	2.2 - 8.5	--	--	--
CADMIUM	0.36	0.03 - 0.89	0.55	0.28 - 1.27	0.42	0.1 - 1.4	0.14
COPPER	130.3	6.9 - 420	39.9	13.1 - 69.6	24	6.5 - 43	10.4
CHROMIUM	26.1	5.9 - 46.0	41.2	21.0 - 71.7	9.6	2.3 - 40	25.4
MERCURY	0.40	0.03 - 1.65	0.21	0.11 - 0.32	--	--	--
LEAD	75.5	18 - 155	21.3	7.3 - 47	6.8	2.7 - 12	4.8
NICKEL	15.2	4.0 - 30	22.6	10.1 - 42.3	16	1.6 - 51	12.9
SILVER	0.84	0.10 - 2.5	0.55	0.05 - 2.66	0.35	0.04 - 1.7	0.03
ZINC	194	29.0 - 390	87.5	42.2 - 148	45	9.8 - 110	48.0
Chl. Hyd. (ppb)							
TOTAL DDT'S	7.1	<0.5 - 17.0	94.1	29.7 - 196	30	<3 - 70	18.9
PCB'S	7.3	<10 - 110	58.3	27.2 - 137	10	<2 - 40	19.2
Organics							
TOC (%)	1.2	0.19 - 3.1	--	--	--	--	0.52
VOL. SOLIDS (%)	3.9	2.0 - 6.2	--	--	3.3	1.8 - 9.5	--
COD (%)	3.5	1.6 - 8.6	--	--	2.4	0.92 - 6.94	--
ORG.NITROGEN (ppm)	24.4	<16 - 183	--	--	790	393 - 1430	--

TABLE 5-4. CHEMICAL CONCENTRATIONS FROM 15 BENTHIC SEDIMENT STATIONS WITH ER-L (BOLD), ER-M, AND AET (SHADED) VALUES (FROM LONG AND MORGAN 1990, MORGAN ET. AL. 1995).

				STATION														
COMPOUND	ER-L	ER-M	AET	1	2	3	4	5	6	7	8	9	10	11	12	13	22	25
Metals (ppm)																		
Arsenic	8.2	[illegible]	[illegible]	<3	4.2	7.4	5.7	6.0	7.0	5.9	8.6	11.2	13.5	10.9	5.7	4.5	9.6	9.0
Cadmium	1.2	[illegible]	[illegible]	0.25	0.53	0.03	0.30	0.29	0.19	0.20	0.26	0.56	0.89	0.33	0.24	0.14	0.27	0.85
Chromium	81	[illegible]	[illegible]	12	19	6	21	32	27	25	34	38	33	44	16	16	24	46
Copper	34	[illegible]	[illegible]	7	20	8	62	164	182	151	[illegible]	167	147	[illegible]	24	41	32	223
Lead	46.7	[illegible]	[illegible]	46	64	18	67	105	61	63	76	105	88	103	43	113	26	155
Mercury	0.15	[illegible]	[illegible]	0.045	0.110	0.028	0.170	0.440	0.680	0.330	0.690	[illegible]	0.650	0.590	0.059	0.069	0.043	0.410
Nickel	20.9	[illegible]	[illegible]	7.0	12.4	4.0	11.2	16.6	14.9	14.3	17.8	22.6	19.2	29.5	8.2	11.6	18.1	20.6
Silver	1	[illegible]	[illegible]	0.25	0.77	0.11	1.07	[illegible]	0.69	0.71	0.76	1.24	0.53	1.38	0.63	0.11	0.10	[illegible]
Zinc	150	[illegible]	[illegible]	53	108	29	134	219	194	190	[illegible]	245	252	[illegible]	80	256	97	[illegible]
Metals exceeding ER-L				0	1	0	4	5	4	4	5	7	5	7	0	3	1	6
Metals exceeding ER-M or AET				0	0	0	0	1	0	0	2	1	0	2	0	0	0	2
Hydrocarbons (ppb)																		
p,p' DDD	2	[illegible]	[illegible]	<0.5	5.0	<0.5	1.0	3.0	<0.7	1.0	<0.8	<1.0	2.0	1.0	5.5	3.0	<0.5	3.0
p,p' DDE	2.2	[illegible]	[illegible]	2.0	7.0	<0.5	5.0	[illegible]	2.0	4.0	<0.8	6.0	[illegible]	4.0	5.1	[illegible]	<0.5	[illegible]
p,p' DDT	1	[illegible]	[illegible]	<0.5	4.0	<0.5	<0.6	<0.9	<0.7	<0.7	<4.0	<5.0	<5.0	<5.0	<3.0	<4.0	<3.0	<4.0
Total DDT & Deriv.	1.58	[illegible]	[illegible]	2.0	16.0	0.0	6.0	12.0	2.0	5.0	0.0	6.0	12.0	5.0	10.6	12.4	0.0	17.0
Chlordane	0.5	[illegible]	[illegible]	1.8	[illegible]	<0.3	<0.3	<0.4	<0.3	<0.3	<0.4	<0.5	<0.4	<0.5	[illegible]	[illegible]	<0.3	[illegible]
Dieldrin	0.02	[illegible]	[illegible]	<0.5	<0.6	<0.5	<0.6	<0.9	<0.7	<0.7	<0.8	<1.0	<0.9	<0.9	<0.5	<0.6	<0.5	<0.9
PCB's	22.7	[illegible]	[illegible]	<10	<10	<10	<20	<20	<20	<20	<20	<30	<20	<20	110	<10	<10	<20
Hydrocarbons exceeding ER-L				2	5	0	2	3	1	2	0	2	2	2	5	4	0	4
Hydrocarbons exceeding ER-M or AET				0	1	0	0	1	0	0	0	0	1	0	1	2	0	2
Total Contaminants																		
Total exceeding ER-L				2	6	0	6	8	5	6	5	9	7	9	5	7	1	10
Total exceeding ER-M or AET				0	1	0	0	2	0	0	2	1	1	2	1	2	0	4

most values were lowered. Note that prior to 1998, all surveys utilized the 1990 values. In Table 5-4, ER-L, ER-M, and AET values are listed for those compounds that were measured in this survey. Compounds, which exceeded the ER-L value, are highlighted by bold type. Those, which *also exceeded either the ER-M or AET values, are additionally highlighted with shading.*

5.3.1. Heavy Metals

5.3.1.1. **Arsenic**

Arsenic is carcinogenic and teratogenic (causing abnormal development) in mammals and is mainly used as a pesticide and wood preservative. Inorganic arsenic can affect marine plants at concentrations as low as 13 to 56 ppm and marine animals at about 2000 ppm (Long and Morgan 1990). The USEPA (1983) gives a terrestrial range of 1-50 ppm, with an average of 5 ppm.

Spatial arsenic patterns. Arsenic concentrations at the 15 sampling stations are listed in Table 5-1 and in Figure 5-1. Highest arsenic values were at Station 10 in Basin E (13.5 ppm), Station 9 in Basin F (11.2 ppm), Station 11 in the upper channel (10.9 ppm) and Station 22 in Oxford Lagoon (9.6 ppm). Lowest values were near the Harbor entrance (Stations 1, and 2 - <3 to 4.2 ppm) and Oxford Lagoon (Station 13 – 4.5 ppm).

Arsenic ranges compared with past years. The range of this year's arsenic values (<3 to 13.5 ppm) was within the overall range of previous years (Table 5-2). Arsenic in the Harbor appears to have neither greatly increased nor decreased since 1988.

Arsenic values compared with other surveys. The Marina del Rey arsenic average and range (7.3 ppm, <3 to 13.5 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 1977 or 1985 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 5-4), and the range for Marina del Rey Harbor sediments this year was <3 to 13.5 ppm. Stations 8, 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.

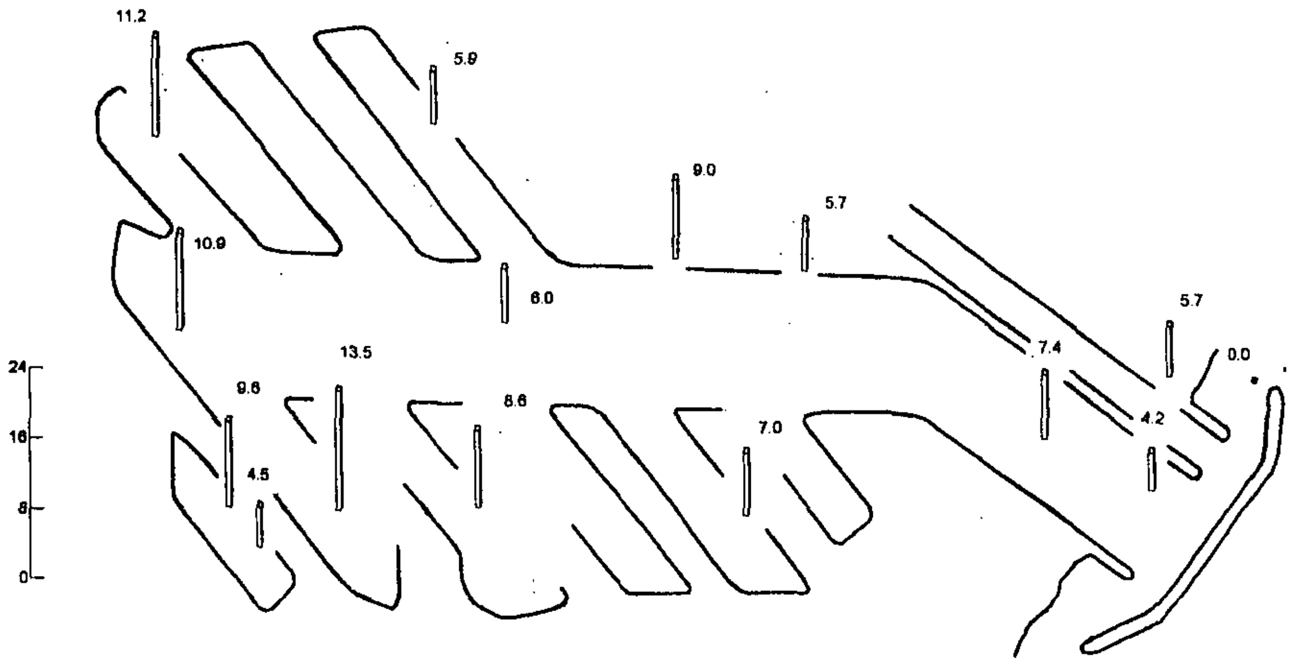
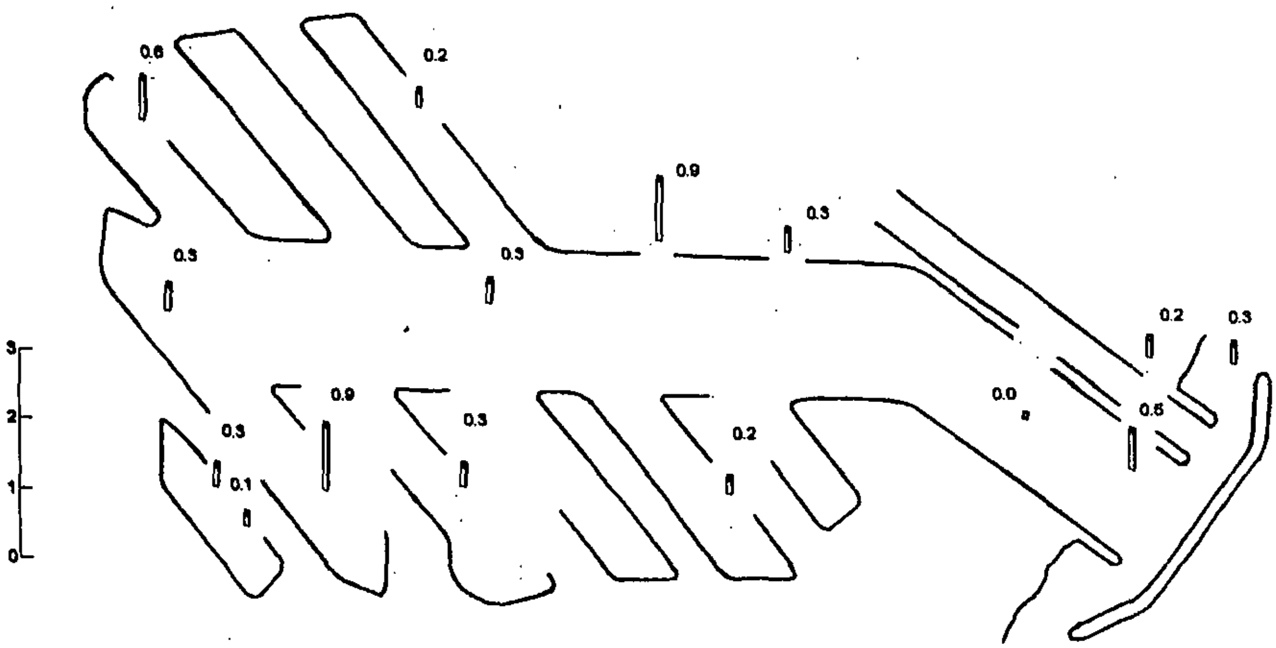


FIGURE 5-2. CADMIUM CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



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 10 in Basin D and Station 25 in mid channel (0.9 ppm each). Remaining stations ranged from 0.03 to 0.6 ppm.

Cadmium ranges compared with past years. The range of this year's cadmium values (0.03 to 0.89 ppm) was below or within the overall range of past surveys (Table 5-2). Since a high of 5.54 ppm was recorded in May of 1991, cadmium values have seemed to exhibit a slight downward trend.

Cadmium values compared with other surveys. The Marina del Rey cadmium average and range (0.36 ppm, 0.03 to 0.89 ppm) were lower than values from Los Angeles Harbor in 1995 (0.55 ppm, 0.28 to 1.27 ppm) and the 1977 SCCWRP Reference Site values (0.42 ppm, 0.1 to 1.4 ppm). However, values were somewhat higher than the 1985 (0.14 ppm) SCCWRP Reference Site average (Table 5-3).

Cadmium values compared with NOAA effects range ratings. The ER-L, ER-M, and AET values for cadmium are 1.2, 9.6, and 5 ppm (Table 5-4). No stations exceeded the ER-L, ER-M and AET values.

5.3.1.3. **Chromium**

Chromium is widely used in electroplating; metal pickling, and many other industrial processes. Chromium typically occurs as either chromium (III) or chromium (VI), the latter being considerably more toxic. Acute effects to marine organisms range from 2,000 to 105,000 ppm for chromium (VI) and 10,300 to 35,500 ppm for chromium (III). Chronic effects range from 445 to 2,000 ppb for chromium (VI) and 2,000 to 3,200 ppb for chromium (III) (Long and Morgan 1990). The terrestrial range is 1–1,000 ppm with an average of 100 ppm (USEPA, 1983).

Spatial chromium patterns. Chromium concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-3. Highest chromium values were at Station 25 in mid channel (46 ppm) and Station 11 in the upper channel (44 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, 3 and 12 - 6 to 19 ppm) and Station 13 (16 ppm) at Oxford Lagoon.

Chromium ranges compared with past years. The range of this year's chromium values (5.9 to 46 ppm) was within the overall range of past surveys (Table 5-2) and about half of last years values (12.5 to 84 ppm). The range for 2000-01 for chromium is the lowest since 1988.

Chromium values compared with other surveys. The Marina del Rey chromium average and range (26.1 ppm, 5.9 to 46 ppm) were lower than Los Angeles Harbor's (41.2 ppm, 21 to 72 ppm) but were higher than either of the 1977 (9.6 ppm, 2.3 to 40 ppm) or 1985 (25.4 ppm) SCCWRP Reference Site Surveys (Table 5-3).

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

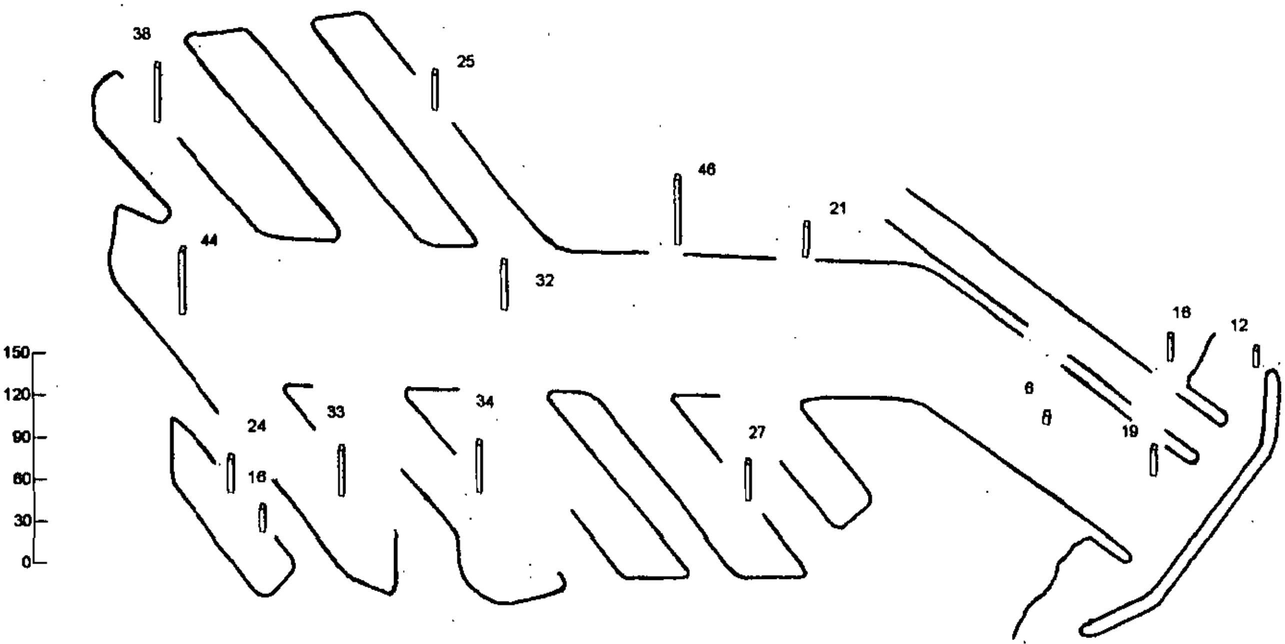
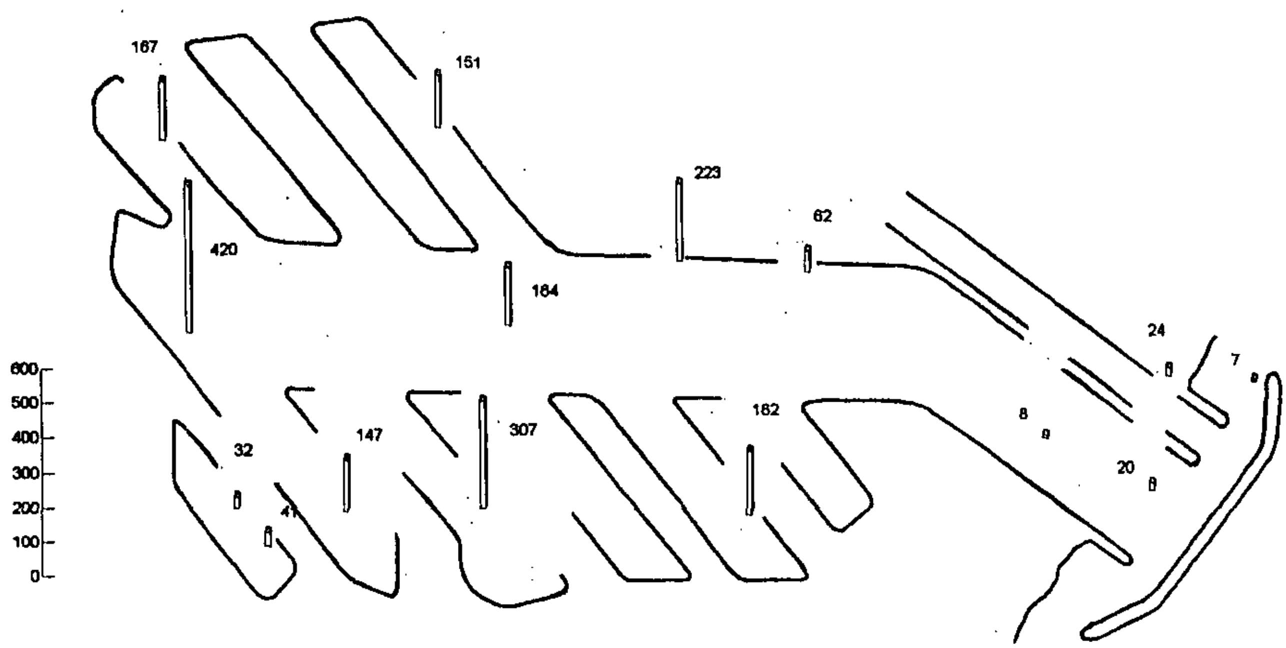


FIGURE 5-4. COPPER CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Chromium values compared with NOAA effects range ratings. The ER-L and ER-M values for chromium are 81 and 370 ppm (Table 5-4). No stations exceeded the ER-L and ER-M. There is no AET value listed for chromium.

5.3.1.4. **Copper**

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

Spatial copper patterns. Copper concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-4. Highest copper values were at Station 11 in the upper channel (420 ppm), Station 8 in Basin D (307 ppm), and Station 25 in mid channel (223 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, 3 and 12 - 7 to 24 ppm) and in Oxford Lagoon (Stations 13 and 22 – 41 and 32 ppm, respectively). Additionally, Station 4 in mid channel (next to Station 25) had a relatively low copper value of 62 ppm.

Copper ranges compared with past years. The range of this year's copper values (6.9 to 420 ppm) was within the overall range of past surveys (Table 5-2). Copper in the Harbor appears to have neither greatly increased nor decreased since 1988.

Copper values compared with other surveys. The Marina del Rey copper average and range (130.3 ppm, 6.9 to 420 ppm) were higher than Los Angeles Harbor (39.9 ppm, 13.1 to 69.6 ppm) and both the 1977 (24 ppm, 6.5 to 43 ppm) and 1985 (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 5-4). Stations 4, 5, 6, 7, 8, 9, 10, 11, 13 and 25 exceeded the ER-L value, and Stations 8 and 11 exceeded both ER-M and AET values.

5.3.1.5. **Iron**

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

Spatial iron patterns. Iron concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-5. Highest iron values were Station 11 in the upper channel (37,000 ppm), Station 10 in Basin E (32,000 ppm), Station 9 in Basin F (28,400 ppm) and Station 25 in mid channel (28,300). Lowest values were near the Harbor entrance (Stations 1, 2, 3, and 12 – 4,900 to 12,900 ppm).

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

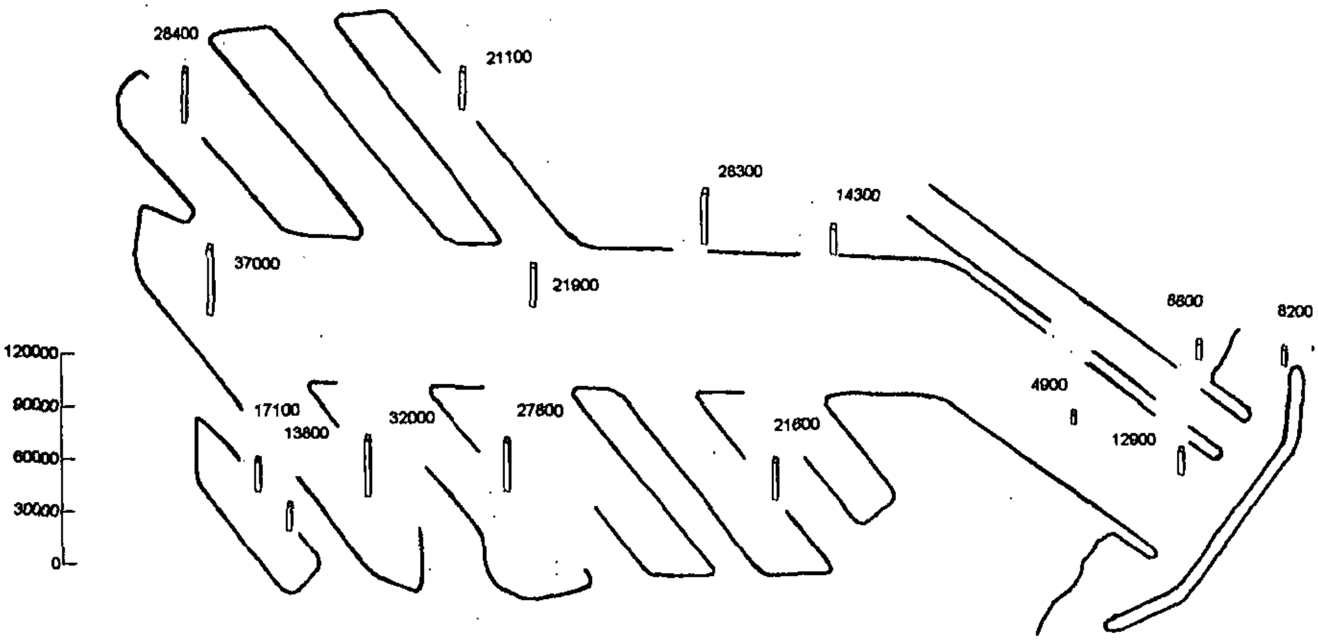
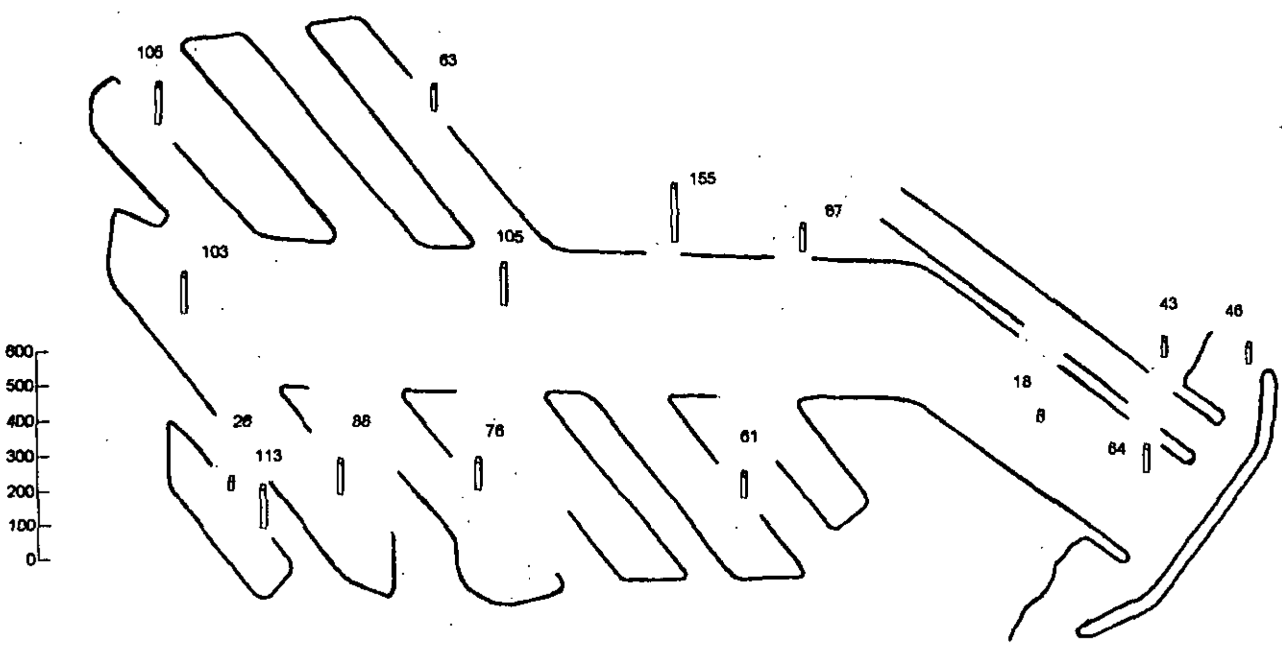


FIGURE 5-6. LEAD CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



Iron ranges compared with past years. The range of this year's iron values (4,900 to 37,000 ppm) was within the overall range of past surveys (Table 5-2). Iron in the Harbor appears to have neither greatly increased nor decreased since 1988.

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 freshwater organisms range from 1.3 to 7.7 ppm, 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. The highest lead value was at Station 25 in mid channel (155 ppm). The lowest value was at Station 3 at the Harbor entrance (18 ppm). All other stations ranged from 26 to 113 ppm.

Lead ranges compared with past years. The range of this year's lead values (18 to 155 ppm) was within the overall range of past surveys (Table 5-2). Lead in the Harbor appears to have neither greatly increased nor decreased since 1988.

Lead values compared with other surveys. This year's Marina del Rey lead average and range (75.5 ppm, 17.7 to 155 ppm) were higher than Los Angeles Harbor (21.3 ppm, 7.3 to 47 ppm) and both the 1977 (6.8 ppm, 2.7 to 12 ppm) and 1985 (10.4 ppm) SCCWRP Reference Site Surveys (Table 5-3).

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

5.3.1.7. **Manganese**

Manganese is generally not considered to be toxic 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 11 in the upper channel (264 ppm), Station 9 in Basin F (239 ppm), Station 10 in Basin E (236 ppm), Station 25 in mid channel (223 ppm) and Station 8 in Basin D (208 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, 3 and 12 – 44 to 115 ppm).

Manganese ranges compared with past years. The range of this year's manganese values (44 to 264 ppm) was within the overall range of past surveys (Table 5-2). Manganese in the Harbor appears to have neither greatly increased nor decreased since 1988.

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. The highest mercury value was at Station 9 in Basin F (1.65 ppm). The lowest values of mercury were found at the Harbor entrance (Stations 1, 2, 3 and 12 – 0.03 to 0.11 ppm) and within Oxford Lagoon (Stations 13 and 22 - 0.07 and 0.04 ppm, respectively). All other values ranged from 0.17 to 0.69 ppm.

Mercury ranges compared with past years. The range of this year's mercury values (0.03 to 1.65 ppm) was relatively close to the overall ranges for the past 13 years, ~~although the high value is among the highest~~ (Table 5-2). Mercury in the Harbor appears to have neither greatly increased nor decreased since 1988.

Mercury values compared with other surveys. The Marina del Rey mercury average and range (0.40 ppm, 0.03 to 1.65 ppm) were higher than Los Angeles Harbor (0.21 ppm, 0.11 to 0.32 ppm) (Table 5-3). Neither the 1977 nor the 1985 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 5-4). Stations 4, 5, 6, 7, 8, 9, 10, 11 and 25 exceeded the ER-L value, and only Station 9 exceeded both the ER-M and AET values.

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

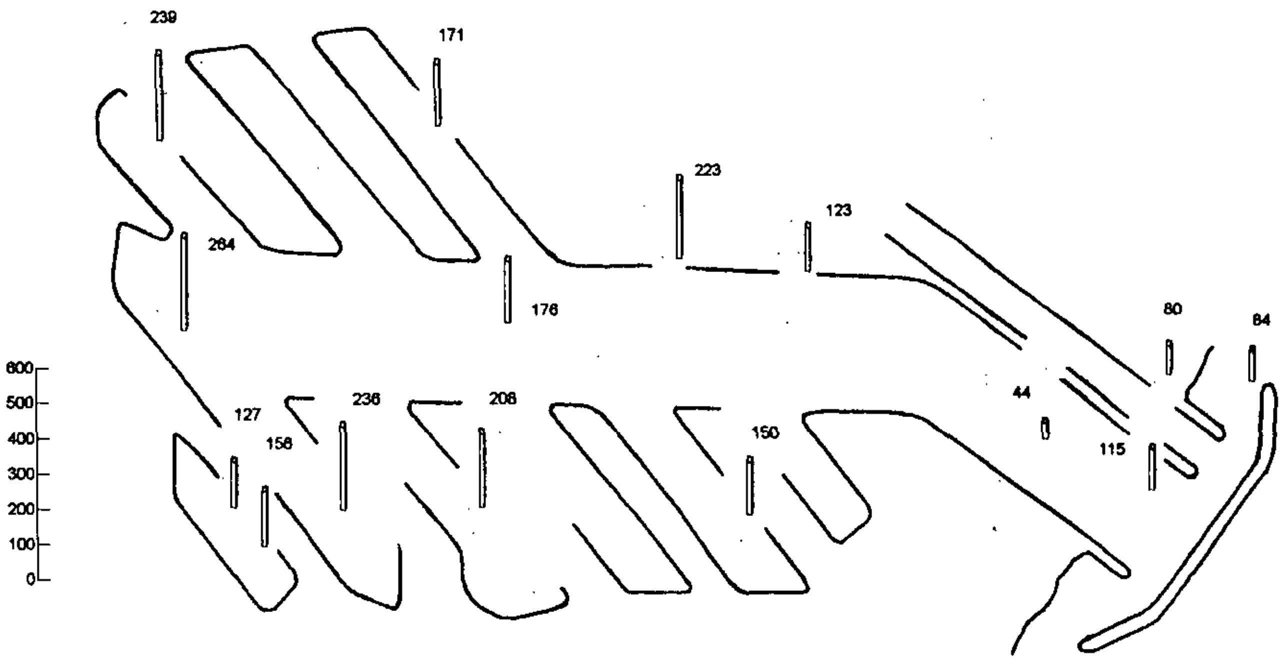
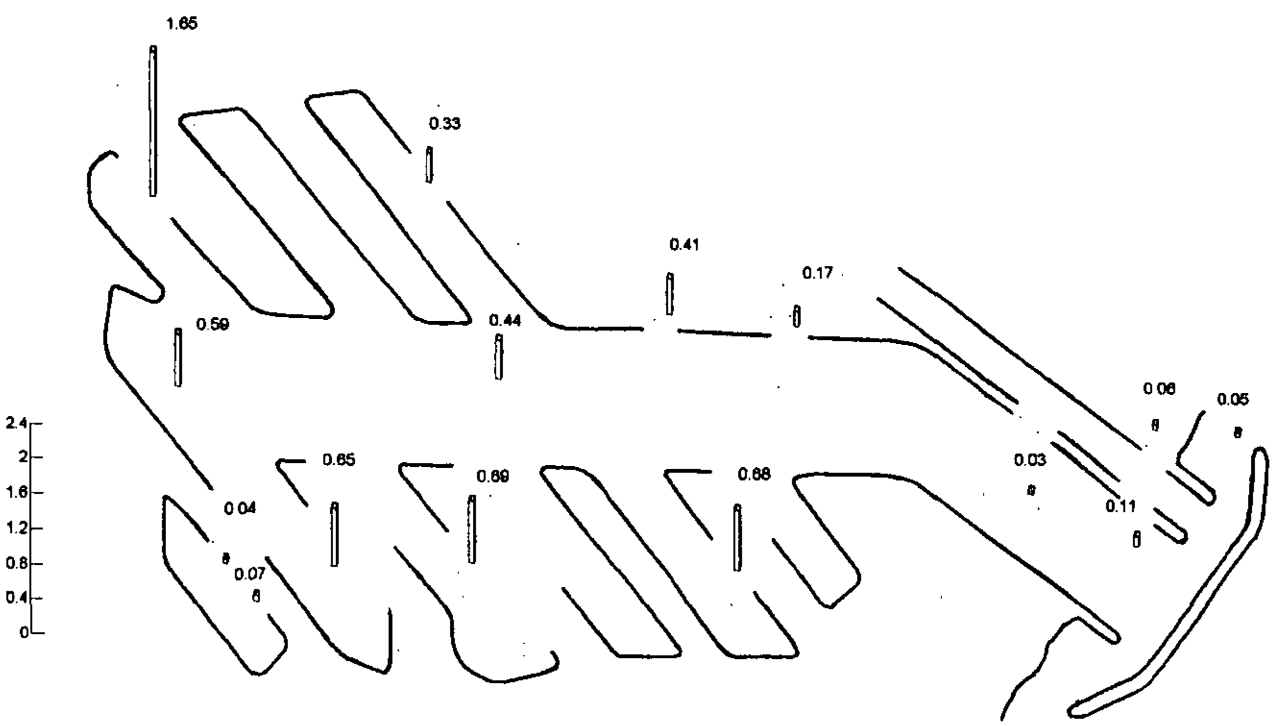


FIGURE 5-8. MERCURY CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



5.3.1.9. **Nickel**

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

Spatial nickel patterns. Nickel concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-9. Highest nickel values were at Station 11 in the upper channel (30 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, 3, and 12 – 4 to 12 ppm) and at Station 13 within Oxford Lagoon (12 ppm) and Station 4 in mid channel (11 ppm). All other stations ranged from 14 to 23 ppm.

Nickel ranges compared with past years. The range of this year's nickel values (4 to 30 ppm) was within the overall range of past surveys (Table 5-2). Altogether, nickel in the Harbor appears to have neither greatly increased nor decreased since 1988.

Nickel values compared with other surveys. The Marina del Rey Harbor nickel average and range (15.2 ppm, 4 to 30 ppm) were somewhat lower than to Los Angeles Harbor (22.6 ppm, 10.1 to 42.3 ppm) and comparable to the 1977 (16 ppm, 1.6 to 51 ppm) and 1985 (12.9 ppm) SCCWRP Reference Site Surveys (Table 5-3).

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

5.3.1.10. **Selenium**

Selenium is used 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 in San Diego County, and were 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. Values were below detection limits (<2 ppm) at all stations.

Selenium ranges compared with past years. Selenium values (<2 ppm) were within or near the overall range of past surveys (Table 5-2).

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

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

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

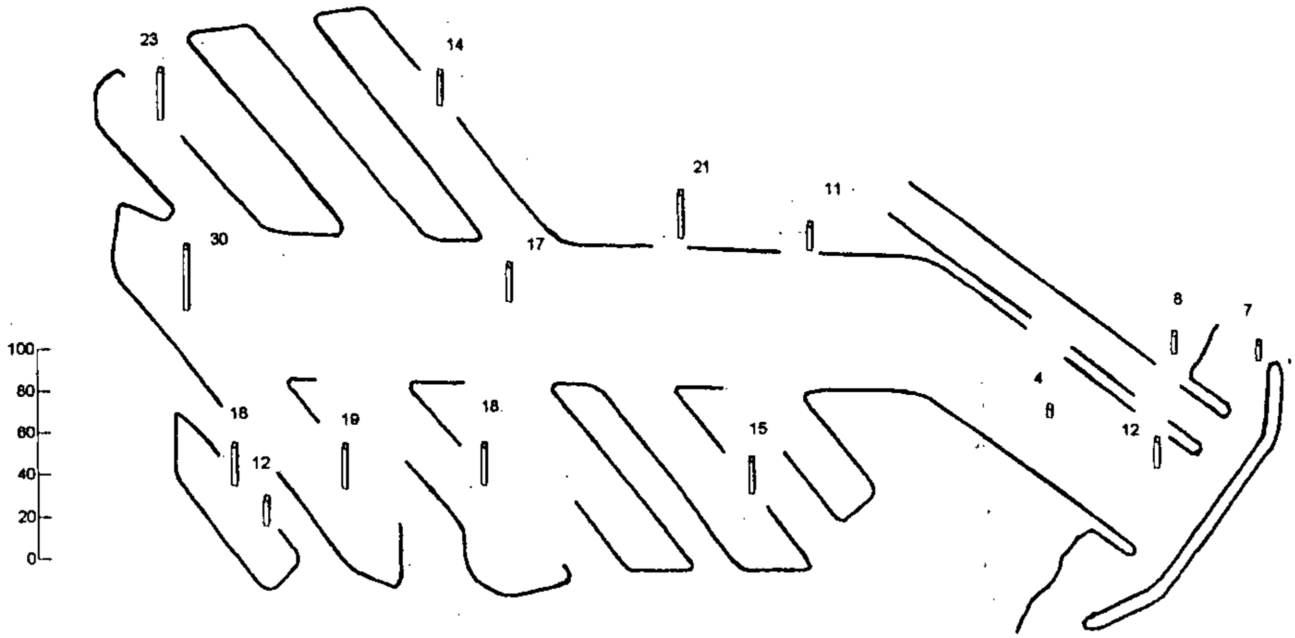
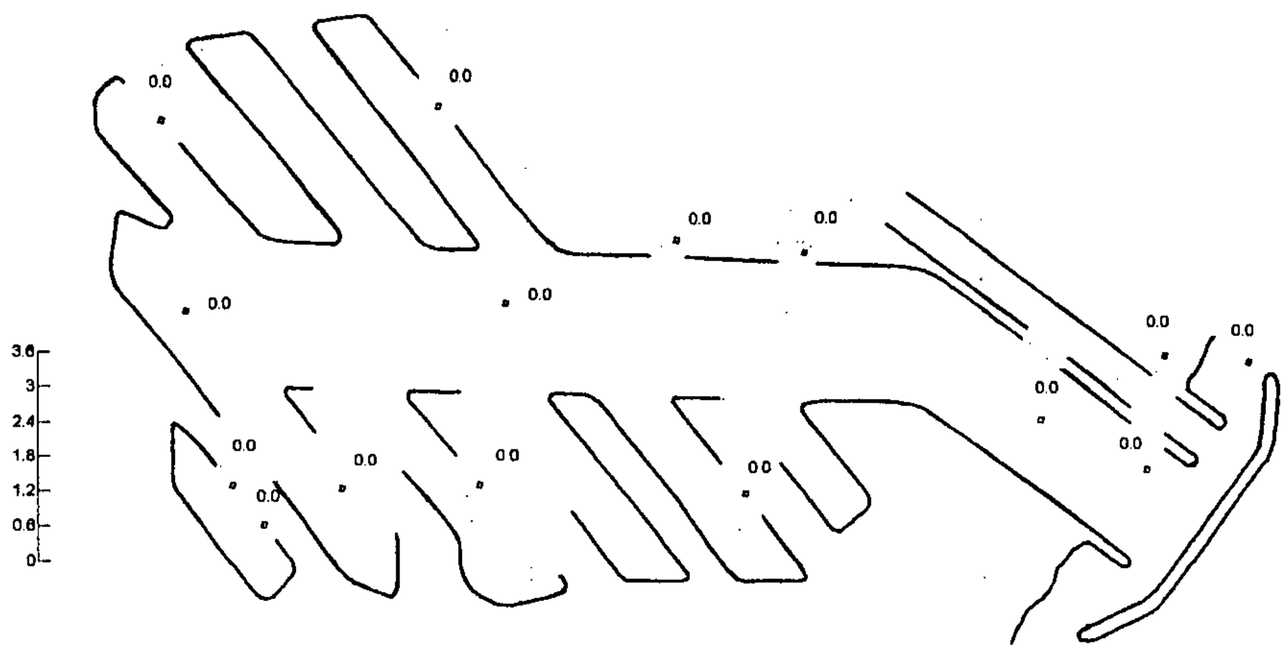


FIGURE 5-10. SELENIUM CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



5.3.1.11. **Silver**

Silver has many uses in commerce and industry including photographic film, electronics, jewelry, coins, and flatware and in medical applications. Silver is toxic to mollusks and is sequestered by them and other organisms. Silver increases in the Southern California Bight with increasing depths, high organic content and percent silt (Mearns et. al., 1991). The range in the rural coastal shelf is from 0.10 to 18 ppm, in bays and harbors from 0.27 to 4.0 ppm, and near outfalls 0.08 to 18 ppm (Soule et al. 1996). The normal terrestrial level ranges from 0.01 to 5.0 ppm, with a mean of 0.05 ppm.

Spatial silver patterns. Silver concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-11. Highest silver concentrations were in midchannel (Stations 4, 5, and 25 – 1.1 to 2.5 ppm), Station 11 in the upper channel (1.4 ppm) and at Station 9 in Basin F (1.2 ppm). Lowest values were in the lower channel (Station 3 - 0.1 ppm) and in Oxford Lagoon (Stations 13 and 22 – 0.1 ppm, each).

Silver ranges compared with past years. The range of this year's silver values (0.1 to 2.5 ppm) was similar to past surveys (Table 5-2). Overall, silver in the Harbor appears to have neither greatly increased nor decreased since 1996.

Silver values compared with other surveys. The Marina del Rey silver average and range (0.84 ppm, 0.1 to 2.5 ppm) were slightly higher than Los Angeles Harbor (0.55 ppm, 0.05 to 2.66 ppm) and somewhat higher than both the 1977 (0.35 ppm, 0.04 to 1.7 ppm) and 1985 (0.03 ppm) SCCWRP Reference Site Surveys (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 5-4). Stations 4, 5, 9, 11 and 25 exceeded the ER-L value; Stations 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 and found it can be toxic in concentrations as low as 50 parts per trillion in water (this value is equivalent to 0.00005 ppm). The terrestrial range for tin is 2 to 200 ppm, with a mean of 10 ppm. No sediment tests other than Soule and Oguri (1988) were mentioned in the literature. The California Department of Fish and Game considers tributyl tin to be the most toxic substance ever released in the marine environment. The Los Angeles Department of Beaches and Harbors banned its use prior to the Federal ban for 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 anti-fouling coatings (Soule et al. 1996).

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

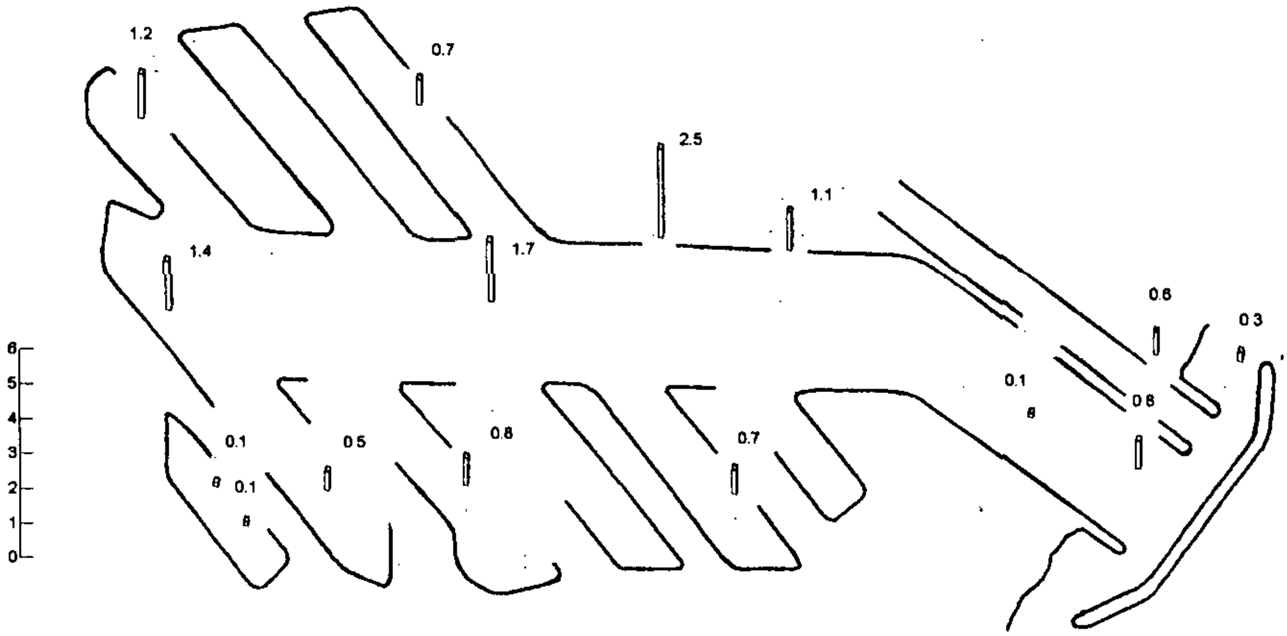
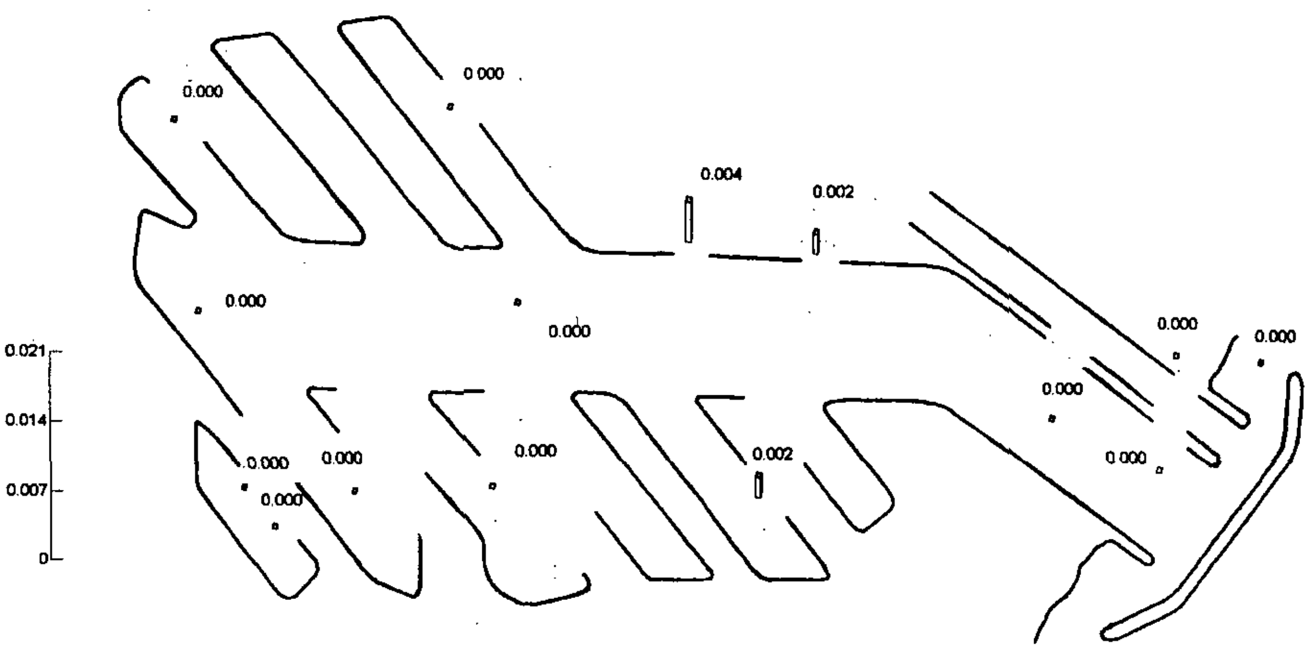


FIGURE 5-12. TRIBUTYL TIN CONCENTRATIONS (PPB) AT 15 BENTHIC SEDIMENT STATIONS.



Spatial tributyl tin patterns. Tributyl tin concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-12. Highest tin concentrations were at Stations 25 and 4 in mid channel (0.004 and 0.002 ppm, respectively) and Station 6 in Basin B (0.002 ppm). Concentrations at all other stations were below the detection limit (0.002 ppm).

Tributyl tin ranges compared with past years. Values reported for the 2000-01 survey (<0.002 – 0.004 ppm) are the lowest recorded since 1988 (Table 5-2) and may reflect a response to the banning of this compound in the Harbor (see above).

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 many stations may be high enough to cause chronic toxicity to mollusks and other marine organisms.

5.3.1.13. **Zinc**

Zinc is widespread in the environment and is also an essential trace element in human nutrition. It is widely used for marine corrosion protection, enters the waters as airborne particulates, and occurs in runoff and sewage effluent. Acute toxicity of zinc in water to marine fish range from 192 to 320,400 ppm, and chronic toxicity to marine mysid shrimp can occur as low as 120 ppm (Long and Morgan 1990). The normal terrestrial range is from 10 to 300 ppm, with a mean of 50 ppm (Soule et al. 1996).

Spatial zinc patterns. Zinc concentrations at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-13. Highest zinc values were at Station 11 in the upper channel (390 ppm), Station 25 in mid channel (340 ppm) and Station 8 in Basin D (320 ppm). Lowest values were near the Harbor entrance (Stations 1, 2, 3 and 12 – 29 to 108 ppm) and Station 13 in Oxford Lagoon (97 ppm).

Zinc ranges compared with past years. The range of this year's zinc values (29 to 390 ppm) was within the overall range of past surveys (Table 5-2). Zinc in the Harbor appears to have neither greatly increased nor decreased since 1988.

Zinc values compared with other surveys. The zinc average and range (194 ppm, 29 to 390 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 5-4). Stations 5, 6, 7, 8, 9, 10, 11, 13, and 25 exceeded ER-L value; and Stations 8, 11, and 25 exceeded AET value. No stations exceeded the ER-M.

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

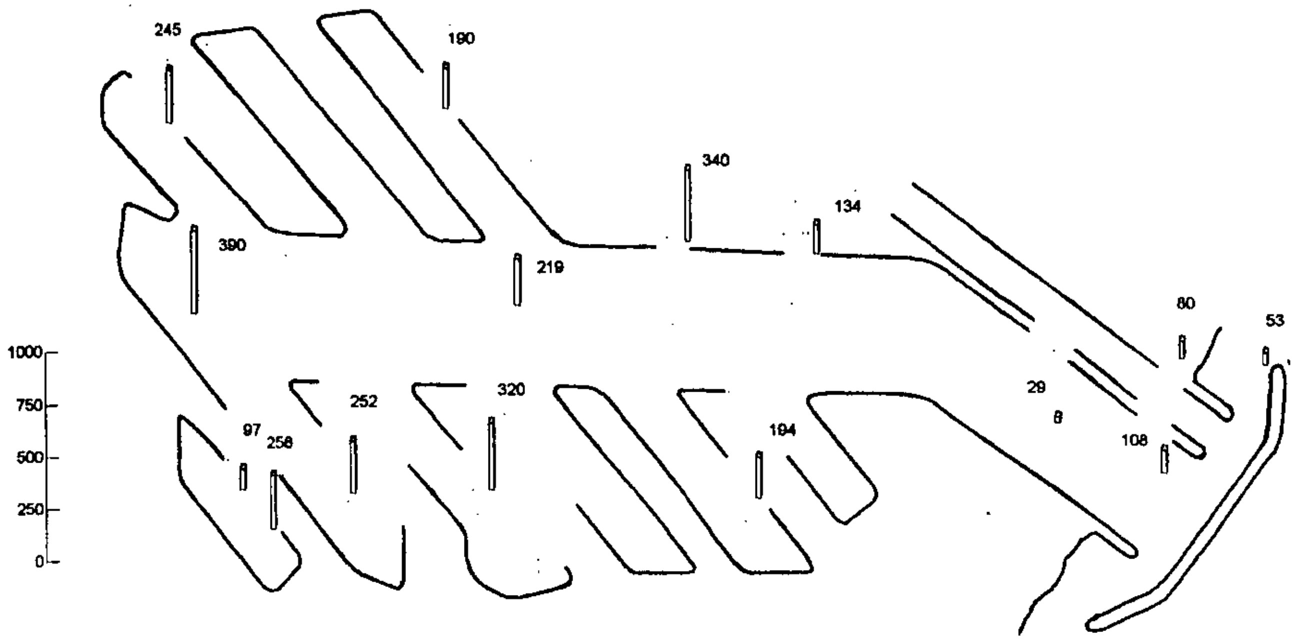
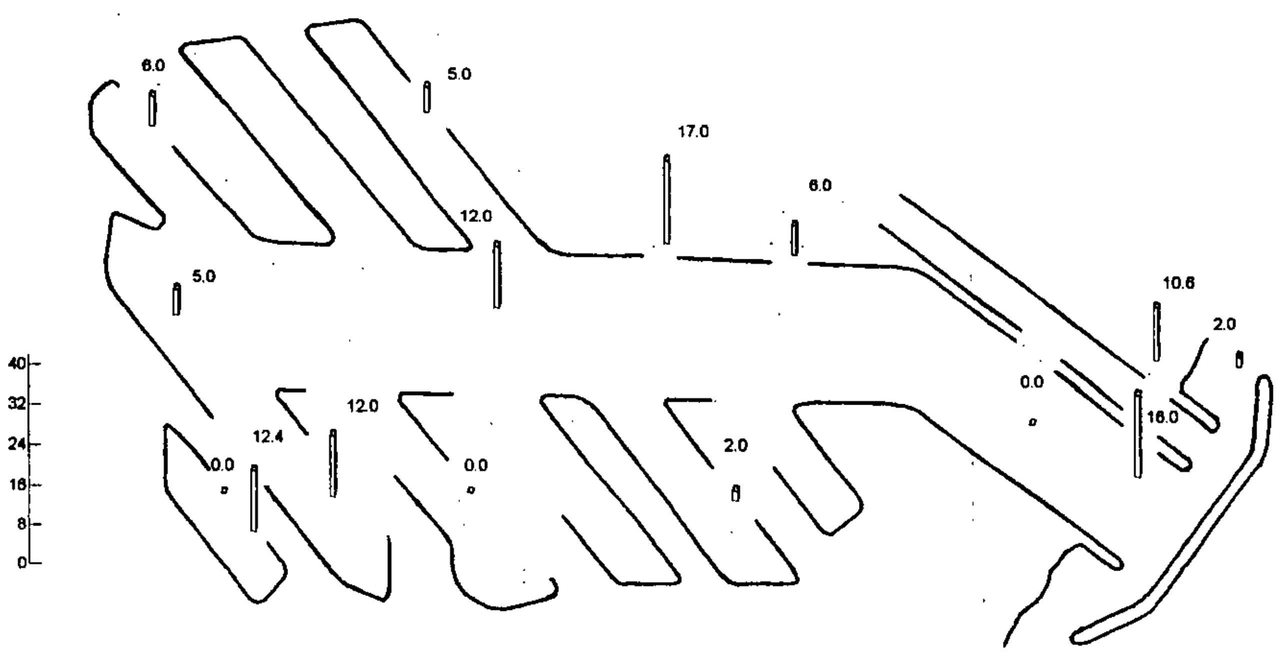


FIGURE 5-14. DDT AND DERIVATIVES CONCENTRATIONS (PPB) AT 15 BENTHIC SEDIMENT STATIONS.



5.3.2. 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 25 in mid channel (17.0 ppb) and Station 2 near the Harbor entrance (16.0 ppb). The next highest combined concentrations were found at Station 13 in Oxford Lagoon (12.4 ppb), Station 12 in Ballona Creek (10.6 ppb) and Station 10 in Basin E (12.0 ppb). The 1999-00 surveys found the lowest concentrations at Stations 25 and 13 (1.0 ppb, each). Lowest values were at Station 22 in Oxford Lagoon, and Stations 3 and 8 near the Harbor entrance (all <0.5 ppb).

DDT ranges compared with past years. The range of this year's values were <0.5 to 4.0 ppb for DDT, <0.5 to 5.5 ppb for DDD, and <0.5 to 14 ppb for DDE. DDT and its derivatives have declined by an order of magnitude since 1988 (Table 5-2).

DDT values compared with other surveys. The Marina del Rey total DDT's average and range (7.1 ppb, <0.5 to 17.0 ppb) were considerably lower than Los Angeles Harbor (94.1 ppb, 29.7 to 196 ppb), the 1977 SCCWRP Reference Site Survey (30 ppb, <3 to 70 ppb), and the 1985 (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 5-4). For DDD, Stations 2, 5, 12, 13 and 25 exceeded the ER-L value, and no stations exceeded either AET or ER-M values. For DDE, Stations 2, 4, 5, 7, 9, 10, 11, 12, 13 and 25 exceeded the ER-L value, Stations 5, 10, 13 and 25 exceeded the AET value, and no stations exceeded the ER-M value. For DDT, Station 2 exceeded the ER-L value, and no stations exceeded either the AET or ER-M values. For all DDT and derivatives combined, Stations 1, 2, 4, 5, 6, 7, 9, 10, 11, 12, 13 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.

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 Station 2 near the Harbor entrance (7.4 ppb) and Station 12 in Ballona Creek (8.1 ppb). All other stations were either below detection limits (<0.3 to <3.0 ppb) or were relatively low (1.8 to 5.0 ppb).

Remaining chlorinated pesticide ranges compared with past years. The range of this year's values for all non-DDT chlorinated pesticides were <0.3 to 8.1 ppb. Non-DDT chlorinated pesticides have experienced some decline since 1998. Previous to 1996, few compounds had been detected, but that was because detection limits were much higher (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 5-4). For chlordane, Stations 1, 2, 12, 13, and 25 exceeded the ER-L value; and, all of these, except Station 1, exceeded both ER-M and AET values. For dieldrin, no stations exceeded the ER-L and ER-M values.

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

Although PCBs 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 PCBs were for dielectric fluids in capacitors, as plasticizers in waxes, in transformer fluids, and hydraulic fluids, in lubricants, and in heat transfer fluids (Laws 1981). Arochlor 1242 was acutely toxic in water to marine shrimp in ranges of 15 to 57 ppm (Long and Morgan 1990).

Spatial PCB patterns. PCB concentrations, specifically Arochlor-1254, were detected only at Station 12 in Ballona Creek (110 ppb), values at all other stations were below detection limits (10 to 30 ppb) (Table 5-1, Figure 5-16).

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

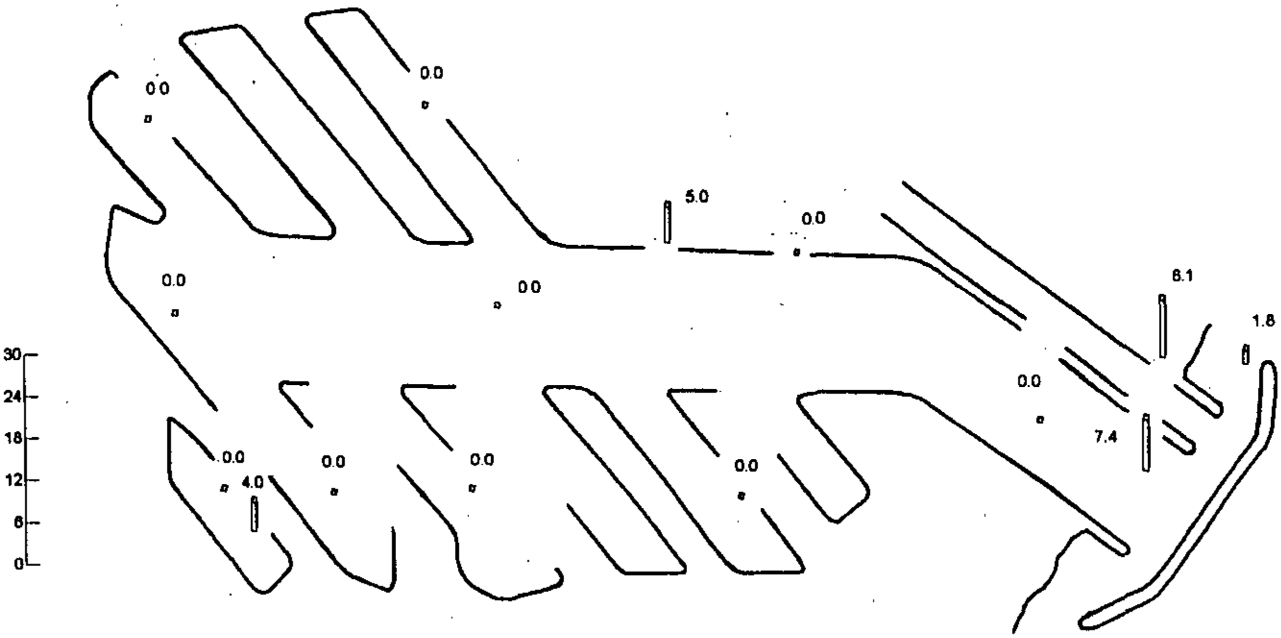
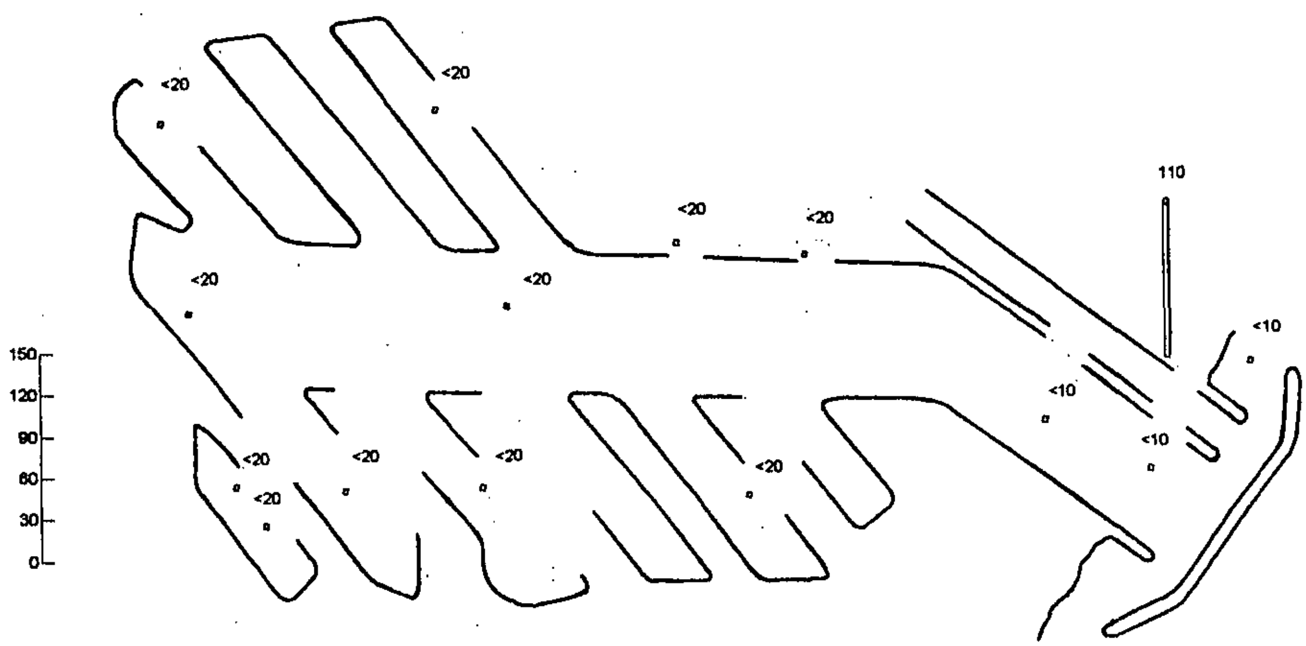


FIGURE 5-16. TOTAL PCB CONCENTRATIONS (PPB) AT 15 BENTHIC SEDIMENT STATIONS.



PCB's compared with past years. This year's values for PCBs were <10 to 110 ppb (Table 5-2). The detect at Station 12 (110 ppb) was the first concentration found since the 1996 survey.

PCB's values compared with other surveys. The Marina del Rey total PCB average and range values (7.30, <10 to 110 ppb) were lower than those of Los Angeles Harbor (58.3 ppb, 27.2 to 137 ppb), the 1977 SCCWRP Reference Site Survey (10 ppb, <2 to 40 ppb) and the 1985 (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 5-4). Only Station 12 exceeded ER-L but not the ER-M or AET values.

5.3.3. Simple Organics

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

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

TOC is a more accurate measure of the amount of carbon derived from plant and animal sources that 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. The highest TOC values were at Station 25 in mid channel (3.1%) and Station 9 in Basin F (2.3%). Lowest values were found near the Harbor entrance, Stations 1, 3, and 12 (0.2 – 0.8%). Stations 2, 11, 10 and 5 had mid range values (1.4 – 1.6%). TOC values at other stations were fairly consistent throughout the Harbor (0.7 – 1.1%).

TOC ranges compared with past years. The range of 2000 values for TOC was 0.19 to 3.1% (Table 5-2), which is well within the ranges of the previous surveys. TOC in the Harbor may have decreased slightly since 1988.

TOC values compared with previous surveys. TOC values were normalized to fine grain Los Angeles Harbor, so they were not comparable to values in this survey. The TOC average and range for Marina del Rey TOC (1.2%, 0.19% to 3.1%) were about three times the 1985 SCCWRP Reference Site Survey of 0.52% (Table 5-3). TOC was not analyzed in the 1977 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).

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

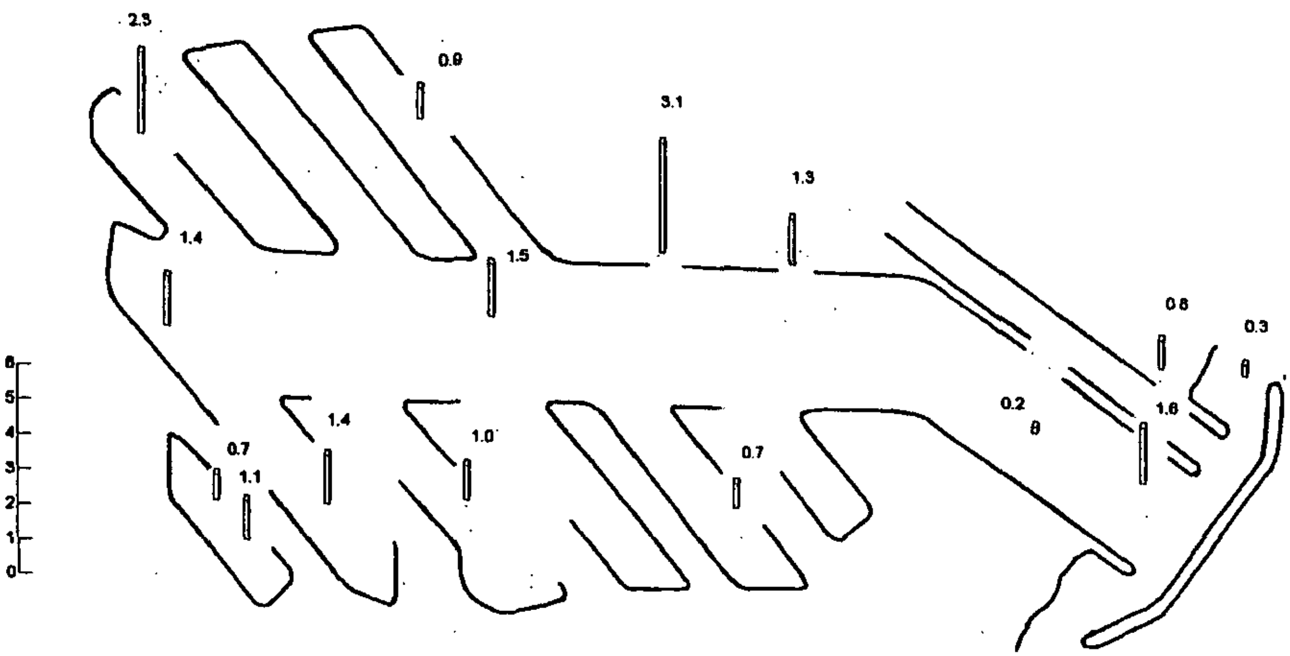
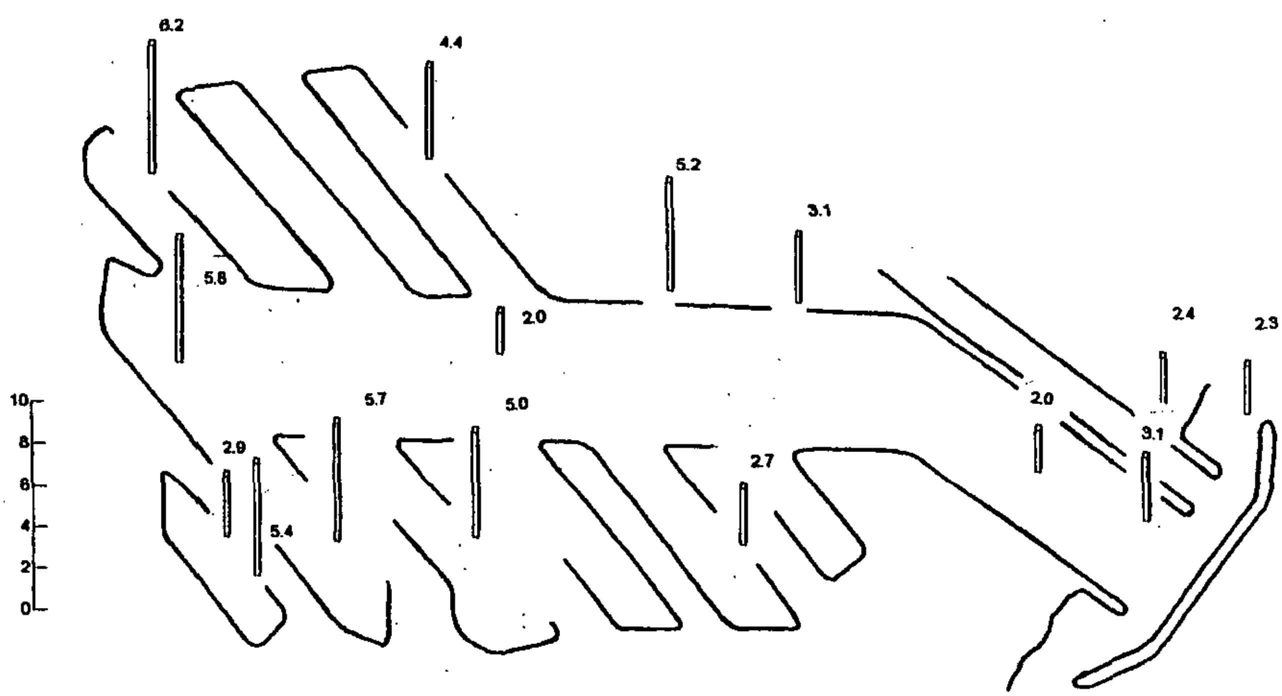


FIGURE 5-18. VOLATILE SOLIDS CONCENTRATIONS (%) AT 15 BENTHIC SEDIMENT STATIONS.



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. Volatile solids concentrations (2.0 - 6.2%) were similar to last year (1.3 – 7.5%). The highest values were at Stations 8 (5.0%), 9 (6.2%), 10 (5.7%), 11 (5.8%), 13 (5.4%), and 25 (5.2%). The lowest values were found at mid to lower channel, Stations 3 and 5 (both 2.0%). All other values ranged from 2.9% to 4.42%.

Volatile solids ranges compared with past years. The range of this year's values for volatile solids was 2.0 - to 6.2% (Table 5-2) and was similar to previous years.

Volatile solids values compared with previous surveys. The average and range for Marina del Rey volatile solids (3.9%, 2.0% to 6.2%) similar to the 1977 SCCWRP Reference Site Survey (3.3%, 1.8% to 9.5%). Volatile solids were not analyzed in the 1985 SCCWRP Survey or in Los Angeles Harbor (Table 5-4).

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

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

Spatial IOD patterns. Concentrations of IOD at the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-19. Highest values were in Oxford Lagoon (Stations 13 and 22 - 1.5% and 1.2%, respectively), Basin E (Station 10 - 3.1%) and in the back Harbor (Station 11 - 2.4%). Station 12 at the Harbor entrance also had a high IOD result (1.1%). No IOD concentrations were found at any other stations.

IOD ranges compared with past years. The range of this year's values for IOD was non detect to 3.1% (Table 5-2). These values are comparable to values from last year's survey (0.07% to 4.0%) but higher than those reported in earlier studies (<0.001% to 2.0%). It is likely that, since the IOD analysis is a non-standardized methodology, differences are related to matrix interference and to differing techniques being used by the previous and present chemistry laboratories.

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

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.

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

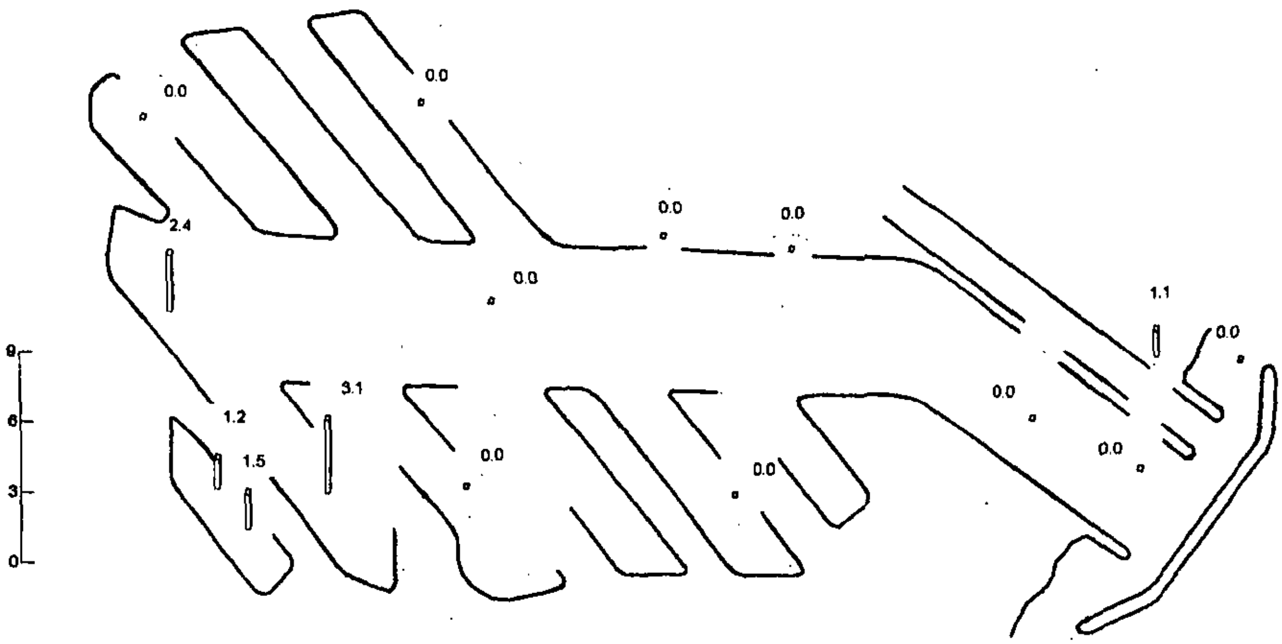
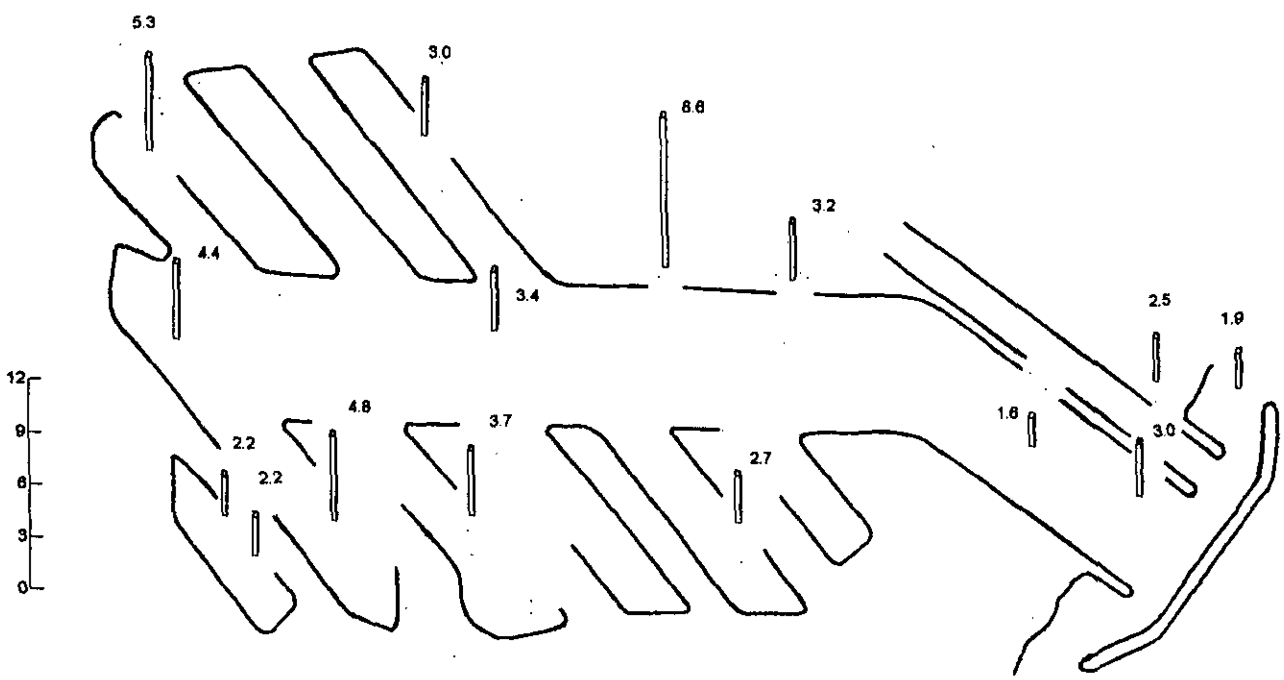


FIGURE 5-20. CHEMICAL OXYGEN DEMAND CONCENTRATIONS (%) AT 15 BENTHIC SEDIMENT STATIONS.



Spatial COD patterns. Concentrations of COD at the 15 stations are listed in Table 5-1 and summarized in Figure 5-20. Highest values were at Station 25 near the Administration docks (8.6%) and at Station 9 in Basin F (5.3%). Station 11 at the back of the Harbor (4.4%) and Station 10 in Basin E (4.8%) had relatively high COD concentrations. The lowest values were near the Harbor entrance (Stations 1, and 3 – 1.9% and 1.6%, respectively) and in Oxford Lagoon at Stations 13 and 22 (2.2% each). Other COD values in the Harbor ranged from 2.5% to 3.7%.

COD ranges compared with past years. The range of 2000 values for COD was 1.6% to 8.6% (Table 5-2), which is well within the ranges of previous surveys. COD in the Harbor appears have neither increased nor decreased since 1988.

COD values compared with previous surveys. The average and range for Marina del Rey COD (3.5%, 1.6% to 8.6%) were comparable to the 1977 SCCWRP Reference Site Survey (2.4%, 0.92% to 6.94%). COD was not analyzed in the 1985 SCCWRP Survey or in Los Angeles Harbor (Table 5-3).

5.3.3.5. **Oil and Grease**

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

Spatial oil and grease patterns. Oil and grease values for the 15 sampling stations are listed in Table 5-1 and summarized in Figure 5-21. Highest values, by far, were from Station 13 in Oxford Lagoon (1510 ppm). Station 25 in mid channel and Station 12 in Ballona Creek (463 ppm and 452 ppm, respectively) also had relatively high concentrations of oil and grease. Stations 9, 10, and 11 had concentrations of oil and grease below detection limits (<10 ppm). Concentrations at all other stations ranged from 63 ppm to 282 ppm.

Oil and grease ranges compared with past years. The range of this year's values for oil and grease was <10 to 1510 ppm, which fall well within the overall range of values for past surveys (Table 5-2). Oil and grease concentrations decreased somewhat since 1988 but are higher than surveys conducted between 1996 and 1998.

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

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

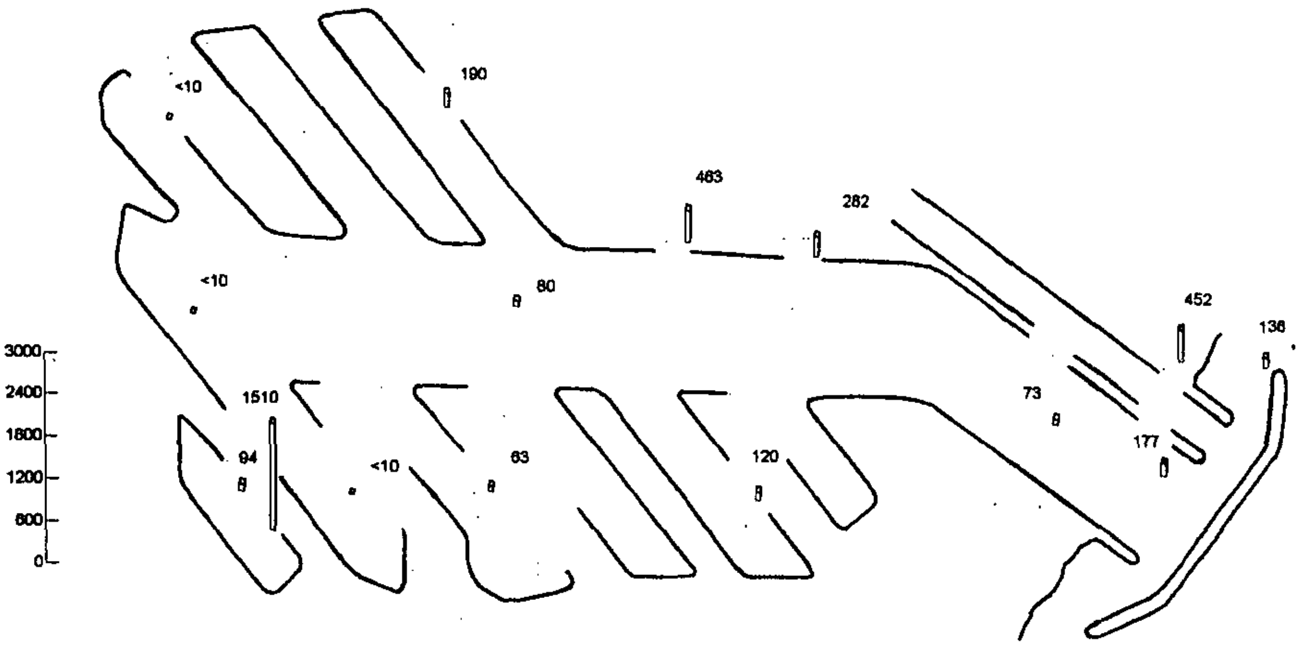
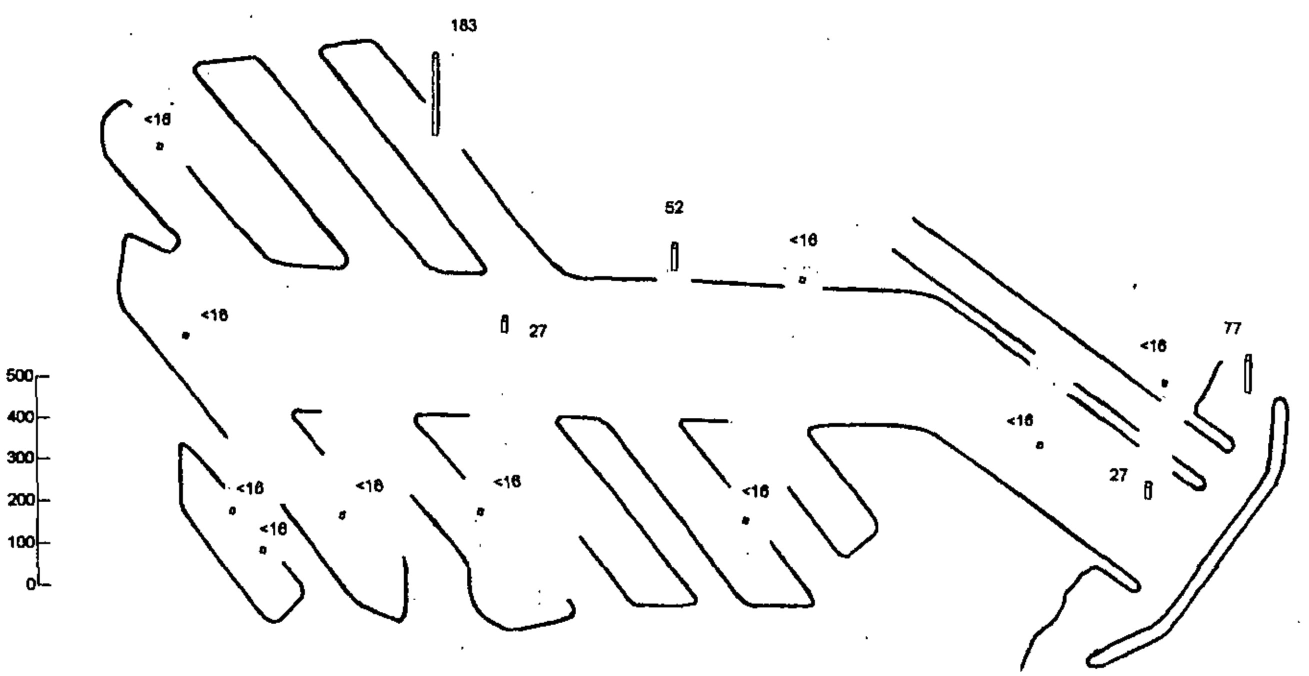


FIGURE 5-22. ORGANIC NITROGEN CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



5.3.3.6. **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). Due to matrix interference the laboratory reported total Kjeldahl nitrogen (TKN) and ammonia values. Reported ammonia concentrations were converted to ammonia as nitrogen and subtracted from the TKN values to achieve a value for organic nitrogen. Where ammonia values exceeded the TKN value, organic nitrogen was reported as below the detection limits for ammonia and TKN (<16 ppm).

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. The highest value was at Station 7 in Basin H (183 ppm). All other stations except Station 1 (77 ppm), Station 2 (27 ppm), Station 5 (27 ppm) and Station 25 (52 ppm) did not have any detected concentrations of organic nitrogen.

Organic nitrogen ranges compared with past years. The range of this year's values for organic nitrogen was <16 to 183 ppm (Table 5-2), is within the range of the past surveys. Organic nitrogen in the Harbor appears to have decreased considerably since 1988.

Organic nitrogen values compared with previous surveys. The average and range for Marina del Rey nitrogen (24.4 ppm, <16 to 183 ppm) were decidedly lower than the range of the 1977 SCCWRP Reference Site Survey (790 ppm, 393 to 1430 ppm). Nitrogen was not analyzed in the 1985 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 to1987, 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. Highest values were at the Harbor entrance, Station 2 (54 ppm) and in mid channel, Station 5 (52 ppm). The lowest value was also located near the Harbor entrance, Station 3 (3 ppm). Values in the rest of the Harbor varied from 18 to 38 ppm.

Ortho phosphate ranges compared with past years. The range of this year's values for ortho phosphate was 3.4 to 54 ppm and is within past ranges (Table 5-2). As discussed above, concentrations have greatly decreased since 1988.

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

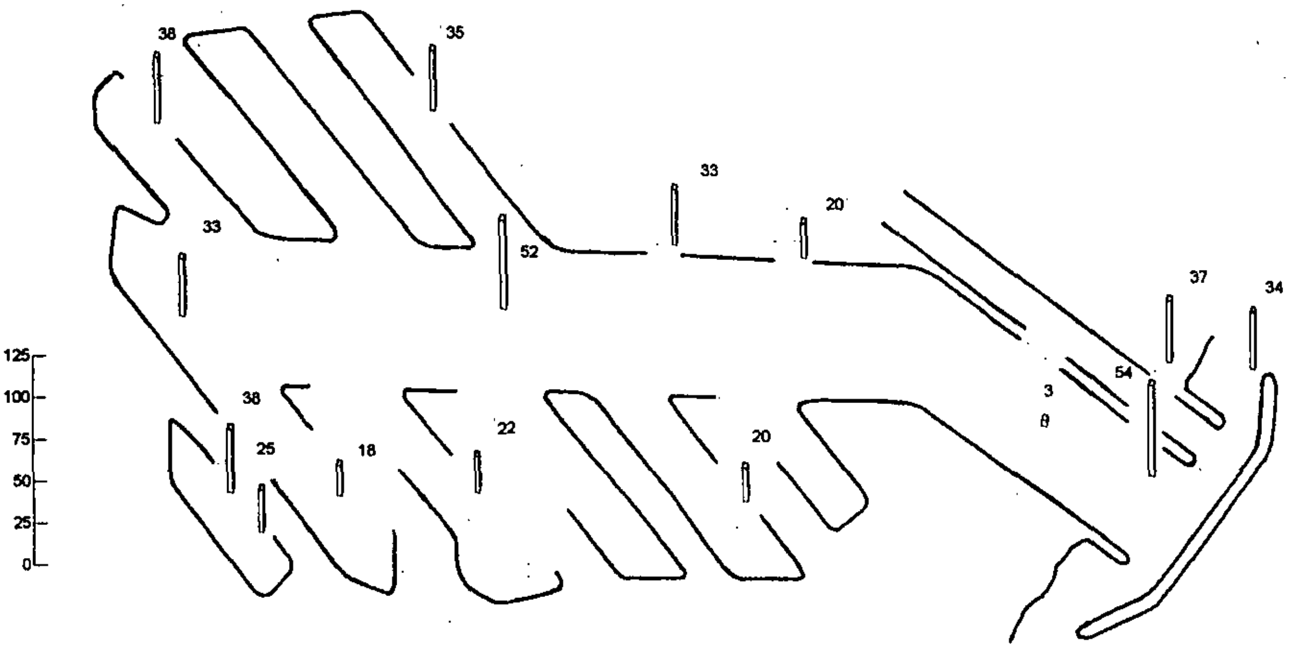
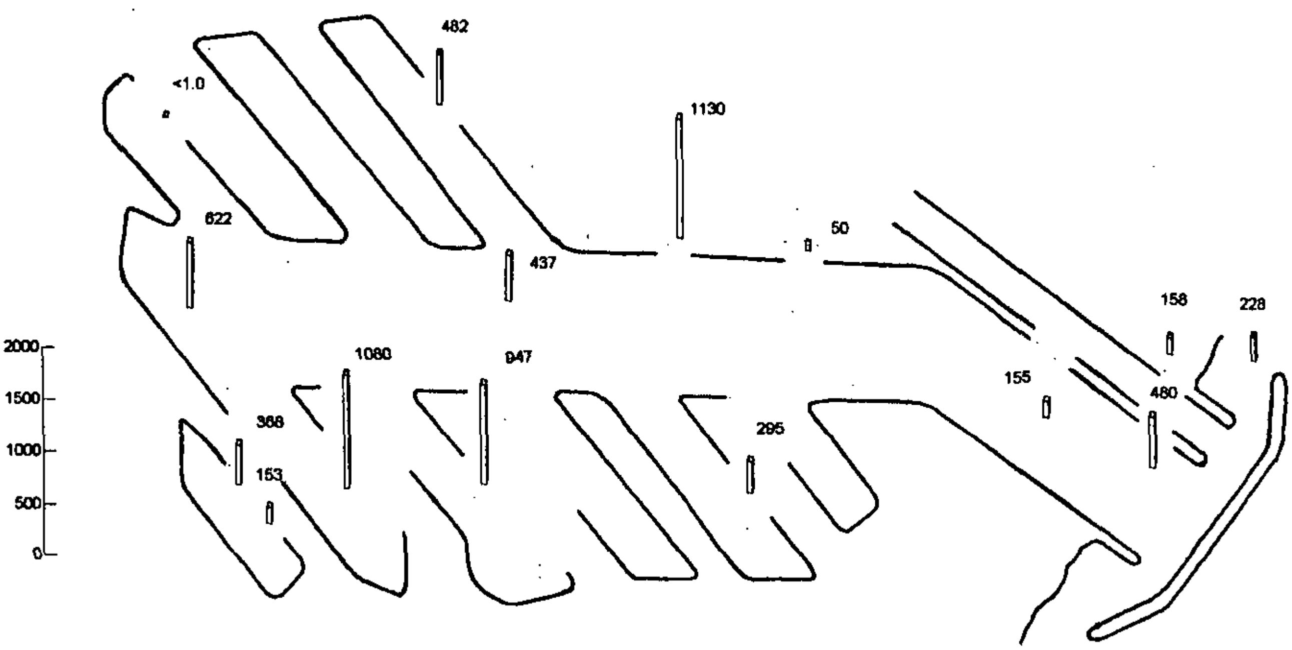


FIGURE 5-24. TOTAL SULFIDE CONCENTRATIONS (PPM) AT 15 BENTHIC SEDIMENT STATIONS.



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 reported at Station 25 in mid channel (1130 ppm), Station 10 in Basin E (1080 ppm) and Station 8 in Basin D (947 ppm). The next highest values occurred at Station 11 at the back of the Harbor (622 ppm), Station 7 in Basin H (482 ppm), Station 5 in mid channel (437 ppm) and Station 2 at the Harbor entrance (480 ppm). The lowest value was at Station 9 in Basin F (<1.0 ppm). Sulfide concentrations at the remaining Harbor stations ranged from 50 ppm to 368 ppm.

Sulfide ranges compared with past years. The range of this year's values for sulfide was <1.0 to 1130 ppm (Table 5-2), which is within the overall range from past surveys. Like ortho phosphate and IOD, concentrations have varied widely over the past thirteen 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 toxicity nor are they common indicators of organic pollution. They will, therefore, not be dealt with to any great extent in this document.

5.3.5. Station Grouping Based on Benthic Contaminants

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

Stations 4, 6, 7, 8 and 22. These stations, located in mid channel, Basins B, D and H and Oxford Lagoon, contained low concentrations of DDT, lead and selenium and a relatively high concentration of TBT. All other constituents were found in moderate quantities.

Stations 2, 12 and 13. These stations had high concentrations of DDT, pesticides, TBT, immediate oxygen demand, oil and grease, organic nitrogen and ortho phosphate. Station 12 is in Ballona Creek, Station 13 in Oxford Lagoon and Station 2 near the Harbor entrance. Additionally, concentrations of several heavy metals and chemical oxygen demand were low. These stations were moderate in all other constituents.

Stations 5, 9, 10 and 11. These stations contained high concentrations most heavy metals, TOC, volatile solids and immediate oxygen demand. Low values of chemical oxygen demand, oil and grease and selenium were found. All other constituents in were moderate quantities. These stations are located in mid channel, Basin F, Basin E and the back Harbor.

Station 25. This station had high concentration of most heavy metals, TOC, volatile solids, chemical oxygen demand, oil and grease, organic nitrogen, sulfides and DDT. Selenium was found in low quantities and all other constituents were found in moderate quantities. Station 25 lies in mid channel between the Administration docks and the public fishing docks.

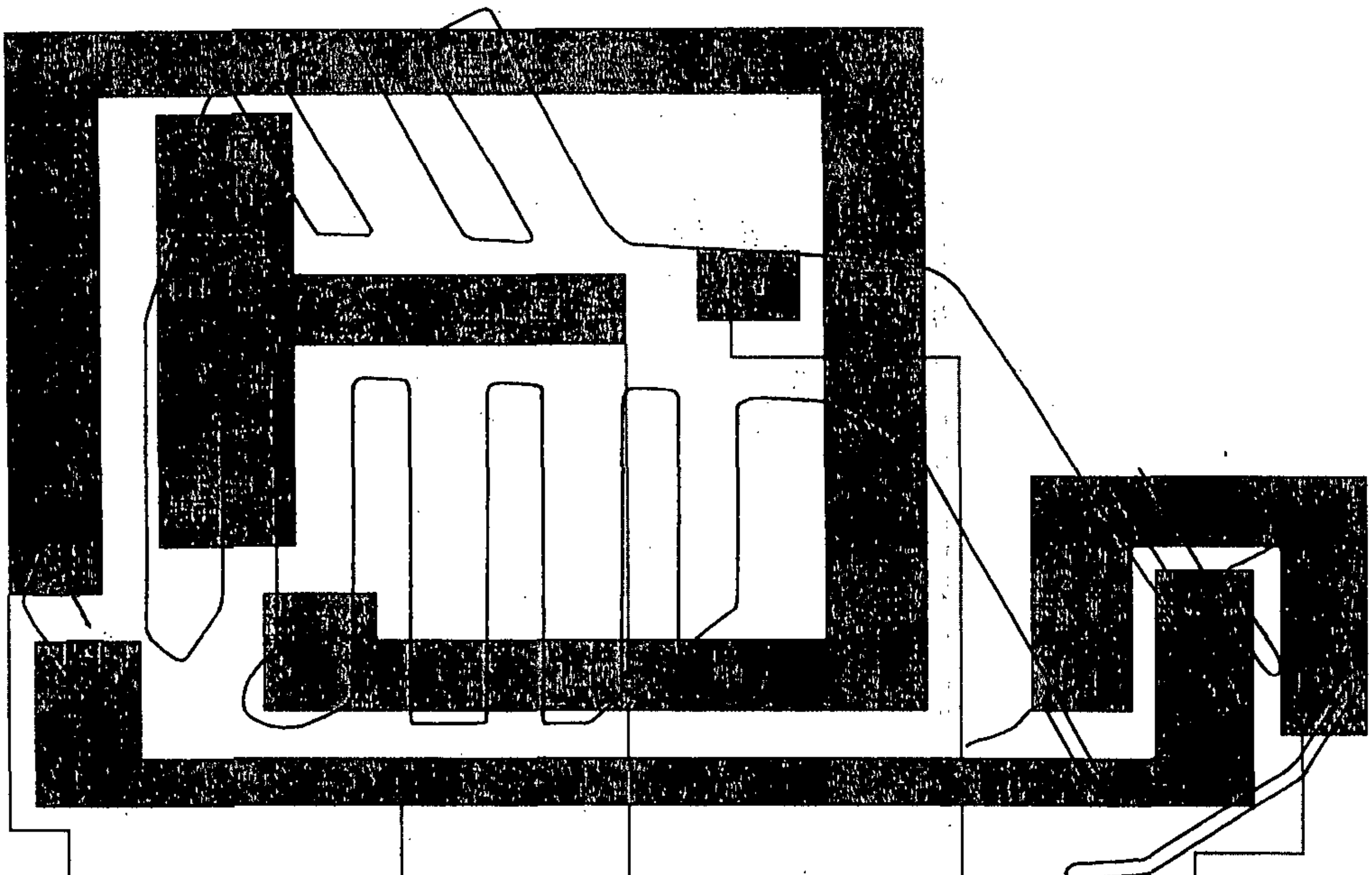
Stations 1 and 3. This group was low in heavy metals, organic compounds, DDT and other chlorinated pesticides and high in TBT and organic nitrogen. These stations are found near the Harbor entrance.

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 from nonpoint origins, contribute to pollution but are difficult to determine. Sediment particle size patterns also influence the distribution of many compounds.

Similar to our past three surveys (Aquatic Bioassay 1997, 1998, 1999), inflows from the Oxford Lagoon and Ballona Creek may be sources of chlorinated pesticides. Sediments from Ballona Creek and Station 2 near the Harbor entrance were much higher than all other stations in DDT-type and other chlorinated pesticides. Water and suspended particles flowing from Ballona Creek may reflect off of the breakwall and deposit onto the sediment surface of Station 2. Stations 1 and 3, usually affected by Ballona Creek influx, did not exhibit similar chemical characteristics and had lower concentrations of DDT derivatives and pesticides. Oxford Lagoon showed variable concentrations of DDTs and pesticides, Station 22 had low concentrations and Station 13 had high concentrations. Basin E, traditionally influenced by Oxford Lagoon, only reported moderate levels of DDTs and pesticides. Interestingly, the highest concentration of DDT occurred at Station 25 in mid channel, next to the public fishing docks and DDT itself was found at Station 4, the neighboring station. Historically, the area surrounding Marina del Rey was once used as a toxic materials dumpsite, so the presence of DDT breakdown products (i.e. DDD and DDE) is not surprising. The presence of DDT itself, however, suggests a fresh source or fresh exposure to the Harbor.

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



Stations 4, 6, 7, 8, 22	Stations 2, 12, 13	Stations 5, 9, 10, 11	Station 25	Stations 1, 3
High in:	**High in:**	**High in:**	**High in:**	**High in:**
TBT	TBT	Arsenic	Arsenic	TBT
--	DDT	Cadmium	Cadmium	Organic Nitrogen
--	Pesticides	Chromium	Chromium	
--	Immediate Oxygen Demand	Copper	Copper	**Low In:**
--	Oil and Grease	Iron	Iron	Arsenic
--	Organic Nitrogen	Lead	Lead	Cadmium
--	Ortho Phosphate	Manganese	Manganese	Chromium
--	--	Mercury	Nickel	Copper
--	--	Nickel	Silver	Iron
--	--	Silver	TBT	Lead
--	--	TBT	Zinc	Manganese
--	--	Zinc	TOC	Mercury
--	--	TOC	Volatile Solids	Nickel
--	**Low In:**	Volatile Solids	Chemical Oxygen Demand	Selenium
--	Arsenic	Immediate Oxygen Demand	Oil and Grease	Silver
--	Cromium	--	Organic Nitrogen	TBT
--	Copper	--	Sulfides	Zinc
--	Iron	--	DDT	DDT
	Manganese		Pesticides	TOC
Low In:	Mercury	**Low In:**		Volatile Solids
DDT	Nickel	Chemical Oxygen Demand	**Low In:**	Chemical Oxygen Demand
Lead	Selenium	Oil and Grease	Selenium	Ortho Phosphate
Selenium	Chemical Oxygen Demand	Selenium		Sulfides
Charateristics: High in TBT. Low in DDT, lead and selenium. Moderate in all other chemical constituents.	**Charateristics:** High concentrations of DDT, TBT, pesticides and some organics. Moderate to low in all other constituents.	**Charateristics:** High in nearly all metals and organics. Moderate to low in all other constituents.	**Charateristics:** High in DDT, other pesticides, most organics and metals. Low in selenium.	**Charateristics:** Low in DDT, other pesticides, organics and metals High in TBT and organic nitrogen.

Although chlorinated hydrocarbon concentrations have declined over the past five years, several 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. Only Station 22 in Oxford Lagoon, Station 3 near the Harbor entrance and Station 8 in Basin D did not exceed any NOAA limits. Additionally, Stations 2, 5, 10, 12, 13 and 25 exceeded the higher limits (ER-M and/or AET) 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). With one exception, pesticide and PCB concentrations were equal to or below last year's and historical values for Los Angeles Harbor but more stations exceeded ER-M, AET or both. Unusually, Station 12 in Ballona Creek had the highest concentration of Arochlor-1254 (a PCB), since 1994. On average, total DDT and PCB concentrations in Marina del Rey Harbor sediments are much lower than those of Los Angeles Harbor and slightly lower than the 1979 and 1987 SCCWRP Reference Site Surveys (Table 5-3).

Again, neither Oxford Lagoon nor Ballona Creek appear to be a source of heavy metals into the Harbor. Areas that do appear to have the highest metal concentrations were mostly mid and back channel stations (Stations 5, 9, 10, 11, and 25). Since most of the metals occur in this area, a likely source of some metals is the thousands of boats that utilize the Marina. Boats have metal components and engines that constantly corrode from salt water and air. Anti-fouling paints contain heavy metals such as copper and tributyl tin that are designed to constantly ablate or leach out to effectively reduce fouling organisms. Short of banning these products, sediments in the Harbor will likely continue to accumulate heavy metals in toxic amounts. Mercury, lead and zinc concentrations were also found in toxic amounts. Both these toxicants might have originated from the historical industrial land uses of the Marina and possibly released by dredging or derived from boating activity. Stations 1, 3 and 12 did not exceed any potentially toxic limits of any metals. All remaining stations exceeded at least one metal limit of "probable" toxicity to marine organisms, based on those listed by NOAA.

Most heavy metals in Marina del Rey sediments fell within, or near to, the range of values measured in Los Angeles Harbor sediments, however, values of copper, lead and zinc were two to three times higher. Los Angeles Harbor, with two entrances, likely maintains better flushing than Marina del Rey Harbor with only one entrance. Additionally, the boat population per unit area in Marina del Rey may be higher than in Los Angeles Harbor. Most, but not all metals were higher than those collected along the open coast.

Except for tributyl tin, heavy metal concentrations have varied since 1988, but haven't greatly increased or decreased over time. However, tributyl tin concentrations were the lowest recorded since 1988 despite being ubiquitous in the Harbor. 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 are banned from use in Marina del Rey Harbor.

Nonspecific organic materials (nutrients, oil and grease, carbonaceous organics, etc.) are not usually considered toxic, however, elevated levels in the sediment can cause anoxic conditions near the Harbor bottom which can lead to a degeneration of the habitat for sensitive fish and invertebrates. Sources of nonspecific organic pollutants vary. Ballona Creek, with high levels of organic compounds, may have directly influenced the high values found at Station 2 since nearby Stations 1 and 3 had low levels of organics.

Ballona Creek may only have contributed some organic nitrogen to Stations 1 and 3 as that was the only organic found in relatively high amounts. Oxford Lagoon did not appear to be a great source of organics this year, areas surrounding Station 13, including Station 22, did not have extremely high organic levels. On the other hand, Stations 5 and 25 in mid channel, Station 9 (Basin F), Station 11 in the back Harbor and Station 10 (Basin E) contained high levels of most organics. Various natural and anthropogenic seepage from boats and other nonpoint runoff undoubtedly contribute considerable amounts of organics to the benthos. Among the compounds historically measured (TOC, volatile solids, COD, and organic nitrogen), all were lower than or comparable to the 1979 SCCWRP Reference Site Survey, except volatile solids which were much higher. There are no NOAA limits for any nonspecific organic compounds.

As discussed in the past four annual reports (Aquatic Bioassay 1997, 1998, 1999, 2000), Harbor sediments that are composed of finer particles, such as silt and clay, also tend to be highest in heavy metals and organics. Sediments with particle sizes dominated by finer components tend to attract many chemical contaminants more readily. Conversely, sediments containing mostly sand and course silt tended to be lower in organics and heavy metals. The exception appears to be chlorinated hydrocarbons that do not appear to show any strong relationship to smaller particle size. Thus, many of the areas that have high concentrations of metals and nonspecific organics tend to be areas of relatively fine sediments.

6. BIOLOGICAL CHARACTERISTICS OF BENTHIC SEDIMENTS

6.1. BACKGROUND

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

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

6.2. MATERIALS AND METHODS

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

6.3. RESULTS

6.3.1. Benthic Infauna

6.3.1.1. **Infaunal Abundance**

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

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

Spatial infaunal abundance patterns. Numbers of individuals at the 13 infaunal sampling stations are listed in Table 6-1 and summarized in Figure 6-1. Counts per grab ranged from 199 to 4286 individuals. Lowest total abundance was at Station 6 in Basin B (199 individuals), Station 9 in Basin F (241 individuals), and at Station 11 at the upper end of the main channel (233 individuals). Highest values were at Station 4 in the main channel (4286 individuals), followed by Station 12 in Ballona Creek (3930 individuals), and Station 25 also in the main channel (3174 individuals). Unlike last year, nematodes, those animals that indicate a disturbed environment, were not found in high percentages at any station. Most individuals found at all stations was the polycheate, *Mediomastus spp.* (6184 individuals total) With the highest abundance found at Station 12 (2765 individuals).

Infaunal abundance patterns compared with past years. Table 6-2 lists abundance ranges per station since 1977. The range of individuals collected this year was 199 to 4286, which is lower than the last two years but not uncommon over the past 17 years listed. Abundance has varied widely as shown in past surveys.

Infaunal abundance values compared with other surveys. The Marina del Rey abundance average (1607 individuals) and range (199 to 4286 individuals) were much higher than in Los Angeles Harbor (105 individuals, 5 to 330 individuals) and the 1979 (422 species, 91 to 1213 individuals) and the 1987 (348 individuals) SCCWRP Reference Site Surveys (Table 6-3). Note that sediments in Marina del Rey Harbor are screened to 0.5 mm, rather than 1.0 mm, which is more typical of sediment surveys.

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]	1412	2000	1559	4286	667	199	1285	1045	241	861	233	3930	3174
No. Species	78	83	94	63	41	19	39	28	22	38	24	72	79
Diversity (SWI)	1.84	2.38	3.33	1.62	2.18	2.18	1.67	1.90	2.16	2.49	2.19	1.44	2.29
Infaunal Index	66.8	64.7	48.0	84.1	67.7	76.0	75.2	70.6	80.8	65.1	71.2	57.7	61.9
Dominance	0.28	0.39	0.75	0.20	0.44	0.60	0.32	0.41	0.51	0.60	0.56	0.24	0.37

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

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

	POPULATION INDICES				
DATE	Individuals	Species	Diversity	Dominance	Infaunal Index
Sep-77	254 - 7506	9 - 67	—	—	—
Sep-78	177 - 1555	15 - 66	—	—	—
Oct-84	242 - 1270	19 - 60	1.81 - 3.09	—	—
Oct-85	196 - 1528	20 - 51	1.06 - 2.78	—	—
Oct-86[1]	275 - 22,552	18 - 79	1.49 - 2.48	—	—
Oct-87	189 - 4216	12 - 50	1.19 - 2.76	—	—
Oct-88	63 - 5651	11 - 74	0.76 - 2.95	—	—
Oct-89[2]	36 - 7610	10 - 72	0.58 - 2.99	—	—
Oct-90	153 - 9741	18 - 69	0.82 - 2.33	—	—
Oct-91	85 - 31,006	14 - 121	0.44 - 2.34	—	—
Oct-92	100 - 2080	10 - 55	1.51 - 2.34	—	—
Oct-94	120 - 105,390	15 - 70	0.48 - 2.83	—	—
Oct-95	65 - 7084	11 - 66	1.17 - 2.91	—	—
Oct-96	216 - 12,640	28 - 78	0.92 - 3.03	0.12 - 0.71	27 - 71
Oct-97	109 - 4818	20 - 88	0.98 - 2.81	0.13 - 0.70	30 - 77
Sep-98	241 - 32,760	18 - 77	1.24 - 2.43	0.22 - 0.65	58 - 72
Oct-99	80 - 16,933	24 - 68	0.48 - 2.79	0.04 - 0.70	61 - 86
Overall Range	**36 - 105,390**	**9 - 121**	**0.44 - 3.09**	**0.04 - 0.71**	**27 - 86**
Oct-00	199 - 4286	19 - 94	1.44 - 3.33	0.20 - 0.75	48 - 84

[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	**1607**	**199 - 4286**	105	5 - 330	422	91- 1213	348
No. Species	**52**	**19 - 94**	35	5 - 64	72	32 - 135	68
Diversity (SWI)	**2.13**	**1.44 - 3.33**	2.92	1.59 - 3.72	3.12	2.19 - 3.98	--
Infaunal Index	**68**	**48 - 84**	74	67 - 83	88	60 - 98	–

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

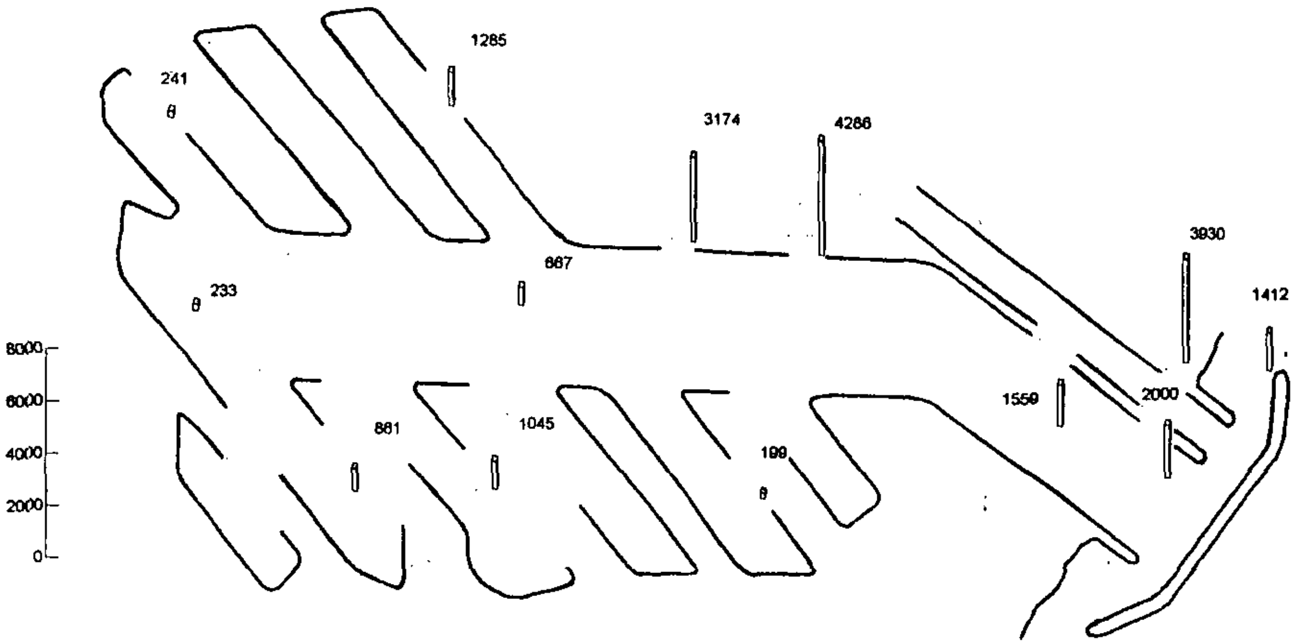
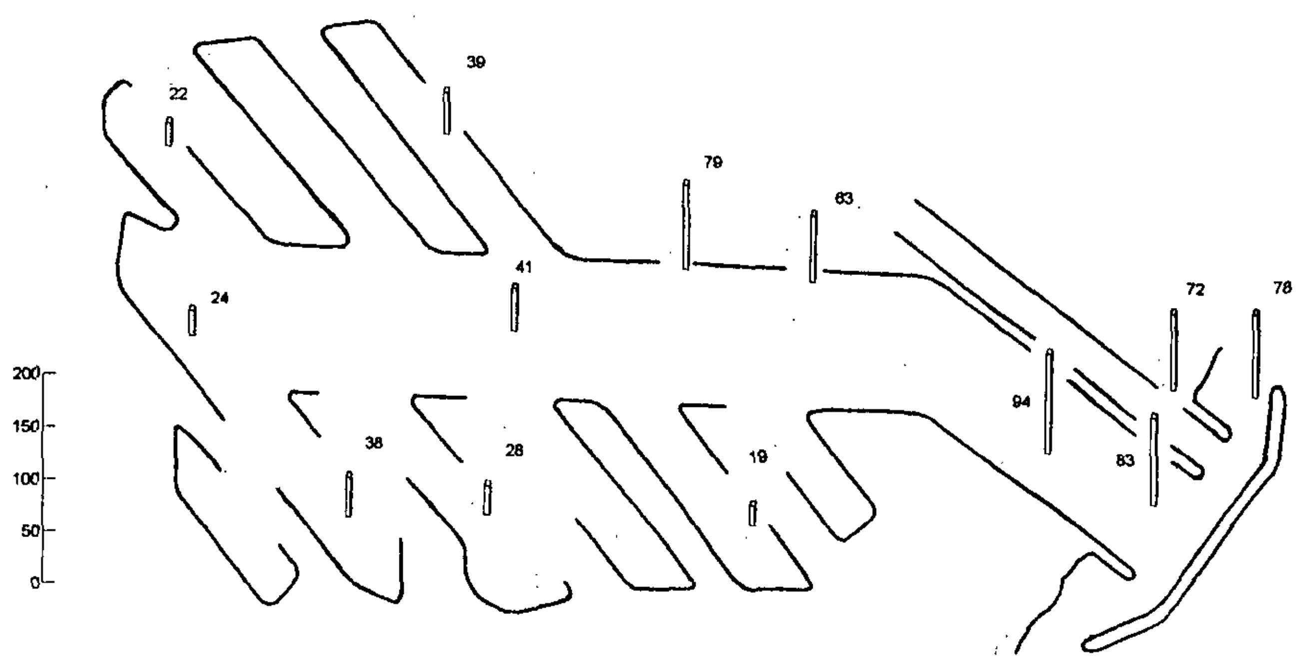


FIGURE 6-2. NUMBER OF INFAUNAL SPECIES AT 13 BENTHIC SEDIMENT STATIONS.



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 19 to 94 per grab (Table 6-1 and Figure 6-2). Lowest species numbers were in the back Harbor and at the ends of Basins B, D and F (Stations 6, 8, 9 and 11 - 19 to 28 species). Highest values were at the Harbor entrance and mid channel (Stations 1, 2, 3, 4, 12 and 25 - 72 to 94 species).

Infaunal species patterns compared with past years. Table 6-2 lists the ranges of species collected per station since 1977. The range of species collected this year was 19 to 94, which falls within the overall range of values for past surveys but more species were found this year than in the past seven years.

Infaunal species values compared with other surveys. The Marina del Rey species count average (52 species) and range (19 to 94 species) were higher than the Los Angeles Harbor (35 species, 5 to 64 species), but lower than the 1979 (72 species, 32 to 135 species) and 1987 (68 species) SCCWRP Reference Site Surveys (Table 6-3). As discussed above (6.3.1.1.), screen sizes among surveys may have been different.

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 1.44 to 3.33 (Table 6-1 and Figure 6-3). The lowest diversity value was in Ballona Creek (Station 12 – 1.44), due to the extremely high counts of *Mediomastus spp.* (2765 individuals). Values were relatively high throughout the Harbor (1.62 to 3.33). The highest value was at Station 3, near the Harbor entrance (3.33).

Infaunal diversity patterns compared with past years. Table 6-2 lists the ranges of diversity values calculated per station since 1984. The range of values this year was 1.44 to 3.33, which is higher than past surveys likely due to the higher number of species. Diversity indices had not been calculated previous to 1984.

FIGURE 6-3. INFAUNAL DIVERSITY AT 13 BENTHIC SEDIMENT STATIONS.

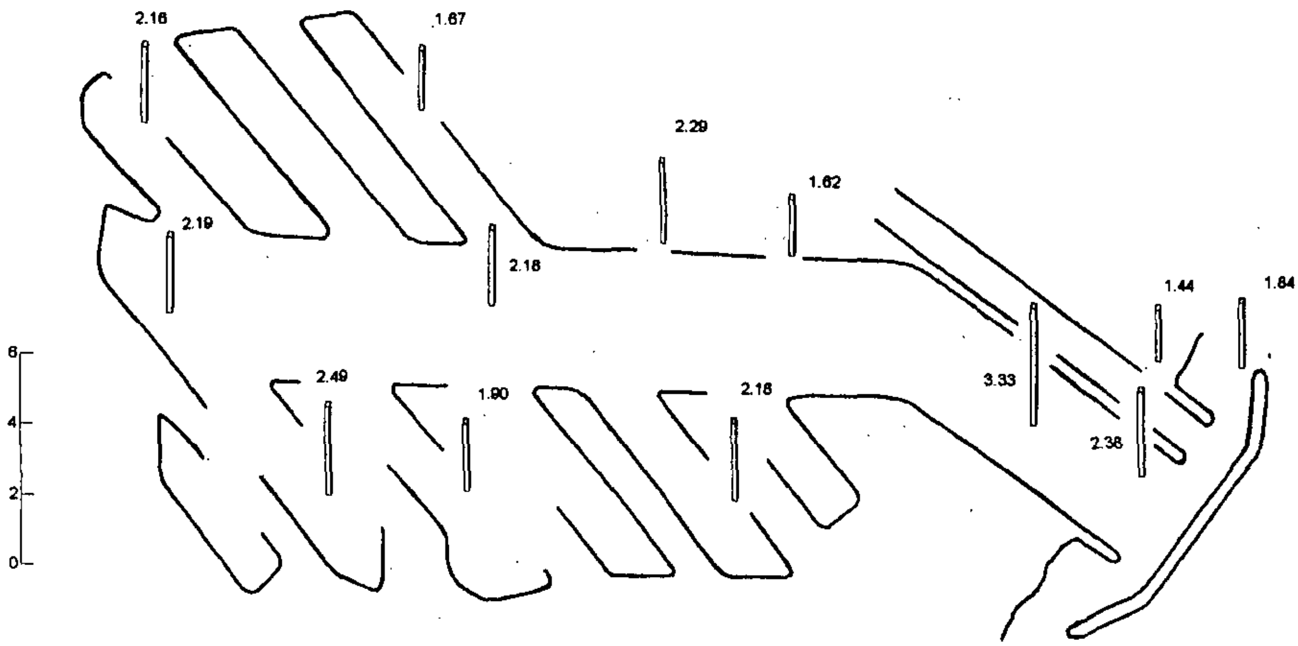
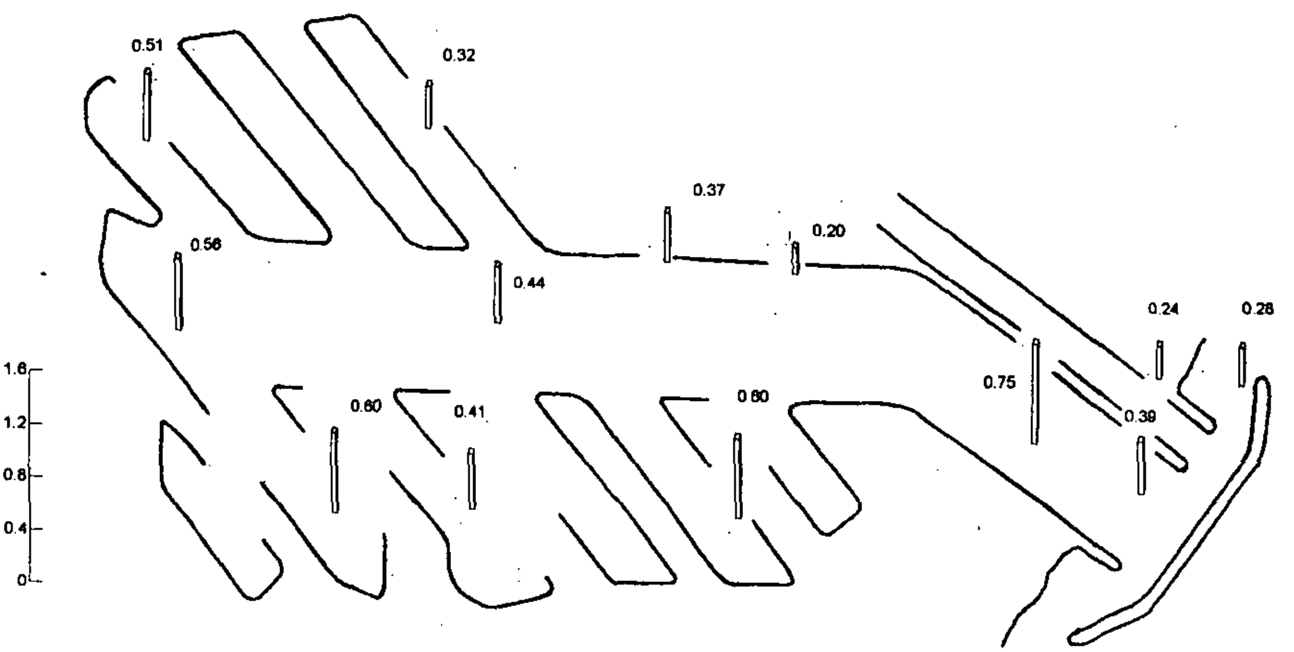


FIGURE 6-4. INFAUNAL DOMINANCE AT 13 BENTHIC SEDIMENT STATIONS.



Infaunal diversity values compared with other surveys. The Marina del Rey diversity average (2.13) and range (1.44 to 3.33) were lower than Los Angeles Harbor (2.92, 1.59 to 3.72) and the 1979 SCCWRP Reference Site Survey (3.12, 2.19 to 3.98). No diversity values were calculated in the 1987 SCCWRP Survey (Table 6-3). As discussed above (6.3.1.1.), screen sizes among surveys may have been different.

6.3.1.4. **Infaunal Dominance**

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

Spatial infaunal dominance patterns. Dominance values at the 13 sediment sampling ranged from 0.20 to 0.75 (Table 6-1 and Figure 6-4). The lowest dominance values were near the Harbor entrance (Stations 1 and 12 - 0.28 and 0.24, respectively) and in mid channel (Station 4 – 0.20). Highest values were also near the Harbor entrance (Station 3 - 0.75) and in Basin B (Station 6 – 0.60, Basin E and back Harbor (Stations 10 and 11 – 0.60 and 0.56, respectively).

Infaunal dominance patterns compared with past years. The dominance range (0.20 to 0.75) was slightly higher compared to those of the past four 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.

Spatial infaunal trophic index patterns. Infaunal trophic index values at the 13 sampling stations ranged from 48 to 84 (Table 6-1 and Figure 6-5). Lowest infaunal index values were at Station 3 near the Harbor entrance (48) and at Station 12 in Ballona Creek (58). The highest values were at Station 4 in mid-channel (84) and Station 9 in Basin F (81). All stations except Stations 3 and 12 had index values (62 to 84) which are defined as "normal" (60 and above).

Infaunal trophic index patterns compared with past years. The infaunal index range (48 to 84) was within the range of the past four years (Table 6-2). 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 (68) and range (48 to 84) 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).

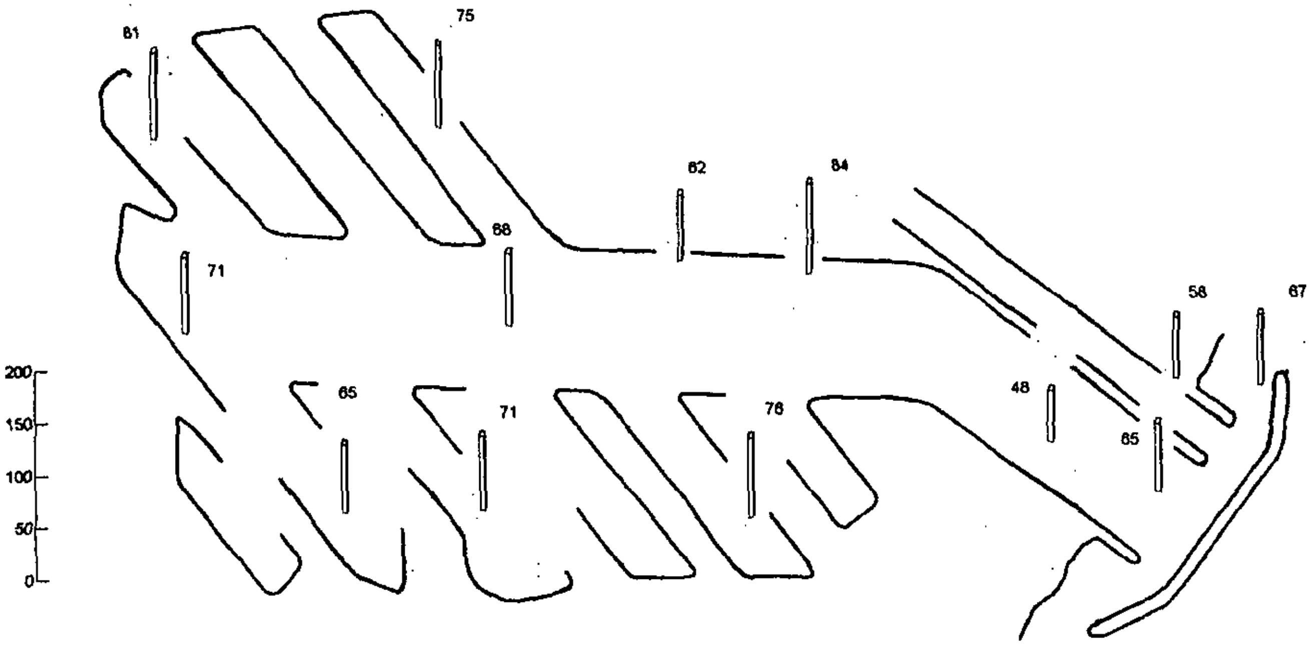
6.3.2. Station Groupings Based on Infaunal Measurements

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.

Station 10. This Station is located in Basin E in the back of the Harbor and is influenced by inflow from Oxford Lagoon. Station 10 is high in diversity and dominance and has a moderate number of individuals and infaunal index values. Among the ten most abundant species, there were eight polychaete worms, one oligochaete worm and one nematode worm. Crustaceans, which are more common in healthier environments, were noticeably absent. Although the nematode and the oligochaete worm are known to be associated with disturbed benthic environments, the infaunal index value was normal (65) probably since these worms did not occur in high numbers. This may be an area of some stress.

Stations 1, 5, 6, 7, 8, 9 and 11. These stations are spread throughout the Harbor. Station 1 is at the Harbor entrance, Station 11 in the back Harbor, Station 5 in mid-channel and Stations 6, 7, 8 and 9 are located in Basins B, H, D and F, respectively. This group was characterized by being high in nothing and low only in number of individuals. Of the ten most abundant species, eight were polychaete worms; one was a phoronid worm and one a nemertean worm. None of these species were indicative of a stressed community, so the infaunal index values were normal (67 to 81). Despite the relatively low numbers, these stations appear to characterize a moderately healthy infaunal environment.

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



Stations 2, 3 and 25. Stations 2 and 3 are located near the Harbor entrance and Station 25 is located in mid-channel. These stations are characterized by a high number of individuals, high species counts and high diversity values but have low in infaunal index values (range: 48 - 65). Of the ten most abundant species, four were polychaete worms, two were bivalves, one was a nematode worm, another was a nemertean worm, one was a phoronid worm and one has an oligochaete worm. This area represents a moderately stressed benthic environment.

Station 4. Station 4 is in mid channel. This station has a high number of individuals and a high infaunal index but is low in diversity and dominance values. Of the ten most abundant species, eight were polychaete worms, one was a crustacean and one was a phoronid worm. Among these ten, only the polychaete worm (*Armandia brevis*) is indicative of unhealthy benthic environments. Despite the presence of this specie, the infaunal trophic index value at this station was the highest (84) of this survey. The near absence of crustaceans in the top ten species and the low values of diversity and dominance suggest that this station may be experiencing some slight environmental stress.

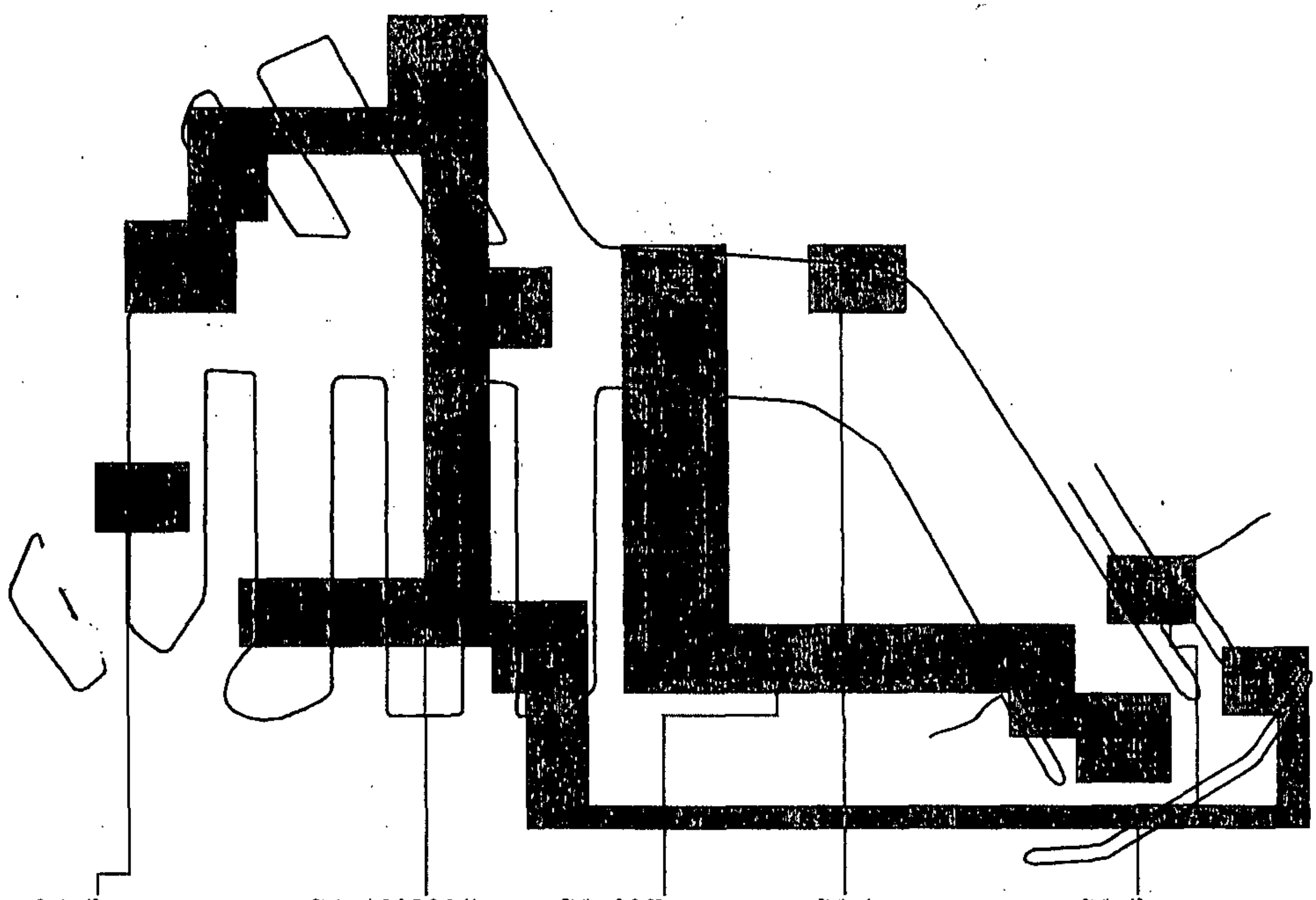
Station 12. This station lies in Ballona Creek near the entrance to the Harbor. This station is characterized by a high number of individuals and low diversity and infaunal index. Of the ten most abundant species, eight were polychaete worms and two were crustaceans. Among the ten most common species, two polychaete worms (*Dorvillea annulata* and *Armandia brevis*) are thought to be representative of unhealthy benthic environments. The infaunal index is below normal (58), which suggests a changing environment. Despite the presence of more than one specie of crustaceans, the low diversity and infaunal index values suggest this station is likely experiencing environmental stress.

6.4. DISCUSSION

As in past surveys, the infaunal community at stations at or near inflows from Oxford Lagoon (Station 10) and Ballona Creek (Stations 2, 3 and 12) appear to be undergoing moderate environmental stress. Additionally, Station 4 and 25 also show some evidence of environmental stress in this survey. These stations contained organisms that are present in sediment near wastewater outfall diffusers, or are otherwise known to be present in disturbed habitats.

Several stations located at the back of the Harbor and Basins (5, 6, 8, 9, and 11) where fewer disturbances might occur were low in individuals and moderate in all other categories. Surprisingly, Station 1 near the entrance to the Harbor grouped with these back-Harbor stations. Ballona Creek and open ocean influences might give this station a mixed signal. These stations were considered the most environmentally healthy in the Harbor.

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



Station 10

High In:
Diversity
Dominance
–

Low In:
–
–
–

Dominants:
Streblospio benedicti (p)
Aphelochaeta "parva" (p)
Euchone limnicola (p)
Mediomastus spp. (p)
Pseudopolydora paucibranchiata (p)
Oligochaeta (o) *
Caulleria pacifica (p)
Exogone cf verugera (p)
Lumbrineris sp. C (Harris) (p)
Nematode (n) *

Characteristics:
Two species present which are indicative of a stressed benthic environment.

Stations 1, 5, 6, 7, 8, 9, 11

High In:
–
–
–

Low In:
Individuals
–
–

Dominants:
Mediomastus spp. (p)
Leitoscoloplos pugettensis (p)
Lumbrineris sp. C (Harris) (p)
Exogone sp. (p)
Phoronis sp. (ph)
Aphelochaeta "parva" (p)
Euchone limnicola (p)
Pseudopolydora paucibranchiata (p)
Carinoma mutabilis (ne)
Lumbrineris sp. (p)

Characteristics:
Moderately healthy group with some evidence of stress.

Stations 2, 3, 25

High In:
Individuals
Species
Diversity

Low In:
Infaunal Index
–
–

Dominants:
Mediomastus spp. (p)
Prionospio heterobranchia (p)
Laevicardium substriatum (b)
Protothaca staminea (b)
Nematode (n) *
Carinoma mutabilis (ne)
Phoronis sp. (ph)
Oligochaeta (o) *
Exogone cf verugera (p)
Notomastus sp. 1 (Phillips) (p)

Characteristics:
Two species present which are indicative of a stressed benthic environment.

Station 4

High In:
Individuals
Infaunal Index
–

Low In:
Diversity
Dominance
–

Dominants:
Phoronis sp. (ph)
Pseudopolydora paucibranchiata (p)
Mediomastus spp. (p)
Exogone sp. (p)
Prionospio heterobranchia (p)
Rudilemboides stenopropodus (c)
Euchone limnicola (p)
Polyophthalamus pictus (p)
Armandia brevis (p) *
Exogone lourei (p)

Characteristics:
One species present which is indicative of a stressed environment.

Station 12

High In:
Individuals
–
–

Low In:
Diversity
Infaunal Index
–

Dominants:
Mediomastus spp. (p)
Armandia brevis (p) *
Polyophthalamus pictus (p)
Dorvillea (Schistomeringos) annulata (p) *
Prionospio heterobranchia (p)
Ericthonius brasiliensis (c)
Prionospio lighti (p)
Pseudopolydora paucibranchiata (p)
Notomastus sp. 1 (Phillips) (p)
Oxyurostylis pacifica (c)

Characteristics:
Two species present which are indicative of a stressed benthic environment.

(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), infaunal trophic index and diversity values as well as number of species tended to be lower, while numbers of individuals tended to be higher. This is not surprising since Marina del Rey is an enclosed harbor and the SCCWRP control sites were at uncontaminated sites along the open coast. When compared to Los Angeles Harbor, numbers of individuals and species were higher; diversity was lower and the infaunal index values slightly lower. Higher diversity patterns in Los Angeles Harbor may be related to the fact that flow patterns there are much less restricted since there are two entrances to the Harbor instead of only one as in Marina del Rey. In addition screening sizes may vary between the two harbors. With the exception of one particularly low dominance value at Station 1 and one particularly high infaunal index value at Station 5, all population variables this year were comparable to past surveys. Overall, there were more species found this year than last, diversity and dominance values were higher, and the majority of infaunal trophic index values were above normal (>60) and none were considered degraded (<30).

7. FISH POPULATIONS

7.1. BACKGROUND

Marina del Rey functions as important small wetlands in a southern California area where about ninety percent of the wetlands have been lost due to development. While the original configuration of the Ballona wetlands was a large natural estuarine system, it was altered radically by the channelization of flow into a creek in the 1920s. Filling and dumping occurred to create farmlands and oil or gas development, altering drainage patterns of small meandering streams and shallow waters. Excavation of the marina in the 1960s and building of the breakwater completed the reconfiguration of the wetlands to the north and west of the creek. Nevertheless, the marina provides a viable habitat for larval, juvenile and adult inshore fish species. The shallow, warm waters are nutrient laden, and the turbidity due to phytoplankton and sediment offer some protection from predatory fish and birds. Some species that frequent the marina as eggs, larvae or juveniles migrate from the warmer waters seaward as adults, returning to spawn outside or inside the marina. Marina fauna are sometimes disturbed by natural events such as large storms, heavy rains and excessive heat, and by manmade impacts due to dredging, oil films, slicks or spills. Illegal dumping of chemicals, sewage or debris may occur in the marina or in flood control channels that drain or impinge on the marina. Thus the marina may have a slightly lower average number of species as compared to marinas with more open access to the ocean, providing better flushing (Soule et al. 1996).

Surveys were first conducted as part of an experimental study of methods by Harbors Environmental Projects in the marina in 1977-1979 with funding assistance from the NOAA-Sea Grant Program. Dr. John S. Stephens, Jr., and his staff from the Vantuna Group at Occidental College continued them in 1980-81 on a voluntary basis. After a hiatus, the Vantuna Group in cooperation with the USC monitoring program for the Department of Beaches and Harbors resumed surveys in 1984 (Soule et al. 1996). Since 1996, Aquatic Bioassay of Ventura, California has conducted the surveys.

7.2. MATERIALS AND METHODS

Trawl sampling was conducted in accordance with *Use of Small Otter Trawls in Coastal Biological Surveys*, EPA 600/3-78/083, August 1978 and *Quality Assurance and Quality Control (QA/QC) for 301(h) Monitoring Programs: Guidance on Field and Laboratory Methods*, Tetra Tech 1986. Survey stations and techniques were standardized in 1984 and include: trawls performed using a semiballoon otter trawl towed in duplicate for five minutes at three locations; a 100 ft (32.8 m) multimesh gill net deployed at three locations for 45 minutes each, and a 100 ft (32.8 m) beach seine deployed at 2.5 m depth about 30 m from the beach and fished to shore. 100-meter diver surveys were performed along the inner side of the breakwater and along the jetties in the entrance channel. Due to low gill net catches, the deployment was extended to two hours in 1998.

Eggs and larvae (ichthyoplankton) were collected around 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.

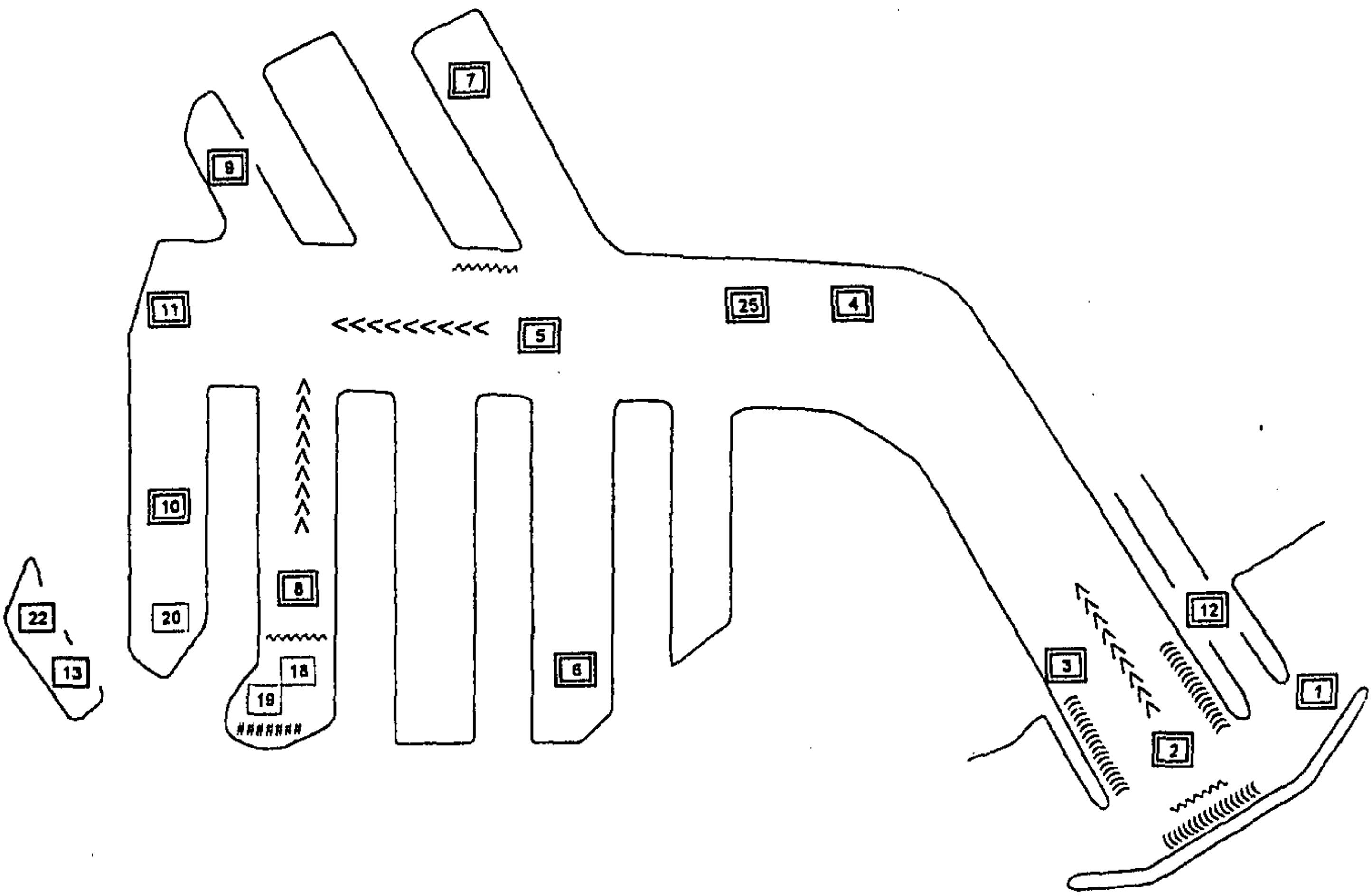
7.3. RESULTS

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 were 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 1985 by various dive and net collection techniques (there was no spring 1985 survey). Among 111 different species collected since 1985, four were present in all 32 surveys: topsmelt (*Atherinops affinis*), opaleye (*Girella nigricans*), blenny (*Hypsoblennius sp.*) and kelp bass (*Paralabrax clathratus*). Fourteen other species have occurred frequently (over 25 times): blacksmith (*Chromis punctipinnis*), black surfperch (*Embiotoca jacksoni*), northern anchovy (*Engraulis mordax*), suite of larval gobies (Gobiedae A/C), rock wrasse (*Halochoeres semicinctus*), giant kelpfish (*Heterostichus rostratus*), diamond turbot (*Hypsopsetta guttulata*), garibaldi (*Hypsypops rubicundus*), dwarf surfperch (*Micrometrus minimus*), bat ray (*Myliobatis californica*), senorita (*Oxyjulis californica*), barred sand bass (*Paralabrax nebulifer*), California halibut (*Paralichthys californicus*), and spotted turbot (*Pleuronichthys ritteri*). These fish are found in the Harbor during both spring and fall, are characteristic of a wide range of habitat types and represent a diverse group of fish families. Several fish species have not been found since 1984 they are shovelnose guitarfish (*Rhinobatos productus*), a croaker specie (Scaenidae) and brown rockfish (*Sebastes auriculatus*). These are not included in Table 7-1.

7.3.1. Bottom Fish

Bottom fish were collected using a standard five-meter headrope otter trawl. Fish were collected at three locations within the Harbor (Figure 7-1) on October 27, 2000 and May 1, 2001. At each station, replicate trawls of five minutes each were conducted. Data from replicate trawls were combined for analysis.

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

TABLE 7-1. EGG, LARVAL, AND ADULT FISH TAXA COLLECTED DURING SPRING (Sp) AND FALL (Fl), 1985 TO PRESENT.

SCIENTIFIC NAME	COMMON NAME	85	86		87		88		89		90		91		92*		93		94		95		96		97		98		99		00			All	All	
		Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Fl	Sp	Sp	Fl	Tot.
Acanthogobius flavimanus	Yellowfin Goby			x		x	x	x	x								x	x	x				x		x	x								6	5	11
Albula vulpes	Bonefish						x								x	x		x								x	x	x	x	x	x			5	5	10
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	x	x	x		4	5	9
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	x	x	13	12	25
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	x	x	16	16	32
Atherinopsis californiensis	Jacksmelt		x	x	x	x			x										x	x			x	x	x		x		x		x	x		9	5	14
Atractoscion nobilis	White Seabass		x	x	x									x												x		x						2	4	6
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	x	x		12	15	27
Citharichthys sp.	Sandab Egg/Larvae																															x	x	1	1	2
Citharichthys stigmaeus	Speckled Sandab				x					x												x	x	x	x	x			x					4	4	8
Citharichthys Type A	Sandab Larvae				x														x		x		x	x	x			x	x	x	x			7	3	10
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	x	x	15	5	20
Damalichthys vacca	Pile Surfperch	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x		x	x	x	x	x				x			x	x		x	13	11	24
Embiotoca jacksoni	Black Surfperch	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	16	15	31
Engraulidae	Anchovy																							x	x					x	x			2	2	4
Engraulis mordax	Northern Anchovy		x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x			x	x	x	x	15	12	27
Fundulus parvipinnis	California Killifish	x		x	x		x	x		x	x	x	x	x			x	x		x	x		x	x	x	x	x	x	x	x	x	x	x	12	13	25
Genyonemus lineatus	White Croaker	x	x		x	x		x	x		x		x	x			x		x		x		x	x	x	x	x		x	x	x		x	14	7	21
Gibbonsia elegans	Spotted Kelpfish	x		x		x			x	x	x	x	x	x		x			x	x		x	x					x	x			x		6	11	17
Gibbonsia sp.	Kelpfish																																	0	0	0
Gillichthys mirabilis	Longjaw Mudsucker			x									x			x			x								x					x		3	3	6
Girella nigricans	Opaleye	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	16	16	32
Gobiesox rhessodon	California Clingfish	x	x		x				x		x	x	x	x	x	x	x		x	x	x		x	x	x	x	x		x	x	x		x	15	8	23
Gobiedae A/C	Goby	x		x		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	12	15	27
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		x	15	14	29
Hermosilla azurea	Zebraperch	x		x				x	x			x			x		x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	10	11	21
Heterodontus francisci	Horn Shark								x		x		x																				x	4	0	4
Heterostichus rostratus	Giant Kelpfish	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x			x	x	x	x		x	x	x	x	x	x	14	14	28
Hippoglossina stomata	Bigmouth Sole		x													x																		1	1	2
Hyperprosopon argenteum	Walleye Surfperch		x											x																				1	1	2
Hypsoblennius sp.	Blenny	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	16	16	32
Hypsoblennius gentilis	Bay Blenny	x	x	x		x																												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										3	3	6
Hypsopsetta guttulata	Diamond Turbot			x	x	x		x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x		x	x	x	x	x	14	13	27
Hypsurus caryi	Rainbow Surfperch												x		x		x				x													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	x	x	15	14	29
Ilypnus gilberti	Cheekspot Goby		x	x	x		x				x	x	x												x							x	x	7	3	10
Kyphosidae	Zebraperch																			x														0	1	1
Lepidogobius lepidus	Bay Goby	x	x			x		x						x	x								x					x	x					4	5	9
Leptocottus armatus	Staghorn Sculpin		x	x	x		x		x	x	x		x	x	x	x				x			x	x	x					x			x	10	7	17
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		x			10	3	13
Micrometrus minimus	Dwarf Surfperch	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x			x	x	x	x		x	x	x	x		x	14	13	27
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		8	13	21
Mustelus californicus	Gray Smoothound													x	x							x								x				1	3	4
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	x	x	x	x	14	12	26
Oligocottus/Clinocottus A	Sculpin									x				x																x				0	3	3
Oxyjulis californica	Senorita	x	x		x	x		x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	14	14	28
Oxylebius pictus	Painted Greenling	x									x																							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	x	x	16	16	32

TABLE 7-1. (CONTINUED)

Paralabrax maculatofasciatus	Spotted Sand Bass	x	x	x	x	x			x	x	x	x	x		x																		x	x					7	6	13
Paralabrax nebulifer	Barred Sand Bass	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	16	15	31
Paralabrax sp.	Sea Bass																									x	x								x	2	1	3
Paralichthys califoricus	California Halibut	x	x	x		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	14	16	30
Perciformes	Perch																									x						x				0	2	2
Phanerodon furcatus	White Surfperch		x			x		x	x		x		x	x			x			x			x		x		x		x		x		x	11	4	15
Pleuronectidae**	Flatfish																	x		x			x		x	x						x		2	4	6
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	x	x	x	14	13	27
Pleuronichthys verticalis	Hornyhead Turbot		x			x					x		x											x	x			x	x	x	x	x		6	5	11
Porichthys myriaster	Specklefin Midshipman																														x		x			2	0	2
Quietula y-cauda	Shadow Goby		x	x	x		x		x	x	x		x														x	x							7	3	10
Raja binoculata	Big Skate																										x										1	0	1
Rhacochilus toxotes	Rubberlip Surfperch					x		x		x	x	x				x													x	x	x			x	5	5	10
Sarda chiliensis	Pacific Bonito			x		x																														0	2	2
Sardinops sagax caeruleus	Pacific Sardine	x	x	x	x	x	x		x			x	x		x	x	x		x	x						x		x	x		x		10	8	18
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	x			3	2	5
Sebastes serranoides	Olive Rockfish	x	x			x	x	x		x			x																						3	4	7
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	9	22
Sphyraena argentea	California Barracuda	x	x			x	x			x	x					x							x				x			x			5	5	10
Squatina californica	Pacific Angel Shark	x																										x	x					1	2	3
Stenobrachius leucopsaura	Northern Lampfish		x									x																				x			2	1	3
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			x			3	2	5
Sygnathus leptorhynchus	Bay Pipefish				x	x			x			x																x	x					3	3	6
Synodus lucioceps	California Lizardfish							x																													0	1	1
Triakis semifaciata	Leopard Shark																										x										1	0	1
Type 32	Fish Egg/Larvae																										x	x	x			x	x	x	x	4	3	7
Type 71	Fish Larvae																											x	x	x	x					2	2	4
Typhlogobius californiensis	Blind Goby		x								x				x		x				x											x		x	7	0	7
Umbrina roncador	Yellowfin Croaker	x		x	x	x		x								x	x	x		x		x	x	x	x	x		x	x	x		x		x	11	8	19
Unidentified egg	Unidentified Egg																									x	x	x	x			x	x	x	x	4	4	8
Unidentified larvae	Unidentifed Larvae																										x			x	x	x	x	x	x	4	3	7
Urolophus halleri	Round Stingray			x	x		x		x				x	x	x		x				x		x		x		x		x	x	x			12	3	15
Xenistius californiensis	Salema					x				x		x						x		x				x		x		x	x					1	8	9
Xystreurys liolepis	Fantail Sole							x						x								x								x	x			0	5	5

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

** Unidentifiable turbot larvae.

7.3.1.1. **Bottom Fish Abundance**

Spatial bottom fish abundance patterns. Numbers of bottom fish collected at the three sampling stations are listed in Table 7-2. The largest haul was in the fall at Station 5 in mid channel (229 individuals). Station 5 had the highest spring total as well, 103 individuals. The smallest catch was at Station 8 in Basin D in the fall (2 individuals). Unlike last year, the total count in the fall (237 individuals) was larger than that in the spring (157 individuals).

The most common fish collected in the fall was the northern anchovy (*Engraulis mordax*) at Station 5 in mid channel (212 individuals). The topsmelt (*Atherinops affinis*) was the most common fish collected in the spring (88 individuals). Fall fish collection yielded only eight individuals between Stations 2 and 8 with only the diamond turbot (*Hypsopsetta guttulata*) collected at both stations (3 individuals total). The highest amount of individual fish collected at Station 2 in the spring was 15 shiner surfperch (*Cymatogaster aggregata*) out of 20 total individuals. Station 8 contained a majority of northern anchovy (*Engraulis mordax*) with 23 individuals out of 34 total individuals. No single fish was collected at all three stations in the fall or spring.

Bottom fish abundance patterns compared with past years. Table 7-6 lists the ranges in numbers of bottom fish collected per station since October 1992. Fish collected during October ranged from 2 to 229 per station, which exceeded the overall range of values for past fall surveys. Spring counts ranged between 20 and 103 and were 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. The greatest numbers of species were captured at Station 5 in mid channel in May (6 species). Station 5 in the fall and Station 2 in the spring each had a species count of five. Station 8 had the lowest species count (2 species) in the fall. Total species counts in the fall (8 species) were lower than counts in the spring (12 species).

Bottom fish species patterns compared with past years. Table 7-6 lists the ranges of species of bottom fish collected per station since October 1992. Bottom fish collected during October ranged from two to five species per station, which is characteristic of past ranges. The spring range of species counts (4 to 6) was also characteristic of past ranges.

7.3.1.3. **Bottom Fish Diversity**

Spatial bottom fish diversity patterns. Species diversity calculated from the three trawl sampling stations are listed in Table 7-2. Highest species diversity was at Station 2 in the main channel in October (1.01). Lowest diversity was at Station 5 in mid channel, during the same season (0.34). Averaged among stations, diversity in the spring (0.68) was higher than in the fall (0.79).

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

		OCTOBER 2000 SAMPLING STATIONS			MAY 2001 SAMPLING STATIONS		
SCIENTIFIC NAME	COMMON NAME	#2	#5	#8	#2	#5	#8
Bottom Fish							
Anchoa delicatissima	Slough Anchovy			1			
Anisotremus davidsoni	Sargo		1				
Atherinops affinis	Topsmelt					88	
Cymatogaster aggregata	Shiner Surfperch				15		8
Engraulis mordax	Northern Anchovy		212			2	23
Genyonemus lineatus	White Croaker					9	
Gobiedae A/C	Goby					2	
Gobisox rhessodon	California Clingfish				1		
Heterostichus rostratus	Giant Kelpfish				1		
Heterodontus francisci	Horn Shark					1	
Hypsopsetta guttulata	Diamond Turbot	2		1			
Myliobatus californica	Bat Ray		8				2
Paralabrax sp.	Sea Bass					1	
Paralabrax clathratus	Kelp Bass	1					
Paralichthys californicus	California Halibut	3	7		1		1
Phanerodon furcatus	White Surfperch				2		
Xystreurys liolepis	Fantail Sole		1				
	Individuals	**6**	**229**	**2**	**20**	**103**	**34**
	Species	**3**	**5**	**2**	**5**	**6**	**4**
	Diversity	**1.01**	**0.34**	**0.69**	**0.90**	**0.59**	**0.88**
Midwater Fish							
Engraulis mordax	Northern Anchovy	8					
	Individuals	**8**	**0**	**0**	**0**	**0**	**0**
	Species	**1**	**0**	**0**	**0**	**0**	**0**
	Diversity	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

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

		NOVEMBER 2000 SAMPLING STATIONS			MAY 2001 SAMPLING STATIONS		
SCIENTIFIC NAME	COMMON NAME	North Jetty	Breakwall	South Jetty	North Jetty	Breakwall	South Jetty
Reef Species							
Anisotremus davidsoni	Sargo				9		
Atherinops affinis	Topsmelt				50		
Atherinopsis californiensis	Jacksmelt		60				
Cheilotrema saturnum	Black Croaker	38		8			
Chromis punctipinnis	Blacksmith		185	7			
Cymatogaster aggregata	Shiner Surfperch	2		4	504		
Damalichthys vacca	Pile Surfperch				12	10	15
Embiotoca jacksoni	Black Surfperch				14	8	57
Girella nigricans	Opaleye	280	25	11	64	50	53
Halichoeres semicinctus	Rock Wrasse					14	5
Hermosilla azurea	Zebraperch	4	5	1	2	3	
Heterostichus rostratus	Giant Kelpfish	1					1
Hypsypops rubicundus	Garibaldi		2			6	
Micrometrus minimus	Dwarf Surfperch				36		15
Oxyjulis californica	Senorita		22	15	5	1	25
Paralabrax clathratus	Kelp Bass		8			22	1
Paralabrax nebulifer	Barred Sand Bass					4	1
Rhacochilus toxotes	Rubberlip Surfperch						1
	Individuals	**325**	**307**	**46**	**696**	**118**	**174**
	Species	**5**	**7**	**6**	**9**	**9**	**10**
	Diversity	**0.48**	**1.21**	**1.59**	**1.05**	**1.72**	**1.85**

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

		OCTOBER 2000 SAMPLING STATIONS						MAY 2001 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													
Citharichthys sp.	Sandab								3				
Engraulis mordax	Northern Anchovy								9				
Gibbonsia sp.	Kelpfish		5										
Gillichthys mirabilis	Longjaw Mudsucker		5										
Gobiedae type A/C	Goby	124	1520	286	1858	8	122	177	262	337	753	79	698
Gobiesox rhessodon	California Clingfish								6		3		18
Heterostichus rostratus	Giant Kelpfish										3		
Hysoblennius sp.	Blenny	14	14	487	608	201	244	362	427	213	452	43	212
Hypsopsetta guttulata	Diamond Turbot										3		
Hypsypops rubicundus	Garibaldi								3				
Ilypnus gilberti	Cheekspot Goby				6						162		55
Pleuronectidae	Flatfish		5										
Typhlogobius californiensis	Blind Goby								9				
Unidentified larvae	Unidentified Larvae			8			20		3				
	Individuals	**138**	**1549**	**781**	**2472**	**209**	**386**	**539**	**722**	**550**	**1376**	**122**	**983**
	Species	**2**	**5**	**3**	**3**	**2**	**3**	**2**	**8**	**2**	**6**	**2**	**4**
	Diversity	**0.33**	**0.12**	**0.71**	**0.57**	**0.16**	**0.81**	**0.63**	**0.90**	**0.67**	**0.99**	**0.65**	**0.81**

Fish Eggs													
Atherinops affinis	Silverside							15				7	30
Citharichthys sp.	Sandab Egg	69	385		16		5	81	44				
Engraulis mordax	Northern Anchovy							52	37		6		
Pleuronichthys ritteri	Spotted Turbot	14	48					7					
Pleuronichthys verticalis	Horneyhead Turbot		10										
Type 32	Fish Egg	207	587					229	37				
Unidentified	Unidentified	207	250	162	71	217	76	185	84	7	13	7	12
	Individuals	**497**	**1280**	**162**	**87**	**217**	**81**	**569**	**202**	**7**	**19**	**14**	**42**
	Species	**4**	**5**	**1**	**2**	**1**	**2**	**6**	**4**	**1**	**2**	**2**	**2**
	Diversity	**1.10**	**1.20**	**0.00**	**0.48**	**0.00**	**0.23**	**1.38**	**1.32**	**0.00**	**0.62**	**0.69**	**0.60**

TABLE 7-5. INSHORE FISH COLLECTED BY BEACH SEINE AT MOTHERS BEACH (STATION 19).

SCIENTIFIC NAME	COMMON NAME	NOVEMBER 2000	MAY 2001
Beach Seine Species			
Atherinops affinis	Topsmelt	1303	486
Anisotremus davidsoni	Sargo		5
Clevlandia ios	Arrow Goby		1
Cymatogaster aggregata	Shiner Surfperch		2
Fundulus parvipinnis	California Killifish	124	2
Hypsopsetta guttulata	Diamond Turbot		28
Leptocottus armatus	Staghorn Sculpin		13
Mugil cephalus	Striped Mullet	88	
Umbrina roncador	Yellowfin Croaker		9
	Individuals	**1515**	**546**
	Species	**3**	**7**
	Diversity	**0.500**	**0.441**

TABLE 7-6. RANGES IN NUMBERS OF ALL INDIVIDUALS AND SPECIES OF FISH JUVENILES AND ADULTS COLLECTED: OCT 1992 - MAY 2001

	BOTTOM FISH			MIDWATER FISH			INSHORE FISH			REEF FISH		
DATE	Individuals	Species	Diversity	Individuals	Species	Diversity	Individuals	Species	Diversity	Individuals	Species	Diversity
Oct-92	3 - 19	2 - 3	—	0 - 54	0 - 2	—	311	4	—	1 - 85	1 - 8	—
Oct-93	3 - 6	3 - 4	—	2 - 28	1 - 1	—	1542	5	—	161 - 278	9 - 13	—
Oct-94	0 - 3	0 - 3	—	1 - 66	1 - 3	—	1016	6	—	110 - 304	11 - 19	—
Oct/Nov-95	1 - 8	1 - 5	—	0 - 31	0 - 1	—	416	6	—	6 - 48	2 - 8	—
Oct-96	3 - 53	2 - 10	0.64 - 2.15	0 - 26	0 - 1	0.00 - 0.00	1791	8	0.42	128 - 1862	9 - 12	0.57 - 1.93
Oct-97	13 - 69	4 - 9	0.80 - 1.80	0 - 2	0 - 2	0.00 - 0.69	646	8	0.56	165 - 5353	7 - 15	0.24 - 1.13
Sep-98	21 - 62	5 - 11	1.44 - 1.84	4 - 11	2 - 3	0.30 - 1.04	1091	12	0.35	145 - 512	10 - 14	1.24 - 1.95
Oct-99	24 - 58	5 - 6	0.41 - 1.32	0 - 1	0 - 1	0.00 - 0.00	234	7	0.31	57 - 243	7 - 14	0.96 - 1.88
Fall Range	**0 - 69**	**0 - 10**	**0.41 - 2.15**	**0 - 66**	**0 - 3**	**0.00 - 0.69**	**234 - 1791**	**4 - 12**	**0.31 - 0.56**	**1 - 5353**	**1 - 19**	**0.24 - 1.95**
Oct/Nov-00	2 - 229	2 -5	0.34 - 1.01	0 - 8	0 - 1	0.00 - 0.00	1515	3	0.50	46 - 325	5 - 7	0.48 - 1.59
May-93	1 - 17	1 - 6	—	1 - 63	1 - 3	—	406	10	—	123 - 544	4 - 13	—
May-94	5 - 20	3 - 5	—	0 - 17	0 - 4	—	1418	6	—	15 - 130	2 - 12	—
May-95	4 - 13	4 - 5	—	0 - 44	0 - 5	—	8165	9	—	0 - 42	0 - 9	—
May-96	2 - 38	1 - 9	—	0 - 34	0 - 2	—	3321	9	—	30 - 320	8 - 16	—
May-97	35 - 69	8 - 9	1.48 - 1.91	0 - 6	0 - 3	0.00 - 0.60	1066	11	0.42	2169 - 7267	5 - 9	0.07 - 0.19
May-98	20 - 147	6 - 13	1.51 - 2.01	0 - 18	0 - 2	0.00 - 0.64	2145	9	0.42	24 - 150	2 - 10	0.56 - 1.88
May-99	18 - 75	6 - 8	0.68 - 1.89	11 - 373	1 - 6	0.00 - 0.37	1884	10	0.65	21 - 163	4 - 10	0.69 - 2.03
Jun-00	70 - 124	6 - 10	0.54 - 1.02	0 - 1	0 - 1	0.00 - 0.00	42	4	0.83	160 - 1077	9 - 15	1.12 - 1.56
Spring Range	**1 - 147**	**1 - 13**	**0.54 - 2.01**	**0 - 373**	**0 - 6**	**0.00 - 0.64**	**42 - 8165**	**4 - 11**	**0.42 - 0.83**	**0 - 7267**	**0 - 16**	**0.07 - 2.03**
May-01	20 - 103	4 - 6	0.59 - 0.90	0	0	0.00 - 0.00	546	7	0.44	118 - 696	9 - 10	1.05 - 1.72

TABLE 7-7. RANGES IN NUMBERS OF INDIVIDUALS AND SPECIES OF FISH LARVAE AND EGGS COLLECTED: OCT. 1992 - MAY 2001

	LARVAL FISH			FISH EGGS		
DATE	Individuals	Species	Diversity	Individuals	Species	Diversity
Oct-92	2790 - 5016	4 - 7	—	79 - 1043	1 - 1	—
Oct-93	309 - 3392	2 - 5	—	37 - 1219	1 - 1	—
Oct-94	720 - 1693	4 - 6	—	18 - 3127	1 - 2	—
Oct/Nov-95	311 - 1791	1 - 3	—	14 - 194	1 - 1	—
Oct-96	1193 - 3396	4 - 7	0.71 - 1.20	36 - 1052	1 - 5	0.00 - 0.81
Oct-97	56 - 2693	2 - 5	0.38 - 0.87	0 - 545	0 - 9	0.00 - 1.40
Sep-98	112 - 1680	2 - 9	0.50 - 0.76	89 - 3316	1 - 4	0.00 - 0.89
Oct-99	177 - 1730	3 - 6	0.61 - 1.11	112 - 4235	1 - 5	0.00 - 0.80
Fall Range	**56 - 5016**	**1 - 9**	**0.38 - 1.20**	**0 - 4235**	**0 - 9**	**0.00 - 1.40**
Oct-00	138 - 2472	2 - 5	0.12 - 0.81	81 - 1280	1 - 5	0.00 - 1.20
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
Jun-00	316 - 6520	2 - 15	0.69 - 1.70	239 - 4128	3 - 8	0.30 - 1.20
Spring Range	**40 - 64,408**	**2 - 15**	**0.42 - 1.70**	**16 - 58,297**	**1 - 8**	**0.00 - 1.50**
May-01	122 - 1376	2 - 8	0.63 - 0.99	7 - 569	1 - 6	0.00 - 1.38

Bottom fish diversity patterns compared with past years. Species diversity values ranged from 0.34 to 1.01 in the fall and from 0.59 to 0.90 in the spring (Table 7-6). Fall ranges tended to be lower than those calculated for the past four years (note that species diversity calculations had not been performed prior to 1997). This might be due to a high abundance of a single species, northern anchovies collected in the fall.

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. Fish collected in gill nets were greater than last year, primarily due to the relatively large catch of eight individuals of northern anchovy (*Engraulis mordax*) at Station 2 in the Harbor mouth during the fall gill net dispatches. No fish were caught in midwater in the spring.

The inherent passivity of gill net sampling for short periods of time makes it an inefficient method of catching fish. Catches may vary, for example, if a school of fish encounter the net or not.

Midwater fish abundance patterns compared with past years. Table 7-6 lists the ranges of individuals of midwater fish collected per station since October 1992. Fish were only caught during the fall sampling (eight individuals) and, is within the range of past surveys. However, no fish were caught during the spring and, although low, the range is not exceptional of past surveys.

7.3.2.2. **Midwater Fish Species**

Spatial midwater fish species patterns. Numbers of midwater fish species collected at the three gill net sampling stations are listed in Table 7-2. At Station 2 near the Harbor entrance, eight northern anchovies (*Engraulis mordax*) were collected. No fish were caught in the other casts.

Midwater fish species patterns compared with past years. Table 7-6 lists the ranges of species of midwater fish collected per station since October 1992. Species counts for fall (zero to one species) and spring (no species) were low but not unusual for these passive gill net catches.

7.3.2.3. **Midwater Fish Diversity**

Spatial midwater fish diversity patterns. Species diversity from the three gill net sampling stations is listed in Table 7-2. Since only one type of fish was caught, diversity values for all locations and seasons were zero.

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

7.3.3. Inshore Fish

Inshore fish were collected using a 32.8-m beach seine at Station 19 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 19) are listed in Table 7-5. More fish were captured in the fall (1515 individuals) than in the spring (546 individuals). Topsmelt (*Atheriops affinis*) dominated fall (1303 individuals) and spring counts (486 individuals). Other fish counts ranged from 1 to 124 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 1992. The number of inshore fish collected during November (1515 individuals) was higher than last year (234 individuals) but was not unusual. Spring counts (546), although higher than last year, were on the low side compared to previous years.

7.3.3.2. Inshore Fish Species

Spatial inshore fish species patterns. Total inshore fish species collected at Mothers' Beach are listed in Table 7-5. More species of fish were collected in the spring (7 species) than in the fall (3 species).

Inshore fish species patterns compared with past years. Table 7-6 lists the range of species of inshore fish collected per station since October 1992. The number of inshore fish species collected during November (3 species) were below the overall range (4 to 12 species). Spring counts (7 species), on the other hand, were typical of past counts.

7.3.3.3. Inshore Fish Diversity

Spatial inshore fish diversity patterns. Species diversity calculations for Mother's Beach are listed in Table 7-5. Species diversity values during fall (0.50) and spring (0.44) were somewhat similar. This is likely related to the overwhelming dominance of topsmelt in both seines.

Inshore fish diversity patterns compared with past years. Species diversity values compared to last year are presented in Table 7-6. The species diversity value for fall (0.50) was higher than last year's (0.31) but well within the range of previous years. The spring species diversity value (0.44) was also within the overall range, but on the low side. Species diversity values were not calculated prior to 1996.

7.3.4. Reef Fish

Divers counted reef fish during three 100-meter swimming underwater transects along the middle of the breakwall and along the north and south jetties near the Harbor entrance on November 13, 2000 and May 22, 2001 (Figure 7-1). 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.

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 north jetty in May (696 individuals), and lowest counts were at the south jetty in the fall (46 individuals). Counts in May (988 individuals) were higher than those taken in October (678 individuals).

Opaleye (*Girella nigricans*) appeared at every sampling site (483 total individuals) with the highest single count at the north jetty in the fall (280 individuals). Shiner surfperch (*Cymatogaster aggregata*) were most common at the north jetty in the spring (504 individuals). Other common fish observed included blacksmith (*Chromis punctipinnis*) with 185 individuals in the fall at north jetty and black surfperch (*Embiotoca jacksoni*) in the spring at all stations.

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 1992. The numbers of reef fish enumerated during October ranged from 46 to 325 individuals per station, which falls within the range of autumn surveys. Similarly, the May range of individuals per station (118 to 696) was comparable to past surveys.

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. As in the previous year, the greatest number of species was observed in May at the south jetty (10 species), and the lowest species count was at the north jetty during the fall (5 species). Total spring species counts (15 species) were higher than the number of species found in the fall (10 species). Four species appeared at all stations in the spring: pile surfperch (*Damalichthys vacca*), black surfperch (*Embiotoca jacksoni*), opaleye (*Girella nigricans*) and senorita (*Oxyjulis californica*).

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 1992. The range of species recorded during the fall, five to seven species per station, and the spring, nine to ten species per station, coincided with ranges from past surveys.

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 7-3. Highest species diversity was at the breakwall in the spring (1.72), and the lowest diversity, like last year, was at the north jetty in the fall (0.48). Overall, average diversity in the fall (1.09) was lower than in the spring (1.47).

Reef fish diversity patterns compared with past years. The range of species diversity values this fall (0.48 to 1.59) and spring (1.05 to 1.72) were characteristic of values recorded over the last four years (Table 7-6). Diversity calculations were not performed prior to 1996.

7.3.5. Larval Fish

Larval fish and fish eggs were collected at three stations: Station 2 near the breakwall, Station 5 in mid channel, and Station 8 in Basin D on October 27, 2000 and May 1, 2001. A 333 um mesh plankton net was deployed at 1.0 m below the surface for two minutes and near the bottom for three minutes. A benthic sled kept the net above the bottom regardless of irregularities in bottom surface.

7.3.5.1. **Larval Fish Abundance**

Spatial larval fish abundance patterns. Numbers of larval fish captured at the three plankton-sampling stations are listed in Table 7-4. Greatest numbers were collected near the bottom in mid channel (Station 5) in the fall (2472 individuals). Smallest catches were at the surface at Station 2 in the fall (138 individuals) and at the surface at Station 8 in the spring (122 individuals). Total counts in the fall (5535 individuals) were somewhat larger those in the spring (4292). As in the past, total surface counts (2339 individuals) were lower than bottom counts (7488). Note that all counts are standardized to numbers per 1000 cubic meters.

Both fall and spring counts were dominated by larval blennies (*Hypsoblennius spp.*) and gobies (Gobiedae A/C, a combination of arrow goby (*Clevelandia ios*), cheekspot goby (*Ilypnus gilberti*), and shadow goby (*Quietula y-cauda*)).

Larval fish abundance patterns compared with past years. Table 7-7 lists the ranges of individuals of larval fish counted per station since October 1992. The fall range (138 to 2472 individuals) and the spring range (122 to 1376 individuals) was low but fell within the range of past ranges.

7.3.5.2. **Larval Fish Species**

Spatial larval fish species patterns. Larval fish species collected at the three plankton-sampling stations are listed in Table 7-4. The highest species count was near the bottom at the breakwall in the spring (eight species). The lowest species counts were at the surface of Station 2 at the breakwater and Station 8 in Basin D during the fall (two species, each) and Station 2, 5 and 8 in the spring (2 species each). Overall, species collected in the fall (7 species) were lower than the amount collected in the spring (11). As usual, average species counts at the surface (3) were much smaller than counts at the bottom (13).

Larval fish species patterns compared with past years. Table 7-7 lists the ranges of larval fish species counted per station since October 1992. Both fall and spring ranges (two to five and two to eight, respectively) were typical of past surveys.

7.3.5.3. **Larval Fish Diversity**

Spatial larval fish diversity patterns. Species diversities calculated from the three plankton sampling stations are listed in Table 7-4. Lowest diversity was near the bottom at the breakwater in October (0.12), and highest diversity was near the bottom in mid channel in spring (0.99). Contrary to last year, average diversity among stations was higher in the spring (0.78) than in the fall (0.45). Average surface diversity (0.53) was lower than average bottom diversity (0.70).

Larval fish diversity patterns compared with past years. The species diversity ranges in fall of 2000 (0.12 to 0.81) and spring, 2001 (0.63 to 0.99), tended to be lower during the past four years (Table 7-7). Species diversity calculations were not performed prior to 1996.

7.3.6. Fish Eggs

Larval fish and fish eggs were collected at three stations: Station 2 near the breakwall, Station 5 in mid channel, and Station 8 in Basin D on October 27, 2000 and May 1, 2001. A 333 um mesh plankton net was deployed at 1.0 m below the surface for two minutes and on the bottom for three minutes. A benthic sled kept the net on the bottom regardless of irregularities in bottom surface and vessel speed.

7.3.6.1. **Fish Egg Abundance**

Spatial fish egg abundance patterns. Numbers of fish eggs at three plankton-sampling stations are listed in Table 7-4. The greatest number of individuals, 1280, was caught at the bottom near the breakwater in the fall. The lowest number of individuals, seven, were found at the surface in mid-channel during the spring haul. Opposite of last year, the total counts in the fall (2324 individuals) were larger than that in the spring (853 individuals), and total counts at the surface (1466 individuals) were smaller than at the bottom (1711 individuals). Note that all counts are standardized to numbers per 1000 cubic meters. The most common identified egg was the *Citharichthys spp.* (Sandab egg) (475 individuals in the fall and 125 in spring). The majority of eggs found in both seasons were identified as Type 32 (1060 total individuals) and Unidentified (1291 total individuals) with most of these found in the fall catches.

Fish egg abundance patterns compared with past years. Table 7-7 lists the ranges of individuals of fish eggs counted per station since October 1992. Numbers of fish eggs counted during October ranged from 81 to 1280 individuals per station, and counts in the spring ranged from 7 to 569. Both were slightly lower that last year, but were within the range 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 at the surface near the breakwall in October (6 species). The lowest specie counts (all Unidentified) were found at two stations: at the surface in mid channel in both the fall and spring and at the surface in Basin D. Species counts in the fall (5 species) and spring (6 species) were similar. The average number of species per sample at the surface (2) and bottom (3) were also similar.

Fish egg species patterns compared with past years. Table 7-7 lists the ranges of species of fish eggs counted per station since October 1992. Fish egg species recorded during October ranged from one to five species per sample and one to six in the spring, which was typical.

7.3.5.3. **Fish Egg Diversity**

Spatial fish egg diversity patterns. Species diversity calculations from the three sampling stations are listed in Table 7-4. Highest diversity was near the surface at the breakwall in May (1.38). The lowest diversity occurred near the surface in mid channel and Basin D in both October and May (0.00). Averaged among samples, spring diversity (0.77) exceeded fall diversity (0.50). Similar to last year, average surface diversity (0.53) was lower than bottom diversity (0.74).

Fish egg diversity patterns compared with past years. Both fall (0.00 to 1.20) and spring (0.00 to 1.38) diversity ranges were representative of surveys from the past four years (Table 7-7). Diversity values were not calculated prior 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, 111 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 16,884 total fish of all age groups (including larvae and eggs) representing 47 different species. By far, the majority of these were either eggs, larvae, or juveniles, which attests to the Harbor's value as a nursery ground for adult Harbor species, as well as species for the Pacific Ocean as a whole.

Bottom fish were collected using a semi-balloon otter trawl at three locations in the Harbor: near the Harbor entrance, in mid channel, and along Basin D. Both fall and spring surveys were representative of past years. Diamond turbot, California halibut, and barred sand bass, prized by both commercial and sport fishermen, were present in several trawls but northern anchovy and topsmelt were caught in the greatest numbers. This year, fall catches had larger individual counts but the spring hauls contained a higher number of species. Average diversity was slightly higher in spring than in fall.

Mid water gill net sampling continues to be of limited use. Since the technique is passive, capture relies on chance that animals will swim into the net. Despite tripling the deployment time from two years ago (to about two hours), only eight northern anchovy were caught along the breakwall in the fall. No fish were caught in mid water during the spring sampling.

Inshore fish were collected by beach seine at Mother's Beach. The number of individuals caught in the fall was in the higher end of the range although in the spring, counts were in the lower end of the range. Although there were fewer species in the fall beach seine, more individual fish were caught. Topsmelt dominated both the fall and spring seines. California killifish were found in both spring and fall seines. Diversity of species was similar across seasons.

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 characteristic of most past surveys. Topsmelt, opaleye, shiner surfperch, and black surfperch were most commonly observed. The number of individual fish was slightly higher in May than October. Without the preponderance of shiner surfperch young of the year by the north jetty in the spring, the total number of individual fish would have been similar.

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 representative of past surveys, although larval fish diversity was not as high as has been observed in the past. The majority of fish larvae and eggs were found in mid channel and near the breakwall in both bottom and surface tows in both fall and spring. The highest number of species was found near the breakwall. Unlike last year, fall tows yielded the greatest abundance of both larval fish and egg counts. The fall sampling was conducted after a heavy rain that may have contributed to this. Gobies and blennies dominated larval counts whereas, with the exception of a profusion of sandab eggs, the majority of eggs went unidentified.

The sampling methods used in Marina del Rey differ somewhat from those of other southern California surveys (i.e. L.A. Harbor, SCCWRP), so fish population characteristics cannot be easily compared. However, it is obvious that the entire Marina continues to support a very abundant and diverse assemblage of fish fauna and serves as a nursery for many species important to local sport and commercial fisheries, as well as the whole coastal environment.

8. CONCLUSIONS

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

The water quality of Marina del Rey Harbor is impacted both temporally and spatially. Temporal impacts included both weather and oceanographic influences. This year, the Harbor experienced cooler water and moderate rainfall. Rainfall was still lower than normal so winter and spring rains exerted a smaller influence on Harbor waters compared to rainier years. Regardless, winter and spring precipitation tended to lower water clarity, salinity, and pH and increased ammonia, bacterial counts, and possibly biochemical oxygen demand (BOD) throughout the Harbor. The influence upon the phytoplankton community was generally limited to the spring. Phytoplankton blooms, in turn, can subsequently raise dissolved oxygen values, and their demise can increase biochemical oxygen demand later in the spring. Dissolved oxygen and BOD increased slightly in the spring and summer and may have been associated with observed red tides. As usual, seasonal temperature changes in the ocean impacted the Harbor, causing colder water in the winter and warmer water in the summer and fall.

The Harbor is spatially impacted by the discharges of Oxford Lagoon and Ballona Creek and the open ocean. The open ocean brought lower temperatures, high dissolved oxygen, salinity and pH primarily to stations located near the Harbor entrance. Ballona Creek, although somewhat less of an influence, decreased water clarity and increased ammonia, BOD and bacteria at these stations. In addition, water here tended to be more yellow-brown in color, rather than green to blue-green. Decreases in salinity at the surface were not as severe as last year.

Flows from Oxford Lagoon affected Basin E and brought decreased water clarity, dissolved oxygen, and elevated levels of BOD and bacteria. Similar to the past survey, Basin D which includes Mother's Beach, appeared less affected by surface runoff than in past years.

Stations in the lower main channel were most like the open ocean and were thus the most natural in the Harbor. These stations were characterized by high dissolved oxygen, pH, and water clarity and low values of BOD. As always, the areas further back into the Marina were warmer, more saline and moderate in dissolved oxygen and water clarity.

Bacterial measurements were made monthly at 18 stations (648 measurements in the year). Total coliform limits were exceeded 20 times, fecal coliform limits 22 times, and enterococcus limits 41 times. The total exceedances (83) were down slightly from last year's numbers (84 exceedances). Among these 83 exceedances, 68 (82%) can be attributable to flows from either Ballona Creek or Oxford Lagoon. Most of the remainder occurred following periods of rainfall. With the exception of enterococcus in the fall, which was higher, the frequency of exceedances was within the range of the past eight years.

Physical characteristics of Harbor sediments (median particle size and sorting) were influenced by energy of water flow that is influenced by Harbor configuration and rainfall intensity. The affect of current and wave action near the entrance and into the upper channel created sediments that were universally coarse and homogenous. A finer, more heterogeneous mix of sediments was found in the back Harbor areas. Sediments at the two stations in Oxford Lagoon had different characteristics from each other but were primarily sand to silt with a wide range of sediment types, suggesting that the flow regime in each of these areas is inconsistent. In the northwest portion of the Harbor, the sediment regime was very fine and moderately narrow. This may suggest that coarser materials have difficulty traveling to this area.

Due to the historical and current land and water uses, the Harbor contains some contamination by heavy metals, DDT and derivatives, pesticides and PCBs, and organics. This year, Oxford Lagoon did not appear to be a source of chlorinated hydrocarbons such as DDT and derivatives or other chlorinated pesticides to Basin E, however, some high concentrations were measured in Oxford Lagoon itself. In contrast, Ballona Creek was high in DDT derivatives and Arochlor-1254 was found at the highest concentration since 1994. DDT itself was found only at Station 4 in mid channel and may suggest a possible fresh source of DDT. Among chlorinated hydrocarbons listed as toxic by NOAA, 11 of 15 Harbor stations exceeded at least one compound at levels "potentially" toxic to benthic organisms, and 6 out of 15 stations had chlorinated hydrocarbons at levels "probably" toxic to benthic organisms. More stations this year were found to have pesticide concentrations that were probably toxic than last year. Despite that, most chlorinated compounds have continued to remain lower than historical values, and levels are much lower those of Los Angeles Harbor and are similar to those of reference samples collected offshore.

Heavy metals tended to be higher in the main channel and Basins F and E, likely originating from the resident boat population. All stations, except Station 1, 3 and 12 at the Harbor entrance, exceeded at least one metal limit of "possible" toxicity, and 5 out of 15 exceeded at least one metal limit of "probable" toxicity, an improvement over last year. Most metal concentrations in Marina del Rey sediments do not appear to have greatly increased or decreased since 1988. Levels of copper, lead, mercury, silver and zinc in Marina del Rey were about two to three times higher than Los Angeles Harbor, although the rest of the metals were similar or lower.

The configuration of Los Angeles Harbor allows for better flushing and offshore movement of contaminated suspended materials since it has two entrances rather than the one like Marina del Rey Harbor. Tributyl tin continues to remain low but ubiquitous when compared to past surveys. This compound was at one time 100 times more concentrated in Harbor sediments. Nonspecific organic compounds, including nutrients and carbonaceous organics, tended to be within the Harbor and away from the Harbor entrance in lower disturbance areas with finer particles.

When compared to Los Angeles Harbor, Marina del Rey infaunal abundances were higher possibly due to the protection an enclosed design may render, and there may be differences in sampling methodology. Infaunal index values and diversity values were comparable to Los Angeles Harbor. Except for individuals, overall infaunal values were higher than past results with infaunal diversity the highest recorded since 1984.

The number of species was much higher this year (248) than last (168). Areas associated with Oxford Lagoon, Ballona Creek, and possibly Venice Canal tended to show some evidence of community disturbance. Infaunal community health did not appear to be strongly related to a stations' benthic grain size patterns but seem to coincide with higher levels of chlorinated hydrocarbons. Nematode and oligochaete worms that are known to be characteristic of highly disturbed benthic sediments were found in low numbers this year. Despite variable metals contamination, mid-channel stations were the healthiest benthic populations in the Harbor.

Like last year, fish enumerations 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. 16,884 total fish of all age groups, representing 47 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 similar to past years for most strata of fish. Mid water gill net sampling caught eight fish of the same specie in the fall. Marina de Rey Harbor continues to sustain an 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.

9. APPENDICES

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9.2. WATER QUALITY DATA AND CRUISE LOGS

Physical Water Quality Data **July 10, 2000**

CRUISE:	MDR 00-07	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	627	3.4
RAIN:	None	J. Mann	Low	1138	1.8

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 mg/l	BOD mg/l
1	847	0	19.62	30.29	6.74	8.17	53.77	85.6	11	3.1	0.08	2.6
2k WSW		1	19.49	33.07	6.74	8.15	60.81	88.3				
		2	19.36	34.43	6.67	8.15	62.34	88.9			0.08	2.2
		3	19.30	34.68	6.62	8.17	62.79	89.0				
		4	19.31	34.67	6.62	8.19	62.15	88.8			0.06	2.7
		5	19.24	34.65	6.73	8.18	62.83	89.0				
		6	19.03	34.66	6.77	8.17	64.42	89.6			0.06	2.6
2	841	0	19.53	34.02	6.51	8.14	60.96	88.4	11	3.0	0.18	2.5
2k WSW		1	19.61	34.23	6.64	8.14	59.69	87.9				
		2	19.46	34.43	6.73	8.13	57.33	87.0			0.15	2.4
		3	19.20	34.54	6.80	8.14	60.98	88.4				
		4	18.93	34.63	6.82	8.14	62.84	89.0			0.14	2.5
		5	18.77	34.69	6.77	8.14	65.78	90.1				
		6	18.73	34.72	6.79	8.13	66.40	90.3			0.05	3.0
3	835	0	20.34	34.76	5.29	8.00	61.70	88.6	11	2.8	0.05	2.3
2k WSW		1	20.32	34.75	5.28	7.98	64.26	89.5				
		2	20.32	34.75	5.24	7.97	65.93	90.1			0.04	1.4
		3	20.32	34.75	5.21	7.96	66.10	90.2				
		4									0.04	1.6
4	912	0	20.37	34.79	6.11	8.06	52.95	85.3	11	2.5	0.03	1.9
4k WSW		1	20.47	34.80	6.39	8.06	52.61	85.2				
		2	20.38	34.78	6.47	8.06	52.07	84.9			0.03	1.8
		3	20.38	34.53	6.45	8.06	52.06	84.9				
		4	19.72	34.63	6.40	8.08	50.72	84.4			0.05	1.9
5	802	0	21.15	34.83	5.88	8.03	59.33	87.8	11	2.8	0.11	1.8
2k WSW		1	21.17	34.80	5.97	8.04	58.82	87.6				
		2	21.10	34.80	6.01	8.04	57.03	86.9			0.06	1.5
		3	20.98	34.76	6.00	8.06	53.60	85.6				
		4	20.80	34.53	6.03	8.07	52.07	84.9			0.06	1.6
		5	20.22	34.83	6.10	8.04	41.57	80.3				
6	812	0	20.82	34.85	6.18	8.06	57.72	87.2	11	2.5	0.05	1.9
2k WSW		1	20.83	34.85	6.31	8.07	56.64	86.8				
		2	20.80	34.84	6.30	8.07	57.17	87.0			0.05	1.1
		3	20.77	34.82	6.31	8.06	56.46	86.7				
		4	20.73	34.85	6.31	8.04	54.88	86.1			0.05	1.0
7	930	0	21.15	34.87	5.68	7.96	53.46	85.5	12	2.7	0.03	1.2
4k WSW		1	21.16	34.86	5.71	7.97	52.59	85.2				
		2	21.14	34.83	5.95	7.96	51.95	84.9			0.04	1.0
		3	21.08	34.75	5.97	7.97	51.26	84.6				
		4	20.73	34.88	5.87	7.99	40.82	79.9			0.01	1.0
8	710	0	21.27	34.92	5.83	7.99	53.15	85.4	10	2.4	0.02	1.0
2k WSW		1	21.28	34.92	5.83	7.98	52.30	85.0				
		2	21.29	34.91	5.88	7.98	52.69	85.2			0.04	1.1
		3	21.28	34.90	5.84	7.98	52.43	85.1				
		4	21.21	34.90	5.75	7.97	51.38	84.7			< 0.01	1.1

July 10, 2000 **(Continued)**

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	752	0	21.29	34.53	5.44	7.87	45.99	82.4	11	1.9	0.03	1.3
2k WSW		1	21.41	34.64	5.56	7.90	43.75	81.3				
		2	21.32	34.78	5.42	7.94	35.14	77.0			0.04	1.1
		3	21.15	34.83	5.30	7.99	31.56	75.0				
		4	21.07	34.84	5.36	8.00	27.13	72.2			0.07	1.3
10	731	0	21.45	34.80	5.62	7.89	51.73	84.8	10	2.2	0.05	1.6
2k WSW		1	21.45	34.80	5.38	7.89	51.83	84.8				
		2	21.46	34.82	5.50	7.89	51.56	84.7			0.05	1.2
		3	21.47	34.83	5.15	7.90	47.61	83.1				
		4	21.45	34.82	4.90	7.92	44.01	81.4			0.04	1.2
11	742	0	21.25	34.75	5.66	7.97	57.89	87.2	11	2.4	0.02	3.7
2k WSW		1	21.26	34.79	5.74	7.98	55.60	86.4				
		2	21.33	34.79	5.80	7.98	55.03	86.1			0.02	1.0
		3	21.22	34.76	5.72	7.98	48.12	83.3				
		4	20.99	34.85	5.76	8.00	40.28	79.7			< 0.01	1.3
12	851	0	21.53	19.00	8.06	8.34	36.24	77.6	11	2.2	0.02	2.7
4k WSW		1	20.83	28.39	7.99	8.24	24.38	70.3				
		2	19.51	34.09	7.94	8.11	26.57	71.8			0.02	3.0
		3	19.21	34.65	7.69	8.08	67.40	90.6				
13	635	0	21.45	34.49	5.42	7.89					0.04	1.6
18	700	0	21.24	34.92	5.61	7.97	53.71	85.6	10	2.3	0.03	1.1
2k WSW		1	21.24	34.93	5.77	7.97	53.96	85.7				
		2	21.20	34.95	5.79	7.97	53.31	85.4			0.05	0.9
19	647	0	20.66	34.64	5.80	7.73					0.08	1.5
20	725	0	21.46	34.80	5.67	7.89	48.34	83.4	10	2.1	0.09	2.1
2k WSW		1	21.49	34.81	5.63	7.90	47.93	83.2				
		2	21.50	34.78	5.50	7.87	46.82	82.7			0.06	1.7
22	620	0	21.26	34.05	3.70	7.85					0.06	2.5
25	916	0	20.87	34.85	6.29	8.07	51.72	84.8	12	2.6	0.06	1.8
6k WSW		1	20.83	34.82	6.68	8.09	51.62	84.8				
		2	20.77	34.75	6.55	8.07	51.26	84.6			0.06	1.8
		3	20.59	34.78	6.60	8.03	54.65	86.0				
		4	20.51	34.67	6.54	8.02	58.12	87.3			0.05	1.5
		5	20.19	34.64	6.62	8.02	60.90	88.3				
	Average		20.63	34.36	6.09	8.02	52.97	85.03	10.9	2.5	0.05	1.8
	Number		78	78	78	78	75	75	15	15	47	47
	St. Dev.		0.80	1.98	0.71	0.10	9.22	4.16	0.6	0.3	0.03	0.7
	Maximum		21.53	34.95	8.06	8.34	67.40	90.61	12	3.1	0.18	3.7
	Minimum		18.73	19.00	3.70	7.73	24.38	70.27	10	1.9	0.01	0.9

Surface Bacteriological Water Data and General Observations **July 10, 2000**

CRUISE:	MDR 00-07	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	627	3.4
RAIN:	None	J. Mann	Low	1138	1.8

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	847	300	300	13	Moderate turbidity.
2	841	70	20	17	Moderate turbidity.
3	835	20	20	8	High turbidity. Gate open 50%. Floating feathers, wood, and plastic bags.
4	912	130	20	17	*Moderate turbidity.*
5	802	130	80	7	Moderate turbidity.
6	812	20	< 20	11	Moderate turbidity.
7	930	230	80	7	Moderate turbidity.
8	710	50	20	2	Moderate turbidity.
9	752	< 20	< 20	7	Moderate turbidity.
10	731	800	500	27	Moderate turbidity.
11	742	80	80	6	Moderate turbidity. Jellyfish in water column.
12	851	800	500	80	Moderate turbidity. Plastic bags in water column. Slight red tide.
13	635	500	40	140	Moderate turbidity. Jellyfish in water column. Ducks swimming.
18	700	20	< 20	23	Moderate turbidity. Jellyfish in water column.
19	647	300	130	500	Moderate turbidity. Jellyfish in water column.
20	725	500	130	80	Moderate turbidity. Jellyfish in water column.
22	620	1300	800	50	Moderate turbidity.
25	916	130	< 20	14	Moderate turbidity. Plastic bags in water column.
	Average	300.0	155.6	56.1	
	Number	18	18	18	
	St. Dev.	355.5	223.9	116.5	
	Maximum	1300	800	500	
	Minimum	20	20	2	

Physical Water Quality Data **August 25, 2000**

CRUISE:	MDR 00-02	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy	Pers.: J. Gelsinger	High	748	4.0
RAIN:	None	J. Mann	Low	1226	2.5

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 mg/l	BOD mg/l
1	1031	0	22.05	31.26	7.11	8.09	67.29	90.6	11	4.1	0.04	1.1
1k WSW		1	21.93	33.30	7.02	8.09	63.34	89.2				
		2	21.95	33.20	6.95	8.10	62.33	88.9			0.03	1.0
		3	21.93	33.40	7.03	8.11	62.51	88.9				
		4	21.56	33.55	7.30	8.11	64.44	89.6			0.04	1.1
		5	21.34	33.55	7.32	8.12	66.11	90.2				
		6	21.19	33.64	7.40	8.11	65.46	89.9			0.04	0.9
2	1016	0	22.75	33.26	7.36	8.09	60.76	88.3	11	3.9	0.04	1.2
1k WSW		1	22.72	33.20	7.27	8.10	59.25	87.7				
		2	22.57	33.16	7.30	8.10	59.59	87.9			0.04	1.1
		3	22.24	33.13	7.39	8.09	60.66	88.3				
		4	21.42	33.57	7.48	8.11	62.23	88.8			0.04	1.2
		5	21.26	33.66	7.54	8.10	64.26	89.5				
3	1005	0	22.77	33.31	6.38	8.05	64.59	89.6	11	3.3	0.04	1.1
1k WSW		1	22.69	33.37	6.52	8.05	61.62	88.6				
		2	22.67	33.37	6.34	8.04	61.64	88.6			0.04	0.8
4	1055	0	23.16	32.98	6.09	8.08	61.20	88.4	11	3.3	< 0.01	1.2
1k WSW		1	23.15	33.42	5.77	8.08	60.40	88.2				
		2	23.40	33.13	7.20	8.07	59.63	87.9			0.03	1.0
		3	23.15	33.15	6.84	8.06	58.07	87.3				
5	935	0	24.09	33.40	5.97	7.98	61.84	88.7	11	2.7	< 0.01	0.8
1k WSW		1	23.95	33.43	5.95	7.99	59.09	87.7				
		2	23.72	33.36	5.92	8.03	51.12	84.6			0.02	1.3
		3	23.11	33.47	6.54	8.03	50.79	84.4				
		4	22.80	33.63	6.45	8.02	46.64	82.6			< 0.01	1.1
6	946	0	23.73	33.51	5.10	7.97	56.07	86.5	11	2.4	< 0.01	1.1
1k WSW		1	23.69	33.52	5.27	7.97	54.07	85.8				
		2	23.66	33.52	5.60	7.97	50.32	84.2			< 0.01	0.9
		3	23.63	33.53	5.42	7.96	49.25	83.8				
		4									< 0.01	1.0
7	1115	0	24.25	33.55	5.48	7.97	50.34	84.2	11	2.9	< 0.01	0.8
1k WSW		1	24.24	33.50	5.46	7.98	49.41	83.8				
		2	24.15	33.40	5.69	7.97	45.41	82.1			< 0.01	1.0
		3	23.79	33.26	5.76	7.95	43.77	81.3				
		4	23.55	33.31	5.84	7.96	32.02	75.2			< 0.01	0.9
8	826	0	24.06	33.54	4.51	7.89	43.21	81.1	12	1.9	< 0.01	1.6
1k WSW		1	24.06	33.54	4.74	7.89	42.49	80.7				
		2	24.05	33.53	4.99	7.89	41.46	80.2			0.04	1.8
		3	23.99	33.52	4.81	7.91	42.28	80.6				
		4	23.93	33.53	4.85	7.87	42.84	80.9			0.04	1.9

August 25, 2000 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	922	0	23.68	33.32	4.69	7.80	59.96	88.0	12	2.0	0.03	1.2
1k WSW		1	24.13	33.26	4.83	7.83	51.50	84.7				
		2	24.15	33.37	5.42	7.90	40.26	79.7			0.02	1.2
		3	23.91	33.53	5.41	7.97	36.56	77.8				
10	856	0	24.18	33.35	4.48	7.89	53.35	85.5	12	2.2	0.04	1.3
1k WSW		1	24.22	33.38	4.67	7.89	51.70	84.8				
		2	24.30	33.37	4.90	7.89	44.64	81.7			0.03	1.1
		3	24.20	33.43	4.83	7.89	38.14	78.6				
		4	24.14	33.47	4.72	7.89	20.58	67.4			0.04	1.2
11	910	0	24.02	33.31	4.45	7.93	59.53	87.8	12	2.9	0.03	1.0
1k WSW		1	24.01	33.36	4.51	7.93	59.39	87.8				
		2	24.05	33.41	5.32	7.94	52.08	85.0			0.05	0.9
		3	23.83	33.53	5.19	7.94	38.77	78.9				
12	1039	0	23.09	24.62	7.44	8.15	43.62	81.3	11	3.0	0.05	1.5
1k WSW		1	22.72	30.99	6.97	8.14	44.40	81.6				
		2	21.88	33.11	7.15	8.09	36.49	77.7			0.05	1.4
		3	21.97	33.24	7.14	8.06	58.19	87.3				
13	935	0	24.51	33.23	3.20	7.75					0.05	6.7
18	815	0	23.90	33.56	5.45	7.94	45.64	82.2	12	2.1	0.05	1.6
1k WSW		1	23.91	33.54	5.59	7.94	44.38	81.6				
		2	23.89	33.52	5.45	7.93	44.18	81.5			0.03	1.8
19	753	0	22.34	33.34	4.64	7.96					0.03	1.2
20	846	0	24.24	33.34	3.99	7.86	54.88	86.1	12	2.1	0.03	5.5
1k WSW		1	24.24	33.40	4.21	7.86	50.07	84.1				
		2	24.31	33.36	4.05	7.87	42.98	81.0			0.03	3.6
22	720	0	22.96	31.77	1.00	7.56					0.05	6.8
25	1103	0	23.78	33.43	3.79	8.03	58.39	87.4	11	3.2	0.02	3.4
1k WSW		1	23.77	33.46	4.55	8.03	57.76	87.2				
		2	23.74	33.33	5.81	8.03	57.40	87.0			0.02	1.0
		3	23.37	33.15	6.43	8.03	56.96	86.9				
		4	22.24	33.60	6.14	8.03	51.72	84.8			0.01	1.0
	Average		23.31	33.18	5.72	7.98	52.41	84.78	11.4	2.8	0.03	1.6
	Number		70	70	70	70	67	67	15	15	42	42
	St. Dev.		0.91	1.13	1.24	0.11	9.65	4.27	0.5	0.7	0.01	1.4
	Maximum		24.51	33.66	7.54	8.15	67.29	90.57	12	4.1	0.05	6.8
	Minimum		21.19	24.62	1.00	7.56	20.58	67.35	11	1.9	0.01	0.8

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

CRUISE:	MDR 00-02	Vessel:	Aquatic Bioassay
WEATHER:	Partly Cloudy	Pers.:	J. Gelsinger
RAIN:	None		J. Mann

TIDE	TIME	HT. (ft)
High	748	4.0
Low	1226	2.5

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1031	5000	300	2	Moderate turbidity.
2	1016	1300	50	2	Moderate turbidity.
3	1005	170	70	2	Moderate turbidity. Tidal gate closed.
4	1055	80	20	2	Moderate turbidity. Floating plastic bags.
5	935	20	20	< 2	Moderate turbidity.
6	946	3000	< 20	5	Moderate turbidity.
7	1115	230	< 20	8	Moderate turbidity. Floating plastic bags.
8	826	50	< 20	5	Moderate turbidity. A few jellyfish in water column.
9	922	< 20	< 20	< 2	Moderate turbidity.
10	856	300	50	22	Moderate turbidity. A few jellyfish in water column.
11	910	70	20	< 2	Moderate turbidity.
12	1039	≥ 16000	700	8	Moderate turbidity.
13	935	500	70	130	Moderate turbidity. Floating algal mats.
18	815	< 20	< 20	13	Moderate turbidity.
19	753	50	20	30	Moderate turbidity.
20	846	210	80	14	Moderate turbidity.
22	720	≥ 16000	700	170	Moderate turbidity.
25	1103	220	20	4	Moderate turbidity. Floating plastic bags.
	Average	2402.2	123.3	23.5	
	Number	18	18	18	
	St. Dev.	5112.6	219.8	47.2	
	Maximum	16000	700	170	
	Minimum	20	20	2	

Physical Water Quality Data **September 21, 2000**

CRUISE:	MDR 00-09	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	551	3.6
RAIN:	None	J. Mann	Low	943	3.1

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 mg/l	BOD mg/l
1	847	0	20.90	33.04	7.14	8.12	71.28	91.9	11	5.2	0.07	1.3
2k WSW		1	20.88	33.52	7.55	8.12	68.26	90.9				
		2	20.82	33.50	7.22	8.14	68.52	91.0			0.06	1.2
		3	20.74	33.51	7.31	8.15	67.74	90.7				
		4	20.66	33.48	7.53	8.15	66.93	90.4			0.06	1.3
		5	20.51	33.48	7.73	8.16	67.43	90.6				
		6	20.32	33.58	7.66	8.16	68.50	91.0			0.07	1.1
2	841	0	20.56	32.81	4.85	8.13	65.99	90.1	11	4.6	0.07	1.7
2k WSW		1	20.70	33.15	5.46	8.13	62.97	89.1				
		2	20.69	33.33	6.37	8.13	66.80	90.4			0.07	1.4
		3	20.70	33.38	7.10	8.13	66.48	90.3				
		4	20.56	33.37	7.47	8.13	67.23	90.6			0.05	1.2
		5	20.32	33.47	6.91	8.13	66.64	90.4				
3	831	0	20.74	33.10	4.80	8.01	67.54	90.7	11	3.6	0.05	1.2
2k WSW		1	20.79	33.15	4.85	8.02	65.86	90.1				
		2	20.82	33.21	5.43	8.03	66.00	90.1			0.06	1.0
		3	20.80	33.26	5.92	8.02	65.78	90.1				
		4	20.71	33.30	5.87	8.02	63.79	89.4			0.06	0.8
4	915	0	20.69	32.96	6.81	8.06	69.57	91.3	11	4.1	0.06	1.2
2k WSW		1	20.72	33.23	6.65	8.05	67.27	90.6				
		2	20.65	33.29	6.63	8.05	66.65	90.4			0.06	1.1
		3	20.46	33.38	6.62	8.07	64.83	89.7				
		4	20.31	33.45	6.67	8.09	64.70	89.7			0.06	0.9
5	804	0	21.42	33.36	6.16	7.97	68.71	91.0	11	4.1	0.06	0.8
2k WSW		1	21.42	33.34	6.06	7.97	67.09	90.5				
		2	21.33	33.24	6.09	7.98	65.08	89.8			0.07	1.0
		3	21.13	32.99	6.21	8.00	66.37	90.3				
		4	20.66	31.94	6.41	8.00	60.38	88.2			0.03	1.1
		5	20.35	30.37	6.48	8.01	57.72	87.2				
6	816	0	21.32	33.40	5.61	7.98	69.91	91.4	11	4.1	0.06	0.8
2k WSW		1	21.34	33.39	5.54	7.98	68.95	91.1				
		2	21.34	33.34	5.70	7.98	69.07	91.2			0.06	0.7
		3	21.04	33.22	6.07	7.98	69.19	91.2				
		4	20.41	33.53	6.04	7.96	50.38	84.2			0.06	0.7
7	932	0	21.43	33.39	5.52	7.99	67.48	90.6	11	3.0	0.07	0.8
2k WSW		1	21.41	33.35	5.57	7.99	66.81	90.4				
		2	21.29	33.30	5.75	8.00	63.44	89.2			0.07	0.7
		3	21.04	33.25	5.95	8.01	59.06	87.7				
		4	20.54	33.46	5.90	8.01	49.36	83.8			0.08	0.9
8	707	0	21.66	33.40	4.80	7.89	67.50	90.6	11	3.5	0.05	0.8
2k WSW		1	21.67	33.39	4.93	7.89	64.91	89.8				
		2	21.67	33.28	5.68	7.91	66.53	90.3			0.12	1.0
		3	21.44	33.13	5.89	7.91	61.98	88.7				
		4	20.83	33.40	5.67	7.86	37.00	78.0			0.05	1.8

September 21, 2000 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	752	0	21.59	33.21	5.63	7.90	63.63	89.3	11	3.0	0.07	0.8
2k WSW		1	21.60	33.25	5.55	7.92	58.95	87.6				
		2	21.46	33.16	5.58	7.93	48.81	83.6			0.08	1.0
		3	21.11	33.08	5.72	7.94	50.32	84.2				
		4	20.51	33.38	5.79	7.95	34.88	76.9			0.08	0.9
10	731	0	21.47	33.21	4.49	7.84	69.18	91.2	11	3.0	0.08	0.7
2k WSW		1	21.48	33.27	4.60	7.84	68.47	91.0				
		2	21.61	33.09	4.89	7.86	68.09	90.8			0.08	0.5
		3	21.19	33.24	5.06	7.88	61.95	88.7				
		4	20.84	33.41	4.96	7.90	32.91	75.7			0.02	0.9
11	742	0	21.65	33.26	4.38	7.89	69.13	91.2	11	3.2	0.03	0.6
2k WSW		1	21.66	33.27	4.41	7.90	68.45	91.0				
		2	21.57	33.23	4.97	7.92	58.00	87.3			0.02	0.7
		3	21.16	33.27	5.42	7.95	54.93	86.1				
		4	20.68	33.48	5.29	7.95	55.45	86.3			0.04	1.9
12	851	0	21.36	25.31	6.89	8.19	57.94	87.2	11	3.1	0.05	2.0
2k WSW		1	21.08	29.50	6.95	8.17	49.91	84.1				
		2	20.57	32.76	6.96	8.12	44.91	81.9			0.03	1.4
13	630	0	23.80	30.69	3.10	8.14					0.04	8.0
18	700	0	21.67	33.41	6.01	7.88	57.60	87.1	11	3.6	0.06	0.8
2k WSW		1	21.67	33.41	6.02	7.88	59.86	88.0				
		2	21.64	33.40	6.04	7.89	62.84	89.0			0.02	0.9
19	643	0	21.29	33.80	5.15	7.97					0.02	1.0
20	725	0	21.55	33.09	4.03	7.80	68.03	90.8	11	2.3	0.02	2.1
2k WSW		1	21.55	33.20	4.01	7.78	68.10	90.8				
		2	21.57	33.23	4.05	7.80	62.23	88.8			0.03	1.0
22	618	0	24.80	29.92	3.80	8.22					0.03	6.8
25	920	0	20.81	33.13	4.11	8.06	68.11	90.8	11	4.1	0.02	1.0
2k WSW		1	20.82	33.20	4.86	8.06	67.99	90.8				
		2	20.88	33.27	5.83	8.04	68.02	90.8			0.02	0.9
		3	20.84	33.19	6.32	8.03	69.35	91.3				
		4	20.20	33.43	6.96	8.03	61.55	88.6			0.02	0.8
		5	20.08	33.47	6.38	8.04	55.93	86.5				
	Average		21.11	33.01	5.80	8.00	62.69	88.81	11.0	3.6	0.05	1.3
	Number		77	77	77	77	74	74	15	15	46	46
	St. Dev.		0.69	1.16	1.01	0.10	8.22	3.30	0.0	0.7	0.02	1.4
	Maximum		24.80	33.80	7.73	8.22	71.28	91.88	11	5.2	0.12	8.0
	Minimum		20.08	25.31	3.10	7.78	32.91	75.74	11	2.3	0.02	0.5

Surface Bacteriological Water Data and General Observations **September 21, 2000**

CRUISE:	MDR 00-09	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	551	3.6
RAIN:	None	J. Mann	Low	943	3.1

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	847	800	800	130	Moderate turbidity.
2	841	300	50	7	Moderate turbidity.
3	831	110	50	11	Moderate turbidity.
4	915	700	50	26	Moderate turbidity.
5	804	50	< 20	130	Moderate turbidity. Surface oil, floating leaves.
6	816	170	50	17	Moderate turbidity. Tidal gate 50% open. Moderate flow.
7	932	110	50	13	Moderate turbidity.
8	707	80	20	17	High turbidity. Many jellyfish in water column.
9	752	1400	20	140	High turbidity.
10	731	500	90	30	High turbidity. Jellyfish in water column.
11	742	170	< 20	23	High turbidity.
12	851	1700	800	50	Moderate turbidity. Floating plastic bags.
13	630	3000	330	1600	High turbidity. Low tide line at 1.5 ft.
18	700	1100	70	140	High turbidity.
19	643	80	70	50	High turbidity.
20	725	800	110	350	High turbidity. Surface oil.
22	618	16000	700	90	High turbidity. Low tide line at 1.5 ft.
25	920	50	20	2	Moderate turbidity.
	Average	1506.7	184.4	157.0	
	Number	18	18	18	
	St. Dev.	3697.4	277.7	370.1	
	Maximum	16000	800	1600	
	Minimum	50	20	2	

Physical Water Quality Data **October 20, 2000**

CRUISE:	MDR 00-04	Vessel: Aquatic Bioassay		TIDE	TIME	HT. (ft)
WEATHER:	Overcast/Fog	Pers.: J. Gelsinger		High	539	4.0
RAIN:	None	J. Mann		Low	1002	3.2

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 mg/l	BOD mg/l
1	835	0	17.68	31.96	7.08	8.12	70.23	91.5	12	6.5	0.12	1.8
3k WSW		1	17.65	32.97	7.23	8.13	66.15	90.2				
		2	17.73	33.33	7.55	8.16	67.27	90.6			0.05	2.5
		3	17.72	33.40	7.87	8.17	68.27	90.9				
		4	17.70	33.42	8.18	8.17	69.63	91.3			0.04	2.3
		5	17.68	33.38	8.55	8.16	70.67	91.7				
		6	17.59	33.23	8.26	8.16	71.72	92.0			0.03	2.2
2	830	0	17.66	30.46	7.26	8.13	70.75	91.7	12	5.6	0.06	1.9
3k WSW		1	17.78	32.17	7.36	8.12	66.52	90.3				
		2	17.68	33.08	7.52	8.13	65.30	89.9			0.10	1.9
		3	17.51	33.25	7.66	8.13	66.92	90.4				
		4	17.39	33.35	7.78	8.13	68.74	91.1			0.06	1.7
		5	17.28	33.40	7.95	8.13	69.32	91.2				
		6	17.20	33.42	7.99	8.14	69.99	91.5			0.06	1.5
3	820	0	18.19	33.22	7.23	8.06	68.31	90.9	11	3.6	0.10	1.2
3k WSW		1	18.20	33.22	7.04	8.07	65.39	89.9				
		2	18.19	33.23	7.01	8.07	65.33	89.9			0.10	1.0
		3	18.10	33.17	7.08	8.08	64.08	89.5				
		4	17.56	33.45	7.18	8.09	63.14	89.1			0.06	0.9
4	900	0	18.46	33.33	6.61	8.08	62.58	88.9	11	3.1	0.10	1.1
3k WSW		1	18.49	33.24	6.72	8.08	60.93	88.4				
		2	18.29	33.29	7.07	8.09	61.86	88.7			0.14	0.9
		3	18.09	33.33	7.24	8.10	62.48	88.9				
		4	18.02	33.34	7.07	8.11	61.50	88.6			0.04	0.9
5	754	0	18.94	33.31	6.83	8.04	67.82	90.7	11	1.8	0.07	0.9
1k WSW		1	18.96	33.31	6.80	8.05	65.86	90.1				
		2	18.94	33.33	6.92	8.06	62.61	89.0			0.05	0.9
		3	18.90	33.28	7.12	8.06	59.66	87.9				
		4	18.71	33.23	7.23	8.07	57.88	87.2			0.03	1.0
		5	18.15	33.48	7.23	8.06	46.86	82.7				
6	806	0	18.82	33.42	6.87	8.06	62.77	89.0	11	3.1	0.03	0.9
1k WSW		1	18.82	33.41	6.66	8.07	62.24	88.8				
		2	18.83	33.39	7.14	8.07	58.14	87.3			0.03	0.9
		3	18.83	33.21	7.34	8.07	60.53	88.2				
		4	18.66	32.79	7.17	8.04	57.93	87.2				
7	915	0	18.97	33.39	5.63	8.04	60.11	88.1	11	2.9	0.06	1.1
3k WSW		1	18.97	33.39	5.94	8.05	58.64	87.5				
		2	18.96	33.35	6.12	8.05	57.53	87.1			0.04	0.7
		3	18.89	33.32	6.27	8.05	55.52	86.3				
		4	18.65	33.39	6.18	8.05	44.44	81.6				
8	703	0	19.11	33.40	6.41	7.99	58.25	87.4	11	2.7	0.05	0.9
1k WSW		1	19.11	33.42	6.45	8.00	56.67	86.8				
		2	19.15	33.41	6.85	8.00	55.15	86.2			0.06	0.9
		3	19.15	33.33	7.01	8.00	50.67	84.4				
		4	19.01	33.23	6.80	8.00	46.40	82.5			0.08	1.1

October 20, 2000 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	744	0	18.93	33.09	6.26	7.94	59.52	87.8	11	1.8	0.10	0.8
1k WSW		1	18.95	33.26	6.15	7.97	47.04	82.8				
		2	19.00	33.29	6.12	8.00	38.43	78.7			0.06	1.1
		3	18.84	33.33	6.20	8.02	40.73	79.9				
		4	18.72	33.38	6.20	8.02	33.35	76.0			0.08	1.3
10	725	0	19.09	33.22	5.67	7.97	52.65	85.2	11	2.2	0.12	0.9
1k WSW		1	19.10	33.26	5.50	7.97	52.13	85.0				
		2	19.18	33.34	5.75	7.97	50.24	84.2			0.10	0.7
		3	19.21	33.30	5.78	7.99	45.62	82.2				
		4	18.96	33.39	5.83	7.99	33.02	75.8			0.11	0.8
11	735	0	18.99	33.10	5.99	7.97	64.38	89.6	11	2.9	0.07	0.7
1k WSW		1	19.14	33.28	5.93	7.99	62.79	89.0				
		2	19.16	33.29	6.23	8.01	60.35	88.1			0.08	0.9
		3	19.04	33.30	6.46	8.03	53.05	85.3				
		4	18.88	33.25	6.37	8.04	53.57	85.6				
12	845	0	18.63	24.68	5.68	8.16	55.16	86.2	12	2.9	0.17	2.2
3k WSW		1	18.02	30.15	6.37	8.12	49.27	83.8				
		2	17.39	33.15	6.65	8.12	67.21	90.5			0.04	1.0
		3	17.37	33.47	6.49	8.12	72.15	92.2				
13	630	0	19.00	33.12	5.30	7.80					0.13	3.0
18	655	0	19.14	33.41	6.23	7.97	53.65	85.6	11	2.2	0.10	0.9
1k WSW		1	19.15	33.42	6.42	7.98	53.04	85.3				
		2	19.15	33.40	6.73	7.98	52.31	85.0			0.10	1.7
		3	19.08	33.41	6.59	7.97	52.31	85.0				
19	644	0	18.60	33.26	6.25	8.02					0.12	1.0
20	715	0	19.02	33.16	5.43	7.95	64.20	89.5	11	2.0	0.06	2.1
1k WSW		1	19.08	33.29	5.36	7.95	59.89	88.0				
		2	19.27	33.29	5.37	7.97	51.00	84.5			0.08	1.5
22	615	0	19.00	32.88	4.50	7.80					0.12	2.3
25	905	0	18.39	33.35	6.20	8.06	63.22	89.2	11	3.9	0.06	0.9
3k WSW		1	18.38	33.31	6.19	8.07	60.30	88.1				
		2	18.33	33.30	6.64	8.07	61.19	88.4			0.04	0.7
		3	18.22	33.31	6.85	8.07	61.86	88.7				
		4	18.05	33.27	6.83	8.08	59.09	87.7			0.07	0.8
		5	17.81	33.30	6.74	8.10	47.96	83.2				
	Average		18.51	33.08	6.66	8.05	58.88	87.40	11.2	3.1	0.08	1.3
	Number		80	80	80	80	77	77	15	15	44	44
	St. Dev.		0.61	1.08	0.76	0.07	8.77	3.50	0.4	1.3	0.03	0.6
	Maximum		19.27	33.48	8.55	8.17	72.15	92.16	12	6.5	0.17	3.0
	Minimum		17.20	24.68	4.50	7.80	33.02	75.80	11	1.8	0.03	0.7

Surface Bacteriological Water Data and General Observations **October 20, 2000**

CRUISE:	MDR 00-04	Vessel:	Aquatic Bioassay
WEATHER:	Overcast/Fog	Pers.:	J. Gelsinger
RAIN:	None		J. Mann

TIDE	TIME	HT. (ft)
High	539	4.0
Low	1002	3.2

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	835	1110	600	140	Moderate turbidity. Plastic bags in water column.
2	830	300	130	80	Moderate turbidity. Plastic bags in water column.
3	820	50	20	9	Moderate turbidity. Low flow from Venice Canal. Plastic bags in water column.
4	900	20	< 20	4	Moderate turbidity.
5	754	130	80	500	Moderate turbidity.
6	806	220	< 20	4	Moderate turbidity.
7	915	230	230	130	Moderate turbidity. Plastic bags in water column.
8	703	370	90	< 2	Moderate turbidity.
9	744	50	< 20	5	Moderate turbidity.
10	725	2800	90	130	High turbidity. Jellyfish in water column.
11	735	110	70	2	Moderate turbidity.
12	845	2800	900	900	Moderate turbidity. Plastic bags in water column.
13	630	16000	220	220	High turbidity. Ducks swimming.
18	655	230	20	4	Moderate turbidity. Jellyfish in water column.
19	644	5000	70	23	Moderate turbidity.
20	715	16000	170	130	Moderate turbidity. Jellyfish in water column.
22	615	≥ 16000	110	240	Low turbidity.
25	905	20	< 20	11	Moderate turbidity. Plastic bags in water column.
	Average	3413.3	160.0	140.8	
	Number	18	18	18	
	St. Dev.	5943.9	230.5	228.4	
	Maximum	16000	900	900	
	Minimum	20	20	2	

Physical Water Quality Data **November 10, 2000**

CRUISE: MDR 00-05
WEATHER: Partly Cloudy
RAIN: None

Vessel: Aquatic Bioassay
Pers.: J. Gelsinger
J. Mann

TIDE	TIME	HT. (ft)
High	739	6.0
Low	1417	-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 mg/l	BOD mg/l
1	835	0	16.91	33.38	6.69	8.20	66.93	90.4	12	4.7	0.11	1.0
2k WSW		1	16.97	33.44	6.79	8.20	65.49	90.0				
		2	17.01	33.48	7.18	8.20	64.56	89.6			0.10	1.0
		3	17.03	33.51	7.42	8.20	63.73	89.3				
		4	17.06	33.47	7.51	8.21	64.00	89.4			0.11	1.1
		5	17.02	33.47	7.57	8.21	63.41	89.2				
		6	16.97	33.48	7.63	8.20	62.08	88.8			0.13	1.1
2	830	0	16.94	33.46	7.52	8.19	60.86	88.3	12	4.1	0.42	1.2
2k WSW		1	16.94	33.47	7.53	8.19	61.55	88.6				
		2	16.94	33.47	7.50	8.19	61.50	88.6			0.12	1.0
		3	16.94	33.47	7.56	8.19	61.62	88.6				
		4	16.93	33.49	7.57	8.19	61.37	88.5			0.08	1.2
		5	16.94	33.49	7.56	8.19	60.20	88.1				
		6	16.93	33.47	7.56	8.19	58.68	87.5			0.06	1.2
3	821	0	16.77	33.42	6.77	8.14	63.94	89.4	12	3.9	0.06	0.9
2k WSW		1	16.96	33.39	6.73	8.14	61.66	88.6				
		2	17.01	33.42	6.78	8.14	59.90	88.0			0.07	0.7
		3	16.99	33.43	6.82	8.16	58.64	87.5				
4	905	0	17.12	33.34	6.83	8.14	60.31	88.1	12	3.9	0.07	0.9
2k WSW		1	17.11	33.34	6.75	8.15	60.48	88.2				
		2	17.10	33.35	6.78	8.15	60.97	88.4			0.12	0.6
		3	17.10	33.36	6.87	8.16	60.47	88.2				
		4	17.10	33.36	6.85	8.16	60.34	88.1			0.15	1.6
5	755	0	17.15	33.24	6.08	8.07	55.60	86.4	12	2.2	0.09	1.1
2k WSW		1	17.16	33.24	6.05	8.07	53.57	85.6				
		2	17.15	33.26	6.06	8.09	54.36	85.9			0.13	0.9
		3	17.15	33.27	6.09	8.09	54.87	86.1				
		4	17.15	33.26	6.24	8.10	56.59	86.7			0.09	1.0
6	807	0	17.17	33.19	5.02	8.01	46.60	82.6	12	2.1	0.09	0.4
2k WSW		1	17.17	33.19	5.20	8.01	45.23	82.0				
		2	17.16	33.19	5.37	8.00	45.59	82.2			0.08	0.3
		3	17.15	33.19	5.31	8.01	44.99	81.9				
7	916	0	17.32	33.19	5.66	8.01	57.25	87.0	12	3.1	0.09	0.3
2k WSW		1	17.31	33.17	5.50	8.01	55.51	86.3				
		2	17.29	33.17	5.53	8.02	54.75	86.0			0.03	0.4
		3	17.25	33.11	5.55	8.01	55.13	86.2				
		4	17.18	33.03	5.55	8.02	55.81	86.4			0.17	0.2
8	705	0	17.11	33.14	5.35	7.95	47.27	82.9	11	2.1	0.03	0.4
2k WSW		1	17.12	33.13	5.48	7.95	45.74	82.2				
		2	17.12	33.12	5.61	7.95	46.61	82.6			0.01	0.5
		3	17.06	33.04	5.63	7.95	47.43	83.0				
		4	16.74	33.21	5.61	7.95	51.21	84.6			0.12	0.4

November 10, 2000 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	946	0	17.43	33.08	5.57	7.99	52.69	85.2	12	2.4	0.06	0.5
2k WSW		1	17.42	33.09	5.58	7.99	49.54	83.9				
		2	17.43	33.08	5.59	7.99	50.64	84.4			0.05	0.3
		3	17.42	32.96	5.59	8.00	48.83	83.6				
		4	17.41	31.31	5.65	8.01	48.94	83.6			0.06	0.3
10	725	0	17.41	32.99	4.84	7.93	41.87	80.4	12	2.7	0.05	0.6
2k WSW		1	17.42	32.98	4.88	7.93	40.89	80.0				
		2	17.43	32.95	4.96	7.93	40.05	79.6			0.11	1.1
		3	17.43	32.73	4.99	7.94	39.71	79.4				
		4	17.46	32.03	4.97	7.94	39.83	79.4			0.04	0.9
11	738	0	17.34	33.10	5.16	7.99	47.49	83.0	12	2.1	0.06	0.5
2k WSW		1	17.34	33.10	5.37	7.99	47.24	82.9				
		2	17.35	33.00	5.63	7.98	45.71	82.2			0.07	0.4
		3	17.32	32.44	5.63	7.99	47.96	83.2				
		4	17.29	29.77	5.57	8.00	48.59	83.5			0.05	0.4
12	845	0	16.61	31.81	7.45	8.18	68.95	91.1	12	4.0	0.06	1.4
2k WSW		1	16.68	33.09	7.21	8.19	66.02	90.1				
		2	17.12	33.46	7.14	8.20	63.38	89.2			0.03	0.9
		3	17.13	33.48	7.19	8.21	66.04	90.1				
13	630	0	17.05	33.24	4.97	7.85					0.04	1.9
18	655	0	16.99	33.14	5.44	7.93	51.41	84.7	11	2.5	0.04	0.5
2k WSW		1	17.01	33.13	5.52	7.93	50.25	84.2				
		2	16.98	33.12	5.67	7.93	51.92	84.9			0.03	0.5
		3	16.90	33.11	5.54	7.93	53.17	85.4				
		4									0.04	0.5
19	650	0	16.67	33.23	5.51	7.96					0.07	0.5
20	720	0	17.41	32.96	4.59	7.93	52.44	85.1	12	2.2	0.05	1.3
2k WSW		1	17.42	32.96	4.68	7.92	50.94	84.5				
		2	17.41	32.96	4.60	7.92	52.17	85.0			0.05	0.5
22	617	0	16.50	33.09	3.70	7.75					< 0.01	1.5
25	910	0	17.19	33.33	6.58	8.12	57.32	87.0	12	1.5	< 0.01	1.1
2k WSW		1	17.19	33.31	6.37	8.12	56.24	86.6				
		2	17.16	33.33	6.45	8.12	55.52	86.3			< 0.01	0.3
		3	17.15	33.33	6.47	8.13	56.19	86.6				
		4	17.16	33.33	6.55	8.13	55.95	86.5			0.03	0.5
		5	17.17	33.31	6.53	8.12	55.08	86.1				
	Average		17.12	33.13	6.10	8.06	54.73	85.86	11.9	2.9	0.08	0.8
	Number		77	77	77	77	74	74	15	15	46	46
	St. Dev.		0.21	0.53	0.94	0.11	7.32	2.93	0.4	1.0	0.06	0.4
	Maximum		17.46	33.51	7.63	8.21	68.95	91.12	12	4.7	0.42	1.9
	Minimum		16.50	29.77	3.70	7.75	39.71	79.38	11	1.5	0.01	0.2

Surface Bacteriological Water Data and General Observations **November 10, 2000**

CRUISE:	MDR 00-05	Vessel:	Aquatic Bioassay
WEATHER:	Partly Cloudy	Pers.:	J. Gelsinger
RAIN:	None		J. Mann

TIDE	TIME	HT. (ft)
High	739	6.0
Low	1417	-0.1

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	835	800	170	170	Moderate turbidity. Floating plastic bags, wood, styrofoam cups.
2	830	80	80	30	Moderate turbidity. Floating plastic bags, wood, styrofoam cups.
3	821	20	< 20	5	Moderate turbidity. Floating plastic bags, wood, styrofoam cups. Venice Canal gate closed.
4	905	< 20	< 20	17	Moderate turbidity. Floating plastic bags, wood, styrofoam cups.
5	755	< 20	< 20	5	Moderate turbidity. Floating plastic bags, wood, styrofoam cups.
6	807	110	20	6	Moderate turbidity.
7	916	300	230	7	Moderate turbidity.
8	705	1100	20	11	Moderate turbidity. Floating plastic bags.
9	946	< 20	< 20	5	Moderate turbidity.
10	725	230	130	50	Moderate turbidity. Floating styrofoam cups.
11	738	50	< 20	2	Moderate turbidity.
12	845	1700	300	500	High turbidity. Floating plastic bags, wood, styrofoam cups.
13	630	500	170	130	Moderate turbidity. Small algal mats. Floating plastic bags and styrofoam cups.
18	655	1300	20	5	Moderate turbidity.
19	650	130	20	11	Moderate turbidity.
20	720	300	70	23	Moderate turbidity. Sulfide odor.
22	617	5000	110	500	Moderate turbidity. Small algal mats
25	910	20	20	2	Moderate turbidity. Floating plastic bags, wood, styrofoam cups.
	Average	650.0	81.1	82.2	
	Number	18	18	18	
	St. Dev.	1196.8	86.3	158.8	
	Maximum	5000	300	500	
	Minimum	20	20	2	

Physical Water Quality Data December 4, 2000

CRUISE:	MDR 00-00	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	445	4.3
RAIN:	None	J. Mann	Low	1036	2.7

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 mg/l	BOD mg/l
1	835	0	14.76	31.65	8.36	8.15	61.48	88.5	15	3.2	0.06	2.2
3k WSW		1	14.76	32.56	8.07	8.15	59.99	88.0				
		2	14.99	33.36	7.94	8.15	59.19	87.7			0.09	2.6
		3	15.04	33.42	7.96	8.16	60.03	88.0				
		4	15.05	33.45	8.04	8.16	60.15	88.1			0.18	1.4
		5	15.08	33.43	8.10	8.18	59.09	87.7				
		6	15.01	33.46	8.19	8.18	60.59	88.2			0.13	1.1
2	824	0	14.75	32.69	7.57	8.15	60.16	88.1	15	3.7	0.09	3.4
3k WSW		1	14.86	33.36	7.44	8.16	58.03	87.3				
		2	15.02	33.33	7.94	8.16	56.74	86.8			0.12	2.9
		3	15.06	33.38	8.17	8.15	56.73	86.8				
		4	15.07	33.39	8.19	8.15	57.21	87.0			0.11	2.6
		5	15.07	33.41	8.20	8.15	58.06	87.3				
		6	15.07	33.41	8.15	8.14	58.93	87.6			0.15	1.8
3	817	0	14.79	33.29	6.33	8.00	67.10	90.5	14	4.1	0.07	0.6
3k WSW		1	14.79	33.33	6.20	8.00	67.29	90.6				
		2	14.89	33.29	6.42	8.01	65.02	89.8			0.05	0.7
		3	14.86	33.34	6.57	8.01	64.05	89.5				
		4	14.91	33.41	6.64	8.02	63.94	89.4			0.06	0.5
4	856	0	15.21	33.32	6.98	8.02	54.84	86.1	12	2.5	0.07	0.9
3k WSW		1	15.21	33.32	6.71	8.02	54.29	85.8				
		2	15.21	33.32	6.71	8.02	53.94	85.7			0.07	0.5
		3	15.21	33.32	6.76	8.02	55.01	86.1				
		4	15.20	33.33	6.73	8.02	55.59	86.3			0.07	0.4
5	752	0	14.99	33.21	6.32	7.94	56.72	86.8	11	3.1	0.07	0.7
1k NE		1	15.00	33.21	6.14	7.95	55.09	86.2				
		2	15.01	33.21	6.15	7.95	54.92	86.1			< 0.01	0.6
		3	15.01	33.24	6.15	7.95	55.61	86.4				
		4	15.06	33.24	6.14	7.95	55.62	86.4			0.05	0.6
6	800	0	14.80	33.23	5.84	7.95	46.18	82.4	11	1.9	< 0.01	0.6
1k NE		1	14.81	33.21	5.65	7.96	45.15	82.0				
		2	14.81	33.23	5.92	7.96	44.42	81.6			0.03	0.5
		3	14.79	33.23	5.94	7.96	45.51	82.1				
		4	14.79	33.23	5.90	7.96	46.08	82.4			0.03	0.5
7	912	0	15.11	33.21	5.17	7.89	59.70	87.9	12	3.8	< 0.01	0.7
3k WSW		1	15.10	33.21	5.02	7.90	58.99	87.6				
		2	15.11	33.20	5.16	7.89	59.78	87.9			< 0.01	0.4
		3	15.09	33.19	5.25	7.89	60.51	88.2				
8	700	0	14.85	33.16	6.56	7.94	60.37	88.1	11	3.6	< 0.01	0.4
1k WSW		1	14.85	33.16	6.73	7.94	60.24	88.1				
		2	14.85	33.16	7.08	7.94	60.20	88.1			0.08	0.6
		3	14.85	33.13	7.18	7.94	60.83	88.3				
		4	14.77	33.15	7.00	7.96	61.42	88.5			0.09	1.7

December 4, 2000 (Continued)

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 u-at/l	BOD mg/l
9	740	0	15.14	33.04	5.26	7.89	47.48	83.0	11	1.9	< 0.01	0.4
1k NE		1	15.15	33.12	5.55	7.90	47.21	82.9				
		2	15.21	33.13	5.65	7.91	46.26	82.5			< 0.01	0.3
		3	15.20	33.15	5.71	7.91	45.10	81.9				
		4	15.20	33.14	5.61	7.92	43.21	81.1			0.10	0.4
10	723	0	14.96	32.93	6.61	7.91	44.39	81.6	11	1.9	< 0.01	0.6
1k WSW		1	15.03	32.99	5.79	7.92	43.34	81.1				
		2	15.12	32.98	5.96	7.91	42.20	80.6			0.04	0.4
		3	15.15	32.97	5.95	7.91	40.55	79.8				
		4									< 0.01	0.8
11	733	0	15.04	33.08	6.25	7.93	43.44	81.2	11	1.7	< 0,01	0.5
1k NE		1	15.03	33.09	6.05	7.94	43.29	81.1				
		2	15.06	33.05	6.21	7.94	41.82	80.4			< 0.01	0.4
		3	15.08	32.69	6.26	7.94	41.38	80.2				
		4	15.11	31.26	6.22	7.94	42.83	80.9			0.13	0.4
12	840	0	14.83	27.61	8.14	8.15	54.27	85.8	14	3.0	0.11	1.4
3k WSW		1	15.00	32.00	7.64	8.14	44.72	81.8				
		2	15.15	33.23	7.56	8.11	46.76	82.7			< 0.01	1.6
		3	15.15	33.40	7.58	8.13	58.16	87.3				
13	623	0	14.95	32.76	5.70	7.87					< 0.01	1.9
18	652	0	14.83	33.18	7.04	7.94	59.44	87.8	11	3.4	< 0.01	0.6
1k WSW		1	14.83	33.18	6.92	7.94	61.42	88.5				
		2	14.82	33.18	7.06	7.94	61.06	88.4			< 0.01	1.0
19	634	0	13.80	33.04	7.19	8.02					< 0.01	1.0
20	718	0	14.98	32.86	5.49	7.90	45.08	81.9	12	1.7	< 0.01	1.3
1k WSW		1	14.97	32.92	5.65	7.90	45.31	82.0				
		2	15.03	32.88	5.54	7.90	44.42	81.6			0.08	0.6
22	610	0	14.95	32.50	5.50	7.80					0.14	1.4
25	900	0	15.22	33.30	5.63	7.98	54.57	85.9	12	2.6	0.09	0.6
3k WSW		1	15.23	33.30	5.55	7.98	52.91	85.3				
		2	15.23	33.30	5.72	7.98	52.70	85.2			0.09	0.5
		3	15.23	33.30	5.94	7.98	52.79	85.2				
		4	15.23	33.30	6.02	7.99	50.84	84.4			0.09	0.5
	Average		14.99	33.04	6.57	7.99	53.77	85.48	12.2	2.8	0.06	1.0
	Number		75	75	75	75	72	72	15	15	46	46
	St. Dev.		0.20	0.74	0.94	0.10	7.38	3.00	1.5	0.8	0.05	0.8
	Maximum		15.23	33.46	8.36	8.18	67.29	90.57	15	4.1	0.18	3.4
	Minimum		13.80	27.61	5.02	7.80	40.55	79.80	11	1.7	0.01	0.3

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

CRUISE:	MDR 00-00	Vessel:	Aquatic Bioassay
WEATHER:	Overcast	Pers.:	J. Gelsinger
RAIN:	None		J. Mann

TIDE	TIME	HT. (ft)
High	445	4.3
Low	1036	2.7

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	835	1300	170	4	Moderate turbidity.
2	824	16000	300	6	Moderate turbidity. Floating oil slick. Canal gate half open.
3	817	80	20	2	Moderate turbidity. Floating oil slick.
4	856	80	20	< 2	Moderate turbidity.
5	752	110	50	110	Moderate turbidity. Floating plastic bags.
6	800	500	50	6	Moderate turbidity. Floating plastic bags and foam cups. Floating oil slick.
7	912	300	70	14	Moderate turbidity.
8	700	110	< 20	4	Low turbidity.
9	740	20	< 20	< 2	Moderate turbidity.
10	723	1700	< 20	21	Low turbidity.
11	733	50	50	< 2	Moderate turbidity.
12	840	16000	40	21	Moderate turbidity. Floating plastic bags.
13	623	≥ 16000	90	90	Low turbidity. Floating plastic bags and foam cups.
18	652	20	< 20	6	Low turbidity.
19	634	90	20	50	Low turbidity.
20	718	2800	110	11	Low turbidity.
22	610	≥ 16000	20	500	Low turbidity.
25	900	230	230	70	Moderate turbidity.
	Average	3966.1	73.3	51.2	
	Number	18	18	18	
	St. Dev.	6658.6	81.3	116.8	
	Maximum	16000	300	500	
	Minimum	20	20	2	

Physical Water Quality Data **January 5, 2001**

CRUISE: MDR 01-01 Vessel: Aquatic Bioassay
WEATHER: Cloudy-Ptly Cloudy Pers.: J. Gelsinger
RAIN: None J. Mann

TIDE	TIME	HT. (ft)
High	518	5.4
Low	1230	0.4

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 mg/l	BOD mg/l
1	851	0	14.32	31.96	7.91	8.04	61.57	88.6	14	3.1	0.14	2.0
1k E		1	14.42	32.63	7.39	8.05	59.33	87.8				
		2	14.43	32.98	7.37	8.06	60.25	88.1			0.12	2.1
		3	14.46	33.24	7.52	8.06	60.89	88.3				
		4	14.46	33.29	7.71	8.06	60.04	88.0			0.11	2.0
		5	14.42	33.36	7.86	8.06	59.30	87.8				
		6	14.40	33.37	7.85	8.04	57.49	87.1			0.09	1.7
2	845	0	14.30	33.29	7.19	8.01	57.04	86.9	14	2.9	0.09	2.3
1k E		1	14.30	33.32	7.24	8.01	55.80	86.4				
		2	14.35	33.34	7.51	8.01	56.53	86.7			0.14	2.3
		3	14.40	33.37	7.81	8.02	57.30	87.0				
		4	14.42	33.37	7.93	8.02	58.57	87.5			0.26	2.1
		5	14.42	33.38	7.96	8.03	58.82	87.6				
		6	14.41	33.38	8.00	8.02	59.41	87.8			0.07	2.2
3	839	0	14.24	33.27	7.10	7.97	62.50	88.9	14	3.4	0.08	1.2
1k E		1	14.21	33.33	6.74	7.97	63.83	89.4				
		2	14.41	33.36	6.87	7.98	59.10	87.7			0.08	0.9
		3	14.59	33.35	6.97	8.02	54.69	86.0				
		4	14.57	33.30	7.18	8.04	52.06	84.9			0.09	0.8
		5	14.48	33.35	7.17	8.02	51.86	84.9				
4	915	0	14.35	33.22	6.51	7.92	56.01	86.5	14	2.9	0.09	1.0
1k E		1	14.36	33.22	6.16	7.92	55.59	86.3				
		2	14.36	33.22	6.44	7.92	54.49	85.9			0.12	0.7
		3	14.37	33.23	6.62	7.93	54.92	86.1				
		4	14.37	33.23	6.46	7.93	55.82	86.4			0.11	0.7
5	809	0	14.23	33.14	6.85	7.86	51.79	84.8	14	2.7	0.09	0.8
1k E		1	14.23	33.14	6.41	7.86	49.83	84.0				
		2	14.23	33.13	6.44	7.87	49.06	83.7			0.07	0.9
		3	14.23	33.12	6.47	7.87	50.52	84.3				
		4	14.23	33.08	6.46	7.86	50.73	84.4			0.07	0.8
6	821	0	13.98	33.13	5.87	7.88	46.44	82.6	16	1.9	0.07	0.9
1k E		1	13.98	33.16	6.10	7.88	46.13	82.4				
		2	13.98	33.16	6.09	7.89	45.61	82.2			0.08	0.5
		3	13.98	33.16	6.28	7.88	45.52	82.1				
		4	13.98	33.16	6.21	7.88	45.64	82.2			0.06	0.5
7	932	0	14.27	33.18	6.20	7.83	58.73	87.5	10	3.1	0.06	0.4
1k E		1	14.27	33.17	5.70	7.84	57.44	87.1				
		2	14.23	33.17	5.89	7.84	57.27	87.0			0.06	0.4
		3	14.22	33.17	6.02	7.84	58.67	87.5				
		4	14.21	33.18	5.97	7.84	59.90	88.0			0.04	0.4
8	705	0	13.91	33.09	6.95	7.88	51.97	84.9	14	2.9	0.02	1.0
1k E		1	13.94	33.08	7.10	7.88	53.15	85.4				
		2	13.95	33.08	7.30	7.89	53.24	85.4			0.11	1.0
		3	13.95	33.09	7.31	7.91	53.70	85.6				
		4	13.92	33.08	7.24	7.91	54.03	85.7			0.06	0.7

January 5, 2001 (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	800	0	14.20	33.02	6.21	7.83	46.11	82.4	14	2.0	0.10	0.5
1k E		1	14.20	33.02	5.97	7.84	45.10	81.9				
		2	14.19	33.06	6.07	7.84	44.53	81.7			0.05	0.5
		3	14.22	33.07	6.06	7.84	44.48	81.7				
		4	14.23	33.03	6.01	7.84	43.45	81.2			0.04	0.6
10	729	0	13.81	32.83	6.29	7.86	37.67	78.3	11	1.8	0.04	0.6
1k E		1	13.82	32.91	6.35	7.86	40.52	79.8				
		2	13.99	32.96	6.36	7.86	41.56	80.3			0.06	0.5
		3	14.11	32.96	6.36	7.85	36.57	77.8				
		4	14.16	32.97	6.34	7.85	38.04	78.5			0.01	0.6
		5	14.22	32.89	6.29	7.85	29.60	73.8				
11	750	0	14.11	33.01	7.04	7.84	41.93	80.5	11	1.9	0.03	0.6
1k E		1	14.11	33.01	6.22	7.84	41.63	80.3				
		2	14.10	33.05	6.27	7.85	41.70	80.4			< 0.01	0.4
		3	14.13	33.06	6.29	7.85	41.09	80.1				
		4	14.15	33.03	6.23	7.85	36.56	77.8			< 0.01	0.5
12	859	0	14.30	27.79	6.52	7.98	43.14	81.0	14	2.7	0.02	1.3
1k E		1	14.54	32.52	5.43	7.94	52.43	85.1				
		2	14.60	33.12	5.43	7.99	54.30	85.8			0.01	2.3
13	630	0	14.12	32.73	6.48	7.73					0.01	1.3
18	656	0	13.86	33.08	6.86	7.88	53.74	85.6	14	2.8	0.02	0.7
1k E		1	13.86	33.07	7.03	7.88	53.09	85.4				
		2	13.85	33.00	7.36	7.89	53.70	85.6			0.08	0.9
		3	13.65	33.07	7.24	7.89	54.08	85.8				
19	642	0	14.00	33.14	7.20	7.89					< 0.01	1.2
20	721	0	13.98	32.87	5.90	7.84	41.67	80.3	11	1.9	< 0.01	0.7
1k E		1	13.99	32.88	6.05	7.84	40.37	79.7				
		2	14.03	32.90	5.98	7.84	40.17	79.6			< 0.01	0.7
22	617	0	14.16	32.92	6.54	7.68					0.02	0.9
25	927	0	14.33	33.19	6.17	7.89	55.34	86.3	10	2.5	0.09	0.7
1k E		1	14.33	33.19	5.67	7.89	52.60	85.2				
		2	14.33	33.20	5.89	7.90	53.93	85.7			0.08	0.5
		3	14.34	33.20	6.14	7.90	55.56	86.3				
		4	14.34	33.21	6.11	7.90	55.68	86.4			0.02	0.5
		5	14.35	33.21	6.03	7.90	55.68	86.4				
	Average		14.21	33.04	6.63	7.91	51.28	84.44	13.0	2.6	0.07	1.0
	Number		80	80	80	80	77	77	15	15	47	47
	St. Dev.		0.20	0.63	0.66	0.08	7.50	3.26	1.9	0.5	0.05	0.6
	Maximum		14.60	33.38	8.00	8.06	63.83	89.38	16	3.4	0.26	2.3
	Minimum		13.65	27.79	5.43	7.68	29.60	73.76	10	1.8	0.01	0.4

Surface Bacteriological Water Data and General Observations January 5, 2001

CRUISE: MDR 01-01
WEATHER: Cloudy-Ptly Cloudy
RAIN: None

Vessel: Aquatic Bioassay
Pers.: J. Gelsinger, J. Mann

TIDE	TIME	HT. (ft)
High	518	5.4
Low	1230	0.4

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	851	700	230	26	High turbidity.
2	845	< 20	< 20	< 2	High turbidity.
3	839	80	20	2	High turbidity. Canal gate open. Flow at 6 kt.
4	915	< 20	< 20	4	High turbidity.
5	809	20	< 20	< 2	Moderate turbidity.
6	821	230	< 20	4	High turbidity. Plastic trash in water column.
7	932	20	< 20	4	Low turbidity.
8	705	220	< 20	11	High turbidity.
9	800	50	< 20	14	Moderate turbidity.
10	729	1400	80	80	Moderate turbidity. Greasy oil slick.
11	750	130	< 20	42	Moderate turbidity.
12	859	16000	1100	140	High turbidity. Plastic trash in water column.
13	630	700	130	130	High turbidity. Floating algal mats.
18	656	110	< 20	13	High turbidity.
19	642	300	170	22	High turbidity.
20	721	300	50	170	Moderate turbidity. Small oil slick.
22	617	2200	110	240	High turbidity. Floating algal mats.
25	927	< 20	< 20	5	High turbidity.
	Average	1251.1	116.1	50.6	
	Number	18	18	18	
	St. Dev.	3725.3	253.4	71.5	
	Maximum	16000	1100	240	
	Minimum	20	20	2	

Physical Water Quality Data **February 15, 2001**

CRUISE: MDR 01-02
WEATHER: Clear
RAIN: None

Vessel: Aquatic Bioassay
Pers.: J. Gelsinger
J. Mann

TIDE	TIME	HT. (ft)
High	305	4.8
Low	1044	0.9

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 mg/l	BOD mg/l
1	1030	0	13.14	30.76	7.70	8.08	30.19	74.1	12	1.5	0.04	1.5
3k WSW		1	13.19	33.12	7.61	8.10	36.11	77.5				
		2	13.41	33.11	7.61	8.15	48.23	83.3			0.04	1.4
		3	13.37	33.25	7.86	8.17	59.08	87.7				
		4	13.34	33.28	7.87	8.17	62.76	89.0			0.03	1.4
		5	13.33	33.29	7.97	8.17	63.43	89.2				
		6									< 0.01	1.1
2	1022	0	13.32	31.62	7.32	8.10	49.84	84.0	12	2.6	0.02	1.0
3k WSW		1	13.36	32.51	7.47	8.10	53.88	85.7				
		2	13.48	32.89	7.84	8.13	52.62	85.2			0.02	1.0
		3	13.39	33.15	8.03	8.15	55.67	86.4				
		4	13.35	33.27	8.33	8.13	56.03	86.5			0.02	1.2
		5	13.34	33.29	8.35	8.15	55.92	86.5				
		6	13.34	33.29	8.21	8.16	56.21	86.6			0.05	1.1
3	1015	0	13.15	31.28	7.31	8.07	55.17	86.2	14	3.2	0.06	1.5
3k WSW		1	13.32	32.65	7.47	8.07	49.00	83.7				
		2	13.37	33.04	7.43	8.11	49.02	83.7			0.03	0.7
4	1100	0	13.53	29.92	8.41	8.05	59.07	87.7	12	3.8	0.04	0.9
3k WSW		1	13.52	31.45	7.83	8.05	58.65	87.5				
		2	13.49	32.91	7.60	8.10	55.49	86.3			0.02	0.7
		3	13.40	33.07	7.70	8.11	55.78	86.4				
		4									0.01	0.7
5	945	0	13.50	31.47	7.64	8.05	41.51	80.3	12	1.9	0.04	0.8
1k WSW		1	13.68	32.18	7.53	8.05	41.11	80.1				
		2	13.58	32.76	7.56	8.05	39.44	79.2			0.02	0.7
		3	13.40	33.04	7.46	8.08	43.15	81.0				
		4	13.37	33.10	7.49	8.11	42.96	81.0			0.03	0.8
6	955	0	12.15	30.96	7.66	8.06	51.01	84.5	12	1.9	0.04	0.9
1k WSW		1	13.11	32.51	7.58	8.05	29.83	73.9				
		2	13.66	32.65	7.73	8.00	33.59	76.1			0.05	0.9
7	1115	0	13.77	30.55	7.46	8.00	54.90	86.1	12	2.4	0.01	0.7
3k WSW		1	13.81	32.18	6.69	8.00	53.42	85.5				
		2	13.77	32.72	6.80	8.00	48.40	83.4			< 0.01	0.6
		3	13.66	32.96	6.82	8.01	43.52	81.2				
8	854	0	13.52	31.95	8.59	7.97	32.04	75.2	15	1.4	0.01	1.0
1k WSW		1	13.74	32.40	7.94	7.95	35.28	77.1				
		2	13.65	32.74	7.28	7.96	37.09	78.0			0.01	0.9
		3	13.52	32.90	7.15	7.99	29.48	73.7				
		4									< 0.01	0.7

February 15, 2001 (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	935	0	13.38	31.76	7.42	8.01	29.34	73.6	12	1.6	0.01	0.8
1k WSW		1	13.35	31.95	7.32	8.02	18.49	65.6				
		2	13.32	32.13	7.21	8.03	7.64	52.6			0.02	0.7
10	917	0	13.00	31.60	6.77	7.92	31.17	74.7	10	1.4	0.02	1.0
1k WSW		1	13.49	32.39	6.62	7.94	26.29	71.6				
		2	13.57	32.84	6.51	8.00	25.66	71.2			0.02	0.9
		3	13.54	32.88	6.52	8.02	23.89	69.9				
		4									0.02	0.8
11	925	0	13.65	31.32	6.67	8.02	35.87	77.4	12	1.4	0.03	0.9
1k WSW		1	13.69	32.04	6.88	8.02	31.04	74.6				
		2	13.55	32.81	6.90	8.02	27.90	72.7			0.04	0.7
12	1040	0	12.53	28.67	6.99	8.02	7.25	51.9	18	0.4	0.06	1.5
3k WSW		1	13.35	25.10	6.98	8.05	14.67	61.9				
		2	13.42	19.05	7.29	8.10	51.68	84.8			0.03	1.3
13	637	0	13.32	31.09	5.20	7.90					0.07	6.3
18	845	0	13.55	32.01	9.04	7.92	24.91	70.6	15	1.9	0.04	1.2
1k WSW		1	13.73	32.35	7.61	7.90	34.76	76.8				
		2	13.63	32.59	6.18	7.93	40.90	80.0			0.04	1.1
19	650	0	8.00	31.08	8.20	8.03					0.06	1.3
20	910	0	13.01	31.85	5.60	7.90	19.21	66.2	10	1.1	0.05	2.8
1k WSW												
22	625	0	13.05	31.76	7.44	7.91					0.04	3.0
25	1105	0	13.66	29.89	8.55	8.03	51.36	84.7	12	2.7	0.02	0.7
3k WSW		1	13.52	32.18	7.30	8.04	51.11	84.6				
		2	13.45	32.85	7.52	8.08	52.06	84.9			0.02	0.7
		3	13.39	33.10	7.60	8.10	52.67	85.2				
		4	13.36	33.17	7.67	8.11	53.82	85.7				
	Average		13.32	31.91	7.43	8.04	41.91	79.32	12.7	1.9	0.03	1.2
	Number		61	61	61	61	58	58	15	15	40	40
	St. Dev.		0.74	2.14	0.67	0.07	14.10	8.28	2.1	0.9	0.02	1.0
	Maximum		13.81	33.29	9.04	8.17	63.43	89.24	18	3.8	0.07	6.3
	Minimum		8.00	19.05	5.20	7.90	7.25	51.89	10	0.4	0.01	0.6

Surface Bacteriological Water Data and General Observations **February 15, 2001**

CRUISE: MDR 01-02	Vessel: Aquatic Bioassay	TIDE High	TIME 305
WEATHER: Clear	Pers.: J. Gelsinger		

CRUISE: MDR 01-02
WEATHER: Clear
RAIN: None

Vessel: Aquatic Bioassay
Pers.: J. Gelsinger
J. Mann

TIDE	TIME	HT. (ft)
High	305	4.8
Low	1044	0.9

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	1030	≥ 16000	9000	900	Moderate turbidity.
2	1022	170	50	6	Moderate turbidity.
3	1015	2200	110	30	Moderate turbidity. Surface oil. Plastic bags in the water. Canal gate fully open. Low flow.
4	1100	1100	170	4	High turbidity. Plastic trash in the water.
5	945	1700	70	2	Moderate turbidity. Plastic trash in the water.
6	955	500	60	2	Moderate turbidity. Plastic trash and leaves in the water.
7	1115	130	80	< 2	High turbidity.
8	854	360	270	8	Moderate turbidity.
9	935	500	110	8	Moderate turbidity.
10	917	9000	80	130	High turbidity. Leaves in the water column.
11	925	700	40	4	Moderate turbidity.
12	1040	≥ 16000	5000	1600	High turbidity. Plastic trash in the water.
13	637	≥ 16000	1100	1600	Moderate turbidity. Plastic trash and leaves in the water.
18	845	3000	90	80	Moderate turbidity. Plastic trash in the water.
19	650	5000	40	27	Low turbidity. Plastic trash in the water.
20	910	≥ 16000	550	240	High turbidity. Leaves in the water column.
22	625	≥ 16000	1400	1600	Low turbidity. Plastic trash and leaves in the water.
25	1105	170	20	2	High turbidity. Plastic trash in the water.
	Average	5807.2	1013.3	346.9	
	Number	18	18	18	
	St. Dev.	6851.8	2315.6	613.9	
	Maximum	16000	9000	1600	
	Minimum	130	20	2	

Physical Water Quality Data **March 7, 2001**

CRUISE:	MDR 01-03	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy	Pers.: J. Gelsinger	High	705	6.3
RAIN:	None	J. Mann	Low	1402	-1.4

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 mg/l	BOD mg/l
1	855	0	14.18	29.69	8.72	8.09	49.48	83.9	16	1.9	0.05	1.9
2k WSW		1	14.05	31.71	8.46	8.10	51.09	84.5				
		2	13.98	32.55	8.48	8.11	54.81	86.0			0.03	1.2
		3	13.95	32.85	8.53	8.12	56.51	86.7				
		4	13.92	32.97	8.64	8.13	59.20	87.7			0.03	1.6
		5	13.93	33.00	8.79	8.14	62.64	89.0				
		6	13.91	33.02	8.90	8.15	64.05	89.5			0.03	1.2
2	847	0	14.48	30.34	8.35	8.03	54.20	85.8	15	2.1	0.03	1.4
2k WSW		1	14.44	31.44	7.88	8.03	52.77	85.2				
		2	14.03	32.62	7.91	8.09	54.24	85.8			0.09	1.3
		3	13.89	33.01	8.40	8.12	56.39	86.7				
		4	13.88	33.04	8.69	8.13	55.88	86.5			0.13	1.3
		5	13.88	33.03	8.64	8.13	54.63	86.0				
		6	13.87	33.02	8.54	8.13	53.20	85.4			0.05	1.2
3	842	0	14.35	30.27	7.80	8.03	56.97	86.9	15	2.6	0.04	1.0
2k WSW		1	14.15	31.99	6.65	8.05	53.85	85.7				
		2	13.98	32.87	7.02	8.10	54.72	86.0			0.04	1.2
4	920	0	14.48	30.11	7.68	8.01	59.99	88.0	8	2.8	0.04	1.5
2k WNW		1	14.40	31.69	7.34	8.02	58.96	87.6				
		2	14.19	32.51	7.60	8.06	56.32	86.6			0.05	1.4
		3	14.05	32.86	7.71	8.10	53.47	85.5				
		4	14.05	32.88	7.71	8.10	52.89	85.3			0.05	1.5
5	810	0	14.79	30.88	7.37	7.97	53.47	85.5	10	2.1	0.04	1.1
1k WSW		1	14.68	31.58	7.41	7.99	49.76	84.0				
		2	14.36	32.22	7.54	8.00	48.55	83.5			0.05	1.3
		3	14.19	32.52	7.51	8.03	52.83	85.3				
		4	14.12	32.39	7.55	8.07	55.93	86.5			0.04	1.0
		5	14.15	30.75	7.68	8.08	56.03	86.5				
6	823	0	14.54	30.25	8.69	8.01	56.51	86.7	15	2.1	0.04	1.4
1k WSW		1	14.55	31.37	7.73	8.01	54.73	86.0				
		2	14.36	32.35	7.74	7.99	50.04	84.1			0.05	1.0
		3	14.26	32.52	7.61	7.97	43.35	81.1				
		4	14.11	32.60	7.43	7.98	40.80	79.9			0.04	0.9
7	940	0	14.82	30.31	8.01	8.01	66.01	90.1	8	3.0	0.07	1.0
2k WNW		1	14.77	31.24	7.51	8.01	65.49	90.0				
		2	14.44	32.37	7.33	7.98	55.87	86.5			0.06	0.9
		3	14.17	32.09	6.93	8.02	50.75	84.4				
		4	14.20	30.07	7.15	8.08	49.80	84.0			0.03	0.8
8	717	0	14.80	30.88	7.63	7.91	47.93	83.2	10	2.0	0.03	1.3
1k WSW		1	14.54	31.92	7.63	7.90	46.27	82.5				
		2	14.39	32.34	7.55	7.89	47.92	83.2			0.03	1.3
		3	14.35	32.39	7.36	7.89	47.52	83.0				
		4	14.26	31.62	7.21	7.90	45.47	82.1			0.02	1.1

March 7, 2001 (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	800	0	14.82	30.21	7.60	7.87	57.81	87.2	10	2.2	0.01	1.0
1k WSW		1	14.63	31.64	7.22	7.89	52.54	85.1				
		2	14.33	32.43	7.06	7.92	39.05	79.1			0.01	1.0
		3	14.18	32.58	6.70	7.96	36.23	77.6				
		4	14.12	32.61	6.69	7.98	33.64	76.2			0.03	2.5
10	737	0	14.53	31.21	6.53	7.87	50.03	84.1	10	1.9	0.03	1.1
1k WSW		1	14.53	32.10	6.51	7.88	45.16	82.0				
		2	14.39	32.38	6.53	7.91	43.40	81.2			0.02	1.1
		3	14.36	32.44	6.54	7.91	42.46	80.7				
		4	14.35	32.35	6.53	7.91	37.77	78.4			0.02	0.9
		5	14.34	32.05	6.53	7.90	38.92	79.0				
11	751	0	14.70	30.92	7.30	7.95	52.25	85.0	10	2.1	0.03	1.1
1k WSW		1	14.60	31.58	7.29	7.95	47.37	83.0				
		2	14.32	32.34	7.28	7.96	48.31	83.4			0.01	1.0
		3	14.14	32.57	7.23	7.96	46.85	82.7				
		4	14.09	32.64	7.23	7.97	47.11	82.8			0.02	1.0
12	905	0	15.00	16.60	8.10	8.09	83.75	95.7	17	0.6	0.03	1.7
2k WSW		1	15.00	21.82	8.60	8.05	62.58	88.9				
		2	15.00	27.03	9.10	8.00	41.40	80.2			0.02	1.1
13	634	0	14.65	29.43	5.50	7.82					0.02	2.6
18	710	0	14.70	31.17	6.28	7.83	40.16	79.6	10	1.9	0.02	1.4
1k WSW		1	14.49	31.88	6.30	7.86	39.79	79.4				
		2									0.02	1.3
19	645	0	13.50	30.82	6.46	7.88					0.05	1.3
20	730	0	14.53	31.47	6.24	7.86	57.93	87.2	10	2.9	0.05	2.0
1k WSW		1	14.46	31.94	6.29	7.87	49.39	83.8				
		2	14.38	32.36	6.28	7.87	45.99	82.4			0.06	1.8
22	625	0	14.68	30.75	5.80	7.70					0.05	2.5
25	935	0	14.58	30.24	7.71	8.01	61.84	88.7	8	2.2	0.05	1.0
2k WNW		1	14.48	31.50	7.20	8.01	62.95	89.1				
		2	14.31	32.39	7.41	8.04	56.98	86.9			0.04	0.9
		3	14.19	32.72	7.48	8.08	52.67	85.2				
		4	14.15	32.33	7.56	8.10	47.00	82.8			0.04	1.2
		5	14.13	31.58	7.57	8.11	40.80	79.9				
	Average		14.34	31.45	7.47	7.99	51.69	84.60	11.5	2.2	0.04	1.3
	Number		76	76	76	76	73	73	15	15	46	46
	St. Dev.		0.30	2.33	0.78	0.10	8.19	3.34	3.2	0.6	0.02	0.4
	Maximum		15.00	33.04	9.10	8.15	83.75	95.66	17	3.0	0.13	2.6
	Minimum		13.50	16.60	5.50	7.70	33.64	76.16	8	0.6	0.01	0.8

Surface Bacteriological Water Data and General Observations **March 7, 2001**

CRUISE:	MDR 01-03	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Partly Cloudy	Pers.:	J. Gelsinger	High	705	6.3
RAIN:	None		J. Mann	Low	1402	-1.4

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	855	≥ 16000	1100	900	High turbidity. Plastic trash in water column.
2	847	1300	170	17	High turbidity. Plastic trash in water column.
3	842	500	70	20	High turbidity. Plastic trash in water column. Canal gate 50% open. Moderate flow.
4	920	1700	80	7	Moderate turbidity.
5	810	800	50	13	Moderate turbidity. Plastic trash in water column.
6	823	230	< 20	7	Moderate turbidity. Plastic trash in water column. Floating leaves on surface.
7	940	1100	300	2	Moderate turbidity.
8	717	2400	500	70	Moderate turbidity.
9	800	500	40	13	Moderate turbidity.
10	737	9000	500	500	Moderate turbidity.
11	751	5000	300	9	Moderate turbidity.
12	905	≥ 16000	16000	≥ 1600	High turbidity. Plastic trash in water column.
13	634	9000	230	300	Moderate turbidity.
18	710	2400	170	17	Moderate turbidity.
19	645	2400	230	33	Moderate turbidity.
20	730	3000	170	900	Moderate turbidity.
22	625	16000	800	900	Moderate turbidity.
25	935	300	130	170	Moderate turbidity.
	Average	4868.3	1158.9	304.3	
	Number	18	18	18	
	St. Dev.	5748.4	3714.7	466.5	
	Maximum	16000	16000	1600	
	Minimum	230	20	2	

Physical Water Quality Data **April 5, 2001**

CRUISE:	MDR 01-04	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear-Cloudy	Pers.: J. Gelsinger	High	757	5.6
RAIN:	None	S. Roush	Low	1432	-0.9

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 mg/l	BOD mg/l
1	935	0	15.16	30.60	9.24	8.28	65.36	89.9	10	3.6	0.04	2.1
5k SSE		1	15.17	32.31	8.50	8.28	61.66	88.6				
		2	15.26	33.09	8.78	8.27	64.40	89.6			0.07	1.4
		3	15.28	33.27	9.02	8.25	62.59	88.9				
		4	15.22	33.36	9.13	8.25	61.53	88.6			0.03	1.4
		5	15.13	33.40	9.28	8.24	64.22	89.5				
		6	15.06	33.42	9.19	8.23	66.95	90.5			0.04	1.5
2	915	0	15.81	33.00	7.90	8.35	56.35	86.6	10	2.9	0.04	2.0
5k E		1	15.76	32.94	8.36	8.37	56.46	86.7				
		2	15.42	33.16	8.59	8.33	57.05	86.9			0,05	1.6
		3	15.16	33.41	8.81	8.29	60.25	88.1				
		4	15.16	33.40	9.03	8.27	61.77	88.7			0.05	1.5
		5	15.12	33.41	9.30	8.25	62.23	88.8				
		6	15.07	33.43	9.46	8.24	62.34	88.9			0.05	2.3
3	900	0	16.26	33.09	7.52	8.20	52.86	85.3	10	2.6	0.03	1.4
5k ENE		1	16.26	33.05	7.61	8.24	54.44	85.9				
		2	16.13	33.05	7.72	8.21	56.90	86.9			0.03	1.0
		3	15.80	33.17	7.85	8.19	54.26	85.8				
		4	15.49	33.40	7.85	8.20	54.97	86.1			0.02	1.0
4	1010	0	16.40	33.08	8.49	8.17	57.09	86.9	10	2.7	0.03	1.6
5k SSE		1	16.37	33.00	7.72	8.20	56.41	86.7				
		2	16.08	33.11	7.77	8.19	57.39	87.0			0.03	1.2
		3	15.73	33.27	7.79	8.20	57.21	87.0				
		4	15.69	33.25	7.82	8.21	58.01	87.3			0.02	1.4
5	830	0	16.75	32.90	7.41	8.14	48.74	83.6	10	2.5	0.03	1.6
2k ENE		1	16.75	32.89	7.51	8.12	52.90	85.3				
		2	16.65	32.86	7.65	8.12	51.26	84.6			0.02	1.1
		3	16.29	33.00	7.81	8.12	51.52	84.7				
		4	15.85	33.31	8.09	8.16	52.35	85.1			0.04	1.2
		5	15.81	33.35	8.46	8.17	53.82	85.7				
6	850	0	16.90	33.06	7.68	8.19	47.46	83.0	10	2.4	0.07	1.5
2k ENE		1	16.90	33.06	7.77	8.21	50.76	84.4				
		2	16.89	33.05	7.81	8.17	51.51	84.7			0.06	0.9
		3	16.87	32.95	7.96	8.15	51.45	84.7				
		4	16.38	33.20	8.02	8.12	42.25	80.6			0.05	0.8
7	1032	0	16.72	33.03	7.76	8.11	52.41	85.1	10	2.0	0.07	1.1
2k SSE		1	16.73	32.97	7.01	8.16	47.38	83.0				
		2	16.64	32.97	7.23	8.14	47.80	83.1			0.04	0.9
		3	16.19	33.18	7.25	8.12	45.50	82.1				
		4	16.07	33.28	7.28	8.15	46.78	82.7			0.04	1.0
8	714	0	17.48	33.04	6.45	7.98	32.27	75.4	10	1.3	0.05	1.8
2k ENE		1	17.51	33.02	6.54	7.98	32.22	75.3				
		2	17.52	33.01	6.58	7.97	32.01	75.2			0.11	1.0
		3	17.51	32.99	6.57	7.97	32.05	75.2				
		4	17.45	32.95	6.55	7.98	32.13	75.3			0.02	1.1

April 5, 2001 (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	810	0	17.05	32.84	7.41	8.09	30.07	74.1	10	2.9	0.03	1.1
2k ENE		1	16.99	32.83	7.46	8.10	30.68	74.4				
		2	16.71	32.94	7.63	8.08	35.50	77.2			0.02	0.8
		3	16.49	32.96	7.73	8.08	39.53	79.3				
		4	16.37	32.34	7.81	8.08	37.58	78.3			0.02	0.9
10	750	0	17.33	32.86	5.54	8.00	43.87	81.4	10	1.7	0.03	1.5
2k ENE		1	17.32	32.87	5.97	8.01	43.65	81.3				
		2	17.30	32.93	6.45	7.99	43.29	81.1			0.03	1.1
		3	17.43	32.92	6.29	7.99	41.95	80.5				
		4	17.42	32.95	6.12	8.01	35.35	77.1			0.04	1.1
		5	17.37	32.98	5.99	8.01	28.05	72.8				
11	801	0	17.03	32.88	7.18	8.09	48.46	83.4	10	1.9	0.03	1.3
2k ENE		1	17.04	32.87	7.23	8.09	48.12	83.3				
		2	16.90	32.90	7.28	8.08	41.87	80.4			0.03	0.8
		3	16.66	32.98	7.31	8.09	41.64	80.3				
		4	16.29	33.19	7.42	8.10	46.96	82.8			0.03	0.9
12	945	0	15.34	26.34	10.26	8.35	54.09	85.8	10	2.9	0.03	2.1
5k SSE		1	15.40	31.81	9.38	8.30	39.78	79.4				
		2	15.45	33.01	9.43	8.23	45.95	82.3			0.03	9.5
		3	15.36	33.26	9.38	8.22	62.61	89.0				
13	617	0	17.05	32.84	4.68	7.87					0.03	2.9
18	655	0	17.44	33.02	6.76	7.97	35.36	77.1	10	1.3	0.03	2.5
2k ENE		1	17.45	32.98	6.78	7.96	35.47	77.2				
		2	17.36	33.01	6.79	7.97	35.34	77.1			0.02	1.4
19	635	0	15.10	33.48	6.06	8.07					0.03	3.7
20	730	0	17.34	32.90	6.09	7.98	43.62	81.3	10	2.0	0.03	2.4
2k ENE		1	17.35	32.91	6.11	7.98	43.08	81.0				
		2	17.38	32.93	6.06	7.98	44.03	81.5			0.03	1.9
22	555	0	17.05	32.83	4.00	7.67					0.04	3.6
25	1020	0	16.45	33.05	8.05	8.12	56.83	86.8	10	2.9	0.02	1.7
2k SSE		1	16.44	33.04	7.42	8.15	48.02	83.2				
		2	16.37	33.01	7.42	8.13	57.08	86.9			0.03	1.1
		3	16.16	33.09	7.47	8.12	56.50	86.7				
		4	15.72	33.37	7.55	8.15	46.25	82.5			0.03	1.2
	Average		16.38	32.92	7.58	8.13	48.92	83.28	10.0	2.4	0.04	1.7
	Number		79	79	79	79	76	76	15	15	47	47
	St. Dev.		0.80	0.84	1.13	0.12	10.05	4.50	0.0	0.7	0.02	1.3
	Maximum		17.52	33.48	10.26	8.37	66.95	90.46	10	3.6	0.11	9.5
	Minimum		15.06	26.34	4.00	7.67	28.05	72.78	10	1.3	0.02	0.8

Surface Bacteriological Water Data and General Observations **April 5, 2001**

CRUISE:	MDR 01-04	Vessel:	Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Clear-Cloudy	Pers.:	J. Gelsinger	High	757	5.6
RAIN:	None		S. Roush	Low	1432	-0.9

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	935	900	70	70	Moderate turbidity.
2	915	80	50	17	Moderate turbidity. Plastic trash in water.
3	900	20	< 20	2	Moderate turbidity.
4	1010	50	20	8	Moderate turbidity. Blue heron nesting in tree.
5	830	80	50	8	Moderate turbidity.
6	850	230	20	12	Moderate turbidity.
7	1032	230	50	< 2	Moderate turbidity.
8	714	210	140	50	Moderate turbidity.
9	810	< 20	< 20	12	Moderate turbidity. Trash in water.
10	750	500	50	8	Moderate turbidity.
11	801	70	20	11	Moderate turbidity. Leaves and trash in water.
12	945	3000	270	22	Moderate turbidity.
13	617	130	20	50	Moderate turbidity. Algae, trash in water. Water fowl present.
18	655	230	< 20	11	Moderate turbidity. Floating debris.
19	635	110	20	13	Moderate turbidity. Floating debris. Strong tidal flux.
20	730	300	< 20	17	Moderate turbidity. Floating oil, trash, and algal mats. Two grebes and two jellyfish present.
22	555	800	50	80	Moderate turbidity. Algae, trash in water.
25	1020	< 20	< 20	2	Moderate turbidity. Plastic trash in water. Two sea lions present.
	Average	387.8	51.7	21.9	
	Number	18	18	18	
	St. Dev.	700.3	62.2	23.8	
	Maximum	3000	270	80	
	Minimum	20	20	2	

Physical Water Quality Data — **May 16, 2001**

CRUISE: MDR 01-05
WEATHER: Overcast
RAIN: None

Vessel: Aquatic Bioassay
Pers.: J. Gelsinger
S. Roush

TIDE	TIME	HT. (ft)
High	459	3.9
Low	1221	0.3

Station/ Wind	Time	Depth m	Temp. C	Sal. 0/00	DO mg/l	pH	Trans %T-.25m	Trans %T-.1m	FU	Secchi m	NH3+NH4 mg/l	BOD mg/l
1	904	0	18.01	31.46	8.19	8.11	46.39	82.5	15	2.9	0.21	2.7
5k NW		1	17.74	32.52	7.34	8.12	44.41	81.6				
		2	17.56	33.24	7.41	8.14	44.23	81.6			0.11	1.9
		3	17.48	33.38	7.76	8.15	48.21	83.3				
		4	17.19	33.17	8.11	8.17	52.65	85.2			0.10	2.5
		5	16.52	33.39	8.35	8.14	56.57	86.7				
		6	16.02	33.53	8.38	8.05	48.50	83.5			0.09	2.0
2	855	0	18.77	32.94	7.61	8.08	53.47	85.5	15	2.9	0.07	2.1
5k NW		1	18.87	33.25	7.30	8.08	52.67	85.2				
		2	18.88	33.06	7.62	8.08	50.85	84.4			0.07	2.4
		3	18.31	32.59	7.78	8.10	50.86	84.4				
		4	16.17	33.58	8.13	8.10	55.04	86.1			0.11	2.4
		5	15.93	33.64	8.14	8.09	51.73	84.8				
		6	15.83	33.70	8.15	8.08	50.59	84.3			0.06	1.5
3	85	0	18.96	33.31	6.82	8.02	57.84	87.2	15	2.9	0.02	1.5
5k NW		1	18.96	33.35	6.37	8.03	56.83	86.8				
		2	18.96	33.31	6.47	8.05	55.32	86.2			< 0.01	1.4
		3	18.78	33.38	6.52	8.07	52.04	84.9				
4	927	0	19.35	33.37	7.47	8.03	53.67	85.6	11	2.1	< 0.01	1.6
5k NW		1	19.36	33.25	6.35	8.05	51.91	84.9				
		2	19.28	32.82	6.84	8.03	52.55	85.1			< 0.01	1.2
		3	17.35	33.80	7.09	8.06	38.20	78.6				
		4									< 0.01	1.0
5	813	0	19.88	33.39	6.65	7.96	54.37	85.9	11	2.1	< 0.01	1.8
5k NW		1	19.81	33.29	6.37	7.97	52.89	85.3				
		2	19.49	33.04	6.87	7.97	49.14	83.7			< 0.01	1.2
		3	18.82	32.84	6.88	8.00	47.12	82.9				
		4	17.67	33.44	6.95	8.07	52.62	85.2			< 0.01	1.6
		5	17.35	33.66	7.09	8.03	36.51	77.7				
6	825	0	19.30	33.48	6.78	7.98	57.97	87.3	11	2.9	< 0.01	1.7
5k NW		1	19.32	33.48	6.55	7.99	57.83	87.2				
		2	19.33	33.47	6.76	7.99	55.31	86.2			< 0.01	0.9
		3	19.33	33.46	6.73	7.97	55.10	86.2				
		4	19.19	33.54	6.69	7.86	36.83	77.9				
7	946	0	19.65	33.38	6.66	8.01	59.29	87.7	11	0.0	< 0.01	1.1
5k NW		1	19.64	33.31	6.50	8.01	59.32	87.8				
		2	19.33	33.05	6.60	7.99	50.57	84.3			0.05	1.0
		3	18.57	33.38	6.62	8.00	43.18	81.1				
8	711	0	19.88	33.47	6.60	7.94	54.09	85.8	11	2.2	0.06	2.5
5k NW		1	19.89	33.47	6.45	7.93	53.91	85.7				
		2	19.87	33.46	6.64	7.92	53.14	85.4			0.02	1.1
		3	19.84	33.38	6.55	7.94	51.97	84.9				
		4	19.54	33.52	6.56	7.85	41.41	80.2			0.02	1.8

May 16, 2001 (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	801	0	19.75	32.94	5.76	7.84	44.34	81.6	11	1.9	0.01	1.9
5k NW		1	19.78	33.15	5.41	7.82	43.94	81.4				
		2	19.61	33.21	5.65	7.86	44.58	81.7			0.02	1.3
		3	19.37	33.27	5.61	7.89	30.46	74.3				
10	738	0	19.81	33.31	4.92	7.82	48.14	83.3	11	1.8	0.02	1.9
5k NW		1	19.82	33.30	4.58	7.82	46.95	82.8				
		2	19.79	33.31	4.70	7.81	43.02	81.0			0.02	1.1
		3	19.78	33.24	4.71	7.81	42.29	80.6				
		4	19.54	32.87	4.70	7.85	28.50	73.1			0.05	1.1
11	751	0	19.80	33.32	6.25	7.93	53.52	85.5	11	2.8	0.05	1.8
5k NW		1	19.80	33.32	6.01	7.93	52.77	85.2				
		2	19.79	33.23	6.31	7.93	50.84	84.4			0.21	1.0
		3	19.12	33.29	6.32	7.94	42.38	80.7				
		4	18.69	33.54	6.32	7.97	37.54	78.3			0.05	1.6
12	911	0	18.45	29.85	7.17	8.05	44.88	81.8	14	1.2	0.02	2.4
5k NW		1	18.08	32.92	5.63	8.06	40.66	79.9				
		2	17.45	33.19	6.69	8.10	35.52	77.2			0.03	2.1
13	631	0	19.78	33.31	5.76	7.97					0.04	3.5
18	700	0	19.82	33.48	6.73	7.92	54.83	86.1	11	2.3	0.07	1.9
5k NW		1	19.83	33.47	6.24	7.94	54.27	85.8				
		2	19.83	33.46	6.53	7.93	54.06	85.7			0.07	1.1
19	640	0	18.51	33.19	6.33	7.95					0.05	4.1
20	728	0	19.82	33.30	4.86	7.81	54.38	85.9	11	2.0	0.04	2.4
5k NW		1	19.83	33.30	4.61	7.80	53.02	85.3				
		2	19.83	33.29	4.58	7.80	51.69	84.8			0.04	1.6
22	615	0	19.32	32.82	8.07	7.96					0.03	5.4
25	935	0	19.45	33.38	6.96	7.97	55.43	86.3	11	2.4	0.02	1.2
5k NW		1	19.46	33.30	6.60	7.98	54.00	85.7				
		2	19.31	33.01	6.68	7.98	54.67	86.0			0.01	0.8
		3	17.89	33.10	6.87	7.97	43.69	81.3				
		4	17.33	32.99	6.90	8.00	15.27	62.5			0.03	1.0
	Average		18.88	33.21	6.60	7.98	48.90	83.36	12.0	2.2	0.05	1.8
	Number		73	73	73	73	70	70	15	15	43	43
	St. Dev.		1.09	0.51	0.95	0.10	7.93	4.00	1.7	0.8	0.05	0.9
	Maximum		19.89	33.80	8.38	8.17	59.32	87.76	15	2.9	0.21	5.4
	Minimum		15.83	29.85	4.58	7.80	15.27	62.51	11	0.0	0.01	0.8

Surface Bacteriological Water Data and General Observations May 16, 2001

CRUISE:	MDR 01-05	Vessel:	Aquatic Bioassay		
WEATHER:	Overcast	Pers.:	J. Gelsinger		
RAIN:	None		S. Roush		

TIDE	TIME	HT. (ft)
High	459	3.9
Low	1221	0.3

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	904	1700	700	14	Moderate turbidity.
2	855	50	< 20	8	Moderate turbidity. Surface debris and litter.
3	85	130	20	2	Moderate turbidity. Tidal gate open. Strong flow.
4	927	80	20	8	Moderate turbidity. Litter present.
5	813	50	50	5	Light turbidity. Oil slick present.
6	825	140	20	7	Moderate turbidity.
7	946	110	70	7	Light turbidity.
8	711	40	< 20	< 2	Light turbidity.
9	801	50	< 20	5	Light turbidity. Major oil slick in area. Strong odor of diesel fuel.
10	738	500	50	17	Light turbidity.
11	751	500	20	< 2	Moderate turbidity.
12	911	800	170	< 2	Light turbidity.
13	631	70	20	4	Light turbidity.
18	700	70	20	5	Light turbidity. Floating algal mats, jellyfish in water. Strong organic odor present.
19	640	2400	< 20	8	Light turbidity.
20	728	170	50	40	Light turbidity. Jellyfish extremely abundant.
22	615	800	130	17	Light turbidity. Floating algal mats and litter. Black-crown night herons nearby.
25	935	80	< 20	2	Light turbidity.
	Average	430.0	80.0	8.6	
	Number	18	18	18	
	St. Dev.	651.3	160.4	9.2	
	Maximum	2400	700	40	
	Minimum	40	20	2	

Physical Water Quality Data **June 1, 2001**

CRUISE:	MDR 01-06	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	644	3.5
RAIN:	None	S. Roush	Low	1238	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 mg/l	BOD mg/l
1	854	0	18.51	32.29	7.49	8.15	59.43	87.8	14	2.9	0.19	2.4
4k SW		1	18.52	32.68	6.57	8.16	58.53	87.5				
		2	18.48	32.80	6.91	8.12	60.18	88.1			0.18	1.7
		3	18.26	33.19	7.07	8.12	59.06	87.7				
		4	18.15	33.35	6.94	8.14	59.91	88.0			0.17	1.3
		5	18.08	33.21	7.07	8.15	62.19	88.8				
		6	17.13	33.54	7.32	8.15	65.36	89.9			0.17	1.2
2	851	0	19.10	33.33	7.83	8.14	56.54	86.7	11	2.9	0.20	2.8
4k SW		1	19.04	33.30	7.13	8.15	55.66	86.4				
		2	18.99	33.16	7.39	8.15	54.76	86.0			0.17	1.6
		3	18.46	32.97	7.56	8.14	54.88	86.1				
		4	17.64	33.25	7.62	8.16	60.25	88.1			0.15	1.8
		5	17.00	33.56	7.65	8.15	63.58	89.3				
		6	16.97	33.55	7.71	8.15	64.22	89.5			0.17	2.0
3	835	0	18.93	33.27	7.20	8.10	59.74	87.9	11	2.6	0.15	3.0
4k SW		1	18.91	33.30	5.78	8.09	60.69	88.3				
		2	18.92	33.28	6.43	8.08	59.41	87.8			0.12	1.0
		3	18.90	33.30	6.45	8.08	57.96	87.3				
		4									0.10	1.2
4	917	0	19.41	33.12	6.77	8.10	58.96	87.6	14	2.9	0.10	2.4
2k SW		1	19.40	33.08	6.92	8.10	59.66	87.9				
		2	18.81	33.24	7.05	8.09	54.42	85.9			0.10	1.5
		3	18.32	33.38	7.07	8.12	39.34	79.2				
		4									0.11	1.4
5	801	0	20.26	33.41	7.15	8.06	60.68	88.3	11	3.2	0.10	1.9
2k SW		1	20.27	33.36	6.45	8.07	60.26	88.1				
		2	20.28	33.15	6.77	8.07	58.23	87.4			0.07	1.4
		3	19.88	33.29	6.83	8.06	55.61	86.4				
		4	19.76	32.71	6.81	8.07	51.91	84.9			0.08	1.2
		5	18.86	29.16	7.14	8.09	52.89	85.3				
6	820	0	20.01	33.48	7.61	8.10	59.92	88.0	11	2.9	0.10	2.7
2k SW		1	20.02	33.44	6.69	8.10	58.07	87.3				
		2	20.01	33.28	6.99	8.10	58.69	87.5			0.13	1.2
		3	19.66	33.39	6.98	8.04	49.28	83.8				
		4	19.38	33.51	6.92	7.94	39.14	79.1			0.10	1.0
7	935	0	20.04	33.45	4.85	8.05	53.86	85.7	12	2.1	0.11	1.5
2k SW		1	20.02	33.45	6.27	8.05	52.51	85.1				
		2	20.01	33.43	6.18	8.04	51.30	84.6			0.10	1.3
		3	19.98	33.16	6.00	8.03	51.31	84.6				
		4									0.12	1.2
8	703	0	20.36	33.48	6.26	7.98	42.03	80.5	11	1.8	0.16	4.9
4k SW		1	20.36	33.48	5.97	7.96	41.46	80.2				
		2	20.37	33.44	5.95	7.96	39.19	79.1			0.12	5.2
		3	20.34	33.36	5.90	7.97	33.85	76.3				
		4	19.99	33.44	5.98	7.90	28.24	72.9			0.10	5.6

June 1, 2001 (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	749	0	19.93	32.50	6.68	7.89	69.42	91.3	11	2.1	0.11	2.0
2k SW		1	20.07	32.92	6.19	7.89	67.97	90.8				
		2	20.20	32.97	6.06	7.92	53.55	85.5			0.10	1.1
		3	19.81	32.05	5.97	7.96	38.39	78.7				
		4	19.64	25.15	6.20	7.95	33.98	76.3			0.12	1.4
10	727	0	20.31	33.26	5.66	7.89	48.94	83.6	11	2.0	0.04	2.8
4k SW		1	20.33	33.34	5.11	7.90	48.14	83.3				
		2	20.33	33.34	5.22	7.91	46.43	82.5			0.12	1.5
		3	20.24	33.32	5.28	7.95	44.65	81.7				
		4	20.05	33.38	5.49	7.94	43.37	81.2			0.11	2.5
		5	19.87	33.48	5.55	7.84	27.65	72.5				
11	738	0	20.28	33.28	6.85	8.00	59.77	87.9	11	2.6	0.09	1.6
4k SW		1	20.28	33.27	6.02	8.00	59.95	88.0				
		2	20.28	33.22	6.10	8.00	59.20	87.7			0.04	1.2
		3	19.97	33.12	6.15	7.99	46.11	82.4				
		4	19.58	32.76	6.23	7.95	34.39	76.6			0.11	1.1
12	902	0	18.47	31.29	7.70	8.13	59.74	87.9	15	2.6	0.07	2.1
2k SW		1	18.72	32.95	6.83	8.13	55.66	86.4				
		2	18.49	33.18	6.88	8.03	56.72	86.8			0.13	1.7
13	626	0	23.00	33.94	5.90	7.65					0.12	4.4
18	654	0	20.25	33.48	6.54	7.96	41.26	80.1	11	1.7	0.07	5.0
4k SW		1	20.26	33.48	5.97	7.96	40.62	79.8				
		2	20.26	33.48	6.17	7.95	39.84	79.4			0.06	3.3
19	642	0	19.92	33.30	6.44	7.89					0.17	2.3
20	720	0	20.30	33.25	5.25	7.87	51.23	84.6	12	2.0	0.07	2.7
4k SW		1	20.31	33.30	4.85	7.88	48.62	83.5				
		2	20.31	33.33	4.88	7.89	41.36	80.2			0.13	3.9
22	612	0	20.10	20.68	7.74	7.52					0.06	4.7
25	924	0	19.64	33.35	6.80	8.06	59.25	87.7	12	2.8	0.06	1.7
2k SW		1	19.60	33.30	6.47	8.05	59.44	87.8				
		2	19.51	33.17	6.35	8.05	58.79	87.6			0.07	1.2
		3	18.70	33.41	6.25	8.05	45.69	82.2				
		4	18.55	33.44	6.37	8.07	26.92	72.0			0.07	1.0
	Average		19.51	32.89	6.50	8.02	52.09	84.63	11.9	2.5	0.11	2.2
	Number		75	75	75	75	72	72	15	15	47	47
	St. Dev.		0.97	1.80	0.74	0.12	9.96	4.43	1.4	0.5	0.04	1.3
	Maximum		23.00	33.94	7.83	8.16	69.42	91.28	15	3.2	0.20	5.6
	Minimum		16.97	20.68	4.85	7.52	26.92	72.03	11	1.7	0.04	1.0

Surface Bacteriological Water Data and General Observations **June 1, 2001**

CRUISE:	MDR 01-06	Vessel: Aquatic Bioassay	TIDE	TIME	HT. (ft)
WEATHER:	Overcast	Pers.: J. Gelsinger	High	644	3.5
RAIN:	None	S. Roush	Low	1238	0.2

Station	Time	Total Coliform (MPN /100ml)	Fecal Coliform (MPN /100ml)	Entero coccus (Col.'s /100ml)	Comments
1	854	50	< 20	6	Moderate turbidity.
2	851	130	< 20	11	Moderate turbidity.
3	835	110	50	23	Moderate turbidity. Strong current from tidal gate.
4	917	130	50	8	Moderate turbidity.
5	801	110	50	9	Moderate turbidity.
6	820	300	20	23	Moderate turbidity.
7	935	170	110	22	Moderate turbidity.
8	703	90	20	7	Moderate turbidity. Red tide present.
9	749	700	20	17	Moderate turbidity.
10	727	800	20	8	Moderate turbidity. Red tide present.
11	738	1400	80	50	Moderate turbidity. Surface fuel oil slick.
12	902	110	40	2	Moderate turbidity.
13	626	210	40	80	Moderate turbidity. Floating algal mats and litter. Jellyfish abundant in water column.
18	654	80	20	< 2	Moderate turbidity. Red tide present.
19	642	20	20	8	Moderate turbidity. Jellyfish abundant in water column.
20	720	500	< 20	50	Moderate turbidity. Jellyfish abundant in water column.
22	612	16000	80	80	Moderate turbidity. Floating algal mats and litter. Organic odor. Black-crown night herons present.
25	924	230	130	11	Moderate turbidity.
	Average	1174.4	45.0	23.2	
	Number	18	18	18	
	St. Dev.	3716.5	34.0	24.9	
	Maximum	16000	130	80	
	Minimum	20	20	2	

9.3. INFAUNAL SPECIES ABUNDANCE LIST

MDR - October 2000		1	2	3	4	5	6	7	8	9	10	11	12	25
SACMIT #														
77	PHYLUM CNIDARIA													
86	Euphysa sp. A (Ljubenkov)			1		1				1				
159.5	Anthozoa, unid.		2	2	2	12		1						1
233.5	*Actiniaria*								2					
241	Edwardsia sp. G				2	3					2			7
294	PHYLUM PLATYHELMINTHES													
309	Platyhelminthes sp. E (Phillips)				2									1
326	Notoplana sp.		1	1										
377	PHYLUM NEMERTEA													
382	*Paleonemertea*				1	3					3		4	2
384	Carinoma mutabilis	24	46	17	3	1		3	1		2		14	8
386	Tubulanidae	1												
387	*Carniomella lactea*	6		1							1			1
394	Tubulanus frenatus	2	1											
396	Tubulanus nothus	1												
398	Tubulanus polymorphus	3	4											
409.5	Lineidae, unid.	10	14											
416	Linues bilineatus	1												
419	*Lineus ruber*			22										
431	Zygeupolia rubens	1												
449	Paranemertes californica	3	15		2			1						1
463	*Amphiporus bimaculatus*					1								
472	Zygonemertes virescens			1										
500.5	PHYLUM NEMATODA													
500.6	Nematode	2	330	17	14	3					22			18
524	PHYLUM MOLLUSCA													
611.5	Gastropoda												1	
747.5	*Vitrinella sp.*												1	
758	Caecum californicum			20										
802	Crepidula adunca		1											
813	Crepidula naticarum		3											
816	Crepidula norrisiarum												1	
955.5	Epitonium sp.												1	
1111	*Alia tuberosa*												1	
1176	Olivella baetica		2											
1221	Conus californica	1												

1236	Kurtziella plumbea		1											
1329	Rictaxis punctocaelatus			1										4
1342	Iselica fenestrata													3
1374.5	Odostomia sp.		1											
1418	Bulla gouldiana	1		2										
1439	Acteocina culcitella	1												
1442	Acteocina harpa												1	1
1449	Acteocina inculta		1	2			1	5		6				
1449.5	Acteocina sp.												1	
1466	Melanochalmys diomedea			1										
1663	Class Bivalvia													
1663.5	Bivalve	1											5	1
1725.5	Mytilidae			1									1	
1753.5	Modiolus sp.			1									2	
1777.5	*Neolepton salmonea*	10												
1778	Argopecten ventricosus												1	
1828	Leptopecten latiauratus	1											3	
1883.5	Diplodonta orbella			37	12									
1974	Rhamphidonta retifera			1										
1978	Rochefortia tumida	5											1	
1983	Rochefortia sp. A		3											
2003	Laevicardium substriatum		20	57	10								7	15
2016	Veneridae			3								1	5	1
2017	Chione californiensis			2										2
2021	Compsomyax subdiaphana													2
2034	*Irusella lamellifera*			1										
2039	Pitar newcombianus			6										1
2048	Protothaca staminea	4	8	133	7			2			1	1	33	32
2058	Protothaca tenerrima		1	98										
2074	Venerupis philippinarum			3	1									
2098	Leporimetis obesa			1										3
2117	Macoma nasuta	1	14	2	3	1	1	1	1			1	2	30
2125	Macoma yoldiformis	1	1											
2125.5	Macoma sp.				9									
2131	Tellina carpenteri												3	1
2144	Tellina modesta	5												
2144.5	Tellina sp.												19	1
2161	Gari fucata													2
2174	Cumingia californica		1	10	1									5

2187.5	Semele sp.			38										4
2188	Theora lubrica													6
2195	Tagelus subteres		1	52	10	1								12
2199	Solen rostiformis	2												
2220	Mactrotoma californica		1	9	1									4
2237	Cryptomya californica													1
2333	Lyonsia californica			2										
2351	Thracia trapezoides		2											
2441	PHYLUM SIPUNCULA													
2441.5	Sipuncula, unid.			2		1								
2478	Thysanocardia nigra	3												
2499	Apionosoma misakiana	1	1	4	1									
2519	PHYLUM ANNELIDA													
2520	Class Polychaete													
2526	Leitoscoloplos pugettensis	4	8		5	2	20	23	107	36	11	23		9
2544	Scoloplos acmeceps			131			2	3	6					4
2547	Paraonidae	1												
2548	Aricidea (Acmira) catherinae	11												
2610.5	Aonides sp.1 (Phillips)			1										
2637	Cossura candida					5				1	5			25
2648	Apoprionospio pygmaea	40	7			1	1							2
2674.5	Dipolydora sp.	2		1	18									
2693.5	Microspio microcera												2	
2701	Polydora cirrosa												3	1
2702	Polydora cornuta										1			
2708	Polydora limicola				1						3			
2711	Polydora nuchalus										1			
2714	Prionospio heterobranchia		113	28	44	19	1	3	10	6	10	1	125	83
2716	Prionospio lighti	62	35		1		2						41	4
2733	Pseudopolydora paucibranchiata			9	1366	307	2	120	406	6	53	4	39	1053
2742	Scolelepis occidentalis							2						
2742.5	Scolelepis sp										1			
2744	Scolelepis squamata				2									10
2751	Scolelepis sp.1 SD		2		4					4				6
2754	Spio maculata			3										
2763	Spiophanes duplex	1												
2764	Spiophanes missionensis		12	1							1		2	1
2764.5	Streblospio benedicti					1			18	4	220	1		37
2797	Spiochaetopterus costarum	8	8											

2802.5	Cirratulidae	2		2				2			2		1	2
2804.5	Aphelochaeta "parva"				9	9	20	692	208	14	122	70	1	25
2822.5	Caulleriella pacifica			23							36			
2833	Chetozone nr. setosa (V-1)	133	1											
2841.4	Cirriformia sp.	2	2	4	3			1			9	17	2	1
2844	Monticellina cryptica	2												1
2851	Monticellina siblina		5											
2866.5	Capitellidae	1												
2870	Capitella capitata			1	1			1	4		4		13	35
2877	Mediomastus acutus	24												
2881.5	Mediomastus spp.	884	887	71	215	52	57	50	121	31	78	33	2765	940
2883	Notomastus lineatus			4										
2887.5	Notomastus sp.1 (Phillips)	1	10	18	3			1	1				34	16
2897.5	Axiothella sp.			6										
2905.5	Euclymeninae	1												
2909	Metasychis disparidentatus					1								
2928	Armandia brevis	2	12	2	33	3		4					220	8
2931.5	Ophelia sp.			1										
2935	Polyophthalmus pictus		8	21	35		1						215	
2947	Phylodocidae	1		10										
2959	Eumida longicornuta		1										2	
2962	Hesionura coineaui difficilis			56										
2980	Phyllodoce hartmanae	2	2										1	
2987	Phyllodoce medipapillata			7										
3024	Harmothoe imbricata												1	
3041.5	Lepidonotus sp.												3	
3064	Tenonia priops	1												
3096	Sthenelais verruculosa	1												
3115	Heteropodarke heteromorpha			2										
3116.5	Microphthalmus sp.	3	1										2	
3120	Podarke pugettensis												1	
3123	Podarkeopsis glabra	7												
3133	Parandalis fauveli		2											
3142	Brania californiensis		4		1									
3152	Exogone cf verugera	1	41	5	9			178			34	15	2	26
3153	Exogone lourei				28	17	1				1			154
3153.5	Exogone sp.	7	2		182	51		1	7	11				1
3164	Odontosyllis phosphorea												1	
3182	Syllides mikeli								1					

3196	Nereididae		3	1							1		1	
3202	Neanthes acuminata							3			3			3
3203	Nereis latescens												1	
3204	Nereis procera	3	17		1								2	
3204.5	Nereis sp.	1												
3209	Platynereis bicanaliculata												1	
3218	Glycera americana		3	2									1	1
3226	Glycera convoluta	7			1									
3227	Glycera nana			2										
3234.5	Glycera sp.			2										
3238	Hemipodus borealis			33										
3241	Glycinde armigera	1												
3248	Goniada littorea	38	19	7	4	1			1				12	
3267	Nephtys caecoides				2			2	1			1	1	
3271	Nepthys californiensis			2										
3272	Nephtys cornuta	2												
3309	Diopatra ornata	6	62										25	
3363	Lumbrineris sp.A (Harris)	5												
3368	Lumbrineris cruzensis													1
3377	Lumbrineris latrielli													1
3380.5	Lumbrineris erecta								2	1	10		16	
3380.6	Lumbrineris sp.C (Harris)	2	12	1	22	67	22	3	4	10	23	2		77
3380.7	Lumbrineris sp.	3	25	2		5		1	4		4	1		5
3404	Dorvillea (Schistomeringos) annulata		48		1			9	5	3	17	5	128	94
3424	Protodorvillea gracilis			175										
3440	Owenia fusiformis		3											
3451	Pherusa capulata				1									
3453	Pherusa inflata													6
3455	Pherusa neopapillata				2									
3474	Pectinaria californiensis	8	3											
3483	Ampharete labrops		2										1	1
3487	Amphicteis scaphobranchiata		1											
3519.5	Terebellidae			1										
3520	Amaeana occidentalis	1	2	9										
3546	Pista disjuncta		6											
3555.5	Polycirrus sp.			6										
3578	Chone mollis			4										
3584	Demonax sp.			1									1	
3591	Euchone limnicola		2		35	4	22	120	75	83	110	27		78

3622	Hydroides pacificus			5					5					
3628	Spirorbidae			1										
3634	Saccocirrus sp.			218	2									
3637	Class Oligochaete													
3637.5	Oligochaeta		14	5			3	8	3	3	50	4	16	120
3647	PHYLUM ARTHROPODA													
3649	Class Pycnogonida													
3649.5	Pycnogonida		1	1										
3664	Anoropallene palpida				2								1	4
3684	Anoplodactylus erectus					1								
3699	Class Ostracoda													
3707	Euphilomedes carcharodonta	1												
3718.5	Bathyleberis sp.				21	12								45
3747	Class Copepoda													
3748.5	Harpactiocoida, unid.		2		1						3		10	3
3757.5	Cyclopoida			19	11									1
3818	Order Mysidacea													
3818.5	Mysidacea									1		1		
3857.5	Deltamysis sp A					3	15							
3858	Order Cumacea													
3893	Campylaspis rubromaculata													1
3928	Diastylopsis tenuis	2												
3935	Oxyurostylis pacifica		1									1	33	
3936	Order Tanaidacea													
3940	Leptochelia dubia			1				1						
3970.5	Pseudotanais sp.				3	3								1
3977	Zeuxo normani			18	4	28		5	1	2				
3980	Order Isopoda													
3994	Haliophasma geminatum			16	7	8		6	4			2		1
3999	Paranthura elegans			2										1
4042	Paracereis cordata			1										
4052	Neastacilla californica		1											
4055	Edotia sublittoralis	3												
4075	Janiralata occidentalis			2	1									
4094	Munnogonium tillerae				2									
4101	Order Amphipoda													
4133	Hartmanodes hartmanae		6										1	
4169.5	Leucothoe sp.					1								
4194	Eobrolgus spinosus					8	12	1						

4337	Atylus tridens												2	
4398.5	Elasmopus antennatus			1										
4401	Maera simile							1						
4433	Amphideutopus oculatus	1	60	2										
4472	Cerapus tubularis		2											
4473	Ericthonius brasiliensis	1	8	1									46	
4484	Jassa slatteryi	5	1											
4505.5	Aoroides sp.	7												
4510	Grandidierella japonica							2		1	3	3	1	
4513	Rudilemboides stenopropodus		26	9	44	2		1					14	8
4517	Monocorophium acherusium					1					1		4	
4524	Podocerus brasiliensis												4	
4528	Podocerus fulanus		3											
4542	Mayerella banksia		9		16			9	6	3	2	2	8	17
4545	Caprellidae	3											1	
4546	Caprella californica	1											2	
4550	Caprella equilibra		5											
4569	Order Decapoda													
4657	Heptacarpus taylori												1	
4735	Amphiporus sp				9			1						
4748	Neotrypaea californiesis					1								
4885	Pyromaia tuberculata												1	
4942.5	Cancer sp.		2											
4982	Pinnixa tubicola	11												
4991	PHYLUM ECHINODERMATA													
5111.5	Amphiuridae	1	3											1
5124	Amphiodia occidentalis		1	2	1									
5213	Dendraster excentricus	1	2											
5284	Leptosynapta sp.	1		3	1									1
5303	PHYLUM PHORONA													
5306	Phoronis sp.	1	3	39	2046	6	10	10	33	5	1	6		48
5346	PHYLUM ECTOPROCTA													
5384	Bowerbankia gracilis		1											
5492	PHYLUM CHORDATA													
5503	Ascidiacea					13								
5546.5	Ascidia paratropa				1									
5605.5	Molgula sp.			3										
5610	Brachiostoma californiense		1	1										
5611	Clevelandia ios					3		1						2

5611.5		Fish larvae													14
		Number of Species per station	77	82	93	62	40	18	38	27	21	37	23	71	78
		Abundance per station	1411	1998	1556	4282	662	193	1278	1037	232	851	222	3918	3149
		Total Number of species	248												
		Total Abundance	20789												
		* = sample split and fraction sorted and counted, then total abundance calculated by multiplication of split fraction. All other													

9.4. FISH SPECIES ABUNDANCE LIST

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

NOVEMBER 2000 — SAMPLING STATIONS

SCIENTIFIC NAME	COMMON NAME	North Jetty				Break wall				South Jetty			
Reef Species		Ad.	Sub.	Juv.	YOY	Ad.	Sub.	Juv.	YOY	Ad.	Sub.	Juv.	YOY
Atherinopsis californiensis	Jacksmelt							60					
Cheilotrema saturnum	Black Croaker			38								8	
Chromis punctipinnis	Blacksmith							185				7	
Cymatogaster aggregata	Shiner Surfperch			2								4	
Girella nigricans	Opaleye			280		25						11	
Hermosilla azurea	Zebraperch			4		5				1			
Heterostichus rostratus	Giant Kelpfish	1											
Hypsypops rubicundus	Garibaldi					2							
Oxyjulis californica	Senorita							22				15	
Paralabrax clathratus	Kelp Bass					7		1					

MAY 2001 — SAMPLING STATIONS

SCIENTIFIC NAME	COMMON NAME	North Jetty				Break wall				South Jetty			
Reef Species		Ad.	Sub.	Juv.	YOY	Ad.	Sub.	Juv.	YOY	Ad.	Sub.	Juv.	YOY
Anisotremus davidsoni	Sargo			1	8								
Atherinops affinis	Topsmelt		50										
Cymatogaster aggregata	Shiner Surfperch				504								
Damalichthys vacca	Pile Surfperch			1	11	3		7					15
Embiotoca jacksoni	Black Surfperch	3	1		10	8				1	2		54
Girella nigricans	Opaleye		5	59		15	12	23		14	1	38	
Halichoeres semicinctus	Rock Wrasse					3	3	8		1	3		1
Hermosilla azurea	Zebraperch			2		3							
Heterostichus rostratus	Giant Kelpfish										1		
Hypsypops rubicundus	Garibaldi					6							
Micrometrus minimus	Dwarf Surfperch				36								15
Oxyjulis californica	Senorita		5				1			18	6		1
Paralabrax clathratus	Kelp Bass					12	8	2				1	
Paralabrax nebulifer	Barred Sand Bass					3	1			1			
Rhacochilus toxotes	Rubberlip Surfperch												1

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - October 27, 2000

Raw data, standardization factors, sorting data

Sample Code	Date collected	Flowmeter reading	Standardization Factor	Wet Plankton volume (ml)	Standardized Plankton volume (ml/1000m^3)	Primary Zooplankton Types	Sorting Record
2S	27-Oct-00	1220	6.91	7	48.38	Copepods. Much terrestrial debris	Sorted BSR 10% Sort check JMR pass
2B	27-Oct-00	1752	4.81	5	24.06	Copepods, Oikopleurids, shrimp larvae. Much terrestrial debris	Sorted BSR 10% Sort check JMR pass
5S	27-Oct-00	1091	7.73	6	46.37	Copepods	Sorted BSR 10% Sort check JMR pass
5B	27-Oct-00	1538	5.48	4	21.93	Copepod, shrimp larvae	Sorted BSR 10% Sort check JMR pass
8S	27-Oct-00	1009	8.36	3	25.07	Copepod	Sorted BSR 10% Sort check JMR pass
8B	27-Oct-00	1660	5.08	7	35.56	Copepods, shrimp larvae, mysidacae	Sorted BSR 10% Sort check JMR pass

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - October 27, 2000

Ichthyoplankton data

Sample Code	Standardization Factor	Taxon	Stage	Number Identified	Stan. Abundance (Standardized to n/1000m^3)	Larval Size (mm) or Egg Stage
2S	6.91	TOTAL LARVAE		20	138.2	
		Gobiidae type A/C	NL	18	124.38	16 @ 2.0 - 2.4 mm
			NL			2 @ 2.5 - 2.9 mm
		Hypsoblennius	NL	2	13.82	2.0 - 2.4 mm
		TOTAL EGGS		72	497.52	
		Plaluronichthys ritteri	EG	2	13.82	St. III, IV
		Egg Type 32	EG	30	207.3	St. III, IV
		Citharichthys	EG	10	69.1	ST. X, XI
		Unidentified	EG	30	207.3	
2B	4.81	TOTAL LARVAE		322	1548.82	
		Pleuronectidae	YS	1	4.81	1.0mm NL (possible Citharichtys embryo)
		Gobiidae type A/C	NL	316	1519.96	313 @ 2.0 - 2.4 mm
			NL			2 @ 2.5 -3.0 mm
			NL			1 @ 3.5 -3.9 mm
		Hypsoblennius	NL	3	14.43	2 @ 2.0 - 2.4 mm
			NL			1 @ 2.5 - 2.9 mm
		Gibbonsia	NL	1	4.81	4.0 - 4.5 mm
		Gillichthys mirablis	NL	1	4.81	3.0 - 3.4 mm
		TOTAL EGGS		266	1279.46	
		Plaluronichthys ritteri	EG	10	48.1	St. III, (1) - VIII
		Pleuronichthys verticalis	EG	2	9.62	St. IV
		Egg Type 32	EG	122	586.82	St. III, IV
		Citharichthys	EG	80	384.8	St. X
		Unidentified *	EG	52	250.12	
		*some look like Type 85, no pigment ~ 30 myomeres 0.96, oil 0.17				

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - October 27, 2000						
Ichthyoplankton data						
Sample Code	**Standardization Factor**	**Taxon**	**Stage**	**Number Identified**	**Stan. Abundance (Standardized to n/1000m^3)**	**Larval Size (mm) or Egg Stage**
5S	7.73	TOTAL LARVAE		101	780.73	
		Gobiidae type A/C	YS	8	61.84	2.0 -2.4 mm
			NL	29	224.17	17 @ 2.0 -2.4 mm
			NL			12 @ 2.5 - 2.9 mm
		Hypsoblennius	NL	63	486.99	2.0 -2.4 mm
		Unidentifiable	FR	1	7.73	damaged (probably Hysoblennius)
		TOTAL EGGS		21	162.33	
		Unidentified	EG	21	162.33	
5B	5.48	TOTAL LARVAE		451	2471.48	
		Gobiidae type A/C	YS	4	21.92	2.0 - 2.4 mm
			NL	335	1835.8	324 @ 2.0 - 2.4 mm
			NL			11 @ 2.5 - 2.9 mm
		Hypsoblennius	NL	111	608.28	2.0 - 2.4 mm
		Ilypnus Gilberti	SL	1	5.48	15.5 mm near transformation
		TOTAL EGGS		16	87.68	
		Citharichthys	EG	3	16.44	St. XI
		Unidentified	EG	13	71.24	

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - October 27, 2000

Ichthyoplankton data

Sample Code	Standardization Factor	Taxon	Stage	Number Identified	Stan. Abundance (Standardized to n/1000m^3)	Larval Size (mm) or Egg Stage
8S	8.36	TOTAL LARVAE		25	209.00	
		Gobiidae type A/C	NL	1	8.36	2.5 - 2.9 mm
		Hypsoblennius	NL	24	200.64	2.0 - 2.4 mm
		TOTAL EGGS		26	217.36	
		Unidentified	EG	26	217.36	
8B	5.08	TOTAL LARVAE		76	386.08	
		Gobiidae type A/C	YS	2	10.16	2.0 - 2.4 mm
			NL	22	111.76	2.0 - 2.4 mm (many damaged)
		Hypsoblennius	NL	48	243.84	2.0 - 2.4 mm
		Unidentifiable	FR	4	20.32	(possibly gobiidae)
		TOTAL EGGS		16	81.28	
		Citharicthys	EG	1	5.08	St. X
		Unidentified	EG	15	76.2	

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 1, 2001							
Raw data, standardization factors, sorting data							
					Standardized		
Sample	Date	Flowmeter	Standardization	Wet Plankton	Plankton volume	Primary	
Code	collected	reading	Factor	volume (ml)	(ml/1000m^3)	Zooplankton Types	Sorting Record
						(comments)	
2S	May-01	1143	7.38	8	59.02	Copepods, Cladocera,	Sorted BSR
						Oikopleura, Polychaeta, shrimp,	20% sort check JMR fail
						Cirripedia, Cyphonautes,	Resort JMR
						Mysidacea	10% sort check JMR pass
						(Many polychaeta tubes with	
						adult worms)	
2B	May-01	2700	3.12	15	46.84	Copepods, Cladocera,	Sorted BSR
						Oikopleura, Polychaeta, shrimp,	10% sort check JMR pass
						Zoea, Cirripedia, Cyphonautes	
5S	May-01	1150	7.33	4	29.33	Copepods	Sorted BSR
							10% sort check JMR pass
5B	May-01	2650	3.18	12	38.18	Copepods, Cladocera,	Sorted BSR
						shrimp, Zoea, Cyphonautes,	10% sort check JMR pass
						Isopoda	
						(Many polychaeta tubes with	
						adult worms)	
8S	May-01	1170	7.21	3	21.62	Very little zooplankton	Sorted BSR
						few Copepods	10% sort check JMR pass
						(Much terrestrial debris,	
						insects and ants).	
8B	May-01	1390	6.07	6	36.40	Copepods, shrimp, Zoea,	Sorted BSR
						Claderocera	10% sort check JMR pass
						(Many polychaeta tubes with	
						adult worms)	

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 1, 2001							
Ichthyoplankton data							
					Stan. Abundance		
Sample	**Standardization**			**Number**	**(Standardized to**	**Larval Size (mm)**	
Code	**Factor**	**Taxon**	**Stage**	**Identified**	**n/1000m^3)**	**or Egg Stage**	
2S	7.38	TOTAL LARVAE		73	538.74		
		Gobiidae type A/C	NL	24	177.12	2.0 - 2.4 mm	
		Hypsoblennius	NL	49	361.62	43 @ 2.0 - 2.4 mm	
			NL			6 @ 2.5 - 2.9 mm	
		TOTAL EGGS		77	568.26		
		Atherinops affinis	EG	2	14.76	St. X	
		Engraulis mordax	EG	7	51.66	St. VII, VIII	
		Pleuronichthys ritteri	EG	1	7.38	St. V	
		Citharichthys	EG	11	81.18	St. IX, X, XI	
		Egg type 32	EG	31	228.78	St. III, VI, VII	
		Unidentified	EG	25	184.50		
2B	3.12	TOTAL LARVAE		232	723.84		
		Citharichthys	YS	1	3.12	2.0 - 2.5 mm	
		Engraulis mordax	YS	2	6.24	(1) 1.5 -2.0 mm (1) 2.5 - 3.0 mm	
			NL	1	3.12	3.0 - 3.5 mm	
		Gobiesox rhessodon	NL	2	6.24	3.0 - 3.5 mm	
		Gobiidae type A/C	NL	84	262.08	78 @ 2.0 - 2.4 mm	
			NL			5 @ 2.4 - 2.5 mm	
			NL			1 @ 3.5 - 4.0 mm	
		Hypsoblennius	NL	137	427.44	135 @ 2.0 - 2.4 mm	
			NL			2 @ 2.5 - 3.0 mm	
		Hypsypops rubicundus	NL	1	3.12	2.5 - 3.0 mm	
		Typhlogobius californiensis	NL	3	9.36	(1) @ 2.5 -2.9 mm (2) @ 3.0 - 3.5 mm	
		Unidentified	YS	1	3.12		
		TOTAL EGGS		65	202.8		
		Engraulis mordax	EG	12	37.44	St. VII, VIII	
		Citharichthys	EG	14	43.68	St. X, XI	
		Egg Type 32	EG	12	37.44	St. II, VI	
		Unidentified	EG	27	84.24		

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 1, 2001							
Ichthyoplankton data							
5S	7.33	TOTAL LARVAE		75	549.75		
		Gobiidae type A/C	YS	12	87.96	2.5 - 3.0 mm	
			NL	34	249.22	32 @ 2.0 - 2.4 mm	
			NL			2 @ 2.5 - 3.0 mm	
		Hypsoblennius	NL	29	212.57	2.0 - 2.5 mm	
		TOTAL EGGS		1	7.33		
		Unidentified	EG	1	7.33		
5B	3.18	TOTAL LARVAE		433	1376.94		
		Gobiidae type A/C	YS	8	25.44	2.0 - 2.5 mm	
			NL	228	725.04	139 @ 2.0 - 2.4 mm	
			NL			83 @ 2.5 - 2.9 mm	
			NL			4 @ 3.0 - 3.4 mm	
			NL			2 @ 3.5 - 4.0 mm	
			SL	1	3.18	8.6 mm	
		Hypsoblennius	NL	132	419.76	2.0 - 2.4 mm	
			NL	10	31.8	2.5 - 3.0 mm	
		Ilypnus gilberti	SL	51	162.18	6.9 -16.5 mm	
		Heterostichus rostratus	FL	1	3.18	8.2 mm	
		Gobiesox rhessodon	NL	1	3.18	4.5 mm	
		Hypsopsetta guttulata	FL	1	3.18	5.0 mm	
		TOTAL EGGS		6	19.08		
		Engraulis mordax	EG	2	6.36	St. VII	
		Unidentified	EG	4	12.72		

Marina del Rey Ichthyoplankton Samples for Aquatic Bioassay & Consulting - May 1, 2001							
Ichthyoplankton data							
					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		17	122.57		
		Gobiidae type A/C	NL	11	79.31	10 @ 2.0 - 2.4 mm	
			NL			1 @ 2.5 3.0 mm	
		Hypsoblennius	NL	6	43.26	5 @ 2.0 - 2.4 mm	
			NL			1 @ 2.5 3.0 mm	
		TOTAL EGGS		2	14.42		
		Atherinops affinis	EG	1	7.21	no development	
		Unidentified	EG	1	7.21		
8B	6.07	TOTAL LARVAE		162	983.34		
		Gobiidae type A/C	YS	9	54.63	2.0 - 2.5 mm	
			NL	106	643.42	102 @ 2.0 - 2.4 mm	
			NL			4 @ 2.5 - 3.0 mm	
		Ilypmus gilberti	SL	9	54.63	7.8 - 13.5 mm	
		Gobiesox rhessodon	NL	2	12.14	3.0 - 4.0 mm	
			FL	1	6.07	5.5 mm	
		Hypsoblennius	NL	35	212.45	32 @ 2.0 -2.4 mm	
			NL			3 @ 2.5 3.0 mm	
		TOTAL EGGS		7	42.49		
		Atherinops affinis	EG	5	30.35	no development?	
		Unidentified	EG	2	12.14	one appears to be similar to	
						A. affinis without a chorion	