PORTS OF LONG BEACH and LOS ANGELES Year 2000 BIOLOGICAL BASELINE STUDY OF SAN PEDRO BAY

Prepared for:

THE PORT OF LONG BEACH

THE PORT OF LOS ANGELES

Prepared by:

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In Association With:

Science Applications International Corporation
Merkel & Associates, Inc.
Keane Biological Consulting
Everest International Consultants

PORTS OF LONG BEACH AND LOS ANGELES
YEAR 2000 BIOLOGICAL BASELINE STUDY
OF SAN PEDRO BAY

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FORWARD

The prevailing thinking until recent times was that the ocean is large and can accept an infinite amount of waste discharges from human activity. It had been documented decades earlier that streams, rivers, and lakes can be affected by waste discharges leading to polluted conditions. Environmental conditions had been documented for some estuaries, especially the brackish–fresh water sections, in Europe, notably United Kingdom prior to World War II. No such studies had been undertaken in United States at that time. The State of California played an important role in the realization that the marine environment can be affected by waste discharges. The establishment of the then California Water Pollution Control Board provided the impetus to study conditions in protected waters and later offshore waters. With EPA arriving on the scene in 1970 and later the establishment of research laboratories in Narragansett, Rhode Island, Gulf Breeze, Florida and Newport, Oregon gave further impetus to determine the causes, effects and control of marine pollution. The Food and Agriculture Organization of the United Nations convened a world wide conference on marine pollution in Rome, Italy, in 1970. The problems caused by marine pollution were now investigated on a world-wide scale.

Los Angeles–Long Beach Harbors played an important role in alerting the public to pollution in the marine environment. Concurrent with the initial studies in the harbors was a survey of some parts of San Francisco Bay. Because of the vastness of the San Francisco Bay, it was not possible to get a picture of the entire system. Since a much smaller area was covered, it was possible to obtain an overview of the entire ecosystem of Los Angeles–Long Beach Harbors. Publication of the results of the different studies in the harbors, especially the raw data, not only called attention to marine pollution, but also permitted others to evaluate the data themselves.

Because of the interest and importance of the harbors by public officials and environmental groups, we have a detailed picture of the environmental conditions in the harbors for the past 50 years. No other marine region of the world can boast of such a record. From the studies of Los Angeles-Long Beach Harbors, we have seen first the realization that marine pollution does occur, and later the first realization that pollution abatement can improve the environment.

Donald J. Reish
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EXECUTIVE SUMMARY

The marine biological environment of Long Beach and Los Angeles Harbors has been periodically studied since the 1950s. Early studies documented severe pollution in several of the basins in the harbors. Comprehensive studies in the 1970s reported a dramatic improvement in marine habitat quality relative to the 1950s, although areas of pollution were still evident in inner harbor and blind-end slip areas.

In the last three decades, the Ports of Long Beach and Los Angeles (Ports) have undertaken long-range development efforts to increase the shipping and commercial capacity of the harbors. During the 1980s and 1990s several separate biological studies were conducted that were limited to either one port or the other in support of these anticipated harbor modifications.

Considerable changes have occurred in the harbors since the comprehensive surveys of the 1970s and more focused surveys of the 1980s and 1990s. Some of these changes included deepening of navigational channels and basins, constructing substantial landfills at Piers 300 and 400 in Los Angeles Harbor, constructing a transportation corridor out to Pier 400, expanding Pier J in Long Beach Harbor, and constructing the west basin of the Cabrillo Marina complex. As part of mitigation for construction and channel deepening, shallow water habitats were created in formerly deepwater areas near Pier 300, the San Pedro Breakwater, and on the east side of Pier 400. Thus, several areas that were previously aquatic habitat are now land, some previous areas that were deep water are now shallow, and circulation patterns within the harbors have been altered.

The Ports retained MEC Analytical Systems, Inc. (MEC) and its subcontractors to conduct environmental studies in Long Beach and Los Angeles Harbors in the year 2000. The goal of this study was to provide an update of quantitative information on physical/chemical and biological conditions within the different marine habitats of the harbors.
The specific objectives of the study were to:

- Measure water quality and sediment grain size to provide physical/chemical characterization of environmental conditions during biological surveys,
- Provide an updated quantitative baseline of the benthic invertebrate community,
- Provide an updated quantitative baseline of larval, juvenile, and adult fish populations,
- Provide an updated description of biological communities attached to rocky riprap habitats,
- Map kelp distribution and describe macroalgae communities,
- Map eelgrass distribution,
- Provide an updated quantitative baseline of bird use patterns,
- Identify relative occurrence of non-indigenous (exotic) species among native populations,
- Compare year 2000 study findings with previous baseline studies.

The Year 2000 Baseline Study is the first comprehensive examination of the status of biological communities within both inner and outer harbor areas of both Ports since the 1970s. It is the first study to map kelp and eelgrass distribution throughout both Ports.

Major findings of the Year 2000 Baseline Study are summarized according to the survey element below.

Physical/Chemical Conditions

Oceanographic conditions at the onset of the Year 2000 Baseline Study were characterized by the dissipation of a weak to moderate La Niña event, which had followed the strong El Niño of 1997-1998. Water quality measurements conducted quarterly for the 2000 study were generally consistent with expected values for near-coastal and harbor environments, and indicated minimal spatial and temporal trends within the harbor complex. Slightly reduced salinities in surface waters at a subset of the monitoring sites reflected freshwater inputs; however, the magnitude of this effect was spatially and temporally limited. Results indicate a continued trend of water quality improvement since the 1970s, with most dissolved oxygen concentrations in excess of 5 milligrams/liter. Episodic and localized changes in some parameters, such as low dissolved oxygen concentrations coinciding with low transmissivity, suggested minor effects possibly associated with sediment resuspension events. Water clarity (transmissivity) decreased with increasing depth and was relatively lower in bottom waters at stations with fine sediments and/or in the vicinity of dredging and/or disposal.

Water circulation in the harbors has been modified by some of the construction activities that have occurred since the 1980s. Review of modeling studies indicate that changes to tidal circulation as a result of construction of Pier 400 mainly involve a blocking of north to south flow through Angel's Gate, which reduces flow velocity into the harbor. The flow under flood current is forced to go around the structure to the east and west. Model studies indicate that reduced flushing does not have significant impacts on dissolved oxygen concentrations. Results of the Year 2000 Baseline Study did not observe any depressions in dissolved oxygen near Pier 400 or within the adjacent Pier 300 Shallow Water Habitat outside the range observed elsewhere in the harbor.

Adult and Juvenile Fish

Studies of adult and juvenile fish were conducted quarterly and employed three different sampling methods including use of large lampara nets to sample pelagic fish throughout the water column, otter trawl to sample bottom-associated (demersal) species, and beach seines to sample shallow nearshore waters. A total of 76 taxa representing 74 unique species of fish were collected with the different sampling nets over all stations and sampling periods. Fish appeared healthy, with a very low incidence (< 0.01%) of obvious abnormalities or external parasites. Northern anchovy (*Engraulis mordax*) and white croaker (*Genyonemous lineatus*) were the abundant species collected in 2000. White croaker was top ranked in terms of biomass. Other species caught in very high abundance were queenfish (*Seriphus politus*), topsmelt (*Atherinops affinis*), and specklefin midshipman (*Porichthys myriaster*). California tonguefish (*Symphurus atricauda*), speckled sanddab (*Citharichthys stigmaeus*), Pacific sardine (*Sardinops sagax*), shiner surfperch (*Cymatogaster aggregata*), salema (*Xenistius californiensis*), and white surfperch (*Phanerodon furcatus*) also had high abundances.

Commercially and/or recreationally important species, including California halibut (*Paralichthys californica*) and barred sand bass (*Paralabrax nebulifer*) had moderate abundance. California halibut was collected primarily with otter trawl nets, and ranked seventh in total abundance and second in total biomass for that sampling gear. California halibut were found at all stations, but more juveniles were found in shallow waters, particularly the created shallow water habitats, which were constructed as part of mitigation for Port development projects. Barred sand bass also were caught primarily by trawls, and ranked tenth in total abundance with that gear.

Fish abundance showed seasonal trends with significantly higher catch during the summer. Similar to previous studies in which day and night samples were collected, a greater variety and more fish were collected at night in the present study. Day/night differences in catch are believed to result from a combination of fish behaviors at night related to decreased visual avoidance of sampling gear, increased dispersal of schooling species, and increased foraging activity at night by several species (Horn and Allen 1981).

More species of fish were collected in shallow water, including all three of the created shallow water mitigation sites (Cabrillo, Pier 300, Long Beach Shallow Water Habitats), than at deepwater stations in open water, channel, basin, and slip habitats. The greater diversity may be explained in part to the greater habitat heterogeneity associated with the shallow water habitats, which were adjacent to rock riprap and/or vegetated areas (e.g., eelgrass beds, kelp bed). For instance, the Cabrillo Shallow Water Habitat is located alongside the San Pedro Breakwater, which supports giant kelp and other macroalgae; the Long Beach Shallow Water Habitat is located adjacent to riprap shoreline along Pier 400 that supports giant kelp and other macroalgae, and extensive eelgrass beds occur within the Pier 300 Shallow Water Habitat.

Little difference was observed in lampara fish catch between inner and outer harbor areas, indicating that pelagic schooling species range in high abundances throughout the harbor complex. In contrast, deepwater habitats in outer to middle harbor areas generally had a greater number, biomass, and variety of trawl-caught fish than inner harbor areas. Benthic invertebrates, which represent an important food source for demersal fish, also exhibited a trend of decreasing habitat quality from outer to inner harbor areas.

Fish catch using lampara nets in 2000 was similar to studies in 1986-1987 in Los Angeles Harbor. On the Long Beach side of the harbor complex, catch values were within the range previously reported in 1994 and 1996; however, basins of the middle and outer Long Beach Harbor had higher abundance in 2000, primarily due to large catches of northern anchovy. Numbers of collected species were similar between 2000 and previous studies.

Evaluation of long-term trends in trawl catch is confounded by smaller sized nets used in previous studies. This is particularly problematic for comparing abundance, since the net size comparison study conducted in the present study indicates considerable catch variability with different sized nets. Nevertheless, trawl catch values appeared to be higher in Long Beach Harbor in 2000 than recorded in 1994 and 1996. The City of Los Angeles has reported shifts in trawl catch abundance in Los Angeles Harbor each year since 1996 that they have attributed to the ongoing construction of Pier 400. Although there was some indication that dredging and/or disposal activities may have resulted in lower lampara fish catch near Pier 400, there was little correspondence between otter trawl fish catch and locations near or away from dredging or disposal in 2000.

An estimate of harbor-wide fish abundance based on 2000 catch data standardized to area and adjusted by net efficiency totaled about 44 million fish. An estimate for only outer Los Angeles

Harbor in 1986-1987 was 15 million fish for that harbor. The higher estimated value for 2000 reflects consideration of the area throughout both inner and outer areas of Long Beach and Los Angeles Harbors. The top five species (northern anchovy, white croaker, queenfish, Pacific sardine, and topsmelt) account for nearly 92% of the total fish populations.

Ichthyoplankton

Forty-nine taxa representing 44 unique species of fish larvae and 13 categories of fish eggs were identified. The most abundant fish larvae were Goby type A (arrow goby, cheekspot goby, and shadow goby) (33%), bay goby (16%), northern anchovy (14%), California clingfish (13%), queenfish (10%), blennies (5%), and white croaker (5%). Dominant egg taxa were unidentified eggs (likely including high numbers of California halibut eggs) (57%) and sciaenid eggs (35%). Although not as abundant, eggs of speckled sanddab, California tonguefish, and spotted turbot together comprised nearly 7% of the collected eggs.

With the exception of the Pier 300 Shallow Water Habitat, which had high larval abundance, and the Long Beach West Basin, which had low larval abundance, the abundances of larvae were generally higher on the Long Beach side of the harbor complex. This bears some similarity to the abundance pattern indicated for adult fish caught by lampara, which generally showed higher abundance in deepwater channel, basins, and slips in Long Beach Harbor. The very high larval abundance noted in the Pier 300 Shallow Water Habitat did not correspond to adult fish distribution, which showed moderate abundance in both the lampara and otter trawl catches at that location. The larval catch was dominated by benthic associated gobies (arrow goby, cheekspot goby, shadow goby), which inhabit burrows and were undersampled by the lampara and trawl nets used to capture adult fish.

Species composition varied among different areas and habitats in the harbor. Larvae of pelagic or demersal species found over sand and/or mud bottoms as adults (e.g., croakers, gobies, anchovies) generally had a wide dispersal pattern within the harbor complex. Some of the species were more strongly associated with deep or shallow water habitats. For example, Goby type A larvae (arrow goby, cheekspot goby, shadow goby) were strongly associated with shallow water habitats, whereas bay goby larvae were more abundant at the deepwater stations. White croakers were substantially more abundant at deepwater habitats, whereas queenfish had localized high abundance in either shallow or deep water. Larvae of flatfish such as California halibut, diamond turbot, speckled sanddab, horneyhead and spotted turbot generally had higher abundances in deepwater habitats in the outer harbor, basins, and channels. Fish associated with vegetation and/or rocky substrate during some part of their life stage (eggs and/or juvenile-adults) (e.g., atherinids, kelpfish, pipefish, reef finspot) had a more localized larval distribution at locations near rirprap or macroalgae beds.

Larval abundance was significantly higher in spring and summer and a secondary peak occurred in the fall. A primary peak in egg abundance during the winter and a secondary peak in summer preceded the periods of higher larval abundance. During the past 30 years, the dominant larval fish and egg species in Long Beach and Los Angeles Harbors have remained relatively consistent although there have been shifts in dominance. Dominant larval fish species in the current study are similar to those caught in the past, but they differ in ranked abundance. The Year 2000 Baseline Study differs from past studies in surveying both inner and outer harbor and shallow and deepwater habitats nearly equally in both harbors. Earlier studies focused more on outer harbor areas. The increased number of shallow water habitats surveyed in 2000 study probably accounts for the higher ranked abundance of gobies and clingfish over northern anchovy in the present study.

The ichthyoplankton survey provided a good measure of the importance of species inhabiting burrows or associated with rocky and/or vegetated habitats in the Long Beach-Los Angeles harbor complex. These species were poorly represented in the adult fish surveys, yet are an important part of the overall ecology of the diverse marine habitats in the harbors. The ichthyoplankton results also demonstrate that a wide variety of fish spawn and develop within Long Beach and Los Angeles Harbors.

Benthic Invertebrates

Over 400 species of benthic infauna (small organisms that live on and within the sediment) and larger macroinvertebrates were collected during the Year 2000 Baseline Study. Both the small infaunal and larger macroinvertebrates exhibited significant declines in abundance between the winter (January-February) and remaining surveys, which may have been related to the dissipation of the La Niña period, which followed the strong 1997-1998 El Niño.

Small infaunal organisms, which tend to be less motile than larger macroinvertebrates, exhibited spatial variability in species composition that appeared to be tied to a combination of factors including water depth, years since dredging/disposal, and habitat quality. Assemblages in the outer harbor differed between shallow and deepwater habitats, and differences were apparent between assemblages from areas that have or have not experienced recent dredging. Areas of recent dredging had fewer species and lower abundance than non-dredged areas, indicating that the recently dredged areas were still in the colonization phase. In general, habitat quality was highest at the created Cabrillo, Pier 300, and Long Beach Shallow Water Habitats and the deep open waters of both harbors. A gradient of decreasing habitat quality was observed in basin and slip habitats and the back channels of the inner harbor.

Larger macroinvertebrates exhibited spatial variability, some of which appeared to relate to water depth and some of which may have been related to habitat and/or dredging/disposal. Assemblages generally differed between shallow and deepwater habitats. Similar to fish, catch abundance was higher in basin habitats in Long Beach Harbor than in the open waters of the outer harbor. The lowest catch was obtained in the inner harbor.

Similar benthic invertebrate species have been collected in the harbors over the past 30 years, but the relative abundances of the species have varied and there has been a shift in the dominance of several species. There has been a steady improvement in benthic habitat quality as demonstrated by increased diversity and less dominance by pollution tolerant benthic infauna species over the past half century. Many areas in the harbors were severely polluted in the 1950s with depauperate faunal assemblages. Polluted and "semi-healthy" areas still exist in the harbors; however, the spatial extent of these areas of relatively poorer habitat quality is not as widespread today. The most polluted area is the Consolidated Slip of Los Angeles Harbor; "semi-healthy" areas exist in the Cerritos Channel of the inner harbor and in confined basins and slips in both harbors. There were different species assemblages in the basins and slips of Los Angeles and Long Beach Harbors, with those in Los Angeles Harbor appearing to have a somewhat lower habitat quality. The quality of these "semi-healthy" areas has improved over the conditions reported in the 1950s and 1970s.

Riprap Associated Organisms

A total of 265 species of invertebrates and algae was identified within the riprap community. Distinct tidal zonation was observed with increasing numbers of species with increasing depth. However, abundances were similar throughout the upper and lower intertidal and subtidal zones.

The riprap community during the Year 2000 Baseline Study exhibited similar spatial patterns and dominant species as reported in the 1980s. Similar to historical studies, more species occurred on riprap in the outer than inner harbor areas. Barnacles dominated the upper intertidal and were conspicuous in the middle to lower intertidal strata. The non-indigenous Mediterranean mussel *Mytilus galloprovincialis* was a dominant in the lower intertidal and shallow subtidal. Tanaid and amphipod crustaceans also were dominant species in the shallow subtidal. Other commonly observed fauna included crabs, sea anemones, sea urchins, and starfish in lower intertidal and shallow subtidal zones. Giant kelp and/or feather boa kelp were overstory species in the subtidal zone of riprap stations in the outer harbor, and sargassum and to a lesser extent feather boa kelp were observed in the inner harbor.

Kelp and Macroalgae

Kelp and macroalgal communities are narrowly distributed within the harbor areas, being principally restricted to the shallow hard bottom environments associated with riprap shorelines, breakwaters, and pier structures, as well as harbor debris (e.g., rubble, mussel shells, calcareous tubes). The true kelp communities were restricted to the outermost portions of the harbor where giant kelp forms a principal component of macroalgal assemblages. While nowhere within the Ports is algal diversity high, there is a general cline of lessening algal diversity from the outermost portions of the harbors to the innermost channel environments.

Giant kelp (*Macrocystis pyrifera*) communities within Long Beach and Los Angeles Harbors are not abundant totaling only about 25 acres in the spring of 2000 and declining to about 14 acres in the fall of 2000. While algal communities within the Ports exhibit year-round presence, there is substantial seasonality to the communities. All of the algal communities appear to exhibit relatively vigorous growth during the spring months. During the summer months, warm temperatures, lack of nutrients and poor water circulation are all likely contributors to a decline in *Macrocystis* dominated communities. Other dominant alga such as *Sargassum muticum* in the inner harbor also likely decline for these same reasons.

The occurrence of giant kelp within the harbors is relatively recent according to reports of prior investigations. *Macrocystis* was established within the Ports as transplants to the San Pedro Breakwater in 1977. The distribution of kelp has expanded within outer Los Angeles Harbor since that time. During the present study, giant kelp also was found along the Middle Breakwater, submerged dike at the Cabrillo Shallow Water Habitat, riprap edges of Pier 400, other localized riprap shorelines, and on cobbles offshore Cabrillo Beach.

Eelgrass

Eelgrass habitat occurs in shallow waters offshore Cabrillo Beach and within the Pier 300 Shallow Water Habitat in Los Angeles Harbor. These beds, while consistent in their occurrence from year to year, exhibit relatively strong seasonal variation in overall area. Eelgrass beds within the Port of Los Angeles ranged from approximately 50 acres in the spring to approximately 100 acres at their peak in the fall. This pattern of expansion and contraction of eelgrass habitat is not atypical of what is regularly observed in other areas where eelgrass occurs in marginal habitat areas that are typically on the deeper fringes of normal depth distribution ranges.

Within the Cabrillo Beach and Pier 300 sites, eelgrass distributions were influenced by light restrictions, seasonality, and extrinsic biotic factors. Large areas that were devoid of eelgrass in March 2000 were dominated by a dense growth of a filamentous brown alga and urchin barrens were also observed within the eelgrass beds.

In addition to the two eelgrass beds located within the Port of Los Angeles, there was a single plant located in Long Beach Harbor within the Cerritos Channel along the north shoreline of Pier A at Berth A88. An eelgrass leaf from a broad-leaved form of eelgrass also was found floating around the Arco Terminal during March 2000. This broad-leaved eelgrass is not at all similar to the eelgrass found within the larger beds found in the Port of Los Angeles and has been noted to occur in deeper waters than the more typical form of eelgrass. These observations suggest that other limited eelgrass beds may exist in the harbors.

Birds

A total of 99 species, representing 31 families, were observed within the Ports of Long Beach and Los Angeles during the 2000-2001 monitoring year. Of that total, 69 species are considered to be dependent on marine habitats. The greatest number of individuals was observed during the July 2000 survey and the first survey in August 2000, primarily due to large numbers of Elegant Terns nesting at Pier 400 that were foraging in the harbor waters. Despite the high abundances observed during July and August, the June through September surveys yielded the lowest numbers of species (36 to 41), and fall and winter surveys yielded the highest numbers of species (43 to 60 species).

The most abundant birds were gulls (44.1% of mean observations during the survey year), and the Western Gull was the most numerous gull species. Diving birds that feed on fish (Aerial Fish Foragers) were second in abundance (22.4% of mean observations); this bird guild was dominated by Elegant Terns and Brown Pelicans. The third most abundant bird guild was waterfowl (21.4% of mean observations), represented largely by Western Grebe, Brant's Cormorant, and Surf Scoter. Upland birds, dominated by large numbers of Rock Doves roosting under docks and pilings, accounted for 5.9% of mean observations. Small shorebirds, large shorebirds, and wading/marshbirds accounted for 2.7%, 1.4%, and 1.5% of mean observations, respectively. Commonly observed species included Surfbirds, Black-bellied Plovers, and Western Sandpipers (small shorebirds); Willets and Black Oystercatchers (large shorebirds); and Great-blue Herons and Black-crowned Night Herons (wading/marshbirds). Raptors accounted for < 0.05% of the mean number of individuals observed. As during previous surveys, birds were not equally distributed among survey zones and habitats; survey zones along the breakwaters supported the highest densities of birds.

Due to variations in total area surveyed, duration and timing of surveys, and survey methods, as well as a reduction in available open water habitat, data collected during the 2000-2001 and previous surveys are not always comparable, particularly raw abundances. However, the total number of species and average number of species (species per survey) during 2000-2001 surveys increased from that of previous surveys. Average number of individuals (number per survey) during 2000-2001 also increased from previous surveys (however, these data were not available for 1986-1987 surveys).

Several sensitive species were observed during the 2000-2001 surveys. The California Brown Pelican accounted for 9.5% of the total observations, which was a substantial increase from the 3.8% of the total observations recorded during the 1973-1974 studies. Peregrine Falcons were observed during 12 of the 20 survey dates; several pairs of Peregrine Falcons are known to nest within the Ports and vicinity. California Least Terns nest in the Port of Los Angeles. There were over 500 nesting pairs in 2000, which was substantially higher than the approximately 100 nesting pairs during the 1986-1987 study. Other sensitive terns nesting within the Port of Los Angeles and observed in high numbers during the 2000 summer surveys were Caspian Tern and Elegant Tern, as well as the related Black Skimmer. Other sensitive species observed during surveys included Black-crowned Night Herons (nesting sites on the Navy Mole of Long Beach West Basin), Black Oystercatcher, Burrowing Owl, and Loggerhead Shrike.

Dredging and Disposal Activities

Lower water clarity (transmissivity) was measured in waters near locations of dredging and disposal activities. Lower water clarity also was measured at stations with finer sediments due to sediment resuspension. With the exception of depth and possibly temperature, physical/chemical parameters such as dissolved oxygen, pH, and salinity provided little insight to species composition of adult fish and ichthyoplankton in different areas of the harbors. Species composition differed between shallow and deepwater habitats, which appeared to be related more to broad dispersal patterns associated with widely distributed pelagic or soft-bottom associated demersal species, or to localized distribution patterns of species associated with rock and/or vegetated habitats.

It is not known to what extent fish and ichthyoplankton abundance may have been affected by dredging and/or disposal activities. An indication that these perturbations may have been influential was the lower abundance of adult fish caught by lampara in outer Los Angeles Harbor near Pier 400; however, lampara catch was high in Long Beach West Basin where dredging also occurred. Larval abundance was lower than expected in Long Beach West Basin, where dredging occurred, and relatively lower in outer Los Angeles Harbor near Pier 400 as compared to outer Long Beach Harbor. On the other hand, there was little correspondence between the abundance of adult fish caught by otter trawl and locations near or away from dredging and disposal activities.

Benthic invertebrate assemblages differed between areas that have or have not experienced recent dredging. Areas of recent dredging had a similar species assemblage as non-dredged areas, but there were fewer species and lower abundance indicating that the recently dredged areas were still in the colonization phase.

Exotic Species

The only exotic (non-indigenous) fish species collected in the 2000 sampling surveys was the yellowfin goby (*Acanthogobius flavimanus*). This species, which was introduced from Japan, has been reported in previous studies of the harbors, but its relative abundance appears to be higher in 2000 as compared to earlier studies.

Non-indigenous fauna potentially comprise about 15% of the invertebrate species that inhabit the harbors. A few of the species are dominant in abundance. The polychaete *Pseudopolydora paucibranchiata* and clam *Theora lubrica* comprised 26% of the total infaunal abundance and the New Zealand bubble snail *Philine auriformis* accounted for 4.5% of the macroinvertebrate abundance in 2000. The relative abundance of these species has increased in the harbors since the 1970s.

Approximately 11% of the species associated with rocky riprap were potentially non-indigenous. Conspicuous were the Mediterranean mussel (*Mytilus galloprovincialis*) and Pacific oyster (*Crassostrea gigas*). While the Mediterranean mussel has been a common inhabitant of the harbors for many years, the occurrence of the Pacific oyster is fairly recent and is localized mainly in Los Angeles Harbor. Its occurrence was not reported during comprehensive studies of Los Angeles Harbor in 1986-1987, and apparently has established since then.

Known occurrences of invasive exotic algae within the harbors include the ubiquitous *Sargassum muticum* and the first discovery of *Undaria pinnatifida* on the eastern Pacific coastline. While *Sargassum* has become a naturalized element of the algal flora and no substantial changes in this species distribution pattern within the Ports are expected, this is not the case with *Undaria*. The relatively recent introduction of *Undaria*, probably as a result of hull fouling or ballast water transport, and its recent identification at a number of other locations along the coast suggest that this species may become much more widespread within Long Beach and Los Angeles Harbors over time.

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1.0 INTRODUCTION

Long Beach and Los Angeles Harbors are located in San Pedro Bay, which lies to the south of the Los Angeles Basin and is bounded by the communities of San Pedro and Wilmington to the west and north and Long Beach to the north and east (Figure 1.1-1). The bay is east of the Palos Verdes peninsula, which separates San Pedro Bay from Santa Monica Bay to the northeast, and extends southeast towards Newport Beach.

Background

The marine biological environment of Long Beach and Los Angeles Harbors has been periodically studied since the 1950s. Early studies documented severe pollution in several of the basins in the harbors. The first comprehensive surveys of biological and physical/chemical conditions in the harbors were initiated in 1971 and continued annually through 1978. A large impetus for those studies was to document existing conditions and evaluate impacts associated with dredging and planned expansion of the Ports of Long Beach and Los Angeles (Ports). During the 1980s and 1990s several separate studies were conducted that were limited to one port or the other in support of separate development projects.

Considerable changes have occurred in the Ports since the comprehensive surveys of the 1970s and more focused surveys of the 1980s and 1990s. Some of these changes include deepening of navigational channels and basins, construction of substantial landfills at Piers 300 and 400 in Los Angeles Harbor, construction of a transportation corridor out to Pier 400, extension of Pier J in Long Beach Harbor, and construction of the west basin of the Cabrillo Marina complex. As mitigation for some of these developments and deepening of shallow water to create channels, shallow water habitats were created in formerly deep water areas near Pier 300, the San Pedro Breakwater, and on the east side of Pier 400. Thus, several areas that were aquatic habitat in prior studies are now land, some previous areas that were deep water are now shallow, and circulation patterns within the harbors have been altered.

The goal of this study was to provide an update of quantitative information on physical/chemical and biological conditions within the different marine habitats of the harbors. An evaluation of the scientific data compared to historical information is also provided to gain understanding of whether there have been significant changes in habitats and resources compared to historical conditions.

It is the intent of this biological baseline study to provide quantitative information in a manner to assist the Ports, resource, and regulatory agencies in their efforts to make environmentally sound decisions regarding future planned port developments. This report provides an updated inventory and assessment of the marine biological environment of Long Beach and Los Angeles Harbors. It is the first study since the 1970s to examine both inner and outer harbor areas of both Ports simultaneously. The study was conducted during the year 2000 and included surveys at varying frequencies (depending upon typical natural variability) of the physical/chemical environment (water quality and sediment grain size), adult and juvenile fish, larval fish (ichthyoplankton), benthic invertebrates, attached organisms on breakwaters and other rocky riprap, kelp and macroalgae, eelgrass, and birds. This study is the first to map kelp and eelgrass throughout both Ports. Historical comparisons take into consideration the major findings of the studies dating from the 1970s and in some cases, where it is possible to do so, examine station specific trends in abundance, number of species, and dominant organisms.

Report Organization

The report is organized into nine technical sections (chapters) that address findings of each study element. Figures and tables are provided at the end of each report section. Section 1 introduces the study and provides historical background on Long Beach and Los Angeles Harbors. Physical/Chemical data are provided in Section 2. Adult and juvenile fish populations are discussed in Section 3, and results of ichthyoplankton surveys are given in Section 4. Benthic and epibentic invertebrate communities are described in Section 5. Results of the riprap surveys are presented in Section 6. Maps of kelp distribution and description of the macroalgae are given in Section 7. Maps of eelgrass distribution are provided in Section 8. The results of monthly to bimonthly bird surveys are described in Section 9. Individuals who participated in the study are acknowledged in Section 10. Literature citations are provided in Section 11.

Several appendices are provided at the back of the document that include additional data summaries and/or summaries of raw survey data. Appendix A provides latitude and longitude coordinates for the surveyed stations. Summaries are provided for physical/chemical data in Appendix B, fish data in Appendix C, ichthyoplankton data in Appendix D, benthic invertebrate data in Appendix E, riprap data in Appendix F, kelp and macroalgae data in Appendix G, and bird data in Appendix H. Appendix I presents a personal reflection on changes in the harbors by Dr. Donald J. Reish, who's early studies in the harbors laid the foundation for not only subsequent studies in the harbors, but also the first benthic ecological studies offshore southern California .

The remaining introduction provides a background of the study site (1.1), objectives of the year 2000 Baseline Study (Section 1.2), and review and comparison with previous studies of the harbors (Section 1.3).

1.1 Background of the Study Site

In the 1800s, San Pedro Bay was the outlet for the Los Angeles and San Gabriel Rivers, which drained substantial watersheds. The harbors were developed from the estuarine outlets of these rivers and from the shallow depths of the bay. Development of the harbors changed the historic shallow estuarine habitat into mainly deepwater habitat. During the early to mid 1900s, three breakwaters (San Pedro, Middle, Long Beach) were constructed to protect the Ports from damaging wave action. From this point in history, the development of the Ports has involved a series of dredge-and-fill operations to deepen channels to accommodate deep draft vessels and to provide fill for additional land areas for terminal development (HEP 1980, USACE 1992).

The harbor complex consists of the Port of Long Beach at the east end, and the Port of Los Angeles at the west end, which are shaded with lighter and darker colors on Figure 1.1-2. The harbor complex consists of open water habitat just north of the breakwaters and channels that lead to basins and slips in the middle and inner reaches of the Ports. Each of the channels, basins, and slips has a name or descriptive phrase that describes its location within each port. The basins and slips vary in size and distance from the harbor entrance, and channels also vary in length, width, and distance from the harbor entrance. These features define different physical habitats that experience different degrees of tidal circulation and exchange within the harbors.

Tidal exchange within San Pedro Bay occurs through two primary openings: Angel's Gate between the San Pedro and Middle Breakwaters, and Queen's Gate between the Middle and Long Beach Breakwaters. Tidal exchange also occurs around the east end of the Long Beach Breakwater. The Los Angeles River empties into the ocean northeast of Pier J at the east end of Long Beach Harbor. The Dominguez Channel drains into the north end of Los Angeles Harbor through the Consolidated Slip. Other freshwater input to the harbors is from the Terminal Island Treatment Plant (TITP), which discharges near Pier 400.

In the last three decades, the Ports have undertaken long-range development plans to accommodate anticipated increases in cargo coming into the harbors. Dredging and landfills to implement the plans have taken place since the 1970s when the first comprehensive baseline studies were conducted (Figures 1.1-3 and 1.1-4).

In 1985, the Main Channel in Los Angeles Harbor was dredged from –35 to –45 feet Mean Lower Low Water (MLLW), and a 190-acre landfill was created at Pier 300 from dredge material. Between 1993 and 2001, the Outer Los Angles Harbor and approach channels were dredged and the dredge material used to construct the 600-acre Pier 400. At the Port of Long Beach side, somewhat smaller-scale dredging has taken place throughout most the harbor from 1990 to the present (Figure 1.1-3). Dredging was ongoing during the Year 2000 Baseline Study in Long Beach West Basin (refer to Figure 1.1-2 for location) and around Pier 400 including the Northern Channel separating Piers 300 and 400.

Three shallow water habitats were created as mitigation for developments within the harbors. These areas are referred to as the "Cabrillo, Pier 300, and Long Beach Shallow Water Habitats." Of these, the Pier 300 Shallow Water Habitat is the oldest, having been created in 1985. Next was the Cabrillo Shallow Water Habitat, which was created in 1993 and completed to its present boundaries in 2000. The Long Beach Shallow Water Habitat was created in 1999.

In addition to disposal at the Cabrillo Shallow Water Habitat, dredge material also was placed during the study at two sites in Long Beach Harbor, which were established for sediment storage and disposal in support of construction. The disposal sites are termed the Western Anchorage Sediment Storage and Disposal Site and Main Channel Site (Figure 1.1-3).

Other changes to the Ports since the 1970s include construction of a transportation corridor out to Pier 400, expansion of Pier J in Long Beach Harbor, and construction of the west basin of the Cabrillo Marina complex.

1.2 Study Objectives

The Ports retained MEC Analytical Systems, Inc. (MEC) and its subcontractors to conduct environmental studies in Long Beach and Los Angeles Harbors in the year 2000. The goal of this study was to provide an update of quantitative information on physical/chemical and biological conditions within the different marine habitats of the harbors. The specific objectives of the study were to:

- Measure water quality and sediment grain size to provide physical/chemical characterization of environmental conditions during biological surveys,
- Provide an updated quantitative baseline of the benthic invertebrate community,
- Provide an updated quantitative baseline of larval, juvenile, and adult fish populations,
- Provide an updated description of biological communities attached to rocky riprap habitats,
- Provide an updated quantitative description of the bird community,
- Map kelp distribution and describe macroalgae communities,
- Map eelgrass distribution,
- Identify relative occurrence of non-indigenous (exotic) species among native populations, and
- Compare year 2000 study findings with historical studies.

The objectives were addressed through the design of an integrated field program that included eight major task elements: physical/chemical conditions, adult and juvenile fish, ichthyoplankton, benthic and epibenthic invertebrates, riprap biota, kelp and macroalgae, eelgrass, and birds. The parameters for the study design were developed by the Ports in consultation with the following resource agencies: California Department of Fish and Game, National Marine Fisheries Service, and U.S. Fish and Wildlife Service. MEC and its subcontractors (referred herein as Associates) prepared a description of methods and scope of work to meet the objectives of the study design in a technical proposal, which was reviewed and approved by the Ports and resource agencies.

Figure 1.2-1 shows the location of water quality, benthic infauna, macroinvertebrate, fish, and ichthyoplankton sampling. These survey elements were co-located so that data would be collected at the same locations for the physical/chemical environment, benthic organisms, and fish stocks. A total of twenty-eight areas were selected by the Ports, fourteen from each harbor, for establishment of stations to measure water quality and benthic conditions. The areas corresponded to different types of habitats within the harbors including deep open water, shallow open water, created shallow water habitat, deep basins, channels, and slips. Because of the more limited extent of shallow water habitat within the harbors, two replicate stations were established in each of four shallow water areas selected for inclusion in the study. These areas were located at a naturally shallow area near Cabrillo Beach; and the Cabrillo, Pier 300, and Long Beach Shallow Water Habitats, which were created as mitigation sites for construction projects in the harbor complex. Thus, a total of thirty-two stations were sampled for water quality, sediment grain size, and infaunal invertebrates. Surveys were conducted over four seasons: winter, spring, summer, and fall.

A representative subset consisting of fourteen (seven from each Port) of the primary benthic stations and all four of the replicate stations at the shallow water locations were sampled for mobile organisms. Thus, a total of eighteen stations were surveyed for fish, ichthyoplankton, and macroinvertebrates.

Locations of riprap stations and kelp transects are shown on Figure 1.2-2. Rip rap was measured at eight locations (four from each Port) in upper intertidal, lower intertidal, and subtidal depth zones and surveys were conducted over four seasons. Kelp was mapped with side-scan sonar in winter and summer to provide information on seasonal variability in kelp bed distribution and/or area. Macroalgae communities were surveyed at 20 locations throughout the harbors during spring and fall by diving biologists to provide characterization of variability of macroalgae communities in different types of habitats.

Birds were surveyed throughout the entire Long Beach-Los Angeles Harbor complex by dividing the harbors into 31 grid zones (Figure 1.2-3). Birds were surveyed on a monthly and bimonthly frequency depending on season to document bird utilization of harbor habitats.

Each of the primary study elements was described in a standardized format to facilitate comparisons and integrations among program elements. Communities were described using summary measures; e.g., number of species, abundance, biomass, and derived community measures (e.g., diversity indices) that describe general community structure. Mean values of the community summary measures, which were standardized based on area sampled, were used for historical comparisons of biological data. Additionally, species composition was described and compared to previous studies. The occurrence of non-indigenous (exotic) species within the harbors was addressed by review of relevant reports and knowledge of qualified taxonomists that have been involved in the identification of marine organisms in the Southern California Bight for the past twenty years.

1.4 Review and Comparison with Previous Studies

Marine studies of the harbors in the 1950s demonstrated that many areas were severely polluted (Reish 1959; see Appendix I). National and state regulations implemented in the late 1960s reinforced clean up efforts in the harbors. During the 1970s studies of the physical/chemical and biological conditions in Los Angeles-Long Beach Harbors were conducted by the Harbors Environmental Projects of the University of Southern California under various sponsorships by the Pacific Lighting Service, NOAA Sea Grant Program, Los Angeles Board of Harbor Commissioners, and U. S. Army Corps of Engineers (HEP 1976, 1980). Soule and Oguri (HEP 1979, 1980) reported a dramatic improvement in marine habitat quality in the 1970s relative to the studies in the 1950s, although areas of pollution were still evident in inner harbor and blind-end slip areas. Clean up efforts continued in the 1970s with installation of dissolved air flotation (DAF) devices in 1973-1974 that significantly reduced biological oxygen demand (BOD) and particulate matter in the vicinity of Fish Harbor, conversion of the TITP in 1977 from primary to secondary treatment, and diversion of fish wastes to the plant for treatment in 1978.

Studies between 1974-1978 also were conducted at selected stations in Long Beach Harbor to compare harbor communities during pre-operational (circulation pumps operating occasionally, but no thermal discharge) and operational (thermal discharge) conditions of the Long Beach Generating Station (EQA-MBC 1978). The intake and discharge for the plant are located just north of the Gerald Desmond Bridge opposite Pier C.

During the 1980s and 1990s, separate studies of Long Beach and Los Angeles Harbors were conducted. MBC (1984) lists several of the different studies, which were conducted to monitor effects of thermal discharges from the Long Beach Generating Station, effects of discharges from the TITP outfall, and harbor developments. Besides being restricted in spatial extent between harbors, several of these studies also were restricted to either inner or outer harbor areas.

An updated biological baseline of inner and outer Los Angeles Harbor was conducted in 1986-1987 by MEC (1988), which included comparison to the comprehensive HEP surveys of the 1970s. Inner and outer harbor areas in Long Beach Harbor were studied in 1994 and 1996 (MEC 1997).

Comparisons with earlier studies are affected by several changes to the harbors including the construction of Piers 300 and 400 and extension of Pier J, which have added new land to the harbors, which were previously open water in earlier studies. Additionally, shallow water habitats have been created in some formerly deepwater areas near Pier 300 ("Pier 300 Shallow Water Habitat"), the San Pedro Breakwater ("Cabrillo Shallow Water Habitat"), and on the east side of Pier 400 ("Long Beach Shallow Water Habitat").

Comparisons also are limited by the manner in which data was previously reported, and/or by differences in methodology. Some of the early studies (e.g., EQA-MBC 1978) provide data summaries across stations without presentation of station-specific data. HEP (1976, 1979, 1980), MBC (1984), MEC (1988, 1996), SAIC and MEC (1997), and City of Los Angeles (e.g., CLA-EMD 2000) provide data tables by station that permit comparisons with data collected in 2000. However, there are some differences in methods, most notably associated with sampling benthic invertebrate and fish communities, that limit direct comparison of some of the historical data with the present study. For example, samples of the benthic infauna community were processed through screens with smaller (0.5 mm) openings during the earlier HEP studies; whereas, screens with larger (1.0 mm) openings were used to process samples collected in latter studies. The 1.0 mm sieve size was used in the present study to be comparable with the more recent harbor studies as well as regional programs throughout the southern California Bight. This study considers the results of a comparative study (MEC 1988), which demonstrated that species abundance rather than composition is affected by screen size, when making historical comparisons of benthic infauna data.

Fish have been previously sampled in the harbors mainly by otter trawl nets and less frequently by lampara, beach seine, and gill nets. Two different sized otter trawl nets (16- and 25-foot) have been used in past studies. The present study used a combination of lampara, beach seine, and otter trawl nets. In order to facilitate historical comparisons, a special study was conducted as part of the Year 2000 Baseline Study that evaluated catch differences in fish and macroinvertebrates using the two different sizes of otter trawls that have been used in past studies. Results, which indicated that the larger net catches more variety and abundance of fish and marcroinvertebrates than with the smaller net, allowed a more quantitative comparison of fish and macroinvertebrate catch in the present study with historical studies.

Figure 1.1-1. California key and vicinity maps.

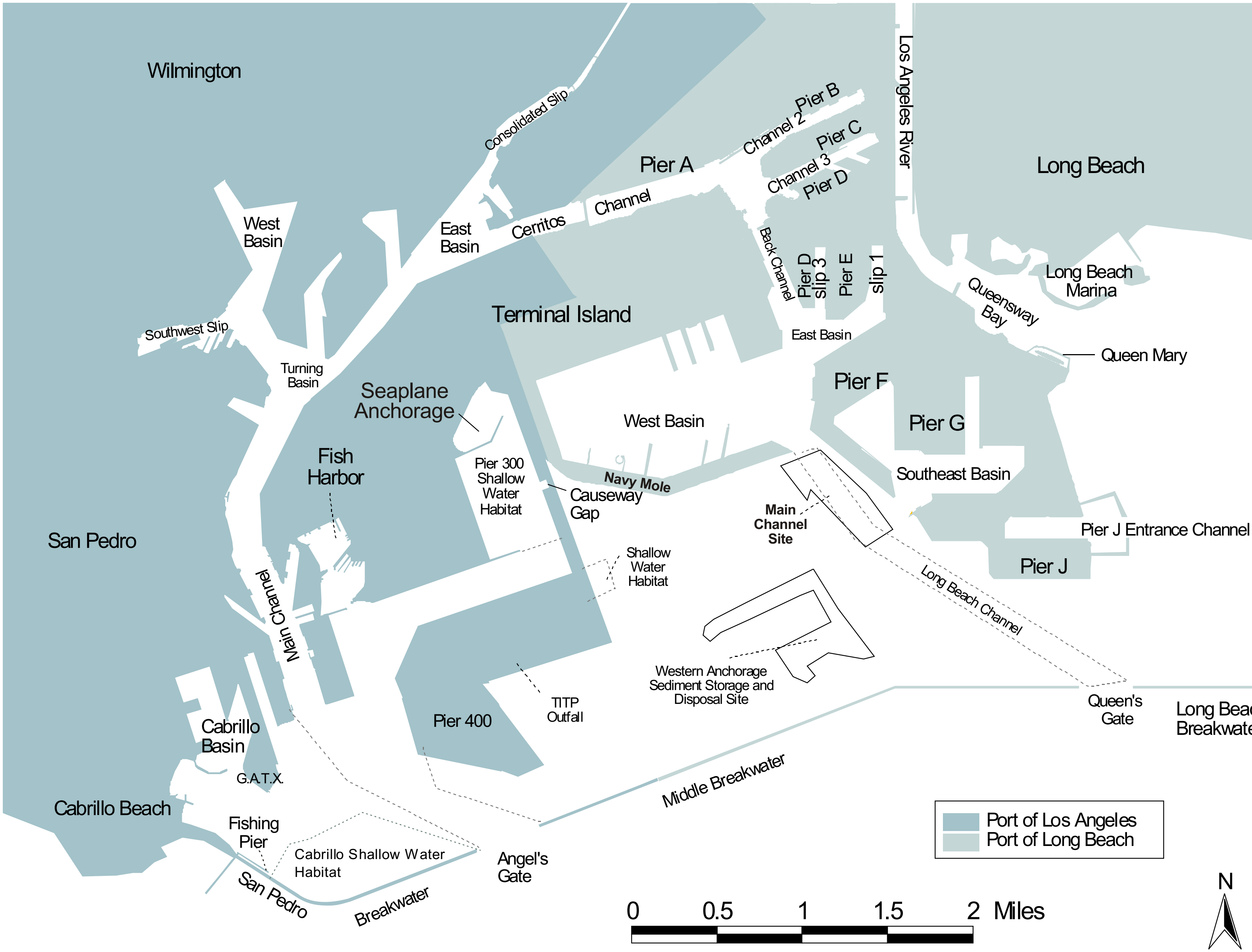


Figure 1.1-2. Map identifying different areas and features in L ong Beach and Los Angeles Harbors.

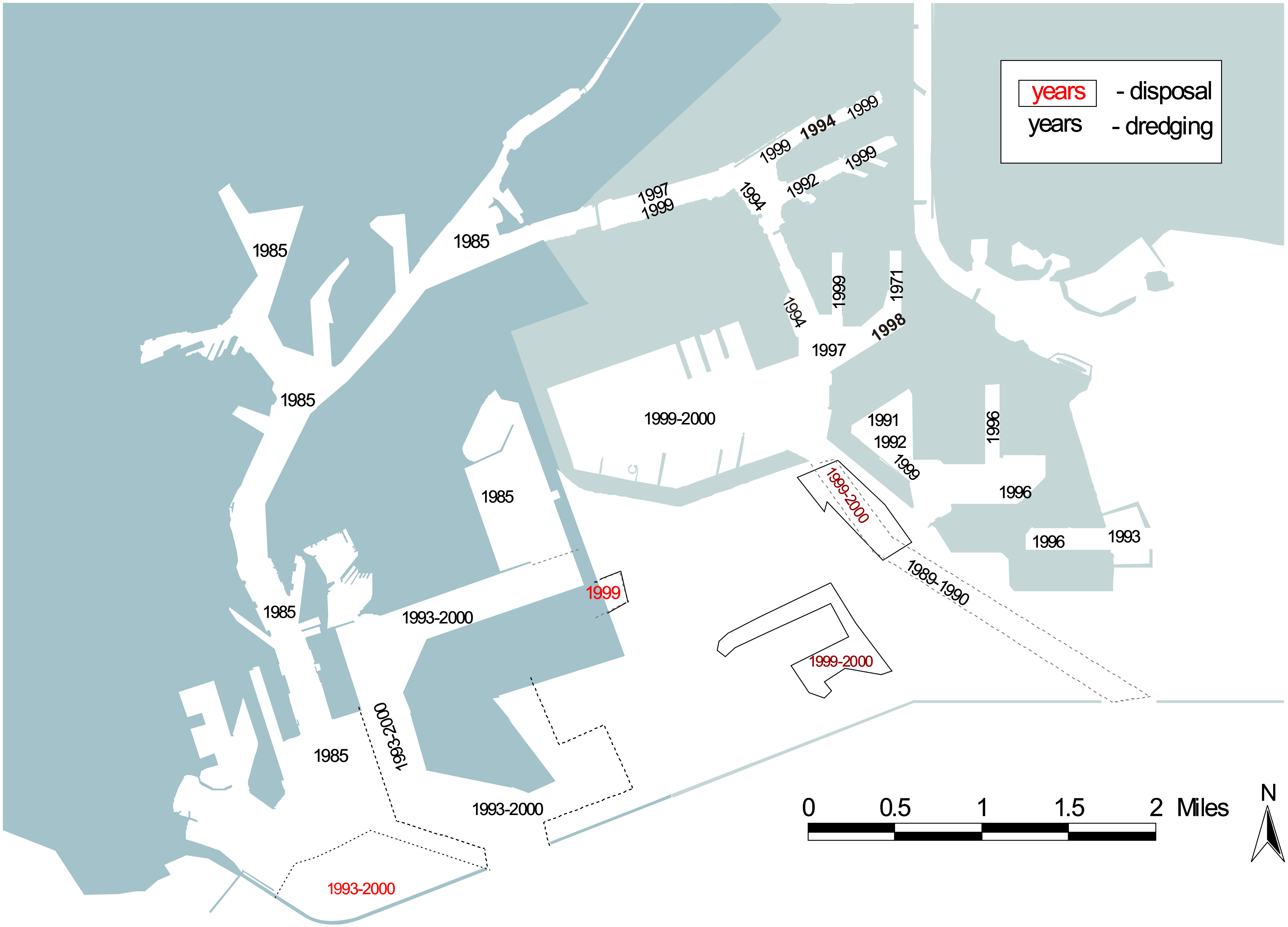


Figure 1.1-3. Areas of recent dredging and disposal in Long Beach and Los Angeles Harbors.

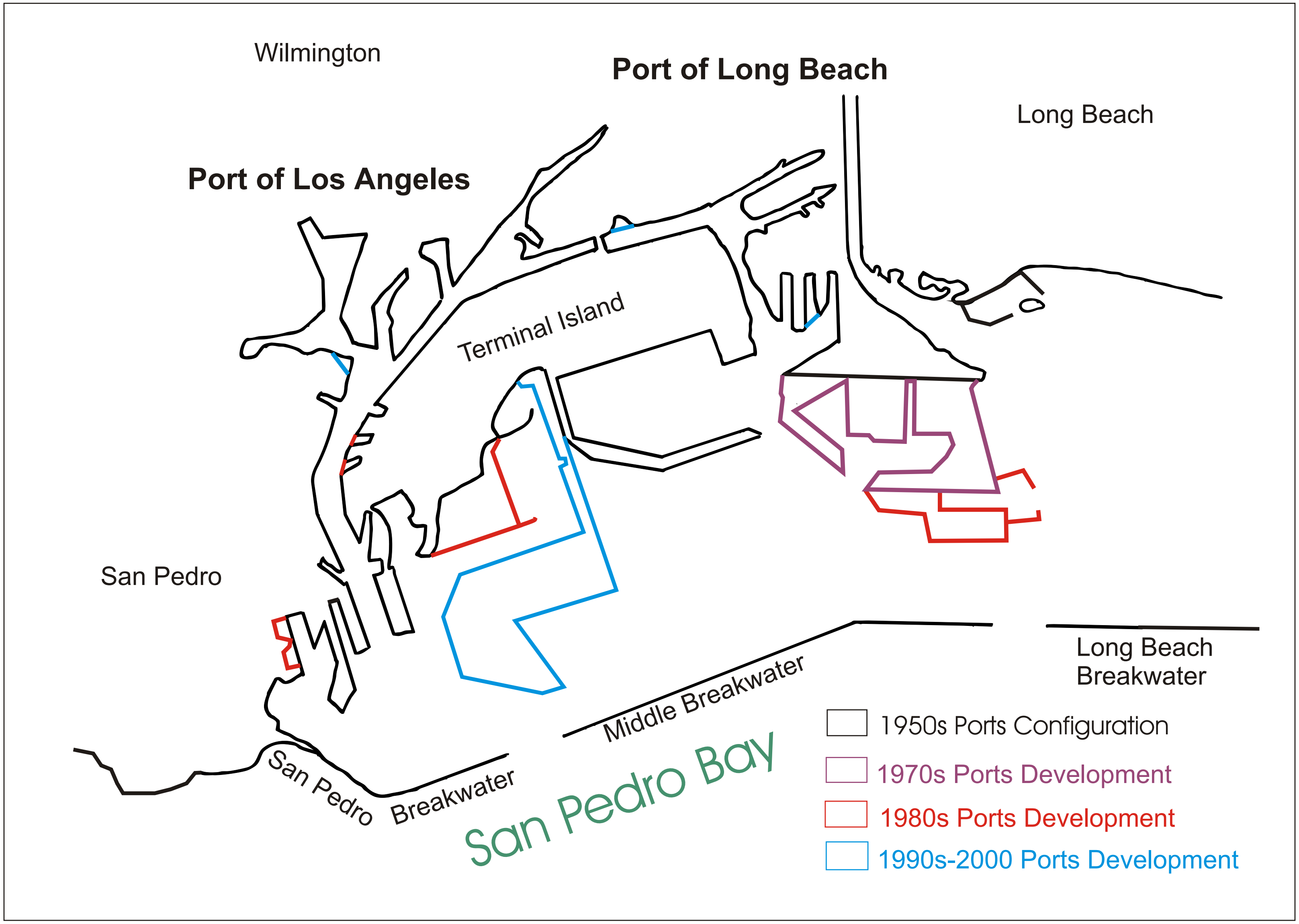


Figure 1.1-4. Historical change in development of Long Beach and Los Angeles Harbors.

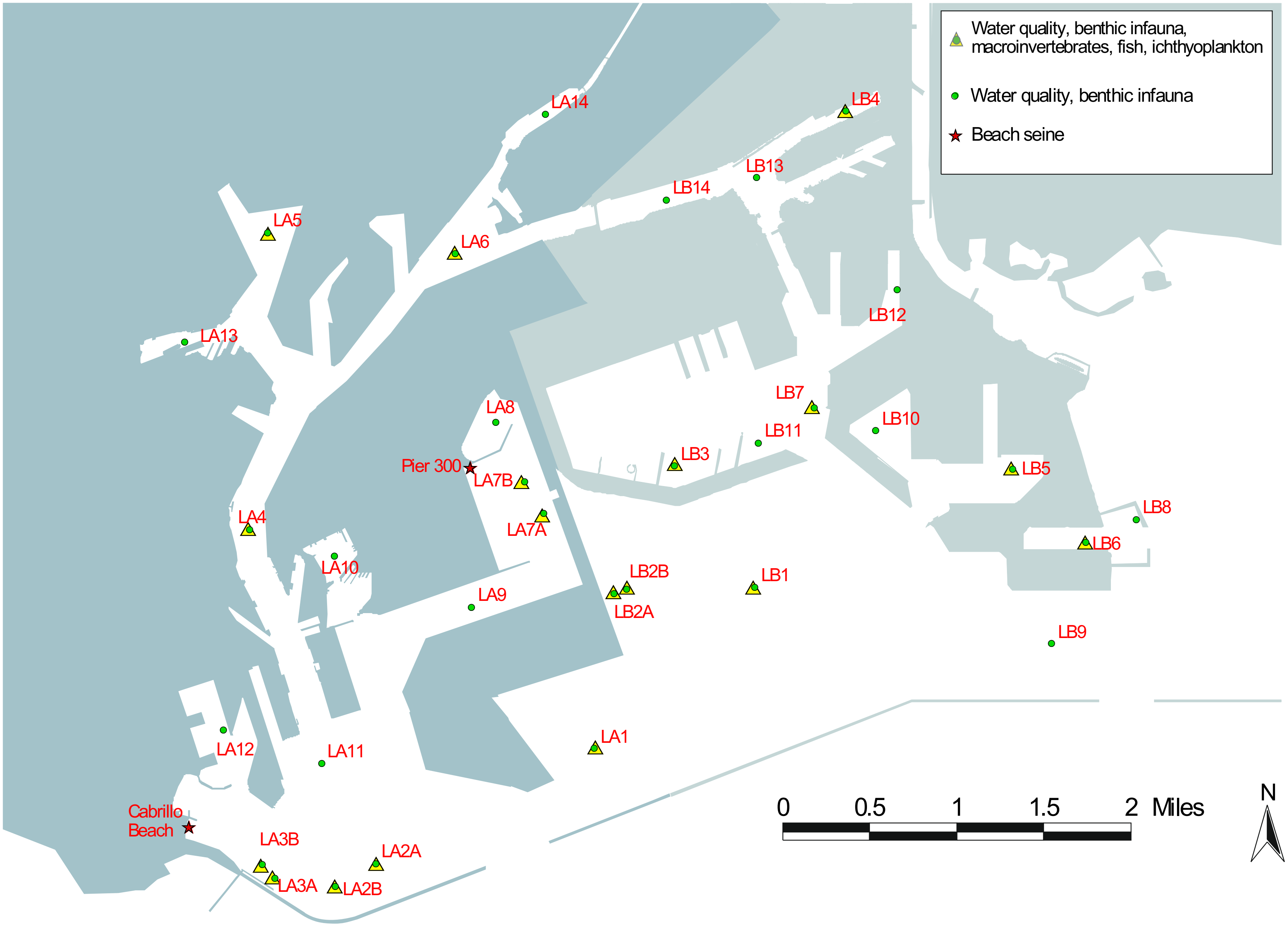


Figure 1.2-1. Location of water quality, benthic infauna, macroinvertebrates, fish, and ichthyoplankton sampling stations in Long Beach and Los Angeles Harbors, January - November 2000.

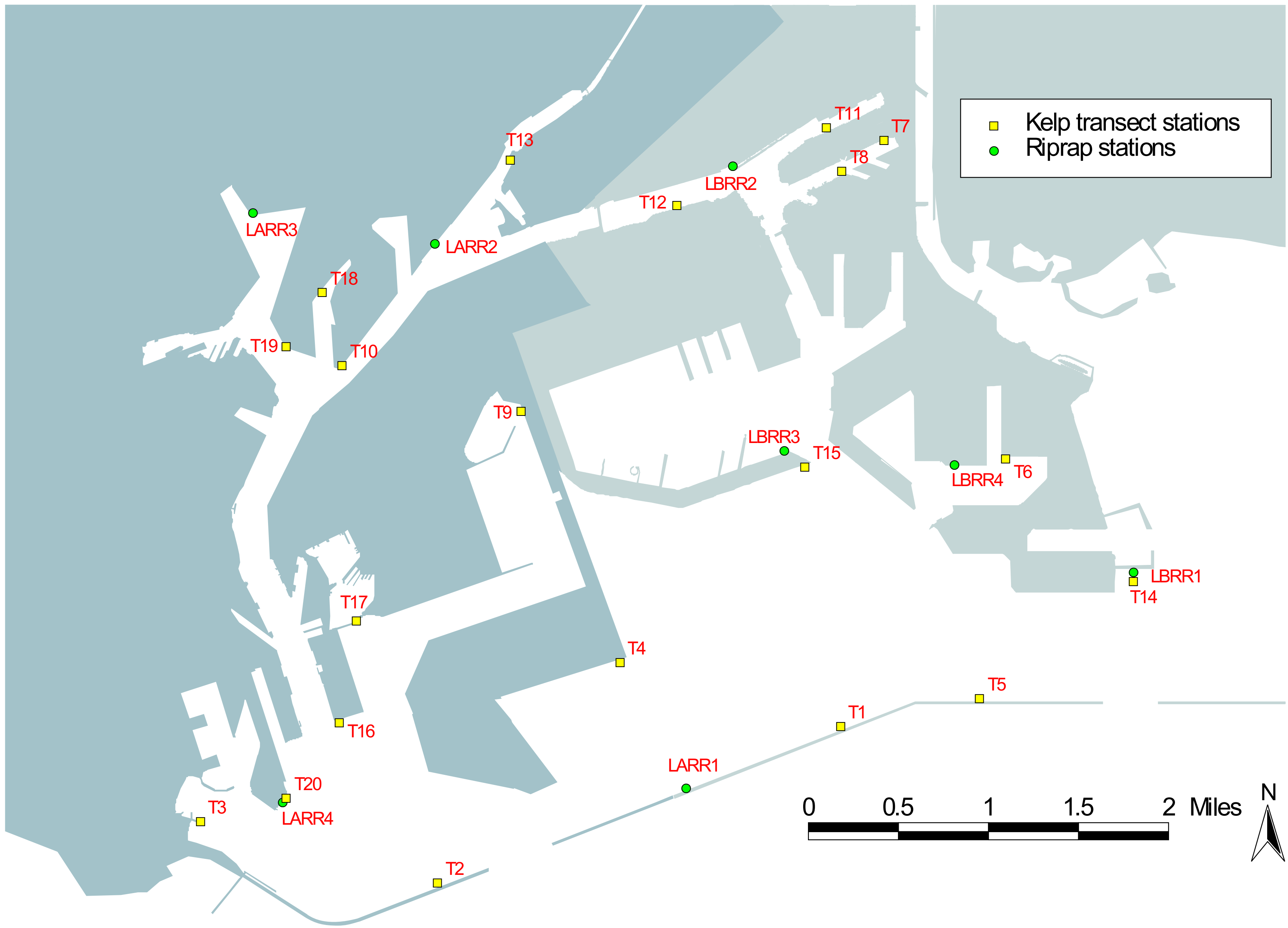


Figure 1.2-2. Location of riprap and kelp transect stations in Long Beach and Los Angeles Harbors, January - November 2000.

Figure 1.2-3. Location of bird survey zones in Long Beach and Los Angeles Harbors, February 2000 - January 2001.

2.0 PHYSICAL AND CHEMICAL CHARACTERISTICS

2.1 Introduction

This section presents results of water quality and sediment grain size measurements conducted within the Ports of Long Beach and Los Angeles harbor complex for the Year 2000 Baseline Study. The results are used to characterize spatial patterns, seasonal variability, and comparisons to historical conditions. This information is important for characterizing the different habitats (e.g., shallow versus deep water, inner versus outer harbor, and slip versus channels) within the harbor complex. This section also provides an evaluation of the circulation study because water circulation within the harbor complex has important effects on water and sediment quality conditions and, consequently, the quality of ecological habitats.

Water quality was measured quarterly at all stations used to survey benthos, fish, and ichthyoplankton. Sediment grain size, which is less variable, was measured on the first survey. Methods used to measure physical/chemical characteristics are described in Section 2.2. Survey results for sediment grain size are given in Section 2.3, and water quality results are provided in Section 2.4. A discussion of changes to tidal circulation resulting from the construction of the Pier 400 Landfill and Transportation Corridor is in Section 2.5. Spatial and temporal patterns in water quality are summarized in Section 2.6, and compared to historical studies in Section 2.7. The chapter concludes with a summary of study findings in Section 2.8.

2.2 Methodology

Water quality was sampled quarterly in January (winter), May (spring), August (summer), and November (fall), 2000. Sediment samples were collected once during the first survey (January). The dates and times of the quarterly water quality surveys, as well as weather conditions and other notable observations, are listed in Table 2.2-1.

Water quality and sediment grain size characteristics were measured at each of the 28 benthic stations, 14 in each harbor (Figure 2.2-1). Two replicate stations were located at shallow water Stations LB2, LA2, LA3, and LA7 to yield a total of 32 samples per survey; the replicate stations were denoted by letter (e.g., LB2A, LB2B). A subset of the stations were sampled for fish and ichthyoplankton; thus, the collected water quality and sediment data characterize those physical/chemical characteristics for those program elements as well. Station coordinates are listed in Appendix A. Water depths of the stations ranged from 4 to 24 meters (m) (13 to 77 feet (ft)) (Figure 2.2-2).

Water quality was assessed by measuring vertical profiles of specific indicators at each station using *in situ* instruments. Parameters measured included temperature, salinity, dissolved oxygen (DO), acidity/alkalinity (pH), and water clarity (transmissivity). Vertical profiles of the water column were obtained using a Seabird SBE25 Sealogger conductivity-temperature-depth (CTD) instrument with additional pH and DO probes and a SeaTech 0.25-centimeter (cm) path length transmissometer. Instruments were calibrated before each survey following the manufacturers' recommendations and MEC's standard operating procedures.

Sediment grain size samples were collected during the first survey (January, 2000) from the portion of the box core sample which was not used for benthic infauna analysis (see Section 5). Approximately 100 grams (g) (wet weight) of sediment were removed from the top 2-cm layer of undisturbed areas of the core, placed in plastic resealable bags, and maintained at 4°Celcius (C) in an insulated ice chest during the survey.

As mentioned above, all water quality measurements were performed using *in situ* profiling equipment. Consequently, laboratory analyses of water samples were not required. Following each survey, water quality data were down-loaded to the MEC database established for this program.

Sediment grain size analyses were performed at MEC's laboratory using the sieve-pipette method according to Plumb (1981).

2.3 Sediment Grain Size

Sediment grain size for the 32 monitoring stations sampled during January, 2000 are summarized in Table 2.3-1.

Sediment grain size varied widely throughout the monitoring area, as well as within individual habitat types. This variability did not appear to be related to water (bottom) depth. For example, sediments from deepwater basin habitat in Los Angeles West and East Basins (Stations LA5, LA6), Cabrillo Basin (Station LA12), and Long Beach West and Southeast Basins (LB3, LB5, LB10, LB11), had water depths from 11 to 21 meters, and contained percentages of fines (particle diameter < 62 microns) ranging from 37 to 99 percent (%), with median particle diameters from 3 to 102 microns (Table 2.3-1). Sediments from deepwater channel habitats in Los Angeles Main Channel (Station LA4), Long Beach Channel (Station LB7), Pier 400 Northern Channel (Station LA9), and Cerritos Channel in the inner harbor (Stations LB13, LB14) had water depths from 16 to 24 meters, and contained from 25 to 94% fines with median particle sizes ranging from 7 to 175 microns. Sediments from deepwater slip habitat in the Los Angeles Southwest Slip (Station LA13), Long Beach Channel 2 slip near Pier B (Station LB4), Long Beach Pier J slip (Stations LB6, LB8), and Long Beach East Basin Slip 1 (Station LB12) had water depths from 11 to 17 meters, and contained from 13 to 99% fines with median diameters ranging from 4 to 109 microns. By comparison, sediments from shallow water habitats in the Cabrillo Shallow Water Habitat (Station LA2), Pier 300 Shallow Water

Habitat (Station LA7), Long Beach Shallow Water Habitat (Station LB2), open waters near Cabrillo Beach (Station LA3), Fish Harbor (Station LA10), Seaplane Anchorage (Station LA8), and Dominguez Channel in the inner harbor (Station LA14) had water depths from 4 to 6 meters, and contained from 20 to 95% fines with median sizes from 7.4 to 126 microns.

Variability among and within habitat types in sediment texture also did not appear to be related to effects from recent dredging. For example, sediments from Station LA6 in Cerritos Channel that was last dredged in 1985 and sediments from Stations LB3 and LB11 (Long Beach West Basin), located in an area dredged from 1999 to present, both contained comparable proportions of fines (75 to 77%) (Figures 2.3-1 and 2.3-2). Also, proportions of fines in sediments from adjacent Stations LA7A and LA7B in the Pier 300 Shallow Water Habitat, which was created in 1985, varied by more than a factor of two (21% and 50%, respectively). Therefore, factors besides dredging/disposal appear to affect the texture of bottom sediments within the Ports. These spatial differences may be related to small-scale circulation patterns that can promote either deposition and accumulation or resuspension and transport of fine-grained sediments.

2.4 Water Quality

Water quality data for the 32 monitoring stations sampled quarterly during January through November, 2000 are summarized in Table 2.4-1. Water quality data for individual monitoring stations and surveys are provided in Appendix B. Seasonal and spatial patterns in dissolved oxygen, acidity/alkalinity (pH), salinity, temperature, and transmissivity (water clarity) are summarized in Sections 2.4.1 through 2.4.5, respectively.

2.4.1 Dissolved Oxygen

DO concentrations in surface, mid-depth, and bottom waters within the study area were consistent with typical values for estuarine and near-coastal waters. Annual mean DO concentrations for all stations ranged from 6.67 to 8.13 milligrams per liter (mg/liter), 5.98 to 7.85 mg/liter, and 4.93 to 7.04 mg/liter for surface, middle, and bottom depth waters, respectively (Table 2.4-1). As expected, the highest DO concentrations typically occurred in surface waters and then decreased with depth, with lowest concentrations in near-bottom waters. Maximum differences between surface and near-bottom waters in DO concentrations at individual sites were approximately 3.5 mg/liter. Depth-related patterns in DO concentrations are related to photosynthesis and atmospheric exchange at the surface and respiration/oxygen consumption near the bottom.

During January and November, waters at all depths throughout the study area were well-oxygenated, with concentrations above 5 mg/liter (Table 2.4-2). All surface waters in May and August, and mid-depth waters in August, were also well-oxygenated (DO concentrations greater than 5 mg/liter), whereas mid-depth and bottom waters at 14 and 25 of 32 sites in May, and bottom waters at 5 of 32 sites in August, contained DO concentrations less than 5 mg/liter. The minimum DO concentration (2.78 mg/liter) occurred during August in near-bottom waters in Long Beach West Basin (Station LB3).

Water column DO concentrations did not exhibit significant spatial patterns within the study area. In general, bottom waters within the deepwater basin and deepwater slip habitats contained slightly lower DO concentrations during spring and summer than open channel and shallow water habitats, whereas concentrations in surface and mid-depth waters were generally comparable within different areas of the harbor complex. The minimum DO concentration at Station LB3 coincided with low water clarity (transmissivity values), and may be attributable to disturbances (e.g., resuspension) of bottom sediments with a high oxygen demand.

Water column DO concentrations generally were lower in May and August than in January and November. Seasonal patterns were somewhat less pronounced in shallow water habitats than in the deeper water habitats. Stronger water column stratification at the deeper water habitats during spring and summer, potentially coupled with accumulation and decomposition of organic matter derived from storm runoff, may account for the slightly lower DO concentrations in bottom waters of the deep water habitats. Alternatively, low DO oxygen concentrations, together with colder water temperatures in May (see Section 2.4.4), could reflect the presence of recently upwelled waters that moved into the harbor from adjacent offshore areas.

2.4.2 Acidity/Alkalinity (pH)

Acidity/alkalinity (pH) conditions within the study area were within normal ranges for coastal waters. Annual mean pH values for surface, mid-depth, and bottom waters at individual stations ranged from 7.86 to 8.09, 7.88 to 8.03, and 7.81 to 7.99, respectively (Table 2.4-1). Gradients or consistent spatial patterns in pH conditions were not apparent. Changes with depth in pH at individual stations typically were minimal (less than 0.1 pH units), with the exception that some of the deeper-water sites had differences between surface and bottom waters of greater than 0.2 pH units during May and August (Table 2.4-3). These latter differences probably reflect depth-related trends in effects from respiration and decomposition of organic matter on carbon dioxide levels. The pH values at individual stations were generally higher in August and November than in January and May. These latter differences may have been due to the effects of primary production (algal photosynthesis) in surface waters.

2.4.3 Salinity

Salinity conditions within the study area were within normal ranges for estuarine and near-coastal waters. Annual mean salinity values for surface, mid-depth, and bottom waters at individual stations ranged from 33.02 to 33.39 parts per thousand (ppt or practical salinity units), 33.19 to 33.46 ppt, and 32.92 to 33.55, respectively (Table 2.4-1). Salinity typically increased with water depth, although the range in salinities at an individual station was relatively small (e.g., generally less than 1 ppt).

In some cases, unusually low salinity values (approximately 25 to 30 ppt) were measured in waters within a few meters of the bottom (e.g., at Station LB12 in Slip 1 of Long Beach East Basin during January and August, 2000 and Station LA11 in outer Los Angeles Harbor during August, 2000) (Table 2.4-4). The Terminal Island Treatment Plant (TITP) discharges treated sewage with low salinity (approximately 2 ppt; CLA-EMD 1999) through a submarine outfall near Pier 400, in the vicinity of Station LA1. No substantial depression in salinity values were measured at Station LA1 (values ranged from 33.06 to 33.73). Because the wastewater plume is positively buoyant and no substantial deviation in salinity was observed at Station LA1, it is unlikely that this discharge source would account for low salinity in bottom waters at Stations LA11 and LB12. The source(s) of the lower salinity bottom water is unknown.

Salinities of surface waters at Station LA14 (Los Angeles Consolidated Slip) and, to a less extent, Station LA6 (Los Angles East Basin) were consistently lower than those of surface waters from adjacent areas (Table 2.4-4). This pattern probably reflects the influence of freshwater inputs from the Dominquez Channel, which flows into the Consolidated Slip area and East Basin of Los Angeles Harbor. Slightly lower salinity also occurred during January and November at several sites within the inner harbor (e.g., Stations LB4, LA5, LB13, and LB14), which may also reflect inputs from Dominquez Channel and/or stormwater runoff. Similarly, lower salinity values at Stations LB6 and LB8 (Pier J slip and Pier J entrance, respectively) may reflect freshwater influence from the Los Angeles River. Reduced salinities at these sites occurred primarily in surface waters, consistent with the presence of a lower density surface lens of brackish water, although mid-depth and bottom waters at a subset of sites also had lower salinities during November compared to corresponding annual mean values. Seasonal differences in salinity of surface, mid-depth, and bottom waters at other sites were minimal (less than 1 ppt).

2.4.4 Temperature

Water temperatures measured during the study were within the expected range for estuarine and near-coastal waters. Annual mean temperatures in surface, mid-depth, and bottom waters over all stations ranged from 16.3 to 18.9 degrees Celsius (°C), 15.3 to 18.3°C, and 14.3 to 17.6°C, respectively (Table 2.4-1). In general, the warmest water temperatures occurred during August, (ranging from 20.6 to 24.2°C in surface waters and 16.5 to 20.7°C in bottom waters), whereas the coldest temperatures occurred during May (ranging from 13.2 to 17.9°C in surface waters and 10.8 to 14.7°C in bottom waters) (Table 2.4-5).

Temperatures ranged up to 1°C higher at several inner harbor stations (LA5, LA6, LA14, LB4, LB14), stations in shallow water basins (LA8, LA7, LA10), the northern channel between Piers 300 and 400 (LA9), and a small slip (LB12) (Table 2.4-5). These minor temperature elevations were likely related to restricted mixing with waters from other portions of the harbor. Solar heating also was undoubtedly influential at the shallow water stations; the warmest temperatures occurred at within the Seaplane Anchorage (Station LA8) and the Pier 300 Shallow Water Habitat (Stations LA7A, B). The coldest temperatures occurred at deepwater open areas in Long Beach and Los Angeles Harbors, such as Stations LA1, LB7, and LB9.

Water temperatures at individual sites were nearly isothermal (i.e., uniform with depth; temperature differences less than 1°C) during January and November (Table 2.4-5). Relatively greater differences in temperatures of surface and bottom waters occurred in May and August. During May, maximum differences in surface and bottom water temperatures were approximately 4°C, whereas maximum differences up to 6°C occurred in August. However, rapid changes with depth, indicative of a strong thermocline, were not evident during May or August.

2.4.5 Transmissivity

Transmissivity (i.e., water clarity) values measured during this study generally were within ranges expected of coastal ports and harbors and lower than values more representative of open coastal waters. Annual mean values for light transmittance in surface, mid-depth, and bottom waters ranged from 42.3 to 70.7%, 37.9 to 68.9%, and 19.6 to 64.4%, respectively (Table 2.4-1). Typically, water clarity in bottom waters was relatively lower than that of surface and mid-depth waters. Lower transmissivity values associated with bottom waters likely are attributable to resuspension of bottom sediments due to natural processes such as currents or human activities, including dredging/disposal and propeller wash from large ships.

Consistently low transmissivity occurred throughout the water column at Station LA8 in the Seaplane Anchorage (Figure 2.3-3, Table 2.4-6). Low transmissivity values also consistently occurred in bottom waters of outer Long Beach Harbor (Station LB9) and Slip 1 in Long Beach East Basin (Station LB12). Low values occurred more sporadically in bottom waters from several other sites, including stations in the vicinity of dredging/disposal (Stations LA9 in the northern channel of Pier 400, Station LB3 in Long Beach West Basin, Stations LB2A and B in the Long Beach Shallow Water Habitat, and Station LA2 in the Cabrillo Shallow Water Habitat). Lower transmissivity also was recorded in the Pier J Slip (Stations LB6, LB8). Low bottom water transmissivity values appear to have been related to a combination of factors, including relatively high percentages (> 80%) of silt-clay in bottom sediments and/or proximity to recent dredging or disposal (Figures 2.3-1, 2.3-2, 2.3-3).

Water clarity was approximately 10% lower in the mid to upper water column at shallow water stations (annual average values of 56.5 and 58.1%, respectively) than at deepwater stations (annual average of 66.5 and 64.1%, respectively). Near the bottom, however, transmissivity values were similar between shallow (annual average of 43.4%) and deepwater (4.19%) stations. As expected, lower transmissivity extended more throughout the water column at shallow water stations than at deepwater stations.

Moderately low transmissivity values were recorded in the Pier 300 Shallow Water Habitat. Although not measured at the sampling stations, which had sandy sediments, there are very fine sediments east of the Shallow Water Habitat (MEC 2001 field observations) in the Pier 300 Basin. It is not known to what extent lower transmissivity values measured in the Pier 300 Shallow Water Habitat resulted from resuspension of the finer sediments under higher velocity flows and/or nearby dredging around Pier 400.

Seasonal patterns in transmissivity were not evident during the study. Thus, even though other water quality parameters, such as salinity, showed evidence of freshwater inputs from river discharges and/or stormwater runoff during winter, these inputs did not appear to influence the measured water clarity during 2000.

2.5 Circulation

The harbor complex is protected from incoming waves by the Federal Breakwater, which consists of three individual rubble-mound breakwater structures. In addition to protecting the harbor from waves, the Federal Breakwater reduces water exchange between the Ports and the rest of San Pedro Bay, hence, creating unique tidal circulation patterns.

In the last three decades, the Ports have undertaken a long-range development plan to increase the capacity of the harbors. For the Port of Los Angeles, the plan included construction of the Pier 400 landfill, transportation corridor, and related channel deepening projects. The Pier 400 transportation corridor essentially divided the Long Beach and Los Angeles Harbors into two halves, with the Port of Long Beach to the east and the Port of Los Angeles to the west. Water exchange between the east and west sides of the Pier 400 transportation corridor is maintained through a 300-ft opening adjacent to the Long Beach West Basin known as the transportation corridor gap or "causeway gap".

This section discusses changes to tidal circulation within the harbor complex resulting from construction of the Pier 400 landfill and transportation corridor. The effects of changes in tidal circulation to water quality also are discussed.

Available Information

Since the 1980s, the U.S. Army Corps of Engineers, Waterways Experiment Station (WES) has conducted a series of studies to model the impact of Pier 400 and Pier 300 expansion on tidal circulation and water quality within the harbor complex. The studies involved the use of two-dimensional (2-D) and three-dimensional (3-D) numerical hydrodynamic models, supplemented by physical model tests. Results of the tidal circulation models were then used as input for water quality modeling to address the effects of changing tidal circulation on water quality in the harbor complex.

In addition to the numerical and physical model studies, WES collected tidal and current field data at various times throughout the harbor complex. The main objective of these field data collection efforts was to provide the information needed to calibrate the numerical hydrodynamic models, instead of providing long-term monitoring of the prototype (field) conditions. Recent WES studies are briefly described below, and key findings are summarized in the following sections.

Seabergh and Outlaw (1984) conducted a numerical model study, using a 2-D, depth-averaged hydrodynamic model, to determine the effect of the proposed Pier 400 on tidal circulation in the harbor complex. Because of changes to the development plan and advances in numerical modeling technology, the study by Seabergh & Outlaw (1984) was later updated (Seabergh et al. 1994, Wang et al. 1995, and Hall 1995) as part of the Los Angeles and Long Beach Harbor Model Enhancement Program.

The study by Seabergh et al. (1994) examined the effect of wind on circulation in the Harbors with a 3-D hydrodynamic model instead of the 2-D model used in the earlier study (Seabergh and Outlaw 1984). The study by Wang et al. (1995) used the 3-D hydrodynamic model representing an updated development plan that was closer to the as-built Pier 400 landfill than earlier model configurations. Hall (1995) then used the hydrodynamic model results as input to a water quality model to evaluate changes in water quality in the harbors resulting from the changes in tidal circulation. The focus of the water quality modeling study was to compare flushing and DO concentrations in the harbors with and without Pier 400. The numerical water quality model (WQM) used for Hall's study was developed for the Los Angeles and Long Beach Harbors Model Enhancement Program (Hall 1990).

Tide and current field data were also collected during varying intervals between June 10, 1987 and October 14, 1987 for the Los Angeles and Long Beach Harbors Model Enhancement Program. The data were collected for the purpose of providing adequate information to calibrate the 3-D hydrodynamic model. Results of the data collection program were summarized in McGehee et al. (1989).

The alignment of the transportation corridor used in studies by Wang et al. (1995) and Hall (1995) was slightly different from the as-built condition. For example, these studies modeled a gap opening of 800 ft near the south end of the transportation corridor near Pier 400, which was different from the as-built condition. The as-built transportation corridor gap is 300 ft wide and it is located near the north end of the transportation corridor adjacent to the Long Beach West Basin. Subsequently, Miller et al. (1998) modified the 3-D model used by Wang et al. (1995) to model tidal conditions in the harbors with the as-built conditions of Pier 400. The Miller et al. study analyzed the impact of an open and closed transportation corridor gap to tidal circulation and water quality in the Harbors. Field measurements were also conducted over a 25-hr period on December 13-14, 1997 to provide additional data for model verification because the previous field data were collected in 1987, prior to harbor modifications.

Most recently, Bunch et al. (2000) used the 3-D model to evaluate three different proposed Pier 300 expansion configurations on water quality within the Pier 300 Shallow Water Habitat. The model used by Miller et al. (1998) was used, however, the grid was modified to depict the proposed Pier 300 expansion configurations within the model.

Model tests, to ensure model accuracy was not degraded by modifying the grid, showed negligible changes to water surface-elevation and water velocity within the study area. Results of this study indicated no detrimental impacts to water quality (as modeled with DO concentrations) with different Pier 300 expansion configurations that included different scenarios with either a 40-ft or 80-ft wide fill condition with deepened main channel, the causeway gap open or closed, and groin in the present or removed

The effects of Pier 400 on tidal circulation and subsequent water quality in the harbors are discussed below. The discussions are based on the 3-D hydrodynamic numerical modeling studies described above. The numerical models were calibrated and verified with field data prior to application to the harbor complex. In general, the 3-D hydrodynamic model provided excellent predictions of water surface elevations and fairly good predictions of tidal currents throughout the harbor complex when compared with field data.

Effect of Pier 400 on Tidal Circulation

The studies by Seabergh & Outlaw (1984) and Wang et al. (1995) showed that, in general, neither the original development plan or Pier 400 with its transportation corridor are having a significant impact to water surface elevations in the harbors. However, the original development plan and Pier 400 does affect tidal circulation in the harbors, especially near Angel's Gate.

Wang et al. (1995) showed that even though the water surface rises and falls in a regular pattern, the associated tidal currents in and out of the harbors through the gaps between the breakwaters could be very different. Tidal currents that occur during rising tides are called flood currents and the tidal currents that occur during falling tides are called ebb currents. Prior to the construction of Pier 400, flood currents entered the harbor through Angel's Gate as a confined jet. During ebb tide, flow in the harbor was drawn from all directions as a potential flow toward the exit. The difference in flood and ebb flows through Angel's Gate resulted in a stronger flood current than the ebb current. The overall flow patterns during typical flood and ebb tide conditions in the harbor complex before construction of Pier 400 are shown in Figure 2.5-1 (a and b, respectively; Angel's Gate at bottom of each figure). The calculated flood and ebb currents shown in Figure 2.5-1 represent flows in the surface layer. In general, flood and ebb currents in bottom layers show the same flow patterns as the surface flows but with lower velocities.

The major impact of the Pier 400 landfill to tidal circulation in the harbors is the blocking of the north to south flow through Angel's Gate. This blocking effect causes a reduction in flow velocity through Angel's Gate. During flood tide, instead of forming a jet flow, the flood current is forced to go around the structure and conform to the shape of the Pier 400 landfill. Typical flood and ebb current patterns in the harbors with Pier 400 in place are shown in Figure 2.5-2 (a and b, respectively; Angel's Gate at bottom of each figure).

Changes in flow velocity resulting from Pier 400 construction under the simulation conditions described in Wang et al. (1995) are shown in Table 2.5-1. During the simulation period, the maximum tidal range was about 4.5 ft. As shown in Table 2.5-1, construction of Pier 400 was predicted to reduce the tidal currents through Angel's Gate and within the harbors.

The flushing and water quality study by Hall (1995) consisted of introducing conservative tracers at different locations throughout the harbors to observe the movement and dilution of the tracer. The results indicated that construction of Pier 400 would inhibit flushing to the west side of the Los Angeles Outer Harbor because of reductions in tidal currents. Reductions in flushing, however, do not have significant impacts on water quality. Specifically, simulated DO concentrations throughout the harbor complex are nearly equivalent with or without Pier 400. The maximum DO difference occurs at the west side of outer Los Angeles Harbor, consistent with the flushing study, which showed that flushing there is inhibited by Pier 400. However, the difference in DO concentrations prior to and after construction of Pier 400 is small. Hall (1995) concluded that the simulated DO concentration with Pier 400 is sufficient to maintain existing aquatic biota. Results of the Year 2000 Baseline Study did not observe any depressions in dissolved oxygen concentrations near Pier 400 or in the Pier 300 Shallow Water Habitat outside the range observed elsewhere in the harbor.

Results from the study by Miller et al. (1998) were similar to those of Wang et al. (1995), and they confirmed that construction of the Pier 400 would have insignificant impacts on water surface elevations in the harbors. Furthermore, the model results showed that currents through the causeway gap are quickly dampened and not observable near Long Beach West Basin, but are elevated within the Pier 300 Shallow Water Habitat.

2.6 Summary of Spatial and Temporal Variations

The following sections summarize spatial and temporal patterns in sediment grain size and water quality characteristics observed during this study.

Sediment Grain Size

As mentioned in Section 2.3, sediment textures varied throughout the study area, but they did not exhibit any obvious gradients or consistent patterns relative to habitat type. Furthermore, there was no apparent relationship between grain size (proportions of fines) and dates of the last dredging activities for individual sampling locations. Previous studies (e.g., MEC 1988) reported spatial trends in sediment texture within portions of the Port of Los Angeles. These patterns consisted of increasing proportions of coarse sediments with increasing bottom depths. Similar relationships over the entire harbor complex were not observed during the present study.

Water Quality

In general, water quality characteristics within the harbor complex did not exhibit large spatial or seasonal trends. Variability for individual water quality parameters within habitat types typically was comparable to variability among habitat types.

DO concentrations slightly decreased with increasing depth, and generally ranged between 5 and 8 mg/l. Slightly lower DO concentrations occurred during spring and summer than winter in bottom waters of deeper areas, possibly due to reduced vertical mixing during summer or movement of recently upwelled waters into the harbor.

The dominant patterns in salinity were related to slightly lower values during winter in surface waters at sites influenced by freshwater inputs from Dominguez Channel and, to a lesser extent, Los Angeles River. Additionally, slightly lower salinities occurred sporadically in bottom waters at two sites during the four quarterly surveys; however, the source(s) for these lower salinity conditions was not apparent. Despite evidence of freshwater inputs to portions of the harbor complex during winter, water clarity (transmissivity) did not exhibit obvious seasonal patterns. Water clarity generally decreased with depth, and relatively low bottom water transmissivity values appear to have been related to a combination of factors, including relatively high percentages (> 80%) of silt-clay in bottom sediments and/or proximity to recent dredging or disposal (Figures 2.3-1, 2.3-2, 2.3-3).

Values of pH did not exhibit appreciable spatial patterns. Values during August and November were generally higher than those occurring during January and April, which may reflect seasonal differences in primary productivity.

Water temperatures exhibited expected seasonal trends, with slightly warmer conditions in summer than in winter. Also, inner harbor and other channel, basin, and slip areas with restricted circulation generally had slightly warmer temperatures than deeper, open areas of the harbor, reflecting effects of solar heating and limited mixing with colder water masses.

2.7 Historical Comparisons

Sediment and water quality conditions within the harbors have changed dramatically over the past several decades (Anderson et al. 1993). Construction of channels and slips altered circulation patterns, as well as the location and magnitude of freshwater inputs which, in turn, altered the composition and quality of harbor waters. In particular, dredging and construction of new piers and slips within the harbor complex changed flow patterns, mixing and residence times of water masses, and rates and distributions of sediment accumulation within harbor channels and basins. Additionally, industrial and municipal wastes and stormwaters were previously discharged from up to 235 outfalls directly to the harbor, leading to the overall degradation of water quality conditions.

Changes within the harbor complex in water quality are exemplified by trends in DO concentrations. In the mid-1950s, waters in some of the slips or basins with restricted circulation were anoxic (i.e., did not contain measurable DO concentrations), while waters from areas with relatively greater circulation contained DO concentrations from approximately 3 to 3.5 mg/liter (Anderson et al. 1993). Following restrictions on discharges of oil refinery wastes in 1970, DO concentrations in harbor waters generally increased to levels from 3.8 to 5.2 mg/liter. However, Soule and Oguri (HEP 1976) measured DO concentrations as low as 1.8 mg/liter in bottom waters at the entrance to Fish Harbor, less than 1 mg/liter in the West Basin, and non-detectable levels in bottom waters of outer Fish Harbor during the early 1970s (refer to Figure 1.1-2 for locations). By 1978, DO concentrations in waters within the inner harbor were consistently above 3.5 mg/liter, while levels below 5 mg/liter occurred most frequently in the Los Angeles Inner Harbor and at the mouth of the Dominguez Channel (HEP 1980). In contrast, recent (1996 through 1998) compliance monitoring for the TITP discharge, in the vicinity of Pier 400, has shown that DO concentrations inside the harbor breakwater were consistently above 5 mg/liter (CLA-EMD 1997, 1998, 1999). As noted in Section 2.4, most of the DO concentrations measured throughout the harbors during the present study also were greater than 5 mg/liter. These long-term trends in DO concentrations reflect improvements in water quality over the past several decades associated with reduced loadings of oxygen consuming wastes.

Values for other water quality parameters, such as temperature, salinity, and pH, measured during the present study were generally consistent with results from previous studies of the harbor complex. These parameters primarily reflect mixing and exchange between freshwater inputs and ocean waters, and are not as sensitive as DO levels to anthropogenic influences. MBC (1984) and MEC (1988) observed gradients in increasing salinity and decreasing temperatures with increasing water depths in portions of Long Beach Harbor/Queensway Bay and Los Angeles Harbor, respectively. In the present study, seasonal reductions in surface water salinity may have been related to freshwater inputs from the Dominguez Channel and Los Angeles River. Temperature-depth gradients were observed in spring and summer, whereas, temperatures were nearly isothermal during fall and winter. The warmest temperatures were measured at shallow water stations in basins probably as a result of solar heating and restricted mixing.

Previous studies noted trends in water quality parameters between inner and outer harbor areas. Soule and Oguri (HEP 1980) reported relatively higher water temperatures, lower DO, and lower pH conditions within inner portions of the harbor compared with conditions in the outer harbor. They attributed these differences to the effects of thermal discharges from electrical generating plants, oil field brine discharges, and other waste discharges to inner harbor waters. In the present study, temperatures generally ranged up to 1^{o}C higher in the inner harbor relative to the outer harbor; however, no other inner versus outer harbor differences in water quality were observed. The slightly warmer temperatures measured in the inner harbor were similar to those measured in shallow water basins, small slips, and the north channel between Piers 300 and 400. Thus, the minor temperature differences observed in 2000 were likely attributed to slightly reduced circulation and mixing, and additionally solar heating in some cases, rather than discharges as in the past.

Water clarity or transmissivity patterns reflect natural processes, including algal (phytoplankton) abundances, river discharges, and sediment resuspension associated with storm wave conditions, as well as human activities such as dredging and propeller wash from large ships. During the present study, water clarity decreased with increasing depth and was relatively lower in bottom waters at stations with fine sediments and/or in the vicinity of dredging and/or disposal.

While results of the present study indicate a continued trend of water quality improvement in the harbors since the 1970s, comparisons with past and future studies should also consider large scale oceanographic and meteorological conditions. In particular, El Niño/La Niña cycles are large-scale events coupled to ocean-atmosphere phenomenon that cause global climate variability over periods of several years (NOAA 2001a). These events can have substantial effects on circulation and currents, upwelling/downwelling, precipitation, river and stormwater discharges and runoff, and water quality, as well as the composition and abundance of biological communities. A summary of climatic patterns, associated with El Niño/La Niña cycles, is presented in Table 2.7-1. The duration and magnitude of the seven strongest La Niña events since 1949 are illustrated in Figure 2.7-1. This figure plots index values that are computed using six variables: sea-level pressure, zonal and meridional components of surface winds, sea surface temperatures, surface air temperature, and total cloudiness fraction of the sky, over the tropical Pacific Ocean. Standardized departure represents the deviation from normal conditions (e.g., values ≤ -1.2 for La Niña conditions). Index values for individual events cover periods of three years.

As shown in Figure 2.7-1, a weak to moderate La Niña event, began in mid-1998 and persisted through early 2000. This event had substantial effects on coastal water quality, including decreased water temperatures and rainfall runoff (Pacific States Marine Fisheries Commission 1999). By about March 2000, essentially normal conditions were re-established and continued through the end of the calendar year. This La Niña cycle followed a strong El Niño event that caused substantially increased water temperatures and rainfall during 1997-1998. On average, rainfall associated with El Niño events are 127 to 140% of normal in southern California.

Other recent El Niño events occurred during 1992, 1987, 1983, and 1973 (NOAA 2001b). Historical studies conducted since the 1970s have occurred during different oceanographic conditions. The 1973-1974 (HEP 1976) and 1984 (MBC 1984) studies followed El Niño conditions; the 1978 (HEP 1980) and 1994 and 1996 (SAIC and MEC 1997) studies were conducted during “normal” years; the 1986-1987 (MEC 1988) study was mostly performed prior to the onset of El Niño; and the annual monitoring studies (CLA-EMD 1994, 1995, 1996, 1997, 1998, 1999, 2000) of the TITP discharge have surveyed a variety of oceanographic conditions since the monitoring began in 1993, including periods before, during, and following El Niño/La Niña cycles.

2.8 Summary

Water quality measurements for this study were generally consistent with expected values for near-coastal and harbor environments, and indicated minimal spatial and temporal trends within the harbor complex. Results of the present study indicate a continued trend of water quality improvement in the harbors since the 1970s. DO

concentrations in this study exceeded 5 mg/l during fall and winter, and mainly exceeded 4 mg/l in spring and summer. Episodic and localized changes in some parameters, such as low dissolved oxygen concentrations coinciding with low transmissivity, suggested minor effects possibly associated with sediment resuspension events and dredging. Lower transmissivity values were recorded near Pier 400, Long Beach West Basin, and Cabrillo Shallow Water Habitat which were likely attributable to dredging or disposal in the vicinity. Minor elevations in temperature occurred within the inner harbor and at stations within shallow water basins, channels, and slips with restricted circulation.
Slightly reduced salinities in surface waters at a subset of the monitoring sites reflected freshwater inputs; however, the magnitude of this effect was spatially and temporally limited.

Changes to tidal circulation as a result of construction of Pier 400 mainly involve a blocking of north to south flow through Angel's Gate, which reduces flow velocity into the harbor. The flow under flood current is forced to go around the structure to the east and west. Model studies indicate that reduced flushing does not have significant impacts on water quality, specifically dissolved oxygen. Results of the Year 2000 Baseline Study did not observe any depressions in dissolved oxygen concentrations near Pier 400 or in the Pier 300 Shallow Water Habitat outside the range observed elsewhere in the harbor.

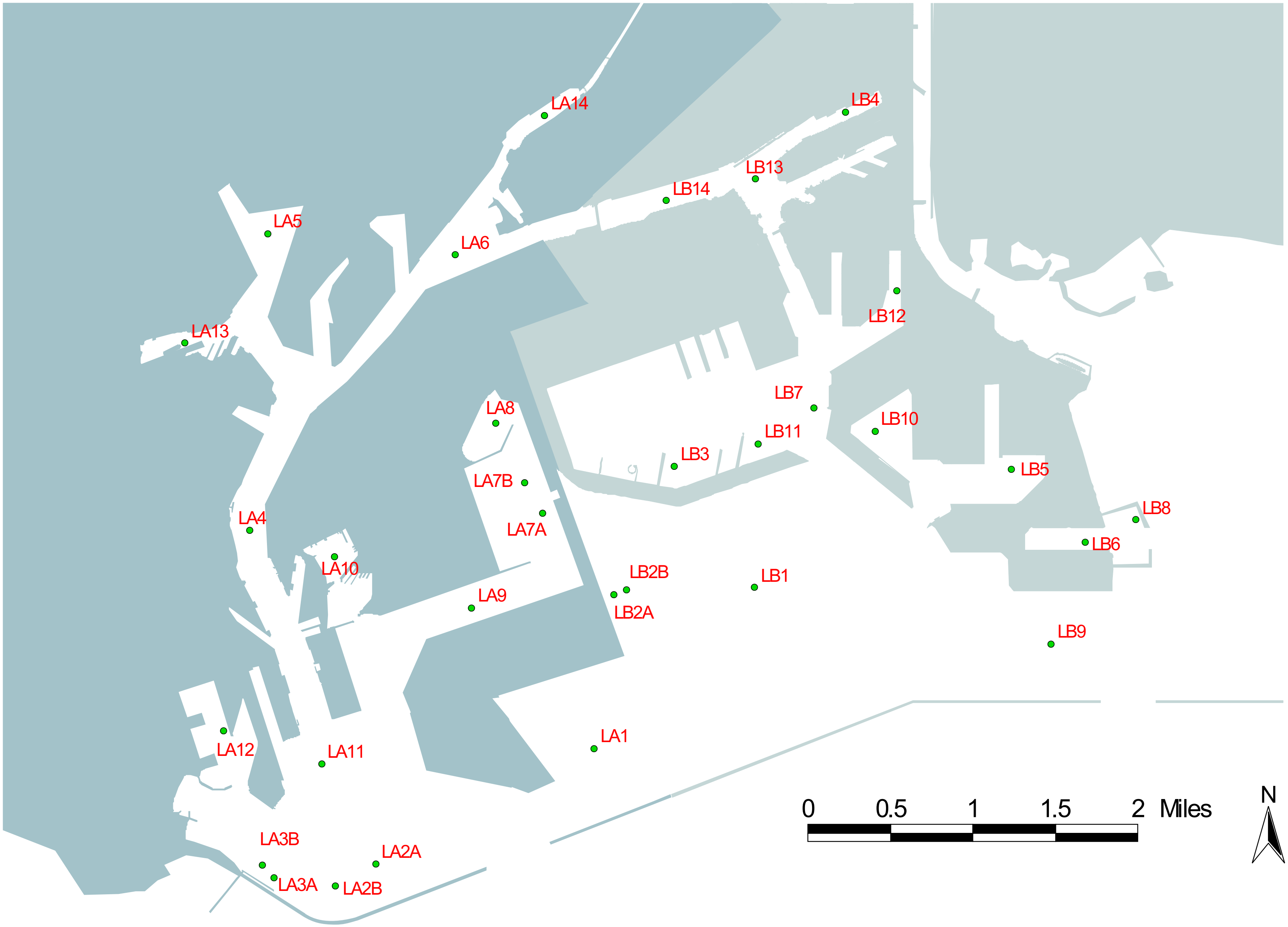


Figure 2.2-1. Benthic and water quality stations in Long Beach and Los Angeles Harbors, January - November 2000.

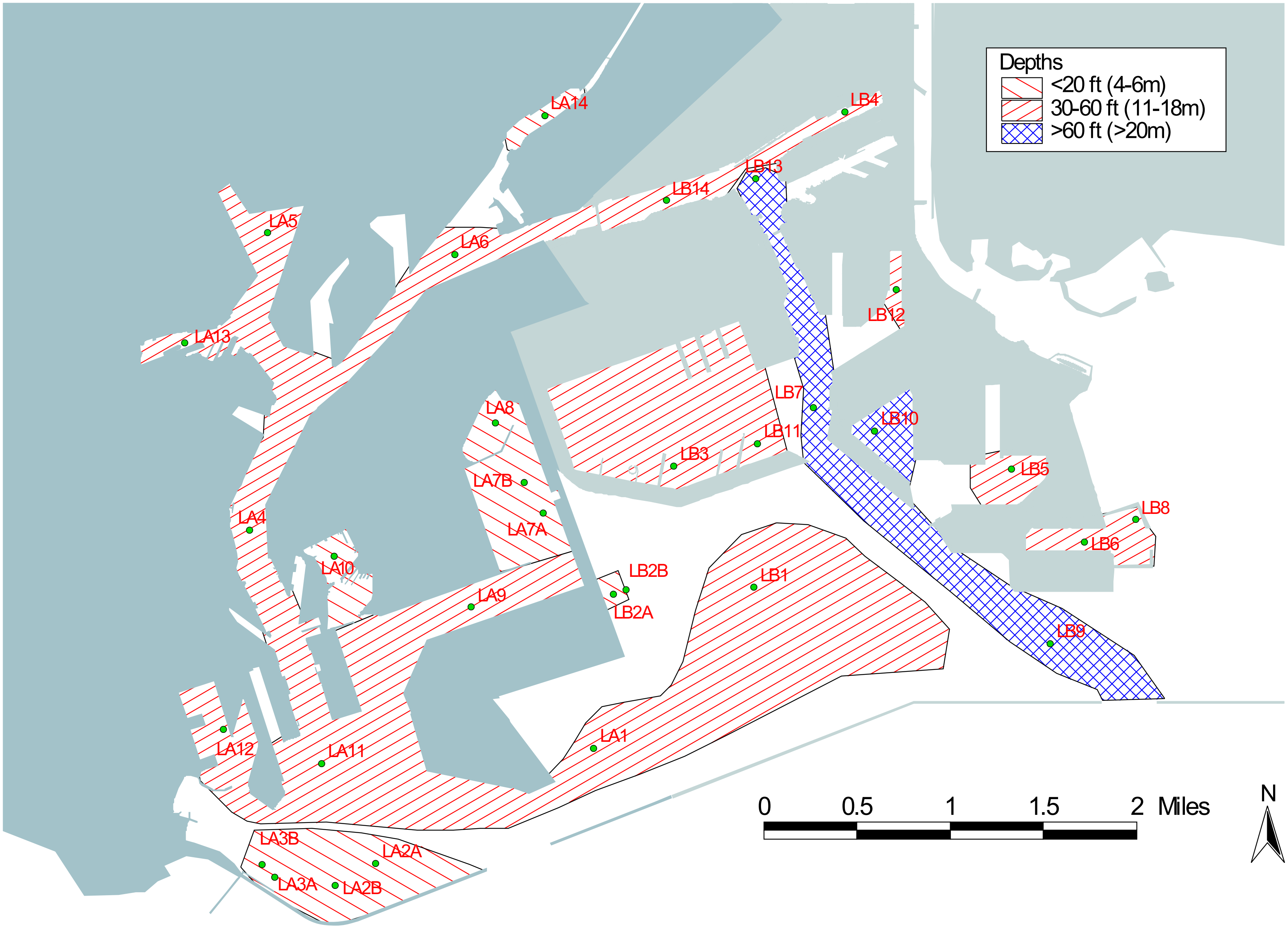


Figure 2.2-2. Mean water depth of benthic and water quality stations in Long Beach and Los Angeles Harbors, January - November 2000.

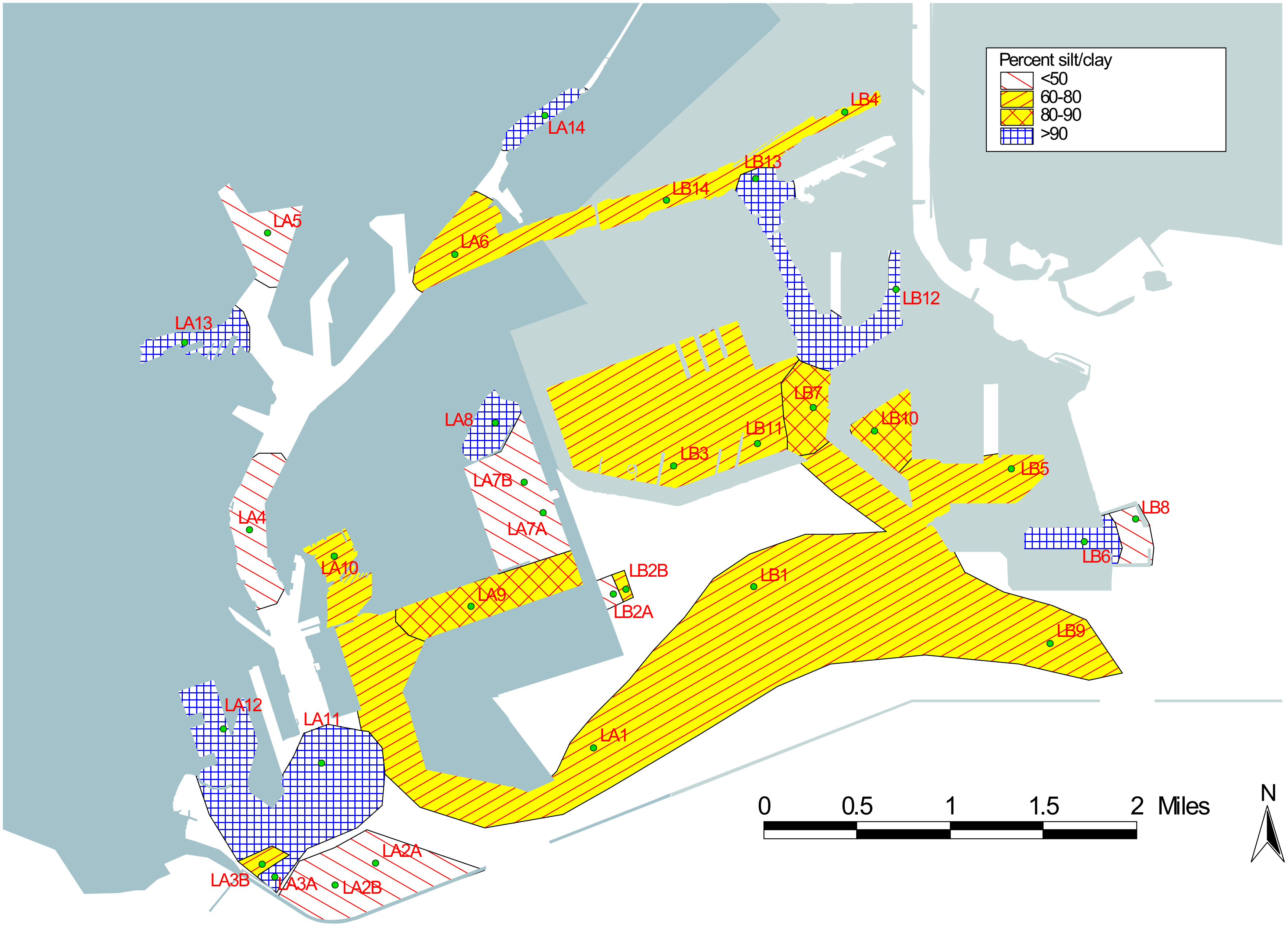


Figure 2.3-1. Percentage of silt/clay in sediments sampled in Long Beach and Los Angeles Harbors, January 2000.

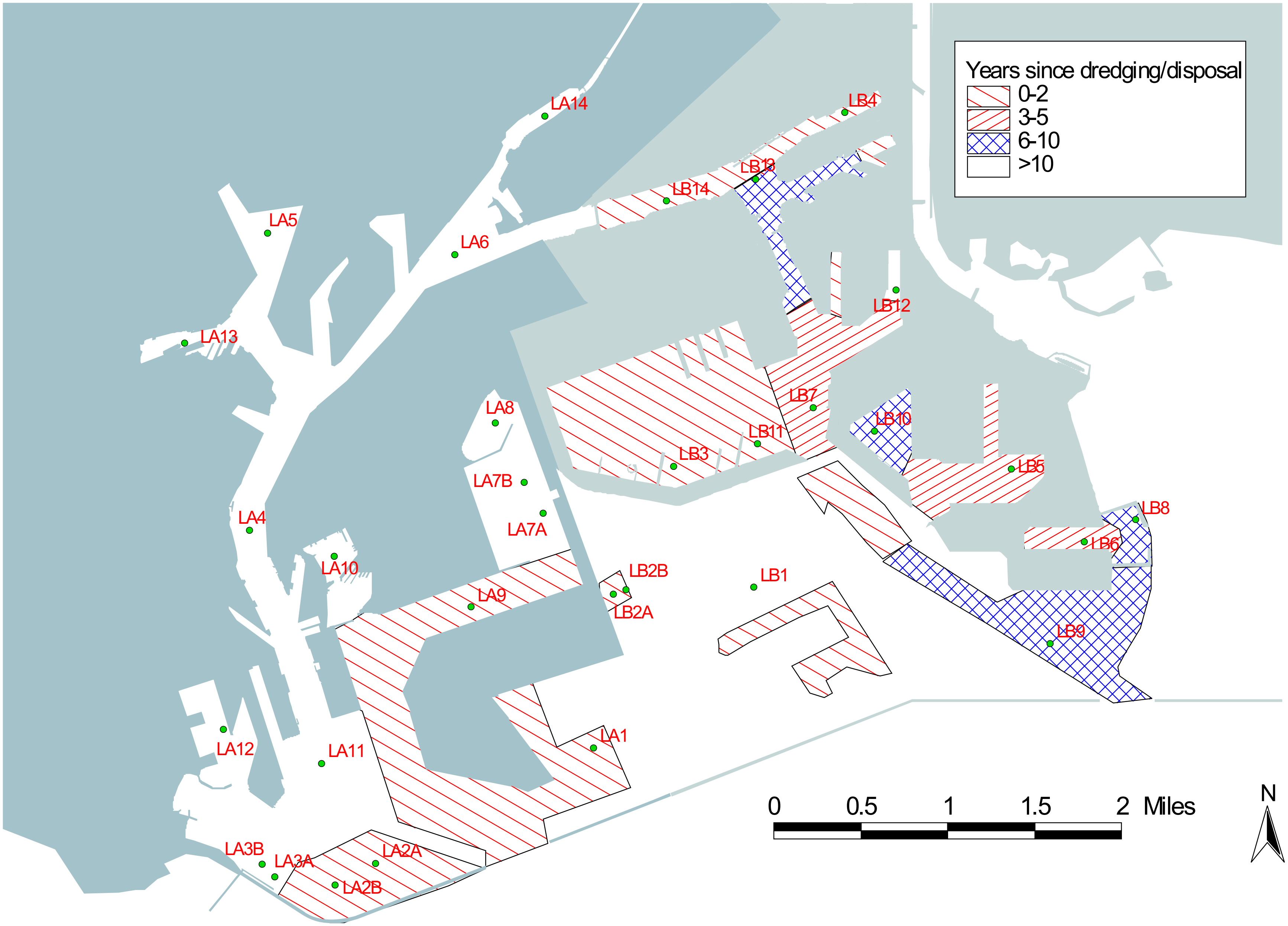


Figure 2.3-2. Comparison of Year 2000 sampling locations with years since dredging and disposal in Long Beach and Los Angeles Harbors.

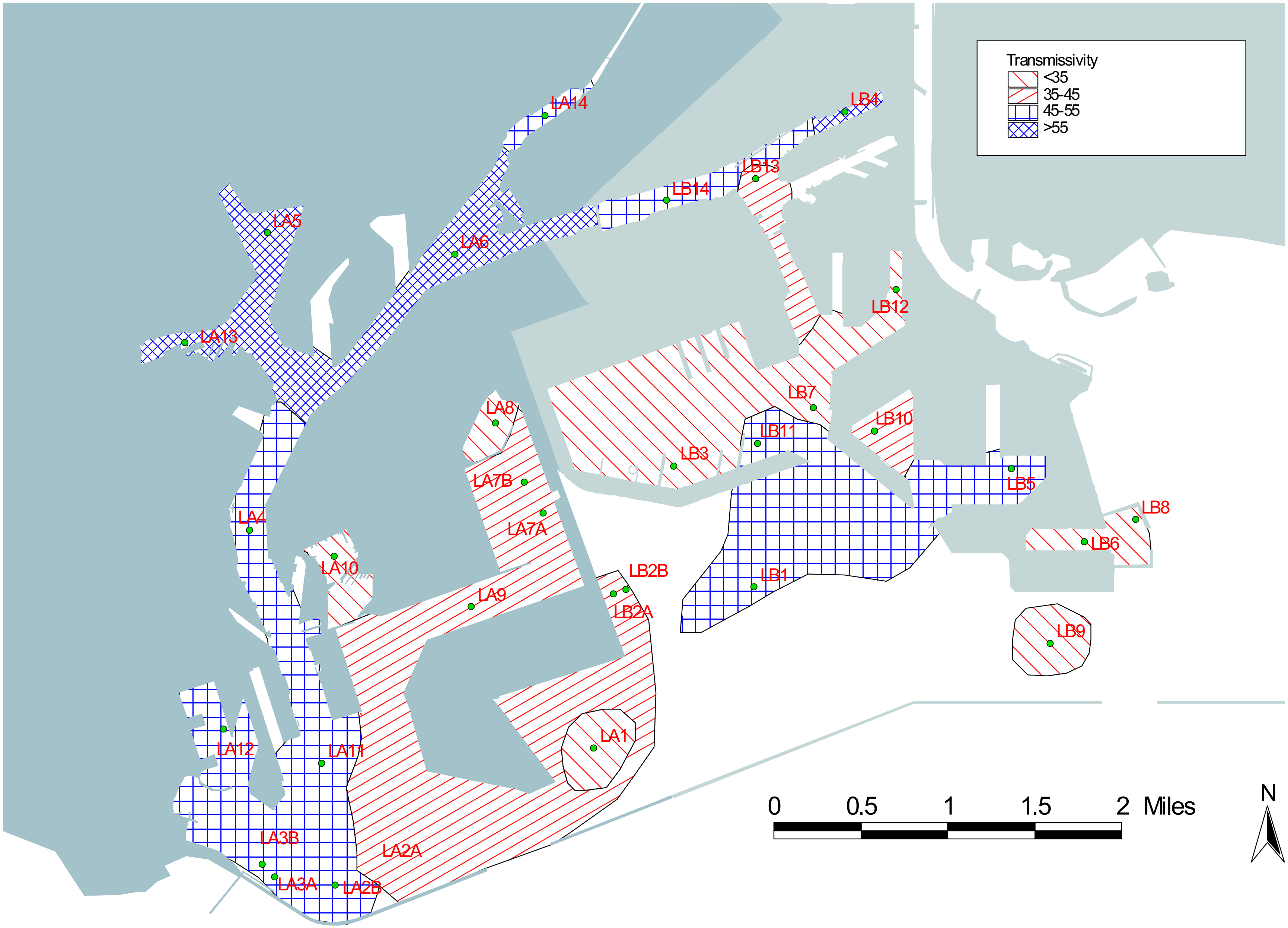
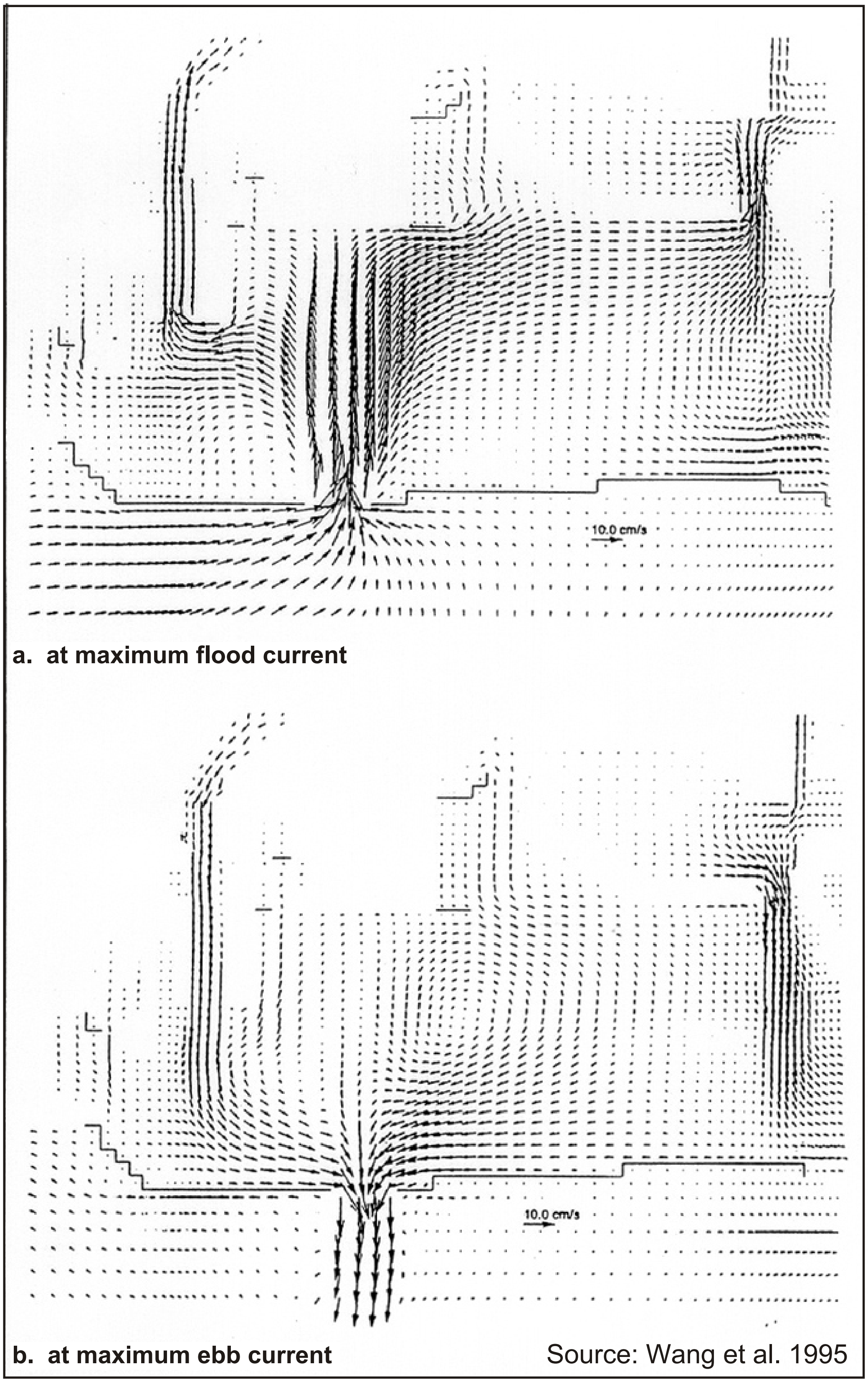


Figure 2.3-3. Mean transmissivity values in bottom waters of Long Beach and Los Angeles Harbors, January - November 2000.



a. at maximum flood current

b. at maximum ebb current

Source: Wang et al. 1995

Figure 2.5-1. Surface layer circulation prior to construction of Pier 400.

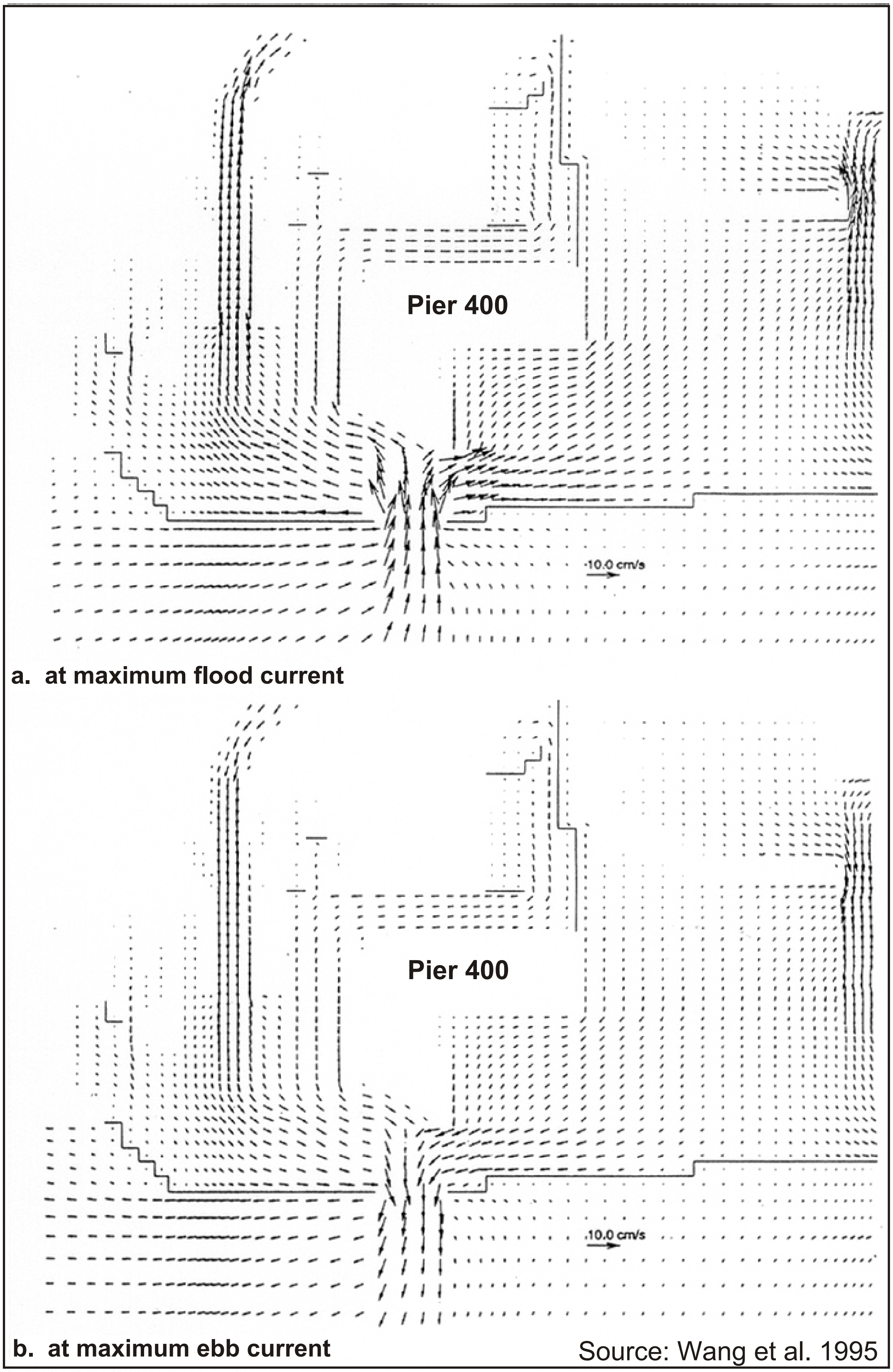
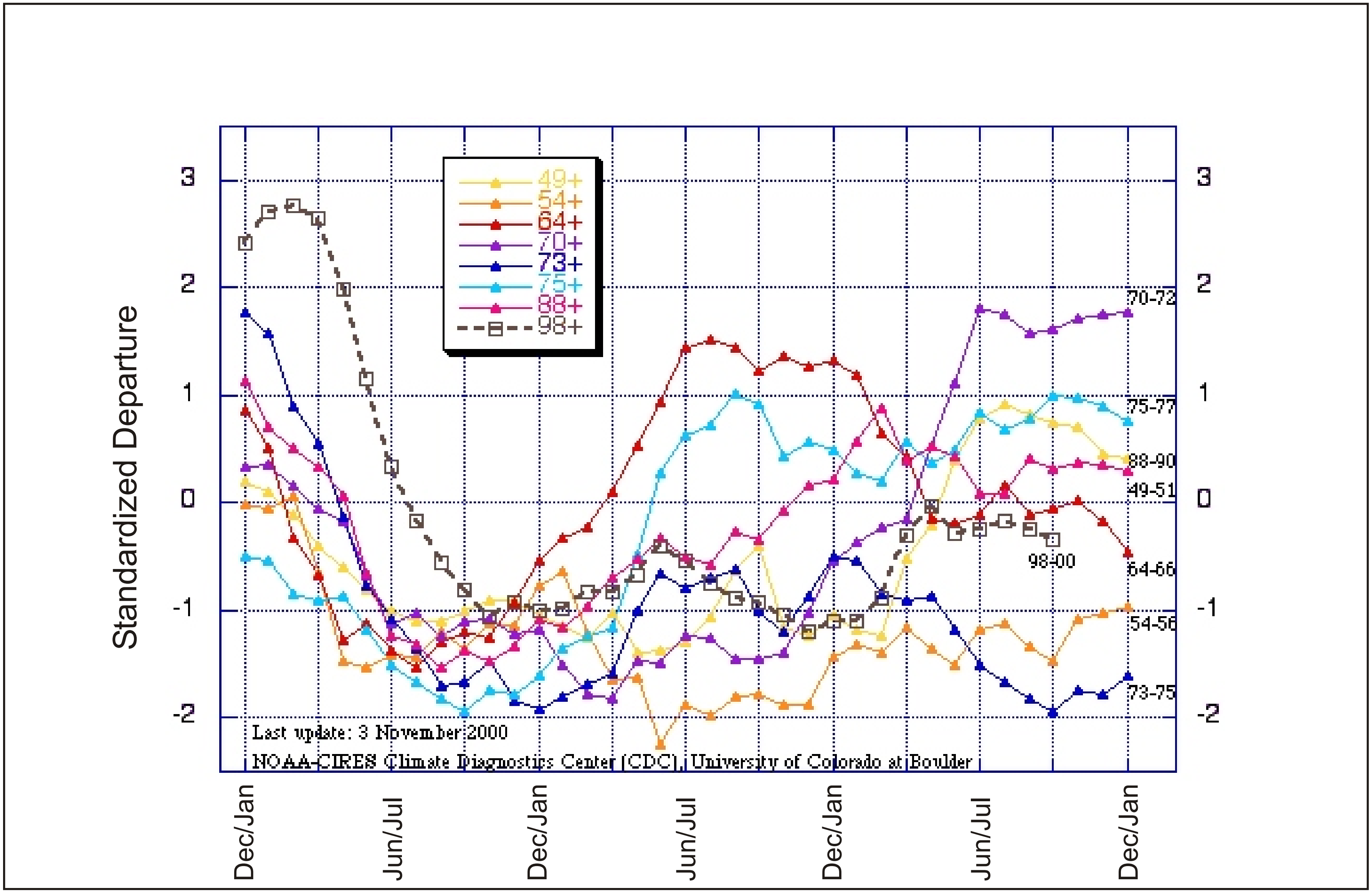


Figure 2.5-2. Surface layer circulation with Pier 400.



Note: La Niña indicated by standardized departure values of ≤ 1.2

Figure 2.7-1. Multivariate ENSO (El Niño-Southern Oscillation) index for the seven strongest La Niña events since 1949, as compared to 1998-2000 conditions.

Table 2.2-1. Survey schedule and conditions for water quality sampling in Long Beach and Los Angeles Harbors, January – November 2000.

Date	Season	Sampling Time	Weather Conditions	Notable Observations
31-Jan-00	Winter	0710-2142	Rain then clearing, light-moderate wind	West Basin Pier 400 project ongoing.
15-May-00	Spring	0740-1730	Overcast to clear, calm-moderate wind	West Basin Pier 400 project ongoing.
16-May-00	Spring	0650-1415	Clear, moderate wind	West Basin Pier 400 project ongoing.
22-Aug-00	Summer	0710-1130	Overcast, calm wind	West Basin Pier 400 project ongoing.
06-Nov-00	Fall	0615-1645	Partly cloudy, light wind	West Basin Pier 400 project ongoing.

Table 2.3-1. Sediment grain size characteristics in Long Beach and Los Angeles Harbors, January 2000.

Habitat / Station	Depth (m)	Median size (phi)	Median size (microns)	Dispersion	Skewness	% Gravel	% Sand	% Silt	% Clay	% Coarse	% Fines (Silt + Clay)	Mean (phi)	Mean (microns)
Deepwater Open													
LA1	13	5.945	16.234	3.030	0.136	0.000	29.412	44.674	25.915	0.018	70.588	6.356	12.208
LA11	16	7.645	4.997	2.424	0.010	0.000	7.298	48.737	43.965	0.032	92.702	7.668	4.916
LB1	12	4.691	38.713	1.598	0.408	0.000	24.121	64.547	11.332	0.030	75.879	5.343	24.638
LB9	25	4.776	36.498	2.138	0.392	0.000	35.773	49.983	14.244	0.042	64.227	5.614	20.414
Deepwater Channel													
LA4	16	2.511	175.450	2.471	0.598	0.265	75.071	13.788	10.876	0.885	24.664	3.989	62.965
LA9	16	7.066	7.464	2.863	-0.068	0.000	15.958	51.553	32.489	0.056	84.042	6.872	8.539
LB7	24	6.946	8.111	2.693	0.060	0.000	10.651	53.770	35.579	0.030	89.349	7.106	7.257
LB13	20	7.167	6.956	2.336	0.162	1.042	5.068	55.194	38.696	1.288	93.891	7.547	5.347
LB14	18	5.900	16.744	2.979	0.284	0.000	19.880	52.356	27.765	0.013	80.120	6.745	9.323
Deepwater Basin													
LA5	17	3.297	101.716	2.894	0.689	0.049	63.097	20.340	16.514	0.120	36.854	5.290	25.552
LA6	16	4.938	32.611	2.459	0.029	5.096	23.226	57.825	13.853	11.163	71.678	5.009	31.062
LA12	11	8.349	3.066	2.542	0.163	0.000	0.747	45.235	54.017	0.216	99.253	8.764	2.300
LB3	15	6.111	14.465	2.921	0.156	0.000	25.432	46.985	27.583	0.026	74.568	6.568	10.542
LB5	15	5.495	22.181	2.738	0.296	0.021	24.356	53.087	22.535	0.115	75.622	6.304	12.654
LB10	21	6.854	8.643	3.130	0.076	0.000	16.672	47.880	35.448	0.031	83.328	7.091	7.333
LB11	15	5.510	21.948	2.658	0.320	0.000	23.036	55.843	21.122	0.022	76.964	6.360	12.173
Deepwater Slip													
LA13	11	7.477	5.614	3.121	0.201	0.000	6.491	49.551	43.958	0.010	93.509	8.106	3.630
LB4	15	5.007	31.098	3.169	0.378	0.059	30.850	44.921	24.171	0.795	69.092	6.206	13.548
LB6	17	6.830	8.791	2.491	0.238	0.000	6.258	58.327	35.415	0.037	93.742	7.422	5.832
LB8	15	3.197	109.033	0.773	-0.064	0.642	86.579	9.308	3.471	0.814	12.779	3.148	112.809
LB12	16	8.056	3.756	2.249	0.195	0.000	0.553	48.732	50.714	0.000	99.447	8.494	2.773
Shallow Mitigation													
LA2A	4	3.900	66.974	1.864	0.282	0.000	52.801	36.443	10.756	0.270	47.199	4.427	46.503
LA2B	4	3.089	117.524	1.577	0.351	0.017	72.491	19.365	8.128	0.241	27.493	3.643	80.069
LA7A	4	2.985	126.325	1.608	0.419	0.359	78.523	12.363	8.755	1.266	21.118	3.659	79.187
LA7B	4	4.030	61.220	2.763	0.534	0.084	49.643	32.958	17.314	0.177	50.272	5.505	22.020
LB2A	4	3.488	89.121	0.788	0.192	0.043	80.136	15.210	4.611	0.124	19.822	3.639	80.262
LB2B	4	4.651	39.791	1.897	0.387	0.000	36.956	51.206	11.837	0.065	63.044	5.386	23.916
Shallow Water Open													
LA3A	4	5.901	16.731	2.615	0.346	0.838	11.327	61.614	26.221	1.010	87.835	6.805	8.942
LA3B	4	6.129	14.293	2.487	0.328	0.000	7.865	66.392	25.743	0.123	92.135	6.944	8.122
Shallow Water Channel													
LA14	6	6.304	12.655	2.439	0.369	0.000	8.534	65.755	25.711	0.274	91.466	7.203	6.786
Shallow Water Basin													
LA8	4	7.088	7.352	2.412	0.215	0.016	5.067	56.760	38.157	0.060	94.917	7.607	5.130
LA10	6	6.778	9.112	3.440	-0.115	0.000	30.063	37.163	32.774	0.068	69.937	6.383	11.985

Table 2.4-1. Mean values of water quality variables in Long Beach and Los Angeles Harbors, January – November 2000.

Habitat / Station	Depth (m)	Dissolved Oxygen (mg/L)			pH			Salinity (ppt)			Temperature (°C)			Transmissivity (%)		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Deepwater Open																
LA1	13	7.37	7.10	6.32	8.00	7.97	7.92	33.32	33.36	33.19	16.34	15.63	14.75	62.50	62.03	29.14
LA11	16	6.98	6.68	6.20	7.92	7.92	7.88	33.24	33.38	32.64	16.85	15.79	14.49	66.11	63.45	44.90
LB1	12	7.78	7.50	6.47	8.05	8.03	7.96	33.35	33.39	33.39	16.80	16.24	15.18	62.26	60.31	46.18
LB9	25	7.84	6.92	6.77	8.09	8.01	7.97	33.15	33.45	33.54	17.19	15.40	14.27	60.64	58.96	19.65
Deepwater Channel																
LA4	16	6.67	6.43	6.20	7.91	7.90	7.89	33.15	33.22	33.38	16.95	16.22	15.09	65.14	63.09	49.91
LA9	16	8.13	6.89	6.27	8.03	7.95	7.91	33.35	33.41	33.27	17.87	15.88	15.03	59.79	53.86	38.77
LB7	24	7.62	6.56	6.22	8.04	7.97	7.93	33.36	33.46	33.51	17.30	15.31	14.44	63.37	55.17	33.82
LB13	20	7.14	6.33	6.03	7.93	7.92	7.92	33.02	33.35	33.44	17.49	16.23	15.23	64.90	60.69	43.48
LB14	18	6.90	6.40	5.84	7.93	7.92	7.88	33.09	33.33	33.35	17.60	16.52	15.45	66.66	57.81	45.24
Deepwater Basin																
LA5	17	6.77	6.37	5.90	7.91	7.90	7.87	33.11	33.22	33.26	18.17	16.62	16.14	65.96	64.06	57.66
LA6	16	6.74	6.26	5.91	7.91	7.91	7.90	32.74	33.23	33.36	17.70	16.61	15.94	68.34	68.20	64.34
LA12	11	7.22	6.62	4.98	7.92	7.94	7.81	33.11	33.36	32.92	17.24	16.00	14.98	70.69	63.66	44.56
LB3	15	7.88	6.39	4.93	8.07	7.97	7.82	33.35	33.40	32.93	17.41	16.28	15.01	58.02	57.27	26.63
LB5	15	7.17	6.82	6.33	8.03	8.00	7.96	33.37	33.42	33.39	17.06	16.22	15.07	65.10	58.73	45.57
LB10	21	7.07	6.61	5.93	8.01	7.98	7.93	33.39	33.42	33.17	16.78	15.84	14.73	68.18	64.20	42.28
LB11	15	7.40	6.51	6.06	8.02	7.97	7.93	33.34	33.38	33.47	17.50	16.35	15.03	64.63	67.43	45.99
Deepwater Slip																
LA13	11	6.84	6.53	6.13	7.89	7.90	7.86	33.10	33.20	33.26	17.55	16.87	16.41	64.53	64.68	62.45
LB4	15	6.78	6.23	5.85	7.87	7.88	7.91	33.15	33.33	33.39	17.77	17.00	15.85	68.70	68.92	60.99
LB6	17	7.11	5.98	5.52	8.05	7.96	7.93	32.93	33.43	33.31	16.88	15.70	15.05	57.57	48.89	31.75
LB8	15	7.24	6.23	5.43	7.91	7.97	7.91	32.87	33.44	33.42	17.01	15.86	15.05	64.19	50.69	27.70
LB12	16	7.41	6.40	5.59	8.03	7.97	7.82	33.33	33.38	30.12	17.78	16.31	15.22	59.44	58.38	19.70
Shallow Mitigation																
LA2A	4	6.97	6.98	6.59	7.95	7.95	7.93	33.29	33.31	33.30	16.58	16.42	16.24	66.53	64.56	42.12
LA2B	4	7.01	6.90	6.61	7.95	7.94	7.93	33.28	33.31	33.33	16.60	16.41	16.31	62.30	63.74	50.94
LA7A	4	7.92	7.85	6.77	8.05	8.03	7.96	33.36	33.39	33.38	18.29	17.11	16.37	54.94	53.88	44.48
LA7B	4	7.53	7.48	7.04	8.02	8.02	7.99	33.37	33.39	33.38	18.32	17.71	16.95	50.46	50.41	39.41
LB2A	4	7.56	7.27	6.85	8.04	8.02	7.99	33.34	33.37	33.38	16.68	16.37	16.17	63.63	58.57	41.07
LB2B	4	7.55	7.21	6.78	8.04	8.02	7.99	33.34	33.37	33.39	16.70	16.38	16.17	61.43	56.90	37.03
Shallow Water Open																
LA3A	4	7.12	6.65	6.09	7.94	7.91	7.88	33.28	33.34	33.41	16.55	15.80	15.08	56.66	61.83	48.51
LA3B	4	7.05	6.58	6.31	7.94	7.91	7.90	33.29	33.34	33.13	16.57	15.69	15.15	60.13	59.64	54.93
Shallow Water Channel																
LA14	6	6.89	6.20	5.58	7.86	7.92	7.88	32.02	33.19	33.24	18.27	16.95	16.60	65.54	57.29	52.85
Shallow Water Basin																
LA8	4	6.86	6.68	5.97	7.97	7.95	7.91	33.37	33.37	33.17	18.89	18.34	17.64	42.34	37.86	22.35
LA10	6	6.90	6.68	5.73	7.95	7.92	7.85	33.35	33.38	33.04	17.85	16.99	16.08	55.72	56.38	49.82

Table 2.4-2. Dissolved oxygen concentrations by survey in Long Beach and Los Angeles Harbors, January – November 2000.

Habitat / Station	Depth (m)	January 2000			May 2000			August 2000			November 2000			Annual Mean		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Deepwater Open																
LA1	13	7.97	8.08	6.93	5.85	5.08	4.31	7.49	7.20	6.74	8.18	8.02	7.31	7.37	7.10	6.32
LA11	16	7.52	7.33	6.78	5.69	4.93	3.91	7.45	6.96	7.04	7.27	7.51	7.06	6.98	6.68	6.20
LB1	12	8.39	8.04	7.05	6.80	5.99	4.68	7.94	7.65	6.81	8.01	8.31	7.35	7.78	7.50	6.47
LB9	25	8.04	7.51	7.08	6.85	4.91	4.20	8.32	7.05	7.86	8.17	8.22	7.95	7.84	6.92	6.77
Deepwater Channel																
LA4	16	6.97	6.85	6.88	5.59	5.27	4.64	7.36	6.81	6.40	6.76	6.78	6.89	6.67	6.43	6.20
LA9	16	7.78	7.57	6.91	7.24	4.48	3.93	7.59	7.46	6.80	9.89	8.05	7.46	8.13	6.89	6.27
LB7	24	7.74	7.29	7.20	7.40	4.72	4.35	7.90	6.78	6.21	7.47	7.46	7.11	7.62	6.56	6.22
LB13	20	7.22	7.20	7.07	7.58	5.17	4.31	7.01	6.26	5.82	6.75	6.69	6.92	7.14	6.33	6.03
LB14	18	6.98	7.01	6.98	5.60	4.87	4.33	7.95	6.98	5.35	7.08	6.76	6.69	6.90	6.40	5.84
Deepwater Basin																
LA5	17	6.74	6.48	6.48	6.11	5.69	5.31	7.19	6.80	5.71	7.02	6.51	6.08	6.77	6.37	5.90
LA6	16	6.49	6.83	6.78	5.88	5.17	4.82	7.76	6.53	5.51	6.85	6.49	6.54	6.74	6.26	5.91
LA12	11	7.34	6.78	5.70	8.02	5.54	4.46	6.80	6.91	4.58	6.71	7.27	5.16	7.22	6.62	4.98
LB3	15	9.26	7.68	6.25	7.63	4.48	4.32	7.74	6.84	2.78	6.90	6.54	6.35	7.88	6.39	4.93
LB5	15	7.89	7.37	7.02	6.18	5.60	4.54	7.50	6.96	6.52	7.08	7.33	7.22	7.17	6.82	6.33
LB10	21	7.77	7.43	6.93	5.82	4.64	4.33	7.30	6.91	5.31	7.41	7.47	7.16	7.07	6.61	5.93
LB11	15	8.16	7.39	6.98	7.06	4.68	4.43	7.24	6.79	6.23	7.14	7.17	6.58	7.40	6.51	6.06
Deepwater Slip																
LA13	11	6.70	6.41	5.92	6.88	5.91	5.54	7.27	7.23	6.70	6.50	6.56	6.37	6.84	6.53	6.13
LB4	15	7.09	6.57	6.72	6.17	5.53	4.53	6.86	6.43	5.68	6.99	6.39	6.45	6.78	6.23	5.85
LB6	17	7.18	6.73	6.13	5.10	4.37	4.25	7.95	6.11	5.30	8.22	6.73	6.40	7.11	5.98	5.52
LB8	15	7.31	6.87	6.47	5.39	4.54	4.12	8.33	6.68	4.71	7.91	6.82	6.41	7.24	6.23	5.43
LB12	16	7.20	6.92	6.65	6.65	4.78	4.16	7.17	5.72	4.79	8.61	8.16	6.78	7.41	6.40	5.59
Shallow Mitigation																
LA2A	4	7.11	7.14	6.79	6.31	6.23	5.93	7.21	7.23	6.37	7.27	7.32	7.26	6.97	6.98	6.59
LA2B	4	7.43	7.36	7.15	6.21	5.76	5.65	7.21	7.31	6.75	7.19	7.16	6.91	7.01	6.90	6.61
LA7A	4	8.53	8.38	8.13	6.50	6.04	4.99	7.37	7.73	6.57	9.29	9.23	7.42	7.92	7.85	6.77
LA7B	4	8.23	8.17	7.86	6.50	6.32	5.86	7.30	7.44	6.99	8.09	7.99	7.45	7.53	7.48	7.04
LB2A	4	8.38	7.81	7.06	5.86	5.25	4.53	7.81	7.74	7.49	8.20	8.28	8.30	7.56	7.27	6.85
LB2B	4	8.49	7.87	6.92	5.64	4.77	4.25	7.80	7.84	7.60	8.28	8.35	8.34	7.55	7.21	6.78
Shallow Water Open																
LA3A	4	7.69	7.39	7.28	6.27	5.16	4.47	7.29	6.85	5.92	7.24	7.19	6.70	7.12	6.65	6.09
LA3B	4	7.46	7.30	7.21	6.13	4.99	4.40	7.22	6.74	6.49	7.36	7.29	7.15	7.05	6.58	6.31
Shallow Water Channel																
LA14	6	6.22	6.26	6.22	9.11	4.90	4.33	6.86	7.74	5.99	5.38	5.89	5.80	6.89	6.20	5.58
Shallow Water Basin																
LA8	4	7.59	7.48	7.52	7.07	6.43	5.77	6.89	6.97	5.16	5.87	5.85	5.41	6.86	6.68	5.97
LA10	6	6.55	6.59	6.33	6.62	5.78	5.18	7.63	7.54	4.63	6.80	6.80	6.77	6.90	6.68	5.73

Note: Values are milligrams per liter (mg/L).

Table 2.4-3. Acidity/Alkalinity (pH) values by survey in Long Beach and Los Angeles Harbors, January – November 2000.

Habitat / Station	Depth (m)	January 2000			May 2000			August 2000			November 2000			Annual Mean		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Deepwater Open																
LA1	13	7.94	7.97	7.92	7.81	7.74	7.70	8.08	8.03	7.95	8.15	8.15	8.11	8.00	7.97	7.92
LA11	16	7.88	7.93	7.92	7.77	7.72	7.64	8.01	7.96	7.92	8.04	8.08	8.05	7.92	7.92	7.88
LB1	12	8.02	8.01	7.98	7.87	7.82	7.74	8.15	8.08	7.98	8.18	8.19	8.13	8.05	8.03	7.96
LB9	25	8.02	8.03	8.00	7.87	7.74	7.69	8.27	8.04	8.03	8.21	8.21	8.17	8.09	8.01	7.97
Deepwater Channel																
LA4	16	7.89	7.90	7.94	7.78	7.77	7.70	7.97	7.93	7.91	7.99	8.00	8.02	7.91	7.90	7.89
LA9	16	7.94	7.95	7.92	7.87	7.72	7.67	8.11	8.03	7.97	8.20	8.10	8.07	8.03	7.95	7.91
LB7	24	7.96	7.99	8.01	7.92	7.74	7.70	8.18	8.01	7.92	8.10	8.13	8.09	8.04	7.97	7.93
LB13	20	7.92	7.98	8.01	7.77	7.74	7.70	8.00	7.96	7.92	8.01	8.02	8.05	7.93	7.92	7.92
LB14	18	7.92	7.97	8.00	7.74	7.72	7.69	8.06	7.98	7.82	8.01	8.01	8.02	7.93	7.92	7.88
Deepwater Basin																
LA5	17	7.88	7.89	7.91	7.81	7.81	7.77	7.95	7.92	7.84	8.00	7.99	7.97	7.91	7.90	7.87
LA6	16	7.83	7.94	7.97	7.78	7.75	7.74	8.03	7.93	7.87	8.00	8.00	8.01	7.91	7.91	7.90
LA12	11	7.87	7.90	7.84	7.85	7.81	7.73	7.97	7.98	7.75	8.00	8.08	7.93	7.92	7.94	7.81
LB3	15	8.09	7.99	7.93	7.97	7.76	7.72	8.15	8.04	7.59	8.08	8.07	8.05	8.07	7.97	7.82
LB5	15	8.03	8.03	8.02	7.80	7.79	7.72	8.14	8.05	7.98	8.15	8.16	8.14	8.03	8.00	7.96
LB10	21	8.04	8.03	8.03	7.77	7.74	7.70	8.08	8.03	7.87	8.14	8.14	8.12	8.01	7.98	7.93
LB11	15	8.00	7.97	7.98	7.90	7.76	7.72	8.10	8.03	7.96	8.10	8.11	8.05	8.02	7.97	7.93
Deepwater Slip																
LA13	11	7.85	7.84	7.81	7.78	7.83	7.80	7.96	7.94	7.87	7.97	7.99	7.98	7.89	7.90	7.86
LB4	15	7.89	7.91	7.99	7.73	7.73	7.71	7.89	7.91	7.92	7.98	7.96	8.01	7.87	7.88	7.91
LB6	17	7.99	8.00	7.99	7.74	7.72	7.70	8.22	8.00	7.92	8.23	8.12	8.10	8.05	7.96	7.93
LB8	15	7.98	8.01	8.00	7.75	7.72	7.69	7.69	8.03	7.87	8.22	8.12	8.10	7.91	7.97	7.91
LB12	16	7.98	7.98	7.99	7.89	7.78	7.73	8.11	8.00	7.52	8.16	8.11	8.04	8.03	7.97	7.82
Shallow Mitigation																
LA2A	4	7.90	7.90	7.88	7.82	7.82	7.80	8.03	8.03	8.00	8.05	8.05	8.05	7.95	7.95	7.93
LA2B	4	7.90	7.90	7.90	7.82	7.79	7.79	8.02	8.03	7.99	8.05	8.05	8.03	7.95	7.94	7.93
LA7A	4	8.00	8.00	7.99	7.86	7.83	7.82	8.10	8.10	7.96	8.22	8.20	8.08	8.05	8.03	7.96
LA7B	4	7.99	7.99	7.98	7.86	7.85	7.82	8.09	8.10	8.07	8.14	8.13	8.10	8.02	8.02	7.99
LB2A	4	8.03	8.01	7.97	7.82	7.79	7.75	8.14	8.11	8.09	8.16	8.17	8.17	8.04	8.02	7.99
LB2B	4	8.03	8.00	7.96	7.81	7.77	7.73	8.13	8.12	8.08	8.18	8.18	8.18	8.04	8.02	7.99
Shallow Water Open																
LA3A	4	7.87	7.88	7.89	7.83	7.77	7.70	8.01	7.95	7.88	8.05	8.06	8.04	7.94	7.91	7.88
LA3B	4	7.86	7.87	7.88	7.82	7.75	7.70	8.03	7.97	7.94	8.06	8.06	8.08	7.94	7.91	7.90
Shallow Water Channel																
LA14	6	7.86	7.90	7.92	7.71	7.74	7.71	7.94	8.03	7.93	7.91	7.99	7.97	7.86	7.92	7.88
Shallow Water Basin																
LA8	4	7.92	7.92	7.93	7.91	7.86	7.82	8.07	8.07	7.95	7.99	7.96	7.94	7.97	7.95	7.91
LA10	6	7.84	7.84	7.84	7.88	7.81	7.75	8.06	7.99	7.77	8.03	8.02	8.03	7.95	7.92	7.85

Table 2.4-4. Salinity values by survey in Long Beach and Los Angeles Harbors, January – November 2000.

Habitat / Station	Depth (m)	January 2000			May 2000			August 2000			November 2000			Annual Mean		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Deepwater Open																
LA1	13	33.32	33.37	33.41	33.60	33.69	33.18	33.29	33.18	33.47	33.06	33.20	32.70	33.32	33.36	33.19
LA11	16	33.13	33.35	33.39	33.49	33.69	33.60	33.37	33.42	30.48	32.97	33.06	33.08	33.24	33.38	32.64
LB1	12	33.33	33.35	33.44	33.59	33.63	33.69	33.33	33.41	33.15	33.14	33.17	33.28	33.35	33.39	33.39
LB9	25	33.16	33.45	33.51	33.58	33.69	33.73	33.03	33.52	33.52	32.82	33.15	33.42	33.15	33.45	33.54
Deepwater Channel																
LA4	16	33.03	33.12	33.33	33.45	33.53	33.69	33.28	33.33	33.43	32.85	32.91	33.06	33.15	33.22	33.38
LA9	16	33.29	33.36	33.39	33.62	33.71	33.73	33.38	33.44	33.43	33.11	33.14	32.52	33.35	33.41	33.27
LB7	24	33.29	33.43	33.49	33.56	33.68	33.70	33.37	33.50	33.46	33.20	33.23	33.40	33.36	33.46	33.51
LB13	20	32.91	33.24	33.40	32.80	33.59	33.66	33.36	33.42	33.45	33.00	33.14	33.23	33.02	33.35	33.44
LB14	18	32.72	33.27	33.40	33.49	33.57	33.63	33.35	33.39	33.39	32.80	33.08	32.99	33.09	33.33	33.35
Deepwater Basin																
LA5	17	32.83	33.09	33.16	33.48	33.53	33.58	33.29	33.34	33.35	32.84	32.91	32.97	33.11	33.22	33.26
LA6	16	31.85	33.11	33.30	33.39	33.50	33.60	33.19	33.31	33.40	32.55	33.02	33.13	32.74	33.23	33.36
LA12	11	33.06	33.36	32.82	33.14	33.64	33.65	33.35	33.40	31.91	32.90	33.03	33.31	33.11	33.36	32.92
LB3	15	33.34	33.39	32.54	33.55	33.61	33.68	33.36	33.39	32.76	33.14	33.19	32.73	33.35	33.40	32.93
LB5	15	33.36	33.39	33.39	33.59	33.64	33.69	33.32	33.39	33.18	33.21	33.25	33.29	33.37	33.42	33.39
LB10	21	33.39	33.40	32.75	33.61	33.65	33.69	33.34	33.40	33.41	33.23	33.25	32.82	33.39	33.42	33.17
LB11	15	33.32	33.37	33.42	33.55	33.60	33.67	33.36	33.40	33.47	33.12	33.17	33.33	33.34	33.38	33.47
Deepwater Slip																
LA13	11	32.92	33.10	33.21	33.47	33.52	33.54	33.21	33.32	33.38	32.81	32.86	32.91	33.10	33.20	33.26
LB4	15	32.75	33.25	33.37	33.53	33.53	33.61	33.36	33.41	33.42	32.94	33.12	33.16	33.15	33.33	33.39
LB6	17	32.85	33.43	33.50	33.58	33.66	33.14	32.98	33.42	33.36	32.31	33.22	33.24	32.93	33.43	33.31
LB8	15	32.86	33.45	33.50	33.51	33.64	33.69	32.98	33.41	33.48	32.12	33.24	33.00	32.87	33.44	33.42
LB12	16	33.26	33.31	29.39	33.57	33.63	33.03	33.37	33.41	24.76	33.14	33.15	33.31	33.33	33.38	30.12
Shallow Mitigation																
LA2A	4	33.24	33.25	33.29	33.55	33.59	33.61	33.42	33.42	33.31	32.97	32.98	32.98	33.29	33.31	33.30
LA2B	4	33.21	33.23	33.27	33.54	33.59	33.59	33.41	33.42	33.40	32.96	32.98	33.04	33.28	33.31	33.33
LA7A	4	33.36	33.35	33.35	33.58	33.63	33.65	33.40	33.47	33.35	33.10	33.12	33.16	33.36	33.39	33.38
LA7B	4	33.36	33.36	33.36	33.59	33.61	33.61	33.40	33.42	33.41	33.14	33.15	33.15	33.37	33.39	33.38
LB2A	4	33.30	33.35	33.40	33.62	33.66	33.61	33.34	33.36	33.37	33.11	33.11	33.13	33.34	33.37	33.38
LB2B	4	33.30	33.35	33.40	33.61	33.65	33.65	33.34	33.36	33.36	33.12	33.12	33.13	33.34	33.37	33.39
Shallow Water Open																
LA3A	4	33.24	33.27	33.29	33.53	33.67	33.70	33.40	33.41	33.40	32.95	33.03	33.24	33.28	33.34	33.41
LA3B	4	33.26	33.29	33.27	33.54	33.70	32.75	33.41	33.40	33.37	32.94	32.97	33.15	33.29	33.34	33.13
Shallow Water Channel																
LA14	6	32.11	33.14	33.18	32.18	33.44	33.53	32.16	33.31	33.29	31.64	32.86	32.96	32.02	33.19	33.24
Shallow Water Basin																
LA8	4	33.36	33.30	33.32	33.61	33.62	33.57	33.44	33.46	32.88	33.09	33.10	32.93	33.37	33.37	33.17
LA10	6	33.31	33.31	32.32	33.58	33.64	33.67	33.45	33.50	33.12	33.06	33.06	33.06	33.35	33.38	33.04

Note: Values are parts per thousand (ppt).

Table 2.4-5. Temperature values by survey in Long Beach and Los Angeles Harbors, January – November 2000.

Habitat / Station	Depth (m)	January 2000			May 2000			August 2000			November 200			Annual Mean		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Deepwater Open																
LA1	13	14.23	14.05	13.82	13.24	11.67	10.88	20.57	19.46	17.22	17.32	17.33	17.07	16.34	15.63	14.75
LA11	16	14.38	13.98	13.71	14.83	12.66	10.74	21.09	19.49	17.08	17.10	17.05	16.42	16.85	15.79	14.49
LB1	12	14.32	14.19	13.89	14.00	13.18	11.81	21.49	20.21	17.91	17.38	17.37	17.11	16.80	16.24	15.18
LB9	25	14.19	13.93	13.35	14.81	11.82	10.77	22.62	18.60	16.40	17.15	17.26	16.58	17.19	15.40	14.27
Deepwater Channel																
LA4	16	14.52	14.27	13.85	15.01	13.96	11.85	20.95	19.61	17.86	17.32	17.04	16.79	16.95	16.22	15.09
LA9	16	14.43	14.38	13.92	16.70	11.79	11.01	22.69	20.28	19.09	17.64	17.06	16.11	17.87	15.88	15.03
LB7	24	14.45	13.98	13.61	15.65	12.03	11.41	21.91	18.13	16.49	17.19	17.10	16.23	17.30	15.31	14.44
LB13	20	14.73	14.39	13.98	15.97	14.24	12.48	21.43	19.05	17.51	17.83	17.23	16.94	17.49	16.23	15.23
LB14	18	14.75	14.25	14.03	15.99	14.32	13.10	21.86	20.26	17.61	17.79	17.27	17.06	17.60	16.52	15.45
Deepwater Basin																
LA5	17	15.43	14.45	14.18	16.63	14.61	13.72	22.97	20.13	19.45	17.65	17.29	17.21	18.17	16.62	16.14
LA6	16	14.90	14.39	14.16	16.23	14.76	13.67	22.02	19.89	18.68	17.65	17.40	17.25	17.70	16.61	15.94
LA12	11	14.81	13.93	13.80	15.09	12.84	11.60	21.63	20.12	17.60	17.42	17.13	16.95	17.24	16.00	14.98
LB3	15	14.61	14.35	14.08	15.56	13.43	12.10	21.91	19.96	16.99	17.58	17.37	16.85	17.41	16.28	15.01
LB5	15	14.52	14.25	14.04	15.13	13.89	11.81	21.42	19.67	17.50	17.19	17.09	16.92	17.06	16.22	15.07
LB10	21	14.45	14.30	13.83	14.68	12.63	11.57	20.78	19.23	16.80	17.20	17.19	16.74	16.78	15.84	14.73
LB11	15	14.56	14.35	14.04	15.77	13.70	11.71	21.99	19.80	17.50	17.70	17.53	16.86	17.50	16.35	15.03
Deepwater Slip																
LA13	11	15.05	14.80	14.61	15.65	14.83	14.47	22.06	20.58	19.29	17.43	17.26	17.28	17.55	16.87	16.41
LB4	15	14.91	14.35	14.08	16.56	15.65	13.73	21.98	20.42	18.35	17.64	17.57	17.23	17.77	17.00	15.85
LB6	17	14.24	14.04	13.85	13.96	12.22	11.64	22.48	19.44	17.78	16.85	17.08	16.91	16.88	15.70	15.05
LB8	15	14.29	14.07	13.87	14.59	12.37	11.58	22.63	19.84	17.89	16.54	17.18	16.86	17.01	15.86	15.05
LB12	16	14.77	14.47	14.09	16.55	13.38	12.19	22.08	19.80	17.82	17.74	17.60	16.79	17.78	16.31	15.22
Shallow Mitigation																
LA2A	4	14.14	14.12	14.04	14.55	14.07	13.77	20.58	20.45	20.14	17.05	17.03	17.03	16.58	16.42	16.24
LA2B	4	14.30	14.21	14.06	14.50	13.89	13.90	20.58	20.48	20.13	17.02	17.06	17.15	16.60	16.41	16.31
LA7A	4	15.20	15.12	15.01	16.85	14.41	13.29	23.36	21.31	19.59	17.74	17.59	17.60	18.29	17.11	16.37
LA7B	4	15.30	15.26	14.98	16.57	15.17	14.41	23.44	22.67	20.75	17.96	17.72	17.67	18.32	17.71	16.95
LB2A	4	14.37	14.26	14.11	13.68	12.81	12.61	21.34	21.09	20.61	17.32	17.33	17.34	16.68	16.37	16.17
LB2B	4	14.39	14.25	14.10	13.80	12.79	12.58	21.26	21.13	20.69	17.35	17.34	17.33	16.70	16.38	16.17
Shallow Water Open																
LA3A	4	14.38	14.28	14.12	14.29	12.29	11.35	20.48	19.58	18.12	17.04	17.05	16.72	16.55	15.80	15.08
LA3B	4	14.30	14.13	14.05	14.11	11.83	11.23	20.82	19.75	18.33	17.07	17.03	16.99	16.57	15.69	15.15
Shallow Water Channel																
LA14	6	14.73	14.39	14.34	17.68	15.12	14.73	22.80	20.81	19.98	17.87	17.48	17.35	18.27	16.95	16.60
Shallow Water Basin																
LA8	4	15.65	15.65	15.65	17.94	16.58	15.72	24.17	23.54	21.66	17.80	17.58	17.54	18.89	18.34	17.64
LA10	6	14.86	14.85	14.54	16.38	14.60	12.69	22.56	20.98	19.61	17.61	17.52	17.48	17.85	16.99	16.08

Note: Values are degrees Celsius (°C).

Table 2.4-6. Transmissivity values by survey in Long Beach and Los Angeles Harbors, January – November 2000.

Habitat / Station	Depth (m)	January 2000			May 2000			August 2000			November 2000			Annual Mean		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Deepwater Open																
LA1	13	61.92	69.21	30.75	60.74	61.79	44.70	63.21	52.83	21.09	64.13	64.30	20.00	62.50	62.03	29.14
LA11	16	64.64	56.86	54.75	66.31	63.85	52.14	66.78	65.92	34.34	66.72	67.16	38.36	66.11	63.45	44.90
LB1	12	65.69	66.03	51.06	57.36	54.07	47.55	64.34	60.62	55.17	61.66	60.54	30.93	62.26	60.31	46.18
LB9	25	68.14	62.14	21.95	62.31	52.37	15.48	51.40	61.44	25.49	60.71	59.89	15.67	60.64	58.96	19.65
Deepwater Channel																
LA4	16	68.72	64.79	42.60	59.34	57.10	51.07	66.88	65.60	42.89	65.63	64.89	63.08	65.14	63.09	49.91
LA9	16	59.41	53.91	38.43	60.55	37.40	7.06	60.12	65.34	62.84	59.08	58.80	46.74	59.79	53.86	38.77
LB7	24	66.99	58.27	37.31	61.54	46.20	29.05	63.76	58.30	38.48	61.19	57.91	30.42	63.37	55.17	33.82
LB13	20	73.94	63.40	49.84	61.91	63.88	29.98	61.13	54.43	43.91	62.62	61.04	50.19	64.90	60.69	43.48
LB14	18	73.03	65.29	53.35	68.50	62.54	36.64	56.53	49.49	39.70	68.57	53.92	51.25	66.66	57.81	45.24
Deepwater Basin																
LA5	17	67.00	66.58	65.75	62.70	52.33	50.53	72.76	69.59	50.17	61.37	67.74	64.19	65.96	64.06	57.66
LA6	16	67.23	69.60	66.62	70.81	64.15	64.47	65.09	67.78	58.13	70.23	71.29	68.14	68.34	68.20	64.34
LA12	11	62.95	61.91	53.43	73.59	61.28	46.62	74.02	62.77	45.94	72.20	68.69	32.22	70.69	63.66	44.56
LB3	15	64.57	67.40	39.29	58.48	64.58	11.77	69.44	68.04	11.33	39.61	29.06	44.13	58.02	57.27	26.63
LB5	15	67.21	60.58	54.12	66.53	61.63	42.89	66.07	56.99	37.35	60.60	55.74	47.92	65.10	58.73	45.57
LB10	21	68.24	69.57	45.94	68.71	53.24	27.37	68.94	65.74	42.46	66.81	68.27	53.33	68.18	64.20	42.28
LB11	15	69.07	71.85	53.37	64.76	67.94	32.17	70.23	69.28	51.48	54.45	60.66	46.93	64.63	67.43	45.99
Deepwater Slip																
LA13	11	75.06	74.66	71.81	51.99	51.41	49.84	68.76	64.92	63.63	62.33	67.75	64.53	64.53	64.68	62.45
LB4	15	75.92	73.83	62.98	64.70	69.15	63.22	66.19	65.20	57.64	68.00	67.48	60.12	68.70	68.92	60.99
LB6	17	70.81	60.90	37.95	53.59	35.14	21.59	41.77	52.90	35.83	64.14	46.60	31.63	57.57	48.89	31.75
LB8	15	72.35	65.69	44.73	61.31	30.53	19.82	56.08	50.75	14.16	67.03	55.80	32.11	64.19	50.69	27.70
LB12	16	69.29	62.13	28.26	65.93	60.36	15.54	59.67	49.89	15.36	42.87	61.14	19.65	59.44	58.38	19.70
Shallow Mitigation																
LA2A	4	65.11	64.53	16.77	65.88	63.02	57.74	67.23	63.98	31.53	67.91	66.72	62.44	66.53	64.56	42.12
LA2B	4	65.31	64.85	32.72	67.00	62.87	64.20	57.07	67.28	56.23	59.83	59.98	50.61	62.30	63.74	50.94
LA7A	4	45.33	42.46	39.23	59.56	56.35	49.35	51.73	57.10	51.56	63.16	59.63	37.80	54.94	53.88	44.48
LA7B	4	39.40	40.30	36.78	56.56	50.83	36.44	55.39	58.74	47.10	50.51	51.76	37.33	50.46	50.41	39.41
LB2A	4	64.90	52.48	23.41	58.85	50.76	28.15	66.06	66.09	61.04	64.70	64.94	51.69	63.63	58.57	41.07
LB2B	4	65.27	50.69	8.30	58.61	46.49	17.84	65.30	65.75	59.78	56.54	64.65	62.19	61.43	56.90	37.03
Shallow Water Open																
LA3A	4	50.75	50.93	48.90	44.50	60.86	43.98	67.10	68.47	48.39	64.29	67.07	52.78	56.66	61.83	48.51
LA3B	4	55.15	56.84	46.23	64.68	56.25	48.57	69.37	62.00	58.70	51.33	63.47	66.20	60.13	59.64	54.93
Shallow Water Channel																
LA14	6	66.37	66.13	63.59	50.20	38.61	56.16	72.21	57.35	34.08	73.40	67.07	57.56	65.54	57.29	52.85
Shallow Water Basin																
LA8	4	36.99	37.76	38.09	48.18	32.58	22.26	48.93	48.85	8.01	35.28	32.26	21.03	42.34	37.86	22.35
LA10	6	61.05	58.52	59.40	36.27	59.91	50.55	62.89	47.47	31.52	62.67	59.64	57.82	55.72	56.38	49.82

Note: Values are percent (%).

Table 2.5-1. Tidal velocity with and without Pier 400.

Location	With Pier 400 Landfill		Without Pier 400 Landfill	
	Max. Flood Velocity (cm/s)	Max. Ebb Velocity (cm/s)	Max. Flood Velocity (cm/s)	Max. Ebb Velocity (cm/s)
Angels Gate	24.8	8.1	32.2	15.1
West of Pier 400	14.8	3.0	18.9	3.6
North of Pier 400	10.6	2.8	16.3	1.4
Near Causeway Gap[2]	2.7	1.8	2.6	2.0

Notes:

[1] Wang et al. (1995) study used a 3-D model and the velocity shown in the table is for the near surface velocity, which is generally slightly higher than the bottom layer velocities. The difference in flood and ebb currents is much smaller for the bottom layers. A prior study by Seabergh & Outlaw (1984) with a 2-D model also showed smaller differences in the depth-averaged flood and ebb currents.

[2] The causeway gap location in the Wang et al. (1995) study is not the same as the as-built location.

Table 2.7-1. Summary of climatic patterns (temperature anomalies) during 1971 to 2000.

Year	January – March	April – June	July – September	October – December
2000	C	C-		C-
1999	C+	C	C-	C
1998	W+	W	C-	C
1997		W	W+	W+
1996	C-			
1995	W			C-
1994			W	W
1993	W-	W	W	W
1992	W+	W+	W-	W-
1991	W-	W-	W	W
1990			W-	W-
1989	C+	C-		
1988	W-		C-	C+
1987	W	W	W+	W
1986			W-	W
1985	C-	C-		
1984	C-	C-		
1983	W+	W		
1982		W-	W	W+
1981				
1980	W-			
1979				
1978	W-			
1977				W-
1976				W-
1975	C-	C-	C	C+
1974	C+	C	C-	C+
1973	W		C-	C+
1972		W-	W	W+
1971	C	C-	C-	C-

Note: C = cold; W = warm; + = strong; - = weak.

Source: http://www.cpc.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.html

3.0 ADULT AND JUVENILE FISHES

ADULT AND JUVENILE FISHES

3.1 Introduction

Surveys of fish populations within Long Beach and Los Angeles Harbors have been conducted since the early 1970s. Horn and Allen (1981) provide a review of the early studies, which were conducted primarily using otter trawls, although some studies also included limited gill net and beach seine sampling. Most studies were of the outer harbors of the Ports, with the notable exception of surveys within both inner and outer Long Beach Harbor that were required for compliance monitoring of the Long Beach Generating Station. Over 100 species of fish were reported from the harbors over the course of studies between 1971 and 1979 (Horn and Allen 1981).

Surveys in the 1980s and 1990s were limited to either one port or the other and may or may not have included both inner and outer harbor areas. These studies also used otter trawls, and some included lampara nets, beach seines, and less frequently gill nets. Several of the studies focused on assessment of fish assemblages within geographically limited areas of the harbor (e.g., Horn and Hagner 1982, Allen et al. 1983, MEC 1999), including the National Pollution Discharge Elimination System (NPDES)-mandated trawls conducted in the vicinity of the TITP wastewater outfall since 1993 (CLA-EMD 1993-2000). Few have encompassed harbor-wide sampling. The last large-scale study of Los Angeles Harbor was conducted in 1986-1987 (MEC 1988) and included a multi-gear (otter trawl, lampara, gill net, minnow seine, beach seine) sampling program of the outer harbor. Surveys of inner and outer harbor areas of Long Beach Harbor have been periodically conducted relative to proposed development projects (MBC 1984; SAIC and MEC 1996, 1997).

The purpose of the Year 2000 Baseline Study was to provide an updated characterization of the fish populations within the harbors. It represents the first study to conduct harbor-wide surveys of fish from both inner and outer harbor areas of both Ports. An additional objective was to compare these new findings with previous studies, where possible, so that there would be an increased understanding of the results in the context of historical trends.

Comparisons with earlier studies take into consideration the substantial construction changes that have taken place over the last 15 years (i.e., Pier 400, expansion of Pier J, and creation of shallow water habitats). Additionally, dredging and disposal activities, and the oceanographic conditions preceding (El Niño) and during (La Niña) the Year 2000 Baseline Study are considered.

Surveys were conducted quarterly at 18 stations representing different habitats in the harbor complex. Similar to more recent studies of the harbors, fish were sampled using a combination of gear types. A lampara net, which was set in a large circle or ellipse and extended from the surface to the bottom, was used to capture pelagic fish. An otter trawl, which was towed near the bottom, was used to collect bottom-associated (demersal) fish and invertebrates. A beach seine was used to provide estimates of fish that inhabit nearshore shallow water.

Day and night samples were collected for both lampara and otter trawl methods, while beach seine samples were collected during the day. Night samples were taken to increase the likelihood of capturing fast swimming fish that may visually avoid sampling gear during the day and to permit capture of bottom and/or schooling fish that disperse into the water column to feed at night. Night samples in combination with day samples provide a more comprehensive list of species and higher abundance estimates of fish populations (e.g., Allen et al. 1983, MEC 1988).

Besides the main sampling program, two special studies were performed to compare the catch between different gear types used in past fish studies in Long Beach and Los Angeles Harbors and other lagoons and harbors. The objective of these comparisons was to develop, if possible, a ratio of the relationship between the catch of the different gear types that potentially could be applied to historical data to enable more direct comparisons with data collected in the present study. One study involved comparison of the catch between lampara and purse seine nets, which differ in dimensions but each sample pelagic fish species. The other study involved comparing catch between two different sized otter trawl nets.

Detailed methods for each gear type are presented in Section 3.2. Separate sections provide description of the results of the pelagic (lampara), demersal (otter trawl), and beach seine sampling (Sections 3.3, 3.4, 3.5, respectively). Within each of those sections, community summary measures, species composition, size frequency distribution of catch, and historical comparisons are made. Section 3.6 addresses the occurrence of non-indigenous or uncommon species in the 2000 catch. The chapter concludes with an integration of the study findings (Section 3.7).

3.2 Methodology

Fish were sampled quarterly in winter (February), spring (May), summer (August), and fall (November) 2000. Adult and juvenile fish were sampled at 14 locations using lampara and otter trawl nets (Figure 3.2-1). Seven of the locations were in Long Beach Harbor (Stations LB1-LB7) and seven were in Los Angeles Harbor (Stations LA1-LA7). Four of the locations occurred in shallow waters (4 to 6 m) and ten were in deep waters (11 to 24 m). Of the ten deepwater locations, two or more stations were sampled among each of four different habitat types (open water, channel, basin, slip). Two stations were established at each of the four shallow water locations to increase balance in the total number of shallow (8) and deepwater (10) stations, and to provide replication of each of the created shallow water habitats, which were completed in different years and conceivably could differ in functional character. Replicate stations were assigned a unique location code (LB2, LA2, LA3, LA7), but were distinguished by a different letter (e.g., LB2A, LB2B). Thus, a total of 18 stations were sampled each survey.

Stations were sampled day and night with otter trawl and lampara nets. Sampling was conducted from Sea Venture's vessel the *M/V Earlybird*. The vessel was equipped with a differential Global Positioning System (dGPS) navigation (± 3 m) and fathometer. Latitude and longitude coordinates were recorded for lampara sampling locations, and at the start and end points for otter trawl tows. The start coordinates for the samples are provided in Appendix A.

Two stations were sampled during the day with a beach seine at shoreline locations at both Cabrillo Beach and adjacent to Pier 300 (Figure 3.2-1).

Methods used for each of these different sampling types, and the special studies, are described in the following subsections. Following that is a description of data analysis methods.

3.2.1 Pelagic (Lampara) Fish Habitat

The lampara net was used to sample pelagic fish, and its depth permitted the entire water column to be sampled at all stations. The lampara is a semi-pursing, round-haul net, having a cork line of approximately 273 m and a depth of 36 m. The net consists of two full-cut wings (100-m length each; 15-cm stretch mesh), a throat or apron with 5-cm mesh, and a sack or bag of 0.9-cm mesh. The net was set in a circle or ellipse, and drawn closed at the bottom during retrieval onto the boat. Lampara surveys were conducted during fair to good weather (Table 3.2-1). Debris on the bottom tore nets at several stations. When this occurred, the station was re-sampled after the net was repaired or with the backup net.

On-board processing of fish was based upon sampling protocols and standard measurement techniques previously used by MEC (1988) and SAIC and MEC (1996, 1997) in Long Beach and Los Angeles Harbors. Lampara hauls containing moderate numbers of fish were processed in their entirety. For hauls containing large numbers of small fish, up to six (6) full scoops were removed from the bag of the net using a standard bait brailer (diameter = 40 cm, depth = 50 cm). The scoops were placed in a holding container for processing. The number of fish remaining in the net was estimated by returning fish to the water with the bait brailer and recording the number of scoops discarded. Scoops were taken randomly from different areas of the catch to ensure that a representative sample was obtained. Any large, conspicuous, or unusual specimens observed in the net were removed and analyzed regardless of catch size. Total abundance by species was estimated for large lampara hauls by mathematically adjusting the species count data by the number of scoops of fish represented by the catch. Total abundance by species was estimated for large hauls by mathematically adjusting the count data by the number of scoops of fish represented in the catch.

Fish were identified to the lowest practicable taxon (usually species), measured, and weighed according to the following protocol:

- The first 30 individuals of each species were measured and weighed separately;

- The next 70 fish were individually measured and a batch weight was recorded;
- The batch weight of the next 400 individuals of a species was recorded;
- An aggregate weight was recorded for all remaining individuals of a species.

Most bony fishes were measured to standard length, and cartilaginous fishes were measured to total length. Very small atherinids and engraulids (< 50 mm) and gobiids (< 30 mm) were identified to the family level. Visual observations for unusual fish conditions such as fin erosion, abnormal pigment, deformities, and external parasites were made. Fish were returned to the water immediately after processing, and species of commercial/sport importance such as California halibut and sand bass were processed first and returned live to the water.

Fish not processed in the field (e.g., small individuals too difficult to identify accurately in the field) were placed in sample jars labeled according to station identification number, sampling gear, and date; preserved in 10% formalin; and returned to the laboratory for analysis. Weight and length data were recorded according to the same protocol used in the field.

3.2.2 Demersal and Epibenthic (Otter Trawl) Fish Habitat

Bottom dwelling fish and epibenthic macroinvertebrates were collected using a 25-ft otter trawl with a 7.6-m headrope, 2.5-cm mesh, and 1.3-cm mesh cod end liner. Otter trawls were fished for five minutes of bottom time (timed from end of wire payout to start of retrieval) at a speed between 2 and 2.5 knots. Otter trawl surveys were conducted during fair to good weather (Table 3.2-2). Debris on the bottom sometimes was recovered in the net. Stations were re-sampled if debris adversely affected the operation of the net.

Fish and macroinvertebrates were identified to the lowest practicable taxon (usually species). Fish were processed (counted, weighed, measured) according to the same protocol described above for lampara sampling. Macroinvertebrates were counted and weighed according to species. Results of macroinvertebrate catch are reported in the benthic chapter (Section 5.4).

3.2.3 Shallow Subtidal (Beach Seine) Fish Habitat

Nearshore fish were collected using a beach seine. The seine was 15-m long by 1.8-m deep, with a mesh size of 0.6 cm in the wings and 0.3 cm in the bag. The seine was set parallel to shore, 15 m from the waterline, and hauled to shore by hand. Beach seine surveys were conducted during good weather (Table 3.2-3). Beach seine samples were processed according to the same protocol described for the lampara net.

3.2.4 Special Studies

A lampara and purse seine comparative study was performed during the winter and summer surveys. The purse seine was 67-m long and 6-m deep, with a mesh size of 1.3 cm; the bag was 6-m long and 6-m deep, with a mesh size of 0.6 cm. The net was set in a circle, pursed at the bottom, and hauled onto the boat. Six of the stations sampled by lampara (LA1 and LB1 in the outer harbor, LA4 and LB7 in the middle harbor, and LA6 and LB4 in the inner harbor) were sampled with a purse seine during the day. Station depths ranged from 12 to 24 m.

The trawl comparison study involved collection of samples with a small trawl (16-ft, 4.9-m) at six of the stations surveyed with the 25-ft (7.6-m) otter trawl. The stations included LA1 and LB1 in the outer harbor, LA4 and LB7 in middle harbor, and LA6 and LB4 in the inner harbor. The 16-ft trawl net had a 4.9-m headrope, 2.5-cm mesh, and 1.3-cm mesh cod end liner. Otter trawls were fished for five minutes of bottom time (timed from end of wire payout to start of retrieval) at a speed between 2 and 2.5 knots. The special study comparisons were made during the summer and fall surveys over both day and night sampling.

Fish were processed in the same manner during the special studies as described previously for lampara and otter trawl (Sections 3.3.1, 3.3.2).

3.2.5 Data Analysis

Data for the different net types were handled in a similar manner. Species were assigned unique numeric codes and the count, length, and weight data were entered by species into databases, which were subjected to standardized quality assurance routines. Abundance and biomass are presented as catch per unit effort (CPUE) in this report. CPUE represents the catch in one set of the lampara net, otter trawl, or beach seine. Fish length data were standardized to one-centimeter size classes. Community measures of species richness and diversity were calculated using the CPUE, and included:

- Number of species or unique taxa,
- Shannon-Wiener diversity ($-\Sigma p_i$ X $\log(p_i)$, where p_i is the count for species i divided by the total count of the sample),
- Margalef species richness (number of species –1/log(total count of sample), and
- Dominance (number of species comprising 75% of the total count of the sample).

Cluster analysis was used to identify groups of stations that were biologically similar. Species composition and relative abundance of the species defined the groups. Cluster analysis was performed separately on the lampara and otter trawl catches. Prior to the analysis, the mean for each species at each station was computed over the four surveys and the day and night samples (i.e., the mean of eight samples was used for each station). Species occurring at only one station were excluded from the analysis. The cluster analysis requires the input of a dissimilarity matrix, which quantifies the (biological community) dissimilarity between all pairs of stations. The Bray-Curtis dissimilarity index (Bray and Curtis 1957) was used with the step-across procedure (Williamson 1978, Bradfield and Kenkel 1987). Before computation of the dissimilarity index, the species abundance data were transformed by square root and standardized by a species mean of abundance values greater than zero. Results of the cluster analysis are presented as a two-way coincidence table with the station-species abundance data matrix displayed as a table of symbols indicating the relative abundance of each species by station. The rows and columns of the table are arranged to correspond to the order of stations and species along the respective station and species dendrograms resulting from the cluster analysis.

To determine whether there were significant differences in catch between day and night and/or among seasons, analysis of variance (ANOVA) was performed on $\log_{10}$ transformed abundance and biomass data, and number of species (untransformed). ANOVAs were a two-way model that also tested for the interaction term, which tested whether diurnal differences in catch differed among seasons.

A mean harbor-wide estimate of fish abundance was computed for Long Beach and Los Angeles Harbors based on the following formula:

Estimated Fish Abundance of Species X in Region Y =
*(annual catch)/4 surveys) * (area [ft] in region Y/area net swept [ft]) * (1/net catch efficiency).*

The regions in the above formula were defined by dividing the harbors according to larger areas around each station. The acreage represented by each region was then determined. Catch efficiency and area swept by the net were based on calculations previously used by MEC (1988), as follows:

Lampara – catch efficiency of 21%, catch area of 4,000 m^2;
Otter Trawl – catch efficiency of 31%, catch area of 1,460 m^2;
Beach Seine – catch efficiency of 70%, catch area of 180 m^2.

Abundance estimates were computed for each fish species and summed for each region, then the estimates for each region were summed to yield the total harbor-wide abundance estimate. Mean catch data for a species was based on either lampara or otter trawl data based on which net was most efficient in capturing that species.

Figures showing seasonal trends in community summary measures (abundance, biomass, species) label the surveys according to month-year (e.g., Feb-00).

3.3 Pelagic Fishes

3.3.1 Community Summary Measures

Abundance

A total of 110,089 fish was collected by lampara nets across the 18 stations and four surveys (Table 3.3-1). Fish were healthy with a very low incidence (< 0.01%) of obvious abnormalities and external parasites. Northern anchovy (*Engraulis mordax*) was the most abundant species collected (67.9% of total catch) (Table 3.3-1). Next in abundance were white croaker (*Genyonemus lineatus*) and queenfish (*Seriphus politus*), each comprising 6.0% of the total catch. Other species accounting for a relative high proportion of the catch included Topsmelt (*Atherinops affinis*) (5.8%), Pacific sardine (*Sardinops sagax*) (4.1%), shiner surfperch (*Cymatogaster aggregata*) (3.0%), and salema (*Xenistius californiensis*) (2.9%).

Nearly three times as many fish were collected at night (81,667) than during the day (28,422), and that difference was statistically significant ($p = 0.0001$). More northern anchovy were collected in both day and night samples than any other species. Four species, including white seabass (*Atractoscion nobilis*), California tonguefish (*Symphurus atricauda*), Pacific sanddab (*Citharichthys sordidus*), and barred pipefish (*Sygnathus auliscus*) were only collected in day samples (Table 3.3-1). A total of eight species were only collected at night, including salema, California scorpionfish (*Scorpaena guttata*), plainfin midshipman (*Porichthys notatus*), black croaker (*Cheilotrema saturnum*), basketweave cusk-eel (*Ophidion scrippsae*), blacksmith (*Chromis punctipinnis*), black rockfish (*Sebastes melanops*), and barcheek pipefish (*Sygnathus exilis*). Species ubiquitously occurring at all stations included northern anchovy, white croaker, queenfish, and topsmelt (Table 3.3-4).

Mean abundance by station (day, night, and averaged over the two time periods) is presented in Table 3.3-2 and Figure 3.3-1. Mean abundance during the day ranged from 15 to 3,535 fish, and mean abundance at night ranged from 191 to 5,988 fish. The highest mean abundances (> 3,000 fish) were at Long Beach West Basin (Station LB3) and Southeast Basin (Station LB5). Other stations with high abundance (913 to 1,341 fish) were in Long Beach Harbor Channel 2 (Station LB4), Pier J Slip (Station LB6), and Long Beach Channel (Station LB7). The lowest mean abundance (147 fish) was at the Los Angeles East Basin (Station LA6). In general, mean abundances were higher among the Long Beach stations (range of 313 to 3,242, mean of 1,351) as compared to the Los Angeles stations (range of 147 to 440, mean of 296).

On average, abundance values were three times higher at deepwater (1,092) than shallow water (356) stations largely due to the relatively high abundance values recorded in basin, slip, and channel habitats in Long Beach Harbor.

Both day and night results showed similar seasonal patterns with summer samples having the highest abundances at all stations and winter samples having the lowest abundances (Figure 3.3-2). Summer abundance values were significantly higher than the winter and spring values (p = 0.002).

Appendix C.1 provides summary tables by season. While there was some variation in locations of high abundance between day and night and seasonal surveys, abundances generally were higher in basin (Stations LB3, LB5), channel (Station LB7), and slip habitats (Stations LB4, LB6) in Long Beach Harbor throughout the study period. One exception included relatively high catch abundances during the day at the Pier 300 Shallow Water Habitat on two of the surveys (winter and fall).

Biomass

A total of 2,924 kg of fish was collected across stations and surveys. Bat rays (*Myliobatis californica*) had the highest total biomass for day and night samples combined (Table 3.3-1). Other species having relatively high total biomass values included California barracuda (*Sphyraena argentea*), white croaker, northern anchovy, and queenfish. California barracuda had the highest day biomass, while bat rays had the highest night-collected biomass.

Mean biomass values were highest for the Cabrillo (43.5 kg across replicate stations) and Pier 300 (62.2 kg across replicate stations) Shallow Water Habitats (Stations LA2, LA7) in Los Angeles Harbor, and secondarily for the Pier J slip (Station LB6) (31.3 kg) and Long Beach Shallow Water Habitat (Station LB2) (21.6 kg). Moderate fish biomass (10.6 to 17.1 kg) was collected in outer Long Beach Harbor (Station LB1), West Basin (Station LB3), and Southeast Basin (Station LB5) (Table 3.3-2). On average, biomass was lowest (2.6 to 6.0 kg) at the deepwater stations in Los Angeles Harbor (Stations LA1, LA4-LA6), a natural shallow water area in Los Angeles Harbor (Stations LA3A, B), and in inner Long Beach Harbor (Station LB4).

The high biomass values were sometimes due to large catches of one fish species or catches of a few large fish. At the Pier 300 Shallow Water Habitat (Station LA7), large catches of California barracuda in February accounted for over 80% of the biomass (Table 3.3-5; Appendix C.1.4). The Cabrillo Shallow Water Habitat (Station LA2A) had high biomass values due to consistent collection of large bat rays, which accounted for 76% of the biomass. High biomass values at Pier J (Station LB6) were largely due to large catches of salema in February and northern anchovy in November. White croaker, northern anchovy, topsmelt, and queenfish had high total biomass values (Table 3.3-1) and were collected at all stations throughout the harbors on all surveys (Table 3.3-5; Appendix C.1.4).

Overall mean biomass values were similar among day and night samples for most surveys, with the exception of a higher fish biomass collected during the day in winter (Figure 3.3-2). This temporal variability was not statistically significant.

Number of Species

A total of 50 species was collected among all stations over all surveys between February and November 2000 (Table 3.3-1). The mean number of species at each station ranged between 6 and 19 over day and night combined (Table 3.2-2). Generally, more species were collected at the Cabrillo, Pier 300, and Long Beach Shallow Water Habitats (average of 16 species over 6 stations) than the other shallow (12 species over 2 stations) or deepwater sites (average of 9 species over 10 stations).

On average, significantly more species were collected at night than during the day ($p = 0.0001$). More species were collected during the summer than winter and spring (Figure 3.3-2), and that difference was statistically significant ($p = 0.0001$).

The highest total numbers of species (29 to 32) over the four quarters were collected from the Pier 300 (Station LA7) and Long Beach (Station LB2) Shallow Water Habitats (Appendix C.1.1). The fewest number of species (11, over all surveys and day-night periods) was collected at the Los Angeles East Basin (Station LA6).

Diversity and Dominance

Diversity indices are derived measures (based on the number of species and the distribution of their abundance) and are considered important because they combine two aspects of community structure into one value, the number of species (species richness) and the relative abundance of species (equitability). Because number of species and equitability often vary independently, several methods are used to calculate diversity. Results for three commonly calculated measures, Shannon-Weiner, Margalef, and Dominance, are presented in Table 3.3-3.

Shannon-Weiner values exhibited similar trends for mean (Table 3.3-3) and seasonal values (Appendix C.1.1). In general, Shannon-Weiner values were higher at shallow water stations (range of 1.28 to 1.70), particularly the Cabrillo, Pier 300, and Long Beach Shallow Water

Habitats, than deepwater stations (range of 0.62 to 1.30). The overall higher values at the shallow stations were likely due to greater habitat diversity (e.g., proximity to riprap rocks, kelp and macroalgae, and/or eelgrass) than at the deeper stations (refer to Sections 7 and 8). The Margalef index showed the same trends, with overall higher values at shallow water stations (range of 1.60 to 3.08) than at deepwater stations (range of 0.92 to 1.47).

Dominance is the minimum number of species necessary to account for 75% of the abundance at a station. Higher dominance values indicate a more equitable distribution of abundance for the species collected. All stations were dominated by a small number of species (1 to 4). In general, higher dominance values (mainly 3 to 4) were at the shallow water stations and open waters of the outer harbors. Dominance values were lower (1 to 2) at deepwater basin, channel, and slip habitats.

3.3.2 Species Composition

Cluster analysis of lampara collected fish produced four different station clusters and four different species clusters (Figures 3.3-3 and 3.3-4; Table 3.3-6). Species with a relatively high abundance within a station cluster group characterize the species composition of the group. Symbols on the two-way coincidence table (Figure 3.3-3) indicate relative abundance by the size of the symbol, which is largest with highest relative abundance. The size of the symbol does not correspond to absolute abundance, which can be found for fish on Table 3.3-4. Because cluster analysis considers relative abundance of each species across the stations it occupies, it is not weighted towards dominant species and provides a more complete assessment of community structure.

The stations clustered primarily by depth. Station Cluster Group 1 included deepwater sites from the middle and inner harbor, and one station in outer Los Angeles Harbor (Stations LA1, LA4, LA5, LA6, LB3, LB4, LB5, LB7). Species Cluster Group A characterized the station groupings. The species cluster group had eight species in relatively high abundance including schooling fish such at northern anchovy, California grunion (*Leuresthes tenuis*), chub mackerel and jack mackerel (*Scomber japonicus*, *Trachurus symmetricus*), sardine, topsmelt, and widely distributed queenfish and specklefin midshipman (*Porichthys myriaster*).

Station Cluster Group 2 consisted of stations at the naturally shallow water area (Station LA3) west of the Cabrillo Shallow Water Habitat. Species Cluster Groups A and B characterized the station group. Seven species had relatively high abundance including California grunion, topsmelt, California lizardfish (*Synodus lucioceps*), pile surfperch (*Rhacochilus vacca*), California tongue fish, fantail sole (*Xystreurys liolepis*), and speckled sanddab (*Citharichthys stigmaeus*).

Station Cluster Group 3 included stations from outer Long Beach Harbor including deep open water (Station LB1), the Shallow Water Habitat (Station LB2), and the Pier J slip (Station LB6). Species Cluster Groups A and C characterized the station group. Sixteen species had relatively high abundances at the stations within the cluster group. Characteristic species included queenfish, white croaker, jacksmelt (*Atherinopsis californiensis*), California halibut (*Paralichthys californica*), and hornyhead turbot (*Pleuronichthys verticalis*). Salema occurred with notably high abundance within the Pier J slip (Station LB6).

Cluster Group 4 comprised the Cabrillo and Pier 300 Shallow Water Habitats (Stations LA2, LA7). Species Cluster Groups C and D characterized this group, and several species from Species Cluster Group A also were relatively abundant. Nineteen species had relatively high abundances at stations within this group. Characteristic species included queenfish, California halibut, fantail sole, spotted turbot (*Pleuronichthys ritteri*), barred sand bass (*Paralabrax nebulifer*), white surfperch (*Panerodon furcatus*), shiner surfperch, black surfperch (*Embiotoca jacksoni*), giant kelpfish (*Heterostichus rostratus*), and sargo (*Anisotremus davidsoni*).

The two-way table for species abundance by station resulted in four main associations among the species. Species Group A consisted mainly of transient and/or ubiquitously occurring species throughout the harbors, such as northern anchovy, chub mackerel, jack mackerel, Pacific sardine, topsmelt, jacksmelt, queenfish, and white croaker. Species Group B consisted of demersal species that are associated mainly with soft bottom areas; e.g., California lizardfish, California tonguefish, and speckled sanddab. Most species in Groups C and D had a limited distribution in the harbors and included a variety of demersal rays and flatfish, and several species (corbina, kelpfish, perch, sand bass) associated with rocky and/or vegetated habitats (termed "habitat associated" in this report). The higher abundance of habitat-associated species in Station Cluster Groups 3 and 4 undoubtedly relates to the proximity of the stations to the San Pedro Breakwater, riprap around Pier 400, riprap at the entrance to Pier J, and eelgrass beds in the Pier 300 Shallow Water Habitat (see Section 8).

Results of the cluster analysis are summarized in Table 3.3-6. With the exception of Station Cluster Group 3, which included both shallow and deepwater stations in outer Long Beach Harbor, species composition varied most by depth. Measured physical parameters that varied by depth included temperature and transmissivity, both of which decreased with increasing depth. On average, temperatures near the bottom were approximately 1^{o}C warmer at shallow water stations than deepwater stations (See Section 2). On the other hand, average transmissivity values near the bottom were similar (within 2%) between shallow and deepwater stations. Differences in transmissivity between shallow and deepwater stations were associated more with the upper water column. On average, near surface to mid-water transimissivity was approximately 10% lower at shallow water stations than deepwater stations. Other physical/chemical conditions such as dissolved oxygen, salinity, sediment grain size, and pH did not exhibit any consistent trends related to station depth. Substantially more species with relatively high abundance were collected at stations in outer Long Beach Harbor and the Cabrillo, Long Beach, and Pier 300 Shallow Water Habitats. Stations in deepwater basins, channels, and slips and the inner harbor of both Ports had fewer relatively abundant species.

3.3.3 Dominant and Selected Species

Out of the 50 species collected over all stations and quarters, eleven accounted for the highest number and/or highest biomass. Generally, schooling fishes were the most abundant and had high biomass values; these included northern anchovy, white croaker, queenfish, topsmelt, and Pacific sardine (Table 3.3-1). Other relatively abundant species included shiner surfperch, salema, and jacksmelt. Size frequency plots for some of the dominant species are presented in Figure 3.3-5. White croaker and queenfish, which were caught in high numbers with lampara nets, were caught in even higher numbers using an otter trawl. Size frequency distributions for those two species are, therefore, discussed with the otter trawl results in Section 3.4. Size frequency histograms for less abundant species caught by lampara are presented in Appendix C.1.2.

Northern anchovy dominated the lampara catch representing 68% of the total abundance. Substantially more were caught during nighttime (58,970) than daytime (15,748), This species was collected at all sampling locations during every survey. More northern anchovies were collected at Long Beach West Basin (Station LB3) and Long Beach Southeast Basin (Station LB5) than any other stations (Table 3.3-4). Sizes ranged between 4 and 14 cm, with more individuals between 5 and 10 cm being caught than any other size classes (Figure 3.3-5). The majority of northern anchovies were less than 10 cm indicating that most were juveniles. The size distribution of northern anchovy collected at each station is presented in Appendix C.1.2; no spatial trends for size were evident for this species.

White croaker was the second most abundant species and accounted for 6% of the total catch. This species also had the third highest total biomass. Similar to northern anchovy, white croaker was collected at all stations over all sampling quarters, and more were caught during nighttime (5,112) than daytime (1,500) surveys. For example, Long Beach Shallow Water Habitat (Station LB2A) had the highest number of white croaker, while outer Long Beach Harbor (Station LB1) had the second highest (see Table 3.3-4). Queenfish also comprised 6% of the total catch, was the third most abundant species, and was collected every quarter at all sampling locations. Queenfish also were caught more at night (6.038) than during the day (539).

Topsmelt was the fourth most abundant species collected, and also comprised approximately 6% of the total catch. Topsmelts were collected at all stations during every survey. Size distributions for this species were generally similar among stations, with average sizes ranging between 5 and 18 cm (Figure 3.3-5). Topsmelts were mostly between 7 and 16 cm; the larger fish in this range (over 10 cm) would have been sexually mature, and the smaller were juveniles. Los Angeles East Basin, Long Beach Channel, and outer Long Beach Harbor stations (LA6, LB7, and LB1) had the largest topsmelts, with sizes reaching 30 cm. No other spatial trends were evident.

The size distributions of other commonly collected pelagic species are shown on Figure 3.3-5. Pacific sardine had two abundant size classes, 7 to 10 cm, and 16 to 18 cm. The smaller fish were juveniles, and the larger fish were just at the maturation stage. Jacksmelts were most abundant in the 24 to 29 cm size range, which were adults. The majority of salema were adults and had a consistent size range of 14 to 15 cm. Adult California barracuda in the 45 to 65 cm size range were the most abundant. Shiner surfperch were generally between 7 and 12 cm, at which size they are sexually mature. White surfperch were widely distributed across a size range of 6 to 22 cm, a mix of juvenile and adult fish.

Commercially and/or recreationally important species, including California halibut and barred sand bass, had low total abundance and low biomass. California halibut ranked 20th in total abundance, with only 59 individuals collected over all stations and surveys, but occurred at 12 out of 18 sampling locations (Table 3.3-4). Most halibut were collected at outer harbor stations. Juvenile to adult sized halibut were collected with sizes ranging from 7 to 64 cm. Small juveniles (≤ 20 cm) were mainly collected at the Long Beach Shallow Water Habitat (Stations

LB2A, B) (Appendix C.1.2). Barred sand bass ranked 18th in total abundance (115 individuals collected), with > 90% of the catch from the Cabrillo, Pier 300, and Long Beach Shallow Water Habitats (Table 3.3-4). Both juveniles and adults were collected with sizes ranging between 13 and 29 cm (Appendix C.1.2).

A notable record of the lampara catch was the occurrence of Pacific cutlassfish (*Trichiurus nitens*). All cutlassfish (8) were collected within the Pier J slip (Station LB6), with all but one being caught during day surveys. This species is found worldwide in warmer waters and in the eastern Pacific Ocean between Peru and San Pedro (Miller and Lea 1972). Little information is available on life history of this species, but the catch of the species has been more common in coastal trawl surveys during the recent El Niño events (L. Honma, personal communication 2000).

3.3.4 Lampara and Purse Seine Comparison

A special study was conducted to compare the pelagic fish catch between two different types of nets. A purse seine (67-m long by 6-m deep) was used to sample six stations during February and August to compare with results of lampara collections (lampara net 273-m long by 36-m deep) (see Methods section 3.2). Lampara nets have been used in several historical studies of the harbor complex (MEC 1988, MBC 1990, SAIC and MEC 1996, 1997). Purse seine nets were used in one previous study of Long Beach Harbor (MBC 1984), but have been used in San Diego Bay and local coastal lagoons.

Results of the purse seine collections are presented in Appendix C.1.5. No fish were collected using the purse seine in February, while only 10 individual of topsmelt were collected in August. Results clearly indicate that the purse seine was not effective in capturing pelagic fish at the stations sampled in Long Beach and Los Angeles Harbors. The poor performance of the purse seine probably related to two factors: (1) the purse seine is 6 m deep and, therefore, only sampled the upper portion of the water column at sampling stations where bottom depths ranged between 12 and 24 m, whereas, the lampara net is 36 m deep and sampled the entire water column; and (2) the purse seine sampled a 357 m^2 area, which is much smaller than the 4,000 m^2 area sampled by lampara.

MBC (1984) used a larger purse seine (91.4 m long by 12.2 m deep), but also found that the net was “not particularly effective” due to a combination of factors including the short length and depth of the net, small area sampled (665 m^2) and length of time required to set and purse the net. Purse seine nets, of the same size as used in the present study, have been used successfully to sample pelagic fishes in San Diego Bay (Allen 1998) and Batiquitos Lagoon (San Diego County) (Merkel & Associates 2001). However, the seine was used to sample shallow or nearshore waters in those embayments. Thus, while the purse seine may be effective for sampling shallow water areas, it is much less effective than the lampara net in capturing pelagic fish in deep water habitats of the harbors.

3.3.5 Summary of Spatial and Temporal Variations

A total of 50 species represented by 110,089 individuals, with a combined weight of 2,924 kg, was collected at 18 stations over 4 seasons of sampling in Long Beach and Los Angeles Harbors.

Abundance generally increased from February (winter) and peaking in August (summer), before decreasing in November (fall) (Figure 3.3-2). In addition, there were significant differences between night and day samples with approximately three times more fish collected at night. These differences primarily were due to large nighttime catches of northern anchovy, white croaker, and queenfish (Table 3.3-1). Those large catches also related to the four-fold difference in mean fish abundance between Long Beach (1,351) and Los Angeles (296) Harbor.

Abundances also exhibited spatial patterns relative to depth and habitat association. Overall mean abundance at the deeper stations (1,092) was three times higher than at shallow water stations (356), primarily due to large nighttime collections of northern anchovy. Results of cluster analyses (Figures 3.3-3 and 3.3-4) identified differences in species composition between stations based on depth, with the deep stations clustering together and the shallow stations forming separate clusters. Additionally, species composition was more varied and included more habitat-associated species at locations in close proximity to breakwaters and/or habitats with kelp, macroalgae, or eelgrass.

Physical/chemical conditions such as dissolved oxygen, pH, and salinity were fairly uniform among stations and, therefore, did not correspond to spatial patterns in fish abundance and species composition. Temperature was the only measured parameter that showed a consistent spatial pattern relative to depth, with slightly warmer waters at shallow stations than deepwater stations. Transmissivity values decreased with depth, but near bottom values were highly variable among stations and did not exhibit consistent trends between shallow and deepwater stations. Instead, lower near bottom transmissivity values were recorded in areas close to dredging or disposal. It is unknown to what extent dredging/disposal may have affected lampara catch. Dredging or disposal was ongoing around Pier 400 and at the Cabrillo Shallow Water Habitat, and lampara catch was relatively low at those locations. However, abundances were relatively low throughout Los Angeles Harbor. Substantially more fish were caught with lampara in Long Beach Harbor, but the highest mean catch was from Long Beach West Basin, which had ongoing dredging during the study.

Temporal biomass patterns were different from the abundance trends described above. There was no significant day-night or seasonal differences in biomass. The significantly higher abundance caught during the summer was the result of numerous small juvenile fish (mainly northern anchovy), which contributed to but did not dominate the summer biomass value. At deepwater stations, white croaker, northern anchovy, and queenfish accounted for most of the fish biomass, although a high catch of salema during the winter survey also contributed greatly to fish biomass within the Pier J slip (Station LB6) (Table 3.3-5, Appendix C.1.4). Bat rays, California halibut, jacksmelt, shiner surfperch, white surfperch, and a seasonally high catch of barracuda accounted for the higher fish biomass in shallow compared to deep waters.

Similar to abundance, more species of fish were collected in summer than winter. More species were collected at the Cabrillo, Pier 300, and Long Beach Shallow Water Habitats (Stations LA2, LA7, LB2) than any other locations. These shallow stations are located in the middle and outer harbor areas. Los Angeles East Basin (Station LA6), located in the inner harbor, had the fewest number of species (Table 3.3-2).

3.3.6 Historical Comparisons

Fish studies in the 1970s primarily used otter trawls, which only incidentally catch pelagic species. Gill nets, which effectively capture pelagic as well as demersal species, were also used in the 1970s, but generally at a reduced level of effort. Sampling of pelagic fish populations using lampara nets has been done infrequently since the late 1980s, with periodic surveys in Los Angeles (MEC 1988, 1999) and Long Beach (MBC 1990; SAIC and MEC 1996, 1997) Harbors and Queensway Bay (MBC 1990).

The most abundant species, in decreasing order of abundance, caught by gill nets during the historical studies included white croaker, northern anchovy, shiner surfperch, queenfish, white surfperch, and walleye surfperch (Horn and Allen 1981). White croaker, northern anchovy, and queenfish have been dominants in the lampara samples; however, other schooling fishes besides perch have been more abundant in the lampara samples than in gill net samples. Northern anchovy, Pacific sardine, white croaker, queenfish, and California grunion were most abundant in lampara samples during 1986-1987 (MEC 1988). Similarly, northern anchovy, Pacific sardine, white croaker, queenfish, and topsmelt or Pacific butterfish were most abundant in lampara samples during the 1990s (MBC 1990, SAIC and MEC 1996, 1997). The same fish species were most abundant in lampara samples during the present study; however, the abundance of Pacific sardine was relatively lower in the present study than that in the 1980s and 1990s.

Results of the present study indicated typical seasonal trends (MEC 1988; SAIC and MEC 1996, 1997), specifically for abundance and number of species, but no temporal patterns with biomass were evident. Spatial trends indicate that the shallow water stations had generally lower abundances, but higher biomass and number of species as compared to the deepwater stations. Similar to previous studies in which day and night samples were collected (MEC 1996; SAIC and MEC 1996, 1997), a greater variety and more fish were collected at night in the present study. Day/night differences in catch are believed to result from a combination of fish behaviors at night related to decreased visual avoidance of sampling gear, increased dispersal of schooling species, and increased foraging activity at night (Horn and Allen 1981).

Previous examinations of species composition of lampara catch showed some differences in assemblages caught near the breakwaters versus other outer Los Angeles Harbor areas in 1986-1987 (MEC 1988) (Figure 3.3-8). However, the main spatial pattern in pelagic fish distribution was related to depth (MEC 1988). Similarly, species assemblages caught in the present study differed by depth. During 2000, pelagic species had a widespread distribution throughout the harbors while more habitat-associated species occurred in the shallow water habitats, which have greater habitat diversity with adjacent rock and/or vegetated areas. The cluster analysis of the present study also indicated some differences in species assemblages in the outer harbor from those in the middle and inner harbor areas. The outer harbor assemblages generally had relatively higher abundances distributed among more species (higher diversity) than those in the middle and inner harbor areas. Dynamic small-scale spatial patterns were noted in Long Beach Harbor in 1996, but there were no consistent differences in species assemblages between outer, middle, and inner harbor areas (MEC 1996; SAIC and MEC 1996, 1997).

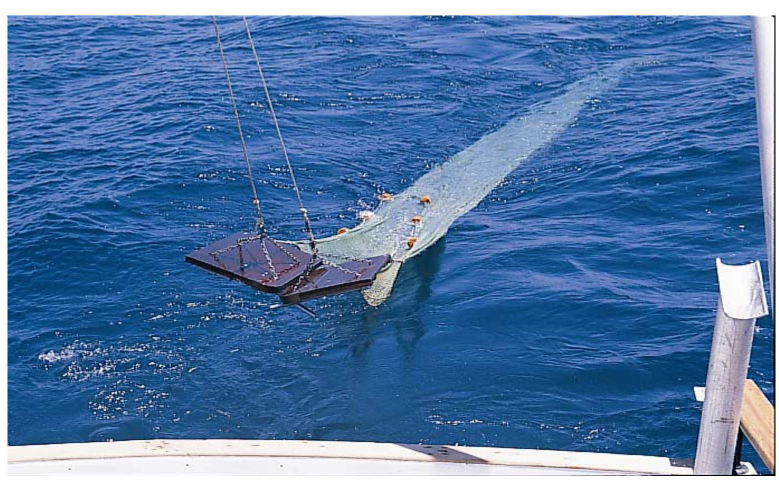
Mean catch for lampara sampling between 1986 and 2000 (MEC 1988, 1996; SAIC and MEC 1997; and present study) is presented in Figure 3.3-6. Mean data were computed across day-night samples except for the 1986-1987 study, which only collected day samples. More data are available for comparison in Long Beach Harbor than Los Angeles Harbor. In general, Long Beach harbor had higher abundances than Los Angeles Harbor in 2000. Unfortunately, lack of historical surveys conducted at the same time for both harbors prevent a comparison of whether this has been a consistent trend or was unique to 2000. On the Los Angeles side of the harbor complex, year 2000 lampara catch values in the outer harbor were similar to those reported in 1986-1987 (MEC 1988). However, the 1986-1987 mean shown on Figure 3.3-6 was based on daytime samples; whereas, the mean for 2000 was computed across day and night samples. Given that fish catch is substantially higher at night (MEC 1996, 1999; SAIC and MEC 1996, 1997), one would have expected the 1986-1987 daytime mean to be lower than the day-night mean for 2000. Examination of daytime data for 2000 demonstrates that pelagic fish abundance in Los Angeles Harbor was lower in 2000 than in 1986-1987.

Catch values for 2000 also were lower than those reported in 1999 for the Cabrillo and Pier 300 Shallow Water Habitats and a deepwater area in Los Angeles Harbor (MEC 1999). The substantially higher values reported in 1999 were from one survey conducted during the peak abundance period (summer); whereas, the 1986-1987 and 2000 abundance values represent mean values over the course of a year or more of sampling.

On the Long Beach side of the harbor-complex, year 2000 values were within the range previously reported in 1994 and 1996 (MEC 1996; SAIC and MEC 1996, 1997). However, localized areas within Long Beach Harbor such as the West Basin (Station LB3) and Southeast Basin (Station LB5) had higher abundance values in 2000 than in the mid-1990s.

No harbor-wide spatial trends in the number of species were evident among studies conducted between 1988 and 2000 (Figure 3.3-7). For all previous lampara studies and the present study, the number of species at inner harbor stations ranged between 4 to 9 species, middle harbor stations recorded 4 to 12 species, and outer harbor stations had 3 to 11 species. The highest numbers of species were reported in the present study at the created Cabrillo, Pier 300, and Long Beach Shallow Water Habitats. The values represent an increase over historical numbers when the location was previously deep water. No overall differences in the number of species were evident between Long Beach and Los Angeles Harbors.

3.4 Demersal and Epibenthic (Trawl) Fishes



3.4.1 Community Summary Measures

Abundance

A total of 57,884 fish was collected by otter trawls (Table 3.4-1). The mean number of fish per trawl was higher during the day (448 fish) than at night (356 fish), although this difference was not significant.

Northern anchovy was the most abundant species collected (22,846), with white croaker, and queenfish also having high abundances (Table 3.4-1). These three species comprised 88% of the total catch. More of the northern anchovies were collected in day samples (95%) than in night samples. Nine species, including grass rockfish (*Sebastes rastrelliger*), bay pipefish (*Sygnathus leptorhynchus*), and sargo were collected only in day samples (Table 3.4-1). Similarly, 12 species, including basketweave cusk-eel, salema, topsmelt, and jacksmelt were collected only at night.

Mean abundance values by station (day and night surveys) are presented in Table 3.4-2 and Figure 3.4-1. Both day and night results showed seasonal patterns, with summer samples having significantly (p=0.0001) higher abundances and winter and spring samples having some of the lowest abundances (Figure 3.4-2). A total of 39,226 fish was collected during the August survey, which represents 68% of the total day-night catch across all seasons.

The highest mean abundance (692 for all surveys, day-night combined) was at Station LA1 in outer Los Angeles Harbor (Table 3.4-2). Other locations with high mean abundances (635 to 676) were at the Long Beach Shallow Water Habitat (Stations LB2A, B), Southeast Basin (Station LB5), and West Basin (Station LB3). The lowest mean abundances were at inner harbor stations in Channel 2 (Station LB4), Los Angeles East Basin (Station LA6), and Los Angeles West Basin (Station LA5). Mean abundances also were low at one, but not the other, of the replicate stations in the Pier 300 Shallow Water Habitat (Station LA7B) and shallow water off Cabrillo Beach (Station LA3B). There was a general trend of lower abundances in the inner harbor than the outer and middle harbor habitats (Figure 3.4-1). Overall mean abundance was nearly three times lower for inner harbor Stations LA5, LA6, LB4 (165 fish) than the other surveyed stations (449 fish) (refer to Table 3.4-2). Total mean abundance was slightly higher at stations in Long Beach Harbor (493 fish) than at stations in Los Angeles Harbor (329 fish) (refer to Table 3.4-2).

There was little difference in abundances between shallow and deepwater stations. For example, mean abundances at deepwater (12 to 24 m) stations ranged from 171 to 692, while the shallow water stations (4 to 6 m) had mean abundances between 117 and 676 (Table 3.4-2). Mean catch abundances across stations and surveys were essentially the same in deep water (410 fish) as in shallow water (392 fish) (refer to Table 3.4-2).

Biomass

A total of 1,145 kg of fish was collected across all surveys (Table 3.4-1). Opposite of abundance, mean biomass values were higher at night (9.6 kg) than during the day (6.3 kg) (Table 3.4-2). Mean biomass values were highest (10 to 15 kg) in the outer harbor (Stations LA1, LB1), Long Beach Main Channel (Station LB7), Long Beach West Basin (Station LB3), Long Beach Shallow Water Habitat (Station LB2), and Cabrillo Shallow Water Habitat (Station LA2) (Table 3.4-2). The lowest biomass values (1 to 3 kg) were collected in the inner harbor (Stations LA5, LA6, LB4). Mean biomass was slightly higher at shallow water stations (8.9 kg) than deepwater stations (7.4 kg). There was little difference in overall trawl fish biomass between Los Angeles Harbor (50% of total) and Long Beach Harbor (50% of total) (refer to Table 3.4-2). Biomass values exhibited a seasonal pattern characterized by higher biomass in spring-summer than fall-winter for samples collected at night. However, there was little variation in biomass values during the day.

Number of Species

A total of 61 species was collected among all stations and surveys between February and November 2000 (Table 3.4-1). Slightly more species (mean of 16 species) were collected at the Cabrillo, Pier 300, and Long Beach Shallow Water Habitats (Stations LA2, LA7, LB2) than at a naturally shallow area near Cabrillo Beach (Station LA3) (mean of 14 species) and all deepwater habitats (mean of 14 species) (Table 3.4-2). The fewest numbers of species (mean of 11-12) were collected in the inner harbor Channel 2 (Station LB4), Los Angeles East Basin (Station LA6), and Los Angeles West Basin (Station LA5).

More species were collected at night (mean of 12 species) than during the day (mean of 8 species) (Figure 3.4-2, Table 3.4-2). However, there were inconsistencies between day and night samples in terms of what surveys collected the most or fewest numbers of species. For example, more species were collected at night during the winter and fall surveys, but those surveys yielded the lowest numbers of species during the day (Figure 3.4-2, Appendix C.2-1). A significant interaction among seasons and day-night collections resulted from the different day and night data trends; therefore, temporal and seasonal differences were not statistically significant with the ANOVA analysis.

The total number of species across day and night for all surveys ranged between 18 and 32, with the most species (30 to 32) collected at the Pier 300 and Long Beach Shallow Water Habitat (Stations LA7 and LB2) (Appendix C.2.1). The lowest numbers of species (18 to 20) were collected in the Los Angeles Main Channel (Station LA4) and inner harbor (Stations LA5, LA6). The mean number of species per trawl was similar between stations in Long Beach and Los Angeles Harbors (15 and 14, respectively).

Diversity and Dominance

Diversity indices/community measures such as Shannon-Weiner, Margalef, and Dominance are presented in Table 3.4-3. Shannon-Wiener diversity values were highest (≥ 1.5) at the Cabrillo and Pier 300 Shallow Water Habitats (Stations LA2, LA7), outer Long Beach Harbor (Station LB1), and Los Angeles Main Channel (Station LA4). Values were lowest (< 1.0) in outer Los Angeles Harbor (Station LA1), Long Beach West Basin (Station LB3), and Pier J slip (Station LB6). Mean diversity values were higher for shallow water (1.47) than deepwater (1.20). Shannon-Wiener diversity was similar between day (1.18) and night (1.20) collections.

Margalef diversity values were higher (more equitable distribution of species) in open water (deep and shallow) and channel habitats (range of 1.97 to 3.06) than basin and slip habitats (range of 1.88 to 2.15) (Table 3.4-3). On average, deepwater stations had lower Margalef values (2.09) than shallow water sites (2.52). Values for night (2.29) samples were slightly higher than day (2.00) collections, although this difference was not statistically significant.

Dominance is the minimum number of species necessary to account for 75% of the abundance at a station. All stations were dominated by a small number of species (1 to 4) (Table 3.4-3). Higher dominance values (3 to 4) during the day were at the shallow water stations and deep waters of outer Long Beach Harbor (Station LB1). At night, there was little spatial pattern with higher dominance values (3 to 4) recorded for one or more stations within each habitat type. The highest combined day-night dominance value (5) was at one of the stations within the Pier 300 Shallow Water Habitat (Station LA7B).

3.4.2 Species Composition

Results of the station and species cluster analyses are presented in Figures 3.4-3 and 3.4-4, and Table 3.4-6. The two-way table identified four station associations (Station Cluster Groups 1-4), which were characterized by different combinations of four species groups (Species Cluster Groups A-D) (Figure 3.4-3).

With one exception (shallow water Stations LA3A, B), the stations clustered primarily by depth. Station Cluster Group 1 mainly included stations from the outer and middle harbors. Species Groups A and C characterized the station group, with species in Group A being relatively more abundant. Twelve species had relatively high abundance at stations within this group. Characteristic species included bay goby, California lizardfish, California tonguefish, fantail sole, hornyhead turbot, northern anchovy, speckled sanddab, specklefin midshipman, and white croaker.

Station Cluster Group 2 consisted of inner harbor stations in Los Angeles East and West Basins (Stations LA5 and LA6) and Long Beach Channel 2 (Station LB4). Species Groups A and C also characterized this group, although abundances of the species occurring at these stations were relatively low. Four species with higher relative abundance included barred sand bass, plainfin midshipman, specklefin midshipman, and yellowchin sculpin.

The Long Beach Shallow Water Habitat (Stations LB2A, B) formed Station Cluster 3. This was a diverse assemblage with relatively abundant species from Species Groups A, B, and C. Seventeen species had relatively high abundances at the stations within this group. Characteristic species included basketweave cusk-eel, California corbina, California halibut, California lizardfish, diamond turbot, English sole, hornyhead turbot, northern anchovy, round stingray, shovelnose guitarfish, and spotted turbot.

Cabrillo and Pier 300 Shallow Water Habitats (Stations LA7A, B and LA2A, B) formed Station Cluster Group 4. Species Groups C and D, and to a lesser extent Species Group A characterized the station group. Sixteen species had relatively high abundances at stations within this group. Characteristic species included barred sand bass, bat ray, California scorpionfish, diamond turbot, fantail sole, shovelnose guitarfish, shiner surfperch, spotted turbot, and white surfperch.

Species Group A included species that were ubiquitous throughout the harbor such as bay goby, California lizardfish, California tonguefish, hornyhead turbot, fantail sole, northern anchovy, queenfish, specklefin midshipman, and white croaker.

Species Group B consisted of species with a more restricted distribution in the harbors such as basketweave cusk-eel, California corbina, English sole, round stingray, and thornback, or that were pelagic species that were incidentally collected by trawls (deepbody anchovy, slough anchovy, jacksmelt).

Species Group C comprised species that were relatively more abundant at the shallow water stations (bat ray, California halibut, diamond turbot, queenfish, shovelnose guitarfish, spotted turbot) and rock associated species (barred sand bass, black surfperch, shiner surfperch, white surfperch).

Species Group D consisted of habitat-associated species such as barcheek pipefish, giant kelpfish, kelp bass, and pile surfperch. The higher incidence of habitat-associated species from Species Groups C and D in Station Cluster Groups 3 and 4 probably relates to the proximity of the stations to the San Pedro Breakwater, riprap around Pier 400, and eelgrass beds in the Pier 300 Shallow Water Habitat.

Results of the cluster analysis are summarized in Table 3.4-6. Species composition varied most by depth and secondarily between outer-middle and inner harbor areas. With the exception of the shallow water area near Cabrillo Beach (Station LA3), which grouped with deepwater stations, all other station groups separated by depth. Among the deepwater stations, there was a substantial difference in species composition between stations from the inner harbor (Stations LA5, LA6, LB4) and other stations. As mentioned in Section 3.3.2, temperature and transmissivity were the only parameters that varied in a consistent way with depth. Generally, temperatures were 1^{o}C warmer at shallow water stations than deepwater stations; transmissivity of near bottom waters did not appreciably differ between shallow and deepwater. Physical/chemical conditions such as dissolved oxygen, salinity, pH, and sediment grain size and provided little insight to the trawl catch species composition. Substantially more species had their higher abundances at stations in the Cabrillo, Long Beach, and Pier 300 Shallow Water Habitats than at other stations sampled in the harbors. In contrast, only a few species had relatively high abundances, and most species had relatively low abundances at stations in the inner harbor.

3.4.3 Dominant and Selected Species

Out of the 61 species collected over all stations and quarters, northern anchovy and white croaker accounted for 75% of the total catch (Table 3.4-1). Generally, schooling fishes were the most abundant and had high biomass values, including northern anchovy, white croaker, and queenfish. Other dominant species included California halibut, shiner surfperch, specklefin midshipman, and white surfperch. Size frequency plots for some of the dominant and common trawl collected species are presented in Figures 3.4-5. Size frequency distribution plots by station for these and other species caught by otter trawl are provided in Appendix C.2.2.

Northern anchovy was the most abundant species, accounting for 39% of the total catch. This species was collected at all sampling locations during every survey. However, abundances were up to one to two orders of magnitude higher during the summer survey than other surveys (Appendix C.2.3). Since more northern anchovies were collected using lampara nets, size frequency distribution for this species was discussed in Section 3.3 (see Figure 3.3-5). Similar sizes (juvenile to adult) were caught with otter trawl.

White croaker was the second most abundant species and accounted for 36% of the total catch (Table 3.4-1). This species had the highest total biomass. Similar to northern anchovy, white croaker was collected at all stations over all sampling quarters. Abundances were substantially higher (up to 2 to 3 times) during the summer and fall than winter and spring surveys (Appendix C.2.3). In general, more individuals were collected at the deepwater stations compared to the shallow locations. The Long Beach West and Southwest Basins (Stations LB3, LB5) had the highest numbers of white croaker (Table 3.4-4). Size classes ranged between 2 and 26 cm and exhibited a bimodal size distribution, with the most abundant smaller sizes ranging between 3 and 11 cm and the more common larger sizes between 17 and 22 cm (Figure 3.4-5). The smaller sizes were juveniles, and the larger sizes were adults. A wide range of sizes were collected at every station, however, relatively more juveniles were collected in deepwater basins and slips than other habitats in the harbors (Appendix C.2.2).

Queenfish comprised 13% of the total catch and was the third most abundant species (Table 3.4-1). Queenfish also were collected every quarter at all stations (Table 3.4-4). Abundances were up to an order of magnitude higher during spring, summer, and fall surveys than during winter (Appendix C.2.3). In general, more individuals were caught at shallow water stations than deepwater stations. Queenfish ranged in size from 2 to 25 cm, and had a bimodal size distribution (Figure 3.4-5). The most abundant smaller sizes ranged between 4 and 9 cm and the more common larger sizes ranged between 13 and 20 cm. In general, juveniles (< 12 cm) were more abundant than adults at the shallow water stations and inner harbor basins, whereas, the size distribution was more bimodal at the deepwater stations (Appendix C.2.2).

Commercially and/or recreationally important species, including California halibut and barred sand bass, had relatively high total abundance and biomass. California halibut ranked seventh in total abundance, with 547 individuals, and ranked second in total biomass over all stations and surveys (Tables 3.4-1, 3.4-5). Halibuts ranged in size from 4 to 73 cm, and had a bimodal distribution. The most abundant small sized fish ranged from 8 to 14 cm and the most abundant large sized fish were from 23 to 34 cm. California halibut mature at a relatively large size (males at 23 to 33 cm, females at 48 to 58 cm); therefore, most of the fish caught in the present study were juveniles and/or young adult males. Small juvenile halibuts (< 20 cm) were mainly collected at the Cabrillo, Long Beach, and Pier 300 Shallow Water Habitats (Stations LA2, LA7, LB2) (Appendix C.2.2).

Barred sand bass ranked tenth, with a total of 310 individuals (Table 3.4-1). They were slightly more abundant at shallow water stations (Table 3.4-4). Sizes ranged between 4 and 31 cm, with the most commonly collected sizes ranging between 13 and 22 cm, a mix of late stage juveniles and young adults.

The size distributions of other species commonly collected by otter trawl are shown on Figure 3.4-5. Most of the specklefin midshipmen were juveniles in the 4 to 9 cm size class. California tonguefish were primarily adults from 11 to 15 cm. Speckled sanddab were most abundant at 5 to 9 cm, a mix of juvenile and adult fish. Bay Goby were mainly 4 to 6 cm, which were likely young adults.

3.4.4 Otter Trawl Size Comparison (Special Study)

During the summer (August) and fall (November) surveys, two different sizes of otter trawls (16 and 25 ft) were used to sample six representative stations within the harbor complex. The purpose of this effort was to assess the differences in catch between the two nets, the sizes of which have been used in historical studies. This assessment, including development of an conversion factor between the two methods, was desired to facilitate comparisons with historical data.

Tables 3.4-7 and 3.4-8 summarize the results of the otter trawl study. There are two different ways to view the results of the study. First, is to look at the means for all six stations and compute the mean ratio of catch difference (Table 3.4-7). For example, in August for the day surveys there were on average 1,686 fish caught per station using the 25 ft net compared to only an average of 458 fish using the 16 ft net, this computes to a ratio of the larger net catching 3.68 times more fish than the smaller net. An alternate view is to compute the catch ratio for each station and then calculate an overall mean ratio e.g., the mean catch ratio during the day for the six individual stations for August using the 25 ft net is 15.8. This rather high ratio was influenced by the large catch at Station LA4 using the larger net and the poor catch using the smaller net at Stations LA4 and LA6. These results indicate that the 25 ft net caught, on average, between 3.68 and 15.8 times more fish in August during the day than the 16 ft net. Because of the large degree of variability associated with the individual trawls, the smaller value appears to be more representative of the differences in net size while the larger value appears to reflect differences in the distribution of fish; i.e., trawl sampling using the different size nets occurred on different days. During the night surveys, the variability of the catch was less and the larger net collected 2.58 to 3.75 times more fish depending upon the averaging method.

Day sampling for the November survey found that the smaller net sampled more fish than the larger net (Table 3.4-7). This result was influenced by large catches of small white croaker at two locations using the smaller otter trawl (Stations LA1 and LB7). The catch ratio for the larger net ranged from 0.32 to 0.62 compared to the smaller net implying that for this survey the smaller net caught about two to three times more fish. As noted above, this result was also influenced by the logistics of the study that required sampling on different dates for the two net sizes tested for this study. During the night surveys the larger net sampled between 0.94 to 2.01 times more fish than the smaller net.

The average difference between the two net sizes for fish abundance for both surveys, day and night was 1.78 to 3.14 more fish sampled with the larger net. Those results are in relative close agreement with the results for the invertebrates, which found a ratio of 3.29 to 3.32 times more invertebrates sampled with the larger net (see Section 5.4.5).

The differences were more consistent for the number of species collected (Table 3.4-7). For the August survey during the day, the larger net collected 1.64 to 2.24 more species; while during the night, the ratio was similar with the range being 1.85 to 2.19, depending upon the averaging method. For the November survey, the values were lower, but consistent, with the larger net sampling 1.05 to 1.23 more fish species during the day and 1.10 to 1.23 more species at night. For both surveys and day and night sampling, the larger net sampled 1.37 to 1.58 more species than the smaller net. These values are a little higher than the overall average for the number of invertebrate species, which ranged from 1.10 to 1.25 more invertebrates for the larger net (see Section 5.4.5).

In summary, the larger net collected about 2.5 times more fish and 1.48 times more species than the smaller net (mean over two surveys, day and night, and different averaging methods). These results demonstrate that net size affects fish abundance, number of species, and diversity estimates. The larger net provides a better description of the species found within the harbor. While appropriate conversion factors can be utilized to make numerical comparisons for abundance and number of species between studies using different net sizes, the list of species present in the harbor would be grossly underestimated using only the smaller net size. Unlike the results found for the invertebrates there appears to be a great benefit in using the larger net size for characterizing the fish communities within the harbor complex.

3.4.5 Summary of Spatial and Temporal Variations

A total of 57,884 fish representing 61 species was collected using otter trawls. There were only minor differences in trawl fish catch between day and night. Slightly more fish were caught using trawls during the day (56% of total catch) than at night (44% of total catch); the difference was not statistically significant. On the other hand, there was a significant seasonal difference in trawl catch with substantially more fish collected in the summer (68% of total catch) than all other seasons combined.

Spatial patterns for abundance were weaker than the temporal patterns. Overall mean catch abundances were similar between deep water (410 fish) and shallow water (392 fish). There also was little difference in otter trawl catch between Los Angeles Harbor (45% of total) and Long Beach Harbor (55% of total). However, there was a general trend of higher abundances in the outer and middle harbor habitats and lower abundances in the inner harbor. Fish biomass and number of species also were lower in the inner harbor. Slightly more species (mean of 16 species) were collected at the Cabrillo, Pier 300, and Long Beach Shallow Water Habitats (Stations LA2, LA7, LB2) than at other stations in the outer and middle harbor areas (mean of 14 species).

Species composition varied spatially according to depth and habitat type. Results of cluster analyses showed two different deepwater species associations. One in the inner harbor characterized by only a few species with relatively high abundances, and the other consisting of broadly distributed species throughout middle and outer harbor areas. The Cabrillo, Pier 300, and Long Beach, Shallow Water Habitats (Stations LA2, LA7, LB2) formed separate cluster groups characterized by relative diverse assemblages, including more species associated with rocky and/or vegetated areas. Two of the shallow water areas (Stations LA2, LA3) were located adjacent to the San Pedro Breakwater, which has adjacent subtidal kelp and algal beds. Similarly, the Long Beach Shallow Water Habitat (Station LB2) is located adjacent to riprap (Section Section 7.0) that fronts the east edge of Pier 400. Extensive eelgrass beds were mapped within the Pier 300 Shallow Water Habitat (see Section 8.0).

3.4.6 Historical Comparisons

The Los Angeles-Long Beach harbor complex is one of the largest and most intensively studied areas in southern California (Fay and Vallee 1978). Otter trawl sampling in the harbors began in the 1970s (e.g., Chamberlain 1973, Stephens et al. 1974, EQA-MBC 1976, HEP 1979), and periodically occurred at various sampling locations within the harbors in the 1980s (Horn and Hagner 1982, Allen et al. 1983, MBC 1984, MEC 1988) and 1990s (CLA-EMD 1993-1999; MEC 1996, 1999; SAIC and MEC 1996, 1997).

A consistent group of fish species has dominated the fish community of the harbors since the 1970s with few exceptions (Table 3.4-9). Generally, the most abundant species have included white croaker, northern anchovy, and queenfish. Relative abundances of these species have varied among different years. The dominance of white croaker relative to other species ranged from moderate levels in the 1970s and early 1980s (35 to 61% of total catch) to high levels in the mid-1980s to mid-1990s (63 to 90% of total catch), and appears to have returned to more moderate levels since 1998 (36 to 47% of total catch). In contrast, northern anchovy comprised 2 to 18% of the total catch during surveys in the 1970s and early-1980s, but were rare in collections from the mid-1980s and 1990s; relative abundance of this species has increased in the harbors over the last two years (12 to 39% of total catch). The relative abundance of queenfish has exhibited considerable interannual variation, ranging from 4 to 38%.

Other species with relative high abundance have included three species of flatfish (California tonguefish, speckled sanddabs, California halibut) and two perch (shiner surfperch, white surfperch). The relative abundances of flatfish species have showed variable trends in dominance that may relate to sampling locations for the different studies. In general, relative abundances of California tonguefish and speckled sanddab have been higher for studies of deepwater outer harbor stations (Stephens et al. 1974, HEP 1979, MBC 1984, MEC 1988, CLA-EMD 1993-1999) than studies that have also included inner harbor and/or shallow water areas (EQA-MBC 1976, 1978; SAIC and MEC 1997, MEC 1999, present study). The relative abundance of California halibut appears to have increased in the harbors; it was not reported in the studies from the 1970s, but has been a consistent member of the fish community in all studies since the 1980s.

Results of the present study indicated that abundance was significantly higher in the summer than other seasons; however, seasonal trends were not apparent for biomass (except for at night) or number of species. Larger catches in summer rather than winter have been reported for some of the historical studies (Stephens et al. 1974, Allen et al. 1983, SAIC and MEC 1997, CLA-EMD 1998), but not others (MBC 1984). Spatial trends indicate only small differences in abundance, biomass, and number of species between the shallow and deepwater stations in 2000.

Results of the cluster analysis indicated a less diverse species composition in deeper waters of the inner harbor as compared to middle and outer harbor areas. Additionally, species composition varied between shallow and deepwater areas, with a greater variety of species associated with rocky and/or vegetated habitats at the Cabrillo, Pier 300, and Long Beach Shallow Water Habitats. No distinct differences were observed between Los Angeles and Long Beach harbors. Abundances tended to be slightly higher among the Long Beach stations, which accounted for 55% of the total catch.

Mean catch for trawl sampling between 1986 and 2000 (MEC 1988; SAIC and MEC 1996, 1997; and the present study) is presented in Figure 3.4-6. Comparisons among studies are hampered by the use of different sized otter trawls. Most of the earlier studies used a 16 ft (4.9 m) otter trawl, whereas a 25 ft (7.6 m) trawl was used in the present study. As indicated in Section 3.4.4, catch variability can be high between the two nets. Because previous studies by MEC included both day and night sampling, means across day-night are included on Figure 3.4-6. Applying an average net difference ratio of 2.6 to earlier data indicates that 2000 catch values were generally similar to those in 1986-1987 in Los Angeles Harbor (MEC 1988), although catch was higher near Pier 400 (Station LA1) in 2000 than in the 1980s. Catch values in 1999 measured by the City of Los Angeles (CLA-EMD 2000) near Pier 400 (during the day with a 25 ft net) were substantially lower than the day-night mean shown on Figure 3.4-6 for 2000. An even higher difference would be indicated if the daytime catch value (1,056) for 2000 was used. CLA-EMD (2000) indicated that continued low abundance and number of species in trawl catch most likely resulted from the ongoing construction activity associated with Pier 400.

Catch values in Long Beach Harbor appeared to be higher in 2000 than recorded in 1994 and 1996 (mainly 1996 data on Figure 3.4-6) in the outer and middle harbor areas (even after applying a net difference ratio of 2.6), and lower in 2000 in the inner harbor. Insufficient data are available to evaluate this in the context of a temporal trend. The dramatic shifts in trawl catch abundance reported by the City of Los Angeles each year from 1996 through 1999 (CLA-EMD 1999, 2000), which they attributed to construction of Pier 400, confound evaluation of spatial trends in fish trawl catch abundance in the harbors over the last five years.

A comparison of patterns in trawl catch in the 1970s and patterns in species composition in the 1980s and 1990s is presented in Figure 3.4-8. Trawl data collected in the 1970s (HEP 1980), which represents totals (not means) in number of species and abundance over four surveys, indicate slightly fewer species and higher abundance in trawl catch in Long Beach Harbor (range 10 to 16 species, mean 12 species; range 182 to 418 fish, mean 302) as compared to Los Angeles Harbor (range 12 to 16 species, mean 14 species; range 184 to 296 fish, mean of 214). That level of difference is considered relatively small. Cluster analysis of 1986-1987 data from Los Angeles Harbor (MEC 1988) indicated different species associations near San Pedro Breakwater, shallow habitat near Pier 300 and Cabrillo Beach, and in deep open waters in the outer harbor. Similar patterns were observed in the present study. Dynamic small-scale spatial patterns were noted in Long Beach Harbor in 1996. In the present study, large-scale spatial patterns were observed with separation of the middle and outer harbor areas from those in the inner harbor, and shallow from deepwater areas.

No temporal trends in the number of species were evident among studies conducted between 1986 and 2000 (Figure 3.4-7), even when taking into consideration differences in catch efficiencies of the two nets. One notable difference, however, concerns the higher mean number of species collected in shallow waters near the San Pedro Breakwater in 2000. Deeper water was sampled in that vicinity in 1987-1987 and fewer species were collected at deeper depths.

3.5 Shallow Subtidal (Beach Seine) Fishes

3.5.1 Community Summary Measures

Abundance

Abundances at the two beach seine locations, Cabrillo Beach and Pier 300 were variable over all sampling quarters. Topsmelt was the most abundant species, and arrow goby (*Clevlandia ios*), and diamond turbot were also commonly collected (Table 3.5-1). These three species comprised 95% of the total catch.

Mean total abundance by station is presented in Table 3.5-2 and Figure 3.5-1. No seasonal patterns in abundance for beach seines were evident. For February surveys, Pier 300 had the highest mean abundance (417), while an average of 57 fish per haul were collected at Cabrillo Beach (Table 3.5-2). Mean abundances were highest in May for Pier 300 (1,921), while Cabrillo Beach had one of the lowest total catches during any quarter. Summer (August) mean abundances were highest at Pier 300 (120), while an average of only 16 individuals were collected at Cabrillo Beach. For November, mean abundances were highest at Cabrillo Beach (59) compared to Pier 300 (21). The high abundance at Pier 300 during the May survey was due to a large haul of topsmelt (Appendix C.3.2).

Biomass

Similar to patterns described above for abundance, biomass values also were relatively variable over all sampling quarters. Mean biomass was lowest during November at Pier 300 (0.02) and highest in February (0.97 kg) at the same station (Table 3.5-2). February had the highest biomass for all quarters at both stations. No difference was found for total mean biomass between stations over all sampling quarters combined.

Number of Species

A total of 17 species were collected at Cabrillo Beach, while 14 species and an unidentified individual from one family (Surfperches; Embiotocidae) were collected at Pier 300 (Table 3.5-1, Table 3.5-2). The greatest number of species (11) was collected at Cabrillo Beach during May sampling, while the fewest species (2) were collected at Pier 300 during November. No differences were found for the mean number of species between stations (Figure 3.5-1).

Diversity and Dominance

Community measures for the beach seines are presented in Table 3.5-2. The mean Shannon-Weiner diversity index was higher at Cabrillo Beach (1.23) than Pier 300 (0.34). With the exception of November (0.10), Shannon-Weiner diversity values at Cabrillo Beach were relatively constant throughout the sampling periods. Similar trends were evident for Pier 300, with November having the lowest value (0.19). Margalef values followed similar trends for both stations, with the lowest values observed in November and the highest values recorded in February and May. Dominance values were fairly constant at Cabrillo Beach, ranging between a low in November (1) and a high in May (4). Dominance was the same (1) at Pier 300 during all sampling periods.

3.5.2 Species Composition

A total of 20 fish species was collected during all surveys at both stations combined (Table 3.5-1). Although not significant, more species (17) were collected at Cabrillo Beach compared to Pier 300 (14). Shallow water species collected at each site included topsmelt, arrow gobies, diamond turbot, pipefish, and giant kelpfish.

Only one species collected by beach seines in 2000, yellowfin goby (*Acanthogobius flavimanus*) can be considered non-indigenous or exotic. Additional detail concerning this species is presented in Section 3.6.

3.5.3 Dominant and Selected Species

Of the 20 species collected over all stations and quarters, three comprised the most abundant, represented 95% of the total catch (Table 3.5-1). Topsmelt was the most abundant species collected at both beach seine stations over all surveys. Topsmelt sizes at Cabrillo ranged between 3 and 15 cm, while Pier 300 had sizes between 2 and 11 cm (Figure 3.5-2); thus, most were juveniles. Arrow goby and diamond turbot were also commonly collected at Pier 300, while dwarf surfperch (*Micrometrus minimus*) was the second most abundant species at Cabrillo. Arrow goby sizes at both sites ranged between 2 and 4 cm, with most gobies in the 3 cm size class. More of the diamond turbot were collected at Pier 300 compared to Cabrillo. Diamond turbot collected at Pier 300 ranged in size from 1 and 11 cm, while the one individual collected at Cabrillo was in the 7 cm size class.

Commercially and/or recreationally important species, including California halibut and barred sand bass, had low total abundances at both stations. An average of 7 California halibut were collected at Cabrillo, while an average of only 1 individual was caught at Pier 300 (Table 3.5.1-1). Halibut at Cabrillo ranged in size between 6 and 23 cm, with most being in the 7 to 10 cm size class (Figure 3.5-2). Halibut from Pier 300 were in the smaller size classes (6 and 8 cm). All collected halibut were juveniles or, in the case of the larger individual, a young male. Barred sand bass were only collected at Cabrillo, with most fish in the 9 to 10 cm size class; no barred sand bass were collected at Pier 300.

3.5.4 Summary of Spatial and Temporal Variations

Spatial and temporal trends were less distinct for the beach seine locations compared to the lampara and trawl stations, as described above in Sections 3.3.4.and 3.4.4. Abundance did not show typical seasonal patterns (see MEC 1988 and SAIC and MEC 1996), with average total abundances being highest in May at Pier 300 and highest in November at Cabrillo. Abundances were lowest in summer (August) at Cabrillo and lowest in November at Pier 300 (Table 3.5-2). Different temporal patterns were observed for biomass. The highest biomass for both seine stations occurred in February, while the lowest values were in August (Cabrillo) and November (Pier 300). Similarly, no distinct patterns for number of species were evident; Cabrillo had more species collected in May (11) compared to all the other sampling periods. More species were collected at Pier 300 in February (9), than any other quarter. Because only two beach seine stations were sampled, spatial trends are difficult to determine. While Pier 300 had higher average abundance, average annual biomass and number of species were essentially the same between stations. The main difference between the two locations was larger catches of topsmelt in three of the four quarters at Pier 300. Because eelgrass occurs at both beach seine locations, the variability in topsmelt catch most likely reflects natural variability rather than a habitat-associated difference between locations.

3.5.5 Historical Comparisons

Few studies have used beach seines to characterize shallow water fishes in the harbors. Table 3.5-3 summarizes results for surveys that have been conducted at Cabrillo Beach and/or Pier 300. Horn and Hagner (1982) conducted a survey in July 1982 at the Seaplane Anchorage. A total of 9 species was caught over day-night sampling: 4 during the day and 9 at night. Queenfish dominated the day catch, and queenfish and California grunion (*Leuresthes tenuis*) were most abundant at night. MEC sampled a beach located just south of the Seaplane Anchorage in 1999 and during the present study. The 1999 survey represents one sampling date, whereas, the site was sampled quarterly in 2000. Substantially more fish and a greater variety were caught in 1999 and 2000 than in 1982. It is not known to what extent the differences between years may relate to difference in the habitats. Extensive eelgrass occurred in the sampling area in 1999 and

2000. No report of eelgrass was made in the 1982 report. The species collected in 1999 and 2000 included a mix of bottom-associated gobies, schooling fish (topsmelt), flatfish (California halibut, diamond turbot), and pipefish. Several of these species are associated with vegetated habitats. The non-indigenous yellowfin goby also was caught in 2000. In contrast, schooling fish (California grunion, queenfish, slough anchovy, walleye surfperch, white croaker) were predominantly caught in 1982; although, walleye surfperch may be associated with rocky and/or vegetated habitats. Results of the 2000 study, which included sediment grain size analysis, indicates that substrate type may have differed among the stations sampled during the present and historical study. In the present study, sediment within the Seaplane Anchorage had a much finer sediment (> 90% silt/clay) than that in the Pier 300 Shallow Water Habitat (< 50% silt/clay).

Allen et al. (1983) sampled juvenile and adult fish with a variety of methods, including a bag (=beach) seine, over a 12-month period at Cabrillo Beach. A total of 37 species was collected with the beach seine over all surveys. Northern anchovy comprised 73% of the catch; queenfish, California grunion, and dwarf surfperch represented 16% of the catch. Fewer species were collected at Cabrillo Beach by MEC in 1999 and the present study. A large part of that difference between the latter and earlier seine studies undoubtedly relates to the number of surveys. Over half of the species reported in 1982 were represented by only a few observations, with the species accounting for < 0.1% of the total fish abundance. With three times as many surveys, it's not surprising that more species were reported in 1982. Dominant species differed somewhat between the earlier and latter surveys, with more species associated with rocky and/or vegetated habitats being caught in the 1999 and 2000 seines. With the exception of the bottom-associated arrow goby (*Clevelandia ios*), other dominant species reported in 1982 were schooling fish (i.e., California grunion, northern anchovy, queenfish, dwarf surfperch). Eelgrass and mobile kelp occurred in the vicinity of the seine location in 1999 and 2000 (see Sections 7 and 8). Allen et al. (1983) reported that *Gracilaria* (red algae) beds were extensive in the shallows off the sand beach.

MBC (1999) sampled fish at two stations at the Southwest Slip in inner Los Angeles harbor. Results of that study indicated that schooling fish (topsmelt, slough anchovy, and deepbody anchovy) and the non-indigenous yellowfin goby were numerically dominant.

The nearshore beach habitat apparently serves as a nursery area for a variety of fish in Los Angeles Harbor. Most of the fish collected in 1999 and 2000 at Cabrillo Beach and the Pier 300 ShallowWater Habitat were juveniles. Horn and Hagner (1982) considered the Seaplane Anchorage an important nursery area. Similarly, Allen et al. (1983) reported that the fish assemblage off Cabrillo Beach was comprised largely of juveniles.

3.6 Exotic Species

The only exotic (non-indigenous) species collected in the 2000 sampling surveys was the yellowfin goby (*Acanthogobius flavimanus*). This species is native to Japan, Korea, and northern China (Miller and Lea 1972, Eschmeyer et al. 1983) and was accidentally introduced into the Sacramento-San Joaquin estuary in the 1950s, through the ballast systems of ships (Brittan et al. 1963). A second population has been reported in Los Angeles, Long Beach Harbor, and Newport Bay (Haaker 1979), and was likely established in the same manner as described above.

A total of 19 individuals were collected in beach seines during the present study, most (18) at the Pier 300 site. This species is also commonly collected in many of the southern California bays and lagoons (MEC 1993, MEC 1999, Merkel and Associates 2001).

The Pacific cutlassfish (*Trichiurus nitens*) is relatively uncommon, but has been collected using the lampara net in previous harbor studies (SAIC and MEC 1996). For the present study, all cutlassfish (8) were collected with the lampara net at the Pier J slip station (LB6), with most (7) being caught during day surveys. This species is found worldwide in warmer waters and in the eastern Pacific Ocean between Peru and San Pedro (Miller and Lea 1972). Little information is available on life history of this species, but abundances have increased in coastal trawl surveys during the recent El Niño events (L. Honma, personal communication 2000). This species is not considered exotic, but rather is notable because it is rarely caught.

3.7 Summary

While there have been numerous site-specific environmental studies conducted in the Long Beach and Los Angeles Harbors during the past several decades, only a few have studied the entire area. Community parameters in the harbor environment are complex reflecting the various habitats and seasonal patterns.

Abundance

Northern anchovy (*Engraulis mordax*) was the most abundant species collected with lampara nets; white croaker (*Genyonemous lineatus*), queenfish (*Seriphus politus*), topsmelt (*Atherinops affinis*), Pacific sardine (*Sardinops sagax*), shiner surfperch (*Cymatogaster aggregata*), and salema (*Xenistius californiensis*) also had high abundances. More fishes were collected in night lampara samples compared to day samples. For trawls, northern anchovy was the most abundant species collected, with white croaker, and queenfish also having high trawl abundances. Topsmelt was the most abundant species collected at the two beach seine locations, Cabrillo and Pier 300. Arrow goby (*Clevlandia ios*) and diamond turbot (*Hypsopsetta guttulata*) also were commonly collected. These three species comprised 95% of the total beach seine catch.

Both day and night results for lampara and trawl surveys showed typical seasonal patterns with summer samples having the highest abundances at all stations and winter samples having the lowest abundances. The highest mean abundance (all surveys combined) was at Station LB3. The lowest mean abundance was at Station LA6. In general, mean abundances were higher among the Long Beach stations compared to the Los Angeles stations. Although there was some indication that dredging and/or disposal activities may have resulted in lower lampara fish catch near Pier 400, there was little correspondence between otter trawl fish catch and locations near or away from these perturbations.

There was a nearly four-fold increase in the number of fish caught at night with lampara during the day. This was mainly due to higher abundance of schooling species such as northern anchovy, white croaker, queenfish, and topsmelt in night samples. This day-night difference relates to the behavior of these species, which tend to form schools at depth during the day and disperse towards the surface at night (Love 1996). Thus, schooling fish are patchy in their distribution during the day (consequently, harder to catch) and more evenly spread out at night (consequently, easier to catch).

Biomass

Similar to patterns observed for abundance, biomass values at all the sampling locations also were variable. Bay rays (*Myliobatis californica*) had the highest total biomass for day and night samples combined. Other species having high total biomass values included California barracuda (*Sphyraena argentea*), white croaker, northern anchovy, and queenfish. California barracuda had the highest day biomass, while bat rays had the highest night-collected biomass. With a few exceptions (night samples in February and August), biomass was highest at the shallow water stations (e.g., LA2A and LA7A) over all quarters. Trawl results for biomass were similar. Bay rays had the highest total trawl biomass for day and night samples combined, with California barracuda, white croaker, northern anchovy, and queenfish also having high biomass values. No difference was found for total mean biomass between beach seine stations over all sampling quarters combined.

Station LA2A had high biomass values due to collections of a single large species (bat ray), which accounted for 76% of the total biomass. This species was only collected at half of the stations sampled. White croaker, northern anchovy, topsmelt, and queenfish had high total biomass values and were collected at all stations throughout the harbors. For trawls, Stations LA2A and LA1 had the highest biomass, primarily due to large catches of bat rays and white croaker.

Number of Species

A total of 76 taxa representing 74 unique species were collected using a combination of gear designed to capture demersal, pelagic, and nearshore fishes. A total of 50 species was captured with lampara nets over all stations and sampling periods. In contrast, 62 species and unidentified individuals from one family (pipefishes; Syngnathidae) were trawl-collected among all stations over all surveys. For beach seines, a total of 17 species was collected at Cabrillo, while 14 species and an unidentified individual from one family (Surfperches; Embiotocidae) were collected at Pier 300. No differences were found for the mean number of beach seine species between stations.

Dominant Species

Out of the 50 species collected over all stations and quarters with lampara nets, 11 comprised the most abundant and/or highest biomass (Table 3.3-1). Five schooling species (northern anchovy, white croaker, queenfish, topsmelt, and Pacific sardines) accounted for 90% of the abundance, and northern anchovy dominated the lampara catch with 68% of the total. These species plus bat rays and California barracuda accounted for 77% of the biomass.

For trawls, six out of the 61 species collected over all stations and quarters represented 95% of the total catch. Similar to lampara catches, schooling species (northern anchovy, white croaker, and queenfish) were the most abundant and accounted for 89% of the abundance. These species as well as California halibut, bat ray, and shovelnose guitarfish accounted for 63% of the biomass.

Of the 17 species collected with beach seines over all stations and quarters, three (topsmelt, arrow goby, and diamond turbot) comprised 95% of the total catch.

Commercially and/or recreationally important species, including California halibut and barred sand bass, had low total abundance and low biomass in lampara catches. For trawls, halibut ranked seventh in total abundance (547 individuals), ranked second in total biomass over all stations and surveys, and occurred at all sampling locations. A total of 310 barred sand bass was collected in trawls, with a fairly even distribution between deep and shallow water stations. California halibut and barred sand bass had low total abundances at both beach seine stations.

Summary of Spatial and Temporal Variations

Abundance patterns for lampara and otter trawl sampling showed typical seasonal variation (see MEC 1988; SAIC and MEC 1996, 1997), with the total number of fish collected (combined day and night surveys) generally increasing in winter (February) and peaking in summer (August), before decreasing in the fall (November). In addition, there were differences between night and day samples. For example, over three times more fishes were collected with the lampara net during night surveys compared to day. These differences were primarily due to large night catches of northern anchovy, white croaker, and queenfish. For trawls, differences were primarily due to large daytime catches of northern anchovy and large nighttime catches of white croaker. Beach seine abundance did not show typical seasonal patterns, with average total abundances being highest in May at Pier 300 and highest November at Cabrillo. Beach seine abundances were lowest in summer (August) at Cabrillo Beach and lowest in November at Pier 300.

In general, more fish were collected from Long Beach Harbor than Los Angeles Harbor, due to large catches of northern anchovy within basins of the middle and outer Long Beach Harbor. Although there was some indication that dredging and/or disposal activities may have resulted in lower lampara fish catch near Pier 400, there was little correspondence between otter trawl fish catch and locations near or away from dredging or disposal.

Little difference was observed in lampara fish catch between inner and outer harbor areas, indicating that pelagic schooling fish species range in high abundances throughout the harbor complex. In contrast, deepwater habitats in outer and middle harbor areas generally had a greater number, biomass, and variety of trawl-caught fish than inner harbor areas.

Temporal biomass patterns from the lampara catch were different from the abundance trends described above. Biomass was highest in February, decreased to a low in May, and increased in the August and November samples. In addition, few differences were evident between day and night biomass values. Lampara catch biomass was highest at shallow water stations, which contributed to a higher mean total biomass collected in Los Angeles Harbor than in Long Beach Harbor. In contrast, trawl biomass showed typical seasonal patterns, with the highest values in summer and lowest in winter. Shallow and deep-water stations also had similar total trawl biomass for nearly all surveys. In addition, no differences were found in total biomass values between Los Angeles and Long Beach harbors, with each accounting for 50% of the total trawl catch. Different temporal patterns were observed for biomass. The highest biomass for both seine stations occurred in February, while the lowest values were in August (Cabrillo) and November (Pier 300)

No distinct temporal trends for the total number of species were observed over all surveys. The number of species was generally the same during all surveys regardless of sampling gear.

More species were collected at the shallow water stations than the deepwater stations with both lampara and trawl nets, and generally fewer numbers of species were caught in the inner harbor. No distinct patterns for number of species collected with beach seines were evident; Cabrillo Beach had more species collected in May (11) compared to all the other sampling periods. More species were collected at Pier 300 in February (9), than any other quarter.

The harbors provide important nursery habitat for a variety of species. Many of the fish caught in 2000 were juveniles. While more juvenile white croaker were caught in deepwater basins and slips, a greater variety of fish used the shallow waters as nursery habitat (e.g., bat rays, California halibut, diamond turbot, queenfish, topsmelt) .

Harbor-Wide Estimates

The total number of fishes occupying Long Beach and Los Angeles harbors was estimated using results from lampara and trawl sampling. The total estimated number of fishes for day, night, and day/night combined is presented in Table 3.6-2. For all species combined (day and night), an estimated 44,591,672 fish occupy both harbor areas (Table 3.6-2). The top five species (northern anchovy, white croaker, queenfish, Pacific sardine, and topsmelt) account for nearly 92% of the total fish populations. These same species ranked in the top five based on day catches and account for over 92% of the total day estimate (Table 3.7-2). For night only estimates, Pacific sardines were replaced with specklefin midshipman (*Porichthys myriaster*) in the top five. These dominant species accounted for an estimated 93% of the total fish population at night within the harbors.

Exotic Species

The only exotic (non-indigenous) species collected in the 2000 sampling surveys was the yellowfin goby (*Acanthogobius flavimanus*). This species is native to Japan, Korea, and northern China (Miller and Lea 1972, Eschmeyer et al. 1983) and was accidentally introduced into the Sacramento-San Joaquin estuary in the 1950s, through the ballast systems of ships (Brittan et al. 1963). A second population has been reported in Los Angeles, Long Beach Harbor, and Newport Bay (Haaker 1979), and was likely established in the same manner as described above. A total of 19 individuals were collected in beach seines during the present study, most (18) at the Pier 300 site. This species is also commonly collected in many of the southern California bays and lagoons (MEC 1993, MEC 1999, Merkel and Associates 2001).

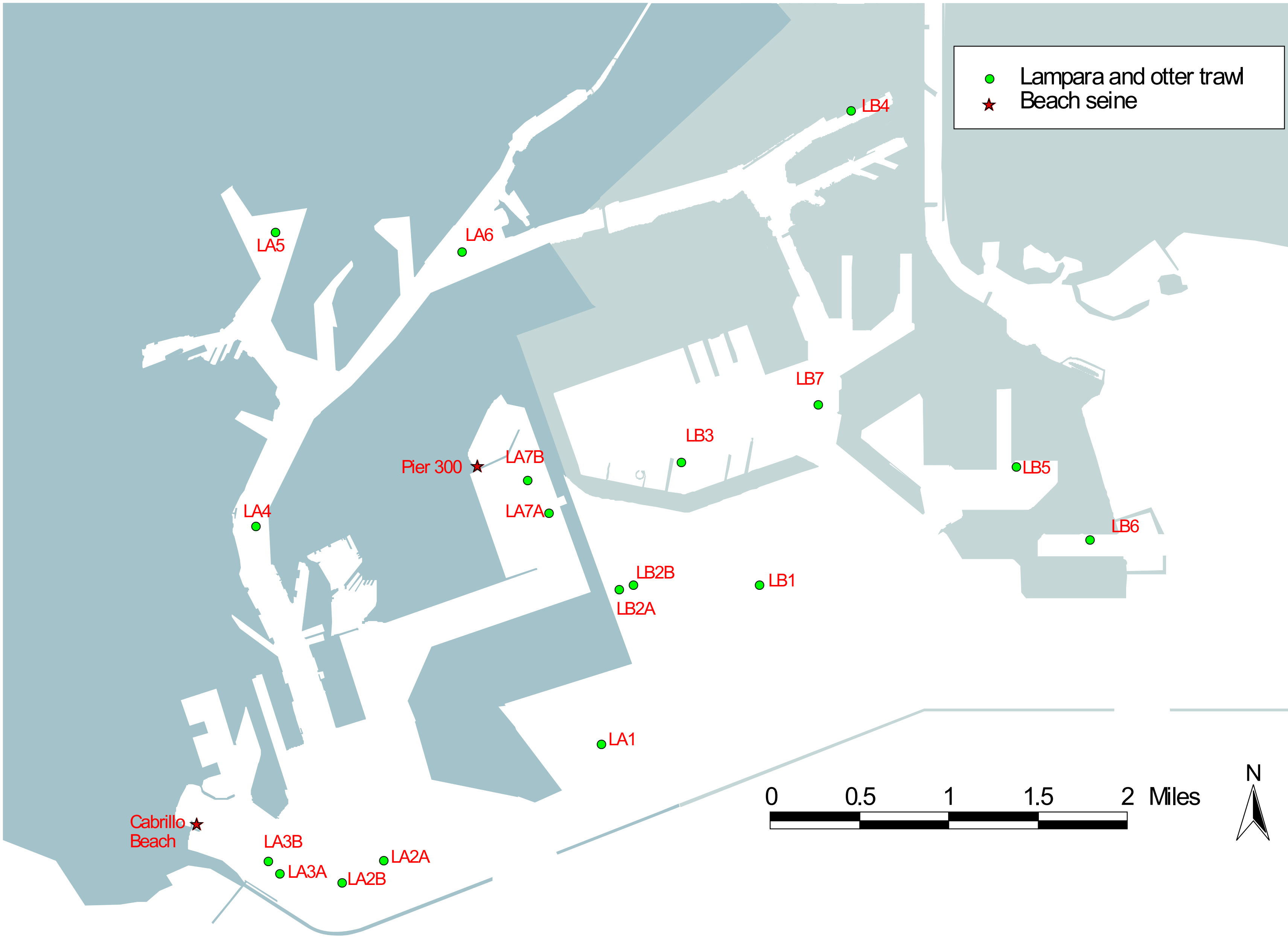


Figure 3.2-1. Fish sampling stations in Long Beach and Los Angeles Harbors, February - November 2000.

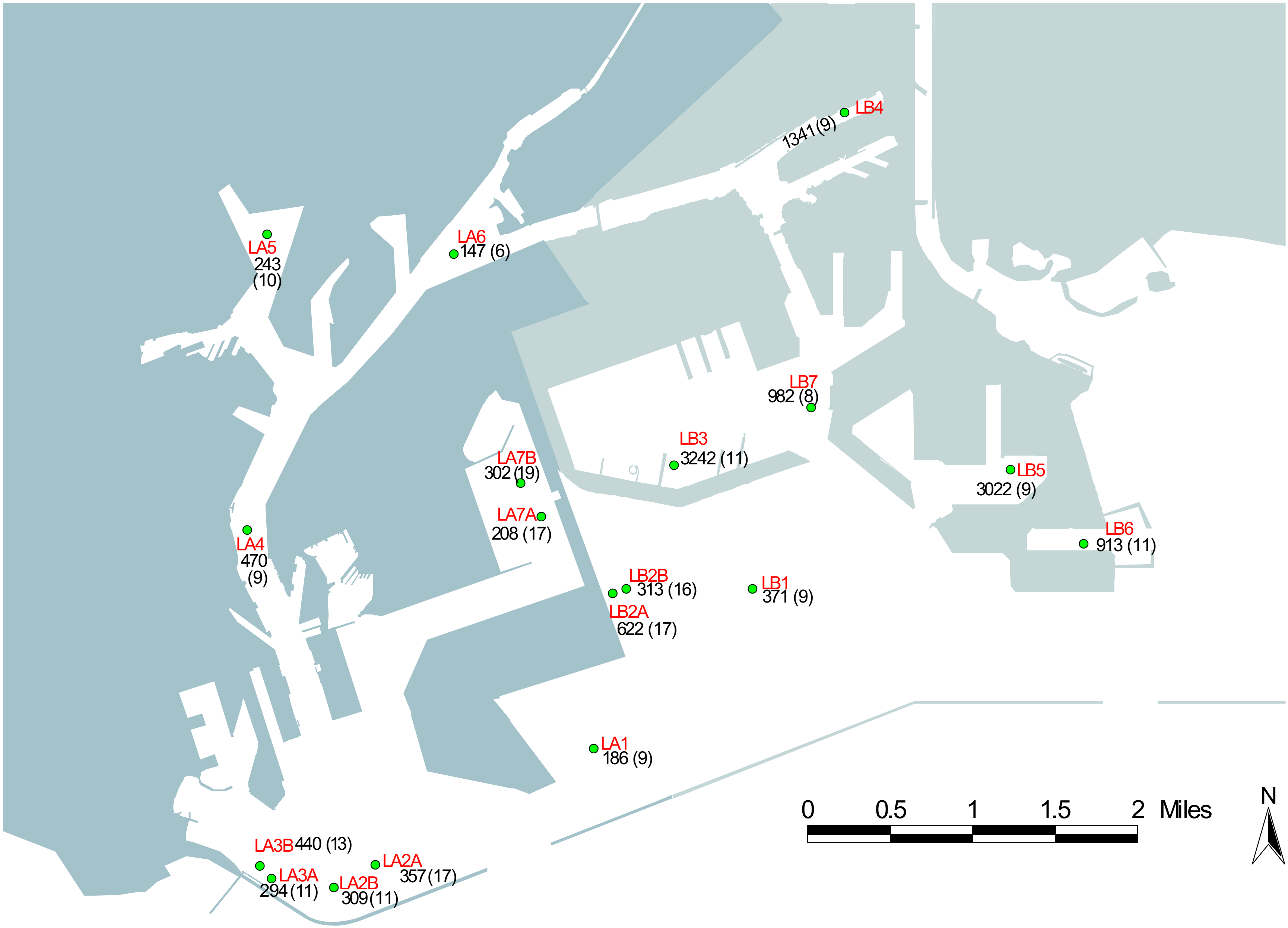


Figure 3.3-1. Mean annual abundance (and number of species) of fish caught by lampara in Long Beach and Los Angeles Harbors, February - November 2000.

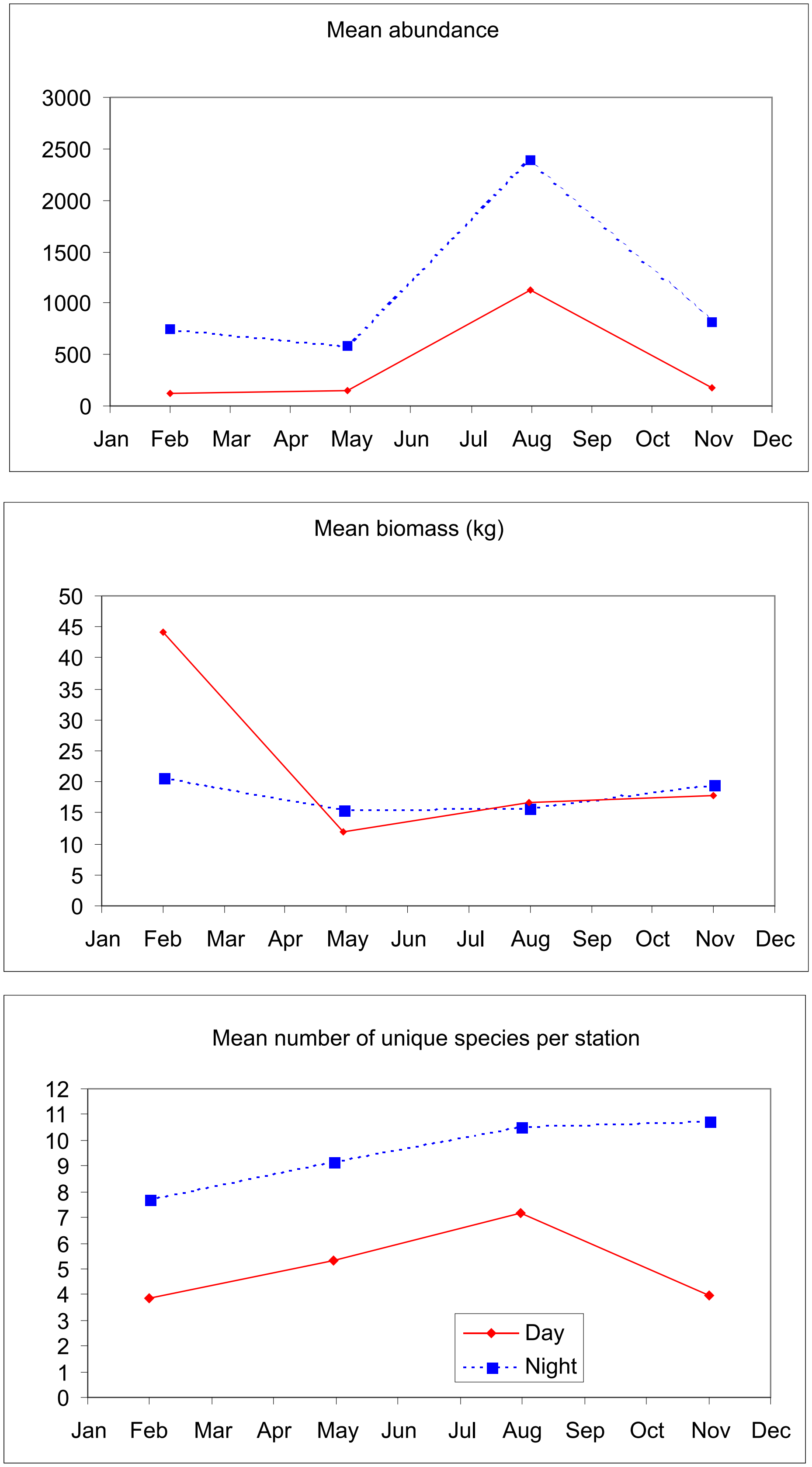


Figure 3.3-2. Seasonal mean abundance, biomass, and number of species of fish caught by lampara in Long Beach and Los Angeles Harbors, February - November 2000.

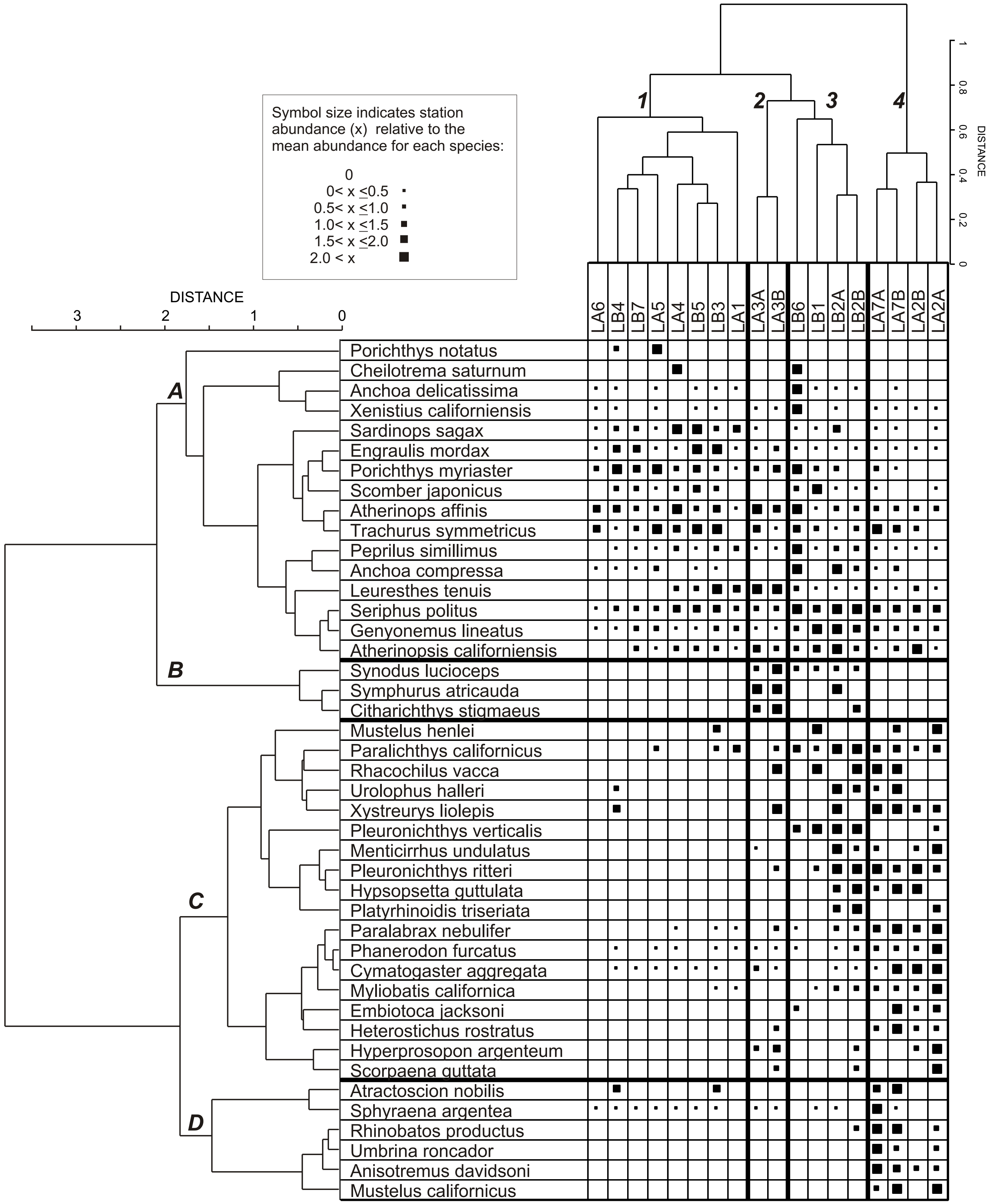


Figure 3.3-3. Cluster analysis of mean species abundance of fish caught by lampara in Long Beach and Los Angeles Harbors, February - November 2000.

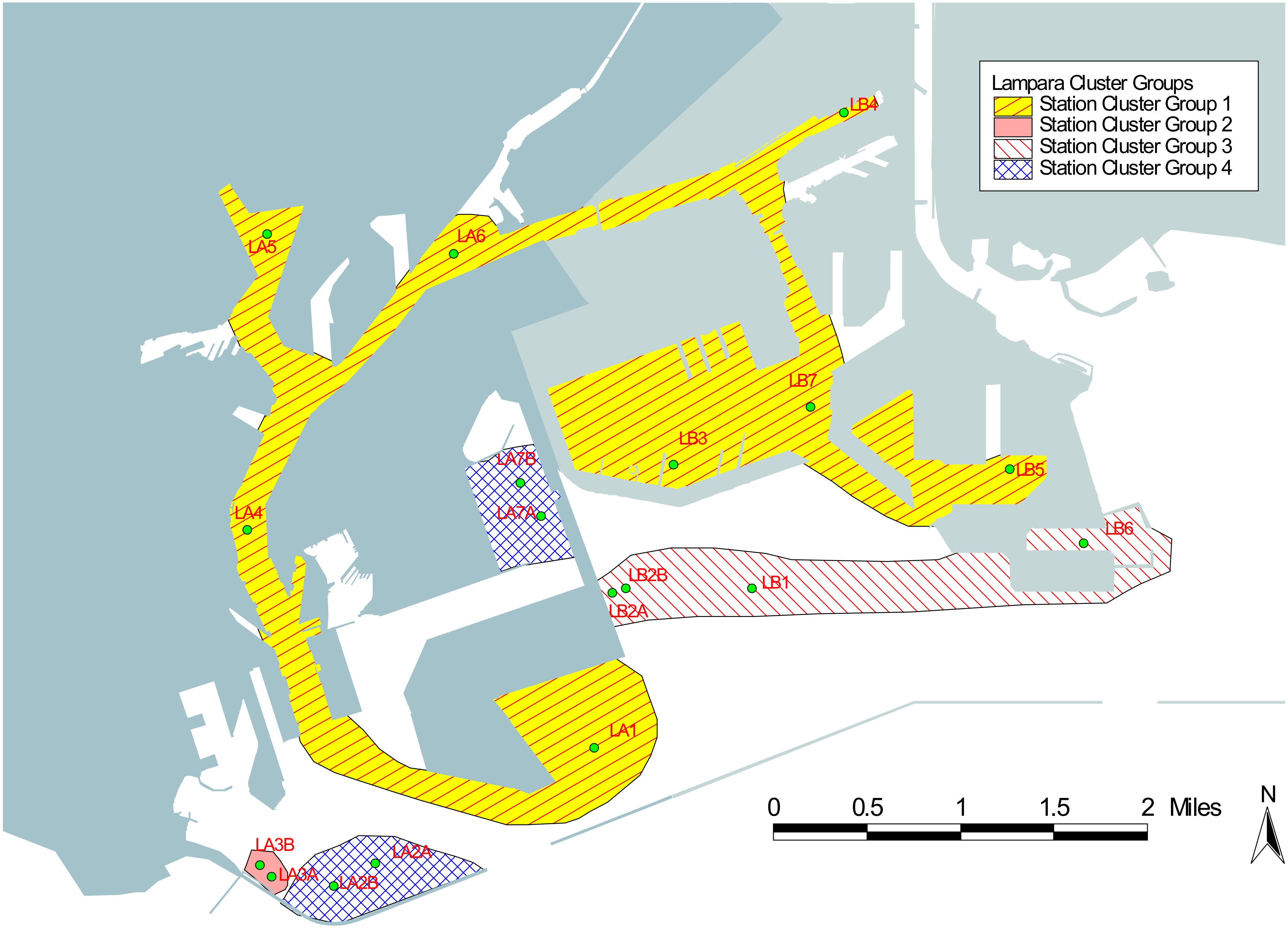


Figure 3.3-4. Map of station groups identified by cluster analysis of fish caught by lampara in Long Beach and Los Angeles Harbors, February - November 2000.

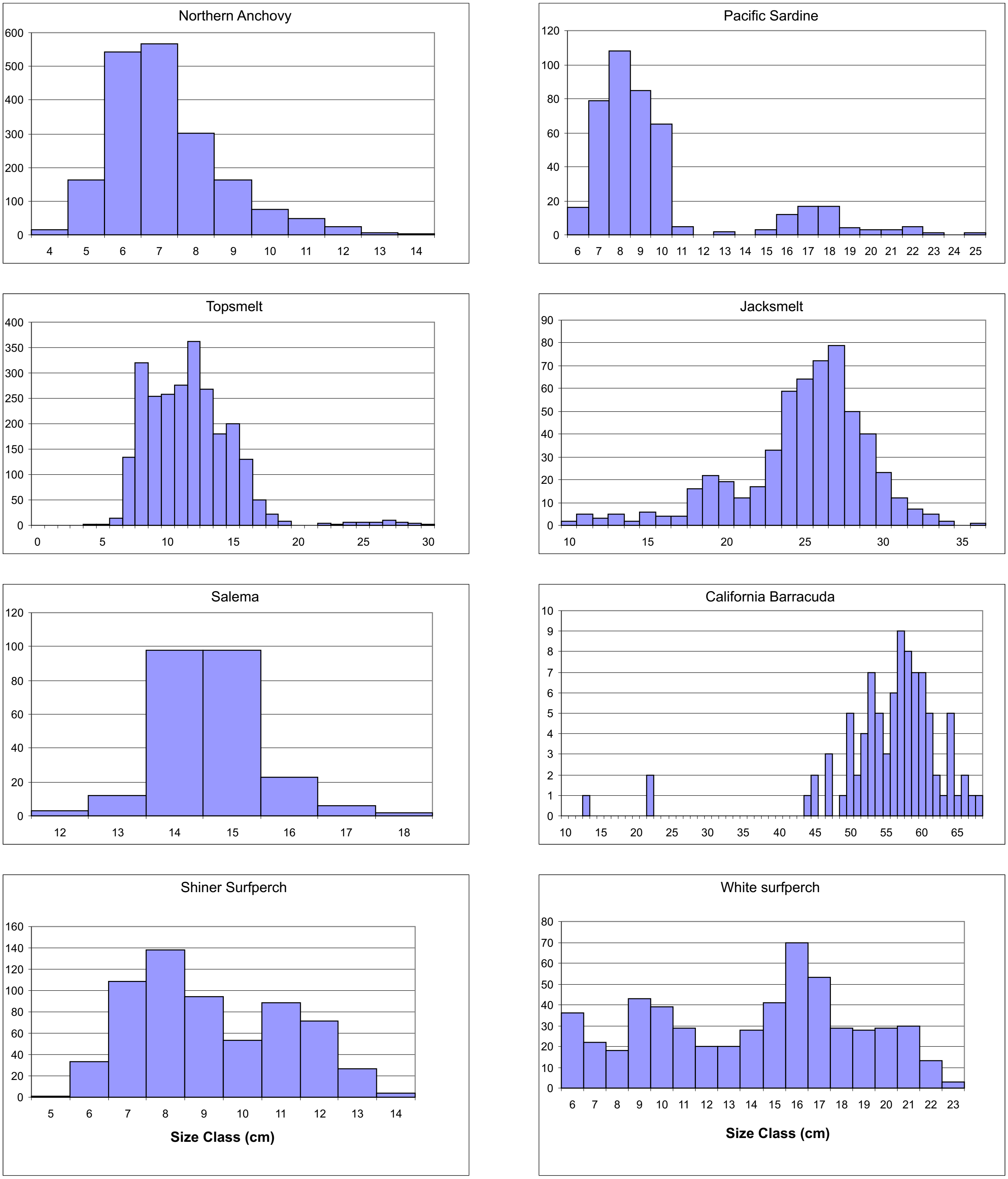


Figure 3.3-5. Size-frequency distribution of selected fish caught by lampara in Long Beach and Los Angeles Harbors, February - November 2000.

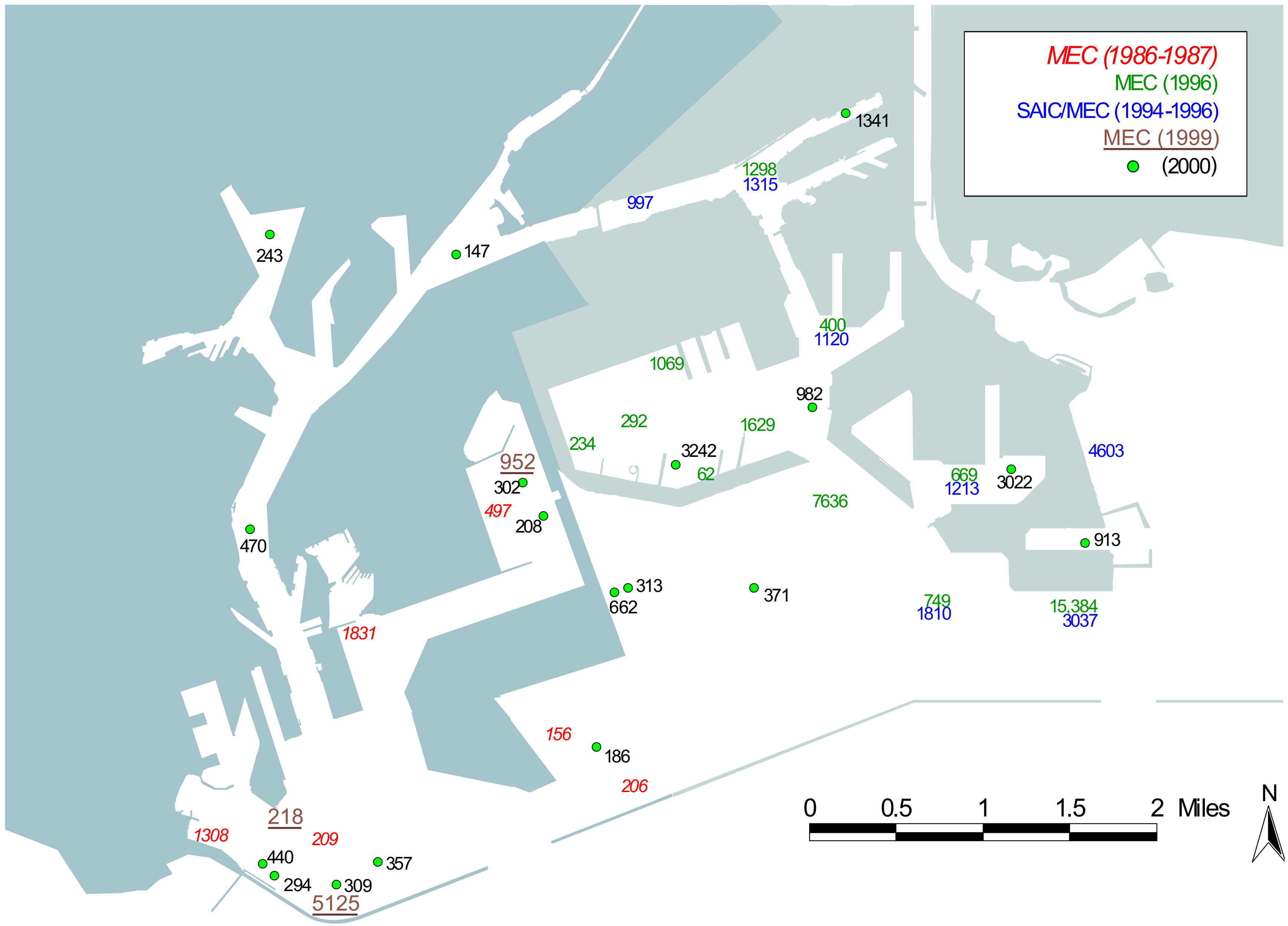


Figure 3.3-6. Historical comparison of mean abundance of fish caught by lampara in Long Beach and Los Angeles Harbors.

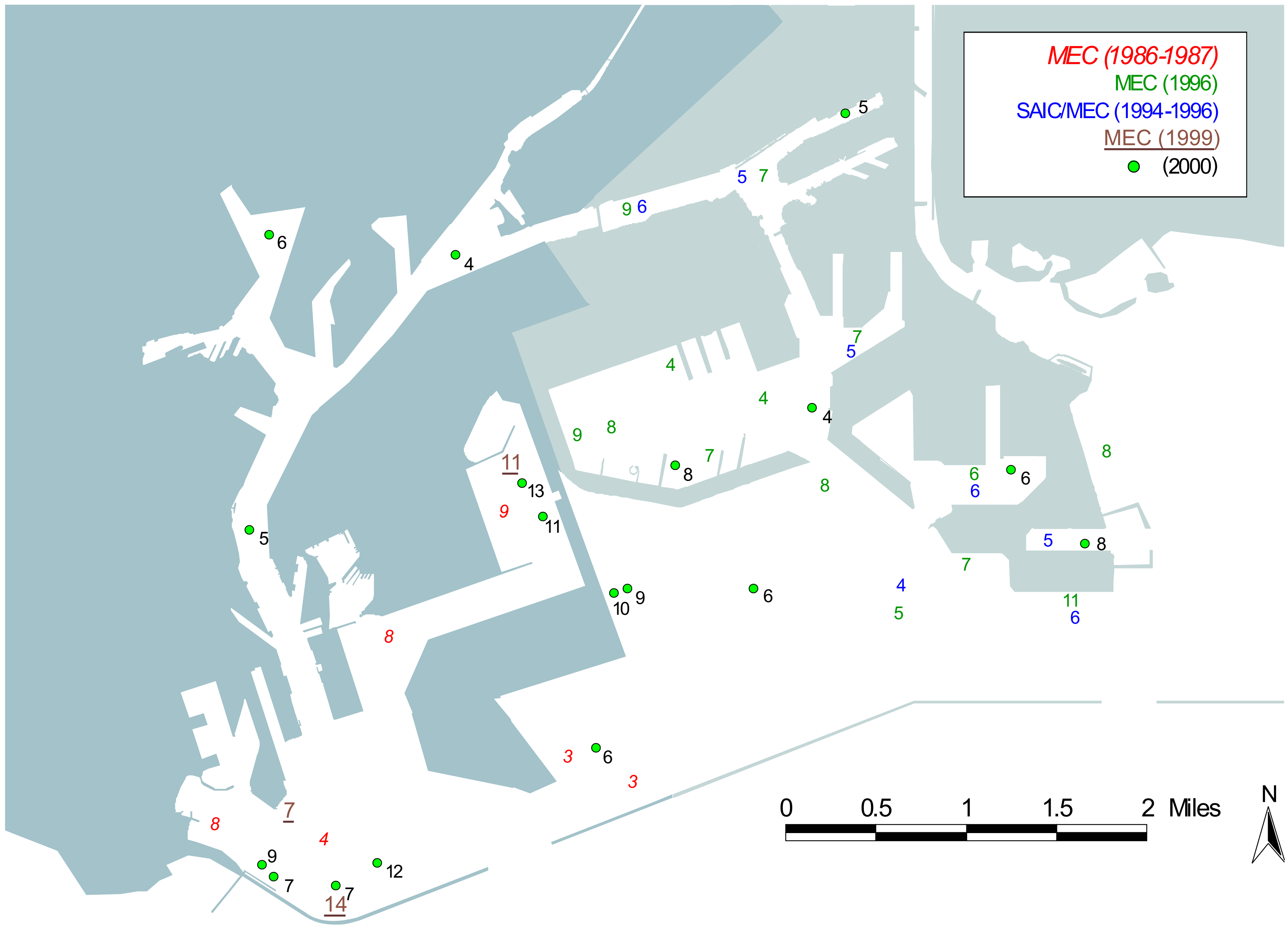


Figure 3.3-7. Historical comparison of mean number of fish species caught by lampara in Long Beach and Los Angeles Harbors.

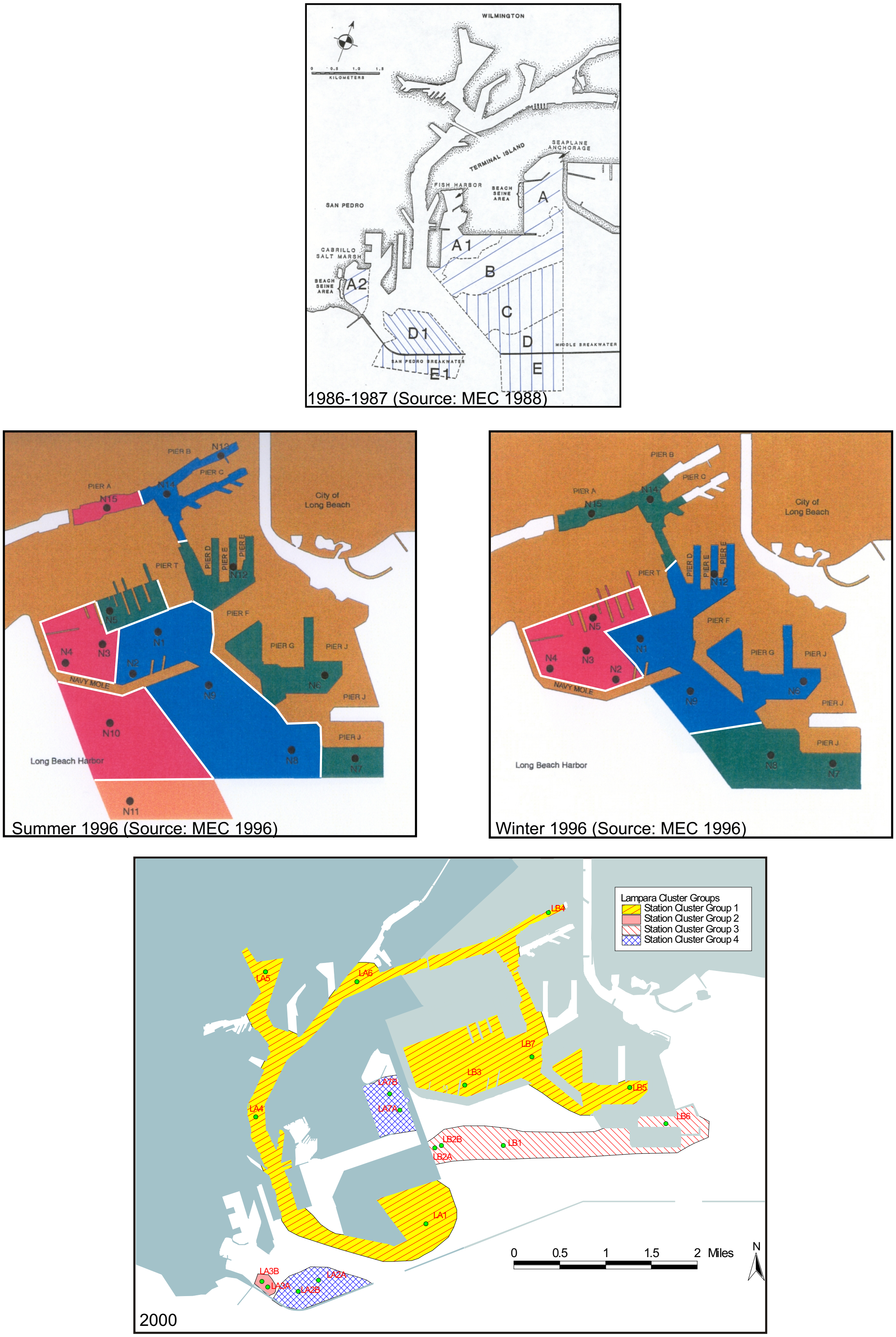


Figure 3.3-8. Historical comparison of cluster analysis station groups of fish caught by lampara in Long Beach and/or Los Angeles Harbors.

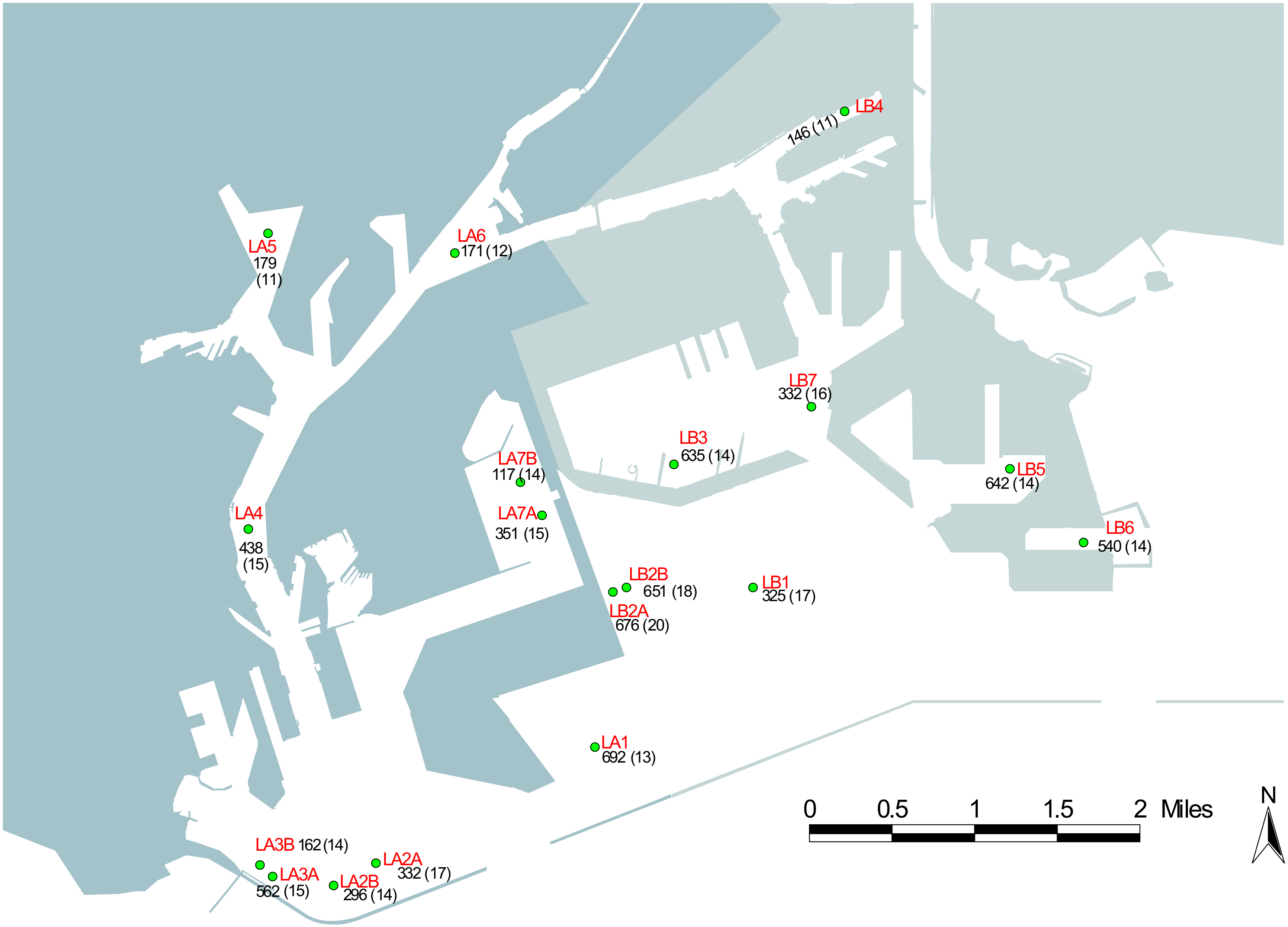


Figure 3.4-1. Mean annual abundance (and number of species) of fish caught by otter trawl in Long Beach and Los Angeles Harbors, February - November 2000.

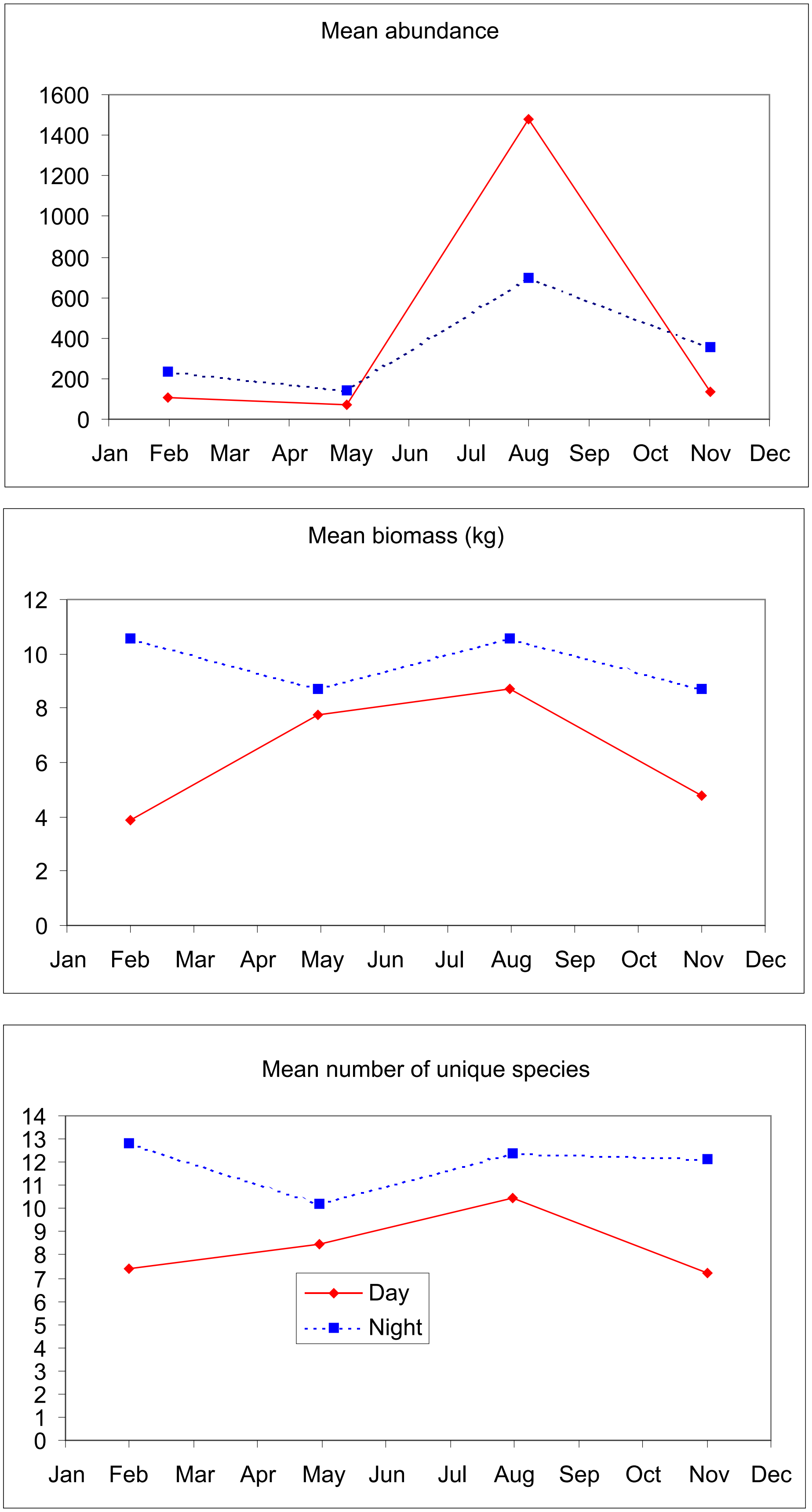


Figure 3.4-2. Seasonal mean abundance, biomass, and number of fish species caught by otter trawl in Long Beach and Los Angeles Harbors, February - November 2000.

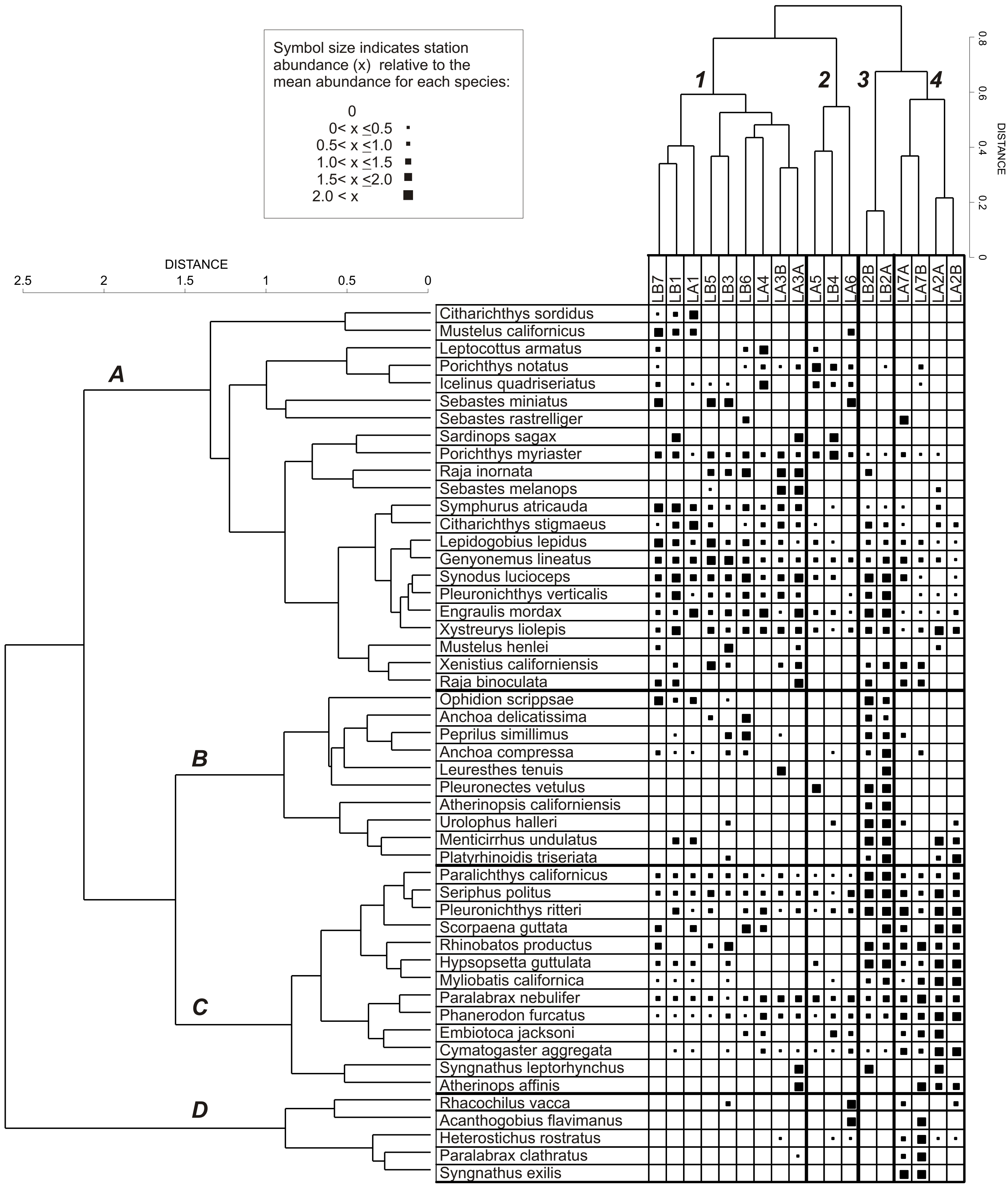


Figure 3.4-3. Cluster analysis of mean species abundance of fish caught by otter trawl in Long Beach and Los Angeles Harbors, February - November 2000.

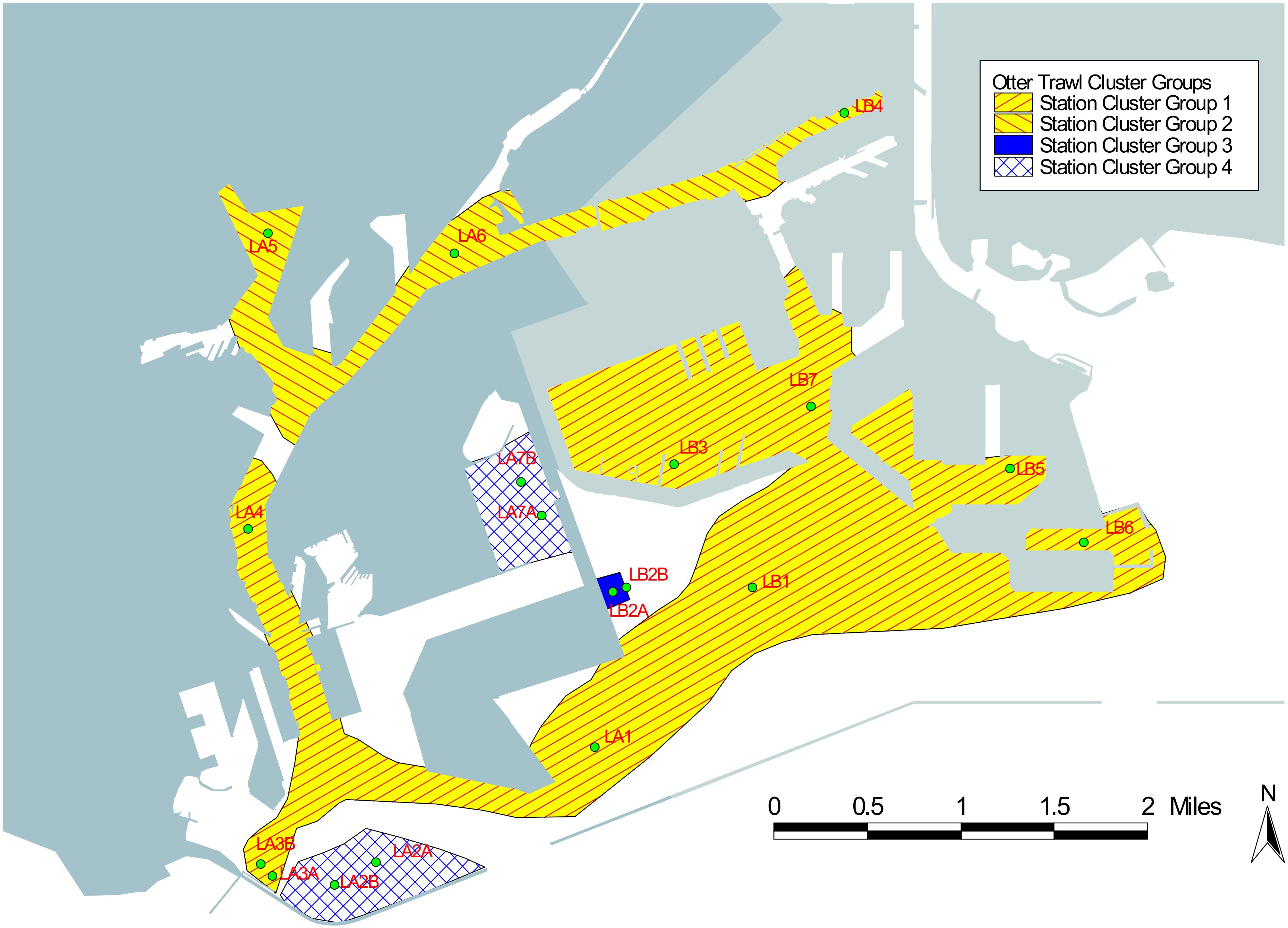


Figure 3.4-4. Map of station groups identified by cluster analysis of fish caught by otter trawl in Long Beach and Los Angeles Harbors, February - November 2000.

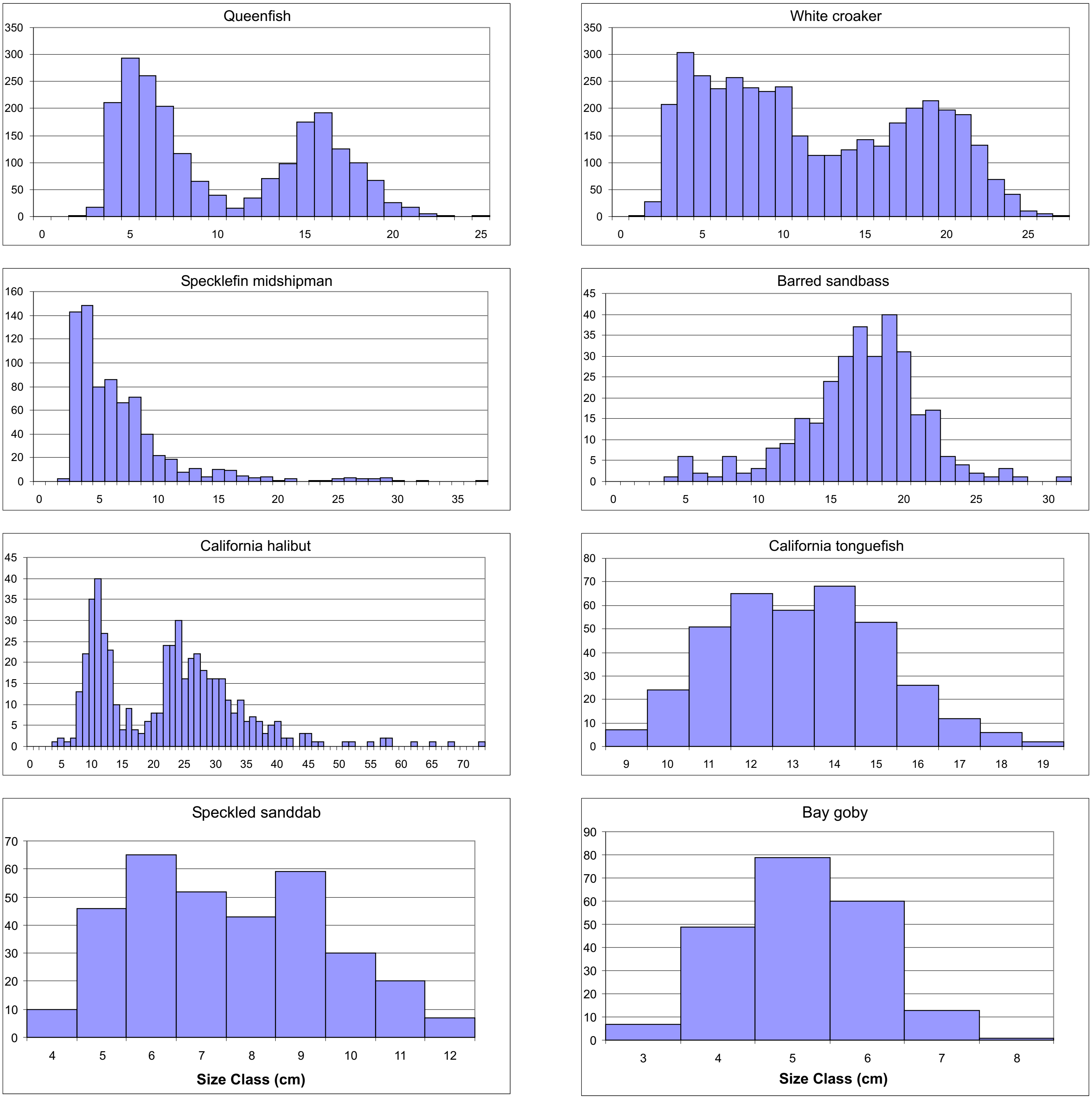


Figure 3.4-5. Size frequency distribution of selected fish caught by otter trawl in Long Beach and Los Angeles Harbors, February - November 2000.

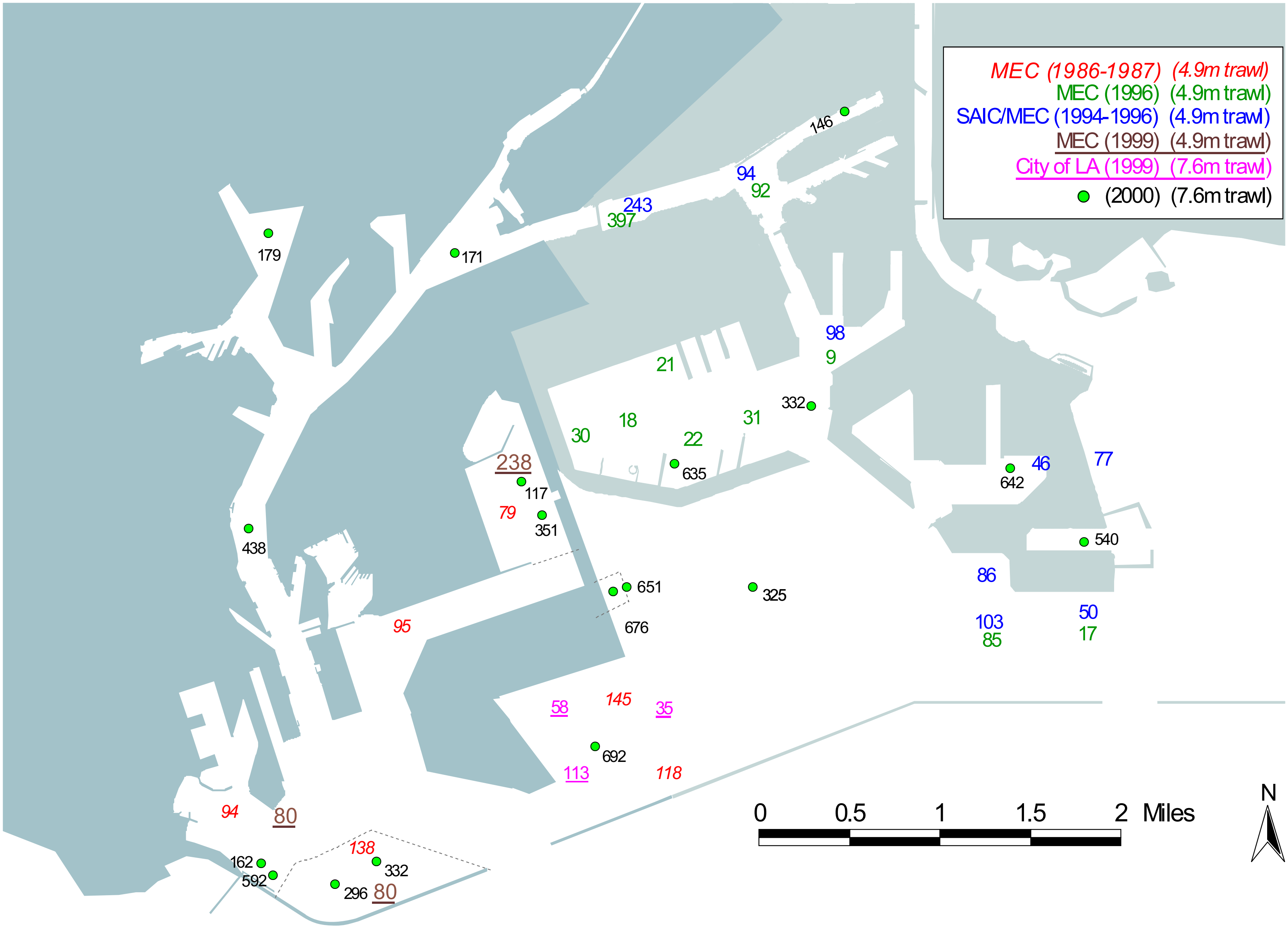


Figure 3.4-6. Historical comparison of mean abundance of fish caught by otter trawl using different sized nets in Long Beach and Los Angeles Harbors.

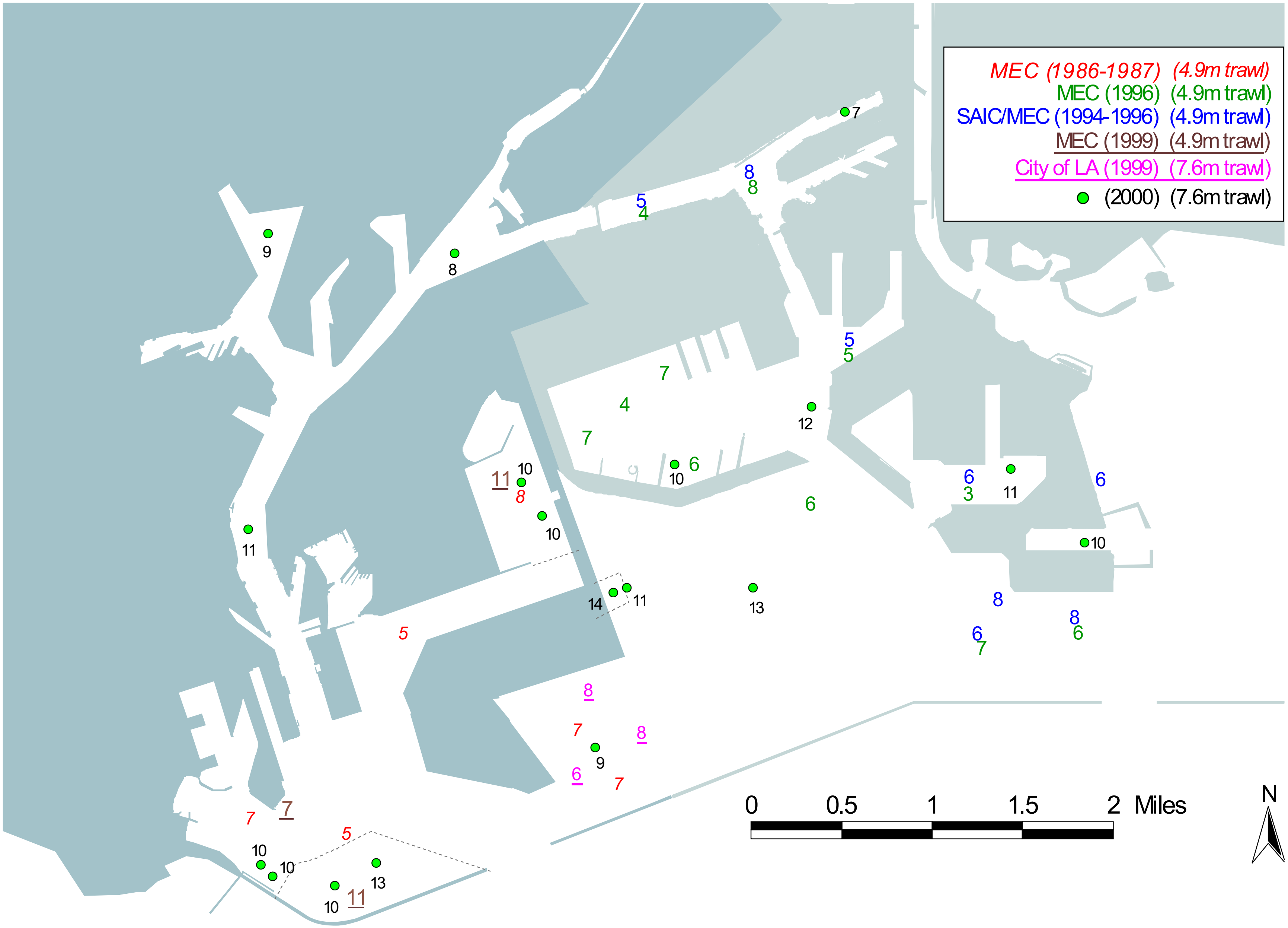


Figure 3.4-7. Historical comparison of mean number of fish species caught by otter trawl using different sized nets in Long Beach and Los Angeles Harbors.

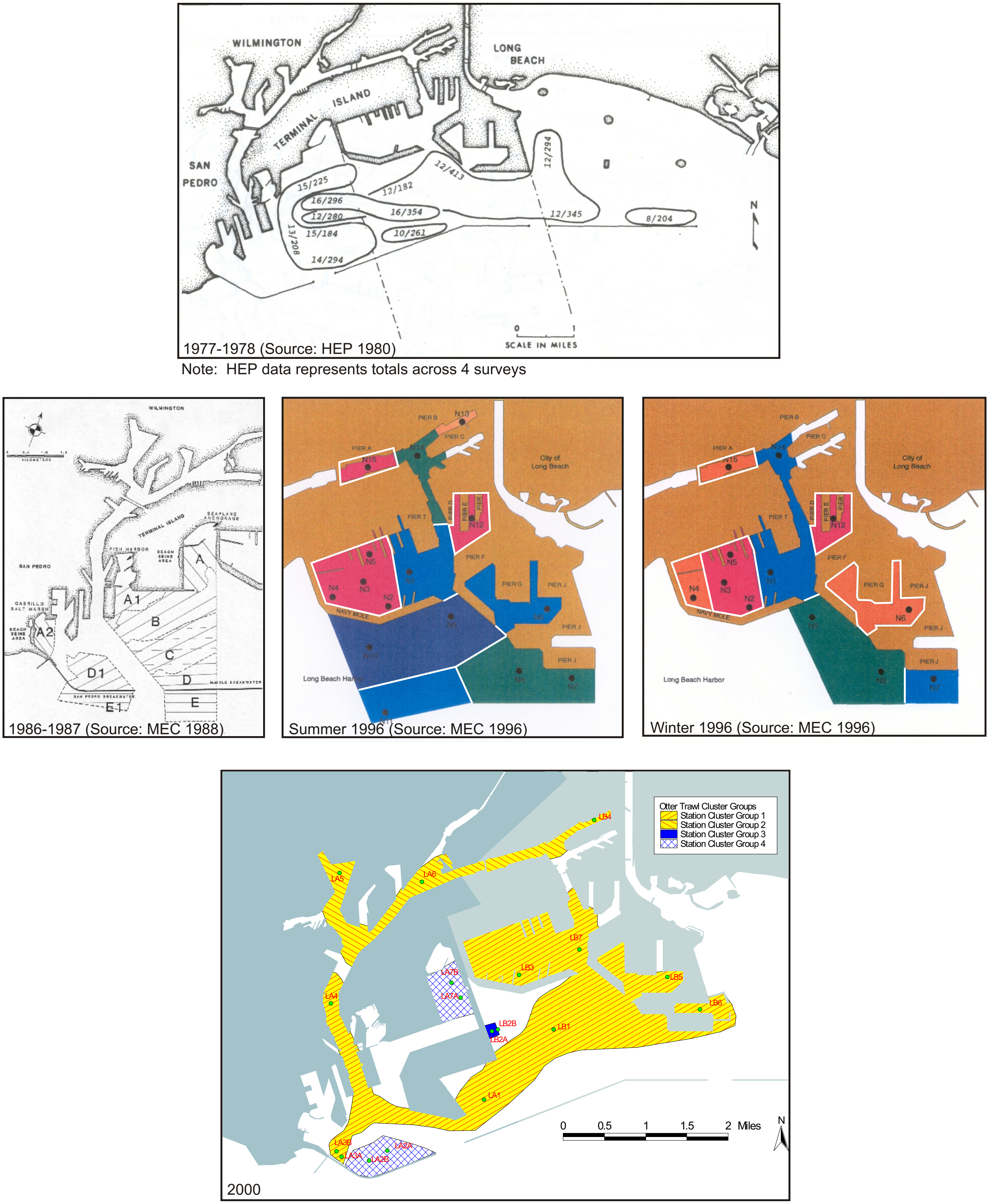


Figure 3.4-8. Historical comparison of cluster analysis station groups of fish caught by otter trawl in Long Beach and Los Angeles Harbors.

Figure 3.5-1. Mean annual abundance (and number of species) of fish caught by beach seine in Los Angeles Harbor, February - November 2000.

Figure 3.5-2. Size frequency distribution of selected fish caught by beach seine in Los Angeles Harbor, February - November 2000.

Table 3.2-1. Survey schedule and conditions for lampara sampling in Long Beach and Los Angeles Harbors, February – November 2000.

Date	Season	Sampling Time	Weather Conditions	Notable Observations
03-Feb-00	Winter	0820-1630	Clear, light wind	Very large haul of barracuda at LA7A.
04-Feb-00	Winter	0745-1420	Overcast, drizzle, light wind	
05-Feb-00	Winter	0730-1255	Clear, light wind	Purse seine comparison.
07-Feb-00	Winter	1755-2025	Overcast, light wind	Abundant salema at LB6.
08-Feb-00	Winter	1800-0050	Overcast, light wind	Rock debris hauled at LA2A (sample good).
09-Feb-00	Winter	1830-0050	Overcast, light wind	
21-May-00	Spring	2035-0330	Some fog, moderate wind	
22-May-00	Spring	2000-0240	Overcast, light wind	Abundant bat rays at LA2A.
23-May-00	Spring	2020-2330	Overcast, light wind	
25-May-00	Spring	0730-1555	Overcast, light wind	Sea lion swimming at LA2A and LA3A, school of large sargo caught at LA7A.
26-May-00	Spring	0655-1050	Clear, light wind	Sediment plume at LB3.
13-Aug-00	Summer	2025-0235	Clear, light wind	
14-Aug-00	Summer	2025-0250	Clear, light wind	Abundant surfperch at LA2B.
15-Aug-00	Summer	2010-0200	Clear, light wind	
17-Aug-00	Summer	0715-1635	Clear, light wind, hot	Large surfperch, bat ray, and sandbass haul at LA2A, abundant sardine and anchovy at LB5 and LB1.
18-Aug-00	Summer	0700-1305	Clear, light wind	
19-Aug-00	Summer	0710-1030	Clear, light wind	Purse seine comparison. Topsmelt at LB4.
12-Nov-00	Fall	1810-0055	Clear, moderate wind, cold	Abundant bat rays at LA2A
13-Nov-00	Fall	1745-0200	Clear, moderate wind, cold	
15-Nov-00	Fall	0635-1530	Clear, light wind	Abundant bat rays at LA2A, large haul at LA7A.
16-Nov-00	Fall	0700-1320	Clear, light wind	

Table 3.2-2. Survey schedule and conditions for otter trawl sampling in Long Beach and Los Angeles Harbors, February-November 2000.

Date	Season	Sampling Time	Weather Conditions	Notable Observations
01-Feb-00	Winter	0820-1700	Clear, calm to moderate wind	
02-Feb-00	Winter	0810-1550	Clear, light wind, warm	Large tire in net at LA6 (sample good), debris on bottom in East Basin, abundant invertebrates at LB4, but no fish.
10-Feb-00	Winter	1700-0620	Rain then partly cloudy, light wind	
11-Feb-00	Winter	1815-2310	Overcast, light wind	Tire in net at LA6 (sample good), floating debris at LB4, finished just ahead of strong storm.
16-May-00	Spring	1535-1715	Partly cloudy, light wind	Abundant ctenophores in hauls.
17-May-00	Spring	0720-1455	Partly cloudy, light wind	Ctenophores at LB2A, LB2B, LB4, LA6.
18-May-00	Spring	2000-0440	Clear then fog, light wind	
19-May-00	Spring	2030-2240	Clear then fog, moderate wind	
19-Aug-00	Summer	1400-1610	Clear, light wind	Abundant small fish.
22-Aug-00	Summer	1310-1620	Overcast, light wind	Large numbers of small fish at LB2A and LA2B.
23-Aug-00	Summer	0735-1835	Clear, moderate/strong wind and chop	Large rock at LA5 caught in net (sample good).
24-Aug-00	Summer	1945-0540	Clear, moderate wind	
25-Aug-00	Summer	2000-0130	Overcast, moderate wind	Snagged net at LB3 (re-sampled).
31-Aug-00	Summer	1320-0108	Clear, moderate to calm wind	
07-Nov-00	Fall	1015-1620	Clear, light wind	Abundant crabs and small sciaenids at LB3 and LB7.
08-Nov-00	Fall	0700-1520	Partly cloudy, light wind	Floating debris at LA6.
09-Nov-00	Fall	1745-0300	Partly cloudy, light wind	
10-Nov-00	Fall	1625-0100	Overcast, light wind	Tire in net at LA6 (sample good).

Table 3.2-3. Survey schedule and conditions for beach seine sampling in Long Beach and Los Angeles Harbors, February-November 2000.

Date	Season	Sampling Time	Weather Conditions	Notable Observations
29-Feb-00	Winter	1300-1545	Clear, light wind, warm	Abundant purple urchins in haul 1 at Cabrillo Beach.
10-May-00	Spring	0945-1315	Overcast, light wind	Abundant post-larval atherinids and diamond turbot at Pier 300 site.
31-Aug-00	Summer	0825-0955	Clear, light wind, warm	
01-Nov-00	Fall	0950-1105	Clear, light wind	

Table 3.3-1. Total abundance and biomass of fish species caught by lampara in Long Beach and Los Angeles Harbors, February – November 2000.

Common Name	Species	Total Abundance				Total Biomass (kg)			
		Day	Night	Total	% of Total	Day	Night	Total	% of Total
Northern anchovy	*Engraulis mordax*	15,748	58,970	74,718	67.87	47.4	176.78	224.18	7.67
White croaker	*Genyonemus lineatus*	1,500	5,112	6,612	6.01	192.3	146.03	338.33	11.57
Queenfish	*Seriphus politus*	539	6,038	6,577	5.97	26.89	183.2	210.09	7.19
Topsmelt	*Atherinops affinis*	2,199	4,136	6,335	5.75	42.75	54.9	97.65	3.34
Pacific sardine	*Sardinops sagax*	3,842	678	4,520	4.11	46.01	4.85	50.86	1.74
Shiner surfperch	*Cymatogaster aggregata*	2,110	1,149	3,259	2.96	32.25	13.38	45.63	1.56
Salema	*Xenistius californiensis*		3,143	3,143	2.85		158.72	158.72	5.43
White surfperch	*Phanerodon furcatus*	512	394	906	0.82	47.62	10.31	57.93	1.98
Jacksmelt	*Atherinopsis californiensis*	622	148	770	0.70	107.49	22.73	130.22	4.45
California barracuda	*Sphyraena argentea*	636	10	646	0.59	630.02	6.73	636.75	21.78
Slough anchovy	*Anchoa delicatissima*	2	560	562	0.51	0.00	2.09	2.09	0.07
California grunion	*Leuresthes tenuis*	129	282	411	0.37	0.57	3.16	3.73	0.13
Bat ray	*Myliobatis californica*	170	162	332	0.30	321.7	372.81	694.51	23.75
Pacific butterfish	*Peprilus simillimus*	57	265	322	0.29	1.38	3.31	4.69	0.16
Jack mackerel	*Trachurus symmetricus*	36	125	161	0.15	5.74	18.9	24.64	0.84
Deepbody anchovy	*Anchoa compressa*	22	105	127	0.12	0.1	1.21	1.31	0.04
Chub mackerel	*Scomber japonicus*	79	45	124	0.11	14.82	4.83	19.65	0.67
Barred sand bass	*Paralabrax nebulifer*	70	45	115	0.10	14.78	7.52	22.30	0.76
Specklefin midshipman	*Porichthys myriaster*	4	88	92	0.08	0.36	2.98	3.34	0.11
California halibut	*Paralichthys californicus*	20	39	59	0.05	37.69	17.58	55.27	1.89
California corbina	*Menticirrhus undulatus*	22	23	45	0.04	9.08	9.8	18.88	0.65
Spotted turbot	*Pleuronichthys ritteri*	11	16	27	0.02	1.32	1.96	3.28	0.11
Shovelnose guitarfish	*Rhinobatos productus*	11	15	26	0.02	18.84	25.57	44.41	1.52
Walleye surfperch	*Hyperprosopon argenteum*	9	10	19	0.02	0.7	0.19	0.89	0.03
Round stingray	*Urolophus halleri*	7	11	18	0.02	2.55	4.93	7.48	0.26
Diamond turbot	*Hypsopsetta guttulata*	5	13	18	0.02	1.75	3.55	5.30	0.18
Grey smoothhound shark	*Mustelus californicus*	5	9	14	0.01	5.4	11.45	16.85	0.58
Sargo	*Anisotremus davidsoni*	12	2	14	0.01	9.44	0.29	9.73	0.33
Fantail sole	*Xystreurys liolepis*	6	8	14	0.01	1.25	3.4	4.65	0.16
Hornyhead turbot	*Pleuronichthys verticalis*	2	11	13	0.01	0.22	1.05	1.27	0.04
California lizardfish	*Synodus lucioceps*	8	2	10	0.01	1.85	0.69	2.54	0.09
Yellowfin croaker	*Umbrina roncador*	3	7	10	0.01	0.53	2.13	2.66	0.09
Thornback	*Platyrhinoidis triseriata*	1	7	8	0.01	0.29	2.1	2.39	0.08
Black surfperch	*Embiotoca jacksoni*	5	3	8	0.01	0.46	0.16	0.62	0.02
Giant kelpfish	*Heterostichus rostratus*	7	1	8	0.01	0.09	0.00	0.09	0.00
Pacific cutlassfish	*Trichiurus nitens*	1	7	8	0.01	0.3	1.37	1.67	0.06
Brown smoothhound shark	*Mustelus henlei*	3	3	6	0.01	4.77	5.54	10.31	0.35
California scorpionfish	*Scorpaena guttata*		6	6	0.01		2.12	2.12	0.07
White seabass	*Atractoscion nobilis*	5		5	0.00	4.21		4.21	0.14
Pile surfperch	*Rhacochilus vacca*	1	4	5	0.00	0.9	1.14	2.04	0.07
Plainfin midshipman	*Porichthys notatus*		5	5	0.00		0.01	0.01	0.00
Speckled sanddab	*Citharichthys stigmaeus*	1	3	4	0.00	0.00	0.02	0.02	0.00
California tonguefish	*Symphurus atricauda*	3		3	0.00	0.06		0.06	0.00
Black croaker	*Cheilotrema saturnum*		2	2	0.00		0.21	0.21	0.01
Basketweave cusk-eel	*Ophidion scrippsae*		2	2	0.00		0.05	0.05	0.00
Blacksmith	*Chromis punctipinnis*		1	1	0.00		0.06	0.06	0.00
Pacific sanddab	*Citharichthys sordidus*	1		1	0.00	0.02		0.02	0.00
Black rockfish	*Sebastes melanops*		1	1	0.00		0.00	0.00	0.00
Barred pipefish	*Syngnathus auliscus*	1		1	0.00	0.00		0.00	0.00
Barcheek pipefish	*Syngnathus exilis*		1	1	0.00		0.00	0.00	0.00
	Total Abundance / Biomass	28,422	81,667	110,089	100.00	1,633.90	1,289.81	2,923.71	100.00
	Total Number of Species	42	46	50	--				

Note: Species listed in decreasing order of abundance.

Table 3.3-2. Mean abundance, biomass, and number of species of fish caught by lampara in Long Beach and Los Angeles Harbors, February – November 2000.

Habitat / Station	Depth (m)	Mean Abundance			Mean Biomass (kg)			Total Mean Number of Species		
		Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Open										
LA1	13	178	194	186	3.41	5.32	4.36	3	8	9
LB1	12	372	369	371	13.74	7.48	10.61	5	7	9
Deepwater Channel										
LA4	16	507	434	470	4.28	6.26	5.27	2	8	9
LB7	24	17	1,947	982	1.24	8.23	4.73	1	7	8
Deepwater Basin										
LA5	17	37	449	243	1.21	4.91	3.06	2	9	10
LA6	16	51	243	147	2.84	2.35	2.59	2	6	6
LB3	15	497	5,988	3,242	9.12	25.16	17.14	7	9	11
LB5	15	3,535	2,509	3,022	12.30	14.12	13.21	3	9	9
Deepwater Slip										
LB4	15	15	2,668	1,341	0.65	14.10	7.37	1	9	9
LB6	17	258	1,568	913	8.60	54.04	31.32	6	10	11
Shallow Mitigation										
LA2A	4	409	306	357	77.93	54.20	66.07	11	12	17
LA2B	4	64	554	309	11.30	30.62	20.96	5	8	11
LA7A	4	249	167	208	167.81	18.69	93.25	9	13	17
LA7B	4	413	191	302	41.10	21.00	31.05	12	13	19
LB2A	6	289	956	622	28.02	24.56	26.29	6	14	17
LB2B	6	64	563	313	14.28	19.33	16.81	5	13	16
Shallow Water Open										
LA3A	4	116	472	294	6.51	5.43	5.97	5	9	11
LA3B	4	38	842	440	4.10	6.59	5.35	6	11	13
Station Mean		395	1,134	765	22.69	17.91	20.30	5	10	12
Total Survey Mean		7,106	20,417	13,761	408.43	322.39	365.41	29	33	39

Table 3.3-3. Mean diversity and dominance of fish caught by lampara in Long Beach and Los Angeles Harbors, February – November 2000.

Habitat / Station	Depth (m)	Shannon-Wiener Diversity			Margalef Diversity			Dominance		
		Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Open										
LA1	13	0.86	1.22	1.26	0.85	1.38	1.47	2	2	3
LB1	12	0.86	1.07	1.30	0.86	1.16	1.39	2	2	3
Deepwater Channel										
LA4	16	0.74	0.98	1.03	0.55	1.22	1.29	1	2	2
LB7	24	NA	0.54	0.63	NA	0.86	0.93	1	1	2
Deepwater Basin										
LA5	17	0.64	1.09	1.23	0.74	1.46	1.58	2	2	2
LA6	16	0.39	0.89	0.93	0.41	0.94	0.92	1	2	2
LB3	15	0.82	0.63	0.66	0.94	1.12	1.35	2	2	2
LB5	15	0.63	0.46	0.51	0.70	1.08	1.11	2	2	2
Deepwater Slip								1	1	1
LB4	15	0.15	0.61	0.62	0.30	1.04	1.07	1	1	1
LB6	17	0.99	1.04	1.02	0.88	1.29	1.42	2	2	2
Shallow Mitigation										
LA2A	4	1.15	1.76	1.70	1.63	1.97	2.46	2	4	4
LA2B	4	1.03	1.34	1.47	1.47	1.25	1.65	2	3	3
LA7A	4	1.25	1.39	1.59	1.69	2.27	2.70	3	3	4
LA7B	4	1.53	1.50	1.50	2.39	2.33	3.08	4	3	3
LB2A	6	0.58	1.24	1.41	1.09	1.92	2.19	1	2	3
LB2B	6	0.84	1.48	1.60	1.13	1.98	2.37	2	3	3
Shallow Water Open										
LA3A	4	1.03	1.15	1.28	0.97	1.39	1.60	2	2	2
LA3B	4	1.08	1.26	1.43	1.38	1.78	2.20	2	2	3
Station Mean		0.86	1.09	1.18	1.06	1.47	1.71	2	2	2

Table 3.3-4. Mean and total abundance of fish species caught over day and night periods by lampara in Long Beach and Los Angeles Harbors, February – November 2000.

Common Name	Species	Mean Abundance																		Total Catch
		Deepwater Open		Deepwater Channel		Deepwater Basin				Deepwater Slip		Shallow Mitigation						Shallow Water Open		
		LA1	LB1	LA4	LB7	LA5	LA6	LB3	LB5	LB4	LB6	LA2A	LA2B	LA7A	LA7B	LB2A	LB2B	LA3A	LA3B	All Stations
Northern anchovy	*Engraulis mordax*	52.4	142.5	100.9	849.6	160.3	64.9	3050.0	2783.1	1210.9	160.3	14.8	89.7	7.5	1.8	141.6	51.9	127.8	329.9	74,718
White croaker	*Genyonemus lineatus*	21.4	156.9	13.3	48.9	26.5	4.6	43.9	6.6	7.8	22.1	49.0	31.4	19.6	45.3	224.8	91.1	7.3	6.1	6,612
Queenfish	*Seriphus politus*	20.9	43.5	40.3	14.3	13.9	4.1	55.5	50.1	21.4	121.0	30.3	33.4	49.6	64.1	113.3	109.8	20.5	16.4	6,577
Topsmelt	*Atherinops affinis*	6.8	8.4	106.4	25.8	29.6	69.1	44.3	29.5	77.4	141.4	16.5	10.5	19.5	10.1	32.5	28.5	87.9	47.9	6,335
Pacific sardine	*Sardinops sagax*	76.1	0.4	198.5	37.0	1.6	0.8	20.5	140.6	17.4	6.9	4.6		0.5	0.1	59.6		0.4		4,520
Shiner surfperch	*Cymatogaster aggregata*			0.4	0.1	0.4		0.1	0.1	0.3		131.6	96.4	5.0	142.6	3.8	6.4	16.1	4.1	3,259
Salema	*Xenistius californiensis*					0.5	1.0	1.1	0.5	1.1	357.2	9.3	7.4	1.9	0.8	0.1		1.6	10.4	3,143
White surfperch	*Phanerodon furcatus*	0.1		0.4		0.4		0.4		0.1	0.3	62.8	10.9	11.9	15.3	0.6	5.8	2.5	1.9	906
Jacksmelt	*Atherinopsis californiensis*	1.0	8.3	2.4	4.0	1.0		4.1	1.9		3.1	1.3	18.6	0.4	2.4	24.0	5.4	13.3	5.1	770
California barracuda	*Sphyraena argentea*		0.5	0.1	0.1	0.1	0.1	0.5	0.3	0.3				75.9	2.3	0.1		0.4	0.1	646
Slough anchovy	*Anchoa delicatissima*	0.1	0.3			0.4	0.3	0.3	0.5	0.3	66.0				0.1	1.6	0.5			562
California grunion	*Leuresthes tenuis*	4.0	0.8	1.4				13.1	0.9		1.9	0.4	0.9	0.4	0.2	0.5	0.3	13.3	13.5	411
Bat ray	*Myliobatis californica*	0.1	0.1					0.4				23.9	5.0	2.4	2.9	3.8	3.0			332
Pacific butterfish	*Peprilus simillimus*	1.8	0.5	3.1	0.4	1.1		3.0	1.0	0.3	20.8	0.4	0.4	0.9	0.3	2.3	2.8	0.9	0.6	322
Jack mackerel	*Trachurus symmetricus*		0.3	1.6	0.3	2.6	1.6	2.6	3.1	0.1	1.2		0.5	2.9	1.8	0.1	0.4	0.9	0.1	161
Deepbody anchovy	*Anchoa compressa*				0.3	0.5	0.1	0.3	0.1	0.4	6.3			0.3	0.6	5.9	1.3			127
Chub mackerel	*Scomber japonicus*		6.8	0.9	0.8	0.1		1.1	2.5	1.4	1.0	0.1		0.4		0.3	0.3			124
Barred sand bass	*Paralabrax nebulifer*	0.3		0.3				0.1			0.1	5.4	1.4	1.5	4.1	0.5	0.4		0.4	115
Specklefin midshipman	*Porichthys myriaster*	0.1	0.3	0.5	0.8	2.9	0.3	0.5	1.0	1.8	1.6			0.3	0.1	0.3		0.5	0.8	92
California halibut	*Paralichthys californicus*	0.6	0.3			0.1		0.1			0.5	0.5	0.4	1.0	0.6	1.1	1.9		0.3	59
California corbina	*Menticirrhus undulatus*											1.8	0.3	0.5		2.5	0.5	0.1		45
Spotted turbot	*Pleuronichthys ritteri*		0.1									0.4	0.6	0.8	0.3	0.5	0.5		0.1	27
Shovelnose guitarfish	*Rhinobatos productus*											0.3		1.4	1.5		0.1			26
Walleye surfperch	*Hyperprosopon argenteum*											1.4	0.1				0.1	0.3	0.5	19
Diamond turbot	*Hypsopsetta guttulata*												0.5	0.1	0.5	0.3	0.9			18
Round stingray	*Urolophus halleri*									0.1				0.1	0.9	0.9	0.3			18
Sargo	*Anisotremus davidsoni*											0.3	0.1	1.0	0.4					14
Grey smoothhound shark	*Mustelus californicus*											0.8		0.1	0.9					14
Fantail sole	*Xystreurys liolepis*									0.1		0.1	0.1	0.4	0.3	0.4			0.3	14

Table 3.3-4. Continued.

Common Name	Species	Mean Abundance																		Total Catch
		Deepwater Open		Deepwater Channel		Deepwater Basin				Deepwater Slip		Shallow Mitigation						Shallow Water Open		
		LA1	LB1	LA4	LB7	LA5	LA6	LB3	LB5	LB4	LB6	LA2A	LA2B	LA7A	LA7B	LB2A	LB2B	LA3A	LA3B	All Stations
Hornyhead turbot	*Pleuronichthys verticalis*		0.4								0.3	0.1				0.4	0.5			13
California lizardfish	*Synodus lucioceps*		0.1								0.1					0.1	0.1	0.1	0.6	10
Yellowfin croaker	*Umbrina roncador*											0.1		0.9	0.2					10
Black surfperch	*Embiotoca jacksoni*										0.1	0.3	0.1		0.5					8
Giant kelpfish	*Heterostichus rostratus*											0.1	0.1	0.1	0.5				0.1	8
Thornback	*Platyrhinoidis triseriata*											0.3				0.3	0.5			8
Pacific cutlassfish	*Trichiurus nitens*										1.0									8
Brown smoothhound shark	*Mustelus henlei*		0.3					0.1				0.3			0.1					6
California scorpionfish	*Scorpaena guttata*											0.5					0.1		0.1	6
White seabass	*Atractoscion nobilis*							0.1		0.1				0.1	0.3					5
Plainfin midshipman	*Porichthys notatus*					0.5				0.1										5
Pile surfperch	*Rhacochilus vacca*		0.1											0.1	0.1		0.1		0.1	5
Speckled sanddab	*Citharichthys stigmaeus*																0.1	0.1	0.3	4
California tonguefish	*Symphurus atricauda*															0.1		0.1	0.1	3
Black croaker	*Cheilotrema saturnum*			0.1							0.1									2
Basketweave cusk-eel	*Ophidion scrippsae*															0.3				2
Blacksmith	*Chromis punctipinnis*								0.1											1
Pacific sanddab	*Citharichthys sordidus*															0.1				1
Black rockfish	*Sebastes melanops*																		0.1	1
Barred pipefish	*Syngnathus auliscus*													0.1						1
Barcheek pipefish	*Syngnathus exilis*													0.1						1
	Total Catch Across Surveys	186	371	470	982	242	147	3,242	3,022	1,341	913	357	309	207	302	622	313	294	440	110,089

Table 3.3-5. Mean and total biomass of fish species caught over day and night periods by lampara in Long Beach and Los Angeles Harbors, February – November 2000.

Common Name	Species	Mean Biomass (kg)																		Total Biomass
		Deepwater Open		Deepwater Channel		Deepwater Basin				Deepwater Slip		Shallow Mitigation						Shallow Water Open		
		LA1	LB1	LA4	LB7	LA5	LA6	LB3	LB5	LB4	LB6	LA2A	LA2B	LA7A	LA7B	LB2A	LB2B	LA3A	LA3B	All Stations
Bat ray	*Myliobatis californica*	0.375	0.025					1.318				50.338	10.894	4.538	5.106	6.750	7.471			694.51
California barracuda	*Sphyraena argentea*		0.315	0.081	0.008	0.185	0.118	0.415	0.126	0.293				75.631	1.954	0.094		0.369	0.006	636.75
White croaker	*Genyonemus lineatus*	0.883	4.029	0.269	0.438	0.490	0.056	1.961	0.456	0.121	2.390	4.278	2.865	3.320	9.786	5.803	3.835	0.731	0.581	338.33
Northern anchovy	*Engraulis mordax*	0.291	0.340	0.444	2.458	0.801	0.281	7.605	8.948	4.764	0.375	0.060	0.206	0.018	0.004	0.378	0.124	0.268	0.660	224.18
Queenfish	*Seriphus politus*	1.078	1.810	1.115	0.361	0.389	0.098	3.064	1.539	0.530	7.151	0.763	0.474	1.228	1.979	1.919	1.330	0.904	0.533	210.09
Salema	*Xenistius californiensis*					0.025	0.048	0.074	0.033	0.058	17.824	0.513	0.403	0.118	0.045	0.008		0.096	0.599	158.72
Jacksmelt	*Atherinopsis californiensis*	0.084	1.170	0.525	0.646	0.170		0.798	0.411		0.629	0.181	2.433	0.110	0.500	5.261	1.183	1.440	0.738	130.22
Topsmelt	*Atherinops affinis*	0.101	0.470	1.320	0.519	0.421	1.759	0.648	0.524	0.828	1.620	0.279	0.150	0.315	0.131	0.533	0.481	1.276	0.833	97.65
White surfperch	*Phanerodon furcatus*			0.014		0.009		0.011		0.019	0.011	3.426	0.570	1.265	1.178	0.025	0.380	0.210	0.124	57.93
California halibut	*Paralichthys californicus*	0.840	0.110			0.028		0.081			0.104	0.281	1.045	1.575	1.395	0.454	0.359		0.638	55.27
Pacific sardine	*Sardinops sagax*	0.635	0.001	1.026	0.215	0.081	0.038	0.116	0.508	0.096	0.033	0.031		0.001		3.574		0.003		50.86
Shiner surfperch	*Cymatogaster aggregata*			0.006	0.001	0.011		0.003	0.001	0.008		1.704	1.018	0.099	2.436	0.044	0.086	0.233	0.055	45.63
Shovelnose guitarfish	*Rhinobatos productus*											0.288		1.765	2.843		0.656			44.41
Jack mackerel	*Trachurus symmetricus*		0.031	0.323	0.040	0.376	0.195	0.440	0.498	0.001	0.121		0.050	0.550	0.310	0.009	0.029	0.100	0.008	24.64
Barred sand bass	*Paralabrax nebulifer*	0.023		0.059				0.081			0.003	1.330	0.300	0.208	0.645	0.043	0.061		0.036	22.3
Chub mackerel	*Scomber japonicus*		1.645	0.026	0.016	0.024		0.043	0.074	0.384	0.076	0.004		0.135		0.005	0.025			19.65
California corbina	*Menticirrhus undulatus*											0.990	0.119	0.406		0.644	0.118	0.084		18.88
Grey smoothhound shark	*Mustelus californicus*											0.761		0.150	1.195					16.85
Brown smoothhound shark	*Mustelus henlei*		0.425					0.269				0.328			0.268					10.31
Sargo	*Anisotremus davidsoni*											0.036	0.011	0.885	0.284					9.73
Round stingray	*Urolophus halleri*									0.113				0.069	0.331	0.323	0.100			7.48
Diamond turbot	*Hypsopsetta guttulata*												0.161	0.071	0.238	0.048	0.145			5.3
Pacific butterfish	*Peprilus simillimus*	0.031	0.006	0.038	0.011	0.016		0.031	0.009	0.004	0.346	0.005	0.004	0.010	0.003	0.026	0.028	0.013	0.006	4.69
Fantail sole	*Xystreurys liolepis*									0.043		0.023	0.098	0.178	0.060	0.124			0.058	4.65
White seabass	*Atractoscion nobilis*							0.113		0.106				0.088	0.220					4.21
California grunion	*Leuresthes tenuis*	0.024	0.004	0.015				0.045	0.003		0.004	0.004	0.008	0.001	0.001	0.003	0.001	0.175	0.180	3.73
Specklefin midshipman	*Porichthys myriaster*	0.001	0.003	0.004	0.021	0.026	0.001	0.021	0.076	0.009	0.010			0.108	0.044	0.044		0.003	0.048	3.34

Table 3.3-5. Continued.

Common Name	Species	Mean Biomass (kg)																		Total Biomass
		Deepwater Open		Deepwater Channel		Deepwater Basin				Deepwater Slip		Shallow Mitigation						Shallow Water Open		
		LA1	LB1	LA4	LB7	LA5	LA6	LB3	LB5	LB4	LB6	LA2A	LA2B	LA7A	LA7B	LB2A	LB2B	LA3A	LA3B	All Stations
Spotted turbot	*Pleuronichthys ritteri*		0.015									0.031	0.113	0.126	0.038	0.026	0.055		0.006	3.28
Yellowfin croaker	*Umbrina roncador*											0.044		0.266	0.023					2.66
California lizardfish	*Synodus lucioceps*		0.028								0.045					0.021	0.048	0.050	0.126	2.54
Thornback	*Platyrhinoidis triseriata*											0.124				0.056	0.119			2.39
California scorpionfish	*Scorpaena guttata*											0.141					0.024		0.100	2.12
Slough anchovy	*Anchoa delicatissima*					0.001		0.001	0.003		0.254					0.001	0.001			2.09
Pile surfperch	*Rhacochilus vacca*		0.125											0.013	0.001		0.113		0.004	2.04
Pacific cutlassfish	*Trichiurus nitens*										0.209									1.67
Deepbody anchovy	*Anchoa compressa*				0.001	0.008	0.003	0.003	0.001	0.005	0.073			0.005	0.006	0.043	0.018			1.31
Hornyhead turbot	*Pleuronichthys verticalis*		0.061								0.024	0.025				0.029	0.020			1.27
Walleye surfperch	*Hyperprosopon argenteum*											0.063	0.020				0.003	0.018	0.009	0.89
Black surfperch	*Embiotoca jacksoni*										0.003	0.024	0.019		0.033					0.62
Black croaker	*Cheilotrema saturnum*			0.005							0.021									0.21
Giant kelpfish	*Heterostichus rostratus*												0.008	0.001	0.003					0.09
California tonguefish	*Symphurus atricauda*															0.004		0.003	0.001	0.06
Blacksmith	*Chromis punctipinnis*								0.008											0.06
Basketweave cusk-eel	*Ophidion scrippsae*															0.006				0.05
Pacific sanddab	*Citharichthys sordidus*															0.003				0.02
Speckled sanddab	*Citharichthys stigmaeus*																0.001		0.001	0.02
Plainfin midshipman	*Porichthys notatus*					0.001														0.01
Total Biomass Across Surveys		4.37	10.61	5.27	4.74	3.06	2.60	17.14	13.22	7.38	31.32	66.07	20.97	93.25	31.06	26.30	16.81	5.97	5.35	**2,923.71**

Table 3.3-6. Summary of biological and physical/chemical habitat characteristics of lampara fish cluster groups.

	Cluster Group			
	1	**2**	**3**	**4**
Station	LA1, LA4, LA5, LA6, LB3, LB4, LB5, LB7	LA3	LB1, LB2, LB6	LA2, LA7
Habitat	Deep Open Water, Deep Basin, Deep Slip, Deep Channel,	Shallow Open Water	Deep Open Water, Shallow Open Water (Mitigation Site), Deep Slip	Shallow Open Water (Mitigation Sites)
Depth (m)	12-24	4	6-17	4
Range of Percent Fines	25-94	88-92	20-94	21-50
Years Since Dredging/ Disposal	0 to > 10	> 10	1 to > 10	0 to > 10
Range Percent Transmissivity •**near surface** •**mid-water** •**near bottom**	(S) 40-73 (M) 29-71 (B) 11-63	45-69 51-68 44-66	42-71 46-69 8-62	39-68 40-67 17-64
Range Mid-water Temperature (°C)	14-20	12-20	13-21	14-23
Range Mid-water Dissolved Oxygen (mg/L)	4.5-8.0	5.0-7.4	4.4-8.3	5.2-9.2
Range Mid-water Salinity (ppt)	33.0-33.7	33.0-33.7	33.1-33.7	33.0-33.6
Total Taxa in Species Cluster Group	26	26	37	38
Number of Relatively Abundant Taxa in Cluster Group	8	7	16	19
Relatively Abundant Taxa in Cluster Group	*Atherinops, Engraulis, Leuresthes, Porichthys, Sardinops, Scomber, Seriphus, Trachurus*	*Atherinops, Citharichthys, Leuresthes, Rhacochilus, Synodus, Symphurus, Xystreurys*	*Anchoa, Atherinopsis, Engraulis, Genyonemus, Hypsopsetta, Paralichthys, Peprillus, Platyrhinoidis, Pleuronichthys* spp.*, Porichthys, Rachochilus, Scomber, Seriphus, Urolophus*	*Anisotremus, Atractoscion, Cymatogaster, Embiotoca, Heterostichus, Hypsopsetta, Myliobatis, Mustelus, Paralabrax, Paralichthys, Phanerodon, Pleuronichthys, Rhinobatos, Rhacochilus, Seriphus, Trachurus, Umbrina, Urolophus, Xystreurys*

Note: S = near surface, M = mid-water, B = near bottom.

Table 3.4-1. Total abundance and biomass of fish species caught by otter trawl in Long Beach and Los Angeles Harbors, February – November 2000.

Common Name	Species	Abundance				Biomass (kg)			
		Day	Night	Total	% of Total	Day	Night	Total	% of Total
Northern anchovy	*Engraulis mordax*	21,699	1,147	22,846	39.47	24.41	2.01	26.42	2.31
White croaker	*Genyonemus lineatus*	6,259	14,503	20,762	35.87	140.78	298.54	439.32	38.37
Queenfish	*Seriphus politus*	1,556	6,149	7,705	13.31	20.48	56.96	77.44	6.76
Shiner surfperch	*Cymatogaster aggregata*	576	745	1,321	2.28	5.73	9.65	15.38	1.34
Specklefin midshipman	*Porichthys myriaster*	133	951	1,084	1.87	2.99	4.90	7.89	0.69
White surfperch	*Phanerodon furcatus*	644	349	993	1.72	37.87	11.97	49.84	4.35
California halibut	*Paralichthys californicus*	282	265	547	0.95	78.06	70.73	148.79	13.00
California tonguefish	*Symphurus atricauda*	143	229	372	0.64	2.69	4.03	6.72	0.59
Speckled sanddab	*Citharichthys stigmaeus*	148	184	332	0.57	0.91	1.42	2.33	0.20
Barred sand bass	*Paralabrax nebulifer*	140	170	310	0.54	17.72	16.95	34.67	3.03
Bay goby	*Lepidogobius lepidus*	107	102	209	0.36	0.13	0.09	0.22	0.02
Spotted turbot	*Pleuronichthys ritteri*	75	104	179	0.31	7.11	6.62	13.73	1.20
Plainfin midshipman	*Porichthys notatus*	44	91	135	0.23	0.06	0.20	0.26	0.02
Hornyhead turbot	*Pleuronichthys verticalis*	47	83	130	0.22	2.96	4.16	7.12	0.62
California lizardfish	*Synodus lucioceps*	52	69	121	0.21	10.89	16.56	27.45	2.40
Fantail sole	*Xystreurys liolepis*	48	46	94	0.16	12.91	10.05	22.96	2.01
Yellowchin sculpin	*Icelinus quadriseriatus*	31	41	72	0.12	0.14	0.18	0.32	0.03
Bat ray	*Myliobatis californica*	13	41	54	0.09	40.51	88.32	128.83	11.25
Deepbody anchovy	*Anchoa compressa*	14	38	52	0.09	0.18	0.52	0.70	0.06
Giant kelpfish	*Heterostichus rostratus*	43	9	52	0.09	0.22	0.05	0.27	0.02
Pacific sanddab	*Citharichthys sordidus*	5	46	51	0.09	0.09	0.13	0.22	0.02
Basketweave cusk-eel	*Ophidion scrippsae*		50	50	0.09	0.00	3.57	3.57	0.31
Pacific butterfish	*Peprilus simillimus*	27	20	47	0.08	0.24	0.22	0.46	0.04
Diamond turbot	*Hypsopsetta guttulata*	13	31	44	0.08	3.11	7.60	10.71	0.94
Round stingray	*Urolophus halleri*	14	21	35	0.06	5.97	9.87	15.84	1.38
Shovelnose guitarfish	*Rhinobatos productus*	18	13	31	0.05	21.02	33.47	54.49	4.76
Black rockfish	*Sebastes melanops*	20	11	31	0.05	0.04	0.02	0.06	0.01
Black surfperch	*Embiotoca jacksoni*	17	7	24	0.04	2.15	0.50	2.65	0.23
Kelp bass	*Paralabrax clathratus*	12	12	24	0.04	0.05	0.05	0.10	0.01
California corbina	*Menticirrhus undulatus*	2	21	23	0.04	1.10	7.65	8.75	0.76
Salema	*Xenistius californiensis*		17	17	0.03		1.09	1.09	0.10
Slough anchovy	*Anchoa delicatissima*	12	4	16	0.03	0.05	0.01	0.06	0.01
California scorpionfish	*Scorpaena guttata*	3	10	13	0.02	0.72	2.67	3.39	0.30
Thornback	*Platyrhinoidis triseriata*	1	12	13	0.02	0.20	2.65	2.85	0.25
California skate	*Raja inornata*	4	7	11	0.02	4.21	3.67	7.88	0.69
Pile surfperch	*Rhacochilus vacca*	2	7	9	0.02	0.16	0.56	0.72	0.06
Big skate	*Raja binoculata*	1	7	8	0.01	0.01	3.94	3.95	0.35
Staghorn sculpin	*Leptocottus armatus*	2	6	8	0.01	0.09	0.03	0.12	0.01
Brown smoothhound shark	*Mustelus henlei*	3	4	7	0.01	3.35	4.82	8.17	0.71
Topsmelt	*Atherinops affinis*		6	6	0.01	0.00	0.23	0.23	0.02
Grey smoothhound shark	*Mustelus californicus*	2	3	5	0.01	1.76	4.02	5.78	0.50
Vermilion rockfish	*Sebastes miniatus*	3	1	4	0.01	0.24	0.13	0.37	0.03
Leopard shark	*Triakis semifasciata*		3	3	0.01		0.95	0.95	0.08
Jacksmelt	*Atherinopsis californiensis*		3	3	0.01		0.43	0.43	0.04
Grass rockfish	*Sebastes rastrelliger*	3		3	0.01	0.07	0.00	0.07	0.01
English sole	*Pleuronectes vetulus*	2	1	3	0.01	0.02	0.03	0.05	0.00
Bay pipefish	*Syngnathus leptorhynchus*	3		3	0.01	0.01		0.01	0.00
Pacific sardine	*Sardinops sagax*	2	1	3	0.01	0.00	0.00	0.00	0.00
Walleye surfperch	*Hyperprosopon argenteum*		2	2	0.00		0.04	0.04	0.00
Barcheek pipefish	*Syngnathus exilis*		2	2	0.00	0.03	0.00	0.03	0.00
Yellowfin goby	*Acanthogobius flavimanus*		2	2	0.00		0.02	0.02	0.00
California grunion	*Leuresthes tenuis*		2	2	0.00		0.00	0.00	0.00
Pipefish (unid.)	*Syngnathus sp*	2		2	0.00	0.00		0.00	0.00
Spotted sand bass	*Paralabrax maculatofasciatus*		1	1	0.00	0.00	0.43	0.43	0.04
Sargo	*Anisotremus davidsoni*	1		1	0.00	0.35		0.35	0.03
Yellowfin croaker	*Umbrina roncador*		1	1	0.00	0.00	0.33	0.33	0.03
Longfin sanddab	*Citharichthys xanthostigma*		1	1	0.00	0.00	0.05	0.05	0.00
Spotted kelpfish	*Gibbonsia elegans*	1		1	0.00	0.01		0.01	0.00
Lingcod	*Ophiodon elongatus*	1		1	0.00	0.01		0.01	0.00
California clingfish	*Gobiesox rhessodon*	1		1	0.00	0.00		0.00	0.00
Cabezon	*Scorpaenichthys marmoratus*	1		1	0.00	0.00		0.00	0.00
Chameleon goby	*Tridentiger trigonocephalus*	1		1	0.00	0.00		0.00	0.00
	Total Abundance and Biomass	32,233	25,651	57,884	100	452	693	1,145	100
	Total Number of Species	50	53	62	--				

Note: Species listed in decreasing order of abundance.

Table 3.4-2. Mean abundance, biomass, and number of species of fish caught by otter trawl in Long Beach and Los Angeles Harbors, February – November 2000.

Habitat / Station	Depth (m)	Mean Abundance			Mean Biomass (kg)			Total Mean Number of Species		
		Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Open										
LA1	13	1,056	329	692	13.11	15.36	14.24	7	11	13
LB1	12	369	280	325	9.67	14.09	11.88	12	14	17
Deepwater Channel										
LA4	16	691	185	438	4.33	6.46	5.39	9	13	15
LB7	24	374	291	332	11.11	15.92	13.52	12	11	16
Deepwater Basin										
LA5	17	232	127	179	0.93	1.60	1.27	7	10	11
LA6	16	43	298	171	1.06	4.65	2.86	4	11	12
LB3	15	576	694	635	7.36	13.70	10.53	8	12	14
LB5	15	499	786	642	4.21	7.44	5.82	9	12	14
Deepwater Slip										
LB4	15	113	178	146	0.95	2.88	1.91	5	8	11
LB6	17	713	366	540	4.75	9.44	7.10	9	11	14
Shallow Mitigation										
LA2A	4	248	397	322	14.22	15.29	14.75	10	15	17
LA2B	4	277	315	296	7.42	13.76	10.59	8	11	14
LA7A	4	65	638	351	5.15	9.33	7.24	9	11	15
LA7B	4	58	176	117	3.82	9.88	6.85	7	13	14
LB2A	6	831	521	676	10.43	12.52	11.47	11	17	20
LB2B	6	900	403	651	9.48	10.15	9.82	10	12	18
Shallow Water Open										
LA3A	4	950	173	562	2.95	4.85	3.90	8	12	15
LA3B	4	66	258	162	1.93	5.86	3.90	8	11	14
Station Mean		448	356	402	6.27	9.62	7.95	8	12	15
Total Survey Mean		8,058	6,413	7,235	112.89	173.19	143.04	31	35	42

Table 3.4-3. Mean diversity and dominance of fish caught by otter trawl in Long Beach and Los Angeles Harbors, February – November 2000.

Habitat / Station	Depth	Shannon-Wiener Diversity			Margalef Diversity			Dominance		
	(m)	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Open										
LA1	13	0.88	1.03	0.97	1.30	1.79	1.97	2	2	2
LB1	12	1.36	1.47	1.50	1.97	2.41	2.48	3	3	3
Deepwater Channel										
LA4	16	1.10	1.59	1.50	1.73	2.35	2.45	2	3	3
LB7	24	1.00	1.09	1.13	1.77	1.81	2.27	2	2	2
Deepwater Basin										
LA5	17	0.97	1.35	1.37	1.45	1.79	1.94	2	3	3
LA6	16	1.05	1.28	1.35	1.26	1.77	1.91	2	3	3
LB3	15	0.90	0.60	0.80	1.29	1.84	1.94	2	1	2
LB5	15	0.86	1.17	1.24	1.46	1.91	2.15	2	2	3
Deepwater Slip										
LB4	15	0.92	1.29	1.39	1.15	1.48	1.95	2	3	3
LB6	17	0.78	0.73	0.77	1.68	1.70	1.88	1	1	2
Shallow Mitigation										
LA2A	4	1.52	1.35	1.65	1.95	2.45	2.74	3	2	3
LA2B	4	1.05	1.30	1.45	1.72	1.94	2.27	2	3	3
LA7A	4	1.51	1.08	1.38	2.05	1.69	2.35	3	2	3
LA7B	4	1.49	1.62	1.89	1.66	2.35	2.48	3	4	5
LB2A	6	1.39	1.15	1.43	2.03	2.82	3.06	3	2	3
LB2B	6	1.55	1.15	1.42	2.01	1.97	2.71	3	2	3
Shallow Water Open										
LA3A	4	1.40	1.19	1.11	1.96	2.09	2.37	3	2	2
LA3B	4	1.46	1.26	1.48	1.80	1.86	2.24	3	2	3
Station Mean		1.18	1.20	1.32	1.68	2.00	2.29	2	2	3

Table 3.4-4. Mean and total abundance of fish species caught over day and night periods by otter trawl in Long Beach and Los Angeles Harbors, February – November 2000.

Common Name	Species	Mean Abundance																		Total Catch
		Deepwater Open		Deepwater Channel		Deepwater Basin				Deepwater Slip		Shallow Mitigation						Shallow Water Open		
		LA1	LB1	LA4	LB7	LA5	LA6	LB3	LB5	LB4	LB6	LA2A	LA2B	LA7A	LA7B	LB2A	LB2B	LA3A	LA3B	All Stations
Northern anchovy	*Engraulis mordax*	506.3	67.8	325.9	33.0	99.1	16.0	153.5	56.6	51.6	240.0	22.0	91.4	15.3	5.5	337.3	350.5	463.5	20.6	22,846
White croaker	*Genyonemus lineatus*	129.5	169.4	41.4	223.0	40.9	61.8	448.3	478.9	38.4	242.1	62.5	28.6	216.3	33.6	130.3	117.3	59.3	73.9	20,762
Queenfish	*Seriphus politus*	21.4	33.8	30.8	32.1	10.5	67.8	15.0	72.4	5.8	26.3	132.6	70.6	70.5	34.4	160.5	136.3	13.1	29.5	7,705
Shiner surfperch	*Cymatogaster aggregata*	0.1	0.1	4.6		0.9	9.9	0.3		0.5		58.9	54.0	20.5	7.3	1.6	1.4	1.8	3.4	1,321
Specklefin midshipman	*Porichthys myriaster*	1.6	16.6	5.0	12.4	11.3	2.3	4.9	15.3	35.5	10.0	0.1		3.5	0.1	0.3	0.5	5.4	10.9	1,084
White surfperch	*Phanerodon furcatus*	1.1	0.8	10.1	0.1	1.9	4.9	3.4	1.5	5.1	0.1	23.3	33.3	11.4	12.3	2.5	5.5	2.5	4.5	993
California halibut	*Paralichthys californicus*	2.0	3.8	0.9	4.0	0.9	1.0	1.4	2.4	0.5	2.4	3.6	5.4	2.6	1.8	16.9	17.4	0.3	1.4	547
California tonguefish	*Symphurus atricauda*	4.3	11.6	1.4	11.0			1.0	1.0	0.1	4.6	1.4		0.1		0.6	0.3	5.1	4.0	372
Speckled sanddab	*Citharichthys stigmaeus*	15.3	4.5	3.4	0.9	0.1			1.8		0.9	2.6	1.0	0.1		1.0	4.6	1.3	4.1	332
Barred sand bass	*Paralabrax nebulifer*	1.4	1.6	3.3	0.6	1.9	2.5	0.4	1.5	1.1	0.6	3.0	2.1	3.6	6.6	2.8	0.9	2.3	2.6	310
Bay goby	*Lepidogobius lepidus*	0.6	2.3	0.5	7.4	1.4		0.9	6.5	0.1	2.8	0.1	0.1	0.8	0.9	0.6	0.5	0.1	0.6	209
Spotted turbot	*Pleuronichthys ritteri*	0.1	2.0	1.8		0.1	0.9		0.5	0.5	0.4	2.6	3.0	2.5	0.8	3.9	3.0	0.3	0.1	179
Plainfin midshipman	*Porichthys notatus*			1.1	0.4	7.9	0.6			4.1	0.4				1.6	0.1		0.5	0.1	135
Hornyhead turbot	*Pleuronichthys verticalis*	0.1	4.1	0.8	1.0		0.3	1.0	0.8		1.3	0.3	0.3		0.1	2.6	1.5	0.9	1.4	130
California lizardfish	*Synodus lucioceps*	0.9	2.1	0.5	1.0	0.4		1.0	1.0	0.5	1.6		0.1	0.6	0.1	1.4	1.6	1.3	1.0	121
Fantail sole	*Xystreurys liolepis*		2.1	0.8	0.5	0.3	0.3	0.4	0.9	0.1	0.9	1.5	0.6	0.1	0.3	0.8	0.8	0.9	0.8	94
Yellowchin sculpin	*Icelinus quadriseriatus*	0.1		5.0	0.4	1.4	1.1	0.3	0.3	0.4					0.1					72
Bat ray	*Myliobatis californica*	0.1	0.1		0.1			0.1		0.1		2.4	1.9	0.1	0.6	0.8	0.4			54
Deepbody anchovy	*Anchoa compressa*	0.1	0.1		0.3			0.3		0.1	0.8				0.4	3.6	0.9			52
Giant kelpfish	*Heterostichus rostratus*						0.1			0.1		0.3	0.3	0.5	5.0				0.3	52
Pacific sanddab	*Citharichthys sordidus*	5.5	0.6		0.3															51
Basketweave cusk-eel	*Ophidion scrippsae*	0.9	0.3		2.4			0.1								1.1	1.5			50
Pacific butterfish	*Peprilus simillimus*		0.1					1.0			2.3			0.3		1.1	1.0		0.1	47
Diamond turbot	*Hypsopsetta guttulata*	0.3	0.1		0.3	0.1		0.1				1.1	0.9	0.1	0.3	1.1	1.1			44
Round stingray	*Urolophus halleri*							0.1		0.1			0.1	0.3		1.9	1.9			35
Shovelnose guitarfish	*Rhinobatos productus*				0.4			0.5	0.1			0.4	0.4	0.4	0.9	0.4	0.5			31
Black rockfish	*Sebastes melanops*								0.1			0.3						1.5	2.0	31
Black surfperch	*Embiotoca jacksoni*			0.3			0.1			0.4	0.1	1.4		0.3	0.5					24
Kelp bass	*Paralabrax clathratus*													0.4	2.5			0.1		24
California corbina	*Menticirrhus undulatus*	0.3	0.3									0.9	0.3			0.6	0.6			23
Salema	*Xenistius californiensis*		0.1					0.1	0.6					0.3	0.3	0.3	0.1	0.3	0.1	17
Slough anchovy	*Anchoa delicatissima*								0.1		1.4					0.1	0.4			16
Thornback	*Platyrhinoidis triseriata*							0.1				0.1	0.6			0.6	0.1			13
California scorpionfish	*Scorpaena guttata*	0.1		0.1	0.1						0.3	0.3	0.4	0.1		0.3				13
California skate	*Raja inornata*							0.1	0.1		0.4						0.1	0.3	0.4	11
Pile surfperch	*Rhacochilus vacca*						0.8	0.1					0.1	0.1						9
Staghorn sculpin	*Leptocottus armatus*			0.6	0.1	0.1					0.1									8

Table 3.4-4. Continued.

Common Name	Species	Mean Abundance																		Total Catch
		Deepwater Open		Deepwater Channel		Deepwater Basin				Deepwater Slip		Shallow Mitigation						Shallow Water Open		
		LA1	LB1	LA4	LB7	LA5	LA6	LB3	LB5	LB4	LB6	LA2A	LA2B	LA7A	LA7B	LB2A	LB2B	LA3A	LA3B	All Stations
Big skate	*Raja binoculata*		0.1		0.1									0.1	0.1		0.1	0.4		8
Brown smoothhound shark	*Mustelus henlei*				0.1			0.5				0.1						0.1		7
Topsmelt	*Atherinops affinis*											0.1	0.1		0.3			0.3		6
Grey smoothhound shark	*Mustelus californicus*	0.1	0.1		0.3		0.1													5
Vermilion rockfish	*Sebastes miniatus*				0.1		0.1	0.1	0.1											4
Jacksmelt	*Atherinopsis californiensis*															0.3	0.1			3
English sole	*Pleuronectes vetulus*					0.1										0.1	0.1			3
Pacific sardine	*Sardinops sagax*		0.1							0.1								0.1		3
Grass rockfish	*Sebastes rastrelliger*										0.1			0.3						3
Bay pipefish	*Syngnathus leptorhynchus*											0.1					0.1	0.1		3
Leopard shark	*Triakis semifasciata*											0.4								3
Yellowfin goby	*Acanthogobius flavimanus*						0.1								0.1					2
Walleye surfperch	*Hyperprosopon argenteum*															0.3				2
California grunion	*Leuresthes tenuis*															0.1			0.1	2
Barcheek pipefish	*Syngnathus exilis*													0.1	0.1					2
Pipefish (unid.)	*Syngnathus sp*																		0.3	2
Sargo	*Anisotremus davidsoni*														0.1					1
Longfin sanddab	*Citharichthys xanthostigma*	0.1																		1
Spotted kelpfish	*Gibbonsia elegans*													0.1						1
California clingfish	*Gobiesox rhessodon*														0.1					1
Lingcod	*Ophiodon elongatus*																	0.1		1
Spotted sand bass	*Paralabrax maculatofasciatus*									0.1										1
Cabezon	*Scorpaenichthys marmoratus*											0.1								1
Chameleon goby	*Tridentiger trigonocephalus*														0.1					1
Yellowfin croaker	*Umbrina roncador*													0.1						1
	Total Catch Across Surveys	692	325	438	332	179	170	635	642	145	540	322	295	351	117	676	651	561	162	57,884

Table 3.4-5. Mean and total biomass of fish species caught over day and night periods by otter trawl in Long Beach and Los Angeles Harbors, February – November 2000.

Common Name	Species	Mean Biomass (kg)																		Total Biomass
		Deepwater Open		Deepwater Channel		Deepwater Basin				Deepwater Slip		Shallow Mitigation						Shallow Water Open		
		LA1	LB1	LA4	LB7	LA5	LA6	LB3	LB5	LB4	LB6	LA2A	LA2B	LA7A	LA7B	LB2A	LB2B	LA3A	LA3B	All Stations
White croaker	*Genyonemus lineatus*	10.599	5.876	1.868	5.943	0.486	0.951	4.303	2.681	0.411	4.046	2.630	1.926	2.963	1.305	2.950	2.884	1.535	1.559	439.32
California halibut	*Paralichthys californicus*	1.108	1.800	0.894	1.546	0.115	0.219	1.006	1.270	0.353	0.650	1.141	0.971	0.803	0.895	3.171	1.884	0.096	0.678	148.79
Bat ray	*Myliobatis californica*	0.060	0.731		0.575			1.875		0.010		6.194	3.574	0.064	1.063	1.353	0.606			128.83
Queenfish	*Seriphus politus*	0.355	0.791	0.553	0.976	0.138	0.495	0.678	0.733	0.141	0.725	0.294	0.188	0.971	0.689	0.494	0.700	0.279	0.483	77.44
Shovelnose guitarfish	*Rhinobatos productus*				2.399			1.013	0.123			0.369	0.275	0.400	1.559	0.298	0.378			54.49
White surfperch	*Phanerodon furcatus*	0.054	0.036	0.704		0.069	0.201	0.204	0.180	0.410		0.948	1.615	0.881	0.253	0.086	0.168	0.209	0.214	49.84
Barred sand bass	*Paralabrax nebulifer*	0.273	0.210	0.344	0.075	0.083	0.245	0.045	0.154	0.124	0.068	0.494	0.296	0.273	0.604	0.405	0.125	0.240	0.279	34.67
California lizardfish	*Synodus lucioceps*	0.271	0.448	0.069	0.304	0.108		0.211	0.155	0.114	0.438		0.026	0.125	0.065	0.344	0.395	0.201	0.159	27.45
Northern anchovy	*Engraulis mordax*	0.689	0.094	0.353	0.095	0.084	0.031	0.215	0.026	0.048	0.258	0.023	0.070	0.016	0.006	0.409	0.446	0.428	0.014	26.42
Fantail sole	*Xystreurys liolepis*		0.564	0.145	0.205	0.059	0.101	0.078	0.164	0.004	0.198	0.344	0.131	0.014	0.028	0.215	0.229	0.263	0.131	22.96
Round stingray	*Urolophus halleri*							0.081		0.073			0.076	0.053		0.850	0.848			15.84
Shiner surfperch	*Cymatogaster aggregata*	0.005	0.001	0.065		0.021	0.214	0.005		0.018		0.618	0.565	0.249	0.074	0.015	0.013	0.016	0.045	15.38
Spotted turbot	*Pleuronichthys ritteri*	0.018	0.313	0.156		0.001	0.026		0.023	0.073	0.055	0.266	0.299	0.104	0.123	0.090	0.124	0.046	0.001	13.73
Diamond turbot	*Hypsopsetta guttulata*	0.111	0.045		0.104	0.028		0.004				0.289	0.206	0.035	0.064	0.234	0.220			10.71
California corbina	*Menticirrhus undulatus*	0.198	0.093									0.494	0.098			0.090	0.123			8.75
Brown smoothhound shark	*Mustelus henlei*				0.128			0.550				0.156						0.188		8.17
Specklefin midshipman	*Porichthys myriaster*	0.031	0.188	0.023	0.146	0.055	0.009	0.060	0.028	0.048	0.070	0.003		0.131		0.073	0.058	0.014	0.053	7.89
California skate	*Raja inornata*							0.106	0.131		0.326						0.269	0.051	0.101	7.88
Hornyhead turbot	*Pleuronichthys verticalis*		0.271	0.066	0.138		0.008	0.025	0.053		0.058	0.020	0.004			0.064	0.051	0.035	0.099	7.12
California tonguefish	*Symphurus atricauda*	0.070	0.248	0.024	0.184			0.018	0.033	0.003	0.098	0.031		0.001		0.014	0.009	0.060	0.050	6.72
Grey smoothhound shark	*Mustelus californicus*	0.138	0.090		0.220		0.275													5.78
Big skate	*Raja binoculata*		0.001		0.156									0.003	0.001		0.119	0.214		3.95
Basketweave cusk-eel	*Ophidion scrippsae*	0.085	0.009		0.246			0.004								0.039	0.064			3.57
California scorpionfish	*Scorpaena guttata*	0.100		0.013	0.031						0.053	0.054	0.094	0.038		0.043				3.39
Thornback	*Platyrhinoidis triseriata*							0.013				0.049	0.153			0.116	0.026			2.85
Black surfperch	*Embiotoca jacksoni*			0.051			0.010			0.028		0.173		0.040	0.030					2.65
Speckled sanddab	*Citharichthys stigmaeus*	0.048	0.049	0.048	0.004	0.003			0.014		0.003	0.040	0.008	0.004		0.006	0.043	0.005	0.020	2.33
Salema	*Xenistius californiensis*		0.011					0.008	0.038					0.018	0.015	0.016	0.008	0.015	0.009	1.09
Leopard shark	*Triakis semifasciata*											0.119								0.95
Pile surfperch	*Rhacochilus vacca*						0.053	0.018					0.008	0.013						0.72
Deepbody anchovy	*Anchoa compressa*	0.003	0.003		0.005			0.004		0.003	0.005				0.003	0.050	0.014			0.70
Pacific butterfish	*Peprilus simillimus*		0.001					0.009			0.020			0.003		0.013	0.010		0.003	0.46

Table 3.4-5. Continued.

Common Name	Species	Mean Biomass (kg) Deepwater Open		Deepwater Channel		Deepwater Basin				Deepwater Slip		Shallow Mitigation						Shallow Water Open		Total Biomass
		LA1	LB1	LA4	LB7	LA5	LA6	LB3	LB5	LB4	LB6	LA2A	LA2B	LA7A	LA7B	LB2A	LB2B	LA3A	LA3B	All Stations
Jacksmelt	*Atherinopsis californiensis*															0.040	0.014			0.43
Spotted sand bass	*Paralabrax maculatofasciatus*									0.054										0.43
Vermilion rockfish	*Sebastes miniatus*				0.014		0.016	0.001	0.015											0.37
Sargo	*Anisotremus davidsoni*														0.044					0.35
Yellowfin croaker	*Umbrina roncador*													0.041						0.33
Yellowchin sculpin	*Icelinus quadriseriatus*			0.024	0.001	0.005	0.004	0.003	0.001	0.001					0.001					0.32
Giant kelpfish	*Heterostichus rostratus*						0.001			0.001		0.003	0.009	0.003	0.015				0.003	0.27
Plainfin midshipman	*Porichthys notatus*			0.001	0.013	0.005	0.001			0.005	0.005				0.001			0.001		0.26
Topsmelt	*Atherinops affinis*											0.011	0.006		0.010			0.001		0.23
Bay goby	*Lepidogobius lepidus*	0.001	0.003		0.009	0.001			0.006		0.004			0.001	0.001				0.001	0.22
Pacific sanddab	*Citharichthys sordidus*	0.016	0.011																	0.22
Staghorn sculpin	*Leptocottus armatus*			0.003	0.008	0.001					0.004									0.12
Kelp bass	*Paralabrax clathratus*													0.001	0.011					0.10
Grass rockfish	*Sebastes rastrelliger*										0.008			0.001						0.07
Slough anchovy	*Anchoa delicatissima*										0.006						0.001			0.06
Black rockfish	*Sebastes melanops*																	0.004	0.004	0.06
Longfin sanddab	*Citharichthys xanthostigma*	0.006																		0.05
English sole	*Pleuronectes vetulus*					0.004										0.001	0.001			0.05
Walleye surfperch	*Hyperprosopon argenteum*															0.005				0.04
Bay pipefish	*Syngnathus leptorhynchus*											0.001					0.001	0.001		0.03
Yellowfin goby	*Acanthogobius flavimanus*						0.001								0.001					0.02
Spotted kelpfish	*Gibbonsia elegans*													0.001						0.01
Lingcod	*Ophiodon elongatus*																	0.001		0.01
Pipefish (unid.)	*Syngnathus sp*																		0.001	0.01
Total Biomass Across Surveys		14.236	11.885	5.400	13.523	1.264	2.861	10.533	5.825	1.918	7.094	14.760	10.596	7.246	6.859	11.481	9.826	3.903	3.904	1,144.90

Table 3.4-6. Summary of biological and physical/chemical habitat characteristics of otter trawl fish cluster groups.

	Cluster Group			
	1	**2**	**3**	**4**
Station	LA1, LB1, LA3, LA4, LB3, LB5, LB6, LB7	LB4, LA5, LA6	LB2	LA2, LA7
Habitat	Deep and Shallow Open Water, Deep Basin, Deep Slip, Deep Channel,	Deep Basin, Deep Slip	Shallow Open Water (Mitigation Site)	Shallow Open Water (Mitigation Sites)
Depth (m)	4-24	15-17	6	4
Range of Percent Fines	25-93	37-72	20-63	21-50
Years Since Dredging/ Disposal	0 to > 10	1 to > 10	1	0 to > 10
Range Percent Transmissivity **•near surface** **•mid-water** **•near bottom**	(S) 42-71 (M) 29-69 (B) 11-66	61-76 52-74 50-67	59-65 46-66 8-62	39-68 40-67 17-64
Range Mid-water Temperature (^{o}C)	12-20	14-20	13-21	14-23
Range Mid-water Dissolved Oxygen (mg/L)	4.4-8.0	5.2-6.8	4.8-8.3	5.8-9.2
Range Mid-water Salinity (ppt)	33.0-33.7	33.0-33.5	33.1-33.7	33.0-33.6
Total Taxa in Species Cluster Group	46	30	34	39
Number of Relatively Abundant Taxa in Cluster Group	12	4	17	16
Relatively Abundant Taxa in Cluster Group	*Citharichthys, Engraulis, Genyonemus, Lepidogobius, Mustelus, Pleuronichthys, Porichthys, Raja, Sebastes, Symphurus, Synodus, Xystreurys*	*Icelinus, Paralabrax, Porichthys myriaster, Porichthys notatus*	*Anchoa, Atherinopsis, Engraulis, Hypsopsetta, Leuresthes, Menticirrhus, Ophidion, Paralabrax, Paralichthys, Peprillus, Platyrhinoidis, Pleuronichthys, Rhinobatos, Seriphus, Synodus, Urolophus, Xystreurys*	*Atherinops, Cymatogaster, Embiotoca, Heterostichus, Hypsopsetta, Menticirrhus, Myliobatis, Paralabrax, Paralichthys, Phanerodon, Pleuronichthys, Rhinobatos, Scorpaena, Seriphus, Sygnathus, Xystreurys*

Note: S = near surface, M = mid-water, B = near bottom.

Table 3.4-7. Comparison of total fish catch between 16-foot and 25-foot otter trawls in Long Beach and Los Angeles Harbors, August and November 2000.

Station	August						November						Aug and Nov, Day and Night		
	Day Trawls			Night Trawls			Day Trawls			Night Trawls			Overall Mean		
	25'	16'	Ratio	25'	16'	Ratio	25'	16'	Ratio	25'	16'	Ratio	25'	16'	Ratio
Abundance															
LA1	4,032	419	9.62	442	196	2.26	66	538	0.12	573	555	1.03	5,113	1,708	2.99
LA4	2,635	93	28.33	291	339	0.86	12	7	1.71	222	82	2.71	3,160	521	6.07
LA6	151	3	50.33	681	117	5.82	3	0	NA	140	23	6.09	975	143	6.82
LB1	770	1,376	0.56	474	219	2.16	325	709	0.46	333	529	0.63	1,902	2,833	0.67
LB4	441	317	1.39	239	58	4.12	3	6	0.50	283	258	1.10	966	639	1.51
LB7	400	83	4.82	414	57	7.26	365	1,158	0.32	246	462	0.53	1,425	1,760	0.81
Mean Station Ratio	15.84			3.75			0.62			2.01			3.14		
Mean Across Stations	1,686	458	3.68	508	197	2.58	155	484	0.32	359	382	0.94	2,708	1,521	1.78
Number of Species															
LA1	2	7	0.29	12	8	1.50	7	8	0.88	12	10	1.20	33	33	1.00
LA4	10	6	1.67	14	10	1.40	5	2	2.50	14	10	1.40	43	28	1.54
LA6	8	3	2.67	11	4	2.75	3	0	NA	10	5	2.00	32	12	2.67
LB1	15	10	1.50	14	10	1.40	11	11	1.00	14	14	1.00	54	45	1.20
LB4	5	1	5.00	11	3	3.67	4	4	1.00	7	6	1.17	27	14	1.93
LB7	14	6	2.33	12	5	2.40	9	12	0.75	9	15	0.60	44	38	1.16
Mean Station Ratio	2.24			2.19			1.23			1.23			1.58		
Mean Across Stations	11	7	1.64	15	8	1.85	8	7	1.05	13	12	1.10	47	34	1.37

Notes:
(1) Ratio is the ratio of (25-foot / 16-foot) otter trawl catch.
(2) To convert 25-foot otter trawl catch data to 16-foot otter trawl catch data, adjust by the inverse ratio (i.e., 1/Ratio).
(3) Only those surveys and stations that used both the 16- and 25-foot nets are included in the comparison (i.e., surveys 3 and 4; Stations LA1, LA4, LA6, LB1, LB4, LB7).

Table 3.4-8. Comparison of fish catch by species between 16-foot and 25-foot otter trawls in Long Beach and Los Angeles Harbors, August and November 2000.

Common Name	Species	Day Trawls		Night Trawls	
		25'	16'	25'	16'
Yellowfin goby	*Acanthogobius flavimanus*		1	1	1
Deepbody anchovy	*Anchoa compressa*		2	2	
Topsmelt	*Atherinops affinis*				1
Pacific sanddab	*Citharichthys sordidus*			46	
Speckled sanddab	*Citharichthys stigmaeus*	52	19	52	43
Shiner surfperch	*Cymatogaster aggregata*	2		86	2
Black surfperch	*Embiotoca jacksoni*	3	2	1	1
Northern anchovy	*Engraulis mordax*	7,434	1,410	334	17
White croaker	*Genyonemus lineatus*	1,025	2,751	2,176	2,246
Giant kelpfish	*Heterostichus rostratus*		3	2	2
Diamond turbot	*Hypsopsetta guttulata*		1	1	1
Yellowchin sculpin	*Icelinus quadriseriatus*	2		5	
Bay goby	*Lepidogobius lepidus*	41	19	9	17
Staghorn sculpin	*Leptocottus armatus*	1			
California corbina	*Menticirrhus undulatus*			1	2
Grey smoothhound shark	*Mustelus californicus*	2		1	
Brown smoothhound shark	*Mustelus henlei*			1	2
Bat ray	*Myliobatis californica*	2		1	
Basketweave cusk-eel	*Ophidion scrippsae*			5	12
Barred sand bass	*Paralabrax nebulifer*	21	3	27	8
California halibut	*Paralichthys californicus*	16	10	19	6
Pacific butterfish	*Peprilus simillimus*		1	1	
White surfperch	*Phanerodon furcatus*	31	16	59	12
English sole	*Pleuronectes vetulus*				1
Spotted turbot	*Pleuronichthys ritteri*	10	4	5	2
Hornyhead turbot	*Pleuronichthys verticalis*	13	5	18	12
Specklefin midshipman	*Porichthys myriaster*	77	64	449	128
Plainfin midshipman	*Porichthys notatus*			26	2
California skate	*Raja inornata*		2		1
Shovelnose guitarfish	*Rhinobatos productus*			1	1
Pacific sardine	*Sardinops sagax*			1	
California scorpionfish	*Scorpaena guttata*		1	2	
Vermilion rockfish	*Sebastes miniatus*	1		1	
Grass rockfish	*Sebastes rastrelliger*		1		
Queenfish	*Seriphus politus*	383	378	930	341
California tonguefish	*Symphurus atricauda*	57	15	64	20
California lizardfish	*Synodus lucioceps*	1	2	7	4
Round stingray	*Urolophus halleri*				1
Salema	*Xenistius californiensis*			1	1
Fantail sole	*Xystreurys liolepis*	5		3	8
	Total Abundance	9,179	4,710	4,338	2,895
	Total Number of Taxa	21	22	34	29

Note: Only those surveys and stations that used both the 16-foot and 25-foot nets are included in the comparison (i.e., Surveys 3 and 4; Stations LA1,LA4, LA6, LB1, LB4, LB7).

Table 3.4-9. Selected historical comparison of the most abundant fish species, in descending order of year 2000 dominance, collected by otter trawl in Long Beach and Los Angeles Harbors.

Species	Stephens et al. 1974[1]	EQA-MBC 1976[2]	EQA-MBC 1978[2]	HEP 1979[1]	MBC 1984[3]	MEC 1988[4]	CLA-EMD 1993[4]	CLA-EMD 1995[4]	SAIC and MEC 1996[3]	SAIC and MEC 1997[2]	CLA-EMD 1998[4]	MEC 1999[5]	2000[6]
Engraulis mordax	17.1	15.2	14.9	2.5	17.7	0.3	nc	nc	< 0.1	< 0.1	nc	12.1	39.5
Genyonemus lineatus	52.4	61.1	49.0	52.4	34.2	71.3	58.7	63.4	75.3	80.0	46	35.9	35.9
Seriphus politus	3.8	5.1	19.0	4.7	37.3	13.7	28.6	8.5	4.1	3.7	27	5.2	13.3
Cymatogaster aggregata	3.7	2.9	1.6			<0.1			<0.1	<0.1		21.2	2.3
Porichthys myriaster					0.2	0.5			2.5	2.1		4.3	1.9
Phanerodon furcatus	3.6	3.8	2.2	1.4	0.9	1.5			0.1	1.3		6.8	1.7
Paralichthys californicus					0.6	2.0	2.3	4.4	3.0	2.7	2.2	1.2	0.9
Symphurus atricauda	8.9	4.2	4.2	26.5	4.0	3.0	6.3	5.1	7.5	3.3	7.4	1.4	0.6
Citharichthys stigmaeus	6.5	1.0		6.7		2.1	2.1	11.5	1.6	1.7	5.9	1.0	0.6
Lepidogobius lepidus		4.4				<0.1			<0.1	0.2		<0.1	0.4
Ophidion scrippsae					0.5				3.7	1.9			<0.1
Peprilus simillimus			2.8		0.6	0.3				<0.1			0.1

Notes: Surveys were conducted in deepwater (9-24 m) areas of the harbors, as follows: [1] both harbors, [2]inner and outer Long Beach Harbor, [3]outer Long Beach Harbor, [4]outer Los Angeles Harbor; Surveys were conducted in shallow to deepwater (5-24 m) areas of the harbors, as follows: [5]outer Los Angeles Harbor, [6]inner and outer Long Beach and LosAngeles Harbors. nc = not counted in sample.

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Table 3.5-1. Mean and total abundance of fish species caught by beach seine in Los Angeles Harbor, February – November 2000.

Common Name	Species	Mean Abundance		Total Catch
		Cabrillo	Pier 300	
Topsmelt	*Atherinops affinis*	20	574	2,376
Arrow goby	*Clevelandia ios*	1	19	80
Diamond turbot	*Hypsopsetta guttulata*	0	11	44
Dwarf surfperch	*Micrometrus minimus*	7	0	28
Bay pipefish	*Syngnathus leptorhynchus*	1	5	22
Yellowfin goby	*Acanthogobius flavimanus*	0	5	19
Giant kelpfish	*Heterostichus rostratus*	1	4	18
Black surfperch	*Embiotoca jacksoni*	2	0	8
California halibut	*Paralichthys californicus*	2	0	8
Staghorn sculpin	*Leptocottus armatus*	1	0	6
Spotted kelpfish	*Gibbonsia elegans*	1	0	5
Queenfish	*Seriphus politus*	1	0	5
Deepbody anchovy	*Anchoa compressa*	1	0	5
Barred sand bass	*Paralabrax nebulifer*	1	0	4
Shadow goby	*Quietula y-cauda*	0	1	3
Barcheek pipefish	*Syngnathus exilis*	0	1	3
Shiner surfperch	*Cymatogaster aggregata*	0	0	1
Cheekspot goby	*Ilypnus gilberti*	0	0	1
Surfperch (unid.)	Embioticidae	0	0	1
Bay blenny	*Hypsoblennius gentilis*	0	0	1
Leopard shark	*Triakis semifasciata*	0	0	1
	Total	39	620	2,633

Note: Species listed in decreasing order of abundance.

Table 3.5-2. Mean abundance, biomass, number of species, diversity, and dominance of fish caught by beach seine in Los Angeles Harbor, February – November 2000.

	February 2000	May 2000	August 2000	November 2000	Annual Mean	Annual Total
Abundance						
Cabrillo	57	23	16	59	39	155
Pier 300	417	1921	120	21	620	2479
Biomass (kg)						
Cabrillo	0.58	0.41	0.14	0.29	0.35	1.42
Pier 300	0.97	0.33	0.23	0.02	0.39	1.54
Number of Species						
Cabrillo	9	11	5	3	7	17
Pier 300	9	7	5	2	6	14
Shannon-Wiener						
Cabrillo	1.53	1.99	1.30	0.10	1.23	
Pier 300	0.37	0.28	0.52	0.19	0.34	
Margalef						
Cabrillo	2.79	2.61	1.15	0.42	1.74	
Pier 300	1.53	0.73	0.73	0.27	0.81	
Dominance						
Cabrillo	3	4	3	1	3	
Pier 300	1	1	1	1	1	

Note: Abundance and biomass based on the mean of two hauls.

Table 3.5-3. Historical comparison of beach seine data in the vicinity of Cabrillo Beach and Pier 300 in Los Angeles Harbor.

Reference	Cabrillo Beach			Pier 300		
	Mean Abundance (Biomass – kg)	**Mean (Total) Number Species**	**Dominant Species**	**Mean Abundance**	**Mean (Total) Number Species**	**Dominant Species**
Year 2000 Baseline	39 (0.35)	7 (12)	*Atherinops affinis* *Micrometus minimus* *Embiotoca jacksoni* *Paralichthys californicus*	620 (0.39)	6 (8)	*Atherinops affinis* *Clevelandia ios* *Hypsopsetta guttulata* *Syngnathus leptorhynchus* *Acanthogobius flavimanus*
MEC 1999	222 (0.69)	10 (12)	*Atherinops affinis* *Cymatogaster aggregata* *Heterostichus rostratus* *Micrometus minimus* *Paralabrax nebulifer*	441 (0.50)	7 (9)	*Atherinops affinis* *Paralichthys californicus* *Hypsopsetta guttulata* *Sygnathus leptorhynchus* *Lepidogobius lepidus*
Allen et al. 1983	383	(37)	*Engraulis mordax* *Seriphus politus* *Leuresthes tenuis* *Micrometus minimus* *Clevelandia ios*			
Horn and Hagner 1982				7 (1.9)	(4)	*Seriphus politus* *Anchoa compressa* *Genyonemus lineatus* *Hyperprosopon argenteum*

Notes: Data are from daytime catch
The number of surveys for each of the studies was, as follows: Year 2000 (4), MEC 1999 (1), Allen et al. 1983 (12), Horn and Hagner 1982 (1)

Table 3.6-1. Combined fish species list by gear type for the Year 2000 Baseline Study of Long Beach and Los Angeles Harbors.

Common Name	Species	Otter Trawl	Lampara	Beach Seine
Yellowfin goby	*Acanthogobius flavimanus*	X		X
Deepbody anchovy	*Anchoa compressa*	X	X	X
Slough anchovy	*Anchoa delicatissima*	X	X	
Sargo	*Anisotremus davidsoni*	X	X	
Topsmelt	*Atherinops affinis*	X	X	X
Jacksmelt	*Atherinopsis californiensis*	X	X	
White seabass	*Atractoscion nobilis*		X	
Black croaker	*Cheilotrema saturnum*		X	
Blacksmith	*Chromis punctipinnis*		X	
Pacific sanddab	*Citharichthys sordidus*	X	X	
Speckled sanddab	*Citharichthys stigmaeus*	X	X	
Longfin sanddab	*Citharichthys xanthostigma*	X		
Arrow goby	*Clevelandia ios*			X
Shiner surfperch	*Cymatogaster aggregata*	X	X	X
Surfperch (unid.)	Embioticidae			X
Black surfperch	*Embiotoca jacksoni*	X	X	X
Northern anchovy	*Engraulis mordax*	X	X	
White croaker	*Genyonemus lineatus*	X	X	
Spotted kelpfish	*Gibbonsia elegans*	X		X
California clingfish	*Gobiesox rhessodon*	X		
Giant kelpfish	*Heterostichus rostratus*	X	X	X
Walleye surfperch	*Hyperprosopon argenteum*	X	X	
Bay blenny	*Hypsoblennius gentilis*			X
Diamond turbot	*Hypsopsetta guttulata*	X	X	X
Yellowchin sculpin	*Icelinus quadriseriatus*	X		
Cheekspot goby	*Ilypnus gilberti*			X
Bay goby	*Lepidogobius lepidus*	X		
Staghorn sculpin	*Leptocottus armatus*	X		X
California grunion	*Leuresthes tenuis*	X	X	
California corbina	*Menticirrhus undulatus*	X	X	
Dwarf surfperch	*Micrometrus minimus*			X
Grey smoothhound shark	*Mustelus californicus*	X	X	
Brown smoothhound shark	*Mustelus henlei*	X	X	
Bat ray	*Myliobatis californica*	X	X	
Basketweave cusk-eel	*Ophidion scrippsae*	X	X	
Lingcod	*Ophiodon elongatus*	X		
Kelp bass	*Paralabrax clathratus*	X		
Spotted sand bass	*Paralabrax maculatofasciatus*	X		
Barred sand bass	*Paralabrax nebulifer*	X	X	X
California halibut	*Paralichthys californicus*	X	X	X
Pacific butterfish	*Peprilus simillimus*	X	X	
White surfperch	*Phanerodon furcatus*	X	X	
Thornback	*Platyrhinoidis triseriata*	X	X	
English sole	*Pleuronectes vetulus*	X		
Spotted turbot	*Pleuronichthys ritteri*	X	X	
Hornyhead turbot	*Pleuronichthys verticalis*	X	X	
Specklefin midshipman	*Porichthys myriaster*	X	X	
Plainfin midshipman	*Porichthys notatus*	X	X	
Shadow goby	*Quietula y-cauda*			X
Big skate	*Raja binoculata*	X		
California skate	*Raja inornata*	X		
Pile surfperch	*Rhacochilus vacca*	X	X	
Shovelnose guitarfish	*Rhinobatos productus*	X	X	
Pacific sardine	*Sardinops sagax*	X	X	
Chub mackerel	*Scomber japonicus*		X	
California scorpionfish	*Scorpaena guttata*	X	X	
Cabezon	*Scorpaenichthys marmoratus*	X		
Black rockfish	*Sebastes melanops*	X	X	
Vermilion rockfish	*Sebastes miniatus*	X		
Grass rockfish	*Sebastes rastrelliger*	X		
Queenfish	*Seriphus politus*	X	X	X
California barracuda	*Sphyraena argentea*		X	
California tonguefish	*Symphurus atricauda*	X	X	
Barred pipefish	*Syngnathus auliscus*		X	
Barcheek pipefish	*Syngnathus exilis*	X	X	X
Bay pipefish	*Syngnathus leptorhynchus*	X		X
Pipefish (unid.)	*Syngnathus* sp.	X		
California lizardfish	*Synodus lucioceps*	X	X	
Jack mackerel	*Trachurus symmetricus*		X	
Leopard shark	*Triakis semifasciata*	X		X
Pacific cutlassfish	*Trichiurus nitens*		X	
Chameleon goby	*Tridentiger trigonocephalus*	X		
Yellowfin croaker	*Umbrina roncador*	X	X	
Round stingray	*Urolophus halleri*	X	X	
Salema	*Xenistius californiensis*	X	X	
Fantail sole	*Xystreurys liolepis*	X	X	
	Total	62	50	21
	Grand Total		76	

Table 3.6-2. Estimated mean total fish population for the Year 2000 Baseline Study in Long Beach and Los Angeles Harbors.

Common Name	Species	Gear Catch Used For Estimation	Abundance			Biomass (kg)		
			Average	Day	Night	Average	Day	Night
Northern anchovy	*Engraulis mordax*	Lampara/Trawl*	26,268,164	22,579,245	29,957,083	57,879	27,663	88,095
White croaker	*Genyonemus lineatus*	Trawl	10,509,209	7,048,051	13,970,366	328,363	232,193	424,534
Queenfish	*Seriphus politus*	Lampara/Trawl*	2,112,806	1,328,645	2,896,968	54,379	26,166	82,591
Pacific sardine	*Sardinops sagax*	Lampara	1,083,804	1,889,934	277,673	6,978	11,788	2,168
Topsmelt	*Atherinops affinis*	Lampara	1,049,549	837,086	1,262,012	19,633	22,459	16,806
Specklefin midshipman	*Porichthys myriaster*	Trawl	678,060	92,800	1,263,320	5,688	2,319	9,056
California tonguefish	*Symphurus atricauda*	Trawl	346,326	194,056	498,596	6,904	4,172	9,637
Speckled sanddab	*Citharichthys stigmaeus*	Trawl	323,245	287,187	359,302	1,967	1,578	2,356
Shiner surfperch	*Cymatogaster aggregata*	Lampara/Trawl*	321,863	354,978	288,748	4,779	5,408	4,150
White surfperch	*Phanerodon furcatus*	Trawl	238,881	304,260	173,502	13,151	18,603	7,700
Salema	*Xenistius californiensis*	Lampara	162,199		324,398	8,327		16,654
Jacksmelt	*Atherinopsis californiensis*	Lampara	158,354	255,142	61,567	23,140	38,649	7,632
California halibut	*Paralichthys californicus*	Trawl	155,483	137,722	173,245	74,754	77,146	72,362
Barred sand bass	*Paralabrax nebulifer*	Trawl	113,727	109,590	117,865	14,269	14,965	13,572
Hornyhead turbot	*Pleuronichthys verticalis*	Trawl	107,338	100,381	114,295	6,738	5,388	8,088
California grunion	*Leuresthes tenuis*	Lampara	102,805	84,529	121,082	697	336	1,059
Bay goby	*Lepidogobius lepidus*	Trawl	92,183	111,412	72,954	101	164	37
Chub mackerel	*Scomber japonicus*	Lampara	90,207	164,004	16,411	20,246	38,376	2,116
Pacific sanddab	*Citharichthys sordidus*	Trawl	83,992	26,746	141,239	449	481	416
California lizardfish	*Synodus lucioceps*	Trawl	76,386	46,714	106,057	17,034	8,719	25,349
Spotted turbot	*Pleuronichthys ritteri*	Trawl	68,666	87,749	49,584	8,975	14,232	3,718
Fantail sole	*Xystreurys liolepis*	Trawl	61,031	58,097	63,965	15,487	17,459	13,516
California barracuda	*Sphyraena argentea*	Lampara	59,921	116,305	3,538	56,922	110,984	2,859
Pacific butterfish	*Peprilus simillimus*	Lampara/Trawl*	48,859	14,629	83,089	614	128	1,099
Plainfin midshipman	*Porichthys notatus*	Trawl	43,748	24,944	62,552	56	12	100
Slough anchovy	*Anchoa delicatissima*	Lampara	30,356	5,776	54,936	115	29	200
Yellowchin sculpin	*Icelinus quadriseriatus*	Trawl	29,276	26,213	32,339	129	111	147
Jack mackerel	*Trachurus symmetricus*	Lampara	28,819	16,393	41,245	4,468	2,654	6,281
Bat ray	*Myliobatis californica*	Lampara	26,297	25,432	27,162	54,255	52,195	56,316
Basketweave cusk-eel	*Ophidion scrippsae*	Trawl	19,330		38,660	1,498		2,996
Diamond turbot	*Hypsopsetta guttulata*	Trawl	10,176	3,455	16,896	3,319	603	6,034
California corbina	*Menticirrhus undulatus*	Lampara/Trawl*	10,656	1,863	19,449	5,606	1,039	10,172
Giant kelpfish	*Heterostichus rostratus*	Trawl	8,529	13,077	3,981	48	68	28
Deepbody anchovy	*Anchoa compressa*	Lampara/Trawl*	8,378	1,987	14,768	132	10	254
Black rockfish	*Sebastes melanops*	Trawl	6,830	8,889	4,771	13	18	9
Shovelnose guitarfish	*Rhinobatos productus*	Trawl	5,962	5,627	6,296	11,222	7,448	14,996
Black surfperch	*Embiotoca jacksoni*	Trawl	5,401	7,812	2,989	613	921	304
Grey smoothhound shark	*Mustelus californicus*	Lampara/Trawl*	5,063	837	9,289	4,951	904	8,997
Big skate	*Raja binoculata*	Trawl	3,751	5,349	2,153	544	53	1,034
Kelp bass	*Paralabrax clathratus*	Trawl	3,673	3,746	3,600	15	15	15
Brown smoothhound shark	*Mustelus henlei*	Lampara/Trawl*	4,574	3,210	5,938	6,800	3,432	10,167
Pile surfperch	*Rhacochilus vacca*	Trawl*	3,245	610	5,880	1,481	49	2,913
California scorpionfish	*Scorpaena guttata*	Trawl	3,241	635	5,847	1,614	160	3,068
Staghorn sculpin	*Leptocottus armatus*	Trawl	2,628	364	4,892	20	17	23
California skate	*Raja inornata*	Trawl	2,375	901	3,848	1,414	784	2,044
Round stingray	*Urolophus halleri*	Lampara/Trawl*	2,307	982	3,632	1,166	367	1,965
Walleye surfperch	*Hyperprosopon argenteum*	Lampara	1,732	1,654	1,810	81	127	34
Thornback	*Platyrhinoidis triseriata*	Lampara/Trawl*	1,783	167	3,400	355	49	661
Longfin sanddab	*Citharichthys xanthostigma*	Trawl	1,601		3,201	80		160
Vermilion rockfish	*Sebastes miniatus*	Trawl	1,467	2,195	738	99	102	96
Sargo	*Anisotremus davidsoni*	Lampara	1,142	1,949	335	789	1,530	49
White seabass	*Atractoscion nobilis*	Lampara	901	1,801		778	1,556	
Yellowfin croaker	*Umbrina roncador*	Lampara	772	410	1,134	216	88	345
Yellowfin goby	*Acanthogobius flavimanus*	Trawl	519		1,038	5		10
Spotted sand bass	*Paralabrax maculatofasciatus*	Trawl	493		986	212		424
Leopard shark	*Triakis semifasciata*	Trawl	465		930	147		295
Pipefish (unid.)	*Syngnathus sp*	Trawl	446	892		2	4	
Bay pipefish	*Syngnathus leptorhynchus*	Trawl	387	774		4	8	
Grass rockfish	*Sebastes rastrelliger*	Trawl	384	767		7	13	
Pacific cutlassfish	*Trichiurus nitens*	Lampara	346	90	603	75	27	124
English sole	*Pleuronectes vetulus*	Trawl	306	36	576	9	0.4	17
Black croaker	*Cheilotrema saturnum*	Lampara	278		556	17		34
Lingcod	*Ophiodon elongatus*	Trawl	223	446		2	4	
Cabezon	*Scorpaenichthys marmoratus*	Trawl	155	310		1	1	
Spotted kelpfish	*Gibbonsia elegans*	Trawl	150	300		2	3	
California clingfish	*Gobiesox rhessodon*	Trawl	150	300		0.2	0.3	
Chameleon goby	*Tridentiger trigonocephalus*	Trawl	150	300		1	1.8	
Blacksmith	*Chromis punctipinnis*	Lampara	148		296	9		18
		Total	44,591,672	36,399,758	52,783,586	849,841	753,781	945,902

Notes: Estimate based on gear most efficient in capturing each species.
Species listed in decreasing order of abundance.

* Gear (trawl, lampara) efficiency varied by day or night and estimate based on appropriate gear by diurnal period.

4.0 ICHTHYOPLANKTON

4.1 Introduction

Los Angeles and Long Beach Harbors support a complex assemblage of adult fishes, many of which spawn within the harbors. In order to gain understanding of the spatial and seasonal trends in spawning, and the abundance and dispersal patterns of larval fish and eggs, a survey of the ichthyoplankton was performed. Many fish species spend their adult lives closely associated with the benthic habitat or rocky areas and would otherwise be underestimated from the adult fish survey using otter trawl and lampara nets. The extensive subtidal riprap habitat in the harbors would be expected to support families of fishes such as the kyphosids (sea chubs), pomacentrids (damselfishes), and labrids (wrasses). Larvae of benthic associated families such as the blenniids (blennies), gobiids (gobies), and gobiesocids (clingfishes) have been collected in large numbers in past surveys. These groups of fishes are poorly represented in surveys by otter trawl and lampara, but may be enumerated through collections of the larval stages.

Studies of the eggs and larvae of fishes in the Los Angeles and Long Beach Harbors began in 1972, and subsequent studies have been conducted regularly since. Major surveys for ichthyoplankton have been by the Harbors Environmental Project (HEP 1976, 1979), Brewer (1983), MBC (1984), and MEC (1988). In contrast to the current quarterly surveys, many of the historical surveys sampled more frequently, but at much fewer stations in the harbors, particularly in the back channels, slips, and basins. Early surveys also utilized variable gear types and sampling protocols, but over time, methods have become increasingly more standardized. This allows for greater comparability between the more recent surveys and, if future studies are conducted similarly, will create a more accurate record of the evolution of habitat utilization within the harbor complex.

Ichthyoplankton surveys were conducted quarterly (February, May, August, and November, 2000) at eighteen stations. The stations were the same as those sampled for adult fish, and were selected to provide representative analysis of different habitat types in the harbor complex. Three tows were performed at each station to sample all strata of the water column. Surveys were performed at night because previous studies (Horn and Hagner 1982) have shown that nighttime collection of fish larvae is far more effective than daytime collection.

Methods of collection and analysis of ichthyoplankton surveys are described in Section 4.2. Ecological information on the ichthyoplankton catch includes community summary measures (Section 4.3), species composition (Section 4.4), and dominant and special interest species (Section 4.5). Spatial and temporal trends are summarized in Section 4.6. The 2000 survey results are compared to historical data in Section 4.7. Exotic species represented in the ichthyoplankton catch are addressed in Section 4.8. The study findings are integrated in the concluding Section 4.9. Figures and tables discussed in the text are presented at the end of the section. Raw data summaries are provided in Appendix D.

4.2 Methodology

4.2.1 Fish Larvae and Eggs

Field Sampling
Ichthyoplankton were sampled using the *M/V Earlybird* at the same station locations described in Section 3 for adult fish sampling (Figure 4.2-1). The entire water column was sampled using two different net types over three different strata. To sample the near surface waters (neuston), a Manta net was suspended off the port side of the bow at the surface of the water, just ahead of the bow wake. The middle portion of the water column was sampled by towing a bongo net in a stepped oblique pattern from the bottom to the surface. The epibenthic habitat was sampled using a wheeled bongo, which suspends the net approximately 13 cm above the bottom. This provided three samples for each of the 18 stations, for a total of 54 samples per quarterly survey.

The Manta net has a rectangular opening 85-cm wide, 17-cm high, and a 0.333-mm mesh Nitex net with a removable cod-end. The net is mounted to a plywood-covered frame with side-mounted floats. The bongo apparatus has paired cylinder-cone nets with a 70-cm diameter opening, 0.333-mm mesh Nitex, and a removable cod-end. Aluminum wheels, 1-m in diameter, were attached to the side of the net frame to maintain the net at a consistent height above the bottom. Tows with manta and bongo nets were conducted for 10 minutes at a speed of approximately 1-knot. General Oceanics flowmeters were mounted at the opening of the nets to record water flow per time and distance, enabling the volume of water sampled to be calculated. All sampling was conducted from the *M/V Earlybird,* and all samples were taken at night to minimize visual net avoidance by the larvae.

Plankton samples collected from bongo and manta net tows were placed in 1-quart glass jars. The samples were preserved with a mixture of 10% buffered formalin in filtered seawater. Samples were labeled with the station ID, gear type, sample strata (neuston, midwater, epibenthic), water depth, date, and time of sampling.

Laboratory Sample Processing
Fish eggs and larvae were sorted from the samples, identified to the lowest practicable taxon (usually genus or species), and counted. Large samples were split in a graduated series of fractions (50%, 25%, 12.5%, etc.) such that sub-samples could be sorted to remove as near to, but not less than, 100 fish larvae and 100 fish eggs. A sub-sample of 100 fish larvae and 100 eggs has been found to be suitable for statistical analysis in ichthyoplankton studies. Counts of fish eggs and larvae were standardized to number per 100 m^3 using flowmeter data taken at the time of sampling. During identification ichthyoplankton were distinguished as larvae, yolk-sac,

and eggs. Identifications were based primarily on *The Early Life Stages of Fishes in the California Current Region, CalCOFI Atlas No. 33* by H.G. Moser (1996), as well as other taxonomic references.

Several taxa of fish larvae are difficult or impossible to separate into discreet species in the early developmental stages. Very few species in family Scorpaenidae (rockfish) are identifiable to species level. Preflexion stage *Hypsoblennius gentilis, H. gilberti,* and *H. jenkinsi* (bay, rockpool, and mussel blenny, respectively) are not distinguishable until the preopercular spines become well developed, and since no later stage individuals were caught in the surveys, all identifications were left at *Hypsoblennius* spp. Most gobies are easily identified in preflexion stage, with the exception of *Clevelandia ios, Ilypnus gilberti*, and *Quietula y-cauda* (arrow goby, cheekspot goby, and shadow goby, respectively), which were identified as Goby type A. Preflexion larvae of these three sympatric species are very similar in habitat utilization, pigmentation, and morphometric characters, and damaged or small specimens often cannot be distinguished (W. Watson, personal communication). These were designated Goby type A in the data. Larvae designated Atherinidae or Gobiidae were too damaged to identify to a lower taxon. *Gibbonsia* spp. (kelpfish) and the *Syngnathus* (pipefish) are two other problematic taxa that often are unidentifiable to the species level.

Identification of fish eggs is much less precise than that of the larvae. Considerable progress has been made in the science over the last 20 years, but many fish eggs cannot be ascribed to an individual species with confidence. Identifications are often made from measurements of the total egg diameter in comparison with the size of the oil globule. Many species have overlap in these characteristics and their eggs may be put into a group of likely possibilities. There were two groups of eggs in the surveys that were unidentifiable to species. After additional research these were designated Egg type A and Egg type B for the May, August, and November survey. Egg type A consisted of (but not absolutely limited to) the species *Anisotremus davidsonii* (sargo), *Oxyjulis californica* (señorita), *Paralichthys californicus* (California halibut), and *Hypsopsetta guttulata* (diamond turbot). The majority of the eggs designated type A were likely halibut eggs (Dave Ambrose, personal communication). Egg type B consisted of *Semicossyphus pulcher* (California sheephead), *Paralabrax clathratus* (kelp bass), *P. maculatofasciatus* (spotted sand bass), *P. nubulifer* (barred sand bass), *Girella nigricans* (opaleye), and *Xystreurys liolepis* (fantail sole). In some situations, such as when the embryo was well developed, or the size ratio of the chorion to the oil globule was unique, eggs of these species were confidently identified to species. Egg types A and B were combined into an unidentified fish egg category for summary tables across surveys, but were separately shown on summary data sheets by survey, which are provided in Appendix D.

4.2.2 Data Analysis

Data from laboratory taxonomic identification sheets were entered into a database and reviewed for completeness prior to data analysis. Ichthyoplankton catch was standardized to number per 100 m^3 using information from flow meters mounted in the net mouth during sample collection. Data given as number per 100 m^3 indicates the raw density of the constituent, but fails to give an accurate estimate of the total number of larvae in a given area with respect to water depth. To account for this and to simplify station comparisons, the weighted number of each species (and stage) was calculated as number per 100 m^2, or the number of a species found under a 100 m^2

area by weighting each stratum by the proportion of the water column sampled by the sampler. This calculation weights the midwater region of the water column much more heavily than the neuston and epibenthic regions, especially at the deeper stations. Both densities per 100 m^2 (in text) and per 100 m^3 (in Appendix D.2) are provided in this report. Densities per 100 m^2 are comparable to that reported by CalCOFI; historical studies of Long Beach and Los Angeles Harbors have variously reported densities as number per 100 m^3 and/or number per 100 m^2.

Seasonal differences in abundance ($\log_{10}$ transformed) and number of species were tested with ANOVA.

Diversity was calculated with three different indices, which are derived measures based upon the number of species (species richness) and their abundances (equitability). The Shannon-Wiener diversity index tends to emphasize the equitability of the species distribution in a community. The Margalef Index incorporates the number of species and total number of individuals. The Dominance Index computes the number of species that account for 75% of the total abundance.

Cluster analysis was performed for the ichthyoplankton data using the weighted abundance for each station averaged over the four surveys. Life stages (larvae, yolk-sac, egg) were kept separate and can be identified on the two-way table by the letter (L, Y, E, respectively) preceding each species name. The cluster analysis was performed identically to those on the adult fish (see Section 3.2-4).

Seasonal differences in abundance ($\log_{10}$ transformed) and number of species were tested with ANOVA.

Figures showing seasonal trends in community summary measures (abundance, biomass, species) label the surveys according to month-year (e.g., Feb-00).

4.3 Community Summary Measures

Abundance

Results of the four quarterly surveys for ichthyoplankton were standardized to number per 100 m^3 for each strata and were weighted over the water column as number per 100 m^2. Each stratum of the water column was weighted by area, with the midwater stratum weighted the highest. The mean catch over all stations was 93,952 fish larvae and 80,928 fish eggs per 100 m^2 (Table 4.3-1). Newly hatched yolk-sac larvae represented approximately 0.2% of the larval catch.

The six most abundant types of fish larvae, in descending order, were Goby type A including arrow goby (*Clevelandia ios*), cheekspot goby (*Ilypnus gilberti*), and shadow goby (*Quietula y-cauda*)); bay goby (*Lepidogobius lepidus)*, northern anchovy (*Engraulis mordax*), California clingfish (*Gobiesox rhessodon*), queenfish (*Seriphus politus*), blennies (*Hypsoblennius* spp.), and white croaker (*Genyonemus lineatus*) (Table 4.3-1). Fish eggs were dominated by unidentified fish eggs and sciaenid eggs, which accounted for 92% of the total. Results of the ichthyoplankton surveys show a very different dominance ranking than surveys of adult fish by otter trawl or lampara. The high abundance of gobiids, gobiesocids, and blenniids indicates the importance of these benthic-associated cryptic species in the overall fish community in the harbors.

Mean larval abundance was highest (11,000 to 15,000 per 100 m^2) in the Long Beach Channel (Station LB7) and the Pier 300 Shallow Water Habitat (Station LA7A) (Figure 4.3-1, Table 4.3-2). Other stations with substantially high mean abundances (7,000 to 8,500 per 100 m^2) were in the Long Beach Southeast Basin (LB5), Long Beach Shallow Water Habitat (LB2A, LB2B), and the second station in the Pier 300 Shallow Water Habitat (LA7B). Moderate abundances (4,800 to 5,200 per 100 m^2) were found at stations in slips of Long Beach Harbor (LB6, LB4). Abundances were relatively lower (1,000 to 4,000 per 100 m^2) in Long Beach West Basin (LB3), open waters of the outer harbor regardless of depth (Stations LA1, LA2, LA3, LB1) except for high abundances noted above at the Long Beach Shallow Water Habitat. Larval abundances also were relatively low in basins and channels of Los Angeles Harbor (Stations LA4, LA5, LA6). With the exception of the Pier 300 Shallow Water Habitat, which had high larval abundance, and the Long Beach West Basin, which had low larval abundance, the abundances of larvae were generally higher on the Long Beach side of the harbor complex.

Fish eggs exhibited a patchy distribution in abundance that did not necessarily correspond to larval fish abundance patterns. Fish eggs were most abundant (7,000 to 11,000) in shallow waters off Cabrillo Beach (Stations LA3A, LA3B), in the Long Beach Channel (Station LB7), and in the Los Angeles East Basin (Station LA6) (Table 4.3-3). Stations with the lowest mean egg abundances (1,000 to 1,200 per 100 m^2) were in the Pier 300 Shallow Water Habitat (Station LA7A) and Los Angeles West Basin (Station LA5).

It is not known to what extent dredging in Long Beach West Basin and around Pier 400, stockpiling of sediment in outer Long Beach Harbor, and disposal at the Cabrillo Shallow Water Habitat may have influenced the relatively lower abundances of larvae in outer Long Beach and Los Angeles Harbors and the Long Beach West Basin areas. However, the data suggests that those perturbations may have been a factor. Larval abundance in Long Beach West Basin (2,310 per 100 m^2), where dredging occurred during the study, was lower than expected based on the higher range of abundances at other basin and slip habitats and adjacent Long Beach Channel in Long Beach Harbor (i.e., 4,835 to 14,636 per 100 m^2) (Figure 4.3-1, Table 4.3-4). Additionally, total mean abundance was lower in outer Los Angeles Harbor near Pier 400 (1,330 per 100 m^2) where dredging occurred than in outer Long Beach Harbor (3,485 per 100 m^2).

Total mean abundance was lower at the Cabrillo Shallow Water Habitat (2,780 per 100 m^2), where disposal occurred during the study, than at the Long Beach Shallow Water Habitat created in 1999 (7,966 per 100 m^2) and the Pier 300 Shallow Water Habitat created in 1985 (9,405 per 100 m^2) (Table 4.3-4). However, total mean abundance at the Cabrillo Shallow Water Habitat was essentially the same as a natural shallow water area (Station LA3) just west of the site. Sediment type at the Cabrillo Shallow Water Habitat (27-47% silt/clay) differs considerably from the natural shallow area to the west (88-92% silt/clay), but is more similar to that in the Long Beach Shallow Water Habitat (20-63% silt/clay) and Pier 300 Shallow Water Habitat (21-50% silt/clay) (see Section 2, Table 2.3-1).

Shallow water habitats had a mean larval abundance (overall mean of 5,961 larvae per 100 m^2) that was higher than deep water habitats (overall mean of 4,812 larvae per 100 m^2) based on consideration of all shallow water habitats (Table 4.3-4). The created Shallow Water Habitats with their sandier substrate type, proximity to riprap, and marine vegetation had a mean larval abundance (overall mean of 6717 per 100 m^2) 1.4 times higher than deepwater habitats.

Different factors most likely contributed to lower larval abundance in Los Angeles inner harbor basins (LA5, LA6). Some of the lowest adult fish catches were in the basins of inner harbor Los Angeles Harbor (see Sections 3.3 and 3.4, Tables 3.3-4 and 3.4-3). Interestingly, the high number of sciaenid eggs collected in Los Angeles East Basin did not correspond with particularly high larval or adult abundance of either white croaker or queenfish, and therefore, probably reflects small-scale patchiness in concentration of the planktonic eggs of these species, which are widely distributed throughout the harbor-complex.

Larval abundance was significantly (p=0.001) higher in the spring and summer than fall and winter, and significantly higher in the fall than in the winter (Figure 4.3-2). Weighted mean abundance was highest in the mid-water portion of the water column (Figure 4.3-2). Abundance was somewhat higher in the epibenthos than that in the neuston. Unweighted abundance was higher in the neuston during the winter and spring surveys, and in mid-water to epibenthic strata in the summer and fall (Appendix D.2).

Fish eggs were significantly (p=0.0001) more abundant in winter, secondarily higher in the summer, and lowest in the spring and fall. The winter peak in egg abundance preceded the spring peak in larval abundance, and the secondary peak in egg abundance in the summer probably accounted for the larval abundance being significantly higher in fall than in winter. Similar to larvae, fish eggs had a higher weighted mean abundance in the mid-water, and lower weighted abundance in the neuston and epibenthic regions (Figure 4.3-1). Unweighted abundance of eggs generally was higher in the neuston, although relatively high abundance also was collected in the epibenthic tows in the fall (Appendix D.2).

Number of Species

For all surveys and stations, a total of 49 categories representing 44 unique species of fish larvae and 13 categories of fish eggs were identified (Table 4.3-1). The total number of different species present was probably higher due to the likelihood of multiple species in generic categories not identified to species (i.e., *Gibbonsia* sp., *Sebastes* sp, *Hypsoblennius* sp.).

The annual mean number of species per station typically was 8 or 9, although there were some stations had as few as 7 or as many as 11 species (Figure 4.3-1, Table 4.3-2). The higher numbers occurred at one of the station replicates, but not the other, at both the Cabrillo and Pier 300 Shallow Water Habitats (Station LA2A, LA7A), in Long Beach Southeast Basin (Station LB5), and in deep waters of outer Long Beach and Los Angeles Harbors (Stations LB1, LA1). The variation among station replicates indicates patchy distribution patterns particularly among species collected in low numbers. The lowest mean number (7) of larval fish species was collected in Los Angeles West Basin (Station LA5).

The highest total annual number of species (22 to 25) occurred in the Cabrillo Shallow Water Habitat (Station LA2), other shallow waters next to the San Pedro Breakwater (Station LA3), Pier 300 Shallow Water Habitat (Station LA7), and deep waters in outer Los Angeles Harbor (Station LA1) near Pier 400 (Table 4.3-4). Most other stations had an annual total of 18 to 20 species of larvae. The lowest annual total numbers (14 to 17 species) were collected in deep water slips of Long Beach Channel 2 and Pier J (LB4, LB6) and the Los Angeles West Basin (LA5).

A similarly high number of species was collected in the epibenthic and midwater regions, with 36 and 35 different species, respectively, for all surveys and stations (Figure 4.3-2, Appendix D.1). Neuston samples yielded 23 species.

More species of larval fish were collected during the spring survey than the other seasons (Figure 4.3-2), and this difference was statistically significant ($p = 0.0001$). Total number of species by survey were 31 for May, 26 for February, 22 for November, and 21 for August (Appendix D.1).

Diversity and Dominance

Mean annual Shannon-Weiner diversity values were highest (1.45 to 1.53) in the Long Beach West Basin (Station LB3) and adjacent Long Beach Channel (Station LB7) (Table 4.3-2). Several of the stations with higher numbers of species had lower Shannon-Weiner diversity values due to a less equitable distribution of abundance among the species present. The Margalef diversity index is more sensitive to overall number of species, regardless of the equitability of distribution. Stations with highest mean annual Margalef diversity values more closely reflected the patterns in number of species. Stations LA2A (1.35) and LA1 (1.33) had the highest Margalef diversity values (Table 4.3-2).

All stations had mean annual dominance values of 2 or 3 (indicating that they had 2 or 3 species accounting for 75% of the total number of larvae collected) (Table 4.3-2). Total annual dominance values indicate that the created shallow water habitats at Cabrillo, Pier 300, and in Long Beach had 1 or 2 species accounting for 75% of the total abundance at those stations. Station LB5 in Long Beach Southeast Basin also had a dominance value of 2. Other stations including the natural shallow water area off Cabrillo and other deep water habitats had dominance values of 3 or 4 (Appendix D.1).

4.4 Species Composition

Cluster analyses of fish larvae and eggs produced four different station clusters and five different species clusters (Figures 4.3-3, 4.3-4, Table 4.4-1). Species with a relatively high abundance within a station cluster group characterize the species composition of the group. Symbols on the two-way coincidence table (Figure 4.3-3) indicate relative abundance by the size of the symbol, which is largest with highest relative abundance. The size of the symbol does not correspond to absolute abundance, which can be found for larvae on Table 4.3-4. Because cluster analysis considers relative abundance of each tested taxa across the stations it occupies, it is not weighted towards dominant species and provides a more complete assessment of spatial patterns with similar species composition.

Station Cluster Group 1, which had the largest number of stations, included all of the deep water sites except Station LB4. The nine stations comprising this group (LB1, LB3, LB5, LB6, LB7, LA1, LA4, LA5, LA6) had a broad range of commonly collected species from the harbor.

Relatively abundant larvae included bay goby, blennies, California halibut, diamond turbot (*Hypsopsetta gutulata)*, horneyhead turbot (*Pleuronichthys verticalis*), northern anchovy, queenfish, white croaker, wooly sculpin (*Clinocottus analis*), and yellowfin goby (*Acanthogobius flavimanus*). Eggs of northern anchovy, horneyhead and spotted turbot (*P. verticalis, P. ritteri,*respectively), queenfish and white croaker (sciaenids), and of unidentified species also were relatively abundant. Most adults of these species live over soft bottoms (sand, mud) or are pelagic. The occurrence of the larvae and eggs of these species in open water, basin, channel, and slip habitats throughout the harbor complex indicates a dynamic dispersal pattern for these common inhabitants of the harbors.

Station Cluster Group 2 consisted of Station LB4 in Long Beach Channel 2. That station had a larval assemblage dominated by atherinids including California grunion (*Leuresthes tenuis*) and topsmelt (*Atherinops affinis*). Juvenile pipefish (*Syngnathus leptorhynchus*), larval bay goby, and unidentified larval gobies also were relatively abundant at this station. Topsmelt lay their eggs on vegetation and pipefish are vegetation-associated. *Sargassum* and *Ulva* were common in the area (see Section 7, Appendix G).

Station Cluster Group 3 included the Pier 300 Shallow Water Habitat (Stations LA7A and LA7B). The stations sampled at this location were characterized by larvae of cheekspot goby, goby type A (arrow goby, cheekspot goby, shadow goby), atherinids (jacksmelt -*Atherinopsis californiensis*, California grunion), giant kelpfish (*Heterostichus rostratus*), unidentified kelpfish (*Gibbonsia* sp.), reef finspot (*Paraclinus integripinnis*), wooly sculpin, and yellowfin goby. Juvenile queenfish and topsmelt also were relatively abundant. Fish eggs comprised a much smaller component of the collected ichthyoplankton; eggs of northern anchovy and unidentified fish eggs were most abundant. Jacksmelt, like topsmelt, lay eggs on vegetation (or floating objects). Kelpfish live among marine plants. Extensive eelgrass beds occur at the site (see Section 8).

The Long Beach Shallow Water Habitat (Stations LB2A and LB2B) formed Station Cluster Group 4. This area was characterized by juvenile northern anchovy, jacksmelt, and topsmelt; larval blennies, California clingfish and queenfish; and eggs of tonguefish (*Symphurus atricauda*), sciaenids, and unidentified fish. Several of these species are associated with vegetation (jacksmelt, topsmelt) and/or rocky habitat (clingfish). Rocky habitat with giant kelp occurs along the east side of Pier 400, which forms the landward side of the Long Beach Shallow Water Habitat. Tonguefish live over sand and mud substrata and produce pelagic eggs. Their relatively high abundance of eggs at this station probably relates to the location of the site in open water of outer Long Beach Harbor.

The Cabrillo Shallow Water Habitat (Stations LA2A, LA2B), and naturally shallow waters off Cabrillo (Stations LA3A, LA3B) comprised Station Cluster Group 5. These stations, which are located near the San Pedro Breakwater, were characterized by a diverse assemblage of larvae including blennies, giant kelpfish (*Heterostichus rostratus*), spotted kelpfish (*Gibbonsis elegans*), Pacific staghorn sculpin (*Leptocottus armatus,)* ronquil (*Rathbunella* sp.), snubnose sculpin (*Orthonopias triacis*), Roughcheek sculpin (*Ruscarius creaseri*), pipefish, and eggs of señorita and speckled sanddab (*Citharichthys stigmatus).* The adults of several of these species are typically associated with vegetated and rocky reef habitats. The occurrence of *Rathbunella* larvae is notable since that taxa generally is associated with cold water; it was only collected during the February survey.

Ichthyoplankton of pelagic or demersal species that range over sand or mud bottoms exhibited a widespread dispersal pattern throughout deep open water, channel, basin, and slip habitats. Ichthyoplankton of fish associated with vegetation and/or rocky substrate during some part of their life stage (e.g., eggs attached to marine plants or rock, juvenile or adults shelter among plants or rocks) were more localized in distribution. Centers of their distribution occurred in shallow water habitats with eelgrass beds (Station LA7), adjacent to riprap habitats with giant kelp and other macroalgae (Stations LB2, LA2, LA3), or in a deep water channel lined with *Sargassum*.

Physical/chemical characteristics such as dissolved oxygen, salinity, and temperature generally exhibited a similar range of variability among stations (Table 4.4-1). Several of the sites had lower water clarity (relatively low transmissivity values) due to dredging or disposal in the vicinity (e.g., LA1, LB1, LB2, LB3) or resupension of silty bottom sediments (e.g., LA3, LB6). With the exception of Cluster Group 2 (Station LB4 in Long Beach Channel 2), all cluster groups had stations with a range of transmissivity values including relatively low values during all or part of the year. The observed differences in water clarity did not appear to have a major influence on species composition of ichthyoplankton during the 2000 Baseline Study.

4.5 Dominant and Selected Species

Fish

The larval fish assemblage in the study area had seven taxa that accounted for 96% of the total catch (Tables 4.3-1, 4.3-5). Goby type A was the most abundant taxon, followed by bay goby, northern anchovy, California clingfish, queenfish, blennies, and white croaker. As a group, gobiid larvae dominated the entire survey, contributing 51% of the total catch.

Goby type A larvae (arrow goby, cheekspot goby, shadow goby) were present at all stations and comprised 33% of the total catch (Tables 4.3-1, 4.3-4). This goby complex was most abundant (> 1000 per 100 m^2) at all shallow water stations (Stations LB2, LA2, LA3, LA7), and in deep water of the Long Beach Channel 2 slip near Pier B (Station LB4) (Table 4.3-4; Figure 4.5-1). Goby type A was least abundant (< 500 per 100 m^2) at deep water stations in outer Long Beach and Los Angeles Harbors (LA1, LB1), Los Angeles East Basin (LA6), and Long Beach Southeast Basin (LB5). Goby type A larvae were present year-round, but were most abundant from summer to fall and least abundant during the winter (Table 4.3-5).

Bay goby larvae were present at all stations and comprised 16% of the total catch (Tables 4.3-1, 4.3-4). Bay goby had a substantially different distribution than goby type A. They were typically more abundant (> 500 to 4,054 per 100 m^2) at deep water stations and were generally much less abundant (50 to 320 per 100 m^2) at the shallow water stations (Table 4.3-3; Figure 4.5-1). Two exceptions included a relatively low number (296 per 100 m^2) of bay goby larvae in the Los Angeles Main Channel (Station LA4), and a relatively high number (684 per 100 m^2) at Pier 300 Station LA7. Bay gobies prefer a muddy substrate and are found offshore to a depth of 200 m, which probably accounts for the generally higher abundances at the deep water stations

(Eschmeyer and Herald 1983). Seasonally, bay goby showed a large spike in larval abundance during the August survey, with fairly stable abundances for the rest of the surveys (Table 4.3-5).

Northern anchovy were present at all stations and comprised 14% of the total catch (Tables 4.3-1, 4.3-4). Distribution of northern anchovy was patchier than the above described gobies. Northern anchovy were most abundant (3,700 to 5,035 per 100 m^2) in Long Beach Southeast Basin (Station LB5) and the Long Beach Channel (Station LB7) (Table 4.3-4; Figure 4.5-2). Lowest numbers (< 100 per 100 m^2) were at shallow water stations off Cabrillo (Stations LA2, LA3), in the Long Beach Shallow Water Habitat (Station LB2), and deep water slip in Long Beach Channel 2 near Pier B (Station LB4) (Table 4.3-4). Seasonal abundance was lowest in February and then peaked in the May survey before dropping to moderate numbers in the summer and fall (Table 4.3-5).

California clingfish were present at all stations and comprised 13% of the total catch (Tables 4.3-1, 4.3-4). Clingfish were most abundant (> 4,000 per 100 m^2) at the Long Beach Shallow Water Habitat (Stations LB2A and LB2B) (Table 4.3-4; Figure 4.5-1). Abundances were variable at other stations ranging from 1 to 765 per 100 m^2. Seasonally, very few clingfish were caught in the February survey. Larval abundance peaked in May before decreasing through summer and fall (Table 4.3-5).

Queenfish were present at all stations and comprised nearly 10% of the total catch (Tables 4.3-1, 4.3-4). Queenfish were most abundant (1,000 to 2,000 per 100 m^2) at the Long Beach Shallow Water Habitat (Stations LB2A, B), Long Beach Channel (Station LB7), and Long Beach Pier J slip (Station LB6): a mixture of the shallow and deep water stations (Table 4.3-4; Figure 4.5-2). Seasonal variability was quite pronounced, with 0 larvae caught during the winter survey and 33,660 larvae per 100 m^2 caught during the May survey. Queenfish abundance then decreased from August through the November survey, when only 10 larvae per 100 m^2 were caught (Table 4.3-5).

Blennies were present at all stations and comprised 5% of the total catch (Tables 4.3-1, 4.3-4; Figure 4.5-1). This suite of species (*Hypsoblennius* spp.) had the highest abundance (> 1,000 per 100 m^2) in Long Beach Channel (Station LB7), next highest abundances (300 to 430 per 100 m^2) in localized shallow water and basin/channel habitats, and the lowest abundances (30 to 61 per 100 m^2) in Los Angeles Main Channel, outer Los Angeles Harbor near Pier 400, and Cabrillo Shallow Water Habitat Station LA2A (Table 4.3-4). The larvae were absent from the February survey and abundance peaked during the August survey with 15,587 larvae per 100 m^2 (Table 4.3-5).

White croaker comprised 5% of the total catch (Table 4.3-1). Distribution in the study area was uneven, with highest abundance (> 2,000 per 100 m^2) in the Long Beach Channel (Station LB7), and moderate abundance (530 to 600 per 100 m^2) at slips in Long Beach Channel 2 near Pier B and the Pier J slip (Stations LB4, and LB6) (Table 4.3-4). Abundances at most other deep water stations ranged from 72 to 282 per 100 m^2. White croaker abundance was very low (< 30 per 100 m^2) at all the shallow water stations, and at the deep open water station (LA1) in outer Los Angeles Harbor near Pier 400. Larval abundance included a bimodal pattern with a peak in May and smaller peak in November (Table 4.3-5). White croaker may spawn year-round, but mainly spawn from November to August (Love 1996).

Larvae of flatfish such as California halibut, diamond turbot, speckled sanddab, horneyhead and spotted turbot generally had higher abundance in deep water habitats in the outer harbor, basins, and channels (Table 4.3-4).

Eggs

With over 57% of the fish eggs collected left unidentified to species level (Table 4.3-1), a discussion of dominant species lacks the type of detail possible with larvae and adults. During all but the first survey, unidentified eggs were grouped into two categories (type A, type B). Egg type A was the dominant category (Appendix D.2). Of the eggs identified as Egg type A, the majority were likely California halibut and to a much lesser extent diamond turbot based on adult abundance. California halibut and diamond turbot represented 13% and 1% of the otter trawl catch, respectively (see Section 3.4, Table 3.4-1). California halibut spawns throughout the year, although most spawn between February and June (Love 1996). Keeping in mind that Egg type A was not distinguished in February, it had a substantial peak abundance in May and decreasing abundance through November. For Egg type B, it is difficult to estimate which of the six possible species may have dominated, although adult barred sand bass comprised more of the adult catch (3% of otter trawl catch) than any of the other potential species (California sheephead, kelp bass, spotted sand bass, opaleye, fantail sole) belonging to the group.

Unidentified eggs were abundant at all stations (Table 4.3-3). Highest abundances (> 2,000 per 100 m^2) were collected in shallow open waters near Cabrillo (Station LA3), deep water in outer Long Beach and Los Angeles Harbor (Station LA1, LB1), Long Beach Channel and Los Angeles Main Channel (Stations LA4, LB7), Los Angeles East Basin (Station LA6), Long Beach West Basin (Station LB3), and deep water slips (Station LB4, LB6).

Eggs of the family Sciaenidae comprised 35% of the total catch (Table 4.3-1). During the February and November surveys, nearly all the sciaenid eggs were white croaker. Sciaenid eggs caught in the May and August surveys were mostly queenfish (Appendix D.2). Sciaenid eggs were collected at all stations in moderate to high abundance (240 to 4,500 per 100 m^2) (Table 4.3-3). With the exception of Los Angeles West Basin (Station LA5) and Long Beach Southeast Basin (Station LB5), abundances were highest (> 1,000 per 100 m^2) at deep water stations regardless of habitat. While this was also generally true for larval stage white croaker, queenfish larvae had a more patchy distribution among shallow and deep water sites.

Speckled sanddab eggs comprised 3.5% of the total catch (Table 4.3-1). Speckled sanddab eggs were caught during all seasons (Appendix D.2) and were distributed across the entire study area. They were most abundant in outer Long Beach and Los Angeles Harbor (Stations LA1, LB1), Long Beach Channel (Station LB7), and at shallow water stations off Cabrillo (LA2, LA3) (Table 4.3-3). They were scarce elsewhere. Larval speckled sanddab were only collected in the Long Beach Channel, however, there was considerable similarity in the egg and adult distribution (see Section 3.4, Table 3.4-4).

California tonguefish eggs comprised 2% of the total catch (Table 4.3-1). Tonguefish eggs were abundant only during the August survey (Appendix D.2). With a patchy distribution, tonguefish eggs were most abundant (350 to 700 per 100 m^2) in outer Los Angeles Harbor (Station LA1) and the Long Beach Shallow Water Habitat (Station LB2), both of which are adjacent to Pier 400. Larval tonguefish were not collected. Adults were a bit more widespread, occurring in highest abundance in both outer Long Beach and Los Angeles Harbors (Stations LB1, LA1), Long Beach Channel (Station LB7), Pier J slip (Station LB6), and shallow waters near Cabrillo (Station LA3) (see Section 3.4, Table 3.4-4).

Spotted turbot eggs comprised 1.6% of the total catch (Table 4.3-1). Spotted turbot eggs were most abundant (170 to 534 per 100 m^2) in Long Beach Channel (Station LB7), Los Angeles Main Channel (Station LA4), and shallow waters near Cabrillo (Station LA3A) (Table 4.3-3), and were present in the study area throughout the year (Appendix D.2). Spotted turbot larvae were predominantly collected in outer Los Angeles Harbor (Station LA1). Adults were collected in highest abundance in outer Long Beach Harbor (Station LB1), Los Angeles Main Channel (Station LA4), and Long Beach, Cabrillo, and Pier 300 Shallow Water Habitats (Stations LB2, LA2, LA7) (see Section 3.4, Table 3.4-4).

Several species that dominated the catch of larvae were not present as eggs in the plankton samples. Goby eggs were absent because the eggs are laid attached to the inner surface of a brood chamber in a burrow constructed and tended by the adults (Brothers, 1975). Clingfish lay their eggs attached on rocks and cobble. Blennies construct a nest in which the eggs are attached (Moser 1996).

4.6 Summary of Spatial and Temporal Variations

A total of 49 taxa representing 44 unique species of fish larvae and 13 categories of fish eggs were identified. Stations showing the highest total annual number of species (22 to 25 taxa) were shallow waters next to the San Pedro Breakwater (Stations LA2, LA3), deep waters in outer Los Angeles Harbor (Station LA1) near Pier 400, and Pier 300 Shallow Water Habitat (combined across Stations LA7A, LAB) (Table 4.3-4). Riprap associated with the breakwater and Pier 400, as well as the eelgrass beds in Pier 300, undoubtedly contributed to the relatively higher number of rock and/or vegetation associated species at those stations. The lowest annual total numbers of species (14 to 17 taxa) were collected in more confined deep water slips in Long Beach Channel 2 near Pier B and near Pier J (LB4, LB6), and in the Los Angeles West Basin (LA5).

The highest larval abundance occurred at Long Beach Channel (Station LB7), and included several taxa (bay goby, northern anchovy, queenfish, blenny, and white croaker). Very high numbers were also collected at the Pier 300 Shallow Water Habitat, but abundance was dominated by bay goby. Generally, more fish larvae were collected in Long Beach Harbor habitats than in corresponding habitats in Los Angeles Harbor. Exceptions were the very high abundance at the Pier 300 Shallow Water Habitat and low abundance at the Long Beach West Basin Station. It is not known to what extent dredging and disposal may have affected larval distribution.

Species composition varied among different areas and habitats in the harbor. Larvae of pelagic and demersal species, which are found over sand and/or mud bottoms as adults, were widely dispersed in the harbor complex. Fish associated with vegetation and/or rocky substrate during some part of their life stage (eggs and/or juvenile-adults) had a more localized larval distribution that was associated with the outer breakwater, riprap around Pier 400, eelgrass beds in the Pier 300 Shallow Water Habitat, and/or other locations near rirprap or with nearby macroalgae beds.

Larval abundance was significantly higher in spring and summer, less high in fall, and lowest in winter. The peaks in larval abundance followed after the peaks in egg abundance.

4.7 Historical Comparisons

Several studies of the ichthyoplankton in the Long Beach- Los Angeles harbor complex and offshore waters have been performed over the last 30 years. HEP (1976 and 1979), Horn and Allen (1981), Brewer (1983), MBC (1984), MEC (1988), and the CalCOFI Atlas No. 34 were used for comparison with the 2000 data (Table 4.7-1).

Species composition in the MEC (1988) survey was dominated (49% of collected larvae) by gobies including bay goby and a goby complex including some combination of arrow goby, cheekspot goby, and shadow goby. Northern anchovy, California clingfish, and queenfish were other important dominants comprising nearly 10 to 14% of the collected fish larvae. Other species with high abundances included white croaker and blennies each representing 5% of the collected larvae, and the exotic yellowfin goby representing approximately 2% of the collected larvae.

All of these species have been represented in previous studies of the harbors. Surveys of 1978-1979 (Brewer 1983) were dominated by northern anchovy, white croaker, and gobiids. Those surveys were notable in that no atherinids were caught within the harbor for the entire year of surveys. HEP (1976, 1979) had similar species dominating the surveys, although northern anchovy accounted for a greater percentage of the total catch (38.4% in 1976, 27.8% in 1979), and gobiid larvae accounted for less of the total catch (5.3% in 1976, and 7.2% in 1979). The primary difference between the current study and the historical studies is that currently there seems to be a lower percentage of northern anchovy (13.9%) and a higher percentage of gobies (51%) and clingfish (13.0%). This could be due in part to variation in the habitats sampled, i.e., the greater number of shallow water sites sampled in the current study where northern anchovy were less abundant, and where Goby type A (arrow goby, cheekspot goby, and/or shadow goby) and clingfish were more abundant. If only the deep water habitats sampled in 2000 are examined, then northern anchovy would rank a close second to bay goby. This is more similar to 1983-1984 when larval gobies accounted for 35% of the catch and northern anchovy represented 26% of the catch (MBC 1984), and 1986-1987 when gobies and northern anchovy accounted for 36% and 30% of the catch, respectively (MEC 1988).

Total abundance comparisons (number of larvae/area) are difficult to make due to the lack of comparable data for some of the historical surveys performed. However, some comparisons can be made between the current study and MEC (1988), MBC (1984), and Brewer, 1983. The outer harbor area (Stations LA1 and LB1) averaged 200 larvae per 100 m^3 in 2000, 102 larvae per 100 m^3 in 1988, 245 larvae per 100 m^3 in 1984, and 205 larvae per 100 m^3 in 1979. The Cabrillo Shallow Water Habitat, a previously open, deep-water area, had 324 larvae per 100 m^3 in 2000, a slight increase over the other outer harbor areas. The Pier 300 Shallow Water Habitat, which was formerly a deep water area, increased in larval abundance from the 1988 survey, averaging 1881 larvae per 100 m^3 in 2000, compared to 193 larvae per 100 m^3 in 1988.

The overall number of species caught in the current study is similar, but slightly lower than previous studies that included more frequent surveys but is higher than previous surveys that included only a few sampling locations. The current study, which surveyed both harbors and inner and outer harbor areas and produced 54 samples over 4 quarterly surveys, identified 49 taxa represented by 44 species. MBC (1984), which surveyed outer Long Beach Harbor over 12 monthly surveys, took 14 samples and identified 59 taxa several of which were identified to category and not species. MEC (1988), which surveyed outer Los Angeles Harbor and the coastal side of the breakwater, took 18 samples over nine bi-monthly surveys and identified 74 taxa represented by 50 species. HEP (1979) took 10 samples over 9 monthly surveys and identified 34 taxa.

Distribution over the water column was similar to past studies. Unweighted abundance of larvae was higher in neuston and/or epibenthic tows depending on survey; eggs were generally collected in highest abundance in the neuston.

Spatial distribution of the numerically dominant species over the current study area showed similarity to the MEC (1988) study. In both the 1988 and 2000 surveys, northern anchovy and bay goby were more abundant in open water areas. Goby type A (arrow goby, cheekspot goby, shadow goby) were most abundant at the Pier 300 Shallow Water Habitat, corresponding to Station LA7 in 2000 and Block A in 1988. Both surveys also showed relatively high abundance of atherinids at this site. There also was a good correlation in distribution of white croaker and queenfish, and the different distributions of the two. Both the 1988 and 2000 studies indicate a preference for deep water sites by white croaker, while queenfish larvae were abundant at both deep water and shallow water sites. Horn and Hagner (1982) surveyed the area of Seaplane Anchorage, adjacent to the Pier 300 Shallow Water Habitat. Like the current study, they found that gobiids and northern anchovy dominated the catch in this location.

Seasonal variation of total abundance was typical for most species in the current study. Many fish may be categorized as either winter or summer spawners, although some spawn year-round. Peaks in egg and larval abundance in past studies have occurred from winter to early spring and again from late summer to early fall (HEP 1976, 1979; CalCOFI Atlas No. 34). Although, MBC (1984) detected only a winter-spring peak. In the current study, several winter spawning species appeared to spawn later in the year than would be expected, thus affecting (decreasing) the February data for total abundance. Historically, northern anchovy, white croaker, and bay goby have shown peak spawning activity from early to late winter (CalCOFI Atlas No. 34), but in the current study, northern anchovy and white croaker abundance peaked in May, and bay goby abundance peaked in August. It is not known to what extent cold waters associated with La Niña may have delayed spawning.

4.8 Exotic Species

The larvae of one exotic species, yellowfin goby (*Acanthogobius flavimanus*), was caught in the ichthyoplankton surveys. This species was introduced from Japan, presumably via ship's ballast water. It was first caught in the U.S. in 1963 in the Sacramento River Delta. Yellowfin goby is a very successful species in California's harbors and wetlands, and attains a larger size than any of the native gobiids (Eschmeyer and Herald 1983).

One notable difference between the current and past studies is that larvae of the exotic yellowfin goby comprised relatively more of the total catch in 2000 (2% of catch, ranked 8th). Larval yellowfin goby ranked ranked 31st in abundance during 1986-1987 (MEC 1988), approximately

50th in abundance during 1983-1984 (MBC 1984), and was not reported in the ichthyoplankton catch in the 1970s, although adults were recorded (Horn and Allen 1981).

4.9 Summary

Ichthyoplankton were surveyed quarterly at 18 stations throughout the Long Beach and Los Angeles Harbors. Forty-nine taxa representing 44 unique species of fish larvae and 13 categories of fish eggs were identified. The most abundant fish larvae were Goby type A (arrow goby, cheekspot goby, and shadow goby) (33%), bay goby (16%), northern anchovy (14%), California clingfish (13%), queenfish (10%), blennies (5%), and white croaker (5%). Dominant egg taxa were unidentified eggs (likely including high numbers of California halibut eggs) (57%) and sciaenid eggs (35%). Although not as abundant, eggs of speckled sanddab, California tonguefish, and spotted turbot together comprised nearly 7% of the collected eggs.

With the exception of the Pier 300 Shallow Water Habitat, which had high larval abundance, and the Long Beach West Basin, which had low larval abundance, the abundances of larvae were generally higher on the Long Beach side of the harbor complex. This bears some similarity to the abundance pattern indicated for adult fish caught by lampara, which generally showed higher abundance in deep water channel, basin, and slips in Long Beach Harbor (see Section 3.3, Figure 3.3-1). Trawl caught adult fish did not show such a strong pattern relative to the different harbors (see Section 3.4, Figure 3.4-1). The very high larval abundance noted in the Pier 300 Shallow Water Habitat did not track with adult fish distribution, which showed moderate abundance in both the lampara and otter trawl catches. The larval catch was dominated by benthic associated gobies (arrow goby, cheekspot goby, shadow goby), which are undersampled by lampara and trawl.

Abundances of fish eggs exhibited some similar and some different patterns relative to that of larvae. There was a general pattern of higher egg abundance in deep water habitats that corresponded to a combination of relatively high abundances of sciaenid and unidentified eggs. At shallow water stations, unidentified eggs were still relatively abundant, but abundances of sciaenid eggs were generally lower than in deep water. Similarly, larval abundances of white croaker were generally lower in shallow water, but larval queenfish exhibited localized high abundance at deep and shallow water stations. Several species that were important members of the catch as larvae (e.g., clingfish, gobies) were not collected as eggs because the eggs either occur in brood chambers or are attached to vegetation, rock, and/or debris.

Species composition varied among different areas and habitats in the harbor. Larvae of pelagic or demersal species found over sand and/or mud bottoms as adults (e.g., croakers, gobies, anchovies) generally had a wide dispersal pattern within the harbor complex. Some of the species were more strongly associated with deep or shallow water habitats. For example, Goby type A larvae (arrow goby, cheekspot goby, shadow goby) were strongly associated with shallow water habitats, whereas bay goby larvae were more abundant at the deep water stations. White croaker were substantially more abundant at deep water habitats, whereas queenfish had localized high abundance in either shallow or deep water. Larvae of flatfish such as California halibut, diamond turbot, speckled sanddab, horneyhead and spotted turbot generally had higher abundance in deep water habitats in the outer harbor, basins, and channels. Fish associated with vegetation and/or rocky substrate during some part of their life stage (eggs and/or juvenile-adults) (e.g., atherinids, kelpfish, pipefish, reef finspot) had a more localized larval distribution, which was associated with the outer breakwater, riprap around Pier 400, eelgrass beds in the Pier 300 Shallow Water Habitat, and/or other locations near rirprap or with nearby macroalgae beds.

Measured physical/chemical parameters such as dissolved oxygen, pH, salinity, temperature, and transmissivity provided little insight to species composition of ichthyoplankton in different areas of the harbors, which appeared to be related more to broad dispersal patterns associated with widely distributed pelagic or soft-bottom associated demersal species, or to localized distribution patterns of species associated with rock and/or vegetated habitats. It is not known to what extent abundance of ichthyoplankton was affected by the dredging and disposal activities that took place immediately before and during the 2000 Baseline Study. An indicator that this may have been influential was a lower than expected larval abundance in Long Beach West Basin, where dredging occurred, and which was adjacent to other channel and basin habitats with relatively high larval abundance values. Another indication of perturbation was the relatively lower abundance values in Los Angeles outer harbor as compared to outer Long Beach Harbor.

Larval abundance was significantly higher in spring and summer and a secondary peak occurred in the fall. A primary peak in egg abundance during the winter and a secondary peak in summer preceded the higher larval abundance periods.

During the past 30 years, the dominant larval fish and egg species in Long Beach and Los Angeles Harbors have remained relatively consistent although there have been shifts in dominance. Dominant larval fish species in the current study are similar to those caught in the past. However, the present study differs in ranked abundance of the species. The 2000 Baseline Study differs from past studies in surveying both inner and outer harbor and shallow and deep water habitats nearly equally in both harbors. Earlier studies focused more on outer harbor areas. The increased number of shallow water habitats surveyed in 2000 study probably accounts for the higher ranked abundance of gobies and clingfish over northern anchovy in the present study.

The ichthyoplankton survey provided a good measure of the importance of species inhabiting burrows or associated with rocky and/or vegetated habitats in the Long Beach- Los Angeles harbor complex. These species were poorly represented in the adult fish surveys, yet are an important part of the overall ecology of the diverse marine habitats in the harbors. The ichthyoplankton results also demonstrate that a wide variety of fish spawn and develop within Long Beach and Los Angeles Harbors.

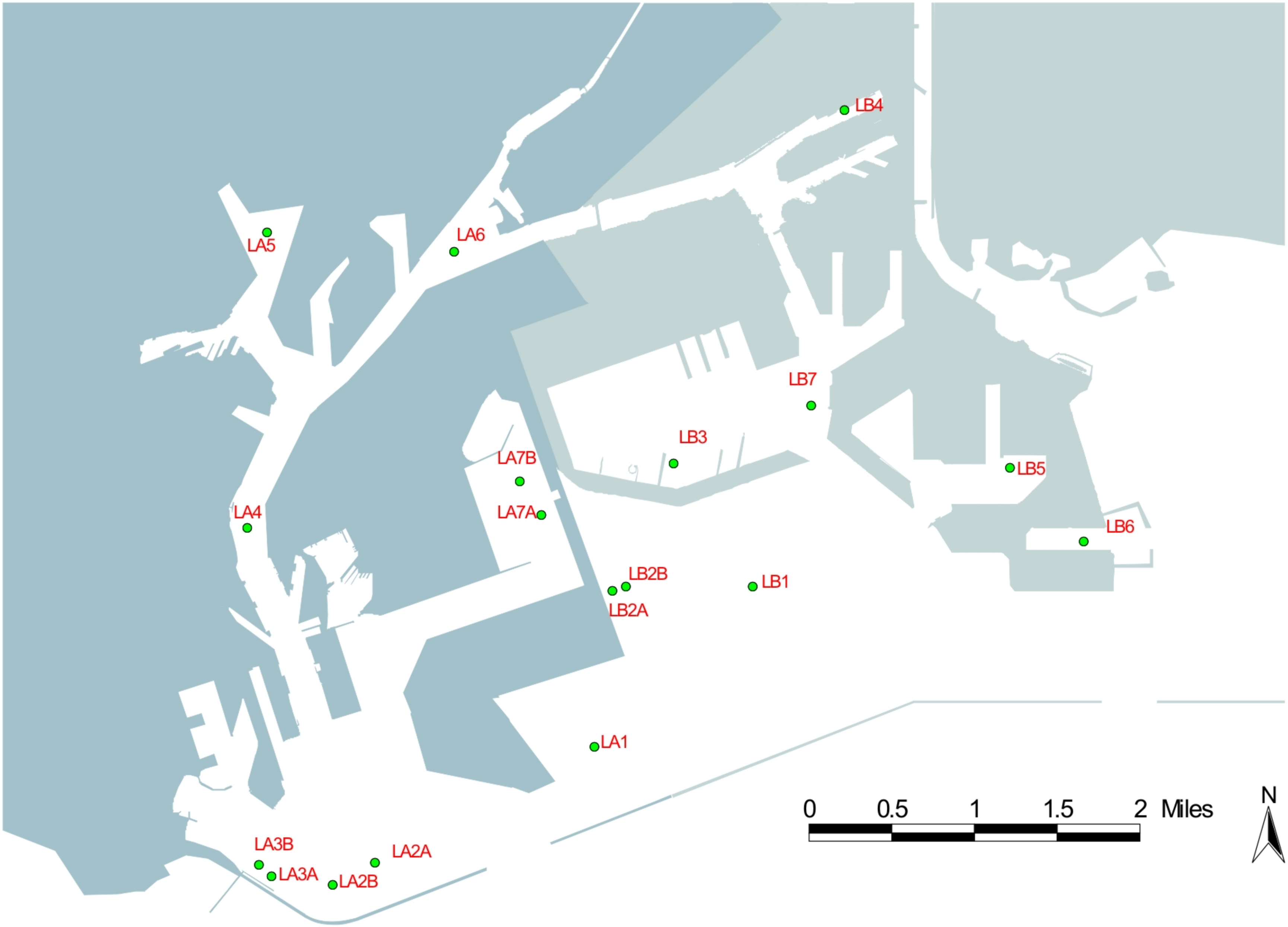


Figure 4.2-1. Ichthyoplankton sampling stations in Long Beach and Los Angeles Harbors, February - November 2000.

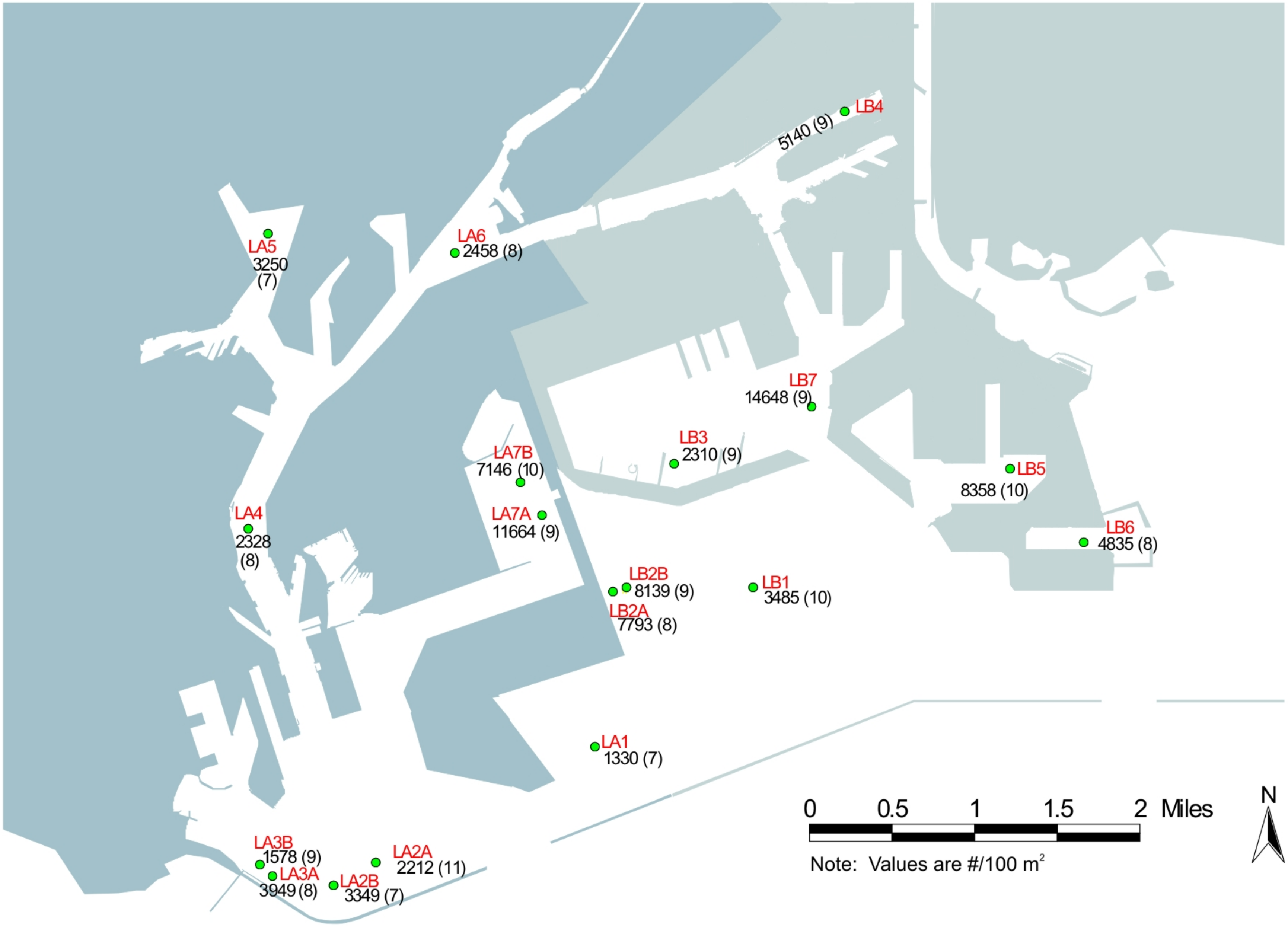


Figure 4.3-1. Weighted mean annual abundance (and number of species) of ichthyoplankton larvae collected in Long Beach and Los Angeles Harbors, February - November 2000.

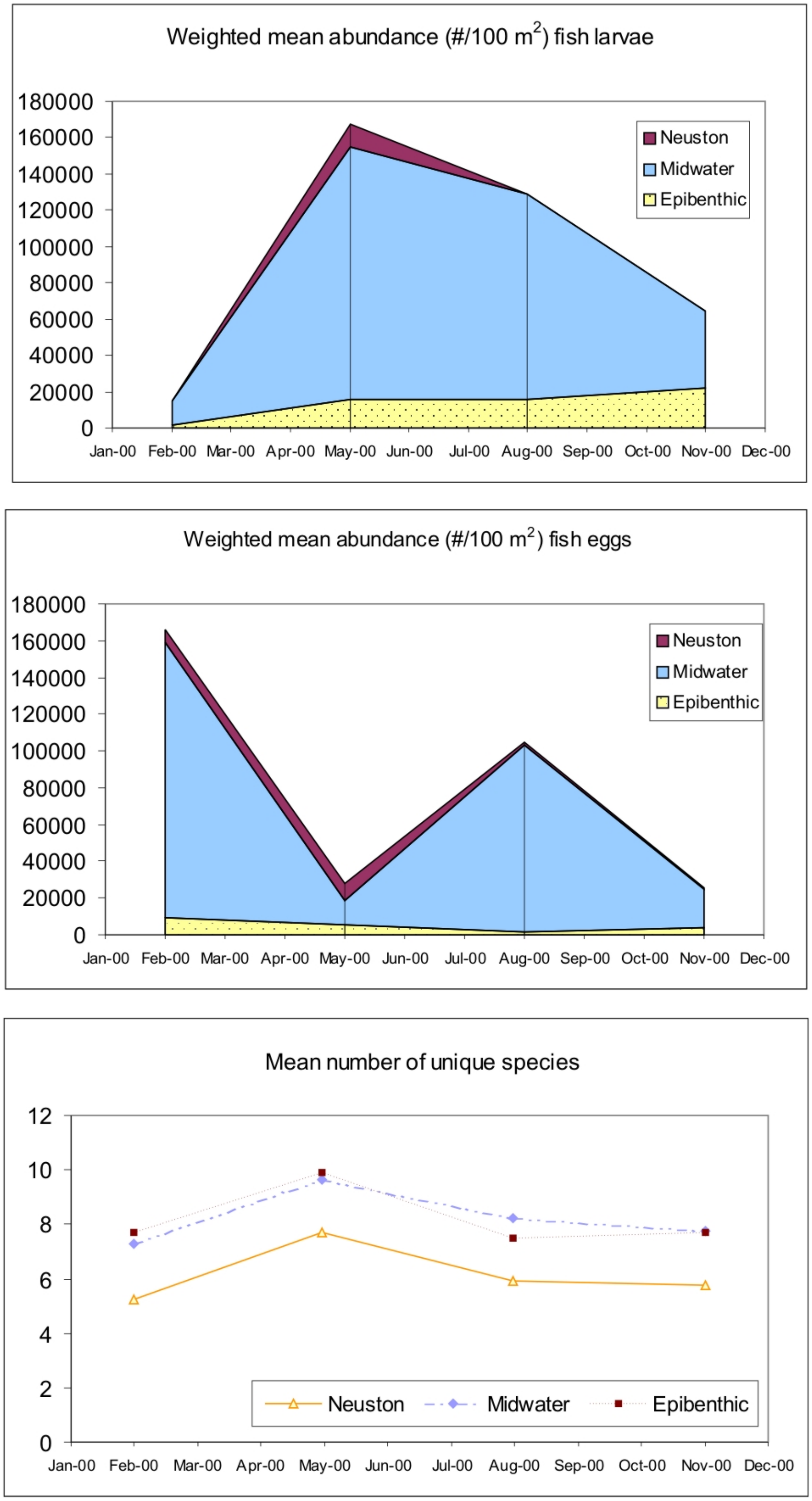


Figure 4.3-2. Seasonal abundance and number of species of ichthyoplankton collected in Long Beach and Los Angeles Harbors, February - November 2000.

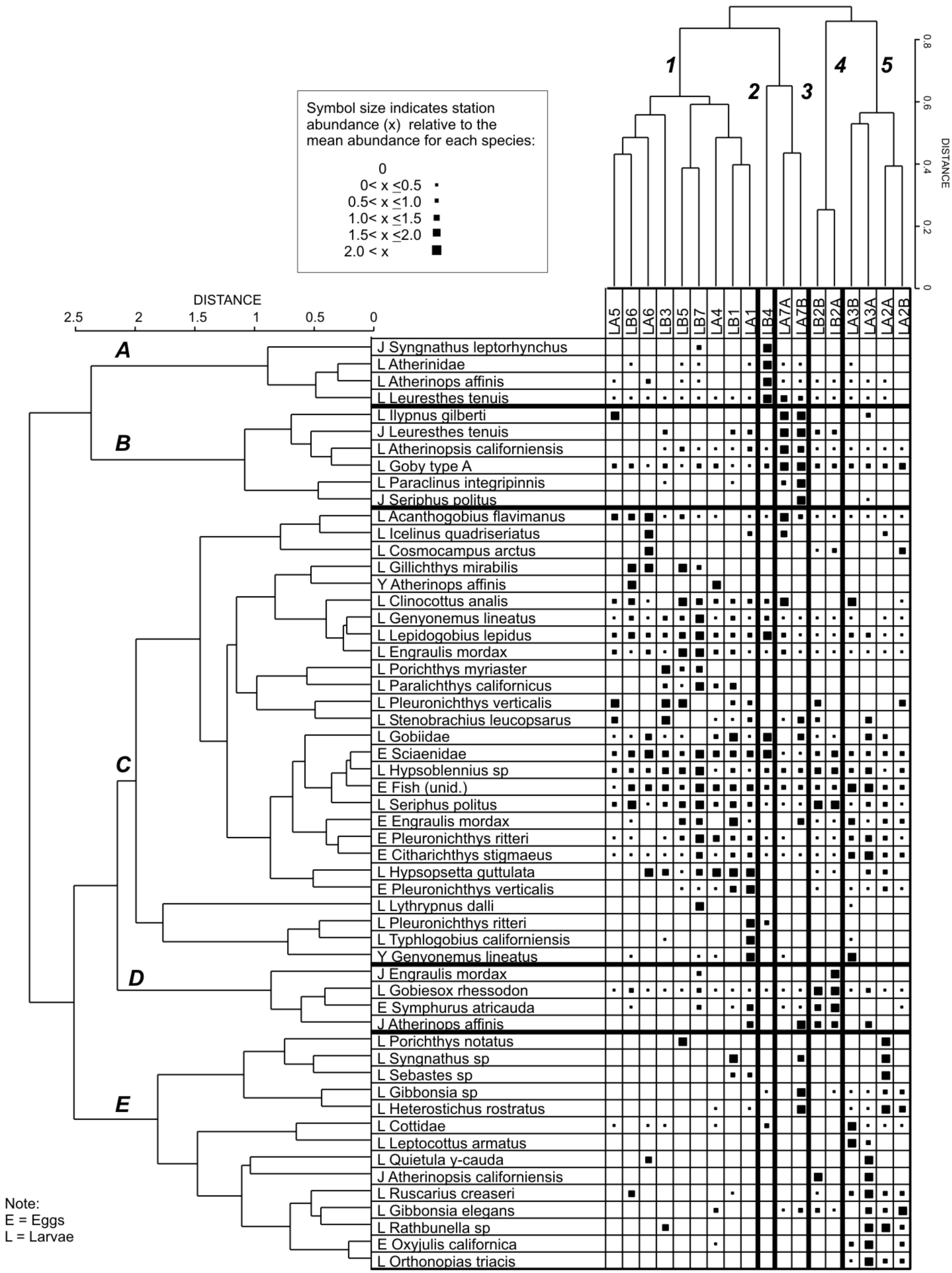


Figure 4.3-3. Cluster analysis of mean species abundance of ichthyoplankton collected in Long Beach and Los Angeles Harbors, February - November 2000.

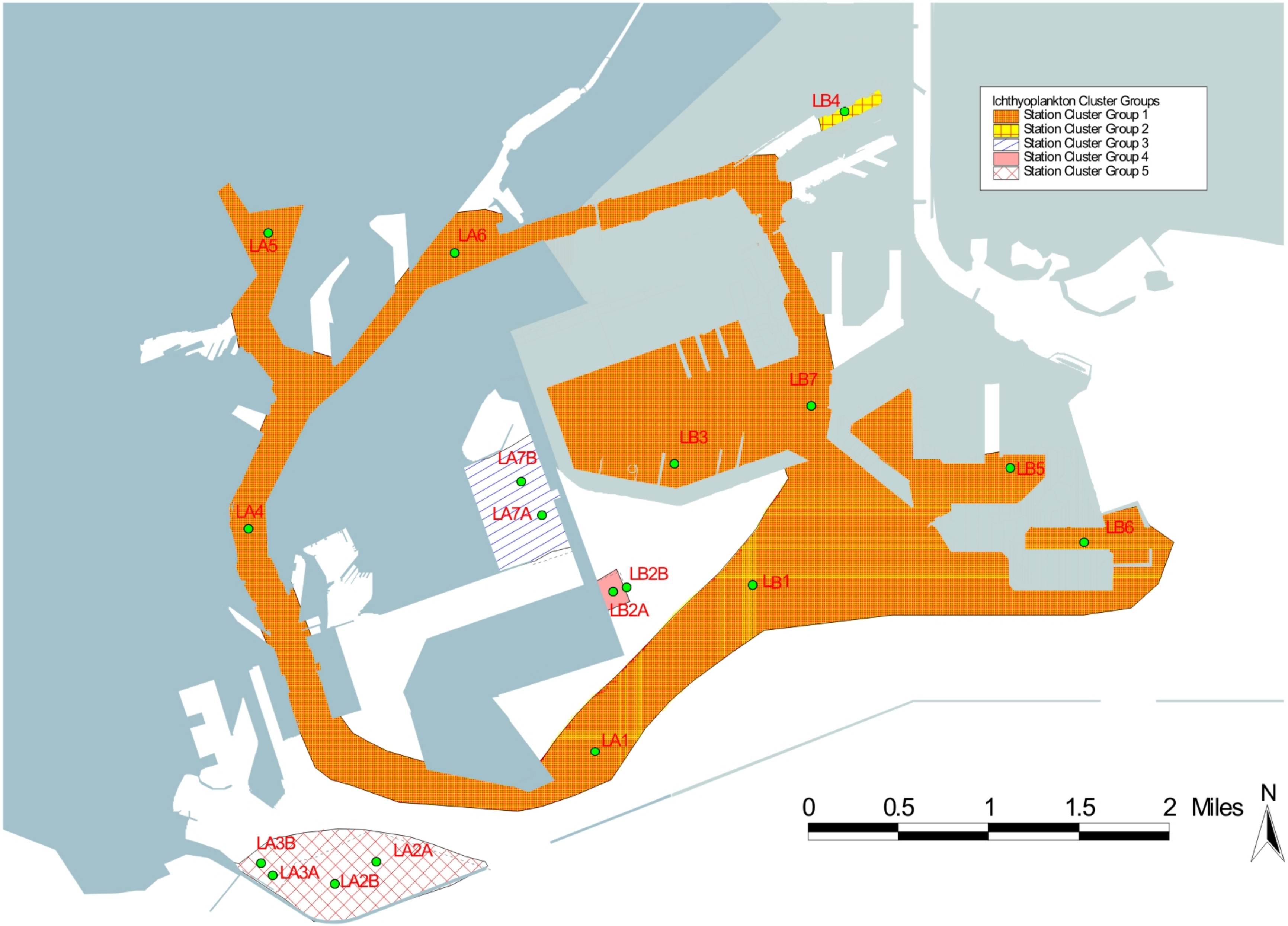


Figure 4.3-4. Map of station groups identified by cluster analysis of ichthyoplankton collected in Long Beach and Los Angeles Harbors, February - November 2000.

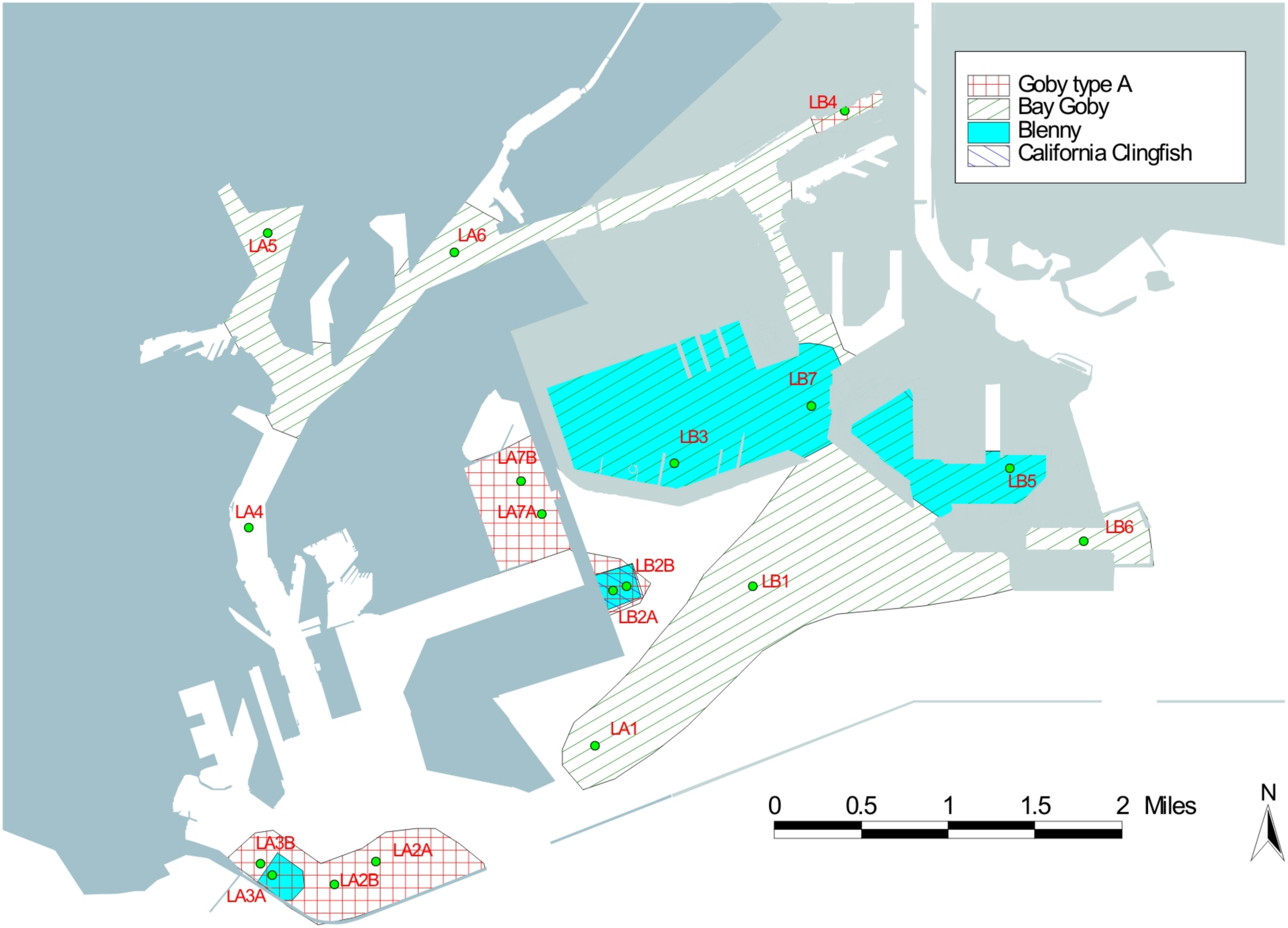


Figure 4.5-1. Areas of highest mean abundance of dominant ichthyoplankton from benthic associated fish in Long Beach and Los Angeles Harbors, February - November 2000.

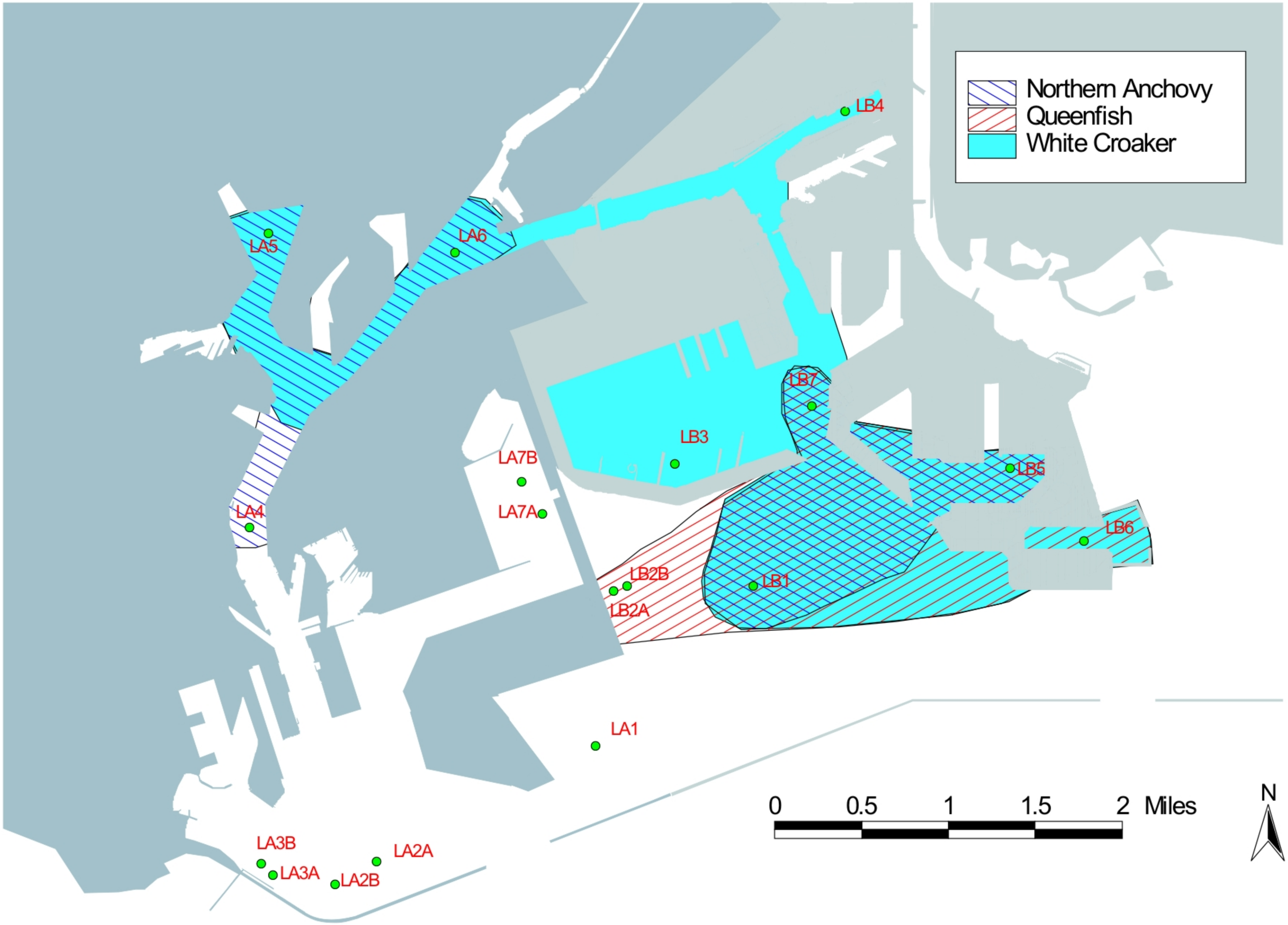


Figure 4.5-2. Areas of highest mean abundance of dominant ichthyoplankton from pelagic and/or demersal fish in Long Beach and Los Angeles Harbors, February - November 2000.

Table 4.2-1. Survey schedule and conditions for ichthyoplankton sampling in Long Beach and Los Angeles Harbors, February – November 2000.

Date	Season	Sampling Time	Weather Conditions	Notable Observations
17-Feb-00	Winter	1920-0325	Partly cloudy, light wind	
18-Feb-00	Winter	1825-2340	Partly cloudy, light wind	
11-May-00	Spring	2025-3340	Clear, wind to 35 kts, very choppy	
12-May-00	Spring	1929-0040	Clear, light wind	
10-Aug-00	Summer	2150-0303	Clear, calm wind, warm	
11-Aug-00	Summer	1945-0201	Clear, calm wind, warm	Trash and debris at LB4.
17-Nov-00	Fall	1820-0220	Clear, calm wind	
18-Nov-00	Fall	1720-2013	Clear, calm wind	

Table 4.3-1. Total and weighted mean abundance of ichthyoplankton larvae and eggs collected in Long Beach and Los Angeles Harbors, February – November 2000.

STAGE	Common Name	Species	Neuston (#/100 m^3)	Midwater (#/100 m^3)	Epibenthic (#/100 m^3)	Weighted Mean Across Water Column (#/100 m^2)	% of Total
Yolksac	White croaker	*Genyonemus lineatus*	11	5	4	60	
	Kelpfish	Clinidae		3		49	
	Yellowchin sculpin	*Icelinus quadriseriatus*		3		49	
	Northern anchovy	*Engraulis mordax*		1		5	
	Topsmelt	*Atherinops affinis*	16			3	
Larvae	Goby Type A	Goby type A	9,929	4,453	10,958	30,960	32.95
	Bay goby	*Lepidogobius lepidus*	318	1,140	1,782	15,331	16.32
	Northern anchovy	*Engraulis mordax*	834	834	2,283	13,110	13.95
	California clingfish	*Gobiesox rhessodon*	4,390	1,694	871	12,250	13.04
	Queenfish	*Seriphus politus*	1,264	826	1,207	9,041	9.62
	Blenny	*Hypsoblennius* sp.	326	479	244	4,797	5.11
	White croaker	*Genyonemus lineatus*	455	212	1,484	4,675	4.98
	Yellowfin goby	*Acanthogobius flavimanus*	6	164	502	1,756	1.87
	Goby (unid.)	Gobiidae	282	33	49	374	0.40
	California grunion	*Leuresthes tenuis*	751	25	54	316	0.34
	Woolly sculpin	*Clinocottus analis*	1	11	71	203	0.22
	Snubnose pipefish	*Cosmocampus arctus*		12	1	107	0.11
	Topsmelt	*Atherinops affinis*	21	7	16	94	0.10
	Roughcheek sculpin	*Ruscarius creaseri*	286	5	3	86	0.09
	Bluebanded goby	*Lythrypnus dalli*		3	3	75	0.08
	Reef finspot	*Paraclinus integripinnis*		20	13	74	0.08
	Speckled sanddab	*Citharichthys stigmaeus*		3		73	0.08
	Kelpfish	*Gibbonsia* sp.		19	12	73	0.08
	Jacksmelt	*Atherinopsis californiensis*	68	6	53	72	0.08
	California halibut	*Paralichthys californicus*		3	8	67	0.07
	Diamond turbot	*Hypsopsetta guttulata*	4	5	7	66	0.07
	Giant kelpfish	*Heterostichus rostratus*		4	50	55	0.06
	Pygmy poacher	*Odontopyxis trispinosa*		2		42	0.04
	Sculpin/Cottid	Cottidae		4	4	41	0.04
	Spotted kelpfish	*Gibbonsia elegans*	13	3	26	35	0.04
	Snubnose sculpin	*Orthonopias triacis*	143	1	5	32	0.03
	Hornyhead turbot	*Pleuronichthys verticalis*		2	8	27	0.03
	Northern lampfish	*Stenobrachius leucopsarus*		1	5	17	0.02
	Silverside (unid.)	Atherinidae	10	1		17	0.02
	Longjaw mudsucker	*Gillichthys mirabilis*		0.3	16	16	0.02
	Cheekspot goby	*Ilypnus gilberti*	26	0.3	9	14	0.01
	Yellowchin sculpin	*Icelinus quadriseriatus*	1		12	9	0.01
	Specklefin midshipman	*Porichthys myriaster*			10	7	0.01
	Blind goby	*Typhlogobius californiensis*	2	1		7	0.01
	Island kelpfish	*Alloclinus holderi*		0.4		5	0.01
	Yellowfin fringehead	*Neoclinus stephensae*		1		5	0.01
	Spotted turbot	*Pleuronichthys ritteri*		0.4	1	5	0.01
	Ronquil	*Rathbunella* sp.		1	2	5	0.01
	Rockfish (unid.)	*Sebastes* sp.	1	1	2	5	0.00
	Staghorn sculpin	*Leptocottus armatus*		0.3	1	4	0.00
	Blackeye goby	*Coryphopterus nicholsi*		1		3	0.00
	Smoothhead sculpin	*Artedius lateralis*			2	1	0.00
	Deepwater blenny	*Cryptotrema corallinum*			2	1	0.00
	Shadow goby	*Quietula y-cauda*			1	1	0.00
	Pipefish (unid.)	*Syngnathus* sp.	5			1	0.00
	Plainfin midshipman	*Porichthys notatus*	2		0.4	1	0.00
	Shortspine combfish	*Zaniolepis frenata*			0.4	0.3	0.00
	Garibaldi	*Hypsypops rubricundus*	1			0.2	0.00
	Bay pipefish	*Syngnathus leptorhynchus*	1			0.1	0.00
		Total	19,138	9,975	19,778	93,952	100.00
Eggs	Fish (unid.)	Fish (unid.)	18,441	4,177	3,652	45,941	56.77
	Croaker	Sciaenidae	5,299	2,260	3,360	28,414	35.11
	Speckled sanddab	*Citharichthys stigmaeus*	2,373	266	121	2,873	3.55
	California tonguefish	*Symphurus atricauda*	445	204	22	1,559	1.93
	Spotted turbot	*Pleuronichthys ritteri*	1,544	69	67	1,308	1.62
	Northern anchovy	*Engraulis mordax*	93	62	38	620	0.77
	Hornyhead turbot	*Pleuronichthys verticalis*	34	15	9	162	0.20
	Señorita	*Oxyjulis californica*	149	1	4	30	0.04
	California halibut	*Paralichthys californicus*		0.4	16	16	0.02
	Pacific sanddab	*Citharichthys sordidus*			5	3	0.00
	Jack mackerel	*Trachurus symmetricus*			2	1	0.00
	English sole	*Pleuronectes vetulus*	3			1	0.00
		Total	28,383	7,054	7,297	80,928	100.00

Note: Species listed in decreasing order of abundance.

Table 4.3-2. Mean abundance, number of species, diversity, and dominance of ichthyoplankton larvae collected in Long Beach and Los Angeles Harbors, February – November 2000.

Habitat / Station	Depth (m)	Weighted Mean Abundance (#/100 m^2)	Mean Number of Species	Shannon-Wiener Diversity	Margalef Diversity	Dominance
Deepwater Open						
LA1	13	1,330	10	1.32	1.33	3
LB1	12	3,485	10	1.34	1.31	3
Deepwater Channel						
LA4	16	2,325	8	1.07	0.96	2
LB7	24	14,636	9	1.45	0.90	3
Deepwater Basin						
LA5	17	3,250	7	1.27	0.85	3
LA6	16	2,458	8	0.99	0.85	2
LB3	15	2,310	9	1.53	1.11	3
LB5	15	8,354	10	1.16	1.15	2
Deepwater Slip						
LB4	15	5,140	9	1.34	1.00	3
LB6	17	4,835	8	1.24	0.83	2
Shallow Mitigation						
LA2A	4	2,212	11	0.82	1.35	2
LA2B	4	3,349	7	0.88	0.95	2
LA7A	4	11,664	9	0.92	1.04	2
LA7B	4	7,146	10	0.87	1.06	2
LB2A	6	7,793	8	1.00	1.05	2
LB2B	6	8,139	9	1.24	1.07	3
Shallow Water Open						
LA3A	4	3,949	8	1.04	0.99	2
LA3B	4	1,578	9	1.30	1.17	3
Station Mean		5,220	9	1.15	1.05	2
Total mean		93,953	25			

Table 4.3-3. Mean abundance of ichthyoplankton eggs collected in Long Beach and Los Angeles Harbors, February – November 2000.

Common Name	Species	Weighted Mean Abundance (#/100 m^2)																		Overall Mean
		Deepwater Open		Deepwater Channel		Deepwater Basin				Deepwater Slip		Shallow Mitigation						Shallow Water Open		
		LA1	**LB1**	**LA4**	**LB7**	**LA5**	**LA6**	**LB3**	**LB5**	**LB4**	**LB6**	**LA2A**	**LA2B**	**LA7A**	**LA7B**	**LB2A**	**LB2B**	**LA3A**	**LA3B**	**All Stations**
Fish (unid.)	Fish (unid.)	2604.8	2938.8	2875.9	4836.5	446.4	2777.3	2165.5	1675.8	2042.4	2285.9	1321.5	1363.9	806.3	1340.7	872.8	658.7	8296.1	6648.1	45,957
Croaker	Sciaenidae	2325.5	2275.9	1234.7	3947.7	663.2	4417.5	2059.5	810.2	2839.3	2483.0	545.4	472.4	241.0	253.4	1258.8	887.4	997.0	702.0	28,414
Speckled sanddab	*Citharichthys stigmaeus*	205.0	268.8	30.8	300.0	20.7	41.3	0.2	11.6	0.5	20.4	199.7	181.3	0.5	4.0	39.0	6.6	1094.3	448.6	2,873
California tonguefish	*Symphurus atricauda*	357.3	32.4		74.3						38.9		1.7	6.1	3.4	693.9	350.7			1,559
Spotted turbot	*Pleuronichthys ritteri*	71.4	61.7	169.8	533.9	0.5		0.4	61.1	1.7	11.5	49.1	21.1	2.5		1.1	0.4	255.3	66.4	1,308
Northern anchovy	*Engraulis mordax*	0.5	216.9		118.3				89.1		2.4	32.0	14.0		55.8	9.6	12.1	4.3	64.8	620
Hornyhead turbot	*Pleuronichthys verticalis*	97.1	42.4	1.2	3.8				2.2			12.9	1.4				0.4	0.2	0.2	162
Señorita	*Oxyjulis californica*			0.3									3.4					22.5	4.0	30
Pacific sanddab	*Citharichthys sordidus*																	3.4		3
Jack mackerel	*Trachurus symmetricus*											1.2								1
English sole	*Pleuronectes vetulus*							0.5												1
	Total Mean	5,662	5,837	4,313	9,815	1,131	7,236	4,226	2,650	4,884	4,842	2,162	2,059	1,056	1,657	2,875	1,916	10,673	7,934	80,928

Table 4.3-4. Mean abundance of ichthyoplankton larvae collected in Long Beach and Los Angeles Harbors, February – November 2000.

Common Name	Species	Deepwater Open		Deepwater Channel		Deepwater Basin				Deepwater Slip		Shallow Mitigation						Shallow Water Open		Overall Mean	Annual Total
		LA1	LB1	LA4	LB7	LA5	LA6	LB3	LB5	LB4	LB6	LA2A	LA2B	LA7A	LA7B	LB2A	LB2B	LA3A	LA3B	All Stations	All Stations
Goby Type A	Goby type A	163.5	499.6	680.5	772.2	623.7	267.2	625.4	249.7	1027.5	825.3	1872.7	2984.8	9531.7	5843.6	706.6	1342.2	2143.9	799.4	30,960	123,838
Bay goby	*Lepidogobius lepidus*	570.4	884.0	295.8	4053.9	912.9	518.3	532.2	1689.6	2715.3	1391.6	55.9	81.2	684.1	173.1	52.7	136.0	265.7	318.5	15,331	61,326
Northern anchovy	*Engraulis mordax*	204.4	798.7	921.1	3729.1	781.0	510.2	106.3	5034.8	81.8	116.3	10.3	1.7	319.3	257.6	61.4	81.2	86.2	8.3	13,110	52,439
California clingfish	*Gobiesox rhessodon*	27.3	55.5	1.5	368.4	9.7	23.4	255.5	40.2	132.2	360.3	3.3	5.4	145.8	306.9	5389.1	4233.6	765.5	126.4	12,250	49,001
Queenfish	*Seriphus politus*	240.0	795.4	254.7	1807.2	286.9	88.2	208.6	498.8	20.5	1145.1	123.2	55.0	20.8	114.3	1236.4	1890.7	228.8	26.1	9,041	36,162
Blenny	*Hypsoblennius* sp.	47.8	163.9	29.9	1185.6	222.6	210.5	335.1	429.4	162.6	181.2	60.9	155.2	245.4	123.3	327.6	432.2	309.7	174.5	4,797	19,190
White croaker	*Genyonemus lineatus*	28.8	175.3	71.9	2448.1	141.1	130.3	199.9	282.1	599.8	531.0	15.7	0.7	18.9	22.6	5.7	2.4		1.3	4,675	18,702
Yellowfin goby	*Acanthogobius flavimanus*	5.3		29.4	8.0	237.1	558.4	0.3	49.1	11.6	227.7	6.4	0.2	513.3	71.1	1.0	4.4	10.0	22.7	1,756	7,024
Goby (unid.)	Gobiidae	0.5	71.3	15.2		3.8	51.0	2.2	1.1	113.7	6.2	13.6			46.8	0.1	1.5	46.9		374	1,495
California grunion	*Leuresthes tenuis*	0.9	1.1	0.1	7.3	1.2	1.7	9.9	7.0	162.1	3.2	1.4		88.2	18.2	1.5	6.1	0.5	5.6	316	1,264
Woolly sculpin	*Clinocottus analis*	4.4	6.0	6.1	16.3	11.1	0.3		53.4	11.1	19.1		0.2	37.0					37.4	203	810
Snubnose pipefish	*Cosmocampus arctus*						74.3						23.7			7.7	0.9			107	426
Topsmelt	*Atherinops affinis*				1.0	0.2	5.0		0.1	76.0		0.3		2.6	4.4	0.4	0.2	0.2	3.9	94	377
Roughcheek sculpin	*Ruscarius creaseri*		0.8								22.4	8.0	3.0				1.4	47.6	3.4	86	346
Bluebanded goby	*Lythrypnus dalli*				73.0														1.8	75	299
Reef finspot	*Paraclinus integripinnis*		0.3					2.2						9.2	61.9					74	294
Speckled sanddab	*Citharichthys stigmaeus*				73.0															73	292
Kelpfish	*Gibbonsia* sp.									2.3		4.5	5.1		55.3	1.9		0.2	3.2	73	290
Jacksmelt	*Atherinopsis californiensis*	8.9	1.1	0.1	0.2			0.2	4.3	2.4		0.6	2.3	39.2	11.6	0.4	0.1	0.5	0.6	72	290
California halibut	*Paralichthys californicus*		14.1	2.7	42.1			6.5	1.4											67	267
Diamond turbot	*Hypsopsetta guttulata*	12.8	15.1	12.3	5.6		9.0	6.1	0.4			1.6				0.1	0.1	2.3		66	263
Giant kelpfish	*Heterostichus rostratus*	0.5		0.5								16.6	9.4		26.1			1.2	0.3	55	218
Pygmy poacher	*Odontopyxis trispinosa*				42.1															42	168
Sculpin/Cottid	Cottidae			0.3		0.7	0.3	0.3		5.0		1.6	0.2					0.5	31.8	41	163
Spotted kelpfish	*Gibbonsia elegans*			3.0								3.3	16.6	0.8	2.1	0.7	2.2	6.2		35	139
Snubnose sculpin	*Orthonopias triacis*											2.5	1.7					26.4	1.3	32	128
Hornyhead turbot	*Pleuronichthys verticalis*	1.7	0.8			5.7		6.9	6.9				2.3				2.2			27	106
Northern lampfish	*Stenobrachius leucopsarus*	0.5	0.3	0.4		3.5		6.5						0.2	1.7		1.4	2.7		17	69
Silverside (unid.)	Atherinidae	0.2			0.1				0.1	15.3	0.2			0.5	0.1				0.3	17	67
Longjaw mudsucker	*Gillichthys mirabilis*				1.3		4.8		4.3		5.2									16	62
Cheekspot goby	*Ilypnus gilberti*					3.5								4.6	5.0			0.5		14	55
Yellowchin sculpin	*Icelinus quadriseriatus*	0.4					4.8					1.1		2.3						9	34
Specklefin midshipman	*Porichthys myriaster*				1.3			4.5	1.1											7	27
Blind goby	*Typhlogobius californiensis*	6.4						0.2											0.1	7	27
Island kelpfish	*Alloclinus holderi*					5.4														5	22
Yellowfin fringehead	*Neoclinus stephensae*																		5.3	5	21
Spotted turbot	*Pleuronichthys ritteri*	4.4								0.6										5	20
Ronquil	*Rathbunella* sp.							0.7				1.6	0.4					2.3		5	20
Rockfish (unid.)	*Sebastes* sp.	0.6	0.8									3.3								5	19
Staghorn sculpin	*Leptocottus armatus*																	0.5	3.2	4	15
Blackeye goby	*Coryphopterus nicholsi*											3.2								3	13
Smoothhead sculpin	*Artedius lateralis*																		1.3	1	5
Deepwater blenny	*Cryptotrema corallinum*																		1.3	1	5
Shadow goby	*Quietula y-cauda*						0.3											0.5		1	3
Pipefish (unid.)	*Syngnathus* sp.		0.2									0.4			0.1					1	3
Plainfin midshipman	*Porichthys notatus*								0.3			0.4								1	3
Shortspine combfish	*Zaniolepis frenata*		0.3																	0	1
Garibaldi	*Hypsypops rubricundus*	0.2																		0	1
Bay pipefish	*Syngnathus leptorhynchus*			0.1																0	0
Total Weighted Mean (per 100 m^2)		1,330	3,485	2,325	14,636	3,250	2,458	2,310	8,354	5,140	4,835	2,212	3,349	11,664	7,146	7,793	8,139	3,949	1,578	93,952	375,808
Total Number of Species		22	20	19	20	17	18	20	20	17	14	25	19	18	20	16	18	23	24		

Table 4.3-5. Seasonal mean abundance of the top ten ranked species of ichthyoplankton larvae collected in Long Beach and Los Angles Harbors, February – November 2000.

Common Name	Species	Weighted Mean Abundance (#/100 m^2)				
		February 2000	May 2000	August 2000	November 2000	Mean
Goby Type A	Goby type A	5,328	18,490	53,674	46,346	30,960
Bay goby	*Lepidogobius lepidus*	3,801	7,940	45,062	4,523	15,331
Northern anchovy	*Engraulis mordax*	551	42,902	5,720	3,266	13,110
California clingfish	*Gobiesox rhessodon*	4	44,102	3,492	1,403	12,250
Queenfish	*Seriphus politus*	0	33,660	2,493	10	9,041
Blenny	*Hypsoblennius* sp.	0	2,086	15,587	1,517	4,797
White croaker	*Genyonemus lineatus*	109	14,528	0	4,065	4,675
Yellowfin goby	*Acanthogobius flavimanus*	4,411	304	0	2,309	1,756
Goby (unidentified)	Gobiidae	83	392	1,020	0	374
California grunion	*Leuresthes tenuis*	29	866	14	355	316

Table 4.4-1. Summary of biological and physical/chemical habitat characteristics of ichthyoplankton cluster groups.

	Cluster Group				
	1	**2**	**3**	**4**	**5**
Station	LA1, LB1, LA4, LA5, LA6, LB3, LB5, LB6, LB7	LB4	LA7	LB2	LA2, LA3
Habitat	Deep Open Water, Basin, Slip, Channel,	Deepwater Slip	Shallow Basin (Mitigation Site)	Shallow Open Water (Mitigation Site)	Shallow Open Water (Mitigation and Natural Sites)
Depth (m)	12-24	15	4	6	4
Range of Percent Fines	25-94	69	21-50	20-63	27-92
Years Since Dredging/ Disposal	0 to > 10	1	>10	1	0 to > 10
Range Percent Transmissivity **•near surface** **•mid-water** **•near bottom**	(S) 42-73 (M) 29-71 (B) 11-67	64-76 65-74 60-63	39-59 40-58 36-52	59-65 46-66 8-62	44-68 51-68 17-64
Range Mid-water Temperature (°C)	13-20	14-20	14-23	13-21	12-20
Range Mid-water Dissolved Oxygen (mg/L)	4.4-8.0	5.5-6.6	6.0-9.2	4.8-8.3	5.2-7.4
Range Mid-water Salinity (ppt)	33.0-33.7	33.1-33.5	33.1-33.6	33.1-33.7	33.0-33.6
Total Taxa in Species Cluster Group	36 L, J, Y 8 E	17 L, J 4 E	20 L, J, Y 4 E	18 L, J 7 E	30 L, J, Y 8 E
Number of Relatively Abundant Taxa in Cluster Group	11 L 4 E	6 L 2 E	12 L, J 2 E	6 L, J 3 E	14 L, J 6 E
Relatively Abundant Taxa in Cluster Group	*Acanthogobius,* *Clinocottus,* *Engraulis,* *Genyonemus,* *Lepidogobius*, *Hypsopsetta*, *Paralichthys,* *Pleuronichthys,* *Seriphus*, *Engraulis* (E), *Pleuronichthys* (E), Sciaenid (E)	*Atherinops,* *Lepidogobius*, Gobies, *Leuresthes,* *Sygnathus*, Sciaenid (E)	*Acanthogobius,* *Atherinops,* *Atherinopsis,* *Clinocottus,* *Gibbonsia,* *Heterostichus,* Gobies, *Leuresthes*, *Ilypnus*, *Seriphus,* *Paraclinus,* *Engraulis* (E)	*Atherinops,* *Atherinopsis,* *Engraulis,* *Gobisox*, *Seriphus*, *Symphurus* (E), Sciaenid (E)	*Gibbonsia,* Gobies, *Heterostichus,* *Leptocottus,* *Orthonopias,* *Rathbunella*, *Ruscarius,* *Citharichthys* (E), *Engraulis* (E), *Pleuronichthys* (E), *Oxyjulis* (E), Sciaenid (E)

Notes: Yolk-sac, larvae, juvenile of same species counted as one unique taxon.
Blennies (*Hypsoblennius* sp.) and unidentified fish eggs were relatively abundant at all stations.
E = eggs, L = larvae, J = juvenile, Y = yolk-sac; S = near surface, M = mid-water, B = near bottom.

Table 4.7-1. Historical comparison of dominant species, number of taxa, and abundance of ichthyoplankton collected in Long Beach and Los Angeles Harbors.

	HEP 1976		HEP 1979		Brewer 1983		MBC 1984		MEC 1988		2000	
Five most abundant larvae (percent of total catch)	*Engraulis mordax*	38.4	*Genyonemus lineatus*	54.1	*Engraulis mordax*	24.8	*Engraulis mordax*	28.1	*Clevelandia ios/ Ilypnus gilberti/ Quietula y-cauda*	29.0	*Clevelandia ios/ Ilypnus gilberti/ Quietula y-cauda*	32.9
	Hypsoblennius spp.	20.4	*Engraulidae*	27.8	*Genyonemus lineatus*	20.2	*Genyonemus lineatus*	27.7	*Engraulis mordax*	25.6	*Lepidogobius lepidus*	16.3
	Sciaenidae	17.2	*Gobiidae*	7.2	*Clevelandia ios/ Ilypnus gilberti*	10.0	*Clevelandia ios/ Ilypnus gilberti/ Quietula y-cauda*	6.0	*Hypsoblennius* spp.	11.4	*Engraulis mordax*	13.9
	Sebastes spp.	8.4	*Hypsoblennius* spp.	5.4	*Hypsoblennius* spp.	8.2	*Hypsoblennius* spp.	8.0	*Genyonemus lineatus*	5.8	*Gobiesox rhessodon*	13
	Gobiidae	5.3	*Seriphus politus*	1.0	*Seriphus politus*	7.4	*Lepidogobius lepidus*	5.8	*Seriphus politus*	5.7	*Seriphus politus*	9.6
Number unique larval taxa	26		34		34		59		74		49	
Larval abundance in outer harbor, open water					205/100 m^3		245/100 m^3		102/100 m^3		200/100 m^3	
Larval abundance at Pier 300									193/100 m^3		1881/100 m^3	

5.0 BENTHIC AND EPIBENTHIC INVERTEBRATES

5.1 Introduction

Organisms living within, on, or associated with the sediment comprise the benthos. Small invertebrates (microscopic to approximately 2 inches in size) that burrow within or anchor to the bottom, and/or feed at the sediment-water interface are termed infauna. Infaunal organisms may filter large volumes of water, burrow within and oxygenate sediments, contribute organics and regenerate nutrients, and serve as food for bottom-feeding fish and other invertebrates. Larger invertebrates that reside at or above the sediment surface are termed epibenthic macroinvertebrates. They may feed on infaunal organisms, algae, plankton, or carrion and like infaunal organisms represent important prey for higher trophic levels including fish, birds, and (for some invertebrate species) man.

Many infaunal organisms and several macroinvertebrates are non-motile or of limited mobility and are therefore sensitive to physical and chemical conditions of the sediment. Species composition of infaunal communities has been used to investigate environmental health and many species have been identified as indicators of pollution or background natural conditions (Pearson and Rosenberg 1978, Reish 1971, MEC 1988, CSDOC 1994).

Thus, invertebrates (e.g., worms, shrimps, crabs, clams, snails, starfish) are important community members because:

- They burrow and feed on sediments thereby altering the physical and chemical nature of the sediments and creating habitat heterogeneity, which can lead to greater biodiversity and a more productivity community.
- Many of them live in direct contact with the sediments and therefore can be good indicators of sediment and habitat quality.
- They tend to be an intermediate trophic link between primary producers (e.g., plankton, algae) and higher trophic levels (e.g., fish, birds, mammals) by converting detritus and organic material from the sediments and sediment-water interface into animal biomass.
- Some are commercially important for food (e.g., lobster, crabs, mussels, clams) while others maybe harvested for bait (ghost shrimp and worms).

Infaunal and epibenthic macroinvertebrates were sampled seasonally (January-February, May, August, and November 2000) from a range of habitats in Long Beach and Los Angeles Harbors. Infaunal invertebrates were collected by boxcore, and macroinvertebrates by otter trawl, using similar methods as in previous studies of the harbors. For the otter trawl sampling, a 25 ft (7.6 m) net was the primary gear used each survey. A special study also was conducted whereby a 16 ft (4.9 m) net was used at several stations to provide comparative information on catch with the smaller net. The comparative study provides useful information for evaluating historical data that utilized these different net sizes.

Infaunal invertebrates and epibenthic macroinvertebrates are separately discussed in this section. Methods used to survey each community are described in Subsection 5.2. Survey results for infauna are presented in Subsection 5.3, and results for macroinvertebrates are given in

Subsection 5.4. Exotic species considered to be non-indigenous to the harbors are identified in Subsection 5.5. A summary of spatial and temporal patterns observed in 2000 and how they compare to historical studies within the harbors is given in Subsection 5.6.

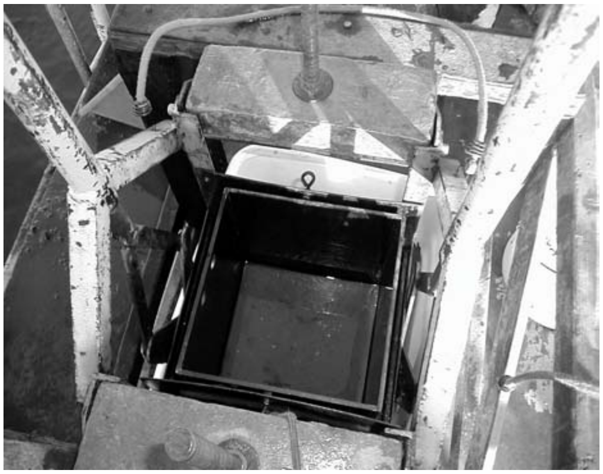
5.2 Methodology

Benthic invertebrates were collected quarterly in January-February (winter), May (spring), August (summer), and November (fall) 2000 (Tables 5.2-1, -2). Infaunal invertebrates were collected at a total of 28 stations, 14 in each harbor (Figure 5.2-1), using a $0.1m^2$ surface area box core sampler. Two replicate stations were located at shallow water Stations LB2, LA2, LA3, and LA7 to yield a total of 32 samples for each survey; the replicates were denoted by letter (e.g., LB2A, LB2B). Macroinvertebrates were collected at the same 14 stations sampled for fish, which represents a subset of the infaunal sampling stations. Methods specific to the infaunal and macroinvertebrate surveys are described in the subsections below.

5.2.1 Infauna

Similar to other studies of the harbors by MEC, the box core sample was separated into 0.06 and 0.04 m^2 sections using an acrylic divider (MEC 1988, 1997, 1999; SAIC 1996). The larger section was used for the infaunal sample, and the smaller section was used for a sediment grain size sample. The infaunal sample size is similar to historical studies, which collected benthic infauna with 0.06 to 0.0625 m^2 coring devices (e.g., HEP 1976, 1980). A 0.1 m^2 coring device also has been used (e.g., MBC 1984, City of Los Angeles 1999).

Target recovery of at least 10 cm of the upper sediment layer, and that had a relatively undisturbed surface layer, were considered sufficient for analysis. Rejected cores were discarded and re-sampled. During the spring survey, sediment at Station LA6 in the Seaplane Anchorage was too compact for full penetration of the core, and a 4.5 cm depth of penetration was accepted. Each sufficient sample was processed through a 1.0-mm mesh screen, placed in a labeled sample jar(s), and 7% magnesium sulfate ($MgSO_4$) seawater solution was added to relax collected animals. After approximately 30 minutes, the sample was fixed with buffered formalin to yield a 10% formalin-seawater solution. Samples were labeled with the station identification number, date, time, depth, gear type, and sieve size.



In the laboratory, infauna samples were transferred from formalin to 70% ethanol within 7 days of sampling for long-term preservation. Infaunal samples were sorted into major taxonomic categories (annelids, crustaceans, echinoderms, molluscs, other minor phyla) using a stereoscopic microscope. Organisms were placed into vials containing 70% ethanol for long-term storage. Qualified taxonomists identified and counted the organisms to the lowest practicable taxon (usually species). Wet weight biomass (to nearest 0.01gram) was quantified for each taxonomic group after the species were identified.

Prior to sorting samples from the first survey, the infaunal samples were split into two equal parts and sorted separately. Both halves were separately analyzed. Abundance, number of species, and biomass data from each sample half were compared to determine whether analysis of half-samples provided representative data for estimating benthic populations. The comparative analysis indicated that analysis of half-samples provided representative measures of abundance and biomass, but underestimated number of species, if species occurred in low abundance. Therefore, sample splits were analyzed only for samples with extremely high abundance by a few species. Whole samples were analyzed for nearly all the collected samples.

Sediment samples were retained during the first survey (winter), placed in labeled plastic bags, and kept on ice in ice chests in the field. Sediment samples were analyzed for grain size using a standard sieve and pipette method (Plumb 1981). Results of the grain size analyses are presented in Section 2.3.

5.2.2 Macroinvertebrates

Benthic epifaunal macroinvertebrates were collected during the day and night along with fish during the otter trawl surveys (see Section 3.2.2 for description of methods). Otter trawl invertebrates were identified to the lowest practicable taxon (usually species) and weighed in the field. Organisms not identified in the field were preserved in buffered formalin and returned to the laboratory for identification and wet weight biomass (g) measurement.

5.2.3 Data Analysis

Infauna data were entered into a database from the taxonomic laboratory sheets. Macroinvertebrate data were coded from the field data sheets and entered into a separate database. Data were subjected to review for completeness and standardized quality assurance routines.

Abundance and biomass are presented as number per 0.06 m^2 (the area of the boxcore) on the raw data tables in Appendix E, and were standardized to number per 0.1 m^2 on summary tables and figures in the text and Appendix E to be consistent with historical data. Abundance and biomass of the trawl collected invertebrates are presented as catch per unit effort (CPUE).

Infaunal abundance and biomass data were $\log_{10}$ transformed and tested for seasonal differences with ANOVA. Number of species also was tested (but not transformed). Diurnal and seasonal differences were looked for in the macroinvertebrate abundance ($\log_{10}$), biomass ($\log_{10}$), and number of species using ANOVA.

Diversity was calculated with three different indices, which are derived measures based upon the number of species (species richness) and their abundances (equitability). The Shannon-Wiener diversity index tends to emphasize the equitability of the species distribution in a community. The Margalex Index incorporates the number of species and total number of individuals. The Dominance Index computes the number of species that account for 75% of the total abundance.

Cluster analysis was performed separately for each set of data. For each species, infauna data were averaged for each station over the four surveys. Rare species (i.e., occurred at less than three stations) were excluded from the analysis. For each macroinvertebrate species, the mean was computed over day and night periods and over the four surveys. Rare species (occurring at only one station) were excluded from the analysis. The cluster analysis for each set of data was performed identically to those on the adult fish (see Section 3.2). Figures of station and species dendrograms and two-way coincidence table were prepared from the cluster analysis. Major cluster groups were assigned alpha (species) or numeric (station) codes, which were indicated on the figures. Maps of the station cluster groups were prepared to show spatial patterns in species composition. Station cluster groups separated by less dissimilarity were assigned similar color, but distinct patterns and groups separated by more dissimilarity were assigned different color patterns.

Figures showing seasonal trends in community summary measures (abundance, biomass, species) label the surveys according to month-year (e.g., Feb-00).

5.3 Infauna

This section first presents a discussion of community summary measures (Section 5.3.1), which is followed by a detailed description and evaluation of species composition (Section 5.3.2) and dominant species (Section 5.3.3). Spatial and temporal patterns are summarized in Section 5.3.4. This section concludes with a comparison of the Year 2000 Baseline Study results with historical studies (Section 5.3.5). Exotic species and overall study findings are addressed together with macroinvertebrates in Sections 5.5 and 5.6, respectively. Raw summary data are provided in Appendix E.1.

5.3.1 Community Summary Measures

Abundance

A total of 52,417 infaunal invertebrates was collected across the 32 stations and four surveys (Table 5.3-1). Mean abundances ranged from 90 to 1,177 individuals /0.1 m^2. Abundances were nearly 3 times higher at shallow water stations (mean of 716 individuals/0.1 m^2) than at deepwater stations (mean of 249 individuals /0.1 m^2).

Of the stations in shallow water, highest mean abundances (mean > 800 individuals/0.1 m^2) were found at the Cabrillo and Pier 300 Shallow Water Habitats (shallow mitigation Stations LA2 and LA7) and at Fish Harbor (Station LA10) (Figure 5.3-1). The lowest mean abundance (383 individuals/0.1 m^2) recorded in shallow water was in the Consolidated Slip of inner Los Angeles Harbor (Station LA14).

Abundances were similar among stations located in deep open waters of the outer harbor, and in channels, basins, and slips throughout the harbors (Figure 5.3-1; Table 5.3-1). The highest mean abundance (515 individuals/0.1 m^2) was found in Channel 2 of inner Long Beach Harbor (Station LB4), and the lowest mean abundance (90 individuals/0.1 m^2) occurred in Slip 1 of the Long Beach East Basin (Station LB12).

Infaunal abundances were significantly (p=0.005) higher during the winter than the spring, summer, or fall surveys.

Biomass

Mean biomass values ranged from 1.37 to 16.4 g/0.1 m^2 with an overall mean of 4.97 g/0.1 m^2 (Table 5.3-1). Average biomass in shallow waters (6.8 g/0.1 m^2) was about 1.7 times higher than in deep waters (4.0 g/0.1 m^2). The lowest biomass values generally were found where abundance values were relatively low, including Slip 1 in Long Beach East Basin (Station LB12), the northern channel between Piers 300 and 400 (Station LA9), East Basin in inner Los Angeles Harbor (Station LA6), and Cabrillo Marina (Station LA12).

Infaunal biomass was higher during the spring survey than the other surveys (Figure 5.3-1), although the difference was not statistically significant.

Number of Species

A total of 400 taxa representing 361 unique species were collected over the four surveys (Table 5.3-1). The mean number of species per station ranged from 12 to 58. The greatest number of species (mean > 40 unique species) were collected in the Cabrillo and Pier 300 Shallow Water Habitats (Stations LA2 and LA7), deepwater habitat in the outer harbors (Stations LA11, LB1, and LB9), the main channel of Los Angeles Harbor (Station LA4), and in Channel 2 (Station LB4) of inner Long Beach Harbor (Figure 5.3-1, Table 5.3-1). The fewest number of species (<

25 unique species) were found at the Cabrillo Marina (LA12), northern channel between Piers 300 and 400 (Station LA9), Fish Harbor (LA10), Consolidated Slip of inner Los Angeles Harbor (Station LA14), and Slip 1 of the East Basin in Long Beach Harbor (Station LB12).

The average number of species was higher at the mitigation Shallow Water Habitats (44 species) than at other shallow water stations (38 species) and at deepwater stations (34 species).

More species were collected during the winter than other surveys (Figure 5.3-2). There was a significant (p=0.0009) decline in number of species between the winter and spring survey, and a significant increase between spring and summer. The number of species did not significantly differ between summer and fall.

Diversity and Dominance

Shannon-Wiener diversity, which considers the equitability of abundance among species, was highest at deepwater stations in the outer harbors (Stations LA1, LB1, LB9), main channel of Los Angeles Harbor (Station LA4), Turning Basin channel of inner Long Beach Harbor (Station LB13), and Channel 2 of inner Long Beach Harbor (Station LB4) (Table 5.3-1). The Margalef Index, which considers the total number of individuals in all species, also was highest at these stations as well as the Pier 300 Shallow Water Habitat (shallow mitigation Station LA7).

Species diversity (Shannon-Wiener and Margalef) generally was lowest at the stations with the fewest number of species; i.e., Fish Harbor (LA10), Consolidated Slip (Station LA14) of inner Los Angeles Harbor, and Slip 1 of the East Basin in Long Beach Harbor (Station LB12).

Dominance values were highest at stations with the highest species diversity and generally lower where diversity values were less (Table 5.3-1). Stations where 14 or more species accounted for 75% of the abundance included deepwater habitat in the outer harbors (Stations LA1, LA11, LB1, LB9), main channel of Los Angeles Harbor (Station LA4), Turning Basin channel of inner Long Beach Harbor (Station LB13), and Channel 2 of inner Long Beach Harbor (Station LB4). Stations where 5 or fewer species accounted for 75% of the abundance included Fish Harbor (Station LA10), Consolidated Slip (Station LA14), Seaplane Anchorage near Pier 300 (Station LB8), Cabrillo Shallow Water Habitat (Station LA2), and Slip 1 of the Long Beach East Basin (Station LB12).

5.3.2 Taxonomic and Species Composition

The infaunal community was numerically dominated by polychaetes (65% of annual mean abundance) and to a lesser extent by crustaceans (23%) (Figure 5.3-3, Table 5.3-2). Molluscs (9%), other minor phyla (2%), and echinoderms (< 1%) were substantially less abundant. Molluscs and polychaetes accounted for most of the infaunal biomass (Figure 5.3-3, Table 5.3-3).

Polychaetes were the most diverse taxonomic group (169 species), followed by crustaceans (79 species) and molluscs (65 species) (Figure 5.3-3, Table 5.3-4). The declines in abundance and number of species between the winter and spring surveys were due largely to a decline in polychaete worms. The higher biomass values noted in the spring were due to the collection of some larger individuals rather than an increase in numbers of molluscs.

Spatial patterns in species composition were investigated with cluster analysis. Nine station cluster groups and ten species cluster groups were identified (Figure 5.3-4). Species with a relatively high abundance within a station cluster group characterize the species composition of the group. Symbols on the two-way coincidence table (Figure 5.3-4) indicate relative abundance by the size of the symbol, which is largest with highest relative abundance. The size of the symbol does not correspond to absolute abundance, which can be found in Appendix E.1.3. Because cluster analysis considers relative abundance of each tested taxa across the stations it occupies, it is not weighted towards dominant species and provides a more complete assessment of community structure. The major difference in species assemblages was separation of many of the shallow water stations from deepwater stations. Additionally, there was separation of stations from relatively enclosed habitats (basins and slips) from those in channels and the open water of the outer harbor. The outer harbors of the Ports had a similar benthic assemblage, and the assemblage was similar throughout Cerritos Channel (Figure 5.3-5). In contrast, the species assemblages in basin and slip habitats differed between Long Beach and Los Angeles Harbors.

The species composition pattern was complex and did not correspond with any single factor such as depth (Figure 2.2-2), sediment grain size (Figure 2.3-1), or years since dredging (Figure 2.3-2). Some combination of these factors and other unmeasured factors undoubtedly influenced the structure of the benthic community. Sediment organic content and contaminants, although not measured in 2000, probably were contributing factors based on assessment of the dominant species comprising each station cluster group according to known reports of pollution sensitivity or tolerance for several of the collected species.

Species reported to occur in higher abundance in areas with low organic enrichment, moderate enrichment, or in highly contaminated habitats are listed in Table 5.3-5. Comparison of station cluster analysis groups with physical features of their habitat and species tolerances are presented in Table 5.3-6. Station cluster groups indicate a gradient of increasing environmental stress (enrichment/contamination) that ranged from the outer to inner harbor, basins to slips, and Long Beach to Los Angeles Harbors.

Station cluster groups with the highest habitat quality, as demonstrated by a diverse fauna and less than 35% of the relatively abundant species known to respond to enrichment and/or pollution, occurred in the outer harbors and the Los Angeles Main Channel. The Cabrillo, Long Beach, and Pier 300 Shallow Water Habitats formed two groups (Cluster Groups 1 and 2), and other stations in the outer harbor as well as the Los Angeles Main Channel comprised two different groups (Station Cluster Groups 5 and 8). The major physical differences among the stations comprising these cluster groups were depth and years since dredging.

Several station cluster groups (4, 6, 7) have species assemblages indicative of “semi-healthy” conditions with nearly 40 to 60% of the relatively abundant taxa known to respond to enrichment and/or pollution. The best quality of these is Station Cluster Group 7, which comprises basin and adjoining channel habitats in Long Beach Harbor. The basin and slip habitats in Los Angeles Harbor (Station Cluster Group 4) have a lower habitat quality with a generally less diverse species assemblage and more of the relatively abundant species known to respond to low levels of enrichment and/or pollution. It’s possible that the qualitative difference in basin habitats between the harbors may relate to dredging. Several of the basins in Long Beach Harbor have been dredged over the last 10 years, whereas it has been 15 years or more since basins were dredged in Los Angeles Harbor. Enrichment and/or pollution appeared to be slightly higher in the Cerritos Channel (Station Cluster Group 6), with a slightly higher proportion of its relatively abundant taxa known to respond to moderate enrichment/pollution.

The least healthy habitat (Station Cluster Group 3) was located in the Consolidated Slip of inner Los Angeles Harbor. That station was depauperate with only 13 species collected on average each survey. The species assemblage was dominated by pollution indicator species.

Another rather impoverished habitat occurred at Station LB12 (Station Cluster Group 9) in Slip 1 of the Long Beach East Basin. On average only 12 species in relatively low abundance were collected each survey. The lack of species with known enrichment/pollution tolerance indicates that the habitat was not contaminated. The station had extremely fine sediments (99% silt/clay), consistently low transmissivity values, and exhibited a wide range of salinity values indicating fresh water influence (Table 5.3-6). Relatively few species (on average, 19 species per survey) also were collected at Station LA12 in Cabrillo Basin (Station Cluster Group 4), which had very fine sediments (99% silt/clay).

More detailed descriptions of the cluster groups are provided below. Station Cluster Group 1 consisted of two stations each from the Cabrillo Shallow Water Habitat (Stations LA2A, B) and the Long Beach Shallow Water Habitat (Stations LB2A, B). Depths ranged from 4 to 6 m. Sediments in both habitats were sandy with low to moderate (20-63%) silt/clay content. These sites were created in the 1990s with disposal events occurring as recent as 1999-2000. The station cluster group was represented by 137 taxa across species cluster groups. Species Cluster Groups A and C had relatively high abundance, and a few species from Cluster Groups B, F, and I had moderate abundance. Relatively abundant species included a diverse mix of amphipod crustaceans (e.g., *Acuminodeutopus heteruropus, Amphideutopus oculatus, Deflexilodes similis, Photis bifurcata*), ostracod crustaceans (*Euphilomedes carcharodonta*), bivalve molluscs (*Chione californiensis, Cooperella subdiaphana, Lyonsia californica, Macoma nasuta, Macoma yoldiformis, Tellina modesta, Thracia curta),* gastropod molluscs (*Acteocina culcitella, Olivella maculata, Nuculana taphria*), polychaetes (e.g., *Apoprionospio pygmaea, Glycera convoluta, Glycinde armigera, Leitoscoloplos puggetensis, Lumbrineris* spp., *Mediomastus* spp., *Monticellina siblina, Pectinaria californiensis, Spiophanes bombyx, Spiophanes missionensis*), and nemerteans (*Paranemertes californica*). Several of these species (e.g., *Euphilomedes, Leitoscoloplos, Lumbrineris, Mediomastus, Monticellina, Macoma, Photis*) have been reported to increase in abundance in areas affected by organic enrichment, and others (e.g., *Pectinaria, Spiophanes*) have been associated with relatively uncontaminated reference sites (Table 5.3-5).

Station Cluster Group 2 comprised three shallow water stations: two in the Pier 300 Shallow Water Habitat (Stations LA7A, B) and one station in the adjacent Seaplane Anchorage (Station LA8). Average depths were similar (4 m) between both areas. However, sediments had a low to moderate (21-50%) silt/clay content in the Pier 300 Shallow Water Habitat, and a high silt/clay (95%) content in the Seaplane Anchorage. These areas have not experienced dredging for over 10 years (i.e., 1985). The station cluster group was represented by 118 taxa across species cluster groups. The species composition was similar to that of Station Cluster Group 1 in having relatively high abundance of species comprising Species Cluster Groups B, although there were some differences in what species had higher abundance in each species cluster group. It also differed in having relatively high abundances of species in Species Cluster Group E. There was moderate abundance of taxa in Species Cluster Groups C and F. Species with relatively high abundance included several polychaetes (e.g., *Armandia brevis*, *Lumbrineris* spp, *Mediomastus* spp., *Prionospio heterobranchia, Pseudopolydora paucibranchiata, Spiophanes missionensis*), bivalve molluscs (*Laevicardium substriatum, Lyonsia californica, Musculista senhousei, Theora lubrica*), amphipod crustaceans (*Eochelidium* sp. A, *Hemiproto* sp. A, *Monocorophium acherusicum, Paramicrodeutopus schmitti, Photis breviceps, Podocerus cristatus, Sinocorophium* cf. *heteroceratum, Xeuxo normani*), ostracod crustaceans (*Euphilomedes carcharodonta*), ophiuroids (*Amphipholis squamata*), and nemerteans (*Zygeupolia rubens*). Several of the species (*Euphilomedes, Lumbrineris, Mediomastus, Photis*, and *Prionospio*) have been reported to increase in abundance in areas slightly affected by organic enrichment (Word and Mearns 1979). Corophid amphipods (e.g., *Monocorophium acherusicum*) also have been reported to respond to organic enrichment (Pearson and Rosenberg 1978). *Amphipolis squamata* feeds on organic detritus and unicellular algae, and is fairly tolerant of environmental change (Austin and Hadfield 1980). *Armandia brevis* is an opportunistic species that may occur in high abundance at locations near sewage outfalls (CSDOC 1994). *Spiophanes missionensis* is associated with uncontaminated coastal sites (Thompson 1982). Although Reish (1959) considered *Pseudopolydora paucibranchia* an indicator of “semi-healthy” habitats in the harbors, that classification does not seem appropriate for the Pier 300 Shallow Water Habitat given the relatively diverse faunal assemblage and more of the relatively abundant taxa being indicative of low enrichment. It’s suspected that eelgrass in the Pier 300 Shallow Water Habitat provides a natural source of vegetative organic detritus that contributes to sediment enrichment at these locations.

Station Cluster Group 3 consisted of shallow water (6 m) Station LA14, which is located in the Consolidated Slip of inner Los Angeles Harbor. Sediments had a high silt/clay content (91%) and the area has not experienced dredging since before the 1980s. Only 24 species characterized the station in the analysis, and only 13 species were collected on average over the four quarterly surveys. Species Cluster Group D had the highest relative abundance and consisted of two pollution-tolerant polychaete species (*Capitella captitata, Dorvillea* (*Schistomeringos*) *annulata*), and a non-native amphipod (*Grandidierella japonica*) (Seapy 1974). This was the most contaminated of the surveyed stations based on the depauperate infaunal assemblage, which was dominated by species considered to be pollution indicators.

Station Cluster Group 4 comprised four enclosed basin and slip stations in Los Angeles Harbor, including Stations LA5 and LA13 in the Southwest Slip and West Basin, Station LA12 in Cabrillo Basin, and Station LA10 in Fish Harbor. These different locations varied in depth and sediment grain size characteristics. None of these stations have been dredged for more than 15 years. The station (LA10) in Fish Harbor averaged 6 m in depth and had sediments with a moderate silt/clay content (70%). Stations at Cabrillo Basin (LA12) and the Southwest Slip (LA13) were similar with an average depth of 11 m, and sediments had a high silt/clay content (94-99%). The station in the West Basin (LA5), which was dredged in 1985, averaged 17 m in depth and had sandy sediments with a low silt/clay content (37%). This station cluster group had a relatively low diversity with 93 taxa represented across stations and the species cluster groups. Species belonging to Species Cluster Group I had the highest relative abundance. Relatively abundant species included polychaetes (*Aphelochaeta monilaris, Cossura* sp. A*, Leitoscoloplos pugettensis, Mediomastus* spp., *Monticellina siblina, Nephtys cornuta, Paraprionospio pinnata,* *Pseudopolydora paucibranchiata*), amphipod crustaceans (*Eochelidium* sp. A), commensal pea crab (*Scleroplax granulata*), and bubble snail (*Philine* sp.). *Pseudopolydora paucibranchiata* was considered an indicator of "semi-healthy' harbor habitats by Reish (1959). This group also has relatively high abundance of other species that Reish (1959) considered as indicators of "healthy" harbor habitats; i.e., *Cossura* and *Tharyx.* It is suspected that what was considered "healthy" then would be considered "semi-healthy" today. *Tharyx* (= *Aphelochaeta* and *Monticellina* in present study*)* has been reported to respond with higher abundance in areas with low to moderately high organic (contaminant) concentrations (Word 1978, Thompson 1982, Dorsey et al. 1983). MBC (1984) considered dominance by *Cossura* an indication of environmental stress. Several of the other relatively abundant species have been associated with low organic enrichment/pollution (*Leitoscoloplos, Paraprionospio, Nepthys cornuta*). The relatively low species diversity among the four stations and occurrence of species indicative of low to moderate enrichment or pollution suggests that a "semi-healthy" classification applies to these stations.

Station Cluster Group 5 consisted of three disparate locations: two shallow water stations (LA3A, B) off Cabrillo Beach, Station LA4 in the main channel of Los Angeles Harbor, and Station LB1 in outer Long Beach Harbor. This group of stations varied according to depth and grain size. The station (LA3) off Cabrillo Beach averaged 4 m in depth and had sediments with a high (87-92 %) silt/clay content. Station LB1 in outer Long Beach Harbor had an average depth of 12 m and sediments with a moderate (70%) silt/clay content. The station in the main channel of Los Angeles Harbor (LA4) had an average depth of 16 m and sandy sediments with a low (25%) silt/clay content. The stations are similar in that none have been dredged since the mid-1980s or earlier. The station cluster group was represented by 148 taxa across species cluster groups. Species Cluster Groups F and I had the highest relative abundance. Relatively abundant species included several polychaetes (*Ampharete labrops, Aphelochaeta monilaris*, *Apoprionospio pygmaea*, *Cossura* sp. A, *Euclymeninae* sp. A, *Glycera americana*, *Laonice cirrata, Leitoscoloplos pugettensis, Lumbrineris* spp., *Marphysa* spp, *Mediomastus* sp., *Metasychis disparidentatus, Pista disjuncta, Spiochaetopterus costrum, Streblosoma* sp. B, *Terebellides californica*), ostracod crustaceans (*Euphilomedes carcharodonta*), isopod crustaceans (*Gnathia crenulatifrons*), bivalve molluscs (*Rochefortia tumida, Tagelus subteres*), and nemerteans (*Paranemertes californica*). Several of these species reportedly respond with higher abundance in areas with low organic enrichment (*Aphelochaeta, Lumbrineris, Leitoscoloplos, Mediomastus, Rochefortia* (reported as *Mysella*), and *Spiochaetopterus costrum* has been associated with areas with moderate organic enrichment (Table 5.3-5). Other species such as *Euclymeninae, Laonice, Marphysa, Metasychis, Pista, Streblosoma,* and *Terebellides* are common in coastal habitats with medium to fine sediment (Hartman 1969) away from sewage gradients (e.g., CSDOC 1994). The relatively high species diversity among the three stations, and occurrence of several species considered characteristic of areas with low enrichment or pollution indicates that these stations had a relatively high habitat quality during the Year 2000 Baseline Study.

Station Cluster Group 6 includes four stations from the Cerritos Channel of the inner harbor. These stations spanned channel (Station LB13, LB14), basin (Station LA6), and slip (Station LB4) habitats. Average depths ranged from 15 to 20 m. Sediments had a moderate (69-80%) silt/clay content at most of these stations, but had a high (94%) silt-clay content at Station LB13. The station in Los Angeles Harbor (LA6) has not been dredged since 1985. Stations on the Long

Beach side were dredged in the mid to late 1990s. The station cluster group was represented by 128 taxa across species cluster groups. Species Cluster Group H, which was dominated by polychaetes (*Aphelochaeta petersenae, Cirratulus spectablis*, *Cirriformia* sp. SD 1, *Sphaerosyllis californiensis*), had the highest abundance at these stations. Several species from Cluster Groups E, F, and I also had relatively high abundance, including several polychaetes (*Euchone limnicola, Exogone lourei, Marphysa* sp. A, *Mediomastus* sp. *Nereis procera*, *Prionospio* sp. A, *Paraprionospio pinnata*), a bivalve mollusc (*Protothaca staminea)*, and nemertean (*Tubulanus*). *Nereis procera* and *Tharyx* (= *Aphelochaeta* and *Monticellina* in present study) was considered indicative of "healthy" habitats in the harbors by Reish (1959), but more recently have been associated with contaminated areas (Word 1978, Thompson 1982, Dorsey et al. 1983). *Cirriformia* and *Euchone* were considered indicative of "semi-healthy" habitats in the harbors (Reish 1959, HEP 1976). *Exogone lourei* opportunistically increases in abundance in areas affected by sewage wastewaters (Dorsey et al. 1983). *Mediomastus*, *Paraprionospio*, and *Prionospio* have been reported to increase in abundance in areas slightly affected by organic enrichment (Pearson and Rosenberg 1978, Word and Mearns 1979). The moderate species diversity among the four stations and occurrence of species indicative of low to moderate enrichment or pollution suggests that a "semi-healthy" classification would be appropriate for these stations.

Station Cluster Group 7 included seven stations in basins and slips and an adjacent channel from middle to outer Long Beach Harbor. Stations LB3, LB11, and LB7 from the West Basin and adjacent channel, Stations LB5 and LB10 from the Southeast Basin, and Stations LB6 and LB8 from the Pier J slip comprised the group. Average depths ranged from 15 to 24 m. Sediments had a moderate to high (75-89%) silt/clay content at most stations. Sediments in the slip of Pier J (Station LB6) had a high silt/clay content (94%), whereas sediments were sandy with a low silt/clay content (13%) near the entrance to Pier J (LB8). All stations were dredged in the 1990s, and stations in the West Basin experienced dredging in 1999-2000. The station cluster group was represented by 126 taxa across species cluster groups. Species Cluster Groups I and to a lesser extent Group F and J characterized the station group. Species in relatively high abundance included polychaetes (e.g., *Aphelochaeta monilaris, Cossura candida, Glcera americana, Leitoscoloplos pugettensis, Lumbrineris* spp., *Montecillina dorsobranchialis, Montecillina siblina, Nereis procera, Paraprionospio pinnata, Prionospio* sp. A, *Spiochaetopterus costarum, Spiophanes berkeleyorum*), phoronids, molluscs (*Philine* sp., *Theora lubrica, Thyasira flexuosa*, *Vitrinella oldroydi*), and crustaceans (*Neotrypaea* sp., *Pinnixa franciscana).* Several species, including *Aphelochaeta* and *Montecillina* (reported as *Tharyx*), *Lumbrineris, Nereis, Paraprionospio*, *Prionospio, Spiochaetopterus,* and *Thyasira* have been associated with low to moderate enrichment/contamination. The relatively low species diversity, considering that seven stations comprised the cluster group, and dominance by species indicative of low to moderate enrichment or pollution suggests these stations had a "semi-healthy" habitat during the Year 2000 Baseline Study.

Station Cluster Group 8 consists of four stations: three in open water in the outer harbor (Stations LA1, LA11, LB9) and one station (LA9) in the northern channel between Piers 300 and 400. Depths ranged from 13 to 25 m. Sediments had moderate to high (69-93%) silt/clay content. The main channel of Long Beach Harbor (Station LB9) was dredged in 1989-1990 and stations near Pier 400 (Stations LA1, LA9) have experienced dredging from 1993 to the present. The main channel of Los Angeles Harbor (Station LA11) has not been dredged since 1985. The station cluster group was represented by a total of 121 taxa across species cluster groups. Species Cluster Groups G and J had higher abundances at these stations than at other stations, and Species Cluster Groups F and I had relatively high abundance. Relatively abundant species included several polychaetes (*Aphelochaeta glandaria, Glycera americana, Laonice cirrata, Leitoscoloplos pugettensis, Lumbrineris* sp. A, *Nephtys cornuta, Nereis procera, Pholoe glabra, Podarkeopsis* sp. A, *Sthenelanella uniformis*, *Teonia priops, Terebellides californica*), molluscs (*Compsomyax subdiaphana, Nassarius perpinguis, Parvilucina tenuisculpta, Rictaxis punctocaelatus, Tellina carpenteri*), and cnidarian (*Edwardsia* sp. G). Several of the species have been associated with areas with low enrichment. *Nereis* and *Parvilucina* has been associated with moderately enriched/contaminated areas. Several of the species reportedly increase in abundance in low enrichment areas (*Aphelochaeta, Leitoscoloplos, Lumbrineris, Nephtys cornuta*). *Sthenelenella* has been reported to be associated with relatively uncontaminated coastal areas (Word and Mearns 1979). The species present at these stations suggest low pollutant concentrations. The lower diversity of species at these stations relative to station group 5, which also is comprised of outer harbor stations, may relate to more recent dredging at some of the stations.

Station Cluster Group 9 consisted of deep water (16 m) Station LB12 in Slip 1 of the East Basin in Long Beach Harbor. Sediments had a high (99 %) silt-clay content and consistently low transmissivity values. Salinity values ranged from 24.8 to 33.1 ppt indicating periodic exposure to freshwater. The station location was last dredged in 1971. Only 29 species at the station were included in the analysis and no species cluster groups were dominant. Species spanning Cluster Groups H-J had low to moderate abundance. Species occurring in relatively high abundance included polychaetes (*Marphysa* sp. A) and molluscs (*Philine* sp., *Theora lubrica, Turbonilla* sp.). *Theora* was associated with “semi-healthy” habitats in the harbors by HEP (1976). The low number of species and abundance at this site indicates it was a “semi-healthy” habitat during this study.

5.3.3 Dominant Species

The polychaete *Pseudopolydora paucibranchiata* accounted for nearly 22% of the total abundance of infauna collected in the harbors (Table 5.3-5). This non-indigenous species is suspected of being introduced from Japan (Cohen and Carlton 1995). Other dominant species, each accounting for approximately 4 to 6% of the total abundance, included an amphipod crustacean (*Amphideutopus oculatus*), ostracod crustacean (*Euphilomedes carcharodonta*), clam (*Theora lubrica*), and polychaete worms (*Cossura* sp. A, *Euchone limnicola, Mediomastus* spp., *Monticellina siblina*). All of these species (*Monticellina* was reported as *Tharyx* sp. in historical studies) have been numerical dominants in previous studies of the harbors (HEP 1976, 1980; MBC 1984, MEC 1988).

Several of these species also had the most widespread distribution, occurring at 30, 31, or all 32 stations (i.e., *Cossura, Euchone, Mediomastus, Monticellina, Theora*). However, their abundance levels varied considerably among stations. Other fairly ubiquitous species included the polychaetes *Chaetezone corona, Leitoscoloplos puggetensis, Nereis procera,* and *Paraprionospio pinnata.*

Amphideutopus oculata was most abundant at stations with the sandiest sediments (Stations LA2, LB2). Abundance of *Cossura* was highest in basin habitats in Long Beach Harbor (Stations LB3, LB5-8, LB10-11). *Monticellina siblina* was widespread throughout the harbors, but abundances were higher at Pier J stations (LB6, LB8), Fish Harbor (LA10), Southwest Slip (LA13), and the Long Beach Shallow Water Habitat (LB2).

Euchone limnicola and *Mediomastus* spp. had higher abundances in the inner harbor (Stations LB4, LA6), shallow waters near Cabrillo Beach (Station LA3), and at the Pier 300 Shallow Water Habitat (Station LA7). *Euphilomedes carcharodonta* and *Pseudopolydora paucibranchiata* had highest abundances at the Cabrillo and Pier 300 Shallow Water Habitats, and at the Seaplane Anchorage. *Mediomastus* and *Pseudopolydora* also had relatively high abundance at Fish Harbor. The semele clam *Theora lubrica* is a non-indigenous species (Seapy 1974). This clam generally had higher abundance in areas with finer sediments and at adjacent stations, even if the sediment was coarser there. The centers of distribution of the above-named species were at stations with finer sediments or with vegetated sediments, both of which would be expected to have relatively high organic content.

Euchone, Pseudopolydora, and/or *Theora* were considered indicative of "semi-healthy" habitats, whereas, *Cossura, Euphilomedes, Mediomastus,* and *Tharyx* were considered characteristic of "healthy" habitats in earlier studies of the harbor (Reish 1959; HEP 1976, 1978). *Euphilomedes* and *Mediomastus*, which also commonly occur in coastal waters, have been reported to increase in abundance in areas slightly affected by organic enrichment (wastewaters) (Word and Mearns 1979), and *Tharyx* has been associated with low to moderately enriched and/or contaminated habitats (Word 1978, Thompson 1982).

5.3.4 Summary of Spatial and Temporal Variations

The benthic community was characterized by more species and higher abundance at the beginning of the survey period, late January 2000, than during the remaining surveys. There was a significant decline (mainly in polychaetes) in abundance and number of species between the winter and spring survey, and recovery to a somewhat lower level in the summer and fall. Otherwise, the benthic community had a similar composition, which was dominated by polychaete worms followed by crustaceans and molluscs, throughout the year.

Species assemblages in the outer harbor had the highest habitat quality as indicated by dominance by species characteristic of uncontaminated to low enrichment areas. Species composition differed between shallow and deepwater habitats. Both shallow and deep open water habitats were relatively diverse, but abundance was nearly three times higher in shallow water. Differences were apparent in assemblages between areas that have or have not experienced recent dredging or disposal. Areas of recent dredging/disposal had a similar species assemblage as non-dredged areas, but there were generally fewer species and lower abundance indicating that the recently dredged areas were still in the colonization phase. Additionally, areas that have not experienced dredging for more than 10 years had more relatively abundant species indicative of enrichment than recently dredged areas. That finding would be consistent with the expectation of relatively lower sediment organic content in more recently disturbed areas.

The main channel of Los Angeles Harbor had a similar species assemblage as the outer harbor. However, the Cerritos Channel of the inner harbor had a different assemblage than the outer harbor that was indicative of poorer habitat quality. There were more relatively abundant taxa in the Cerritos Channel that have been associated with low to moderate enrichment than in the lower main channel and outer harbor. The worst habitat quality was in the Consolidated Slip of the inner harbor. The species assemblage at that location was dominated by pollution indicator species characteristic of substantial contamination.

Different species assemblages also were found in the basins and slips that were indicative of poorer habitat quality than in the outer harbor. The basins and slips of Los Angeles Harbor appeared to have somewhat lower habitat quality than the basins and slips of Long Beach Harbor. One exception was in Slip 1 of Long Beach East Basin (Station LB12), which had one of the most impoverished of the habitats sampled.

5.3.5 Historical Comparisons

The benthic community of the harbors was first studied in the 1950s by Reish (1959; see Appendix I). The harbor environment was quite different then with several inner harbor and slip areas severely polluted and devoid of marine life or dominated by the polychaete *Capitella capitata*, which is considered an indicator of pollution or disturbance (Reish 1959, Pearson and Rosenberg 1978). Areas considered "healthy" occurred in the outer harbor and were dominated by the polychates *Cossura candida, Nereis procera,* and *Tharyx* ? *parvus*.

During the 1960s, clean up efforts and stricter guidelines on discharges led to a dramatic improvement in the quality of the benthic habitat being reported in the 1970s. Soule and Oguri (HEP 1980) reported that the harbor system appeared to react as a newly exposed substrate would, with rapid colonization in 1971-1973 and leveling off or stabilization reached by 1974. Some decreases in benthic populations were noted between 1975-1978 that were attributed to changes in waste treatment. Fish processors installed dissolved air flotation (DAF) devices in 1974-1975 that significantly reduced BOD and particulate matter in the vicinity of Fish Harbor (HEP 1980). Additionally, the Terminal Island Treatment Plant (TITP) was converted from primary to secondary treatment in 1977, and fish wastes were diverted to the plant for treatment in 1978. The decreases in abundance of benthic infauna noted at several stations between 1971 and 1978 actually are considered a sign of improvement in habitat quality related to a decrease in dominance by opportunistic, pollution-tolerant (or enrichment) species. Habitat quality improved throughout the harbor in the 1970s, however, species assemblages in the inner harbor, basins, and slips were not as rich as in open waters of the outer harbor.

During the 1980s and 1990s, separate studies of Long Beach and Los Angeles Harbors were conducted. Some of these were restricted to outer harbor areas being considered for future development (e.g., Reish 1982a, MBC 1984). The City of Los Angeles has been conducting surveys since 1993 in outer Los Angeles Harbor to study the effects of the TITP outfall. Only two recent studies have surveyed stations in both the inner and outer harbor areas. These included an updated baseline of Los Angeles Harbor in 1986-1987 (MEC 1988), and a baseline of selected areas of Long Beach Harbor in 1994 and 1996 (MEC 1996; SAIC and MEC 1996, 1997).

Similar species have been collected in the harbors over the last 30 years (Table 5.3-8). However, the relative abundances of the species have varied, and there has been a shift in the dominance of several species. Although not included on Table 5.4-8 because of the more localized distribution of stations around Pier 400, a similar list of dominants has been reported from the TITP outfall monitoring studies: in decreasing order of dominance, the five most abundant species in 1999 included *Monticellina siblina, Petaloclymene pacifica, Theora lubrica, Chaetezone corona, Cossura* sp. A, and *Amphideutopus* oculatus (CLA-EMD 2000). Decreased dominance by the pollution-tolerant polychaete *Capitella capitata* indicates a continued improvement in the quality of the benthic habitat in the harbors. *Capitella* ranked as one of the top five dominants in the 1970s and 1983. That species was not one of the top ten dominant species in 1986-1987, 1994 and 1996, or 2000.

Further comparison of the 2000 Baseline Study with historical studies must consider how the samples were processed. Early studies by HEP (1976, 1980) and MBC (1984) processed samples through a 0.5 mm sieve, while most latter studies processed samples through a 1.0 mm sieve. Abundance is substantially higher when a 0.5 mm sieve is used (smaller species generally occur in higher abundances than larger species); however, species composition is similar using either a 0.5 mm or 1.0 mm sieve (i.e., the same species are caught, but smaller species are caught in proportionally lower numbers) (MEC 1988).

Mean abundance and number of species collected in 1973-1974 are not directly comparable to that of the 2000 Baseline Study because the earlier study used a 0.5 mm sieve to process samples (Figure 5.3-6). Nevertheless, review of that historical data is valuable for understanding overall spatial patterns in benthic assemblages that were present in the harbors in the 1970s. Comparison of the relative size of the circle (abundance) and square symbols (species) on Figure 5.3-6 shows that most of the main channel, Cerritos Channel, and Southeast Basin in Long Beach Harbor were characterized by high abundance among few species. Basins and slips in Los Angeles Harbor (including Fish Harbor) and the Consolidated Slip of the inner harbor had relatively low abundance and number of species. The outer harbor areas were characterized by relatively high abundance and number of species.

Patterns in species composition and community structure were analyzed by HEP (1980) using cluster analysis (Figure 5.3-7), which illustrates different benthic assemblages between outer and inner harbor, and open water and confined slips or basins. This gradient in species composition was associated with an increasing gradient of pollutant concentrations towards the inner harbor and in confined slips and basins (HEP 1980). Highly polluted areas are characterized by a depauperate fauna (i.e., low abundance and species), areas with less pollution and/or with organic enrichment ("semi-healthy") are characterized by high abundance among few to moderate numbers of species, and "healthy" areas are characterized by moderate to high abundance among a diverse fauna (e.g., Pearson and Rosenberg 1978). Thus, the basins and slips (including Consolidated Slip and Fish Harbor) in Los Angeles Harbor were most polluted, channels throughout both harbors and the basin/slips in Long Beach Harbor were semi-polluted, and the outer harbor areas were relatively healthy in the 1970s.

Figure 5.3-8 compares mean abundance between the 2000 Baseline Study and historical studies from the 1980s and 1990s that used a 1.0 mm sieve to process samples. Figure 5.3-9 compares mean number of species between the Year 2000 Baseline Study and historical studies from the

1970s through 1990s since screen size does not substantially affect the number of collected species (although a few more species would be expected to be recovered with a 0.5 mm sieve). Similar to historical studies, the open water outer harbor areas in 2000 exhibit "healthy" habitat conditions characterized by relatively high abundance and number of species. Although the depression in abundance and number of species around Pier 400 in the present study suggest lower habitat quality that probably relates to recent dredging in that area.

The largest difference between the recent and historical studies is the substantial increase in the abundance of infauna at locations that are now the Cabrillo and Pier 300 Shallow Water Habitats (Figure 5.3-8 and Figure 5.3-9). These areas were deepwater habitat in the 1970s, and the Cabrillo Shallow Water Habitat was deepwater habitat up until the early 1990s. The occurrence of a relatively diverse fauna associated with the high abundance indicates a healthy assemblage at both locations. The fewer number of species observed in the Pier 300 Shallow Water Habitat during 1986-1987 probably relates to those surveys being conducted within one to two years of creation of that habitat (i.e., the site had not yet fully colonized). In 1999, a special study was conducted by MEC (1999) that compared infauna at both the Cabrillo and Pier 300 Shallow Water Habitats with that of a deepwater area offshore the GATX Terminal. Results between 1999 and 2000 were similar with substantially higher infaunal abundance in the shallow-water habitats than the deepwater habitat. Similarly, the number of species was highest in the Pier 300 Shallow Water Habitat and the Cabrillo Shallow Water Habitat and deepwater area in the outer harbor had a similar number of species.

Another difference between the present study and historical studies is an increase in the number of species and abundance at Fish Harbor over time (Figure 5.3-8, Figure 5.3-9). This trend indicates continued improvement of habitat quality at this site. Because the relatively high abundance in the present study is associated with a moderate number of species, organic enrichment is indicated at that location. Thus, the site has improved from a severely polluted condition in the 1970s to a "semi-healthy" habitat in recent years.

Other areas indicative of an increased habitat quality over time, as demonstrated by a substantial increase in number of species, include inner harbor stations and the Consolidated Slip (Station LA14). In the 1970s, stations in the inner harbor had about half as many species as those in the outer harbor. In the 1980s there were still fewer number of species in the inner harbor, particularly slips and basins, than in the outer harbor, but the difference was not as pronounced as in the 1970s. Figure 5.3-10 compares the cluster analysis results from the 1970s and 1980s in Los Angeles Harbor and demonstrates the decrease in the pollution gradient between inner and outer harbor areas in the 1980s. An outer harbor assemblage extended up the main channel to about the Vincent Thomas Bridge, and the "semi-healthy" species assemblage extended north of the bridge in the channel, basin, and slip habitats of the inner harbor (Figure 5.3-10). Changes at the Consolidated Slip (cluster group Z in the 1970s, VI in the 1980s on Figure 5.3-10) have been subtle. That location remains the most polluted of the surveyed stations in earlier and recent studies; however, the number of species has substantially increased from a mean of 5 species in the 1970s to 13 in the 1980s and the present study (Figure 5.3-9).

Cabrillo Basin, which was constructed in the 1980s, had a "semi-healthy" habitat in the 1980s (Figure 5.3-10) as indicated by a moderate number of species (28) and relatively high abundance (639 individuals per 0.1 m^2) (Figures 5.3-8, 9). This area remains "semi-healthy" today with the species assemblage similar to that in the basins and slips of the inner harbor (Figure 5.3-5). However, there appears to have been a decrease in habitat quality at this location over time with fewer species (19) and a relatively lower abundance (138 per 0.1 m^2) collected in 2000 than in the 1980s.

No data are available for inner and outer harbor areas in Long Beach Harbor in the 1980s. However, a study by MBC (1984) indicates that outer harbor areas had a fairly uniform species assemblage (Figure 5.3-11) characterized by a relatively large number of species and mean abundances similar to those of the present Baseline Study (Figures 5.3-8, 5.3-9). In the early to mid 1990s, surveys (MEC 1996; SAIC and MEC 1996, 1997) indicated a different species assemblage in channel, basin, and slip areas spanning inner to outer Long Beach Harbor that differed from assemblages in open waters of the outer harbor (Figure 5.3-12). In the present study, there was separation between the assemblage in Cerritos Channel of the inner harbor from that of basin and slip habitats, which both differed from the assemblages in the outer harbor (Figure 5.3-5). The more confined basins and slips and inner channel had a slightly less diverse assemblage than that of open waters of outer Long Beach Harbor (Figure 5.3-9).

The 2000 study showed a significant decrease in abundance and number of species between the winter and spring survey and recovery to a lower level in summer and fall. Studies in 1983-1984 also showed higher winter than summer abundances, but no significant seasonal difference in number of species. No significant seasonal differences in abundance or number of species were observed in 1986-1987. HEP reported little seasonal difference in number of species throughout the harbor, little seasonality in abundance at outer harbor stations, and increased abundance at inner harbor stations in spring and/or fall in 1978. Given that the 1983-1984 study was during an El Niño period and the 2000 study followed a strong El Niño and La Niña period, it is possible that these large-scale oceanographic conditions contributed to the more marked seasonality in benthic populations during these years.

5.4 Epibenthic Macroinvertebrates

This section first presents a discussion of summary community measures (Section 5.3.1), which is then followed by a detailed description and evaluation of species composition (Section 5.3.2) and dominant species (Section 5.3.3). Spatial and temporal patterns are summarized in Section 5.3.4. Results of the comparative study using two different otter trawl net sizes (16 and 25 ft) are given in Section 5.4.5. This section concludes with a comparison of the 2000 Baseline Study results with historical studies (Section 5.4.6). Raw summary data are provided in Appendix E.2.

5.4.1 Community Summary Measures

<u>Abundance</u>

A total of 9,185 invertebrates representing 63 taxa was collected during the one-year survey (Table 5.4-1). Five species accounted for 94.6 % of the catch; black spotted *shrimp (Crangon nigromaculata* 50.7%), tuberculate pear crab (*Pyromaia tuberculata* 27.9%), Xantus' swimming crab (*Portunus xantusii* 10.2%), the recently introduced and invasive species New Zealand bubble snail (*Philine auriformis* 4.5%), and the spotwrist hermit crab (*Pagurus spilocarpus* 1.4%).

Table 5.4-2 provides a summary of mean abundance for day and night sampling and for the combined effort. Mean catch for day sampling ranged from 9 to 328 individuals with the greatest catch in the Long Beach Channel (Station LB7) and least at Channel 2 (Station LB4) in inner Long Beach Harbor. The Cabrillo, Long Beach, and Pier 300 Shallow Water Habitats (Stations LA2, LA7, and LB2) also tended to have low average abundances. Mean catch per station for night sampling ranged from 14 to 244 individuals with the greatest catch at the Pier J Slip (Station LB6) and least catch at the Pier 300 Shallow Water Habitat (Station LA7B). Mean catch per station for night sampling (82 individuals) collected almost twice as many invertebrates as day sampling (46 individuals). Long Beach West Basin (Station LB3) had the greatest difference between day and night sampling with 4.8 times more invertebrates caught at night than during the day. The Cabrillo, Long Beach, and Pier 300 Shallow Water Habitats (Stations LA2, LA7, and LB2) averaged 2.4 times more invertebrates at night than day, but 1.5 times more invertebrates were collected during the day in deep water at channel Stations LA4 and LB7. The mean day-night combined abundances ranged from 13 to 247 individuals and was greatest at Long Beach Channel Station LB7 and least at Channel 2 (Station LB4) (Figure 5.4-1).

On average (across stations and day/night), mean abundance was 2 times higher at deepwater stations (83 individuals) than shallow water stations (39 individuals). Abundance data by species and station are given in Table 5.4.4. Abundance data by station and season, and abundance by species for each season and station are presented in Appendix E.2 (E.2.1 and E.2.2, respectively).

Seasonal trends of invertebrate abundance, biomass, and number of species are presented in Figure 5.4-2. Invertebrate abundance was significantly greater at night than during the day ($p<0.001$), and the winter (February) survey had significantly greater abundance ($p<0.001$) than the other surveys.

Biomass

The 9,185 invertebrates collected comprised a total wet-weight biomass of 146.6 kg (Table 5.4-2). Interestingly, while night abundance was much greater than day abundance, the night biomass was less than the day biomass. This indicates that on average, individuals with greater biomass were caught during the day. Night biomass averaged only about 41% of the day biomass. Mean biomass for day sampling ranged from 0.04 to 4.31 kg with the greatest biomass in outer Long Beach Harbor (Station LB1) and least in outer Los Angeles Harbor (Station LA1).

Mean biomass per station for night sampling ranged from 0.03 to 2.99 kg with the greatest biomass in shallow waters of outer Los Angeles Harbor (Station LA3A) and the least biomass in deep waters of outer Los Angeles Harbor (Station LA1).

On average, a higher mean macroinvertebrate biomass was caught at shallow water stations (1.4 g) than at deep water stations (0.7 g) due to the capture of starfish (*Pisaster*) and sea hares (*Aplysia*) at some of the shallow water sites (Table 5.4-5). Biomass data by species for each season and station are presented in Appendix E.2.3.

There was no significant difference between day and night surveys for biomass and, as found for abundance, the February survey had significantly greater biomass ($p<0.001$) than the other three seasonal surveys.

Number of Species

A total of 63 taxa, representing 61 unique species, was collected from all stations and surveys (Table 5.4-1). As mentioned above, five species accounted for 94.6 % of the catch; about half of the taxa were represented by four or fewer individuals. The average number of species caught per trawl for all four surveys ranged from 2 to 7. Table 5.4-2 provides a summary of mean number of species for day and night sampling and for the combined effort. Mean number of species for day sampling ranged from 2 to 7 taxa with the greatest number of species at Long Beach Channel Station LB7 and least in deep waters of outer Los Angeles Harbor (Station LA1) and the Long Beach Shallow Water Habitat (Station LB2A). Mean number of species per station for night sampling ranged from 3 to 6 taxa per trawl with the greatest number of species caught in Long Beach Southeast Basin (Station LB5) and the least at five stations (LA1, LB1, LA5, LA2A, and LB2B). There was, on average, four species per trawl collected for both day and night sampling. The mean number of taxa collected for the combined day-night average was 5 to 8 taxa per trawl and was greatest at three stations (LB7, LB4, and LA7A) and least for six stations (LA1, LB1, LB3, LA2A, LA7B, and LB2B) (Figure 5.4-1).

On average, a similar mean number of species was collected at shallow (6 species) and deep (5 species) water stations. There was no difference between day and night surveys for number of species, and like the other measures, February had significantly more species ($p<0.001$) than the other three surveys and the May survey had species than the August survey. The fall (November) survey was not different from either the May or August surveys.

Diversity Indices and Dominance

Table 5.4-3 provides a summary of the three diversity and dominance measures for combined surveys by day and night sampling and for the combined effort. In general, the diversity values were low for all stations. This is because five species accounted for almost 95% of the abundance and therefore all the stations tended to have few species and low equitability. This is most evident for the dominance values which ranged from only 1 to 3 species accounting for 75% of the trawl catch at all stations for day, night, and combined sampling. Mean Shannon-Wiener diversity for day sampling ranged from 0.38 to 1.30 with the greatest diversity at Cabrillo Shallow Water Habitat station (LA2B) and Pier 300 Shallow Water Habitat (Station LA7A), and lowest diversity at Pier J Slip (Station LB6). Margalef diversity for day sampling ranged from 0.49 to 1.80 with highest diversity at Channel 2 (Station LB4) in inner Long Beach Harbor, and lowest diversity, as found for Shannon-Wiener Diversity, was at Pier J (Station LB6). Mean Shannon-Wiener diversity for night sampling ranged from 0.44 to 1.16 with highest diversity at the Pier 300 Shallow Water Habitat (Station LA7A), and was lowest at Pier J (Station LB6). Margalef Diversity for night sampling ranged from 0.54 to 1.71 with the greatest diversity again occurring at Channel 2 Station LB4, but lowest diversity was in outer Long Beach Harbor (Station LB1). Night diversity values tended to be a little less than the day values.

5.4.2 Species Composition

The mean abundance by taxa for each station averaged over all surveys both day and night is presented in Table 5.4-4. The most abundant species tended to be found at all stations, but abundances were variable. The black spotted shrimp, the most abundant invertebrate, and the introduced New Zealand bubble snail had greatest abundance at the deepwater stations and lower abundance at the shallow mitigation stations. The turberculate pear crab was rather evenly distributed throughout the harbor complex but had very high abundance at Long Beach Channel Station LB7. Xantus' swimming crab was more abundant in shallow water habitats, but patterns for other taxa were not evident.

Cluster analysis was utilized to delineate similar species assemblages and habitats and the results are summarized in Figures 5.4-3 and 5.4-4. Species with a relatively high abundance within a station cluster group characterize the species composition of the group. Symbols on the two-way coincidence table (Figure 5.4-3) indicate relative abundance by the size of the symbol, which is largest with highest relative abundance. The size of the symbol does not correspond to absolute abundance, which can be found in Table 5.4-4. Because cluster analysis considers relative abundance of each tested taxa across the stations it occupies, it is not weighted towards dominant species and provides a more complete assessment of community structure. The cluster analysis identified three major separations each comprising two station groups for a total of six station cluster groups (1-6). Three species cluster groups were identified (A-C), Species Cluster A containing ubiquitous species and those preferring deeper areas of the harbor, Species Cluster B characterizing shallow water habitats, and Species Cluster C characterizing the back harbor and Long Beach slips and basins.

Station Cluster Groups 1 and 2 shared similarity in being comprised of species primarily from Species Cluster Group A. Station Cluster Group 1 comprised the Long Beach Shallow Water Habitat (Stations LB2A and LB2B) and the nearby deep water outer Long Beach Harbor Station LB1. The proximity of these stations appeared to more important than depth in distinguishing this cluster group. Station Cluster Group 2 contained three deep water stations: outer Los Angeles Harbor (Station LA1), main channel of Los Angeles Harbor (Station LA4), and Long Beach West Basin (Station LB3), which are not located in close proximity. However, all three of these stations are from deeper areas of the harbor suggesting that water depth may be important for distinguishing this cluster. Dredging and disposal also may have been influential since dredging was ongoing around Pier 400 (near Station LA1) and in Long Beach West Basin.

Species Cluster Group A contained 15 species, including four of the five most abundant species (exclusive of Xantus' swimming crab). As mentioned above, these abundant taxa were found at almost all stations and therefore they contribute little to discriminating differences between station clusters (i.e., habitats). However, the less abundant species in this cluster grouping are more typical of deeper areas in the harbor including the spiny sandstar (*Astropecten armatus*), spotwrist hermit crab, California spiny lobster, several species of gastropds, and one nudibranch and it is these taxa that delineate Station Cluster Groups 1 and 2. The difference between Station Cluster Groups 1 and 2 is that Station Cluster Group 1 contains the spiny sandstar, spotwrist hermit crab, and lobster while Station Cluster Group 2 does not, and Station Cluster Group 2 has relatively higher abundance of molluscs (*Discodoris sandiegensis, Philine auriformis*).

There was similarity between Station Cluster Groups 3 and 4 that most likely related to depth. Station Cluster Group 3 included four stations, two in the Cabrillo Shallow Water Habitat (Stations LA2A and LA2B), and two in nearby shallow water (Stations LA3A and LA3B). Station Cluster Group 4 contained the Pier 300 Shallow Water Habitat (Stations LA7A and LA7B). Species Cluster B contained 11 species including the Xantus' swimming crab and shallow water species including California sea hare (*Aplysia californica*), Gould's bubble snail (*Bulla gouldiana*), and striped sea slug (*Navanax inermis*). These taxa are the ones that delineate this shallow-water invertebrate assemblage, and the main difference between Station Cluster Groups 3 and 4 is that these clusters have different proportions of these species.

Finally there was similarity among Station Cluster Groups 5 and 6. Station Cluster Group 5 contained three stations characterizing deep water areas in Long Beach Harbor including the Southeast Basin (Station LB5), Pier J Slip (Station LB6), and main channel (Station LB7). Station Cluster 6 included Long Beach Pier B Slip (Station LB4), Los Angeles West Basin (Station LA5), and Los Angeles East Basin (Station LA6). Species Cluster Group C contained 13 species that help to delineate Station Cluster Groups 5 and 6 from all other station clusters. The main difference between Station Clusters Groups 5 and 6 is that the back harbor (Station Cluster Group 6) had fewer of the ubiquitous species from Species Cluster Group A and more of the species from Species Cluster C compared to Station Cluster Group 5.

5.4.3 Dominant and Special Interest Species

Five species accounted for 94.6 % of the total catch: black spotted shrimp *(Crangon nigromaculata* - 50.7%), tuberculate pear crab (*Pyromaia tuberculata* - 27.9%), Xantus' swimming crab (*Portunus xantusii* - 10.2%), New Zealand bubble snail (*Philine auriformis* - 4.5%), and the spotwrist hermit crab (*Pagurus spilocarpus* - 1.4%) (Tables 5.4-1 and 5.4-3). The significant decline in abundance between February and May surveys was largely due to decreases in abundance of black spotted shrimp and Xantus' swimming crab (Figure 5.4-5).

Five other species accounted for 78.3 % of the biomass: California spiny *lobster (Panulirus interruptus*- 22.3%), giant-spined star (*Pisaster giganteus* - 21.4%), California sea hare *Aplysia californica* - 15.1%), short-spined sea star (*Pisaster brevispinus* - 15.1%), and the sheep crab (*Loxorhynchus grandis* - 4.4%) (Table 5.4-5). Thus, only a few species dominated the invertebrate catch.

Several of the invertebrates found within the harbors have economic importance for the commercial and sport fishing industry, although commercial fishing does not occur within the Ports. The harbors provide nursery and adult habitat for many species, which contributes to the maintenance of these resources within and offshore San Pedro Bay. California spiny lobster, which generally ranks in the top three for commercial importance and number one for recreational sport divers, was found in all areas of the harbor. Other species of interest include the ghost shrimp (*Neotrypaea californiensis*), which has been commercially harvested for the bait industry; brown shrimp (*Penaeus californiensis*), a large and very edible shrimp; sea urchins; *Cancer* crabs; and the California sea hare, which has been used in medical research.

5.4.4 Summary of Spatial and Temporal Variations

Trawl invertebrate catch varied according to location in the harbor with similar species composition in shallow waters near Cabrillo Beach (Stations LA2, LA3) and the Pier 300 Shallow Water Habitat (Station LA7), Long Beach outer harbor stations regardless of depth (Stations LB1, LB2), basins and lower channel in Long Beach Harbor (Stations LB5, LB6, LB7), inner harbor habitats (Stations LA5, LA6, LB4), and a more disparate group including deep water stations in the main channel and outer Los Angeles Harbor and Long Beach West Basin (Stations LA1, LA4, LB3).

There was a significant decline in abundance, biomass, and number of species of trawl caught invertebrates between the winter and spring survey, and catch was lower on remaining surveys. This difference was associated primarily with a decline in the catch of blackspotted shrimp and Xantus' swimming crab.

5.4.5 Otter Trawl Size Comparison

During the summer survey (August) and fall surveys (November) two different sizes of otter trawls (16 and 25 ft) were used to sample six representative stations within the harbor complex. The purpose of this effort was to provide a conversion factor between the two methods so that historical data that utilized different size nets could be compared to the methodology used for this baseline study. In addition, this comparison of methods could be used to determine if the smaller net size collected a representative sample of the harbor fauna and could be utilized for future studies providing economic benefits in reducing the effort needed for baseline or monitoring studies.

Tables 5.4-6 and 5.4-7 summarize the results of this otter trawl study. Two different ways were used to examine results on Table 5.4-6. One way was to compute the ratio of catch difference for each station and then calculate an overall mean ratio (e.g., 2.30 times as many invertebrates were caught with a 25 ft net than with a 16 ft net during the day in August). An alternate way was to total the catch across stations for the 25 and 16 ft trawls and compute a mean ratio of catch difference (e.g., 1.73 times as many invertebrates were caught with a 25 ft net than with a 16 ft net during the day in August). During the night surveys, the larger net collected 1.59 to 3.32 times more invertebrates depending upon the averaging method.

The November survey the had much greater catch ratios for the larger net because of the very large catch of black spotted shrimp and tuberculate pear crab at Long Beach Channel station (LB7). These species are patchy in their distribution and the difference between the catch for 16 and 25 ft nets may have been due more to the sampling being conducted at different times rather than the expected differences in sampling efficiencies of the nets. With the inclusion of station LB7 the larger net collected 7.53 to 15.4 times more invertebrates during the day and 1.29 to 7.94 times more invertebrates for the night sampling depending on the averaging method.

The average difference between the two net sizes for invertebrate abundance for both surveys, and averaged over day and night, was approximately 3.3 times more invertebrates sampled with the larger net regardless of averaging method.

For the number of species collected the differences were more consistent. For the August survey during the day the larger net collected 0.90 to 1.52 more species while during the night the ratio fell to 0.81 to 1.06 or there was little difference between the nets. For the November survey the larger net consistently sampled more species than the smaller net and the ratio was 1.53 to 2.17 more species for the day and 1.26 to 1.90 species for the night. Overall, both nets sampled a similar number of species. The average ratio difference between the two net sizes for both surveys and averaged over day and night ranged from 1.10 to 1.25 more taxa in the larger net than the smaller net.

If one were to sum the entire catch across stations and seasons, approximately four times as many invertebrates were caught during the day with the 25 ft net than with the 16 ft net; whereas, a similar number of invertebrates was caught at night (ratio difference 1.2) (Table 5.4-7). A similar number of species were caught during the day and night, and the number of species caught by the different sized nets was similar. There was no difference between the nets in the rank order of abundance of dominant species (*Crangon nigromaculata, Philine auriformis, Pyromaia tuberculata*), but there were some shifts in rank order abundance of species caught in lower abundance, which is not unexpected given the patchy occurrence of those species.

In summary, results of sampling with 25 ft and 16 ft otter trawl nets will produce fairly comparable data for number of species and identifying dominant species. In contrast, catch abundance was not comparable between the two nets. As expected, abundances were higher with the larger net. Given that there was considerable variability in catch between day and night and seasonal periods, a single ratio factor may not be appropriate for comparing abundance between historical studies if they vary in effort regarding seasonal sampling. Even in the case of studies that survey across seasons, the ratios in catch difference vary between day and night periods. On average, differences in abundance between the nets were larger during the day (ratios of 4.9 to 8.6) than at night (1.4 to 5.6). On average over day and night periods, 3.3 times more invertebrates were caught with the 25 ft net than with the 16 ft net. These results suggest that, for characterizing the invertebrate communities (i.e., documenting species occurrence and what species dominate the catch), there may not be a great benefit in utilizing the larger otter trawl net.

5.4.6 Historical Comparisons

Early studies using otter trawls to sample fish in the harbor did not report catch data for the invertebrates (e.g., HEP 1976, 1980; MBC 1984). One minor exception was the report by EQA-MBC (1978), which noted that the black spotted shrimp (*Crangon nigromaculata)* was the only species caught in sufficient numbers during trawls in Long Beach Harbor to warrant its mention in the catch record. The first comprehensive study of epibenthic macroinvertebrates was by MEC (1988) in outer Los Angeles Harbor. Trawls in inner and outer Long Beach Harbor were collected in 1994 and 1996 (MEC 1996; SAIC and MEC 1996, 1997). Since 1993, the City of Los Angeles has reported trawl invertebrate catch in the vicinity of the TITP outfall as part of their annual NPDES monitoring program (e.g., CLA-EMD 2000).

Table 5.4-8 compares the ten most abundant species collected by trawls from the 2000 Baseline Study with selected other available studies. Similar species have dominated the catch since the 1980s. However, one notable difference in the catch was the occurrence of several fouling organisms in the trawls from Los Angeles Harbor in the 1980s (*Balanus*, *Corynactis, Crepidula, Mytilus*). Additionally, the ophiuroid *Ophiothrix spiculata* was caught in relatively higher abundance in the 1980s than in the 1990s and 2000. In contrast, the introduced New Zealand bubble snail (*Philine auriformis*) has been caught in higher abundance in the 1990s and 2000 than in the 1980s.

Annual monitoring by CLA-EMD (1993-2000) indicates the black spotted shrimp has accounted for 31 to 74% of the trawl catch in outer Los Angeles Harbor over the past seven years. One notable exception was in 1998, which was during a period of strong El Niño, when black spotted shrimp only accounted for 13% of the catch and the Xantus' swimming crab and New Zealand bubble snail dominated the catch (CLA-EMD 1999). The New Zealand bubble snail has increased in abundance over the past seven years with that species only accounting for 4.5% of the catch in 1995 and 30% of the catch in 1999 (CLA-EMD 1996, 2000). During the 1998 El Niño period, the New Zealand bubble snail accounted for 36% of the catch (CLA-EMD 1999). Abundance of the Xantus swimming crab generally is low in the harbors, but increased to over 30% of the catch during the 1998 El Niño (CLA-EMD 1999).

Inner harbor areas have been less studied by otter trawl. MBC (1993) reported that the blackspotted shrimp comprised 86% of the catch during their NDPES monitoring of the Harbor Generating Station. It too dominated the catch throughout inner and outer Long Beach Harbor in 1996. Similar to what was found in the 2000 Baseline Study, the same dominant species occurred throughout inner and outer Long Beach Harbor in 1996 (MEC 1996).

Mean abundance and number of species of trawl caught invertebrates from the 1986-1987 study of outer Los Angeles Harbor (MEC 1988), 1996 study of inner and outer Long Beach Study, and selected stations from the 1999 TITP monitoring (CLA-EMD 2000) are presented in Figures 5.4-6 and 5.4-7, respectively. Different sized otter trawls have been used in the past; i.e., smaller nets (16 ft, 4.9 m) were used in the 1980s and 1990s by MEC, and larger nets (25 ft, 7.6 m) were used in the present study and by the City of Los Angeles since the 1990s. As indicated by the present study, both nets provide a fairly representative measure of number of species; however, abundance values can be highly variable and the larger net on average collects approximately three times as many invertebrates as the small net (Section 5.4.5).

Taking the net size difference in consideration, the comparison with historical studies indicates that the Cabrillo and Pier 300 Shallow Water Habitats supported a higher abundance and number of species in 2000 than when they were deepwater habitats (Cabrillo) or only recently created (Pier 300) (Figures 5.4-6 and 5.4-7). Differences between the shallow water and deepwater habitats were not as apparent in 1999. MEC (1999) conducted a single survey in August 1999 of the Cabrillo and Pier 300 Shallow Water Habitats and a deepwater area offshore the GATX Terminal. During that survey, only a few macroinvertebrates were collected at the Pier 300 Shallow Water Habitat. The number of species and abundances were similar at the Cabrillo Shallow Water Habitat and deepwater area, which were similar to that measured in the present study. The poor catch at the Pier 300 site was limited to macroinvertebrates, and perhaps related to the relatively high abundance of fish caught in the trawls, which were three times more abundant than in comparable trawls at the Cabrillo Shallow Water Habitat and deepwater area (see Section 3.4.6).

Similar numbers of species were collected in 1996 and 2000 in Long Beach Harbor (Figure 5.4-7), but abundance (if adjusted by 3) apparently was higher in 1996 prior to the 1997-1998 El Niño. The City of Los Angeles reported a 40% reduction in trawl invertebrate catch between 1996 and 1997, and a further 19% reduction between 1997 and 1998; total invertebrate catch was substantially higher in 1999 and was within 11% of the 1996 levels (CLA-EMD 1997, 1998, 1999).

5.5 Exotic Species

The species lists on Tables 5.3-7 and 5.4-1 include symbols indicating non-indigenous (*) or cryptogenic (?) status, and Appendix E.1 includes these symbols for all collected species where appropriate (absence of a symbol denotes the species is considered native). Species considered cryptogenic have unresolved status because there is some question regarding their taxonomic status and affinity to species described from other parts of the world, there is question regarding the native distribution of the species, or the species has a cosmopolitan distribution that is unresolved relative to dispersal mechanism.

A total of 25 non-indigenous and 35 cryptogenic species were identified among the 409 species represented by the collected infauna and macroinvertebrates. Thus, about 15% of the taxa in the harbors are potentially non-native in origin. In terms of abundance, non-indigenous fauna comprise a substantial part of the benthic community. Over 30% of the infaunal abundance came from non-indigenous taxa: the dominants *Pseudopolydora paucibranchiata* and *Theora lubrica* alone comprised 26% of the total abundance. The non-indigenous New Zealand bubble snail, *Philine auriformis*, accounted for approximately 4.5% of the macroinvertebrate abundance. The presence of the New Zealand bubble snail is notable since this is a predator upon native infauna and epifauna (J. Ljubenkov, personal communication). These species also have been introduced to San Francisco Bay in northern California (Cohen and Carlton 1995). The relative abundance of these species has increased in the harbors since the 1970s (refer to Tables 5.3-8 and 5.4-8).

Other non-native species collected in low to relatively high abundance included amphipods (*Grandidierella japonica, Sinocorophium* cf. *heteroceratum*, *Sinocorophium* sp.), clam (*Venerupis phillipinarium*), mussels (*Musculista senhousei, Mytilus galloprovincialis*), and several polychaete worms (*Ancistrosyllis groenlandica, Aricidea horikoshii, A. catherinae, A. wassi, Boccardia hamata, Dipolydora bidentata, D. socialis, Hydroides pacificus, Levensensia gracilis, Neanthes acuminata, Nicolea gracilibranchis, Polydora cornuta, Sigambra tentaculata, Syllis (Typosyllis) nipponica*).

5.6 Summary

Benthic invertebrates exhibited spatial and temporal variability during the Year 2000 Baseline Study. Both the small infauna and larger macroinvertebrates exhibited significant declines in abundance between the winter (January-February) and remaining surveys. During this time there was a major shift in oceanographic conditions related to the dissipation of the La Niña period, which followed the strong 1997-1998 El Niño. For the macroinvertebrates, the decline was characterized by a significant decrease in the catch of two pelagic crustaceans: the black spotted bay shrimp and Xantus' swimming crab. The black spotted bay shrimp is a common dominant resident of the harbors. The Xantus swimming crab is not a common member of the harbor fauna, but increased during the recent El Niño. Its decline during the present study may have been related to the change back to more normal oceanographic conditions with the dissipation of the La Niña condition during the study.

Small infaunal organisms, which tend to be less motile than their larger macroinvertebrate counterparts, exhibited spatial variability in species composition that appeared to be tied to a combination of factors including water depth, years since dredging/disposal, and habitat quality. Assemblages in the outer harbor differed between shallow and deep water habitats, and differences were apparent between assemblages from areas that have or have not experienced recent dredging. Areas of recent dredging had a similar species assemblage as non-dredged areas, but there were fewer species and lower abundance indicating that the recently dredged areas were still in the colonization phase. In general, habitat quality was highest at the created Shallow Water Habitats in Long Beach and Los Angeles Harbors and the deep open waters of both harbors. A gradient of decreasing habitat quality was observed in basins and slip habitats and the back channels of the inner harbor.

Larger macroinvertebrates exhibited spatial variability some of which appeared to relate to water depth, and other patterns that may have been related to habitat and/or dredging/disposal. Assemblages generally differed between shallow and deep water habitats. Catch abundance was higher in basin habitats in Long Beach Harbor than in the open waters of the outer harbor. The lowest catch was obtained in the inner harbor.

There has been a steady improvement in benthic habitat quality as demonstrated by increased diversity and less dominance by pollution-tolerant benthic infauna species over the past half century. Many areas in the harbors were severely polluted in the 1950s with depauperate faunal assemblages. Cessation of discharges of cannery wastes and conversion of the discharge from the TITP outfall from primary to secondary treated effluent has substantially reduced the amount of organic particulates and other pollutants introduced to harbor waters. There also has been stricter control of non-point source discharges from Port tenants (S. Crouch and R. Appy, personal communications). These controls on pollutant sources have resulted in improvements in the diversity of benthic infaunal assemblages, and less dominance by opportunistic pollution-tolerant species.

Polluted and “semi-healthy” areas still exist in the harbors; however, the spatial extent of these areas of relatively poorer habitat quality is not as widespread today. The most polluted area occurs in the Consolidated Slip of Los Angeles Harbor; “semi-healthy” areas exist in Cerritos Channel of the inner harbor, and in confined basins and slips in both harbors. There were different species assemblages in the basins and slips of Los Angeles and Long Beach Harbors, with those in Los Angeles Harbor appearing to have a somewhat lower habitat quality. The quality of these “semi-healthy” areas has improved over the conditions reported in the 1950s and 1970s.

Non-indigenous fauna potentially comprise about 15% of the invertebrate species that inhabit the harbors. A few of the species are dominant in abundance. The polychaete *Pseudopolydora paucibranchiata* and clam *Theora lubrica* comprised 26% of the total infaunal abundance and the New Zealand bubble snail *Philine auriformis* accounted for 4.5% of the macroinvertebrate abundance in 2000. The relative abundance of these species has increased in the harbors since the 1970s.

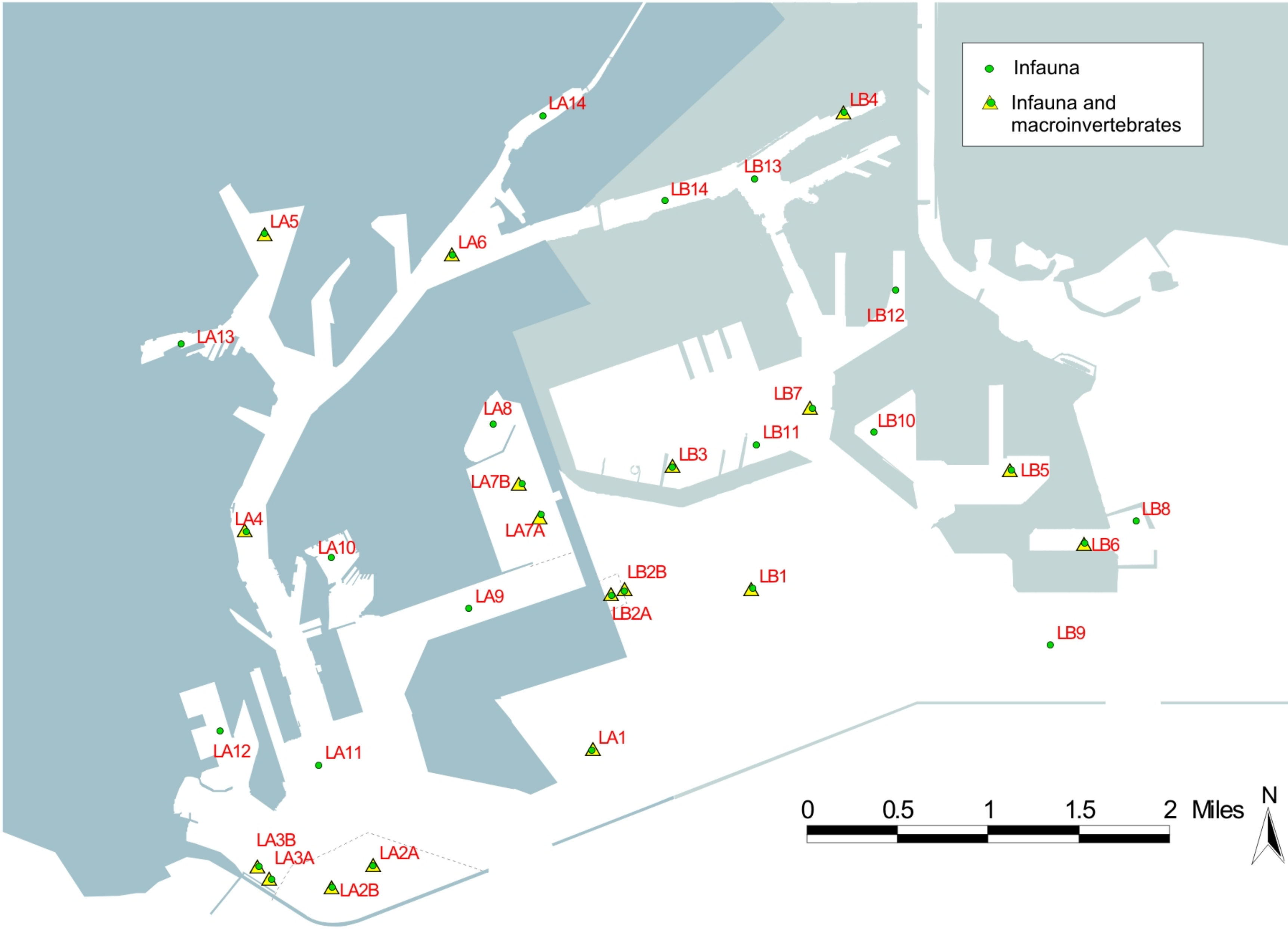


Figure 5.2-1. Benthic infauna and macroinvertebrate sampling stations in Long Beach and Los Angeles Harbors, January - November 2000.

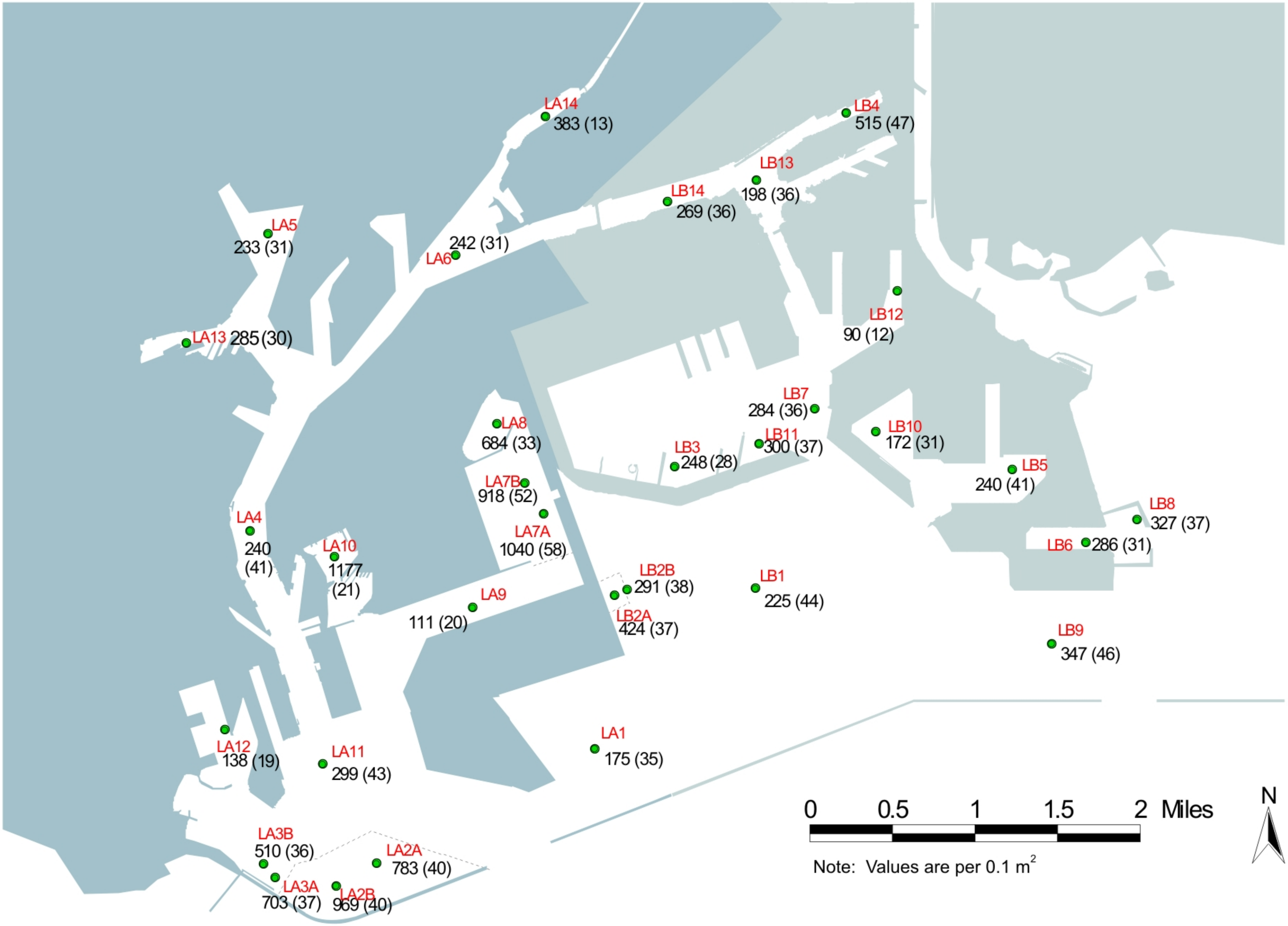


Figure 5.3-1. Mean annual abundance (and number of species) of benthic infauna collected in Long Beach and Los Angeles Harbors, January - November 2000.

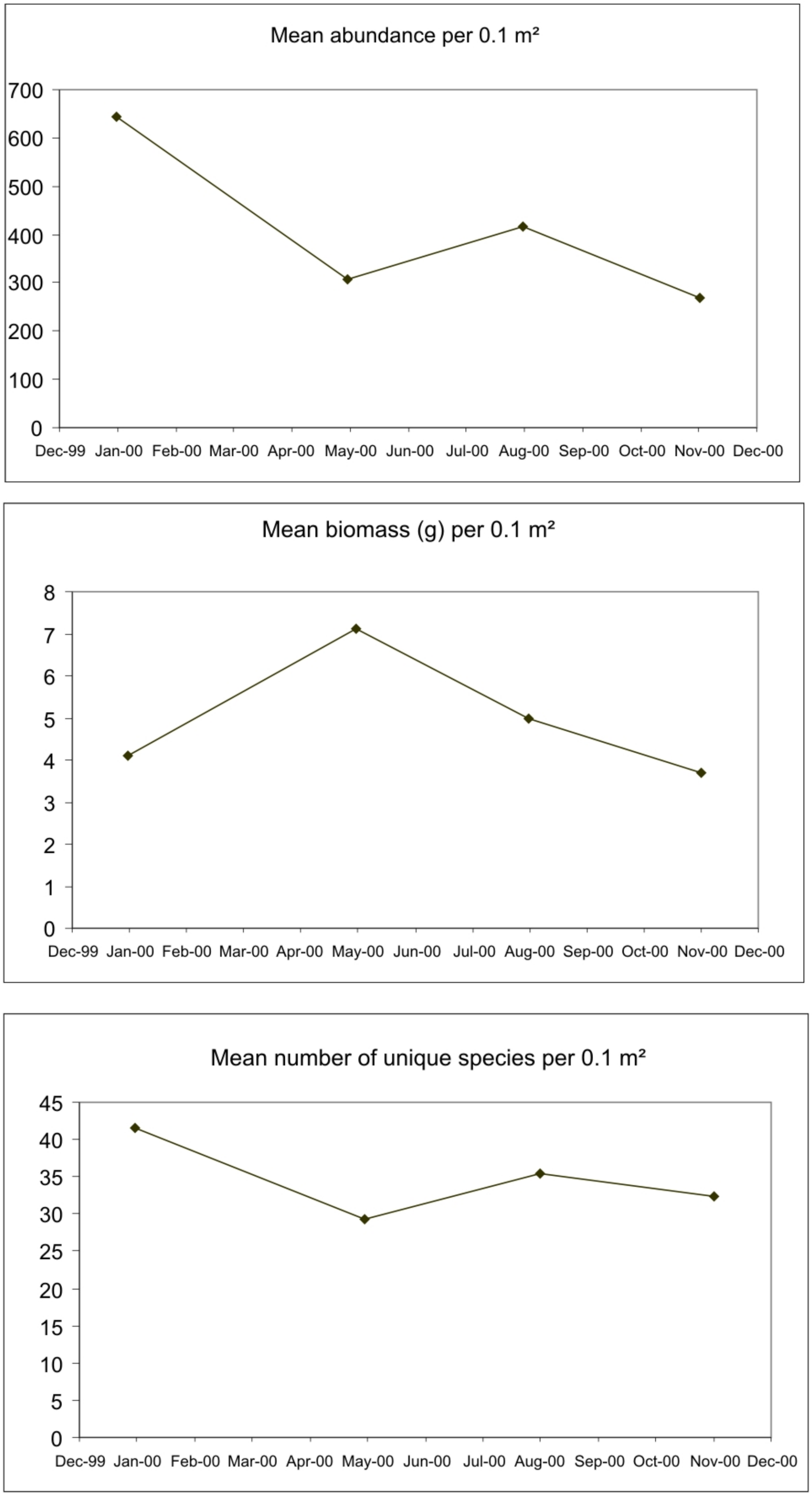


Figure 5.3-2. Seasonal mean abundance, biomass, and number of species of benthic infauna collected in Long Beach and Los Angeles Harbors, January - November 2000.

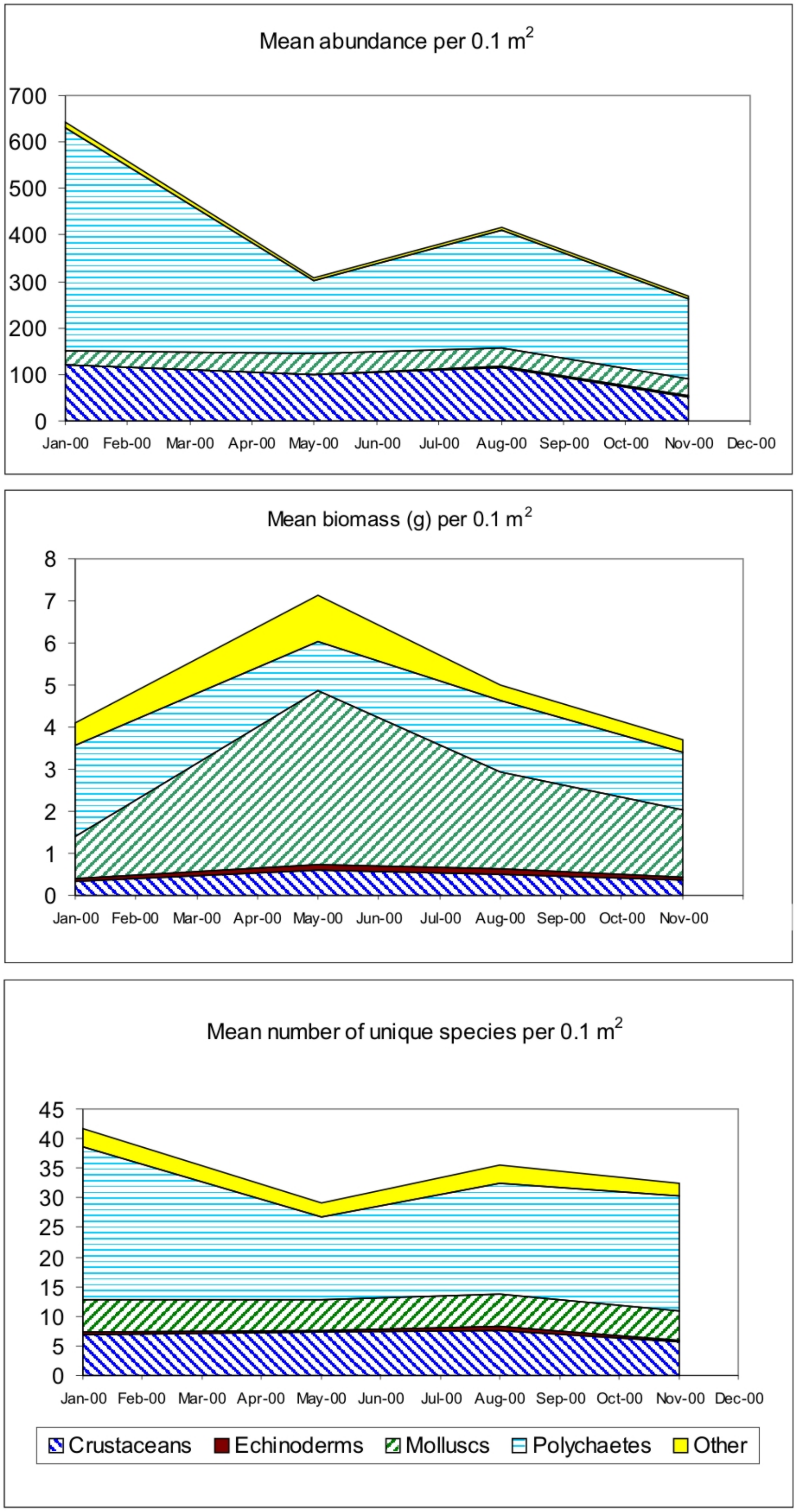


Figure 5.3-3. Seasonal mean abundance, biomass, and number of species by taxonomic groups of benthic infauna collected in Long Beach and Los Angeles Harbors, January - November 2000.

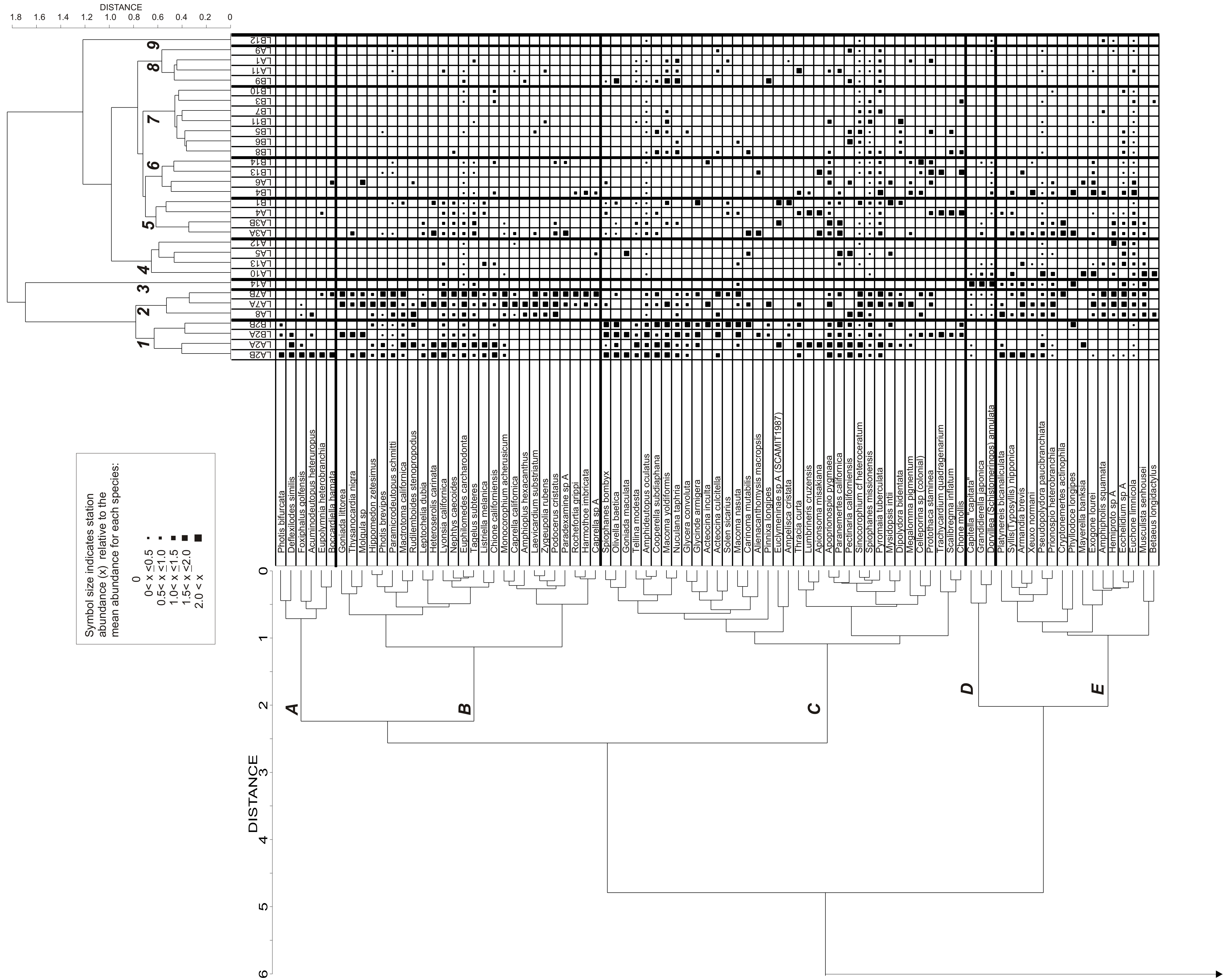


Figure 5.3-4. Cluster analysis of mean species abundance of benthic infauna collected in Long Beach and Los Angeles Harbors, January - November 2000.

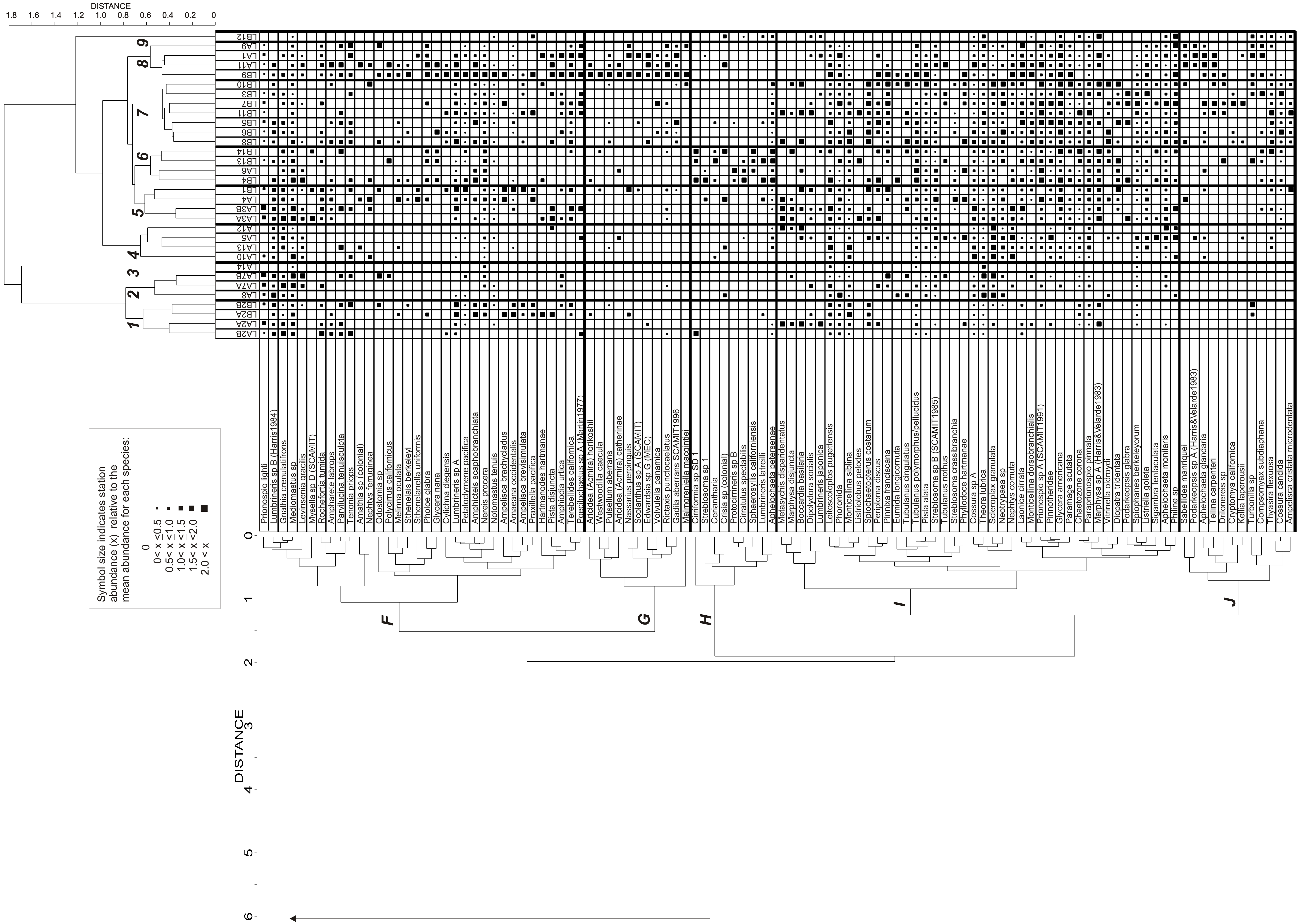


Figure 5.3-4. Continued.

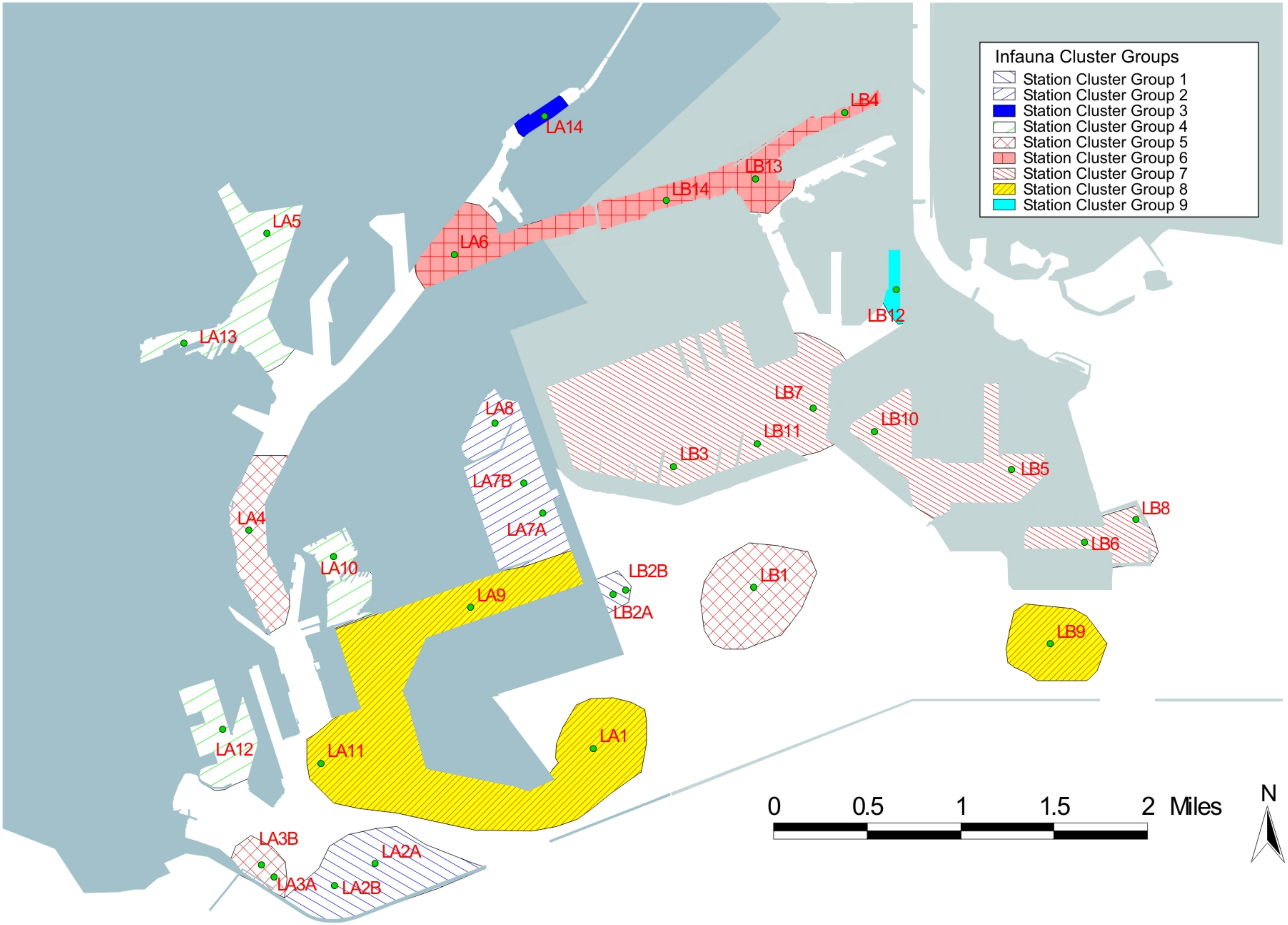
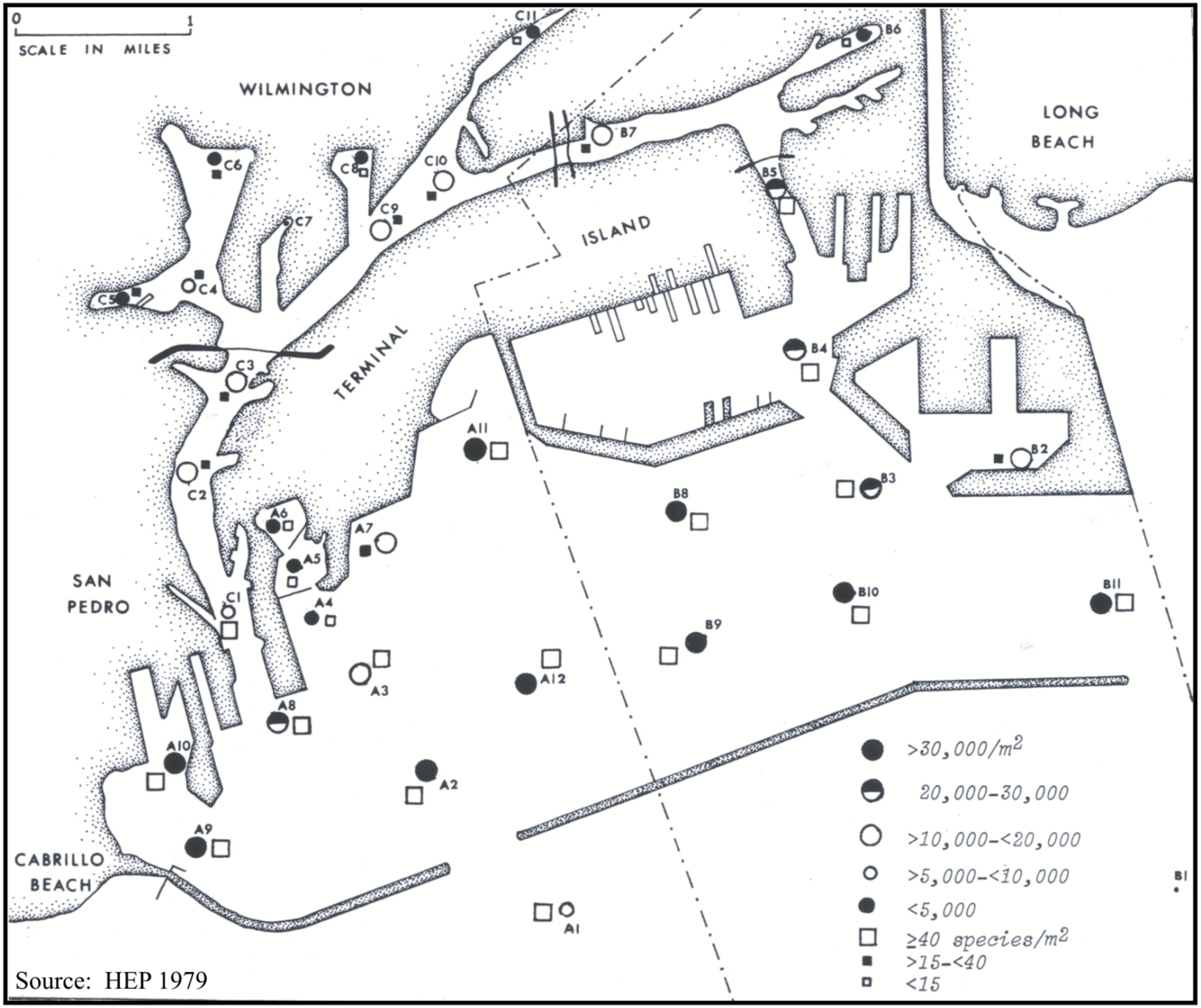


Figure 5.3-5. Map of station groups identified by cluster analysis of benthic infauna collected in Long Beach and Los Angeles Harbors, January - November 2000.



Source: HEP 1979

Figure 5.3-6. Historical abundance and number of species of benthic infauna collected in Long Beach and Los Angeles Harbors in 1973-1974.

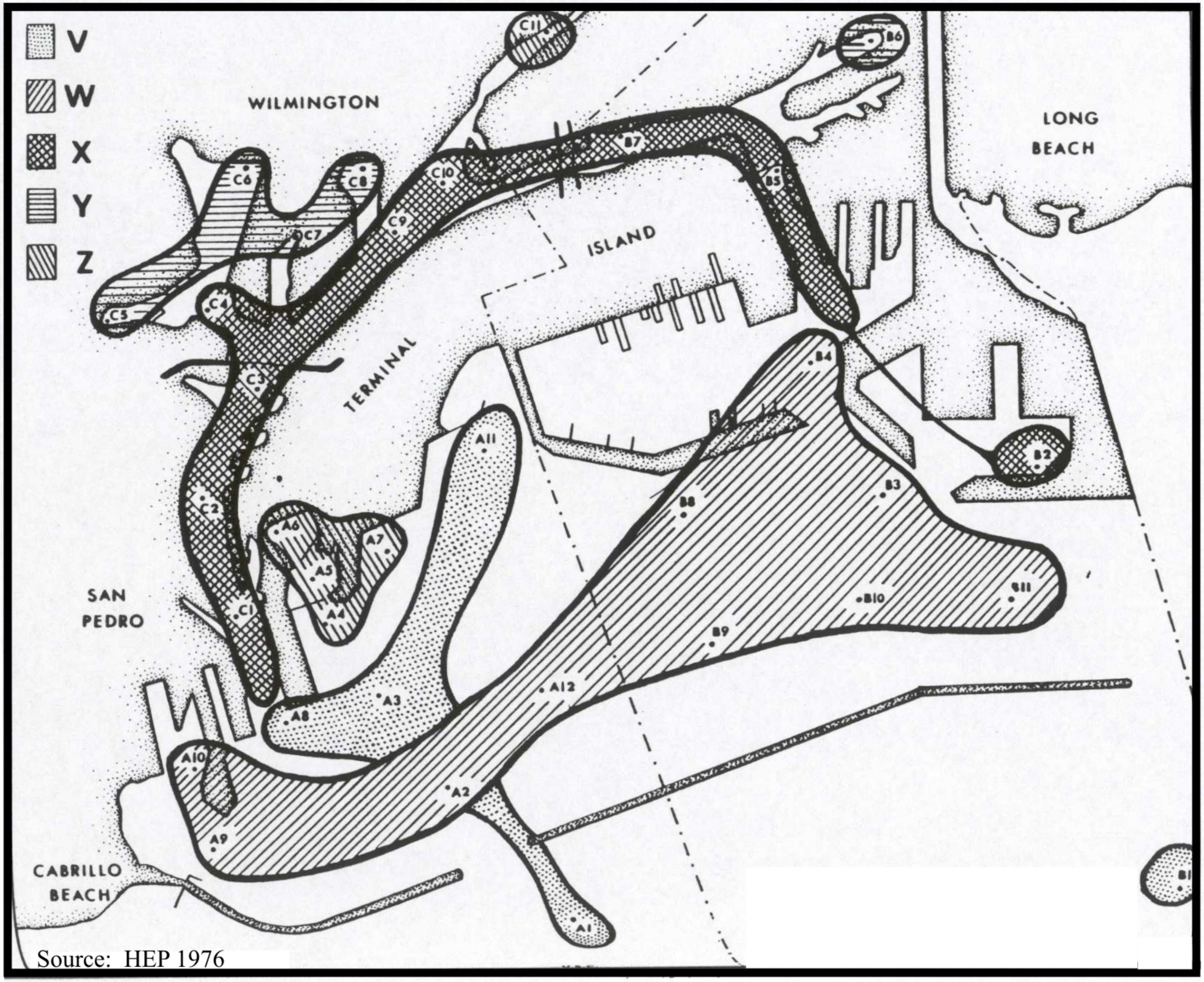


Figure 5.3-7. Map of station groups identified by cluster analysis of benthic infauna collected in Long Beach and Los Angeles Harbors in 1973-1974.

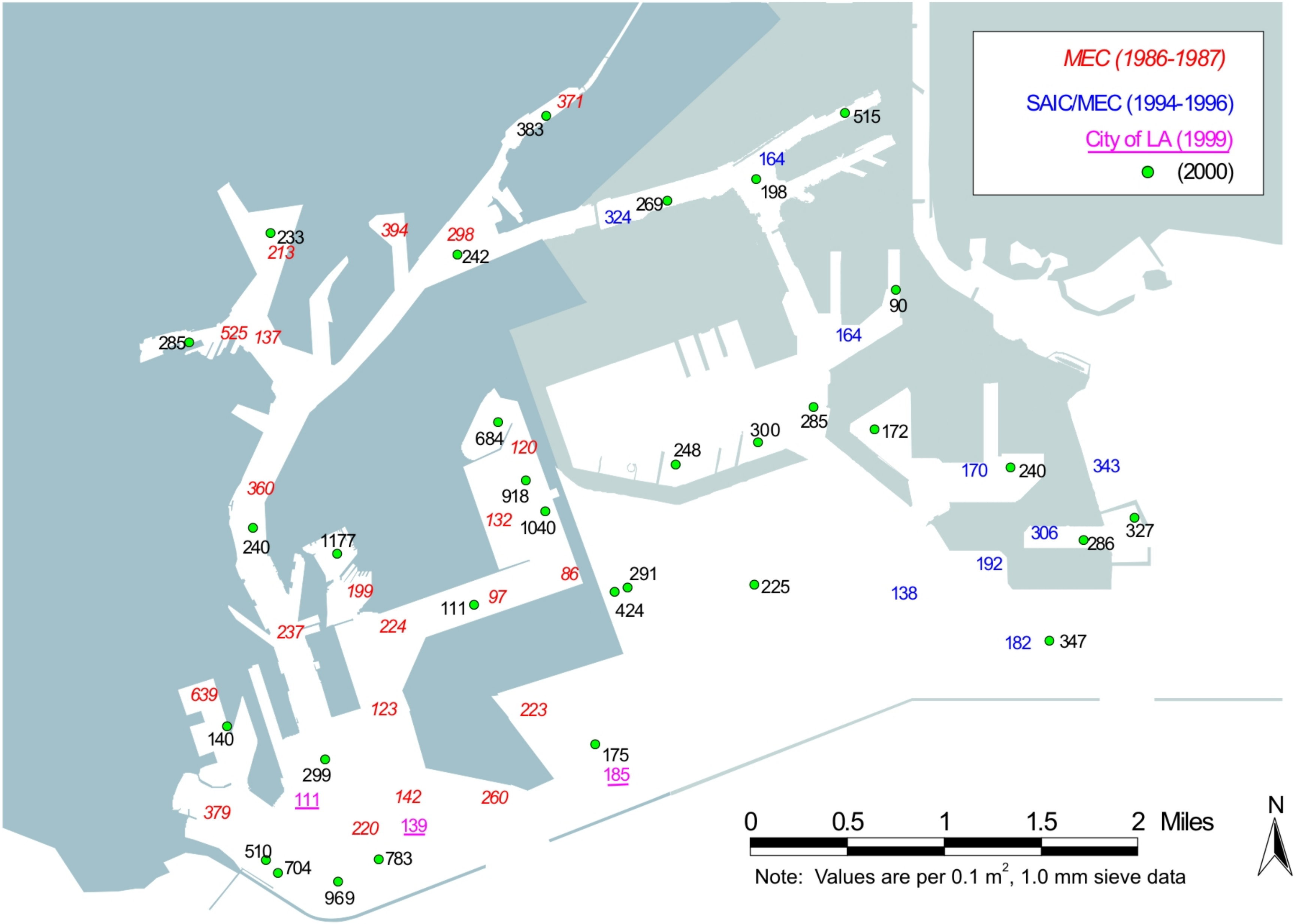


Figure 5.3-8. Historical comparison of mean abundance of benthic infauna collected in Long Beach and Los Angeles Harbors.

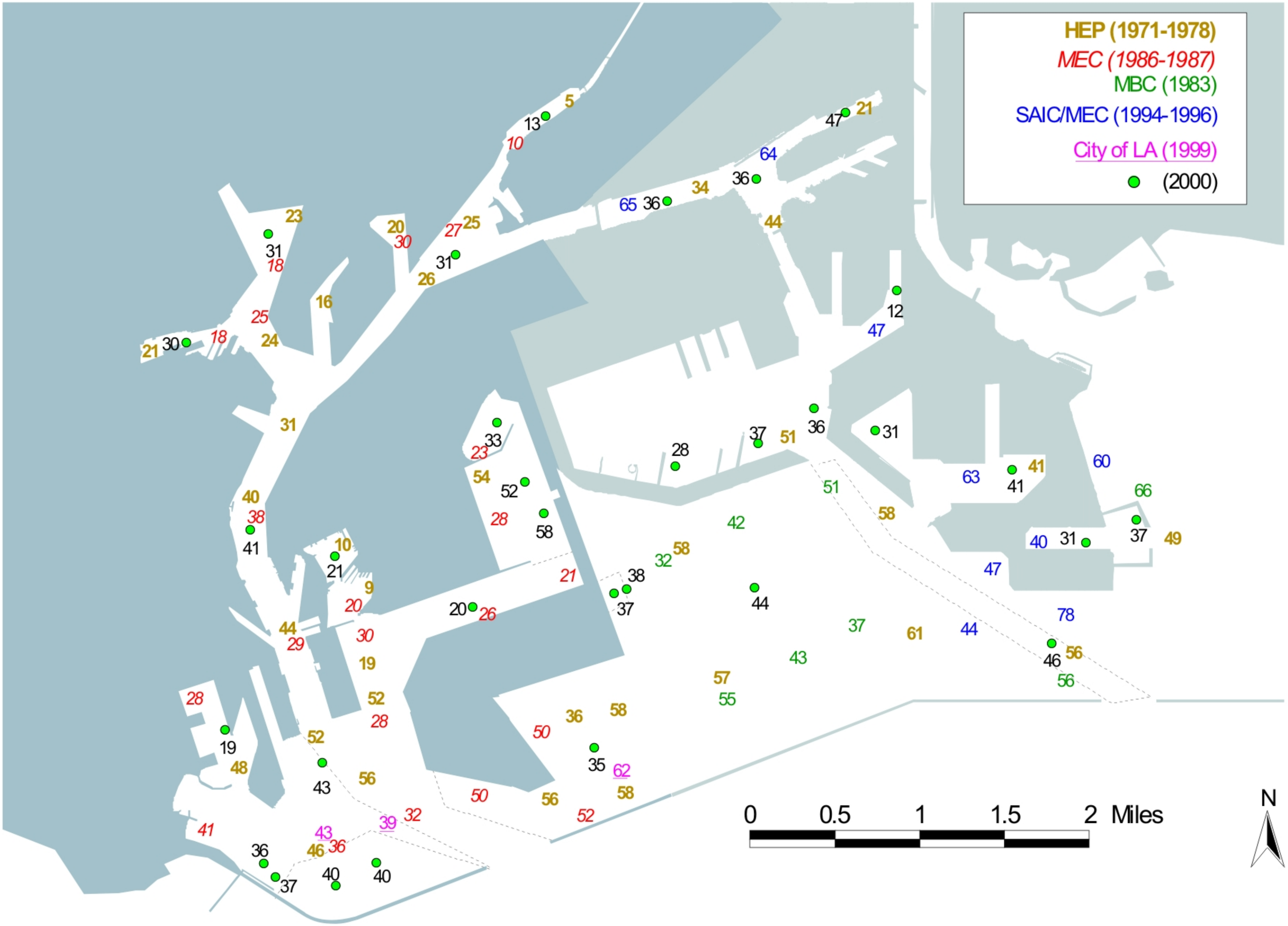


Figure 5.3-9. Historical comparison of mean number of benthic infauna species collected in Long Beach and Los Angeles Harbors.

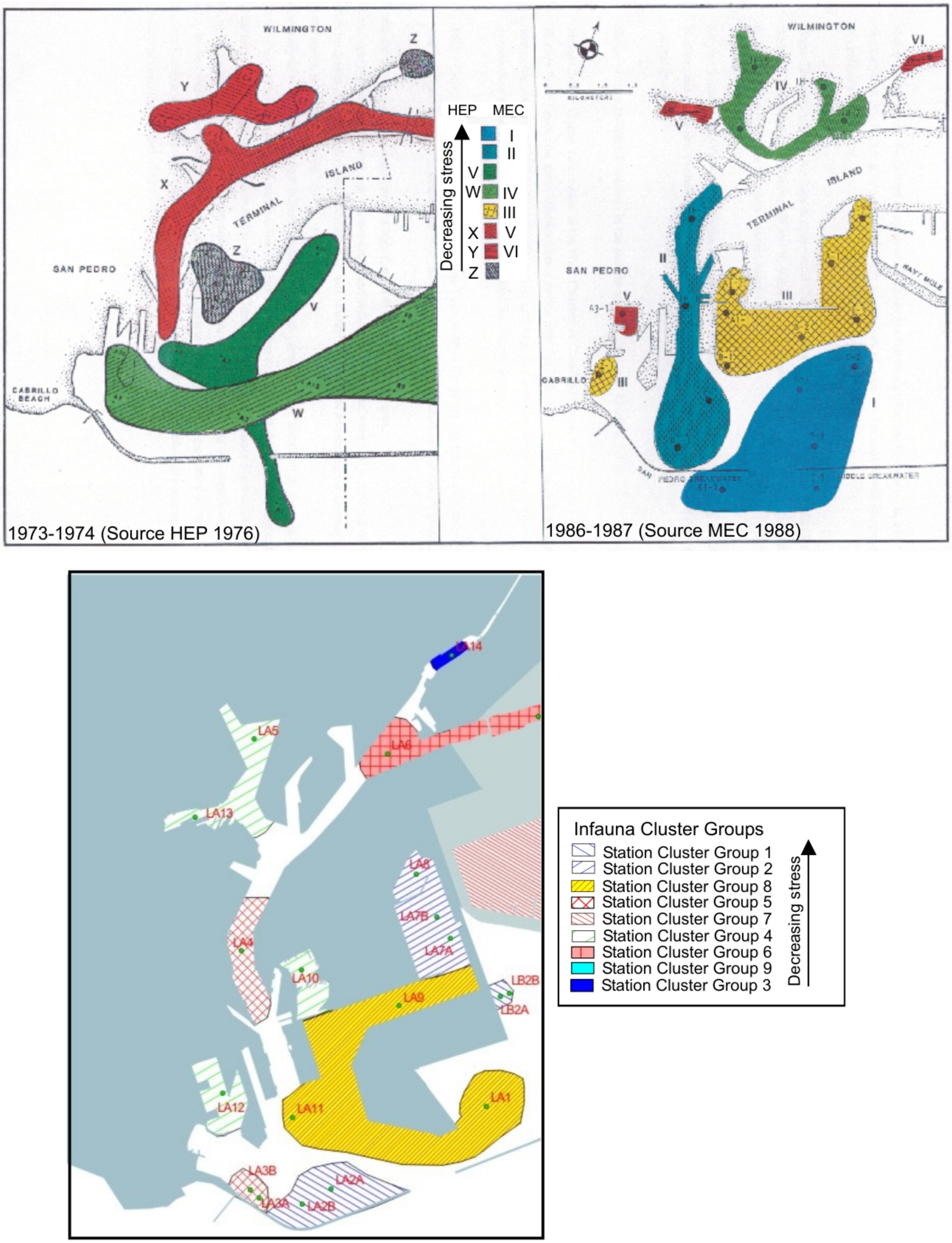


Figure 5.3-10. Historical comparison of cluster analysis station groups of benthic infauna collected in Los Angeles Harbor.

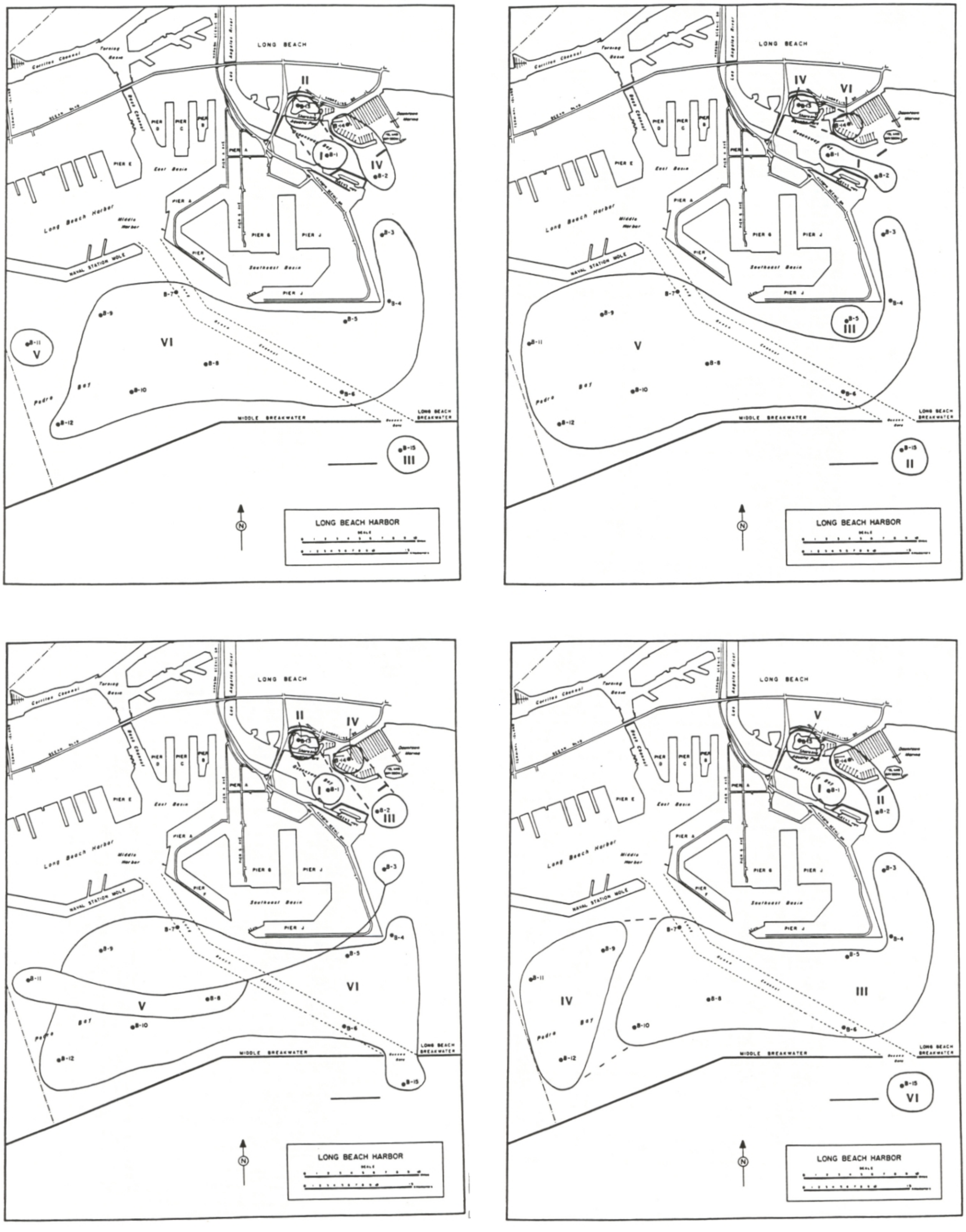


Figure 5.3-11. Map of station groups identified by cluster analysis of benthic infauna in Long Beach Harbor in 1983 (Source MBC 1984).

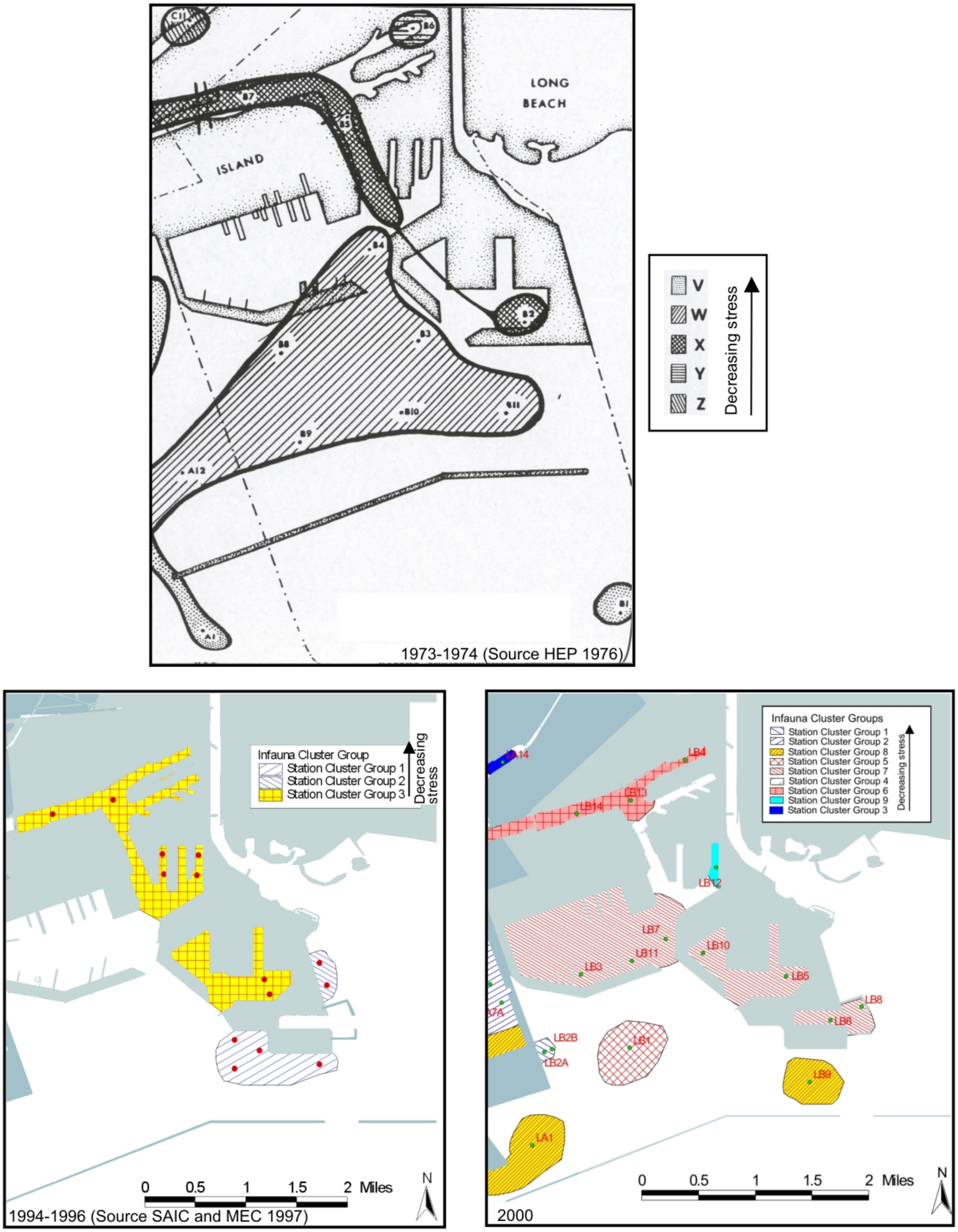


Figure 5.3-12. Historical comparison of cluster analysis station groups of benthic infauna collected in Long Beach Harbor.

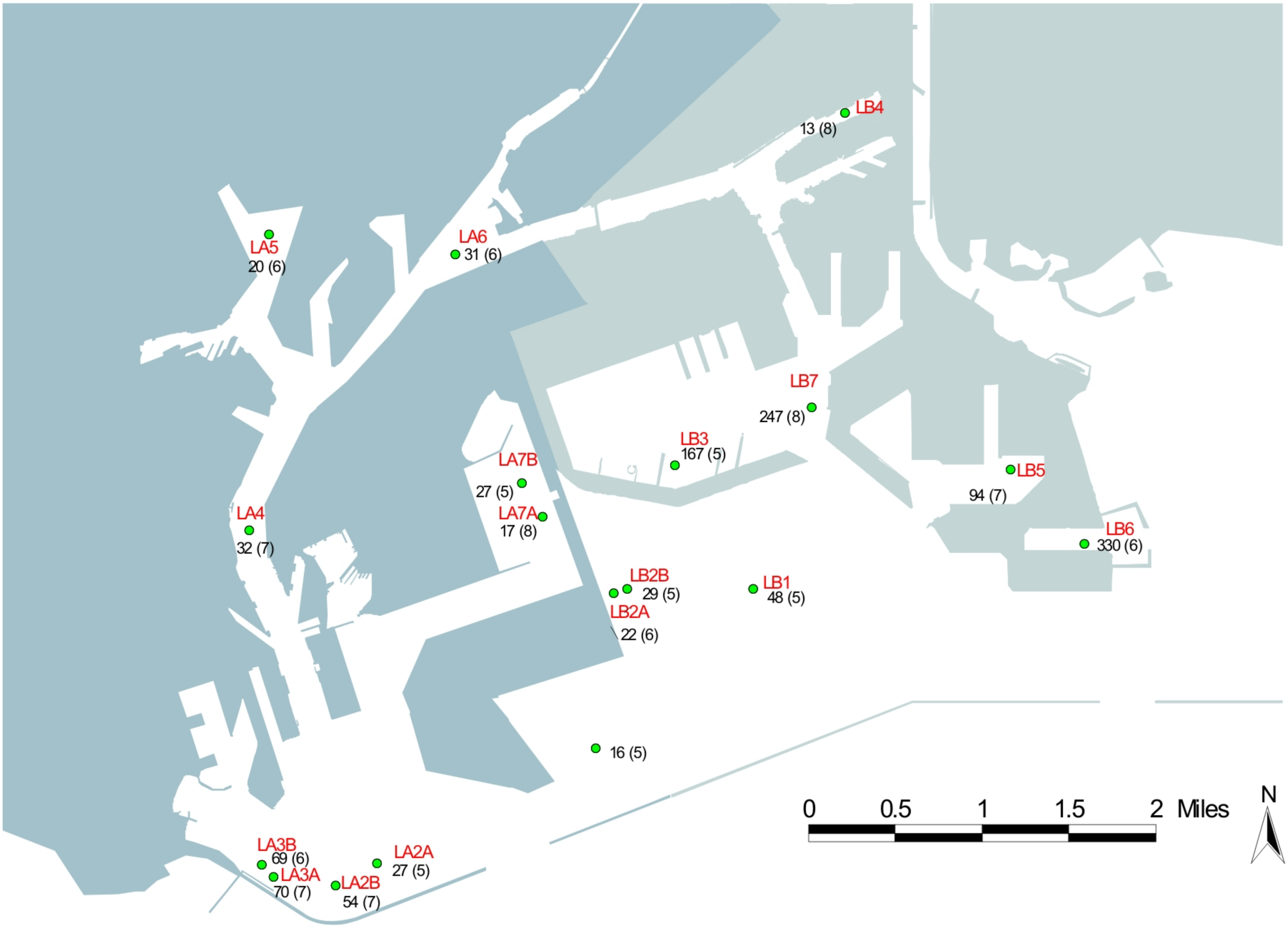


Figure 5.4-1. Mean annual abundance (and number of species) of macroinvertebrates caught by otter trawl in Long Beach and Los Angeles Harbors, February - November 2000.

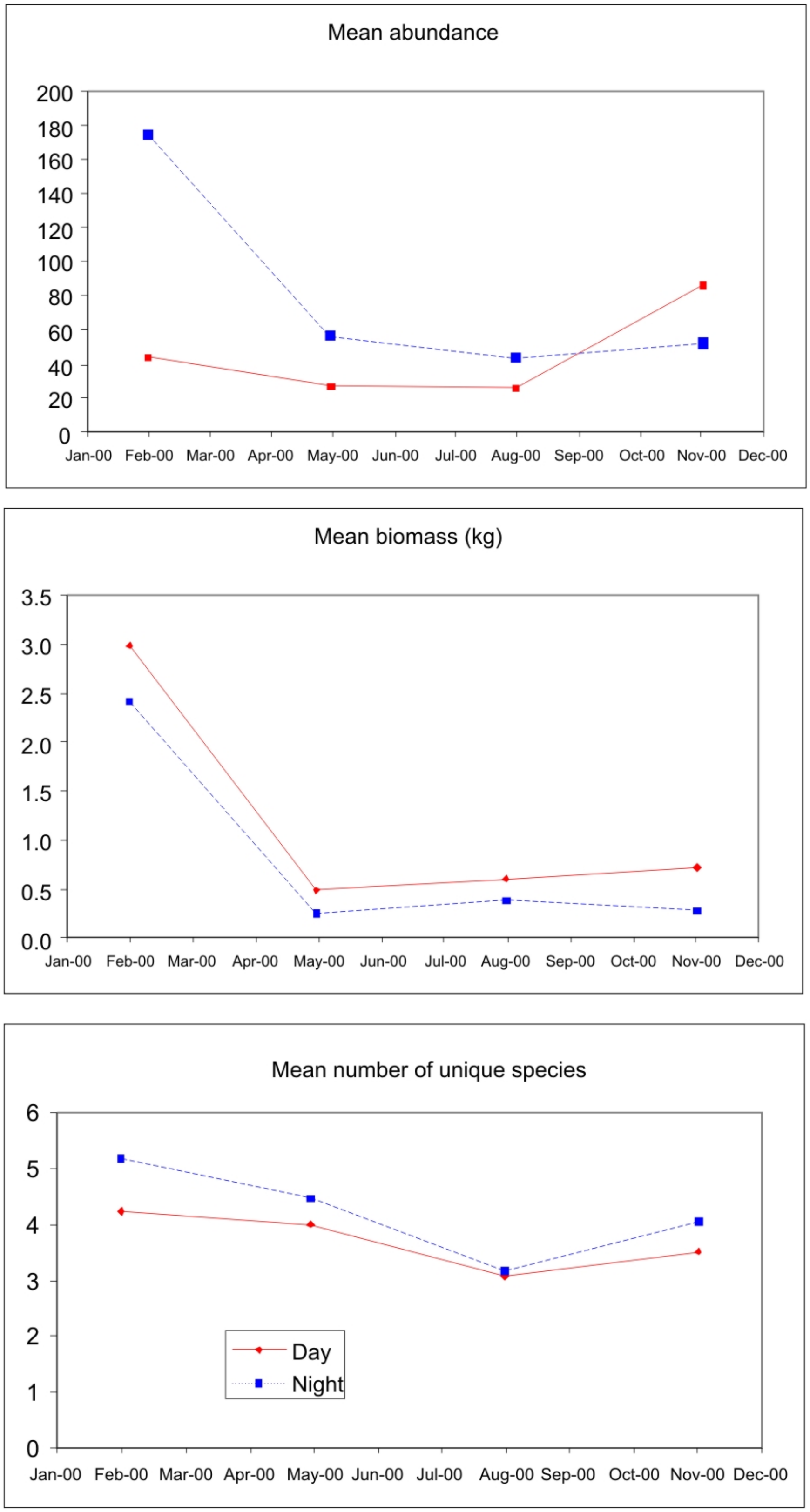


Figure 5.4-2. Seasonal mean abundance, biomass, and number of species of macroinvertebrates caught by otter trawl in Long Beach and Los Angeles Harbors, February - November 2000.

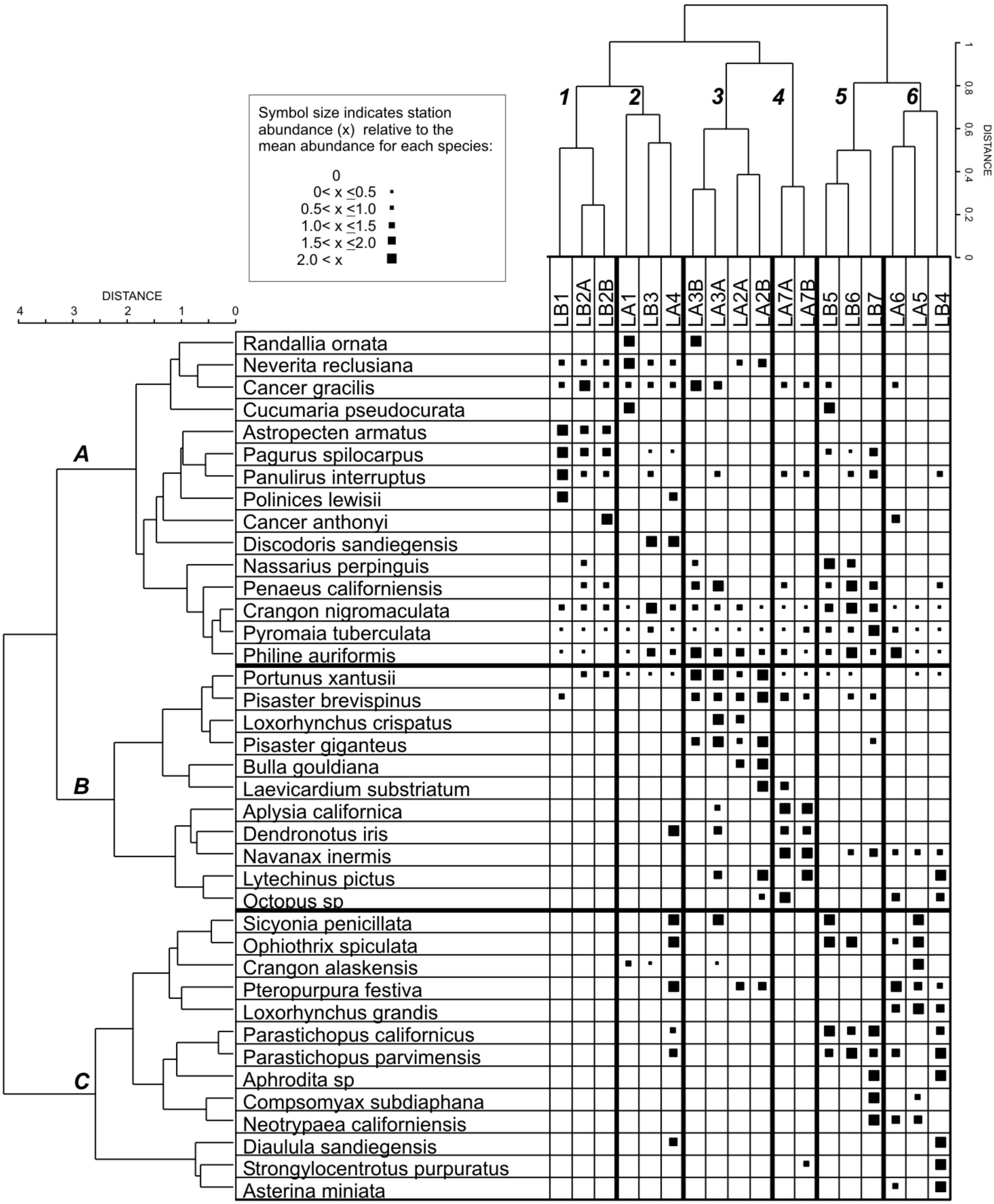


Figure 5.4-3. Cluster analysis of mean species abundance of macroinvertebrates caught by otter trawl in Long Beach and Los Angeles Harbors, February - November 2000.

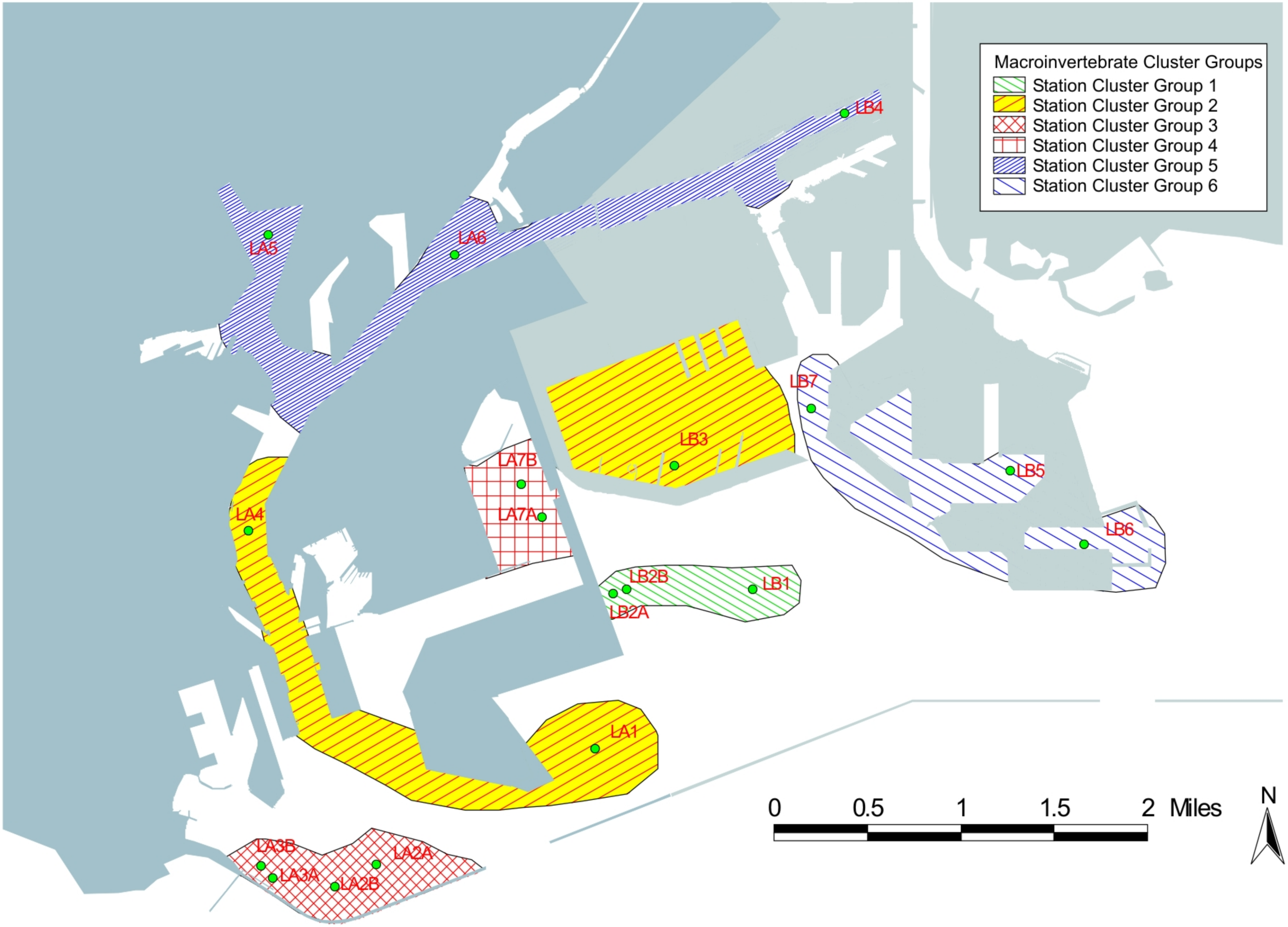


Figure 5.4-4. Map of station groups identified by cluster analysis of macroinvertebrates caught by otter trawl in Long Beach and Los Angeles Harbors, February - November 2000.

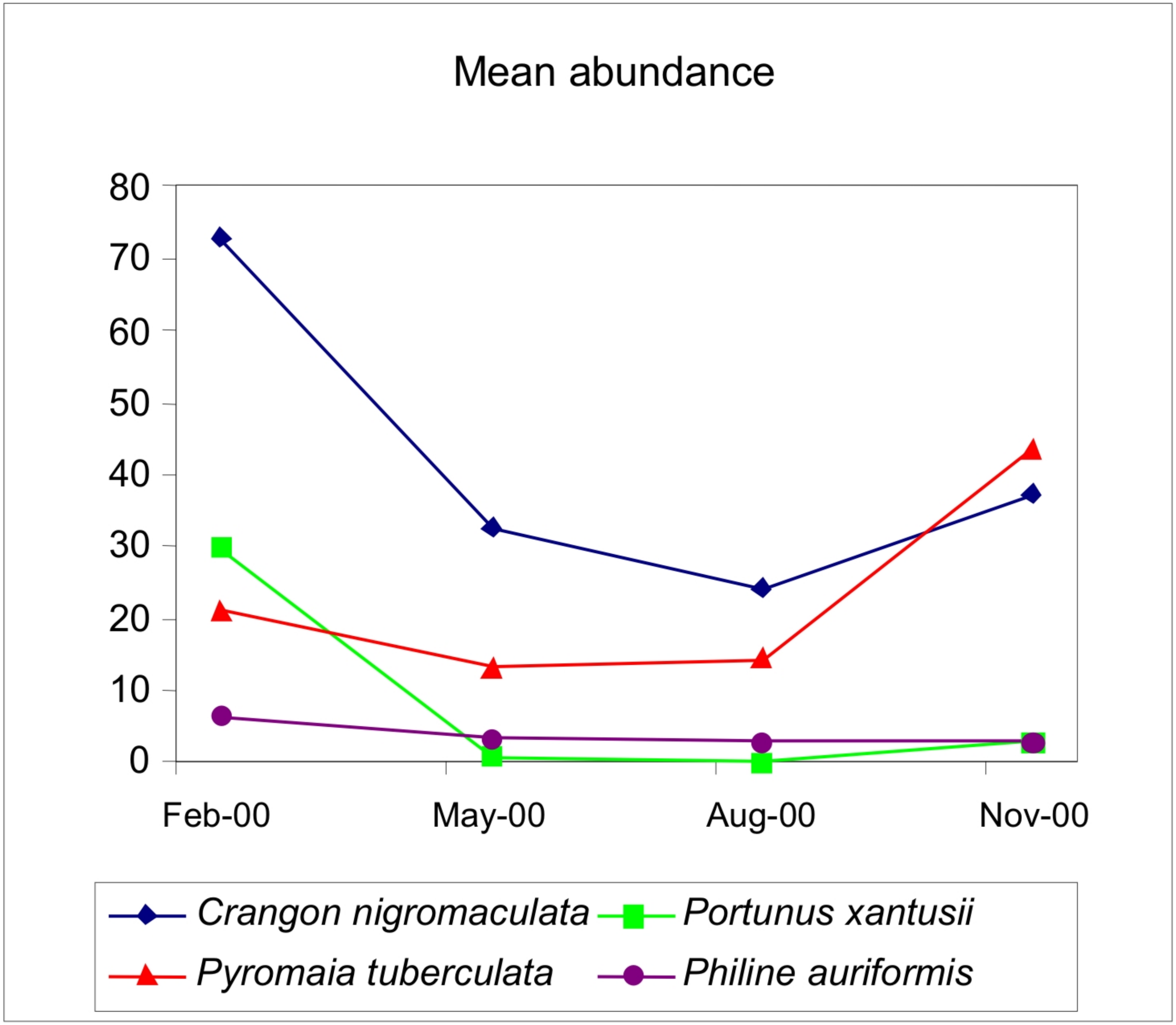


Figure 5.4-5. Seasonal mean abundance of dominant macroinvertebrates caught by otter trawl in Long Beach and Los Angeles Harbors, February - November 2000.

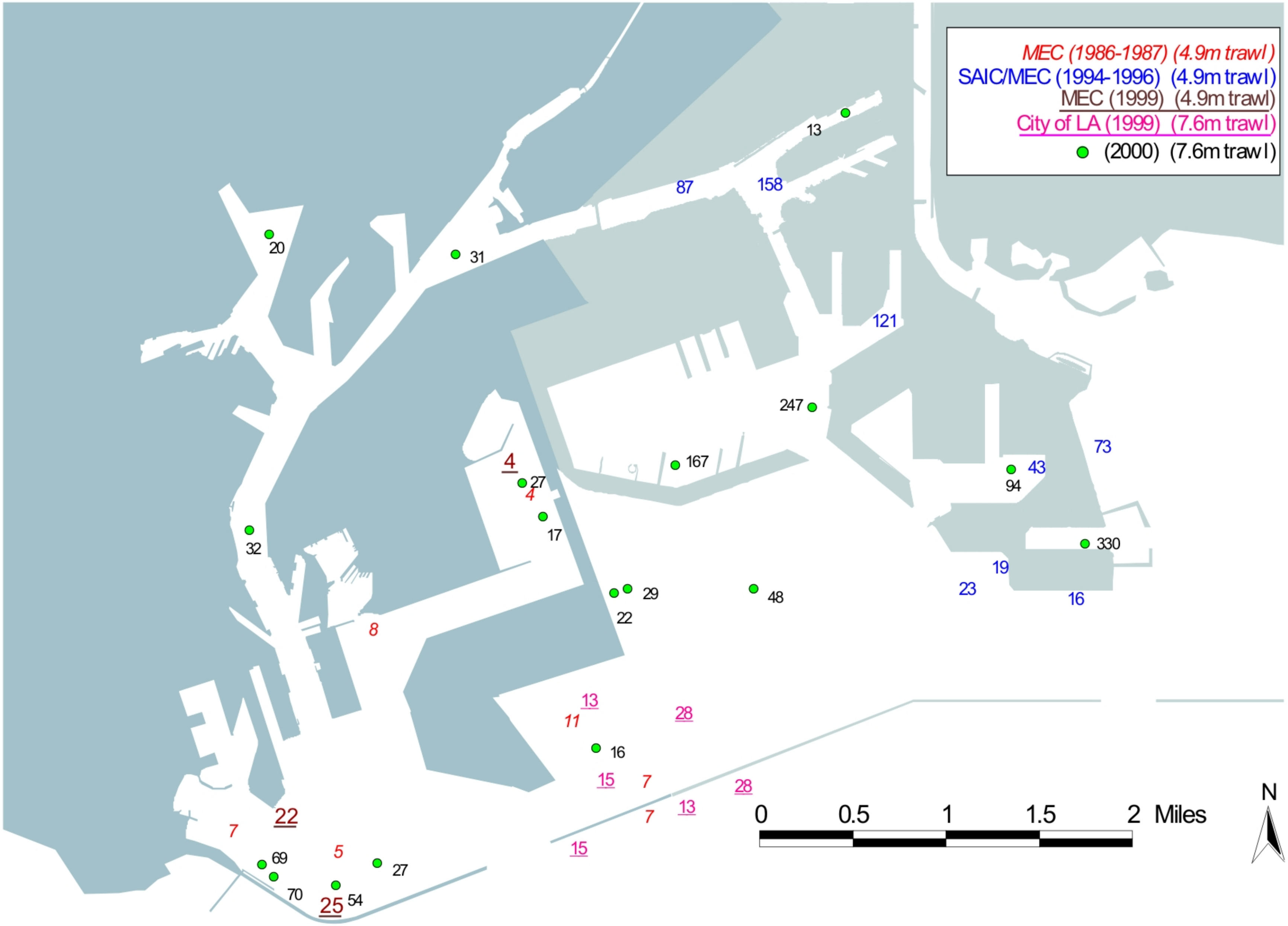


Figure 5.4-6. Historical comparison of mean abundance of macroinvertebrates caught by otter trawl in Long Beach and Los Angeles Harbors.

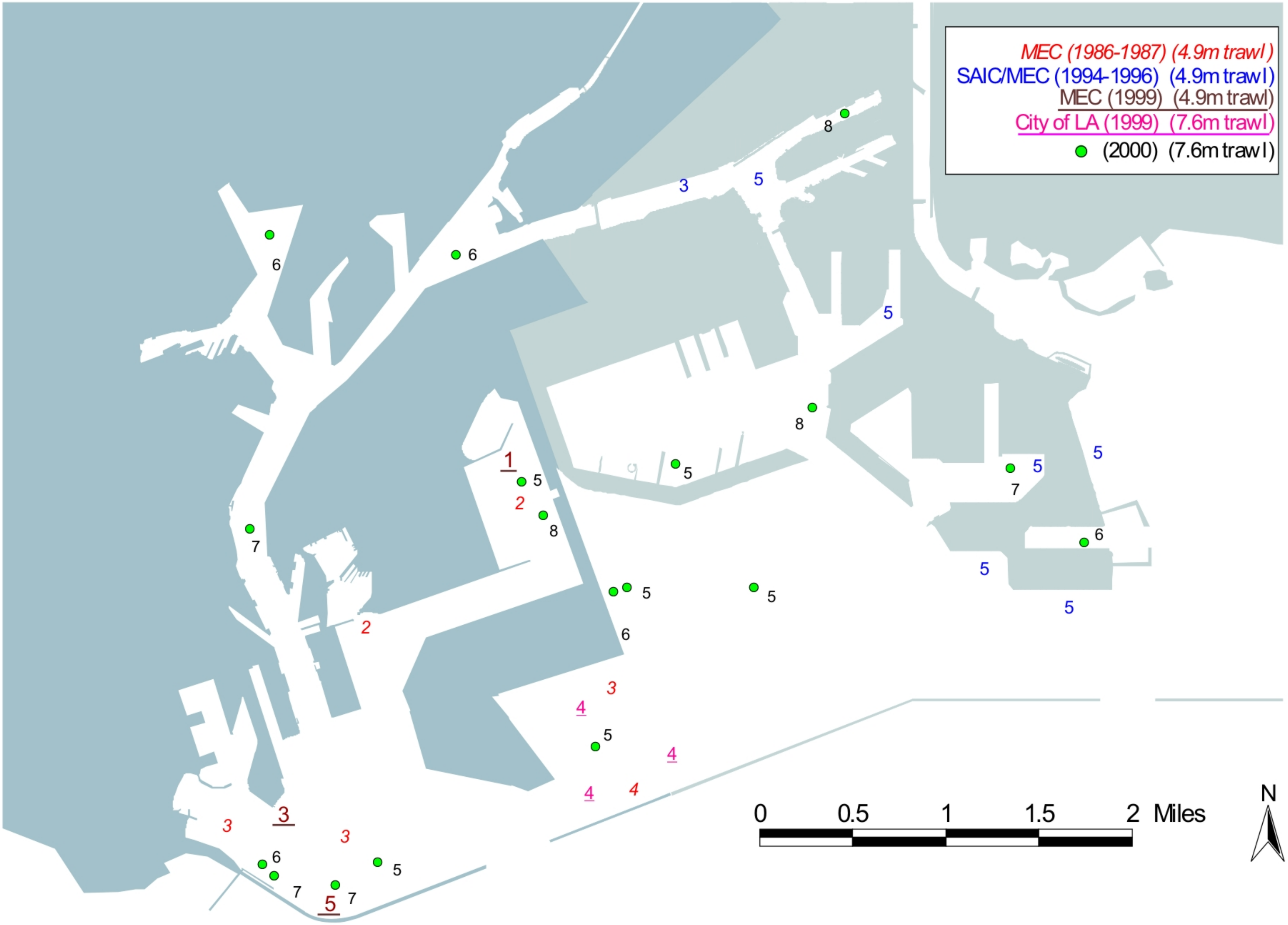


Figure 5.4-7. Historical comparison of mean number of macroinvertebrate species caught by otter trawl in Long Beach and Los Angeles Harbors.

Table 5.2-1. Survey schedule and conditions for infauna sampling in Long Beach and Los Angeles Harbors, January – November 2000.

Date	Season	Sampling Time	Weather Conditions	Notable Observations
31-Jan-00	Winter	0710-2142	Rain then clearing, light-moderate wind	
15-May-00	Spring	0740-1730	Overcast to clear, calm-moderate wind	LA6 substrate too compact for 10 cm sample, 4.5 cm sample accepted.
16-May-00	Spring	0650-1415	Clear, moderate wind	
21-Aug-00	Summer	0800-1650	Overcast to clear, calm wind	
22-Aug-00	Summer	0710-1130	Overcast, calm wind	
06-Nov-00	Fall	0615-1645	Partly cloudy, light wind	LB12 sediment very fine, few animals observed.
07-Nov-00	Fall	0620-0815	Clear, Santa Ana conditions	

Table 5.2-2. Survey schedule and conditions for otter trawl sampling in Long Beach and Los Angeles Harbors, February – November 2000.

Date	Season	Sampling Time	Weather Conditions	Notable Observations
01-Feb-00	Winter	0820-1700	Clear, calm to moderate wind	
02-Feb-00	Winter	0810-1550	Clear, light wind, warm	Large tire in net at LA6 (sample good), debris on bottom in East Basin, abundant invertebrates at LB4, but no fish.
10-Feb-00	Winter	1700-0620	Rain then partly cloudy, light wind	
11-Feb-00	Winter	1815-2310	Overcast, light wind	Tire in net at LA6 (sample good), floating debris at LB4, finished just ahead of strong storm.
16-May-00	Spring	1535-1715	Partly cloudy, light wind	Abundant ctenophores in hauls.
17-May-00	Spring	0720-1455	Partly cloudy, light wind	Ctenophores at LB2A, LB2B, LB4, LA6.
18-May-00	Spring	2000-0440	Clear then fog, light wind	
19-May-00	Spring	2030-2240	Clear then fog, moderate wind	
19-Aug-00	Summer	1400-1610	Clear, light wind	Abundant small fish.
22-Aug-00	Summer	1310-1620	Overcast, light wind	Large numbers of small fish at LB2A and LA2B.
23-Aug-00	Summer	0735-1835	Clear, moderate/strong wind and chop	Large rock at LA5 caught in net (sample good).
24-Aug-00	Summer	1945-0540	Clear, moderate wind	
25-Aug-00	Summer	2000-0130	Overcast, moderate wind	Snagged net at LB3 (re-sampled).
31-Aug-00	Summer	1320-0108	Clear, moderate to calm wind	
07-Nov-00	Fall	1015-1620	Clear, light wind	Abundant crabs and small sciaenids at LB3 and LB7.
08-Nov-00	Fall	0700-1520	Partly cloudy, light wind	Floating debris at LA6.
09-Nov-00	Fall	1745-0300	Partly cloudy, light wind	
10-Nov-00	Fall	1625-0100	Overcast, light wind	Tire in net at LA6 (sample good).

Table 5.3-1. Mean abundance, biomass, number of species, diversity, and dominance of benthic infauna collected in Long Beach and Los Angeles Harbors, January – November 2000.

Habitat / Station	Depth (m)	Abundance	Biomass	Number of Species	Shannon-Wiener Diversity	Margalef Diversity	Dominance
Deepwater Open							
LA1	13	175	1.87	35	3.07	7.17	14
LA11	16	299	1.91	43	2.85	8.32	14
LB1	12	225	3.60	44	3.26	8.71	17
LB9	25	347	4.02	46	3.28	8.44	16
Deepwater Channel							
LA4	16	240	8.50	41	3.28	8.13	17
LA9	16	111	1.57	20	2.17	4.53	7
LB7	24	284	3.95	36	2.68	6.80	11
LB13	20	198	16.40	36	3.20	7.49	17
LB14	18	269	4.20	36	2.89	6.89	12
Deepwater Basin							
LA5	17	233	2.11	31	2.69	6.01	9
LA6	16	242	1.37	31	2.95	6.17	11
LA12	11	138	1.67	19	2.38	4.14	7
LB3	15	248	2.31	28	2.50	5.45	7
LB5	15	239	3.25	35	2.97	6.88	12
LB10	21	172	2.16	31	2.99	6.42	13
LB11	15	300	3.89	37	2.73	6.90	10
Deepwater Slip							
LA13	11	285	5.62	30	2.48	5.71	7
LB4	15	515	8.98	47	3.09	8.35	14
LB6	17	286	3.01	31	2.67	5.98	9
LB8	15	327	2.50	37	2.74	7.09	11
LB12	16	90	1.55	12	1.41	3.60	4
Shallow Mitigation							
LA2A	4	783	16.05	40	2.22	6.47	5
LA2B	4	969	9.48	40	2.04	6.28	4
LA7A	4	1,040	7.71	58	2.89	8.93	10
LA7B	4	918	7.16	52	2.83	8.15	9
LB2A	6	424	4.26	37	2.22	6.60	6
LB2B	6	291	4.79	38	2.72	7.11	11
Shallow Water Open							
LA3A	4	703	7.31	37	2.65	6.79	10
LA3B	4	510	2.40	36	2.92	6.87	11
Shallow Water Channel							
LA14	6	383	3.15	13	1.41	2.41	3
Shallow Water Basin							
LA8	4	684	3.26	33	2.14	5.41	5
LA10	6	1,177	9.19	21	1.10	3.13	2
Station Mean		410	4.97	35	2.61	6.48	10
Grand Total Across Stations		52,417	636.77	361			

Note: Values are per 0.1 m^2.

Table 5.3-2. Mean and total abundance of benthic infauna within taxonomic groups and collected in Long Beach and Los Angeles Harbors, January – November 2000.

Habitat / Station	Depth (m)	Crustaceans	Echinoderms	Molluscs	Polychaetes	Others	Annual Mean	Grand Total Across Surveys
Deepwater Open								
LA1	13	11	5	48	99	13	176	703
LA11	16	11	1	53	219	15	299	1,197
LB1	12	71	1	17	132	4	225	902
LB9	25	33	7	77	213	17	347	1,387
Deepwater Channel								
LA4	16	40	1	14	175	10	240	960
LA9	16	7	2	58	42	4	112	447
LB7	24	30	3	31	213	9	285	1,138
LB13	20	22	0	7	155	14	198	792
LB14	18	22	0	31	207	9	269	1,075
Deepwater Basin								
LA5	17	58	0	8	161	6	233	933
LA6	16	8	0	6	215	12	242	967
LA12	11	41	0	9	88	2	140	560
LB3	15	32	1	19	194	3	249	995
LB5	15	42	1	51	141	5	240	958
LB10	21	35	0	15	119	3	172	687
LB11	15	18	1	39	237	5	300	1,202
Deepwater Slip								
LA13	11	50	0	24	206	5	285	1,140
LB4	15	36	2	13	454	12	515	2,062
LB6	17	28	1	24	228	5	286	1,145
LB8	15	25	0	42	251	9	327	1,307
LB12	16	3	1	54	32	0	90	360
Shallow Mitigation								
LA2A	4	248	1	79	448	9	783	3,133
LA2B	4	481	0	51	431	5	969	3,877
LA7A	4	472	6	40	506	16	1,040	4,158
LA7B	4	450	8	107	343	10	918	3,672
LB2A	6	241	0	28	147	8	424	1,697
LB2B	6	134	2	38	109	8	291	1,163
Shallow Water Open								
LA3A	4	97	1	28	570	8	704	2,815
LA3B	4	89	0	33	381	6	510	2,038
Shallow Water Channel								
LA14	6	55	0	40	286	1	383	1,532
Shallow Water Basin								
LA8	4	165	4	119	380	16	685	2,740
LA10	6	25	0	19	1,129	3	1,177	4,707
Mean Total		3,081	50	1,220	8,508	253	13,112	52,447

Note: Values are per $0.1m^2$.

Table 5.3-3. Mean and total biomass of benthic infauna within taxonomic groups collected in Long Beach and Los Angeles Harbors, January – November 2000.

Habitat / Station	Depth (m)	Crustaceans	Echinoderms	Molluscs	Others	Polychaetes	Annual Mean	Grand Total Across Surveys
Deepwater Open								
LA1	13	0.02	0.38	0.49	0.05	0.93	1.87	7.48
LA11	16	0.02	0.00	0.28	0.05	1.55	1.91	7.63
LB1	12	0.28	0.15	1.76	0.05	1.36	3.60	14.38
LB9	25	0.08	0.22	1.33	0.17	2.23	4.02	16.07
Deepwater Channel								
LA4	16	0.58	0.00	2.79	0.58	4.55	8.50	34.02
LA9	16	0.04	0.00	1.00	0.02	0.50	1.57	6.27
LB7	24	0.80	0.04	0.73	0.02	2.37	3.95	15.82
LB13	20	0.31	0.00	12.47	2.48	1.14	16.40	65.58
LB14	18	0.18	0.00	1.38	0.58	2.05	4.20	16.78
Deepwater Basin								
LA5	17	0.35	0.00	0.02	0.12	1.63	2.11	8.45
LA6	16	0.03	0.00	0.04	0.08	1.22	1.37	5.48
LA12	11	0.07	0.00	0.15	0.00	1.46	1.67	6.68
LB3	15	0.79	0.00	0.13	0.00	1.38	2.31	9.23
LB5	15	0.25	0.03	1.43	0.25	1.29	3.25	13.00
LB10	21	0.28	0.00	0.08	0.14	1.65	2.16	8.65
LB11	15	0.22	0.14	0.63	0.04	2.86	3.89	15.55
Deepwater Slip								
LA13	11	0.65	0.01	1.04	2.89	1.03	5.62	22.48
LB4	15	0.20	0.00	4.87	0.95	2.96	8.98	35.92
LB6	17	0.56	0.13	0.53	0.02	1.79	3.02	12.07
LB8	15	0.42	0.00	0.46	0.08	1.55	2.50	10.02
LB12	16	0.00	0.00	1.33	0.00	0.22	1.55	6.22
Shallow Mitigation								
LA2A	4	0.56	0.00	13.12	0.36	2.01	16.05	64.18
LA2B	4	0.87	0.05	6.99	0.09	1.48	9.48	37.90
LA7A	4	0.83	0.82	2.79	1.53	1.74	7.71	30.83
LA7B	4	1.31	0.73	3.19	0.15	1.78	7.16	28.63
LB2A	6	0.28	0.00	1.52	1.31	1.15	4.26	17.05
LB2B	6	0.25	0.03	2.90	0.52	1.08	4.79	19.15
Shallow Water Open								
LA3A	4	0.82	0.08	1.08	2.59	2.75	7.31	29.23
LA3B	4	0.18	0.00	0.60	0.05	1.58	2.40	9.62
Shallow Water Channel								
LA14	6	0.13	0.00	2.67	0.00	0.36	3.15	12.62
Shallow Water Basin								
LA8	4	0.87	0.00	1.71	0.16	0.52	3.26	13.03
LA10	6	2.65	0.00	2.63	2.94	0.98	9.19	36.75
Mean Total		14.84	2.80	72.12	18.28	51.16	159.20	636.78

Note: Values are per 0.1 m^2.

Table 5.3-4. Mean and total number of species of benthic infauna within taxonomic groups collected in Long Beach and Los Angeles Harbors, January – November 2000.

Habitat / Station	Depth (m)	Crustaceans	Echinoderms	Molluscs	Polychaetes	Others	Combined Annual Mean	Grand Total
Deepwater Open								
LA1	13	4	1	8	19	4	35	80
LA11	16	3	1	8	27	5	43	90
LB1	12	11	1	6	25	2	44	90
LB9	25	6	1	11	24	4	46	91
Deepwater Channel								
LA4	16	8	0	4	26	3	41	98
LA9	16	3	1	5	10	1	20	56
LB7	24	6	1	6	21	2	36	68
LB13	20	5	0	3	24	4	36	87
LB14	18	7	0	5	21	3	36	74
Deepwater Basin								
LA5	17	6	0	2	20	3	31	65
LA6	16	4	0	2	24	2	31	69
LA12	11	4	0	2	13	1	19	34
LB3	15	6	0	3	17	1	28	62
LB5	15	7	1	5	21	2	35	77
LB10	21	5	0	3	22	1	31	65
LB11	15	6	1	5	24	3	37	69
Deepwater Slip								
LA13	11	8	0	3	17	2	30	61
LB4	15	7	1	4	32	4	47	103
LB6	17	4	0	5	20	2	31	64
LB8	15	5	0	6	24	3	37	82
LB12	16	2	0	2	8	0	12	34
Shallow Mitigation								
LA2A	4	11	0	8	17	4	40	90
LA2B	4	14	0	9	15	2	40	86
LA7A	4	18	2	10	25	4	58	113
LA7B	4	16	2	10	20	4	52	97
LB2A	6	8	0	7	17	5	37	89
LB2B	6	6	0	9	19	3	38	85
Shallow Water Open								
LA3A	4	10	1	4	19	3	37	99
LA3B	4	7	0	6	22	2	36	85
Shallow Water Channel								
LA14	6	2	0	3	8	1	13	31
Shallow Water Basin								
LA8	4	12	1	5	13	3	33	72
LA10	6	4	0	2	14	1	21	46
Mean Total		6	0	4	16	2	35	75
Grand Total Across Surveys		79	6	65	169	42	NA	361

Notes: Values are per 0.1 m^2.
NA = not applicable.

Table 5.3-5. Selected benthic infauna species reported to be representative of background, organically enriched (transitional, semi-healthy), and polluted (contaminated) habitats.

Background	Organically Enriched		Polluted
	Low Enrichment	Moderate Enrichment	
Ampelisca spp. [3]	*Anaitides* spp. [2]	*Bittium* spp. [3]	*Armandia bioculata* [3]
Amphiodia spp. [3,4]	*Axinopsida serricata* [3,4]	*Boccardia proboscidea* [5]	*Capitella capitata* [1,2,3,4]
Cossura candida [1]	*Cerianthus* spp. [2]	*Cirriformia luxuriosa* [1,2]	Dorvilleidae [2,3,4]
Heterophoxus oculatus[3]	*Chloeia pinnata* [4]	*Eteone* spp. [2]	*Nereis procera* [4]
Maldane sarsi [3]	*Corophium acherusicum* [2]	*Exogone lourei* [5]	*Notomastus* sp. [2,4]
Metaphoxus, Paraphoxus[3]	*Eumida sanguinea* [2]	*Heteromastus filiformis* [2]	Oligochaeta [2]
Nereis procera [1]	*Euphilomedes* spp. [3,4]	*Macoma carlottensis, nasuta* [2,3]	*Ophryotrocha* spp. [3]
Pectinaria californiensis [3]	*Glycinde picta* [2]	*Nereis diversicolor* [2]	Rochefortia (= *Mysella*) *pedroana* [4]
Phoronis spp. [3,4]	*Goniada maculata* [2]	*Nereis grubei* [5]	*Schistomeringos longicornis* [2,3,4]
Spiophanes missionensis [4]	*Hetreophoxus oculatus* [4]	*Ophiodromus puggetensis* [2]	*Solemya* spp. [2,3]
Stenenelenella uniformis [3]	*Leitoscoloplos (=Haploscoloplos)* [2]	*Parvilucina tenuisculpta* [3,4]	Stenothoidae amphipods [3]
Tharyx ? parvus [1]	*Lumbrineris* spp. [2]	*Polydora ciliata, ligni* [2]	*Tharyx* spp. [4]
	Mediomastus spp. [3,4]	*Pseudopolydora paucibranchiata* [1,2]	
	Neanthes spp. [2]	*Schistomeringos longicornis* [1]	
	Nephtys cornuta[2]	*Scololepis fulginosa* [2]	
	Photis spp. [3]	*Spiochaetopterus costarum* [3,4]	
	Paraprionospio (= *Prionospio*) *pinnata* [2]	*Streblospio benedicti* [2]	
	Prionospio lighti (cirrifera), heterobranchia, steenstrupi [2,4]	*Tharyx* spp. [5]	
	Pygospio elegans [2]	*Thyasira flexuosa*[2]	
	Rochefortia (= *Mysella*) *pedroana, tumida* [3]		
	Scoloplos armiger [2]		
	Tharyx spp. [3]		

Notes: (1) Species reported by Pearson and Rosenberg were assigned based on review of their comments. Species reported as "transitional" by Thompson were assigned based on consistency with other reports.
(2) Species in more than one category were considered transitional.

Sources: [1] Reish 1959, [2] Pearson and Rosenberg 1978, [3] Word 1978, [4] Thompson 1982, [5] Dorsey et al. 1983.

Table 5.3-6. Summary of biological and physical/chemical habitat characteristics of benthic infauna cluster groups.

	Cluster Group								
	1	2	3	4	5	6	7	8	9
Station	LA2, LB2	LA7, 8	LA14	LA5,10, 12, 13	LA3,4, LB1	LA6, LB4 LB13,14	LB3,5,6,7,8,10, LB11	LA1,9,11, LB9	LB12
Physical Characteristics of Stations within Cluster Groups									
Habitat	Shallow Open Water (Mitigation Sites)	Shallow Water (Mitigation and Basin Sites)	Shallow Channel	Deep Basin, Slip	Deep/Shallow Open Water, Channel	Deep Channel, Slip	Deep Basin, Channel	Deep Open Water, Channel	Deep Slip
Depth (m)	4-6	4	6	11-20	4-16	11-20	15-24	13-25	16
Range of Percent Fines	20-63	21-95	92	37-99	25-92	69-94	13-94	64-93	99
Years Since Dredging/Disposal	0-2	> 10	> 10	> 10	> 10	1 to > 10	0-10	0-10	> 10
Range Percent Transmissivity Near Bottom	8.3-64.6	8.0-51.6	34.0-63.6	31.5-66.8	42.6-55.2	30.0-66.6	11.3-54.1	7.0-62.8	15.4-28.3
Range Bottom Temperature °C	12.6-20.7	13.3-21.7	14.3-20.0	11.6-19.6	11.2-18.3	12.5-18.3	11.6-17.9	10.8-19.0	12.2-17.8
Range Bottom Dissolved Oxygen (mg/L)	4.2-8.3	5.2-7.3	4.3-6.2	4.3-7.2	4.3-7.2	4.3-7.1	4.3-7.2	3.9-7.9	4.2-6.8
Range Bottom Salinity (ppt)	33.0-33.3	33.2-33.6	33.0-33.5	31.9-33.7	32.7-33.7	33.1-33.6	32.7-33.7	30.5-33.7	24.8-33.1
Biological Characteristics of Stations within Cluster Groups									
Range of Mean Number Species	36-40	33-58	13	19-36	36-44	31-47	28-37	20-46	12
Range of Mean Abundance	291-969	684-1084	383	138-1177	225-703	198-515	172-327	111-347	90
Total Taxa in Species Cluster Groups	137	118	24	93	148	128	124	121	29
Number of Relatively Abundant Taxa (% of Total) in Groups	32 (23%)	26 (22%)	4 (17%)	11 (12%)	25 (17%)	19 (15%)	30 (24%)	31 (26%)	6 (17%)
Number of Relatively Abundant Taxa (% of Abundant Taxa) Associated with Different Levels of Enrichment/Pollution									
Low Enrichment	7 (22%)	7 (27%)	0	6 (55%)	7 (28%)	5 (26%)	9 (30%)	5 (16%)	0
Moderate Enrichment	1 (3%)	1 (4%)	0	1 (9%)	1 (4%)	3 (16%)	2 (7%)	2 (6%)	0
Polluted/Contaminated	0	1 (4%)	2 (50%)	0	0	0	0	0	0

Table 5.3-7. Total abundance of dominant benthic infauna species collected in Long Beach and Los Angeles Harbors, January – November 2000.

Taxonomic group	Species	Total abundance	% of total
Polychaetes	*Pseudopolydora paucibranchiata* *	11,448	21.8
Crustaceans	*Amphideutopus oculatus*	3,393	6.5
Polychaetes	*Cossura* sp. A	3,077	5.9
Molluscs	*Theora lubrica* *	2,475	4.7
Crustaceans	*Euphilomedes carcharodonta*	2,267	4.3
Polychaetes	*Monticellina siblina*	2,258	4.3
Polychaetes	*Euchone limnicola*	1,988	3.8
Polychaetes	*Mediomastus* sp.	1,983	3.8
Polychaetes	*Spiophanes berkeleyorum*	1,043	2.0
Polychaetes	*Chaetozone corona*	907	1.7
Crustaceans	*Sinocorophium cf heteroceratum* *	872	1.7
Crustaceans	*Paramicrodeutopus schmitti*	755	1.4
Polychaetes	*Cossura candida*	707	1.3
Polychaetes	*Aphelochaeta petersenae*	697	1.3
Crustaceans	*Eochelidium* sp. A *	662	1.3
Polychaetes	*Paraprionospio pinnata*	622	1.2
Crustaceans	*Scleroplax granulata*	610	1.2
Polychaetes	*Dorvillea (Schistomeringos) annulata*	557	1.1
Polychaetes	*Capitella "capitata"*	538	1.0
Polychaetes	*Streblosoma* sp. B (SCAMIT1985)	493	0.9
Polychaetes	*Aphelochaeta monilaris*	490	0.9
Crustaceans	*Monocorophium acherusicum* ?	408	0.8
Polychaetes	*Lumbrineris* sp.	405	0.8
Polychaetes	*Leitoscoloplos pugettensis*	398	0.8
Crustaceans	*Leptochelia dubia*	368	0.7
Crustaceans	*Photis brevipes*	352	0.7
Polychaetes	*Exogone lourei*	330	0.6
Polychaetes	*Spiophanes missionensis*	315	0.6
Polychaetes	*Nereis procera*	298	0.6
Polychaetes	*Prionospio heterobranchia*	285	0.5
Polychaetes	*Prionospio lighti*	270	0.5
Polychaetes	*Paramage scutata*	260	0.5
Other Minor Phyla	*Tubulanus polymorphus/pellucidus*	258	0.5
Polychaetes	*Lumbrineris* sp. A ?	253	0.5
Crustaceans	*Grandidierella japonica* *	248	0.5
Molluscs	*Tellina modesta*	248	0.5
Polychaetes	*Aphelochaeta* sp.	245	0.5
Molluscs	*Tagelus subteres*	227	0.4
Polychaetes	*Pista alata*	220	0.4
Crustaceans	*Gnathia crenulatifrons*	218	0.4
Polychaetes	*Notomastus tenuis*	208	0.4
Polychaetes	*Laonice cirrata* ?	207	0.4
	Total represented by dominant species	43,865	83.7
	Total abundance of all species	52,417	100.0
	Total number of species	361	

Notes: Species listed in decreasing order of abundance.
* = Non-indigenous species.
? = Cryptogenic taxa of unknown status because origin is unknown or taxonomic status is in question.

Table 5.3-8. Historical comparison of the ten most abundant infaunal taxa, in descending order of dominance, collected in Long Beach and Los Angeles Harbors.

Year	1954	1973-1974	1978	1983	1986-1987	1994 and 1996	2000
Source	Reish 1959	HEP 1976	HEP 1980	MBC 1984 **	MEC 1988*	SAIC/MEC 1997 **	
1	*Pseudopolydora paucibranchiata*	*Tharyx ? parvus*	*Cossura candida*	*Cossura candida*	*Cossura candida*	*Cossura candida*	*Pseudopolydora paucibranchiata*
2	*Tharyx parvus*	*Capitita ambiseta*	*Mediomastus californiensis*	*Prinospio cirrifera*	*Prionospio lighti*	*Leitoscoloplos pugettensis*	*Amphideutopus oculatus*
3	*Cossura candida*	*Cossura candida*	*Tharyx* sp.	*Capitella capitata*	*Mediomastus* spp.	*Aphelochaeta multifilis* Type 2	*Cossura* sp. A
4	*Capitella capitata*	*Capitella capitata*	*Prionospio cirrifera*	*Pseudopolydora paucibranchiata*	*Levinsenia gracilis*	*Chaetozone corona*	*Theora lubrica*
5	*Cirriformia luxuriosa*	*Paraonis gracilis oculata*	*Capitella capitata*	*Polydora ligni*	*Euchone limnicola*	*Amphideutopus oculatus*	*Euphilomedes carcharodonta*
6	*Dorvillea articulata*	*Euchone limnicola*	*Paraonis gracilis oculata*	*Tharyx* sp.	*Theora lubrica*	*Mediomastus* sp.	*Monticellina siblina*
7	*Phoronids*	*Chaetozone corona*	*Euchone limnicola*	*Mediomastus ambiseta*	*Tharyx* sp. C	*Monticellina tesselata*	*Euchone limnicola*
8	*Nereis procera*	*Sigambra tentaculata*	*Haploscoloplos elongatus*	*Carinomella lactea*	Nematoda	*Monticellina* sp. 1	*Mediomastus* spp.
9	*Capitita ambiseta*	*Prionospio cirrifera*	*Sigambra tentaculata*	*Mediomastus californiensis*	*Tharyx* sp. A	*Paraprionospio pinnata*	*Spiophanes berkeleyorum*
10	*Macoma nasuta*	*Schistomeringos longicornis*	*Nephtys cornuta franciscana*	*Paraprionospio pinnata*	*Tharyx tesselata*	*Euclymene grossanewporti*	*Chaetozone corona*

Notes: Surveys conducted throughout Long Beach and Los Angeles Harbors unless indicated otherwise.
* Surveys conducted in Los Angeles Harbor.
** Surveys conducted in Long Beach Harbor.

Table 5.4-1. Total abundance of macroinvertebrates caught over day and night periods by otter trawl in Long Beach and Los Angeles Harbors, February – November 2000.

Common Name	Species	Total Abundance	% of Total
Black spotted shrimp	*Crangon nigromaculata*	4,660	50.73
Tuberculate pear crab	*Pyromaia tuberculata*	2,561	27.88
Xantus swimming crab	*Portunus xantusii*	933	10.16
New Zealand bubble snail	*Philine auriformis* *	409	4.45
Spotwrist hermit crab	*Pagurus spilocarpus*	130	1.42
Graceful crab	*Cancer gracilis*	44	0.48
Gould's bubble snail	*Bulla gouldiana*	33	0.36
Brown shrimp	*Penaeus californiensis*	31	0.34
Striped sea slug	*Navanax inermis*	29	0.32
Northern cranson shrimp	*Crangon alaskensis*	28	0.30
California spiny lobster	*Panulirus interruptus*	26	0.28
Recluz's moonsnail	*Neverita reclusiana*	23	0.25
Spiny brittle star	*Ophiothrix spiculata*	22	0.24
California sea hare	*Aplysia californica*	21	0.23
Stimpson's shrimp	*Heptacarpus stimpsoni*	16	0.17
Bat star	*Asterina miniata*	16	0.17
Short spined sea star	*Pisaster brevispinus*	16	0.17
Festive murex	*Pteropurpura festiva*	14	0.15
Spiny sand star	*Astropecten armatus*	14	0.15
Giant spined star	*Pisaster giganteus*	12	0.13
California sea cucumber	*Parastichopus californicus*	12	0.13
Blacktail shrimp	*Crangon nigricauda*	11	0.12
Fat basket shell	*Nassarius perpinguis*	11	0.12
Octopus	*Octopus* sp.	10	0.11
Warty sea cucumber	*Parastichopus parvimensis*	8	0.09
White sea urchin	*Lytechinus pictus*	7	0.08
Purple sea urchin	*Strongylocentrotus purpuratus*	6	0.07
Rainbow nudibranch	*Dendronotus iris*	5	0.05
Milky venus clam	*Compsomyax subdiaphana*	5	0.05
Sheep crab	*Loxorhynchus grandis*	5	0.05
Spotted ridgeback prawn	*Sicyonia penicillata*	4	0.04
San Diego sea slug	*Diaulula sandiegensis*	4	0.04
Bay ghost shrimp	*Neotrypaea californiensis*	4	0.04
Baetic olive snail	*Olivella baetica*	4	0.04
Sea grape	*Listriolobus pelodes*	3	0.03
Kellet's whelk	*Kelletia kelletti*	3	0.03
Lewis' moonsnail	*Polinices lewisii*	3	0.03
Egg cockle clam	*Laevicardium substriatum*	3	0.03
Moss crab	*Loxorhynchus crispatus*	3	0.03
Round spoon shell	*Periploma discus*	3	0.03
Yellow crab	*Cancer anthonyi*	3	0.03
California cone	*Conus californicus*	2	0.02
Ringed nudibranch	*Discodoris sandiegensis*	2	0.02
Yellow shore crab	*Hemigrapsus oregonensis*	2	0.02
Sea cucumber	*Cucumaria pseudocurata*	2	0.02
Speckled turban	*Tegula gallina*	2	0.02
Sea mouse worm	*Aphrodita* sp.	2	0.02
Basket shell	*Nassarius* sp.	2	0.02
Purple globe crab	*Randallia ornata*	2	0.02
Mudflat octopus	*Octopus bimaculoides*	1	0.01
Red sea urchin	*Strongylocentrotus fransciscanus*	1	0.01
Rosy razor clam	*Solen rosaceus*	1	0.01
Ridgeback prawn	*Sicyonia ingentis*	1	0.01
Flatworm	*Prosthiostomidae*	1	0.01
Basket shell	*Nassarius tiarula*	1	0.01
Bubble snail	*Philine* sp. A (SCAMIT)	1	0.01
Shrimp	*Heptacarpus palpator*	1	0.01
Modest tellin clam	*Tellina modesta*	1	0.01
Channeled basket shell	*Nassarius fossatus*	1	0.01
Red cock shrimp	*Lysmata californica*	1	0.01
Marine worm	*Lyonsia californica*	1	0.01
Sandflat elbow crab	*Heterocrypta occidentalis*	1	0.01
Hairy rock crab	*Cancer jordani*	1	0.01
	Total Abundance	9,185	
	Total Number of Species	61	

Notes: Species listed in decreasing order of abundance.
* = Non-indigenous species.

Table 5.4-2. Mean abundance, biomass, and number of species of macroinvertebrates caught by otter trawl in Long Beach and Los Angeles Harbors, February – November 2000.

Habitat / Station	Depth (m)	Mean Abundance			Mean Biomass (kg)			Mean Number of Species		
		Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Open										
LA1	13	13	19	16	0.04	0.03	0.03	2	3	5
LB1	12	51	46	48	4.31	0.90	2.60	5	3	5
Deepwater Channel										
LA4	16	11	54	32	0.10	0.18	0.14	4	5	7
LB7	24	328	167	247	1.56	1.29	1.43	7	4	8
Deepwater Basin										
LA5	17	18	22	20	0.37	0.57	0.47	4	3	6
LA6	16	18	45	31	0.05	0.58	0.32	4	5	6
LB3	15	125	210	167	0.19	0.17	0.18	3	5	5
LB5	15	16	171	94	0.06	0.37	0.22	3	6	7
Deepwater Slip										
LB4	15	9	17	13	0.52	0.73	0.62	4	5	8
LB6	17	86	244	165	0.12	1.12	0.62	3	5	6
Shallow Mitigation										
LA2A	4	11	42	27	0.95	0.65	0.80	3	3	5
LA2B	4	13	96	54	2.98	1.70	2.34	5	5	7
LA7A	4	12	23	17	3.72	1.16	2.44	4	5	8
LA7B	4	41	14	27	0.53	1.13	0.83	3	4	5
LB2A	6	16	28	22	0.93	0.21	0.57	2	4	6
LB2B	6	10	49	29	0.07	0.28	0.18	3	3	5
Shallow Water Open										
LA3A	4	21	118	70	3.93	2.05	2.99	5	5	7
LA3B	4	27	111	69	1.18	1.82	1.50	3	4	6
Station Mean		46	82	64	1.20	0.83	1.02	4	4	6
Total Survey Mean		823	1,474	1,148	21.60	14.96	18.28	25	23	33
Grand Total		9,185			146.6			61		

Table 5.4-3. Mean diversity and dominance of macroinvertebrates caught by otter trawl in Long Beach and Los Angeles Harbors, February – November 2000.

Habitat / Station	Depth (m)	Shannon-Wiener Diversity			Margalef Diversity			Dominance		
		Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Open										
LA1	13	0.56	0.84	0.91	0.71	0.96	1.01	1	1	2
LB1	12	1.02	0.48	0.97	0.94	0.54	0.93	2	1	2
Deepwater Channel										
LA4	16	1.17	1.11	1.28	1.36	1.17	1.50	3	2	3
LB7	24	0.80	0.77	0.78	1.05	0.63	1.11	2	2	2
Deepwater Basin										
LA5	17	1.04	0.92	1.29	1.08	0.88	1.38	3	2	3
LA6	16	0.97	1.10	1.15	1.00	1.12	1.33	2	3	2
LB3	15	0.64	0.67	0.72	0.59	0.77	0.75	1	1	2
LB5	15	1.16	0.71	0.83	1.44	0.94	1.17	2	1	2
Deepwater Slip										
LB4	15	1.10	1.27	1.56	1.80	1.71	2.32	3	3	4
LB6	17	0.38	0.44	0.51	0.49	0.75	0.86	1	1	1
Shallow Mitigation										
LA2A	4	1.02	0.86	1.28	1.19	0.64	1.37	3	2	3
LA2B	4	1.30	0.96	1.38	1.55	1.05	1.68	3	2	3
LA7A	4	1.30	1.16	1.58	1.76	1.47	2.00	2	3	3
LA7B	4	0.49	0.82	0.73	0.71	0.98	1.14	1	2	1
LB2A	6	0.48	1.20	1.32	0.70	1.30	1.57	2	3	3
LB2B	6	1.05	0.64	0.94	1.07	0.76	1.06	2	1	2
Shallow Water Open										
LA3A	4	1.17	0.95	1.24	1.51	0.97	1.35	2	2	2
LA3B	4	0.79	0.79	1.14	0.93	0.69	0.98	2	2	3
Station Mean		0.91	0.87	1.09	1.11	0.96	1.31	2	2	2

Table 5.4-4. Mean and total abundance of macroinvertebrate species caught over day and night periods by otter trawl in Long Beach and Los Angeles Harbors, February – November 2000.

Species	Mean Abundance																		Total Catch
	Deepwater Open		Deepwater Channel		Deepwater Basin			Deepwater Slip		Shallow Mitigation							Shallow Water Open		
	LA1	LB1	LA4	LB7	LA5	LA6	LB3	LB5	LB4	LB6	LA2A	LA2B	LA7A	LA7B	LB2A	LB2B	LA3A	LA3B	All Stations
Crangon nigromaculata	8.0	28.6	18.3	74.8	7.0	7.3	122.5	74.6	3.0	142.6	9.6	3.9	7.0	1.1	10.6	16.3	27.1	20.3	4,660
Pyromaia tuberculata	3.6	8.8	8.5	163.4	7.6	13.5	36.6	12.1	4.4	11.6	3.5	3.1	4.5	21.9	0.8	4.1	5.9	6.3	2,561
Portunus xantusii	0.6		1.0		0.4		0.4	0.3	0.1	1.5	5.8	37.9	0.6	0.3	5.5	5.4	28.0	29.0	933
Philine auriformis	0.1	0.1	1.6	2.6	0.3	8.3	4.9	2.1	0.1	6.1	5.9	2.0	1.0	0.4	0.1		4.9	10.6	409
Pagurus spilocarpus		7.3	0.1	2.4			0.1	1.8		0.3					2.4	2.0			130
Cancer gracilis	0.1	0.4	0.1			0.1	0.1	0.3					0.3	0.1	1.5	0.1	0.8	1.6	44
Bulla gouldiana											1.0	3.1							33
Penaeus californiensis				0.5				0.3	0.1	1.0			0.1		0.1	0.1	1.1	0.5	31
Navanax inermis				0.4	0.3	0.1			0.1	0.3			1.1	1.4					29
Crangon alaskensis	0.4				2.9		0.1										0.1		28
Panulirus interruptus		1.4		0.5			0.1		0.1	0.1			0.3	0.1	0.1	0.3	0.3		26
Neverita reclusiana	1.3	0.1	0.1				0.3				0.1	0.5			0.3	0.3			23
Ophiothrix spiculata			0.8		0.8	0.1		0.5		0.6									22
Aplysia californica													1.1	1.4			0.1		21
Asterina miniata						0.1			1.9										16
Heptacarpus stimpsoni							2.0												16
Pisaster brevispinus		0.1		0.1						0.1	0.3	0.5	0.3	0.1			0.3	0.3	16
Astropecten armatus		1.0													0.4	0.4			14
Pteropurpura festiva			0.5		0.3	0.4			0.1		0.3	0.3							14
Parastichopus californicus			0.1	0.4				0.5	0.3	0.3									12
Pisaster giganteus				0.1							0.1	0.6					0.4	0.3	12
Crangon nigricauda	1.4																		11
Nassarius perpinguis								0.8		0.4					0.1			0.1	11
Octopus sp.						0.3			0.3			0.1	0.6						10
Parastichopus parvimensis			0.1	0.1		0.1		0.1	0.3	0.3									8
Lytechinus pictus									0.3			0.3		0.3			0.1		7
Strongylocentrotus purpuratus									0.6					0.1					6
Compsomyax subdiaphana				0.5	0.1														5
Dendronotus iris			0.3										0.1	0.1			0.1		5
Loxorhynchus grandis					0.4	0.1			0.1										5
Diaulula sandiegensis			0.1						0.4										4
Neotrypaea californiensis				0.3	0.1	0.1													4

Table 5.4-4. Continued.

Species	Mean Abundance																		Total Catch
	Deepwater Open		Deepwater Channel		Deepwater Basin			Deepwater Slip		Shallow Mitigation							Shallow Water Open		
	LA1	LB1	LA4	LB7	LA5	LA6	LB3	LB5	LB4	LB6	LA2A	LA2B	LA7A	LA7B	LB2A	LB2B	LA3A	LA3B	All Stations
Olivella baetica												0.5							4
Sicyonia penicillata			0.1		0.1			0.1									0.1		4
Cancer anthonyi						0.1										0.3			3
Kelletia kelletti												0.4							3
Laevicardium substriatum												0.3	0.1						3
Listriolobus pelodes				0.4															3
Loxorhynchus crispatus											0.1						0.3		3
Periploma discus				0.4															3
Polinices lewisii		0.3	0.1																3
Aphrodita sp.				0.1					0.1										2
Conus californicus			0.3																2
Cucumaria pseudocurata	0.1							0.1											2
Discodoris sandiegensis			0.1				0.1												2
Hemigrapsus oregonensis						0.3													2
Nassarius sp.												0.3							2
Randallia ornata	0.1																	0.1	2
Tegula gallina				0.3															2
Cancer jordani											0.1								1
Heptacarpus palpator									0.1										1
Heterocrypta occidentalis												0.1							1
Lyonsia californica													0.1						1
Lysmata californica						0.1													1
Nassarius fossatus							0.1												1
Nassarius tiarula																		0.1	1
Octopus bimaculoides				0.1															1
Philine sp. A (SCAMIT)						0.1													1
Prosthiostomidae									0.1										1
Sicyonia ingentis	0.1																		1
Solen rosaceus												0.1							1
Strongylocentrotus fransciscanus									0.1										1
Tellina modesta												0.1							1
Total Catch Across Surveys	16	48	32	247	20	31	167	93	13	165	27	54	17	27	22	29	69	69	9,185

Table 5.4-5. Mean and total biomass of macroinvertebrate species caught by otter trawl in Long Beach and Los Angeles Harbors, February – November 2000.

Species	Mean Biomass (kg)																		Total Biomass
	Deepwater Open		Deepwater Channel		Deepwater Basin				Deepwater Slip		Shallow Mitigation						Shallow Water Open		
	LA1	**LB1**	**LA4**	**LB7**	**LA5**	**LA6**	**LB3**	**LB5**	**LB4**	**LB6**	**LA2A**	**LA2B**	**LA7A**	**LA7B**	**LB2A**	**LB2B**	**LA3A**	**LA3B**	**All Stations**
Panulirus interruptus		2.313		0.413			0.038		0.150	0.094			0.325	0.088	0.400	0.094	0.169		32.65
Pisaster giganteus				0.375							0.281	1.250					1.294	0.725	31.40
Aplysia californica													1.813	0.663			0.300		22.20
Pisaster brevispinus		0.088		0.269						0.156	0.363	0.650	0.194	0.001			0.494	0.563	22.20
Loxorhynchus grandis					0.425	0.169			0.188										6.25
Crangon nigromaculata	0.008	0.039	0.013	0.051	0.006	0.005	0.099	0.055	0.004	0.243	0.014	0.009	0.009	0.003	0.018	0.015	0.023	0.016	5.01
Loxorhynchus crispatus											0.069						0.538		4.85
Portunus xantusii	0.001		0.010		0.006		0.001		0.001	0.006	0.025	0.244	0.004	0.001	0.016	0.011	0.101	0.121	4.40
Pyromaia tuberculata	0.010	0.018	0.011	0.173	0.009	0.019	0.039	0.019	0.008	0.015	0.006	0.005	0.008	0.029	0.001	0.006	0.008	0.008	3.11
Pagurus spilocarpus		0.096	0.001	0.028			0.001	0.009		0.004					0.098	0.029			2.10
Parastichopus californicus			0.001	0.068				0.115	0.016	0.029									1.82
Penaeus californiensis				0.016				0.008	0.001	0.039			0.005		0.003	0.005	0.044	0.030	1.20
Octopus sp.						0.015			0.081			0.025	0.026						1.18
Asterina miniata						0.005			0.135										1.12
Navanax inermis				0.011	0.009	0.003			0.001	0.004			0.053	0.046					1.01
Parastichopus parvimensis			0.036	0.005		0.020		0.006	0.023	0.030									0.96
Bulla gouldiana											0.023	0.060							0.66
Polinices lewisii		0.021	0.050																0.57
Cancer anthonyi						0.069										0.001			0.56
Astropecten armatus		0.040													0.011	0.016			0.54
Cancer gracilis	0.001	0.004	0.001			0.006	0.001	0.003					0.004	0.001	0.016	0.001	0.010	0.024	0.54
Philine auriformis	0.001	0.001	0.001	0.004	0.001	0.005	0.005	0.003	0.001	0.003	0.010	0.006	0.004	0.001	0.001		0.004	0.009	0.43
Pteropurpura festiva			0.004		0.001	0.003			0.001		0.001	0.035							0.35
Neverita reclusiana	0.011	0.003	0.001				0.003				0.001	0.013			0.008	0.003			0.33
Kelletia kelletti												0.025							0.20
Nassarius sp.												0.019							0.15
Dendronotus iris			0.005										0.001	0.001			0.008		0.12
Octopus bimaculoides				0.013															0.10
Sicyonia penicillata			0.001		0.004			0.005									0.004		0.10
Strongylocentrotus purpuratus									0.010					0.001					0.09
Cancer jordani											0.010								0.08
Randallia ornata	0.001																	0.009	0.07

Table 5.4-5. Continued.

Species	Mean Biomass (kg)																		Total Biomass
	Deepwater Open		Deepwater Channel		Deepwater Basin				Deepwater Slip		Shallow Mitigation						Shallow Water Open		
	LA1	LB1	LA4	LB7	LA5	LA6	LB3	LB5	LB4	LB6	LA2A	LA2B	LA7A	LA7B	LB2A	LB2B	LA3A	LA3B	All Stations
Aphrodita sp.				0.001					0.003										0.02
Compsomyax subdiaphana				0.001	0.001														0.02
Crangon nigricauda	0.003																		0.02
Diaulula sandiegensis			0.001						0.003										0.02
Ophiothrix spiculata			0.001		0.001	0.001		0.001		0.001									0.02
Solen rosaceus												0.003							0.02
Conus californicus			0.001																0.01
Crangon alaskensis	0.001				0.001		0.001										0.001		0.01
Cucumaria pseudocurata	0.001							0.001											0.01
Heptacarpus stimpsoni							0.001												0.01
Heterocrypta occidentalis												0.001							0.01
Listriolobus pelodes				0.001															0.01
Lytechinus pictus									0.001			0.001		0.001			0.001		0.01
Strongylocentrotus fransciscanus									0.001										0.01
Discodoris sandiegensis			0.001				0.001												0.01
Hemigrapsus oregonensis						0.001													0.01
Heptacarpus palpator									0.001										0.01
Laevicardium substriatum												0.001	0.001						0.01
Lyonsia californica													0.001						0.01
Lysmata californica						0.001													0.01
Nassarius fossatus							0.001												0.01
Nassarius perpinguis								0.001		0.001					0.001			0.001	0.01
Nassarius tiarula																		0.001	0.01
Neotrypaea californiensis				0.001	0.001	0.001													0.01
Olivella baetica												0.001							0.01
Periploma discus				0.001															0.01
Philine sp. A (SCAMIT)						0.001													0.01
Prosthiostomidae									0.001										0.01
Sicyonia ingentis	0.001																		0.01
Tegula gallina				0.001															0.01
Tellina modesta												0.001							0.01
Total Biomass Across Surveys	0.04	2.62	0.14	1.43	0.47	0.32	0.19	0.22	0.63	0.62	0.80	2.35	2.45	0.84	0.57	0.18	3.02	1.51	146.6

Table 5.4-6. Comparison of total macroinvertebrate catch between 16-foot and 25-foot otter trawls in Long Beach and Los Angeles Harbors, August and November 2000.

Station	August						November						Aug and Nov, Day and Night		
	Day Trawls			Night Trawls			Day Trawls			Night Trawls			Overall Mean		
	25'	16'	Ratio	25'	16'	Ratio	25'	16'	Ratio	25'	16'	Ratio	25'	16'	Ratio
Abundance															
LA1	0	7	0.00	28	5	5.60	26	3	8.67	30	23	1.30	84	38	2.21
LA4	10	45	0.22	50	32	1.56	7	11	0.64	26	18	1.44	93	106	0.88
LA6	45	10	4.50	67	10	6.70	9	2	4.50	41	1	41.00	162	23	7.04
LB1	46	8	5.75		125	0.00	35	17	2.06	31	41	0.76	112	191	0.59
LB4	2	9	0.22	14	15	0.93	2	3	0.67	9	4	2.25	27	31	0.87
LB7	77	25	3.08	200	39	5.13	1032	36	28.67	62	68	0.91	1371	168	8.16
Mean Station Ratio		2.30			3.32			7.53			7.94			3.29	
Mean Across Stations	36	21	1.73	72	45	1.59	222	14	15.43	40	31	1.28	370	111	3.32
Number of Species															
LA1	0	3	0.00	3	2	1.50	4	1	4.00	3	3	1.00	10	9	1.11
LA4	4	2	2.00	3	6	0.50	3	6	0.50	4	4	1.00	14	18	0.78
LA6	4	1	4.00	4	3	1.33	3	2	1.50	6	1	6.00	17	7	2.43
LB1	4	2	2.00	0	5	0.00	4	4	1.00	2	5	0.40	10	16	0.63
LB4	2	7	0.29	3	3	1.00	2	2	1.00	6	3	2.00	13	15	0.87
LB7	5	6	0.83	4	2	2.00	10	2	5.00	3	3	1.00	22	13	1.69
Mean Station Ratio		1.52			1.06			2.17			1.90			1.25	
Mean Across Stations	4	4	0.90	3	4	0.81	5	3	1.53	5	4	1.26	17	16	1.10

Notes:
(1) Ratio is the ratio of (25 foot / 16 foot) otter trawl catch.
(2) To convert 16-foot otter trawl catch data to 25-foot otter trawl catch data, adjust by the inverse ratio (i.e., 1/Ratio).
(3) Only those surveys and stations that used both the 16- and 25-foot nets are included in the comparison (i.e., Surveys 3 and 4; Stations LA1, LA4, LA6, LB1, LB4, LB7).

Table 5.4-7. Comparison of macroinvertebrate catch by species between 16-foot and 25-foot otter trawls used in Long Beach and Los Angeles Harbors, August and November 2000.

Taxonomic Group	Species	Day Trawls		Night Trawls	
		25'	16'	25'	16'
Crustaceans	*Pyromaia tuberculata*	949	149	154	184
	Crangon nigromaculata	250	113	330	247
	Pagurus spilocarpus	12	3	1	10
	Portunus xantusii	1		3	5
	Panulirus interruptus	2	4	1	4
	Crangon alaskensis		2	3	
	Penaeus californiensis		5		
	Cancer sp.		2		2
	Heptacarpus sp.		3		
	Hemigrapsus oregonensis	2			
	Cancer antennarius		1		
	Cancer anthonyi			1	
	Loxorhynchus crispatus				1
	Neotrypaea californiensis	1			
	Pugettia producta		1		
	Randallia ornata		1		
	Sicyonia ingentis	1			
	Sicyonia penicillata			1	
Echinoderms	*Asterina miniata*	1	7	5	1
	Astropecten armatus	5	1		3
	Pisaster brevispinus			1	2
	Lytechinus pictus		1	1	
	Ophiothrix spiculata		1	1	
	Patiria miniata		1		1
	Strongylocentrotus fransciscanus		1		
	Strongylocentrotus purpuratus	1	1		
Molluscs	*Philine auriformis*	46	3	48	2
	Diaulula sandiegensis	1		2	2
	Compsomyax subdiaphana	4			
	Periploma discus	3			
	Navanax inermis	1	2		
	Octopus sp.			2	1
	Tegula gallina	2			
	Acanthodoris brunnea				1
	Anisodoris sp.		1		
	Neverita reclusiana			1	
	Octopus rubescens				1
	Pteropurpura festiva			1	
	Pteropurpura sp.		1		
Other minor phyla	*Parastichopus californicus*	5	1	1	1
	Listriolobus pelodes	3			
	Parastichopus parvimensis			1	
Polychaete	*Aphrodita* sp.	1			1
	Total Abundance	1,291	305	558	473
	Total Number of Species	20	23	19	19

Note: Only those surveys and stations that used both the 16- and 25-foot nets are included in the comparison (i.e., Surveys 3 and 4; Stations LA1, LA4, LA6, LB1, LB4, LB7).

Table 5.4-8. Historical comparison of the ten most abundant macroinvertebrate taxa, in descending order of dominance, collected by otter trawl in Long Beach and Los Angeles Harbors.

Year	1986-1987	1993	1996	1998	1999	2000
Source	MEC 1988*	CLA - EMD 1994*	MEC 1996**	CLA - EMD 1999*	CLA - EMD 2000*	
1	*Balanus pacificus*	*Crangon nigromaculata*	*Pyromaia tuberculata*	*Philine auriformis*	*Crangon nigromaculata*	*Crangon nigromaculata*
2	*Pyromaia tuberculata*	*Pyromaia tuberculata*	*Crangon nigromaculata*	*Portunus xantusii*	*Philine auriformis*	*Pyromaia tuberculata*
3	*Ophiothrix spiculata*	*Pagurus spilocarpus*	*Philine auriformis*	*Crangon nigromaculata*	*Crangon alaskensis*	*Portunus xantusii*
4	*Muricea* spp.	*Portunus xantusii*	*Dendronotus iris*	*Astropecten armatus*	*Sicyonia ingentis*	*Philine auriformis*
5	*Corynactis californica*	*Penaeus californiensis*	*Portunus xantusii*	*Sicyonia ingentis*	*Pyromaia tuberculata*	*Pagurus spilocarpus*
6	*Crangon nigromaculata*	*Kelletia kelletia*	*Loligo opalescens*	*Pyromaia tuberculata*	*Astropencten armatus*	*Cancer gracilis*
7	*Mytilus edulis/californianus*	*Loxorhynchus grandus*	*Pagurus spilocarpus*	*Pagurus spilocarpus*	*Penaeus californiensis*	*Bulla gouldiana*
8	*Portunus xantusii*		*Asterina miniata*	*Nassarius perpinguis*	*Portunus xantusii*	*Panaeus californiensis*
9	*Crepidula dorsata*		*Parastichopus californicus*	*Penaeus californiensis*	*Nassarius perpenguis*	*Navanax inermis*
10	*Chama arcana*		*Octopus* sp.		*Virgularia galapagensis*	*Crangon alaskensis*

Notes: Surveys conducted throughout Long Beach and Los Angeles Harbors unless indicated otherwise.
* Surveys conducted in Los Angeles Outer Harbor.
** Surveys conducted in Long Beach Inner and Outer Harbor.

6.0 RIPRAP BIOTA

6.1 Introduction

Riprap biota occupies much of the shoreline in Long Beach and Los Angeles Harbors. Riprap habitat made of boulders is found at the outer breakwaters and along the shoreline of many of the basins and channels. Pilings that support wharves and piers throughout the harbors also provide hard-bottom substrate for riprap communities. Riprap habitat extends from the upper tidal zone to the subtidal zone.

Riprap habitat provides surface for attachment of invertebrates and algae as well as shelter for motile organisms such as fish. Riprap organisms include overstory organisms that can be observed from the surface and understory organisms that may be concealed by larger organisms.

Riprap biota in the harbors has been examined in past studies. MBC (1984) described the community structure, recovery, and trophic interactions of riprap habitats in Long Beach Harbor and Queensway Bay. Baseline studies of riprap biota in Los Angeles Harbor were conducted by MEC (1988). That report covered reconnaissance and changes through time for dominant overstory riprap organisms, measurements of physical conditions in riprap areas, and spatial and temporal variability and recovery of riprap biota.

The objective of the Year 2000 Baseline Study was to provide an updated characterization of the riprap community in Long Beach and Los Angeles Harbors. Riprap associated invertebrates and algae were surveyed at four locations in each harbor over four seasons. Quadrats were sampled and biologist divers made general field observations to describe physical features and commonly observed organisms. Methods used to survey the community are described in Section 6.2. Ecological information on riprap biota in this report includes community summary measures (Section 6.3), species composition (Section 6.4), dominant species (Section 6.5), and spatial and temporal variation (Section 6.6). The survey results are compared to historical data in Section 6.7. Exotic species considered non-indigenous to the harbors are identified in Section 6.8. The chapter concludes with an integration of the study findings (Section 6.9). Raw summary data are provided in Appendix F.

6.2 Methodology

6.2.1 Diver Surveys

Riprap biota, including invertebrates and algae, were sampled quarterly in early March (winter), May (spring), August (summer), and November (fall) 2000 (Table 6.2-1). Sampling included examination and collection of riprap biota at four locations (inner and outer harbor, north- and south-facing) in each harbor for a total of eight stations (Figure 6.2-1). Stations were identified by harbor (e.g., LBRR1 = Long Beach riprap stations). Photographs were taken at each station to show general distribution of the habitat and tidal zonation (Figures 6.2-2 and 6.2-3).

Long Beach Harbor Station LBRR1 was located at the Pier J breakwater. Riprap boulders were four to five feet in diameter. Station LBRR2 was near the Turning Basin of Cerritos Channel near some gas lines that extend into the water. The upper and lower tidal zones consisted of small boulders, one to two feet in diameter. The subtidal zone was characterized by silt with shell hash and a few rocks. Station LBRR3 was in the Long Beach West Basin. Large, cement slabs were found in the upper and lower tidal zone, and cement slabs and rocks made up the substrate in the subtidal zone. Station LBRR4 was in the Southeast Basin. The upper and lower tidal zones consisted of one- to three-foot-diameter boulders, with three-foot-diameter boulders in the subtidal zone.

Los Angeles Harbor Station LARR1 was on the Middle Breakwater. Boulders were five to six feet in diameter. Station LARR2 was in the East Basin. The upper and lower tidal zones were comprised mostly of cement slabs, with some rocks in the lower zone. The subtidal zone had a few rocks, some debris, and silt. A large amount of debris (e.g., concrete rubble, tires, boards, metal debris) was observed on the boulders. Station LARR3 was in the Los Angeles West Basin near a loading dock. Divers swam through pilings to reach the site, which had concrete substrate in the upper and lower tidal zones and concrete with rocks (1.5 ft in diameter) in the subtidal zone. Station LARR3 differed from all other sites in being shaded by the wharf. Station LARR4 was situated at the end of the G.A.T.X. Terminal in outer Los Angeles Harbor. Large, concrete blocks were found throughout the upper, lower, and subtidal zones.

Similar to the 1987-1988 baseline surveys, riprap sampling for understory organisms in the present study utilized two quadrats (7.5- by 15-cm), established at three tidal levels (upper intertidal, lower intertidal, and subtidal). Tidal levels were defined based on water level and the dominant species characterizing the tidal zonation of each level. The upper intertidal represented the high tide zone and was dominated by barnacles. The lower intertidal ranged from mid-tide to low tide and was characterized by the occurrence of mussels. The shallow subtidal zone ranged a few feet below Mean Lower Low Water (MLLW). NOAA tide charts for Long Beach Harbor were used for tide reference. For each tidal level, all of the organisms in a randomly sited 7.5- x 15-cm quadrat were removed by scraping with a 2.5-cm-wide chisel. Scrapings were placed in 0.333-mm mesh labeled bags, transferred to the surface, placed in jars labeled with station identification numbers, and fixed in 10% buffered formalin. For each survey, there were a total of 48 samples (8 stations x 3 strata x 2 replicates). Organisms observed by the diving biologists outside the quadrats, in particular those in the overstory, were recorded by species and relative abundance (i.e., abundant, common, or few).

In the laboratory, scraped quadrat samples were sorted into six major taxonomic groups, including molluscs, polychaetes, crustaceans, echinoderms, minor invertebrate phyla (others), and algae. Organisms were identified to the lowest practicable taxon (usually species) and counted. Algae and colonial animals were classified as present, common, or abundant based on the presence of one, two to five, or more than five colonies or holdfasts per sample, respectively. Wet weight biomass was measured for each of the six taxonomic groups.

6.2.2 Data Analyses

Count and biomass data for the scraping samples were entered into a database from the taxonomic laboratory sheets and reviewed for completeness. Data for these samples are presented as abundance and biomass per 0.01125 m^2 (7.5 cm by 15 cm area). ANOVA was performed on the scraping data for number of species, $\log_{10}$ transformed abundance, and biomass to look for seasonal differences.

Diversity was calculated with three different indices, which are derived measures based upon the number of species (species richness) and their abundances (equitability). The Shannon-Wiener diversity index tends to emphasize the equitability of the species distribution in a community. The Margalex Index incorporates the number of species and total number of individuals. The Dominance Index computes the number of species that account for 75% of the total abundance.

Figures showing seasonal trends in community summary measures (abundance, biomass, species) label the surveys according to month-year (e.g., Mar-00).

6.3 Community Summary Measures

Abundance

For the four surveys, a total of 13,434 invertebrates/0.01125 m^2 was collected from riprap scrapings (Table 6.3-1). Mean total abundances (mean of the eight stations) were similar for the three strata, varying from 134 individuals/0.01125 m^2 found in the subtidal to 145/0.01125 m^2 in the upper intertidal (Table 6.3-1). Abundance of invertebrates in scraped quadrats followed a gradient with higher numbers in the outer harbor and lower numbers in the inner harbor (Figure 6.3-1). Mean total abundance across tidal zones was similarly high (> 650 individuals/0.01125 m^2) at stations on the Middle Breakwater (LARR1), near the GATX Terminal (LARR4), and Pier J breakwater (LBRR1). Moderate mean total abundance values ranged from 381 to 418/0.01125 m^2 in Long Beach West (LBRR3) and Southeast (LBRR4) Basins. Mean total abundance values were lower (202 to 317/0.01125 m^2) at inner harbor stations in the Cerritos Channel and Los Angeles Harbor East Basin (LBRR2, LARR2). The lowest mean total abundance (22/0.01125 m^2) was recorded in Los Angeles West Basin at Station LARR3, which differed from the other sites in being shaded by a wharf.

Among the eight stations, Station LARR4 had the greatest mean total abundance of invertebrates in the upper stratum (442), Station LARR1 had the greatest number in the lower stratum (315), and Station LBRR1 had the highest number in the subtidal zone (317) (Table 6.3-1). Again, Station LARR3 had the lowest mean total abundances (3 to13 individuals/0.01125 m^2) for all three strata.

Total mean abundance was lowest in winter and greatest in summer (Figure 6.3-2). This seasonal pattern was exhibited by each stratum, except abundance continued to increase through November in the upper intertidal (Appendix F). The seasonal differences were not statistically significant.

Biomass

For the four surveys and eight stations, the overall mean total biomass was 169.3 g/0.01125 m^2, with 12.3% (20.8 g/0.01125 m^2) in the upper tidal zone, 38.1% (64.6 g/0.01125 m^2) in the lower tidal zone, and 49.5% (83.9 g/0.01125 m^2) in the subtidal zone (Table 6.3-1). For the eight stations, mean total biomass ranged from 8.1 (Station LBRR1) to 33.1 g/0.01125 m^2 (Station LARR2) in the upper zone, 40.4 (Station LARR2) to 101.2 g/0.01125 m^2 (Station LBRR3) in the lower zone, and 28.1 or 28.2 (Stations LARR1, LARR3) to 218.8 g/0.01125 m^2 (Station LBRR3) in the subtidal zone.

Number of Species

A total of 265 species was found in the riprap scrapings for the eight stations and four surveys (Table 6.3-1). The number of species increased with depth with the lowest total number (60 species) in the upper intertidal, a moderate total number (124 species) in the lower intertidal, and the highest total number (226 species) in the subtidal zone (Appendix F.3.2).

Spatial patterns in number of species varied somewhat among different tidal zones. Stations on the Middle Breakwater (LARR1), Pier J Breakwater (LBRR1), and in Long Beach West (LBRR3) and Southeast (LBRR4) Basins had the highest mean number of species (41 to 55/0.01125 m^2) across surveys (Figure 6.3-1; Table 6.3-3). Station LARR4 near the GATX Terminal in outer Los Angeles Harbor had a lower mean value (35 species/0.01125 m^2) similar to those (26 to 34 species/0.01125 m^2) in the Cerritos Channel (LBRR2) and Los Angeles East Basin (LARR2). Similar to abundance, Station LARR3 in Los Angeles West Basin had the fewest number of species (16/0.01125 m^2). Station LARR1 had the greatest mean total number of species in the upper (13/0.01125 m^2) and lower (25/0.01125 m^2) intertidal zones (Table 6.3-1). In the subtidal zone, the greatest mean total number of species per station was 40/0.01125 m^2, found at Stations LARR1, LBRR1, and LBRR3. However, Station LARR3 had the lowest mean number of species over all three tidal zones (4 to 10/0.01125 m^2).

Of the four surveys, the winter survey had the highest mean number of species and the summer survey the lowest (Figure 6.3-2). However, these differences were not statistically significant.

Diversity and Dominance

Values for diversity indices (Shannon-Wiener, Margalef, Dominance) were greatest in subtidal waters (Table 6.3-1). Mean Shannon-Wiener diversity was 1.39 in the upper tidal zone, 2.02 in the lower tidal zone, and 2.89 in the subtidal zone. Mean Margalef diversity was 2.70 in the upper tidal zone, 5.09 in the lower tidal zone, and 10.07 in the subtidal zone. For both indices, values were generally highest in the March survey compared to the other three surveys (Appendix F.2). For the upper and lower intertidal strata, Shannon Wiener diversity was greatest (2.2 in the upper and 2.53 in the lower intertidal) at Station LARR3 in the Long Beach West Basin, and lowest (1.01 in the upper and 1.41 in the lower intertidal) at Station LARR2 in Los Angeles East Basin (Table 6.3-4). For the subtidal zone, Shannon Wiener diversity was greatest (3.43) at Stations LARR1 (Middle Breakwater) and LBRR4 (Long Beach Southeast Basin) and lowest (1.9) at Station LARR3 (Los Angeles East Basin). No station patterns were seen in Margalef diversity.

Dominance values ranged from 2 to 6 (mean = 3) in the upper tidal zone, from 2 to 7 (mean = 4) in the lower tidal zone, and from 5 to 19 (mean = 11) in the subtidal zone (Table 6.3-1). Among the eight stations, Station LARR3 (Los Angeles West Basin) had the highest dominance values in the upper and lower intertidal zones but the lowest in the subtidal zone. No other station patterns were observed for this index. In general, dominance was higher in March than in the other seasons (Appendix F.2).

6.4 Species Composition

A complete list of species found at riprap stations in the quadrat scrapings and by diver observations is presented in Appendix F.1.

Scraped Quadrats

At all eight stations surveyed by scrapings, crustaceans were the taxonomic group with the highest abundances and greatest number of species (Tables 6.3-2 and 6.3-3; Appendix F.3). Crustaceans made up 87.6% of the mean total abundance (127/0.01125 m^2) in the upper intertidal zone, 61.7% in the lower intertidal zone, and 61.2% (82/0.01125 m^2) in the subtidal zone (Figure 6.3-3; Table 6.3-2). Molluscs comprised 11.7% (17/0.01125 m^2) of the mean total abundance for the upper intertidal zone, 31.9% (45/0.01125 m^2) for the lower intertidal zone, and 15.7% (21/0.01125 m^2) for the subtidal zone.

Crustaceans contributed most to biomass in the upper intertidal zone, with 14.19 g/0.01125 m^2, or 68.1% of the mean total biomass (Table 6.3-4). Molluscs comprised most of the mean biomass in the lower intertidal and subtidal zones, with 47.78 (74.0%) and 72.82 g/0.01125 m^2 (86.8%), respectively. Molluscs comprised the greatest portion of the biomass at all stations, except LARR1, where crustaceans were dominant (Figure 6.3-3; Table 6.3-4). Mean total biomass was greatest in winter (67.75 g/0.01125 m^2) and ranged from 50.97 to 54.88 g/0.01125 m^2 for the other three seasons (Figure 6.3-2; Appendix F.2). There was no statistically significant difference in biomass over the seasons.

Among taxonomic groups, outer harbor Stations LARR1, LARR4, and LBRR1 had the highest crustacean abundances, and numbers of species of crustaceans were greatest at Stations LARR1, LBRR1, and LBRR3 (Figure 6.3-3, Tables 6.3-2 and 6.3-3).

Within the polychaete group, abundance and number of species were greatest at outer harbor Stations LARR1 and LBRR1 (Figure 6.3-3; Tables 6.3-2 and 6.3-3). *Polydora limicola* was found in high numbers at both these stations (Appendix F.3).

Station LARR1 had the greatest abundance, and Stations LARR1 and LBRR3 had the most number of molluscan species (Figure 6.3-3, Tables 6.3-2 and 6.3-3). Open water stations LARR1, LARR4, and LBRR1 and Long Beach West Basin Station LBRR3 had relatively high numbers of the Mediterranean mussel *Mytilus galloprovincialis* (Appendix F.3). The clam *Lasaea subviridis* was particularly abundant at Stations LARR1 and LBRR3. Five species of the limpet *Collisella* were found, and four of them occurred at open water Station LBRR1.

For echinoderms, the greatest abundance occurred at Long Beach West and Southeast Basins (Stations LBRR3 and LBRR4) (Table 6.3-2). Few species of echinoderms were collected in the quadrat scrapings. The brittlestar *Amphipholis squamata*, which lives in algal holdfasts, branches of coralline algae, and rock crevices, was particularly abundant at these stations (Appendix F.3).

Abundance of miscellaneous taxa in scraped quadrats was greatest at Station LARR1 on the Middle Breakwater. The aggregating anemone *Anthropleura elegantissima* was the highest contributor to this abundance.

Station LARR1 on the Middle Breakwater and Station LARR4 near the G.A.T.X. Terminal had the highest biomass of algal species in the scraped quadrats. The highest number of species of algae (14) was collected in quadrats at Station LARR1 on the Middle Breakwater (Appendix F.3.1). Most other stations had 6 to 8 species of algae collected. Exceptions included Station LBRR4 in Long Beach Southeast Basin, where no algae were collected, and Station LARR3 in Los Angeles West Basin where only two species of algae were collected in quadrats. The brown alga *Colpomenia sinuosa* had the highest frequency, occurring at seven of the eight stations.

Diver Observations

Overstory organisms were determined by diver observations of the riprap habitat (Appendix F.5). Many species were the same as those found in the understory (or scraping samples) such as *Balanus*, *Chthalamus*, mussels, etc. Several other species, on the other hand, were not collected in the understory scraped samples. These included large organisms such as starfish (*Brisaster*, *Pisaster*, *Asterina*), sea cucumber (*Parastichopus*), moss crab (*Loxorhynchus grandis*), California spiny lobster (*Panulirus interruptus*), wavy turban (*Astraea undosa*), and giant keyhole limpet (*Megathura crenulata*). Many fish were also observed, including topsmelt (*Atherinops affinis*), blacksmith (*Chromis punctipinnis*), pile perch (*Rhacochilus vacca*), black perch (*Embiotoca jacksoni*), opaleye (*Girella nigricans*), bay blenny (*Hypsoblennius gentilis*), rockpool blenny (*H. gilberti*), rainbow seaperch (*Hypsurus caryi*), garibaldi (*Hypsypops rubicundus*), bat ray (*Myliobatis californica*), kelp bass (*Paralabrax clathratus*), barred sand bass (*P. nebulifer*), and white seaperch (*Phanerodon furcatus*). Substantially more of these organisms were observed at the outer and middle harbor riprap stations.

Overstory macroalgae occurred at most stations. Giant kelp (*Macrocystis pyrifera*), feather boa kelp (*Egregia menziesii*), and sargassum (*Sargassum muticum*) occurred in the subtidal at Station LBRR3 in Long Beach West Basin. Feather boa kelp was observed at all outer harbor stations (LARR1, LARR4, LBRR1) and in the Cerritos Channel (LBRR2). Sargassum also occurred in the Cerritos Channel (LBRR2), and was present in Los Angeles East Basin (LARR2). Fewer overstory algal species were observed in the inner harbor.

The organism most commonly observed in Los Angeles East Basin (LARR3) was the oyster *Crassostrea gigas*. No macroalgae was observed by divers in Los Angeles East Basin at Station LARR3.

6.5 Dominant Species

Species with overall abundances (all stations, all surveys) of at least 5% of the total in scraped quadrats per stratum are listed in Table 6.3-5 (See also Appendix F.5). Also listed on Table 6.3-5 are overstory species observed to have common (1 to 2 individuals per m^2) and/or abundant (> 10 per m^2) occurrence.

The acorn barnacles *Chthalamus fissus* and *Balanus glandula* comprised 47.0% and 37.5 % of the overall total abundance, respectively, in the upper intertidal zone. These barnacles are common in the upper tidal zone and the upper portion of lower tidal zone on rocks and pier pilings from San Francisco to Baja California (Newman and Abbott 1980). Their high abundances in these zones are due to their high resistance to desiccation. Where they co-occur, *B. glandula* generally out competes *C. fissus* for space, but *B. glandula* is also the preferred food item for several larger invertebrates; thus, both species occur in high numbers. The rough limpet *Collisella scabra* also was abundant in the upper intertidal (4.9% of total abundance). This limpet is common in the upper tidal zone of rocky areas from Cape Arago Oregon to southern Baja California (Morris et al. 1980). Divers also noted *Littorina* snails as common to abundant in the upper intertidal of most sites. Station LARR3 under the wharf in Los Angeles West Basin lacked these indicator species in the upper intertidal. Instead the upper to lower intertidal was dominated by the oyster *Crassostrea gigas*.

The Mediterranean mussel *M. galloprovincialis* extended from the mid-tide through lower intertidal (13.4% of total abundance) to the subtidal (8.3% of total abundance) zones, as is typical of this species. The clam *Lasaea subviridis*, which lives among the byssal threads of mussels, also characterized the lower tidal zone (9.3% of total abundance) at some stations (Table 6.3-5). Barnacles co-occurred with the mussels in the middle to lower intertidal zone, and the rough limpet also was relatively abundant. Sea anemones (*Anthopleura*), chitons (*Polyplacophora*), gooseneck barnacles (*Pollicipes polymerus*), *Tetraclita* barnacles, and *Littorina* (which migrate up and down with tide level) characterized this stratum. Mussles comprised more of the abundance at outer harbor stations (LARR1, LARR4, LBRR1) and in Long Beach West Basin (LBRR3). A greater variety of species characterizing the lower intertidal zone were found on the Middle Breakwater (Station LARR1). Again, the riprap community at Station LARR3 was dominated by oysters.

The subtidal scraped quadrats were dominated by several of the same species from the higher tidal levels, but at lower abundances. The crustaceans *Joeropsis* sp. (4.7% of total abundance), *Paramicrodeutopus schmitti* (4.9% of total abundance), and tanaids (15.7% of total abundance) were found in high numbers in the subtidal zone (Table 6.3-5). Other common to abundant species in the subtidal, depending on station, included sea anemones, wavy turban snail (*Astraea undosa*), purple sea urchins (*Strongylocentrotus purpuratus*), worm snails (vermetid gastropods), several species of algae, and fish. A greater variety of common to abundant overstory species was noted on the Middle Breakwater (Station LARR1).

6.6 Summary of Spatial and Temporal Variations

Spatial patterns for riprap abundance are summarized in Figure 6.3-1. Mean annual abundance was highest in outer harbor stations (LARR1, LARR4, and LBRR1), intermediate in middle harbor basin stations (LBRR4, LBRR3), lower in inner harbor Los Angeles East Basin and Cerritos Channel (LARR2, LBRR2), and lowest in Los Angeles West Basin (Station LARR3). Number of species for the four surveys was highest in the outer harbor on the Middle Breakwater (LARR1), on Pier J riprap (LBRR1), and on riprap in the West Basin (LBRR3). The most poorly developed assemblage, which was dominated by Pacific oyster, occurred at Station LARR3. That station differed from all others in being shaded by a wharf.

Abundance and number of species were greatest in the open water stations due to greater water circulation and tidal flushing in these areas. Of the eight stations surveyed, Station LARR3 was the furthest from open waters and shaded by a wharf. Both factors probably contributed to low abundance and number of species at this station.

Temporal variations in the riprap community were slight and no statistical differences in abundance, biomass, or number of species were detected.

6.7 Historical Comparisons

Previous studies of the riprap community in Long Beach and Los Angeles Harbors have been limited (see MEC 1988). Historical studies have indicated that tidal level was a major factor in determining of the distribution of riprap organisms. Location within the harbor and season of the year also contributed. Reish (1982b) studied two locations, one at the Seaplane Anchorage and the other on the outer edge of the Navy Mole, and found considerable seasonal variability in abundance, biomass, and number of species in scraped quadrat samples. The high tide zone was dominated by barnacles (*Chthamalus fissus* and *Balanus glandula*), and mussels were conspicuous in the lower intertidal zone although many other organisms such as crustaceans, polychaetes, and other molluscs were associated with the lower intertidal community.

MBC (1984) reported that the middle tidal zone in Long Beach Harbor and Queensway Bay was dominated by *Chthalamus* (*C. fissus* and *C. dalli*), *B. glandula*, and *C. scabra* during all seasons. Mussels, *Chthalamus*, *B. glandula*, the slipper snail *Crepidula onyx*, nematodes, and *Polydora* characterized the lower and subtidal zones in Queensway Bay (near a freshwater source) for all seasons. Mussels and high abundances of other dominant species were found in the lower tidal zone in the outer Long Beach Harbor in most seasons; and mussels, coralline algae, and low abundances of dominant species were found in the subtidal zone in the outer harbor in most seasons. MBC (1984) reported that abundances of riprap biota in Long Beach Harbor and Queensway Bay were greatest in lower intertidal zones, followed by subtidal zones, and were lowest in middle tidal zones. Number of species showed a gradient across tidal zones, with the most species in the subtidal zone, followed by the lower intertidal zone, and then the upper intertidal zone. Number of species was greater in the outer harbor compared to areas affected by freshwater runoff.

MEC (1988) conducted an extensive study of riprap biota throughout inner and outer Los Angeles Harbor. Various species of barnacles dominated the upper tidal stratum; and mussels, barnacles, bryozoans, algae, and other groups dominated the lower intertidal and subtidal levels. Abundance of riprap biota was significantly lower in the upper intertidal zone compared to the lower intertidal and subtidal zones. Number of riprap species was significantly higher in the subtidal zone and significantly lower in the upper intertidal zone, while the lower intertidal zone had an intermediate number of species. Species distributions within these groups varied between inner and outer harbor locations. Coastal taxa such as *Tetraclita rubescens* and *Chthalamus* were found in the outer harbor; whereas *Balanus amphitrite*, which is considered a bay taxon, was found in the inner harbor. Within the outer harbor, distribution of dominant taxa, particularly in the lower intertidal zone, was affected by water movement. At Terminal Island, where there was strong wave exposure, the upper intertidal zone supported *Chthalamus*, limpets, shore crabs (*Pachygrapsus crassipes*), and *B. glandula*, and the lower intertidal zone supported mussels, *Chthalamus*, *B. glandula*, and *T. rubescens*. At San Pedro Breakwater, where there was less water movement, the upper zone was characterized by *Chthalamus*, the isopod *Ligia*, and shorecrabs; and the aggregate anemone, *B. glandula*, *T. rubescens,* and the feather boa kelp *Egregia menziesii* were found in the lower intertidal zone. Although temporal variation was seen in several riprap species, temporal differences for the most part were not significant.

The present study indicated that the riprap community has been fairly stable in the harbors over the last couple of decades. Distinct tidal zonation and similar species dominants have been documented in the 2000 and historical studies. The acorn barnacles *Balanus* and *Chthalamus* made up about 85% of the abundance of the upper intertidal zone, and over 50% of the middle to lower intertidal zone in 2000. The rough limpet made up about 5% of the upper and 5% of the lower intertidal zones. Mussels were dominant in the middle to lower intertidal and shallow subtidal zones. Also similar to previous studies, *Tetraclita* was a dominant in the lower intertidal, and a variety of invertebrates and algae characterized the shallow intertidal. While *B. amphitrite* was used as a community indicator of inner harbor riprap in 1986-1987 (MEC 1988), it was not a dominant species in 2000. *B. amphitrite* was found in highest densities at inner harbor stations in 2000; however, *B. glandula* and *C. fissus* were much more abundant than *B. amphitrite* at inner harbor stations similar to other areas of the harbors.

Although previous studies showed substantial differences in abundance among tidal zones, abundances in scraped quadrats were similar for the three tidal zones in the present study. It is likely that abundance reported for different tidal zones relates to where the samples were taken, and slight method differences account for the different abundance relationships reported by MBC (1984), MEC (1988), and in the present study. The present and historical studies are similar in reporting an increase in number of species with increasing depth. Also similar to the 1986-1987 study (MEC 1988), the riprap community was more developed in the outer harbor where there is good tidal flushing and less developed in the inner harbor where circulation is less.

6.8 Exotic Species

The list of dominant species on Table 6.3-5 and complete list in Appendix F.1 include symbols indicating non-indigenous (*) or cryptogenic (?) species. A total of 16 non-indigenous and 13 cryptogenic species were identified among the 265 species observed in the riprap community. Thus, about 11% of the riprap fauna are potentially non-native in origin.

The most conspicuous non-indigenous species observed in the riprap community was the Mediterranean mussel *Mytilus galloprovincialis*. That mussel is widespread throughout the harbors, and was noted at all riprap stations except in Los Angeles East Basin (LARR3). This mussel has occurred in the harbor for many years, but was misidentified in earlier studies as *Mytilus edulis*.

The non-indigenous Pacific oyster *Crassostrea gigas* occurred in relative high abundance at Station LARR3 in Los Angeles West Basin. The distribution of that oyster in the harbors is being studied by the California Department of Fish and Game, who indicate that the highest densities are in the Los Angeles West Basin, followed by moderate densities in the Main Channel and East Basin, and lower densities in Cerritos Channel and Pier 300 (R. Lewis, personal communication). Few locations in Long Beach Harbor have this oyster. That oyster originates from Asia and was introduced to northern California for commercial purposes, but no known successful commercial introduction was established in southern California (R. Lewis, personal communication).

A total of 14 other non-indigenous species were collected, many of them the same as noted in the benthic infauna collections. These included the polychaetes *Boccardia hamata, Dipolydora giardi, D. socialis, Neanthes acuminata, Nicolea gracilibranchis, Polydora cornuta, P. ligni, P. limnicola, P. websteri, Pseudopolydora paucibranchiata, Syllis (Syllis) gracilis, S. (Typosyllis) fasciata, S. (Typosyllis) nipponica,* and *S. (Typosyllis) orientalis.* The cryptogenic species included several crustaceans and polychaetes (Appendix F.1).

6.9 Summary

A total of 265 species of invertebrates and algae were identified within the riprap community. Distinct tidal zonation was observed with increasing numbers of species with increasing depth. However, abundances were similar throughout the upper and lower intertidal and subtidal zones.

The riprap community of Long Beach and Los Angeles Harbors has been fairly stable with similar zonation and dominant species since the 1980s. Similar to historical studies, barnacles dominated the upper intertidal and were conspicuous in the middle to lower intertidal strata. The non-indigenous Mediterranean mussel *Mytilus galloprovincialis* was a dominant in the lower intertidal and shallow subtidal. Tanaid and amphipod crustaceans also were dominant species in the shallow subtidal. Other commonly observed fauna included crabs, sea anemones, sea urchins, and starfish in lower intertidal and shallow subtidal zones. Giant kelp and/or feather boa kelp were overstory species in the subtidal zone of riprap stations in the outer harbor, and sargassum and to a lesser extent feather boa kelp were observed in the inner harbor. The greater variety of species on riprap in the outer harbor relative to the inner harbor also was consistent among the present and historical studies.

Most members of riprap community were native species, and approximately 11% were potentially non-native. Conspicuous non-indigenous species included the Mediterranean mussel and Pacific oyster. While the Mediterranean mussel has been a common inhabitant of the harbor for many years, the occurrence of the Pacific oyster is fairly recent and is localized mainly in Los Angeles Harbor. Its occurrence was not reported during comprehensive studies of Los Angeles Harbor in 1986-1987, and apparently has established since then.

Figure 6.2-1. Riprap sampling stations in Long Beach and Los Angeles Harbors, March - November 2000.

Station LBRR1

Station LBRR2

Station LBRR3

Station LBRR4

Figure 6.2-2. Photographs of riprap stations in Long Beach Harbor.

Station LARR1

Station LARR2

Station LARR3

Station LARR4

Figure 6.2-3. Photographs of riprap stations in Los Angeles Harbor.

Figure 6.3-1. Mean annual abundance (and number of species) of riprap biota across tidal zones in Long Beach and Los Angeles Harbors, March - November 2000.

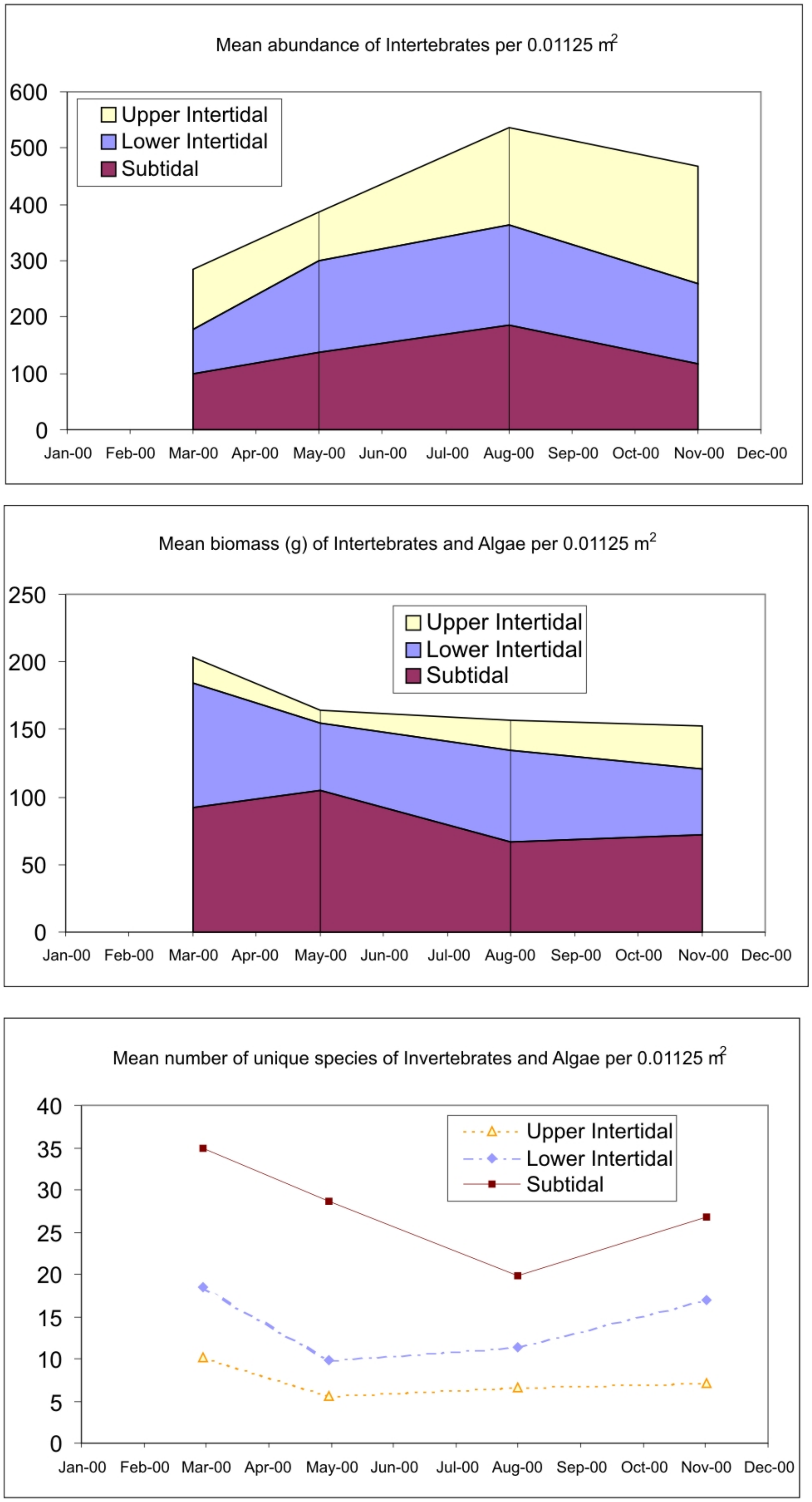


Figure 6.3-2. Seasonal mean abundance, biomass ,and number of species riprap biota by tidal zones in Long Beach and Los Angeles Harbors, March - November 2000.

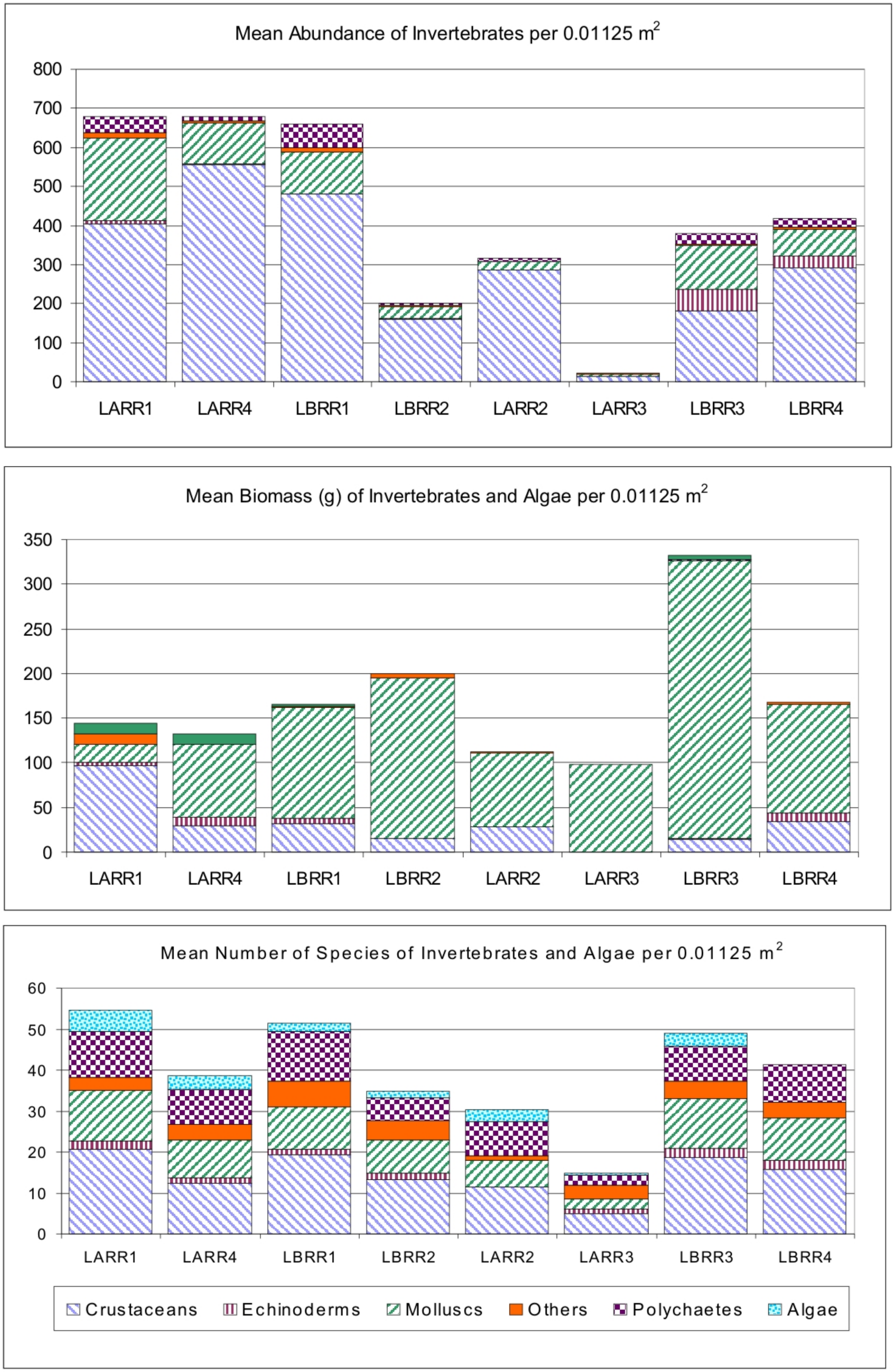


Figure 6.3-3. Mean abundance, biomass, and number of species of riprap biota by taxonomic groups across tidal zones in Long Beach and Los Angeles Harbors, March - November 2000.

Table 6.2-1. Survey schedule and conditions for riprap sampling in Long Beach and Los Angeles Harbors, March – November 2000.

Date	Season	Sampling Time	Weather Conditions	Notable Observations
03-Mar-00	Winter	0900-1700	Overcast with some light rain	Trash and debris at LBRR2, LBRR4, and LARR2, visibility 2.5-4 ft.
08-May-00	Spring	0950-1635	Sunny and warm	Trash and debris at LARR3 and LBRR2, visibility 7-10 ft.
07-Aug-00	Summer	1030-1615	Sunny and warm	Trash and debris at LBRR4, LBRR2, LARR2, visibility 9-20 ft.
21-Nov-00	Fall	1040-1515	Sunny and warm	Trash and debris at LBRR2, LBRR4, LARR2, visibility 10-18 ft.

Table 6.3-1. Mean abundance, biomass, number of species, diversity, and dominance of riprap biota by tidal zones in Long Beach and Los Angeles Harbors, March – November 2000.

Tidal Zone	Habitat	Station	Abundance*	Biomass	Number of Species	Shannon-Wiener Diversity*	Margalef Diversity*	Dominance
Upper Intertidal	Open	LARR1	189	32.37	13	1.66	3.32	3
		LARR4	442	23.90	11	1.03	2.27	2
		LBRR1	118	8.13	8	1.14	2.11	2
	Channel	LBRR2	76	12.29	10	1.20	2.98	2
	Basin	LARR2	120	33.13	7	1.01	1.94	2
		LARR3	3	27.15	4	2.20	3.83	6
		LBRR3	71	12.36	10	1.64	2.65	3
		LBRR4	141	17.40	10	1.25	2.53	2
Upper Intertidal Mean			145	20.84	9	1.39	2.70	3
Lower Intertidal	Open	LARR1	315	83.35	25	2.33	6.02	5
		LARR4	189	65.43	23	2.16	6.64	4
		LBRR1	224	74.24	24	2.13	6.91	4
	Channel	LBRR2	40	63.11	13	1.87	4.15	3
	Basin	LARR2	135	40.36	16	1.41	3.97	2
		LARR3	7	43.11	9	2.53	4.55	7
		LBRR3	96	101.19	13	1.96	4.87	4
		LBRR4	120	46.05	14	1.78	3.57	3
Lower Intertidal Mean			141	64.60	17	2.02	5.09	4
Subtidal	Open	LARR1	175	28.18	40	3.43	12.98	19
		LARR4	49	43.18	21	2.50	7.20	8
		LBRR1	317	83.66	40	2.71	12.73	6
	Channel	LBRR2	87	124.85	27	3.24	10.60	13
	Basin	LARR2	62	39.41	23	2.58	7.25	8
		LARR3	13	28.09	10	1.90	5.84	5
		LBRR3	214	218.83	40	3.32	11.85	13
		LBRR4	158	104.95	33	3.43	12.10	16
Subtidal Mean			134	83.89	29	2.89	10.07	11
Total Mean Across Tidal Zones			420	169.34	39	2.10	5.95	6
Grand Total Across Surveys			13,434	5,418.79	265			

Notes: Values are per 0.01125 m^2 quadrat.
* Algae not included.

Table 6.3-2. Mean abundance of riprap invertebrates within taxonomic groups by and across tidal zones in Long Beach and Los Angeles Harbors, March – November 2000.

Tidal Zone / Habitat	Station	Crustaceans	Echinoderms	Molluscs	Other Minor Phyla	Polychaetes	Mean Total	Grand Total Across Surveys
Upper Intertidal								
Open	LARR1	150	0	37	2	0	189	755
	LARR4	403	0	39	0	0	442	1,769
	LBRR1	106	0	12	0	0	118	474
Channel	LBRR2	68	1	7	0	0	76	303
Basin	LARR2	115	0	5	0	0	120	480
	LARR3	1	0	2	0	0	3	11
	LBRR3	55	0	16	0	0	71	285
	LBRR4	120	0	20	0	0	141	563
Upper Intertidal Mean		127	0	17	0	0	145	4,636
Lower Intertidal								
Open	LARR1	138	0	153	10	14	315	1,261
	LARR4	128	0	48	5	8	189	756
	LBRR1	159	0	47	5	14	224	897
Channel	LBRR2	30	0	9	1	0	40	159
Basin	LARR2	122	0	12	0	1	135	541
	LARR3	3	1	2	0	0	7	27
	LBRR3	37	0	57	1	2	96	384
	LBRR4	82	0	33	3	2	120	478
Lower Intertidal Mean		87	0	45	3	5	141	4,502
Subtidal								
Open	LARR1	117	7	22	4	25	175	698
	LARR4	25	1	19	1	4	49	197
	LBRR1	215	1	48	6	47	317	1,270
Channel	LBRR2	61	3	15	2	6	87	347
Basin	LARR2	49	0	5	0	8	62	249
	LARR3	10	0	1	2	0	13	52
	LBRR3	91	55	38	2	28	214	855
	LBRR4	89	29	17	4	20	158	631
Subtidal Mean		82	12	21	2	17	134	4,296
Total Mean Across Tidal Zones								
Open	LARR1	405	7	212	15	40	678	2,714
	LARR4	556	1	106	5	12	680	2,721
	LBRR1	480	1	108	11	60	660	2,640
Channel	LBRR2	159	3	30	3	7	202	808
Basin	LARR2	285	0	23	0	9	317	1,270
	LARR3	14	1	5	2	1	22	89
	LBRR3	182	55	112	2	30	381	1,523
	LBRR4	292	29	70	6	22	418	1,671
Total Mean Across Tidal Zones		297	12	83	6	22	420	NA
Grand Total Across Surveys		9,490	390	2,657	180	718	NA	13,434

Notes: Values are per 0.01125 m^2 quadrat.
NA = not applicable.

Table 6.3-3. Mean number of species of riprap biota within taxonomic groups by and across tidal zones in Long Beach and Los Angeles Harbors, March – November 2000.

Tidal Zone / Habitat / Station		Crustaceans	Echinoderms	Molluscs	Other Minor Phyla	Polychaetes	Algae	Mean Total	Grand Total Across Surveys
Upper Intertidal									
Open	LARR1	4	0	4	3	1	1	13	25
	LARR4	4	0	4	1	2	0	11	18
	LBRR1	3	0	4	1	0	0	8	14
Channel	LBRR2	4	1	3	2	1	0	10	18
Basin	LARR2	4	0	2	0	0	0	7	14
	LARR3	2	0	2	0	1	0	4	10
	LBRR3	4	0	4	2	0	0	10	18
	LBRR4	4	1	4	1	0	0	10	17
Upper Intertidal Mean		4	0	3	1	1	0	9	17
Lower Intertidal									
Open	LARR1	8	1	6	2	5	3	25	53
	LARR4	9	0	5	3	6	1	23	47
	LBRR1	10	0	4	4	6	1	24	51
Channel	LBRR2	5	0	4	2	2	0	13	22
Basin	LARR2	5	0	3	1	5	1	16	30
	LARR3	3	1	2	1	2	0	9	16
	LBRR3	6	0	4	2	2	0	13	30
	LBRR4	3	0	5	3	4	0	14	23
Lower Intertidal Mean		6	0	4	2	4	1	17	34
Subtidal									
Open	LARR1	16	2	8	2	9	3	40	95
	LARR4	6	2	5	2	4	3	21	47
	LBRR1	15	2	7	5	11	2	40	96
Channel	LBRR2	10	1	6	3	5	2	27	70
Basin	LARR2	8	0	4	1	8	2	23	45
	LARR3	4	0	1	3	2	1	10	26
	LBRR3	14	2	10	4	7	3	40	88
	LBRR4	14	2	6	2	8	0	33	79
Subtidal Mean		11	1	6	3	7	2	29	68
Total Mean Across Tidal Zones									
Open	LARR1	21	2	12	3	11	5	55	126
	LARR4	12	2	9	4	9	3	39	78
	LBRR1	19	2	10	6	12	2	52	114
Channel	LBRR2	13	2	8	5	6	2	35	82
Basin	LARR2	12	0	7	1	9	3	30	61
	LARR3	5	1	3	3	3	1	16	39
	LBRR3	19	2	12	4	9	3	49	106
	LBRR4	16	2	10	4	9	0	41	90
Total Mean Across Tidal Zones		15	2	9	4	8	2	39	NA
Grand Total Across Surveys		76	6	54	39	62	28	NA	265

Notes: Values are per 0.01125 m^2 quadrat.
NA = not applicable.

Table 6.3-4. Mean biomass of riprap biota within taxonomic groups by and across tidal zones in Long Beach and Los Angeles Harbors, March – November 2000.

Tidal Zone / Habitat / Station		Crustaceans	Echinoderms	Molluscs	Other Minor Phyla	Polychaetes	Algae	Mean Total	Grand Total Across Surveys
Upper Intertidal									
Open	LARR1	30.92	0.00	1.33	0.13	0.00	0.00	32.37	129.49
	LARR4	22.29	0.00	1.62	0.00	0.00	0.00	23.90	95.61
	LBRR1	6.83	0.00	1.30	0.01	0.00	0.00	8.13	32.52
Channel	LBRR2	10.99	0.00	1.29	0.01	0.00	0.00	12.29	49.17
Basin	LARR2	17.66	0.00	15.47	0.00	0.00	0.00	33.13	132.51
	LARR3	0.23	0.00	26.91	0.00	0.01	0.00	27.15	108.58
	LBRR3	7.75	0.00	4.61	0.00	0.00	0.00	12.36	49.43
	LBRR4	16.85	0.00	0.55	0.00	0.00	0.00	17.40	69.61
Upper Intertidal Mean		14.19	0.00	6.63	0.02	0.00	0.00	20.84	666.92
Lower Intertidal									
Open	LARR1	60.00	0.00	13.82	3.25	0.02	6.26	83.35	333.41
	LARR4	7.27	0.00	49.28	0.01	0.04	8.84	65.43	261.72
	LBRR1	15.42	0.00	58.71	0.03	0.08	0.00	74.24	296.94
Channel	LBRR2	4.56	0.00	58.52	0.03	0.00	0.00	63.11	252.45
Basin	LARR2	8.53	0.00	31.62	0.01	0.00	0.20	40.36	161.42
	LARR3	0.01	0.00	43.09	0.01	0.00	0.00	43.11	172.42
	LBRR3	6.52	0.00	94.66	0.01	0.00	0.00	101.19	404.74
	LBRR4	13.45	0.00	32.56	0.02	0.02	0.00	46.05	184.18
Lower Intertidal Mean		14.47	0.00	47.78	0.42	0.02	1.91	64.60	2,067.28
Subtidal									
Open	LARR1	6.52	3.66	4.20	8.61	0.19	5.03	28.18	112.73
	LARR4	0.60	9.36	30.31	0.20	0.14	2.58	43.18	172.73
	LBRR1	10.12	5.42	64.55	0.33	0.29	2.94	83.66	334.64
Channel	LBRR2	0.09	0.01	119.78	4.06	0.04	0.87	124.85	499.38
Basin	LARR2	2.47	0.00	34.97	1.24	0.08	0.64	39.41	157.62
	LARR3	0.03	0.00	27.78	0.27	0.00	0.01	28.09	112.35
	LBRR3	0.15	0.75	212.33	0.10	0.75	4.76	218.83	875.33
	LBRR4	3.55	9.64	88.67	2.82	0.24	0.04	104.95	419.81
Subtidal Mean		2.94	3.60	72.82	2.20	0.22	2.11	83.89	2,684.59
Total Mean Across Tidal Zones									
Open	LARR1	97.44	3.66	19.34	11.98	0.20	11.29	143.91	575.63
	LARR4	30.15	9.36	81.20	0.21	0.18	11.43	132.52	530.06
	LBRR1	32.38	5.42	124.56	0.37	0.37	2.94	166.03	664.10
Channel	LBRR2	15.64	0.01	179.59	4.10	0.05	0.87	200.25	801.00
Basin	LARR2	28.66	0.00	82.06	1.25	0.09	0.84	112.89	451.55
	LARR3	0.27	0.00	97.78	0.28	0.01	0.01	98.34	393.35
	LBRR3	14.42	0.75	311.59	0.11	0.75	4.76	332.38	1,329.50
	LBRR4	33.85	9.64	121.78	2.85	0.25	0.04	168.40	673.60
Total Mean Across Tidal Zones		31.60	3.60	127.24	2.64	0.24	4.02	169.34	NA
Grand Total Across Surveys		1,011.12	115.31	4,071.57	84.53	7.56	128.70	NA	5,418.79

Notes: Values are per 0.01125 m^2 quadrat.
NA = not applicable.

Table 6.3-5. Mean abundance of dominant riprap biota in scraped quadrats, and commonly observed species outside the quadrats, by tidal zones in Long Beach and Los Angeles Harbors, March – November 2000.

Species	Mean Abundance	Percent Abundance	Open Water			Channel	Basins			
			LARR1	LARR4	LBRR1	LBRR2	LARR2	LARR3	LBRR3	LBRR4
Upper Intertidal										
Balanus glandula	434	37.5	90	115	32	45	82	0	28	43
Chthalmus fissus	545	47.0	45	283	72	21	25	0	22	77
Collisella scabra	56	4.9	8	20	7	3	3	0	9	6
Littorina sp.			C-A	C	C-A	C	C-A		C-A	C-A
Ostreidae								C-A		
Lower Intertidal										
Balanus glandula	284	25.3	93	19	51	17	57	0	17	30
Chthalmus fissus	302	26.8	13	80	81	9	57	0	14	48
Collisella scabra	57	5.1	17	11	8	1	4	0	3	13
Lasaea subviridis	105	9.3	63	1	0	0	1	0	29	11
Mytilus galloprovincialis *	151	13.4	52	30	35	5	3	0	21	5
Anthopleura sp.			C-A							
Chlorophyta (green algal turf)			C							
Corallina sp.			A					C		
Littorina sp.			C	C	C-A	C	C		C-A	C
Ostreidae								C-A		
Pollicipes polymerus					C					
Polyplacophora					C					
Tegula funebralis									C	
Tetraclita sp.			A	C-A	C-A		A			C-A
Ulva sp.			A							
Subtidal										
Balanus glandula	82	7.7	12	2	41	1	21	0	1	5
Chthalmus fissus	106	9.8	6	15	43	17	9	0	3	15
Joeropsis sp.	51	4.7	8	1	2	7	1	0	19	13
Mytilus galloprovincialis *	89	8.3	6	13	37	6	1	0	20	7
Paramicrodeutopus schmitti	53	4.9	0	0	2	0	0	7	28	16
Tanaidae	168	15.7	34	2	95	6	7	1	15	8
Anthopleura sp.			A	C						
Astraea undosa			C-A		C				C	
Colpomenia sp.			C	C	A				C-A	
Corallina sp.			C-A		A				C	
Ectoprocta			A							
Egregia sp.			C							
Embiotocidae				C			C			
Girella nigricans										C
Hypsoblennius gentilis				C						
Macrocystis pyrifera									C-A	
Ostreidae								C		
Polyplacophora			C							
Porifera								C		
Sargassum sp.									C-A	
Strongylocentrotus purpuratus			C-A	C-A	C	C			C	C-A
Styela sp.								C-A		
Tegula funebralis										C
Tetraclita sp.										C
Ulva sp.					A		A			
Vermetidae					A	C-A				

Notes: Values are per 0.01125 m^2 quadrat.
* = Non-indigenous species.
A = Abundant, C = Common.

7.0 KELP AND MACROALGAE

7.1 Introduction

Kelp forests are important to the physical and biological processes of nearshore environments. They add structural complexity to the water column and provide food, substrate, and shelter for a variety of vertebrate and invertebrate species (Quast 1968, Leighton 1971, Wing and Clendenning 1971, Edwards 1980, Harrold and Pearse 1987, Duggins et al. 1989). Edwards (1980) found 62 invertebrate species in just the holdfasts of *Laminaria hyperborea* in the northern Atlantic. Wing and Clendenning (1971) calculated that giant kelp (*Macrocystis pyrifera*) provided 15.4 m^2 of surface area for every m^2 of substratum in a southern California kelp bed. They also found 2,811 individuals per dm^2 belonging to eight taxonomic groups (ostracods, copepods, amphipods, decapods, polychaetes, nematodes, turbellarians, and molluscs). The increased abundance of invertebrates in kelp forests provides an important trophic link between the plankton and larger consumers that feed on plankton-consuming invertebrates (Quast 1968). The increased physical structure of kelp forests also provides shelter for juvenile fish (Ebeling and Laur 1985).

Physically, kelps alter and reduce currents and waves (Foster and Schiel 1985, Koehl and Alberte 1988), decrease light intensity (Pearse and Hines 1979, Reed and Foster 1984) and increase sedimentation (Eckman et al. 1989). Each of these factors can influence the recruitment of other kelp forest inhabitants (Duggins et al. 1990). Duggins et al. (1990) demonstrated that flow velocity, sedimentation, and reduced light intensity/microalgal cover all have important but variable effects on recruitment, dependent upon the invertebrate species investigated. Although the effects of kelp forest structure may vary, the general rule seems to be that kelps provide for increased habitat and species diversity over comparable areas lacking a kelp component.

Kelp and other macroalgae range widely in their interspecific tolerances to persistent environmental conditions. Some species, such as giant kelp require cool, nutrient rich, marine waters, with relatively high circulation conditions. Other species such as sea lettuce (*Ulva* spp.) can occur in very warm, brackish to hypersaline, stagnant waters. The broad range of tolerances and habitat requirements that is expressed by algae provides a useful tool in the analysis of large-scale ecological trends. However, in order to distinguish and interpret directional trends, it is essential that normal seasonal variability within a macroalgal community be at least rudimentarily understood. For this reason, the investigations reported on in this section encompass both Spring and Fall 2000 surveys.

This section documents the methods employed to survey, map, and characterize kelp and macroalgae within Long Beach and Los Angeles Harbors. The results of aerial kelp canopy mapping and subtidal macroalgal community characterization are provided for surveys completed in spring and fall 2000. The focus of the investigation was on canopy-forming kelp species, which are of ecological value as the base of a diverse association of marine life. There are two habitat defining kelp species in the Ports of Long Beach and Los Angeles. These are giant kelp and feather boa kelp (*Egregia menziesii*). These two species are discussed in the most detail; however, other dominant species of macroalgae that were observed during diver surveys are also addressed.

In addition to the native macroalgae, documenting the occurrence of exotic species was also a focus of the surveys. The invasive exotic *Sargassum muticum* is well established in nearly all southern California bays. However, its intrasystem distribution patterns are still not well documented and its overwhelming dominance of some algal communities makes it a species of great interest when looking at long-term habitat trends. Other exotic species of notable occurrence are *Codium fragile* ssp. *tomentosoides*, a species now common along the eastern Pacific coast, and *Undaria pinnatifida*, a native of Japan. The discovery of *Undaria pinnatifida* during the present survey represents the first known occurrence of this species on the west coast of North America. Although marine vegetation generally provides for increased faunal diversity over similar habitats without vegetation, the introduction of new species poses a number of potential problems. These species may provide habitat and food for a variety of organisms, but there is often little or no information regarding their potential impacts to fauna that evolved under a different set of habitat parameters. This study provides information to make historical comparisons on *S. muticum* relative abundance with other species and if repeated could act as a baseline for future monitoring of the spread and ecological consequences of *Undaria*. Although *Sargassum* and *Undaria* are not distinguishable from aerial surveys, the distributions noted in the diver surveys provide a starting point for future assessment of these species.

7.2 Methodology

7.2.1 Aerial Photography

On March 17, 2000, 12 true color aerial spot images of the entire harbor area were taken at a scale of 1:1600. The images were layered and geo-rectified to form a single mosaic image. This image served as the base image for both the kelp mapping effort and for portions of the spatial analyses work completed for eelgrass communities (Section 8). To detect the extent of the kelp canopy, color infrared (IR) aerial imagery was flown on March 17 and September 25, 2000. For each survey, the approximately 60 color IR tiles were taken at a scale of 1:600, which allowed an approximately 0.7 m mapping resolution. Because digital base maps of the harbors were not available, bathymetric charts were scanned and registered based on reference markers on the charts. The shoreline was digitized from the bathymetric charts and then color IR images were registered to the digitized shoreline. The boundaries of the macroalgal community were identified and mapped from the IR images in an ArcView® Geographical Information System (GIS) format onto the aerial spot image of the harbors.

Kelp canopy cover was ground-truthed by navigating the perimeter of canopies while collecting positional data using a dGPS with an accuracy of ± 1 m. These data were also entered into the ArcView® GIS format for comparison to the aerial survey work and a refined boundary line was developed for the canopy. Using aerial survey combined with the ground-truthed transect methods, canopy distribution and dominant composition of kelp communities was identified. Seasonal differences in canopy cover were also addressed by the use of two survey periods.

7.2.2 Diver Surveys

To provide a characterization of the species composition and vertical distribution of macroalgal beds, 20 permanent survey transects were established throughout Los Angeles and Long Beach Harbors in an attempt to cover the variability of possible habitat types (Figure 7.2-1). Transect endpoints were recorded using a dGPS (Appendix G). Transects were surveyed in spring 2000 (May 3-17) and again in fall 2000 (September 27 – November 21).

Surveys were performed by SCUBA divers using a modified belt transect methodology. Two divers swam from the waterline down to the harbor floor following a fiberglass measuring tape. The divers would search for the dominant benthic crusts, foliose, and canopy forming macroalgae that occurred within two meters of either side of the measuring tape. Surveys were stopped along a given transect at the point where algae was no longer was found and the probability of encountering further algae on lower portions of the transect was low. Data were collected to note the vertical distribution and general abundance of the dominant macroalgal species present on each transect. Notes were made on biological and physical factors that might dictate or influence the distribution of kelp at each site. The dominant associated fauna was also noted, but not systematically quantified.

Observed algae were generally recorded by genus because either multiple species were not observed within a genus or because identification below genera was not readily possible and extremely similar species were potentially found within the harbors. For species categorically grouped at the genus level, little information is lost since the grouped species have ecologically similar roles and are, for the most part, functionally interchangeable. Specific names are occasionally used when their use would more thoroughly characterize a given algal community, for example in the identification of exotic species. Additionally, the two benthic species *Dictyota flabellata* and *Pachydictyon coriaceum*, have not been distinguished in this report due to microscopic taxonomic differences (Dawson and Foster 1982) and speciation that is suspect (Stewart 1991). For these reasons, *Dictyota* and *Pachydictyon* identified in this survey have simply been denoted as *Dictyota*. In the survey results, references to number of species are intended to indicate dominant species and are generally identified by their genera.

Algal specimens were collected when identification assistance was needed. The specimens were identified in the laboratory using Marine Algae of California (Abbott and Hollenberg 1976) and Seashore Plants of California (Dawson and Foster 1982). Specimens that posed particular taxonomic problems were taken to Jepson Herbarium at University of California, Berkeley and taxonomy was verified or performed by Dr. Paul Silva.

7.2.3 Data Analysis

Data were collected to determine community composition within kelp habitats identified by aerial photography. As such, there are no analyses supported by this data because individual abundances were not quantified. Rather, we have used species diversity and presence/absence data to explain differences among algal communities.

7.3 Kelp Bed Distribution

Areal coverage of the kelp canopy in the harbors for the spring 2000 (Figures 7.3-1 and 7.3-2) and fall 2000 (Figures 7.3-3 and 7.3-4) surveys represents the distribution of *Macrocystis* and *Egregia* dominated kelp communities. *Sargassum* dominated communities are not mapped. This non-kelp macroalgae is the dominant over much of the shoreline throughout the middle and inner portions of the harbors and is also well represented in the outer harbor as a subordinate element to the canopy forming kelps.

Spatial Distribution

Within the harbors, all kelp beds are located on artificial structures (typically riprap) or occur as a result of unique circulation patterns within the harbor environs. Kelp beds are located predominantly within the most exposed portions of both harbors. The most expansive kelp beds, while still limited in extent relative to larger natural beds found on the outer coast, are found just within the outer breakwater.

The most extensive kelp beds are found within Los Angeles Harbor in the areas of the Cabrillo Shallow Water Habitat near Angels Gate. The Cabrillo Shallow Water Habitat was constructed by building a submerged dike [at -15 ft to -20 ft Mean Lower Low Water (MLLW)] around the perimeter of the area to be made shallow. The first phase of shallow water habitat development consisted of an approximately 196-acre plateau. Later a second approximately 80 acre area was added at the Angels Gate end of the shallow water habitat. Historically, the entire perimeter of the retaining dike intermittently supported a narrow ring of *Macrocystis* (R. Appy, personal communication). In 2000, the surveys revealed the presence of discontinuous stands of kelp with heavy kelp being located in the region of the submerged dike closest to Angles Gate. Elsewhere, much of the submerged dike has been over-run by shallow shifting sands and other deposited sediments resulting in a limitation in the availability of suitable habitat to support kelp. Given the shallow nature of sand coverage over rock, it is anticipated that the extent of suitable hard bottom habitat may vary over time and with the frequency and severity of storms impacting the outer harbors causing re-exposure of rocky substrates.

Elsewhere along the shorelines of the outer breakwater and some of the riprap shorelines within the outer harbors, narrow bands of kelp dominated alternately by *Macrocystis* or *Egregia* occur. These bands are limited to a narrow distribution pattern by the lack of suitable habitat availability to form broader beds. In some instances jetties slope steeply up from the bottom of the harbor at 1.5:1 to 2:1 (run:rise) slopes. The distribution of *Egregia*, limited to a relatively narrow depth range of approximately +3 ft to -8 ft MLLW, is often bounded by intertidal conditions at the upper limit and depth at the lower limit. Where the deeper growing *Macrocystis* occurs, this species is often limited by higher wave energy and biological activities at the upper extreme, and lack of suitable habitat at the lower limits where the riprap meets the sandy harbor floor. This is the condition of riprap shorelines throughout Long Beach Harbor and through most of Los Angeles Harbor.

One very interesting observation made during the surveys was that of mobile kelp beds. It appears that some of the kelp beds located in the vicinity of Cabrillo Beach are substantially comprised of *Macrocystis* that has migrated into the harbor as mature sporophytes from outside of the harbor. It is believed that these plants are derived from the southern shoreline of the Palos Verdes Peninsula although the exact origin is not known. The process by which kelp is transported to the Cabrillo Beach area is clear. Kelp sporophytes growing on cobbles reach a size large enough to float the cobbles off of the bottom. These kelp plants with attached cobbles are entrained in the currents entering the outer harbor through Angels Gate or other breakwater openings. The kelp floats through the deeper water harbor areas drifts into the shallows near Cabrillo Beach where it eddies out and comes to rest when the attached cobbles drag to a stop on the bottom. The bottom in the area between Cabrillo Beach and the Cabrillo Beach Youth Facility is littered with hundreds of rounded beach worn cobbles, many still supporting remnants of coralline algae, bits of holdfasts, or other biological indicators that these were transported from areas quite different than naturally found on the silty sediment bottom where they have come to rest. This phenomenon was first noted as a result of direct observations of active transport of cobbles by mature kelp during dives made for purposes of eelgrass habitat assessments (Section 8).

While much of the Cabrillo Beach kelp is present as a result of translocation of adult sporophytes, this does not mean that the area is unsuited to the natural occurrence of kelp and several attached *Macrocystis* were found on the riprap near the beach. Elsewhere in the shallows around Cabrillo Beach, the Cabrillo Beach Youth Facility, and the Cabrillo Shallow Water Habitat scattered debris supports growth of algae in an opportunistic fashion. The algae most common in these areas are *Macrocystis* and *Sargassum*.

Temporal Variability

Macroalgal communities are known to vary in both space and time along a variety of scales (Dayton et al. 1998). Within the Ports, spatial and temporal trends in kelp abundance may be related to larger climatic and oceanographic processes in southern California or to processes related to more local changes in biological, water quality, and substrate conditions.

Large-scale reductions in kelp coinciding with El Niño Southern Oscillation (ENSO) events have been well documented. Storms and associated surge can remove algal species from jetty habitats in the outer harbors. Periods of benign conditions can allow substrate to be buried making it unavailable for algae recruitment. High summer temperatures and poor flushing can stress some species causing them to weaken and be more susceptible to physical and biological damage. Herbivores can also become locally abundant removing much of the standing stock of algae. Algae not directly consumed can be lost due to holdfast cavitation or feeding on stipes, also causing plants to wash away (Leighton 1960, Tegner et al. 1995). Finally, at the other end of the spectrum, *Macrocystis* beds can seem to suddenly appear when large plants drift into the harbor having lifted their associated substrate (e.g., boulders, cobbles) off the bottom and ultimately eddying out in the calm protected shallows.

Within the harbors, the recruitment of kelp onto new substrate appears to be relatively rapid. This is attested to by the fact that while still under construction, Pier 400 began to support kelp on its shorelines within the second year of placement in the outer harbor. Further, kelp in the vicinity of Cabrillo Beach and Cabrillo Shallow Water Habitat appears to come and go from debris that is intermittently silted over or scoured to re-expose suitable hard substrate.

Temporal variability was noted during the present investigations conducted in the spring and fall 2000. During the spring surveys, total mapped canopy cover of *Macrocystis* was 24.80 acres and that of *Egregia* canopy was 2.14 acres (Figure 7.3-1 and 7.3-2). By fall, the cover of

Macrocystis had declined substantially to 14.16 acres and with *Egregia* increasing slightly to 2.59 acres of *Egregia* (Figure 7.3-3 and 7.3-4). Kelp beds examined during the spring were generally healthy and robust, if not fully matured. When revisited during the fall of the same year, these canopies were more sparse and individual kelp plants appeared heavily weathered, exhibiting various states of deterioration. It is possible that warmer waters and poorer circulation within the harbors relative to that found on the open coastline contribute to kelp declines during the summer months. Whether these declines were temperature or nutrient mediated, resulted from excessive herbivory, or a combination of factors is not known.

Sargassum exhibited relatively large fluctuations in biomass on a seasonal basis. While present year-round, *Sargassum* expanded significantly during the spring existing well in the summer before declining in the fall and being almost non-existent in the winter. Both the density and frond length supported many times higher biomass and vertical structure during the spring and summer than was observed in fall and winter while conducting other program elements (e.g., bird surveys).

7.4 Species Composition

Species composition within algal communities is determined by a host of abiotic and biotic factors. Abiotic factors such as water temperature, waves and surge, sediment inundation and scour, salinity, water depth, and substrate dictate which species a particular site is capable of supporting. Several of these factors are controlled by regional climate and current patterns of the Southern California Bight, as well as site geometrics. Seawater temperatures are generally higher south of Point Conception supporting a greater variety of red and non-kelp brown seaweeds. To the north of Point Conception, cooler nutrient rich waters support greater biomass in the form of large kelps but lower diversity overall (Abbott and Hollenberg 1976). Winter and spring storms further enhance algal community dynamics. The movement of sand and sediment can mean inundation of existing plants and scouring of the substrate that prevents many species from colonizing. However, some ephemeral opportunistic algae such as *Ulva* spp. and *Gigartina* spp. thrive in such dynamic environments where more competitive species are restricted from occurring or are slower to colonize new primary space. Moreover, the wave and surge forces during winter storms remove older individuals creating space for recruitment and reducing competition among existing individuals and colonizers.

Biotic factors work in concert with abiotic factors to further structure kelp communities actually observed at a given site at any given time. The distinction could be made that abiotic factors determine the potential community and biotic factors determine the realized community. Competition for resources such as space and light (Dayton 1975, Pearse and Hines 1979, Reed and Foster 1984) can reduce the potential species composition to a reduced and structured suite of species with a gradient of space and light requirements dictated not only by the physical environment but also by neighboring algae. Marine algae must also survive in the presence of numerous grazers (e.g., sea urchins, molluscs, fish), some of which have specific forage preferences (Leighton 1971, Lubchenco 1978). Further influencing the realized structure of any given macroalgal community is a weighted, lottery type recruitment system in which the availability and suitability of space into which algae may recruit is often unpredictable. Further, the availability of recruitable spores and gametes of various species are similarly unpredictable but certainly not equal in either a seasonal or numeric sense.

As a result of both predictable and unpredictable conditions in the biotic and abiotic factors that structure faunal communities, algal communities are expected to vary over time. This variation is most likely to be detectable at the level of community composition as reflected in algal biomass and diversity. Less commonly, these changes may result in changes in the community structuring dominant species. Such occurrences do occur, as witnessed by the occasional large-scale die-off of *Macrocystis* during El Niño events.

Species Composition Across Spatial Gradients

The distribution of kelp and macroalgal communities is subject to spatial and temporal gradients of change in the physical and biological environments. While clear distinct boundaries are rare in natural systems, they are useful in describing such systems. As such, spatial gradients observed in the harbor system are described as being inner, middle, and outer harbor environments relative to kelp community structure.

Community types can generally be characterized from the physical and biological conditions observed on the sampled transects. The dominant algal genera encountered on each transect are listed in Table 7.4-1. However, the observed dominance by these species is likely influenced by temporal dynamics in the physical and biotic factors that shape the kelp communities. For this reason, this pattern of diversity and the specific composition of the communities should be viewed as a snapshot of a more variable condition. Appendix G provides depth distributions of algae along each transect.

Inner Harbor

In the inner harbor (North), tidal flushing is reduced, wave surge and currents decrease, water temperatures and sedimentation increase, dissolved oxygen levels decline, and freshwater intrusion decreases salinity during the winter while evaporation increases the salinity during the summer (refer to Section 2.4). Each of these factors can affect the potential species supported at a given location as discussed above. Restrictions in tidal circulation tend to inhibit the highly productive kelp and macroalgae such as *Egregia* and *Macrocystis*. As a result, *Sargassum*, *Ulva*, and *Colpomenia* were the dominant species consistently encountered along inner harbor transects where tidal flushing is greatly reduced. *Sargassum*, although an upright branching species, does not provide the same level of structure and colonizing space as the larger kelp species. *Ulva* and *Colpomenia* are smaller non-articulated forms that provide food for other organisms, but do not provide structure to the water column or a stable substrate for encrusting organisms.

Transects T-7, T-8, T-10, T-11, T-12, T-13, T-18, and T-19 were characteristic of innermost harbor habitats (Figure 7.2-1). *Sargassum muticum* was present at all of these transects, generally in broad, dense bands extending from about 0 to –13 ft MLLW. In some instances, *S. muticum* was encountered growing as deep as -24 ft MLLW. *Colpomenia* sp. and *Ulva* sp. were also present in a significant number of transects sampled at inner harbor study sites (see Appendix G). The greatest observed diversity at the innermost sampled sites was in Long Beach Channel 2 near Pier D (Transect T-8), with six dominant species. The lowest diversity was seen in Slip 1 near the Los Angeles Turning Basin (Transect T-18), which had a monotypic stand of *Sargassum* extending from -2 to -20 ft MLLW.

Middle Harbor

Transects in Long Beach Southeast Basin (T-6), Seaplane Anchorage (T-9), and near the Coast Guard Basin in Los Angeles Harbor (T-17) were characteristic of middle harbor habitats (Figure 7.2-1). *Sargassum* was present at all sampled middle harbor transects. The kelps *Macrocystis* and *Egregia* were both present at T-6 and absent from T-9. *Macrocystis* was present at T-17. Although these sites tended to vary in terms of the species present, diversity was generally higher than at the innermost harbor sites with a maximum of nine dominant species observed at T-6, and a minimum of three observed at T-17. Moreover, the algae present, other than *Sargassum*, tended to be more upright, articulated forms such as *Codium fragile*, or fleshy forms such as *Macrocystis*, *Egregia*, *Colpomenia*, and *Dictyota* spp. and less ephemeral sheet forms such as *Ulva* and *Enteromorpha*.

Outer Harbor

Within the outer harbor, transects were conducted on both the San Pedro Breakwater (Transect T-2) and Middle Breakwater (Transect T-1 and T-5), and outer harbor riprap shorelines (T-3, T-4, T-14, T-15, T-16, T-20) (Figure 7.2-1). Algal diversity was typically much higher in outer harbor sites, as compared with middle and inner harbor sites, with the greatest observed diversity (12 dominant species) occurring along the San Pedro Breakwater at Transect T-2. Diversity was also high (maximum of 11 species) on outer harbor transects conducted on riprap. There were two exceptions to this trend, one each occurring on an outer breakwater and on an outer harbor riprap shoreline. At Transects T-5 on the Middle Breakwater and T-20 near the GATX Terminal in Los Angeles Harbor, only three species were observed. Transect T-5 is an outer breakwater transect with low kelp diversity, but exceptional faunal abundance. At this site, it was the presence of herbivores, primarily the purple and red sea urchins (*Strongylocentrotus purpuratus* and *S. franciscanus*, respectively) at densities of approximately 60 individuals/m^2, that restricted the abundance and distribution of algae. This density greatly exceeds that necessary to maintain an area free of stiped and foliose macroalgae (Mooney 2001). The lower depth limit of algae is at approximately +0.4 feet above MLLW. This tidal height is roughly the upper physiological limit of purple sea urchins and is above that for red sea urchins (Schroeter 1978). While the transect survey revealed a site heavily impacted by grazers to form classic urchin barrens, the canopy surveys revealed the presence of some *Macrocystis* growing at depth near the breakwater (Appendix G). Such plants were surviving on boulders surrounded by soft sediments that had not been crossed by urchin fronts (large aggregations) at the time of the surveys. These deeper plants were not noted in the dive surveys because they are relatively sparse and in some cases found beyond the area sampled by transects. It is worth noting that during the 1986-1987 baseline investigations, similar observations of urchin barrens were noted in the vicinity of the present studies Transect T-2 (MEC 1988). Similar to the present study, there was a higher abundance of invertebrates and fish noted in the urchin barrens than in the surrounding canopied habitats in the 1986-1987 study.

At Transect T-20, the lower algal diversity (three dominant species) seems to be due to the dominance of *Macrocystis*. *Macrocystis* abundance and canopy cover is exceptionally high at this site. *Macrocystis* canopy is known to greatly reduce the availability of light below the canopy (Reed and Foster 1984) and this is probably the mechanism restricting understory diversity at this site. *Macrocystis* will probably persist until physically disturbed at this site because its density is likely high enough to prevent intrusion by sea urchins (Mattison et al. 1977). Moreover, as a dominant perennial species, *Macrocystis* is not likely to be outcompeted by other algae once established. Although kelp diversity was low at this site, the abundance of canopy forming kelps is important for numerous fish species (Quast 1968, Ebeling and Laur 1985, Dean et al. 2000). The luxuriant *Macrocystis* growth seems to be supporting increased abundance of surfperch and opaleye at this site.

In general, outer harbor transects were dominated by *Macrocystis* and *Egregia*. *Macrocystis* was present in eight of the nine outer harbor transects. Only T-5 was missing *Macrocystis*. At Transect T-5, *Egregia* dominated the macroalgae, but only in intertidal habitats where sea urchins could not graze. *Egregia* is a shallow subtidal to intertidal algae capable of persisting above the physiological limit of urchins. *Egregia* was present at six of the nine outer harbor sites often occupying relatively shallow water habitats and yielding to *Macrocystis* in deeper water. Understory species such as the coralline red algae, *Corallina* spp., the red alga *Rhodymenia*, and the brown algae *Dictyota* and *Colpomenia* were also common in outer harbor habitats. Finally, the introduced alga, *Sargassum muticum*, was found at four of the nine outer harbor sites. However, outer harbor *Sargassum* was typically less robust and less common than at the inner harbor sites.

Species Composition Over Depth Gradients

In addition to aiding in the description of horizontal species distribution patterns, the twenty transects surveyed during the course of the program also allow for an exploration of vertical zonation of species within the harbors. Figure 7.4-1 provides a mean vertical distribution summary of raw distribution data included in Appendix G. Figure 7.4-1 identifies the distribution range from the mean shallowest occurrence to the mean deepest occurrence across all transects on which the species were encountered. Because of the relatively small sample sizes for some species and the occurrence of a number of physical and biological factors that differentially influenced the distribution at the various sites, these values should not be considered an exploration of physiologic tolerances, but rather are offered as a characterization of the realized macroalgal communities within the harbors.

Not surprisingly, there are vertical differences in the distribution ranges of the algae represented within the harbors. In mixed algal beds, canopy forming species such as *Macrocystis* and *Egregia* influence the light environments at depth and may limit the lower depth ranges of prostrate or short-statured foliose species. Algae occurring over the greatest vertical range included *Macrocystis* and the introduced species *Sargassum* and *Undaria.* The narrowest distribution was found in the shorter-statured foliose algae such as *Gigartina* and *Chondracanthus*. For all species, the lower limit of growth was found to be more variable than the upper limit. Most algae were represented within the low intertidal to shallow subtidal ranges but fell out of the community at substantially different depths depending upon presence and density of light competitive species, density of herbivores, ambient water clarity, and availability of suitable substrate at depth. A notable occurrence was the presence of *Macrocystis* into the low intertidal zone. This observation is not new to this study and was previously noted in MEC 1988 where it was attributed to the protected nature of the harbor relative to the more rigorous environment of the outer coastline.

7.5 Summary of Spatial and Temporal Variations

Macroalgal Community Characterizations

Notwithstanding the variation in algal composition that was observed between various portions of the harbor or across vertical gradients, there were generally three different types of hard-bottom kelp/macroalgae communities represented within the harbor environment at the time of the investigation. These include those associated with riprap shorelines and breakwater environments, those associated with debris fields and harbor structures, and the unique mobile giant kelp beds found in the Cabrillo Beach area. There are no native hard-bottom habitats within either the Port of Long Beach or the Port of Los Angeles. For this reason, macroalgal habitats can be reasonably described as opportunistic on substrates that have been artificially provided either intentionally or unintentionally over time.

Riprap Associated Kelp/Macroalgae

Riprap associated macroalgal communities were typically the most diverse within the harbors. Because these habitats extend from the intertidal down to the harbor bottom at various depths, those algae that were restricted to shallower depths, such as *Gigartina* and *Egregia* were represented in these areas but rarely in other locations. Within deeper portions of this habitat, the dominant species was either *Macrocystis* within the outer harbor areas, or *Sargassum* in the inner harbor areas. Within the most inner harbor environments, *Sargassum* was the overwhelming dominant with other algae being opportunistic species such as *Ulva*.

Macrocystis kelp canopy was approximately 25 acres during the spring survey but by fall had reduced by about 44% to approximately 14 acres. *Sargassum* in the inner harbor exhibits substantial seasonal variability, with summer highs and winter lows. Reasons for the decline are not known and may relate to one or more factors such as temperature, nutrients, and/or herbivory. The extent of *Egregia* in the outer harbor was similar in spring and fall.

Figure 7.5-1 provides a graphic illustration of the riprap macroalgal communities found in the harbors. This figure represents data from: (a) outer harbor Transect T-4 (Pier 400), and (b) inner harbor Transect T-13 (Dominguez Channel).

Debris Fields and Harbor Structures Kelp/Macroalgae

Scattered debris fields were found within shallow waters in various areas in the harbor. In some instances, these fields were defined by local spillage of construction rubble, discharged rubbish, or accumulation of debris that has drifted into the harbor from such sources as Los Angeles River discharges. In other cases, the material consisted of biogenic wastes such as mussels and calcareous worm tubes that had been dislodged from floats, piles, or vessels. These debris fields were typically very small and provided limited space for recruitment of algae. Further, most of these fields lacked substantial vertical relief and as such were limited in the diversity of algae they supported. As a result of their low relief, these debris fields are relatively transitory as suitable macroalgae support structure since they are often covered by sediment over time. Common species within the debris fields included exotic species such as *Sargassum* and *Undaria*. The ephemeral green algae, *Ulva* was also common in these areas. Within outer harbor areas, *Macrocystis* was not an uncommon species within such sites.

In addition to harbor debris fields, there are a number of areas within the Ports that support macroalgal communities on harbor related structures. These include navigation markers, docks, containment booms, piers, and ship-hulls. Common elements within these habitats are *Sargassum* and *Undaria*, as well as a number of turf and short-foliose red algae, such as *Gigartina*, and green algae including *Ulva* and *Enteromorpha*.

Figure 7.5-2 provides a graphic illustration characterizing a composite of sites designed to typify macroalgal communities of both debris fields and harbor structure environments.

Mobile Kelp Beds
Mobile kelp beds have been described previously (Section 7.3). These beds are found around the riprap point at Cabrillo Beach and consist principally of *Macrocystis* on beach worn cobbles that also sometimes support crustose coralline algae. The silty sand bottom within these beds is littered with such cobbles, some retaining remnants of deteriorating holdfasts. The shallower portions of this bed are intermixed with eelgrass habitat near the jetty point that divides Cabrillo Beach from the Cabrillo Launch Ramp.

Figure 7.5-4 provides a graphic illustration characterizing the mobile kelp beds off Cabrillo Beach. This depiction draws from information gathered from Transect T-3 (Cabrillo Beach Launch Ramp) and eelgrass ground-truthing surveys in this area.

7.6 Historical comparisons

The history of *Macrocystis pyrifera* in the Ports has been short. Port habitats supported little *Macrocystis* until transplantation efforts with local and Mexican strain giant kelp in 1977 (Rice 1983). Since then, kelp abundance has increased greatly while fluctuating in general synchrony with populations located outside the Ports (see review in MEC 1988). Interestingly, kelp habitat has never been a substantial target for habitat management efforts within the harbors, but rather has been a product of various fortuitous circumstances that have resulted in creation of suitable hard bottom substrate within areas that provide appropriate circulation to support kelp. Such suitable habitat includes the abundant rock breakwaters and shorelines as well as the rock containment structure that retains the Cabrillo Shallow Water Habitat. Kelp distribution has increased from a localized occurrence on the San Pedro Breakwater to other rocky shorelines in Los Angeles Harbor, including riprap edges of Pier 400 and the submerged dike at the Cabrillo Shallow Water Habitat, both of which were not present when the 1986-1987 study was conducted. Kelp also has expanded to the Middle Breakwater and other localized areas in the outer harbor. The suitable site conditions combined with available recruits from the nearby Palos Verde Peninsula and more recently, the kelp beds now established within the harbor, have provided for a viable community that is, albeit limited, a productive element of the harbor's marine communities.

Limited scientific or management work has been done on the kelp forest habitats within the Ports. Perhaps the most intensive kelp study in this area was that conducted by MEC in 1986-1987 (MEC 1988). The MEC study was designed to estimate the annual production and turnover of *Macrocystis* and *Sargassum* along the outer harbor breakwater in the Port of Los Angeles. *Macrocystis* was found to have exceptional productivity compared to other productivity studies in California (MEC 1988). The authors attributed this productivity to two physical components of breakwater habitat. The first is the steep slope of riprap and jetties that results in a narrow band of kelp with a large edge to volume ratio and thus greater light penetration into the beds. The second is the diminished energy within the breakwater protected habitat that allows kelp to grow at shallower than normal depths further enhancing light absorption.

A review of personal observations made by the authors and anecdotal reports made by port staff and contractors quickly confirms the ephemeral nature of kelp, particularly *Macrocystis*, both on short-term seasonal scales and long term, inter-annual scales. For example, in the fall of 1999, considerable kelp grew on the west and southern margins of Pier 400 in Los Angeles Harbor. Throughout 2000, however, no kelp was detected at these locations. Conversely, kelp studies conducted in June 1986 were deemed to be suitable to characterize the extent of the kelp bed on portions of the San Pedro Breakwater throughout the period of completion of a kelp productivity study extending from June 1986 through February 1987 (MEC 1988). Within the 1988 study, it was explicitly noted that the extent of kelp canopy was not remapped during the study since observations of the same marked points suggested that the canopy had not changed appreciably. These disparate observations suggest that the dynamics of kelp beds within the harbor are not simple and to better understand these temporal variations would require a long-term surveillance program adequate to characterize and distinguish seasonal and interannual variability.

Because the present study is the first to systematically quantify kelp habitat within the harbors, it is not possible to make any substantive comparisons to prior inventory work. However, the present study helps to build an inventory and baseline of algal species present within kelp forested habitats, as well as to map the distribution of kelp canopy throughout the Ports of Long Beach and Los Angeles, and will be a useful baseline for future comparisons. The current data are complementary to the previous MEC study (MEC 1988), which addressed questions regarding productivity and community support roles provided by the community dominant *Macrocystis*. This prior investigation, through its more narrow focus, provides insight into some of the community structuring features that are not readily approachable through a limited interval inventory such as that completed in the present investigation.

7.7 Invasive Exotic Species

Exotic species have become a common element of the flora and fauna of southern California waters. Some of these species have an invasive nature and are potentially detrimental to the native biota. Two invasive species of algae that were detected in the Ports during this study, *Sargassum muticum* and *Undaria pinnatifida,* are discussed below. In addition, the potential for the occurrence of the highly invasive Mediterranean strain of *Caulerpa taxifolia* is also addressed.

Sargassum muticum

Sargassum muticum is a brown alga whose presence on the west coast of the North America is extensive and well documented . This species is thought to have been inadvertently introduced to Washington in the 1930s on Japanese oysters. The species spread rapidly and currently extends as far south as Baja California. The ecological impact of this species is not well understood, but it has generally been accepted as a permanent part of local flora due its wide distribution and the difficulty of eradication. The detection of this species during this study was expected. *Sargassum* growth is highly seasonal in nature. Within southern California, *S.*

muticum peaks in growth in late-spring to early-summer and declines to a yearly low in the Winter. MEC (1988) estimated standing crop within *Sargassum* beds in Los Angeles Harbor to range from a low of less than 1 g/m^2 during November 1986 to over 5 kg/m^2 at its peak in June 1987. From these data, MEC (1988) estimated the annual productivity of *Sargassum* to be at least 5 $kg/m^2/yr$, a productivity rate far less than the 70 $kg/m^2/yr$ estimated for *Macrocystis* within the harbor.

Undaria pinnatifida

Undaria pinnatifida was detected for the first time in the United States during the diver surveys for this project in spring 2000. This kelp species is native to Japan where it is cultured and harvested for commercial uses. It has been introduced both inadvertently and intentionally in Europe where it has grown rapidly and been reported to out-compete native species and pose a significant economic problem as a fouling agent. *Undaria* is introduced primarily by boat hulls and ballast water. Infestations of this species in Tasmania, Australia, and throughout New Zealand are being taken very seriously and aggressive campaigns are underway to eradicate or slow the spread of this species.

Undaria was detected during different program elements in Los Angeles Harbor near Cabrillo Beach Launch Ramp and near the U.S. Coast Guard Base along the Main Channel. It was observed in Long Beach Harbor in Channel 3 north of Pier D and in Channel 2 near Pier C. It may occur in other locations throughout both harbors and focused surveys would be needed to confirm that.

Subsequent to the report of its occurrence in the harbors, *Undaria* has been reported to occur at Port Hueneme, in Santa Barbara Harbor, and most recently at Catalina Island. Eradication efforts are under way at the latter two sites. It is believed by many scientists that a successful eradication is not possible due to its mode of reproduction, which involves the release of millions of motile spores that are readily spread locally through natural dispersion and to remote locales by shipping traffic.

Caulerpa taxifolia

Perhaps the most insidious invasive alga ever to have been found on a U.S. coastline was also discovered in 2000, but not within the harbors. The highly invasive exotic green alga *Caulerpa taxifolia* was discovered in two coastal water bodies in San Diego County (Agua Hedionda Lagoon) and Orange County (Huntington Harbour) during the summer of 2000 and could potentially occur in other locations along the coast. This popular saltwater aquarium seaweed is suspected to have been introduced through dumping of aquarium waste into a storm drain. Once established it is readily spread by boat anchors and fishing gear to new locations. Its aggressive growth pattern allows it to quickly displace native habitats with a dense monoculture of toxic algae that has no native predators to control it. Within the Mediterranean Sea and infested waters of Australia, measures to quarantine fishing grounds and anchorage areas are being used to slow the spread of this species.

At the time of writing, aggressive eradication efforts were underway at both Huntington Harbour and Agua Hedionda Lagoon. Greater optimism exists for the eradication of *Caulerpa* than for the elimination of *Undaria*. This is due to the lack of sexual reproductive capabilities in the strain that has been introduced. Because the species is spread only by fragmentation and vegetative growth, it is believed that effective detection followed by control efforts can be successful in combating the spread of *Caulerpa*.

This species can be detected through dive surveys, aerial photography, and sidescan sonar surveys, all techniques utilized during the present baseline study to survey for eelgrass and kelp. No *Caulerpa* was detected or encountered in either Port, however surveys for this species were not comprehensive, nor targeted.

7.8 Summary

Kelp and macroalgal communities are narrowly distributed within the harbor areas, being principally restricted to the shallow hard bottom environments associated with riprap shorelines, breakwaters, and pier structures, as well as other harbor debris. The true kelp communities are restricted to the outermost portions of the harbor where giant kelp forms a principal component of macroalgal assemblages. While nowhere within the Ports is algal diversity high, there is a general cline of lessening algal diversity from the outermost portions of the harbors to the innermost channel environments.

Kelp communities within the Long Beach and Los Angeles Harbors are not abundant totaling only about 25 acres in the spring of 2000 and declining to about 14 acres in the fall of 2000. While algal communities within the Ports exhibit year-round presence, there is substantial seasonality to the communities. All of the algal communities appear to exhibit relatively vigorous growth during the spring months. During the summer months, warm temperatures, lack of nutrients and poor water circulation are all likely contributors to a decline in *Macrocystis* dominated communities. Other dominant alga also likely decline for these same reasons.

The occurrence of giant kelp within the harbors is a relatively recent occurrence according to reports made in prior investigations. *Macrocystis* was transplanted to sections of the San Pedro Breakwater, including introduction of a Mexican strain. Whether the majority or even some of the kelp present within the Ports at this time are from this strain is unknown. Studies conducted during the last biological baseline (MEC 1988) demonstrated a tremendous productivity of giant kelp along the outer breakwater, however, this investigation did not attempt to quantify the distribution of kelp or other macroalgal flora. However, it is apparent that kelp distribution has increased in Los Angeles Harbor since 1986-1987, which it was restricted to the San Pedro Breakwater. During the present study, kelp also was mapped along portions of the Middle Breakwater, Pier 400, on a submerged dike at the Cabrillo Shallow Water Habitat, and other riprap shorelines in outer Los Angeles Harbor.

Known occurrences of invasive exotic algae within the harbors include the ubiquitous *Sargassum muticum* and the first discovery of *Undaria pinnatifida* on the eastern Pacific coastline. While *Sargassum* has become a naturalized element of the algal flora and no substantial changes in this species distribution patterns within the Ports are expected, this is not the case with *Undaria*. The relatively recent introduction of *Undaria*, probably as a result of hull fouling or ballast water transport and its recent identification at a number of other locations along the shoreline including Port Hueneme, Santa Barbara Harbor, Catalina Island, suggest that this species may become much more widespread within the harbors over time. In Europe, *Undaria* has grown rapidly and been reported to out-compete native species and pose a significant economic problem as a fouling agent. The degree to which this species may become a problem in southern California is unknown. Eradication efforts are underway at some of the other infestation areas, however, due to its mode of reproduction, which involves the release of millions of motile spores, these eradication efforts may not be successful.

Figure 7.2-1. Kelp transect sampling stations in Long Beach and Los Angeles Harbors, March and September 2000.

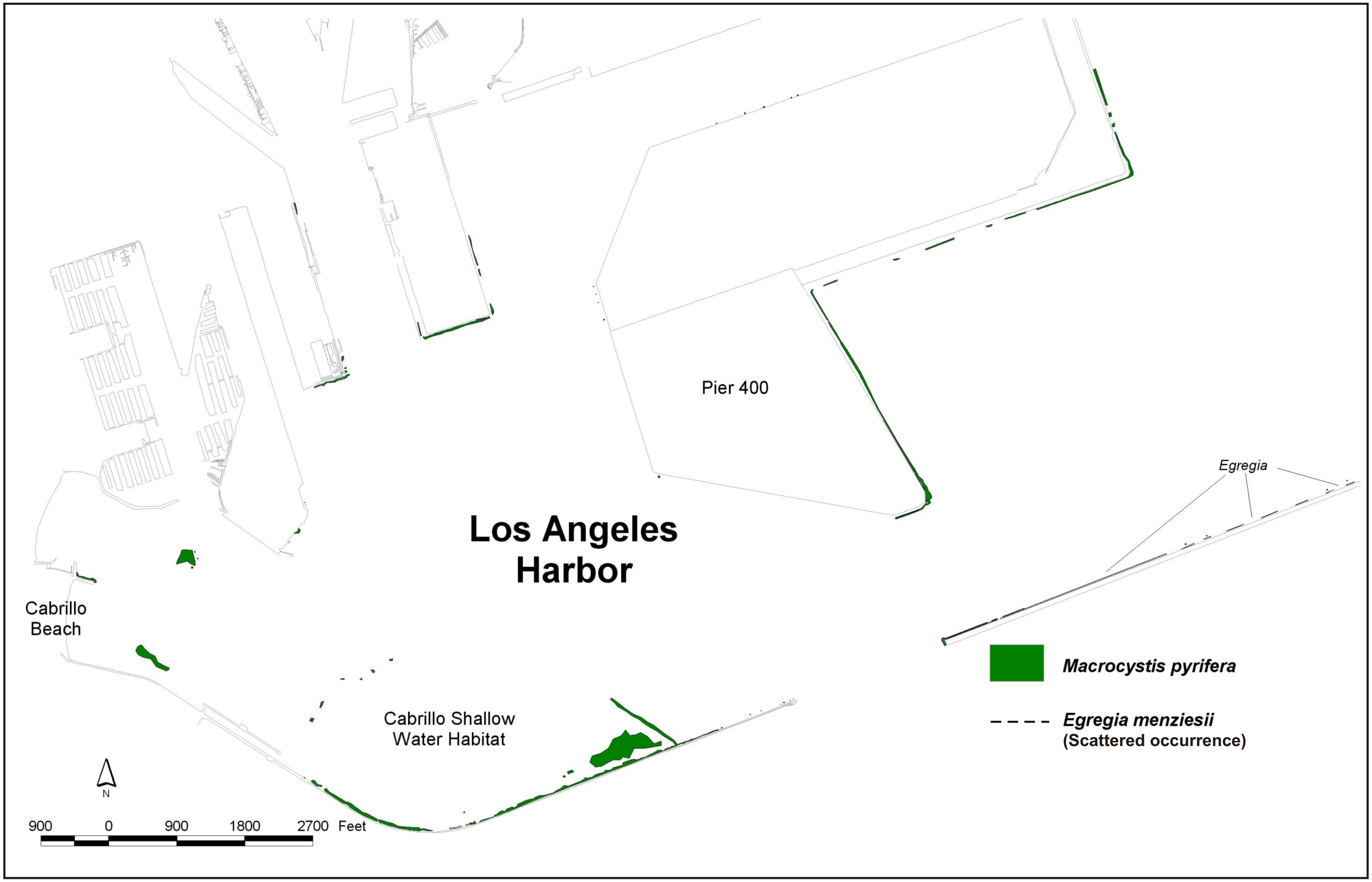


Figure 7.3-1. Kelp canopy in Los Angeles Harbor, March 2000.

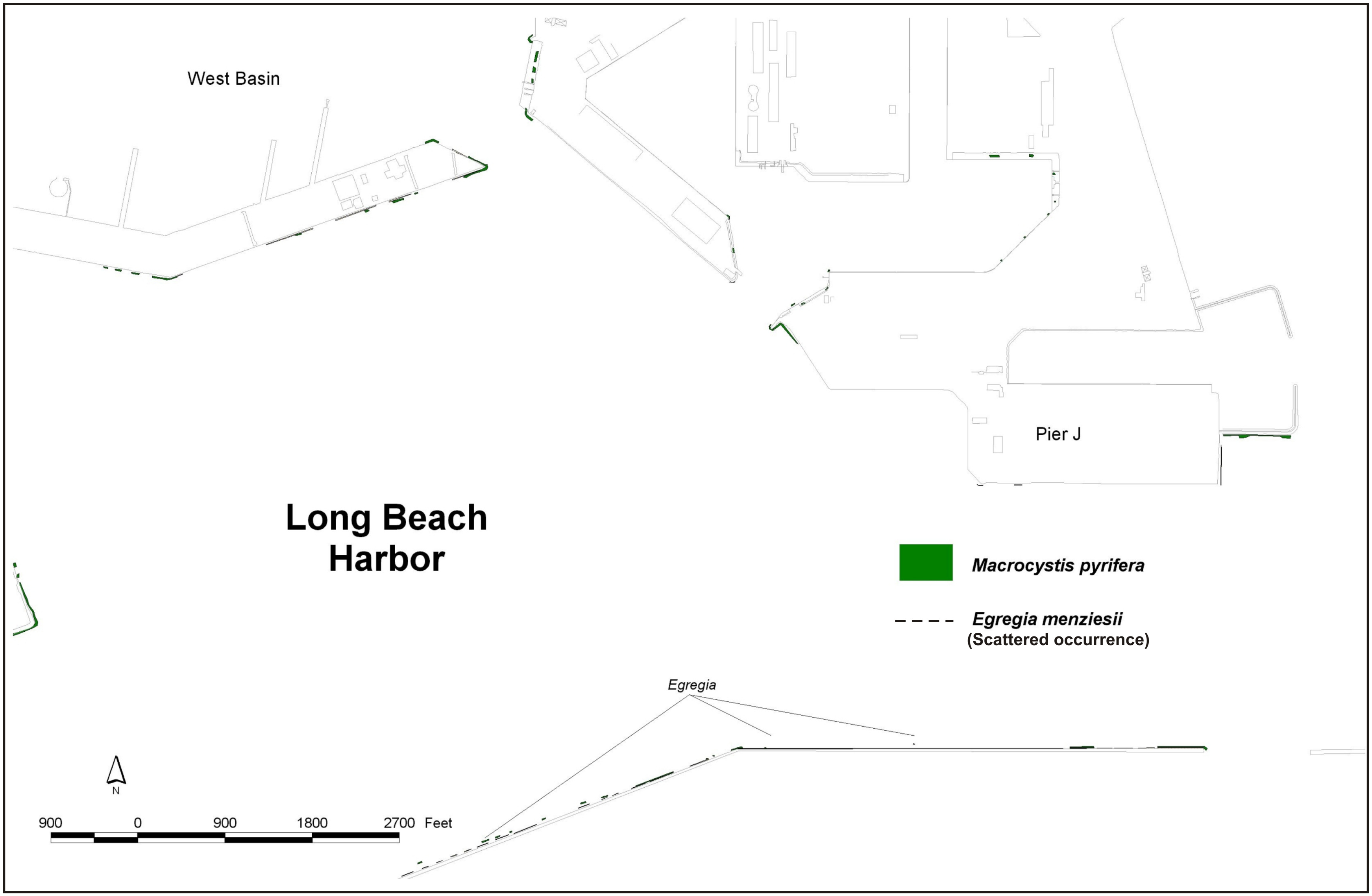


Figure 7.3-2. Kelp canopy in Long Beach Harbor, March 2000.

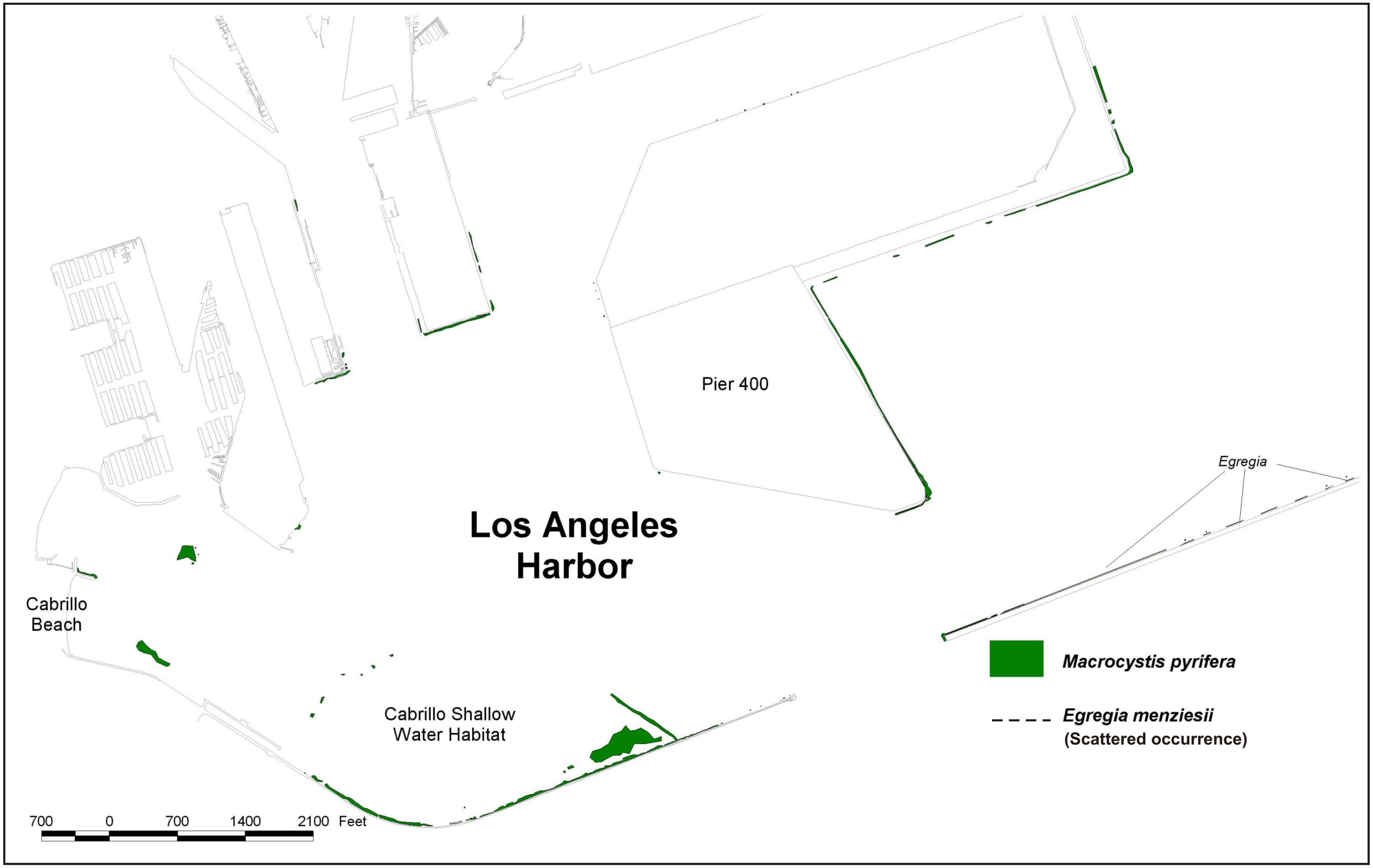


Figure 7.3-3. Kelp canopy in Los Angeles Harbor, September 2000.

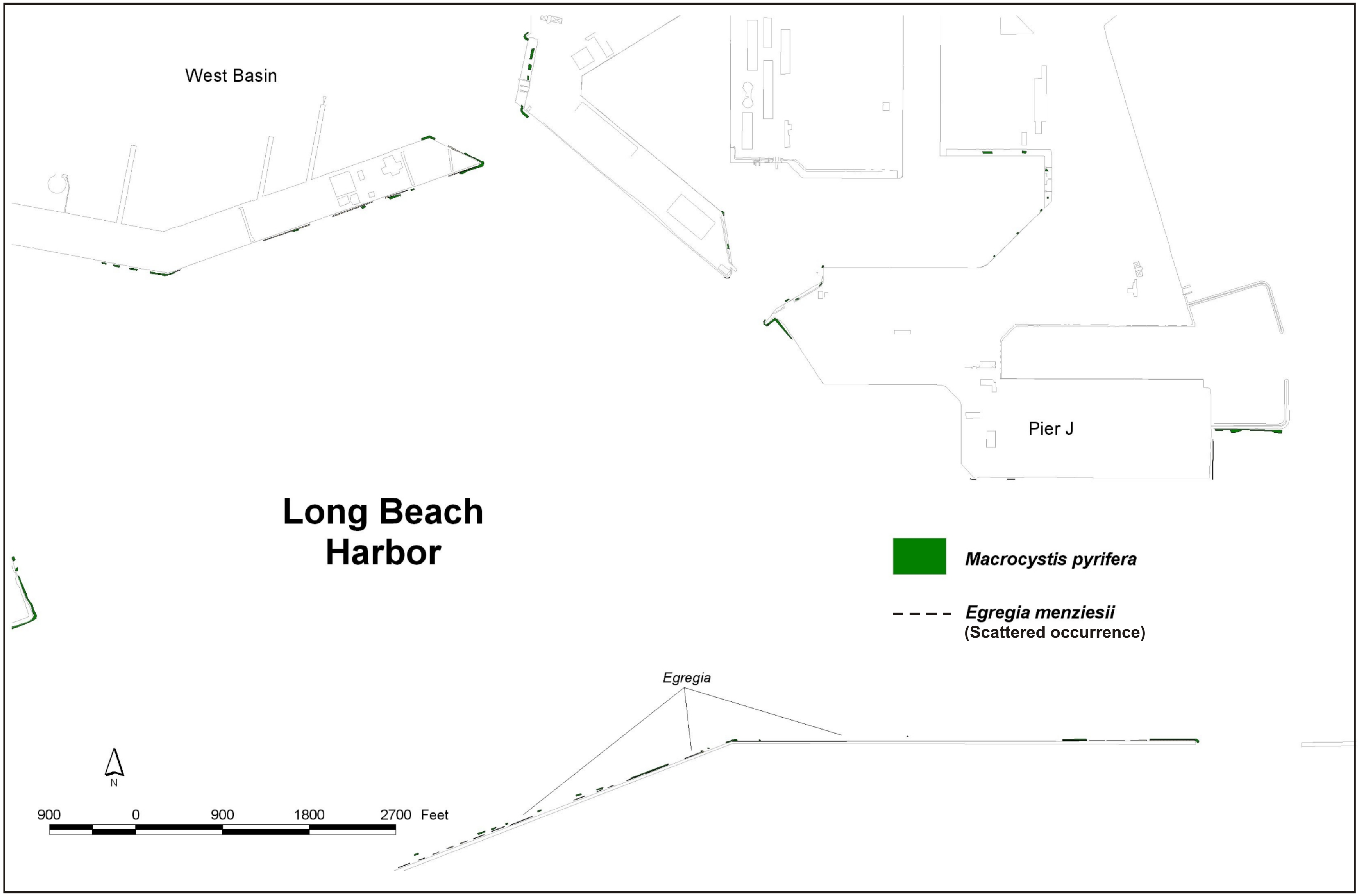


Figure 7.3-4. Kelp canopy in Long Beach Harbor, September 2000.

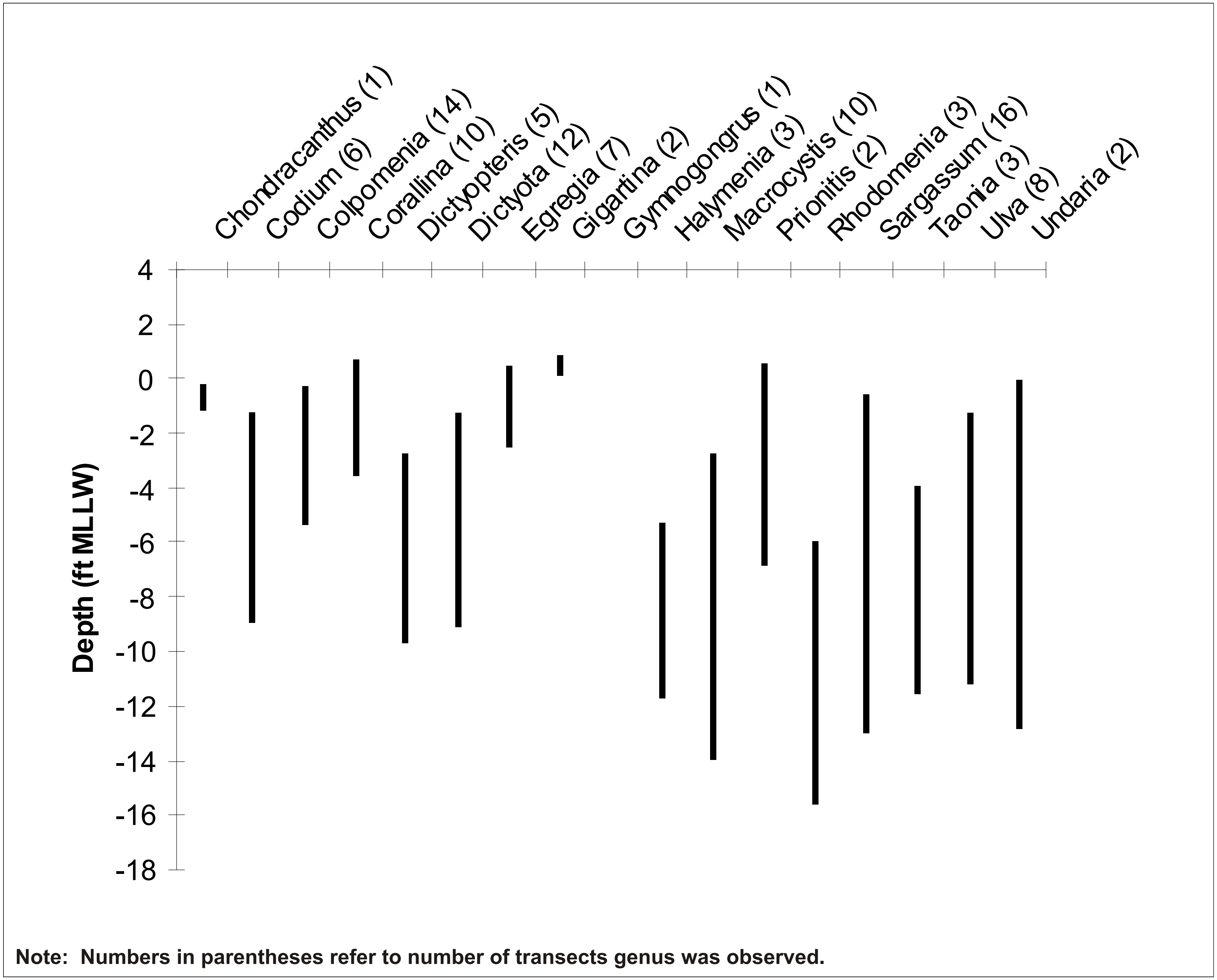


Figure 7.4-1. Mean vertical distribution of macroalgae in Long Beach and Los Angeles Harbors, May and September - November 2000.

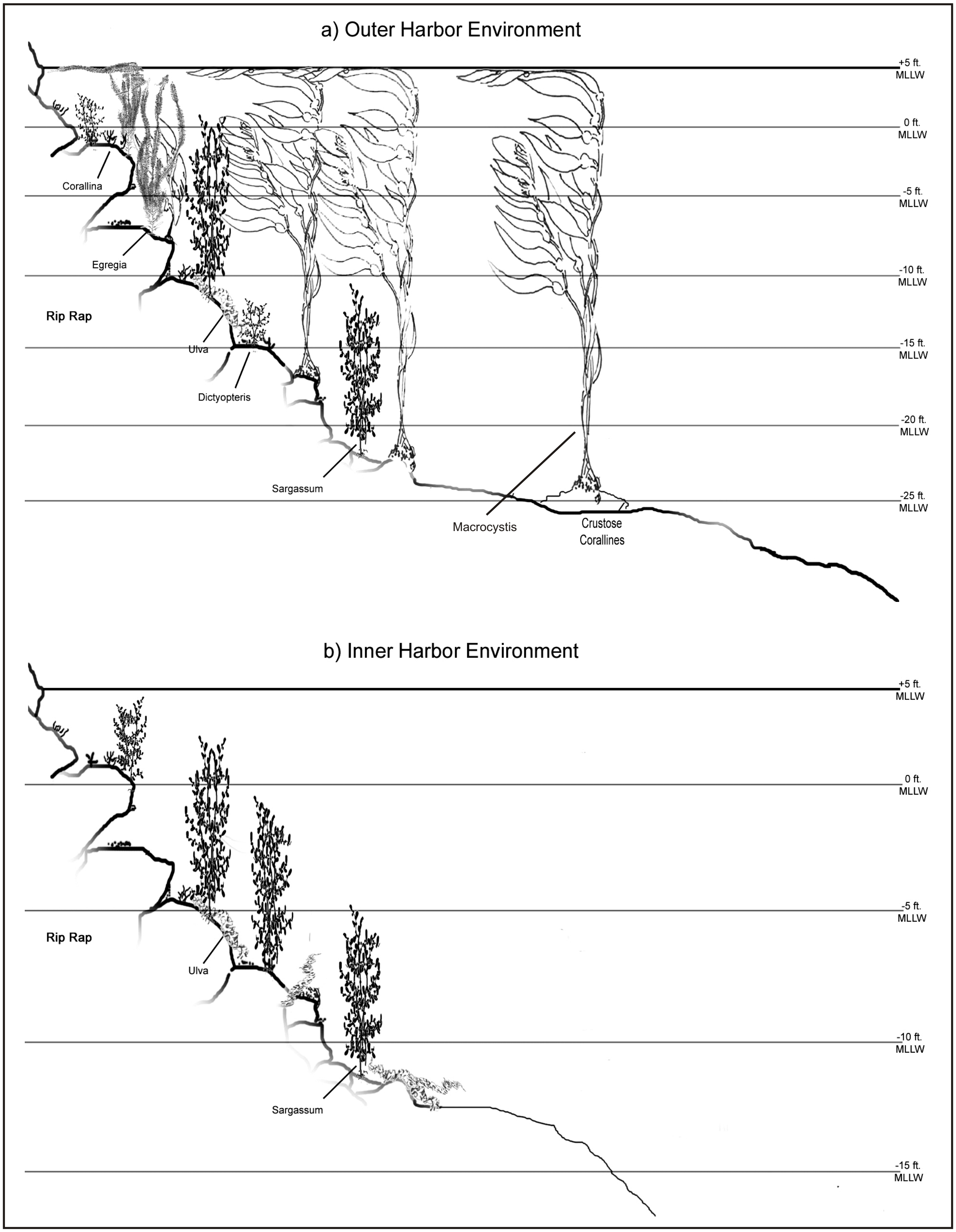


Figure 7.5-1. Typical macroalgal community on riprap in outer and inner harbor environments.

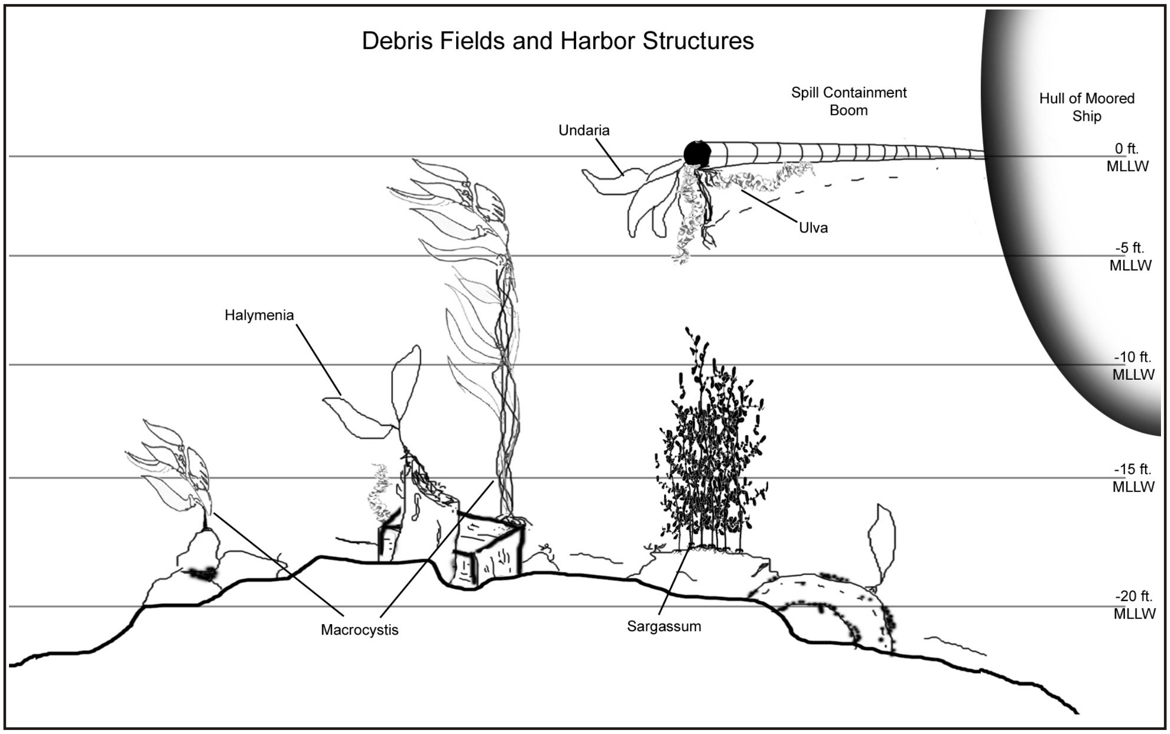


Figure 7.5-2. Typical macroalgal community within and on harbor debris fields and structures.

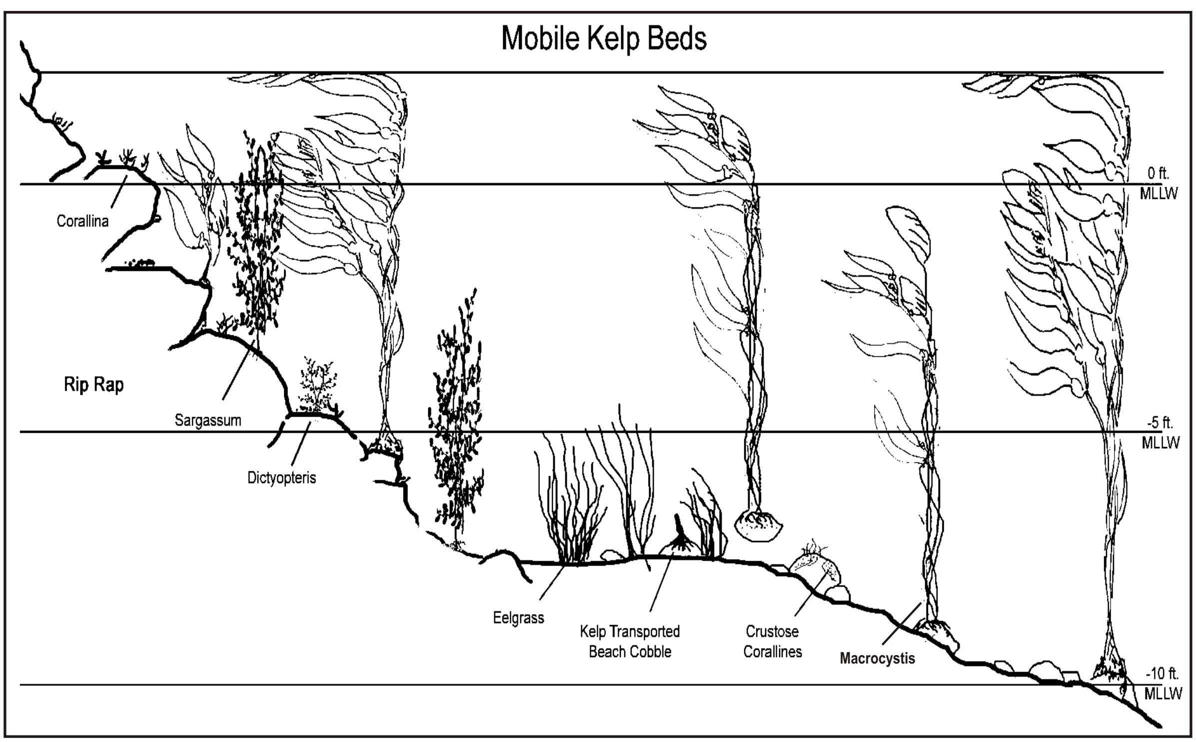


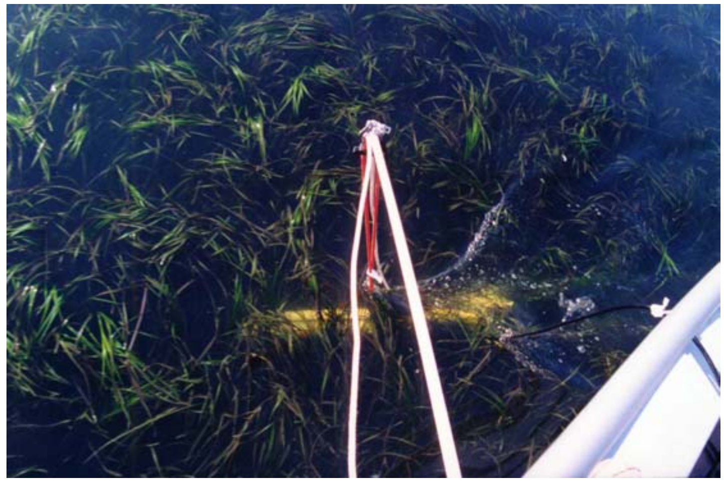
Figure 7.5-3. Typical macroalgal community within and around Cabrillo Beach mobile kelp beds.

Table 7.4-1. Species list (genera) of kelp and macroalgae by transect in Long Beach and Los Angeles Harbors, May and September-November 2000.

Species	Transect																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Chondracanthus			✓																	
Codium		✓				✓			✓						✓	✓				
Colpomenia	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓		✓			
Corallina	✓	✓	✓		✓	✓			✓					✓	✓	✓				✓
Dictyopteris		✓	✓			✓								✓		✓				
Dictyota	✓	✓	✓	✓	✓	✓		✓	✓			✓		✓	✓	✓				
Egregia	✓			✓	✓	✓									✓	✓				✓
Gigartina		✓	✓																	
Gymnogongrus			✓																	
Halymenia				✓				✓		✓										
Macrocystis	✓	✓	✓	✓		✓								✓	✓	✓	✓			✓
Pachydictyon																				
Prionitis			✓																	
Rhodomenia		✓	✓											✓						
Sargassum		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
Taonia		✓		✓		✓														
Ulva		✓		✓				✓	✓	✓	✓	✓	✓							
Undaria								✓								✓				

8.0 EELGRASS

8.1 Introduction



Eelgrass (*Zostera marina* L.) is a marine vascular plant indigenous to the soft-bottom bays and estuaries of the Northern Hemisphere. The species is found from middle Baja California and the Sea of Cortez to northern Alaska along the west coast of North America and is fairly common in healthy, shallow bays and estuaries. Eelgrass is a dominant, community structuring plant that forms expansive meadows or smaller beds. Within the southern portion of its range, the upper limits of eelgrass vertical distribution are typically set by desiccation stress. Throughout its range, eelgrass is generally limited along its deeper fringe by the reduction of light to a level below which photosynthesis is unable to balance respiration and meet the metabolic demands of the plant to sustain net growth (the photocompensation depth).

Eelgrass meadows are recognized as an important ecological community in shallow bays and estuaries. This habitat has important biological values such as providing a nursery area for marine life, as well as functioning as an important structural environment for resident bay and estuarine species. Eelgrass is a nursery area for many commercially and recreationally important finfish and shellfish species, including those that are resident within the bays and estuaries, many of the anadramous fish species found along the Pacific coast, and oceanic species which enter the estuaries to breed or spawn. Anchovies and other silversides often spend extensive amounts of time within eelgrass habitats during development, and larval forms of a wide variety of other species may be seasonally found in abundance within eelgrass habitat. Among other recreationally important species, California halibut, spiny lobster, and sand bass make use of eelgrass beds as habitat within southern Californian eelgrass beds. Finally, eelgrass provides a relatively unique habitat that supports a high diversity of non-commercially or recreationally important species whose ecological roles are less well appreciated or understood. Besides providing important habitat for fish, eelgrass is considered to be an important resource supporting migratory birds during critical life stages such as migration. Eelgrass is particularly important to waterfowl such as black brant that feed nearly exclusively on the plants and on a number of other species that make a diet of both eelgrass and the epiphytic growth which occurs on the leaves.

Eelgrass also supports epiphytic plants and animals that in turn are grazed upon by other invertebrates, larval and juvenile fish, and birds. Epiphytic growth on eelgrass blades is dominated by diatoms and encrusting organisms such as the bryzoan *Bugula neritina*. Also common sessile organisms include serpulid worms (Serpula vermicularis), the exotic amemone *Bnodiopsis*, and young scallops *Leptopectin latiauratis*. Mobile organisms that are common epiphytic species include skeleton shrimps (*Caprella* sp.) and painted limpets (*Notacmea* *depicta*). Egg masses of such species as bubble snails (*Bulla gouldiana*) are commonly hung in eelgrass beds and, at times, can be a visibly dominant component of the eelgrass canopy biomass.

Eelgrass is a significant primary producer, supplying detrital-based food webs, and is further directly grazed upon by invertebrates, fish, and birds, thus contributing to the system at multiple trophic levels (Phillips and Watson 1984, Thayer et al. 1984). Studies in California have demonstrated the abundance of fish and invertebrates within eelgrass habitats (Hoffman 1986, Kitting 1994). In addition to these readily identifiable biological values, eelgrass also traps and removes suspended particulates, stabilizes bottom sediments, cycles nutrients, and generates oxygen during daylight hours (Ward et al. 1984, Thayer et al. 1984, Wyllie-Echeverria and Rutten 1989, Merkel & Associates 2000a).

Throughout southern California, eelgrass is generally distributed sporadically in bays and estuaries. Dredging and filling of coastal wetlands, degradation of water quality, and loss of suitable habitat by other means has resulted in a fragmented distribution of this habitat. Today, within the Southern California Bight, eelgrass remains well represented in San Diego Bay, Mission Bay, the recently restored Batiquitos Lagoon, and Agua Hedionda Lagoon. It is more limited in its distribution within other systems such as Oceanside Harbor, Dana Point Harbor, Newport Bay, Huntington Harbour, Alamitos Bay, and Anaheim Bay. Eelgrass beds also occur in San Pedro Bay within the shallow waters of Los Angeles Harbor. Eelgrass, as a vegetated shallow water habitat, is considered to be a special aquatic site under section 404(b)(1) of the federal Clean Water Act of 1972 (as amended). This section describes recent inventories of these resources within the ports, discusses the dynamics of these habitats, and compares the survey results with historic survey data.

8.2 Methodology

For the surveys, a combination of mapping tools was applied. These included photogrammetric methods, acoustic techniques (side-scan sonar and down-looking sonar surveys), and diver surveys. Using these tools, the eelgrass bed distribution and density were determined over two seasons. These methods have been previously used to produce maps of eelgrass distribution and density at numerous sites in California (Merkel 1988, 1992, Merkel & Associates 1997, 1998a, 1999a, 1999b, 2000b, and US Navy SWDIV 1994).

Eelgrass surveys were conducted at the end of the winter season and at the height of the summer growing season in order to detect seasonal variability, area, and density. Acoustic surveys were conducted on March 18 and August 22, 2000, with diver surveys conducted on April 3 and September 26, 2000. Survey methods are described below.

8.2.1 Aerial Photography

An aerial photogrammetric survey of the Ports was completed to provide a shoreline basemap and to plot kelp and macroalgae distribution (Section 7). This resource was also useful in defining the upper edge of eelgrass beds and to assist in documenting the absence of eelgrass within portions of the harbors. However, due to some distortion within the photogrammetry, all edges of identified eelgrass beds were defined using on-the-ground techniques.

8.2.2 Side-Scan Sonar

The field acoustic surveys involved the integration of a dGPS with side-scan sonar and fathometer systems. Navigation and positioning for the survey were conducted using a Leica MX400 GPS receiver equipped with a differential correction receiver, which utilized the U.S. Coast Guard FM correction beacons. Vessel positional data were linked to an on-board PC and integrated with navigation monitors. Data were collected and analyzed digitally using side-scan data collection software and GeoDAS analysis software. Survey trackline positional fixes were saved to the computer hard drive and were simultaneously applied to plotted side-scan records as textual fiducial marks. The system resolution was ± 3 m as a combined error of the navigation system and side-scan equipment. All data were collected in degrees decimal minutes latitude and longitude using the North American Datum of 1983 in feet (NAD 83). The data were then subsequently converted and plotted onto a basemap of the harbors generated during the kelp survey using State Plane coordinates in feet (NAD 83).

The surveys were conducted aboard the 24-foot R/V Merkel-1, operated by Merkel & Associates. Side-scan data were collected using side-scan sonar operating at 600 kilohertz (kHz). During each survey, the vessel ran a series of parallel tracklines spaced 30 m apart to ensure adequate overlap between adjacent side-scan swaths. The first track was run within 10 m from the shoreline and was positioned so shoreline features such as riprap rubble or beach interfaces could be seen in the survey record. A navigation fix was collected every 2 seconds during data collection. Vessel position was maintained along the tracklines using an on-board, real-time video display with a two-second position refresh frequency and graphic as well a digital display of velocity and trackline variance.

Bathymetric data were collected using a digital fathometer operating at a frequency of 200 kHz with the 15 ° beam angle transducer. All fathometer data were recorded on a 0 to 15 ft vertical scale and the gain was adjusted to maximize the detection of eelgrass.

8.2.3 Diver Surveys

Divers were used to ground-truth acoustic records of eelgrass, characterize the health and vigor of the eelgrass, and to collect eelgrass shoot densities data within identified patches of eelgrass. Turion (shoot) density within eelgrass patches was determined by counting all of the shoots within a 1/16 m^2 quadrat. A total of 100 turion counts were taken at three locations during the winter survey and again during the summer 2000 survey.

8.2.4 Data Analysis

Mapping techniques and areal coverage determination made use of a mix of analytical techniques applied in the mapping efforts identified previously. Clustered eelgrass patches were encompassed by a boundary line, which defined the spatial extent of the eelgrass bed. These beds were further subdivided into areas occurring within differing ranges of areal coverage including 5%-25% (low density), 25%-75% (medium density), and > 75% (dense) cover. A minimum coverage of 5% was used for mapping purposes and to define aggregations of eelgrass plants that constitute a bed. Where individual plants were too far apart to be aggregated into beds achieving 5% plant cover, individual plants were considered to be the boundaries of the bed.

Following completion of the surveys, sonar traces were downloaded and processed into a georectified trackline. Using ArcView Version 3.2a, the eelgrass habitat was heads-up digitized as a theme over the shoreline basemap generated from the true color images flown for the kelp monitoring. All plots were generated based on California State Plane Zone 5 (NAD 83).

8.3 Eelgrass Distribution

Two areas supporting eelgrass beds were identified within Los Angeles Harbor (Figure 8.3-1). These two areas are referred to as Cabrillo Beach and Pier 300. The Cabrillo Beach eelgrass bed lies at the far west end of outer Los Angeles Harbor, off of Cabrillo Beach and the Cabrillo Beach Youth Facility. The second area lies just east of Pier 300 and includes the shallow water habitat and old Seaplane Anchorage.

Cabrillo Beach

March 2000

In the nearshore waters off of Cabrillo Beach and the Cabrillo Beach Youth Facility, 21.66 acres of eelgrass were detected during the March 2000 survey (Figures 8.3-2). During the March 2000 survey, there were 5.64 acres of eelgrass off the southern swimming beach. At this site, eelgrass was nearly absent inside the swimming boom and adjacent shallows (< 5% cover) with very occasional small eelgrass plants, one to two inches in tall, with only one or two narrow blades each. There were also occasional larger, isolated plants that were completely smothered by filamentous brown algae, which weighed the plants down in a prostrate position on the mud in many cases. A cool winter combined with the proliferation of this alga likely caused a substantial and more prolonged seasonal dieback in the eelgrass at this location. Despite a dieback of above-ground biomass, a dense mat of eelgrass rhizomes continued to persist in the sandy bottom. During the March 2000 survey, there were low numbers of purple and red sea urchins (*Strongylocentrotus purpuratus* and *S. franciscanus*, respectively) in this area of the shore.

East of the outer swimming area boom was a large, healthy bed of eelgrass in deeper water (-6 to -8 ft MLLW) on a mud bottom. The plants were 3 to 5 ft tall with a low epiphytic load. The brown alga observed further inshore was not present in the deeper water. Purple sea urchins were very common, but preferred grazing on pieces of drift kelp, which were common in the eelgrass bed. Mean leaf shoot density ($\pm$ standard deviation) in the bed was 134.4 $\pm$ 41.2 shoots/m^2 (n=20).

Off of the youth facility at Cabrillo Beach, the eelgrass bed measured 16.02 acres in March 2000. Near the outflow of the salt marsh, the bed was composed of dense, short eelgrass (1 to 2 ft tall) growing in shallow water (0 to 4 ft MLLW) on sandy substrate. This growth form is typical of higher energies that occur within the wave exposed shallows. During the March survey, the eelgrass was not flowering in this area and had a mean leaf shoot density of 289.6 $\pm$ 87.2 shoots/m^2 (n=20). The rest of the eelgrass bed, generally located off of the swimming float in deeper water (4 to 10 ft MLLW) with a muddy substrate, was dense and healthy in March 2000, with occasional flowers. The plants were typically 2 to 5 ft tall, with a very light epiphytic load. Leaf shoot density in this area measured 332.8 $\pm$ 97.5 shoots/m^2 (n=20). Notable within this bed was a large barren area supporting a sizable front (large aggregation) of purple urchins. This area had been grazed to the sediment surface by the urchin front, which was lined up against the surrounding eelgrass beds at the time of the survey.

August 2000

During the August 2000 survey, eelgrass cover increased dramatically off of Cabrillo Beach (Figure 8.3-3). Eelgrass reached a combined total cover of 42.27 acres across the Cabrillo Beach and Cabrillo Beach Youth Facility shallows. This represented an increase of approximately 95% total areal cover of above-ground eelgrass between March and August of 2000. More dramatic still was the change observed within the Cabrillo Beach portion of this area, where 19.76 acres of healthy, flowering eelgrass was mapped, representing an approximate increase in above-ground eelgrass cover from March 2000 to August 2000 of nearly 650%. Eelgrass had regrown inside the swim boom and further north to the 0 ft MLLW sand shoreline and up to the rip-rap shorelines as well. The brown alga observed in March was not detected and urchins were again observed in small numbers. Mean leaf shoot density in the regrown area was 396.8 $\pm$ 72.2 shoots/m^2 (n=20) and the plants were 4 to 5 ft tall. The eelgrass in the deeper water was also healthy, with a very low epiphytic load, and 4 to 5 ft tall. Mean leaf shoot density was 278.4 $\pm$ 72.4 shoots/m^2 (n=20).

The beds off the youth facility measured 22.51 acres with flowering plants being found throughout the site. While not as substantial a change as observed off of the beach to the south, this represented an approximately 40% increase in above-ground bed coverage. Leaf shoot density in the shallow area near the marsh was 267.2 $\pm$ 81.0 shoots/m^2 (n=20). Throughout the rest of the bed the eelgrass was very dense and healthy, with a very low epiphytic load and few urchins present. Leaf shoot density in this area was 202.4 $\pm$ 45.6 shoots/m^2 (n=20). The large bare patch observed in March had regenerated and was undetectable.

Pier 300

March 2000

The Pier 300 eelgrass beds occurred in shallow water within two basins (Figure 8.3-1). The first is the old Seaplane Anchorage. The second is the Pier 300 Shallow Water Habitat. A combined area total of 28.52 acres of eelgrass was detected at the Pier 300 site during the March 2000 survey (Figure 8.3-4). In contrast to the Cabrillo Beach eelgrass bed, the Pier 300 bed featured abundant and diverse fauna. During both surveys, species such as the brown sea hare (*Aplysia californica*), navanax (*Navanax inermis*) with egg masses, topsmelt (*Atherinops affinis*), gobies (Gobiidae), and many larval fish were observed in the eelgrass bed. During the March survey, a large California spiny lobster (*Panulirus interruptus*) was encountered in the dense eelgrass as were several larger fish that moved too quickly ahead of divers to be identified.

Off the southern beach, 22.23 acres of eelgrass were detected in the March 2000 survey. A dense band of eelgrass grew along the shoreline on muddy substrate that extended south along the riprap and became more sparse in the deeper water to the east. The grass was healthy and had a very light epiphytic load. The eelgrass was 3 to 5 ft tall with a mean leaf shoot density in the main portion of the bed of 202.4 $\pm$ 41.2 shoots/m^2 (n=20). The outer boundary of the bed occurred along a defined boundary where the sediment changed from mud to a hard packed sand. The margins of the beds were interspersed with the low-growing red alga *Hypnea* sp.

In the old Seaplane Anchorage, 6.29 acres of eelgrass were mapped in March 2000. The beds generally occurred on the western and northern margins of the small harbor, with a small dense bed in the far northeast corner. At this location the eelgrass grew on a firm, clay substrate at an elevation range between 0 and approximately -6 ft MLLW. A very narrow band of moderate density eelgrass occurred at the base of the riprap that forms the east boundary of the harbor (western edge of Pier 400). The eelgrass in Seaplane Anchorage was flowering in March, generally short (6 to 8 inches in height), with narrow blades. The mean leaf shoot density at this site was 132.8 $\pm$ 50.4 shoots/m^2 (n=20). Of interest during this survey was an aggregation of up to fifteen large leopard sharks (*Triakis semifasciata*) in the eelgrass bed on the north side of the harbor. Along the small sand beach in the southwest corner, three smoothhound sharks (*Mustelus* sp.) were observed in the shallows. A Port of Los Angeles employee standing on Pier 300 during the survey indicated that the gathering of sharks in this area was a regular occurrence.

August 2000

In August, the two eelgrass beds off of Pier 300 had expanded to a total area of 42.70 acres, representing a net increase in aerial coverage of approximately 50% between March and August (Figure 8.3-5). During this survey, the shallow water habitat bed off the Pier 300 beach occupied the same general location but many of the gaps had been filled, resulting in 38.42 acres of eelgrass being mapped and a net increase of 73% from March of the same year. However, the main bed of eelgrass paralleling the beach was less dense than in the March 2000 survey, due primarily to the high epiphytic load found on the beds and a senescence of some of the eelgrass. Nearly all of the eelgrass was more than 90% covered by the exotic anemone (*Bunodeopsis* sp.), which were in turn heavily coated by deposited sediment. The eelgrass was not flowering, and was generally 3 to 5 ft tall with a mean leaf shoot density in the central portion of the bed of 171.2 $\pm$ 32.4 shoots/m^2 (n=20). In the outer, more easterly portions of the bed, the *Hypnea* observed in the prior survey appeared to have grown to a much greater and denser extent in the prior months and was itself smothered by a heavy sediment and epiphyte load and was dying back.

In the Seaplane Anchorage in August 2000, 4.28 acres of eelgrass were detected, representing a net a net decrease in cover of 47% from March to August. The eelgrass was not flowering and continued to be of small stature and narrow leaf width. This represents the only area within the survey that declined in coverage between March and August. At 147.2 $\pm$ 30.6 shoots/m^2 (n=20), similar leaf shoot densities as found in March 2000 were recorded. The eelgrass was healthy with a low epiphytic load.

Other Eelgrass Beds

In order to identify potential locations of eelgrass growth in the harbors, bathymetric charts provided by the Ports were reviewed and all areas less than 20 ft MLLW were identified as targets. Each of these target sites were examined with sidescan sonar and single beam sonar surveys. While only the two areas of eelgrass habitat discussed above were identified within the Ports, there is evidence that at least one other eelgrass bed exists somewhere in the harbors and extremely small beds or individual plants could readily have been missed during the surveys. One such bed was identified by project team divers during the surveys of riprap communities.

Within the Cerritos Channel, along the north shoreline of Pier A at Berth A88 in Long Beach Harbor, a small patch of eelgrass (probably a single plant) was identified.

During the March 2000 eelgrass survey, a single blade of fresh, recently detached, eelgrass was found floating in the waters of the Arco Terminal in the Port of Long Beach. This eelgrass blade was distinct from the eelgrass found at either Pier 300 or Cabrillo Beach in that it was derived from a broad-leaved eelgrass population. Elsewhere where this eelgrass form occurs, it has typically been found in distinct patches and not mixed with the more common narrower leaf populations. It is also not uncommon to find this broad-leaved eelgrass in deeper waters than the more typical eelgrass beds. Based on the occurrence of such eelgrass within waters between 20 and 30 ft in depth at the mouth of San Diego Bay and in approximately 30 ft of water near the La Jolla Canyon, it would not be surprising if the origin of the eelgrass was in fringing areas of the outer harbor. However, it is not believed that a substantial bed exists based on the lack of more leaves in the drift and shoreline wrack found around the harbor.

8.4 Spatial and Temporal Variations

Background on Eelgrass Dynamics

Eelgrass beds may be both spatially and temporally dynamic. Fluctuations in eelgrass distribution and quality are responsive to prolonged small-scale as well as large-scale environmental changes. However, eelgrass does not typically respond to short-term environmental fluctuations such as daily weather or short-term elevation of turbidity. As a result, eelgrass is considered to be an integrator of environmental averages and a good indicator of environmental trends.

There are a number of factors which can influence the distribution of eelgrass, including light regime, substrate type, and energetics of the environment (Backman and Barilotti 1976, Williams and McRoy 1982, Dennison and Alberte 1985, Dennison 1987, Fonseca and Kenworthy 1987, Fonseca *et al.* 1983, Thom and Albright 1990, Zimmerman *et al*. 1990, 1994, Moore *et al.* 1993, Masini *et al*. 1995). In addition, it has been demonstrated that biological controls including epiphytic growth, spatial competitors such as benthic algae, and bioturbation can also have a substantial effect on the growth and distribution of eelgrass (Penhale 1977, Sand-Jensen 1977, Merkel 1990). Numerous authors have noted that high temperatures can restrict the occurrence of eelgrass and can influence the species metabolism (Bulthuis 1987, Marsh *et al.* 1986, Biebl and McRoy 1971), the reproductive mode of a population (Thayer *et al.* 1975, Phillips and Backman 1983, Phillips and Lewis 1983), or can lead to un-seasonal diebacks or a complete absence of eelgrass within an effected area (Phillips and Backman 1983, Phillips 1984).

Throughout its range, eelgrass exhibits seasonality in growth. In the most northerly portions of its range (e.g. portions of Alaska), eelgrass goes completely dormant during the winter, dropping all of its leaves and sustaining reserves within its underground rhizome system (Phillips and Watson 1984, Backman 1991). At the southernmost extreme (e.g. the Sea of Cortez), eelgrass dies off during the mid-summer and plants are replaced by seedling recruitment in the fall as water temperatures cool. Between these extremes, eelgrass response is variable with seasonal declines and expansions being reflective of the range of environmental conditions experienced during a given year or within the particular waterbody in which eelgrass occurs. In southern California, the seasonal variability in eelgrass growth is perhaps the most limited. Eelgrass often grows year-round, flowering may occur during any month, although it is most pronounced in the late spring (Ewanchuck 1995, Ruckelshaus 1996). While eelgrass may be present at any period of the year, the conditions of an eelgrass bed may fluctuate markedly between seasons. During the winter, growth slows or stops, eelgrass beds thin, and changes in distribution are most predictably associated with declines within deeper waters and expansion along the shallower intertidal margins. During the summer, eelgrass recedes within the intertidal margin and expands along the deeper fringe, eelgrass leaves elongate and shoot density increases. While these patterns are the norm, they too are extremely variable.

In addition to normal seasonal and interannual variation in eelgrass bed distribution, eelgrass can also be effected by sporadic and episodic events of a physical or biological nature. From various monitoring conducted over the past two decades, it is clear that eelgrass responds negatively to El Niño Southern Oscillation (ENSO) events. In southern California, eelgrass fluctuations amounting to declines of more than 70% within Mission Bay and San Diego Bay beginning in October 1997 followed by recovery to greater than 100% of pre-existing beds by June 1999 were likely attributable to ENSO influences (Merkel & Associates 2000b). Changes in the environment during the 1998 ENSO within southern California were principally related to the effects of elevated sea levels and to a lesser degree increased run-off. Both of these influences worked to diminish light levels and caused precipitous die-off of eelgrass within marginal environments. Similar declines were also noted in all other systems in which more limited investigations were conducted. Following El Niño events, eelgrass recovery occurs through a combination of seedling recruitment and vegetative regrowth. These large-scale events, combined with the response of eelgrass in habitat restoration programs, provide unique insight into the dynamics of eelgrass colonization and disturbance recovery.

Eelgrass may be damaged by intermittent or prolonged biological disturbances as well. Perhaps the most well known and dramatic biological impact that has been noted with this species was the wasting disease in the north Atlantic that reduced the abundance of eelgrass by as much as 90% during the 1930s (Rasmussen 1977). However, other small-scale biological factors are much more common. Ephemeral algae and other epiphytes can rapidly overgrow eelgrass beds where high nutrient concentrations and warm waters exist. These diebacks are frequently observed in eelgrass communities when the epiphytic load reduces the amount of light reaching the plant to a level at which photosynthesis can no longer meet the metabolic demands of the plant (Hanson 2000). Prolonged plankton blooms can have comparable effects on eelgrass. Skates and rays are frequently found to cause heavy bioturbation within eelgrass beds as they forage for benthic invertebrates. Intertidal and shallow subtidal eelgrass beds may be grazed down by large flocks of foraging waterfowl, particularly black brandt. Also, urchins moving as large aggregations, also called urchin fronts, may also crop eelgrass down to the sediment surface. Because herbivores eat the leaf shoots, but leave the rhizome and root structures intact, these types of impacts are generally relatively short-lived and transitory.

<u>Eelgrass Dynamics within Los Angeles Harbor Beds</u>

Within areas that provide the appropriate light, depth, and bottom type to support eelgrass, the extent of each eelgrass bed within Los Angeles Harbor appeared to be further limited by not only these factors but others as well.

During March 2000, the outer boundary of the eelgrass along the Pier 300 Shallow Water Habitat beach corresponded to the boundary between two different substrate types. Eelgrass growing in soft mud reached a bed edge in deeper water that was defined by a very hard packed fine sand with a thin cap of shell fragments. The material was comparable to an intact formational deposit in perceived strength and hardness by the biologists inspecting the area. This material may be comprised of deposits of drift sediment derived from the recent construction of the Pier 400 project. This speculation is based on having observed similar deposits from dredge material drift surrounding material disposal sites in San Diego Bay. Alternatively, this may reflect an artifact of older dredging or fill work. Notwithstanding the source of the substrate change, eelgrass expanded over the harder substrate during the expansion that occurred between March and August. This suggests that either the substrate is not wholly unsuited to the growth of eelgrass, or the newly deposited sediment layer that has collected on the surface has provided an adequate substrate for growth of eelgrass.

During the March 2000 survey a large barren in the middle of the eelgrass bed off of the Cabrillo Beach Youth Facility was defined by the intensive grazing pressures of sea urchins. The western side of the bare patch was ringed by a grazing front of primarily purple sea urchins that were stacked up three individuals tall. This phenomenon is commonly reported to temporarily clear large areas of kelp beds (Leighton 1960). Further, during the same period large urchin barrens were also detected in areas expected to support kelp along the outer breakwater (see Section 7). In the bare area were large masses of urchins four to five feet wide and two to three individuals thick wrapped up in blades of grazed eelgrass. During the August 2000 survey, the bare area had been completely recolonized by eelgrass and very few urchins were observed in the area. The effects of such grazing pressures by transitory population explosions or intermittent presence of herbivores are notable, but not likely to be significant in the long-term structuring of eelgrass communities within the harbor. Because grazing does little damage to the subsurface rhizome mat, rapid recovery following relaxation of grazing pressures was observed.

Similar transitory conditions that limit eelgrass include heavy growth of benthic algae such as was observed during the March 2000 surveys in portions of both Cabrillo and Pier 300 eelgrass beds. By August 2000, these ephemeral algal blooms had declined and eelgrass had recovered and voids in the beds had been filled in completely. However, by this same period those beds that had been the most luxuriant during March had become heavily covered by epiphytes and were beginning to decline.

While the dramatic increase in the coverage of the eelgrass beds off both Cabrillo Beach and Pier 300 between the March 2000 and August 2000 surveys emphasizes the temporal and spatial dynamics associated with this species, it is not unexpected. Similar large-scale seasonal changes have been noted in other systems. This is especially true where eelgrass is found in marginal environments over large areas of the bottom.

It is important to recognize that most eelgrass is constantly in a state of flux responding to multiple environmental factors that are both highly predictable (seasonal cycles) as well as less predictable (interannual and episodic cycles). Within eelgrass beds under "optimal" conditions, extrinsic environmental influences result in less recognizable effects on the bed than are observed in marginal environments where minor changes in the environment may result in a substantial expansion or decline in eelgrass. The observed expansion of eelgrass in Los Angeles

Harbor between March and August 2000 is not atypical for marginal environments with very flat bathymetry. Even minor improvements in light conditions can result in substantial increases in eelgrass density and coverage if eelgrass is near the photocompensation depth where photosynthesis balances metabolic demands or where other factors, such as heavy epiphytic loading, exacerbate the effects of normal light attenuation through the water column. Further, such changes can be extremely rapid due to the tremendous growth rates of eelgrass. In the warmer waters of southern California, eelgrass may expand vegetatively from a single planted eelgrass unit at a rate in excess of 8.8 cm^2/day with a rhizome elongation rate in excess of 1.2 cm/day (Merkel 1990b and unpublished data). Assuming these rates of eelgrass expansion and the presence of some viable rhizome material through much of the existing eelgrass areas, or some seedling recruitment, the magnitude of change from March to August 2000 is well within the range of what could be expected in a dynamic eelgrass meadow.

8.5 Historical Comparisons

While the eelgrass expansion between March and August of 2000 has been discussed in the context of seasonality and interannual variability, a strong argument could be made that two sampling periods do not provide enough data to rule out the possibility that there is a directional trend component to the changes observed. For this reason, it is worthwhile to examine the historic records to determine if a greater amount of information may be derived to answer questions regarding trends in eelgrass distribution within the harbors.

Historic Surveys and Methods

The most recent surveys of eelgrass resources in the study area were conducted in 1996 and again in 1999 by the Southern California Marine Institute. These studies surveyed eelgrass within specific portions of Los Angeles Harbor where eelgrass was known to exist. The 1996 report only covered eelgrass at Cabrillo Beach, while the 1999 report looked at both Cabrillo Beach and the Pier 300 Shallow Water Habitat (Gregorio 1999). Survey methodology involved use of visual observations, fathometer readings, and diver transects. While these methods provide less detailed and comprehensive data than the side-scan sonar methodology employed in the current study, it does allow for comparisons of overall areal extent and shoot density comparisons. Within beds that are relatively solid, the methods used by Gregorio would tend to over-estimate coverage relative to side-scan survey data, while in sparse beds, these surveys would tend to underestimate eelgrass coverage. Given this condition, it is not clear whether the present survey would be expected to result in higher or lower estimates of cover than truly exist. However, gauging from the mapped survey results and knowledge of the bottom conditions, it is believed that the studies conducted in 1996 and 1999 reflect a good representation of eelgrass that is suitable for comparison to the data from the current 2000 surveys.

Comparisons with Present Eelgrass Distributions

Off Cabrillo beach, a total of 24.6 acres of eelgrass was reported in 1996, increasing to a reported 54.5 acres in the October 1999 survey (Gregorio 1999). It is not known during what month the 1996 survey was conducted. In March 2000, eelgrass coverage at Cabrillo Beach was 21.66 acres; rising to 42.27 acres by August of that year. At Pier 300, the October 1999 survey reported a total of 49.7 acres in the shallow water habitat and Seaplane Anchorage combined (Gregorio 1999). This is nearly identical to the 42.7 acres detected during the August 2000 survey but well above the 28.52-acre coverage observed in March 2000. Figure 8.5-1 illustrates the relationship between eelgrass areal coverage observed between sites and years.

The pattern of change between October 1999, March 2000, and August 2000 is highly indicative of cyclic seasonal variability rather than a period of expanding eelgrass coverage. Further lending support to the conditions being reflective of seasonal cycles, in addition to raw acreage similarities, a comparison of coverage maps from the 1999 and 2000 survey show very similar eelgrass distribution patterns. While the survey data suggest repeated patterns of eelgrass fluctuation, they also clearly indicate the potential for reaching variable conclusions with respect to the presence or absence of eelgrass based purely on the timing of completion of surveys.

8.6 Summary

Eelgrass beds support a rich ecological community that has historically been widespread along the Pacific coast, including Southern California. This habitat has dwindled in abundance due, in part to coastal development activities and has been identified as a special aquatic site under the federal Clean Water Act. As deepwater harbors, few portions of the Long Beach and Los Angeles Harbors provide the shallow clear water environmental conditions that are considered to be suitable for the presence of eelgrass.

The eelgrass habitat surveys conducted during March and August of 2000 indicate the presence of eelgrass beds within two sites (Cabrillo Beach and the Pier 300 Shallow Water Habitat) in the Los Angeles Harbor. These beds, while consistent in their occurrence from year to year, exhibit relatively strong seasonal variation patterns in overall areal extent. The collective eelgrass total within the Port of Los Angeles ranges from approximately 50 acres in the spring to approximately 100 acres at their peak in the fall. This pattern of expansion and contraction of eelgrass habitat is not atypical of what is regularly observed in other areas where eelgrass occurs in marginal habitat areas that are typically on the deeper fringes of normal depth distribution ranges.

Within the Cabrillo Beach and Pier 300 sites, eelgrass distribution patterns were noted to be influenced both by what would be best attributed to light restrictions as well as a number of extrinsic biotic factors. Large areas that were devoid of eelgrass in March 2000 were dominated by a dense growth of a filamentous brown alga and urchin barrens were also observed within the eelgrass beds.

In addition to the two eelgrass beds located within the Port of Los Angeles, there was a single plant located in Long Beach Harbor within the Cerritos Channel along the north shoreline of Pier A at Berth A88. Further, it is believed that other eelgrass beds also likely exist in the Port's based on the observation of an eelgrass leaf from a broad-leaved form of eelgrass that was found floating around the Arco Terminal during March 2000. This broad-leaved eelgrass is not at all similar to the eelgrass found within the larger beds found in the Port of Los Angeles and has been noted to occur in deeper waters than the more typical form of eelgrass. These observations suggest that other limited eelgrass beds may exist in the harbors.

Figure 8.3-1. Location of major eelgrass beds in Long Beach and Los Angeles Harbors, March and August 2000.

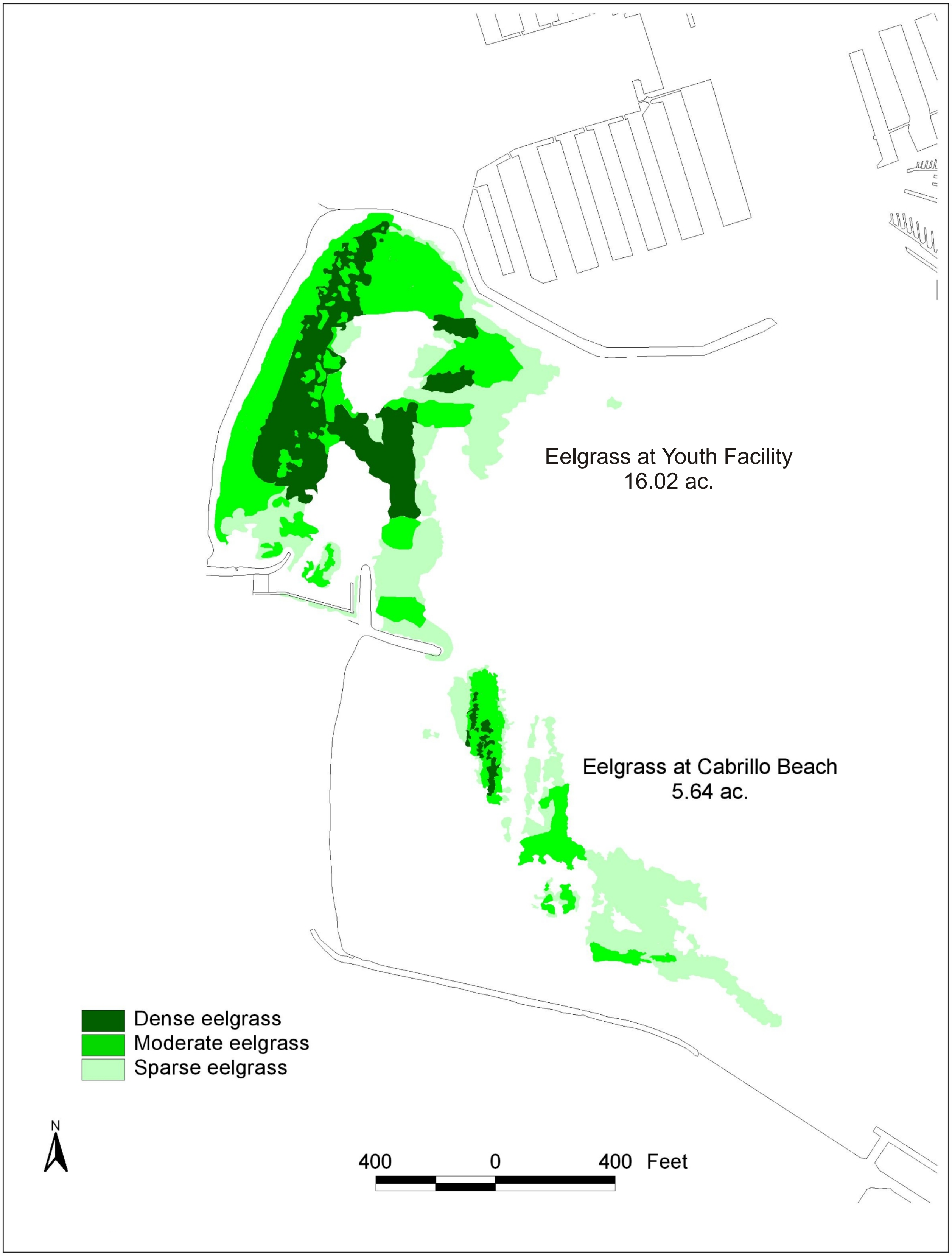


Figure 8.3-2. Eelgrass distribution at Cabrillo Beach in Los Angeles Harbor, March 2000.

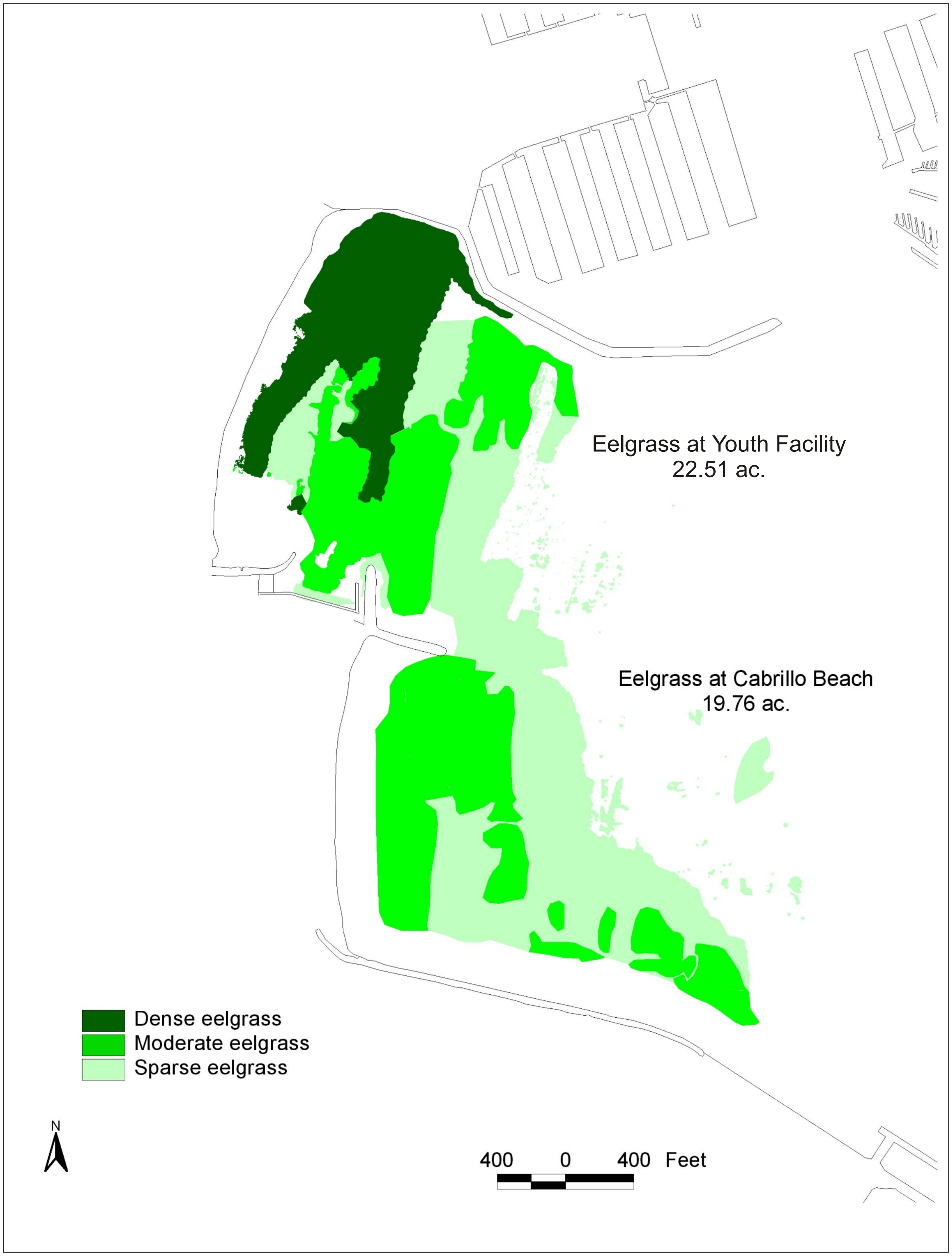


Figure 8.3-3. Eelgrass distribution at Cabrillo Beach in Los Angeles Harbor, August 2000.

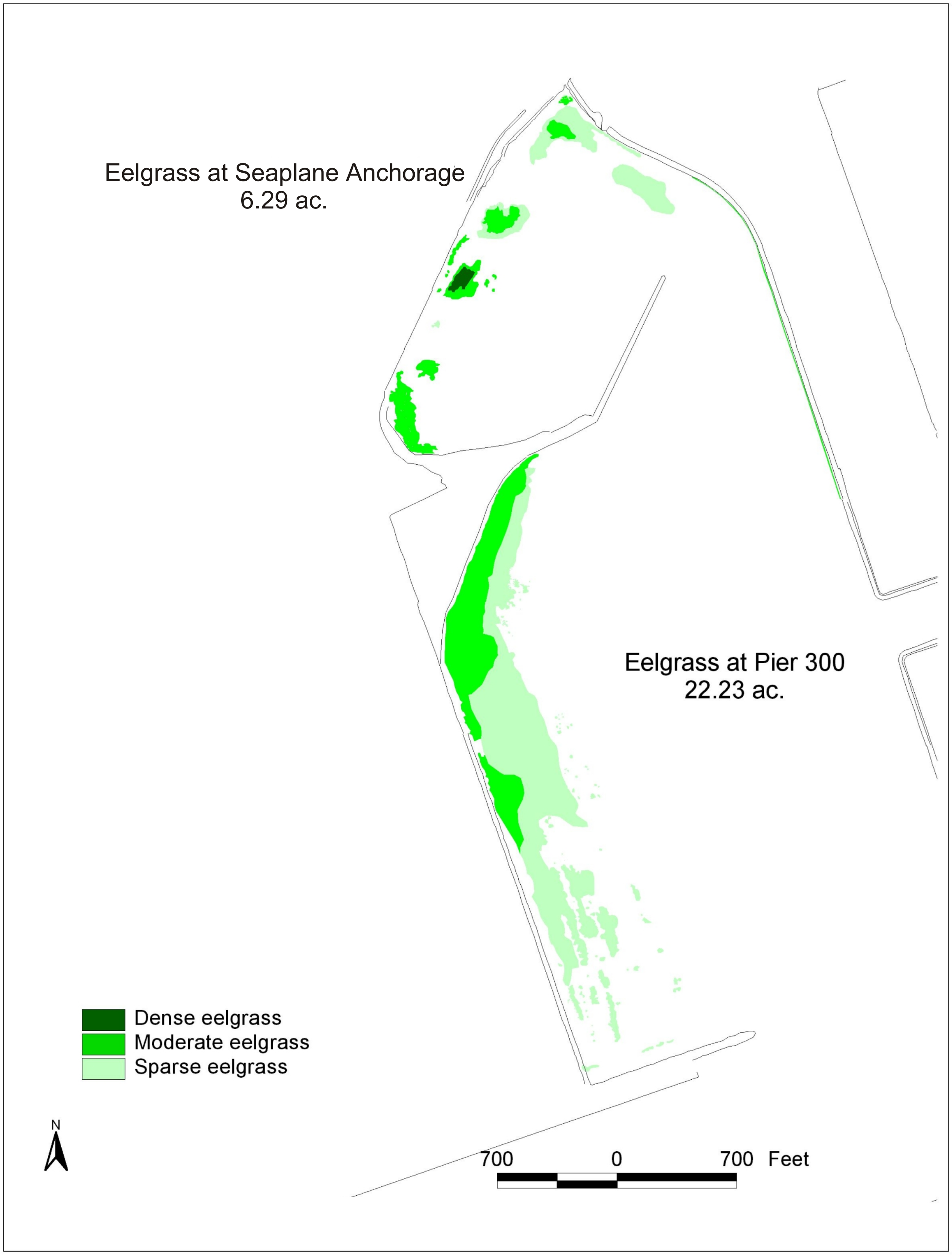


Figure 8.3-4. Eelgrass distribution at Pier 300 in Los Angeles Harbor, March 2000.

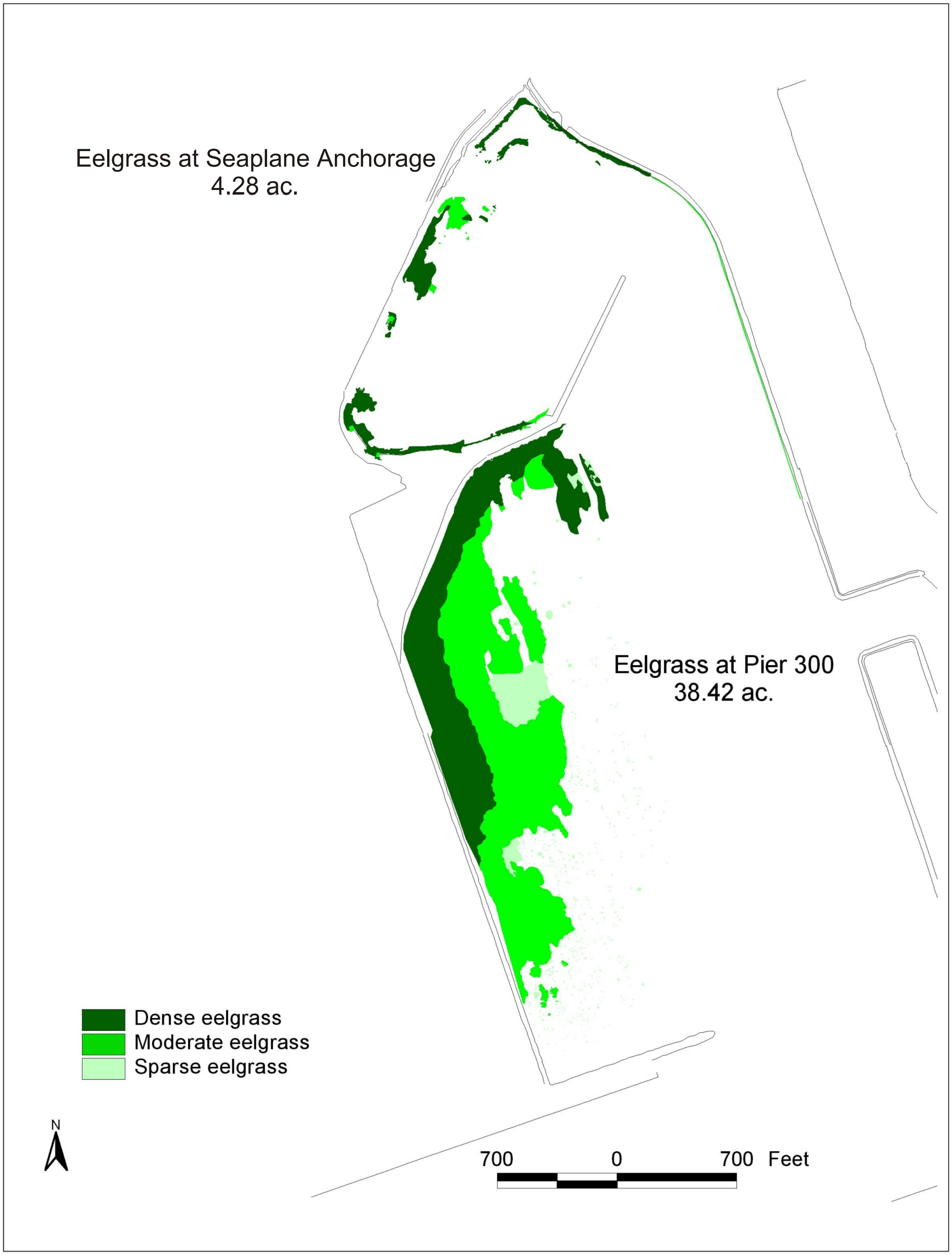


Figure 8.3-5. Eelgrass distribution at Pier 300 in Los Angeles Harbor, August 2000.

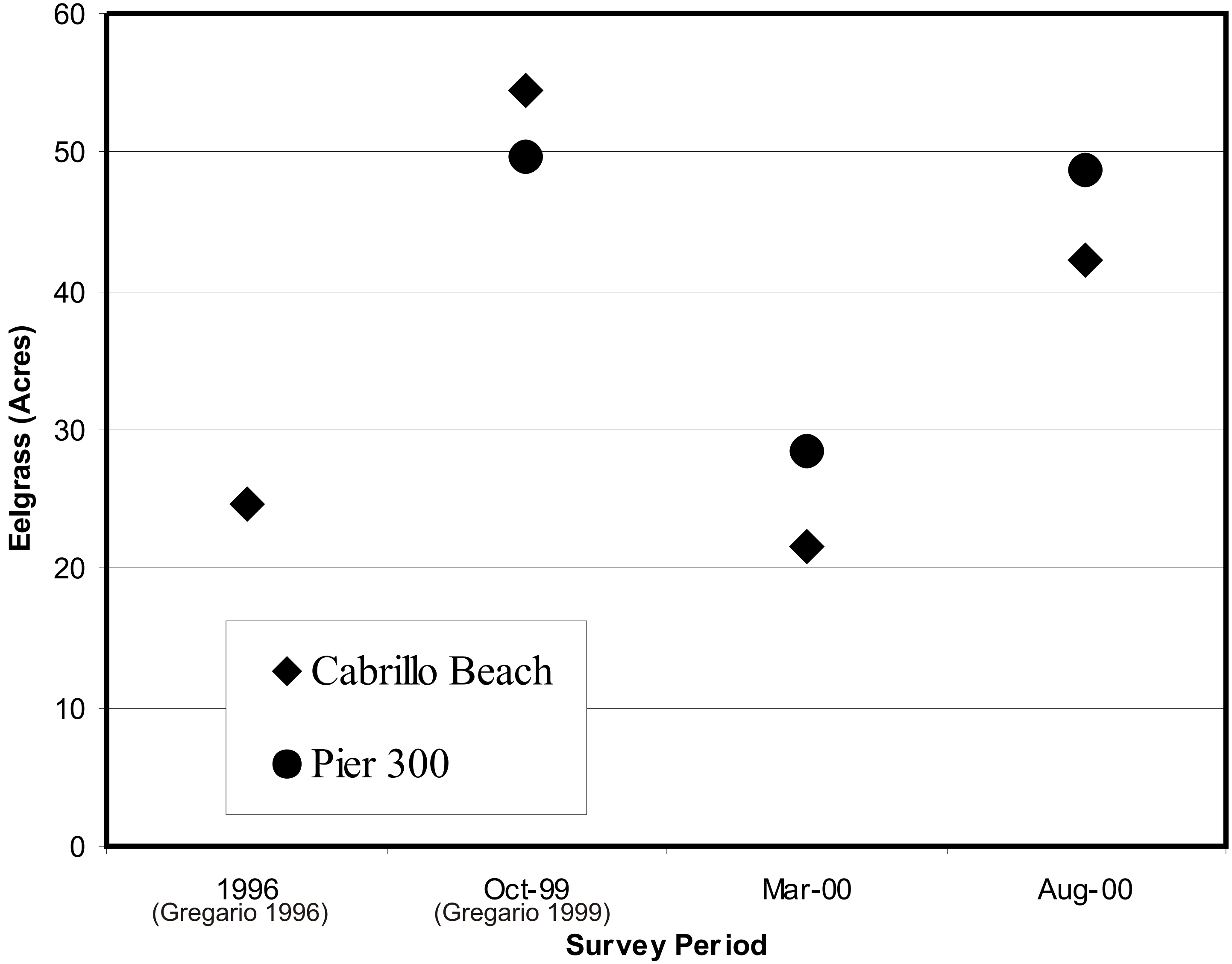


Figure 8.5-1. Historical comparison of eelgrass coverage in Los Angeles Harbor.

9.0 BIRDS

9.1 Introduction

The coastal zones of Southern California, including the shoreline, estuaries, bays, harbors, provide important habitat for large numbers of shorebirds, waterfowl, and other wetland-associated birds. As part of the southern California coastal complex, the open water and other habitats located within the Ports of Long Beach and Los Angeles (Ports) support important nesting, foraging, and resting habitat for numerous avian species, including the state and federally endangered California Least Tern and California Brown Pelican and the state endangered Peregrine Falcon. In order to document these bird resources, the Ports have conducted several previous studies of the avifauna over the past twenty-five years. Methods for the largest and most comprehensive of these are summarized below:

- *Studies of Marine-associated Birds in Los Angeles and Long Beach Harbors during 1973-1974 and 1978,* prepared by Harbors Environmental Projects, 1976 and 1979. The 1973-1974 work included 43 surveys of 48 zones throughout the nearshore (not open water) habitats of inner and outer harbors of both Ports. The 1978 work included quarterly surveys within 31 of the original 43 zones. Data collected included counts of each species observed within each zone.

- *Outer Long Beach Harbor-Queensway Bay Biological Baseline Survey*, prepared by MBC (1984). Work included 36 weekly and biweekly surveys to record species, counts, habitat utilization (4 habitat types), and bird activity within ten large stations/survey zones in the outer harbor and Queensway Bay of the Port of Long Beach.

- *A Biological Baseline and Ecological Evaluation of Habitats in Los Angeles Harbor and Adjacent Waters*, prepared by MEC (1988). Work included 24 bimonthly and monthly surveys of the outer harbor of the Port of Los Angeles and data collected included species, count, and habitat utilization in seven large blocks/zones.

The results of these studies indicate that over 100 species of birds make use of the various habitats within the Ports for foraging and roosting. Some of these species are year-round residents of the area, others may winter at the Ports, and some species only visit the area briefly during migration. Reports of these studies and others also reveal that at least 18 bird species breed and nest within the Ports, including the federally and state-listed endangered California Least Tern (scientific names of bird species are included in Appendix H.1). Several focused studies on California Least Tern breeding and foraging have been conducted in the Ports area, including Keane Biological Consulting (2000a and 2000b). Other focused studies on breeding bird species in the Ports are discussed in Keane (2000a – three other tern species and Black Skimmers) and MBC (2000 – Black-crowned Night Herons). Other than the California Least

Tern, listed species using the Ports include the state-listed endangered Peregrine Falcon and the federally- and state-listed endangered California Brown Pelican.

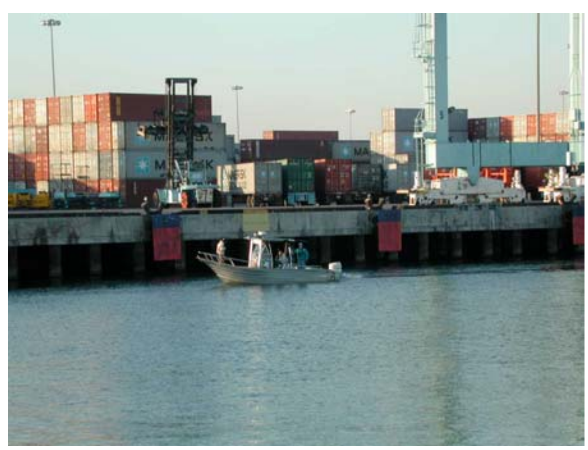
The most recent of the large-scale surveys listed above was completed more than ten years ago (MEC 1988). Few of the surveys completed over the past twenty-five years have utilized the same methodology or sampling intervals, and each study has encompassed a different sampling area within the Ports, thus making accurate comparisons among surveys difficult. Comparisons between studies are further complicated by the fact that several physical changes have taken place within the Ports within the past ten years, including the construction of Pier 400 within the Port of Los Angeles and the extension of Pier J (Maersk/Sealand Container Terminal) in the Port of Long Beach. Because of these changes in habitat quantity and quality, along with a lack of a recent comprehensive study of the open water and other habitats within the Ports, the current study was conducted.

The purpose of the 2000 Baseline Study was to update information regarding the species composition, abundance, temporal and spatial distribution, and habitat utilization of birds within the marine habitats of Long Beach and Los Angeles Harbors. Birds were surveyed throughout the harbors monthly and bimonthly depending on season for one year. Methods used for field surveys are described in Section 9.2. The abundance and diversity of the avifauna are presented in Section 9.3. Species composition including dominant, sensitive, and rarely sighted birds are described in Section 9.4. Bird utilization of different habitats within the harbors are addressed in Section 9.5. Section 9.6 provides a summary of spatial and temporal pattern observed during the 2000 Baseline Study. Results are compared to historical studies in Section 9.7. The chapter concludes with an integration of the study findings (Section 9.8). Raw summary data are provided in Appendix H.

9.2 Methodology

9.2.1 Field Surveys

Prior to the first bird survey, the inner and outer harbors of the Ports were divided into 31 survey zones (Figure 9.2-1). The zone boundaries were established in the same locations as the 1983-1984 (MBC 1984) and 1986-1987 (MEC 1988) studies in order to facilitate comparisons between studies. Minor modifications to the survey zones were necessary to accommodate recent changes to the harbor environment, such as the Pier 400 landfill, Pier J expansion, and to eliminate study block overlaps. There is a gap in the numbering of the bird zones (i.e., no zones 16, 17, and 18) associated with the above considerations. Thus, there were 31 zones surveyed, which were numbered zones 1-15 and 19-34.



Saturation surveys were completed by boat in all zones. Bird counts were completed with binoculars by one observer and recorded by another observer. The boat operator was also a trained ornithologist and assisted with observations. Boat travel within a given station was conducted in a manner that minimized flushing of birds to avoid double counts or observer-induced changes in bird behavior or habitat use. Data recorded for each observation included species identity, numbers of individuals, habitat in which the birds occurred, and bird activity. Habitats were designated as open water (> 1 foot), shallow water (< 1 foot), sand beach, mud flat, bridge, riprap, dock/piling, barge, buoy, salt marsh, anchor line, spill boom, and aerial (for flying birds). Bird activities were categorized as foraging, resting, courting, nesting, or flying. Other relevant information about particular observations, such as presence of banded, dead, or injured individuals, was also noted. During each survey, environmental data were recorded including wind speed and direction, sea surface and sky conditions, tide status, level of human activity, and any other circumstances that may have influenced the behavior and occurrence of the birds. Observations of marine mammals were also noted. California sea lions were commonly observed during the bird surveys, mainly in the Outer Harbor through main channel areas. Many were observed resting on buoys. Harbor seals and bottle-nosed dolphins were seen on occasion. A small California gray whale was observed in the Outer Harbor in February and March, and a dead whale was observed in April 2000 (Appendix H).

Surveys were conducted once monthly between April 16th and August 14th and twice monthly from August 15th through April 15th. For months when two surveys were completed, surveys are designated as "A" and "B" in the report text and graphics. Surveys were more frequent during the fall and winter months to more thoroughly document the increase in avian activity that occurs in southern California during post-breeding dispersal, migration, and over-wintering. This approach of increased surveys during fall and winter months has been utilized in previous surveys (MBC 1984, MEC 1988). Each survey was conducted under suitable environmental conditions over a two to three day period, beginning early in the mornings and ending in the late morning or early afternoons. Surveys were discontinued for the day if wind, visibility, rain, or other factors were deemed to be unsuitable for accurate and effective data collection.

9.2.2 Data Analysis

All survey data were initially recorded in the field on hard copy data sheets and then transferred in the office and laboratory to digital database files. Hard copies of the field data were stored at a central, off-premises location. Data were analyzed to identify spatial and temporal trends in total avian abundance, numbers of species, and habitat usage. To better manage data and simplify presentation, individual bird species were assigned to one of eight ecological guilds: Small Shorebirds, Large Shorebirds, Wading/Marshbirds, Waterfowl, Aerial Fish Foragers, Raptors, Gulls, and Upland Birds. The assignment of bird species to the various guilds is indicated in Appendix H.1. This appendix also includes scientific names for all species observed. Patterns of habitat usage, activity, and seasonal variation of ecological guilds were then determined. Finally, all data collected were compared to the greatest extent possible to results of previous bird monitoring programs within the harbors.

Due to variations in total area surveyed, duration and timing of surveys, and survey methods, as well as a reduction in available open water habitat, data comparisons among current and previous surveys do not focus on raw abundances. With few exceptions, average numbers per survey and per area were calculated for the current surveys in order to allow comparisons with previous surveys to the greatest extent possible. While total abundances of birds for each survey are presented in the tables, the majority of the discussion below focuses on mean abundances and percent composition of individual species and avian guilds, and densities of guilds within survey zones. Descriptions of methods used to make current and previous survey data comparable are presented in the appropriate sections of this report.

9.3 Abundance and Diversity

A total of 99 species, representing 31 families were observed within the Ports of Long Beach and Los Angeles during the 2000-2001 monitoring year. Of these species, 69 are considered to be water-associated, and dependent on the marine habitats of the Ports for food and shelter. Table 9.3-1 provides a summary of total numbers of species and individual birds observed during each of the 20 surveys. The greatest number of individuals was observed during the July 2000 survey and the first survey in August 2000. This high summer abundance was due primarily to large numbers of a few species including Elegant Terns nesting at Pier 400, which were foraging in the harbor waters, as well as, large numbers of California Brown Pelicans, Heermann's Gulls, and Western Gulls. Despite the high abundances observed during July and August, the June through September surveys yielded the lowest numbers of species, and fall and winter surveys yielded the highest numbers of species (Figure 9.3-1).

9.4 Species Composition

9.4.1 Abundant Species

Table 9.4-1 provides a summary of average abundance and percent composition of species and guilds observed over the 2000-2001 monitoring year. Average abundances were calculated by first averaging values for months during which more than one survey was completed (to obtain a monthly average), and then averaging monthly values to obtain a yearly average. This approach was utilized in order to compare data with those of previous studies, which vary in sampling frequency and intensity. Percent composition for species and guilds was obtained using the yearly averages.

The most abundant guild was Gulls, which accounted for 44.1% of the mean observations during the survey year. Abundant gull species included Western Gull and Heermann's Gull, which comprised 28% and 13% of mean individuals, respectively. The second most abundant guild was Aerial Fish Foragers, which accounted for 22.4% of the mean observations. Most numerous were Elegant Tern and California Brown Pelican (10.4%, and 9.5% of the mean observations, respectively). The third most abundant guild was Waterfowl (21.4% of the mean observations), dominated by large numbers of Western Grebe, Brant's Cormorant, and Surf Scoter, (8.3%, 5.0%, and 3.1% of the mean observations, respectively). Upland Birds, dominated by large numbers of Rock Doves roosting under docks and on pilings throughout the Ports, accounted for 5.9% of the mean observations. Small Shorebirds, Large Shorebirds, and Wading/Marshbirds accounted for 2.7%, 1.4%, and 1.5% of the mean observations, respectively. While abundances of individual species in these guilds were comparatively low, commonly observed species included Surfbirds, Black-bellied Plovers, and Western Sandpipers (Small Shorebirds), Willets and Black Oystercatchers (Large Shorebirds), Great-blue Herons and Black-crowned Night Herons (Wading/Marshbirds). Raptors accounted for < 0.05% of the mean numbers of individuals observed.

9.4.2 Sensitive Species

Several sensitive avian species were observed during the 2000-2001 surveys. Table 9.4-2 provides the legal and protective status of each of the sensitive species observed within the Ports. Species for which protective status applies only to nesting colonies or rookeries (rather than foraging or wintering areas) are only included if they are known to nest on-site; species not known to nest on-site are described below, but are not included in the table.

The California Brown Pelican accounted for 9.5% of the total observations during the 2000-2001 surveys (Table 9.4-1). The majority of individuals were observed roosting along the riprap of the outer breakwater. The highest numbers of individuals were observed during summer months with a maximum count of 1,181 individuals observed in July 2000. This species has consistently been one of the most abundant species within the Ports, accounting for 14% of the birds observed in the most recent biological baseline study of the Port of Los Angeles (MEC 1988), and 15.1% of total birds observed during the 1983-1984 study of outer Long Beach Harbor (MBC 1984). These numbers represent an increase since the 1970's when the Brown Pelican accounted for only 3.8% during 1973 studies (HEP 1980).

While this species does not nest within the Ports (the nearest nesting colonies are on west Anacapa and Santa Barbara Islands), the Ports, particularly the outer breakwater and open water, provide valuable roosting and feeding habitat.

A pair of Peregrine Falcons was observed nesting on the Schuyler F. Heim Bridge that separates the Ports of Long Beach and Los Angeles inner harbors. One or both birds were observed in the vicinity of the bridge on 12 of the 20 survey dates. This species was reported to occur within the harbor as early as 1982, and a single individual was documented in 1984 (ACOE 1984, MBC 1984). No Peregrine Falcons were observed during the 1986-1987 biological baseline surveys completed for the Port of Los Angeles (MEC 1988). Several pairs of Peregrine Falcons are known to nest within the Ports and their vicinity.

Four species of terns, including the state and federally endangered California Least Tern, and the related Black Skimmer have nested within the Port of Los Angeles at Pier 400 beginning in 1995. California Least Terns reportedly nested within the Ports as early as the late 1800's and have been observed within the harbor almost every year since monitoring studies began in 1973 (Keane Biological Consulting 2000). Prior to 1995, Least Tern nesting sites were located within the Port of Los Angeles on Terminal Island. In addition to the Least Tern, other species with sensitive status (Elegant Terns, Caspian Terns, and Black Skimmers) have nested on Pier 400 in recent years. Caspian Terns began nesting at the site in 1996 and the other species first nested in 1998. Construction on Pier 400 was ongoing during the 2000-2001 bird surveys.

While a large portion of the Pier 400 peninsula is currently available to nesting terns due to ongoing construction activities, an approximately 15.7 acre permanent nesting site will be available to the Least Terns and other birds upon completion of Pier 400 (Keane Biological Consulting 2000). During the 2000-2001 surveys, the highest numbers of terns were observed during spring and summer months. California Least Terns were only observed within the Ports during the April through August surveys (a total of 12, 104, 94, 88, and 8 individuals observed during April, June, July, and August, respectively, Table 9.4-1). California Least Terns migrate south for the winter in September. The majority of Least Tern observations were of individuals foraging or flying in the vicinity of Pier 400, although Least Terns were also observed foraging along the outer breakwater and in the inner harbors. Focused breeding surveys for the 2000 season indicate that a total of 565 nests (a 54% increase since 1999) were established along Pier 400 with an estimated 570 chicks fledged (Keane Biological Consulting 2000).

The Elegant Tern was the most numerous tern species observed during the surveys, accounting for over 7,000 individuals for all surveys combined and an average of 615 individuals per survey (Table 9.4-1). Elegant Terns were primarily observed in Zones 7 and 8 along the western riprap of Pier 400 during the July 2000A survey, when 3,656 nests were estimated on Pier 400 and adults were foraging for food for their young (Keane Biological Consulting 2000). Observations of Caspian Terns during surveys were lower than for Elegant Terns, with an average of 35.7 individuals per survey (Table 9.3-1). Observations peaked during April 2000 (117 individuals) when Caspian Terns were initiating nests along Pier 400 (an estimated total of 336 nests were initiated in 2000). Numbers of Black Skimmers peaked at 183 during the August 2000A, as this species typically initiates nesting in mid to late summer after most terns have fledged chicks. Approximately 115 Black Skimmer nests were counted at Pier 400 in 2000 (Keane Biological Consulting 2000). While nesting success was not quantitatively monitored for these species, low numbers of dead chicks and high numbers of fledged chicks suggest that reproductive success for Elegant and Caspian Terns was excellent. However, no Black Skimmer chicks were fledged, possibly due to disturbance by Peregrine Falcons or gulls that reportedly visited the nesting area in August, after most terns had left the area (Keane Biological Consulting 2000).

A nesting colony of Black-crowned Night Herons and Great Blue Herons was located within the Port of Long Beach at Gull Park, Navy Mole, at the mouth of the West Basin. This location is a mitigation site constructed in 1998 for removal of nesting trees at the Long Beach Naval Station. Both species of herons accepted the mitigation site as a rookery. During the 2000-2001 surveys, Black-crowned Night Herons were observed in many survey zones throughout the Ports. However, they were concentrated in Zone 23 in the Port of Long Beach West Basin during the spring months, with peak numbers of individuals occurring in the rookery during May and June 2000 (51 and 58 individuals, respectively, Table 9.4-1). Similarly, numbers of Great Blue Herons were highest during summer months, peaking in September 2000. In addition to individuals located at the Gull Park rookery, high numbers of Great Blue Herons were observed resting along the riprap at the Port of Los Angeles' Pier 400 (Zones 7 and 8).

A nesting colony of Black Oystercatchers was observed within the riprap along the entire length of outer breakwater within the both Ports (Zones 15, 12, 9, 3, 2, 19). The species has been present within the Ports since at least 1973 (HEP 1979). Individuals were observed on all but one survey date, with the highest numbers observed during September (75 and 33 individuals during A and B surveys, respectively) and October 2000 (63 and 20 individuals observed during A and B surveys, respectively). Lower numbers of individuals were observed during the winter months, but individuals remained concentrated along the breakwater. Black Oystercatchers typically nest along rocky shores and islands along the Pacific coast of North America (National Geographic Society 1999) and the nesting colony within the Ports is considered unusual.

Although surveys focused on the water habitats of the Ports, bird use of adjacent areas was also recorded, and one individual Burrowing Owl was observed along the riprap in Zone 10 during the March 2000A survey. It is not known whether this individual maintained an active burrow in this area. Loggerhead Shrikes were observed, primarily in the Port of Long Beach and Los Angeles inner harbors, on four occasions (April 2000, August 2000, November 2000A, and January 2001B). All birds were observed on riprap or dock/piling habitat.

Species observed during the 2000-2001 surveys for which protective status applies only to nesting colonies or rookeries, and which are not known to nest within the Ports include Common Loon (DFG CSC, FWS MNBMC- see Table 9.4-2 for legend), Double-crested Cormorant (DFG CSC), Great Egret (SA), Snowy Egret (SA), White-faced Ibis (DDFG CSC, FWS MNBMC), Osprey (DFG CSC), Long-billed Curlew (DFG CSC, FWS MNBMC, NAS WL), California Gull (DFG CSC), Forster's Tern (NAS WL), and Tufted Puffin (DFG CSC).

9.4.3 Rare Sightings

Several sightings of species not commonly observed within the Ports were noted during the course of the 2000-2001 surveys. One Tufted Puffin was observed during the March 2000A survey. The individual was observed floating near the breakwater in Zone 3 of the Port of Los Angeles. This species is not commonly observed in nearshore coastal waters of southern California and typically winters over deeper ocean waters; however, the species may be a casual visitor during the spring (Unitt 1984, Hamilton and Willick 1996). For example, only three individuals were recorded in San Diego County between 1968 and 1984, all of which were observed during spring and summer months (Unitt 1984). Only one observation, of a sick individual in March 1993, was recently reported in Orange County (Hamilton and Willick 1996).

One Cassin's Auklet was observed during the November 2000B survey, also floating near the breakwater in the Port of Los Angeles. Like the Tufted Puffin, this species is only a casual visitor to southern California nearshore coastal waters. While it occurs in local waters year round, it is typically pelagic and is most commonly observed in small numbers at distances greater than five miles from shore (Unitt 1984, National Geographic Society 1999).

An American Oystercatcher was observed during both survey dates in October 2000 and during the November 2000B survey. The bird was observed on the breakwater in Zone 15 in the Port of Long Beach on all three occasions. This species is more typically found along coastal beaches and mudflats along the Atlantic coast of North America and along both coasts of Mexico, but is known to be an accidental visitor to southern California (Unitt 1984). In addition to this species, as mentioned previously, a nesting colony of Black Oystercatchers was observed along the outer breakwater. Despite the differing ranges of the American and Black Oystercatcher, the two species are considered to be closely related and it has been suggested that a "hybrid zone" may occur within Baja California (Ehrlich et al. 1988). As a result, the American Oystercatcher observed during the current surveys may be a hybrid.

A Parasitic Jaeger was observed near the breakwater along the boundary of the two Ports during the October 2000A survey. While sightings of this species along the Pacific coast are not uncommon during fall months, individuals more typically pelagic and do not commonly enter bays and estuaries.

9.5 Habitat Utilization

Distribution and Abundance in Survey Zones

The thirty-one zones surveyed during 2000-2001 varied both in size and habitat complexity. As a result, densities of bird guilds within each survey zone (individuals/acre) were calculated in order to compare data across zones (Table 9.5-1). Total numbers of individuals observed in each zone are reported when appropriate to compare results with previous surveys (Table 9.5-2).

The greatest numbers of individuals (9,435) were observed within Zone 23, of which 67% were Waterfowl including large numbers of cormorants and grebes (Table 9.5-2). Other zones with high total numbers of individuals included Zones 7, 8, 34, and 4 (with 9,239, 7,548, 7,524, and 7,392 individuals, respectively). These five zones together comprised 35% of the total individuals observed during the 2000-2001 surveys. The large numbers observed in Zones 7 and 8 corresponded to high numbers of Aerial Fish Foragers nesting on Pier 400 (including a single sighting of 4,200 Elegant Terns resting on and foraging near the riprap in July 2000). Large numbers observed in Zones 34 and 4 corresponded primarily to flocks of gulls foraging in the vicinity of the Municipal Fish Market at Berth 72 and the numerous fish processing plants in Fish Harbor. It is difficult to compare these results with previous surveys as areas that now correspond to Zones 7 and 8 were previously Open Water habitat, and areas that correspond to Zones 4 and 34 have not been surveyed since 1978. However, the results of the 1978 surveys indicate that large numbers of individuals were consistently observed in the area corresponding to Zone 34 (HEP 1979).

In contrast to the raw abundance data, the greatest densities of birds were observed within Zone 15 (84.9 individuals/acre) and Zone 12 (73.0 individuals/acre) along the outer breakwater within the Port of Long Beach (Table 9.5-1). These two zones accounted for 48% of all birds observed during the 1983-1984 surveys, indicating a pattern of high usage of the breakwater as a foraging and resting area (MBC 1984). Other zones that supported high densities of birds during the 2000-2001 surveys included Zone 1 at Cabrillo Beach (68.2 individuals/acre), Zone 4 (40.2 individuals/acre), and Zone 33 (37.8 individuals/acre) in the Port of Los Angeles. All three zones supported both high numbers and densities of gulls (Table 9.5-1 and 9.5-2). In addition, Zones 1 and 33 also supported high numbers of waterfowl (11.5 and 10.2 individuals/acre, respectively). Densities were not provided for previous surveys, so density comparisons among surveys is not possible.

Gulls accounted for the largest densities within the Ports of Los Angeles and Long Beach inner and outer harbors (Table 9.5-1). Waterfowl yielded the second highest densities within the Port of Los Angeles inner and outer harbors (62.8 and 62.4 individuals/acre, respectively). The four zones that comprise shallow water habitat within the Port of Los Angeles maintained relatively high densities of Waterfowl, primarily due to large numbers of Surf Scoters and Grebes. High densities of Aerial Fish Foragers were noted in the Port of Los Angeles inner and outer harbors, due to the nesting colonies for multiple tern species at Pier 400. Densities of Small and Large

Shorebirds were highest along the outer breakwater (Zones 12 and 15) within the Port of Long Beach, due to riprap foraging habitat. Zone 33 in the Port of Los Angeles also maintained relatively high densities of Small Shorebirds due to the presence of mudflat foraging area. Upland Birds, dominated by Rock Doves had highest densities in inner harbor zones of both Ports where they were observed resting and nesting under loading docks. Upland Birds were nearly absent from outer harbor zones.

During previous surveys, the highest numbers of individuals were noted in survey zones that contained the greatest physical heterogeneity (greater diversity of habitat types) (HEP 1979). This pattern was also observed during the 2000-2001 surveys. Survey zones that included the largest variety of habitats were Zone 27, (with 13 habitat types), Zone 2 (12 habitat types), and Zones 10, 23, and 33 (each with 11 habitat types) (Table 9.5-3a). Zones 2, 27, 10 and 23 all contained high numbers of individuals (Table 9.5-2). However, these zones were not among the highest in terms of densities. The total densities in these four zones were 17.1, 33.9, 8.39, and 12.5, individuals/acre, respectively (Table 9.5-1). Much smaller, more physically homogeneous areas, such as Zones 12 and 15, each of which only contained four habitat types, yielded the highest bird densities (Tables 9.5-2 and 9.5-3a).

Species richness (number of species present) within each zone was also related to physical heterogeneity and habitat diversity. Zone 27, with the greatest number of habitat types (13) supported 42 species, although the greatest numbers of species (49) was observed in zone 33, with 11 habitat types (Figure 9.5-1, Table 9.5-3a). Zones 23 and 10 contained 47 and 48 species, respectively during the 2000-2001 surveys. High numbers of species (49) were also recorded in Zones 1 and 2 at Cabrillo Beach. These two zones supported 7 and 12 habitat types, respectively. The sand beach habitat within these two zones supported a variety of species including 7 species of Gulls, 8 species of Aerial Fish Foragers (including 5 species of terns), 9 species of Small Shorebirds, and 5 species of Large shorebirds. In contrast, Zones 11 and 14 contained the fewest habitat types (7 and 3, respectively) and supported the lowest numbers of species (15 and 16, respectively).

<u>Distribution and Abundance in Habitat Types</u>

Table 9.5-3b provides the total number of individuals from each bird guild within each habitat type available within the Ports. It was not possible to calculate the acreage of each habitat type within the Ports and, therefore, densities of guilds within habitats was not calculated. Qualitatively, open water, riprap, dock/pilings, and boat/barge were the most abundant habitat types within the Ports, occurring in 31, 30, 28, and 25 of the 31 survey zones, respectively. Buoy habitat was also available in 25 survey zones, but did not account for a high overall area. In contrast, mudflat habitat was only available in two zones (Zones 27 and 33), and sand beach habitat was only available in six zones (Zones 1, 2, 5, 6, 27, and 33).

The most highly utilized habitat type during the 2000-2001 surveys was riprap, which was recorded as habitat for 25% of the total bird observations (Table 9.5-3b). As discussed above, the heavily utilized riprap habitat was located along the outer breakwater in the Port of Long Beach and along Pier 400 in the Port of Los Angeles. Dock/piling, open water, and sand beach accounted for 24%, 21%, and 6% of the total observations, respectively. In addition, 14% of the birds were recorded flying (Aerial) and were not assigned to any habitat.

The various habitat types recorded within the Ports were utilized differently by each guild (Figure 9.5-2). A total of 62% of Waterfowl observations were recorded within open water habitat. Large flocks of diving ducks, such as Western Grebes and Surf Scoters, were observed in the open water of the outer Ports, often foraging within schools of bait that periodically entered the harbor. In contrast, Large and Small Shorebirds were more frequently observed within riprap habitat (accounting for 55% and 74%, of total Small and Large Shorebird observations, respectively) (Table 9.5-3b, Figure 9.5-2). These two guilds were also observed foraging within sand beach habitat, accounting for 26% and 18% of the total Small and Large Shorebird observations, respectively. Gulls primarily utilized dock/piling and riprap habitat, accounting for 32% and 25% of the total Gull observations, respectively. Gulls were more likely to occur next to areas with high human disturbance, than were other guilds. Aerial Fish Foragers were primarily observed along riprap (47%), and flying/foraging (28%). High riprap usage was the result of large numbers of Brown Pelicans along the outer breakwater, as well as large numbers of terns at Pier 400. Upland Birds were primarily observed within Dock/Piling habitat and or flying (aerial). Wading/Marshbirds utilized a variety of habitats including riprap, dock/piling, and boat/barge. A total of 34% of Raptors were observed flying (aerial), and the remainder utilized a variety of habitats including dock/piling, riprap, and bridge.

Activity

All individuals were recorded as resting, foraging, flying, courting, or nesting. A total of 90,255 individuals, accounting for 77% of total observations, were observed resting during the 2000-2001 surveys (Table 9.5-4). Foraging, flying, courting, and nesting accounted for 11%, 12%, 0.2%, and 0.1%, of total observations, respectively. Species from only four of the eight guilds were observed courting (Waterfowl, Aerial Fish Foragers, Gulls, and Upland Birds). There was a trend toward increased foraging within the outer harbor. Foraging accounted for 13%, 11%, and 13% of the activities for birds observed in the Long Beach and Los Angeles outer harbors and Los Angeles Shallow Water Habitat, respectively. Foraging accounted for only 8% of the activities for total birds observed in the inner harbors of both Ports.

Species from three guilds (Wading/Marshbirds, Gulls, and Upland Birds) were observed nesting. Nesting species included Black-crowned Night Heron and Great Blue Heron at the Gull Park, Navy Mole rookery, as discussed in Section 9.4.2. Western Gulls were also observed nesting, primarily on buoys in the inner harbors of both Ports. Several upland species including American Crow, Barn Swallow, and Rock Dove also nest within the Ports, the latter two species nest under docks and pilings in both Ports. Other species known to nest within the Ports includes Black Oystercatcher, California Least Tern, Royal Tern, Elegant Tern, Caspian Tern, and Black Skimmer. These species were not observed nesting, but were observed tending young during the 2000-2001 surveys.

9.6 Summary of Spatial and Temporal Variations

Seasonal Variation

Bird abundance within southern California bays and estuaries typically follows a seasonal pattern, with the greatest numbers of individuals and species occurring during the fall and winter months as many species migrate from summer breeding grounds to spend the winter in warmer southern California waters (Unitt 1984, Ehrlich et al. 1988, Merkel & Associates, Inc. 2000). This pattern has also been evident from results of historical surveys within the Ports of Long

Beach and Los Angeles (HEP 1979, MBC 1984, U.S. Army Corps of Engineers 1984, MEC 1988). During 1978 surveys of the harbor, average number of species per station ranged from 8.38 during the winter to 3.6 during the summer (HEP 1979). Similarly, numbers of individuals per station ranged from 114.97 during the fall migration, to 55.97 during the summer months. The 1983-1984 surveys of the Port of Long Beach (MBC 1984) found that numbers of species ranged from 44 during December and January surveys to 17 during June surveys. Total numbers of individuals followed a similar pattern, with the greatest number of individuals observed during fall and winter months.

Seasonal variation was similar during the 2000-2001 surveys. The greatest number of species (60) was observed during January 2001, while the lowest number (36) was observed during June 2000 (Table 9.4-1, Figure 9.3-1). Only two Small Shorebird species (Black-bellied Plover and Ruddy Turnstone) were observed in June, while ten Small Shorebird species were observed in January. Numbers of Large Shorebird, Waterfowl, and Gull species observed in June were 3, 10, and 3, respectively, while numbers of species observed for these same three guilds in January were 6, 20, and 7, respectively (Table 9.4-1). While this evidence indicates that numerous species are migratory and utilize the Ports as a wintering ground, several species were observed during both summer and winter surveys and 16 species were observed during all survey months. These species include Western Grebe, Brown Pelican, Brant's and Double-crested Cormorant, Great Blue Heron, Black-crowned Night Heron, Mallard, Surf Scoter, Black Oystercatcher, Heermann's and Western Gull, Caspian and Elegant Tern, Black Skimmer, and two upland species, American Crow and Rock Dove.

Figure 9.6-1 provides the number of individuals within bird guilds for each survey during the 2000-2001 surveys. Figure 9.6-2 (a-g) provides a breakdown of seasonal abundance of selected species observed within the Ports on each survey date. For ease of comparison, species included in Figure 9.6-2 are generally grouped by family and/or close relatives rather than by guild. The seasonal pattern for 2000-2001 was different than previous surveys, when abundances during summer months were low. Total abundance of individuals in 2000 was highest from June to August because of large numbers of Aerial Fish foragers nesting at Pier 400 and foraging at several survey stations (Figure 9.6-1). The greatest number of individuals (11,780) was observed in July 2000, 50% of which were Aerial Fish Foragers. Total abundance of Gulls also peaked in July, with 4,701 individuals accounting for 40% of the total individuals for the month (Table 9.4-1, Figure 9.6-1). The lowest number of total individuals (3,525) was observed in May 2000, when most wintering species had departed for summer breeding grounds, but prior to the arrival of large numbers of nesting Aerial Fish Foragers (Table 9.4-1, Figure 9.6-1). Distributions of other avian guilds followed expected seasonal patterns. Numbers of Small Shorebirds, Large Shorebirds, and Waterfowl were greatest during winter and early spring months. Numbers of Wading/Marshbirds, Upland Birds, and Raptors remained low and were constant throughout the year.

In many instances during the 2000-2001 surveys, the seasonal distribution of bird guilds was dominated by one or two species (Figure 9.6-2a-g). While a pattern of increased numbers of Aerial Fish Foragers was observed during summer months in previous surveys, this guild has not previously been noted to dominate the total abundance of all birds during these months (HEP 1979, MBC 1984). The large abundance of Aerial Fish Foragers during July and August was due almost entirely to numbers of Elegant Terns (Figure 9.6-2a). The increase in this species, and of other Aerial Fish Foragers, is primarily due to the establishment of a nesting colony at the newly constructed Pier 400, an area not in existence during previous surveys.

The large abundance of Gulls during the same summer months can be attributed to numbers of Heermann's and Western Gulls (Figure 9.6-2b). Typically, the highest numbers of Heermann's Gulls are observed within the Ports during the fall. For example, in 1984 this species accounted for over half of all birds observed in September in the Port of Long Beach (MBC 1984). In 1978, Heermann's Gulls accounted for 44% of all birds observed in October in the Port of Los Angeles (HEP 1979). This is likely because Heermann's gulls breed during the spring off the coast of Baja California and spend the post-breeding season in southern California, with maximum populations present from mid-July to mid-November (Small 1994). Numbers of Western Gulls remained high throughout the year, peaking during July and August when adults and juveniles disperse from the Channel Island breeding colonies to the mainland after the breeding season.

Figure 9.6-2 illustrates the seasonal abundance of several other species. Numbers of Brown Pelicans were highest during summer and fall months (Figure 9.6-2c). This corresponds to previous surveys for which data on seasonal abundance by species is provided, in which numbers of Brown Pelicans peaked in the fall during post-breeding dispersal (HEP 1979, MBC 1984). Brown Pelicans are known to be most common in southern California from June to October, with the lowest numbers occurring in April and May (Garrett and Dunn 1981). Numbers of cormorants were typically higher during fall and winter months (Figure 9.6-2c), possibly also related to dispersal from breeding grounds on the Channel Islands and further north. Seasonal patterns for Waterfowl were most apparent for Western Grebes and Surf Scoters, which were abundant in fall and winter months (peaking in March with a total of 1,981 and 989 individuals, respectively, for the month), but were low during summer months (Figures 9.6-2d and 9.6-2e). While numbers of Small Shorebirds peaked during fall and winter months, seasonal patterns were evident for multiple species, with the most seasonal variation apparent for Black-bellied Plover and Surfbird (Figures 9.6-2f and 9.6-2g); during the March 2000B survey over 500 Surfbirds were observed along the Port of Long Beach outer breakwater. Substantial seasonal variation for Large Shorebirds was most notable for Willets and Black Oystercatchers. Black Oystercatchers were present during all months of the year, but numbers peaked during late summer, just after the breeding season and before dispersal of juveniles. Numerous pairs of oystercatchers and their young were observed along the outer breakwater during September and October 2000.

Spatial Variation

The results of the 2000-2001 surveys indicate spatial variation among survey zones and habitat types in the abundance and diversity of species within the Ports of Long Beach and Los Angeles (see Sections 9.5). The greatest numbers of individuals were observed within Zones 23, 7, 8, 34, and 4. In contrast to the raw abundance data, the greatest densities of birds were observed within Zones 15 and 12 along the outer breakwater within the Port of Long Beach. Species richness within each zone corresponded to habitat diversity within zones, with the greatest number of species observed in Zones 23 and 10. The most highly utilized habitat type was riprap, which was recorded as the habitat for 25% of total avian observations. Dock/piling, open water, and sand beach accounted for 24%, 21%, and 6% of total observations, respectively (Table 9.5-3b). The various habitat types recorded within the Ports were utilized differently by each guild. Gulls primarily used dock/piling and riprap habitat, while Waterfowl were observed within open water habitat. Large and Small Shorebirds were most frequently observed on riprap habitat.

Despite the spatial patterns of bird abundance, density, and species richness across survey zones and habitats of the Ports, individual species displayed a high level of roosting site fidelity. In several instances, this fidelity does not appear to be related to life history of the species (e.g. foraging or nesting requirements). For example, Mew Gulls were observed within the Ports as scattered individuals within a total of 15 survey zones. However, a flock of between 16 and 52 Mew Gulls was observed along the same floating dock within Zone 23 on nine of the eleven survey dates in which this species occurred in the harbor (accounting for 62% of total Mew Gull observations). Similarly, 36% of all California Gulls were observed resting in the water and along one abandoned dock in Zone 27 in the Port of Los Angeles during the winter months. In both cases, the docks didn't appear to provide particularly unique roosting habitat or to be located near high quality foraging habitat for these species.

In other instances, observed fidelity within the Ports appears to be related to the habitat needs of a species. For example, Black Oystercatchers were observed within 9 survey zones. However, this species requires rocky substrate for foraging and nesting, and as a result, 87% of total observations of this species were recorded within Zones 12 and 15, along the riprap of the outer breakwater. While all species of gulls combined were observed in all 31 survey zones, 36% of Gull observations were within Zones 1, 2, 4, and 34. These zones are located next to bait barges, fish markets, and fish processing plants. Similarly, while Brown Pelicans were observed in all survey zones, 40% of pelican observations were within Zones 9, 12, and 15 along the outer breakwater. Breakwaters provide a roosting location that is relatively free of disturbance and is located adjacent to foraging habitat for pelicans. During six aerial surveys conducted in 1992 and 1993 of 20 pelican roost sites from the California-Mexico border to Point Conception, 65% of all pelicans were found on artificial structures, primarily breakwaters (Jacques et al. 1995).

In addition to the habitat needs of individual species, observed fidelity to habitat types may be explained in part by consistency of habitat availability within the Ports. Mudflat, coastal salt marsh, and shallow water habitats dominate many bays and estuaries of southern California. As a result, the spatial distribution of birds depends upon a combination of habitat availability and quality. For example, within Batiquitos Lagoon, in Carlsbad, California, the distribution of shorebirds and waterfowl is determined largely by tidal conditions (mudflat availability). In addition, the patchy distribution of habitats and the food they provide for birds throughout the lagoon has resulted in a few locations that consistently support the highest densities of individuals (Merkel & Associates, Inc. 2000). In contrast, the majority of available habitat within the Ports of Long Beach and Los Angeles consists of riprap, open water, and dock/pilings, the availability of which is not typically tidally influenced. In addition, habitats within the Ports that vary in area with tides, such as Sand Beach and Mudflat, do not account for a large percentage of total area within the harbor. As a result, the daily movement of flocks of birds from one area to another was not observed. The unvarying availability of most habitats may also account for the fidelity of some avian species to certain roosting within zones of the Ports.

9.7 Historical Comparisons

As mentioned previously, the previous bird surveys of the Long Beach and Los Angeles Harbors have utilized the differing methodology and sampling intervals, and each study has encompassed a different sampling area within the harbors. Several physical changes have taken place within the Ports during the last ten years, making comparisons with previous surveys more difficult. Despite these difficulties, some general trends in diversity and abundance of birds within the harbors are discernible. Table 9.7-1 provides a historical comparison of the percent composition of the ten most abundant species observed during the 2000-2001 surveys. Percent composition was obtained using yearly averages for each species, similar to the method utilized for Table 9.4-1. It should be noted that these numbers are not normalized to area surveyed. The 2000-2001 surveys covered a larger area than any previous study. Due to the site fidelity of a number of species, an increase in area covered corresponded to an increase in total abundance of birds, but did not necessarily correspond to an equal increase in abundance of each individual species.

Total numbers of species observed during each major survey to date are 77, 53, 85, 72, and 99 (24 of which are considered upland birds) during 1973-74, 1978, 1983-1984, 1986-1987, and 2000-2001 studies, respectively (Figure 9.7-1) (HEP 1979, MBC 1984, MEC 1988). Total numbers of species are difficult to compare, again due to differences in survey area among surveys. An average of 31 species was observed per survey during the 1973-1974 and the 1978 surveys within outer Los Angeles Harbor (HEP 1979). Averages of 33 and 50 species observed during 1983-1984 surveys of the Port of Long Beach and the current 2000-2001 surveys, respectively (Figure 9.7-1) (MBC 1984). This number was not available for the 1986-1987 surveys. The 1983-1984 surveys only included the Port of Long Beach; thus, an increase in average number of species between the current and 1983-1984 surveys is expected. The increase in average number of species between the current surveys and 1973-1974 and 1986-1978 surveys is likely due to the fact that the two earlier surveys recorded few upland species and did not include the inner harbor areas (MEC 1988).

A decrease in total bird abundance, and particularly the abundance of gulls was observed between the 1973-1974 surveys and the 1978 surveys within the Port of Long Beach and Los Angeles outer harbors (HEP 1979). The decline in total bird abundance was indicated by a reduction in average number of individuals (from 5,665 to 2,240) observed per survey over the same survey zones in 1973 and 1978, respectively (Figure 9.7-2). The decrease was observed for Western Gull, Heermann's Gull, and California Gull. This decline was attributed to the reduction in particulate matter in the water associated with the installation of secondary treatment of sewage and cannery waste in the Port of Los Angeles outer harbor. During the 1983-1984 studies within the Long Beach outer harbor, and the 1986-1987 surveys of Los Angeles outer harbor, this decline in gull abundance continued (Table 9.7-1). The decline in average number of total individuals also continued for 1986-1987 surveys (Figure 9.7-2), but these data are unavailable for the 1983-1984 surveys. However, during the 2000-2001 surveys, an increase in abundance (and percent composition) of Western Gull, Heermann's Gull, and California Gull was observed (Table 9.7-1). While the percent composition of Western Gulls has increased greatly, this may be in part due to the expanded survey area of the 2000-2001 surveys, which included the inner harbors that are a resting area for large numbers of this species. Percent composition of Heerman's Gull may seem lower in 2000-2001 compared with previous surveys because this species prefers the riprap and dock/piling habitats in the outer harbor, and total abundance of this species did not increase greatly by inclusion of the inner harbor in the surveys.

Percent composition of Brown Pelicans has increased since the 1973-1974 study (Table 9.7-1). This species was second most abundant and accounted for 15% (6,742 individuals) of the total number of birds observed over 36 surveys in outer Long Beach Harbor during 1983-1984 (MBC 1984). Brown Pelicans accounted for 14% (2,037 individuals) of the total observations over 24 surveys in outer Los Angeles Harbor during 1986-1987 surveys (MEC 1988). HEP (1979) reported approximately 100 more individuals per survey during 1978 compared to 1973-1974 and suggested that this may reflect the greater breeding success of the species over that in the late 1960s and early 1970s, perhaps attributable to decreased concentrations of DDT. However, MEC (1988) indicated that there was conflicting evidence that concentrations of DDT in marine fish were substantially lower than in the 1970s, and noted that increased pelican abundance may not be solely attributable to decreased DDT discharges. During the current survey, Brown Pelicans accounted for 9.5% (11,468) of the total observations over 20 surveys in both inner and outer Long Beach and Los Angeles Harbors (Table 9.4-1). Although the percentage of Brown Pelicans from the current study decreased relative to the surveys in the 1980s, the number of pelicans did not. The lower percentage in the current study may be due in part to the inclusion of the inner harbor in the survey area. Brown Pelicans were most abundant along the outer breakwater (a primary area surveyed during 1983-1984 and 1986-1987). Therefore, inclusion of the inner harbor in the study did not greatly increase the numbers of pelicans, but did increase the overall total number of observed birds; consequently, decreasing the percent composition of pelicans during the 2000-2001 surveys.

Of the other six historically abundant species included in Table 9.7-1, only the Surf Scoter has experienced a dramatic decline since previous surveys. It is not clear why this decline has been observed since the 1986-1987 surveys, but it is possible that a temporary reduction in available food for this species (primarily molluscs and crustaceans) has occurred as a result of dredging activity in the Ports. In contrast, percent composition of terns (most notably the Elegant Tern) has increased dramatically due to the availability of nesting habitat at the newly construction Pier 400. Percent composition of Western Grebes also increased from 5.44% of total observations during 1986-1987 surveys to 8.31% during 2000-2001 surveys; this is likely due, at least in part, to the addition of inner harbor stations during 2000-2001, where many Western Grebes were observed. Percent composition of Great Blue Herons, and Brant’s and Double-crested Cormorants are comparable to previous surveys (Table 9.7-1).

Figure 9.7-3 summarizes percent composition of the various bird guilds for the 1973-74, 1978, 1986-87, and 2000-2001 surveys. Numbers of Upland Birds among the four surveys aren’t comparable as some of the different studies recorded few or no upland species (MEC 1988). As stated previously, percent composition of Gulls decreased between the 1973-74 surveys and the 1986-1987 surveys but increased once again in 2000-2001, due in part to the inclusion of the inner harbor and to the construction of Pier 400 in Los Angeles Harbor, which is used by large flocks of roosting gulls (Keane, pers. comm.). As mentioned previously, Aerial Fish Foragers also increased in 2000-2001 from previous surveys (Figure 9.7-3), likely due to the initiation of nesting in recent years at the Port of Los Angeles by Elegant Terns, Caspian Terns and Black Skimmers, and an increase in the number of nesting Least Terns (Keane 2000). Percent composition of Waterfowl decreased in 2000-2001 from previous surveys (Figure 9.7-3), due in part to inclusion of the inner harbor, which supported few waterfowl species, and to a decrease in numbers of Surf Scoters discussed above. Percent composition of Wading/Marshbirds, which includes herons and egrets, was similar to that for 1986-1987 surveys (Figure 9.7-3). The slight increase in this guild is likely attributed to the addition of roosting habitat for herons at Pier 400 and due to the nesting habitat at the end of the Navy Mole, where most observations of these species were recorded. Composition of Small and Large Shorebirds was similar to that for 1978 but reduced from that for 1986-1987, possibly because of the inclusion of the inner harbor areas, which supported few shorebird observations.

9.8 Summary

Long Beach and Los Angeles Harbors provide valuable habitat for foraging, resting, and breeding by birds. Several previous studies have been conducted in recent years (1973-1974, 1978, 1984, and 1986-1987) to document the bird resources of the Ports. The results of these studies indicate that over 100 avian species use the various habitats within the Ports seasonally, year-round, or during migration, including large numbers of California Brown Pelicans, an endangered species, and 18 species that nest within the Ports. Nesting species include endangered California Least Tern and Peregrine Falcon.

The 2000-2001 surveys used survey zones with boundaries in the same locations as the 1983-1984 (MBC 1984) and 1986-1987 (MEC 1988) studies in order to facilitate comparisons between studies. Minor modifications to the survey zones were necessary to accommodate recent changes to the harbors. Saturation surveys were completed by boat of all zones, with one trained ornithologist observing and another recording data. Data recorded for each observation included species identity, numbers of individuals, habitat in which the birds occurred, and bird activity. Surveys were conducted once monthly between April 16th and August 14th and twice monthly from August 15th through April 15th. Data were analyzed to identify spatial and temporal trends in total avian abundance, numbers of species, and habitat usage. To better manage data and simplify presentation, individual bird species were assigned to one of eight ecological guilds: Small Shorebirds, Large Shorebirds, Wading/Marshbirds, Waterfowl, Aerial Fish Foragers, Raptors, Gulls, and Upland Birds.

A total of 99 species, representing 31 families were observed within the Ports of Long Beach and Los Angeles during the 2000-2001 monitoring year. Of these species, 69 are considered to be dependent on marine habitats. The greatest number of individuals was observed during the July 2000 survey and the first survey in August 2000, primarily due to large numbers of Elegant Terns nesting at Pier 400 that were foraging in the harbor waters. Despite the high abundances observed during July and August, the June through September surveys yielded the lowest numbers of species (36 to 41), and fall and winter surveys yielded the highest numbers of species (43 to 60 species).

The most abundant bird guild was Gulls (44.1% of mean observations during the survey year); Western Gulls were the most numerous gull species. The second most abundant guild was Aerial Fish Foragers (22.4% of mean observations) dominated by Elegant Terns and Brown Pelicans, and third most abundant guild was Waterfowl (21.4% of mean observations) represented largely by Western Grebe, Brant's Cormorant, and Surf Scoter. Upland Birds, dominated by large numbers of Rock Doves roosting under docks and pilings, accounted for

5.9% of mean observations. Small Shorebirds, Large Shorebirds, and Wading/Marshbirds accounted for 2.7%, 1.4%, and 1.5% of mean observations, respectively. Commonly observed species included Surfbirds, Black-bellied Plovers, and Western Sandpipers (Small Shorebirds), Willets and Black Oystercatchers (Large Shorebirds), Great-blue Herons and Black-crowned Night Herons (Wading/Marshbirds). Raptors accounted for < 0.05% of mean numbers of individuals observed.

Several sensitive species were observed during the 2000-2001 surveys, including the California Brown Pelican which accounted for 9.5% of the total observations, a dramatic increase from only 3.8% during 1973 studies. Peregrine Falcons were observed during 12 of the 20 survey dates; several pairs of Peregrine Falcons are known to nest within the Ports and vicinity. In addition to the endangered California Least Tern, nesting within the Ports during previous studies, other sensitive terns nesting within the Ports and observed in high numbers during summer surveys were Caspian Tern and Elegant Tern, as well as the related Black Skimmer. California Least Tern numbers have increased from approximately 100 nesting pairs during the 1986-1987 study to over 500 nesting pairs in 2000. Black-crowned Night Herons (nesting on the Navy Mole), Black Oystercatcher, Burrowing Owl, and Loggerhead Shrike were other sensitive species observed during surveys.

As during previous surveys, birds were not equally distributed among survey zones and habitats; Zones 12 and 15 along the breakwaters supported the highest densities of birds; the high use of breakwaters correlates with the fact that the most highly utilized habitat type during the 2000-2001 surveys was riprap. Bird activities recorded during surveys were as follows: resting 77%, foraging 11%, flying 12%, courting 0.2%, and nesting 0.1% of the total observations.

Due to variations in total area surveyed, duration and timing of surveys, and survey methods, as well as a reduction in available open water habitat, data collected during the 2000-2001 and previous surveys are not always comparable, particularly raw abundances. However, the total number of species and average number of species (species per survey) during 2000-2001 surveys increased from that of previous surveys. The average number of individuals (number per survey) during 2000-2001 also increased from previous surveys (however, these data are not available for 1986-1987 surveys). In terms of bird guilds, percent composition of gulls and waterfowl decreased but aerial fish foragers increased from previous surveys. This may be partly due to the fact that the 1986-1987 surveys didn't include the inner harbor, and to the recent construction of Pier 400 which serves as an important nesting colony for tern species.

Figure 9.2-1. Location of bird survey zones in Long Beach and Los Angeles Harbors, February 2000 - January 2001.

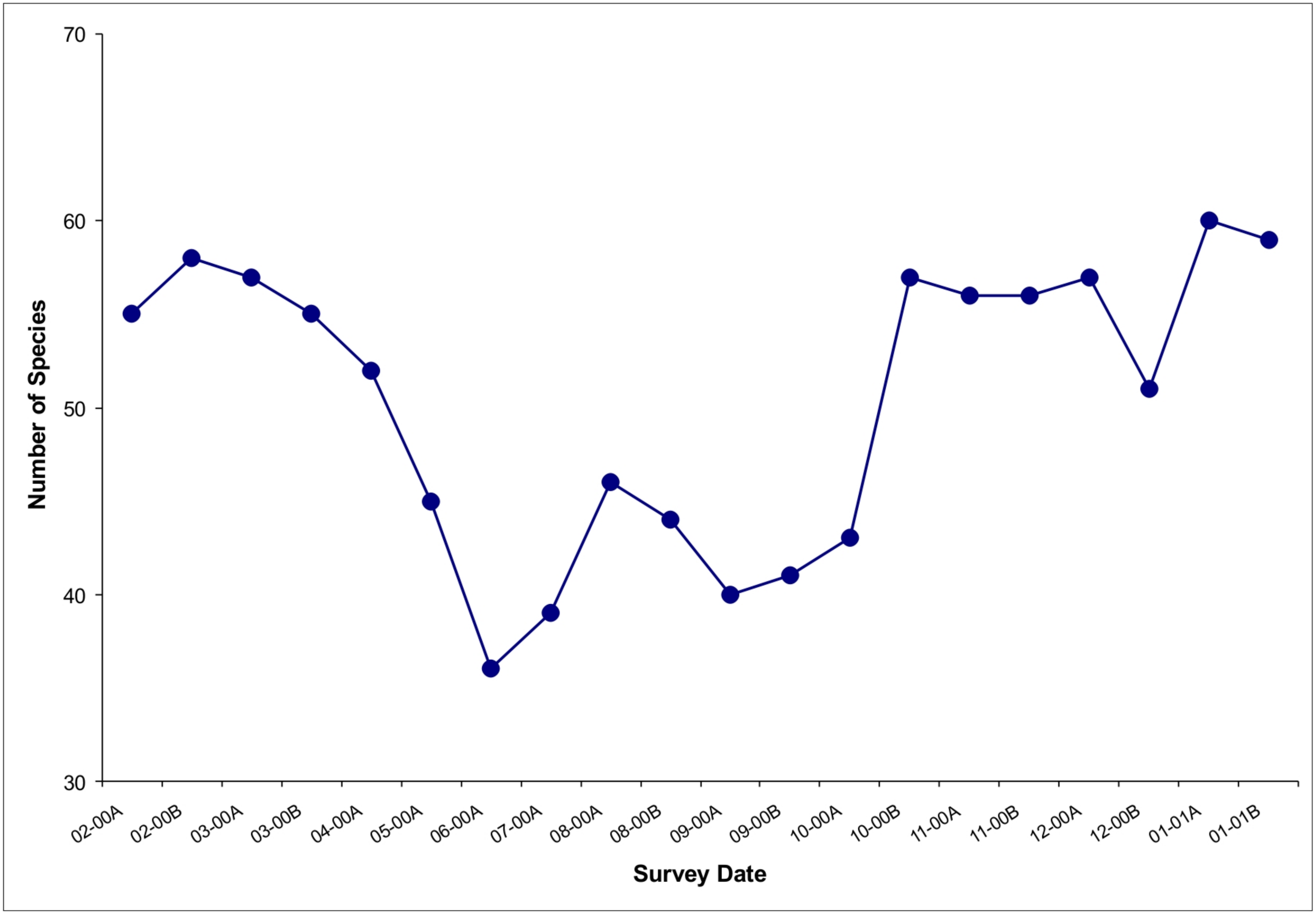


Figure 9.3-1. Number of species of birds observed per survey in Long Beach and Los Angeles Harbors, February 2000 - January 2001.

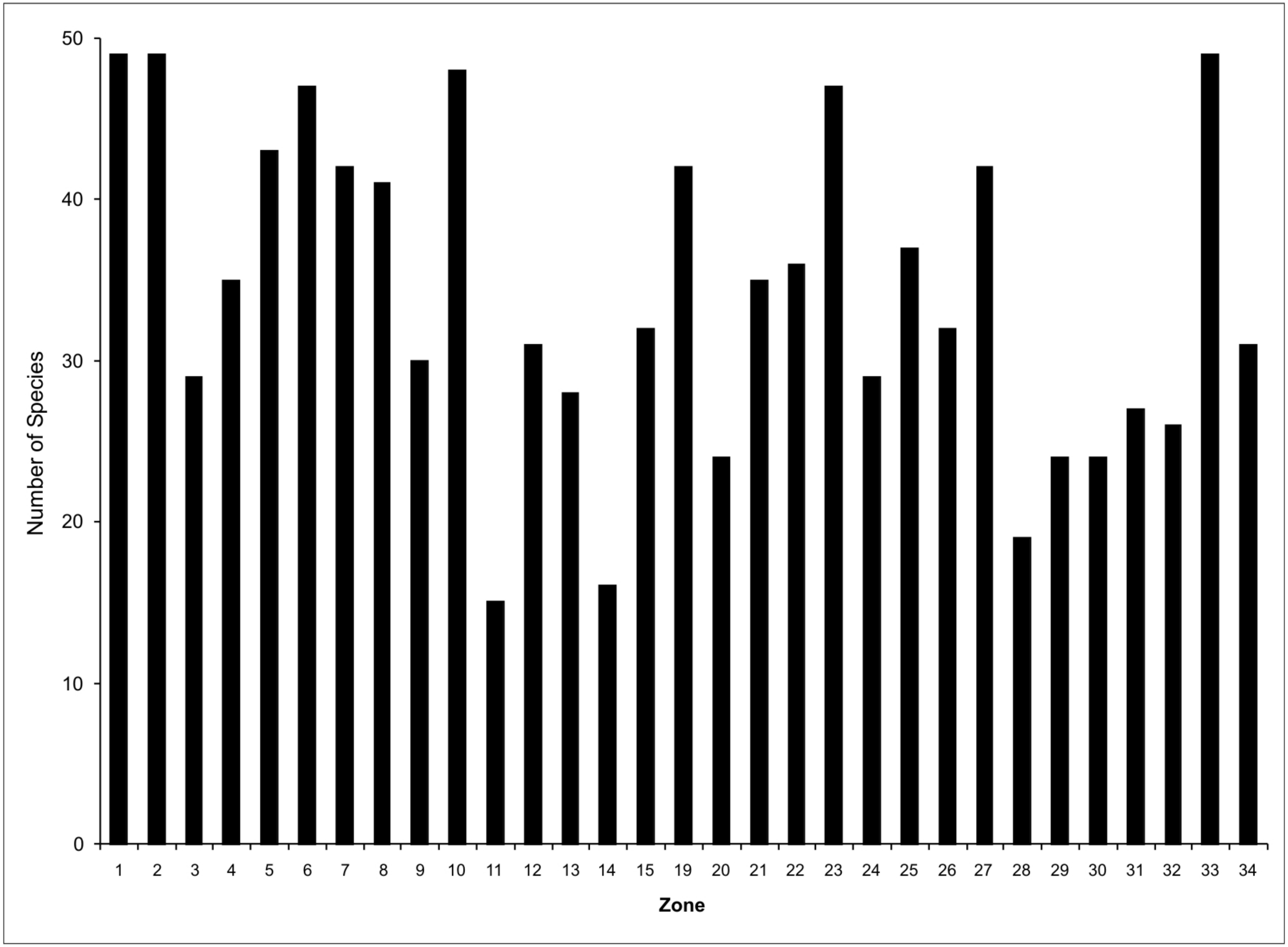


Figure 9.5-1. Mean number of species of birds observed per survey zone in Long Beach and Los Angeles Harbors, February 2000 - January 2001.

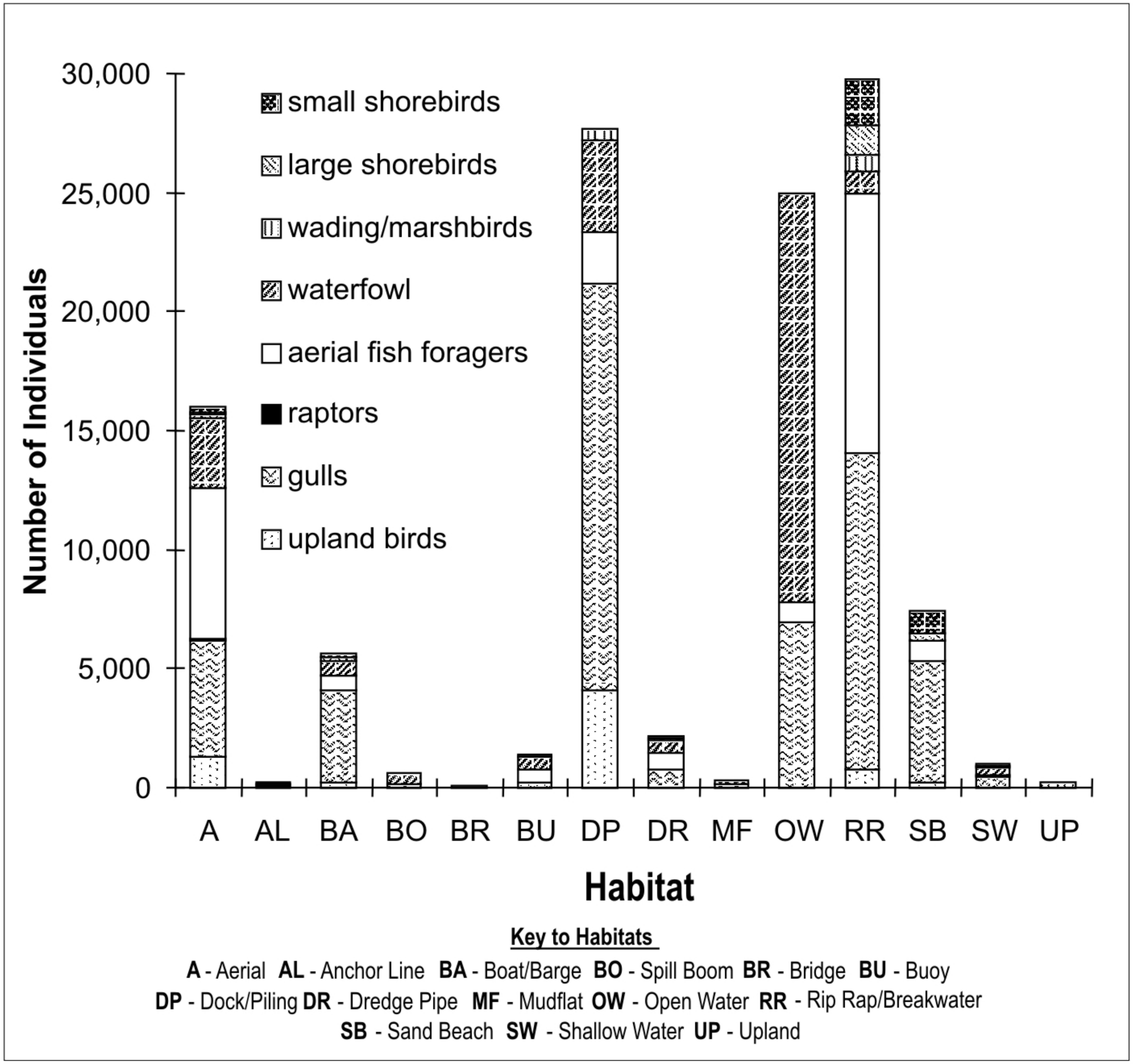


Figure 9.5-2. Mean number of individuals by bird guilds within different habitats in Long Beach and Los Angeles Harbors, February 2000 - January 2001.

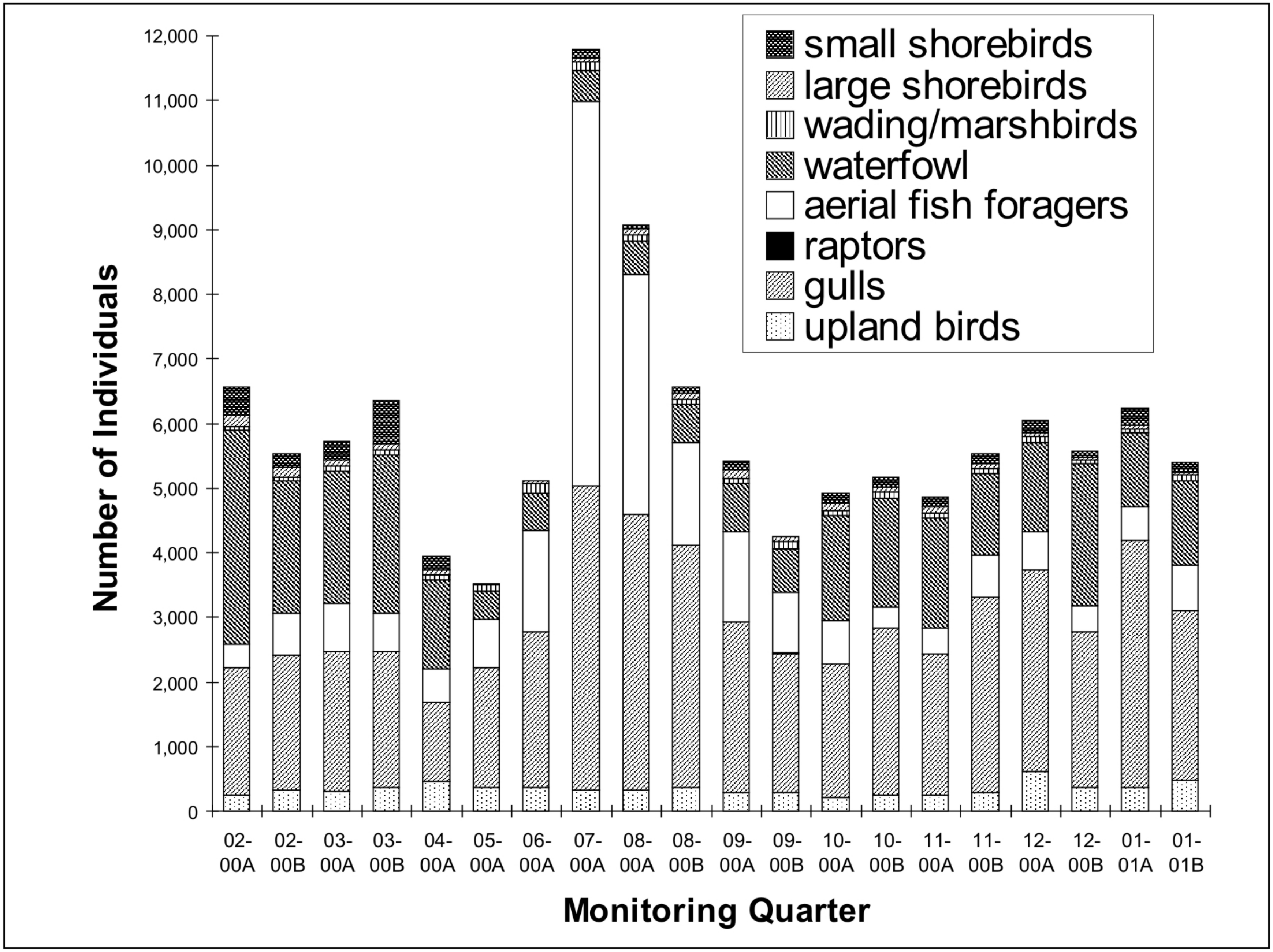


Figure 9.6-1. Total number of individuals by bird guilds and surveys in Long Beach and Los Angeles Harbors, February 2000 - January 2001.

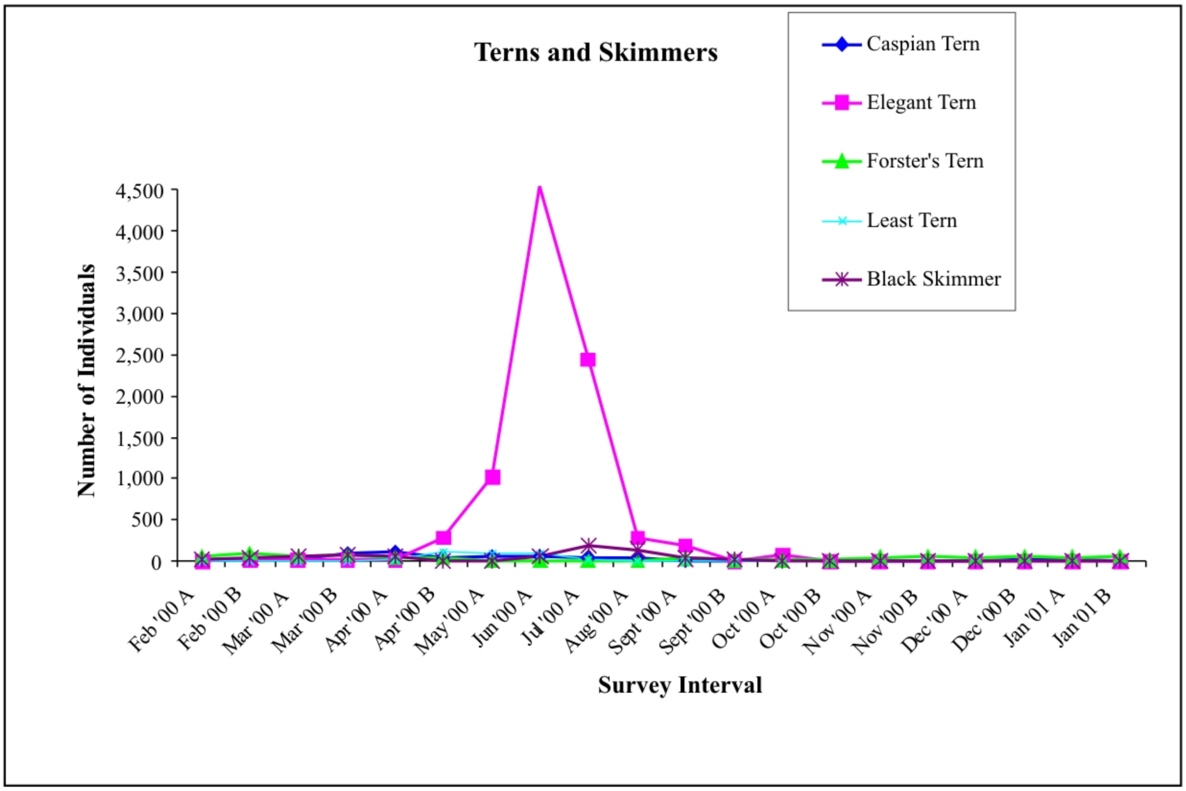


Figure 9.6-2a. Numbers of terns and skimmers by survey in Long Beach and Los Angeles Harbors, February 2000 - January 2001.

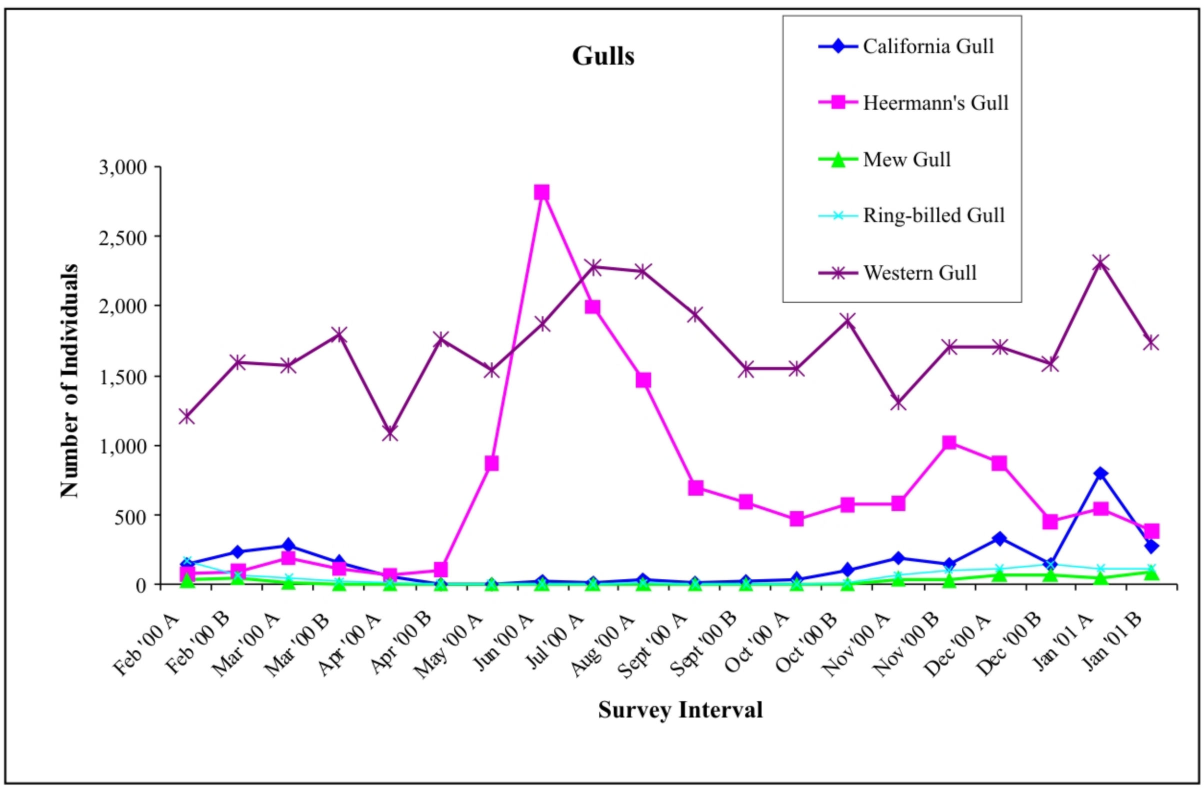


Figure 9.6-2b. Numbers of gulls by survey in Long Beach and Los Angeles Harbors, February 2000 - January 2001.

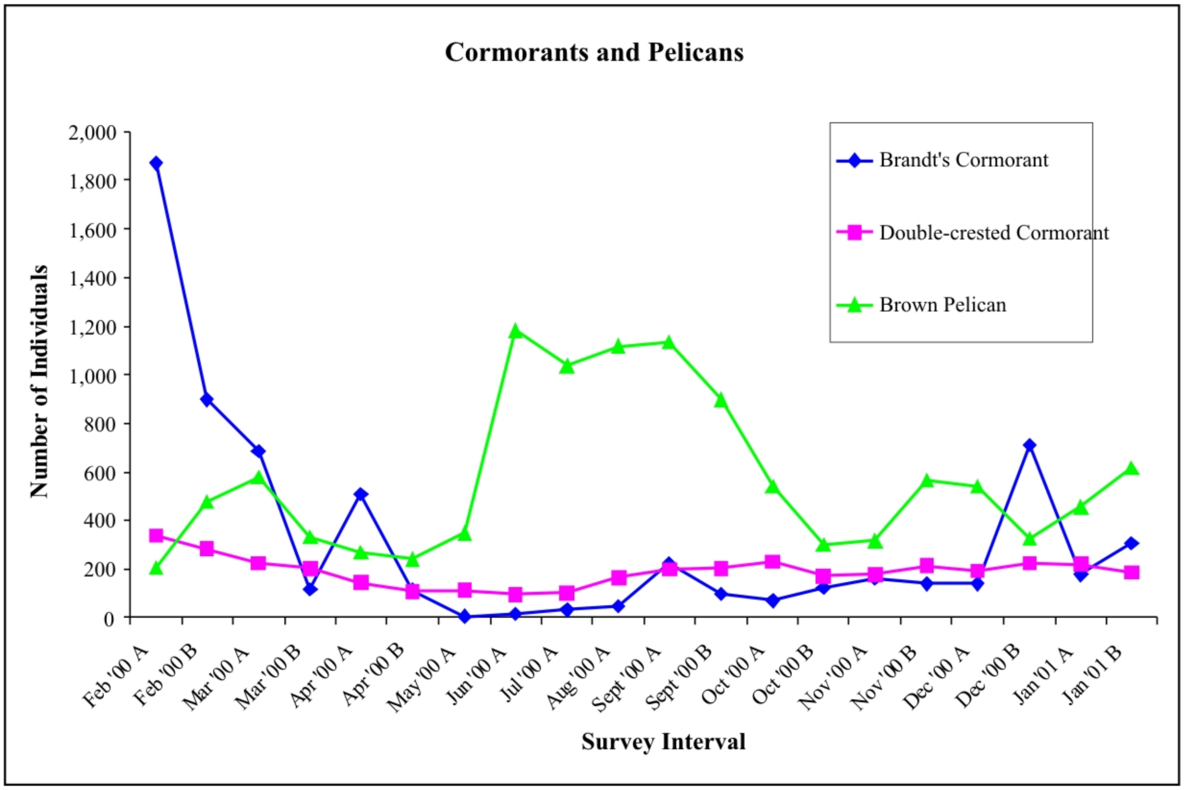


Figure 9.6-2c. Numbers of cormorants and pelicans by survey in Long Beach and Los Angeles Harbors, February 2000 - January 2001.

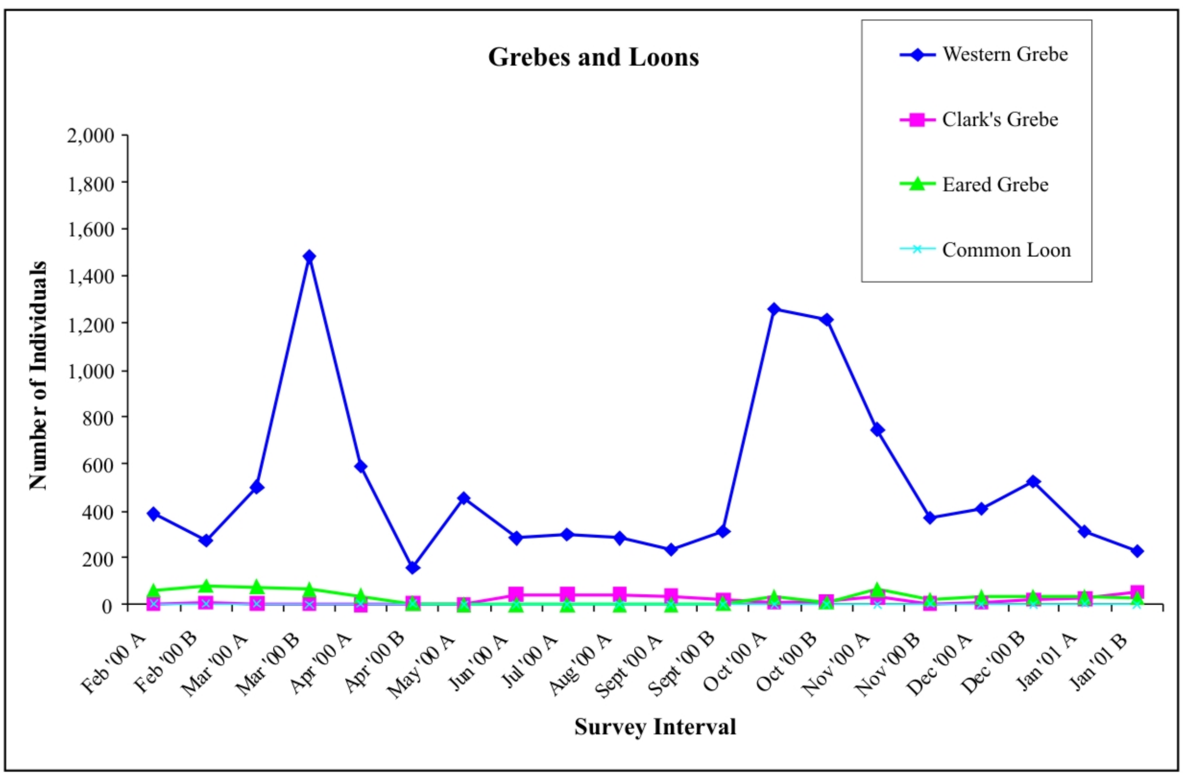
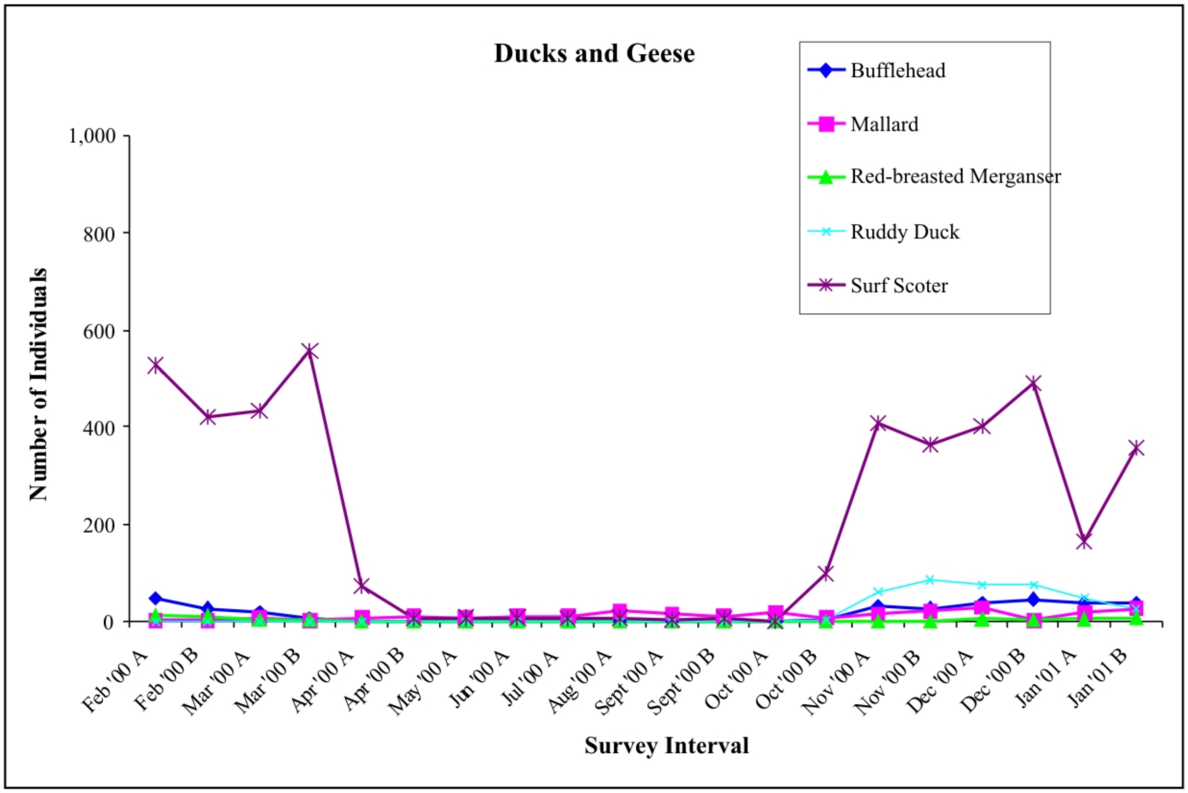
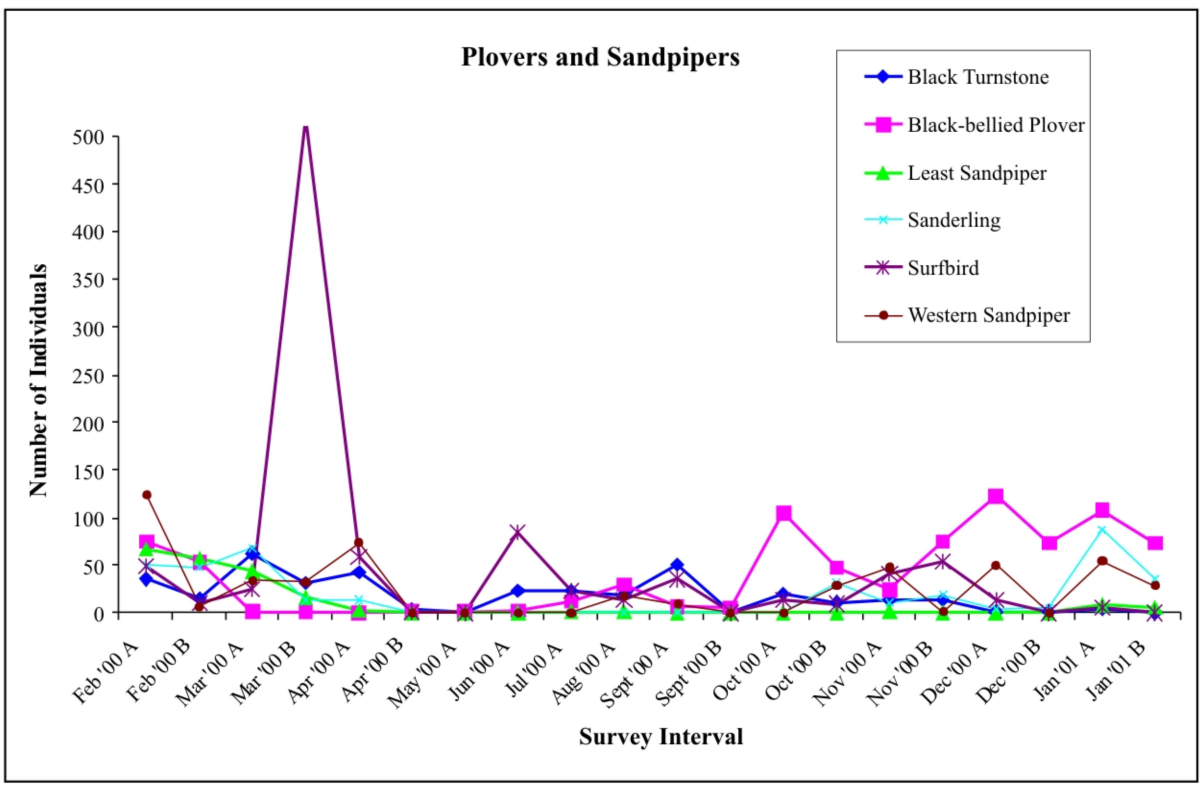


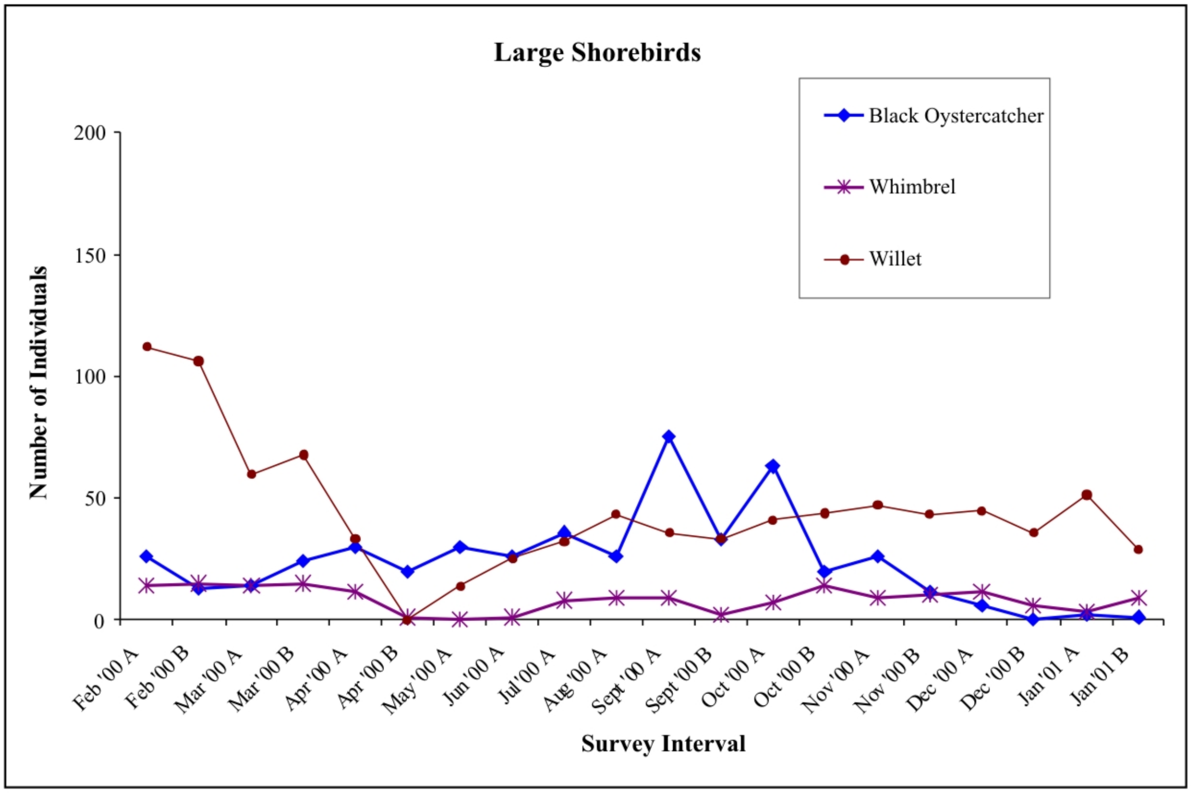
Figure 9.6-2d. Numbers of grebes and loons by survey in Long Beach and Los Angeles Harbors, February 2000 - January 2001.



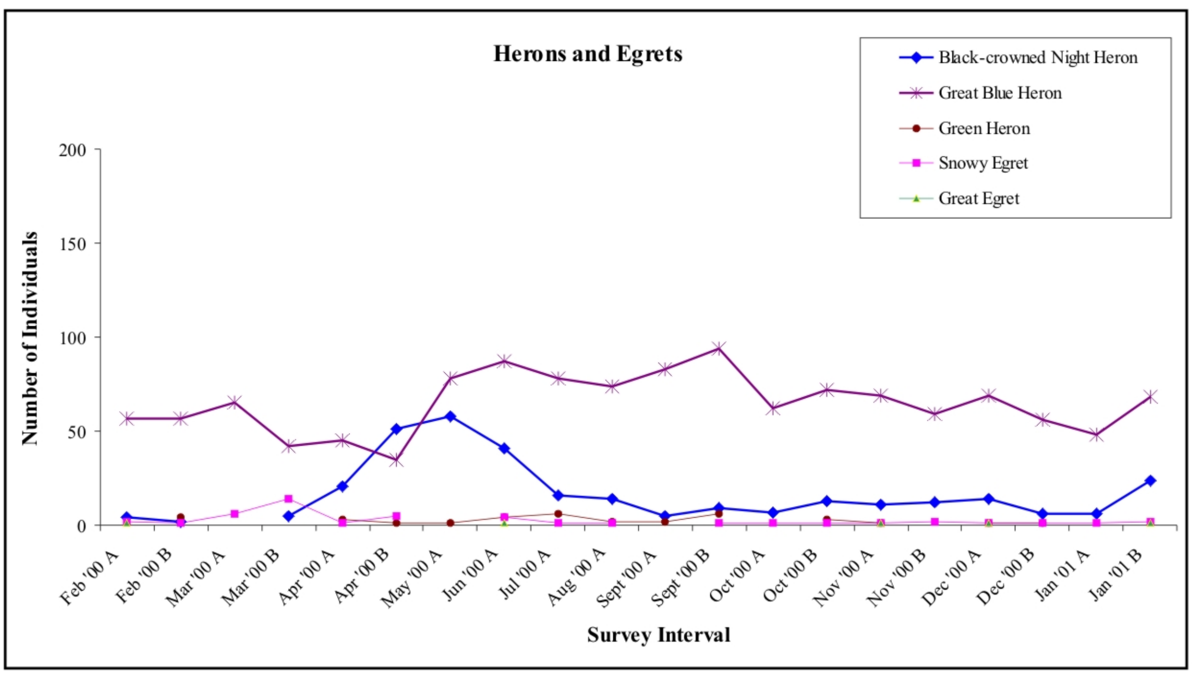
9.6-2e. Numbers of ducks and geese by survey in Long Beach and Los Angeles Harbors, February 2000 - January 2001.



9.6-2f. Numbers of plovers and sandpipers by survey in Long Beach and Los Angeles Harbors, February 2000 - January 2001.



9.6-2g. Numbers of large shorebirds by survey in Long Beach and Los Angeles Harbors, February 2000 - January 2001.



9.6-2h. Numbers of herons and egrets by survey in Long Beach and Los Angeles Harbors, February 2000 - January 2001.

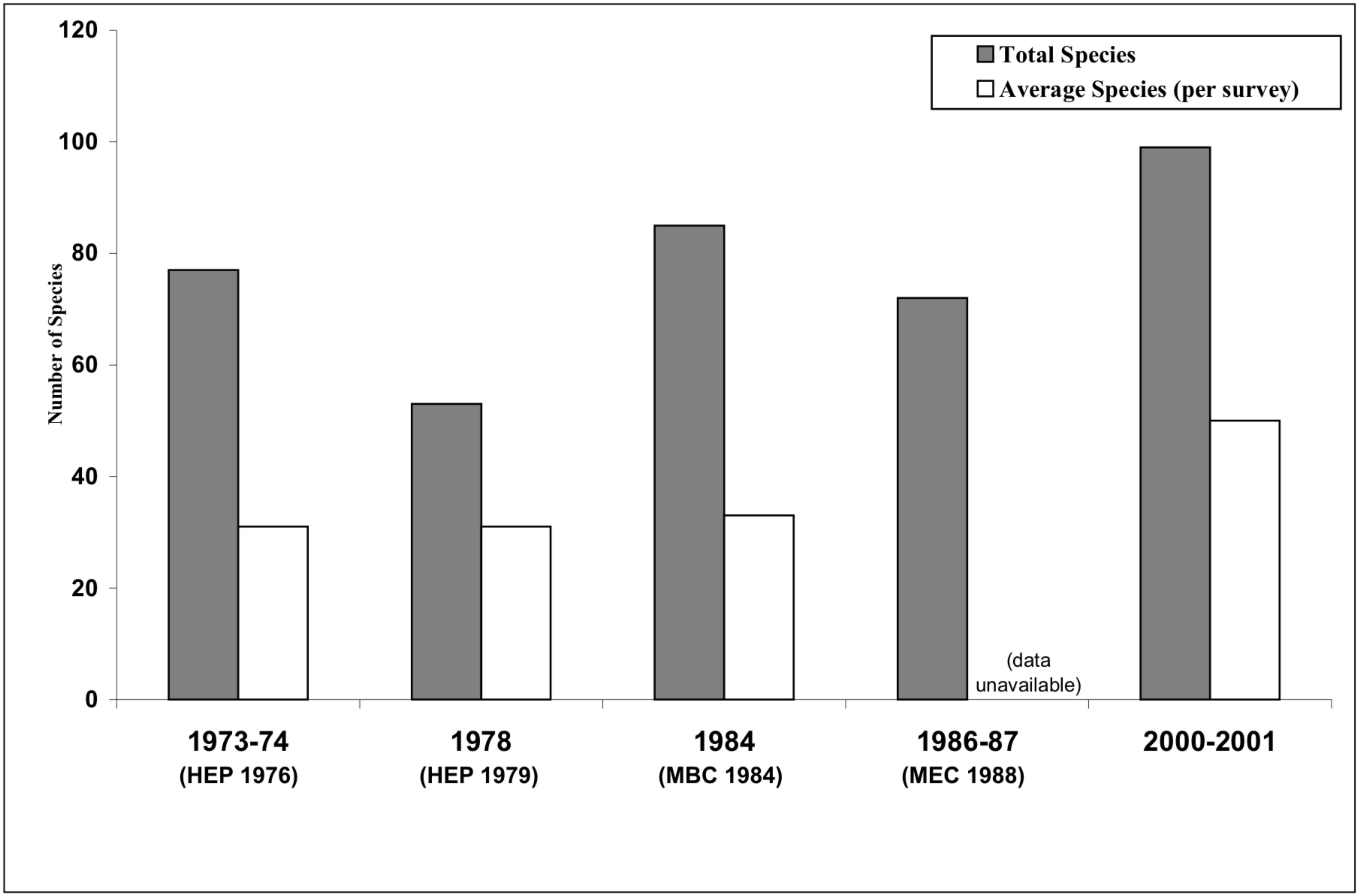


Figure 9.7-1. Historical comparison of the total and mean number of species of birds in Long Beach and Los Angeles Harbors.

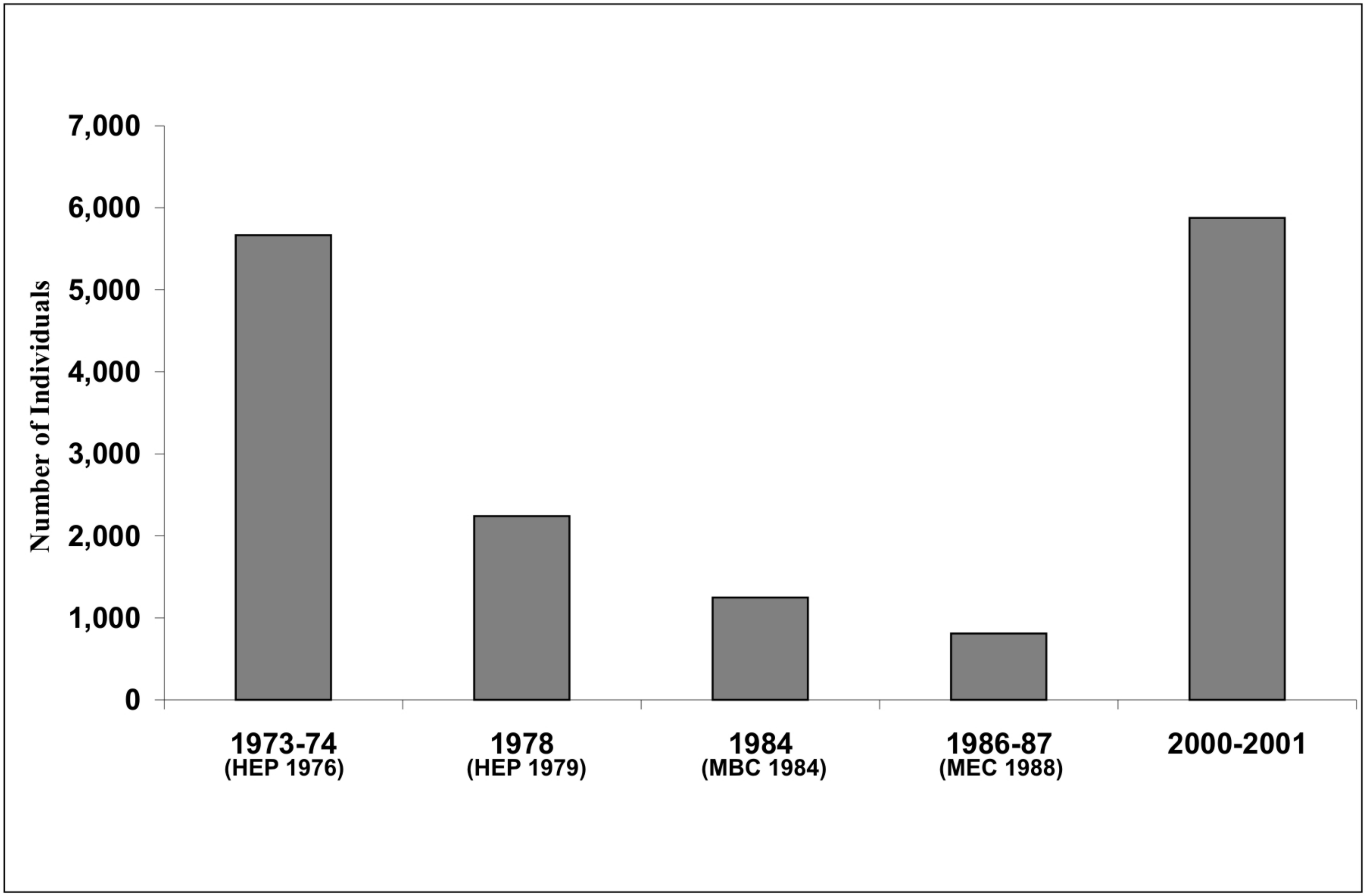


Figure 9.7-2. Historical comparison of the mean number of birds in Long Beach and Los Angeles Harbors.

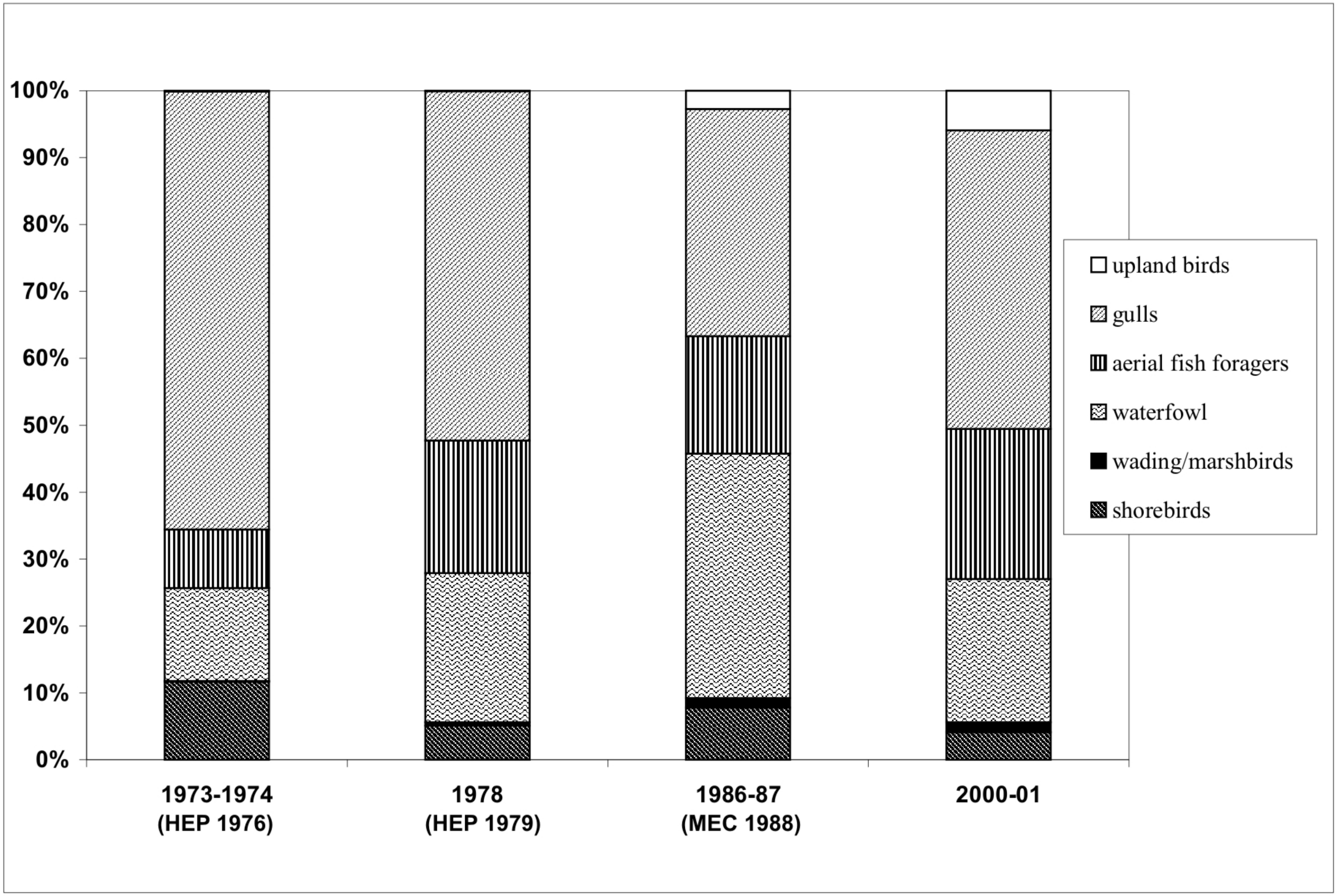


Figure 9.7-3. Historical comparison of percent composition of bird guilds in Long Beach and Los Angeles Harbors.

Table 9.3-1. Total number of species and individuals of birds observed by survey in Long Beach and Los Angeles Harbors, February 2000 – January 2001.

Survey Date	Number of Species	Total Individuals
February 2000-A	55	6,559
February 2000-B	58	5,527
March 2000-A	57	5,713
March 2000-B	55	6,346
April 2000-A	52	3,950
May 2000-A	45	3,525
June 2000-A	36	5,113
July 2000-A	39	11,780
August 2000-A	46	9,080
August 2000-B	44	6,569
September 2000-A	40	5,410
September 2000-B	41	4,250
October 2000-A	43	4,912
October 2000-B	57	5,160
November 2000-A	56	4,866
November 2000-B	56	5,539
December 2000-A	57	6,055
December 2000-B	51	5,564
January 2001-A	60	6,247
January 2001-B	59	5,394
Mean per Survey	50	5,878

Table 9.4-1. Mean abundance and percent composition of birds observed in Long Beach and Los Angeles Harbors, February 2000 – January 2001.

SPECIES	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	YEARLY AVG.	% TOTAL
Black-bellied Plover	64	2	0	1	1	3	21	6.5	76.5	50	98	90.5	34.5	
Killdeer	0.5	1	2	2	0	0	0	0	0	0.5	0	0	0.5	
Semipalmated Plover	0	2	0	0	0	0	0	0	2	4	0	2	0.8	
Plovers	**64.5**	**5**	**2**	**3**	**1**	**3**	**21**	**6.5**	**78.5**	**54.5**	**98**	**92.5**	**35.8**	**0.6**
Black Turnstone	25	47	42	4	0	23	21	26	16	13.5	1.5	2	18.4	
Dowitcher species	0	0	0	0	0	6	0	0	0	0	0	0	0.5	
Dunlin	0.5	0	0	0	0	0	0	0	0	0	0	0	0.0	
Least Sandpiper	62	30	3	0	0	0	1	0	0	1	0	6.5	8.6	
Ruddy Turnstone	6	16.5	10	0	2	6	7	4	3	2	0.5	0.5	4.8	
Sanderling	49.5	41	14	0	0	0	0	0	15.5	15	4.5	61.5	16.8	
Spotted Sandpiper	7.5	7.5	6	0	0	0	5	3.5	4.5	4.5	5	4.5	4.0	
Surfbird	30	272	58	1	0	84	18	17.5	11.5	48	6.5	2.5	45.8	
Unidentified Sandpiper*	14.5	9	0	0	0	0	0.5	5.5	0.5	0	0	0	2.5	
Western Sandpiper	65.5	33.5	74	0	0	0	9	4.5	14.5	24.5	25.5	41.5	24.4	
Small Sandpipers and Relatives	**260.5**	**456.5**	**207**	**5**	**2**	**119**	**61.5**	**61**	**65.5**	**108.5**	**43.5**	**119**	**125.8**	**2.1**
TOTAL SMALL SHOREBIRDS	**325**	**461.5**	**209**	**8**	**3**	**122**	**82.5**	**67.5**	**144**	**163**	**141.5**	**211.5**	**161.5**	**2.7**
American Oystercatcher	0	0	0	0	0	0	0	0	1	0.5	0	0	0.1	
Black Oystercatcher	19.5	19	30	20	30	26	31	54	41.5	18.5	3	1.5	24.5	
Oystercatchers	**19.5**	**19**	**30**	**20**	**30**	**26**	**31**	**54**	**42.5**	**19**	**3**	**1.5**	**24.6**	**0.4**
American Avocet	**0**	**0.5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0**	**<0.05**
Long-billed Curlew	0	0	1	0	0	3	0.5	0.5	0	1	0	1.5	0.6	
Marbled Godwit	9	3	0	0	0	0	6	3.5	1.5	2.5	4	4.5	2.8	
Wandering Tattler	6	6	11	3	1	8	8.5	4.5	2	0	0	0	4.2	
Whimbrel	14.5	14.5	12	1	0	1	8.5	5.5	10.5	9.5	9	6	7.7	
Willet	109	64	33	0	14	25	37.5	34.5	42.5	45	40.5	40	40.4	
Yellowlegs species	0	0	0	0	0	0	0	0	0	0	0	4	0.3	
Large Sandpipers and Relatives	**138.5**	**87.5**	**57**	**4**	**15**	**37**	**61**	**48.5**	**56.5**	**58**	**53.5**	**56**	**56.0**	**0.9**
TOTAL LARGE SHOREBIRDS	**158**	**107**	**87**	**24**	**45**	**63**	**92**	**102.5**	**99**	**77**	**56.5**	**57.5**	**80.7**	**1.4**

Table 9.4-1. Continued.

SPECIES	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	YEARLY AVG.	% TOTAL
Black-crowned Night Heron	3	2.5	21	51	58	41	15	7	10	11.5	10	15	20.4	
Great Blue Heron	57	53.5	45	35	78	87	76	88.5	67	64	62.5	58	64.3	
Great Egret	0.5	0	0	0	0	1	0	0	0	0.5	0.5	0.5	0.3	
Green Heron	2	0	3	1	1	4	4	4	1.5	0.5	1	0	1.8	
Snowy Egret	1.5	10	1	5	0	4	1	0.5	1	1.5	1	1.5	2.3	
Herons and Bitterns	**64**	**66**	**70**	**92**	**137**	**137**	**96**	**100**	**79.5**	**78**	**75**	**75**	**89.1**	**1.5**
White Faced Ibis	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.5**	**0**	**0**	**0**	**0**	**0.0**	**<0.05**
TOTAL WADING/MARSHBIRDS	**64**	**66**	**70**	**92**	**137**	**137**	**96**	**100.5**	**79.5**	**78**	**75**	**75**	**89.2**	**1.5**
Brown Pelican	**337.5**	**455.5**	**268**	**239**	**346**	**1181**	**1077**	**1019**	**419**	**441.5**	**433.5**	**535**	**562.6**	**9.5**
Black Skimmer	30.5	65.5	58	4	1	65	165	22.5	1	3.5	2.5	2.5	35.1	
Caspian Tern	9.5	57	117	51	70	57	40	4	5	4	6.5	7	35.7	
Common Tern	0	0	0	0	0	0	0	0	0	0	1	0	0.1	
Elegant Tern	4	14.5	15	288	1026	4550	1355	93	40.5	0.5	0.5	0.5	615.6	
Forster's Tern	82	65	48	48	0	3	3	22	17	53.5	53.5	54.5	37.5	
Least Tern	0	0	12	104	94	88	4	0	0	0	0	0	25.2	
Parisitic Jaeger	0	0	0	0	0	0	0	0	1	0	0	0	0.1	
Royal Tern	41	1.5	0	13	35	15	0	1	1	0	0	2	9.1	
Terns	**167**	**203.5**	**250**	**508**	**1226**	**4778**	**1567**	**142.5**	**65.5**	**61.5**	**64**	**66.5**	**758.3**	**12.8**
Belted Kingfisher	**6**	**2**	**0**	**0**	**0**	**0**	**10**	**18.5**	**13**	**10**	**10**	**5.5**	**6.3**	**0.1**
TOTAL AERIAL FISH FORAGERS	**510.5**	**661**	**518**	**747**	**1572**	**5959**	**2654**	**1180**	**497.5**	**513**	**507.5**	**607**	**1,327.1**	**22.4**
Common Loon	5.5	3.5	3	8	1	0	0.5	0	1	2.5	1.5	2.5	2.4	
Pacific Loon	1.5	0.5	3	1	0	0	0	0.5	1	0.5	1.5	0.5	0.8	
Loons	**7**	**4**	**6**	**9**	**1**	**0**	**0.5**	**0.5**	**2**	**3**	**3**	**3**	**3.3**	**0.1**
Clark's Grebe	8	6	2	3	0	42	44	28.5	12.5	18.5	14.5	41	18.3	
Eared Grebe	69	70.5	40	6	0	1	0	3	22	45	34	30.5	26.8	
Grebe-unidentified	0	0	0	0	0	0	0	0	0	0	0	16.5	1.4	
Horned Grebe	4.5	2	0	3	1	0	0	0	0	0	2	3.5	1.3	
Pied-billed Grebe	9	11	1	1	0	3	4	5.5	9	11.5	5	6.5	5.5	
Western Grebe	329.5	990.5	588	159	452	284	292.5	271.5	1236.5	560	466	270	491.6	
Grebes	**420**	**1080**	**631**	**172**	**453**	**330**	**340.5**	**308.5**	**1280**	**635**	**521.5**	**368**	**545.0**	**9.2**

Table 9.4-1. Continued.

SPECIES	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	YEARLY AVG.	% TOTAL
Brandt's Cormorant	1387	400.5	509	114	4	15	39.5	160	97	151	425	239.5	295.1	
Double-crested Cormorant	308.5	215	147	107	111	95	134	201	199.5	193.5	211	204	177.2	
Pelagic Cormorant	3	2	0	0	1	1	4.5	2.5	3	2	9.5	9	3.1	
Unidentified Cormorant	4	30	0	5	0	0	0	1	1	1	0	0	3.5	
Cormorants	**1703**	**647.5**	**656**	**226**	**116**	**111**	**178**	**364.5**	**300.5**	**347.5**	**645.5**	**452.5**	**479.0**	**8.1**
American Green-winged Teal	0	0	0	0	0	0	0	0	0	0.5	0	0	0.0	
American Wigeon	0	0	0	0	0	0	0	0	0.5	0	0	0	0.0	
Black Brant	0	3	1	2	0	0	0	0	0	0	0	0	0.5	
Bufflehead	38	12.5	0	0	0	0	0	0	1.5	30.5	42	37.5	13.5	
Cinnamon Teal	0	0	0	0	0	0	0	0	0	0	0	2.5	0.2	
Domestic Goose	2.5	2	2	0	1	8	5	5	2.5	2	5	1.5	3.0	
Greater Scaup	0	0.5	4	5	6	0	4.5	0	0.5	2	1.5	5.5	2.5	
Lesser Scaup	10	4	0	0	0	0	0	0	0	0	1	5.5	1.7	
Mallard	3.5	6.5	9	11	9	12	16.5	13.5	13	18	16.5	24	12.7	
Red-breasted Merganser	12	2	0	0	0	0	0	0	0	0	5	7	2.2	
Ruddy Duck	0	0	0	0	0	0	0	0	2	73.5	75.5	38	15.8	
Surf Scoter	473	494.5	73	6	8	8	7	4	49	386	445.5	262	184.7	
Unidentified Scaup	0	0	0	0	0	0	0	0	5.5	0	17.5	0	1.9	
Ducks, Swans, Geese	**539**	**525**	**89**	**24**	**24**	**28**	**33**	**22.5**	**74.5**	**512.5**	**609.5**	**383.5**	**238.71**	**4.0**
American Coot	**1.5**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**4**	**0**	**1**	**3.5**	**0.9**	**<0.05**
Cassin's Auklet	0	0	0	0	0	0	0	0	0	0.5	0	0	0.0	
Tufted Puffin	0	0.5	0	0	0	0	0	0	0	0	0	0	0.0	
Auks and Puffins	**0**	**0.5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.5**	**0**	**0**	**0.1**	
TOTAL WATERFOWL	**2670**	**2257**	**1382**	**431**	**594**	**469**	**552**	**697**	**1661**	**1499**	**1781**	**1211**	**1266.9**	**21.4**
California Gull	184	220	53	0	0	19	17	12	70	164	233.5	530	125.2	
Glaucous-winged Gull	12	9.5	2	1	0	0	0.5	0	0	6.5	21	22	6.2	
Heermann's Gull	86.5	148.5	69	102	871	2813	1728.5	643	522	798.5	656	461.5	741.6	
Herring Gull	29	10.5	0	0	0	0	0.5	0.5	3.5	11	18	6	6.6	
Mew Gull	38.5	3.5	0	0	0	0	0	0	0.5	31.5	64.5	68.5	17.3	
Ring-billed Gull	119.5	33	9	1	2	0	7	2.5	8.5	87.5	124.5	112	42.2	
Unidentified Gull	159.5	27.5	0	0	0	0	0.5	1	0	0	0	0	15.7	
Western Gull	1394	1684	1084	1756	1534	1869	2258	1738	1722.5	1505	1638.5	2022.5	1,683.8	
TOTAL GULLS	**2023**	**2137**	**1217**	**1860**	**2407**	**4701**	**4012**	**2397**	**2327**	**2604**	**2756**	**3223**	**2,638.6**	**44.6**

Table 9.4-1. Continued.

SPECIES	Feb-00	Mar-00	Apr-00	May-00	Jun-00	Jul-00	Aug-00	Sep-00	Oct-00	Nov-00	Dec-00	Jan-01	YEARLY AVG.	% TOTAL
Osprey	0	0	0	1	0	0	0	0	0.5	0	0	0	0.1	
Red-shouldered Hawk	0	0	0	0	0	1	0	0	0	0	0	0	0.1	
Red-tailed Hawk	0	0	0	0	0	0	0	0.5	0	1	1	1	0.3	
Hawks and Harriers	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**0.5**	**0.5**	**1**	**1**	**1**	**0.5**	**<0.05**
American Kestrel	0	0	1	0	0	0	0	0	0.5	0	0	0	0.1	
Peregrine Falcon	1.5	1	2	2	1	0	0	0.5	0	0.5	1	0	0.8	
Unidentified Falcon	0	0.5	0	0	0	0	0	0.5	0	0	0	0	0.1	
Falcons	**1.5**	**1.5**	**3**	**2**	**1**	**0**	**0**	**1**	**0.5**	**0.5**	**1**	**0**	**1.0**	**<0.05**
Burrowing Owl	**0**	**0.5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0**	**<0.05**
TOTAL RAPTORS	1.5	2	3	3	1	1	0	1.5	1	1.5	2	1	1.5	**<0.05**
Mourning Dove	1.5	3	1	5	5	0	1	0	1	0.5	0	1	1.6	
Rock Dove	210	271.5	356	282	278	287	288	256	202	213.5	279	264	265.6	
Spotted Dove	0	0	0	0	0	0	0	0	0	0	0.5	0	0.0	
Anna's Hummingbird	0	0	0	0	1	0	0	0	0	0	0	0	0.1	
Unidentified Hummingbird	0	0	0	0	0	0	0.5	0	0	0	0	0	0.0	
Great-tailed Grackle	0	0	0	0	0	0	0	0	0	0	0	24.5	2.0	
House Sparrow	0	0	6	0	1	0	0	0	0	0	0	1	0.7	
Song Sparrow	0	0.5	0	0	0	0	0	0	0	0	0	0	0.0	
Western Meadowlark	0	0	0	0	0	0	0	0	5.5	0	0	0	0.5	
White-crowned Sparrow	2	0.5	0	0	0	0	0	0	0	2.5	0	0	0.4	
Yellow-rumped Warbler	0	0	0	0	0	0	0.5	0	0	0	0	0	0.0	
American Goldfinch	0	0	0	0	0	0	0	0	0	2	0	0	0.2	
House Finch	25.5	14	6	14	18	0	2	0	1	19.5	190	124	34.5	
Lesser Goldfinch	0	0	0	0	0	0	0	0	0	2.5	0	0	0.2	
Black Phoebe	2	0	0	0	0	0	1.5	1	0.5	0.5	2.5	1.5	0.8	
Say's Phoebe	0	0	0	0	0	0	0	1	0.5	1	1	0	0.3	
Loggerhead Shrike	0	0	1	0	0	0	0.5	0	0	1	0	0.5	0.3	
Barn Swallow	0	4.5	45	34	39	31	29	2.5	0	0	0	0	15.4	
Rough-winged Swallow	0	0	2	1	0	0	0	0.5	0	0	0	0	0.3	
Violet-green Swallow	3	0	0	0	0	0	0	0	0	0	0	0	0.3	
Northern Mockingbird	0	0	0	0	1	0	0.5	0	0.5	1	0.5	1.5	0.4	
American Pipit	0	0	0	0	0	0	0	0	0	0	0	1.5	0.1	
European Starling	8	13.5	23	8	0	3	2	9.5	2	0.5	9	6	7.0	
American Crow	38.5	28	22	13	11	7	11	14	10.5	22	6	9	16.0	
Common Raven	0.5	3	2	3	0	0	0	0	3.5	1	2	1	1.3	
TOTAL UPLAND BIRDS	**291**	**338.5**	**464**	**360**	**354**	**328**	**336.5**	**284.5**	**227**	**267.5**	**490.5**	**435.5**	**348.1**	**5.9**
ALL BIRDS	**6043**	**6030**	**3950**	**3525**	**5113**	**11780**	**7825**	**4830**	**5036**	**5203**	**5810**	**5821**	**5,913.6**	**100.0**

Table 9.4-2. Status of sensitive bird species observed within Long Beach and Los Angeles Harbors, February 2000 – January 2001.

Common Name	Scientific Name	State Status[1]	Federal Status[1]	Other[1,2]	Nesting at Ports
California Brown Pelican	*Pelecanus occidentalis californicus*	Endangered	Endangered	DFG FPS, FWS MNBMC	No
American Peregrine Falcon*	*Falco peregrinus anatum*	Endangered	De-listed 1999	DFG FPS, FWS MNBMC	Yes
Western Snowy Plover[3]	*Charadrius alexandrinus nivosus*		Threatened	DFG CSC, FWS MNBMC	No
California Least Tern	*Sterna antillarum browni*	Endangered	Endangered	DFG FPS, FWS MNBMC	Yes
Great Blue Heron*	*Ardea herodias*			DFG SA	Yes
Black-crowned Night Heron*	*Nyctocorax nycticorax*			DFG SA	Yes
Black Oystercatcher*	*Haematopus bachmani*			DFG SA, NAS WL	Yes
Caspian Tern*	*Sterna caspia*			DFG SA	Yes
Elegant Tern*	*Sterna elegans*			DFG CSC, FWS MNBMC, FSC	Yes
Black Skimmer*	*Rynchops niger*			DFG CSC	Yes
Burrowing Owl*	*Athene cunicularia hypugea*			DFG CSC, FWS MNBMC, FSC	?
Loggerhead Shrike	*Lanius ludovicianus*			DFG CSC, FWS MNBMC, FSC	Yes[4]

Notes: *Status applies to nesting sites only

[1]Source: California Department of Fish and Game, California Natural Diversity Database, Special Animals List, January 2001.

[2]DFG FPS = Fish and Game Fully Protected Species, DFG CSC = Fish and Game California Special Concern Species, FWS MNBMC = U.S. Fish and Wildlife Service Migratory Non-game Birds of Management Concern, SA = Special Animal tracked by Fish and Game, but no protective status, NAS WL = National Audubon Society California watch list, FSC = U.S. Fish and Wildlife Service Federal Species of Concern (no longer an active designation, provided for informational purposes only).

[3]This species not observed during 2000-2001 surveys but known to occur (but not nest) at Ports.

[4]This species not observed nesting during 2000-2001 surveys, bur reported to nest within Ports (ACOE 1984).

Table 9.5-1. Densities (individuals/acre) of bird guild members by survey zones in Long Beach and Los Angeles Harbors, February 2000 – January 2001.

Guild	1	2	3	4	5	6	7	8	9	10	11
Small Shorebirds	1.03	0.28	0.22	0.03	2.49	2.89	0.17	0.22	1.28	0.26	
Large Shorebirds	0.39	0.12	0.18	0.16	1.95	1.13	0.48	0.06	0.58	0.11	
Wading/Marshbirds	0.55	0.35	0.06	0.45	0.76	0.24	0.62	0.16	0.02	0.23	
Waterfowl	11.45	2.72	3.59	2.72	9.68	8.89	2.29	2.23	0.83	6.17	1.99
Aerial Fish Foragers	9.10	2.01	4.60	5.75	1.66	4.86	17.84	8.69	11.44	0.36	0.15
Raptors					0.06	0.004	0.004	0.01	0.01	0.001	
Gulls	43.15	10.15	13.29	29.51	2.17	5.16	11.39	4.62	7.93	0.91	0.35
Upland Birds	2.56	1.48	0.02	1.66	3.64	0.36	0.10	1.00	0.01	0.35	
Total	68.24	17.12	21.97	40.27	22.41	23.54	32.90	16.99	22.10	8.39	2.49

Guild	12	13	14	15	19	20	21	22	23	24	25
Small Shorebirds	11.24	6.35	0.01	5.74	0.67	0.00	0.26	0.02	0.01	0.01	0.05
Large Shorebirds	3.50	0.93		8.18	0.31	0.01	0.32	0.01	0.02	0.01	
Wading/Marshbirds	0.16	0.26		0.11	0.35	0.03	0.28	0.10	0.45	0.14	0.45
Waterfowl	10.09	5.11	0.72	2.73	6.36	0.50	11.64	1.24	8.44	1.44	1.49
Aerial Fish Foragers	22.25	1.35	0.32	33.44	2.72	2.65	1.15	0.27	0.65	0.24	0.79
Raptors								0.00	0.00		0.01
Gulls	25.77	4.29	0.40	34.68	22.10	2.24	12.60	7.10	2.22	6.11	8.64
Upland Birds	0.01	0.34		0.02	0.23		0.50	0.76	0.74	0.56	1.89
Total	73.03	18.63	1.45	84.90	32.74	5.43	26.74	9.50	12.54	8.50	13.33

Guild	26	27	28	29	30	31	32	33	34	Total
Small Shorebirds	0.07	0.88			0.05	0.03	0.01	5.36	0.01	39.65
Large Shorebirds						0.05		0.39	0.004	18.88
Wading/Marshbirds	0.61	0.40	0.21	0.08	0.75	0.22	0.15	1.07	0.11	9.39
Waterfowl	3.63	3.56	0.29	0.44	1.94	0.53	0.62	10.21	1.13	124.67
Aerial Fish Foragers	0.31	0.20	0.26	0.24	1.09	0.10	0.13	3.70	5.28	143.59
Raptors	0.10	0.01				0.01	0.01	0.02	0.00	0.26
Gulls	12.90	20.06	9.12	4.93	4.57	0.76	8.43	12.53	19.53	347.61
Upland Birds	1.90	8.86	8.41	1.11	7.56	1.35	1.60	4.53	1.05	52.60
Total	19.52	33.95	18.30	6.80	15.96	3.04	10.95	37.82	27.11	736.65

Table 9.5-2. Total abundance of bird guilds by survey zones in Long Beach and Los Angeles Harbors, February 2000 – January 2001.

Guild	1	2	3	4	5	6	7	8	9	10	11
Small Shorebirds	101	117	46	5	155	657	49	97	173	218	
Large Shorebirds	38	50	38	29	121	256	136	27	78	90	
Wading/Marshbirds	54	147	13	82	47	54	173	69	3	195	
Waterfowl	1,121	1,130	740	500	602	2,018	642	991	113	5161	1,678
Aerial Fish Foragers	891	837	947	1,056	103	1,104	5,010	3,861	1,550	304	129
Raptors					4	1	1	4	1	1	
Gulls	4,226	4,218	2,736	5,416	135	1,172	3,199	2,053	1,075	759	292
Upland Birds	251	616	5	304	226	82	29	446	1	295	
Total	6,682	7,115	4,525	7,392	1,393	5,344	9,239	7,548	2,994	7,023	2,099

Guild	12	13	14	15	19	20	21	22	23	24	25
Small Shorebirds	758	240	4	320	119	1	23	4	4	1	9
Large Shorebirds	236	35		456	55	2	28	3	13	1	
Wading/Marshbirds	11	10		6	62	6	25	23	341	23	75
Waterfowl	680	193	459	152	1,131	103	1,034	299	6,351	232	246
Aerial Fish Foragers	1,500	51	205	1,863	484	549	102	65	490	38	130
Raptors								1	2		2
Gulls	1,737	162	258	1,932	3,929	464	1,119	1,710	1,674	987	1,427
Upland Birds	1	13		1	41		44	182	560	90	313
Total	4,923	704	926	4,730	5,821	1,125	2,375	2,287	9,435	1,372	2,202

Guild	26	27	28	29	30	31	32	33	34	Total
Small Shorebirds	5	169			2	4	1	245	2	3,529
Large Shorebirds						6		18	1	1,717
Wading/Marshbirds	42	77	8	5	31	28	14	49	31	1,704
Waterfowl	249	685	11	27	80	67	58	467	314	27,534
Aerial Fish Foragers	21	38	10	15	45	12	12	169	1,464	23,055
Raptors	7	1				1	1	1	1	29
Gulls	885	3,863	346	306	188	95	784	573	5,421	53,141
Upland Birds	130	1,706	319	69	311	169	149	207	290	6,850
Total	1,339	6,539	694	422	657	382	1,019	1,729	7,524	117,559

Table 9.5-3. Occurrence of habitats by survey zones in Long Beach and Los Angeles Harbors, February 2000 – January 2001.

Survey Zone	A	AL	BA	BO	BR	BU	DP	DR	MF	OW	RR	SB	SW	UP	Total Habitats
1	X			X		X	X			X	X	X	X		**8**
2	X	X	X	X		X	X	X		X	X	X	X	X	**12**
3	X		X	X		X	X	X		X	X			X	**9**
4	X	X	X	X		X	X	X		X	X		X		**10**
5	X	X	X			X	X			X	X	X	X	X	**10**
6	X		X		X	X	X	X		X	X	X	X		**10**
7	X	X	X			X	X	X		X	X		X		**9**
8	X		X			X		X		X	X		X		**7**
9	X		X				X			X	X				**5**
10	X		X	X	X	X	X	X		X	X		X	X	**11**
11	X		X			X	X	X		X	X				**7**
12	X					X				X	X		X		**5**
13	X		X				X			X	X		X		**6**
14	X					X				X					**3**
15	X		X				X			X	X		X		**6**
19	X		X			X	X			X	X		X		**7**
20	X					X	X	X		X	X				**6**
21	X	X					X			X	X		X		**6**
22	X	X	X	X		X	X			X	X		X		**9**
23	X	X	X	X		X	X	X		X	X		X	X	**11**
24	X	X	X	X		X	X			X	X		X		**9**
25	X	X	X	X		X	X			X	X		X	X	**10**
26	X	X	X		X	X	X			X	X				**8**
27	X	X	X	X	X	X	X		X	X	X	X	X	X	**13**
28	X	X	X	X		X	X			X	X				**8**
29	X	X		X		X	X	X		X					**7**
30	X	X	X	X			X			X	X		X		**8**
31	X	X	X	X		X	X	X		X	X		X		**10**
32	X	X	X	X		X	X			X	X		X		**9**
33	X		X	X		X	X	X	X	X	X	X	X		**11**
34	X	X	X	X			X			X	X		X		**8**

Habitat Codes: A = Aerial, AL = Anchor Line, BA = Boat/Barge, BO = Spill Boom, BR = Bridge, BU = Buoy, DP = Dock/Piling, MF = Mudflat, OW = Open Water, RR = Riprap, SB = Sand Beach, SW = Shallow Water, UP = Upland

Table 9.5-4. Total abundance of bird guild members by habitats in Long Beach and Los Angeles Harbors, February 2000 – January 2001.

Guild	HABITAT TYPE														Total
	A	AL	BA	BO	BR	BU	DP	DR	MF	OW	RR	SB	SW	UP	
Small Shorebirds	251		124				6	94	146	8	1,947	909	44		3,529
Large Shorebirds	57		2	4			9	4	4		1,266	310	61		1,717
Wading/Marshbirds	128	1	143	54		40	450	19	8	9	642	4	13	193	1,704
Waterfowl	2,949	51	592	392		612	3,833	597	13	17,145	983	48	319		27,534
Aerial Fish Foragers	6,396	27	633	64		470	2,188	637		898	10,867	823	50	2	23,055
Raptors	10		1		3		8				6	1			29
Gulls	4,899	123	3,847	124	7	267	17,042	809	159	6,943	13,284	5,137	498	2	53,141
Upland Birds	1,324	59	269	1	36		4,124	2		1	798	202	1	33	6,850
Total Observations	16,014	261	5,611	639	46	1,389	27,660	2,162	330	25,004	29,793	7,434	986	230	117,559
% of Total	14%	0%	5%	1%	0%	1%	24%	2%	0%	21%	25%	6%	1%	0%	100%

Habitat Codes: A = Aerial, AL = Anchor Line, BA = Boat/Barge, BO = Spill Boom, BR = Bridge, BU = Buoy, DP = Dock/Piling, MF = Mudflat, OW = Open Water, RR = Riprap, SB = Sand Beach, SW = Shallow Water, UP = Upland

Table 9.5-5. Activities of bird guild members in Long Beach and Los Angeles Harbors, February 2000 – January 2001.

Guild	Resting	Foraging	Flying	Courting	Nesting	Total
small shorebirds	1,588	1,691	250			3,529
large shorebirds	1,164	496	57			1,717
wading/marshbirds	1,316	130	128		130	1,704
waterfowl	18,716	5,878	2,938	2		27,534
aerial fish foragers	16,075	2,228	4,719	33		23,055
raptors	18	1	10			29
gulls	46,371	2,063	4,695	4	8	53,141
upland birds	5,007	367	1,261	191	24	6,850
Total Observations	90,255	12,854	14,058	230	162	117,559

Table 9.7-1. Historical comparison of percent composition of ten common species of birds observed in Long Beach and Los Angeles Harbors.

Species		Year				
Common name	**Scientific Name**	1973-74[1]	1978[2]	1983-84[3]	1986-87[4]	2000-2001
Podicipedidae (Grebes)						
Western Grebe	*Aechmophorus occidentalis*	0.12	4.49	2.56	5.44	8.31
Pelecanidae (Pelicans)						
California Brown Pelican	*Pelecanus occidentalis californicus*	3.82	14.06	15.00	14.00	9.51
Phalacrocoracidae (Cormorants)						
Double-crested Cormorant	*Phalacrocorax auritus*	0.77	2.32	1.48	2.65	3.00
Brandt's Cormorant	*Phalacrocorax penicillatus*	0.02	0.11	5.71	1.57	4.99
Ardeidae (Herons and Bitterns)						
Great Blue Heron	*Ardea herodias*	0.07	0.31	0.02	1.14	1.08
Anatidae (Swans, Geese, and Ducks)						
Surf Scoter	*Melanitta perspicillata*	14.36	11.55	5.89	25.55	3.12
Laridae (Terns, Jaegers, Gulls)						
Elegant Tern	*Sterna elegans*	0.40	0.42	0.28	0.37	10.41
California Gull	*Larus californicus*	6.60	0.71	0.58	0.08	2.12
Western Gull	*Larus occidentalis*	22.37	13.92	13.87	19.91	28.47
Heermann's Gull	*Larus heermanni*	28.60	28.42	27.39	9.32	12.54

Note: [1]HEP 1976; [2]HEP 1979; [3]MBC 1984; [4]MEC 1988.

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MEC Analytical Systems, Inc. managed the Year 2000 Baseline Study and supervised water quality, fish, ichthyoplankton, benthos, and riprap surveys. Karen Green was Project Manager of the Baseline Study; principal author of the introduction and benthic invertebrate chapters; contributing author of juvenile and adult fish, ichthyoplankton, and riprap chapters; designed and participated in MEC-led field studies; and was senior editor for the report.

Dr. Douglas Diener was contributing author to the benthic (macroinvertebrates) and juvenile and adult fish (special studies) chapters, co-designed field studies, and identified invertebrate crustaceans and echinoderms. Bill Isham was senior author of the ichthyoplankton chapter, supervised the ichthyoplankton surveys, identified larval fish, and supervised otter trawl and beach seine field surveys of juvenile and adult fish. Dr. Cynthia Collins was contributing author of the riprap chapter, supervised benthic and water quality surveys, and identified molluscs.

Sheila Holt also supervised benthic and water quality surveys and performed laboratory analysis of benthic samples. Brian Riley supervised riprap dive surveys. Additional MEC personnel who participated in field surveys and laboratory processing of samples included Jessica Erickson, Sandra Gonsalez, Karen Helyer, Brian Hester, MaryAnn Irwin, Joel Magsalin, Tom Matrone, Chris Osuch, Olga Weaver, and Satomi Yonemasu. Taxonomic identification of invertebrates and algae from benthic and riprap samples was performed by the following individuals in addition to the ones named above: Larry Deischer (algae), Jessica Erickson (barnacles), John Ljubenkov (molluscs, miscellaneous phyla), Tony Phillips (polychaetes). Leslie Harris (polychaetes), John Ljubenkov (molluscs, miscellaneous phyla), and Dr. Douglas Diener (crustaceans) identified non-indigenous fauna from the species lists generated from the 2000 surveys.

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Kathy Keane of Keane Biological Consulting was task leader for the bird study. The bird chapter was authored by Holly Henderson, Kathy Keane, and Rachael Woodfield. These individuals as well as Bob Schallmann, Jeff Johnson, Steve Rink, Tracy Wurth, and Navroop Jassal conducted the field survyes.

SAIC contributed to water quality and fisheries biology. Charles Phillips was senior author of the physical/chemical chapter. Daniel Heilprin was contributing author of the juvenile and adult fish chapter and task leader for the lampara field surveys. Edward Basmadjian participated as a field scientist and taxonomist on lampara and beach seine surveys. Dr. Andrew Lissner consulted on exotic species issues.

Dr. Robert Smith provided multivariate analyses of data. Ying Poon and David Cannon at EIC were contributing authors to the physical/chemical chapter (circulation). Dr. Donald J. Reish prepared his personal reflections on environmental changes that have occurred in Long Beach and Los Angeles Harbors since the 1950s.

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APPENDIX A

Station Coordinates

STATION COORDINATES AND DEPTHS
Water Quality and Benthos

STATION	COORDINATES (NAD83)				DEPTH meters
	LATITUDE		LONGITUDE		
LA1	33	43.150	118	14.415	13
LA2A	33	42.543	118	15.795	4
LA2B	33	42.427	118	16.051	4
LA3A	33	42.469	118	16.434	4
LA3B	33	42.538	118	16.510	4
LA4	33	44.305	118	16.589	16
LA5	33	45.871	118	16.476	17
LA6	33	45.759	118	15.291	16
LA7A	33	44.391	118	14.735	4
LA7B	33	44.556	118	14.854	4
LA8	33	44.869	118	15.032	4
LA9	33	43.896	118	15.187	16
LA10	33	44.166	118	16.056	6
LA11	33	43.072	118	16.136	11
LA12	33	43.249	118	16.754	11
LA13	33	45.293	118	16.997	11
LA14	33	46.493	118	14.721	6

LB1	33	44.000	118	13.400	12
LB2A	33	43.964	118	14.290	6
LB2B	33	43.988	118	14.211	6
LB3	33	44.640	118	13.905	15
LB4	33	46.509	118	12.823	15
LB5	33	44.622	118	11.772	15
LB6	33	44.236	118	11.306	17
LB7	33	44.946	118	13.022	24
LB8	33	44.354	118	10.986	15
LB9	33	43.700	118	11.525	25
LB10	33	44.824	118	12.636	21
LB11	33	44.760	118	13.376	15
LB12	33	45.569	118	12.498	16
LB13	33	46.157	118	13.388	20
LB14	33	46.042	118	13.953	18

STATION COORDINATES AND DEPTHS

Trawl, Lampara, and Ichthyoplankton

STATION	COORDINATES (NAD83)				DEPTH meters
	LATITUDE		LONGITUDE		
LA1	33	43.150	118	14.415	13
LA2A	33	42.543	118	15.795	4
LA2B	33	42.427	118	16.051	4
LA3A	33	42.470	118	16.434	4
LA3B	33	42.538	118	16.510	4
LA4	33	44.305	118	16.589	16
LA5	33	45.871	118	16.476	17
LA6	33	45.759	118	15.291	16
LA7A	33	44.391	118	14.735	4
LA7B	33	44.556	118	14.854	4
LB1	33	44.000	118	13.400	12
LB2A	33	43.964	118	14.290	6
LB2B	33	43.988	118	14.211	6
LB3	33	44.640	118	13.905	15
LB4	33	46.509	118	12.823	15
LB5	33	44.622	118	11.772	15
LB6	33	44.236	118	11.306	17
LB7	33	44.946	118	13.022	24

STATION COORDINATES

Riprap Stations

STATION	COORDINATES (NAD83)			
	LATITUDE		LONGITUDE	
LARR1	33	42.937	118	13.847
LARR2	33	45.816	118	15.431
LARR3	33	45.978	118	16.584
LARR4	33	42.863	118	16.394
LBRR1	33	44.075	118	11.011
LBRR2	33	46.228	118	13.546
LBRR3	33	44.722	118	13.223
LBRR4	33	44.642	118	12.144

Coordinates for Diver Transect Surveys of Macroalgae

Transect #	Location	Coordinates (UTM)	
T1	Outer Breakwater, LB	6495129.501 E	1720354.050 N
T2	Outer Breakwater, LA	6482967.112 E	1715649.327 N
T3	Outer Rip-Rap Shore, LA	6475876.310 E	1718004.120 N
T4	Outer Rip-Rap Shore, LA	6489287.574 E	1723190.771 N
T5	Outer Breakwater, LB	6501046.532 E	1721767.993 N
T6	Southeast Basin, LB	6501837.012 E	1729567.485 N
T7	Channel 3, LB	6497786.952 E	1739707.196 N
T8	Channel 3, LB	6496406.022 E	1738618.568 N
T9	Old Seaplane Landing, LA	6486684.178 E	1730551.739 N
T10	East Basin Channel, LA	6480489.811 E	1732679.216 N
T11	Channel 2, LB	6496374.896 E	1740195.663 N
T12	Cerritos Channel, LB	6491114.936 E	1737625.337 N
T13	East Basin, LA	6485885.352 E	1739121.967 N
T14	Outer Rip-Rap Shore, LB	6505692.174 E	1725867.556 N
T15	Outer Rip-Rap Shore, LB	6495370.953 E	1729341.423 N
T16	Outer Rip-Rap Shore, LA	6480343.765 E	1721147.577 N
T17	Fish Harbor Entrance, LA	6480849.072 E	1724339.865 N
T18	Slip 1, LA	6479924.493 E	1735146.172 N
T19	Turning Basin, LA	6478733.280 E	1733261.006 N
T20	Outer Rip-Rap Shore, LA	6478666.258 E	1718633.732 N

APPENDIX B

Water Quality Data

B.1 Raw Data – Water Quality

LA/LB BASELINE - JANUARY 2000
Water Quality Measurements - Dissolved oxygen (mg/L)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	7.97	7.11	7.43	7.69	7.46	6.97	6.74	6.49	8.53	8.23	7.59	7.78	6.55	7.52	7.34	6.70	6.22
1	7.99	7.13	7.40	7.74	7.38	6.95	6.75	6.48	8.62	8.21	7.48	7.79	6.59	7.43	7.30	6.72	6.26
2	7.98	7.14	7.36	7.39	7.30	6.94	6.77	6.61	8.38	8.17	7.52	7.75	6.56	7.41	7.26	6.70	6.41
3	7.97	7.04	7.28	7.28	7.21	6.93	6.69	6.73	8.13	7.86		7.73	6.59	7.36	7.01	6.71	6.26
4	8.06	6.79	7.15			6.91	6.63	6.80				7.69	6.52	7.37	6.86	6.60	6.25
5	8.10					6.88	6.59	6.80				7.64	6.33	7.38	6.78	6.41	6.23
6	8.08					6.85	6.57	6.83				7.58		7.42	6.71	6.40	6.22
7	8.09					6.87	6.54	6.84				7.57		7.37	6.64	6.21	
8	7.74					6.85	6.51	6.83				7.53		7.33	6.60	6.19	
9	7.42					6.88	6.48	6.84				7.47		7.15	6.34	6.05	
10	7.35					6.87	6.50	6.80				7.30		7.04	5.70	5.92	
11	7.22					6.86	6.52	6.78				7.22		7.04			
12	6.93					6.87	6.47	6.80				7.16		7.01			
13						6.93	6.44	6.80				7.15		6.95			
14						6.83	6.47	6.80				6.91		6.90			
15						6.88	6.49	6.78						6.78			
16							6.48										
17							6.48										
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	8.39	8.38	8.49	9.26	7.09	7.89	7.18	7.74	7.31	8.04	7.77	8.16	7.20	7.22	6.98
1	8.37	8.39	8.49	9.31	7.11	7.84	7.20	7.71	7.29	8.03	7.73	8.15	7.21	7.22	6.97
2	8.36	8.38	8.47	9.33	7.07	7.79	7.11	7.73	7.24	8.14	7.76	8.17	7.20	7.17	7.02
3	8.35	8.33	8.22	9.25	6.95	7.74	6.95	7.93	7.31	8.24	7.75	8.13	7.17	7.13	7.07
4	8.29	7.81	7.87	9.11	6.71	7.72	7.01	7.97	7.37	8.23	7.76	8.03	7.15	7.09	7.06
5	8.15	7.69	7.99	8.63	6.67	7.54	6.96	8.03	7.23	8.23	7.74	7.95	7.13	7.07	7.06
6	8.04	7.76	7.69	7.99	6.65	7.49	6.79	8.09	7.03	8.21	7.72	7.74	7.07	7.11	7.09
7	7.89	7.46	7.08	7.68	6.57	7.45	6.79	8.07	6.93	8.22	7.65	7.39	6.95	7.11	7.10
8	7.81	7.06	6.92	7.15	6.66	7.37	6.73	7.87	6.87	8.21	7.54	7.38	6.92	7.11	7.04
9	7.67			6.66	6.80	7.25	6.65	7.60	6.73	8.03	7.47	7.31	6.91	7.15	7.01
10	7.58			6.40	6.57	7.21	6.73	7.28	6.60	7.85	7.43	7.21	6.83	7.20	7.05
11	7.28			6.06	6.59	7.18	6.89	7.20	6.74	7.63	7.30	7.11	6.72	7.21	7.04
12	7.05			5.99	6.67	7.12	6.92	7.29	6.84	7.51	7.28	7.16	6.70	7.13	7.05
13				6.06	6.69	7.09	6.90	7.31	6.88	7.44	7.25	7.17	6.69	7.15	7.03
14				6.25	6.72	7.08	6.81	7.31	6.79	7.40	7.14	6.98	6.60	7.13	7.04
15						7.02	6.67	7.33	6.47	7.35	7.10		6.55	7.12	6.98
16							6.13	7.38		7.22	7.13		6.65	7.09	6.96
17								7.36		7.21	7.17			7.08	6.98
18								7.35		7.26	7.14			7.09	
19								7.28		7.34	7.07			7.07	
20								7.25		7.30	6.93				
21								7.26		7.35					
22								7.26		7.37					
23								7.24		7.26					
24								7.20		7.08					

LA/LB BASELINE - JANUARY 2000
Water Quality Measurements - pH

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	7.94	7.90	7.90	7.87	7.86	7.89	7.88	7.83	8.00	7.99	7.92	7.94	7.84	7.88	7.87	7.85	7.86
1	7.94	7.90	7.89	7.87	7.86	7.89	7.88	7.87	7.99	7.99	7.92	7.94	7.84	7.89	7.87	7.86	7.89
2	7.94	7.90	7.90	7.88	7.87	7.89	7.89	7.89	8.00	7.99	7.93	7.94	7.84	7.90	7.88	7.86	7.90
3	7.94	7.89	7.90	7.89	7.88	7.89	7.89	7.92	7.99	7.98		7.94	7.84	7.91	7.89	7.87	7.90
4	7.96	7.88	7.90			7.89	7.89	7.93				7.94	7.84	7.91	7.89	7.85	7.91
5	7.97					7.90	7.90	7.93				7.94	7.84	7.92	7.90	7.84	7.91
6	7.97					7.90	7.90	7.94				7.94		7.93	7.90	7.84	7.92
7	7.98					7.90	7.89	7.94				7.95		7.93	7.90	7.84	
8	7.97					7.90	7.89	7.94				7.95		7.93	7.90	7.83	
9	7.94					7.91	7.89	7.95				7.94		7.93	7.87	7.82	
10	7.93					7.92	7.90	7.95				7.94		7.93	7.84	7.81	
11	7.93					7.92	7.89	7.95				7.93		7.93			
12	7.92					7.92	7.90	7.96				7.93		7.93			
13						7.93	7.91	7.96				7.93		7.92			
14						7.93	7.91	7.97				7.92		7.92			
15						7.94	7.91	7.97						7.92			
16							7.91										
17							7.91										
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	8.02	8.03	8.03	8.09	7.89	8.03	7.99	7.96	7.98	8.02	8.04	8.00	7.98	7.92	7.92
1	8.02	8.03	8.03	8.09	7.89	8.03	7.99	7.96	7.98	8.03	8.04	8.00	7.98	7.92	7.92
2	8.02	8.03	8.03	8.09	7.89	8.03	7.99	7.97	7.98	8.03	8.05	8.00	7.98	7.93	7.93
3	8.02	8.03	8.02	8.09	7.87	8.03	7.99	7.99	7.99	8.04	8.05	8.00	7.98	7.93	7.94
4	8.02	8.01	8.00	8.08	7.86	8.03	8.00	8.01	8.01	8.04	8.05	8.00	7.98	7.95	7.94
5	8.01	7.99	8.00	8.06	7.87	8.03	8.01	8.01	8.01	8.05	8.05	7.99	7.98	7.96	7.95
6	8.01	8.00	7.99	8.01	7.89	8.03	8.00	8.02	8.01	8.05	8.04	7.99	7.98	7.97	7.96
7	8.00	7.98	7.97	7.99	7.91	8.03	8.00	8.03	8.01	8.05	8.04	7.97	7.98	7.97	7.97
8	8.00	7.97	7.96	7.96	7.93	8.03	8.00	8.02	8.01	8.05	8.04	7.97	7.98	7.97	7.97
9	8.00			7.93	7.96	8.02	8.00	8.00	8.00	8.04	8.03	7.97	7.98	7.97	7.97
10	8.00			7.92	7.96	8.02	8.00	7.98	8.00	8.04	8.03	7.97	7.98	7.98	7.98
11	7.99			7.91	7.97	8.02	8.01	7.98	8.00	8.03	8.03	7.96	7.98	7.99	7.98
12	7.98			7.91	7.98	8.02	8.01	7.99	8.00	8.03	8.03	7.97	7.98	7.99	7.98
13				7.91	7.99	8.02	8.01	8.00	8.01	8.02	8.03	7.98	7.99	8.00	7.99
14				7.93	7.99	8.02	8.01	8.00	8.00	8.02	8.02	7.98	7.99	8.00	7.99
15						8.02	8.01	8.00	8.00	8.02	8.02		7.99	8.00	7.99
16							7.99	8.01		8.02	8.03		7.99	8.00	7.99
17								8.01		8.02	8.03			8.00	8.00
18								8.01		8.02	8.03			8.00	
19								8.01		8.02	8.03			8.01	
20								8.01		8.02	8.03				
21								8.01		8.02					
22								8.01		8.02					
23								8.01		8.01					
24								8.01		8.00					

LA/LB BASELINE - JANUARY 2000
Water Quality Meausrements - Salinity (ppt)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	33.32	33.24	33.21	33.24	33.26	33.03	32.83	31.85	33.36	33.36	33.36	33.29	33.31	33.13	33.06	32.92	32.11
1	33.32	33.24	33.22	33.25	33.26	33.03	32.83	32.39	33.35	33.36	33.30	33.30	33.31	33.21	33.10	32.95	32.89
2	33.32	33.25	33.23	33.27	33.29	33.03	32.92	32.72	33.35	33.36	33.32	33.31	33.31	33.24	33.23	33.01	33.10
3	33.33	33.28	33.28	33.29	33.27	33.04	33.01	32.94	33.35	33.36		33.31	33.31	33.27	33.32	33.05	33.14
4	33.35	33.29	33.27			33.05	33.04	33.04				33.31	33.33	33.29	33.34	33.10	33.15
5	33.36					33.05	33.06	33.08				33.33	32.32	33.32	33.36	33.10	33.17
6	33.37					33.08	33.07	33.08				33.34		33.33	33.37	33.12	33.18
7	33.39					33.10	33.08	33.09				33.36		33.34	33.37	33.13	
8	33.39					33.12	33.09	33.11				33.36		33.35	33.38	33.15	
9	33.39					33.15	33.09	33.14				33.35		33.39	33.41	33.18	
10	33.40					33.17	33.09	33.17				33.36		33.39	32.82	33.21	
11	33.41					33.19	33.13	33.27				33.37		33.39			
12	33.41					33.26	33.15	33.29				33.37		33.39			
13						33.30	33.16	33.30				33.38		33.39			
14						33.33	33.16	33.30				33.39		33.39			
15						33.33	33.16	33.30						33.39			
16							33.16										
17							33.16										
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	33.33	33.30	33.30	33.34	32.75	33.36	32.85	33.29	32.86	33.16	33.39	33.32	33.26	32.91	32.72
1	33.33	33.30	33.30	33.34	32.79	33.36	32.93	33.29	32.90	33.26	33.39	33.32	33.26	32.93	32.86
2	33.33	33.30	33.31	33.34	32.93	33.37	33.09	33.30	33.07	33.29	33.39	33.32	33.26	32.94	32.96
3	33.33	33.32	33.33	33.34	33.09	33.37	33.25	33.30	33.19	33.31	33.39	33.32	33.26	33.03	33.00
4	33.33	33.35	33.35	33.35	33.17	33.38	33.32	33.31	33.26	33.32	33.39	33.32	33.27	33.14	33.05
5	33.33	33.36	33.36	33.37	33.19	33.38	33.35	33.31	33.36	33.33	33.39	33.32	33.28	33.16	33.11
6	33.35	33.37	33.39	33.38	33.23	33.38	33.38	33.32	33.39	33.33	33.39	33.34	33.30	33.18	33.18
7	33.37	33.39	33.40	33.39	33.25	33.38	33.40	33.32	33.41	33.34	33.39	33.37	33.31	33.19	33.24
8	33.38	33.40	33.40	33.40	33.26	33.39	33.43	33.33	33.45	33.39	33.39	33.37	33.31	33.19	33.25
9	33.40			33.41	33.30	33.40	33.46	33.33	33.46	33.40	33.39	33.38	33.33	33.20	33.27
10	33.41			33.41	33.33	33.40	33.47	33.38	33.47	33.42	33.40	33.38	33.35	33.24	33.29
11	33.43			33.42	33.35	33.40	33.48	33.41	33.48	33.44	33.40	33.39	33.36	33.31	33.30
12	33.44			33.42	33.36	33.40	33.49	33.43	33.49	33.45	33.41	33.39	33.37	33.34	33.36
13				33.42	33.37	33.40	33.49	33.43	33.49	33.46	33.41	33.41	33.38	33.35	33.38
14				32.54	33.37	33.41	33.50	33.43	33.50	33.46	33.42	33.42	33.39	33.36	33.39
15						33.39	33.50	33.44	33.50	33.47	33.43		32.92	33.36	33.39
16							33.50	33.45		33.48	33.44		29.39	33.36	33.40
17								33.45		33.49	33.44			33.37	33.40
18								33.47		33.48	33.45			33.39	
19								33.49		33.48	33.46			33.40	
20								33.49		33.49	32.75				
21								33.49		33.49					
22								33.49		33.50					
23								33.49		33.51					
24								33.49		33.51					

LA/LB BASELINE - JANUARY 2000
Water Quality Measurements - Temperature (^oC)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	14.23	14.14	14.30	14.38	14.30	14.52	15.43	14.90	15.20	15.30	15.65	14.43	14.86	14.38	14.81	15.05	14.73
1	14.20	14.14	14.27	14.36	14.27	14.53	15.40	14.75	15.19	15.30	15.65	14.39	14.85	14.24	14.76	14.90	14.58
2	14.15	14.12	14.21	14.28	14.13	14.52	15.03	14.65	15.12	15.26	15.65	14.35	14.86	14.18	14.55	14.82	14.44
3	14.06	14.04	14.06	14.12	14.05	14.51	14.76	14.54	15.01	14.98		14.33	14.85	14.16	14.12	14.83	14.39
4	14.05	14.04	14.06			14.48	14.65	14.46				14.33	14.77	14.13	13.97	14.89	14.36
5	14.05					14.44	14.58	14.41				14.32	14.54	14.07	13.93	14.80	14.34
6	14.05					14.38	14.53	14.41				14.37		14.06	13.89	14.80	14.34
7	14.02					14.32	14.49	14.40				14.38		14.01	13.86	14.80	
8	13.96					14.27	14.47	14.39				14.36		13.98	13.82	14.80	
9	13.94					14.19	14.45	14.35				14.25		13.88	13.79	14.78	
10	13.91					14.12	14.43	14.31				14.20		13.87	13.80	14.61	
11	13.85					14.07	14.30	14.20				14.15		13.84			
12	13.82					13.98	14.26	14.18				14.14		13.80			
13						13.90	14.21	14.16				14.11		13.77			
14						13.85	14.20	14.16				13.92		13.73			
15						13.85	14.19	14.16						13.71			
16							14.19										
17							14.18										
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	14.32	14.37	14.39	14.61	14.91	14.52	14.24	14.45	14.29	14.19	14.45	14.56	14.77	14.73	14.75
1	14.32	14.37	14.37	14.60	14.88	14.51	14.28	14.44	14.30	14.14	14.48	14.56	14.76	14.72	14.72
2	14.31	14.34	14.31	14.58	14.79	14.50	14.29	14.41	14.31	14.12	14.49	14.55	14.70	14.71	14.65
3	14.30	14.29	14.26	14.56	14.70	14.47	14.28	14.38	14.31	14.12	14.49	14.53	14.67	14.63	14.59
4	14.27	14.26	14.25	14.52	14.59	14.38	14.26	14.38	14.29	14.12	14.49	14.48	14.66	14.46	14.57
5	14.24	14.23	14.18	14.44	14.52	14.33	14.23	14.37	14.26	14.12	14.49	14.44	14.62	14.44	14.49
6	14.19	14.19	14.15	14.39	14.42	14.33	14.17	14.36	14.21	14.12	14.47	14.41	14.53	14.43	14.40
7	14.15	14.17	14.10	14.35	14.35	14.29	14.14	14.33	14.18	14.11	14.43	14.35	14.49	14.43	14.31
8	14.11	14.11	14.10	14.29	14.29	14.25	14.04	14.30	14.07	14.02	14.38	14.32	14.47	14.43	14.28
9	14.09			14.25	14.22	14.20	14.01	14.27	14.05	13.99	14.36	14.28	14.38	14.42	14.25
10	14.02			14.21	14.15	14.20	13.93	14.13	14.00	13.95	14.30	14.26	14.31	14.39	14.21
11	13.92			14.17	14.11	14.20	13.90	14.04	13.95	13.93	14.27	14.21	14.27	14.26	14.20
12	13.89			14.15	14.10	14.20	13.88	13.98	13.92	13.93	14.25	14.14	14.21	14.16	14.12
13				14.13	14.08	14.19	13.87	13.95	13.90	13.93	14.19	14.06	14.17	14.14	14.07
14				14.08	14.08	14.09	13.86	13.94	13.88	13.91	14.14	14.04	14.14	14.12	14.05
15						14.04	13.85	13.91	13.87	13.87	14.07		14.11	14.11	14.04
16							13.85	13.87		13.87	14.02		14.09	14.10	14.03
17								13.84		13.86	13.98			14.09	14.03
18								13.74		13.78	13.92			14.02	
19								13.64		13.72	13.85			13.98	
20								13.63		13.62	13.83				
21								13.61		13.60					
22								13.61		13.50					
23								13.61		13.36					
24								13.61		13.35					

LA/LB BASELINE - JANUARY 2000
Water Quality Measurements - Transmissivity (%)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	61.92	65.11	65.31	50.75	55.15	68.72	67.00	67.23	45.33	39.40	36.99	59.41	61.05	64.64	62.95	75.06	66.37
1	61.99	63.86	65.33	50.54	55.42	68.65	67.43	67.87	44.85	39.84	37.76	58.87	61.33	60.18	59.37	72.91	67.75
2	62.68	64.53	64.85	50.93	56.84	68.57	67.38	69.18	42.46	40.30	38.09	57.30	58.65	56.25	62.69	71.86	66.62
3	65.66	36.74	46.11	48.90	46.23	68.34	66.06	70.11	39.23	36.78		56.64	58.52	56.60	66.49	73.40	66.13
4	69.05	16.77	32.72			67.67	63.41	70.14				56.60	59.38	56.27	62.10	74.43	65.69
5	69.55					67.41	60.04	69.46				56.68	59.40	56.97	61.91	74.66	64.18
6	69.21					66.54	62.77	69.44				55.24		57.54	64.55	75.06	63.59
7	68.58					65.34	64.44	69.56				53.91		57.26	64.67	75.97	
8	63.45					64.79	66.01	69.60				52.76		56.86	63.95	76.60	
9	58.86					64.16	66.58	69.57				48.62		50.34	58.95	75.92	
10	55.02					63.40	66.60	69.40				42.37		47.06	53.43	71.81	
11	45.26					62.63	67.17	68.53				40.45		46.82			
12	30.75					60.26	67.69	66.62				41.41		51.00			
13						52.88	66.36	66.48				42.62		54.30			
14						44.21	65.47	66.51				38.43		54.90			
15						42.60	65.83	66.62						54.75			
16							66.09										
17							65.75										
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	65.69	64.90	65.27	64.57	75.92	67.21	70.81	66.99	72.35	68.14	68.24	69.07	69.29	73.94	73.03
1	65.60	65.03	65.12	64.48	78.27	66.63	70.94	66.94	71.93	68.90	69.06	69.22	69.04	73.63	72.79
2	65.42	65.02	64.60	64.24	78.23	66.06	71.27	66.97	71.92	70.22	69.94	69.33	69.07	73.68	71.66
3	65.22	64.81	50.36	65.12	77.38	64.73	70.45	66.89	71.07	70.69	69.86	70.56	66.87	72.93	70.35
4	65.53	52.48	50.69	66.25	75.65	63.16	68.38	66.62	69.62	70.42	69.90	70.14	65.46	69.06	69.64
5	65.85	40.24	61.80	66.77	75.03	60.92	66.76	66.68	68.25	69.98	69.91	68.50	66.13	65.25	68.39
6	66.03	47.45	45.19	65.72	74.46	60.53	66.22	66.96	67.65	69.88	69.86	71.41	65.07	64.68	65.08
7	65.25	39.05	16.61	67.40	73.83	60.61	64.53	67.52	66.83	69.72	69.74	71.85	63.55	64.58	64.35
8	65.18	23.41	8.30	66.07	73.13	60.58	60.90	66.74	65.69	69.26	69.75	68.41	62.13	64.36	65.06
9	66.60			58.74	71.05	55.84	60.49	65.28	64.94	68.17	69.71	66.52	58.23	64.28	65.29
10	66.18			54.08	71.71	56.00	62.17	61.68	64.09	66.81	69.57	67.50	53.77	63.40	63.13
11	58.37			44.90	69.99	57.63	62.39	58.08	63.03	62.97	69.43	66.79	54.97	61.15	63.56
12	51.06			40.19	67.34	59.15	61.26	58.27	61.70	62.14	69.07	63.77	51.81	58.24	63.07
13				41.11	65.32	58.03	59.24	58.93	60.76	61.98	68.43	61.18	45.85	55.97	61.04
14				39.29	62.98	53.80	55.49	58.92	53.39	61.16	67.47	53.37	37.79	55.36	59.49
15						54.12	48.99	58.80	44.73	56.99	65.84		29.34	54.73	55.67
16							37.95	58.80		52.37	63.92		28.26	54.50	52.28
17								57.32		52.15	63.09			54.26	53.35
18								55.38		50.72	60.73			53.18	
19								46.83		49.30	51.93			49.84	
20								44.43		45.75	45.94				
21								43.98		44.73					
22								42.78		42.36					
23								40.56		31.15					
24								37.31		21.95					

LA/LB BASELINE -MAY 2000
Water Quality Measurements - Dissolved oxygen (mg/L)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	5.85	6.31	6.21	6.27	6.13	5.59	6.11	5.88	6.50	6.50	7.07	7.24	6.62	5.69	8.02	6.88	9.11
1	5.78	7.28	6.95	7.84	8.19	5.54	6.48	6.40	6.32	6.91	7.36	7.15	7.11	6.25	7.66	6.63	5.37
2	5.86	6.70	6.48	6.68	6.42	5.55	6.12	6.35	6.19	6.32	6.43	6.01	5.89	5.58	6.71	6.06	5.06
3	5.59	6.23	5.76	5.85	5.83	5.52	5.99	5.86	6.04	6.17	5.77	5.49	5.78	5.45	6.47	6.02	4.90
4	5.31	6.12	5.74	5.53	5.65	5.43	5.99	5.84	5.33	5.86		5.25	5.16	5.40	5.80	5.94	4.52
5	5.13	5.93	5.65	5.35	5.22	5.43	5.97	5.44	4.99			4.92	5.20	5.33	5.71	5.91	4.33
6	5.08			5.16	4.99	5.31	5.84	5.28				4.59	5.18	5.05	5.54	5.87	
7	4.84			5.02	4.81	5.23	5.78	5.17				4.48		4.95	5.06	5.80	
8	4.74			4.83	4.73	5.35	5.69	5.13				4.37		4.93	4.84	5.65	
9	4.62			4.77	4.62	5.27	5.64	4.99				4.33		4.66	4.88	5.54	
10	4.55			4.59	4.39	5.25	5.56	4.88				4.25		4.47	4.60		
11	4.34			4.47	4.40	4.98	5.56	4.78				4.21		4.44	4.46		
12	4.31					4.91	5.47	4.83				4.14		4.29			
13						4.92	5.46	4.78				4.03		4.24			
14						4.77	5.40	4.82				3.93		4.09			
15						4.68	5.31							3.91			
16						4.63											
17						4.64											
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	6.80	5.86	5.64	7.63	6.17	6.18	5.10	7.40	5.39	6.85	5.82	7.06	6.65	7.58	5.60
1	7.39	6.52	5.54	8.01	6.73	6.89	5.05	7.70	6.51	6.77	6.75	7.39	7.05	6.40	5.62
2	6.72	5.58	5.53	6.35	6.07	6.15	4.87	7.28	5.25	6.67	5.72	8.73	6.11	5.85	5.55
3	6.59	5.48	5.53	5.41	6.03	6.11	4.82	7.11	5.05	6.64	5.70	6.37	5.56	5.77	5.41
4	6.44	5.25	4.77	4.97	5.92	6.01	4.76	6.88	5.03	6.46	5.53	5.69	5.13	5.70	5.31
5	6.18	4.79	4.70	4.95	5.85	5.84	4.71	6.75	4.79	6.28	5.34	5.41	5.14	5.66	5.25
6	5.99	4.73	4.54	4.72	5.65	5.64	4.44	6.40	4.62	6.11	5.08	4.79	4.96	5.58	5.15
7	5.52	4.53	4.34	4.48	5.53	5.60	4.42	5.38	4.54	5.45	5.04	4.68	4.78	5.40	5.03
8	5.29		4.25	4.67	5.41	5.08	4.37	5.07	4.48	5.75	4.87	4.59	4.71	5.29	4.87
9	5.12			4.62	5.20	4.74	4.35	4.22	4.44	5.54	4.68	4.51	4.40	5.17	4.85
10	4.87			4.43	5.01	4.71	4.34	4.71	4.41	5.13	4.64	4.61	4.25	5.05	4.79
11	4.74			4.20	4.73	4.64	4.30	4.71	4.34	4.84	4.62	4.45	4.25	4.89	4.72
12	4.68			4.24	4.71	4.62	4.28	4.72	4.28	4.91	4.56	4.34	4.18	4.87	4.60
13				4.16	4.65	4.63	4.26	4.71	4.17	4.73	4.57	4.31	4.09	4.80	4.50
14				4.32	4.53	4.54	4.16	4.66	4.12	4.52	4.57	4.43	4.16	4.70	4.38
15							4.25	4.62		4.40	4.52			4.62	4.35
16								4.58		4.37	4.50			4.55	4.33
17								4.52		4.35	4.48			4.29	
18								4.47		4.33	4.44			4.31	
19								4.44		4.32	4.36				
20								4.42		4.29	4.33				
21								4.38		4.27					
22								4.38		4.22					
23								4.36		4.20					
24								4.35							

LA/LB BASELINE -MAY 2000
Water Quality Measurements - pH

DEPTH (m)	LA5	LA6	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	7.81	7.78	7.81	7.82	7.82	7.83	7.82	7.78	7.86	7.86	7.91	7.87	7.88	7.77	7.85	7.78	7.71
1	7.82	7.71	7.81	7.57	7.82	7.83	7.82	7.78	7.86	7.81	7.85	7.87	7.88	7.78	7.87	7.78	7.74
2	7.82	7.79	7.80	7.82	7.81	7.84	7.83	7.78	7.85	7.85	7.86	7.84	7.85	7.77	7.87	7.82	7.75
3	7.82	7.78	7.79	7.82	7.79	7.81	7.82	7.78	7.83	7.84	7.82	7.81	7.81	7.76	7.86	7.82	7.74
4	7.83	7.78	7.77	7.81	7.79	7.79	7.79	7.77	7.79	7.82		7.79	7.76	7.75	7.84	7.81	7.74
5	7.82	7.76	7.75	7.80	7.79	7.78	7.77	7.77	7.82			7.75	7.75	7.75	7.83	7.82	7.71
6	7.81	7.76	7.74			7.77	7.75	7.77				7.73	7.75	7.73	7.81	7.81	
7	7.81	7.75	7.73			7.76	7.74	7.77				7.72		7.72	7.78	7.81	
8	7.81	7.75	7.72			7.75	7.73	7.77				7.72		7.72	7.77	7.80	
9	7.80	7.74	7.72			7.74	7.73	7.77				7.71		7.69	7.77	7.80	
10	7.17	7.74	7.71			7.72	7.72	7.76				7.70		7.68	7.75		
11	7.79	7.74	7.70			7.70	7.70	7.74				7.69		7.68	7.73		
12	7.79	7.74	7.70					7.74				7.68		7.67			
13	7.79	7.74						7.73				7.67		7.66			
14	7.78	7.74						7.72				7.67		7.65			
15	7.77							7.71						7.64			
16								7.71									
17								7.70									
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	7.87	7.82	7.81	7.97	7.73	7.80	7.74	7.92	7.75	7.87	7.77	7.90	7.89	7.77	7.74
1	7.87	7.82	7.81	7.97	7.74	7.77	7.74	7.90	7.75	7.87	7.77	7.90	7.90	7.77	7.74
2	7.87	7.81	7.80	7.86	7.73	7.81	7.73	7.91	7.75	7.86	7.77	7.89	7.87	7.76	7.74
3	7.86	7.80	7.80	7.82	7.73	7.81	7.73	7.91	7.76	7.86	7.78	7.88	7.83	7.76	7.74
4	7.86	7.79	7.77	7.79	7.73	7.81	7.74	7.89	7.76	7.85	7.78	7.83	7.81	7.76	7.73
5	7.84	7.76	7.76	7.78	7.74	7.81	7.74	7.89	7.74	7.84	7.77	7.80	7.80	7.76	7.72
6	7.82	7.76	7.74	7.76	7.73	7.80	7.72	7.86	7.73	7.82	7.76	7.77	7.79	7.76	7.72
7	7.80	7.75	7.73	7.76	7.73	7.79	7.72	7.80	7.72	7.81	7.76	7.76	7.78	7.75	7.72
8	7.79		7.73	7.77	7.57	7.77	7.72	7.77	7.72	7.80	7.75	7.75	7.78	7.75	7.72
9	7.77			7.75	7.71	7.74	7.72	7.76	7.72	7.79	7.74	7.74	7.76	7.74	7.72
10	7.76			7.73	7.71	7.74	7.71	7.74	7.72	7.77	7.74	7.74	7.75	7.73	7.71
11	7.75			7.72	7.72	7.73	7.71	7.74	7.71	7.75	7.74	7.73	7.74	7.73	7.71
12	7.74			7.71	7.72	7.73	7.71	7.74	7.71	7.74	7.73	7.72	7.74	7.73	7.70
13				7.71	7.72	7.73	7.71	7.74	7.70	7.73	7.73	7.72	7.73	7.72	7.70
14				7.72	7.71	7.72	7.70	7.74	7.69	7.72	7.72	7.72	7.73	7.72	7.70
15							7.70	7.73		7.71	7.72			7.72	7.69
16								7.73		7.70	7.72			7.71	7.69
17								7.72		7.70	7.72			7.70	
18								7.72		7.70	7.71			7.70	
19								7.71		7.70	7.70				
20								7.71		7.69	7.70				
21								7.71		7.69					
22								7.71		7.69					
23								7.70		7.69					
24								7.70							

LA/LB BASELINE -MAY 2000
Water Quality Meausrements - Salinity (ppt)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	33.60	33.55	33.54	33.53	33.54	33.45	33.48	33.39	33.58	33.59	33.61	33.62	33.58	33.49	33.14	33.47	32.18
1	33.60	33.56	33.55	33.56	33.61	33.46	33.52	33.43	33.58	33.62	33.59	33.63	33.68	33.60	33.29	33.49	32.59
2	33.61	33.57	33.61	33.60	33.65	33.48	33.51	33.46	33.59	33.61	33.62	33.60	33.58	33.55	33.51	33.52	33.13
3	33.64	33.59	33.59	33.64	33.63	33.52	33.52	33.40	33.63	33.62	33.57	33.65	33.64	33.55	33.63	33.52	33.44
4	33.66	33.62	33.59	33.66	33.66	33.52	33.53	33.45	33.66	33.61		33.66	33.66	33.58	33.61	33.52	33.52
5	33.67	33.61	33.59	33.68	33.68	33.54	33.53	33.46	33.65			33.69	33.68	33.61	33.64	33.52	33.53
6	33.69			33.67	33.70	33.55	33.53	33.49				33.70	33.67	33.64	33.65	33.52	
7	33.70			33.68	33.70	33.53	33.53	33.50				33.71		33.66	33.67	33.53	
8	33.71			33.68	33.70	33.53	33.53	33.55				33.70		33.69	33.68	33.53	
9	33.71			33.70	33.71	33.53	33.53	33.57				33.71		33.70	33.70	33.54	
10	33.72			33.72	33.71	33.60	33.55	33.58				33.72		33.70	33.70		
11	33.73			33.70	32.75	33.61	33.56	33.58				33.73		33.70	33.65		
12	33.18					33.61	33.56	33.59				33.73		33.71			
13						33.65	33.57	33.59				33.73		33.72			
14						33.67	33.58	33.60				33.73		33.74			
15						33.68	33.58							33.60			
16						33.68											
17						33.69											
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	33.59	33.62	33.61	33.55	33.53	33.59	33.58	33.56	33.51	33.58	33.61	33.55	33.57	32.80	33.49
1	33.61	33.60	33.60	33.56	33.50	33.70	33.60	33.52	33.56	33.58	33.61	33.55	33.64	33.56	33.52
2	33.60	33.61	33.61	33.58	33.52	33.59	33.60	33.56	33.59	33.58	33.60	33.54	33.55	33.53	33.54
3	33.60	33.61	33.66	33.58	33.52	33.59	33.60	33.56	33.60	33.59	33.61	33.58	33.61	33.54	33.55
4	33.60	33.66	33.65	33.59	33.52	33.59	33.62	33.56	33.63	33.61	33.61	33.60	33.61	33.54	33.55
5	33.61	33.65	33.65	33.60	33.52	33.58	33.65	33.57	33.64	33.62	33.61	33.60	33.62	33.55	33.57
6	33.63	33.65	33.66	33.61	33.51	33.58	33.65	33.63	33.64	33.63	33.60	33.60	33.63	33.55	33.57
7	33.65	33.65	33.66	33.61	33.53	33.64	33.65	33.62	33.64	33.62	33.62	33.60	33.63	33.56	33.58
8	33.65		33.65	33.63	33.55	33.64	33.66	33.67	33.65	33.64	33.66	33.61	33.65	33.57	33.57
9	33.67			33.64	33.58	33.63	33.66	33.66	33.65	33.66	33.65	33.62	33.64	33.59	33.58
10	33.69			33.65	33.61	33.67	33.66	33.67	33.66	33.67	33.65	33.64	33.66	33.62	33.60
11	33.69			33.65	33.62	33.68	33.68	33.68	33.67	33.67	33.66	33.67	33.67	33.61	33.62
12	33.69			33.66	33.61	33.68	33.68	33.68	33.68	33.69	33.67	33.67	33.67	33.61	33.63
13				33.68	33.61	33.70	33.68	33.68	33.69	33.70	33.69	33.69	33.65	33.60	33.64
14				33.68	33.61	33.69	33.68	33.68	33.69	33.72	33.68	33.67	33.03	33.60	33.64
15							33.14	33.68		33.72	33.69			33.61	33.64
16								33.69		33.72	33.69			33.65	33.63
17								33.69		33.72	33.69			33.67	
18								33.69		33.72	33.69			33.66	
19								33.69		33.72	33.70				
20								33.70		33.72	33.69				
21								33.70		33.72					
22								33.70		33.72					
23								33.70		33.73					
24								33.70							

LA/LB BASELINE -MAY 2000

Water Quality Measurements - Temperature (^{o}C)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	13.24	14.55	14.50	14.29	14.11	15.01	16.63	16.23	16.85	16.57	17.94	16.70	16.38	14.83	15.09	15.65	17.68
1	13.17	14.44	14.41	14.00	13.86	14.93	16.22	16.24	16.46	16.70	17.77	16.36	16.25	14.46	14.84	15.77	16.93
2	13.01	14.36	14.09	13.93	13.63	14.74	15.72	16.25	15.54	15.17	16.58	15.08	15.60	14.09	14.39	14.98	15.79
3	12.55	14.07	13.89	13.02	13.23	14.37	15.09	16.13	14.41	14.52	15.72	13.89	14.60	13.91	13.92	14.87	15.12
4	12.26	13.75	13.91	12.74	12.69	14.33	14.92	15.65	13.77	14.41		13.23	13.88	13.53	13.56	14.83	14.84
5	12.01	13.77	13.90	12.37	12.25	14.03	14.80	15.20	13.29			12.38	13.14	13.26	13.19	14.77	14.73
6	11.67			12.29	11.83	13.81	14.71	14.94				11.98	12.69	12.91	12.84	14.71	
7	11.49			12.03	11.75	14.01	14.66	14.76				11.79		12.66	12.45	14.62	
8	11.35			11.88	11.64	14.03	14.61	14.42				11.73		12.10	12.19	14.57	
9	11.24			11.65	11.45	13.96	14.52	14.21				11.48		11.73	11.97	14.47	
10	11.08			11.48	11.27	13.31	14.36	14.07				11.30		11.56	11.76		
11	10.94			11.35	11.23	13.01	14.11	13.99				11.16		11.44	11.60		
12	10.88					12.94	14.02	13.91				11.02		11.29			
13						12.54	13.96	13.89				11.00		11.13			
14						12.24	13.88	13.67				11.01		10.88			
15						12.17	13.72							10.74			
16						12.07											
17						11.85											
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	14.00	13.68	13.80	15.56	16.56	15.13	13.96	15.65	14.59	14.81	14.68	15.77	16.55	15.97	15.99
1	13.97	13.68	13.76	15.54	16.56	15.14	13.74	15.53	14.33	14.77	14.62	15.74	16.62	15.86	15.71
2	13.93	13.61	13.64	14.49	16.56	15.11	13.67	15.57	13.54	14.69	14.57	15.34	16.01	15.68	15.48
3	13.87	13.37	12.99	14.21	16.50	15.09	13.41	15.50	13.10	14.41	14.35	15.00	14.66	15.43	15.11
4	13.76	12.81	12.79	13.96	16.29	15.05	12.97	15.30	12.80	13.96	14.02	14.31	14.30	15.28	15.01
5	13.59	12.72	12.70	13.79	16.09	14.91	12.56	15.09	12.53	13.58	13.90	13.97	14.01	15.15	14.77
6	13.18	12.63	12.57	13.57	15.86	14.67	12.40	14.02	12.46	13.29	13.74	13.80	13.67	14.97	14.58
7	12.88	12.61	12.58	13.43	15.65	13.89	12.31	13.25	12.37	13.21	13.46	13.70	13.38	14.79	14.38
8	12.67		12.58	13.24	15.22	13.44	12.22	12.62	12.25	12.96	12.91	13.43	13.05	14.59	14.32
9	12.34			13.02	14.68	13.09	12.13	12.37	12.16	12.60	12.71	13.27	12.80	14.24	14.17
10	11.97			12.83	14.12	12.68	12.04	12.18	12.03	12.28	12.63	12.92	12.57	13.85	13.97
11	11.86			12.64	13.88	12.28	11.90	12.05	11.87	12.03	12.44	12.51	12.38	13.74	13.67
12	11.81			12.43	13.80	12.20	11.82	12.03	11.72	11.82	12.18	12.26	12.20	13.73	13.42
13				12.18	13.75	11.94	11.76	12.00	11.63	11.56	11.96	11.96	12.18	13.71	13.18
14				12.10	13.73	11.81	11.71	11.93	11.58	11.28	11.88	11.71	12.19	13.64	13.11
15							11.64	11.84		11.14	11.83			13.39	13.11
16								11.71		11.05	11.80			12.86	13.10
17								11.61		11.00	11.73			12.52	
18								11.58		10.99	11.65			12.48	
19								11.52		10.98	11.56				
20								11.43		10.97	11.57				
21								11.42		10.90					
22								11.41		10.84					
23								11.41		10.77					
24								11.41							

LA/LB BASELINE -MAY 2000
Water Quality Measurements - Transmissivity (%)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	60.74	65.88	67.00	44.50	64.68	59.34	62.70	70.81	59.56	56.56	48.18	60.55	36.27	66.31	73.59	51.99	50.20
1	60.77	65.44	66.78	49.15	63.12	59.32	63.02	70.45	59.14	55.01	43.32	58.11	24.14	64.49	73.07	52.09	46.49
2	60.62	64.76	65.12	62.00	63.07	57.77	60.13	70.75	58.47	50.83	32.58	51.19	62.42	63.13	70.98	48.68	40.60
3	60.26	63.02	62.87	59.75	62.19	56.31	51.53	71.02	56.35	43.44	22.26	44.06	59.91	62.60	58.37	49.50	38.61
4	60.48	61.01	63.99	59.32	59.99	56.14	49.92	70.23	46.45	36.44		34.18	50.44	61.39	65.12	50.51	56.29
5	61.26	57.74	64.20	60.01	57.60	56.76	52.30	66.88	49.35			38.57	51.09	60.54	63.57	51.41	56.16
6	61.79			60.86	56.25	57.13	52.91	64.80				33.10	50.55	60.66	61.28	51.65	
7	61.85			60.00	56.00	56.91	52.74	64.15				37.40		62.07	57.57	51.17	
8	61.93			58.13	55.31	56.98	52.33	64.40				38.56		63.85	55.06	50.67	
9	60.87			55.96	55.10	57.10	52.05	64.98				39.16		62.67	54.85	49.84	
10	57.31			50.64	51.30	57.99	52.90	64.88				38.15		64.23	52.27		
11	48.81			43.98	48.57	58.26	51.54	65.26				37.15		65.49	46.62		
12	44.70					58.29	51.64	65.19				29.07		65.64			
13						55.61	51.46	64.55				13.61		64.74			
14						52.89	51.19	64.47				7.06		58.20			
15						52.70	50.53							52.14			
16						52.67											
17						51.07											
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	57.36	58.85	58.61	58.48	64.70	66.53	53.59	61.54	61.31	62.31	68.71	64.76	65.93	61.91	68.50
1	57.08	49.15	57.71	58.55	69.56	66.37	53.98	61.32	60.35	62.16	68.22	65.06	66.96	67.53	68.01
2	56.96	58.71	55.92	59.30	69.34	66.39	52.30	61.66	57.13	60.94	67.63	64.47	64.83	67.39	66.82
3	56.07	56.22	54.60	62.42	69.72	66.32	51.37	61.75	46.69	58.34	65.79	66.16	63.65	68.20	66.70
4	55.68	50.76	46.49	64.55	69.50	65.94	49.73	61.84	37.82	55.62	60.94	66.71	61.51	67.78	67.40
5	55.14	47.17	40.09	66.92	69.39	65.06	49.77	61.62	34.93	53.54	55.80	66.81	62.55	67.21	67.93
6	54.07	43.35	30.63	66.54	69.48	63.51	45.46	61.91	34.59	54.22	62.52	68.22	62.45	65.95	65.70
7	54.84	28.15	21.15	64.58	69.15	61.63	38.37	60.92	30.53	55.75	62.39	67.94	60.36	65.30	63.61
8	56.63		17.84	64.81	69.67	57.01	35.14	56.98	30.73	57.57	58.67	65.19	57.98	64.80	62.54
9	57.42			60.97	67.09	52.60	34.29	52.99	30.04	59.55	55.73	61.21	47.74	63.88	62.26
10	54.62			52.49	66.73	52.47	32.64	49.58	29.76	57.52	53.24	55.29	39.75	62.09	61.39
11	49.95			44.06	65.60	48.83	31.23	46.86	32.31	55.01	50.60	47.06	37.07	59.50	58.27
12	47.55			32.17	65.01	48.43	30.00	46.20	29.08	52.37	45.98	38.73	34.42	58.99	54.10
13				19.44	63.94	47.46	29.45	46.03	25.00	47.74	43.49	36.80	24.63	58.81	47.32
14				11.77	63.22	42.89	26.47	45.39	19.82	41.11	40.54	32.17	15.54	57.20	41.03
15							21.59	43.67		34.44	39.13			53.48	39.23
16								41.33		23.85	38.51			42.82	36.64
17								38.19		17.46	37.64			32.05	
18								36.57		15.94	35.83			29.98	
19								34.75		15.83	29.76				
20								31.74		15.55	27.37				
21								30.55		15.70					
22								30.22		16.42					
23								29.35		15.48					
24								29.05							

LA/LB BASELINE -AUGUST 2000
Water Quality Measurements - Dissolved oxygen (mg/L)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	7.49	7.21	7.21	7.29	7.22	7.36	7.19	7.76	7.37	7.30	6.89	7.59	7.63	7.45	6.80	7.27	6.86
1	7.49	7.22	7.25	7.29	7.32	7.40	7.22	7.81	7.18	7.30	6.92	7.62	7.72	7.48	6.83	7.34	7.00
2	7.55	7.24	7.28	7.30	7.25	7.40	7.46	7.88	7.49	7.44	6.97	7.95	7.67	7.54	7.03	7.48	7.54
3	7.42	7.23	7.31	7.20	7.17	7.39	7.59	7.35	7.73	7.69	6.08	7.85	7.54	7.60	7.04	7.37	7.76
4	7.45	6.87	7.18	7.08	7.07	7.30	7.63	7.19	7.03	6.99	5.16	7.76	6.18	7.59	7.00	7.35	7.74
5	7.42	6.37	6.75	6.99	6.93	7.15	7.49	7.10	6.57			7.46	5.58	7.36	7.40	7.23	7.37
6	7.20			6.85	6.74	6.98	7.32	6.86				7.20	4.63	7.21	6.91	7.18	6.88
7	6.95			6.75	6.85	6.91	7.03	6.64				6.99		6.95	6.83	7.13	5.99
8	7.07			6.59	6.98	6.85	6.91	6.53				6.91		6.96	6.80	7.20	
9	6.95			6.41	6.99	6.81	6.80	6.52				6.80		6.81	6.59	7.15	
10	6.56			6.33	6.90	6.76	6.65	6.47						6.68	6.16	6.70	
11	6.46			5.92	6.49	6.77	6.51	6.25						6.73	4.58		
12	6.74					6.75	6.28	6.07						6.79			
13						6.65	6.23	5.99						6.79			
14						6.64	6.06	5.66						6.74			
15						6.66	5.83	5.55						7.04			
16						6.63	5.70	5.51									
17						6.51	5.73										
18						6.40	5.71										
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	7.94	7.81	7.80	7.74	6.86	7.50	7.95	7.90	8.33	8.32	7.30	7.24	7.17	7.01	7.95
1	7.95	7.85	7.81	7.84	6.85	7.55	8.06	7.94	8.32	8.40	7.33	7.21	7.21	7.09	8.00
2	8.00	7.83	7.87	7.76	6.89	7.61	8.11	7.95	8.29	8.74	7.34	7.45	7.09	6.97	8.03
3	8.03	7.74	7.84	7.62	6.72	7.64	7.78	7.89	7.94	8.20	7.39	7.51	6.57	6.96	8.12
4	7.98	7.59	7.72	7.63	6.75	7.55	7.24	7.56	7.19	7.96	7.40	7.19	6.38	6.95	7.94
5	7.84	7.60	7.67	7.50	6.72	7.24	6.75	7.42	7.04	7.88	7.39	6.85	6.21	6.79	7.36
6	7.65	7.49	7.60	7.22	6.34	7.06	6.60	6.95	6.93	7.69	7.40	6.75	5.83	6.69	6.67
7	7.43			6.84	6.43	6.96	6.30	6.88	6.68	7.46	7.17	6.79	5.72	6.49	6.88
8	7.25			6.69	5.36	6.88	6.11	6.84	6.33	7.35	7.69	6.82	6.06	6.37	6.81
9	6.52			6.21	6.00	6.87	6.08	6.78	6.17	7.21	6.98	6.53	6.02	6.30	6.98
10	6.21			5.91	5.79	6.81	5.92	6.81	6.06	6.94	6.91	6.05	5.86	6.26	6.68
11	6.72			5.71	5.74	6.49	5.80	6.83	6.03	6.84	6.75	5.98	5.67	6.18	6.62
12	6.81			4.76	5.80	6.39	5.73	6.78	5.48	7.05	6.55	6.04	5.15	6.13	6.55
13				3.86	5.68	6.45	5.60	6.54	5.06	7.28	6.28	5.78	4.91	6.07	6.67
14				2.78		6.52	5.49	6.38	4.71	7.50	6.23	6.23	4.79	5.98	6.37
15							5.30	6.05		7.73	6.31			5.94	6.25
16								6.01		8.32	6.42			5.95	6.33
17								6.26		8.41	6.24			5.92	5.35
18								6.37		8.43	6.14			5.85	
19								6.40		8.34	5.64			5.82	
20								6.34		8.17	5.31				
21								6.38		7.80					
22								6.42		7.83					
23								6.21		7.86					
24															

LA/LB BASELINE -AUGUST 2000
Water Quality Measurements - pH

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	8.08	8.03	8.02	8.01	8.03	7.97	7.95	8.03	8.10	8.09	8.07	8.11	8.06	8.01	7.97	7.96	7.94
1	8.08	8.03	8.02	8.00	8.03	7.97	7.96	8.03	8.10	8.09	8.07	8.11	8.05	8.01	7.97	7.96	7.95
2	8.08	8.03	8.03	8.00	8.02	7.97	7.97	8.01	8.12	8.10	8.07	8.11	8.04	8.01	7.98	7.96	8.03
3	8.08	8.03	8.03	7.99	8.01	7.97	7.98	7.99	8.10	8.11	8.02	8.09	7.99	8.02	7.99	7.95	8.04
4	8.07	8.00	8.02	7.98	8.00	7.96	7.98	7.97	8.01	8.07	7.95	8.07	7.89	8.01	7.98	7.94	8.03
5	8.06	8.00	7.99	7.97	7.98	7.95	7.96	7.96	7.96			8.03	7.84	8.00	7.99	7.94	8.00
6	8.03			7.95	7.97	7.94	7.95	7.94				8.01	7.77	7.99	7.98	7.93	7.96
7	8.00			7.94	7.96	7.94	7.93	7.93				8.00		7.97	7.97	7.92	7.93
8	8.01			7.93	7.97	7.93	7.92	7.93				7.99		7.96	7.96	7.93	
9	7.99			7.92	7.97	7.93	7.92	7.92				7.97		7.95	7.93	7.92	
10	7.94			7.90	7.96	7.93	7.91	7.92						7.94	7.89	7.87	
11	7.93			7.88	7.94	7.93	7.90	7.91						7.93	7.75		
12	7.95					7.93	7.89	7.90						7.94			
13						7.93	7.88	7.89						7.93			
14						7.93	7.87	7.86						7.93			
15						7.83	7.85	7.87						7.92			
16						7.93	7.83	7.87									
17						7.92	7.83										
18						7.91	7.84										
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	8.15	8.14	8.13	8.15	7.89	8.14	8.22	8.18	7.69	8.27	8.08	8.10	8.11	8.00	8.06
1	8.15	8.14	8.13	8.14	7.88	8.14	8.22	8.17	8.24	8.24	8.09	8.10	8.10	8.00	8.06
2	8.15	8.13	8.13	8.12	7.90	8.13	8.20	8.17	8.20	8.20	8.09	8.12	8.08	8.01	8.06
3	8.15	8.11	8.12	8.11	7.88	8.12	8.14	8.15	8.13	8.16	8.09	8.10	8.05	8.01	8.06
4	8.14	8.11	8.11	8.11	7.94	8.10	8.08	8.12	8.09	8.15	8.09	8.06	8.03	8.00	8.04
5	8.11	8.09	8.09	8.09	7.94	8.07	8.05	8.08	8.08	8.13	8.09	8.04	8.02	7.99	7.98
6	8.08	8.09	8.08	8.06	7.92	8.06	8.04	8.05	8.06	8.11	8.08	8.04	7.99	7.98	7.96
7	8.06			8.04	7.91	8.05	8.01	8.04	8.03	8.09	8.06	8.03	8.00	7.97	7.97
8	8.03			8.02	7.91	8.04	8.00	8.03	8.01	8.08	8.05	8.03	8.00	7.96	7.97
9	7.96			7.98	7.91	8.03	7.99	8.03	7.99	8.07	8.04	7.99	8.00	7.96	7.98
10	7.94			7.95	7.91	8.02	7.98	8.03	7.98	8.04	8.03	7.96	7.98	7.96	7.95
11	7.98			7.91	7.91	7.98	7.97	8.02	7.97	8.03	8.01	7.96	7.95	7.95	7.95
12	7.98			7.82	7.92	7.97	7.96	8.01	7.92	8.04	7.98	7.95	7.90	7.95	7.95
13				7.74	7.92	7.98	7.94	7.99	7.89	8.05	7.95	7.94	7.87	7.94	7.95
14				7.59		7.98	7.93	7.97	7.87	8.05	7.96	7.96	7.52	7.94	7.93
15							7.92	7.94		8.06	7.96			7.94	7.92
16								7.95		8.08	7.96			7.93	7.91
17								7.96		8.08	7.94			7.93	7.82
18								7.96		8.08	7.92			7.92	
19								7.96		8.07	7.88			7.92	
20								7.95		8.05	7.87				
21								7.95		8.03					
22								7.95		8.03					
23								7.92		8.03					
24															

LA/LB BASELINE -AUGUST 2000
Water Quality Meausrements - Salinity (ppt)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	33.29	33.42	33.41	33.40	33.41	33.28	33.29	33.19	33.40	33.40	33.44	33.38	33.45	33.37	33.35	33.21	32.16
1	33.30	33.42	33.41	33.40	33.41	33.29	33.33	33.20	33.36	33.40	33.44	33.40	33.45	33.39	33.35	33.24	32.74
2	33.30	33.42	33.42	33.41	33.41	33.28	33.34	33.28	33.40	33.42	33.46	33.42	33.46	33.40	33.39	33.32	33.26
3	33.31	33.42	33.42	33.41	33.40	33.30	33.32	33.26	33.47	33.42	33.43	33.42	33.50	33.40	33.39	33.32	33.30
4	33.33	33.41	33.42	33.41	33.40	33.30	33.33	33.27	33.44	33.41	32.88	33.45	33.46	33.43	33.40	33.33	33.31
5	33.26	33.31	33.40	33.41	33.40	33.30	33.34	33.29	33.35			33.44	33.46	33.42	33.40	33.32	33.28
6	33.18			33.41	33.40	33.30	33.34	33.30				33.43	33.12	33.41	33.40	33.32	33.28
7	33.40			33.41	33.40	33.31	33.34	33.31				33.43		33.40	33.41	33.32	33.29
8	33.44			33.41	33.41	33.31	33.34	33.31				33.44		33.42	33.41	33.33	
9	33.45			33.41	33.42	33.33	33.34	33.32				33.43		33.43	33.40	33.34	
10	33.44			33.44	33.44	33.34	33.34	33.34						33.47	33.43	33.38	
11	33.48			33.40	33.37	33.37	33.34	33.37						33.47	31.91		
12	33.47					33.40	33.35	33.37						33.46			
13						33.42	33.35	33.39						33.47			
14						33.43	33.35	33.41						33.20			
15						33.43	33.35	33.41						30.48			
16						33.43	33.35	33.40									
17						33.43	33.35										
18						33.43	33.35										
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	33.33	33.34	33.34	33.36	33.36	33.32	32.98	33.37	32.98	33.03	33.34	33.36	33.37	33.36	33.35
1	33.33	33.35	33.34	33.38	33.36	33.33	33.01	33.37	33.03	33.17	33.34	33.37	33.37	33.31	33.35
2	33.33	33.35	33.35	33.38	33.37	33.34	33.15	33.38	33.19	33.32	33.34	33.38	33.37	33.37	33.35
3	33.34	33.36	33.36	33.37	33.38	33.34	33.23	33.39	33.38	33.36	33.35	33.38	33.39	33.37	33.38
4	33.36	33.37	33.37	33.37	33.38	33.38	33.29	33.39	33.44	33.39	33.35	33.39	33.38	33.39	33.40
5	33.40	33.37	33.37	33.37	33.40	33.38	33.36	33.45	33.42	33.44	33.35	33.39	33.39	33.39	33.40
6	33.41	33.37	33.36	33.38	33.40	33.38	33.39	33.43	33.39	33.47	33.38	33.40	33.39	33.42	33.37
7	33.42			33.39	33.41	33.39	33.42	33.45	33.41	33.46	33.38	33.40	33.41	33.42	33.38
8	33.45			33.40	33.41	33.40	33.42	33.45	33.42	33.47	33.39	33.41	33.42	33.42	33.36
9	33.44			33.41	33.45	33.43	33.39	33.45	33.46	33.50	33.39	33.42	33.43	33.41	33.39
10	33.45			33.44	33.43	33.46	33.40	33.47	33.47	33.51	33.40	33.45	33.43	33.42	33.38
11	33.45			33.45	33.42	33.45	33.42	33.49	33.49	33.53	33.43	33.44	33.42	33.42	33.37
12	33.15			33.45	33.44	33.46	33.43	33.50	33.48	33.52	33.46	33.46	33.43	33.43	33.36
13				33.46	33.42	33.47	33.44	33.48	33.48	33.52	33.47	33.48	33.44	33.44	33.40
14				32.76		33.18	33.46	33.48	33.48	33.52	33.46	33.47	24.76	33.43	33.39
15							33.36	33.47		33.54	33.47			33.43	33.38
16								33.48		33.53	33.48			33.45	33.48
17								33.48		33.52	33.47			33.45	33.39
18								33.48		33.52	33.47			33.45	
19								33.48		33.51	33.46			33.45	
20								33.48		33.50	33.41				
21								33.48		33.50					
22								33.48		33.50					
23								33.46		33.52					
24															

LA/LB BASELINE -AUGUST 2000

Water Quality Measurements - Temperature (°C)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	20.57	20.58	20.58	20.48	20.82	20.95	22.97	22.02	23.36	23.44	24.17	22.69	22.56	21.09	21.63	22.06	22.80
1	20.57	20.58	20.55	20.47	20.58	20.87	22.33	21.96	23.34	23.33	24.13	22.45	22.39	20.93	21.59	21.96	22.16
2	20.47	20.52	20.52	20.35	20.49	20.64	21.47	20.88	23.20	22.67	23.54	21.64	22.06	20.54	21.02	21.30	21.63
3	20.44	20.45	20.48	20.23	20.41	20.50	21.24	20.65	21.31	21.53	21.86	21.47	20.98	20.44	20.72	20.91	21.29
4	20.42	20.18	20.26	20.06	20.20	20.23	20.98	20.49	20.25	20.75	21.66	20.91	20.51	20.18	20.38	20.65	20.81
5	20.01	20.14	20.13	19.78	19.89	20.16	20.69	20.24	19.59			20.28	20.08	19.99	20.27	20.58	20.45
6	19.46			19.58	19.75	20.00	20.42	20.02				19.95	19.61	19.83	20.12	20.51	20.33
7	19.57			19.40	19.58	19.94	20.34	19.92				19.66		19.73	19.85	20.44	19.98
8	19.10			19.15	19.27	19.81	20.25	19.89				19.26		19.49	19.61	20.36	
9	18.41			19.07	19.06	19.61	20.13	19.82				19.09		18.83	19.24	20.14	
10	18.15			18.51	18.50	19.46	19.97	19.63						18.22	18.61	19.29	
11	17.70			18.12	18.33	19.15	19.92	19.43						17.66	17.60		
12	17.22					18.79	19.80	19.34						17.55			
13						18.49	19.66	19.13						17.30			
14						18.24	19.59	18.86						17.14			
15						18.12	19.54	18.69						17.08			
16						17.96	19.51	18.68									
17						17.89	19.44										
18						17.86	19.45										
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	21.49	21.34	21.26	21.91	21.98	21.42	22.48	21.91	22.63	22.62	20.78	21.99	22.08	21.43	21.86
1	21.49	21.31	21.26	21.66	21.92	21.37	22.39	21.87	22.46	22.06	20.76	21.75	22.02	21.41	21.88
2	21.47	21.20	21.23	21.07	21.85	21.10	21.73	21.80	21.91	21.47	20.77	21.22	21.83	21.40	21.92
3	21.36	21.09	21.13	20.93	21.74	20.97	21.16	21.46	20.98	21.29	20.75	21.02	21.38	21.32	21.71
4	21.09	20.90	20.86	20.80	21.47	20.40	20.48	21.09	21.01	21.12	20.69	20.65	20.83	21.03	21.32
5	20.57	20.70	20.72	20.52	21.09	19.95	20.26	20.09	20.75	20.64	20.60	20.41	20.42	20.73	20.25
6	20.21	20.61	20.69	20.23	20.69	19.78	20.01	19.66	20.32	20.13	20.28	20.13	20.04	20.13	20.40
7	19.84			19.96	20.42	19.67	19.76	19.24	19.84	20.04	19.94	19.80	19.80	19.66	20.41
8	19.05			19.57	19.97	19.47	19.44	18.91	19.33	19.86	19.74	19.46	19.48	19.39	20.56
9	18.66			19.12	19.29	18.94	19.01	18.86	18.99	19.57	19.55	19.12	19.24	19.28	20.26
10	18.53			18.64	18.95	18.32	18.76	18.73	18.79	19.28	19.23	18.62	18.97	19.05	20.14
11	18.17			18.08	18.95	18.06	18.62	18.43	18.35	18.97	18.80	18.43	18.68	18.83	20.16
12	17.91			17.72	18.56	17.90	18.44	18.13	18.08	18.60	18.01	18.08	18.28	18.58	20.17
13				17.49	18.35	17.63	18.31	17.90	17.94	18.17	17.49	17.67	17.94	18.34	19.91
14				16.99		17.50	18.06	17.67	17.89	17.94	17.47	17.50	17.82	18.23	19.67
15							17.78	17.37		17.63	17.38			18.16	19.68
16								17.27		17.14	17.16			17.91	18.32
17								17.07		17.09	17.06			17.68	17.61
18								16.97		16.96	16.91			17.54	
19								16.89		16.74	16.79			17.51	
20								16.82		16.62	16.80				
21								16.78		16.50					
22								16.64		16.46					
23								16.49		16.40					
24															

LA/LB BASELINE -AUGUST 2000
Water Quality Measurements - Transmissivity (%)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	63.21	67.23	57.07	67.10	69.37	66.88	72.76	65.09	51.73	55.39	48.93	60.12	62.89	66.78	74.02	68.76	72.21
1	63.07	67.93	64.54	67.50	68.86	66.47	71.24	65.07	53.71	55.70	49.01	59.44	60.99	66.47	59.69	68.23	69.44
2	61.53	66.49	66.51	68.89	68.25	64.65	69.21	65.23	53.51	58.74	48.85	52.55	58.28	64.75	68.76	67.94	64.10
3	59.90	63.98	67.28	68.83	67.86	64.36	67.84	66.87	57.10	58.88	22.50	58.27	47.47	63.71	61.65	65.72	60.46
4	61.10	41.24	63.23	67.21	67.97	63.86	68.20	66.97	53.72	47.10	8.01	64.71	35.84	64.30	64.56	65.73	57.35
5	58.93	31.53	56.23	67.75	65.79	63.75	65.75	67.18	51.56			65.34	32.54	65.74	64.49	64.92	54.12
6	52.83			68.47	62.00	64.92	65.75	67.60				65.42	31.52	64.60	62.77	65.03	47.02
7	56.58			67.78	67.05	65.32	66.04	67.67				64.47		64.59	67.00	66.09	34.08
8	60.13			64.72	69.47	65.87	67.20	67.78				63.98		65.92	67.25	66.93	
9	60.46			63.06	68.33	65.60	69.59	67.98				62.84		68.43	69.94	66.70	
10	51.83			58.10	63.62	65.09	70.94	67.46						66.97	69.41	63.63	
11	44.89			48.39	58.70	64.78	70.80	66.35						61.34	45.94		
12	21.09					64.63	70.58	64.78						59.32			
13						63.24	68.50	62.90						53.09			
14						60.80	66.19	57.54						36.46			
15						61.71	56.56	57.79						34.34			
16						55.06	53.21	58.13									
17						48.86	52.60										
18						42.89	50.17										
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	64.34	66.06	65.30	69.44	66.19	66.07	41.77	63.76	56.08	51.40	68.94	70.23	59.67	61.13	56.53
1	64.68	66.17	65.22	67.07	65.68	66.00	47.97	63.35	54.76	54.14	69.11	69.98	59.52	61.27	56.66
2	64.69	66.40	65.50	67.49	66.30	64.71	57.92	63.31	55.38	57.12	68.82	62.64	57.27	61.04	56.63
3	64.77	66.09	65.75	66.69	69.57	63.57	57.24	63.44	54.35	61.46	69.19	64.42	60.65	60.43	56.90
4	64.23	64.41	64.74	66.74	65.98	61.71	46.66	63.19	54.52	63.99	68.86	71.00	59.88	59.92	55.41
5	62.56	62.79	62.41	67.60	65.59	58.98	46.99	62.72	54.91	66.14	67.97	71.91	54.69	59.16	50.73
6	60.62	61.04	59.78	68.09	66.23	57.38	50.82	60.74	51.21	64.20	67.74	70.32	54.85	58.28	50.74
7	57.20			68.04	65.20	56.99	54.19	60.13	50.75	62.55	66.77	69.28	49.89	57.59	47.74
8	56.33			68.47	64.25	57.38	52.90	59.18	50.03	61.86	65.92	69.14	43.14	56.08	48.39
9	55.75			68.24	63.19	55.67	47.31	59.71	51.89	61.42	65.50	69.47	39.15	53.62	49.49
10	51.92			71.28	60.62	53.59	42.03	60.50	55.67	60.38	65.74	68.07	40.50	54.43	50.09
11	56.33			69.90	60.20	52.59	39.85	59.29	51.84	60.07	65.21	65.83	44.52	57.12	48.08
12	55.17			33.96	59.54	50.32	39.38	58.30	40.87	61.44	63.19	60.99	47.73	53.15	44.13
13				19.85	57.64	45.26	39.43	56.64	25.69	56.94	61.94	52.99	40.18	53.04	39.28
14				11.33		37.35	38.70	55.81	14.16	50.84	58.95	51.48	15.36	54.33	47.81
15							35.83	52.52		53.83	55.83			54.85	45.26
16								51.99		65.78	49.40			53.48	50.07
17								51.58		67.91	50.65			49.42	39.70
18								50.35		67.27	52.62			44.94	
19								48.99		60.02	45.62			43.91	
20								47.04		47.34	42.46				
21								47.09		33.83					
22								43.97		33.07					
23								38.48		25.49					
24															

LA/LB BASELINE -NOVEMBER 2000
Water Quality Measurements - Dissolved oxygen (mg/L)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	8.18	7.27	7.19	7.24	7.36	6.76	7.02	6.85	9.29	8.09	5.87	9.89	6.80	7.27	6.71	6.50	5.38
1	8.16	7.25	7.20	7.25	7.38	6.89	7.02	6.80	9.33	8.13	5.98	9.80	6.79	7.22	6.58	6.49	5.43
2	8.22	7.29	7.19	7.24	7.37	6.81	6.86	6.77	9.23	7.99	5.85	9.69	6.78	7.26	6.76	6.48	5.61
3	8.22	7.32	7.16	7.26	7.38	6.07	6.98	6.71	8.50	7.75	5.41	9.25	6.80	7.32	7.00	6.52	5.89
4	8.13	7.30	7.05	7.26	7.36	6.85	6.70	6.61	7.42	7.45		8.77	6.81	7.39	7.15	6.56	6.00
5	8.01	7.26	6.91	7.18	7.29	6.81	6.67	6.56				8.69	6.76	7.45	7.15	6.56	5.80
6	7.98			7.19	7.06	6.83	6.62	6.55				8.40	6.77	7.47	7.27	6.39	
7	8.02			7.12	6.91	6.82	6.55	6.54				8.15		7.51	7.12	6.46	
8	7.98			6.94	6.87	6.78	6.55	6.49				8.11		7.55	6.85	6.43	
9	7.94			6.75	7.06	6.78	6.51	6.53				8.05		7.59	6.49	6.37	
10	7.87			6.79	7.15	6.82	6.48	6.54				8.06		7.62	5.93		
11	7.69			6.70		6.87	6.45	6.55				7.97		7.62	5.16		
12	7.55					6.94	6.40	6.57				7.87		7.54			
13	7.31					6.99	6.36	6.56				7.70		7.29			
14						7.00	6.35	6.54				7.54		7.06			
15						6.99	6.30	6.54				7.49					
16						6.95	6.25					7.44					
17						6.89	6.08					7.46					
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	8.01	8.20	8.28	6.90	6.99	7.08	8.22	7.47	7.91	8.17	7.41	7.14	8.61	6.75	7.08
1	8.04	8.19	8.30	6.90	6.85	7.08	8.17	7.45	7.90	8.15	7.40	7.15	8.63	6.78	7.18
2	8.09	8.21	8.35	6.88	6.80	7.12	8.10	7.51	7.89	8.20	7.44	7.19	8.65	6.78	7.00
3	8.21	8.28	8.35	6.89	6.79	7.19	8.07	7.51	7.78	8.21	7.44	7.26	8.65	6.81	6.98
4	8.26	8.28	8.34	6.79	6.78	7.24	7.50	7.51	7.93	8.22	7.43	7.23	8.63	6.82	6.83
5	8.30	8.03	8.33	6.64	6.69	6.71	7.56	7.55	7.86	8.24	7.43	7.13	8.45	6.71	6.82
6	8.31	8.30	8.34	6.58	6.56	7.33	6.99	7.55	7.70	8.28	7.47	7.05	8.28	6.70	6.80
7	8.74			6.54	6.44	7.33	6.80	7.54	7.05	8.28	7.44	7.17	8.16	6.68	6.81
8	8.21			6.52	6.39	7.33	6.73	7.53	6.82	8.27	7.45	7.22	7.98	6.66	6.78
9	8.17			6.50	6.41	7.33	6.67	7.53	6.76	8.26	7.45	7.04	7.29	6.67	6.76
10	8.10			6.52	6.41	7.36	6.62	7.53	6.75	8.23	7.47	6.95	6.83	6.69	6.76
11	7.64			6.59	6.37	7.35	6.61	7.52	6.72	8.21	7.44	7.12	6.80	6.70	6.78
12	7.35			6.58	6.47	7.33	6.58	7.46	6.64	8.22	7.42	7.11	6.80	6.71	6.79
13				6.40	6.48	7.33	6.55	7.48	6.49	8.22	7.42	6.95	6.77	6.74	6.77
14				6.35	6.45	7.29	6.53	7.48	6.51	8.28	7.40	6.58	6.78	6.76	6.74
15					6.45	7.22	6.51	7.45	6.41	8.32	7.37			6.80	6.74
16							6.40	7.42		8.34	7.33			6.84	6.69
17								7.36		8.34	7.69			6.89	6.69
18								7.34		8.18	7.22			6.89	
19								7.37		8.11	7.20			6.92	
20								7.34		8.08	7.16				
21								7.26		8.03					
22								7.15		7.90					
23								7.17		8.34					
24								7.11		7.95					

LA/LB BASELINE -NOVEMBER 2000
Water Quality Measurements - pH

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	8.15	8.05	8.05	8.05	8.06	7.99	8.00	8.00	8.22	8.14	7.99	8.20	8.03	8.04	8.00	7.97	7.91
1	8.16	8.05	8.05	8.05	8.06	7.98	8.00	8.00	8.22	8.14	7.99	8.20	8.02	8.04	8.01	7.97	7.93
2	8.16	8.05	8.05	8.06	8.07	7.99	8.00	8.00	8.20	8.13	7.96	8.19	8.02	8.05	8.04	7.98	7.97
3	8.16	8.05	8.05	8.06	8.06	8.00	8.00	8.01	8.11	8.11	7.94	8.15	8.02	8.06	8.05	7.99	7.99
4	8.15	8.05	8.04	8.06	8.06	8.00	7.99	8.00	8.08	8.10		8.14	8.02	8.06	8.06	7.99	7.98
5	8.14	8.05	8.03	8.05	8.06	8.00	8.00	8.00				8.14	8.03	8.07	8.07	7.99	7.97
6	8.14			8.06	8.05	8.00	7.99	8.00				8.11	8.03	8.07	8.08	7.98	
7	8.15			8.06	8.06	8.00	7.99	8.00				8.11		8.08	8.07	7.98	
8	8.14			8.05	8.05	8.00	7.99	8.00				8.10		8.08	8.05	7.99	
9	8.14			8.05	8.07	8.00	7.99	8.00				8.10		8.08	8.03	7.98	
10	8.14			8.05	8.08	8.01	7.99	8.00				8.11		8.09	7.98		
11	8.12			8.04		8.01	7.99	8.01				8.10		8.09	7.93		
12	8.12					8.01	7.99	8.01				8.10		8.07			
13	8.11					8.02	7.99	8.01				8.09		8.07			
14						8.02	7.99	8.01				8.08		8.05			
15						8.02	7.98	8.01				8.07					
16						8.02	7.98					8.08					
17						8.02	7.97					8.07					
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	8.18	8.16	8.18	8.08	7.98	8.15	8.23	8.10	8.22	8.21	8.14	8.10	8.16	8.01	8.01
1	8.18	8.16	8.18	8.08	7.98	8.15	8.22	8.11	8.21	8.21	8.14	8.10	8.16	8.01	8.00
2	8.18	8.16	8.18	8.08	7.99	8.15	8.21	8.11	8.20	8.21	8.14	8.11	8.15	8.01	8.01
3	8.20	8.17	8.18	8.08	7.98	8.15	8.22	8.12	8.20	8.21	8.14	8.11	8.15	8.02	8.01
4	8.19	8.17	8.18	8.08	7.97	8.15	8.20	8.12	8.20	8.21	8.14	8.10	8.14	8.02	8.00
5	8.19	8.17	8.18	8.07	7.95	8.16	8.16	8.12	8.20	8.21	8.14	8.10	8.13	8.02	8.01
6	8.19	8.17	8.18	8.07	7.94	8.16	8.13	8.12	8.16	8.22	8.14	8.10	8.12	8.01	8.01
7	8.18			8.07	7.94	8.16	8.12	8.12	8.13	8.22	8.14	8.11	8.11	8.01	8.01
8	8.18			8.07	7.96	8.16	8.12	8.12	8.12	8.21	8.14	8.10	8.10	8.01	8.02
9	8.18			8.07	7.96	8.16	8.12	8.13	8.12	8.21	8.14	8.09	8.04	8.02	8.01
10	8.17			8.07	7.97	8.16	8.12	8.13	8.12	8.21	8.14	8.09	8.04	8.02	8.02
11	8.14			8.07	7.97	8.16	8.12	8.12	8.12	8.21	8.14	8.10	8.04	8.03	8.02
12	8.13			8.07	7.98	8.15	8.12	8.13	8.11	8.21	8.14	8.08	8.04	8.03	8.02
13				8.05	8.00	8.15	8.12	8.13	8.10	8.22	8.14	8.08	8.04	8.03	8.02
14				8.05	8.01	8.15	8.12	8.13	8.10	8.22	8.14	8.05	8.04	8.04	8.02
15					8.01	8.14	8.12	8.12	8.10	8.22	8.13			8.04	8.02
16							8.10	8.12		8.22	8.13			8.05	8.02
17								8.12		8.21	8.13			8.05	8.02
18								8.12		8.20	8.12			8.05	
19								8.12		8.19	8.12			8.05	
20								8.11		8.19	8.12				
21								8.10		8.18					
22								8.10		8.18					
23								8.10		8.18					
24								8.09		8.17					

LA/LB BASELINE -NOVEMBER 2000
Water Quality Meausrements - Salinity (ppt)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	33.06	32.97	32.96	32.95	32.94	32.85	32.84	32.55	33.10	33.14	33.09	33.11	33.06	32.97	32.90	32.81	31.64
1	33.06	32.98	32.96	32.95	32.94	32.85	32.85	32.57	33.11	33.15	33.11	33.11	33.06	32.98	32.94	32.82	32.17
2	33.06	32.98	32.96	32.95	32.95	32.85	32.84	32.70	33.12	33.15	33.10	33.12	33.06	33.00	32.98	32.83	32.71
3	33.11	32.98	32.98	32.95	32.95	32.85	32.89	32.80	33.15	33.16	32.93	33.12	33.06	33.02	32.97	32.85	32.86
4	33.16	32.98	33.03	32.96	32.95	32.85	32.89	32.86	33.16	33.15		33.12	33.06	33.03	32.98	32.85	32.90
5	33.18	32.98	33.04	33.00	32.97	32.86	32.89	32.88				33.13	33.06	33.05	33.00	32.86	32.96
6	33.18			33.03	33.06	32.87	32.90	32.93				33.13	33.06	33.05	33.03	32.87	
7	33.20			33.09	33.09	32.88	32.90	32.97				33.13		33.06	33.06	32.88	
8	33.20			33.17	33.13	32.89	32.91	33.02				33.14		33.07	33.12	32.89	
9	33.22			33.20	33.14	32.91	32.91	33.05				33.14		33.09	33.18	32.91	
10	33.24			33.24	33.15	32.92	32.92	33.05				33.16		33.11	33.28		
11	33.25			33.24		32.95	32.93	33.08				33.17		33.15	33.31		
12	33.27					32.98	32.94	33.12				33.19		33.20			
13	32.70					32.99	32.94	33.13				33.21		33.23			
14						33.01	32.95	33.13				33.23		33.08			
15						33.04	32.96	33.13				33.25					
16						33.05	32.96					33.27					
17						33.06	32.97					32.52					
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	33.14	33.11	33.12	33.14	32.94	33.21	32.31	33.20	32.12	32.82	33.23	33.12	33.14	33.00	32.80
1	33.14	33.11	33.12	33.13	32.94	33.21	32.46	33.20	32.44	32.83	33.23	33.13	33.14	33.00	32.84
2	33.14	33.11	33.12	33.14	32.93	33.22	32.70	33.20	32.66	32.84	33.23	33.13	33.14	33.00	32.92
3	33.14	33.11	33.12	33.14	32.94	33.22	32.83	33.20	32.83	32.96	33.24	33.14	33.14	33.00	32.99
4	33.14	33.12	33.12	33.15	32.99	33.23	32.91	33.20	32.95	32.97	33.24	33.15	33.14	33.05	33.01
5	33.15	33.12	33.12	33.18	33.09	33.24	32.99	33.20	32.99	32.98	33.24	33.16	33.14	33.07	33.02
6	33.17	33.13	33.13	33.18	33.11	33.25	33.12	33.20	33.15	32.98	33.24	33.16	33.14	33.07	33.03
7	33.18			33.19	33.11	33.25	33.19	33.20	33.21	33.03	33.25	33.17	33.15	33.13	33.04
8	33.19			33.20	33.12	33.25	33.22	33.20	33.24	33.06	33.25	33.18	33.17	33.13	33.06
9	33.21			33.22	33.13	33.25	33.27	33.21	33.25	33.09	33.25	33.20	33.19	33.14	33.08
10	33.23			33.22	33.13	33.26	33.29	33.21	33.26	33.10	33.25	33.20	33.21	33.14	33.09
11	33.27			33.25	33.14	33.26	33.30	33.23	33.31	33.10	33.25	33.24	33.23	33.14	33.11
12	33.28			33.31	33.15	33.26	33.32	33.23	33.35	33.15	33.25	33.27	33.26	33.14	33.12
13				33.35	33.16	33.27	33.33	33.23	33.37	33.18	33.26	33.30	33.30	33.14	33.12
14				32.73	33.17	33.28	33.34	33.23	33.38	33.20	33.26	33.33	33.31	33.15	33.13
15					33.16	33.29	33.36	33.25	33.00	33.21	33.27			33.15	33.15
16							33.24	33.29		33.24	33.30			33.18	33.16
17								33.31		33.36	33.31			33.20	32.99
18								33.31		33.41	33.31			33.22	
19								33.34		33.41	33.32			33.23	
20								33.35		33.42	32.82				
21								33.35		33.43					
22								33.35		33.43					
23								33.37		33.43					
24								33.40		33.42					

LA/LB BASELINE -NOVEMBER 2000

Water Quality Measurements - Temperature (^oC)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	17.32	17.05	17.02	17.04	17.07	17.32	17.65	17.65	17.74	17.96	17.80	17.64	17.61	17.10	17.42	17.43	17.87
1	17.32	17.04	17.01	17.04	17.06	17.31	17.58	17.65	17.61	17.83	17.75	17.58	17.58	17.04	17.34	17.38	17.65
2	17.32	17.03	17.01	17.04	17.05	17.31	17.65	17.55	17.59	17.72	17.58	17.46	17.54	17.03	17.18	17.33	17.58
3	17.34	17.03	17.06	17.03	17.05	17.29	17.42	17.48	17.61	17.67	17.54	17.35	17.52	17.02	17.10	17.28	17.48
4	17.35	17.03	17.13	17.02	17.03	17.24	17.36	17.42	17.60	17.67		17.33	17.51	17.02	17.11	17.27	17.45
5	17.35	17.03	17.15	17.03	17.03	17.20	17.34	17.38				17.25	17.49	17.02	17.12	17.26	17.35
6	17.35			17.05	17.10	17.13	17.33	17.42				17.17	17.48	17.03	17.13	17.26	
7	17.33			17.07	17.08	17.08	17.31	17.42				17.13		17.05	17.19	17.26	
8	17.32			17.00	17.02	17.06	17.30	17.40				17.09		17.06	17.25	17.25	
9	17.26			16.90	16.99	17.04	17.29	17.38				17.06		17.07	17.16	17.28	
10	17.20			16.73	16.99	17.01	17.28	17.38				16.94		17.06	16.99		
11	17.16			16.72		16.97	17.27	17.34				16.87		17.00	16.95		
12	17.10					16.94	17.25	17.27				16.75		16.74			
13	17.07					16.92	17.25	17.25				16.57		16.66			
14						16.89	17.24	17.24				16.50		16.42			
15						16.84	17.23	17.25				16.47					
16						16.81	17.22					16.32					
17						16.79	17.21					16.11					
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	17.38	17.32	17.35	17.58	17.64	17.19	16.85	17.19	16.54	17.15	17.20	17.70	17.74	17.83	17.79
1	17.38	17.33	17.35	17.58	17.64	17.19	17.11	17.20	16.85	17.15	17.21	17.69	17.74	17.75	17.69
2	17.38	17.33	17.34	17.58	17.62	17.18	17.28	17.19	16.99	17.16	17.21	17.67	17.72	17.63	17.59
3	17.38	17.33	17.34	17.55	17.63	17.16	17.33	17.19	17.28	17.19	17.21	17.66	17.72	17.57	17.43
4	17.38	17.33	17.33	17.53	17.65	17.14	17.31	17.19	17.32	17.19	17.21	17.64	17.68	17.40	17.40
5	17.37	17.33	17.33	17.47	17.69	17.12	17.17	17.19	17.31	17.19	17.21	17.62	17.63	17.35	17.39
6	17.37	17.34	17.33	17.41	17.66	17.11	17.14	17.18	17.28	17.19	17.21	17.60	17.62	17.35	17.36
7	17.37			17.37	17.63	17.10	17.10	17.18	17.23	17.22	17.20	17.53	17.60	17.31	17.34
8	17.35			17.35	17.57	17.09	17.08	17.18	17.18	17.24	17.20	17.43	17.55	17.28	17.30
9	17.31			17.28	17.55	17.08	17.04	17.17	17.12	17.26	17.20	17.37	17.48	17.25	17.27
10	17.22			17.26	17.49	17.08	17.02	17.15	17.11	17.26	17.19	17.28	17.36	17.23	17.24
11	17.15			17.21	17.44	17.07	17.01	17.10	17.13	17.26	17.18	17.14	17.25	17.24	17.21
12	17.11			17.11	17.38	17.06	16.99	17.10	17.04	17.26	17.18	17.06	17.14	17.23	17.20
13				17.05	17.29	17.01	16.98	17.09	16.95	17.28	17.16	17.00	16.93	17.23	17.19
14				16.85	17.24	16.98	16.98	17.07	16.88	17.28	17.14	16.86	16.79	17.20	17.17
15					17.23	16.92	16.97	16.99	16.86	17.26	17.09			17.18	17.16
16							16.91	16.83		17.25	16.98			17.12	17.14
17								16.74		17.01	16.89			17.04	17.06
18								16.73		16.90	16.84			16.99	
19								16.62		16.84	16.81			16.94	
20								16.55		16.76	16.74				
21								16.48		16.66					
22								16.45		16.65					
23								16.33		16.63					
24								16.23		16.58					

LA/LB BASELINE -NOVEMBER 2000
Water Quality Measurements - Transmissivity (%)

DEPTH (m)	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14
0	64.13	67.91	59.83	64.29	51.33	65.63	61.37	70.23	63.16	50.51	35.28	59.08	62.67	66.72	72.20	62.33	73.40
1	64.04	67.87	60.62	65.87	62.89	65.38	65.33	69.50	60.37	49.43	35.94	56.60	62.56	66.38	70.34	64.48	71.30
2	64.05	67.60	61.38	66.06	66.91	65.57	63.76	68.97	59.63	51.76	32.26	53.64	60.31	65.56	66.11	65.89	67.39
3	64.45	66.72	59.98	65.80	67.33	65.19	65.56	69.71	51.04	46.72	21.03	58.04	59.64	65.69	67.88	66.58	67.07
4	63.71	63.60	57.20	66.32	66.28	64.65	67.01	67.95	37.80	37.33		61.54	60.05	66.26	68.65	67.00	62.81
5	63.84	62.44	50.61	66.84	63.47	64.16	67.83	66.79				63.04	60.67	66.68	67.09	67.75	57.56
6	61.99			67.07	50.75	64.02	68.96	69.09				58.90	57.82	67.07	68.69	67.78	
7	64.30			64.43	44.57	64.01	69.47	70.91				59.07		67.16	68.06	67.75	
8	63.88			54.73	48.75	63.88	67.81	71.29				58.82		67.40	67.35	67.42	
9	61.06			52.67	63.22	64.89	67.74	70.87				58.80		67.65	56.81	64.53	
10	52.86			53.81	66.20	65.51	67.46	70.92				58.92		68.08	38.07		
11	35.45			52.78		66.30	66.88	70.81				57.51		67.49	32.22		
12	28.30					66.67	66.80	69.73				55.19		63.38			
13	20.00					66.24	66.60	68.30				52.97		54.85			
14						65.59	66.06	68.15				57.74		38.36			
15						64.51	66.29	68.14				62.09					
16						63.63	65.39					62.31					
17						63.08	64.19					46.74					
18																	
19																	
20																	
21																	
22																	
23																	
24																	

DEPTH (m)	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
0	61.66	64.70	56.54	39.61	68.00	60.60	64.14	61.19	67.03	60.71	66.81	54.45	42.87	62.62	68.57
1	61.74	64.92	59.05	40.13	68.60	60.52	64.12	61.16	67.20	60.75	64.96	55.22	51.23	63.15	66.20
2	61.84	65.00	62.89	39.97	68.95	60.13	64.03	60.98	66.75	60.66	69.05	55.13	57.53	63.32	64.00
3	61.88	64.94	64.65	38.63	68.57	59.02	64.04	60.93	65.85	60.31	69.09	55.55	57.65	63.38	62.07
4	61.91	64.48	64.57	36.08	68.46	57.69	63.72	60.89	64.28	58.30	68.90	56.70	58.89	63.15	61.02
5	61.89	61.03	63.93	31.19	67.81	56.51	59.40	60.94	63.57	57.69	68.82	58.91	60.03	62.86	57.59
6	60.54	51.69	62.19	28.68	66.84	56.20	53.93	60.89	62.61	57.98	68.59	60.27	60.41	62.89	55.99
7	59.21			29.06	66.69	55.93	48.37	60.89	58.41	59.82	68.49	60.66	61.14	62.65	55.10
8	59.88			31.29	67.48	55.74	46.60	60.86	55.80	61.38	68.65	61.21	61.01	61.99	54.19
9	60.74			30.49	66.34	55.58	45.34	60.56	54.51	61.89	68.44	61.18	60.82	61.42	53.92
10	60.63			27.15	66.94	55.40	43.76	59.99	50.61	62.59	68.27	59.79	58.89	61.04	54.76
11	43.94			29.62	65.65	55.25	41.63	57.30	52.50	62.52	67.38	56.63	52.19	61.06	55.49
12	30.93			29.13	65.27	55.14	37.58	57.91	52.34	59.89	66.73	54.69	46.74	60.93	54.96
13				31.70	63.70	53.96	41.49	58.08	40.13	56.83	66.44	57.04	42.73	60.75	53.99
14				44.13	61.05	51.75	42.12	56.81	38.21	53.12	65.77	46.93	19.65	60.37	52.45
15					60.12	47.92	44.25	51.35	32.11	51.49	64.38			60.00	52.23
16							31.63	50.06		50.51	61.42			58.66	51.92
17								50.00		40.05	57.69			55.31	51.25
18								52.22		29.89	55.26			51.90	
19								51.63		27.51	54.24			50.19	
20								49.51		25.05	53.33				
21								46.34		20.09					
22								44.33		19.03					
23								41.52		17.32					
24								30.42		15.67					

APPENDIX C

Fish Data

C.1 Lampara Data

Lampara Catch

Abundance

Area	February 2000			May 2000			August 2000			November 2000			Annual Mean			Annual Total		
	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean
Deepwater Basin																		
LA5	16	85	51	125	1372	749	5	278	142	0	59	30	37	449	243	146	1794	970
LA6	130	121	126	15	342	179	27	45	36	33	462	248	51	243	147	205	970	588
LB3	189	3353	1771	584	218	401	1021	19523	10272	192	857	525	497	5988	3242	1987	23950	12968
LB5	15	1881	948	0	46	23	14045	6635	10340	78	1475	776	3535	2509	3022	14138	10037	12088
Deepwater Channel																		
LA4	1	141	71	191	739	465	1819	547	1183	18	308	163	507	434	470	2029	1735	1882
LB7	18	265	142	43	285	164	1	4273	2137	6	2965	1485	17	1947	982	68	7788	3928
Deepwater Open																		
LA1	15	26	21	150	93	122	34	371	203	512	284	398	178	194	186	711	774	742
LB1	86	101	94	32	255	144	1287	998	1143	83	122	103	372	369	371	1488	1476	1482
Deepwater Slip																		
LB4	0	3032	1516	31	5108	2569	0	377	189	28	2153	1091	15	2668	1341	59	10670	5365
LB6	95	3016	1556	394	171	283	415	483	449	128	2604	1366	258	1568	913	1032	6274	3653
Shallow Mitigation																		
LA2A	323	127	225	215	236	226	911	325	618	186	534	360	409	306	357	1635	1222	1428
LA2B	88	117	103	70	176	123	38	1856	947	58	67	63	64	554	309	254	2216	1235
LA7A	606	48	327	127	343	235	212	191	202	49	84	67	249	167	208	994	666	830
LA7B	7	105	56	166	197	182	48	271	160	1431	189	810	413	191	302	1652	762	1207
LB2A	516	557	537	383	432	408	203	1705	954	55	1129	592	289	956	622	1157	3823	2490
LB2B	13	103	58	18	346	182	205	1026	616	19	776	398	64	563	313	255	2251	1253
Shallow Water Open																		
LA3A	69	159	114	41	52	47	55	1193	624	298	485	392	116	472	294	463	1889	1176
LA3B	32	308	170	36	32	34	59	2820	1440	23	209	116	38	842	440	150	3369	1760
Survey Mean	123	753	438	146	580	363	1133	2384	1758	178	820	499	395	1134	765	1579	4537	3058
Survey Total	2219	13545	7882	2621	10443	6532	20385	42917	31651	3197	14762	8979	7106	20417	13761	28422	81667	55045

Lampara Catch

Biomass

Area	February 2000			May 2000			August 2000			November 2000			Annual Mean			Annual Total		
	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Combined	Day	Night	Combined
Deepwater Basin																		
LA5	0.73	2.92	1.82	3.64	10.38	7.01	0.47	4.23	2.35	0.00	2.12	1.06	1.21	4.91	3.06	4.83	19.65	12.24
LA6	3.94	0.73	2.33	0.31	3.23	1.77	0.23	1.64	0.94	6.88	3.80	5.34	2.84	2.35	2.59	11.35	9.40	10.38
LB3	14.28	18.48	16.38	8.71	9.10	8.90	8.01	45.06	26.53	5.46	28.02	16.74	9.12	25.16	17.14	36.46	100.66	68.56
LB5	1.71	19.33	10.52	0.00	0.87	0.44	43.28	25.03	34.15	4.22	11.25	7.73	12.30	14.12	13.21	49.21	56.48	52.84
Deepwater Channel																		
LA4	0.65	3.07	1.86	2.82	4.82	3.82	11.08	13.32	12.20	2.56	3.83	3.19	4.28	6.26	5.27	17.12	25.03	21.07
LB7	2.88	2.00	2.44	0.99	2.13	1.56	0.17	15.28	7.73	0.91	13.51	7.21	1.24	8.23	4.73	4.94	32.92	18.93
Deepwater Open																		
LA1	0.51	0.72	0.62	7.03	9.04	8.03	1.82	9.80	5.81	4.27	1.72	3.00	3.41	5.32	4.36	13.63	21.28	17.45
LB1	14.33	10.96	12.64	4.95	8.43	6.69	31.98	7.75	19.86	3.70	2.81	3.25	13.74	7.48	10.61	54.95	29.93	42.44
Deepwater Slip																		
LB4	0.00	14.59	7.30	1.13	26.13	13.63	0.00	4.32	2.16	1.48	11.34	6.41	0.65	14.10	7.37	2.61	56.38	29.50
LB6	6.77	156.72	81.74	11.65	6.19	8.92	14.58	23.52	19.05	1.40	29.73	15.56	8.60	54.04	31.32	34.39	216.17	125.28
Shallow Mitigation																		
LA2A	38.02	11.62	24.82	69.35	74.05	71.70	69.19	26.29	47.74	135.17	104.83	120.00	77.93	54.20	66.07	311.73	216.79	264.26
LA2B	8.38	7.25	7.82	8.23	20.54	14.38	18.53	38.23	28.38	10.08	56.44	33.26	11.30	30.62	20.96	45.22	122.46	83.84
LA7A	599.30	13.30	306.30	34.93	35.30	35.12	12.34	12.81	12.57	24.67	13.34	19.00	167.81	18.69	93.25	671.24	74.75	373.00
LA7B	13.44	29.79	21.61	41.91	16.03	28.97	12.09	9.38	10.73	96.94	28.82	62.88	41.10	21.00	31.05	164.39	84.01	124.20
LB2A	56.83	35.36	46.10	1.90	29.81	15.86	44.08	14.63	29.36	9.25	18.44	13.85	28.02	24.56	26.29	112.07	98.24	105.15
LB2B	23.95	33.50	28.73	5.82	21.24	13.53	23.92	14.47	19.20	3.43	8.11	5.77	14.28	19.33	16.81	57.12	77.32	67.22
Shallow Water Open																		
LA3A	5.53	2.27	3.90	3.49	2.08	2.79	8.26	7.76	8.01	8.77	9.62	9.20	6.51	5.43	5.97	26.05	21.73	23.89
LA3B	4.29	8.94	6.62	8.26	2.38	5.32	1.96	10.92	6.44	1.91	4.10	3.01	4.10	6.59	5.35	16.41	26.35	21.38
Survey Mean	44.20	20.64	32.42	11.95	15.65	13.80	16.78	15.80	16.29	17.84	19.55	18.69	22.69	17.91	20.30	90.76	71.64	81.20
Survey Total	795.53	371.54	583.53	215.11	281.75	248.43	301.98	284.44	293.21	321.10	351.82	336.46	408.43	322.39	365.41	1633.71	1289.55	1461.63

Lampara Catch

Number of Species

Area	February 2000			May 2000			August 2000			November 2000			Annual Mean			Annual
	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Total
Deepwater Basin																
LA5	2	7	8	4	10	11	3	11	12	0	7	7	2	9	10	18
LA6	1	3	3	2	8	8	2	6	6	3	6	7	2	6	6	11
LB3	9	5	9	7	8	12	6	10	10	4	13	14	7	9	11	22
LB5	4	7	8	0	5	5	6	12	12	3	10	11	3	9	9	17
Deepwater Channel																
LA4	1	6	7	1	8	8	4	11	13	3	8	9	2	8	9	16
LB7	1	5	6	1	4	4	1	11	12	1	9	9	1	7	8	13
Deepwater Open																
LA1	4	6	8	4	8	10	4	7	8	1	9	9	3	8	9	14
LB1	4	7	9	4	7	8	8	8	11	5	7	9	5	7	9	20
Deepwater Slip																
LB4	0	10	10	2	9	10	0	8	8	2	8	8	1	9	9	19
LB6	5	9	9	3	6	7	10	12	17	5	12	12	6	10	11	22
Shallow Mitigation																
LA2A	6	12	14	11	10	14	15	11	19	10	15	21	11	12	17	29
LA2B	3	2	5	5	9	11	12	13	19	1	8	9	5	8	11	22
LA7A	5	4	8	13	19	21	11	13	19	8	14	18	9	13	17	33
LA7B	4	13	14	17	14	22	14	11	20	12	14	21	12	13	19	32
LB2A	9	16	19	5	12	15	8	11	16	1	16	16	6	14	17	31
LB2B	3	10	12	7	11	15	8	15	17	2	16	18	5	13	16	28
Shallow Water Open																
LA3A	3	7	8	3	8	9	9	8	13	6	11	12	5	9	11	19
LA3B	5	10	14	7	9	13	8	12	13	4	11	13	6	11	13	25
Survey Mean	4	8	10	5	9	11	7	11	14	4	11	12	5	10	12	
Survey Total Unique	25	35	40	29	32	38	32	30	40	28	35	36	29	33	39	50

Lampara Catch

Shannon-Weiner Diversity

	February 2000			May 2000			August 2000			November 2000			Annual Mean		
Area	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Basin															
LA5	0.62	1.18	1.44	0.35	0.54	0.78	0.95	1.65	1.68	NA	1.00	1.00	0.64	1.09	1.23
LA6	NA	0.49	0.70	0.24	0.75	0.83	0.66	1.53	1.42	0.27	0.77	0.77	0.39	0.89	0.93
LB3	1.25	0.14	0.38	0.24	0.99	0.51	0.98	0.09	0.17	0.82	1.28	1.57	0.82	0.63	0.66
LB5	1.08	0.11	0.15	NA	0.67	0.67	0.29	0.24	0.31	0.52	0.82	0.93	0.63	0.46	0.51
Deepwater Channel															
LA4	NA	1.08	1.11	NA	0.28	0.69	0.41	1.42	1.08	1.06	1.14	1.22	0.74	0.98	1.03
LB7	NA	0.78	0.97	NA	0.57	0.75	NA	0.32	0.32	NA	0.49	0.49	NA	0.54	0.63
Deepwater Open															
LA1	0.95	1.32	1.74	0.58	0.91	1.14	1.05	1.27	1.34	NA	1.38	0.82	0.86	1.22	1.26
LB1	0.78	1.06	1.37	0.65	1.10	1.21	0.90	0.78	1.12	1.13	1.33	1.51	0.86	1.07	1.30
Deepwater Slip															
LB4	NA	0.33	0.33	0.14	0.10	0.13	NA	1.27	1.27	0.15	0.75	0.77	0.15	0.61	0.62
LB6	1.10	0.29	0.41	0.46	0.99	0.77	1.27	1.36	1.38	1.14	1.52	1.53	0.99	1.04	1.02
Shallow Mitigation															
LA2A	0.72	1.58	1.46	1.39	1.83	1.83	1.15	1.64	1.51	1.34	1.98	2.00	1.15	1.76	1.70
LA2B	0.17	0.69	1.15	1.07	1.66	1.68	1.84	1.41	1.47	NA	1.62	1.56	1.03	1.34	1.47
LA7A	0.07	1.07	0.40	1.70	1.56	1.92	1.47	0.95	1.73	1.75	1.98	2.31	1.25	1.39	1.59
LA7B	1.15	1.60	1.71	1.83	1.27	1.64	2.35	1.10	1.54	0.77	2.04	1.10	1.53	1.50	1.50
LB2A	0.42	1.31	1.52	0.12	1.02	1.16	1.20	1.24	1.45	NA	1.40	1.50	0.58	1.24	1.41
LB2B	0.54	1.77	1.89	1.23	1.16	1.21	1.38	1.42	1.64	0.21	1.56	1.64	0.84	1.48	1.60
Shallow Water Open															
LA3A	0.48	0.87	1.14	0.69	1.80	1.73	1.78	0.67	0.84	1.16	1.25	1.41	1.03	1.15	1.28
LA3B	1.02	1.39	1.61	1.40	1.73	2.01	0.93	0.38	0.46	0.99	1.55	1.66	1.08	1.26	1.43
Survey Mean	0.74	0.95	1.08	0.81	1.05	1.15	1.16	1.04	1.15	0.87	1.33	1.32	0.86	1.09	1.18

NA - Not applicable

Lampara Catch

Margalef Diversity

Area	February 2000			May 2000			August 2000			November 2000			Annual Mean		
	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Basin															
LA5	0.36	1.35	1.52	0.62	1.25	1.37	1.24	1.78	1.95	NA	1.47	1.47	0.74	1.46	1.58
LA6	NA	0.42	0.36	0.37	1.20	1.19	0.30	1.31	1.17	0.57	0.81	0.97	0.41	0.94	0.92
LB3	1.53	0.49	0.98	0.94	1.30	1.64	0.72	0.91	0.91	0.57	1.78	1.87	0.94	1.12	1.35
LB5	1.11	0.80	0.93	NA	1.04	1.04	0.52	1.25	1.11	0.46	1.23	1.36	0.70	1.08	1.11
Deepwater Channel															
LA4	NA	1.01	1.21	NA	1.06	1.02	0.40	1.59	1.54	0.69	1.22	1.38	0.55	1.22	1.29
LB7	NA	0.72	0.89	NA	0.53	0.52	NA	1.20	1.32	NA	1.00	1.00	NA	0.86	0.93
Deepwater Open															
LA1	1.11	1.53	1.88	0.60	1.54	1.64	0.85	1.01	1.17	NA	1.42	1.20	0.85	1.38	1.47
LB1	0.67	1.30	1.53	0.87	1.08	1.24	0.98	1.01	1.29	0.91	1.25	1.50	0.86	1.16	1.39
Deepwater Slip															
LB4	NA	1.12	1.12	0.29	0.94	1.05	NA	1.18	1.18	0.30	0.91	0.91	0.30	1.04	1.07
LB6	0.88	1.00	0.99	0.33	0.97	0.95	1.49	1.78	2.35	0.82	1.40	1.39	0.88	1.29	1.42
Shallow Mitigation															
LA2A	0.87	2.27	2.13	1.86	1.65	2.13	2.05	1.73	2.53	1.72	2.23	3.04	1.63	1.97	2.46
LA2B	0.45	0.21	0.75	0.94	1.55	1.82	3.02	1.59	2.39	NA	1.66	1.66	1.47	1.25	1.65
LA7A	0.62	0.77	1.08	2.48	3.08	3.25	1.87	2.28	3.00	1.80	2.93	3.48	1.69	2.27	2.70
LA7B	1.54	2.58	2.76	3.13	2.46	3.56	3.36	1.79	3.30	1.51	2.48	2.71	2.39	2.33	3.08
LB2A	1.28	2.37	2.58	0.67	1.81	2.09	1.32	1.34	1.99	NA	2.13	2.12	1.09	1.92	2.19
LB2B	0.78	1.94	2.31	2.08	1.71	2.37	1.32	2.02	2.25	0.34	2.25	2.55	1.13	1.98	2.37
Shallow Water Open															
LA3A	0.47	1.18	1.29	0.54	1.77	1.76	2.00	0.99	1.68	0.88	1.62	1.65	0.97	1.39	1.60
LA3B	1.15	1.57	2.23	1.67	2.31	2.84	1.72	1.38	1.51	0.96	1.87	2.20	1.38	1.78	2.20
Survey Mean	0.92	1.26	1.47	1.16	1.51	1.75	1.45	1.45	1.81	0.89	1.65	1.80	1.06	1.47	1.71

NA - Not applicable

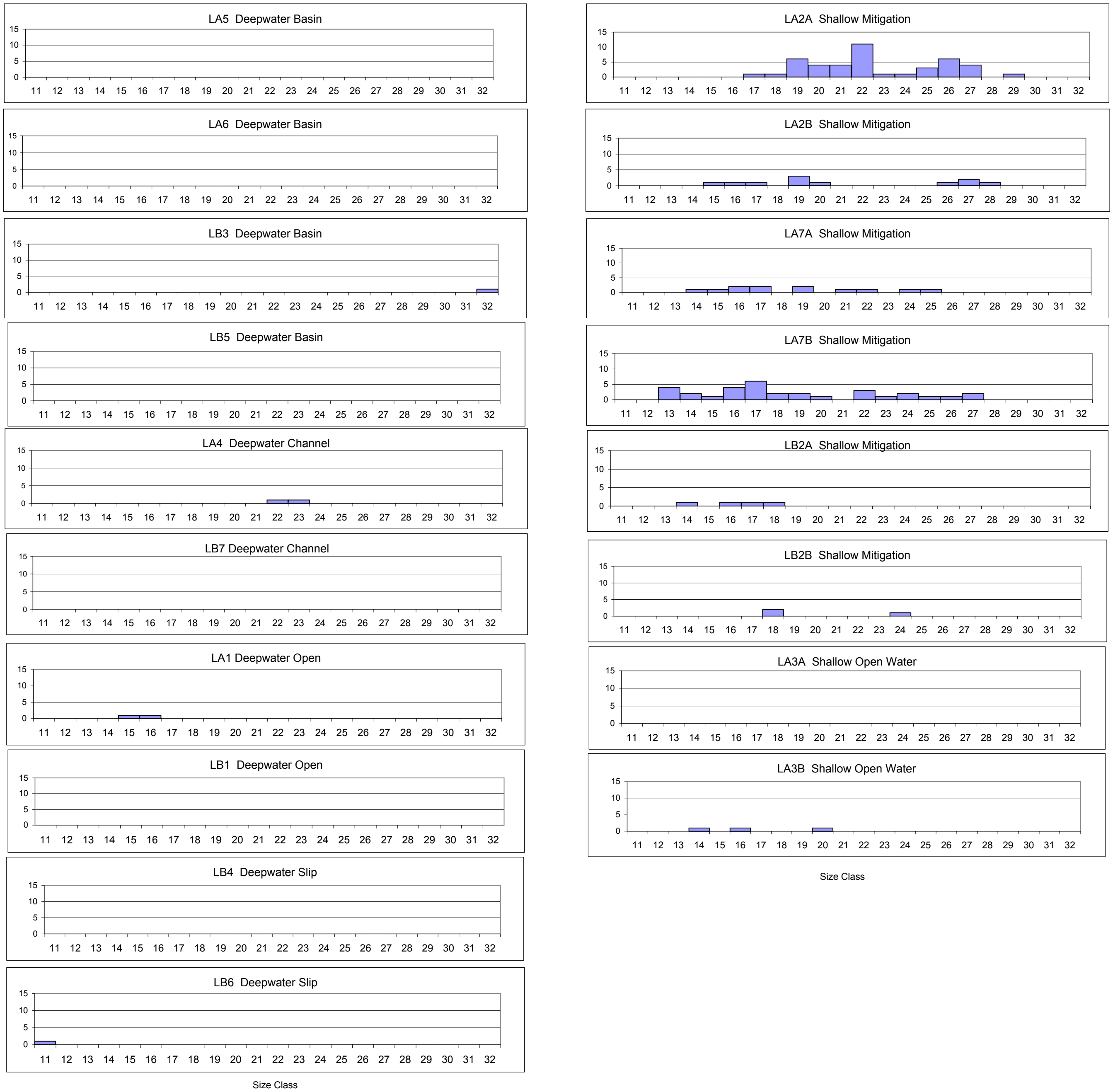
Lampara Catch

Dominance Index

Area	February 2000			May 2000			August 2000			November 2000			Annual Mean		
	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Basin															
LA5	2	2	3	1	1	1	2	3	3	NA	2	2	2	2	2
LA6	1	1	2	1	1	1	2	3	3	1	2	2	1	2	2
LB3	2	1	1	1	2	1	2	1	1	2	2	3	2	2	2
LB5	2	1	1	1	2	1	2	1	1	2	2	3	2	2	2
Deepwater Channel															
LA4	1	2	2	1	1	1	1	3	2	2	2	2	1	2	2
LB7	1	2	2	1	1	2	1	1	1	1	1	1	1	1	2
Deepwater Open															
LA1	2	2	4	1	1	2	2	3	3	1	2	1	2	2	3
LB1	2	2	3	1	2	3	2	1	2	2	3	3	2	2	3
Deepwater Slip															
LB4	1	1	1	1	1	1	NA	2	2	1	1	1	1	1	1
LB5	2	1	1	1	1	1	1	1	1	1	1	2	1	1	1
LB6	2	1	1	1	2	1	2	2	3	2	3	3	2	2	2
Shallow Mitigation															
LA2A	1	3	3	3	4	4	2	3	3	2	4	4	2	4	4
LA2B	1	2	3	2	3	3	5	2	3	1	3	3	2	3	3
LA7A	1	2	1	3	3	4	3	1	3	4	4	6	3	3	4
LA7B	3	3	3	4	2	3	7	2	3	1	5	2	4	3	3
LB2A	1	2	2	1	2	2	2	2	3	1	2	3	1	2	3
LB2B	1	4	4	3	2	2	3	3	3	1	3	3	2	3	3
Shallow Water Open															
LA3A	1	1	2	2	4	3	3	1	1	2	2	3	2	2	2
LA3B	2	2	3	2	3	4	1	1	1	2	3	3	2	2	3
Survey Mean	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2

NA - Not applicable

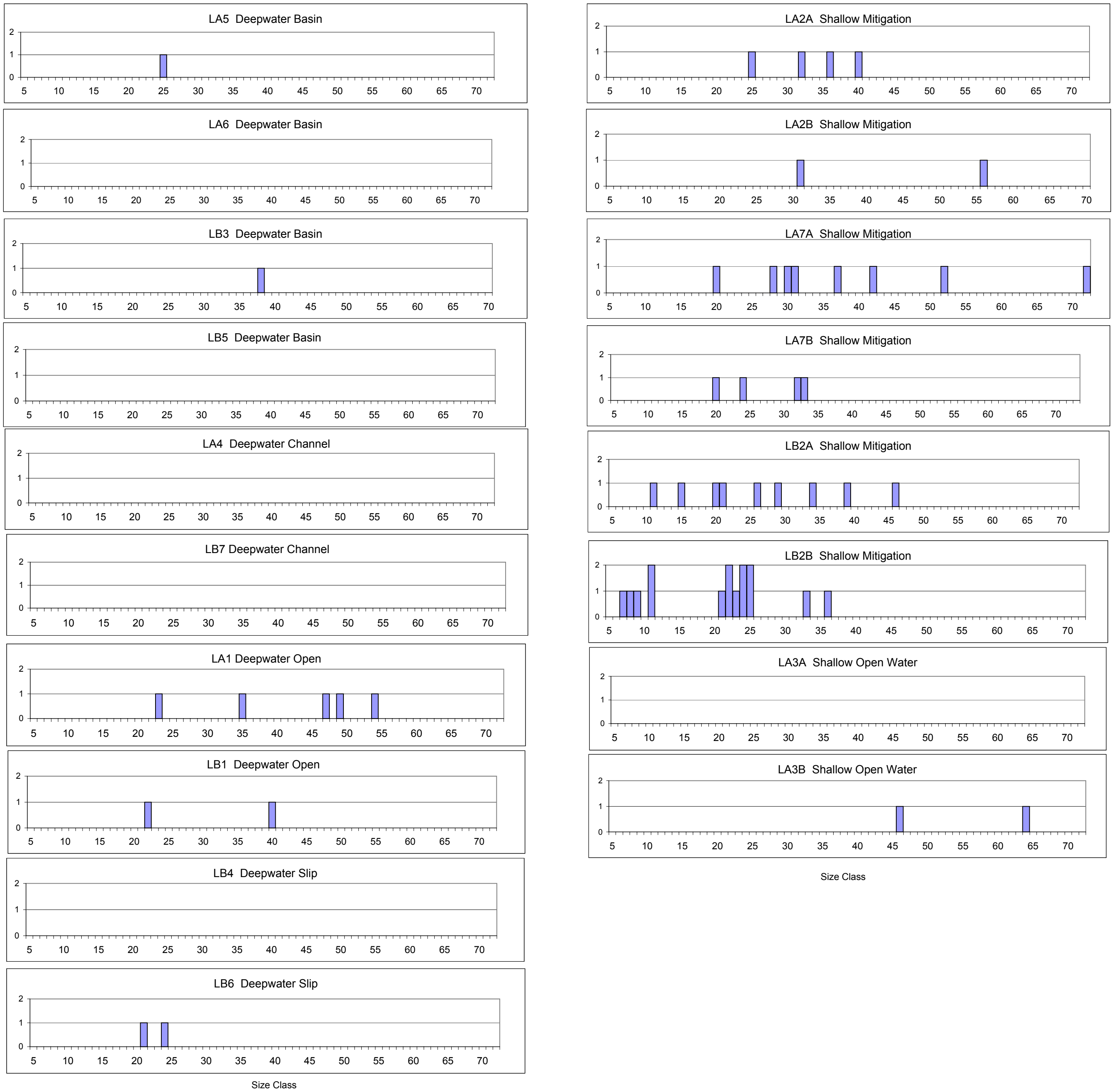
Size/Frequency Chart
Lampara Barred Sand Bass Catch
(Annual Total)



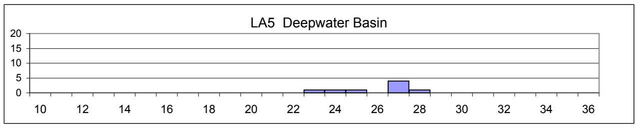
Size/Frequency Chart
Lampara Bat Ray Catch
(Annual Total)

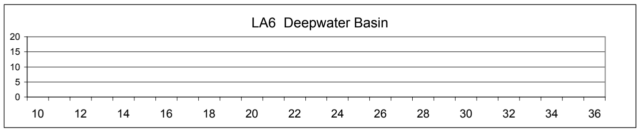
Size/Frequency Chart
Lampara California Barracuda Catch
(Annual Total)

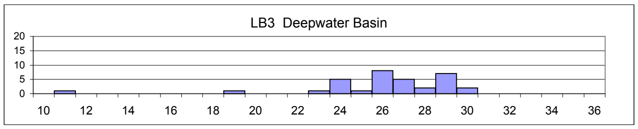
Size/Frequency Chart
Lampara California Halibut Catch
(Annual Total)

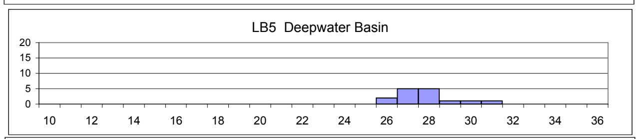


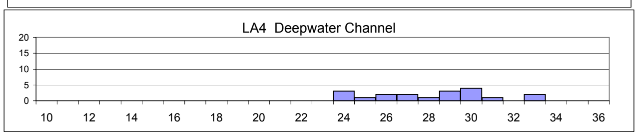
Size/Frequency Chart
Lampara Jacksmelt Catch
(Annual Total)

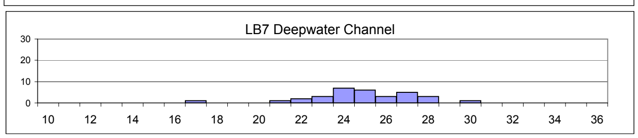


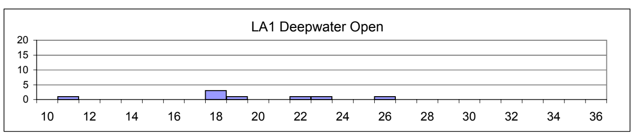


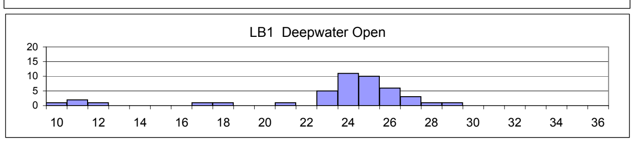


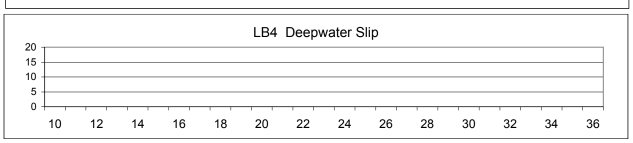


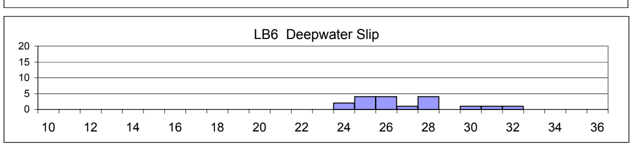




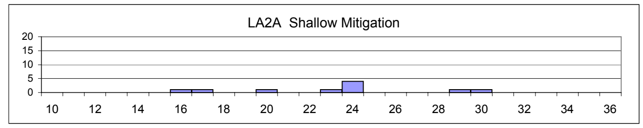


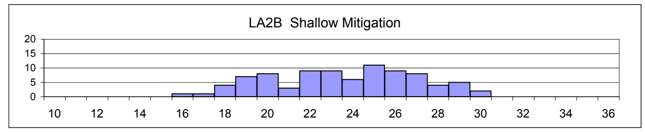


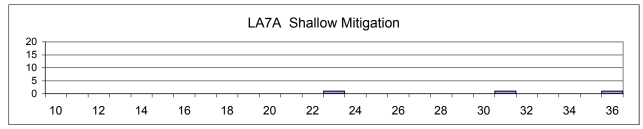


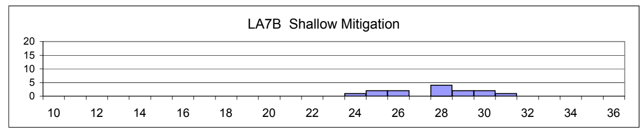


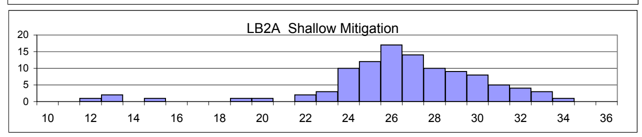
Size Class

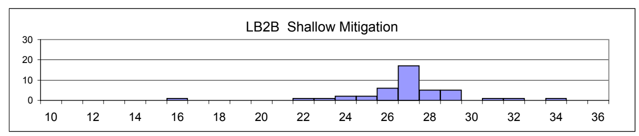


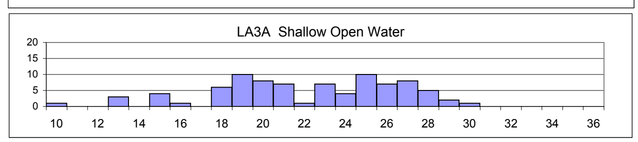


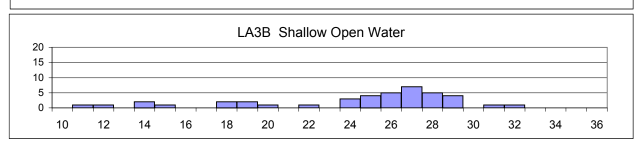






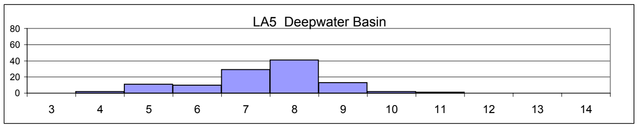


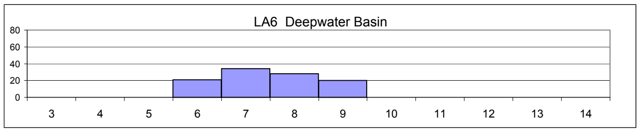


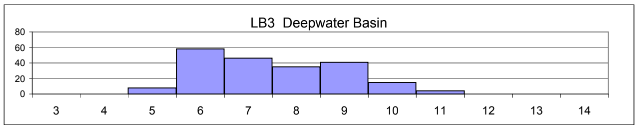


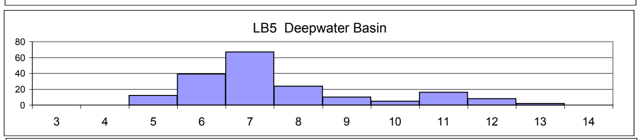
Size Class

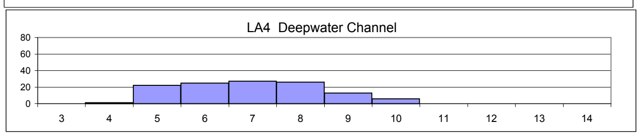
Size/Frequency Chart
Lampara Northern Anchovy Catch
(Annual Total)

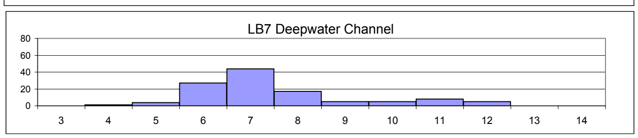


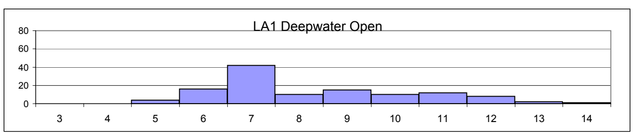


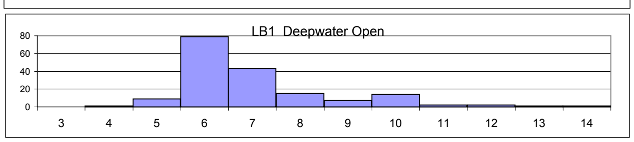


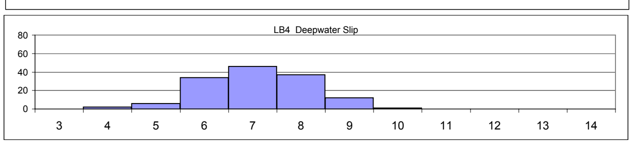


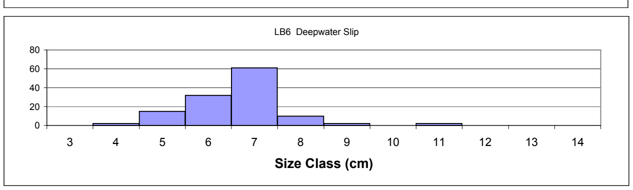


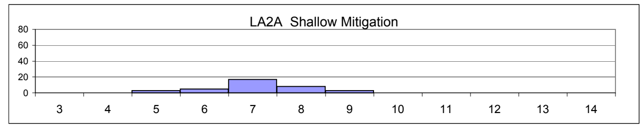


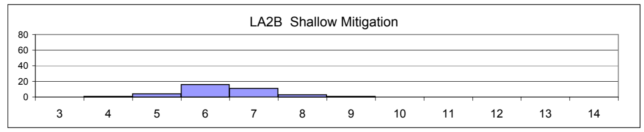


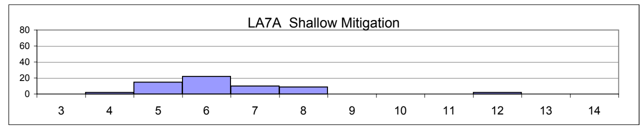


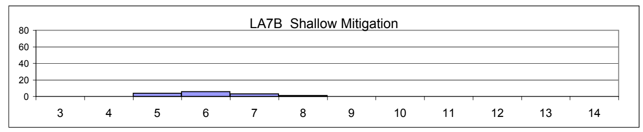


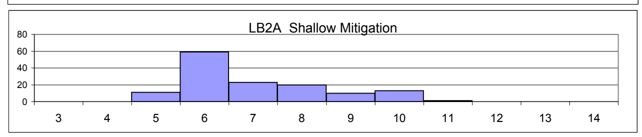


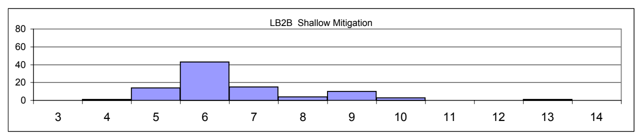


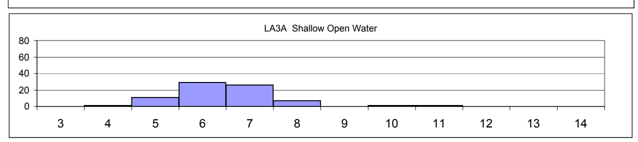


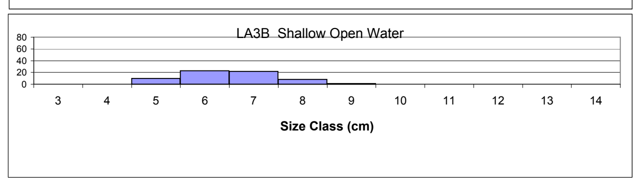




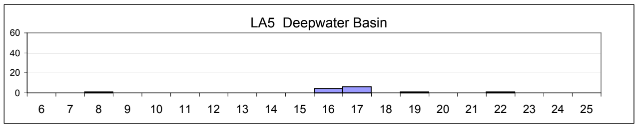


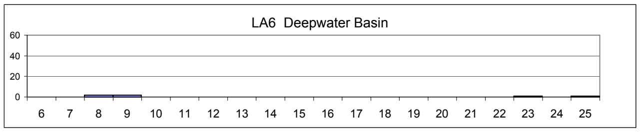


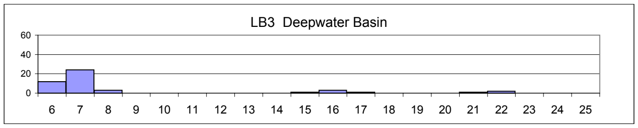


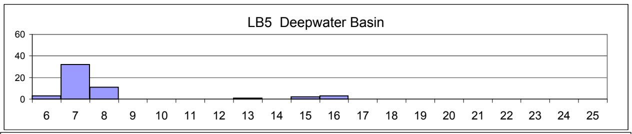


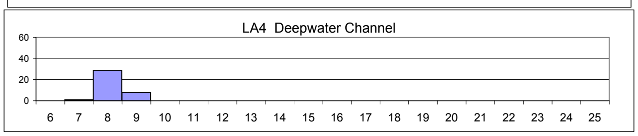
Size/Frequency Chart
Pacific Sardine Catch
(Annual Total)

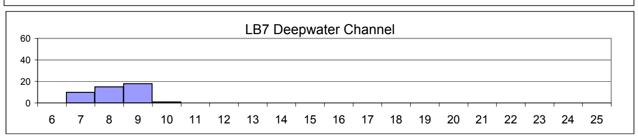


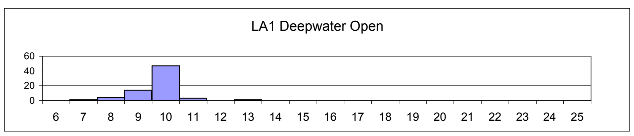


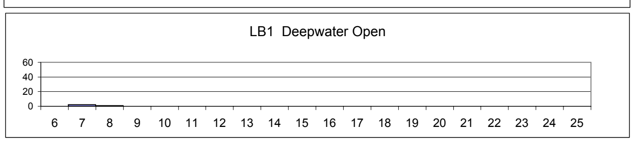


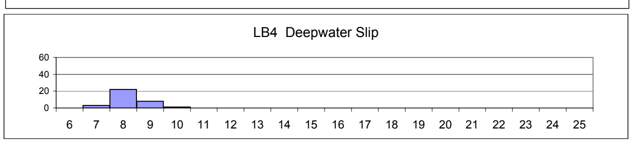


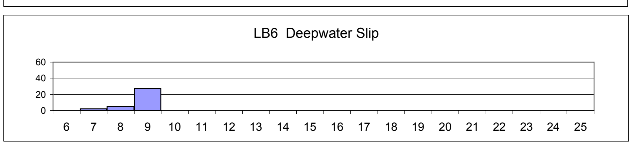




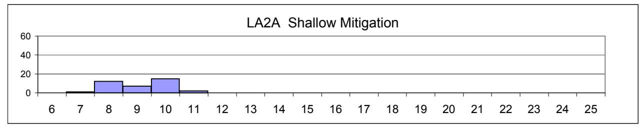


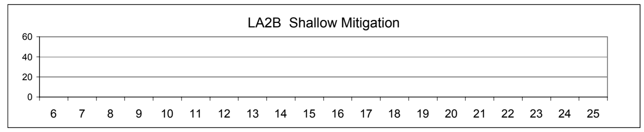


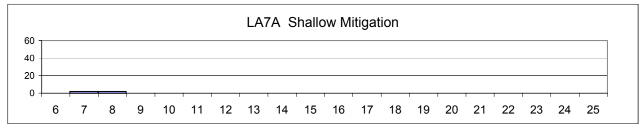


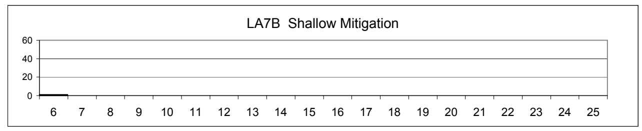


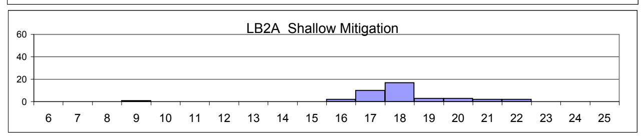
Size Class

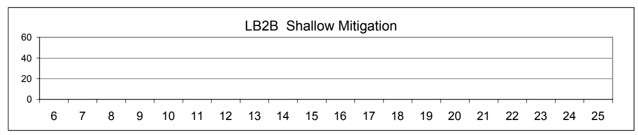


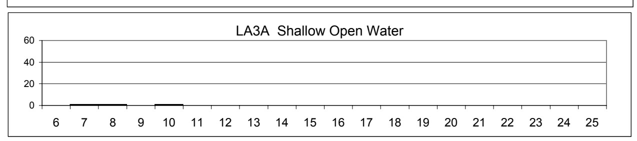


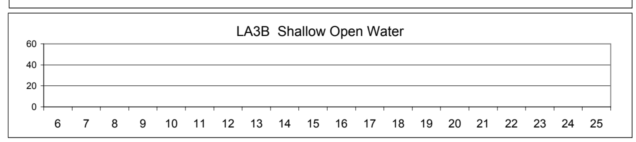






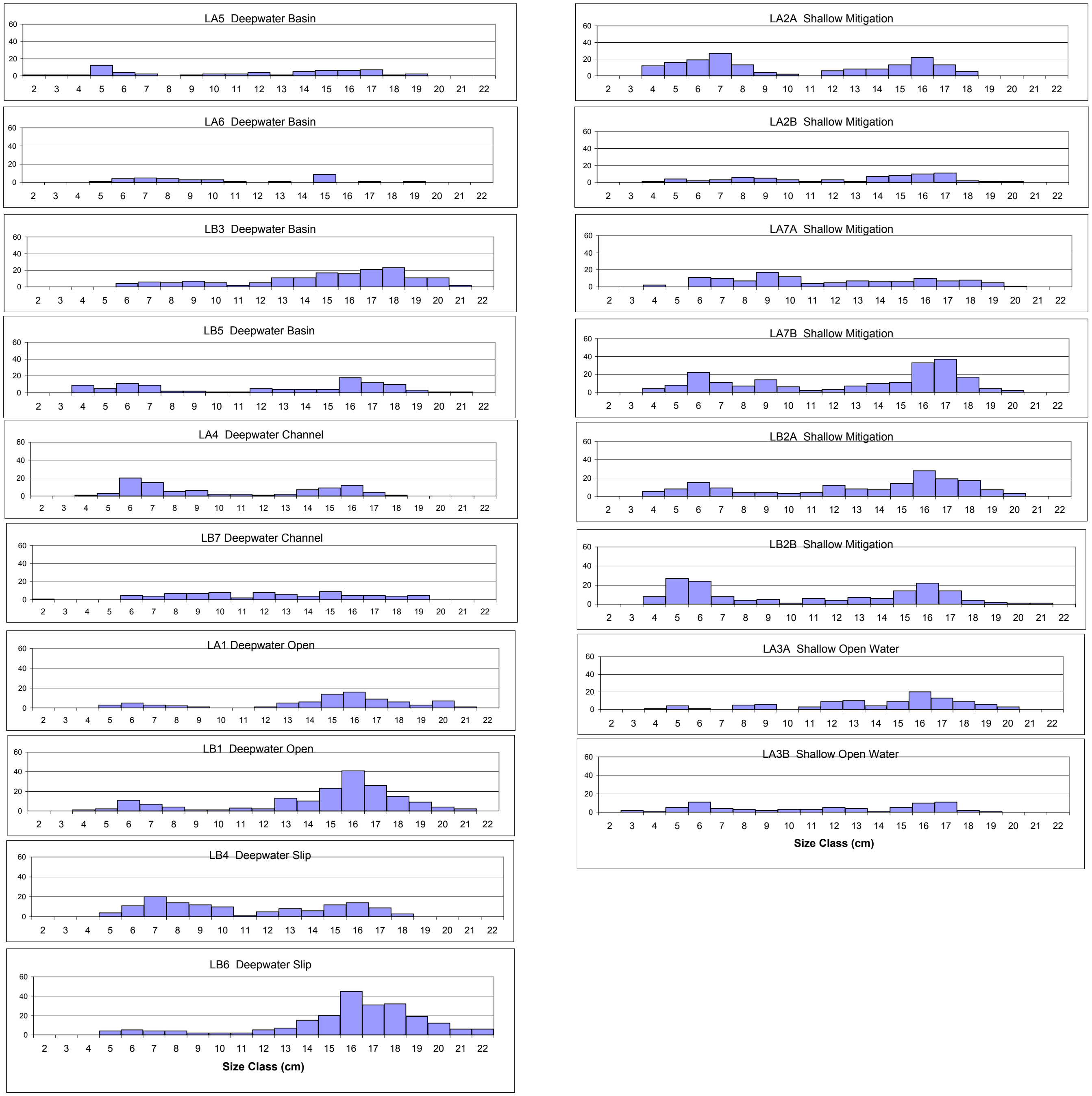




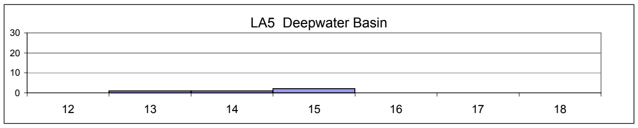


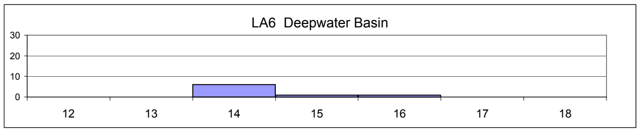
Size Class

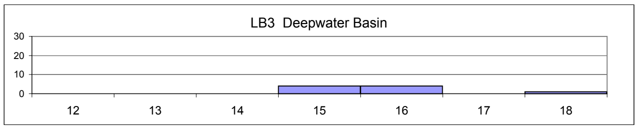
Size/Frequency Chart
Lampara Queenfish Catch
(Annual Total)

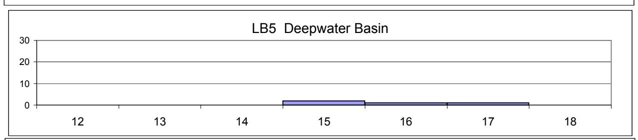


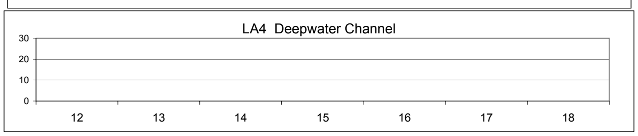
Size/Frequency Chart
Lampara Salema Catch
(Annual Total)

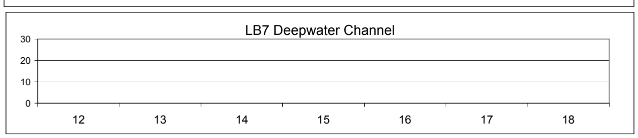


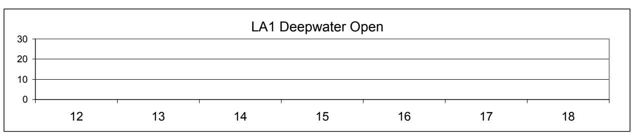


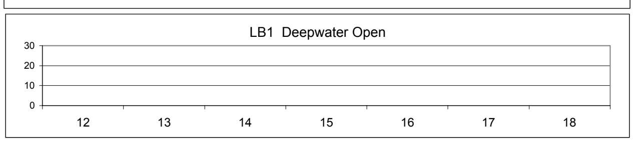


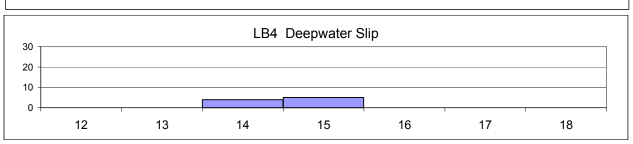


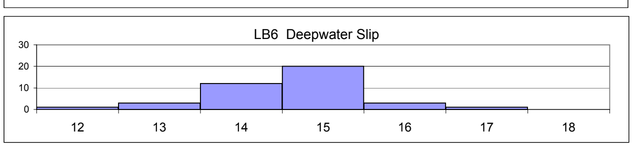




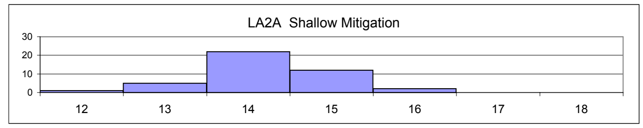


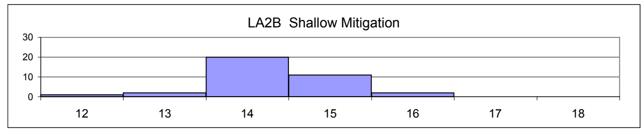


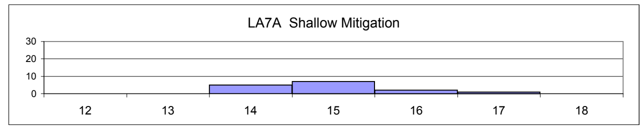


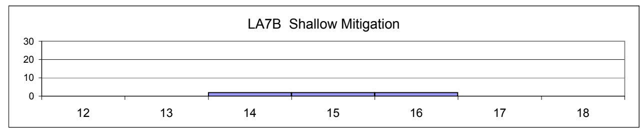


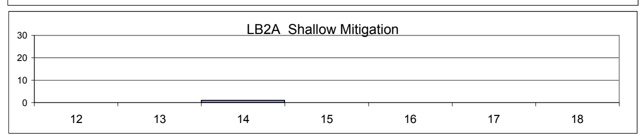
Size Class

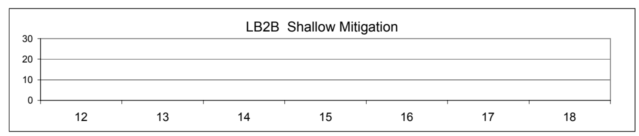


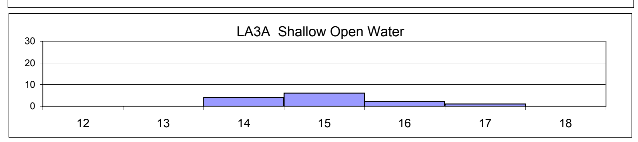


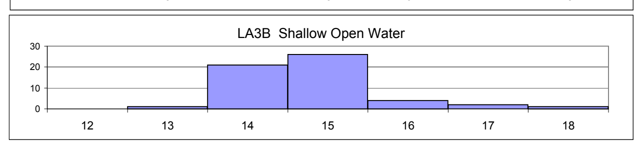






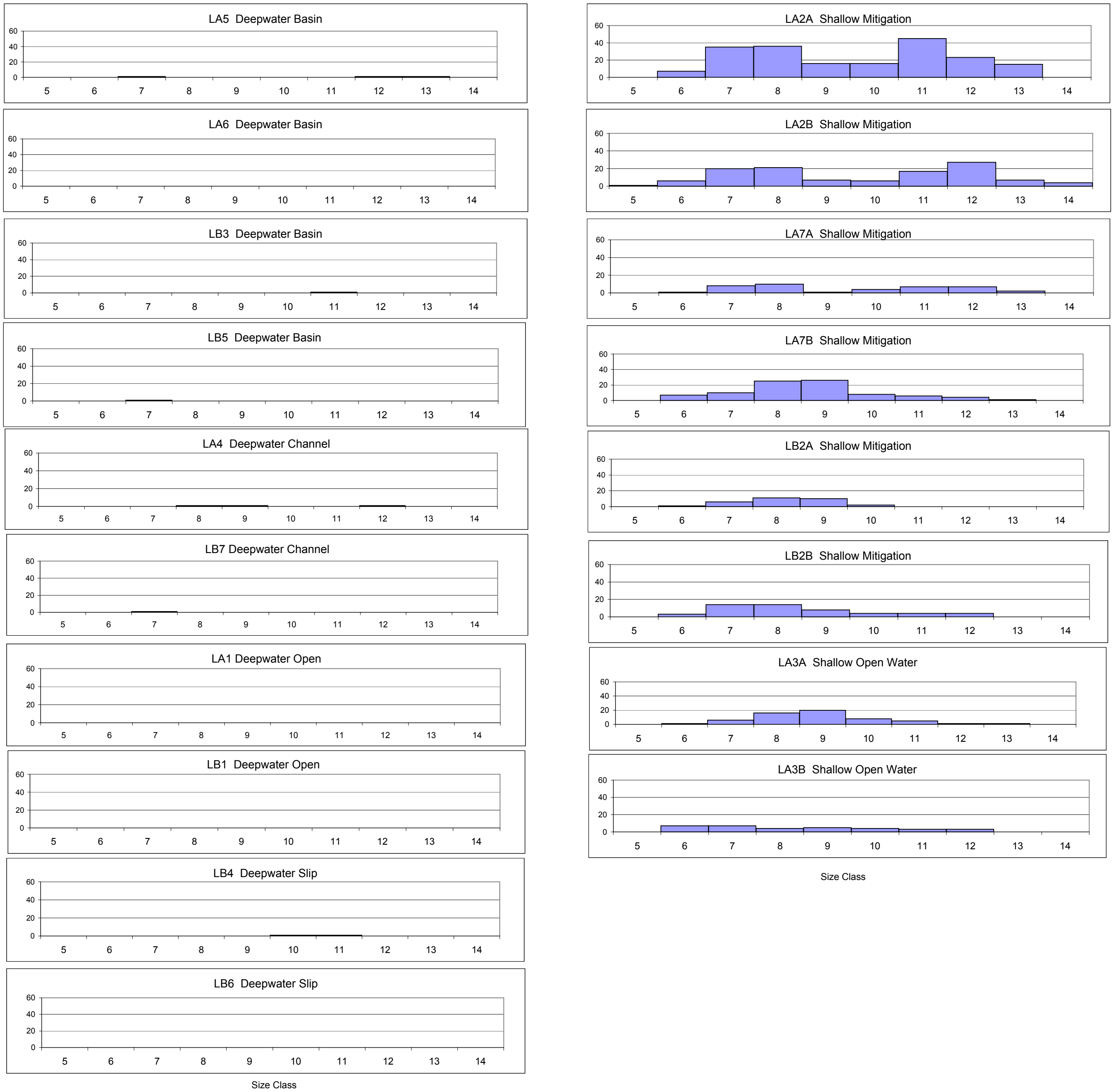




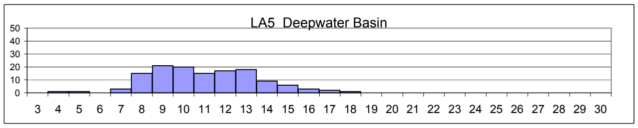


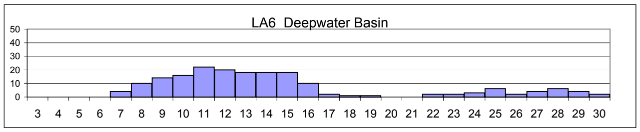
Size Class

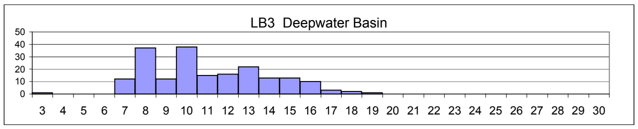
Size/Frequency Chart
Lampara Shiner Surfperch Catch
(Annual Total)

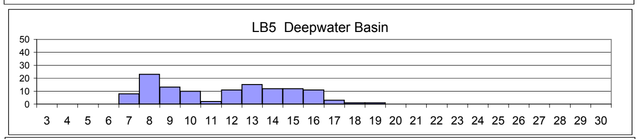


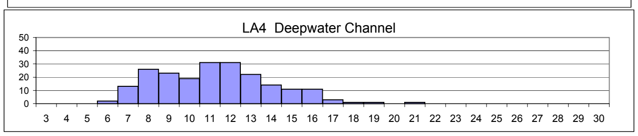
Size/Frequency Chart
Lampara Topsmelt Catch
(Annual Total)

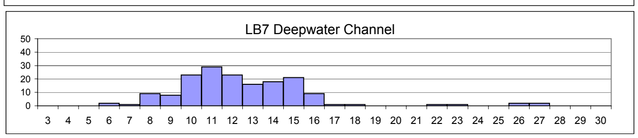


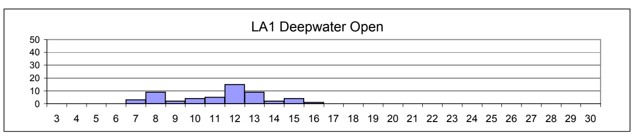


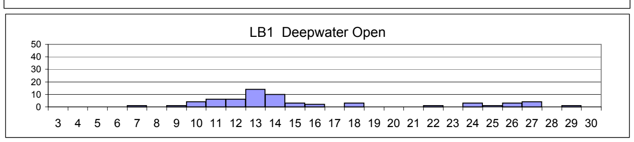


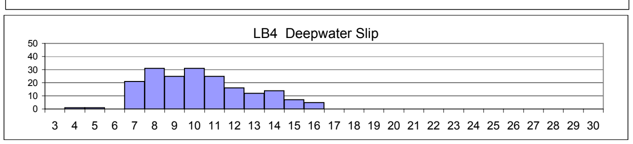


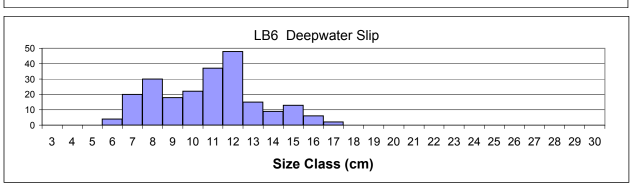


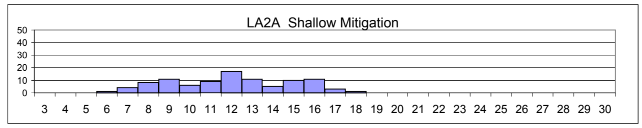


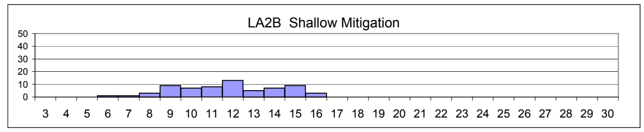


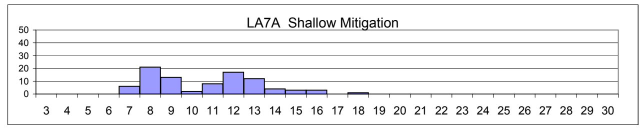


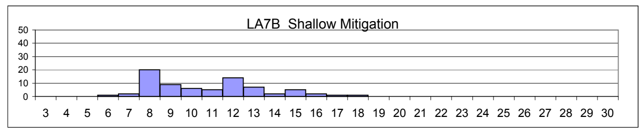


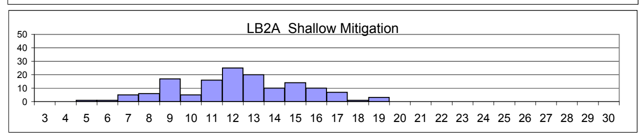


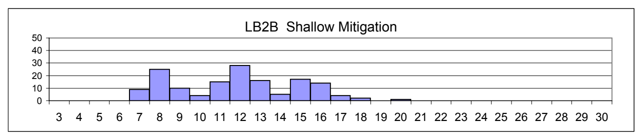


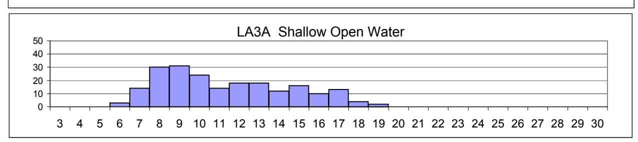


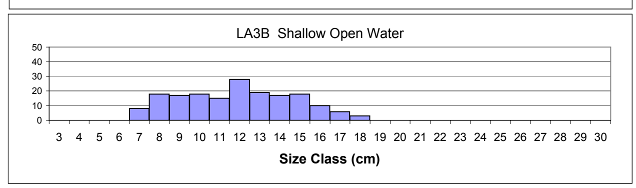




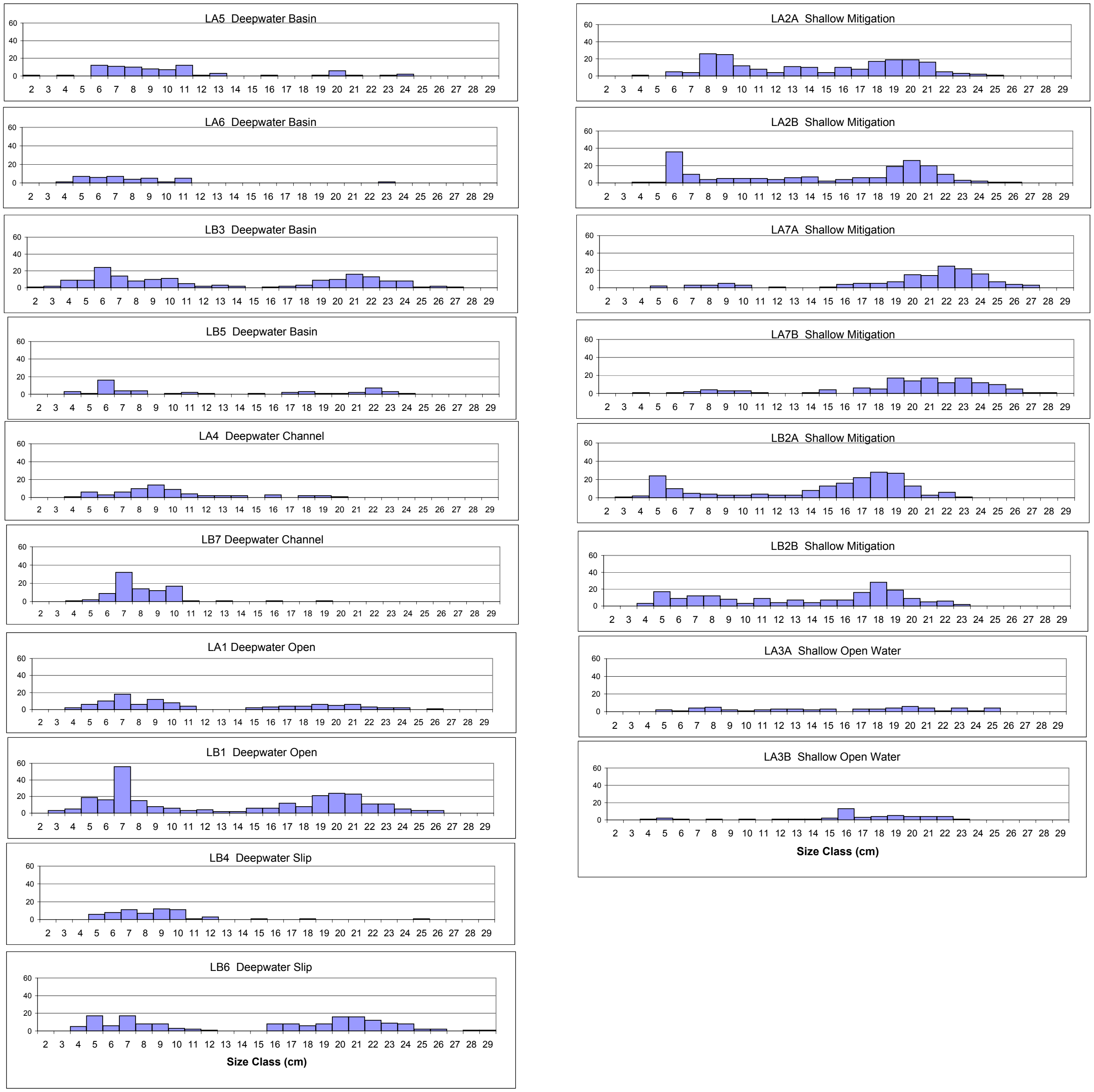








Size/Frequency Chart
Lampara White Croaker Catch
(Annual Total)



Size/Frequency Chart
Lampara White Surfperch Catch
(Annual Total)

February 2000
Lampara Catch - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Shovelnose guitarfish	*Rhinobatos productus*													1					
Round stingray	*Urolophus halleri*													1					
Bat ray	*Myliobatis californica*		21								4		13	11	1				
Pacific sardine	*Sardinops sagax*							11					475		3				
Northern anchovy	*Engraulis mordax*											1			1				
California lizardfish	*Synodus lucioceps*					1													
Specklefin midshipman	*Porichthys myriaster*					1													
Topsmelt	*Atherinops affinis*	3	1		4			5	130				7		56		6	57	
Jacksmelt	*Atherinopsis californiensis*			85	60	18				1		61	7		3		1	8	18
California grunion	*Leuresthes tenuis*	10		1									4						
Jack mackerel	*Trachurus symmetricus*			2	5										6		7		
White seabass	*Atractoscion nobilis*														1				
White croaker	*Genyonemus lineatus*	1	1							1	1	20			100			21	
California corbina	*Menticirrhus undulatus*												7						
Queenfish	*Seriphus politus*														18			8	
Shiner surfperch	*Cymatogaster aggregata*		250																
White surfperch	*Phanerodon furcatus*		49			11				2	1								
California barracuda	*Sphyraena argentea*						1			600		4	1						
Pacific cutlassfish	*Trichiurus nitens*																	1	
Chub mackerel	*Scomber japonicus*																1		
California halibut	*Paralichthys californicus*	1									1								
Fantail sole	*Xystreurys liolepis*		1										1						
Spotted turbot	*Pleuronichthys ritteri*									2									
Hornyhead turbot	*Pleuronichthys verticalis*												1						
California tonguefish	*Symphurus atricauda*					1													

Total catch - Day		15	323	88	69	32	1	16	130	606	7	86	516	13	189	0	15	95	18
Number of species - Day		4	6	3	3	5	1	2	1	5	4	4	9	3	9	0	4	5	1

February 2000
Lampara Catch - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Grey smoothhound shark	*Mustelus californicus*										1								
Shovelnose guitarfish	*Rhinobatos productus*										5								
Thornback	*Platyrhinoidis triseriata*		1										1						
Round stingray	*Urolophus halleri*										1								
Bat ray	*Myliobatis californica*		11							5	6	1	7	6					
Pacific sardine	*Sardinops sagax*	1											2		5		6		
Northern anchovy	*Engraulis mordax*	14	1		18	15	12	52	100	4	2	4	4	15	3257	2801	1850	7	188
Deepbody anchovy	*Anchoa compressa*										2		36	2		1			1
Slough anchovy	*Anchoa delicatissima*							1					13	1		2			
California lizardfish	*Synodus lucioceps*				1														
Plainfin midshipman	*Porichthys notatus*							1								1			
Specklefin midshipman	*Porichthys myriaster*							4								1			
Basketweave cusk-eel	*Ophidion scrippsae*												2						
Topsmelt	*Atherinops affinis*	1	32	56	121	171	98	8	20		12	2	379	3	84	168	4	13	63
Jacksmelt	*Atherinopsis californiensis*	6			12	13	4						8		3		1	10	
California grunion	*Leuresthes tenuis*				3	22	10							1					
Black rockfish	*Sebastes melanops*					1													
California scorpionfish	*Scorpaena guttata*		1																
Barred sand bass	*Paralabrax nebulifer*										1								
Jack mackerel	*Trachurus symmetricus*							17			1						14	7	
Salema	*Xenistius californiensis*		1		2	64										1		2853	
White croaker	*Genyonemus lineatus*	2	26	61		15	12			29	14	58		23		1		17	9
California corbina	*Menticirrhus undulatus*												2						
Queenfish	*Seriphus politus*	2	49		2	1	5	2	1	10	57	33	94	35	4	55	5	100	4
Shiner surfperch	*Cymatogaster aggregata*		2			5								15					
White surfperch	*Phanerodon furcatus*										1					1			
Pile surfperch	*Rhacochilus vacca*											1							
Blacksmith	*Chromis punctipinnis*																1		
Giant kelpfish	*Heterostichus rostratus*		1																
Pacific cutlassfish	*Trichiurus nitens*																	7	
Speckled sanddab	*Citharichthys stigmaeus*					1													
California halibut	*Paralichthys californicus*		1									2	5	2				3	
Fantail sole	*Xystreurys liolepis*												1						
Spotted turbot	*Pleuronichthys ritteri*		1										2						
Diamond turbot	*Hypsopsetta guttulata*										2		1						
Total catch - Night		26	127	117	159	308	141	85	121	48	105	101	557	103	3353	3032	1881	3016	265
Number of species - Night		6	12	2	7	10	6	7	3	4	13	7	15	10	5	10	7	9	5

May 2000
Lampara Catch - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Brown smoothhound shark	*Mustelus henlei*														1				
Shovelnose guitarfish	*Rhinobatos productus*									1	3								
Thornback	*Platyrhinoidis triseriata*		1																
Round stingray	*Urolophus halleri*									1	2								
Bat ray	*Myliobatis californica*	1	12							3	4			1					
Pacific sardine	*Sardinops sagax*										1								
Northern anchovy	*Engraulis mordax*	125						1		10	4		375		557.5				
California lizardfish	*Synodus lucioceps*					3						1	1	1					
Specklefin midshipman	*Porichthys myriaster*									1									
Topsmelt	*Atherinops affinis*		6		29	14	191	114	14		11	4	5	1		30		342	43
Jacksmelt	*Atherinopsis californiensis*		4								2								
Barred sand bass	*Paralabrax nebulifer*		23	5		1				1				1	1				
Jack mackerel	*Trachurus symmetricus*							1	1		2								
Sargo	*Anisotremus davidsoni*									7	1								
White croaker	*Genyonemus lineatus*	16	131	33	11	14		9		44	27	26		12	11			39	
California corbina	*Menticirrhus undulatus*		3		1														
Queenfish	*Seriphus politus*	8								1	79	1			12				
White seabass	*Atractoscion nobilis*															1			
Shiner surfperch	*Cymatogaster aggregata*		7	29						10	2								
Walleye surfperch	*Hyperprosopon argenteum*		2																
White surfperch	*Phanerodon furcatus*		25	1		1				44	15		1		1				
Pile surfperch	*Rhacochilus vacca*													1					
California barracuda	*Sphyraena argentea*										10								
Pacific butterfish	*Peprilus simillimus*																	13	
Pacific sanddab	*Citharichthys sordidus*												1						
California halibut	*Paralichthys californicus*		1			2				2	1			1	1				
Fantail sole	*Xystreurys liolepis*					1					1								
Spotted turbot	*Pleuronichthys ritteri*									2	1								
Diamond turbot	*Hypsopsetta guttulata*			2															
Total catch - Day		150	215	70	41	36	191	125	15	127	166	32	383	18	584.5	31	0	394	43
Number of species - Day		4	11	5	3	7	1	4	2	13	17	4	5	7	7	2	0	3	1

May 2000
Lampara Catch - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Grey smoothhound shark	*Mustelus californicus*									1	4								
Brown smoothhound shark	*Mustelus henlei*											2							
Shovelnose guitarfish	*Rhinobatos productus*									7									
Thornback	*Platyrhinoidis triseriata*													1					
Round stingray	*Urolophus halleri*															1			
Bat ray	*Myliobatis californica*		19	10						2	3		3		1				
Northern anchovy	*Engraulis mordax*						701	1163	283	2	1	148	25	7	157	5036	38		7
Deepbody anchovy	*Anchoa compressa*								1										
Slough anchovy	*Anchoa delicatissima*																	2	
Plainfin midshipman	*Porichthys notatus*							3											
Specklefin midshipman	*Porichthys myriaster*	1			3	2	1	11	2	1		2	1			5	1		
Topsmelt	*Atherinops affinis*	3	47		3	5	8	1	19	6		3	9	35		14	1	100	22
Jacksmelt	*Atherinopsis californiensis*						2			1	1		2	2	3				
California scorpionfish	*Scorpaena guttata*		2			1													
Barred sand bass	*Paralabrax nebulifer*	1	4	2			1			4	1			1					
Jack mackerel	*Trachurus symmetricus*			2		1	1		5	23	8	1	1	3	15		2		
Salema	*Xenistius californiensis*		65	58	10	9		4	8	14	5		1		2	8			
White croaker	*Genyonemus lineatus*	70	58	48	10	1	17	172	15	39	13	41	293	218	13	17	4	14	243
California corbina	*Menticirrhus undulatus*		6										4	3					
Yellowfin croaker	*Umbrina roncador*									4									
Queenfish	*Seriphus politus*	13	2	21	17	11	8	12	9	210	135	58	90	69	26	24		53	13
Shiner surfperch	*Cymatogaster aggregata*		12	30	4	1		2		10	4				1	2			
White surfperch	*Phanerodon furcatus*	1	21		4			3		10	19			5				1	
Pile surfperch	*Rhacochilus vacca*									1	1								
California barracuda	*Sphyraena argentea*							1			1								
Chub mackerel	*Scomber japonicus*																	1	
Pacific butterfish	*Peprilus simillimus*	1																	
Speckled sanddab	*Citharichthys stigmaeus*				1														
California halibut	*Paralichthys californicus*	3								3			2						
Fantail sole	*Xystreurys liolepis*			1		1				3			1			1			
Spotted turbot	*Pleuronichthys ritteri*			4						2									
Diamond turbot	*Hypsopsetta guttulata*										1			2					
Total catch - Night		93	236	176	52	32	739	1372	342	343	197	255	432	346	218	5108	46	171	285
Number of species - Night		8	10	9	8	9	8	10	8	19	14	7	12	11	8	9	5	6	4

August 2000
Lampara Catch - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Grey smoothhound shark	*Mustelus californicus*		5																
Shovelnose guitarfish	*Rhinobatos productus*		1							1	3								
Bat ray	*Myliobatis californica*		7	2							1		3	2					
Pacific sardine	*Sardinops sagax*						1583								150		1106		
Northern anchovy	*Engraulis mordax*					2				44		891			723		12907	17	
California lizardfish	*Synodus lucioceps*																	1	
Specklefin midshipman	*Porichthys myriaster*																	2	
Topsmelt	*Atherinops affinis*	14	3		16	46	226	3	17	106	5	4	19	66	37		1	81	
Jacksmelt	*Atherinopsis californiensis*												110	23					
California grunion	*Leuresthes tenuis*	2			1	2									27				
Barred pipefish	*Syngnathus auliscus*									1									
Barred sand bass	*Paralabrax nebulifer*		13	2		1				3	7		4	1				1	
Jack mackerel	*Trachurus symmetricus*				2		3	1				1							1
Sargo	*Anisotremus davidsoni*			1						1	2								
White croaker	*Genyonemus lineatus*	2	91	6	13	4			10	19	12	269	60	81	72		6	35	
California corbina	*Menticirrhus undulatus*		3	1									5						
Yellowfin croaker	*Umbrina roncador*		1																
Queenfish	*Seriphus politus*	16	32	1	4	1				9	3	66			12		12	240	
White seabass	*Atractoscion nobilis*									1	2								
Shiner surfperch	*Cymatogaster aggregata*		588								1								
Black surfperch	*Embiotoca jacksoni*		1	1							1							1	
Walleye surfperch	*Hyperprosopon argenteum*		1	1	2														
White surfperch	*Phanerodon furcatus*		162	18	13	2				26	3			30				1	
California barracuda	*Sphyraena argentea*				3														
Giant kelpfish	*Heterostichus rostratus*			1		1				1	4								
Chub mackerel	*Scomber japonicus*						7					54		1			14		
Pacific butterfish	*Peprilus simillimus*		1															36	
California halibut	*Paralichthys californicus*		2	2				1			3			1					
Spotted turbot	*Pleuronichthys ritteri*											1	1						
Hornyhead turbot	*Pleuronichthys verticalis*											1							
Diamond turbot	*Hypsopsetta guttulata*			2							1								
California tonguefish	*Symphurus atricauda*				1								1						
Total catch - Day		34	911	38	55	59	1819	5	27	212	48	1287	203	205	1021	0	14045	415	1
Number of species - Day		4	15	12	9	8	4	3	2	11	14	8	8	8	6	0	6	10	1

August 2000
Lampara Catch - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Thornback	*Platyrhinoidis triseriata*													3					
Round stingray	*Urolophus halleri*										1			1					
Bat ray	*Myliobatis californica*		8	7						2			4	4					
Pacific sardine	*Sardinops sagax*	3	13		1			1	1	4		3			6	1	8	1	11
Northern anchovy	*Engraulis mordax*	148	117	718	981	2608	40	61	2		7	57	688	253	19263	133	6335	37	4009
Deepbody anchovy	*Anchoa compressa*							4		2					1	2	1		1
Slough anchovy	*Anchoa delicatissima*							2											
California lizardfish	*Synodus lucioceps*					1													
Specklefin midshipman	*Porichthys myriaster*					3	3	8			1		1		1		4		6
Topsmelt	*Atherinops affinis*	18	1	21	85	50	132	64	9	6	19	14	55	29	11	165	51	38	28
Jacksmelt	*Atherinopsis californiensis*			6			1											3	3
California grunion	*Leuresthes tenuis*			6	6	17	1					1			28		7	15	
California scorpionfish	*Scorpaena guttata*		1											1					
Barred sand bass	*Paralabrax nebulifer*	1	1	2		1				1									
Jack mackerel	*Trachurus symmetricus*						5	1	6		3					1	2		
Salema	*Xenistius californiensis*									1									
White croaker	*Genyonemus lineatus*	75	20	95	10	10	77	30	12	2	10	749	643	265	91	40	17	7	131
California corbina	*Menticirrhus undulatus*									1									
Black croaker	*Cheilotrema saturnum*						1											1	
Queenfish	*Seriphus politus*	125	71	239	100	100	261	97	15	152	197	171	289	419	103	33	203	277	76
Shiner surfperch	*Cymatogaster aggregata*		79	690	7	24	1	1		11	15		13	31			1		1
White surfperch	*Phanerodon furcatus*		13	67		1				2	15		1	10					
Pile surfperch	*Rhacochilus vacca*					1													
California barracuda	*Sphyraena argentea*										1								
Chub mackerel	*Scomber japonicus*		1							1			2	1	9		5	7	6
Pacific butterfish	*Peprilus simillimus*			3	3	4	25	9		6	2	2	8	1	10	2	1	94	1
California halibut	*Paralichthys californicus*	1		1									1	5				1	
Spotted turbot	*Pleuronichthys ritteri*			1															
Hornyhead turbot	*Pleuronichthys verticalis*											1		2				2	
Diamond turbot	*Hypsopsetta guttulata*													1					
Total catch - Night		371	325	1856	1193	2820	547	278	45	191	271	998	1705	1026	19523	377	6635	483	4273
Number of species - Night		7	11	13	8	12	11	11	6	13	11	8	11	15	10	8	12	12	11

November 2000
Lampara Catch - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Brown smoothhound shark	*Mustelus henlei*		2																
Shovelnose guitarfish	*Rhinobatos productus*		1																
Round stingray	*Urolophus halleri*										3								
Bat ray	*Myliobatis californica*		77							7									
Pacific sardine	*Sardinops sagax*	512							1										
Northern anchovy	*Engraulis mordax*											11						79	
Deepbody anchovy	*Anchoa compressa*																	22	
Slough anchovy	*Anchoa delicatissima*											2							
Topsmelt	*Atherinops affinis*				141	1	8		31	17	16.5	40			130	27	64		6
Jacksmelt	*Atherinopsis californiensis*			58	34	10	6				16.5		55	18	10		13		
California grunion	*Leuresthes tenuis*				15	11				3	1.5			1	50				
Barred sand bass	*Paralabrax nebulifer*		2							2	1.5								
Jack mackerel	*Trachurus symmetricus*						4												
White croaker	*Genyonemus lineatus*				1						267	29						5	
California corbina	*Menticirrhus undulatus*		2																
Yellowfin croaker	*Umbrina roncador*										1.5								
Queenfish	*Seriphus politus*											1						15	
Shiner surfperch	*Cymatogaster aggregata*		28		106						1089								
Black surfperch	*Embiotoca jacksoni*		1																
Walleye surfperch	*Hyperprosopon argenteum*		3																
White surfperch	*Phanerodon furcatus*		68		1					11	25.5								
California barracuda	*Sphyraena argentea*								1	6	6				2	1	1		
Chub mackerel	*Scomber japonicus*									2									
Pacific butterfish	*Peprilus simillimus*																	7	
Speckled sanddab	*Citharichthys stigmaeus*					1													
California halibut	*Paralichthys californicus*									1									
Fantail sole	*Xystreurys liolepis*										1.5								
Spotted turbot	*Pleuronichthys ritteri*		2								1.5								
Total catch - Day		512	186	58	298	23	18	0	33	49	1431	83	55	19	192	28	78	128	6
Number of species - Day		1	10	1	6	4	3	0	3	8	12	5	1	2	4	2	3	5	1

November 2000
Lampara Catch - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Grey smoothhound shark	*Mustelus californicus*		1								2								
Brown smoothhound shark	*Mustelus henlei*										1								
Shovelnose guitarfish	*Rhinobatos productus*									2	1								
Thornback	*Platyrhinoidis triseriata*												1						
Round stingray	*Urolophus halleri*												7						
Bat ray	*Myliobatis californica*		36	21							5				1				
Pacific sardine	*Sardinops sagax*	93	24		2		5	1	4							138	5	54	285
Northern anchovy	*Engraulis mordax*	132			24	14	55	5	134			28	41	140	442	1717	1135	1143	2592
Deepbody anchovy	*Anchoa compressa*										3		11	8	1			28	
Slough anchovy	*Anchoa delicatissima*	1							2		1			3	2		4	526.1	
Specklefin midshipman	*Porichthys myriaster*				1										3	8	3	11	
Topsmelt	*Atherinops affinis*	15	42	7	304	96	188	42	313	21	17		139	94	36	215	109	500	44
Jacksmelt	*Atherinopsis californiensis*	2	6				6	8		1		5	10		14			4	11
California grunion	*Leuresthes tenuis*	20	3		81	56						5							
Barcheek pipefish	*Syngnathus exilis*									1									
Barred sand bass	*Paralabrax nebulifer*						1			1	22								
Jack mackerel	*Trachurus symmetricus*							1	1									3	1
Sargo	*Anisotremus davidsoni*		2																
Salema	*Xenistius californiensis*		8	1	1	10					1				7		4	5	
White croaker	*Genyonemus lineatus*	5	65	8	13	5		1		23	18	63	450	130	64	4	26	39	8
California corbina	*Menticirrhus undulatus*			1						3			2	1					
Yellowfin croaker	*Umbrina roncador*									3									
Queenfish	*Seriphus politus*	3	88	6	41	18	48		8	15	42	18	433	355	269	59	181	275	21
Shiner surfperch	*Cymatogaster aggregata*		87	22	12	3	2			9	30		17	5					
Black surfperch	*Embiotoca jacksoni*										3								
Walleye surfperch	*Hyperprosopon argenteum*		5			4								1					
White surfperch	*Phanerodon furcatus*		164	1	2		3				43		3	1	2				
California barracuda	*Sphyraena argentea*					1				1					2	1	1		1
Chub mackerel	*Scomber japonicus*							1								11			
Pacific butterfish	*Peprilus simillimus*	13	2		4	1				1		2	10	21	14		7	16	2
Speckled sanddab	*Citharichthys stigmaeus*													1					
California halibut	*Paralichthys californicus*									2			1	6					
Spotted turbot	*Pleuronichthys ritteri*					1							1	4					
Hornyhead turbot	*Pleuronichthys verticalis*		1									1	2	2					
Diamond turbot	*Hypsopsetta guttulata*									1			1	4					
Total catch - Night		284	534	67	485	209	308	59	462	84	189	122	1129	776	857	2153	1475	2604	2965
Number of species - Night		9	15	8	11	11	8	7	6	14	14	7	16	16	13	8	10	12	9

February 2000
Lampara Catch - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Shovelnose guitarfish	*Rhinobatos productus*													5.25					
Round stingray	*Urolophus halleri*													0.30					
Bat ray	*Myliobatis californica*		29.15								3.05		24.45	18.40	5.20				
Pacific sardine	*Sardinops sagax*							0.54					28.37		0.33				
Northern anchovy	*Engraulis mordax*											0.00			0.01				
California lizardfish	*Synodus lucioceps*					0.31													
Specklefin midshipman	*Porichthys myriaster*					0.00													
Topsmelt	*Atherinops affinis*	0.05	0.03		0.18			0.19	3.94				0.25		1.39		0.02	0.26	
Jacksmelt	*Atherinopsis californiensis*			8.23	5.01	3.25				0.15		9.18	1.17		0.38		0.19	1.31	2.02
California grunion	*Leuresthes tenuis*	0.03		0.04									0.02						
Jack mackerel	*Trachurus symmetricus*			0.12	0.34										0.85		1.36		
White seabass	*Atractoscion nobilis*														0.90				
White croaker	*Genyonemus lineatus*	0.27	0.15							0.20	0.38	2.62			3.78			4.05	
California corbina	*Menticirrhus undulatus*												1.56						
Queenfish	*Seriphus politus*														1.45			0.86	
Shiner surfperch	*Cymatogaster aggregata*		3.77																
White surfperch	*Phanerodon furcatus*		3.75			0.72				0.20	0.22								
California barracuda	*Sphyraena argentea*						0.65			598.45		2.53	0.75						
Pacific cutlassfish	*Trichiurus nitens*																	0.30	
Chub mackerel	*Scomber japonicus*																0.15		
California halibut	*Paralichthys californicus*	0.17									9.80								
Fantail sole	*Xystreurys liolepis*		0.18										0.26						
Spotted turbot	*Pleuronichthys ritteri*									0.31									
Hornyhead turbot	*Pleuronichthys verticalis*												0.01						
California tonguefish	*Symphurus atricauda*					0.01													
Total catch - Day		0.51	37.02	8.38	5.53	4.29	0.65	0.73	3.94	599.30	13.44	14.33	56.83	23.95	14.28	0.00	1.71	6.77	2.02

February 2000
Lampara Catch - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Grey smoothhound shark	*Mustelus californicus*										3.25								
Shovelnose guitarfish	*Rhinobatos productus*										11.80								
Thornback	*Platyrhinoidis triseriata*		0.70										0.30						
Round stingray	*Urolophus halleri*										0.55								
Bat ray	*Myliobatis californica*		8.85							10.15	10.75	0.20	12.65	31.13					
Pacific sardine	*Sardinops sagax*	0.02											0.22		0.22		0.19		
Northern anchovy	*Engraulis mordax*	0.17	0.00		0.06	0.05	0.06	0.14	0.44	0.04	0.01	0.04	0.01	0.07	16.19	10.35	16.17	0.08	1.13
Deepbody anchovy	*Anchoa compressa*										0.01		0.19	0.01		0.02			0.00
Slough anchovy	*Anchoa delicatissima*							0.00					0.01	0.00		0.00			
California lizardfish	*Synodus lucioceps*				0.40														
Plainfin midshipman	*Porichthys notatus*							0.00								0.00			
Specklefin midshipman	*Porichthys myriaster*							0.06								0.00			
Basketweave cusk-eel	*Ophidion scrippsae*												0.05						
Topsmelt	*Atherinops affinis*	0.01	0.26	0.74	0.94	2.48	0.90	0.14	0.24		0.09	0.04	12.87	0.07	1.16	1.44	0.12	0.55	0.69
Jacksmelt	*Atherinopsis californiensis*	0.49			0.62	0.82	0.94						1.17		0.67		0.26	1.87	
California grunion	*Leuresthes tenuis*				0.08	0.66	0.12							0.01					
Black rockfish	*Sebastes melanops*					0.00													
California scorpionfish	*Scorpaena guttata*		0.35																
Barred sand bass	*Paralabrax nebulifer*										0.24								
Jack mackerel	*Trachurus symmetricus*							2.50			0.12						2.27	0.50	
Salema	*Xenistius californiensis*		0.03		0.11	3.60										0.05		142.31	
White croaker	*Genyonemus lineatus*	0.01	0.44	6.51		1.24	0.87			2.69	0.94	6.33		0.45		0.06		2.52	0.07
California corbina	*Menticirrhus undulatus*												0.56						
Queenfish	*Seriphus politus*	0.01	0.21		0.07	0.00	0.18	0.07	0.05	0.42	1.02	2.47	3.83	0.62	0.25	2.53	0.25	6.92	0.11
Shiner surfperch	*Cymatogaster aggregata*		0.04			0.09								0.41					
White surfperch	*Phanerodon furcatus*										0.03					0.15			
Pile surfperch	*Rhacochilus vacca*											1.00							
Blacksmith	*Chromis punctipinnis*																0.06		
Giant kelpfish	*Heterostichus rostratus*		0.00																
Pacific cutlassfish	*Trichiurus nitens*																	1.37	
Speckled sanddab	*Citharichthys stigmaeus*					0.01													
California halibut	*Paralichthys californicus*		0.60									0.88	2.78	0.74				0.60	
Fantail sole	*Xystreurys liolepis*												0.56						
Spotted turbot	*Pleuronichthys ritteri*		0.15										0.02						
Diamond turbot	*Hypsopsetta guttulata*										1.00		0.16						
Total catch - Night		0.72	11.62	7.25	2.27	8.94	3.07	2.92	0.73	13.30	29.79	10.96	35.36	33.50	18.48	14.59	19.33	156.72	2.00

May 2000
Lampara Catch - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Brown smoothhound shark	*Mustelus henlei*														2.150				
Shovelnose guitarfish	*Rhinobatos productus*									1.000	7.000								
Thornback	*Platyrhinoidis triseriata*		0.290																
Round stingray	*Urolophus halleri*									0.550	0.675								
Bat ray	*Myliobatis californica*	3.000	42.150							8.300	11.250			2.700					
Pacific sardine	*Sardinops sagax*										0.002								
Northern anchovy	*Engraulis mordax*	1.271						0.002		0.031	0.005		1.487		2.909				
California lizardfish	*Synodus lucioceps*					0.414						0.215	0.170	0.380					
Specklefin midshipman	*Porichthys myriaster*									0.310									
Topsmelt	*Atherinops affinis*		0.199		1.297	0.414	2.821	1.902	0.162		0.199	0.036	0.138	0.030		0.277		4.849	0.993
Jacksmelt	*Atherinopsis californiensis*		0.575								0.490								
Barred sand bass	*Paralabrax nebulifer*		6.140	1.242		0.150				0.100				0.270	0.650				
Jack mackerel	*Trachurus symmetricus*							0.158	0.143		0.450								
Sargo	*Anisotremus davidsoni*									6.730	1.175								
White croaker	*Genyonemus lineatus*	2.110	16.232	5.309	1.524	1.797		1.582		8.780	4.615	4.580		1.385	1.582			5.838	
California corbina	*Menticirrhus undulatus*		1.015		0.670														
Queenfish	*Seriphus politus*	0.644								0.057	4.842	0.115			0.770				
White seabass	*Atractoscion nobilis*															0.850			
Shiner surfperch	*Cymatogaster aggregata*		0.190	1.086						0.367	0.042								
Walleye surfperch	*Hyperprosopon argenteum*		0.099																
White surfperch	*Phanerodon furcatus*		2.261	0.160		0.056				4.916	1.429		0.089		0.003				
Pile surfperch	*Rhacochilus vacca*													0.900					
California barracuda	*Sphyraena argentea*										8.800								
Pacific butterfish	*Peprilus simillimus*																	0.963	
Pacific sanddab	*Citharichthys sordidus*												0.018						
California halibut	*Paralichthys californicus*		0.200			5.100				3.450	0.460			0.150	0.650				
Fantail sole	*Xystreurys liolepis*					0.325					0.220								
Spotted turbot	*Pleuronichthys ritteri*									0.342	0.260								
Diamond turbot	*Hypsopsetta guttulata*			0.430															
Total catch - Day		7.025	69.351	8.227	3.491	8.256	2.821	3.644	0.305	34.933	41.914	4.946	1.902	5.815	8.714	1.127	0.000	11.650	0.993

May 2000
Lampara Catch - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Grey smoothhound shark	*Mustelus californicus*									1.200	2.590								
Brown smoothhound shark	*Mustelus henlei*											3.400							
Shovelnose guitarfish	*Rhinobatos productus*									10.020									
Thornback	*Platyrhinoidis triseriata*													0.225					
Round stingray	*Urolophus halleri*															0.900			
Bat ray	*Myliobatis californica*		56.700	13.350						2.500	4.600		4.500		3.200				
Northern anchovy	*Engraulis mordax*						3.319	6.138	1.479	0.005	0.001	1.054	0.194	0.061	0.682	23.426	0.118		0.015
Deepbody anchovy	*Anchoa compressa*								0.016										
Slough anchovy	*Anchoa delicatissima*																	0.008	
Plainfin midshipman	*Porichthys notatus*							0.008											
Specklefin midshipman	*Porichthys myriaster*	0.008			0.016	0.330	0.006	0.080	0.014	0.550		0.024	0.003			0.021	0.270		
Topsmelt	*Atherinops affinis*	0.027	1.218		0.038	0.108	0.212	0.010	0.448	0.132		0.053	0.196	0.971		0.258	0.002	1.336	0.518
Jacksmelt	*Atherinopsis californiensis*						0.402			0.325	0.255		0.296	0.264	0.452				
California scorpionfish	*Scorpaena guttata*		0.580			0.800													
Barred sand bass	*Paralabrax nebulifer*	0.115	1.430	0.235			0.254			0.452	0.105			0.115					
Jack mackerel	*Trachurus symmetricus*			0.275		0.058	0.240		0.408	4.403	1.515	0.078	0.070	0.232	2.670		0.278		
Salema	*Xenistius californiensis*		3.655	3.182	0.590	0.532		0.198	0.376	0.872	0.290		0.057		0.111	0.413			
White croaker	*Genyonemus lineatus*	3.192	5.608	0.603	0.725	0.073	0.237	1.884	0.351	6.930	2.145	0.712	18.210	15.155	0.982	0.178	0.206	2.199	1.315
California corbina	*Menticirrhus undulatus*		3.465										0.872	0.690					
Yellowfin croaker	*Umbrina roncador*									1.295									
Queenfish	*Seriphus politus*	0.566	0.048	0.400	0.583	0.324	0.150	0.432	0.139	3.265	3.162	3.104	4.572	3.141	0.975	0.543		2.426	0.279
Shiner surfperch	*Cymatogaster aggregata*		0.375	0.998	0.112	0.029		0.076		0.195	0.016				0.023	0.055			
White surfperch	*Phanerodon furcatus*	0.004	0.969		0.014			0.071		0.266	0.298			0.021				0.004	
Pile surfperch	*Rhacochilus vacca*									0.099	0.010								
California barracuda	*Sphyraena argentea*							1.480			0.600								
Chub mackerel	*Scomber japonicus*																	0.220	
Pacific butterfish	*Peprilus simillimus*	0.082																	
Speckled sanddab	*Citharichthys stigmaeus*				0.002														
California halibut	*Paralichthys californicus*	5.050								1.015			0.670						
Fantail sole	*Xystreurys liolepis*			0.780		0.130				1.422			0.170			0.340			
Spotted turbot	*Pleuronichthys ritteri*			0.715						0.358									
Diamond turbot	*Hypsopsetta guttulata*										0.440			0.365					
Total catch - Night		9.044	74.048	20.538	2.080	2.384	4.820	10.377	3.231	35.304	16.027	8.425	29.810	21.240	9.095	26.134	0.874	6.193	2.127

August 2000
Lampara Catch - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Grey smoothhound shark	*Mustelus californicus*		5.400																
Shovelnose guitarfish	*Rhinobatos productus*		1.500							0.550	2.740								
Bat ray	*Myliobatis californica*		26.600	4.150							1.250		5.000	1.800					
Pacific sardine	*Sardinops sagax*						8.186								0.364		3.833		
Northern anchovy	*Engraulis mordax*					0.002				0.056		1.481			1.944		37.971	0.038	
California lizardfish	*Synodus lucioceps*																	0.360	
Specklefin midshipman	*Porichthys myriaster*																	0.054	
Topsmelt	*Atherinops affinis*	0.268	0.039		0.247	1.125	2.179	0.095	0.197	2.098	0.080	0.084	0.324	1.638	0.155		0.016	1.362	
Jacksmelt	*Atherinopsis californiensis*												28.614	5.772					
California grunion	*Leuresthes tenuis*	0.005			0.003	0.007									0.072				
Barred pipefish	*Syngnathus auliscus*									0.003									
Barred sand bass	*Paralabrax nebulifer*		2.350	0.725		0.085				0.330	0.587		0.338	0.100				0.024	
Jack mackerel	*Trachurus symmetricus*				0.455		0.510	0.150				0.165							0.170
Sargo	*Anisotremus davidsoni*			0.094						0.350	1.100								
White croaker	*Genyonemus lineatus*	0.238	9.723	0.637	2.690	0.648			0.033	3.965	2.385	14.046	7.835	11.309	4.501		1.013	1.858	
California corbina	*Menticirrhus undulatus*		2.400	0.600									1.795						
Yellowfin croaker	*Umbrina roncador*		0.350																
Queenfish	*Seriphus politus*	1.308	0.438	0.145	0.254	0.001				0.717	0.200	2.718			0.972		0.130	10.436	
White seabass	*Atractoscion nobilis*									0.700	1.760								
Shiner surfperch	*Cymatogaster aggregata*		6.025								0.043								
Black surfperch	*Embiotoca jacksoni*		0.155	0.150							0.100							0.022	
Walleye surfperch	*Hyperprosopon argenteum*		0.068	0.155	0.143														
White surfperch	*Phanerodon furcatus*		12.678	3.055	1.501	0.186				3.562	0.465			2.885				0.088	
California barracuda	*Sphyraena argentea*				2.950														
Giant kelpfish	*Heterostichus rostratus*			0.056		0.002				0.006	0.017								
Chub mackerel	*Scomber japonicus*						0.207					13.159		0.180			0.313		
Pacific butterfish	*Peprilus simillimus*		0.015															0.348	
California halibut	*Paralichthys californicus*		1.450	7.900				0.220			0.903			0.240					
Spotted turbot	*Pleuronichthys ritteri*											0.120	0.150						
Hornyhead turbot	*Pleuronichthys verticalis*											0.205							
Diamond turbot	*Hypsopsetta guttulata*			0.862							0.458								
California tonguefish	*Symphurus atricauda*				0.018								0.028						
Total catch - Day		1.819	69.191	18.529	8.261	2.056	11.082	0.465	0.230	12.337	12.088	31.978	44.084	23.924	8.008	0.000	43.276	14.590	0.170

August 2000
Lampara Catch - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Thornback	*Platyrhinoidis triseriata*													0.720					
Round stingray	*Urolophus halleri*										0.400			0.500					
Bat ray	*Myliobatis californica*		20.500	14.300						5.900			7.400	5.750					
Pacific sardine	*Sardinops sagax*	0.011	0.053		0.008			0.004	0.160	0.013		0.009			0.015	0.008	0.017	0.003	0.035
Northern anchovy	*Engraulis mordax*	0.681	0.477	1.649	2.040	5.196	0.042	0.118	0.007		0.012	0.083	1.281	0.580	37.986	0.379	14.114	0.108	9.711
Deepbody anchovy	*Anchoa compressa*							0.062		0.039					0.013	0.020	0.010		0.010
Slough anchovy	*Anchoa delicatissima*							0.007											
California lizardfish	*Synodus lucioceps*					0.290													
Specklefin midshipman	*Porichthys myriaster*					0.051	0.020	0.067			0.350		0.350		0.162		0.336		0.167
Topsmelt	*Atherinops affinis*	0.301	0.002	0.295	1.042	0.852	2.217	0.771	0.102	0.097	0.370	0.265	0.824	0.274	0.171	2.869	1.341	0.596	0.562
Jacksmelt	*Atherinopsis californiensis*			1.150			0.250											1.115	0.495
California grunion	*Leuresthes tenuis*			0.018	0.013	0.053	0.002					0.004			0.063		0.016	0.033	
California scorpionfish	*Scorpaena guttata*		0.200											0.185					
Barred sand bass	*Paralabrax nebulifer*	0.060	0.200	0.191		0.046				0.050									
Jack mackerel	*Trachurus symmetricus*						0.970	0.012	0.830		0.390					0.014	0.074		
Salema	*Xenistius californiensis*									0.071									
White croaker	*Genyonemus lineatus*	1.199	1.251	9.691	0.469	0.722	1.036	0.446	0.072	0.003	1.236	1.953	2.253	0.888	2.144	0.587	2.326	0.520	2.071
California corbina	*Menticirrhus undulatus*									1.000									
Black croaker	*Cheilotrema saturnum*						0.040											0.170	
Queenfish	*Seriphus politus*	6.047	2.692	3.163	4.073	3.353	8.407	2.610	0.473	5.165	5.582	5.401	2.127	4.030	4.032	0.417	6.649	19.003	2.018
Shiner surfperch	*Cymatogaster aggregata*		0.688	5.803	0.064	0.267	0.027	0.005		0.093	0.109		0.104	0.218			0.005		0.008
White surfperch	*Phanerodon furcatus*		0.198	1.298		0.021				0.032	0.194		0.009	0.108					
Pile surfperch	*Rhacochilus vacca*					0.032													
California barracuda	*Sphyraena argentea*										0.710								
Chub mackerel	*Scomber japonicus*		0.026							0.270			0.035	0.020	0.342		0.127	0.393	0.130
Pacific butterfish	*Peprilus simillimus*			0.035	0.048	0.038	0.304	0.130		0.072	0.023	0.026	0.117	0.009	0.133	0.028	0.017	1.265	0.077
California halibut	*Paralichthys californicus*	1.500		0.460									0.130	0.935				0.225	
Spotted turbot	*Pleuronichthys ritteri*			0.175															
Hornyhead turbot	*Pleuronichthys verticalis*											0.006		0.115				0.190	
Diamond turbot	*Hypsopsetta guttulata*													0.140					
Total catch - Night		9.799	26.287	38.228	7.757	10.921	13.315	4.232	1.644	12.805	9.376	7.747	14.630	14.472	45.061	4.322	25.032	23.621	15.284

November 2000
Lampara Catch - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Brown smoothhound shark	*Mustelus henlei*		2.62																
Shovelnose guitarfish	*Rhinobatos productus*		0.8																
Round stingray	*Urolophus halleri*										1.02								
Bat ray	*Myliobatis californica*		124.8							9.45									
Pacific sardine	*Sardinops sagax*	4.27							0.122										
Northern anchovy	*Engraulis mordax*											0.02						0.169	
Deepbody anchovy	*Anchoa compressa*																	0.102	
Slough anchovy	*Anchoa delicatissima*											0.004							
Topsmelt	*Atherinops affinis*				0.888	0.007	0.047		5.816	0.069	0.071	3.281			1.737	0.079	0.385		0.905
Jacksmelt	*Atherinopsis californiensis*			10.075	5.887	1.832	1.655				3.255		9.253	3.43	2.1		2.835		
California grunion	*Leuresthes tenuis*				0.072	0.066				0.012	0.006			0.004	0.232				
Barred sand bass	*Paralabrax nebulifer*		0.522							0.53	0.63								
Jack mackerel	*Trachurus symmetricus*						0.86												
White croaker	*Genyonemus lineatus*				0.27						63.71	0.322						0.327	
California corbina	*Menticirrhus undulatus*		1.04																
Yellowfin croaker	*Umbrina roncador*										0.18								
Queenfish	*Seriphus politus*											0.07						0.752	
Shiner surfperch	*Cymatogaster aggregata*		0.382		1.537						18.8								
Black surfperch	*Embiotoca jacksoni*		0.029																
Walleye surfperch	*Hyperprosopon argenteum*		0.234																
White surfperch	*Phanerodon furcatus*		4.647		0.12					1.145	3.458								
California barracuda	*Sphyraena argentea*								0.94	5.65	5.52				1.39	1.4	1		
Chub mackerel	*Scomber japonicus*									0.81									
Pacific butterfish	*Peprilus simillimus*																	0.047	
Speckled sanddab	*Citharichthys stigmaeus*					0.004													
California halibut	*Paralichthys californicus*									7									
Fantail sole	*Xystreurys liolepis*										0.255								
Spotted turbot	*Pleuronichthys ritteri*		0.098								0.042								
Total catch - Day		4.270	135.172	10.075	8.774	1.909	2.562	0.000	6.878	24.666	96.945	3.697	9.253	3.434	5.459	1.479	4.220	1.397	0.905

November 2000
Lampara Catch - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Grey smoothhound shark	*Mustelus californicus*		0.69								3.72								
Brown smoothhound shark	*Mustelus henlei*										2.14								
Shovelnose guitarfish	*Rhinobatos productus*									2.55	1.2								
Thornback	*Platyrhinoidis triseriata*												0.145						
Round stingray	*Urolophus halleri*												2.58						
Bat ray	*Myliobatis californica*		92.95	55.35							9.95				2.14				
Pacific sardine	*Sardinops sagax*	0.777	0.2		0.007		0.018	0.108	0.019							0.756	0.023	0.257	1.68
Northern anchovy	*Engraulis mordax*	0.212			0.04	0.027	0.133	0.011	0.318			0.048	0.052	0.275	1.129	3.95	3.212	2.667	8.797
Deepbody anchovy	*Anchoa compressa*										0.039		0.153	0.125	0.01			0.479	
Slough anchovy	*Anchoa delicatissima*	0.003							0.004		0.003			0.008	0.009		0.016	2.015	
Specklefin midshipman	*Porichthys myriaster*				0.001										0.011	0.047	0.003	0.029	
Topsmelt	*Atherinops affinis*	0.151	0.482	0.163	5.574	1.771	2.181	0.257	3.157	0.121	0.24		1.513	0.866	0.558	1.686	2.3	4.045	0.492
Jacksmelt	*Atherinopsis californiensis*	0.181	0.876				0.963	1.358		0.4		0.18	1.591		2.78			0.745	1.8
California grunion	*Leuresthes tenuis*	0.151	0.029		1.242	0.653						0.027							
Barcheek pipefish	*Syngnathus exilis*									0.003									
Barred sand bass	*Paralabrax nebulifer*						0.215			0.195	3.591								
Jack mackerel	*Trachurus symmetricus*							0.19	0.178									0.465	0.15
Sargo	*Anisotremus davidsoni*		0.29																
Salema	*Xenistius californiensis*		0.414	0.042	0.072	0.662					0.073				0.483		0.258	0.279	
White croaker	*Genyonemus lineatus*	0.038	0.82	0.173	0.174	0.173		0.005		3.999	2.883	1.669	6.267	1.483	2.708	0.135	0.096	1.797	0.037
California corbina	*Menticirrhus undulatus*			0.35						2.25			0.355	0.245					
Yellowfin croaker	*Umbrina roncador*									0.841									
Queenfish	*Seriphus politus*	0.04	2.706	0.076	2.259	0.588	0.179		0.12	0.19	1.031	0.599	4.816	2.846	16.06	0.753	5.267	16.81	0.481
Shiner surfperch	*Cymatogaster aggregata*		2.152	0.252	0.154	0.051	0.024			0.13	0.475		0.249	0.061					
Black surfperch	*Embiotoca jacksoni*										0.16								
Walleye surfperch	*Hyperprosopon argenteum*		0.103			0.068								0.018					
White surfperch	*Phanerodon furcatus*		2.9	0.037	0.054		0.114				3.316		0.098	0.024	0.088				
California barracuda	*Sphyraena argentea*					0.048				0.95					1.93	0.94	0.01		0.06
Chub mackerel	*Scomber japonicus*							0.192								3.07			
Pacific butterfish	*Peprilus simillimus*	0.168	0.022		0.048	0.009				0.009		0.017	0.092	0.212	0.118		0.063	0.138	0.011
Speckled sanddab	*Citharichthys stigmaeus*													0.013					
California halibut	*Paralichthys californicus*									1.135			0.051	0.8					
Spotted turbot	*Pleuronichthys ritteri*					0.052							0.042	0.44					
Hornyhead turbot	*Pleuronichthys verticalis*		0.2									0.265	0.22	0.039					
Diamond turbot	*Hypsopsetta guttulata*									0.57			0.215	0.65					
Total catch - Night		1.721	104.834	56.443	9.625	4.102	3.827	2.121	3.796	13.343	28.821	2.805	18.439	8.105	28.021	11.337	11.248	29.727	13.508

Purse Seine Catch

February 2000
No fish caught by purse seine

Area	August 2000			
	Abundance	Biomass	Number of Species	Dominance
Deepwater Basin				
LA6	0	0.00	0	NA
Deepwater Channel				
LA4	0	0.00	0	NA
LB7	0	0.00	0	NA
Deepwater Open				
LA1	0	0.00	0	NA
LB1	0	0.00	0	NA
Deepwater Slip				
LB4	10	0.10	1	1

All 10 fish caught at LB4 were Topsmelt (*Atherinops affinis*)

NA - Not applicable

C.2 Otter Trawl Data

25' Trawl Fish Catch

Abundance

Area	February 2000			May 2000			August 2000			November 2000			Annual Mean			Annual Total		
	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean
Deepwater Basin																		
LA5	31	118	75	52	69	61	838	217	528	5	103	54	232	127	179	926	507	717
LA6	9	259	134	9	112	61	151	681	416	3	140	72	43	298	171	172	1192	682
LB3	450	642	546	97	48	73	1498	1133	1316	257	954	606	576	694	635	2302	2777	2540
LB5	38	186	112	54	78	66	1291	1947	1619	612	933	773	499	786	642	1995	3144	2570
Deepwater Channel																		
LA4	53	149	101	63	79	71	2635	291	1463	12	222	117	691	185	438	2763	741	1752
LB7	403	257	330	328	245	287	400	414	407	365	246	306	374	291	332	1496	1162	1329
Deepwater Open																		
LA1	52	119	86	73	181	127	4032	442	2237	66	573	320	1056	329	692	4223	1315	2769
LB1	315	238	277	66	76	71	770	474	622	325	333	329	369	280	325	1476	1121	1299
Deepwater Slip																		
LB4	11	175	93	20	16	18	411	239	325	9	283	146	113	178	146	451	713	582
LB6	126	395	261	110	383	247	2257	278	1268	359	409	384	713	366	540	2852	1465	2159
Shallow Mitigation																		
LA2A	19	148	84	70	120	95	735	1025	880	167	295	231	248	397	322	991	1588	1290
LA2B	6	69	38	41	72	57	990	832	911	69	285	177	277	315	296	1106	1258	1182
LA7A	38	44	41	50	281	166	164	1687	926	9	538	274	65	638	351	261	2550	1406
LA7B	37	62	50	97	278	188	80	228	154	18	134	76	58	176	117	232	702	467
LB2A	224	443	334	40	75	58	3033	1170	2102	25	395	210	831	521	676	3322	2083	2703
LB2B	38	278	158	55	154	105	3474	1002	2238	31	176	104	900	403	651	3598	1610	2604
Shallow Water Open																		
LA3A	15	200	108	28	123	76	3731	177	1954	27	191	109	950	173	562	3801	691	2246
LA3B	35	392	214	19	149	84	188	311	250	23	180	102	66	258	162	265	1032	649
Survey Mean	106	232	169	71	141	106	1482	697	1090	132	355	244	448	356	402	1791	1425	1608
Survey Total	1900	4174	3037	1272	2539	1906	26678	12548	19613	2383	6390	4386	8058	6413	7235	32233	25651	28942

25' Trawl Fish Catch

Biomass (kg)

	February 2000			May 2000			August 2000			November 2000			Annual Mean			Annual Total		
Area	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean
Deepwater Basin																		
LA5	1.07	1.46	1.27	1.07	1.20	1.14	1.00	2.78	1.89	0.60	0.94	0.77	0.93	1.60	1.27	3.74	6.39	5.06
LA6	0.44	6.85	3.64	0.70	3.43	2.07	2.90	6.12	4.51	0.23	2.22	1.22	1.06	4.65	2.86	4.26	18.62	11.44
LB3	5.61	11.98	8.80	4.84	0.85	2.84	4.94	13.91	9.43	14.04	28.07	21.05	7.36	13.70	10.53	29.42	54.82	42.12
LB5	0.37	3.92	2.14	4.89	8.40	6.64	7.26	8.64	7.95	4.32	8.81	6.57	4.21	7.44	5.82	16.83	29.77	23.30
Deepwater Channel																		
LA4	2.71	9.38	6.05	8.32	4.54	6.43	5.50	9.51	7.51	0.80	2.39	1.60	4.33	6.46	5.39	17.33	25.82	21.58
LB7	14.23	26.69	20.46	8.90	5.39	7.14	9.56	15.91	12.73	11.75	15.72	13.73	11.11	15.92	13.52	44.44	63.70	54.07
Deepwater Open																		
LA1	3.82	11.23	7.53	39.98	14.98	27.48	5.64	21.86	13.75	2.99	13.38	8.19	13.11	15.36	14.24	52.43	61.45	56.94
LB1	7.99	14.27	11.13	9.57	9.40	9.48	12.71	22.68	17.69	8.42	10.00	9.21	9.67	14.09	11.88	38.69	56.35	47.52
Deepwater Slip																		
LB4	0.41	2.59	1.50	1.02	0.13	0.57	1.65	3.63	2.64	0.72	5.16	2.94	0.95	2.88	1.91	3.80	11.51	7.66
LB6	0.47	13.36	6.91	5.11	8.62	6.87	9.07	7.65	8.36	4.36	8.13	6.24	4.75	9.44	7.10	19.01	37.76	28.38
Shallow Mitigation																		
LA2A	3.96	8.90	6.43	7.82	19.71	13.76	35.41	23.14	29.28	9.69	9.42	9.55	14.22	15.29	14.75	56.88	61.16	59.02
LA2B	1.53	7.33	4.43	4.83	8.07	6.45	14.60	18.28	16.44	8.73	21.36	15.05	7.42	13.76	10.59	29.69	55.04	42.36
LA7A	3.45	5.64	4.55	8.88	18.28	13.58	7.43	5.91	6.67	0.84	7.50	4.17	5.15	9.33	7.24	20.59	37.34	28.96
LA7B	7.47	18.37	12.92	3.54	15.20	9.37	2.69	1.56	2.13	1.60	4.41	3.00	3.82	9.88	6.85	15.29	39.53	27.41
LB2A	10.26	18.57	14.41	10.83	10.79	10.81	13.33	9.87	11.60	7.28	10.84	9.06	10.43	12.52	11.47	41.70	50.07	45.89
LB2B	3.99	14.31	9.15	12.56	16.78	14.67	15.43	7.75	11.59	5.96	1.77	3.86	9.48	10.15	9.82	37.94	40.61	39.28
Shallow Water Open																		
LA3A	0.28	6.17	3.22	3.12	5.34	4.23	5.65	4.79	5.22	2.76	3.09	2.93	2.95	4.85	3.90	11.81	19.39	15.60
LA3B	1.68	8.88	5.28	3.40	5.31	4.36	1.73	5.73	3.73	0.92	3.53	2.22	1.93	5.86	3.90	7.73	23.45	15.59
Survey Mean	3.87	10.55	7.21	7.74	8.69	8.22	8.69	10.54	9.62	4.78	8.71	6.74	6.27	9.62	7.95	25.09	38.49	31.79
Survey Total	69.72	189.90	129.81	139.35	156.42	147.88	156.50	189.73	173.12	86.00	156.73	121.37	112.89	173.19	143.04	451.57	692.78	572.18

25' Trawl Fish Catch

Number of Species

	February 2000			May 2000			August 2000			November 2000			Annual Mean			Annual
Area	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Total
Deepwater Basin																
LA5	6	12	13	5	8	10	11	9	12	4	9	10	7	10	11	18
LA6	3	11	12	3	10	11	8	11	13	3	10	10	4	11	12	19
LB3	12	17	20	7	7	10	4	11	11	10	14	15	8	12	14	27
LB5	2	14	14	12	12	16	11	12	13	10	9	13	9	12	14	21
Deepwater Channel																
LA4	9	13	15	10	11	15	10	14	15	5	14	15	9	13	15	20
LB7	11	16	20	12	8	14	14	12	17	9	9	12	12	11	16	27
Deepwater Open																
LA1	8	11	14	9	9	13	2	12	12	7	12	13	7	11	13	24
LB1	12	16	19	10	12	12	15	14	18	11	14	17	12	14	17	26
Deepwater Slip																
LB4	4	11	13	5	4	9	5	11	13	4	7	9	5	8	11	22
LB6	1	10	10	10	11	14	16	10	17	8	13	14	9	11	14	23
Shallow Mitigation																
LA2A	7	15	17	9	13	15	15	15	19	10	15	18	10	15	17	28
LA2B	4	6	9	8	11	14	14	14	18	7	14	14	8	11	14	23
LA7A	10	7	14	7	11	13	13	12	16	5	13	16	9	11	15	30
LA7B	9	15	16	7	14	15	7	11	13	6	10	12	7	13	14	30
LB2A	12	18	18	11	14	17	13	15	20	7	22	25	11	17	20	32
LB2B	8	17	18	11	11	17	14	14	20	8	7	15	10	12	18	31
Shallow Water Open																
LA3A	6	10	13	10	11	16	8	12	13	9	14	16	8	12	15	26
LA3B	9	12	15	6	7	11	8	14	15	7	12	14	8	11	14	23
Survey Mean	7	13	15	8	10	13	10	12	15	7	12	14	8	12	15	
Survey Total	26	35	39	33	33	42	34	34	42	32	39	43	31	35	42	62

25' Trawl Fish Catch

Shannon-Wiener Diversity

	February 2000			May 2000			August 2000			November 2000			Annual Mean		
Area	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Basin															
LA5	1.37	1.20	1.36	0.90	1.54	1.51	0.30	1.05	0.90	1.33	1.60	1.69	0.97	1.35	1.37
LA6	0.85	1.04	1.13	1.00	1.38	1.48	1.25	1.11	1.16	1.10	1.58	1.63	1.05	1.28	1.35
LB3	0.61	0.58	0.63	1.10	1.23	1.23	0.67	0.34	0.78	1.21	0.24	0.54	0.90	0.60	0.80
LB5	0.34	1.17	1.30	1.78	1.91	2.05	0.54	0.82	0.79	0.79	0.79	0.82	0.86	1.17	1.24
Deepwater Channel															
LA4	1.67	1.58	1.75	1.49	1.64	2.00	0.13	1.56	0.52	1.10	1.59	1.72	1.10	1.59	1.50
LB7	0.77	1.52	1.15	0.68	1.00	0.93	1.11	1.09	1.13	1.44	0.74	1.33	1.00	1.09	1.13
Deepwater Open															
LA1	1.19	1.11	1.26	1.22	1.04	1.15	0.01	1.12	0.41	1.11	0.86	1.04	0.88	1.03	0.97
LB1	1.10	1.59	1.41	1.82	1.92	1.95	1.34	1.48	1.55	1.17	0.87	1.08	1.36	1.47	1.50
Deepwater Slip															
LB4	0.89	1.27	1.30	1.21	1.16	1.87	0.29	1.70	1.27	1.31	1.02	1.13	0.92	1.29	1.39
LB6	NA	0.86	0.70	0.71	0.46	0.54	0.61	0.63	0.80	1.02	0.98	1.06	0.78	0.73	0.77
Shallow Mitigation															
LA2A	1.79	1.59	1.86	1.41	1.24	1.44	1.67	0.89	1.48	1.20	1.66	1.81	1.52	1.35	1.65
LA2B	1.33	0.38	0.71	0.93	1.90	1.95	0.98	1.26	1.50	0.94	1.65	1.66	1.05	1.30	1.45
LA7A	1.76	1.36	1.93	1.31	1.03	1.31	1.42	0.83	1.10	1.52	1.11	1.19	1.51	1.08	1.38
LA7B	1.86	2.22	2.44	1.17	1.03	1.38	1.43	1.34	1.77	1.48	1.88	1.97	1.49	1.62	1.89
LB2A	1.28	1.01	1.22	2.19	1.38	1.88	0.62	0.81	1.04	1.50	1.39	1.56	1.39	1.15	1.43
LB2B	1.83	1.12	1.34	1.79	1.30	1.55	0.77	0.99	1.08	1.80	1.20	1.71	1.55	1.15	1.42
Shallow Water Open															
LA3A	1.58	0.88	1.09	1.99	1.03	1.42	0.05	1.50	0.28	1.98	1.33	1.66	1.40	1.19	1.11
LA3B	1.99	0.94	1.18	1.67	1.01	1.28	0.67	1.65	1.78	1.49	1.44	1.67	1.46	1.26	1.48
Survey Mean	1.31	1.19	1.32	1.35	1.29	1.50	0.77	1.12	1.07	1.31	1.22	1.41	1.18	1.20	1.32

NA - Not Applicable

25' Trawl Fish Catch

Margalef Diversity

Area	February 2000			May 2000			August 2000			November 2000			Annual Mean		
	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Basin															
LA5	1.46	2.31	2.40	1.01	1.65	1.88	1.49	1.49	1.58	1.86	1.73	1.92	1.45	1.79	1.94
LA6	0.91	1.80	1.97	0.91	1.91	2.09	1.40	1.53	1.78	1.82	1.82	1.81	1.26	1.77	1.91
LB3	1.80	2.48	2.72	1.31	1.55	1.81	0.41	1.42	1.27	1.62	1.89	1.97	1.29	1.84	1.94
LB5	0.27	2.49	2.40	2.76	2.52	3.07	1.40	1.45	1.48	1.40	1.17	1.63	1.46	1.91	2.15
Deepwater Channel															
LA4	2.01	2.40	2.64	2.17	2.29	2.82	1.14	2.29	1.75	1.61	2.41	2.57	1.73	2.35	2.45
LB7	1.67	2.70	2.93	1.90	1.27	2.05	2.17	1.83	2.39	1.36	1.45	1.71	1.77	1.81	2.27
Deepwater Open															
LA1	1.77	2.09	2.53	1.86	1.54	2.17	0.12	1.81	1.31	1.43	1.73	1.86	1.30	1.79	1.97
LB1	1.91	2.74	2.85	2.15	2.54	2.22	2.11	2.11	2.39	1.73	2.24	2.47	1.97	2.41	2.48
Deepwater Slip															
LB4	1.25	1.94	2.30	1.34	1.08	2.23	0.66	1.83	1.85	1.37	1.06	1.41	1.15	1.48	1.95
LB6	NA	1.51	1.44	1.91	1.68	2.10	1.94	1.60	2.04	1.19	2.00	1.96	1.68	1.70	1.88
Shallow Mitigation															
LA2A	2.04	2.80	3.13	1.88	2.51	2.67	2.12	2.02	2.41	1.76	2.46	2.77	1.95	2.45	2.74
LA2B	1.67	1.18	1.85	1.88	2.34	2.75	1.88	1.93	2.26	1.42	2.30	2.21	1.72	1.94	2.27
LA7A	2.47	1.59	2.95	1.53	1.77	2.07	2.35	1.48	1.99	1.82	1.91	2.38	2.05	1.69	2.35
LA7B	2.22	3.39	3.26	1.31	2.31	2.36	1.37	1.84	2.09	1.73	1.84	2.19	1.66	2.35	2.48
LB2A	2.03	2.79	2.61	2.71	3.01	3.37	1.50	1.98	2.28	1.86	3.51	3.97	2.03	2.82	3.06
LB2B	1.92	2.84	2.95	2.50	1.99	2.99	1.59	1.88	2.26	2.04	1.16	2.63	2.01	1.97	2.71
Shallow Water Open															
LA3A	1.85	1.70	2.23	2.70	2.08	2.99	0.85	2.13	1.45	2.43	2.48	2.79	1.96	2.09	2.37
LA3B	2.25	1.84	2.31	1.70	1.20	1.95	1.34	2.26	2.25	1.91	2.12	2.45	1.80	1.86	2.24
Survey Mean	1.74	2.25	2.53	1.86	1.96	2.42	1.44	1.83	1.94	1.69	1.96	2.26	1.68	2.00	2.29

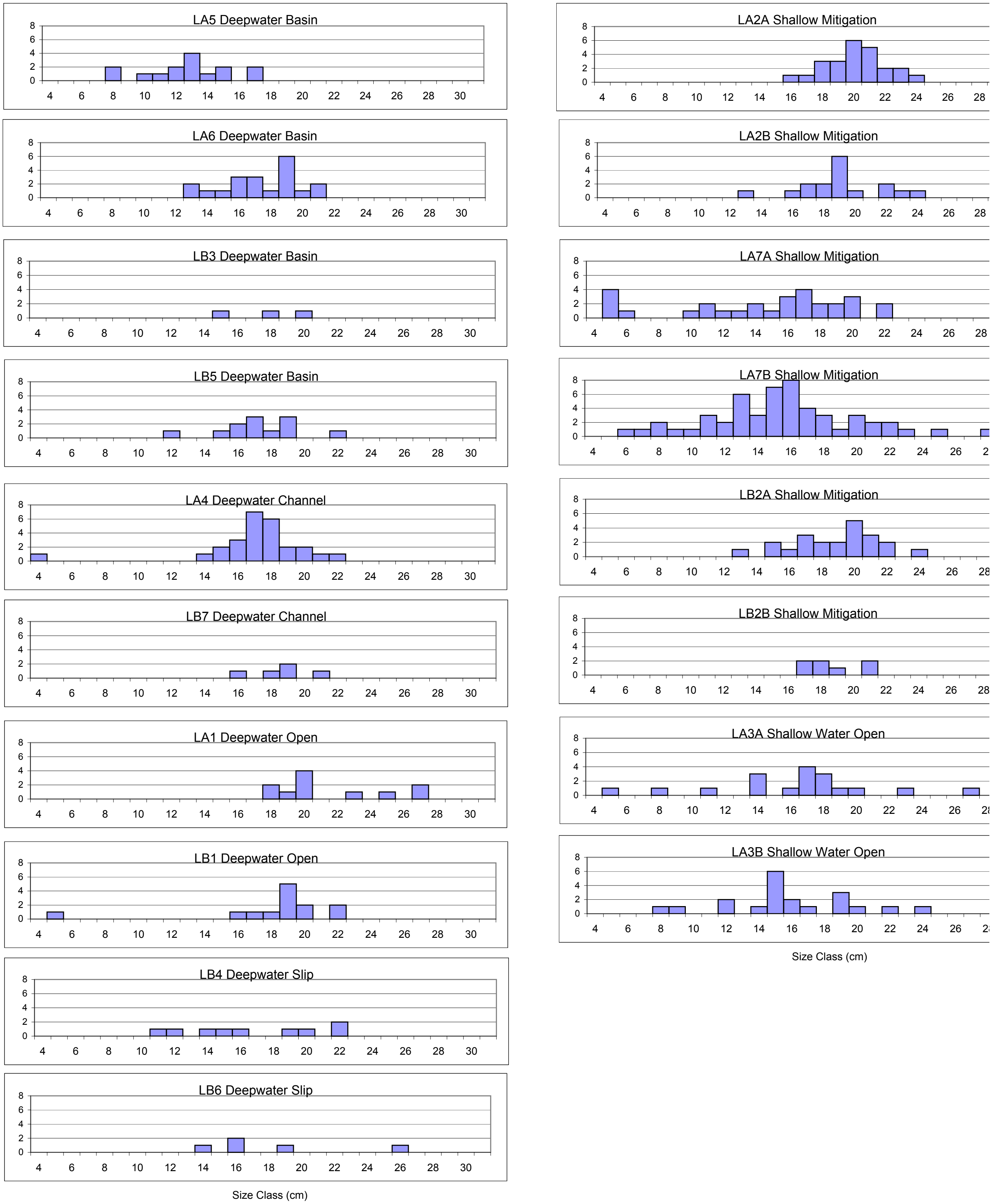
NA - Not Applicable

25' Trawl Fish Catch

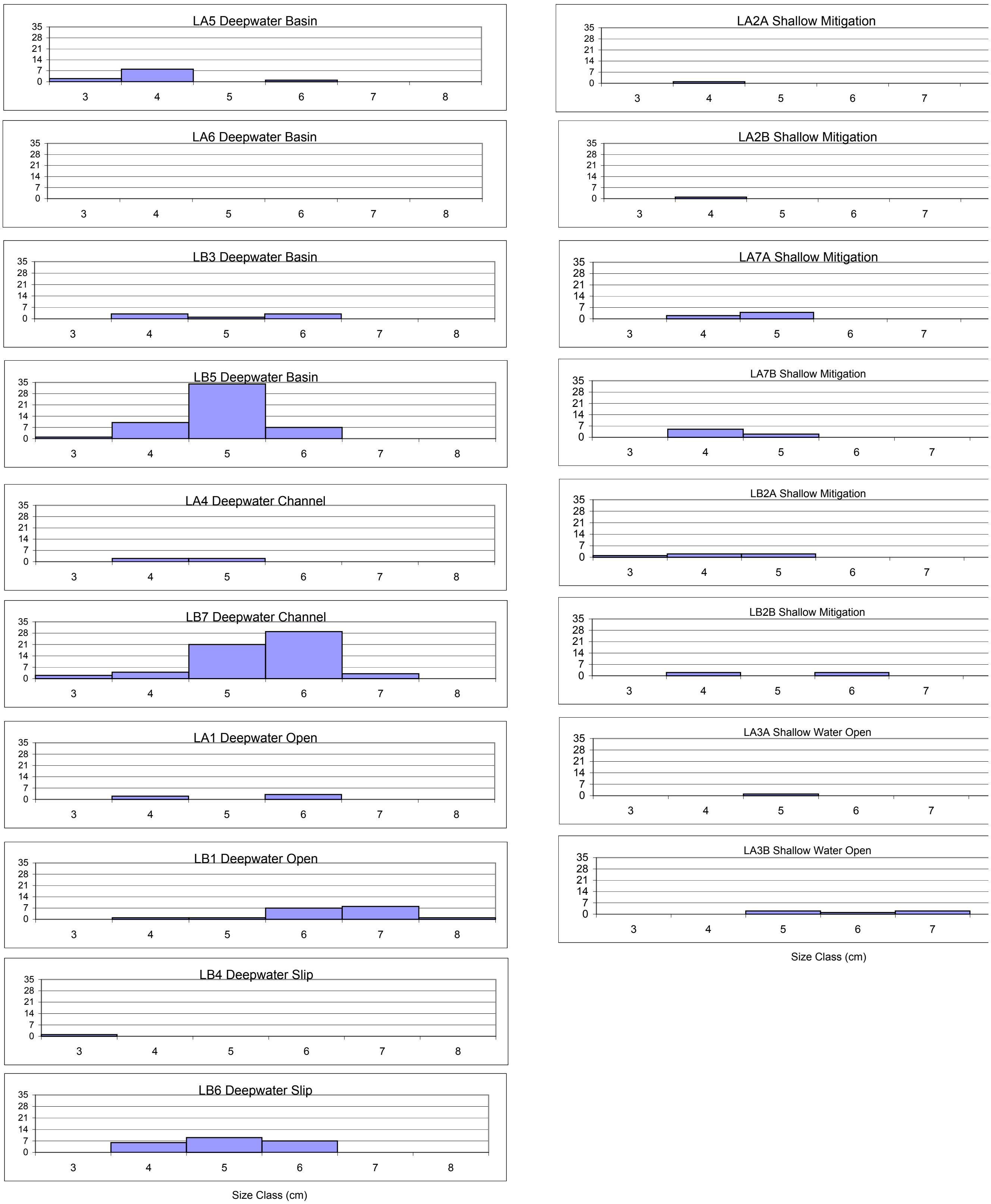
Dominance Index

	February 2000			May 2000			August 2000			November 2000			Annual Mean		
Area	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Basin															
LA5	3	2	3	2	3	3	1	2	2	3	3	3	2	3	3
LA6	2	2	2	2	3	3	2	2	2	3	3	3	2	3	3
LB3	1	1	1	2	2	2	2	1	2	2	1	1	2	1	2
LB5	1	2	2	4	4	5	1	2	1	2	1	2	2	2	3
Deepwater Channel															
LA4	3	3	3	2	3	4	1	3	1	2	3	4	2	3	3
LB7	1	3	2	1	2	1	2	2	2	3	1	2	2	2	2
Deepwater Open															
LA1	2	2	2	2	2	2	1	2	1	2	2	2	2	2	2
LB1	2	3	2	4	5	6	2	2	3	2	2	2	3	3	3
Deepwater Slip															
LB4	2	2	2	2	2	4	1	4	2	3	2	2	2	3	3
LB6	1	1	1	1	1	1	1	1	2	2	2	2	1	1	2
Shallow Mitigation															
LA2A	4	2	4	2	2	2	3	1	3	2	3	4	3	2	3
LA2B	3	1	1	1	4	4	2	2	3	2	3	3	2	3	3
LA7A	3	2	4	2	2	2	2	1	2	3	2	2	3	2	3
LA7B	4	5	7	2	2	2	3	3	4	3	4	5	3	4	5
LB2A	2	1	2	6	3	5	1	1	2	3	2	2	3	2	3
LB2B	4	1	2	4	2	3	1	2	2	4	2	3	3	2	3
Shallow Water Open															
LA3A	3	1	2	4	2	2	1	3	1	5	2	3	3	2	2
LA3B	5	1	2	4	2	2	1	3	3	3	2	3	3	2	3
Survey Mean	3	2	2	3	3	3	2	2	2	3	2	3	2	2	3

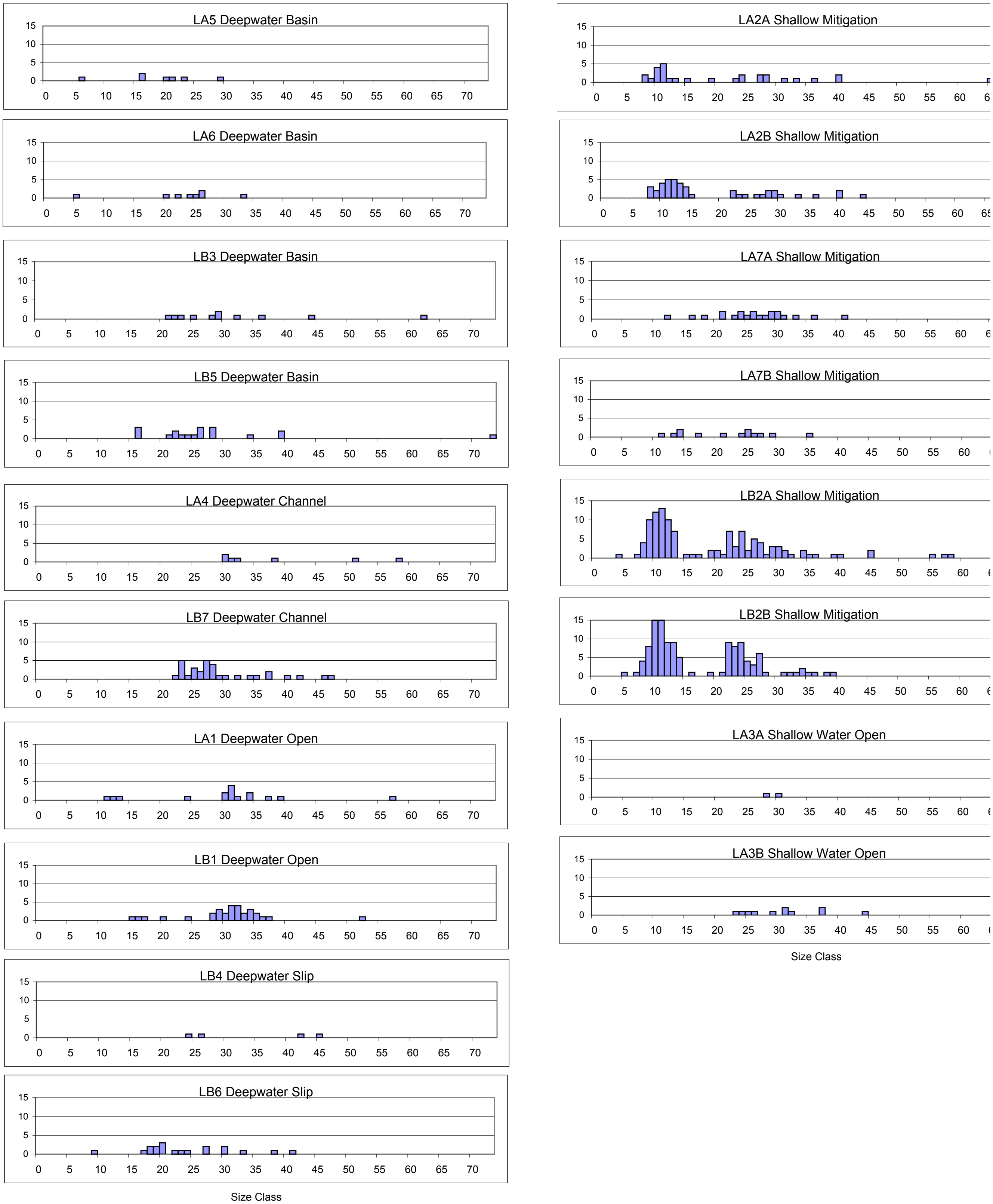
Size/Frequency Chart
'25 Trawl Barred Sand Bass Catch
(Annual Total)



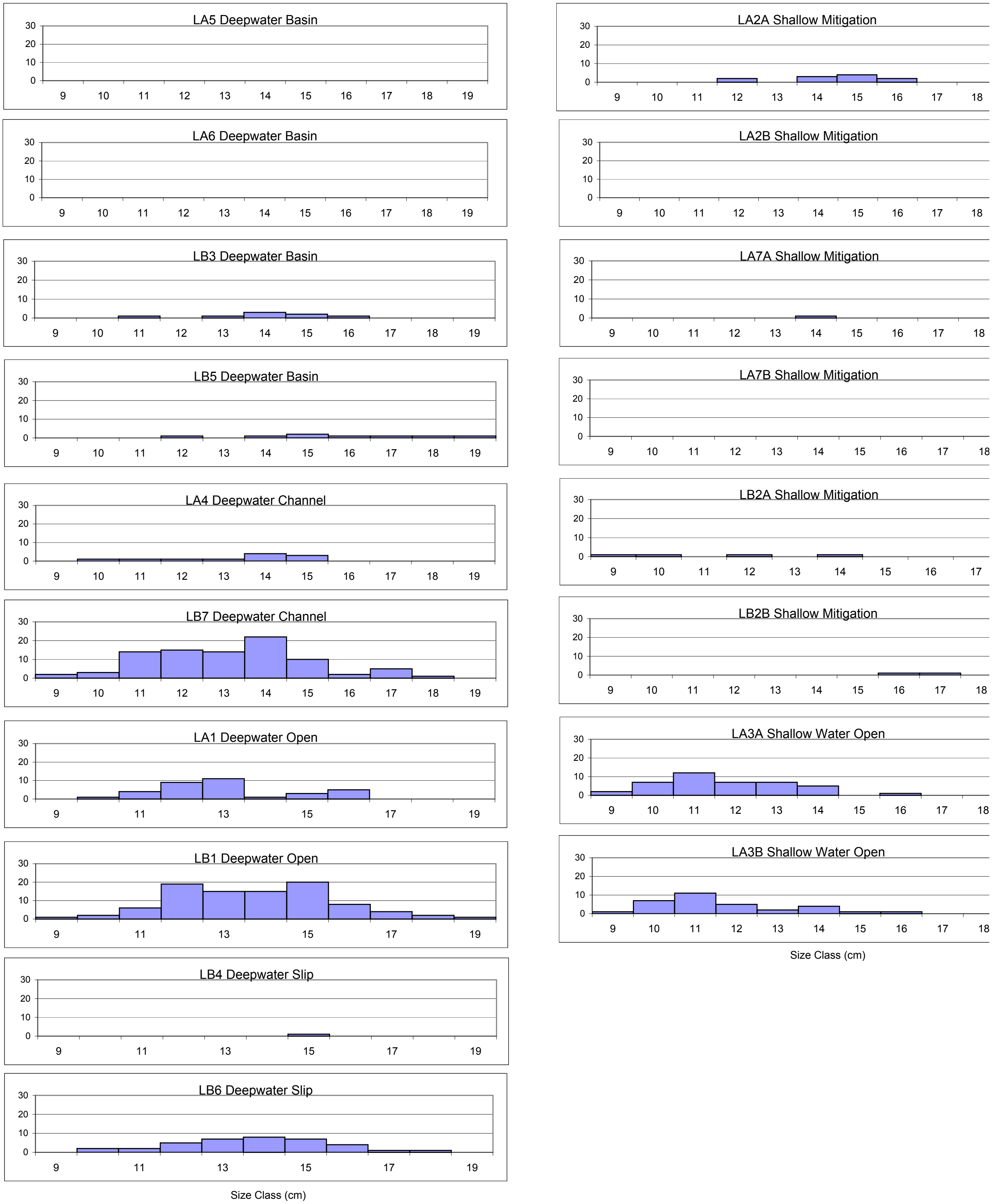
Size/Frequency Chart
'25 Trawl Bay Goby Catch
(Annual Total)



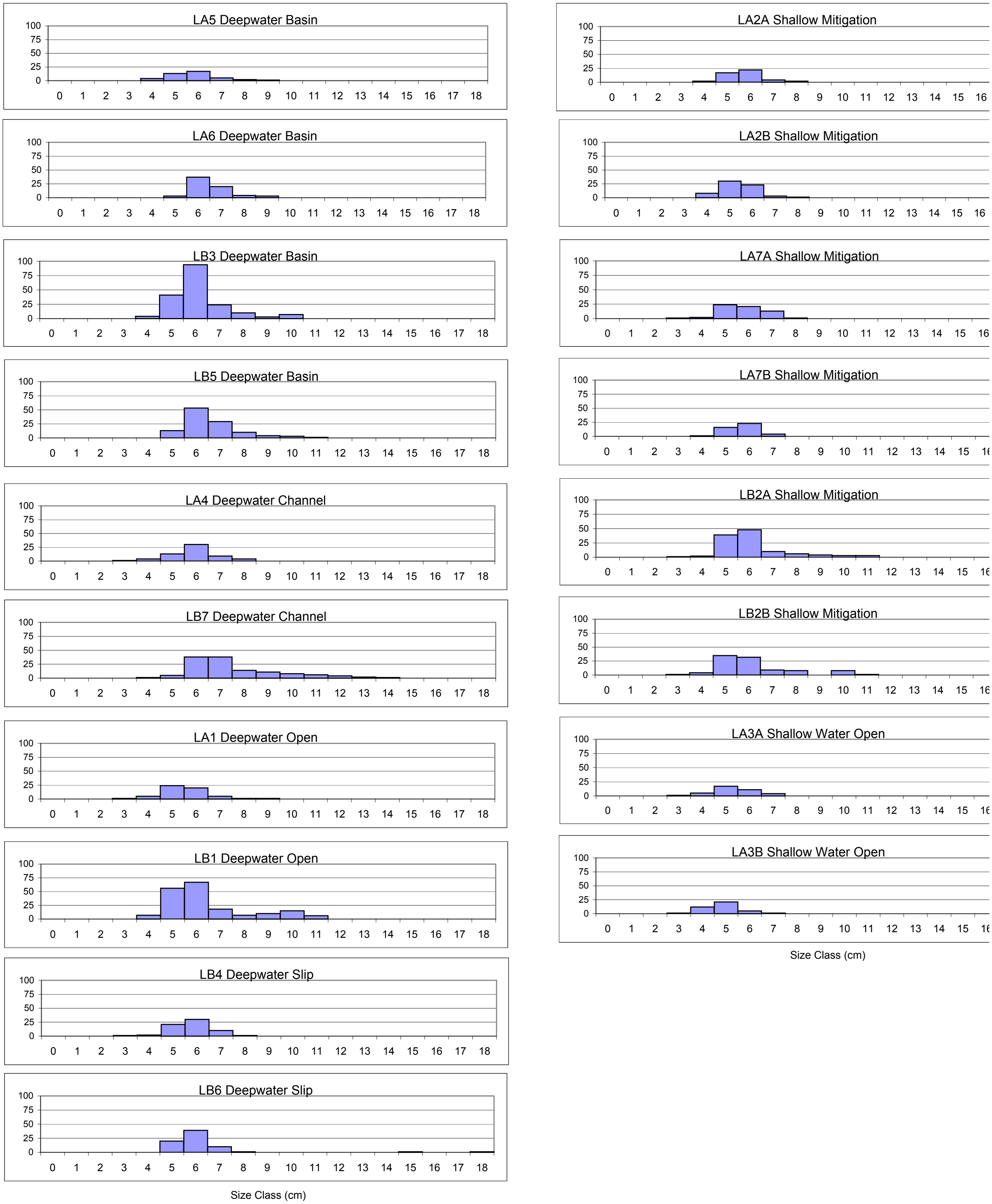
Size/Frequency Chart
'25 Trawl California Halibut Catch
(Annual Total)



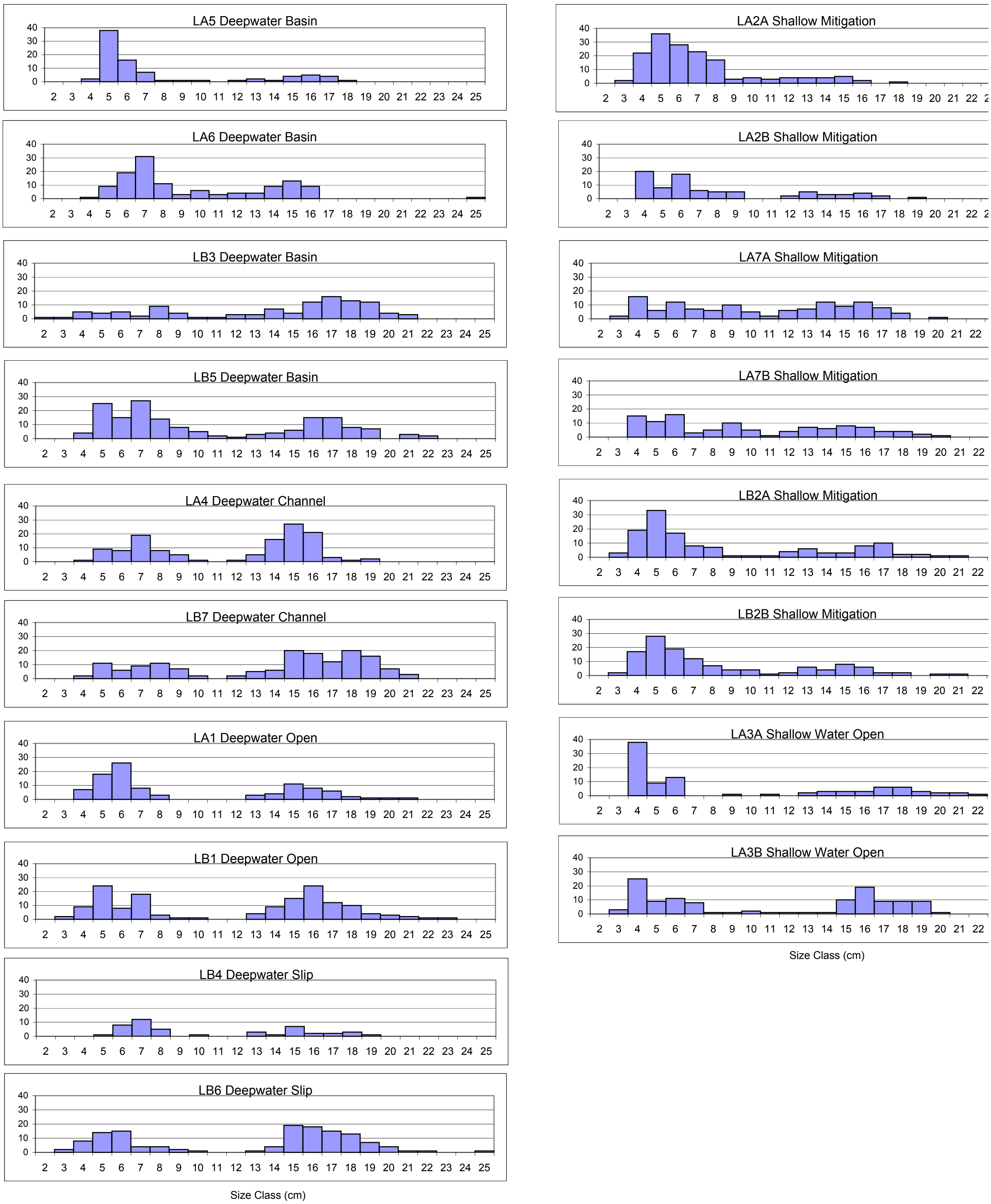
Size/Frequency Chart
'25 Trawl California Tonguefish Catch
(Annual Total)



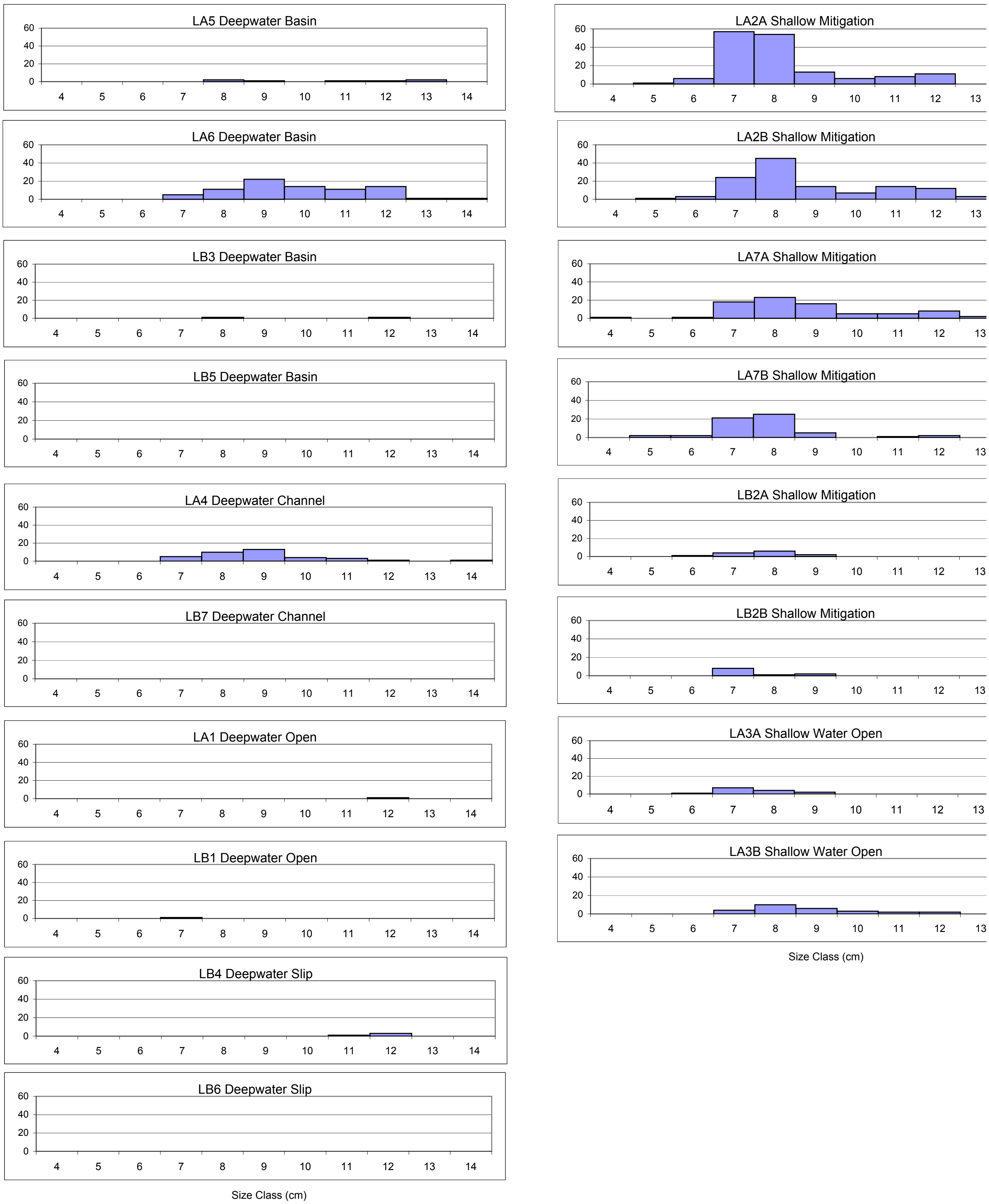
Size/Frequency Chart
'25 Trawl Northern Anchovy Catch
(Annual Total)



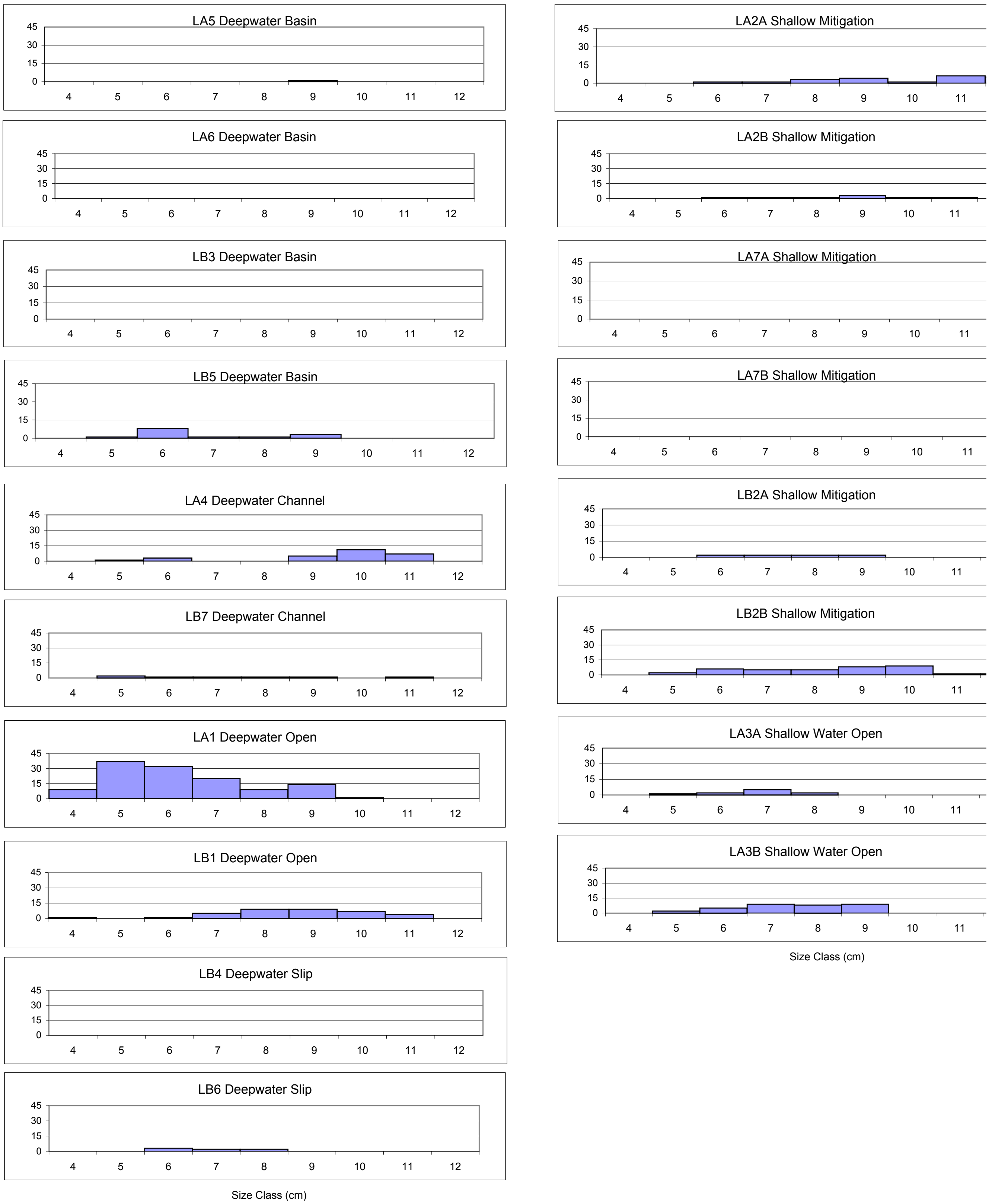
Size/Frequency Chart
'25 Trawl Queenfish Catch
(Annual Total)



Size/Frequency Chart
'25 Trawl Shiner Surfperch Catch
(Annual Total)

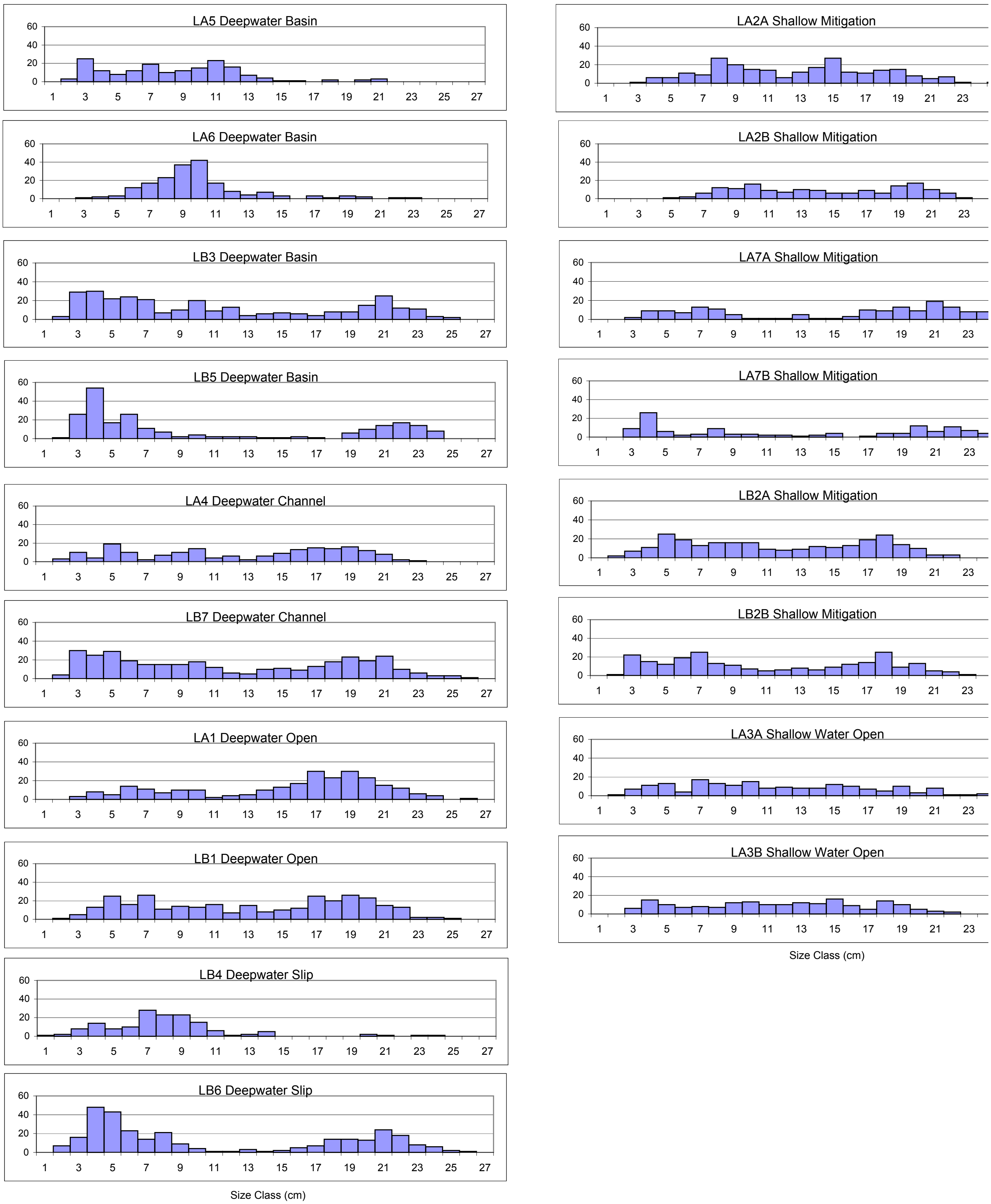


Size/Frequency Chart
'25 Trawl Speckled Sanddab Catch
(Annual Total)

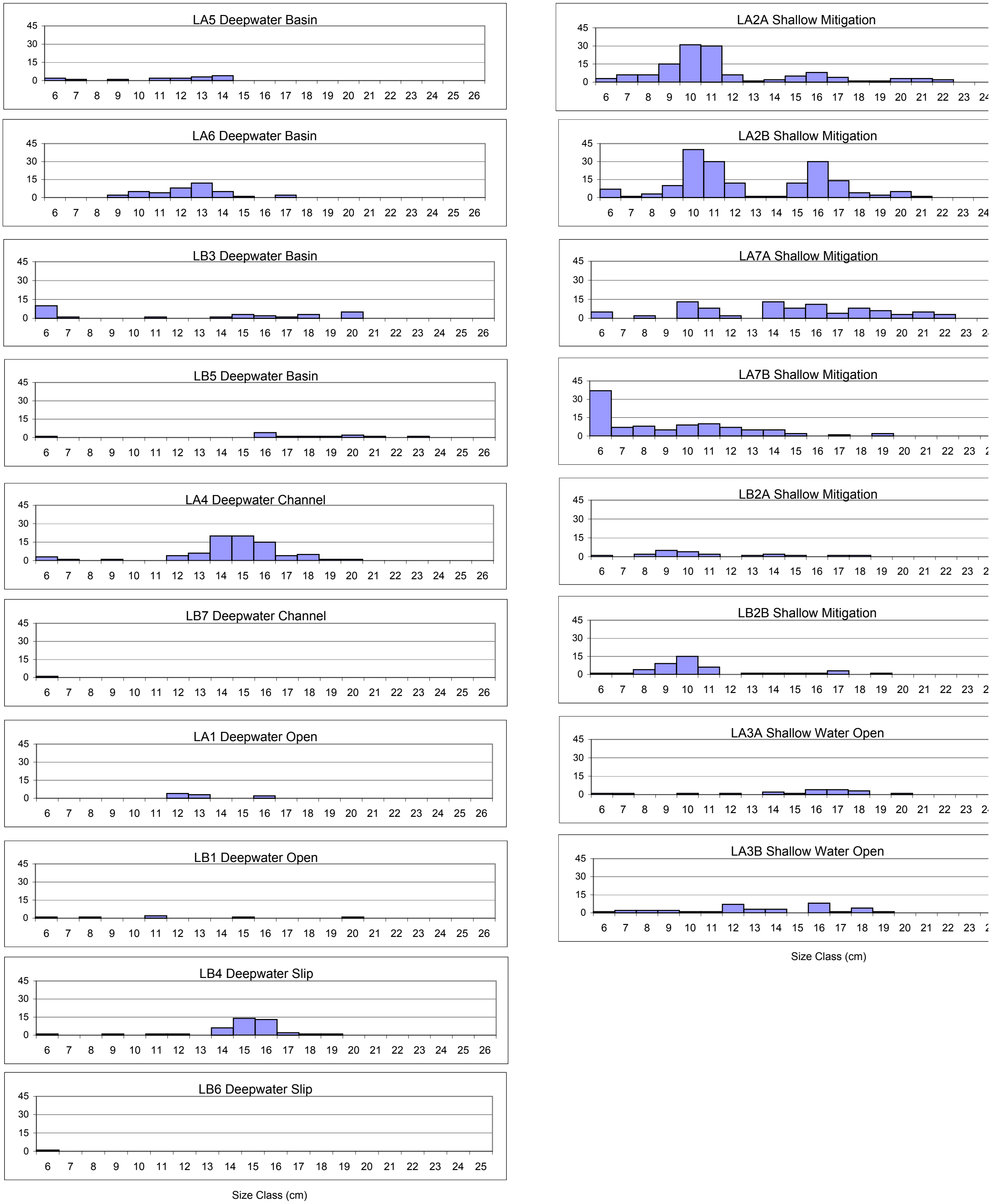


Size/Frequency Chart
'25 Trawl Specklefin Midshipman Catch
(Annual Total)

Size/Frequency Chart
'25 Trawl White Croaker Catch
(Annual Total)



Size/Frequency Chart
'25 Trawl White Surfperch Catch



February 2000
Otter Trawl Fish - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Shovelnose guitarfish	*Rhinobatos productus*										2								
Big skate	*Raja binoculata*											1							
Round stingray	*Urolophus halleri*													2					
Northern anchovy	*Engraulis mordax*	1									4	107	80	5	44		34		
Deepbody anchovy	*Anchoa compressa*												9						2
California lizardfish	*Synodus lucioceps*	1			1										2	1			4
Specklefin midshipman	*Porichthys myriaster*				4	4									5				
Bay pipefish	*Syngnathus leptorhynchus*		1		1														
Black rockfish	*Sebastes melanops*		1		5	10													
Yellowchin sculpin	*Icelinus quadriseriatus*	1					18	4							1				2
Barred sand bass	*Paralabrax nebulifer*	1					4	2		2	5	2	1		2	1			2
White croaker	*Genyonemus lineatus*	34				4	17	17		9	3	179	112	9	384	8	4	126	335
Queenfish	*Seriphus politus*									1		7	2						24
Shiner surfperch	*Cymatogaster aggregata*								2										
White surfperch	*Phanerodon furcatus*	8	4				7	3	6	15	14				2				
Spotted kelpfish	*Gibbonsia elegans*									1									
Giant kelpfish	*Heterostichus rostratus*			1						2									
Bay goby	*Lepidogobius lepidus*									5	5		4	2	5	1			9
Pacific sanddab	*Citharichthys sordidus*											5							
Speckled sanddab	*Citharichthys stigmaeus*	4	2			4	1			1		2		7					2
California halibut	*Paralichthys californicus*	2	5	2		1	2	4	1	1	2	4	8	10	2				9
Fantail sole	*Xystreurys liolepis*		2	1	1	4	1				1	3	1	1	1				
Spotted turbot	*Pleuronichthys ritteri*		4	2		1	2			1	1	1	1						
Hornyhead turbot	*Pleuronichthys verticalis*					2						2	2	2					
Diamond turbot	*Hypsopsetta guttulata*							1					2		1				1
California tonguefish	*Symphurus atricauda*				3	5	1					2	2		1				13
Total Catch - Day		52	19	6	15	35	53	31	9	38	37	315	224	38	450	11	38	126	403
Number of species - Day		8	7	4	6	9	9	6	3	10	9	12	12	8	12	4	2	1	11

February 2000
Otter Trawl Fish - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Grey smoothhound shark	*Mustelus californicus*								1			1							
Brown smoothhound shark	*Mustelus henlei*														1				
Shovelnose guitarfish	*Rhinobatos productus*									1	2				2				1
Thornback	*Platyrhinoidis triseriata*												3						
Big skate	*Raja binoculata*				3					1	1			1					1
Round stingray	*Urolophus halleri*													3	1	1			
Bat ray	*Myliobatis californica*		3								4		3	2					
Northern anchovy	*Engraulis mordax*		1						2		1	38	14	14	15	2	9		19
Deepbody anchovy	*Anchoa compressa*												14	5	2	1			
California lizardfish	*Synodus lucioceps*	1				3	1			2		6	1		1	2	2	5	3
Plainfin midshipman	*Porichthys notatus*							4	4		13					16			1
Specklefin midshipman	*Porichthys myriaster*	1	1		7	13	1	10	6			2		1	14	26	1	33	6
Basketweave cusk-eel	*Ophidion scrippsae*											1	7	8	1				14
Topsmelt	*Atherinops affinis*										2								
Black rockfish	*Sebastes melanops*		1		5	5													
California scorpionfish	*Scorpaena guttata*		1	1															1
Yellowchin sculpin	*Icelinus quadriseriatus*						17	2	5						1	3	2		1
Staghorn sculpin	*Leptocottus armatus*						5	1											
Spotted sand bass	*Paralabrax maculatofasciatus*															1			
Barred sand bass	*Paralabrax nebulifer*	1			8	15	4	3		2	3		1		1		1	1	1
Salema	*Xenistius californiensis*					1									1		2		
White croaker	*Genyonemus lineatus*	84	73	64	161	311	81	84	192	23	16	121	352	213	568	111	136	306	150
California corbina	*Menticirrhus undulatus*	2										1	2	2					
Queenfish	*Seriphus politus*	14	39		5	20	23	2	9	11	7	14	11	7	27	10	16	36	35
Shiner surfperch	*Cymatogaster aggregata*		11			5	1	2	29	4									
White surfperch	*Phanerodon furcatus*				1	2		1	6										
Bay goby	*Lepidogobius lepidus*	1	1					7			2	1	1		1		3	1	
Speckled sanddab	*Citharichthys stigmaeus*	10	3	1			7					1	4	4					
California halibut	*Paralichthys californicus*	1	2			1		1			7	9	10	7	1		4	7	8
Fantail sole	*Xystreurys liolepis*		4				3		1		1	1	1	1	1		3	2	1
English sole	*Pleuronectes vetulus*							1											
Spotted turbot	*Pleuronichthys ritteri*	1	3	1	1		2		4		1	1	2	1		2	3	1	
Hornyhead turbot	*Pleuronichthys verticalis*			1	2	6	2				1	3	12	3	4		2		1
Diamond turbot	*Hypsopsetta guttulata*		4	1							1	1	3	4					
California tonguefish	*Symphurus atricauda*	3	1		7	10	2					37	2	2			2	3	14
Total Catch - Night		119	148	69	200	392	149	118	259	44	62	238	443	278	642	175	186	395	257
Number of species - Night		11	15	6	10	12	13	12	11	7	15	16	18	17	17	11	14	10	16

LA/LB Baseline - May 2000
Otter Trawl Fish - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Brown smoothhound shark	*Mustelus henlei*														2				
Shovelnose guitarfish	*Rhinobatos productus*									1			2	2			1		1
California skate	*Raja inornata*													1				1	
Round stingray	*Urolophus halleri*												4						
Bat ray	*Myliobatis californica*	1	1																
Pacific sardine	*Sardinops sagax*															1			
Northern anchovy	*Engraulis mordax*										9				23	11	1		
California lizardfish	*Synodus lucioceps*	1			4	4	2			1		3	3	6	2		4	3	
Plainfin midshipman	*Porichthys notatus*							1											1
Specklefin midshipman	*Porichthys myriaster*				1			4						1	4			2	3
California clingfish	*Gobiesox rhessodon*										1								
Bay pipefish	*Syngnathus leptorhynchus*													1					
Black rockfish	*Sebastes melanops*				2	1											1		
Vermilion rockfish	*Sebastes miniatus*														1				
Lingcod	*Ophiodon elongatus*				1														
Yellowchin sculpin	*Icelinus quadriseriatus*							1											
Cabezon	*Scorpaenichthys marmoratus*		1																
Barred sand bass	*Paralabrax nebulifer*	2	2	1			3		2	5	1		6	4		1	2		
White croaker	*Genyonemus lineatus*	46	34		8	6	16	37		10	52	29	8	23	61		27	94	283
Queenfish	*Seriphus politus*				1							1						1	8
Shiner surfperch	*Cymatogaster aggregata*	1	9								2								
Black surfperch	*Embiotoca jacksoni*						1												
White surfperch	*Phanerodon furcatus*		19	32	6	3	32	9	5	28	30	1	4	1	4	5	5	1	1
Pile surfperch	*Rhacochilus vacca*			1						1									
Giant kelpfish	*Heterostichus rostratus*			1															
Bay goby	*Lepidogobius lepidus*	3															6	2	13
Speckled sanddab	*Citharichthys stigmaeus*	15	2	1	1	3	2					7	1	4				1	2
California halibut	*Paralichthys californicus*	2		3	1	2	4			4	2	5	7	11		2	2	1	7
Fantail sole	*Xystreurys liolepis*		1		3		1					3	1				3		2
Spotted turbot	*Pleuronichthys ritteri*		1	1			1		2			8	3						
Hornyhead turbot	*Pleuronichthys verticalis*											6					1		
Diamond turbot	*Hypsopsetta guttulata*			1										1					1
California tonguefish	*Symphurus atricauda*	2					1					3	1				1	4	6
Total Catch - Day		73	70	41	28	19	63	52	9	50	97	66	40	55	97	20	54	110	328
Number of Species - Day		9	9	8	10	6	10	5	3	7	7	10	11	11	7	5	12	10	12

LA/LB Baseline - May 2000
Otter Trawl Fish - Number per haul

Night Samples																			
Shovelnose guitarfish	*Rhinobatos productus*										2		1	2					
Thornback	*Platyrhinoidis triseriata*		1												1				
California skate	*Raja inornata*				1														
Round stingray	*Urolophus halleri*			1									2	3					
Bat ray	*Myliobatis californica*		6	2							1								
Northern anchovy	*Engraulis mordax*						1	3			1				4		11		55
California lizardfish	*Synodus lucioceps*	1			3		1	1		2	1	5	4	6			1	2	
Plainfin midshipman	*Porichthys notatus*				2	1		4	1									1	1
Specklefin midshipman	*Porichthys myriaster*				4	8	5	27	4				1		2	7	2		
Basketweave cusk-eel	*Ophidion scrippsae*	6											2	4					2
Topsmelt	*Atherinops affinis*			1															
Barcheek pipefish	*Syngnathus exilis*									1	1								
California scorpionfish	*Scorpaena guttata*		1																
Yellowchin sculpin	*Icelinus quadriseriatus*						2												
Barred sand bass	*Paralabrax nebulifer*		3	7	1		2		9	5	5	1	1				1		
Salema	*Xenistius californiensis*				1						1								
White croaker	*Genyonemus lineatus*	129	83	25	92	100	21	22	68	56	23	33	51	104	28	6	25	351	163
California corbina	*Menticirrhus undulatus*												1						
Yellowfin croaker	*Umbrina roncador*									1									
Queenfish	*Seriphus politus*	7	11	7	13	31	35	8	6	194	207	10	3	3	1	2	15	5	14
Shiner surfperch	*Cymatogaster aggregata*		1	16					1	4	4								
Black surfperch	*Embiotoca jacksoni*								1									1	
White surfperch	*Phanerodon furcatus*		8	7					15	7	25	1	1		11				
Pile surfperch	*Rhacochilus vacca*								6										
Bay goby	*Lepidogobius lepidus*				1	2	4	3		1		2			1		13	5	3
Speckled sanddab	*Citharichthys stigmaeus*	25			1	2	6	1				4	1	13			1	3	
Longfin sanddab	*Citharichthys xanthostigma*	1																	
California halibut	*Paralichthys californicus*	2	2	2						9	3	2	5	11			4	6	2
Fantail sole	*Xystreurys liolepis*		1							1		5		2		1		2	
Spotted turbot	*Pleuronichthys ritteri*		1	2			1				3	2		2			1		
Hornyhead turbot	*Pleuronichthys verticalis*		1						1			4	1	4			1	1	
Diamond turbot	*Hypsopsetta guttulata*	1		2							1		1						
California tonguefish	*Symphurus atricauda*	9	1		4	5	1					7					3	6	5
Total Catch - Night		181	120	72	123	149	79	69	112	281	278	76	75	154	48	16	78	383	245
Number of Species - Night		9	13	11	11	7	11	8	10	11	14	12	14	11	7	4	12	11	8

August 2000
Otter Trawl Fish - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Grey smoothhound shark	*Mustelus californicus*																		2
Brown smoothhound shark	*Mustelus henlei*		1																
Shovelnose guitarfish	*Rhinobatos productus*		2	3						1	1								
Thornback	*Platyrhinoidis triseriata*												1						
Bat ray	*Myliobatis californica*		3	2								1	1			1			
Pacific sardine	*Sardinops sagax*				1														
Northern anchovy	*Engraulis mordax*	4027	163	700	3705	159	2579	785	28	95		296	2569	2740	1058	382	25	1881	64
Deepbody anchovy	*Anchoa compressa*												1	2					
California lizardfish	*Synodus lucioceps*			1														3	
Plainfin midshipman	*Porichthys notatus*							41											
Specklefin midshipman	*Porichthys myriaster*				1	1		1		3		8	1				1	3	6
Vermilion rockfish	*Sebastes miniatus*																1		1
Grass rockfish	*Sebastes rastrelliger*									2								1	
California scorpionfish	*Scorpaena guttata*																	2	
Yellowchin sculpin	*Icelinus quadriseriatus*							1	1										
Staghorn sculpin	*Leptocottus armatus*																	1	1
Barred sand bass	*Paralabrax nebulifer*		12	3	1	3	6	3	1	6	15	3		1		2	2	1	1
White croaker	*Genyonemus lineatus*		53	12	12	8	27	1	49	7		320	229	333	415	25	1095	293	277
Queenfish	*Seriphus politus*	5	148	17	1	1	2		67	2		94	153	294	24		157	21	16
Shiner surfperch	*Cymatogaster aggregata*		278	181				2		2	11	1	2	3					
Black surfperch	*Embiotoca jacksoni*		9							2	1								
White surfperch	*Phanerodon furcatus*		52	54	5	12	14	1		36	16	2	4	37			5		
Giant kelpfish	*Heterostichus rostratus*									2	35								
Bay goby	*Lepidogobius lepidus*							1				14		2			1	7	12
Chameleon goby	*Tridentiger trigonocephalus*										1								
Pacific butterfish	*Peprilus simillimus*												1					18	
Speckled sanddab	*Citharichthys stigmaeus*			1			1					1		3			2		2
California halibut	*Paralichthys californicus*		7	8				1	3	2		2	56	47			1	3	1
Fantail sole	*Xystreurys liolepis*		3	2			1		1			2		1				1	1
English sole	*Pleuronectes vetulus*													1					
Spotted turbot	*Pleuronichthys ritteri*		2	5			2	1	1	4		1	11	7		1		1	
Hornyhead turbot	*Pleuronichthys verticalis*		1	1		2	1					5	4	3			1	3	1
Diamond turbot	*Hypsopsetta guttulata*		1																
California tonguefish	*Symphurus atricauda*				5	2	2					20			1			18	15
Total Catch - Day		4032	735	990	3731	188	2635	838	151	164	80	770	3033	3474	1498	411	1291	2257	400
Number of species - Day		2	15	14	8	8	10	11	8	13	7	15	13	14	4	5	11	16	14

August 2000
Otter Trawl Fish - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Brown smoothhound shark	*Mustelus henlei*				1										1				
Leopard shark	*Triakis semifasciata*		2																
Thornback	*Platyrhinoidis triseriata*			3										1					
Round stingray	*Urolophus halleri*									1			5	1					
Bat ray	*Myliobatis californica*		3	7									1						1
Pacific sardine	*Sardinops sagax*											1							
Northern anchovy	*Engraulis mordax*	20	6	31	3	6	17	4	96	19	25	43	30	30	60	16	362	2	119
California lizardfish	*Synodus lucioceps*	3										1	1	1	2	1			1
Plainfin midshipman	*Porichthys notatus*				2		7	6								17		1	
Specklefin midshipman	*Porichthys myriaster*	6			23	59	5	8	2	15	1	122		2	1	75	63	20	15
Basketweave cusk-eel	*Ophidion scrippsae*											1							
California grunion	*Leuresthes tenuis*					1							1						
California scorpionfish	*Scorpaena guttata*												2						
Yellowchin sculpin	*Icelinus quadriseriatus*						1	1	3										
Barred sand bass	*Paralabrax nebulifer*	1	4	3	2	1	4	3	2	1	7	5	7	2		2	2	2	1
White croaker	*Genyonemus lineatus*	313	144	61	88	80	148	141	145	1274	137	239	130	194	1050	81	1450	239	252
California corbina	*Menticirrhus undulatus*		3	1									1	3					
Queenfish	*Seriphus politus*	33	779	516	40	124	69	52	411	250	30	11	937	700	10	22	25	2	4
Shiner surfperch	*Cymatogaster aggregata*		55	158	6	10	7		16	108	18		8	6		4			
Black surfperch	*Embiotoca jacksoni*										2								
White surfperch	*Phanerodon furcatus*		2	28	1	7	20	1	2	4	1		9	6	2	19	1		
Pile surfperch	*Rhacochilus vacca*														1				
Giant kelpfish	*Heterostichus rostratus*										5					1			
Bay goby	*Lepidogobius lepidus*	1		1		3						1					29	7	7
Yellowfin goby	*Acanthogobius flavimanus*								1		1								
Pacific butterfish	*Peprilus simillimus*					1				1									
Pacific sanddab	*Citharichthys sordidus*	44																	2
Speckled sanddab	*Citharichthys stigmaeus*		5			4	6					15					5		
California halibut	*Paralichthys californicus*	6	7	12	1	7	1	1	2	1		4	24	43	4		7		1
Fantail sole	*Xystreurys liolepis*		1	1		1						2	1				1	2	
Spotted turbot	*Pleuronichthys ritteri*		7	9			3			12	1		13	11					
Hornyhead turbot	*Pleuronichthys verticalis*	1			1		1		1			8			1		1	1	2
Diamond turbot	*Hypsopsetta guttulata*	1	3	1						1				2					
California tonguefish	*Symphurus atricauda*	13	4		9	7	2					21			1	1	1	2	9
Total catch - Night		442	1025	832	177	311	291	217	681	1687	228	474	1170	1002	1133	239	1947	278	414
Number of species - Night		12	15	14	12	14	14	9	11	12	11	14	15	14	11	11	12	10	12

November 2000
Otter Trawl Fish - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Shovelnose guitarfish	*Rhinobatos productus*		1												1				
California skate	*Raja inornata*																1	1	
Round stingray	*Urolophus halleri*												2	6					
Bat ray	*Myliobatis californica*		2											1					
Northern anchovy	*Engraulis mordax*		6									54			23		2	35	4
Slough anchovy	*Anchoa delicatissima*																1	11	
California lizardfish	*Synodus lucioceps*				1			2				1	2						
Plainfin midshipman	*Porichthys notatus*							1											
Specklefin midshipman	*Porichthys myriaster*							1							5		8	3	63
Pipefish (unid.)	*Syngnathus sp*					2													
California scorpionfish	*Scorpaena guttata*									1									
Yellowchin sculpin	*Icelinus quadriseriatus*						1	1											
Kelp bass	*Paralabrax clathratus*				1					3	8								
Barred sand bass	*Paralabrax nebulifer*	3	3	1	5	1			1	2	4	2	4			2	1		
Sargo	*Anisotremus davidsoni*										1								
White croaker	*Genyonemus lineatus*	11										197			162.3		393	245	119.3
California corbina	*Menticirrhus undulatus*		2																
Queenfish	*Seriphus politus*	1	1									56			47		203	59	142
Shiner surfperch	*Cymatogaster aggregata*		76	2			1				1			2					
Black surfperch	*Embiotoca jacksoni*										1					3			
White surfperch	*Phanerodon furcatus*	1	71	51	6	9	8		1		3	2			5	3	1		
Giant kelpfish	*Heterostichus rostratus*		1			1													
Bay goby	*Lepidogobius lepidus*																		15
Pacific butterfish	*Peprilus simillimus*														8				
Speckled sanddab	*Citharichthys stigmaeus*	44	4	4	3	8	1					2		6			1	2	1
California halibut	*Paralichthys californicus*	2		9					1	2		3	13	10	1				4
Fantail sole	*Xystreurys liolepis*				2	1							2	1					
English sole	*Pleuronectes vetulus*												1						
Spotted turbot	*Pleuronichthys ritteri*			1	1		1					3		3		1			
Hornyhead turbot	*Pleuronichthys verticalis*				2							4			2				2
Diamond turbot	*Hypsopsetta guttulata*			1									1	2					
California tonguefish	*Symphurus atricauda*	4			6	1				1		1			3		1	3	15
Total Catch - Day		66	167	69	27	23	12	5	3	9	18	325	25	31	257	9	612	359	365
Number of species - Day		7	10	7	9	7	5	4	3	5	6	11	7	8	10	4	10	8	9

November 2000
Otter Trawl Fish - Number per haul

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Grey smoothhound shark	*Mustelus californicus*	1																	
Brown smoothhound shark	*Mustelus henlei*																		1
Leopard shark	*Triakis semifasciata*		1																
Shovelnose guitarfish	*Rhinobatos productus*														1				1
Thornback	*Platyrhinoidis triseriata*			2									1						
California skate	*Raja inornata*				1	3									1			1	
Round stingray	*Urolophus halleri*									1			2						
Bat ray	*Myliobatis californica*		1	4						1			1		1				
Northern anchovy	*Engraulis mordax*	2					10	1	2	8	4	4	5	15	1	2	9	2	3
Deepbody anchovy	*Anchoa compressa*	1									3	1	5					6	
Slough anchovy	*Anchoa delicatissima*												1	3					
California lizardfish	*Synodus lucioceps*				1	1						1			1		1		
Plainfin midshipman	*Porichthys notatus*						2	6					1					1	
Specklefin midshipman	*Porichthys myriaster*	6			3	2	29	39	6	10		1			8	176	47	19	6
Basketweave cusk-eel	*Ophidion scrippsae*	1																	3
Topsmelt	*Atherinops affinis*		1		2														
Jacksmelt	*Atherinopsis californiensis*												2	1					
Vermilion rockfish	*Sebastes miniatus*								1										
California scorpionfish	*Scorpaena guttata*	1		2			1												
Yellowchin sculpin	*Icelinus quadriseriatus*						1	1			1								
Kelp bass	*Paralabrax clathratus*										12								
Barred sand bass	*Paralabrax nebulifer*	3		2	1	1	3	4	5	6	13		2			1	3	1	
Salema	*Xenistius californiensis*				1					2	1	1	2	1			3		
White croaker	*Genyonemus lineatus*	419	113	67	113	82	21	25	40	351	38	237	160	62	917.8	76	701.1	283	205
California corbina	*Menticirrhus undulatus*		2	1								1	1						
Queenfish	*Seriphus politus*	111	83	25	45	60	117	22	49	106	31	77	178	86	11	12	163	86	14
Shiner surfperch	*Cymatogaster aggregata*		41	75	8	12	28	3	31	46	22		3		2				
Black surfperch	*Embiotoca jacksoni*		2				1												
Walleye surfperch	*Hyperprosopon argenteum*												2						
White surfperch	*Phanerodon furcatus*		30	94	1	3			4	1	9		2		3	14			
Giant kelpfish	*Heterostichus rostratus*		1			1			1										
Pacific butterfish	*Peprilus simillimus*									1		1	8	8					
Speckled sanddab	*Citharichthys stigmaeus*	24	5	1	5	12	3					4	2				5	1	
California halibut	*Paralichthys californicus*	1	6	7					1	2		1	12		3	2	1	2	
Fantail sole	*Xystreurys liolepis*			1	1			2				1			1				
Spotted turbot	*Pleuronichthys ritteri*		3	3			2			3			1					1	
Hornyhead turbot	*Pleuronichthys verticalis*				2	1	2					1	2		1			5	2
Diamond turbot	*Hypsopsetta guttulata*		1	1									2						
California tonguefish	*Symphurus atricauda*	3	5		7	2	2					2			2			1	11
Total Catch - Night		573	295	285	191	180	222	103	140	538	134	333	395	176	954	283	933	409	246
Number of species - Night		12	15	14	14	12	14	9	10	13	10	14	22	7	14	7	9	13	9

February 2000
Otter Trawl Fish - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Shovelnose guitarfish	*Rhinobatos productus*										5.750								
Big skate	*Raja binoculata*											0.013							
Round stingray	*Urolophus halleri*													0.750					
Northern anchovy	*Engraulis mordax*	0.001									0.004	0.165	0.106	0.005	0.051		0.055		
Deepbody anchovy	*Anchoa compressa*												0.099						0.041
California lizardfish	*Synodus lucioceps*	0.355			0.105										0.516	0.305			0.924
Specklefin midshipman	*Porichthys myriaster*				0.007	0.007									0.038				
Bay pipefish	*Syngnathus leptorhynchus*		0.005		0.008														
Black rockfish	*Sebastes melanops*		0.002		0.005	0.011													
Yellowchin sculpin	*Icelinus quadriseriatus*	0.004					0.088	0.019							0.005				0.006
Barred sand bass	*Paralabrax nebulifer*	0.170					0.437	0.069		0.119	0.336	0.232	0.036		0.230	0.067			0.225
White croaker	*Genyonemus lineatus*	2.423				0.004	0.519	0.017		2.310	0.301	4.345	1.329	0.009	0.523	0.038	0.312	0.466	9.166
Queenfish	*Seriphus politus*									0.001		0.102	0.167						0.710
Shiner surfperch	*Cymatogaster aggregata*								0.059										
White surfperch	*Phanerodon furcatus*	0.339	0.881				0.335	0.072	0.126	0.874	0.496				0.270				
Spotted kelpfish	*Gibbonsia elegans*									0.013									
Giant kelpfish	*Heterostichus rostratus*			0.009						0.014									
Bay goby	*Lepidogobius lepidus*									0.005	0.005		0.004	0.002	0.005	0.001			0.010
Pacific sanddab	*Citharichthys sordidus*											0.085							
Speckled sanddab	*Citharichthys stigmaeus*	0.020	0.046			0.031	0.012			0.025		0.040		0.041					0.022
California halibut	*Paralichthys californicus*	0.510	1.872	0.860		0.650	0.875	0.672	0.250	0.062	0.314	1.023	7.403	2.605	3.925				2.374
Fantail sole	*Xystreurys liolepis*		0.535	0.155	0.140	0.826	0.255				0.115	1.760	0.560	0.550	0.002				
Spotted turbot	*Pleuronichthys ritteri*		0.620	0.505		0.011	0.170			0.031	0.150	0.145	0.002						
Hornyhead turbot	*Pleuronichthys verticalis*					0.090						0.059	0.058	0.023					
Diamond turbot	*Hypsopsetta guttulata*							0.220					0.435		0.032				0.590
California tonguefish	*Symphurus atricauda*				0.016	0.045	0.021					0.021	0.058		0.009				0.197
Total biomass - Day		3.822	3.961	1.529	0.281	1.676	2.712	1.069	0.435	3.454	7.471	7.990	10.257	3.985	5.606	0.411	0.367	0.466	14.265

February 2000
Otter Trawl Fish - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Grey smoothhound shark	*Mustelus californicus*								2.200			0.720							
Brown smoothhound shark	*Mustelus henlei*														0.700				
Shovelnose guitarfish	*Rhinobatos productus*									1.300	3.200				4.050				10.500
Thornback	*Platyrhinoidis triseriata*												0.590						
Big skate	*Raja binoculata*				1.713					0.019	0.013			0.950					1.250
Round stingray	*Urolophus halleri*													2.050	0.650	0.580			
Bat ray	*Myliobatis californica*		3.200								6.000		5.450	3.400					
Northern anchovy	*Engraulis mordax*		0.002						0.008		0.001	0.238	0.076	0.079	0.076	0.006	0.042		0.197
Deepbody anchovy	*Anchoa compressa*												0.221	0.077	0.027	0.016			
California lizardfish	*Synodus lucioceps*	0.130				0.470	0.105			0.664		1.235	0.135		0.105	0.500	0.240	1.050	1.127
Plainfin midshipman	*Porichthys notatus*							0.010	0.011		0.013					0.024			0.002
Specklefin midshipman	*Porichthys myriaster*	0.004	0.021		0.010	0.019	0.001	0.053	0.022			0.011		0.009	0.092	0.046	0.005	0.323	0.102
Basketweave cusk-eel	*Ophidion scrippsae*											0.057	0.246	0.359	0.031				1.440
Topsmelt	*Atherinops affinis*										0.079								
Black rockfish	*Sebastes melanops*		0.001		0.005	0.007													
California scorpionfish	*Scorpaena guttata*		0.145	0.080															0.250
Yellowchin sculpin	*Icelinus quadriseriatus*						0.094	0.011	0.025						0.006	0.013	0.008		0.004
Staghorn sculpin	*Leptocottus armatus*						0.023	0.005											
Spotted sand bass	*Paralabrax maculatofasciatus*															0.425			
Barred sand bass	*Paralabrax nebulifer*	0.120			0.703	1.545	0.317	0.107		0.100	0.215		0.110		0.125		0.082	0.001	0.077
Salema	*Xenistius californiensis*					0.065									0.064		0.108		
White croaker	*Genyonemus lineatus*	8.141	1.868	6.801	3.035	4.347	6.786	0.974	3.032	3.085	2.238	6.341	7.137	4.085	3.691	0.468	1.711	8.564	6.250
California corbina	*Menticirrhus undulatus*	1.585										0.195	0.310	0.460					
Queenfish	*Seriphus politus*	0.558	0.156		0.377	1.229	1.143	0.109	0.208	0.368	0.398	0.705	0.499	0.117	1.806	0.462	0.788	1.858	1.883
Shiner surfperch	*Cymatogaster aggregata*		0.214			0.101	0.055	0.074	0.706	0.103									
White surfperch	*Phanerodon furcatus*				0.051	0.084		0.025	0.186										
Bay goby	*Lepidogobius lepidus*	0.001	0.001					0.007			0.002	0.003	0.001		0.002		0.003	0.001	
Speckled sanddab	*Citharichthys stigmaeus*	0.022	0.055	0.010			0.111					0.017	0.017	0.006					
California halibut	*Paralichthys californicus*	0.450	0.375			0.620		0.057			5.753	2.994	2.656	1.297	0.125		0.360	0.805	2.756
Fantail sole	*Xystreurys liolepis*		1.270				0.544		0.350		0.100	0.450	0.230	0.455	0.260		0.337	0.468	0.465
English sole	*Pleuronectes vetulus*							0.030											
Spotted turbot	*Pleuronichthys ritteri*	0.140	0.655	0.155	0.160		0.139		0.100		0.120	0.068	0.028	0.140		0.053	0.111	0.180	
Hornyhead turbot	*Pleuronichthys verticalis*			0.022	0.056	0.154	0.040				0.001	0.201	0.232	0.048	0.174		0.058		0.172
Diamond turbot	*Hypsopsetta guttulata*		0.910	0.265							0.232	0.355	0.615	0.715					
California tonguefish	*Symphurus atricauda*	0.079	0.023		0.059	0.136	0.023					0.681	0.016	0.065			0.065	0.072	0.216
Total biomass - Night		11.231	8.896	7.333	6.169	8.776	9.381	1.462	6.848	5.639	18.366	14.270	18.569	14.313	11.984	2.593	3.918	13.322	26.690

May 2000
Otter Trawl Fish - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Brown smoothhound shark	*Mustelus henlei*														2.100				
Shovelnose guitarfish	*Rhinobatos productus*									0.900			1.875	1.250			0.975		1.650
California skate	*Raja inornata*													2.150				0.055	
Round stingray	*Urolophus halleri*												2.275						
Bat ray	*Myliobatis californica*	0.480	2.050																
Pacific sardine	*Sardinops sagax*															0.001			
Northern anchovy	*Engraulis mordax*										0.009				0.036	0.012	0.001		
California lizardfish	*Synodus lucioceps*	0.088			0.420	0.645	0.285			0.088		0.345	0.703	1.519	0.485		0.750	0.800	
Plainfin midshipman	*Porichthys notatus*							0.003											0.058
Specklefin midshipman	*Porichthys myriaster*				0.002			0.023						0.435	0.021			0.030	0.182
California clingfish	*Gobiesox rhessodon*										0.001								
Bay pipefish	*Syngnathus leptorhynchus*													0.005					
Black rockfish	*Sebastes melanops*				0.011	0.007											0.001		
Vermilion rockfish	*Sebastes miniatus*														0.008				
Lingcod	*Ophiodon elongatus*				0.005														
Yellowchin sculpin	*Icelinus quadriseriatus*							0.004											
Cabezon	*Scorpaenichthys marmoratus*		0.004																
Barred sand bass	*Paralabrax nebulifer*	0.730	0.430	0.049			0.308		0.278	0.595	0.120		0.915	0.542		0.190	0.103		
White croaker	*Genyonemus lineatus*	35.566	3.333		1.196	0.697	1.826	0.708		1.898	2.370	3.604	1.141	3.232	1.853		1.469	3.393	2.672
Queenfish	*Seriphus politus*				0.125							0.125						0.042	0.473
Shiner surfperch	*Cymatogaster aggregata*	0.038	0.338								0.036								
Black surfperch	*Embiotoca jacksoni*						0.203												
White surfperch	*Phanerodon furcatus*		1.448	2.708	0.425	0.157	1.818	0.329	0.325	3.327	0.574	0.004	0.219	0.003	0.334	0.398	0.644	0.003	0.004
Pile surfperch	*Rhacochilus vacca*			0.057						0.102									
Giant kelpfish	*Heterostichus rostratus*			0.060															
Bay goby	*Lepidogobius lepidus*	0.005															0.006	0.002	0.015
Speckled sanddab	*Citharichthys stigmaeus*	0.056	0.007	0.004	0.002	0.019	0.035					0.100	0.012	0.062				0.009	0.002
California halibut	*Paralichthys californicus*	2.950		1.550	0.290	1.880	3.675			1.965	0.425	2.870	3.155	3.141		0.420	0.385	0.700	3.055
Fantail sole	*Xystreurys liolepis*		0.150		0.640		0.120					0.425	0.280				0.470		0.482
Spotted turbot	*Pleuronichthys ritteri*		0.055	0.162			0.022		0.096			1.708	0.224						
Hornyhead turbot	*Pleuronichthys verticalis*											0.326					0.029		
Diamond turbot	*Hypsopsetta guttulata*			0.240										0.220					0.238
California tonguefish	*Symphurus atricauda*	0.062					0.024					0.058	0.034				0.052	0.080	0.070
Total biomass - Day		39.975	7.815	4.830	3.116	3.405	8.316	1.067	0.699	8.875	3.535	9.565	10.833	12.559	4.837	1.021	4.885	5.114	8.901

May 2000
Otter Trawl Fish - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Shovelnose guitarfish	*Rhinobatos productus*										2.700		0.505	1.765					
Thornback	*Platyrhinoidis triseriata*		0.390												0.095				
California skate	*Raja inornata*				0.320														
Round stingray	*Urolophus halleri*			0.610									1.065	1.485					
Bat ray	*Myliobatis californica*		9.100	3.050							2.500								
Northern anchovy	*Engraulis mordax*						0.003	0.011			0.001				0.006		0.027		0.193
California lizardfish	*Synodus lucioceps*	0.445			0.695		0.148	0.260		0.253	0.520	1.112	1.224	1.382			0.126	0.690	
Plainfin midshipman	*Porichthys notatus*				0.012	0.003		0.013	0.003									0.042	0.041
Specklefin midshipman	*Porichthys myriaster*				0.017	0.031	0.046	0.229	0.040				0.332		0.041	0.036	0.011		
Basketweave cusk-eel	*Ophidion scrippsae*	0.612											0.062	0.149					0.244
Topsmelt	*Atherinops affinis*			0.050															
Barcheek pipefish	*Syngnathus exilis*									0.002	0.001								
California scorpionfish	*Scorpaena guttata*		0.275																
Yellowchin sculpin	*Icelinus quadriseriatus*						0.013												
Barred sand bass	*Paralabrax nebulifer*		0.480	0.917	0.169		0.189		0.921	0.602	0.327	0.172	0.162				0.080		
Salema	*Xenistius californiensis*				0.065						0.048								
White croaker	*Genyonemus lineatus*	11.732	4.982	1.512	3.231	3.677	2.304	0.356	0.974	9.176	3.118	4.980	5.503	8.525	0.540	0.039	1.452	4.800	2.594
California corbina	*Menticirrhus undulatus*												0.198						
Yellowfin croaker	*Umbrina roncador*									0.334									
Queenfish	*Seriphus politus*	0.405	0.197	0.123	0.786	1.543	1.634	0.315	0.217	5.009	4.186	0.616	0.237	0.238	0.035	0.018	0.823	0.346	1.338
Shiner surfperch	*Cymatogaster aggregata*		0.049	0.502					0.040	0.130	0.020								
Black surfperch	*Embiotoca jacksoni*								0.075									0.004	
White surfperch	*Phanerodon furcatus*		0.037	0.028					0.683	0.244	0.122	0.064	0.003		0.132				
Pile surfperch	*Rhacochilus vacca*								0.423										
Bay goby	*Lepidogobius lepidus*				0.001	0.003	0.004	0.003		0.001		0.004			0.001		0.013	0.005	0.003
Speckled sanddab	*Citharichthys stigmaeus*	0.149			0.003	0.005	0.085	0.017				0.039	0.002	0.167			0.011	0.011	
Longfin sanddab	*Citharichthys xanthostigma*	0.053																	
California halibut	*Paralichthys californicus*	0.950	3.820	0.553						2.426	0.674	0.940	1.238	2.255			5.625	2.164	0.885
Fantail sole	*Xystreurys liolepis*		0.136							0.105		0.858		0.269		0.033		0.386	
Spotted turbot	*Pleuronichthys ritteri*		0.077	0.302			0.094				0.700	0.151		0.400			0.065		
Hornyhead turbot	*Pleuronichthys verticalis*		0.146						0.055			0.325	0.043	0.149			0.096	0.094	
Diamond turbot	*Hypsopsetta guttulata*	0.500		0.420							0.280		0.217						
California tonguefish	*Symphurus atricauda*	0.134	0.018		0.041	0.045	0.015					0.143					0.071	0.082	0.089
Total biomass - Night		14.980	19.707	8.067	5.340	5.307	4.536	1.203	3.431	18.281	15.197	9.404	10.791	16.784	0.850	0.126	8.400	8.624	5.388

August 2000
Otter Trawl Fish - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Grey smoothhound shark	*Mustelus californicus*																		1.760
Brown smoothhound shark	*Mustelus henlei*		1.250																
Shovelnose guitarfish	*Rhinobatos productus*		1.603	2.205						1.000	0.820								
Thornback	*Platyrhinoidis triseriata*												0.200						
Bat ray	*Myliobatis californica*		20.050	5.050								5.850	2.000			0.075			
Pacific sardine	*Sardinops sagax*				0.002														
Northern anchovy	*Engraulis mordax*	5.481	0.160	0.532	3.420	0.102	2.769	0.657	0.029	0.086		0.233	3.042	3.407	1.422	0.342	0.032	2.017	0.092
Deepbody anchovy	*Anchoa compressa*												0.010	0.027					
California lizardfish	*Synodus lucioceps*			0.205														0.960	
Plainfin midshipman	*Porichthys notatus*							0.002											
Specklefin midshipman	*Porichthys myriaster*				0.039	0.050		0.013		0.799		0.324	0.250				0.001	0.203	0.425
Vermilion rockfish	*Sebastes miniatus*																0.115		0.106
Grass rockfish	*Sebastes rastrelliger*									0.009								0.056	
California scorpionfish	*Scorpaena guttata*																	0.422	
Yellowchin sculpin	*Icelinus quadriseriatus*							0.006	0.001										
Staghorn sculpin	*Leptocottus armatus*																	0.031	0.055
Barred sand bass	*Paralabrax nebulifer*		1.752	0.485	0.305	0.402	0.857	0.172	0.165	0.605	1.370	0.470		0.192		0.420	0.272	0.074	0.175
White croaker	*Genyonemus lineatus*		2.152	1.061	1.308	0.145	0.037	0.001	1.041	0.867		2.540	2.320	4.665	1.616	0.483	3.905	1.978	4.898
Queenfish	*Seriphus politus*	0.160	0.902	0.439	0.001	0.001	0.003		0.379	0.134		1.031	1.329	3.383	1.786		1.340	1.332	0.436
Shiner surfperch	*Cymatogaster aggregata*		2.304	1.472				0.071		0.066	0.081	0.006	0.017	0.029					
Black surfperch	*Embiotoca jacksoni*		1.283							0.322	0.047								
White surfperch	*Phanerodon furcatus*		2.422	1.565	0.525	0.479	1.134	0.069		2.676	0.257	0.175	0.269	1.283			0.603		
Giant kelpfish	*Heterostichus rostratus*									0.006	0.114								
Bay goby	*Lepidogobius lepidus*							0.001				0.021		0.002			0.001	0.008	0.014
Chameleon goby	*Tridentiger trigonocephalus*										0.001								
Pacific butterfish	*Peprilus simillimus*												0.006					0.160	
Speckled sanddab	*Citharichthys stigmaeus*			0.010			0.015					0.006		0.024			0.010		0.012
California halibut	*Paralichthys californicus*		0.660	0.817				0.003	0.821	0.635		0.810	3.623	1.949			0.845	0.648	0.320
Fantail sole	*Xystreurys liolepis*		0.485	0.283			0.240		0.455			0.453		0.100				0.460	0.690
English sole	*Pleuronectes vetulus*													0.011					
Spotted turbot	*Pleuronichthys ritteri*		0.132	0.463			0.246	0.005	0.005	0.423		0.105	0.137	0.176		0.325		0.115	
Hornyhead turbot	*Pleuronichthys verticalis*		0.011	0.010		0.530	0.105					0.188	0.131	0.186			0.132	0.213	0.278
Diamond turbot	*Hypsopsetta guttulata*		0.245																
California tonguefish	*Symphurus atricauda*				0.049	0.020	0.045					0.501			0.020			0.397	0.295
Total Catch - Day		5.641	35.411	14.597	5.649	1.729	5.451	1.000	2.896	7.628	2.690	12.713	13.334	15.434	4.844	1.645	7.256	9.074	9.556

August 2000
Otter Trawl Fish - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Brown smoothhound shark	*Mustelus henlei*				1.500										1.600				
Leopard shark	*Triakis semifasciata*		0.700																
Thornback	*Platyrhinoidis triseriata*			0.676										0.205					
Round stingray	*Urolophus halleri*									0.020			1.520	0.248					
Bat ray	*Myliobatis californica*		11.350	8.735									1.170						4.600
Pacific sardine	*Sardinops sagax*											0.003							
Northern anchovy	*Engraulis mordax*	0.021	0.007	0.032	0.004	0.008	0.018	0.004	0.209	0.019	0.028	0.054	0.031	0.030	0.085	0.022	0.037	0.002	0.281
California lizardfish	*Synodus lucioceps*	1.145										0.330	0.305	0.255	0.460	0.095			0.375
Plainfin midshipman	*Porichthys notatus*				0.002		0.005	0.006								0.017		0.001	
Specklefin midshipman	*Porichthys myriaster*	0.225			0.034	0.312	0.076	0.090	0.002	0.239	0.001	1.168		0.007	0.006	0.144	0.132	0.022	0.329
Basketweave cusk-eel	*Ophidion scrippsae*											0.011							
California grunion	*Leuresthes tenuis*					0.001							0.002						
California scorpionfish	*Scorpaena guttata*												0.340						
Yellowchin sculpin	*Icelinus quadriseriatus*						0.002	0.002	0.003										
Barred sand bass	*Paralabrax nebulifer*	0.150	0.744	0.437	0.360	0.062	0.465	0.128	0.187	0.072	0.639	0.730	0.985	0.265		0.166	0.219	0.351	0.110
White croaker	*Genyonemus lineatus*	16.542	5.733	4.115	2.038	2.033	2.897	1.704	1.984	2.366	0.395	15.768	2.369	2.127	8.507	0.615	4.677	6.874	8.799
California corbina	*Menticirrhus undulatus*		1.662	0.326									0.170	0.515					
Queenfish	*Seriphus politus*	0.249	0.894	0.879	0.208	0.411	1.115	0.605	2.953	1.231	0.236	0.532	1.005	0.835	0.748	0.607	0.521	0.075	0.259
Shiner surfperch	*Cymatogaster aggregata*		0.446	1.222	0.035	0.146	0.079		0.302	0.974	0.121		0.061	0.039		0.135			
Black surfperch	*Embiotoca jacksoni*										0.107								
White surfperch	*Phanerodon furcatus*		0.038	0.566	0.021	0.273	1.592	0.050	0.042	0.087	0.007		0.135	0.064	0.163	1.597	0.095		
Pile surfperch	*Rhacochilus vacca*														0.135				
Giant kelpfish	*Heterostichus rostratus*										0.008					0.010			
Bay goby	*Lepidogobius lepidus*	0.001		0.001		0.007						0.002					0.029	0.008	0.007
Yellowfin goby	*Acanthogobius flavimanus*								0.006		0.009								
Pacific butterfish	*Peprilus simillimus*					0.017				0.011									
Pacific sanddab	*Citharichthys sordidus*	0.130																	0.004
Speckled sanddab	*Citharichthys stigmaeus*		0.056			0.020	0.090					0.142					0.016		
California halibut	*Paralichthys californicus*	2.861	0.078	0.742	0.480	2.269	2.600	0.190	0.428	0.375		2.370	1.276	2.523	1.954		2.295		0.750
Fantail sole	*Xystreurys liolepis*		0.160	0.175		0.077						0.360	0.185				0.500	0.263	
Spotted turbot	*Pleuronichthys ritteri*		0.220	0.347			0.281			0.246	0.012		0.317	0.225					
Hornyhead turbot	*Pleuronichthys verticalis*	0.002			0.004		0.250		0.004			0.730			0.004		0.103	0.006	0.335
Diamond turbot	*Hypsopsetta guttulata*	0.390	0.950	0.026						0.275				0.415					
California tonguefish	*Symphurus atricauda*	0.207	0.105		0.103	0.098	0.044					0.511			0.013	0.022	0.019	0.044	0.144
Total catch - Night		21.923	23.142	18.279	4.788	5.734	9.514	2.779	6.120	5.914	1.564	22.712	9.871	7.753	13.676	3.430	8.643	7.647	15.993

November 2000
Otter Trawl Fish - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Shovelnose guitarfish	*Rhinobatos productus*		1.35												1.65				
California skate	*Raja inornata*																1.05	0.95	
Round stingray	*Urolophus halleri*												0.7	2.25					
Bat ray	*Myliobatis californica*		3.5											1.45					
Northern anchovy	*Engraulis mordax*		0.011									0.059			0.028		0.002	0.041	0.005
Slough anchovy	*Anchoa delicatissima*																0.004	0.048	
California lizardfish	*Synodus lucioceps*				0.104			0.6				0.27	0.375						
Plainfin midshipman	*Porichthys notatus*							0.001											
Specklefin midshipman	*Porichthys myriaster*							0.001							0.011		0.011	0.01	0.121
Pipefish (unid.)	*Syngnathus sp*					0.008													
California scorpionfish	*Scorpaena guttata*									0.3									
Yellowchin sculpin	*Icelinus quadriseriatus*						0.001	0.001											
Kelp bass	*Paralabrax clathratus*				0.003					0.007	0.037								
Barred sand bass	*Paralabrax nebulifer*	0.53	0.55	0.23	0.382	0.077			0.035	0.025	0.873	0.082	0.775			0.091	0.13		
Sargo	*Anisotremus davidsoni*										0.35								
White croaker	*Genyonemus lineatus*	0.985										2.02			10.01		1.835	2.973	7.121
California corbina	*Menticirrhus undulatus*		1.1																
Queenfish	*Seriphus politus*	0.14	0.002									2.259			0.401		1.144	0.254	1.886
Shiner surfperch	*Cymatogaster aggregata*		1.088	0.061			0.01				0.008			0.027					
Black surfperch	*Embiotoca jacksoni*										0.075					0.22			
White surfperch	*Phanerodon furcatus*	0.09	2.021	5.095	0.612	0.638	0.701		0.102		0.252	0.051			0.58	0.212	0.1		
Giant kelpfish	*Heterostichus rostratus*		0.006			0.006													
Bay goby	*Lepidogobius lepidus*																		0.017
Pacific butterfish	*Peprilus simillimus*														0.069				
Speckled sanddab	*Citharichthys stigmaeus*	0.094	0.061	0.043	0.011	0.032	0.001					0.005		0.038			0.004	0.004	0.003
California halibut	*Paralichthys californicus*	1.115		2.802					0.092	0.49		3.05	4.798	1.311	1.2				2.23
Fantail sole	*Xystreurys liolepis*				1.2	0.14							0.455	0.45					
English sole	*Pleuronectes vetulus*												0.012						
Spotted turbot	*Pleuronichthys ritteri*			0.19	0.21		0.087					0.311		0.037		0.2			
Hornyhead turbot	*Pleuronichthys verticalis*				0.149							0.297			0.022				0.113
Diamond turbot	*Hypsopsetta guttulata*			0.31									0.165	0.395					
California tonguefish	*Symphurus atricauda*	0.036			0.093	0.015				0.014		0.019			0.071		0.045	0.077	0.25
Total Catch - Day		2.990	9.689	8.731	2.764	0.916	0.800	0.603	0.229	0.836	1.595	8.423	7.280	5.958	14.037	0.723	4.325	4.357	11.746

November 2000
Otter Trawl Fish - Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Grey smoothhound shark	*Mustelus californicus*	1.1																	
Brown smoothhound shark	*Mustelus henlei*																		1.02
Leopard shark	*Triakis semifasciata*		0.25																
Shovelnose guitarfish	*Rhinobatos productus*														2.4				7.04
Thornback	*Platyrhinoidis triseriata*			0.537									0.135						
California skate	*Raja inornata*				0.09	0.812									0.85			1.6	
Round stingray	*Urolophus halleri*									0.4			1.25						
Bat ray	*Myliobatis californica*		0.3	11.75						0.51			2.2		15				
Northern anchovy	*Engraulis mordax*	0.008					0.028	0.003	0.004	0.016	0.005	0.007	0.013	0.044	0.002	0.002	0.02	0.002	0.008
Deepbody anchovy	*Anchoa compressa*	0.021									0.016	0.018	0.068					0.038	
Slough anchovy	*Anchoa delicatissima*												0.004	0.011					
California lizardfish	*Synodus lucioceps*				0.275	0.15						0.28			0.109		0.12		
Plainfin midshipman	*Porichthys notatus*						0.003	0.007					0.002					0.002	
Specklefin midshipman	*Porichthys myriaster*	0.015			0.003	0.002	0.049	0.042	0.013	0.01		0.002			0.273	0.152	0.068	0.039	0.024
Basketweave cusk-eel	*Ophidion scrippsae*	0.074																	0.285
Topsmelt	*Atherinops affinis*		0.09		0.005														
Jacksmelt	*Atherinopsis californiensis*												0.32	0.112					
Vermilion rockfish	*Sebastes miniatus*								0.132										
California scorpionfish	*Scorpaena guttata*	0.8		0.665			0.1												
Yellowchin sculpin	*Icelinus quadriseriatus*						0.003	0.003			0.007								
Kelp bass	*Paralabrax clathratus*										0.047								
Barred sand bass	*Paralabrax nebulifer*	0.475		0.236	0.002	0.035	0.156	0.178	0.362	0.06	0.94		0.235			0.049	0.346	0.122	
Salema	*Xenistius californiensis*				0.051					0.14	0.07	0.087	0.131	0.063			0.19		
White croaker	*Genyonemus lineatus*	9.46	2.985	1.93	1.473	1.559	0.559	0.128	0.594	3.992	2.014	7.425	3.801	0.427	7.359	1.444	6.1	3.326	6.099
California corbina	*Menticirrhus undulatus*		1.19	0.45								0.535	0.039						
Queenfish	*Seriphus politus*	1.317	0.199	0.057	0.722	0.678	0.541	0.078	0.195	1.032	0.676	0.985	0.713	1.028	0.634	0.041	1.247	1.802	0.816
Shiner surfperch	*Cymatogaster aggregata*		0.498	1.272	0.097	0.107	0.371	0.033	0.604	0.717	0.317		0.042		0.04				
Black surfperch	*Embiotoca jacksoni*		0.098				0.205												
Walleye surfperch	*Hyperprosopon argenteum*												0.043						
White surfperch	*Phanerodon furcatus*		0.725	2.938	0.037	0.076			0.147	0.039	0.313		0.063		0.16	1.074			
Giant kelpfish	*Heterostichus rostratus*		0.012			0.007			0.009										
Pacific butterfish	*Peprilus simillimus*									0.008		0.011	0.087	0.08					
Speckled sanddab	*Citharichthys stigmaeus*	0.038	0.086	0.003	0.025	0.06	0.016					0.026	0.016				0.065	0.001	
California halibut	*Paralichthys californicus*	0.03	2.323	0.451					0.16	0.448		0.35	1.212		0.845	2.4	0.65	0.88	
Fantail sole	*Xystreurys liolepis*			0.43	0.115			0.47				0.195			0.36				
Spotted turbot	*Pleuronichthys ritteri*		0.363	0.262			0.214			0.13			0.005					0.14	
Hornyhead turbot	*Pleuronichthys verticalis*				0.072	0.017	0.125					0.027	0.045		0.008			0.146	0.195
Diamond turbot	*Hypsopsetta guttulata*		0.203	0.38									0.415						
California tonguefish	*Symphurus atricauda*	0.043	0.097		0.124	0.026	0.024					0.055			0.032			0.028	0.228
Total Catch - Night		13.381	9.419	21.361	3.091	3.529	2.394	0.942	2.220	7.502	4.405	10.003	10.839	1.765	28.072	5.162	8.806	8.126	15.715

Total Abundance (number/haul)

	August 2000			November 2000			Annual Mean		
Area	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean
Deepwater Basin									
LA6	3	117	60	0	23	12	2	70	36
Deepwater Channel									
LA4	93	339	216	7	82	45	50	211	130
LB7	83	57	70	1158	462	810	621	260	440
Deepwater Open									
LA1	419	196	308	538	555	547	479	376	427
LB1	1376	219	798	709	529	619	1043	374	708
Deepwater Slip									
LB4	317	58	188	6	258	132	162	158	160
Survey Mean	382	164	273	403	318	361	392	241	317
Survey Total	2291	986	1639	2418	1909	2164	2355	1448	1901

Biomass (kg/haul)

	August 2000			November 2000			Annual Mean		
Area	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean
Deepwater Basin									
LA6	0.172	2.256	1.214	0.000	1.373	0.687	0.086	1.815	0.950
Deepwater Channel									
LA4	0.420	3.184	1.802	0.247	1.363	0.805	0.334	2.274	1.304
LB7	0.882	0.732	0.807	13.752	19.357	16.555	7.317	10.045	8.681
Deepwater Open									
LA1	4.578	8.476	6.527	4.848	8.791	6.820	4.713	8.634	6.673
LB1	7.546	6.279	6.913	4.842	7.599	6.221	6.194	6.939	6.567
Deepwater Slip									
LB4	0.298	0.531	0.415	0.565	2.147	1.356	0.432	1.339	0.885
Survey Mean	2.316	3.576	2.946	4.042	6.772	5.407	3.179	5.174	4.177
Survey Total	13.896	21.458	17.677	24.254	40.630	32.442	19.075	31.044	25.060

Number of Species

	August 2000			November 2000			Annual Mean		
Area	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Basin									
LA6	3	4	7	0	5	5	2	5	6
Deepwater Channel									
LA4	6	10	11	2	10	11	4	10	11
LB7	6	5	6	12	15	17	9	10	12
Deepwater Open									
LA1	7	8	9	8	10	12	8	9	11
LB1	10	10	12	11	14	16	11	12	14
Deepwater Slip									
LB4	1	3	4	4	6	7	3	5	6
Survey Mean	6	7	8	6	10	11	6	8	10

Shannon-Wiener Diversity

Area	August 2000			November 2000			Annual Mean		
	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Basin									
LA6	1.10	0.63	0.75	NA	0.90	0.90	1.10	0.76	0.83
Deepwater Channel									
LA4	1.27	0.81	1.23	0.41	1.13	1.32	0.84	0.97	1.27
LB7	1.21	1.12	1.23	0.66	0.72	0.72	0.94	0.92	0.97
Deepwater Open									
LA1	0.87	0.71	0.94	0.41	0.60	0.55	0.64	0.66	0.75
LB1	0.95	0.92	1.03	0.97	0.60	0.92	0.96	0.76	0.97
Deepwater Slip									
LB4	NA	0.70	0.54	1.33	0.91	0.99	1.33	0.81	0.77
Survey Mean	1.08	0.81	0.95	0.76	0.81	0.90	0.92	0.81	0.93

Margalef Diversity

Area	August 2000			November 2000			Annual Mean		
	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Basin									
LA6	1.82	0.63	1.25	NA	1.28	1.28	1.82	0.95	1.26
Deepwater Channel									
LA4	1.10	1.54	1.65	0.51	2.04	2.23	0.81	1.79	1.94
LB7	1.13	0.99	1.01	1.56	2.28	2.16	1.35	1.64	1.59
Deepwater Open									
LA1	0.99	1.33	1.25	1.11	1.42	1.57	1.05	1.38	1.41
LB1	1.25	1.67	1.49	1.52	2.07	2.11	1.38	1.87	1.80
Deepwater Slip									
LB4	NA	0.49	0.51	1.67	0.90	1.08	1.67	0.70	0.79
Survey Mean	1.26	1.11	1.19	1.28	1.67	1.74	1.35	1.39	1.46

Dominance Index

Area	August 2000			November 2000			Annual Mean		
	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Basin									
LA6	3	1	1	NA	2	2	3	2	2
Deepwater Channel									
LA4	2	1	2	1	2	2	2	2	2
LB7	2	2	2	1	1	1	2	2	2
Deepwater Open									
LA1	2	1	2	1	1	1	2	1	2
LB1	2	1	2	2	1	2	2	1	2
Deepwater Slip									
LB4	1	1	1	3	2	2	2	2	2
Survey Mean	2	1	2	2	2	2	2	1	2

NA - Not Applicable

August 2000

16' Otter Trawl Abundance (number per haul)

Common Name	Scientific Name	LA1	LA4	LB1	LB4	LB7	LA6
Northern anchovy	*Engraulis mordax*	165	45	676	317	1	
California lizardfish	*Synodus lucioceps*	1					
Specklefin midshipman	*Porichthys myriaster*		27	3		19	
Grass rockfish	*Sebastes rastrelliger*						1
Barred sand bass	*Paralabrax nebulifer*		1				
White croaker	*Genyonemus lineatus*	237	7	599		44	
Queenfish	*Seriphus politus*	8	12	89		3	
Black surfperch	*Embiotoca jacksoni*						1
White surfperch	*Phanerodon furcatus*		1	3			
Giant kelpfish	*Heterostichus rostratus*						1
Bay goby	*Lepidogobius lepidus*	2		1		15	
Yellowfin goby	*Acanthogobius flavimanus*					1	
Speckled sanddab	*Citharichthys stigmaeus*	4		1			
California halibut	*Paralichthys californicus*			2			
Spotted turbot	*Pleuronichthys ritteri*			1			
Hornyhead turbot	*Pleuronichthys verticalis*			1			
California tonguefish	*Symphurus atricauda*	2					

Total Catch - Day	419	93	1376	317	83	3
Number of Species - Day	7	6	10	1	6	3

Common Name	Scientific Name	LA1	LA4	LB1	LB4	LB7	LA6
Shovelnose guitarfish	*Rhinobatos productus*	1					
Round stingray	*Urolophus halleri*	1					
Northern anchovy	*Engraulis mordax*	3		3		5	
California lizardfish	*Synodus lucioceps*	1					
Specklefin midshipman	*Porichthys myriaster*		8	7	4	2	
Barred sand bass	*Paralabrax nebulifer*		3	1			1
White croaker	*Genyonemus lineatus*	163	256	166	44	33	95
Queenfish	*Seriphus politus*	13	61	29	10	2	15
Shiner surfperch	*Cymatogaster aggregata*		1				
Black surfperch	*Embiotoca jacksoni*		1				
White surfperch	*Phanerodon furcatus*		3				6
Bay goby	*Lepidogobius lepidus*			1		15	
Speckled sanddab	*Citharichthys stigmaeus*	10	4	2			
California halibut	*Paralichthys californicus*			2			
Fantail sole	*Xystreurys liolepis*		1				
Hornyhead turbot	*Pleuronichthys verticalis*		1	7			
California tonguefish	*Symphurus atricauda*	4		1			

Total Catch - Night	196	339	219	58	57	117
Number of Species - Night	8	10	10	3	5	4

August 2000
16' Otter Trawl Biomass (kg per haul)

Common Name	Scientific Name	LA1	LA4	LB1	LB4	LB7	LA6
Yellowfin goby	*Acanthogobius flavimanus*					0.02	
Speckled sanddab	*Citharichthys stigmaeus*	0.01		0.004			
Black surfperch	*Embiotoca jacksoni*						0.047
Northern anchovy	*Engraulis mordax*	0.092	0.045	0.365	0.298	0.001	
White croaker	*Genyonemus lineatus*	4.215	0.009	5.884		0.676	
Giant kelpfish	*Heterostichus rostratus*						0.005
Bay goby	*Lepidogobius lepidus*	0.002		0.002		0.015	
Barred sand bass	*Paralabrax nebulifer*		0.165				
California halibut	*Paralichthys californicus*			0.587			
White surfperch	*Phanerodon furcatus*		0.09	0.041			
Spotted turbot	*Pleuronichthys ritteri*			0.005			
Hornyhead turbot	*Pleuronichthys verticalis*			0.325			
Specklefin midshipman	*Porichthys myriaster*		0.097	0.102		0.042	
Grass rockfish	*Sebastes rastrelliger*						0.12
Queenfish	*Seriphus politus*	0.016	0.014	0.231		0.128	
California tonguefish	*Symphurus atricauda*	0.018					
California lizardfish	*Synodus lucioceps*	0.225					
	Total Biomass - Day	4.578	0.42	7.546	0.298	0.882	0.172

Common Name	Scientific Name	LA1	LA4	LB1	LB4	LB7	LA6
Shovelnose guitarfish	*Rhinobatos productus*	3.200					
Round stingray	*Urolophus halleri*	0.380					
Northern anchovy	*Engraulis mordax*	0.004		0.004		0.006	
California lizardfish	*Synodus lucioceps*	0.240					
Specklefin midshipman	*Porichthys myriaster*		0.008	0.007	0.004	0.002	
Barred sand bass	*Paralabrax nebulifer*		0.400	0.100			0.175
White croaker	*Genyonemus lineatus*	4.162	1.948	3.825	0.342	0.563	1.449
Queenfish	*Seriphus politus*	0.425	0.364	0.127	0.185	0.146	0.248
Shiner surfperch	*Cymatogaster aggregata*		0.030				
Black surfperch	*Embiotoca jacksoni*		0.085				
White surfperch	*Phanerodon furcatus*		0.222				0.384
Bay goby	*Lepidogobius lepidus*			0.003		0.015	
Speckled sanddab	*Citharichthys stigmaeus*	0.022	0.042	0.018			
California halibut	*Paralichthys californicus*			1.675			
Fantail sole	*Xystreurys liolepis*		0.080				
Hornyhead turbot	*Pleuronichthys verticalis*		0.005	0.498			
California tonguefish	*Symphurus atricauda*	0.043		0.022			
	Total Biomass - Night	8.476	3.184	6.279	0.531	0.732	2.256

November 2000
16' Otter Trawl Abundance (number per haul)

Common Name	Scientific Name	LB7	LA1	LB1	LA4	LB4	LA6
Deepbody anchovy	*Anchoa compressa*			2			
Speckled sanddab	*Citharichthys stigmaeus*	5	7	2			
Black surfperch	*Embiotoca jacksoni*					1	
Northern anchovy	*Engraulis mordax*		19	187			
White croaker	*Genyonemus lineatus*	921	493	449			
Giant kelpfish	*Heterostichus rostratus*					2	
Diamond turbot	*Hypsopsetta guttulata*	1					
Bay goby	*Lepidogobius lepidus*	1					
Barred sand bass	*Paralabrax nebulifer*	1	1				
California halibut	*Paralichthys californicus*	4	4				
Pacific butterfish	*Peprilus simillimus*	1					
White surfperch	*Phanerodon furcatus*		2	2	6	2	
Spotted turbot	*Pleuronichthys ritteri*			3			
Hornyhead turbot	*Pleuronichthys verticalis*	2		2			
Specklefin midshipman	*Porichthys myriaster*	12		1	1	1	
California skate	*Raja inornata*	2					
California scorpionfish	*Scorpaena guttata*		1				
Queenfish	*Seriphus politus*	198	11	57			
California tonguefish	*Symphurus atricauda*	10		3			
California lizardfish	*Synodus lucioceps*			1			

	LB7	LA1	LB1	LA4	LB4	LA6
Total Catch - Day	1158	538	709	7	6	0
Number of Species - Day	12	8	11	2	4	0

Common Name	Scientific Name	LB7	LA1	LB1	LA4	LB4	LA6
Yellowfin goby	*Acanthogobius flavimanus*						1
Topsmelt	*Atherinops affinis*			1			
Speckled sanddab	*Citharichthys stigmaeus*	1	8	18			
Shiner surfperch	*Cymatogaster aggregata*						1
Northern anchovy	*Engraulis mordax*	1	3	1	1		
White croaker	*Genyonemus lineatus*	394	455	459	10	154	17
Giant kelpfish	*Heterostichus rostratus*					2	
Diamond turbot	*Hypsopsetta guttulata*	1					
Bay goby	*Lepidogobius lepidus*	1					
California corbina	*Menticirrhus undulatus*			1		1	
Brown smoothhound shark	*Mustelus henlei*	2					
Basketweave cusk-eel	*Ophidion scrippsae*	12					
Barred sand bass	*Paralabrax nebulifer*	1	1		1		
California halibut	*Paralichthys californicus*	1		1	1		1
White surfperch	*Phanerodon furcatus*		1	1		1	
English sole	*Pleuronectes vetulus*			1			
Spotted turbot	*Pleuronichthys ritteri*			2			
Hornyhead turbot	*Pleuronichthys verticalis*	2		1	1		
Specklefin midshipman	*Porichthys myriaster*	12	1	1	7	86	
Plainfin midshipman	*Porichthys notatus*				2		
California skate	*Raja inornata*		1				
Queenfish	*Seriphus politus*	19	83	35	57	14	3
California tonguefish	*Symphurus atricauda*	10	1	4			
California lizardfish	*Synodus lucioceps*	2			1		
Salema	*Xenistius californiensis*				1		
Fantail sole	*Xystreurys liolepis*	3	1	3			

	LB7	LA1	LB1	LA4	LB4	LA6
Total Catch - Night	462	555	529	82	258	23
Number of Species - Night	15	10	14	10	6	5

November 2000
16' Otter Trawl Biomass (kg per haul)

Common Name	Scientific Name	LB7	LA1	LB1	LA4	LB4	LA6
Deepbody anchovy	*Anchoa compressa*			0.036			
Speckled sanddab	*Citharichthys stigmaeus*	0.02	0.023	0.013			
Black surfperch	*Embiotoca jacksoni*					0.075	
Northern anchovy	*Engraulis mordax*		0.022	0.169			
White croaker	*Genyonemus lineatus*	7.326	1.131	3.567			
Giant kelpfish	*Heterostichus rostratus*					0.035	
Diamond turbot	*Hypsopsetta guttulata*	0.44					
Bay goby	*Lepidogobius lepidus*	0.001					
Barred sand bass	*Paralabrax nebulifer*	0.135	0.145				
California halibut	*Paralichthys californicus*	2.05	2.38				
Pacific butterfish	*Peprilus simillimus*	0.008					
White surfperch	*Phanerodon furcatus*		0.35	0.052	0.246	0.205	
Spotted turbot	*Pleuronichthys ritteri*			0.265			
Hornyhead turbot	*Pleuronichthys verticalis*	0.115		0.123			
Specklefin midshipman	*Porichthys myriaster*	0.081		0.002	0.001	0.25	
California skate	*Raja inornata*	2.6					
California scorpionfish	*Scorpaena guttata*		0.75				
Queenfish	*Seriphus politus*	0.735	0.047	0.175			
California tonguefish	*Symphurus atricauda*	0.241		0.08			
California lizardfish	*Synodus lucioceps*			0.36			
	Total Biomass (kg) - Day	13.752	4.848	4.842	0.247	0.565	0

Common Name	Scientific Name	LB7	LA1	LB1	LA4	LB4	LA6
Yellowfin goby	*Acanthogobius flavimanus*						0.043
Topsmelt	*Atherinops affinis*			0.007			
Speckled sanddab	*Citharichthys stigmaeus*	0.005	0.024	0.11			
Shiner surfperch	*Cymatogaster aggregata*						0.035
Northern anchovy	*Engraulis mordax*	0.003	0.004	0.001	0.002		
White croaker	*Genyonemus lineatus*	13.319	8.146	4.459	0.391	1.532	0.638
Giant kelpfish	*Heterostichus rostratus*					0.025	
Diamond turbot	*Hypsopsetta guttulata*	0.195					
Bay goby	*Lepidogobius lepidus*	0.001					
California corbina	*Menticirrhus undulatus*			0.525		0.275	
Brown smoothhound shark	*Mustelus henlei*	1.4					
Basketweave cusk-eel	*Ophidion scrippsae*	1.377					
Barred sand bass	*Paralabrax nebulifer*	0.29	0.066		0.069		
California halibut	*Paralichthys californicus*	0.34		0.4	0.192		0.64
White surfperch	*Phanerodon furcatus*		0.019	0.011		0.096	
English sole	*Pleuronectes vetulus*			0.011			
Spotted turbot	*Pleuronichthys ritteri*			0.355			
Hornyhead turbot	*Pleuronichthys verticalis*	0.29		0.083	0.017		
Specklefin midshipman	*Porichthys myriaster*	0.163	0.001	0.001	0.008	0.098	
Plainfin midshipman	*Porichthys notatus*				0.002		
California skate	*Raja inornata*		0.115				
Queenfish	*Seriphus politus*	0.326	0.258	0.229	0.29	0.121	0.017
California tonguefish	*Symphurus atricauda*	0.24	0.013	0.147			
California lizardfish	*Synodus lucioceps*	0.785			0.32		
Salema	*Xenistius californiensis*				0.072		
Fantail sole	*Xystreurys liolepis*	0.623	0.145	1.26			
	Total Biomass (kg) - Night	19.357	8.791	7.599	1.363	2.147	1.373

C.3 Beach Seine Data

Beach Seine Catch

	February 2000	May 2000	August 2000	November 2000	Annual Mean	Annual Total
Abundance						
Cabrillo	57	23	16	59	39	155
Pier 300	417	1921	120	21	620	2479
Biomass (kg)						
Cabrillo	0.58	0.41	0.14	0.29	0.35	1.42
Pier 300	0.97	0.33	0.23	0.02	0.39	1.54
Number of Species						
Cabrillo	9	11	5	3	7	17
Pier 300	9	7	5	2	6	14
Shannon-Wiener						
Cabrillo	1.53	1.99	1.30	0.10	1.23	
Pier 300	0.37	0.28	0.52	0.19	0.34	
Margalef						
Cabrillo	2.79	2.61	1.15	0.42	1.74	
Pier 300	1.53	0.73	0.73	0.27	0.81	
Dominance						
Cabrillo	3	4	3	1	3	
Pier 300	1	1	1	1	1	

Note: Abundance and Biomass based on the mean of two hauls

February 2000
Beach Seine Catch

Common Name	Scientific Name	Cabrillo Beach		Pier 300	
		Haul 1	Haul 2	Haul 1	Haul 2
Catch - Number per haul					
Leopard shark	*Triakis semifasciata*	1			
Deepbody anchovy	*Anchoa compressa*	**9**			
Topsmelt	*Atherinops affinis*	33	2	218	553
Barcheek pipefish	*Syngnathus exilis*				4
Bay pipefish	*Syngnathus leptorhynchus*	3		10	12
Queenfish	*Seriphus politus*	10			
Black surfperch	*Embiotoca jacksoni*			2	
Dwarf surfperch	*Micrometrus minimus*	45	3		1
Bay blenny	*Hypsoblennius gentilis*				1
Spotted kelpfish	*Gibbonsia elegans*	1		1	1
Giant kelpfish	*Heterostichus rostratus*	5		17	13
California halibut	*Paralichthys californicus*	1	1		
Diamond turbot	*Hypsopsetta guttulata*			1	
Total Catch		98	6	249	585
Number of species		7	3	6	7
Biomass - kg per haul					
Leopard shark	*Triakis semifasciata*	0.220			
Deepbody anchovy	*Anchoa compressa*	0.035			
Topsmelt	*Atherinops affinis*	0.188	0.002	0.345	1.172
Barcheek pipefish	*Syngnathus exilis*				0.004
Bay pipefish	*Syngnathus leptorhynchus*	0.003		0.016	0.026
Queenfish	*Seriphus politus*	0.020			
Black surfperch	*Embiotoca jacksoni*			0.162	
Dwarf surfperch	*Micrometrus minimus*	0.422	0.089		0.012
Bay blenny	*Hypsoblennius gentilis*				0.025
Spotted kelpfish	*Gibbonsia elegans*	0.001		0.001	0.001
Giant kelpfish	*Heterostichus rostratus*	0.030		0.080	0.084
California halibut	*Paralichthys californicus*	0.145	0.009		
Diamond turbot	*Hypsopsetta guttulata*			0.009	
Total Catch		1.063	0.100	0.613	1.324

May 2000
Beach Seine Catch

Common Name	Scientific Name	Cabrillo Beach		Pier 300	
		Haul 1	Haul 2	Haul 1	Haul 2
Catch - Number per haul					
Topsmelt	*Atherinops affinis*	1		2866	751
Barcheek pipefish	*Syngnathus exilis*	1			
Bay pipefish	*Syngnathus leptorhynchus*		1	12	5
Staghorn sculpin	*Leptocottus armatus*	1			
Barred sand bass	*Paralabrax nebulifer*	4	3		
Surfperch (unid.)	*Embioticidae*			1	
Shiner surfperch	*Cymatogaster aggregata*	2			
Black surfperch	*Embiotoca jacksoni*	8	6		
Dwarf surfperch	*Micrometrus minimus*	3	4		
Spotted kelpfish	*Gibbonsia elegans*	3	4		
Arrow goby	*Clevelandia ios*	1	3	86	29
Cheekspot goby	*Ilypnus gilberti*				2
Shadow goby	*Quietula y-cauda*			5	
California halibut	*Paralichthys californicus*		1		
Diamond turbot	*Hypsopsetta guttulata*			57	28
Total Catch		24	22	3027	815
Number of species		9	7	6	5
Biomass - kg per haul					
Topsmelt	*Atherinops affinis*	0.001		0.289	0.089
Barcheek pipefish	*Syngnathus exilis*	0.002			
Bay pipefish	*Syngnathus leptorhynchus*		0.001	0.032	0.006
Staghorn sculpin	*Leptocottus armatus*	0.001			
Barred sand bass	*Paralabrax nebulifer*	0.133	0.056		
Surfperch (unid.)	*Embioticidae*			0.001	
Shiner surfperch	*Cymatogaster aggregata*	0.052			
Black surfperch	*Embiotoca jacksoni*	0.317	0.182		
Dwarf surfperch	*Micrometrus minimus*	0.003	0.014		
Spotted kelpfish	*Gibbonsia elegans*	0.024	0.018		
Arrow goby	*Clevelandia ios*	0.001	0.003	0.035	0.029
Cheekspot goby	*Ilypnus gilberti*				0.002
Shadow goby	*Quietula y-cauda*			0.005	
California halibut	*Paralichthys californicus*		0.017		
Diamond turbot	*Hypsopsetta guttulata*			0.122	0.042
Total Catch		0.534	0.291	0.484	0.168

August 2000
Beach Seine Catch

Common Name	Scientific Name	Cabrillo Beach		Pier 300	
		Haul 1	Haul 2	Haul 1	Haul 2
Catch - Number per haul					
Topsmelt	*Atherinops affinis*	3	8	147	52
Bay pipefish	*Syngnathus leptorhynchus*				1
Staghorn sculpin	*Leptocottus armatus*	6	3		
Yellowfin goby	*Acanthogobius flavimanus*	1		12	24
California halibut	*Paralichthys californicus*	8	2		2
Diamond turbot	*Hypsopsetta guttulata*		1	1	
Total Catch		18	14	160	79
Number of species		4	4	3	4
Biomass - kg per haul					
Topsmelt	*Atherinops affinis*	0.003	0.009	0.204	0.184
Bay pipefish	*Syngnathus leptorhynchus*				0.002
Staghorn sculpin	*Leptocottus armatus*	0.115	0.051		
Yellowfin goby	*Acanthogobius flavimanus*	0.005		0.017	0.028
California halibut	*Paralichthys californicus*	0.069	0.015		0.013
Diamond turbot	*Hypsopsetta guttulata*		0.009	0.007	
Total Catch		0.192	0.084	0.228	0.227

November 2000
Beach Seine Catch

Common Name	Scientific Name	Cabrillo Beach		Pier 300	
		Haul 1	Haul 2	Haul 1	Haul 2
Catch - Number per haul					
Topsmelt	*Atherinops affinis*	40	75		2
Staghorn sculpin	*Leptocottus armatus*	1			
Arrow goby	*Clevelandia ios*			23	17
California halibut	*Paralichthys californicus*		1		
Total Catch		41	76	23	19
Number of species		2	2	1	2
Biomass - kg per haul					
Topsmelt	*Atherinops affinis*	0.104	0.407		0.002
Staghorn sculpin	*Leptocottus armatus*	0.021			
Arrow goby	*Clevelandia ios*			0.023	0.017
California halibut	*Paralichthys californicus*		0.041		
Total Catch		0.125	0.448	0.023	0.019

APPENDIX D

Ichthyoplankton Data

D.1 Summary Tables by Season
D.2 Raw Data

Icthyoplankton Larvae

Total Abundance (#/100m^3)

Habitat / Station	February 2000	May 2000	August 2000	November 2000	Annual Mean
Neuston					
Deepwater Basin					
LA5	6	35	0	0	10
LA6	24	293	5	0	80
LB3	0	16	8	19	11
LB5	8	68	28	134	59
Deepwater Channel					
LA4	2	15	0	0	4
LB7	80	135	11	5	58
Deepwater Open					
LA1	8	45	25	10	22
LB1	29	39	16	18	26
Deepwater Slip					
LB4	49	5885	34	3	1493
LB6	8	87	0	10	26
Shallow Mitigation					
LA2A	8	75	99	30	53
LA2B	0	0	87	7	24
LA7A	14	2631	16	117	695
LA7B	48	6382	28	98	1639
LB2A	8	78	57	9	38
LB2B	2	74	184	9	67
Shallow Water Open					
LA3A	13	59161	11	29	14804
LA3B	7	64	19	29	30
Neuston Total	**315**	**75083**	**628**	**526**	**19138**
Midwater					
Deepwater Basin					
LA5	73	292	364	33	190
LA6	169	145	167	31	128
LB3	9	113	362	75	140
LB5	74	1660	498	26	564
Deepwater Channel					
LA4	122	292	70	28	128
LB7	19	936	1187	146	572
Deepwater Open					
LA1	6	140	278	33	114
LB1	6	424	452	24	227
Deepwater Slip					
LB4	10	559	774	131	368
LB6	206	431	306	91	258
Shallow Mitigation					
LA2A	159	157	737	288	336
LA2B	9	98	2313	256	669
LA7A	51	126	975	6202	1838
LA7B	170	879	4122	1657	1707
LB2A	16	4898	344	52	1327
LB2B	19	4007	533	63	1155
Shallow Water Open					
LA3A	51	116	277	25	117
LA3B	55	24	427	31	134
Midwater Total	**1225**	**15297**	**14186**	**9192**	**9975**
Epibenthic					
Deepwater Basin					
LA5	210	2795	217	91	828
LA6	147	2962	270	49	857
LB3	22	202	449	1400	518
LB5	168	829	580	33	403
Deepwater Channel					
LA4	104	824	44	191	291
LB7	67	6714	504	105	1848
Deepwater Open					
LA1	170	199	155	130	164
LB1	26	523	3236	47	958
Deepwater Slip					
LB4	42	1463	669	393	642
LB6	744	338	1231	3477	1447
Shallow Mitigation					
LA2A	8	640	1427	407	620
LA2B	37	215	2666	412	832
LA7A	140	332	1933	20300	5676
LA7B	499	98	6517	4213	2832
LB2A	17	371	1109	22	380
LB2B	31	1292	494	83	475
Shallow Water Open					
LA3A	158	1632	882	158	707
LA3B	6	731	413	51	300
Epibenthic Total	**2597**	**22160**	**22793**	**31562**	**19778**

Icthyoplankton Larvae

Number of Species

STATION	February 2000	May 2000	August 2000	November 2000	Annual Mean[1]
Neuston					
Deepwater Basin					
LA5	1	2	0	0	1
LA6	2	4	1	0	2
LB3		4	1	1	2
LB5	1	4	3	5	3
Deepwater Channel					
LA4	1	5	0	0	2
LB7	2	4	1	2	2
Deepwater Open					
LA1	1	6	6	2	4
LB1	3	5	3	2	3
Deepwater Slip					
LB4	2	8	1	1	3
LB6	2	3	0	2	2
Shallow Mitigation					
LA2A	2	8	4	3	4
LA2B			3	1	2
LA7A	2	6	5	5	5
LA7B	4	7	2	3	4
LB2A	2	5	4	2	3
LB2B	1	6	5	3	4
Shallow Water Open					
LA3A	1	7	1	4	3
LA3B	1	7	2	4	4
Neuston Total	**9**	**19**	**10**	**8**	**12**
Midwater					
Deepwater Basin					
LA5	6	6	3	7	6
LA6	3	9	4	2	5
LB3	4	9	4	7	6
LB5	7	6	6	6	6
Deepwater Channel					
LA4	7	6	5	3	5
LB7	5	7	8	7	7
Deepwater Open					
LA1	1	7	6	8	6
LB1	2	8	5	4	5
Deepwater Slip					
LB4	4	8	3	7	6
LB6	7	7	6	6	7
Shallow Mitigation					
LA2A	10	8	4	3	6
LA2B	2	10	4	4	5
LA7A	4	5	5	7	5
LA7B	5	8	6	6	6
LB2A	3	4	5	5	4
LB2B	5	5	6	7	6
Shallow Water Open					
LA3A	6	7	4	2	5
LA3B	6	6	5	5	6
Midwater Total	**16**	**21**	**13**	**15**	**16**
Epibenthic					
Deepwater Basin					
LA5	5	7	3	6	5
LA6	6	9	3	5	6
LB3	5	9	8	7	7
LB5	8	7	6	6	7
Deepwater Channel					
LA4	9	6	2	6	6
LB7	4	3	8	6	5
Deepwater Open					
LA1	8	8	5	2	6
LB1	9	9	7	3	7
Deepwater Slip					
LB4	5	6	6	7	6
LB6	6	5	8	5	6
Shallow Mitigation					
LA2A	4	8	6	5	6
LA2B	6	8	1	4	5
LA7A	3	6	5	6	5
LA7B	4	6	4	7	5
LB2A	7	8	6	3	6
LB2B	4	7	5	6	6
Shallow Water Open					
LA3A	8	7	5	5	6
LA3B	2	9	5	4	5
Epibenthic Total	**20**	**24**	**13**	**19**	**19**

1. rounded to nearest whole number

Icthyoplankton Larvae

Shannon-Wiener Diversity

STATION	February 2000	May 2000	August 2000	November 2000
Neuston				
Deepwater Basin				
LA5	0	0.41	NA	NA
LA6	0.45	1.28	0	NA
LB3		1.39	0	0
LB5	0	1.34	0.8	0.42
Deepwater Channel				
LA4	0	1.55		
LB7	0.24	0.92	0	0.69
Deepwater Open				
LA1	0.69	1.59	1.73	0.64
LB1	1.08	1.48	1.01	0.56
Deepwater Slip				
LB4	0.27	1.56	0.35	0
LB6	0.69	0.47	0	0.69
Shallow Mitigation				
LA2A	0.69	1.68	0.89	0.92
LA2B			0.85	0
LA7A	0.5	1.58	1.61	1.34
LA7B	0.99	1.27	0.45	0.9
LB2A	0.64	1.28	1.09	0.69
LB2B	0	1.43	1.07	1.1
Shallow Water Open				
LA3A	0	1.19	0	1.28
LA3B	0.69	1.69	0.64	1.42
Midwater				
Deepwater Basin				
LA5	1.14	1.56	0.99	1.37
LA6	0.45	1.82	1.3	0.3
LB3	1.33	1.57	1.35	1.62
LB5	1.25	0.7	0.99	1.38
Deepwater Channel				
LA4	0.98	1.16	1.37	0.68
LB7	1.37	1.39	1.5	1.45
Deepwater Open				
LA1	0	1.26	0.97	1.89
LB1	0.56	1.24	1.44	1.33
Deepwater Slip				
LB4	1.35	1.55	0.69	1.41
LB6	1.35	1.14	1.14	1.36
Shallow Mitigation				
LA2A	1.01	1.51	0.3	0.26
LA2B	0.68	1.63	0.41	0.19
LA7A	0.44	1.4	0.59	0.84
LA7B	0.4	1.5	0.44	0.87
LB2A	0.7	0.68	1.06	1.17
LB2B	1.38	0.99	1.21	1.35
Shallow Water Open				
LA3A	1.11	1.27	1.21	0.27
LA3B	1.28	1.59	1.34	0.95
Epibenthic				
Deepwater Basin				
LA5	1.01	1.36	1.06	1.04
LA6	0.56	1.5	0.88	0.75
LB3	1.23	1.72	1.81	1.51
LB5	1.4	1.09	0.94	1.33
Deepwater Channel				
LA4	1.49	0.91	0.56	0.76
LB7	1.32	1.03	1.28	1.41
Deepwater Open				
LA1	1.43	1.27	0.61	0.69
LB1	1.84	1.56	1.39	0.84
Deepwater Slip				
LB4	1.33	1.54	1.38	1.04
LB6	1.19	0.93	1.32	1.13
Shallow Mitigation				
LA2A	1.33	1.34	0.33	0.34
LA2B	1.33	1.64	0	0.2
LA7A	0.11	1.43	0.42	0.44
LA7B	0.33	1.31	0.55	0.86
LB2A	1.51	1.45	1.12	1.04
LB2B	1.08	1.17	1.05	1.12
Shallow Water Open				
LA3A	1.18	1	1.01	0.41
LA3B	0.67	1.27	1.07	0.57

Icthyoplankton Larvae

Margalef Diversity

STATION	February 2000	May 2000	August 2000	November 2000
Neuston				
Deepwater Basin				
LA5	0	0.28	NA	NA
LA6	0.31	0.53	0	NA
LB3	NA	1.08	0	0
LB5	0	0.71	0.6	0.82
Deepwater Channel				
LA4	0	1.48	NA	NA
LB7	0.23	0.61	0	0.61
Deepwater Open				
LA1	0	1.31	1.55	0.44
LB1	0.59	1.09	0.72	0.35
Deepwater Slip				
LB4	0.26	0.81	0	0
LB6	0.48	0.45	NA	0.44
Shallow Mitigation				
LA2A	0.47	1.62	0.65	0.59
LA2B			0.45	0
LA7A	0.38	0.63	1.45	0.84
LA7B	0.78	0.68	0.3	0.44
LB2A	0.48	0.92	0.74	0.45
LB2B	0	1.16	0.77	0.92
Shallow Water Open				
LA3A	0	0.55	0	0.89
LA3B	0	1.44	0.34	0.89
Midwater				
Deepwater Basin				
LA5	1.17	0.88	0.34	1.72
LA6	0.39	1.61	0.59	0.29
LB3	1.34	1.69	0.51	1.39
LB5	1.39	0.67	0.81	1.54
Deepwater Channel				
LA4	1.25	0.88	0.94	0.6
LB7	1.35	0.88	0.99	1.2
Deepwater Open				
LA1	0	1.21	0.89	2
LB1	0.55	1.16	0.65	0.94
Deepwater Slip				
LB4	1.32	1.11	0.3	1.23
LB6	1.13	0.99	0.87	1.11
Shallow Mitigation				
LA2A	1.77	1.38	0.45	0.35
LA2B	0.44	1.96	0.39	0.54
LA7A	0.76	0.83	0.58	0.69
LA7B	0.78	1.03	0.6	0.67
LB2A	0.72	0.35	0.68	1.01
LB2B	1.35	0.48	0.8	1.45
Shallow Water Open				
LA3A	1.27	1.26	0.53	0.31
LA3B	1.25	1.57	0.66	1.16
Epibenthic				
Deepwater Basin				
LA5	0.75	0.76	0.37	1.11
LA6	1	1	0.36	1.03
LB3	1.29	1.51	1.15	0.83
LB5	1.37	0.89	0.79	1.43
Deepwater Channel				
LA4	1.72	0.74	0.26	0.95
LB7	0.71	0.23	1.13	1.07
Deepwater Open				
LA1	1.36	1.32	0.79	0.21
LB1	2.46	1.28	0.74	0.52
Deepwater Slip				
LB4	1.07	0.69	0.77	1
LB6	0.76	0.69	0.98	0.49
Shallow Mitigation				
LA2A	1.47	1.08	0.69	0.67
LA2B	1.39	1.3	0	0.5
LA7A	0.4	0.86	0.53	0.5
LA7B	0.48	1.09	0.34	0.72
LB2A	2.13	1.18	0.71	0.64
LB2B	0.87	0.84	0.64	1.13
Shallow Water Open				
LA3A	1.38	0.81	0.59	0.79
LA3B	0.54	1.21	0.66	0.76

Icthyoplankton Larvae

Dominance Index

STATION	February 2000	May 2000	August 2000	November 2000
Neuston				
Deepwater Basin				
LA5	1	1	NA	NA
LA6	1	3	1	NA
LB3		3	1	1
LB5	1	3	2	1
Deepwater Channel				
LA4	1	4	NA	NA
LB7	1	2	1	2
Deepwater Open				
LA1	2	4	4	2
LB1	3	4	2	2
Deepwater Slip				
LB4	1	3	1	1
LB6	2	1	NA	2
Shallow Mitigation				
LA2A	2	4	2	2
LA2B			2	1
LA7A	1	3	4	2
LA7B	2	2	1	2
LB2A	2	2	2	2
LB2B	1	3	2	3
Shallow Water Open				
LA3A	1	2	1	3
LA3B	2	4	2	3
Midwater				
Deepwater Basin				
LA5	2	4	2	3
LA6	1	4	2	1
LB3	3	3	3	3
LB5	2	1	2	2
Deepwater Channel				
LA4	2	2	3	1
LB7	3	3	3	3
Deepwater Open				
LA1	1	2	2	5
LB1	1	2	3	3
Deepwater Slip				
LB4	3	3	1	3
LB6	3	2	2	3
Shallow Mitigation				
LA2A	2	3	1	1
LA2B	2	3	1	1
LA7A	1	3	1	1
LA7B	1	3	1	1
LB2A	1	1	2	2
LB2B	3	2	2	2
Shallow Water Open				
LA3A	2	2	3	1
LA3B	2	3	3	2
Epibenthic				
Deepwater Basin				
LA5	2	3	2	2
LA6	1	3	2	1
LB3	2	3	4	3
LB5	2	2	2	2
Deepwater Channel				
LA4	3	2	1	1
LB7	3	2	2	3
Deepwater Open				
LA1	3	2	1	2
LB1	5	3	3	2
Deepwater Slip				
LB4	3	3	3	2
LB6	2	2	2	2
Shallow Mitigation				
LA2A	3	2	1	1
LA2B	2	4	1	1
LA7A	1	3	1	1
LA7B	1	2	1	1
LB2A	3	3	2	2
LB2B	2	2	2	2
Shallow Water Open				
LA3A	2	2	2	1
LA3B	2	2	2	1

Icthyoplankton Eggs

Total Weighted Abundance (#/100 m^2)

Habitat / Station	February 2000	May 2000	August 2000	November 2000	Mean Annual	Total Annual
Deepwater Basin						
LA5	2879	111	891	642	1131	4,523
LA6	9227	951	18458	308	7236	28,944
LB3	11399	1985	651	2869	4226	16,904
LB5	9636	75	125	764	2650	10,600
Deepwater Channel						
LA4	14557	573	563	1557	4313	17,251
LB7	17431	5549	7388	8891	9815	39,258
Deepwater Open						
LA1	14327	1328	4114	2877	5662	22,646
LB1	18599	83	2468	2197	5837	23,347
Deepwater Slip						
LB4	1851	238	16826	621	4884	19,535
LB6	12213	516	4775	1866	4842	19,369
Shallow Mitigation						
LA2A	4748	1454	2254	191	2162	8,647
LA2B	3734	846	3502	155	2059	8,237
LA7A	3203	54	931	37	1056	4,225
LA7B	6256	11	300	62	1657	6,629
LB2A	4925	34	6419	122	2875	11,500
LB2B	4215	26	3269	155	1916	7,665
Shallow Water Open						
LA3A	10371	10197	20990	1134	10673	42,692
LA3B	16382	3780	10729	845	7934	31,737
Total	165,952	27,813	104,653	25,292	80,928	323,710

Icthyoplankton Larvae

Total Weighted Abundance (#/100m^2)

Habitat / Station	Depth (m)	February 2000	May 2000	August 2000	November 2000	Mean Annual
Deepwater Basin						
LA5	17	1101	6475	4932	494	3250
LA6	16	2501	4171	2717	443	2458
LB3	15	139	1706	5431	1963	2310
LB5	15	1385	24063	7454	514	8354
Deepwater Channel						
LA4	16	2040	5446	1237	578	2325
LB7	24	511	26766	27815	3451	14636
Deepwater Open						
LA1	13	188	1736	2935	460	1330
LB1	12	91	6239	7303	309	3485
Deepwater Slip						
LB4	15	165	8531	9872	1992	5140
LB6	17	3437	6898	5185	3819	4835
Shallow Mitigation						
LA2A	4	667	1159	5543	1481	2212
LA2B	4	65	527	11456	1349	3349
LA7A	4	261	1099	5390	39906	11664
LA7B	4	890	3673	17508	6511	7146
LB2A	6	94	27894	2898	287	7793
LB2B	6	142	28323	3647	444	8139
Shallow Water Open						
LA3A	4	582	11718	3151	344	3949
LA3B	4	563	771	4623	356	1578
Total		14820	167192	129098	64701	93953

Icthyoplankton Larvae

Number of Species

Habitat / Station	Depth (m)	February 2000	May 2000	August 2000	November 2000	Mean Annual
Deepwater Basin						
LA5	17	8	9	4	8	7
LA6	16	7	13	5	5	8
LB3	15	7	13	8	7	9
LB5	15	11	10	9	10	10
Deepwater Channel						
LA4	16	11	11	5	6	8
LB7	24	7	9	11	8	9
Deepwater Open						
LA1	13	9	13	8	9	10
LB1	12	11	13	8	6	10
Deepwater Slip						
LB4	15	7	10	8	9	9
LB6	17	9	8	8	7	8
Shallow Mitigation						
LA2A	4	10	17	9	7	11
LA2B	4	6	11	4	6	7
LA7A	4	7	10	9	10	9
LA7B	4	8	11	8	12	10
LB2A	6	8	10	8	6	8
LB2B	6	7	9	9	9	9
Shallow Water Open						
LA3A	4	10	9	5	8	8
LA3B	4	7	14	6	8	9
Total Unique Species		26	31	21	22	25

Icthyoplankton Larvae

Shannon-Wiener Diversity

Habitat / Station	Depth (m)	February 2000	May 2000	August 2000	November 2000	Total Annual
Deepwater Basin						
LA5	17	1.16	1.52	1.03	1.38	1.83
LA6	16	0.47	1.72	1.40	0.35	2.01
LB3	15	1.45	1.64	1.41	1.61	1.91
LB5	15	1.34	0.73	1.02	1.53	1.28
Deepwater Channel						
LA4	16	1.02	1.16	1.37	0.72	1.53
LB7	24	1.48	1.36	1.50	1.46	1.82
Deepwater Open						
LA1	13	1.14	1.31	0.97	1.84	1.69
LB1	12	1.22	1.28	1.47	1.40	1.81
Deepwater Slip						
LB4	15	1.51	1.65	0.79	1.40	1.52
LB6	17	1.35	1.15	1.21	1.24	1.86
Shallow Mitigation						
LA2A	4	1.03	1.63	0.33	0.30	0.75
LA2B	4	1.20	1.77	0.36	0.20	0.53
LA7A	4	0.39	1.93	0.59	0.75	0.81
LA7B	4	0.43	1.55	0.51	0.99	0.88
LB2A	6	0.93	0.70	1.15	1.20	0.99
LB2B	6	1.38	1.00	1.21	1.37	1.27
Shallow Water Open						
LA3A	4	1.20	1.20	1.32	0.42	1.47
LA3B	4	1.30	1.56	1.34	0.98	1.57
Station Mean		1.11	1.38	1.05	1.06	1.42

Icthyoplankton Larvae

Margalef Diversity

Habitat / Station	Depth (m)	February 2000	May 2000	August 2000	November 2000	Total Annual
Deepwater Basin						
LA5	17	1.00	0.91	0.35	1.13	1.48
LA6	16	0.77	1.44	0.51	0.66	1.63
LB3	15	1.22	1.61	0.81	0.79	1.97
LB5	15	1.38	0.89	0.90	1.44	1.63
Deepwater Channel						
LA4	16	1.31	1.16	0.56	0.79	1.75
LB7	24	0.96	0.78	0.98	0.86	1.64
Deepwater Open						
LA1	13	1.53	1.61	0.88	1.30	2.21
LB1	12	2.22	1.37	0.79	0.87	1.89
Deepwater Slip						
LB4	15	1.18	0.99	0.76	1.05	1.31
LB6	17	0.98	0.79	0.82	0.73	1.11
Shallow Mitigation						
LA2A	4	1.38	2.27	0.93	0.82	2.31
LA2B	4	1.20	1.60	0.32	0.69	1.68
LA7A	4	1.08	1.29	0.93	0.85	1.49
LA7B	4	1.03	1.22	0.72	1.25	1.56
LB2A	6	1.54	0.88	0.88	0.88	1.26
LB2B	6	1.21	0.78	0.98	1.31	1.54
Shallow Water Open						
LA3A	4	1.41	0.85	0.50	1.20	1.97
LA3B	4	0.95	1.96	0.59	1.19	2.40
Station Mean		1.24	1.24	0.73	0.99	1.71

Icthyoplankton Larvae

Dominance Incex

Habitat / Station	Depth (m)	February 2000	May 2000	August 2000	November 2000	Total Annual
Deepwater Basin						
LA5	17	2	3	2	3	4
LA6	16	1	4	3	1	4
LB3	15	3	4	3	3	4
LB5	15	3	1	2	3	2
Deepwater Channel						
LA4	16	2	2	3	1	3
LB7	24	3	3	3	3	4
Deepwater Open						
LA1	13	2	2	2	4	3
LB1	12	2	2	3	3	4
Deepwater Slip						
LB4	15	3	3	1	3	3
LB6	17	3	2	2	2	4
Shallow Mitigation						
LA2A	4	2	2	1	1	1
LA2B	4	2	4	1	1	1
LA7A	4	1	4	1	1	1
LA7B	4	1	3	1	1	1
LB2A	6	2	1	2	3	2
LB2B	6	3	2	2	3	2
Shallow Water Open						
LA3A	4	2	2	3	1	3
LA3B	4	2	3	3	2	3
Station Mean		2	3	2	2	3

February 2000
Ichthyoplankton Catch - Abundance (number per 100 m^3)

STAGE	COMMON	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Neuston																				
Yolksac	Croaker	Sciaenidae									3									
	White croaker	*Genyonemus lineatus*									3								8	
Larvae	Bay goby	*Lepidogobius lepidus*							6										4	
	California grunion	*Leuresthes tenuis*				13						31	8				46	8		75
	Goby Type A	Goby type A		4								3		3						
	Jacksmelt	*Atherinopsis californiensis*	4				3				11	10	8		2		4			5
	Pipefish	Syngnathidae										3								
	Roughcheek sculpin	*Ruscarius creaseri*											12							
	Silverside (unid.)	Atherinidae	4				3												4	
	Topsmelt	*Atherinops affinis*								4	3			5						
	White croaker	*Genyonemus lineatus*		4																
	Yellowfin goby	*Acanthogobius flavimanus*						2		20										
Juvenile	Jacksmelt	*Atherinopsis californiensis*				11														
Total Larvae*			8	8		24	7	2	6	24	20	48	29	8	2		49	8	16	80
Eggs	Fish eggs	Fish eggs	1,422	330	1,159	4,638	3,799	19	3	4	2,648	2,434	3,866	2,621	3,728	652	11	2,512	426	1,175
	California halibut	*Paralichthys californicus*						6					59			13			16	
	Croaker	Sciaenidae	514	118	247	431	131	2	3		285	432	1,309	865	1,501	613	4	2,839	426	423
	English sole	*Pleuronectes vetulus*														13				
	Hornyhead turbot	*Pleuronichthys verticalis*																55		63
	Northern anchovy	*Engraulis mordax*				108							119	27	48				16	16
	Speckled sanddab	*Citharichthys stigmaeus*		4	37			8				68	119	54	48			109	8	
	Spotted turbot	*Pleuronichthys ritteri*	30		12	378	131	29					238	27				218	8	
	Turbot	*Pleuronichthys* sp				54														
Total eggs			1,967	453	1,455	5,609	4,061	64	6	4	2,933	2,935	5,710	3,594	5,325	1,291	15	5,733	898	1,677
Midwater																				
Yolksac	Northern anchovy	*Engraulis mordax*												1						
	White croaker	*Genyonemus lineatus*	3																	
Larvae	Bay goby	*Lepidogobius lepidus*	6	26		22	18	16	14	9	2	8	5	3	4	4	3	42	87	6
	Cheekspot goby	*Ilypnus gilberti*							1											
	Diamond turbot	*Hypsopsetta guttulata*		2												2				1
	Fish (unid.)	Fish (unid.)																1		
	Goby (unid.)	Gobiidae						4	1						1					
	Goby Type A	Goby type A		115	5	24	24	90	11	12	46	155		12	10	2	3	14	52	5
	Hornyhead turbot	*Pleuronichthys verticalis*														2				
	Jacksmelt	*Atherinopsis californiensis*										2						1		
	Kelpfish	*Gibbonsia* sp		2	4		1													
	Longjaw mudsucker	*Gillichthys mirabilis*																1		
	Northern anchovy	*Engraulis mordax*		3				3					2						16	7
	Northern lampfish	*Stenobrachius leucopsarus*				1			1						1					
	Ronquil	*Rathbunella* sp		2		1														
	Roughcheek sculpin	*Ruscarius creaseri*		2		1	1								1				1	
	Sculpin/Cottid	Cottidae		2													1			
	Spotted kelpfish	*Gibbonsia elegans*						1			1									
	Staghorn sculpin	*Leptocottus armatus*					1													
	White croaker	*Genyonemus lineatus*		2				2	1			2		1				1	1	
	Woolly sculpin	*Clinocottus analis*						2										4	1	
	Yellowfin goby	*Acanthogobius flavimanus*		6		3	9	6	44	149	2	3			3		3	11	48	1
Total Larvae*			8	159	9	51	55	122	73	169	51	170	6	17	19	9	10	75	206	19
Eggs	Fish eggs	Fish eggs	729	557	474	789	1,368	662	109	409	701	1,511	746	475	221	509	121	328	548	552
	Northern anchovy	*Engraulis mordax*		31	14		26						76	7	4			20		19
	California halibut	*Paralichthys californicus*																	7	
	Croaker	Sciaenidae	369	382	298	197	153	211	84	198	146	250	609	290	270	239	12	116	252	71
	Hornyhead turbot	*Pleuronichthys verticalis*	28	10									15							
	Speckled sanddab	*Citharichthys stigmaeus*							6	12				20						39
	Spotted turbot	*Pleuronichthys ritteri*	9															4		
Total eggs			1,135	980	785	987	1,547	873	200	619	847	1,760	1,447	791	496	748	133	467	807	682

February 2000

Ichthyoplankton Catch - Abundance (number per 100 m^3)

STAGE	COMMON	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
													Epibenthic							
Yolksac	Fish (unid.)	Fish (unid.)										5								
	White croaker	*Genyonemus lineatus*	1					1			1									1
Larvae	Anchovy (unid.)	Engraulidae																43		
	Bay goby	*Lepidogobius lepidus*	84	2	12	22	4	17	19	9		10	11	2	12	13	17	83	225	24
	California clingfish	*Gobiesox rhessodon*						1						1	1		1	2		
	Diamond turbot	*Hypsopsetta guttulata*																2		
	Fish (unid.)	Fish (unid.)								1										
	Giant kelpfish	*Heterostichus rostratus*	3			4		1												
	Goby (unid.)	Gobiidae	1						2						1					
	Goby Type A	Goby type A	15	2	18	103	3	42	25	3	138	464	2	9	16	2	7	18	156	9
	Jacksmelt	*Atherinopsis californiensis*						1						1						
	Kelpfish	*Gibbonsia* sp		3	1	1														
	Longjaw mudsucker	*Gillichthys mirabilis*																	6	
	Northern anchovy	*Engraulis mordax*	30					10	13	4			2	1					6	20
	Northern lampfish	*Stenobrachius leucopsarus*	3			3		2			1	10	2							
	Reef finspot	*Paraclinus integripinnis*											2							
	Rockfish (unid.)	*Sebastes* C37											5							
	Roughcheek sculpin	*Ruscarius creaseri*			1	1							2							
	Sculpin/Cottid	Cottidae			1	3		2	4	1						2	3			
	Shadow goby	*Quietula y-cauda*								1										
	Shortspine combfish	*Zaniolepis frenata*											2							
	Staghorn sculpin	*Leptocottus armatus*				3														
	White croaker	*Genyonemus lineatus*	1	2										1		4		3	12	
	Woolly sculpin	*Clinocottus analis*			1								2					5		
	Yellowchin sculpin	*Icelinus quadriseriatus*	1																	
	Yellowfin goby	*Acanthogobius flavimanus*	30		1	18		29	147	128	1	15		2	2	2	14	12	340	14
Total Larvae*			172	8	37	158	6	105	210	149	142	504	26	17	31	22	42	168	744	68
Eggs	Fish eggs	Fish eggs	280	611	186	487	58	411	112	438	69	255	2,183	257	340	1,883	128	729	663	1,838
	Northern anchovy	*Engraulis mordax*	3												14			20	10	28
	Croaker	Sciaenidae	44	271	170	164	13	246	252	245	35	115	51	146	99	62	11	260	260	97
	Hornyhead turbot	*Pleuronichthys verticalis*			4		1	5												
	Speckled sanddab	*Citharichthys stigmaeus*												4						
	Spotted turbot	*Pleuronichthys ritteri*	8																	
Total eggs*			335	882	360	651	72	662	364	683	104	370	2,234	407	453	1,945	139	1,009	932	1,963

* Totals are $\pm$1 due to rounding.

May 2000

Ichthyoplankton Catch - Abundance (number per 100 m^3)

STAGE	COMMON	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
												Neuston								
Yolksac	Topsmelt	*Atherinops affinis*						8											8	
Larvae	Blenny	*Hypsoblennius sp*	16			563	23	4		84	150			3	14		112	11	8	
	SnubnoseSculpin	*Orthonopias triacis*		8		563														
	Mussel Blenny	*Hypsoblennius jenkinsi*											6							
	Blind Goby	*Typhlogobius californiensis*					3									4				
	Bay goby	*Lepidogobius lepidus*		4			3			126							1065			
	Bay pipefish	*Syngnathus leptorhynchus*						2												
	California clingfish	*Gobiesox rhessodon*				14649					902	1883		6	6		112			
	California grunion	*Leuresthes tenuis*	12	36			7	2	30	42			17	37	37		2074	25	75	95
	Cheekspot goby	*Ilypnus gilberti*										105								
	Diamond turbot	*Hypsopsetta guttulata*											6	3	3			4		
	Fish (unid.)	Fish (unid.)													3					
	Garibaldi	Hypsypops rubricundus	4																	
	Goby (unid.)	*Gobiidae*				1127								3						
	Goby Type A	Goby type A	4	8		34933	13			42	639	3086		26	9	4	729			
	Jacksmelt	*Atherinopsis californiensis*		4									6			4	56			
	Northern anchovy	*Engraulis mordax*	4			1690		2			545	942			6		112	25		7
	Pipefish (unid.)	*Syngnathus sp*											6							
	Queenfish	*Seriphus politus*	4	8		4507		4			263	262				4				4
	Rockfish (unid.)	*Sebastes sp*		4																
	Roughcheek sculpin	*Ruscarius creaseri*				1127	3													
	Silverside (unid.)	Atherinidae																4		4
	Spotted kelpfish	*Gibbonsia elegans*										52								
	Topsmelt	*Atherinops affinis*		4			10		5											26
	White croaker	*Genyonemus lineatus*									132	52					1625		4	
Juvenile	Bay pipefish	*Syngnathus leptorhynchus*															56			4
Total Larvae*			45	75	0	59161	64	23	35	293	2631	6382	39	78	77	16	5941	68	94	139
Eggs	California tonguefish	*Symphurus atricauda*																	4	
	Croaker	Sciaenidae		32	12	2254	84	13	20	42		7								
	Egg Type A	Egg Type A	90	20	12	32116	956	17		168	9			3			546		15	26
	Egg Type B	Egg Type B	8	4	4															
	Fish (unid.)	Fish (unid.)			28	3381						3			3		84		11	
	Hornyhead turbot	*Pleuronichthys verticalis*	4		8															
	Queenfish	*Seriphus politus*	90	79	4	3381			5		9					52	42	18		4
	Senorita	*Oxyjulis californica*				563	34													
	Speckled sanddab	*Citharichthys stigmaeus*		40	4	7888	503								3	4				
	Spotted turbot	*Pleuronichthys ritteri*	37		32	4507	151	11									42			
Total eggs*			228	174	104	54,090	1,728	40	25	210	19	10		3	6	56	715	18	30	29

May 2000

Ichthyoplankton Catch - Abundance (number per 100 m^3)

STAGE	COMMON	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
											Midwater									
Yolksac	Kelpfish	Clinidae						3												
	Yellowchin sculpin	*Icelinus quadriseriatus*						3												
Larvae	Blenny	*Hypsoblennius sp*		14	5	6	4			5	35	60			29	15	5	47	9	
	SnubnoseSculpin	*Orthonopia triacis*			2	2														
	Blind Goby	*Typhlogobius californiensis*	2																	
	Bay goby	*Lepidogobius lepidus*	2	14	7			18	37	28			7			2	233	47	13	79
	Blackeye goby	*Coryphopterus nicholsi*		3																
	California clingfish	*Gobiesox rhessodon*			5	26	8			3	2	86	11	3784	2398	2	5		81	7
	California grunion	*Leuresthes tenuis*										9					26			
	California halibut	*Paralichthys californicus*											4			2				7
	Diamond turbot	*Hypsopsetta guttulata*	5					3		3			4							
	Giant kelpfish	*Heterostichus rostratus*			2							9								
	Goby (unid.)	Gobiidae								3		9					10			
	Goby Type A	Goby type A	7	54	17	66	7	27	35	18	37	448	4	223	497	15	93	16	9	
	Northern anchovy	*Engraulis mordax*	50		2	5	3	186	128	53	37	155	156	37	29	9	5	1381		336
	Northern lampfish	*Stenobrachius leucopsarus*														2				
	Pygmy poacher	*Odontopyxis trispinosa*																		7
	Queenfish	*Seriphus politus*	68	60	49	10	1	44	50	13		86	196	853	1053	56		93	274	236
	Rockfish (unid.)	*Sebastes sp*		3																
	Roughcheek sculpin	*Ruscarius creaseri*		6	2														4	
	Silverside (unid.)	Atherinidae															5			
	Spotted kelpfish	*Gibbonsia elegans*			7	2														
	Topsmelt	*Atherinops affinis*					1										26			
	White croaker	*Genyonemus lineatus*	7	3				15	27	18	15	17	43			9	150	78	40	265
	Yellowfin goby	*Acanthogobius flavimanus*							16	3										
Total Larvae*			140	157	98	116	24	298	292	145	126	879	424	4898	4007	113	559	1660	431	936
Eggs	Sanddab	*Citharichthys sp*					43													
	California tonguefish	*Symphurus atricauda*			2														3	
	Croaker	Sciaenidae	11		59	13	64	11		5		2	2		2	51			8	
	Egg Type A	Egg Type A	45	97	52	102	190		6	28	7			2		4	8	2	5	11
	Egg Type B	Egg Type B	5	3	2					3										
	Fish (unid.)	Fish (unid.)		11	19	6	11	2		3			2			2	3		10	2
	Queenfish	*Seriphus politus*	47	43	3											81		3		62
	Senorita	*Oxyjulis californica*			3															
	Speckled sanddab	*Citharichthys stigmaeus*		46	16	26							2	4	2				5	
	Spotted turbot	*Pleuronichthys ritteri*		26	17	2	8	19												11
Total eggs*			109	226	175	149	316	32	6	38	7	2	5	6	4	137	10	5	32	86

May 2000
Ichthyoplankton Catch - Abundance (number per 100 m^3)

STAGE	COMMON	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
											Epibenthic									
Larvae	Blenny	*Hypsoblennius sp*	6			13					93			19	13	2				
	Smoothhead Sculpin	*Artedius lateralis*					8													
	SnubnoseSculpin	*Orthonopias triacis*		12			8													
	Deepwater Blenny	*Cryptotrema corallinum*					8													
	Bay goby	*Lepidogobius lepidus*			6		8		304	384			14	4		23	350	31	4	
	California clingfish	*Gobiesox rhessodon*	6	12	2	401	175	8	55	82		2	36	75	621	17	155	23	107	
	California grunion	*Leuresthes tenuis*									146	51								
	California halibut	*Paralichthys californicus*						15					9					8		
	Cheekspot goby	*Ilypnus gilberti*									27	5								
	Croaker	Sciaenidae																		70
	Diamond turbot	*Hypsopsetta guttulata*				13							14							
	Fish (unid.)	Fish (unid.)											5							
	Giant kelpfish	*Heterostichus rostratus*		31	44															
	Goby (unid.)	Gobiidae								27							13			
	Goby Type A	Goby type A	10	255	52	1056	381	8	194	192	40	10	23	94	177	15	401	8	4	
	Hornyhead turbot	*Pleuronichthys verticalis*	10										5		13	4				
	Longjaw mudsucker	*Gillichthys mirabilis*								27										
	Northern anchovy	*Engraulis mordax*	39	37		40	8	526	1522	1618		5	173	15	13	8	13	442		2867
	Queenfish	*Seriphus politus*	122	267	46	94	129	244	526	247			209	157	443	63	78	302	203	1119
	Rockfish (unid.)	*Sebastes sp*	3																	
	Ronquil	*Rathbunella sp*			2											4				
	Roughcheek sculpin	*Ruscarius creaseri*			6															
	Spotted kelpfish	*Gibbonsia elegans*		19	56	13								4	13					
	Topsmelt	*Atherinops affinis*								27	13	24								
	White croaker	*Genyonemus lineatus*	3				8	23	166	329			41			65	453	16	19	2728
	Yellowchin sculpin	*Icelinus quadriseriatus*		6						27	13									
	Yellowfin goby	*Acanthogobius flavimanus*							28					4						
Juvenile	Topsmelt	*Atherinops affinis*										2								
Total Larvae*			199	640	215	1632	731	824	2795	2962	332	100	528	371	1292	202	1463	829	338	6784
Eggs	Croaker	Sciaenidae	55	99	57	19	30	11		100			2			86		4		4301
	Egg Type A	Egg Type A		298	122	120	225	11	21	420	13					15	3		12	52
	Egg Type B	Egg Type B	10	12			8													
	Fish (unid.)	Fish (unid.)	10	19	5	6	11			20				4	2			4	2	682
	Hornyhead turbot	*Pleuronichthys verticalis*		12	2			2												
	Pacific sanddab	*Citharichthys sordidus*				19														
	Queenfish	*Seriphus politus*		19		3		6			13	5				8			19	
	Senorita	*Oxyjulis californica*					15	2												
	Speckled sanddab	*Citharichthys stigmaeus*	10	50	27		23	6					9					2	2	
	Spotted turbot	*Pleuronichthys ritteri*	3	93	12	10	27	8			13									
Total eggs*			87	603	226	178	339	46	21	541	40	5	11	4	2	110	3	10	35	5035

* Totals are ±1 due to rounding.

August 2000

Ichthyoplankton Catch - Abundance (number per 100 m^3)

STAGE	COMMON	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
			Neuston																	
Larvae	Bay goby	*Lepidogobius lepidus*	6		5					5	3		5	6				4		
	Blenny	*Hypsoblennius sp*	6	9	49	11	6				3	23	8	34		8		4		
	California grunion	*Leuresthes tenuis*	3								3	5	3				30	20		11
	Goby Type A	Goby type A	3	72	34		13				3			11						
	Jacksmelt	*Atherinopsis californiensis*												6						
	Northern anchovy	*Engraulis mordax*	3																	
	Pipefish (unid.)	*Syngnathus sp*		9																
	Plainfin midshipman	*Porichthys notatus*		9																
	Silverside (unid.)	Atherinidae															4			
	Topsmelt	*Atherinops affinis*									3									
	Yellowchin sculpin	*Icelinus quadriseriatus*	3																	
Juvenile	California grunion	*Leuresthes tenuis*	16								160	154	19	23		36				
	Jacksmelt	*Atherinopsis californiensis*																		
	Topsmelt	*Atherinops affinis*	3			4								6						
Total Larvae*			44	99	87	15	19	0	0	5	175	183	35	86	0	44	34	28	0	11
Eggs	California tonguefish	*Symphurus atricauda*	250								38	84		510					6	
	Croaker	Sciaenidae	50			38				2111	19	70	11	46		16	840	16	49	33
	Egg Type A	Egg Type A		404	146	312	332	44		1086			5				138		11	55
	Egg Type B	Egg Type B		108	10	8								17						
	Fantail sole	*Xystreurys liolepis*																		
	Fish (unid.)	Fish (unid.)		63	5		19			211		5	5	40			20		14	4
	Northern anchovy	*Engraulis mordax*										37							3	
	Queenfish	*Seriphus politus*																		
	Speckled sanddab	*Citharichthys stigmaeus*	3	54	15	34	38				3		16	6					14	4
	Spotfin croaker	*Roncador stearnsi*	9																	
	Spotted turbot	*Pleuronichthys ritteri*	6																	15
Total eggs*			318	628	175	391	390	44	0	3408	60	197	38	619	0	16	998	16	97	110
			Midwater																	
Larvae	Anchovy	*Engraulis sp*	5																	
	Bay goby	*Lepidogobius lepidus*	197	7	69	88	101	32	198	79	71	70	205	25	74	106	614	353	197	581
	Blenny	*Hypsoblennius sp*	10	22	137	113	63	6	66	49	62	70	43	179	216	75	27	64	36	202
	Bluebanded goby	*Lythrypnus dalli*																		13
	California clingfish	*Gobiesox rhessodon*	10			13	25							10	7	60		8	7	50
	Giant kelpfish	*Heterostichus rostratus*		7																
	Goby (unid.)	Gobiidae		7						10		35	26				27			
	Goby Type A	Goby type A	46	694	2084	63	214	19	99		824	3769	119	125	216	121	107	32	44	114
	Kelpfish	*Gibbonsia sp*										70								
	Northern anchovy	*Engraulis mordax*						6		10	9		43		13				7	177
	Queenfish	*Seriphus politus*	10					6				35	17		7			32	15	38
	Reef finspot	*Paraclinus integripinnis*									9	70								
	Sculpin/Cottid	Cottidae					13													
	Snubnose pipefish	*Cosmocampus arctus*			23					20				5						
	Speckled sanddab	*Citharichthys stigmaeus*																		13
	Woolly sculpin	*Clinocottus analis*					13											8		
Juvenile	Northern anchovy	*Engraulis mordax*												10						
Total Larvae*			278	737	2313	277	427	70	364	167	975	4122	452	354	533	362	774	498	306	1187
Eggs	California tonguefish	*Symphurus atricauda*	137								4		9	439	202				7	13
	Croaker	Sciaenidae	137			67	38	13	66	893	84		26	519	202	30	881		269	177
	EGG_TYPE_A	Egg Type A	25	234	653	1847	867	13		167			60				400		7	50
	EGG_TYPE_B	Egg Type B	5	18		50	13				93			50	34					
	Fish (unid.)	Fish (unid.)	5	3		34				89	31		17		20		80	8	22	
	Hornyhead turbot	*Pleuronichthys verticalis*	5																	
	Northern anchovy	*Engraulis mordax*										53								
	Queenfish	*Seriphus politus*																	29	
	Speckled sanddab	*Citharichthys stigmaeus*	71	73	142	252	126	6					85							13
	Spotfin croaker	*Roncador stearnsi*			28										34	15				
	Spotted turbot	*Pleuronichthys ritteri*	15			17							17							63
Total eggs*			400	327	824	2267	1043	32	66	1149	213	53	213	1007	492	45	1362	8	335	316

August 2000

Ichthyoplankton Catch - Abundance (number per 100 m^3)

STAGE	COMMON	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
			Epibenthic																	
Larvae	Bay goby	*Lepidogobius lepidus*	132	7		62	93		77	96	20	366	1552	54	68	154	210	432	674	270
	Blenny	*Hypsoblennius sp*		7		31	21	11		19	39		99	215	141	38		12	35	7
	Bluebanded goby	*Lythrypnus dalli*					10													
	California clingfish	*Gobiesox rhessodon*	3	7		103	31				59	366	66	97	5	51	144		24	15
	Goby (unid.)	Gobiidae	2	13		10						73				13		6	35	
	Goby Type A	Goby type A	12	1333	2666	625	258	33	93	154	1757	5638	759	700	276	115	249	49	331	29
	Kelpfish	*Gibbonsia sp*		7										11			13			
	Longjaw mudsucker	*Gillichthys mirabilis*																	24	7
	Northern anchovy	*Engraulis mordax*	3						46				528			26	13	56	71	146
	Queenfish	*Seriphus politus*	3	54		51					59	73	198	32		13	39	19	12	22
	Reef finspot	*Paraclinus integripinnis*														13				
	Snubnose pipefish	*Cosmocampus arctus*													5					
	Specklefin midshipma	*Porichthys myriaster*														26		6		7
	Woolly sculpin	*Clinocottus analis*											33						24	
Juvenile	Bay goby	*Lepidogobius lepidus*																		29
	Northern anchovy	*Engraulis mordax*																		15
	Queenfish	*Seriphus politus*										659								
	White croaker	*Genyonemus lineatus*																		15
Total Larvae*			155	1427	2666	882	413	44	217	270	1933	7176	3236	1109	494	448	669	580	1231	562
Eggs	California tonguefish	*Symphurus atricauda*	6										50		26					7
	Croaker	Sciaenidae	2							559	59	73		65	42		170		22	37
	EGG_TYPE_A	Egg Type A		127	69	226	124		15	116			25			13	26	6		37
	EGG_TYPE_B	Egg Type B	1	20		21								86	10				11	
	Fantail sole	*Xystreurys liolepis*																6		
	Fish (unid.)	Fish (unid.)							15	58				22						
	Hornyhead turbot	*Pleuronichthys verticalis*																		7
	Jack mackerel	*Trachurus symmetricus*		7																
	Northern anchovy	*Engraulis mordax*										73			5					
	Speckled sanddab	*Citharichthys stigmaeus*	5	54	23	51	10	11					25							7
	Spotfin croaker	*Roncador stearnsi*												22						
	Spotted turbot	*Pleuronichthys ritteri*											25							
Total eggs*			14	208	92	297	134	11	31	732	59	146	124	194	83	13	197	12	34	95

* Totals are ±1 due to rounding.

November 2000
Ichthyoplankton Catch - Abundance (number per 100 m^3)

STAGE	COMMON	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
											Neuston									
Larvae	Bay goby	*Lepidogobius lepidus*											5							
	Blenny	*Hypsoblennius sp*				4	3				4			5				3	5	3
	California grunion	*Leuresthes tenuis*	6				3				48	36			3	19	3	122	5	3
	Goby Type A	Goby type A	3	16	7	8	9				4				3			3		
	Jacksmelt	*Atherinopsis californiensis*		11		12	12				43	57	14							
	Silverside (unid.)	Atherinidae					3				13	3								
	Topsmelt	*Atherinops affinis*		3		4						3		5	3			3		
	White croaker	*Genyonemus lineatus*									4									
	Woolly sculpin	*Clinocottus analis*																3		
Total Larvae*			10	30	7	29	29	0	0	0	117	98	18	9	9	19	3	134	10	5
Eggs	Croaker	Sciaenidae	6												6					
	Egg Type A	Egg Type A	41	24	18	127	117	32	146	37	22	21	5	139	53	260	187		15	94
	Fish (unid.)	Fish (unid.)	19	5		12	23	3		5				9		65	5			8
	Hornyhead turbot	*Pleuronichthys verticalis*	3			4														
	Speckled sanddab	*Citharichthys stigmaeus*	99	73	25	37	32	3			9	9		79	29		14			
	Spotted turbot	*Pleuronichthys ritteri*		3		58	53	165	11		4					9		3		
	Turbot	*Pleuronichthys sp*				4														
	White croaker	*Genyonemus lineatus*	118	33	36	62	29	41		66	22	12	23	19	38	734	16	24	35	104
Total eggs*			287	138	78	304	254	243	158	109	56	42	27	245	126	1068	222	27	50	205
											Midwater									
Yolksac	White croaker	*Genyonemus lineatus*					2													
Larvae	Bay goby	*Lepidogobius lepidus*	3					3			585	85				8	3		20	24
	Blenny	*Hypsoblennius sp*	3	8	4	2			2		117	42	10	7	12	2	19	8	1	3
	California clingfish	*Gobiesox rhessodon*					2				59	71		5	5	5	15	2		5
	California grunion	*Leuresthes tenuis*					2				59				3	2				
	Goby Type A	Goby type A	8	271	247	23	23	21	20	28	4857	1260	5	33	35	24	70	2	34	14
	Hornyhead turbot	*Pleuronichthys verticalis*			2				2									2		
	Island kelpfish	*Alloclinus holderi*							2											
	Jacksmelt	*Atherinopsis californiensis*	3		2							14								
	Northern anchovy	*Engraulis mordax*	9					3	3		176	184	5	5	5	12	17	12	4	27
	Queenfish	*Seriphus politus*													1					
	Spotted turbot	*Pleuronichthys ritteri*	2																	
	White croaker	*Genyonemus lineatus*	3	8					2	3			5	3	1	22	3		30	70
	Woolly sculpin	*Clinocottus analis*	2				2		3								3	2	3	3
	Yellowfin fringehead	*Neoclinus stephensae*					2													
	Yellowfin goby	*Acanthogobius flavimanus*									351									
Total Larvae*			33	288	256	25	33	28	33	31	6202	1657	24	52	63	75	131	26	91	146
Eggs	Croaker	Sciaenidae														5				
	Egg Type A	Egg Type A	2		4	19	15	14	8			19	24	2	12	17	27		3	130
	Fish (unid.)	Fish (unid.)	5	2				2					10	2		2		2		
	Speckled sanddab	*Citharichthys stigmaeus*	5	11	7	50	37					2	5	2				2		
	Spotted turbot	*Pleuronichthys ritteri*		4		6	10	20										8	1	18
	White croaker	*Genyonemus lineatus*	74	22	20	35	12	57	26	22	5	2	157	7	8	132	17	30	57	227
Total eggs*			85	38	31	110	75	92	34	22	5	22	196	11	20	156	44	41	61	375

November 2000

Ichthyoplankton Catch - Abundance (number per 100 m^3)

STAGE	COMMON	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
			Epibenthic																	
Larvae	Bay goby	*Lepidogobius lepidus*						33	13	2						453	24		609	31
	Blenny	*Hypsoblennius sp*	65	7	8			2						6		21	3	2	36	
	California clingfish	*Gobiesox rhessodon*				6	4				211	376		6		41	56	3		2
	California grunion	*Leuresthes tenuis*														21				
	Cheekspot goby	*Ilypnus gilberti*				3														
	Fish (unid.)	Fish (unid.)						18												
	Giant kelpfish	*Heterostichus rostratus*				3	2	2				113								
	Goby Type A	Goby type A		380	396	144	44	146	62	39	18397	3235	22	11		226	275	7	1362	11
	Hornyhead turbot	*Pleuronichthys verticalis*							2											
	Jacksmelt	*Atherinopsis californiensis*									211									
	Kelpfish	*Gibbonsia sp*		7	4															
	Northern anchovy	*Engraulis mordax*	65	3				6	8	2	423	38	2			165	10	18	36	13
	Plainfin midshipman	*Porichthys notatus*																2		
	Queenfish	*Seriphus politus*																		
	Reef finspot	*Paraclinus integripinnis*										38								
	Shadow goby	*Quietula y-cauda*				3														
	Spotted turbot	*Pleuronichthys ritteri*															3			
	White croaker	*Genyonemus lineatus*		10	4			2	4	5		38	24			473	21	2	1434	44
	Woolly sculpin	*Clinocottus analis*					2		2	2	211									4
	Yellowfin goby	*Acanthogobius flavimanus*									846	376								
Juvenile	Queenfish	*Seriphus politus*				3														
Total Larvae*			130	407	412	161	51	209	91	49	20300	4213	47	22	0	1400	393	33	3477	105
Eggs	Croaker	Sciaenidae														700				
	Egg Type A	Egg Type A	65	2	4	6	4	8		2		9	2	11		185	3	2	72	49
	Fish (unid.)	Fish (unid.)	97			3	2	2	16							41				20
	Hornyhead turbot	*Pleuronichthys verticalis*																		
	Speckled sanddab	*Citharichthys stigmaeus*	32	3	2	89	38													
	Spotted turbot	*Pleuronichthys ritteri*		2	2	3	8	8					2					3	36	5
	White croaker	*Genyonemus lineatus*	2498	9	12	19	15	35	220	7	13	2	12	22			5	15	1219	194
Total eggs*			2693	15	19	119	67	53	236	8	13	11	16	34	0	926	9	20	1326	268

* Totals are ±1 due to rounding.

APPENDIX E

Infauna and Macroinvertebrate Data

E.1 Infauna Data

CRUSTACEANS

	Name	Count		Name	Count
	Amphideutopus oculatus	3393		Ampelisca brachycladus	8
	Euphilomedes carcharodonta	2267		Mayerella banksia	8
*	Sinocorophium cf heteroceratum	872		Photis lacia	8
	Paramicrodeutopus schmitti	755		Alienacanthomysis macropsis	7
*	Eochelidium sp A	662		Betaeus sp	7
	Scleroplax granulata	610		Caprella mendax	7
?	Monocorophium acherusicum	408		Caprella sp	7
	Leptochelia dubia	368		Eusarsiella thominx	7
	Photis brevipes	352		Betaeus longidactylus	5
*	Grandidierella japonica	248		Heptacarpus sp	5
	Gnathia crenulatifrons	218		Postasterope barnesi	5
	Pinnotheridae	193		Aoridae	3
	Neotrypaea californiensis	188		Balanus pacificus	3
	Caprella californica	183		Crangon sp	3
	Foxiphalus golfensis	162		Dynamenella sp	3
	Pyromaia tuberculata	133		Leuroleberis sharpei	3
?	Hemiproto sp A	118		Liljeborgia geminata	3
	Listriella goleta	103		Mysida	3
	Pinnixa franciscana	102		Neomysis kadiakensis	3
	Xeuxo normani	83		Oxyurostylis pacifica	3
	Neotrypaea sp	68		Parasterope sp	3
	Ampelisca cristata	65		Pinnixa hiatus	3
	Podocerus cristatus	62		Xenoleberis californica	3
*	Sinocorophium sp	58		Ampithoe sp	2
?	Deflexilodes similis/D. sp 1	37		Balanus trigonus	2
	Ampelisca cristata microdentata	35		Corophium sp	2
	Pinnixa sp	35		Cumella californica	2
	Hippomedon zetesimus	32		Cumella sp	2
	Photis bifurcata	27		Grapsidae	2
?	Caprella sp A	23		Hemigrapsus oregonensis	2
	Listriella melanica	23		Hemigrapsus sp	2
	Acuminodeutopus heteruropus	22		Liljeborgia pallida	2
	Ampelisca brevisimulata	22		Listriella diffusa	2
	Rudilemboides stenopropodus	22		Listriella eriopisa	2
?	Paradexamine sp A	20		Melita sp	2
	Corophiidae	18		Micropleustes nautilus	2
	Heteroserolis carinata	18		Mysidella sp	2
	Photis californica	17		Paracerceis sp	2
	Anoplodactylus erectus	15		Photis parvidons	2
	Mysidopsis intii	15		Photis sp	2
	Pinnixa longipes	15	?	Photis sp OC1	2
	Foxiphalus obtusidens	13		Pinnixa schmitti	2
	Nebalia "pugettensis"	13		Portunus xantusii	2
	Westwoodilla caecula	13		Upogebia pugettensis	2
	Hartmanodes hartmanae	12		Upogebia sp	2
	Megalopa/Zoea	12			
	Amphilochus sp	10			
	Calanoida (copepod)	10			
	Neastacilla californica	10			
	Neotrypaea gigas	10			

* Non-indigenous
? Status unclear

ECHINODERMS

Name	Count
Amphiodia urtica	55
Amphipholis squamata	40
Amphiodia sp	28
Amphiuridae	15
Amphioplus sp	12
Amphipholis sp	12
Ophiuroidea	7
Leptosynapta sp	5
Amphiodia occidentalis	2
Amphiodia psara	2
Amphioplus hexacanthus	2
Amphiura arcystata	2
Ophiothrix spiculata	2

* Non-indigenous
? Status unclear

Ranked Order of Abundance (0.1 m^2 area)
Infauna

MOLLUSCS

	Name	Count
*	Theora lubrica	2475
	Tellina modesta	248
	Tagelus subteres	227
	Pulsellum aberrans	163
	Macoma yoldiformis	120
	Rictaxis punctocaelatus	117
	Bivalvia	115
	Olivella baetica	110
	Lyonsia californica	98
	Gadila aberrans SCAMIT1996	87
	Thyasira flexuosa	82
	Nuculana taphria	77
	Mactrotoma californica	62
*	Musculista senhousei	55
	Rochefortia tumida	50
	Cooperella subdiaphana	47
	Vitrinella oldroydi	45
*	Philine auriformis	35
	Rochefortia grippi	35
	Laevicardium substriatum	33
	Parvilucina tenuisculpta	32
	Periploma discus	32
	Acteocina culcitella	30
	Compsomyax subdiaphana	30
	Macoma nasuta	30
	Philine sp A (SCAMIT)	30
	Chione californiensis	28
	Macoma sp	28
*	Venerupis phillipinarium	27
	Cylichna diegensis	22
	Solen sicarius	22
	Turbonilla sp	22
	Kellia laperousii	18
	Cryptomya californica	17
	Nassarius perpinguis	17
	Rochefortia coani	17
	Volvulella panamica	17
	Tellina carpenteri	15
	Odostomia sp	13
	Protothaca staminea	13
	Thracia curta	13
	Acteocina inculta	12
	Rochefortia sp B (SCAMIT)	12
	Leptopecten latiauratus	10
	Saxicavella nybakkeni	8
	Rochefortia compressa	7
	Philine sp	7
	Tagelus sp	7
	Crepidula sp	5
	Modiolus sp	5
	Trachycardium quadragenarium	5
	Ensis myrae	3
	Neolepton subtrigona	3
	Protothaca sp	3
	Psephidia brunnea	3
	Adontorhina cyclia	2
	Alia carinata	2
	Astyris gausapata	2
	Axinopsida serricata	2
	Cyathodonta pedroana	2
	Iselica fenestrata	2
	Juliacorbula luteola	2
	Kurtziella plumbea	2
	Kurtzina beta	2
	Lasaea subviridis	2
	Mactra nasuta	2
*	Mytilus galloprovincialis	2
	Neverita reclusiana	2
	Ophiodermella inermis	2
	Orobitella sp	2
	Rochefortia sp	2
	Scaphopoda	2
	Thracia sp	2

* Non-indigenous
? Status unclear

OTHER MINOR PHYLA

	Name	Count
	Tubulanus polymorphus/pellucidus	258
	Phoronida	187
	Lineidae	147
	Paranemertes californica	48
	Zygeupolia rubens	33
	Nemertea	30
	Edwardsia sp G (MEC)	27
	Celleporina sp (colonial)	23
	Ceriantharia	23
	Tubulanus cingulatus	22
	Apionsoma misakiana	17
	Molgula sp	17
	Scolanthus sp A (SCAMIT)	17
	Crisia sp (colonial)	15
	Carinoma mutabilis	12
	Tubulanus nothus	12
	Thysanocardia nigra	10
	Gobiidae	8
	Amathia sp (colonial)	7
	Bryozoa (colonial)	7
	Filicrisia sp (colonial)	7
	Athenaria	5
	Cryptonemertes actinophila	5
	Enteropneusta	5
	Listriolobus pelodes	5
	Paleonemertea	5
	Actiniaria	3
	Anemonactis sp. A	3
	Bugula sp (colonial)	3
*	Bunodeopsis sp A	3
	Ctenostomata	3
	Ectoprocta (colonial)	3
	Notoplana sp	3
	Scrupocellaria sp (colonial)	3
	Styela montereyensis	3
	Stylatula elongata	3
	Amphiporus sp	2
	Bugula neritina (colonial)	2
	Clavipora occidentalis (colonial)	2
	Glottidia albida	2
	Leptoplanidae sp A (MEC)	2
	Limnactiniidae sp A (SCAMIT)	2
	Lineus bilineatus	2
	Nephasoma sp	2
	Pachycerianthus fimbriatus	2
	Platyhelminthes	2
	Porichthys myriaster	2
	Porifera (colonial)	2
?	Rhizocaulus verticillatus	2
	Styela truncata	2
	Stylatula sp A (MEC)	2
	Zaolutus actius	2

* Non-indigenous
? Status unclear

Ranked Order of Abundance (0.1 m^2 area)
Infauna

POLYCHAETES

	Name	Count		Name	Count
*	Pseudopolydora paucibranchiata	11448		Marphysa sp A (Harris&Velarde1983)	38
	Cossura sp A	3077	?	Euchone incolor	37
	Monticellina siblina	2258		Megalomma pigmentum	35
	Euchone limnicola	1988		Nephtys caecoides	33
	Mediomastus sp	1983	?	Spiochaetopterus costarum	33
	Spiophanes berkeleyorum	1043		Cirratulus spectabilis	32
	Chaetozone corona	907		Marphysa disjuncta	32
	Cossura candida	707		Boccardia basilaria	30
	Aphelochaeta petersenae	697		Pectinaria californiensis	30
	Paraprionospio pinnata	622	*	Syllis(Typosyllis) nipponica	30
	Dorvillea (Schistomeringos) annulata	557		Tenonia priops	30
	Capitella "capitata"	538	?	Glycera convoluta	28
	Streblosoma sp B (SCAMIT1985)	493		Phyllodoce hartmanae	28
	Aphelochaeta monilaris	490		Pista disjuncta	27
	Lumbrineris sp	405	?	Lumbrineris latreilli	25
	Leitoscoloplos pugettensis	398		Pholoe glabra	20
	Exogone lourei	330		Platynereis bicanaliculata	20
	Spiophanes missionensis	315		Armandia brevis	17
	Nereis procera	298	?	Lumbrineris japonica	17
	Prionospio heterobranchia	285		Praxillella pacifica	17
	Prionospio lighti	270	*	Aricidea (Acmira) horikoshii	15
	Paramage scutata	260		Chone mollis	15
?	Lumbrineris sp A	253		Nephtys ferruginea	15
	Aphelochaeta sp	245		Poecilochaetus sp A (Martin1977)	15
	Pista alata	220		Sabellides manriquei	15
	Notomastus tenuis	208		Sthenelais berkeleyi	15
?	Laonice cirrata	207		Glycera nana	13
	Petaloclymene pacifica	198		Lumbrineris cruzensis	13
	Monticellina dorsobranchialis	160		Malmgreniella sp	13
*	Levinsenia gracilis	145		Chaetozone hedgpethi	12
	Prionospio sp A (SCAMIT1991)	143		Cirriformia sp SD 1	12
?	Glycera americana	112		Glycinde armigera	12
?	Spiophanes bombyx	108		Metasychis disparidentatus	12
	Terebellides californica	105	*	Aricidea (Acmira) catherinae	10
?	Lumbrineris sp B (Harris1984)	103		Drilonereis sp	10
	Cirratulidae	100		Eupolymnia heterobranchia	10
	Maldanidae	98	*	Nicolea gracilibranchis	10
	Streblosoma crassibranchia	95	?	Scalibregma inflatum	10
	Amphicteis scaphobranchiata	92		Aphelochaeta glandularia	8
	Amaeana occidentalis	82		Eumida longicornuta	8
	Aphelochaeta glandaria	82		Jasmineira sp A	8
	Cirratulus sp	82		Podarkeopsis glabra	8
	Apoprionospio pygmaea	78		Podarkeopsis sp A (Harris&Velarde1983)	8
	Oligochaeta	75		Poecilochaetus sp	8
	Ampharete labrops	73		Sabellaria gracilis	8
?	Protocirrineris sp	73	*	Boccardiella hamata	7
*	Dipolydora bidentata	60		Chone minuta	7
*	Dipolydora socialis	52		Diopatra ornata	7
	Nephtys cornuta	50		Frabicinuda limnicola	7
*	Sigambra tentaculata	50	?	Harmothoe imbricata	7
?	Streblosoma sp 1	50		Malmgreniella macgintiei	7
	Melinna oculata	42	?	Owenia fusiformis	7
	Monticellina sp	42		Phyllodoce longipes	7
	Diopatra tridentata	40		Polycirrus sp	7

* Non-indigenous
? Status unclear

Ranked Order of Abundance (0.1 m^2 area)
Infauna

POLYCHAETES

	Name	Count
	Sphaerosyllis californiensis	7
	Sthenelanella uniformis	7
?	Arcteobia cf anticostiensis	5
	Boccardia pugettensis	5
	Diopatra sp	5
	Euclymeninae sp A (SCAMIT1987)	5
	Goniada littorea	5
?	Goniada maculata	5
	Lumbrineris californiensis	5
	Marphysa sp	5
?	Pilargis sp 1	5
	Polydora sp	5
	Polynoidae	5
	Pseudopotamilla sp	5
	Sabellidae	5
*	Neanthes acuminata	4
	Capitellidae	3
	Caulleriella hamata	3
?	Chaetozone "setosa"	3
	Chaetozone sp	3
	Cirriformia sp	3
?	Cirriformia sp 1	3
	Demonax sp	3
	Gymnonereis crosslandi	3
?	Lanice conchilega	3
	Lumbrineris limicola	3
	Lysippe sp A (Williams1985)	3
?	Micropodarke dubia	3
	Microspio pigmentata	3
	Onuphidae	3
	Onuphis sp 1 (PtLoma1983)	3
	Polycirrus californicus	3
*	Polydora cornuta	3
	Sabellaria sp	3
?	Scoloplos "armiger"	3
	Ampharetidae	2
*	Ancistrosyllis groenlandica	2
	Anotomastus gordiodes	2
	Arcteobia sp	2
	Aricidea (Acmira) sp	2
*	Aricidea (Aricidea) wassi	2
	Caulleriella pacifica	2
	Chaetozone sp HYP3	2
	Chone albocincta	2
	Chone sp B (Harris1984)	2
	Cirrophorus furcatus	2
	Diopatra splendidissima	2
	Euchone hancocki	2
	Euchone sp	2
	Eulalia californiensis	2
	Eunice americana	2
	Euphrosine bicirrata	2
	Exogone sp	2
	Glycera sp	2
	Grubeulepis mexicana	2
	Halosydna johnsoni	2
	Harmothoe hirsuta	2
	Hesperonoe complanata	2
	Hesperonoe laevis	2
	Heteromastus sp	2
*	Hydroides pacificus	2
	Leitoscoloplos panamensis	2
	Lumbrineris erectus	2
	Malmgreniella sp A (SCAMIT 1997)	2
	Mooresamytha bioculata	2
	Myriochele striolata	2
	Myxicola infundibulum	2
?	Notomastus hemipodus	2
	Onuphis eremita parva	2
	Onuphis sp	2
	Ophiodromus pugettensis	2
	Parougia caeca	2
	Pherusa neopapillata	2
	Pholoides asperus	2
	Phyllodoce sp	2
?	Pilargis sp 2	2
	Polydora cirrosa	2
?	Polydora sp A	2
?	Polyophthalmus pictus	2
	Prionospio sp	2
?	Protocirrineris sp B	2
	Samytha californiensis	2
	Scyphoproctus oculatus	2
	Spiophanes fimbriata	2
?	Sternaspis fossor	2
	Streblosoma sp	2
	Syllis(Ehlersia) hyperioni	2
	Syllis(Typosyllis) farallonensis	2

* Non-indigenous
? Status unclear

Abundance (per 0.1 m^2)
Infauna

Habitat / Station	Depth (m)	January 2000	May 2000	August 2000	November 2000	Annual Mean	Annual Total
Deepwater Basin							
LA5	17	260	148	253	270	233	932
LA6	16	495	140	213	118	242	967
LA12	11	158	192	135	68	138	553
LB3	15	525	128	133	207	248	993
LB5	15	280	192	148	337	239	957
LB10	21	210	88	232	157	172	687
LB11	15	390	203	318	288	300	1200
Deepwater Channel							
LA4	16	317	225	85	332	240	958
LA9	16	207	53	127	58	111	445
LB7	24	413	145	233	345	284	1137
LB13	20	337	107	115	233	198	792
LB14	18	433	172	258	212	269	1075
Deepwater Open							
LA1	13	235	90	213	162	175	700
LA11	16	535	143	143	373	299	1195
LB1	12	250	167	283	202	225	902
LB9	25	517	233	433	203	347	1387
Deepwater Slip							
LA13	11	365	193	325	257	285	1140
LB4	15	1167	73	515	307	515	2062
LB6	17	590	132	138	285	286	1145
LB8	15	627	252	200	228	327	1307
LB12	16	77	112	2	170	90	360
Shallow Mitigation							
LA2A	4	617	538	1715	262	783	3132
LA2B	4	755	957	1812	353	969	3877
LA7A	4	1222	950	1510	477	1040	4158
LA7B	4	963	1040	1072	597	918	3672
LB2A	6	817	418	290	172	424	1697
LB2B	6	433	240	327	163	291	1163
Shallow Water Basin							
LA8	4	760	832	738	407	684	2737
LA10	6	1875	1110	948	773	1177	4707
Shallow Water Channel							
LA14	6	795	410	105	222	383	1532
Shallow Water Open							
LA3A	4	2448	85	133	147	703	2813
LA3B	4	1542	85	183	228	510	2038
Mean		644	308	417	269	410	1638
Total		20613	9853	13338	8612	13104	52417

Biomass
Infauna

Habitat / Station	Depth (m)	January 2000	May 2000	August 2000	November 2000	Annual Mean	Annual Total
Deepwater Basin							
LA5	17	1.92	0.83	1.87	3.83	2.11	8.45
LA6	16	2.02	0.50	1.33	1.63	1.37	5.48
LA12	11	1.42	2.63	1.17	1.47	1.67	6.68
LB3	15	3.58	1.50	1.67	2.48	2.31	9.23
LB5	15	2.12	2.67	1.80	6.42	3.25	13.00
LB10	21	2.10	1.53	3.47	1.55	2.16	8.65
LB11	15	4.85	2.35	6.50	1.85	3.89	15.55
Deepwater Channel							
LA4	16	8.62	9.37	7.80	8.23	8.50	34.02
LA9	16	2.92	0.90	2.02	0.43	1.57	6.27
LB7	24	3.05	1.88	4.98	5.90	3.95	15.82
LB13	20	1.97	58.57	2.90	2.15	16.40	65.58
LB14	18	4.72	2.85	6.78	2.43	4.20	16.78
Deepwater Open							
LA1	13	3.22	1.13	1.07	2.07	1.87	7.48
LA11	16	1.37	3.70	1.02	1.55	1.91	7.63
LB1	12	4.00	4.35	4.12	1.92	3.60	14.38
LB9	25	4.72	2.48	5.88	2.98	4.02	16.07
Deepwater Slip							
LA13	11	0.82	12.38	4.28	5.00	5.62	22.48
LB4	15	3.57	8.85	19.70	3.80	8.98	35.92
LB6	17	3.40	1.60	3.07	3.98	3.01	12.05
LB8	15	1.25	2.23	2.95	3.58	2.50	10.02
LB12	16	0.65	4.72	0.02	0.83	1.55	6.22
Shallow Mitigation							
LA2A	4	5.20	40.50	13.03	5.45	16.05	64.18
LA2B	4	1.93	6.83	25.63	3.50	9.48	37.90
LA7A	4	5.40	8.43	12.13	4.87	7.71	30.83
LA7B	4	4.68	7.40	9.17	7.38	7.16	28.63
LB2A	6	5.27	3.10	2.38	6.30	4.26	17.05
LB2B	6	3.13	6.53	2.17	7.32	4.79	19.15
Shallow Water Basin							
LA8	4	1.98	6.70	2.80	1.55	3.26	13.03
LA10	6	13.82	7.67	2.88	12.38	9.19	36.75
Shallow Water Channel							
LA14	6	11.13	0.17	0.10	1.22	3.15	12.62
Shallow Water Open							
LA3A	4	12.05	12.17	3.38	1.63	7.31	29.23
LA3B	4	4.05	1.53	1.65	2.38	2.40	9.62
Mean		4.09	7.13	4.99	3.69	4.97	19.90
Total		130.90	228.07	159.72	118.08	159.19	636.77

Number of Species
Infauna

Habitat / Station	Depth (m)	January 2000	May 2000	August 2000	November 2000	Annual Mean	Annual Total
Deepwater Basin							
LA5	17	33	21	30	39	31	65
LA6	16	38	30	29	26	31	69
LA12	11	21	17	16	21	19	34
LB3	15	40	22	22	27	28	62
LB5	15	39	27	26	49	35	77
LB10	21	36	20	39	28	31	65
LB11	15	41	30	40	36	37	69
Deepwater Channel							
LA4	16	53	43	25	43	41	98
LA9	16	34	17	20	9	20	56
LB7	24	44	24	37	38	36	68
LB13	20	46	31	28	40	36	87
LB14	18	39	41	35	27	36	74
Deepwater Open							
LA1	13	53	21	33	31	35	80
LA11	16	59	33	42	38	43	90
LB1	12	51	36	50	38	44	90
LB9	25	53	41	54	35	46	91
Deepwater Slip							
LA13	11	29	24	35	33	30	61
LB4	15	53	23	73	38	47	103
LB6	17	40	24	24	36	31	64
LB8	15	29	39	40	40	37	82
LB12	16	17	18	1	13	12	34
Shallow Mitigation							
LA2A	4	46	40	48	25	40	90
LA2B	4	35	51	45	30	40	86
LA7A	4	60	55	70	47	58	113
LA7B	4	51	45	64	49	52	97
LB2A	6	51	34	38	25	37	89
LB2B	6	48	38	35	29	38	85
Shallow Water Basin							
LA8	4	38	30	32	33	33	72
LA10	6	25	9	26	25	21	46
Shallow Water Channel							
LA14	6	17	5	11	20	13	31
Shallow Water Open							
LA3A	4	62	20	29	35	37	99
LA3B	4	50	26	37	32	36	85
Mean		42	29	35	32	35	75
Total unique species		235	215	237	209	224	361

Shannon-Wiener Diversity
Infauna

Habitat / Station	Depth (m)	January 2000	May 2000	August 2000	November 2000	Annual Mean	Annual Total
Deepwater Basin							
LA5	17	2.91	2.04	2.87	2.95	2.69	3.35
LA6	16	2.9	3.05	2.84	3.02	2.95	3.45
LA12	11	2.41	1.99	2.18	2.94	2.38	2.8
LB3	15	2.42	2.74	2.34	2.5	2.50	2.92
LB5	15	3.12	2.62	2.81	3.34	2.97	3.66
LB10	21	3.27	2.45	3.22	3	2.99	3.66
LB11	15	2.91	2.34	2.98	2.7	2.73	3.23
Deepwater Channel							
LA4	16	3.6	3.41	3.07	3.05	3.28	3.92
LA9	16	2.79	2.57	2.06	1.24	2.17	2.85
LB7	24	2.98	2.36	2.94	2.44	2.68	3.21
LB13	20	3.28	3.3	2.93	3.27	3.20	3.77
LB14	18	2.8	3.22	2.94	2.58	2.89	3.29
Deepwater Open							
LA1	13	3.56	2.74	2.9	3.06	3.07	3.75
LA11	16	2.92	2.77	3.52	2.2	2.85	3.21
LB1	12	3.25	3.1	3.43	3.26	3.26	3.81
LB9	25	3.31	3.27	3.38	3.16	3.28	3.79
Deepwater Slip							
LA13	11	2.21	2.44	2.82	2.44	2.48	2.97
LB4	15	2.67	3.03	3.73	2.93	3.09	3.42
LB6	17	2.39	2.68	2.74	2.86	2.67	3.04
LB8	15	2.09	2.77	3.14	2.94	2.74	3.19
LB12	16	2.62	1.84	0	1.17	1.41	2.1
Shallow Mitigation							
LA2A	4	2.79	2.4	1.71	1.99	2.22	2.39
LA2B	4	1.81	2.12	1.93	2.29	2.04	2.26
LA7A	4	2.89	2.42	3.05	3.21	2.89	3.2
LA7B	4	2.9	2.45	2.98	2.98	2.83	3.1
LB2A	6	2.23	1.78	2.48	2.38	2.22	2.51
LB2B	6	2.92	2.94	2.28	2.72	2.72	3.1
Shallow Water Basin							
LA8	4	2.51	1.53	2.02	2.49	2.14	2.37
LA10	6	1.13	0.41	0.95	1.92	1.10	1.22
Shallow Water Channel							
LA14	6	1.55	0.49	1.47	2.12	1.41	1.94
Shallow Water Open							
LA3A	4	1.78	2.61	3.1	3.12	2.65	2.26
LA3B	4	2.46	3.03	3.24	2.96	2.92	2.99

Margalef Diversity
Infauna

Habitat / Station	Depth (m)	January 2000	May 2000	August 2000	November 2000	Annual Mean	Annual Total
Deepwater Basin							
LA5	17	6.34	4.46	5.77	7.47	6.01	10.12
LA6	16	6.5	6.55	5.77	5.86	6.17	10.69
LA12	11	4.39	3.37	3.41	5.39	4.14	5.68
LB3	15	6.78	4.83	4.79	5.39	5.45	9.55
LB5	15	7.42	5.48	5.57	9.04	6.88	11.96
LB10	21	7.24	4.79	7.7	5.94	6.42	10.63
LB11	15	7.33	6.04	7.43	6.79	6.90	10.34
Deepwater Channel							
LA4	16	9.91	8.56	6.1	7.93	8.13	15.27
LA9	16	6.85	4.62	4.39	2.25	4.53	9.84
LB7	24	7.8	5.15	7.29	6.94	6.80	10.27
LB13	20	8.48	7.21	6.38	7.89	7.49	13.95
LB14	18	6.83	8.63	6.74	5.37	6.89	11.28
Deepwater Open							
LA1	13	10.51	5.01	6.6	6.56	7.17	13.08
LA11	16	10.05	7.18	9.2	6.84	8.32	13.54
LB1	12	9.98	7.6	9.54	7.72	8.71	14.14
LB9	25	9.06	8.09	9.53	7.08	8.44	13.39
Deepwater Slip							
LA13	11	5.2	4.84	6.45	6.35	5.71	9.19
LB4	15	7.94	5.81	12.56	7.1	8.35	14.32
LB6	17	6.64	5.26	5.2	6.81	5.98	9.64
LB8	15	4.72	7.57	8.15	7.93	7.09	12.15
LB12	16	4.18	4.04		2.59	3.60	6.14
Shallow Mitigation							
LA2A	4	7.61	6.75	6.78	4.75	6.47	11.81
LA2B	4	5.56	7.87	6.29	5.41	6.28	10.97
LA7A	4	8.94	8.51	10.13	8.13	8.93	14.32
LA7B	4	7.86	6.84	9.74	8.16	8.15	12.47
LB2A	6	8.07	5.97	7.17	5.18	6.60	12.71
LB2B	6	8.45	7.44	6.44	6.11	7.11	12.83
Shallow Water Basin							
LA8	4	6.04	4.67	5.09	5.82	5.41	9.59
LA10	6	3.42	1.23	3.94	3.91	3.13	5.66
Shallow Water Channel							
LA14	6	2.59	0.73	2.41	3.89	2.41	4.4
Shallow Water Open							
LA3A	4	8.36	4.83	6.39	7.59	6.79	13.19
LA3B	4	7.17	6.36	7.66	6.3	6.87	11.82

Dominance Index
Infauna

Habitat / Station	Depth (m)	January 2000	May 2000	August 2000	November 2000	Annual Mean	Annual Total
Deepwater Basin							
LA5	17	10	4	10	11	9	14
LA6	16	11	12	9	12	11	16
LA12	11	7	4	5	12	7	8
LB3	15	6	9	7	7	7	9
LB5	15	13	7	9	18	12	23
LB10	21	14	9	15	13	13	21
LB11	15	11	8	11	8	10	15
Deepwater Channel							
LA4	16	22	18	15	14	17	28
LA9	16	10	11	6	2	7	14
LB7	24	11	7	14	10	11	17
LB13	20	17	20	13	16	17	27
LB14	18	9	18	11	8	12	15
Deepwater Open							
LA1	13	22	10	10	13	14	26
LA11	16	13	13	22	6	14	19
LB1	12	19	16	19	14	17	26
LB9	25	15	16	18	14	16	25
Deepwater Slip							
LA13	11	5	7	10	7	7	9
LB4	15	10	14	21	11	14	20
LB6	17	5	10	9	11	9	12
LB8	15	4	13	16	12	11	16
LB12	16	9	3	1	2	4	5
Shallow Mitigation							
LA2A	4	8	6	3	4	5	6
LA2B	4	3	3	4	5	4	4
LA7A	4	8	7	10	13	10	12
LA7B	4	9	6	10	10	9	10
LB2A	6	4	2	9	7	6	7
LB2B	6	12	14	6	11	11	17
Shallow Water Basin							
LA8	4	7	2	4	6	5	6
LA10	6	2	1	1	4	2	2
Shallow Water Channel							
LA14	6	3	1	2	5	3	4
Shallow Water Open							
LA3A	4	3	9	15	13	10	6
LA3B	4	5	15	14	11	11	9

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Benthic Infauna Survey - Abundance (number per 0.06 m²)

	STATION																															
Species Name	**LA1**	**LA2A**	**LA2B**	**LA3A**	**LA3B**	**LA4**	**LA5**	**LA6**	**LA7A**	**LA7B**	**LA8**	**LA9**	**LA10**	**LA11**	**LA12**	**LA13**	**LA14**	**LB1**	**LB2A**	**LB2B**	**LB3**	**LB4**	**LB5**	**LB6**	**LB7**	**LB8**	**LB9**	**LB10**	**LB11**	**LB12**	**LB13**	**LB14**
	CRUSTACEANS																															
Acuminodeutopus heteruropus			8								4																					
Alienacanthomysis macropsis																			1													
Ampelisca brachycladus						1																			1		1					
Ampelisca brevisimulata																			1	2												
Ampelisca cristata																			1	1												
Ampelisca cristata microdentata																		1					1						2			
Amphideutopus oculatus		80	70	30	111	10			75	82	1		2					1	117	57	4	2	1						3			
Anoplodactylus erectus										2	2																					
Aoridae																															2	
Calanoida (copepod)						1																1										
Caprella californica				15						6	2				1																	
Caprella sp				1	1																											
Corophiidae		2	3	7	1				43	34	10									2	3		4	1	1			1			3	
Corophium sp																													1			
Cumella californica																														1		
Cumella sp																														1		
Deflexilodes similis/D. sp 1		5																	4													
Eochelidium sp A				6	5		20		39	21	10				22	27	21					6	4			7		7			1	
Euphilomedes carcharodonta		22	21	35	34	9	1		96	105	19				1	1		3	22	30		3	1								1	
Eusarsiella thominx				2							2																					
Foxiphalus golfensis		1	4																													
Foxiphalus obtusidens			1																													
Gnathia crenulatifrons	1			2		4		1	5	3	2					2		2		1		1	2		1						1	7
Grandidierella japonica				14	5					2	2					1	70															1
Hartmanodes hartmanae	1																					1										
Hemigrapsus oregonensis				1																												
Hemiproto sp A			1	6	4	1							4		1	1														1		
Heteroserolis carinata			1	2					1									1														
Hippomedon zetesimus		1							11	1	1																					
Leptochelia dubia		7	31	20	10				12																							
Listriella goleta	1					2	4							1		1					7			1			1					
Listriella melanica		5	1																													
Micropleustes nautilus				1																												
Mysidopsis intii																		1														
Neotrypaea californiensis										1											5			3				5			1	
Neotrypaea gigas						3														1												
Neotrypaea sp							1				1													2	4			2	1			
Paradexamine sp A				5					1																							
Paramicrodeutopus schmitti		1		4					1	19	28																				4	
Photis bifurcata			1																	1												
Photis brevipes		12		1					32	24																					3	
Photis californica		1	2						9										1													
Photis lacia			1																													
Pinnixa franciscana						2			2	2														1			1	1				
Pinnixa longipes									1																		2					
Pinnixa sp																							1									
Podocerus cristatus				6	3				1																							
Pyromaia tuberculata				1				1																	1							
Rudilemboides stenopropodus		2									5																					
Scleroplax granulata					1		1			6	1				2						3					1		10				1
Sinocorophium heteroceratum		52		4	5				2	11										4			5	1				1			1	1
Westwoodilla caecula																											1					
Xenoleberis californica																1			2													
Xeuxo normani				5					3								1					3										
	ECHINODERMS																															
Amphiodia sp						1						1									1						1					
Amphiodia urtica	2			1						1								1			1						2		1			
Amphipholis sp											2														1					1		
Amphipholis squamata										1																						
Amphiuridae		1																					1							1		
Ophiuroidea																		1														
	MINOR PHYLA																															
Amathia sp (colonial)														1																		
Apionsoma misakiana		3		2		3																									2	
Bugula neritina (colonial)												1																				
Carinoma mutabilis				1					1																							
Celleporina sp (colonial)											1								1													2
Ceriantharia													4																		3	

January 2000

Benthic Infauna Survey - Abundance (number per 0.06 m²)

	STATION																															
Species Name	**LA1**	**LA2A**	**LA2B**	**LA3A**	**LA3B**	**LA4**	**LA5**	**LA6**	**LA7A**	**LA7B**	**LA8**	**LA9**	**LA10**	**LA11**	**LA12**	**LA13**	**LA14**	**LB1**	**LB2A**	**LB2B**	**LB3**	**LB4**	**LB5**	**LB6**	**LB7**	**LB8**	**LB9**	**LB10**	**LB11**	**LB12**	**LB13**	**LB14**
Crisia sp (colonial)																																2
Cryptonemertes actinophila				1	1					1																						
Edwardsia sp G (MEC)	1																															
Filicrisia sp (colonial)																																2
Gobiidae										1																						
Limnactiniidae sp A (SCAMIT)																			1													
Lineidae	1	1		5	4	1	1	3	6	4	7	1	4	6		1			1	2			1	2	2	3	3				1	1
Molgula sp									1										1													
Nemertea	1							1																		1	1		1			
Pachycerianthus fimbriatus													2																			
Paranemertes californica		1		3	4		2											1	1	4												
Phoronida	2		1		1	6					16	1		1					1			1			3				1		2	
Thysanocardia nigra				1					1																							
Tubulanus cingulatus																										1						
Tubulanus nothus														1							1				1							
Tubulanus polymorphus/pellucidus	1	2	1	1		5	1	12	2			5		6	1	3		1		1		11	2	2	1	3	8		1		1	5
Zaolutus actius		1																														
	MOLLUSCS																															
Acteocina culcitella											1								4													
Bivalvia					1				1	1	4	1					1			1							1			3		
Compsomyax subdiaphana												1												1			2					
Cooperella subdiaphana										1										4												
Crepidula sp								1																								
Cryptomya californica																								1								
Cylichna diegensis														1													1					
Ensis myrae																			2													
Kellia laperousii	1																															
Laevicardium substriatum				1					1																							
Lyonsia californica				1	1	1			3	1				3				1		2												
Macoma nasuta									1	1									4					1								
Macoma yoldiformis	1	2			1				3					1				2	3	3					1	1	5		2			
Mactra californica											2							1		2												
Modiolus sp									1																							
Musculista senhousei				1	1				1	2	4		6																			
Nassarius perpinguis												1																				
Nuculana taphria					2					1									2	2				1			3					
Odostomia sp										2		2								1						1	1					
Olivella baetica				1	1															1							2					
Parvilucina tenuisculpta		1												1									1									
Periploma discus									1													1		1			1					
Philine auriformis																													1	2		
Philine sp A (SCAMIT)														1							1				1							1
Protothaca staminea	1					1		1	1										1													1
Psephidia brunnea														2																		
Pulsellum aberrans	1													1													4					
Rictaxis punctocaelatus	4											1		1													3					
Rochefortia coani																			1													
Rochefortia compressa																		1														
Rochefortia grippi																						1										
Rochefortia tumida					1	1			2					1											1							
Scaphopoda														1																		
Solen sicarius	1					1														4												
Tagelus sp				4																												
Tagelus subteres		3	1	9	12				3	3									3												1	1
Tellina carpenteri	2													1														1				
Tellina modesta	3	24	1	4	4									1				1	1													
Theora lubrica	11	2		21	8	1		1	3	34	64	36	10	22	3		13	3		1	6	3	5		11		3	5	8	10	1	1
Thracia curta									1					2						1												
Thyasira flexuosa							1														1		1	2				1	3			3
Trachycardium quadragenarium																															1	
Turbonilla sp	1											1									1							1			1	
Venerupis phillipinarium																	1															
Vitrinella oldroydi	1										1													7	1			4				
	POLYCHAETES																															
Amaeana occidentalis	1					1												1	2				2									
Ampharete labrops			2			3								12													1					
Amphicteis scaphobranchiata														6					8	1	1	2			1		4					
Ancistrosyllis groenlandica																						1										
Anotomastus gordiodes									1																							

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Benthic Infauna Survey - Abundance (number per 0.06 m²)

	STATION																														
Species Name	**LA1**	**LA2A**	**LA2B**	**LA3A**	**LA3B**	**LA4**	**LA5**	**LA6**	**LA7A**	**LA7B**	**LA8**	**LA9**	**LA10**	**LA11**	**LA12**	**LA13**	**LA14**	**LB1**	**LB2A**	**LB2B**	**LB3**	**LB4**	**LB5**	**LB6**	**LB7**	**LB8**	**LB9**	**LB10**	**LB11**	**LB12**	**LB13**	**LB14**
Aphelochaeta glandaria	12						1	4				3	2	7				3						2	8	1	5		2			
Aphelochaeta monilaris	1				1	1	6	3	2	4		4		1	10	1		1			6	3	6	11	21	13	5		3	4	1	4
Aphelochaeta petersenae		1					3	8								4		1			2	13	1		1			14	8	8	35	53
Aphelochaeta sp	1						1	4				1			2			1				63	4				1	1		2	1	38
Apoprionospio pygmaea		5	1	3	7	1		1	6	1									2	1									2		1	
Arcteobia cf *anticostiensis*						2																										
Aricidea (Acmira) catherinae														1													3					
Aricidea (Acmira) horikoshii														1					1			1					4					
Armandia brevis			1	1													1														1	
Boccardia pugettensis							2																					1				
Capitella "capitata"		2	2										4				58															
Capitellidae						1																										
Chaetozone "setosa"																			1			1										
Chaetozone corona	1	1		1		13	8	1						2		2		4	9	8	43	5	16	5	5	19			28		6	29
Chone minuta																															3	
Chone mollis						1														1						1					2	
Cirratulidae			1	1				6								1			2			6	2		1						1	2
Cirratulus sp								18														21								1	6	
Cirriformia sp								1																								
Cirriformia sp SD 1			2																			1										2
Cossura candida															2			1			125	15	4	79	22	8	2	6	22	1	2	4
Cossura sp A	17	2	2	146	197	2	10	17	14	4	32	17	314	106	8	92		15	1	6	6	30	12	85	26	104	47	7	13	1	20	12
Diopatra splendidissima									1																							
Diopatra tridentata								1										1			1	1	2					1				
Dipolydora bidentata																		2											6			
Dipolydora socialis				1	1				1									2							1							
Dorvillea (Schistomeringos) annulata						1		2	1	2	2	1	4			1	253					14								2	1	
Euchone hancocki			1																													
Euchone limnicola			5	22	56	9	19	69	14	23	8	6	24	38	23	23		1		7	20	261		11		3		5	1	2	2	5
Euchone sp						1																										
Euclymeninae sp A (SCAMIT1987)		1			1													1														
Eumida longicornuta											1											1					1					
Eupolymnia heterobranchia						1																										
Exogone lourei			2	7		3		14	4	1			44	1		1						20							1		6	
Exogone sp																						1										
Frabicinuda limnicola																															4	
Glycera americana	1					1		1						1				1			1			1	2	1		1	1			
Glycera convoluta			1																													
Glycera nana														1								1		1								
Glycinde armigera																			1	1												
Goniada maculata							1												1												
Gymnonereis crosslandi	1																															
Hydroides pacificus																1															
Jasmineira sp A																															5	
Laonice cirrata	4	1			2							4		3				1		2		3		1	1	1	2		1		1	1
Leitoscoloplos panamensis		1																															
Leitoscoloplos pugettensis	2	5		4	12		3		2		4	2	2	6	1	5	3	1	5	4	2	18	14	1	3	2	16	3	2			4
Levinsenia gracilis				7	5		3		8	8			2	5		3						10			1	1	2					
Lumbrineris californiensis																							2						1			
Lumbrineris cruzensis		3				3																										
Lumbrineris erectus													2																			
Lumbrineris japonica	1	1																			1											1
Lumbrineris latreilli						2																3	1								4	
Lumbrineris limicola																			1													
Lumbrineris sp	4	2			3	12	2	1	2	2	1		4	1	1	2		7	4	2	3	8	2	6	1	4	2	3	2		3	3
Lumbrineris sp A	5				1	1	1							3				1	7	9	1			2	3	2	3	2	3			
Lumbrineris sp B (Harris1984)			1	2	3	3	1			2	5		4	3	1	1			1	1	1		2	1				1				
Lysippe sp A (Williams1985)														1																		
Maldanidae	1					1				1								1	2	1		4		1		4	2		3			2
Malmgreniella sp																		1					1				2					
Marphysa disjuncta						1				1																		1				2
Marphysa sp																													1	1		
Marphysa sp A (Harris&Velarde1983)	1	2												1						1	1							1				
Mediomastus sp	5	49	21	76	98	12	7	19	87	59	20	8	138	11	2	6		15	37	12	6	81	18	19	13	47	24	9	12	2	23	11
Megalomma pigmentum								1	6																							
Melinna oculata														1					1													
Metasychis disparidentatus				1																												
Micropodarke dubia				1																		1										
Microspio pigmentata																		1														

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Species Name	STATION																														
	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
Monticellina dorsobranchialis	1	1				1		1		2				3		1		1			1	5	4	7	7	6	20			1	8	1
Monticellina siblina	8	29	1		19	8	28	21	11	4		1	46	8	3	20		33	120	50	20	7	26	76	55	124		7	62		10	37
Myxicola infundibulum																															1	
Neanthes acuminata																	2															
Neanthes arenaceodentata																	1															
Nephtys caecoides		2		1	1					1																						
Nephtys cornuta	1			2	4		3		1				4	1	1	1					1	2		1	1		1	2				
Nephtys ferruginea						1								1								1						1				
Nereis procera	6				1	6		8	1			1		3				4	8	1	1	8		2	2	10	26	1	4		4	7
Notomastus hemipodus											1																					
Notomastus tenuis		1		1	1	2			1		2			1				2		1			1		1		25	1	1			
Oligochaeta													2				43															
Onuphidae														2																		
Onuphis sp				1																												
Paramage scutata								3				1		6		1					1	7					7					3
Paraprionospio pinnata	3			1	2	3	5	5	5	2		4		1	3	6		2	3	4	7	11	6	3	4			8	8	1	6	2
Pectinaria californiensis												1							1													
Petaloclymene pacifica	2	1					1					1						8	2			1					24		4			1
Pherusa neopapillata																											1					
Pholoe glabra	1											1		1					2								1					1
Phyllodoce hartmanae						3	1	2													1											
Phyllodoce longipes				1													1			1												
Phyllodoce sp			1																													
Pista alata	1							3			1			3	1			1						1			10	2	1			1
Pista disjuncta	1				1														3								1					
Platynereis bicanaliculata									1																							
Podarkeopsis glabra				1																			1		1							
Podarkeopsis sp A (Harris&Velarde1983)	1											1		1																		
Poecilochaetus sp																											1					
Poecilochaetus sp A (Martin1977)	2																				1				2		2					
Polycirrus californicus										1																	1					
Polycirrus sp														2																	2	
Polydora cornuta									1								1															
Polynoidae																												1				
Praxillella pacifica						1													1								1		2			
Prionospio heterobranchia		1		21	12		1	3	29	3	18		20				2					4										
Prionospio lighti		16		17	36				6	22	2	2						2		4	1		3	2	6	1			2		2	
Prionospio sp									1																							
Prionospio sp A (SCAMIT1991)	2					7	1	9				4		4						1	1	8	2	1	5	3	1	5	4		2	1
Protocirrineris sp								34																								
Protocirrineris sp B																							1									
Pseudopolydora paucibranchiata		10	78	919	235				149	55	165	2	1596		5	1	4	1				2				1			1			
Sabellaria gracilis																															5	
Sabellides manriquei	1																											1				
Samytha californiensis														1																		
Scalibregma inflatum						3													1				1									
Scoloplos "armiger"																		2														
Scyphoproctus oculatus																						1										
Sigambra tentaculata	1			1			2					1		1								2		1	4			1				
Spiochaetopterus costarum					1															1	1		1		1	1						
Spiophanes berkeleyorum	2					1	4	1		1			2	1		7		1		1	22		1		15		1		5			2
Spiophanes bombyx		1	9	1		2		5										1	6	1												
Spiophanes missionensis	2		2		1			1	10	3	2		2	2				3	3	7	2			1	1	1			1		3	
Sthenelais berkeleyi																											2					
Sthenelanella uniformis	1					2																										
Streblosoma crassibranchia						17												1				2	2	2				1				
Streblosoma sp																						1										
Streblosoma sp 1																						8										
Streblosoma sp B (SCAMIT1985)	6			2	1	3	10	9	1	2		5		12	1	1					1	6		3			3		2			1
Syllis(Typosyllis) farallonensis																															1	
Syllis(Typosyllis) nipponica				2						1							1					1										
Tenonia priops	1		1		1								2					1		1							1					
Terebellides californica	2											1						2	1	2				1	2		8					1
Total Abundance	141	370	283	1469	925	190	156	297	733	578	456	124	2250	321	95	219	477	150	413	260	315	700	168	354	248	376	310	126	234	46	202	260
Number of Taxa	56	47	36	65	52	57	34	40	62	53	40	35	27	61	22	31	18	54	53	51	42	58	42	43	46	31	59	39	44	20	50	42

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Species Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
	STATION																															
	CRUSTACEANS																															
Ampelisca brevisimulata																		1										1				
Ampelisca cristata																		5														
Ampelisca cristata microdentata																		2						1		1				1		
Amphideutopus oculatus		53	193	6	5	16				1								3	137	38	1	1			2	6				1		1
Anoplodactylus erectus											2																					
Balanus pacificus																															2	
Betaeus longidactylus											2																					
Betaeus sp													4																			
Caprella californica										1																						
Caprella sp A										3																						
Corophiidae															1																	
Crangon sp			1																													
Deflexilodes similis/D. sp 1		6	7																													
Eochelidium sp A			1	1			1	1	4	14	4				2	2						2	1			3						1
Euphilomedes carcharodonta		43	49			4		1	31	151	17							1	53	25		1	2				9					3
Foxiphalus golfensis		6	16																													
Foxiphalus obtusidens			1																													
Gnathia crenulatifrons		1	2			1			8	1								1	1		2			2								1
Grandidierella japonica																	4															
Grapsidae											1																					
Hartmanodes hartmanae	1			1																								1				
Hemiproto sp A				1	1				8	5	2	1			16																	
Heptacarpus sp									3																							
Heteroserolis carinata		1																														
Hippomedon zetesimus			1						1																							
Leptochelia dubia		1	7						38	2																						
Leuroleberis sharpei																									1							
Listriella eriopisa																										1						
Listriella goleta	1					1	1							1		2		1			6		1			3	2		1		1	
Listriella melanica			1															1														
Megalopa/Zoea					2							1									1	1										
Melita sp			1																													
Monocorophium acherusicum									27	43	4																					
Mysida																		1														
Mysidella sp			1																													
Mysidopsis intii								1																								
Neomysis kadiakensis		1	1																													
Neotrypaea californiensis					1		6			1	1	1	4	2		3					1		1	2	1			1	2		5	1
Neotrypaea gigas											2																					
Neotrypaea sp																		1					1								1	
Nerocila californica						6																										
Oxyurostylis pacifica			1																													
Paracerceis sp											1																					
Paradexamine sp A									1																							1
Paramicrodeutopus schmitti			1						7	7	5																					1
Photis bifurcata			9																													
Photis brevipes		6	2						39	28	2								3													
Photis lacia			2																													
Pinnixa franciscana							1			5								4			3		4			2	1	6	2			1
Pinnixa hiatus		2																														
Pinnixa longipes																				1												
Pinnixa sp	1					1										1		5	2											1		
Pinnotheridae	6	2				2	23	1		1		1	2	5	1	2		3			1	2	15	2	13	3	12	4	3		7	1
Podocerus cristatus																																1
Pyromaia tuberculata		10	4	2	1	1			12	11		1		1					2			1				1		1			1	
Rudilemboides stenopropodus		2						1																								
Scleroplax granulata	2	4		10	4	5	35	1	1	10	20	1	24	1	34	22		3		2	11	2	9	6		13	6	19	3		7	3
Sinocorophium heteroceratum		7							3	8	9							27	1	2	1		17	3	1	1			1			
Westwoodilla caecula																		1														1
Xeuxo normani									4																							1
	ECHINODERMS																															
Amphiodia occidentalis									1																							
Amphiodia sp																				3							4					
Amphiodia urtica	2																			2												
Amphipholis sp									2		1																					
Amphipholis squamata									1	9																						
Amphiuridae					1																											

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Species Name	STATION																															
Species Name	**LA1**	**LA2A**	**LA2B**	**LA3A**	**LA3B**	**LA4**	**LA5**	**LA6**	**LA7A**	**LA7B**	**LA8**	**LA9**	**LA10**	**LA11**	**LA12**	**LA13**	**LA14**	**LB1**	**LB2A**	**LB2B**	**LB3**	**LB4**	**LB5**	**LB6**	**LB7**	**LB8**	**LB9**	**LB10**	**LB11**	**LB12**	**LB13**	**LB14**
Ophiothrix spiculata														1																		
Ophiuroidea			1																													
	MINOR PHYLA																															
Amathia sp (colonial)						1								1		1																
Bugula sp (colonial)									1																							
Celleporina sp (colonial)											1											1									1	1
Ceriantharia																						1	1								2	1
Crisia sp (colonial)														1		1																
Ectoprocta (colonial)									1	1																						
Edwardsia sp G (MEC)	1																									1	1					
Filicrisia sp (colonial)														1																		
Glottidia albida						1																										
Gobiidae									1																							
Lineidae							1		3	1									1		1	1					1					
Listriolobus pelodes				1																											1	
Molgula sp			2						1										1													
Nemertea										1																						
Notoplana sp									2																							
Paranemertes californica		1	1							2																						
Phoronida	7	2	3							1	3							4		3				1	5	5	5		1			
Scolanthus sp A (SCAMIT)	3																										3					
Scrupocellaria sp (colonial)									1		1																					
Styela montereyensis																2																
Thysanocardia nigra			1							1																						
Tubulanus cingulatus					1					1	1																	1				1
Tubulanus polymorphus/pellucidus						1	1	2	1			1		1					1				1			1	1	1	1		2	1
	MOLLUSCS																															
Acteocina culcitella																				1						1						
Acteocina inculta									3											3												1
Adontorhina cyclia																																1
Bivalvia									2	1										1						1		2	1		1	1
Compsomyax subdiaphana	2				1																	1								1		1
Cooperella subdiaphana				1		1														1			1			2	1					
Crepidula sp						1																										
Cryptomya californica																					1					1						
Cylichna diegensis																								1			1					
Gadila aberrans SCAMIT1996	3											2		2													13					
Iselica fenestrata												1																				
Kellia laperousii							1																									
Laevicardium substriatum											1																					
Leptopecten latiauratus						3				2																						
Lyonsia californica		1	4						2	3	2					1																
Macoma nasuta										1									1	3												
Macoma yoldiformis			1						2										3	5			1				4					
Mactra nasuta												1																				
Musculista senhousei									1	1	1		2																			
Nassarius perpinguis																			1													
Nuculana taphria																			5	3				1		3	2					
Olivella baetica			9															2	1	1							1					
Ophiodermella inermis																				1												
Orobitella sp																								1								
Parvilucina tenuisculpta					1									1		1				1							1					
Periploma discus		1		2																			2				1	1				
Philine auriformis															1									1	1	1	3			1		1
Philine sp					1																											
Protothaca staminea																															2	
Pulsellum aberrans																				1						5						
Rictaxis punctocaelatus	1								1			2		9				2					1	2	3		5					
Rochefortia coani																			1	6												
Rochefortia sp																		1														
Rochefortia tumida		1	2											1												1					1	
Saxicavella nybakkeni				5																												
Solen sicarius										1										3												
Tagelus subteres		9	1			3			1		1							1													1	
Tellina carpenteri																											1		1			
Tellina modesta		11	7																1													
Theora lubrica	10	1	3	8	7	4		3	8	61	127	10	10	29	6	37					5	1	29	22	7	57			51	33	2	24
Thracia curta		1				1																										

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Species Name	STATION																														
	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
Thyasira flexuosa																1							2		1	2	1	1	1	1		
Trachycardium quadragenarium						1													1													
Turbonilla sp	1																		1	3										1		
Vitrinella oldroydi							1																			2					2	
Volvulella panamica																									1		1					
	POLYCHAETES																															
Amaeana occidentalis														1				3	2	6												
Ampharete labrops		1	1		2	1								1				1	1							2						
Amphicteis scaphobranchiata						3								1						1						1			1			
Aphelochaeta monilaris						2																	1		1							
Aphelochaeta petersenae			1		1	1	1	3								2					1	2	4					4	1	10	3	5
Aphelochaeta sp								4						1															1			1
Apoprionospio pygmaea			4															1														
Arcteobia cf anticostiensis						1																										
Aricidea (Acmira) catherinae								1																								
Armandia brevis			1						2																							
Boccardia basilaria		2													1											1			1			
Capitella "capitata"			1							1							218															
Caulleriella pacifica								1																								
Chaetozone corona		3			1	3	2		3	2			2			1		1	4	1	12		9	7					23	9	1	6
Chaetozone hedgpethi								3																								
Chaetozone sp																							1									
Chone mollis						1																									1	
Cirratulidae								10																							1	
Cirratulus sp								1																								
Cirriformia sp			1																													
Cirriformia sp SD 1																															1	
Cossura candida															1						3			9								
Cossura sp A		1						6	1	2			2	4		2			1	1				1	1		2			1		3
Diopatra sp					1									1												1						
Diopatra tridentata																							1					1			1	
Dipolydora bidentata									1																							
Dipolydora socialis	1								1									1							1				2			
Dorvillea (Schistomeringos) annulata																	14															1
Drilonereis sp																													1			
Euchone limnicola				1		9	5	10	23	37	5	2			3	2					5	4	1		1	4			1	1	1	4
Eumida longicornuta																												1				
Exogone lourei			1					3	6																						1	4
Glycera americana				1	1	2								1							2	2	1			1	1	1				2
Glycera convoluta									1											2												
Glycera nana																											1					
Glycinde armigera																			1													
Goniada littorea									1																							
Goniada maculata			1																													
Grubeulepis mexicana						1																										
Gymnonereis crosslandi							1																									
Harmothoe imbricata										2																						
Hesperonoe laevis				1																												
Lanice conchilega														1																		
Laonice cirrata					1									3									1				2	1				
Leitoscoloplos pugettensis									3		1					8		1	1	1												
Lumbrineris cruzensis																						1										
Lumbrineris japonica		3			1																									1		
Lumbrineris sp	1	4	4		3	8	1	1	2	4						3		1	1	1	1	5		2		3	1	1	1		1	2
Lumbrineris sp A		1												1								1	1				3					
Lumbrineris sp B (Harris1984)		1	4	1						1	3			1				3	1	2	1			1		1					1	
Lysippe sp A (Williams1985)																															1	
Maldanidae			1		1	2													2	1									1			
Malmgreniella macgintiei												1																				
Malmgreniella sp												1															1					1
Marphysa disjuncta		3		1											1														1			2
Marphysa sp					1																											
Marphysa sp A (Harris&Velarde1983)																														1		1
Mediomastus sp		1	21					11	6	1								1														
Megalomma pigmentum									4																							1
Melinna oculata						6																					2					
Metasychis disparidentatus		1													1											1						
Monticellina siblina		1	1			1		4		1			2		1	4		3	10	4	2	1		1	1	3			2		1	2

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	STATION																															
Species Name	**LA1**	**LA2A**	**LA2B**	**LA3A**	**LA3B**	**LA4**	**LA5**	**LA6**	**LA7A**	**LA7B**	**LA8**	**LA9**	**LA10**	**LA11**	**LA12**	**LA13**	**LA14**	**LB1**	**LB2A**	**LB2B**	**LB3**	**LB4**	**LB5**	**LB6**	**LB7**	**LB8**	**LB9**	**LB10**	**LB11**	**LB12**	**LB13**	**LB14**
Monticellina sp																														1		
Mooresamytha bioculata																										1						
Nephtys caecoides		4	1							1									1													
Nephtys cornuta								1																								
Nereis procera						5	1	1	4	1									5	3		1			3	1	1		1		1	1
Notomastus tenuis		2				2	1		1											1	1				1	1	23	1		1	1	
Onuphis sp 1 (PtLoma1983)																			1													
Owenia fusiformis									1											1												
Paramage scutata	1			2	5	3	1					2		2	3	1							1	4			4					7
Paraprionospio pinnata	1	1		2		6	1	2	2					1	4			1	1	4		4	3	4		2		1	5	1	5	
Pectinaria californiensis		1						1			2									1			1	1			1					
Petaloclymene pacifica	1									7								5		1					1		4		1			2
Pholoe glabra						1																									1	
Phyllodoce hartmanae								1																								
Phyllodoce longipes																						1										
Pilargis sp 1					1																						2					
Pista alata				3	2	2		1						3	3	2		1							1	7	5	2	2		1	
Pista disjuncta				1										2													2					
Platynereis bicanaliculata						1																										
Poecilochaetus sp			1				1					1																	1			
Praxillella pacifica						1														1							1			1		
Prionospio heterobranchia			1					1	4	2	1						2															
Prionospio lighti									1									1														
Prionospio sp A (SCAMIT1991)																															1	
Protocirrineris sp								4																								
Pseudopolydora paucibranchiata		119	189			1		1	267	173	276		614	1	35	8	8	2				1										
Sabellaria sp																															1	
Sabellidae									2																							
Sabellides manriquei												1																				
Sigambra tentaculata																						2										1
Sphaerosyllis californiensis								1																								2
Spiochaetopterus costarum		1					1											1	1					1	1	1						
Spiophanes berkeleyorum							2									6		1	1		11			1	32	2	2		3			5
Spiophanes bombyx			2						1																							
Spiophanes missionensis			1					1	10	5										1	3				5				1			
Sthenelais berkeleyi						1								1						1				1			2					
Streblosoma crassibranchia						10																							1			
Streblosoma sp B (SCAMIT1985)	5				3	7			1	4				1	1	1		2				4	1			1		1	3			
Tenonia priops	1		1							1											1			1								
Terebellides californica	2				1							1		2						1					2							
Total Abundance	54	323	574	51	51	135	89	84	570	624	499	32	666	86	115	116	246	100	251	144	77	44	115	79	87	151	140	53	122	67	64	103
Number of Taxa	22	42	52	20	27	45	22	32	58	49	30	19	10	34	18	25	5	39	35	42	24	25	30	26	24	42	43	22	33	18	36	43

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Species Name	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
																CRUSTACEANS																
Acuminodeutopus heteruropus																			1													
Alienacanthomysis macropsis				2																											1	
Ampelisca brevisimulata																		3			1					1	1					
Ampelisca cristata	1																	19		2												
Ampelisca cristata microdentata																									1			1	5			
Amphideutopus oculatus	1	78	128	10	8	2	2	1	16	9	1							20	80	96		1	1				2					
Amphilochus sp									5	1																						
Ampithoe sp									1																							
Anoplodactylus erectus										1	2																					
Balanus trigonus																						1										
Betaeus longidactylus																					1											
Calanoida (copepod)																4																
Caprella californica									73	5				3																		
Caprella mendax									4																							
Caprella sp			2																													
Caprella sp A							1		1	5												1										
Crangon sp																1																
Eochelidium sp A				1	1		14	1	26	19	6				5	8	2					13						2				1
Euphilomedes carcharodonta		77	68	2			7		74	68	38		1	1	1	5			8	11		3	1				8					13
Foxiphalus golfensis		2	45						1		1																					
Foxiphalus obtusidens		3	3																													
Gnathia crenulatifrons		3	8	4	1		2		4							2		5							1		4				1	
Grandidierella japonica													12			1	2															
Hemigrapsus sp																						1										
Hemiproto sp A									9	5			1			1																
Heteroserolis carinata		2							1																							
Laticorophium baconi																			1													
Leptochelia dubia		7	6						65	2																						
Leuroleberis sharpei																			1													
Liljebergia geminata									1													1										
Listriella diffusa						1																										
Listriella goleta				1	2	1		1						2		3		1							1		1		1			
Listriella melanica									2	1						2																
Mayerella banksia		2						1					2																			
Megalopa/Zoea																2																
Monocorophium acherusicum		7	7						37	10			3																			
Mysida																1																
Mysidopsis intii							1		1	1								1		1												
Neotrypaea californiensis																					1			5	12			7	1			
Neotrypaea sp				2	3	5	2			2	4					3							1								2	2
Paradexamine sp A										4																						
Paramicrodeutopus schmitti			32						90	109	22	1		2				1		1												
Parasterope sp									1																							
Photis bifurcata																			2													
Photis brevipes		11	28						10	5									1				1									
Photis lacia																			2													
Photis parvidons																					1											
Pinnixa franciscana														1				4					1	1	5		4				1	
Pinnixa longipes																			1								1					
Pinnixa sp					1	1																						2	1			1
Pinnotheridae																1					1							1			1	
Podocerus cristatus									7	2	4																					
Postasterope barnesi																			3													
Pyromaia tuberculata			1	1		1			1					1				1				11			1	1	1					
Rudilemboides stenopropodus																				2												
Scleroplax granulata				4		3	5	6	2	6	7		1		1	6		2			6				3		1	1	1			2
Sinocorophium heteroceratum	1	45	53						37	26	59	2		4																		
Sinocorophium sp																		2	1				4	10	2				8		1	2
Upogebia pugettensis													1																			
Upogebia sp										1																						
Westwoodilla caecula																											4					
Xeuxo normani			6						1		2					1						20										
																ECHINODERMS																
Amphiodia psara										1																						
Amphiodia sp																											3					
Amphiodia urtica	2								1	2															2		4		1			
Amphioplus sp									5		2																					
Amphipholis squamata									3	2	3					1						3										
Amphiura arcystata				1																												
Amphiuridae	1											2															1					
Ophiuroidea																		1														
																MINOR PHYLA																
Amphiporus sp		1																														
Athenaria																			1	2												

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Species Name	STATION																														
	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
Bryozoa (colonial)						1	1										1															1
Bugula sp (colonial)																						1										
Carinoma mutabilis							1													1						1						
Celleporina sp (colonial)										1									1			1										1
Ceriantharia																						1									1	
Crisia sp (colonial)						1								1																		
Edwardsia sp G (MEC)	3													2													2					
Enteropneusta																											1					
Filicrisia sp (colonial)														1																		
Gobiidae																1			1													
Leptoplanidae sp A (MEC)										1																						
Lineidae	3	3			1				2				1	1						1							1					
Lineus bilineatus																					1											
Listriolobus pelodes																													1			
Molgula sp										1																						
Nemertea		1													1					1											1	
Nephasoma sp																															1	
Paranemertes californica		1	1				1							1		1						1										
Phoronida				2	1			1						2					1	1	2				2	1	1	2	1		3	
Porichthys myriaster																						1										
Porifera (colonial)																						1										
Rhizocaulus verticillatus																				1												
Scolanthus sp A (SCAMIT)																		1									2					
Styela truncata																						1										
Stylatula elongata																			1													
Stylatula sp A (MEC)	1																															
Thysanocardia nigra																			2													
Tubulanus cingulatus																							1			1	1	2	1			
Tubulanus nothus										1				1																	1	
Tubulanus polymorphus/pellucidus		1		1				2	1							1	1	2				3	1	2	2	2	5		2		1	1
Zygeupolia rubens									11	2	1																		1			
	MOLLUSCS																															
Acteocina culcitella										4	1	1		1						1												
Bivalvia	4	4	1		4	2			2	3	1			1				2		1			1				1		5			
Chione californiensis			2							1										1		1										1
Compsomyax subdiaphana												1									1										1	1
Cooperella subdiaphana		2	2						1	1										1												
Cryptomya californica																									3							
Cylichna diegensis			1															1									2					
Gadila aberrans SCAMIT1996	13											2						1					11	1		3		1				
Kellia laperousii																									6							
Kurtziella plumbea									1																							
Kurtzina beta																										1						
Laevicardium substriatum									1	3	2																					
Lasaea subviridis																						1										
Lyonsia californica		8	10						4	5										1												
Macoma nasuta										2																						
Macoma sp			1						3	1									1	1												
Macoma yoldiformis		9	7						2											2									1			
Mactrotoma californica		11	1						2	6	5								1													
Modiolus sp			1						1																							
Musculista senhousei									2				1																			
Mytilus galloprovincialis																						1										
Nassarius perpinguis																											1					
Nuculana taphria	2	1	3							1				1						1							3					
Odostomia sp																		1														
Olivella baetica		4	3							2								1	10	5							7					
Parvilucina tenuisculpta			1		1					1		1				1										1						3
Periploma discus	1																					1					1		1			
Philine auriformis					1																	1			1	1		2				
Philine sp							1																									
Philine sp A (SCAMIT)	1				1						1	5	2																			
Pulsellum aberrans																											52					
Rictaxis punctocaelatus	1		1		1							5		3				1									11					
Rochefortia compressa				2																												1
Rochefortia grippi									2	17												1										
Rochefortia sp B (SCAMIT)																			7													
Rochefortia tumida			3	1	1	1			1			1						2		1				1	2							
Solen sicarius										1								1														
Tagelus subteres		22	7							20	2																		2			
Tellina modesta		24	19															2	2	12							1					
Theora lubrica	15	4	2	3	1		9	6	8	16	24	38	14	1	5	9	3	5	2		2	13	16	6	8	5		12	1			17
Thracia curta		1																														
Thracia sp																						1										
Thyasira flexuosa												2						1			1		1		1							4

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	STATION																															
Species Name	**LA1**	**LA2A**	**LA2B**	**LA3A**	**LA3B**	**LA4**	**LA5**	**LA6**	**LA7A**	**LA7B**	**LA8**	**LA9**	**LA10**	**LA11**	**LA12**	**LA13**	**LA14**	**LB1**	**LB2A**	**LB2B**	**LB3**	**LB4**	**LB5**	**LB6**	**LB7**	**LB8**	**LB9**	**LB10**	**LB11**	**LB12**	**LB13**	**LB14**
Turbonilla sp																											1				1	
Vitrinella oldroydi						2																			1	2			1			2
Volvulella panamica	1																										1					
	POLYCHAETES																															
Amaeana occidentalis																		4	7	1		1					1					
Ampharete labrops			1											2								1				5		3				
Ampharetidae																							1									
Amphicteis scaphobranchiata								2												1	1		3		1	2	2	1	1			
Aphelochaeta monilaris	11			2	8		5		2	2		1	1		29	2		1			1	13		1	4	1		7	4			1
Aphelochaeta petersenae					1	1	3	8								2						16	5		3			12	2		13	17
Aphelochaeta sp						2																2						1				
Aphelochaeta glandularia					1									4																		
Apoprionospio pygmaea		1						1	1					1					1							1						
Aricidea (Acmira) horikoshii																											1					
Aricidea (Aricidea) wassi																		1														
Armandia brevis										1																						
Boccardia basilaria		1			1			1										2										1	1			
Boccardiella hamata			2					1																								
Capitella "capitata"									1	5							19															
Caulleriella hamata																						2										
Chaetozone corona						2	3		2	1						14		3	2	5	2	3	9	4	2			4	27		9	32
Chaetozone hedgpethi								2														2										
Chaetozone sp																										1						
Chaetozone sp HYP3																				1												
Chone albocincta																										1						
Chone minuta																						1										
Chone mollis																			1													
Cirratulidae								14							1							4										1
Cirratulus sp							1																									
Cirratulus spectabilis																						19										
Cirriformia sp 1			1																												1	
Cossura candida				2																	12			9	3			9	8			2
Cossura sp A	21	3		2	11	1	12		8	4	3	1	27	8	7	3		17				16		2	1	2	7	1	1			2
Diopatra ornata																			1	1												
Diopatra tridentata						1												2				1			1			2				
Dipolydora bidentata		3																1						1								
Dipolydora socialis	1	2							1									1	1										7			
Dorvillea (Schistomeringos) annulata									1	1	1		2				1					5										
Drilonereis sp																											1				1	
Euchone incolor								22																								
Euchone limnicola		11			11	2	27		93	59	22		8		6	20	1					22				7			1			1
Eumida longicornuta																						1										
Euphrosine bicirrata																						1										
Eupolymnia heterobranchia			4							1																						
Exogone lourei								2	15	3	2		3	1								13									2	
Glycera americana	1				1	1			1			1		1		1		2			1	1	3	1			2	2	1		1	2
Glycera convoluta		1																	2	4												
Glycera nana														1																		
Glycinde armigera		1								1								1														
Goniada littorea																			1													
Halosydna johnsoni																						1										
Harmothoe imbricata									1													1										
Heteromastus sp									1																							
Laonice cirrata		1		3	5	2						5		6		1		1				2	6	1	4	1	5	2	2		3	1
Leitoscoloplos pugettensis	1		4		5		7		2	1	1		1	3		3		3		2		7	1			5	7					1
Levinsenia gracilis	1							2	1	4						1						6										
Lumbrineris cruzensis		1																														
Lumbrineris japonica	1																															
Lumbrineris limicola																				1												
Lumbrineris sp		1	2		1		1	1	2	3			2	5	1	2		6	4	3		9		4	3	3	5		1			2
Lumbrineris sp A	1	1	1	1	2													2	1	1	1	1			3	3	5	1	3		1	
Lumbrineris sp B (Harris1984)									1						1							1					1					
Maldanidae	1						3	1	3		1			1				3									4		2			
Malmgreniella macgintiei																											2	1				
Marphysa sp A (Harris&Velarde1983)				2	1			1															1					1		1	1	1
Mediomastus sp	16	6	10	2	1			1	20	19	1	1	6	1	1			6	4	2		9				3	3				1	2
Megalomma pigmentum	1	1		1					1										1			1										
Melinna oculata																						1					3					
Metasychis disparidentatus					1	1																										
Monticellina dorsobranchialis	1	1												1				1			2		1		2	3	2					
Monticellina siblina	2		2	4	5		2	4	3	4			8		1	41		9	4	13	3	3	3	7	2	30		3	10		2	9
Monticellina sp																										1					2	8
Nephtys caecoides									1	2																						
Nephtys cornuta																											2					
Nephtys ferruginea					1								1															1				

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Species Name	STATION																														
	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
Nereis procera								3		1				1						1	1			1	6		1		1			1
Notomastus tenuis						1	1							2											1		22	1				
Oligochaeta																	1															
Onuphis sp 1 (PtLoma1983)																			1													
Paramage scutata															2							3	1	1	2	3	16	6	1			5
Paraprionospio pinnata	3	1		5	2	7	11	6	4			1		2	2	5		9			6	5	10	2	3	4	1	4	33		8	3
Pectinaria californiensis		2	2				3																	1								
Petaloclymene pacifica																		5				6					11		3			
Pholoe glabra																						1			1							
Pholoides asperus																															1	
Phyllodoce hartmanae		1					1																			1	2	1				
Pista alata			1	9	3			1	1					1	2							3	1		1	1	12	8	2			2
Pista disjuncta				1	1																					1						
Platynereis bicanaliculata		1	3																													
Ophiodromus pugettensis																						1										
Podarkeopsis glabra																						1										
Podarkeopsis sp A (1983)	1																															
Poecilochaetus sp A (Martin1977)					1																											
Polydora sp																												1				
Polydora sp A	1																															
Polynoidae																										1		1				
Praxillella pacifica																		1														
Prionospio heterobranchia		2							5	5	3		1									2						1				
Prionospio lighti	7	1	1						4	5	5			1				1								1	1					
Prionospio sp A (SCAMIT1991)														4														1				
Protocirrineris sp																						6										
Pseudopolydora paucibranchiata		647	591	7	9			17	171	133	213	3	465	1	14	34	31		1			5				2						
Sabellaria sp								1																								
Sabellides manriquei																										1						
Scalibregma inflatum																										1						
Sigambra tentaculata							1															1										
Sphaerosyllis californiensis																															1	
Spiochaetopterus costarum																		1										1	1			
Spiophanes berkeleyorum		1				5	19	11	5	1				2		5	1	1			30	7	2	15	42	8	10	21	29		5	7
Spiophanes bombyx			1						2										6	11							1					
Spiophanes missionensis		4	1			1			28	10	2		1	1				1	5	1			1			2			8			
Sternaspis fossor																											1					
Sthenelais berkeleyi																						1										
Sthenelanella uniformis																		1														
Streblosoma crassibranchia					1	1																1		1				2				
Streblosoma sp 1																						11										
Streblosoma sp B (SCAMIT1985)	1				3	2	5	7	2		1		1	4	1	6					2	2		5				6	4			2
Syllis(Typosyllis) nipponica			7										3									1										
Tenonia priops												2								1		1										
Terebellides californica	5			2	6									2				3					1	1	1	5			3			
Total Abundance	128	1029	1087	80	110	51	152	128	906	643	443	76	569	86	81	195	63	170	174	196	80	309	89	83	140	120	260	139	191	1	69	155
Number of Taxa	35	51	48	29	39	27	30	30	74	66	33	20	26	43	18	36	11	53	40	39	23	75	28	24	38	41	59	41	43	1	30	37

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Benthic Infauna Survey - Abundance (number per 0.06 m2)

Species Name	STATION																															
	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
	CRUSTACEANS																															
Ampelisca brachycladus																		1	1													
Ampelisca brevisimulata																													2			
Ampelisca cristata																		8	2													
Ampelisca cristata microdentata																		3								1			1			
Amphideutopus oculatus	4	13	80	3	1	2			27	3								10	41	30	1		5			1			1			
Caprella californica									1	3																						
Caprella sp A										3																						
Dynamenella sp											2																					
Eochelidium sp A			2	1		1			10	8	14				5	6						3	4	9		1						1
Euphilomedes carcharodonta		4	13	1	1	7	4		27	34	63			1			1	4	2	4	2	1	1				7	2				1
Foxiphalus golfensis		1	20																													
Gnathia crenulatifrons	1	1	1	9	1		4	1	2						2	3		1				2	8				5					
Grandidierella japonica										1	2		1			1	30															
Hartmanodes hartmanae																			2													
Hemiproto sp A										1			1		2																	
Heteroserolis carinata			2																													
Hippomedon zetesimus			1						1											1												
Leptochelia dubia									12	1																						
Liljeborgia pallida								1																								
Listriella goleta												2				1		1							1			3	1			
Listriella melanica						1																										
Monocorophium acherusicum									7	8	4																					
Mysidopsis intii		1																1														
Nebalia "pugettensis"																					8											
Neotrypaea californiensis							3				1	3	1		1			1			2			9	5	8		4	1			
Neotrypaea sp										1																						
Oxyurostylis pacifica			1																													
Paramicrodeutopus schmitti			31						15	65									2	4												
Photis brevipes									1											2												
Photis sp																							1									
Photis sp OC1									1																							
Pinnixa franciscana																		2							1				1			2
Pinnixa longipes									2																		1					
Pinnixa schmitti	1																															
Pinnixa sp																					2			1								
Podocerus cristatus										10	3																					
Portunus xantusii				1																												
Pyromaia tuberculata	1					1			1																3	1						1
Rudilemboides stenopropodus									1																							
Scleroplax granulata						1	1			4		1						4			2	1		3	1	3	1	1	1		1	
Sinocorophium sp	3	1	1	1					32	46		1				1		7					2	4	8		2			2	4	
Westwoodilla caecula																											1					
Xeuxo normani									1								2															
	ECHINODERMS																															
Amphiodia sp	1													1													1					
Amphiodia urtica	2									1														3	2							
Amphioplus hexacanthus																											1					
Amphipholis squamata																						1										
Amphiuridae	1																															
Leptosynapta sp									2	1																						
Ophiuroidea																							1									
	MINOR PHYLA																															
Actiniaria											2																					
Anemonactis sp. A											2																					
Bunodeopsis sp A								1		1																						
Carinoma mutabilis				1																1												
Celleporina sp (colonial)										1																						1
Ceriantharia																															2	
Clavipora occidentalis (colonial)											1																					
Crisia sp (colonial)						1					1																			1		
Ctenostomata						1	1																									
Edwardsia sp G (MEC)	1	1												2												1						
Enteropneusta	1																										1					
Gobiidae																			1													
Lineidae	1	1											1	1					1						2							
Molgula sp								3																								
Nemertea						1			1	1						1	1										2				1	
Paleonemertea			3																													
Paranemertes californica							1							1					1													
Phoronida	2				1	1									1				1		1			3	3						3	
Platyhelminthes		1																														
Scolanthus sp A (SCAMIT)																							1									
Stylatula elongata																				1												

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	STATION																															
Species Name	**LA1**	**LA2A**	**LA2B**	**LA3A**	**LA3B**	**LA4**	**LA5**	**LA6**	**LA7A**	**LA7B**	**LA8**	**LA9**	**LA10**	**LA11**	**LA12**	**LA13**	**LA14**	**LB1**	**LB2A**	**LB2B**	**LB3**	**LB4**	**LB5**	**LB6**	**LB7**	**LB8**	**LB9**	**LB10**	**LB11**	**LB12**	**LB13**	**LB14**
Tubulanus cingulatus						1																										
Tubulanus nothus							1																									
Tubulanus polymorphus/pellucidus	2			1			3	4	1				1	3				1		1		3	4	2		1	1	1	1		4	1
Zygeupolia rubens										2	2			1																		
MOLLUSCS																																
Acteocina culcitella			2							1																						
Alia carinata																														1		
Astyris gausapata						1																										
Axinopsida serricata															1																	
Bivalvia				1						3	1				2	1				1					1			2		1		
Chione californiensis		4	2						1	1						1					1							1				
Compsomyax subdiaphana	2																				2											
Cooperella subdiaphana		4	3																1				1									
Crepidula sp								1																								
Cryptomya californica																									4							
Cyathodonta pedroana																				1												
Cylichna diegensis																		1								1	1		2			
Juliacorbula luteola								1																								
Kellia laperousii																									2	1						
Laevicardium substriatum									6	3													2									
Leptopecten latiauratus										1																						
Lyonsia californica		1	1						1								1		1													
Macoma nasuta		1				1										1	1															
Macoma sp									1	1	1						5			1											1	
Macoma yoldiformis		3	2						1									2									1		1			
Mactrotoma californica		3							1	2																						
Musculista senhousei									1	1			5			1	5															
Nassarius perpinguis	3																	2									2					
Neolepton subtrigona																	1						1									
Neverita reclusiana														1																		
Nuculana taphria	1								2		1			1												1	3					
Olivella baetica		1	3															1	6	3							1					
Parvilucina tenuisculpta														1															1			
Periploma discus							1											1							1							1
Philine auriformis					2										1																	
Philine sp																					1				1							
Philine sp A (SCAMIT)							2																2									
Protothaca sp										1													1									
Pulsellum aberrans	5													4		1							4				18	2				
Rictaxis punctocaelatus				1	1									1											3		5					1
Rochefortia coani																				2												
Rochefortia tumida	1		2																								1					
Solen sicarius										1																						
Tagelus subteres	3	8	1						3	10	1						3					1										
Tellina carpenteri														1											2							
Tellina modesta		17	10		1														1	1									1			
Theora lubrica	17		1		23	7	1		6	32	38	24	4	30		2	48				23	1	37	5	8	3	9		7	75	1	2
Thracia curta			1																													
Thyasira flexuosa					1																	1	2	1		4			3			5
Venerupis phillipinarium																	15															
Volvulella panamica														1										1	2		2					
POLYCHAETES																																
Amaeana occidentalis					2							1				1		8		2				1					1			
Ampharete labrops				1																		2	1									
Amphicteis scaphobranchiata	1			2		1		1						1								3	2									
Aphelochaeta monilaris	11	1		13	15	3	2	1	1					1	5	1		4			1	5	3	2	7	1		1		1	2	1
Aphelochaeta petersenae					1		1	8							2	1						43	8	2	6	2		11	8	1	15	35
Aphelochaeta sp				1				2	1					2							1				3						1	4
Apoprionospio pygmaea		1																		1									1		1	1
Arcteobia sp																				1												
Aricidea (Acmira) catherinae							1																									
Aricidea (Acmira) horikoshii														1																		
Aricidea (Acmira) sp																															1	
Armandia brevis											1					1																
Boccardia basilaria							1								1											1		2	1			
Boccardiella hamata										1																						
Capitella "capitata"									7		1		3				3															
Capitellidae										1																						
Chaetozone corona				1	1		13	1		1				1		8			7			2	8	8		2		4	37		15	15
Chone mollis																					1											
Chone sp B (Harris1984)																															1	
Cirratulidae					5																									1		
Cirratulus sp																															1	
Cirriformia sp SD 1																						1										

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	STATION																															
Species Name	**LA1**	**LA2A**	**LA2B**	**LA3A**	**LA3B**	**LA4**	**LA5**	**LA6**	**LA7A**	**LA7B**	**LA8**	**LA9**	**LA10**	**LA11**	**LA12**	**LA13**	**LA14**	**LB1**	**LB2A**	**LB2B**	**LB3**	**LB4**	**LB5**	**LB6**	**LB7**	**LB8**	**LB9**	**LB10**	**LB11**	**LB12**	**LB13**	**LB14**
Cirrophorus furcatus																		1														
Cossura candida				2	1																		7	39	3	4	4	2	1	4	1	5
Cossura sp A	7			7	14	27	13	5	4	4	12	1	123	111	2	15		10		1		24	23	3	7	1		1	2	9	11	13
Demonax sp																															2	
Diopatra ornata																			2													
Diopatra tridentata					1		1	1																	1	1					2	
Dipolydora bidentata									12	1								1					3	1		1			3			
Dipolydora socialis				1			2											1	1											1		
Dorvillea (Schistomeringos) annulata								3					17			2	4															
Drilonereis sp																									1			1			1	
Euchone limnicola				5	9	4	1	2	7	22	17		29	1		16	1	1		1	4	6	7			1			1	1	2	
Eulalia californiensis																															1	
Eunice americana																								1								
Exogone lourei								4	16	2	7		30																		1	
Glycera americana	2					1						1	1									1	1	3	2	1	1	2		1		
Glycera convoluta										1									2	2			1									
Glycera nana																								1							1	1
Glycera sp			1																													
Glycinde armigera																		1														
Goniada littorea										1																						
Harmothoe hirsuta						1																										
Hesperonoe complanata							1																									
Lanice conchilega						1																										
Laonice cirrata	1		2	1	3	1	1					1		5		1					1	1	4	1	2	1	4	2	2		3	
Leitoscoloplos pugettensis			1	3	5		1	1	2					5		3		3	1	2		1	5	1	1		4	2	2			2
Levinsenia gracilis										4			1	3		1		1		1		6					1					
Lumbrineris latreilli																			1			1								1	2	
Lumbrineris sp					2	3	6	3	1		2		1		2	1					1	1	4	4	1	3	1		4		6	
Lumbrineris sp A	3	2	2	1	10	7		1			1		1	10				8	5	5	1	1	2	1	1	5	5		1			
Lumbrineris sp B (Harris1984)											1					1						2	1	1								
Maldanidae					1	1								1					1			1		1					2		1	
Malmgreniella sp																												1				
Malmgreniella sp A (SCAMIT 1997)									1																							
Marphysa disjuncta				1	2																							1				2
Marphysa sp A (Harris&Velarde1983)	1					1												1				1						1				
Mediomastus sp		5		1	7	10	4	7	15	10	3		26	8	1		4	5		1	2	10	3	1	2	5	4	2		2	17	1
Megalomma pigmentum																						3										
Melinna oculata						8										1							1			1						
Metasychis disparidentatus																													1			
Microspio pigmentata			1																													
Monticellina dorsobranchialis							1							2		1							1		2		1		2		1	
Monticellina siblina				8	8	3	18		1	3	1		27		3	62	1	4	4	12	19	14		32	9	40	1	7	28		6	14
Monticellina sp																															5	8
Myriochele striulata																							1									
Nephtys caecoides		1				1					1							1								1						
Nephtys cornuta							1						1	1																		
Nephtys ferruginea						2																										
Nereis procera				1	1	3	1						1	3		1	2			3		3	2	1	2		1		1		3	
Nicolea gracilibranchis						4			2																							
Notomastus tenuis						1			1					2									1			1	14					
Onuphis eremita parva																				1												
Owenia fusiformis																				2												
Paramage scutata	4			3		3									2	1					2	6	8			1	7	14				
Paraprionospio pinnata	3					6	9	2					1	4	1	3		5			4	1	5	5	2	10		6	4		5	4
Parougia caeca						1																										
Petaloclymene pacifica						3	1			1	1							11				5	1	1		1					2	
Pholoe glabra														1													1					
Phyllodoce hartmanae							1																		1	1						
Pilargis sp 2																															1	
Pista alata	1				1					1	1			1	1						3		2	2	1	2	3	5				
Pista disjuncta				1											1						1											
Platynereis bicanaliculata											5						1															
Podarkeopsis glabra																					1											
Podarkeopsis sp A (Harris&Velarde1983)							1																									
Poecilochaetus sp A (Martin1977)					1																											
Polydora cirrosa	1																															
Polydora sp																							1						1			
Polyophthalmus pictus													1																			
Prionospio heterobranchia								4	16	8	2		5				2															
Prionospio lighti									1	1	1		4					1					1									
Prionospio sp A (SCAMIT1991)				1	2	3			2					1		1							4		2				2		1	
Pseudopolydora paucibranchiata		80	18	6	5		1		24	33	46		177		2	6	2				1	1	1			1						
Pseudopotamilla sp																															3	
Sabellidae									1																							

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Species Name	STATION																														
	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LA8	LA9	LA10	LA11	LA12	LA13	LA14	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7	LB8	LB9	LB10	LB11	LB12	LB13	LB14
Sabellides manriquei						2								3																		
Sigambra tentaculata							6							1										1	1							2
Spiochaetopterus costarum				1																		1		1				1				
Spiophanes berkeleyorum				1		3	35	4		4						5		1			33	6	5	11	100	7	4	8	35		3	2
Spiophanes bombyx			3						1										8	3												
Spiophanes fimbriata															1																	
Spiophanes missionensis			1	1	1	1	2		2	6	1		1						8	7		2		2		4			7		3	1
Streblosoma crassibranchia						10	3	1														1										
Streblosoma sp 1	1					9		1																								
Streblosoma sp B (SCAMIT1985)	8	1		3	6	47	12	7		1				5	2	1		2			3	15	6	3		10		4	1		1	
Syllis(Ehlersia) hyperioni																															1	
Syllis(Typosyllis) nipponica						1					1																					
Tenonia priops																							1			1						
Terebellides californica				2	1																		1						1			
Total Abundance	97	157	212	88	137	199	162	71	286	358	244	35	464	224	41	154	133	121	103	98	124	184	202	171	207	137	122	94	173	102	140	127
Number of Taxa	33	25	30	35	34	46	39	27	50	52	36	9	26	39	22	35	21	38	25	30	28	40	51	38	40	41	37	29	39	15	43	27

E.2 Macroinvertebrate Data

25' Trawl Invertebrate Catch

Total Abundance

Area	Depth (m)	February 2000 Day	February 2000 Night	February 2000 Mean	May 2000 Day	May 2000 Night	May 2000 Mean	August 2000 Day	August 2000 Night	August 2000 Mean	November 2000 Day	November 2000 Night	November 2000 Mean	Annual Mean Day	Annual Mean Night	Annual Mean Mean	Annual Total Day	Annual Total Night	Annual Total Mean
Deepwater Basin																			
LA5	17	12	36	24	3	38	21	47	9	28	10	6	8	18	22	20	72	89	81
LA6	16	11	58	35	5	13	9	45	67	56	9	41	25	18	45	31	70	179	125
LB3	15	200	604	402	77	37	57	1	34	18	221	165	193	125	210	167	499	840	670
LB5	15	0	443	222	21	97	59	13	64	39	31	79	55	16	171	94	65	683	374
Deepwater Channel																			
LA4	16	12	108	60	14	31	23	10	50	30	7	26	17	11	54	32	43	215	129
LB7	24	79	359	219	122	47	85	77	200	139	1032	62	547	328	167	247	1310	668	989
Deepwater Open																			
LA1	13	13	0	7	11	19	15	0	28	14	26	30	28	13	19	16	50	77	64
LB1	12	81	105	93	40	46	43	46	0	23	35	31	33	51	46	48	202	182	192
Deepwater Slip																			
LB4	15	5	39	22	26	4	15	2	14	8	2	9	6	9	17	13	35	66	51
LB6	17	0	60	30	87	553	320	134	104	119	124	259	192	86	244	165	345	976	661
Shallow Mitigation																			
LA2A	4	33	137	85	3	1	2	5	16	11	4	15	10	11	42	27	45	169	107
LA2B	4	29	343	186	6	17	12	7	9	8	8	13	11	13	96	54	50	382	216
LA7A	4	29	37	33	5	7	6	12	27	20	1	20	11	12	23	17	47	91	69
LA7B	4	100	13	57	25	11	18	28	22	25	11	8	10	41	14	27	164	54	109
LB2A	6	48	88	68	3	7	5	8	8	8	3	10	7	16	28	22	62	113	88
LB2B	6	14	127	71	11	59	35	11	7	9	3	1	2	10	49	29	39	194	117
Shallow Water Open																			
LA3A	4	47	293	170	12	20	16	18	82	50	8	76	42	21	118	70	85	471	278
LA3B	4	82	292	187	11	17	14	4	46	25	11	90	51	27	111	69	108	445	277
Survey Mean		44	175	109	27	57	42	26	44	35	86	52	69	46	82	64	183	327	255
Survey Total		795	3142	1969	482	1024	753	468	787	628	1546	941	1244	823	1474	1148	3291	5894	4593

25' Trawl Invertebrate Catch

Total Biomass

Area	Depth	February 2000			May 2000			August 2000			November 2000			Annual Mean			Annual Total		
	(m)	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean
Deepwater Basin																			
LA5	17	0.01	2.13	1.07	0.01	0.11	0.06	1.36	0.01	0.68	0.08	0.01	0.04	0.37	0.57	0.47	1.46	2.26	1.86
LA6	16	0.13	1.46	0.80	0.01	0.05	0.03	0.03	0.06	0.04	0.03	0.76	0.39	0.05	0.58	0.32	0.19	2.34	1.27
LB3	15	0.18	0.49	0.34	0.09	0.04	0.06	0.04	0.05	0.04	0.47	0.11	0.29	0.19	0.17	0.18	0.78	0.70	0.74
LB5	15	0.00	0.59	0.29	0.20	0.12	0.16	0.02	0.72	0.37	0.03	0.07	0.05	0.06	0.37	0.22	0.25	1.50	0.88
Deepwater Channel																			
LA4	16	0.02	0.53	0.28	0.35	0.10	0.22	0.02	0.05	0.03	0.01	0.03	0.02	0.10	0.18	0.14	0.39	0.70	0.55
LB7	24	4.35	2.74	3.54	0.27	0.05	0.16	0.43	0.16	0.30	1.19	2.22	1.70	1.56	1.29	1.43	6.25	5.17	5.71
Deepwater Open																			
LA1	13	0.01	0.00	0.01	0.06	0.05	0.05	0.00	0.02	0.01	0.07	0.04	0.06	0.04	0.03	0.03	0.15	0.11	0.13
LB1	12	11.80	3.13	7.46	0.07	0.05	0.06	0.30	0.00	0.15	5.06	0.42	2.74	4.31	0.90	2.60	17.23	3.60	10.41
Deepwater Slip																			
LB4	15	0.18	1.81	1.00	0.55	0.04	0.29	1.25	0.77	1.01	0.11	0.29	0.20	0.52	0.73	0.62	2.09	2.90	2.49
LB6	17	0.00	1.36	0.68	0.10	2.71	1.41	0.21	0.08	0.14	0.15	0.33	0.24	0.12	1.12	0.62	0.46	4.48	2.47
Shallow Mitigation																			
LA2A	4	0.25	2.59	1.42	0.09	0.00	0.04	0.01	0.01	0.01	3.45	0.02	1.73	0.95	0.65	0.80	3.79	2.62	3.21
LA2B	4	6.26	6.31	6.29	0.02	0.25	0.13	3.34	0.03	1.69	2.31	0.21	1.26	2.98	1.70	2.34	11.93	6.81	9.37
LA7A	4	10.57	2.26	6.41	4.17	0.21	2.19	0.15	1.97	1.06	0.00	0.21	0.11	3.72	1.16	2.44	14.89	4.64	9.76
LA7B	4	1.35	3.23	2.29	0.03	0.14	0.08	0.73	1.06	0.89	0.02	0.11	0.07	0.53	1.13	0.83	2.12	4.53	3.33
LB2A	6	3.30	0.34	1.82	0.06	0.08	0.07	0.33	0.36	0.35	0.02	0.07	0.04	0.93	0.21	0.57	3.71	0.84	2.28
LB2B	6	0.05	0.80	0.43	0.15	0.31	0.23	0.09	0.03	0.06	0.00	0.00	0.00	0.07	0.28	0.18	0.29	1.14	0.71
Shallow Water Open																			
LA3A	4	10.65	6.53	8.59	2.54	0.08	1.31	2.52	1.51	2.02	0.01	0.10	0.05	3.93	2.05	2.99	15.72	8.22	11.97
LA3B	4	4.70	7.11	5.91	0.01	0.02	0.02	0.01	0.03	0.02	0.00	0.12	0.06	1.18	1.82	1.50	4.73	7.28	6.00
Survey Mean		2.99	2.41	2.70	0.49	0.24	0.37	0.60	0.38	0.49	0.72	0.28	0.50	1.20	0.83	1.02	4.80	3.32	4.06
Survey Total		53.82	43.41	48.62	8.77	4.40	6.58	10.82	6.92	8.87	13.01	5.11	9.06	21.60	14.96	18.28	86.42	59.84	73.13

25' Trawl Invertebrate Catch

Number of Species

Area	Depth (m)	February 2000 Day	February 2000 Night	February 2000 Combined	May 2000 Day	May 2000 Night	May 2000 Combined	August 2000 Day	August 2000 Night	August 2000 Combined	November 2000 Day	November 2000 Night	November 2000 Combined	Annual Mean Day	Annual Mean Night	Annual Mean Combined	Annual Total Day	Annual Total Night	Annual Total Combined
Deepwater Basin																			
LA5	17	3	3	4	2	4	6	6	2	6	4	4	7	4	3	6	11	6	12
LA6	16	5	6	9	2	4	4	4	4	5	3	6	7	4	5	6	9	12	16
LB3	15	4	5	6	3	5	5	1	3	3	5	5	6	3	5	5	6	11	12
LB5	15	0	7	7	8	5	10	1	6	6	3	4	4	3	6	7	9	11	13
Deepwater Channel																			
LA4	16	5	4	7	5	10	12	4	3	4	3	4	5	4	5	7	10	12	17
LB7	24	7	5	8	4	4	6	5	4	6	10	3	11	7	4	8	17	8	18
Deepwater Open																			
LA1	13	2	0	2	3	6	8	0	3	3	4	3	5	2	3	5	7	8	11
LB1	12	8	6	9	3	2	4	4	0	4	4	2	4	5	3	5	8	7	10
Deepwater Slip																			
LB4	15	4	7	9	9	4	12	2	3	5	2	6	7	4	5	8	12	14	20
LB6	17	0	5	5	3	9	9	5	2	5	2	4	4	3	5	6	6	13	13
Shallow Mitigation																			
LA2A	4	4	5	6	3	1	4	2	2	4	3	3	5	3	3	5	9	5	11
LA2B	4	5	7	9	2	3	4	5	3	6	6	5	9	5	5	7	13	11	18
LA7A	4	5	5	7	5	4	7	5	5	9	1	7	7	4	5	8	10	12	14
LA7B	4	4	4	6	3	3	5	2	4	5	4	3	5	3	4	5	10	8	12
LB2A	6	3	5	6	2	5	7	2	3	4	2	4	5	2	4	6	7	8	11
LB2B	6	4	6	8	4	4	7	3	2	3	1	1	2	3	3	5	7	7	10
Shallow Water Open																			
LA3A	4	7	7	9	8	4	8	3	5	5	3	5	6	5	5	7	12	12	15
LA3B	4	6	6	9	3	3	5	1	3	3	3	4	5	3	4	6	8	8	11
Survey Mean		4	5	7	4	4	7	3	3	5	4	4	6	4	4	6			
Survey Total		25	28	34	30	26	39	22	19	28	23	20	31	25	23	33	52	43	63

25' Trawl Invertebrate Catch

Shannon-Wiener Diversity

Area	Depth (m)	February 2000 Day	February 2000 Night	February 2000 Combined	May 2000 Day	May 2000 Night	May 2000 Combined	August 2000 Day	August 2000 Night	August 2000 Combined	November 2000 Day	November 2000 Night	November 2000 Combined	Annual Mean Day	Annual Mean Night	Annual Mean Combined
Deepwater Basin																
LA5	17	0.96	0.69	1.02	0.64	1.04	1.27	1.33	0.69	1.30	1.22	1.24	1.56	1.04	0.92	1.29
LA6	16	1.29	0.96	1.19	0.50	0.94	0.88	1.14	1.15	1.17	0.94	1.35	1.37	0.97	1.10	1.15
LB3	15	0.52	0.34	0.43	0.70	1.21	0.98	NA	0.58	0.62	0.69	0.56	0.87	0.64	0.67	0.72
LB5	15	NA	0.55	0.55	1.57	0.69	0.96	NA	0.94	1.03	0.76	0.68	0.78	1.16	0.71	0.83
Deepwater Channel																
LA4	16	1.52	0.72	0.93	1.25	1.86	1.99	0.94	0.78	0.94	0.96	1.09	1.23	1.17	1.11	1.28
LB7	24	0.96	0.86	0.92	0.56	0.80	0.76	1.08	0.67	0.83	0.60	0.76	0.63	0.80	0.77	0.78
Deepwater Open																
LA1	13	0.27	NA	0.27	0.93	1.26	1.59	NA	0.62	0.62	0.48	0.64	1.14	0.56	0.84	0.91
LB1	12	1.24	1.18	1.27	0.72	0.10	0.74	1.14	NA	1.14	0.96	0.14	0.75	1.02	0.48	0.97
Deepwater Slip																
LB4	15	1.33	1.22	1.42	1.67	1.39	1.91	0.69	0.80	1.16	0.69	1.68	1.77	1.10	1.27	1.56
LB6	17	NA	0.61	0.61	0.17	0.48	0.45	0.81	0.34	0.70	0.17	0.34	0.30	0.38	0.44	0.51
Shallow Mitigation																
LA2A	4	1.28	1.33	1.46	1.10	NA	1.39	0.67	0.23	0.89	1.04	1.01	1.40	1.02	0.86	1.28
LA2B	4	1.47	0.58	0.86	0.45	1.03	1.12	1.55	1.06	1.70	1.73	1.18	1.84	1.30	0.96	1.38
LA7A	4	1.21	0.49	1.26	1.61	1.28	1.75	1.10	1.07	1.53	NA	1.78	1.77	1.30	1.16	1.58
LA7B	4	0.57	1.16	0.90	0.33	0.60	0.50	0.15	0.55	0.39	0.89	0.97	1.13	0.49	0.82	0.73
LB2A	6	0.27	1.19	1.06	0.64	1.48	1.83	0.38	0.97	0.92	0.64	1.17	1.48	0.48	1.20	1.32
LB2B	6	0.99	1.26	1.33	1.24	0.26	0.77	0.92	0.41	1.09	NA	NA	0.56	1.05	0.64	0.94
Shallow Water Open																
LA3A	4	1.40	0.79	1.12	1.98	1.16	1.67	0.56	0.86	1.01	0.74	0.97	1.16	1.17	0.95	1.24
LA3B	4	0.70	0.74	1.21	0.92	0.58	1.24		0.75	0.80	0.76	1.11	1.31	0.79	0.79	1.14
Survey Mean		1.00	0.86	0.99	0.94	0.95	1.21	0.89	0.73	0.99	0.83	0.98	1.17	0.91	0.87	1.09

NA - Not Applicable

25' Trawl Invertebrate Catch

Margalef Diversity

	Depth	February 2000			May 2000			August 2000			November 2000			Annual Mean		
Area	(m)	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Basin																
LA5	17	0.80	0.56	0.77	0.91	0.82	1.35	1.30	0.46	1.24	1.30	1.67	2.16	1.08	0.88	1.38
LA6	16	1.67	1.23	1.89	0.62	1.17	1.04	0.79	0.71	0.85	0.91	1.35	1.53	1.00	1.12	1.33
LB3	15	0.57	0.62	0.75	0.46	1.11	0.84	NA	0.57	0.56	0.74	0.78	0.84	0.59	0.77	0.75
LB5	15	NA	0.98	0.98	2.30	0.87	1.89		1.20	1.15	0.58	0.69	0.64	1.44	0.94	1.17
Deepwater Channel																
LA4	16	1.61	0.64	1.25	1.52	2.62	2.89	1.30	0.51	0.73	1.03	0.92	1.14	1.36	1.17	1.50
LB7	24	1.37	0.68	1.15	0.62	0.78	0.97	0.92	0.57	0.89	1.30	0.48	1.43	1.05	0.63	1.11
Deepwater Open																
LA1	13	0.39	NA	0.39	0.83	1.70	2.06	NA	0.60	0.60	0.92	0.59	0.99	0.71	0.96	1.01
LB1	12	1.59	1.07	1.53	0.54	0.26	0.67	0.78	NA	0.78	0.84	0.29	0.72	0.94	0.54	0.93
Deepwater Slip																
LB4	15	1.86	1.64	2.11	2.46	2.16	3.23	1.44	0.76	1.44	1.44	2.28	2.50	1.80	1.71	2.32
LB6	17	NA	0.98	0.98	0.45	1.27	1.24	0.82	0.22	0.73	0.21	0.54	0.50	0.49	0.75	0.86
Shallow Mitigation																
LA2A	4	0.86	0.81	0.97	1.82	NA	2.16	0.62	0.36	0.99	1.44	0.74	1.36	1.19	0.64	1.37
LA2B	4	1.19	1.03	1.35	0.56	0.71	0.96	2.06	0.91	1.80	2.40	1.56	2.63	1.55	1.05	1.68
LA7A	4	1.19	1.11	1.43	2.49	1.54	2.41	1.61	1.21	2.18	NA	2.00	1.97	1.76	1.47	2.00
LA7B	4	0.65	1.17	1.06	0.62	0.83	1.12	0.30	0.97	1.02	1.25	0.96	1.36	0.71	0.98	1.14
LB2A	6	0.52	0.89	1.02	0.91	2.06	2.61	0.48	0.96	1.08	0.91	1.30	1.56	0.70	1.30	1.57
LB2B	6	1.14	1.03	1.41	1.25	0.74	1.41	0.83	0.51	0.69	NA	NA	0.72	1.07	0.76	1.06
Shallow Water Open																
LA3A	4	1.56	1.06	1.37	2.82	1.00	2.02	0.69	0.91	0.87	0.96	0.92	1.13	1.51	0.97	1.35
LA3B	4	1.13	0.88	1.35	0.83	0.71	1.20		0.52	0.51	0.83	0.67	0.87	0.93	0.69	0.98
Survey Mean		1.13	0.96	1.21	1.22	1.20	1.67	1.00	0.70	1.01	1.07	1.04	1.34	1.11	0.96	1.31

25' Trawl Invertebrate Catch

Dominance Index

Area	Depth (m)	February 2000 Day	Night	Combined	May 2000 Day	Night	Combined	August 2000 Day	Night	Combined	November 2000 Day	Night	Combined	Annual Mean Day	Night	Combined
Deepwater Basin																
LA5	17	2	1	2	2	2	2	3	2	3	3	3	3	3	2	3
LA6	16	3	2	2	1	2	2	2	3	2	2	3	3	2	3	2
LB3	15	1	1	1	1	2	2	1	1	1	2	1	2	1	1	2
LB5	15	1	1	1	3	1	1	1	2	2	2	1	2	2	1	2
Deepwater Channel																
LA4	16	3	1	2	3	4	5	2	2	2	2	2	2	3	2	3
LB7	24	2	2	2	1	2	2	2	2	2	1	2	1	2	2	2
Deepwater Open																
LA1	13	1	1	1	2	2	3	1	1	1	1	1	2	1	1	2
LB1	12	2	2	2	2	1	2	2	1	2	2	1	2	2	1	2
Deepwater Slip																
LB4	15	3	2	2	3	3	5	2	2	2	2	4	5	3	3	4
LB6	17	1	1	1	1	1	1	2	1	2	1	1	1	1	1	1
Shallow Mitigation																
LA2A	4	3	3	3	3	1	3	2	1	2	2	2	3	3	2	3
LA2B	4	3	1	1	1	2	2	4	2	4	4	2	5	3	2	3
LA7A	4	2	1	2	4	3	4	2	2	3	1	4	4	2	3	3
LA7B	4	1	2	1	1	1	1	1	1	1	2	2	2	1	2	1
LB2A	6	1	2	2	2	4	5	1	2	2	2	2	3	2	3	3
LB2B	6	2	2	2	3	1	1	2	1	3	1	1	1	2	1	2
Shallow Water Open																
LA3A	4	2	2	2	5	2	3	1	2	2	1	2	2	2	2	2
LA3B	4	1	2	2	2	1	3	1	2	2	2	2	3	2	2	3
Survey Mean		2	2	2	2	2	3	2	2	2	2	2	3	2	2	2

February 2000
25' Otter Trawl Macroinvertebrate Catch (number/haul)

GROUP	*NAME*	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Crustacean	*Penaeus californiensis*				2	1													4
	Heptacarpus stimpsoni														11				
	Crangon alaskensis							7											
	Crangon nigromaculata	12	9	4	15	2	4	3		3	2	49	45	9	173				14
	Panulirus interruptus											6	1						2
	Neotrypaea californiensis								1										
	Pagurus spilocarpus											17		3					1
	Loxorhynchus crispatus				1														
	Pyromaia tuberculata		3	10	1	1	2	2	6	16	85	2			2	2			56
	Cancer gracilis	1			5	9	1		1			1	2	1					
Echinoderm	*Astropecten armatus*											3							
	Asterina miniata															1			
	Pisaster brevispinus					2						1							
	Pisaster giganteus			3	2														1
	Ophiothrix spiculata						3												
	Parastichopus parvimensis															1			1
Mollusc	*Polinices lewisii*											2							
	Neverita reclusiana													1					
	Pteropurpura festiva															1			
	Kelletia kelletti			3															
	Philine auriformis		13	9	21	67	2		2						14				
	Navanax inermis									1	6								
	Bulla gouldiana		8																
	Aplysia californica									7	7								
	Octopus sp								1	2									

	Total Count - Day	13	33	29	47	82	12	12	11	29	100	81	48	14	200	5	0	0	79
	Number of species - Day	2	4	5	7	6	5	3	5	5	4	8	3	4	4	4	0	0	7

February 2000
25' Otter Trawl Macroinvertebrate Catch (number/haul)

GROUP	*NAME*	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
	Night Samples																		
	Penaeus californiensis				6	3							1	1				7	
	Heptacarpus stimpsoni														5				
	Heptacarpus palpator															1			
	Lysmata californica								1										
	Crangon nigromaculata		48	18	84	72	81	27	20	33	7	52	37	55	550	23	380	50	155
	Panulirus interruptus				2							3		1				1	2
Crustacean	*Pagurus spilocarpus*											35	5	7	1		14		10
	Randallia ornata					1													
	Loxorhynchus crispatus				1														
	Loxorhynchus grandis							2	1							1			
	Pyromaia tuberculata		13				21	7	34			12		21	47	9	42		190
	Cancer gracilis				1	4				1		2	10		1		2		
	Portunus xantusii		43	298	198	210	5						35	42					
	Asterina miniata															3			
Echinoderm	*Pisaster giganteus*		1	2	1	2													
	Ophiothrix spiculata																2		
	Lytechinus pictus			1							1								
Minor Phyla	*Strongylocentrotus purpuratus*															1			
	Parastichopus californicus																1	1	
	Parastichopus parvimensis																	1	
	Polinices lewisii						1												
	Neverita reclusiana			4								1							
	Philine sp A (SCAMIT)								1										
Mollusca	*Philine auriformis*		32	7						1	2						2		
	Navanax inermis															1			2
	Bulla gouldiana			13															
	Aplysia californica									1	3								
	Octopus sp								1	1									
	Total Count - Night	0	137	343	293	292	108	36	58	37	13	105	88	127	604	39	443	60	359
	Number of species - Night	0	5	7	7	6	4	3	6	5	4	6	5	6	5	7	7	5	5

May 2000

25' Otter Trawl Macroinvertebrate Catch (number/haul)

GROUP	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Crustacean	*Penaeus californiensis*				1												1		
	Sicyonia penicillata				1														
	Crangon nigromaculata	5			1							12		1	10		11	84	22
	Panulirus interruptus									1									
	Neotrypaea californiensis							1											
	Pagurus spilocarpus											1							
	Pyromaia tuberculata			5	3	4	8		4	1	23	27		5	59	12	3		98
	Heterocrypta occidentalis			1															
	Cancer anthonyi													2					
	Cancer jordani		1																
	Portunus xantusii				2		1												
Echinoderm	*Astropecten armatus*												2	3					
	Asterina miniata															5			
	Ophiothrix spiculata						2										2		
	Lytechinus pictus															1			
	Strongylocentrotus fransciscanus															1			
	Strongylocentrotus purpuratus										1					3			
	Cucumaria pseudocurata	1															1		
	Parastichopus californicus																1		
	Parastichopus parvimensis						1									1	1		
Mollusc	*Neverita reclusiana*	5	1																
	Pteropurpura festiva							2	1										
	Nassarius perpinguis					1							1				1	1	
	Philine auriformis		1		2	6									8	1		2	
	Navanax inermis									1									1
	Aplysia californica				1					1									
	Diaulula sandiegensis															1			
	Dendronotus iris				1		2			1	1								
	Octopus bimaculoides																		1
Minor Phyla	*Prosthiostomidae*															1			
Total Count - Day		11	3	6	12	11	14	3	5	5	25	40	3	11	77	26	21	87	122
Number of Species - Day		3	3	2	8	3	5	2	2	5	3	3	2	4	3	9	8	3	4

May 2000
25' Otter Trawl Macroinvertebrate Catch (number/haul)

GROUP	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
Crustacean	*Penaeus californiensis*															1			
	Sicyonia penicillata																1		
	Crangon nigricauda	11																	
	Crangon nigromaculata				9	14	12	7	2			45		56	17		78	489	31
	Panulirus interruptus													1					
	Neotrypaea californiensis																		1
	Pagurus spilocarpus						1						1	1				2	
	Randallia ornata	1																	
	Pyromaia tuberculata	1	1	6	7	2	6	24	9	2	9		1		12	1	11	6	14
	Portunus xantusii	1		3	3	1	2	3					3			1			
Echinoderm	*Asterina miniata*								1										
	Pisaster brevispinus																	1	
	Ophiothrix spiculata						1	4										5	
	Parastichopus californicus																	1	
	Parastichopus parvimensis																	1	
Mollusc	*Aphrodita sp*															1			
	Neverita reclusiana	4					1						1	1					
	Pteropurpura festiva						4		1										
	Nassarius fossatus														1				
	Nassarius perpinguis																1	2	
	Conus californicus						2												
	Philine auriformis	1			1		1			1	1	1	1		6		6	46	1
	Navanax inermis									3	1								
	Bulla gouldiana			8															
	Discodoris sandiegensis						1								1				
	Laevicardium substriatum									1									
Total Count - Night		19	1	17	20	17	31	38	13	7	11	46	7	59	37	4	97	553	47
Number of Species - Night		6	1	3	4	3	10	4	4	4	3	2	5	4	5	4	5	9	4

August 2000
25' Otter Trawl Macroinvertebrate Catch (number/haul)

GROUP	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
	Day Samples																		
Crustaceans	*Penaeus californiensis*																	1	
	Sicyonia penicillata							1											
	Crangon alaskensis							15											
	Crangon nigromaculata						1	13	8			22		6				67	43
	Panulirus interruptus										1					1			
	Pagurus spilocarpus											3	7	4					6
	Loxorhynchus grandis							1											
	Pyromaia tuberculata		3	1	15	4	7	16	12	8	27	16		1	1		13	64	24
	Cancer gracilis									1									
	Hemigrapsus oregonensis								2										
Echinoderms	*Astropecten armatus*											5	1						
	Pisaster brevispinus			2	1														
	Ophiothrix spiculata							1											
	Parastichopus californicus						1									1			2
Molluscs	*Tegula gallina*																		2
	Pteropurpura festiva		2	2															
	Philine auriformis				2		1		23									1	
	Navanax inermis									1								1	
	Bulla gouldiana			1															
	Tellina modesta			1															
	Lyonsia californica									1									
	Octopus sp									1									
Total catch - Day		0	5	7	18	4	10	47	45	12	28	46	8	11	1	2	13	134	77
Number of species - Day		0	2	5	3	1	4	6	4	5	2	4	2	3	1	2	1	5	5

August 2000
25' Otter Trawl Macroinvertebrate Catch (number/haul)

GROUP	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
	Night Samples																		
Crustaceans	*Penaeus californiensis*																1		
	Crangon nigromaculata	22	15		59	33	35	5	17	18					28		46	93	146
	Panulirus interruptus									1									
	Pagurus spilocarpus												4	1					1
	Pyromaia tuberculata	5		2	14	10	11	4	23	3	19		3	6	4	10	10	11	50
	Cancer gracilis										1								
	Portunus xantusii				1								1						
Echinoderms	*Asterina miniata*															2			
	Pisaster brevispinus				1					2									
	Parastichopus californicus																2		
Molluscs	*Neverita reclusiana*	1													2				
	Pteropurpura festiva								1										
	Nassarius perpinguis																4		
	Olivella baetica			4															
	Philine auriformis		1		7	3	4		26	3							1		3
	Navanax inermis										1								
	Bulla gouldiana			3															
	Aplysia californica										1								
	Octopus sp															2			
Total catch - Night		28	16	9	82	46	50	9	67	27	22	0	8	7	34	14	64	104	200
Number of species - Night		3	2	3	5	3	3	2	4	5	4	0	3	2	3	3	6	2	4

November 2000
25' Otter Trawl Macroinvertebrate Catch (number/haul)

GROUP	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
	Day Samples																		
Crustaceans	*Sicyonia ingentis*	1																	
	Crangon nigromaculata	1	1	1	1							19		3	61		22	119	156
	Panulirus interruptus											1			1				
	Neotrypaea californiensis																		1
	Pagurus spilocarpus											2	2						1
	Loxorhynchus crispatus		1																
	Pyromaia tuberculata	23		1		2	4	5	5		8	13	1		156		2	5	845
	Portunus xantusii	1			1					1	1				2				
Echinoderms	*Patiria miniata*															1			
	Pisaster brevispinus		2	2							1								
	Lytechinus pictus										1								
	Strongylocentrotus purpuratus															1			
	Parastichopus californicus																		1
Molluscs	*Aphrodita sp*																		1
	Nassarius sp			1															
	Nassarius tiarula					1													
	Navanax inermis							2	1										
	Diaulula sandiegensis						1												
	Laevicardium substriatum			2															
	Solen rosaceus			1															
	Compsomyax subdiaphana							1											4
	Periploma discus																		3
	Philine auriformis				6	8	2	2	3						1		7		17
Total catch - Day		26	4	8	8	11	7	10	9	1	11	35	3	3	221	2	31	124	1029
Number of species - Day		4	3	6	3	3	3	4	3	1	4	4	2	1	5	2	3	2	9

November 2000
25' Otter Trawl Macroinvertebrate Catch (number/haul)

GROUP	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
	Night Samples																		
Crustaceans	*Penaeus californiensis*									1									
	Sicyonia penicillata						1												
	Crangon alaskensis	3			1			1							1				
	Crangon nigromaculata	24	4	8	48	41	13	1	11	2		30	3		141	1	60	239	31
	Panulirus interruptus											1							
	Pyromaia tuberculata		8		7	27	9	3	15	6	4		1		12	1	16	7	30
	Cancer anthonyi								1										
	Portunus xantusii	3	3	2	19	21				4	1		5	1	1		2	12	
Echinoderms	*Patiria miniata*															3			
	Pisaster brevispinus																		1
	Ophiothrix spiculata							1	1										
	Lytechinus pictus			1	1											1			
	Parastichopus californicus															1			
	Parastichopus parvimensis								1										
Molluscs	*Nassarius sp*			1															
	Octopus sp			1						1									
	Neverita reclusiana												1						
	Navanax inermis									3	3							1	
	Diaulula sandiegensis															2			
	Philine auriformis					1	3		12	3					10		1		
Total catch - Night		30	15	13	76	90	26	6	41	20	8	31	10	1	165	9	79	259	62
Number of species - Night		3	3	5	5	4	4	4	6	7	3	2	4	1	5	6	4	4	3

February 2000
25' Otter Trawl Macroinvertebrate Biomass (kg/haul)

GROUP	*NAME*	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
Crustacean	*Penaeus californiensis*				0.069	0.040													0.130
	Heptacarpus stimpsoni														0.005				
	Crangon alaskensis							0.010											
	Crangon nigromaculata	0.012	0.029	0.018	0.024	0.002	0.005	0.003		0.007	0.002	0.065	0.090	0.017	0.165				0.027
	Panulirus interruptus											10.500	3.200						1.050
	Neotrypaea californiensis								0.003										
	Pagurus spilocarpus											0.255		0.022					0.013
	Loxorhynchus crispatus				2.500														
	Pyromaia tuberculata		0.012	0.015	0.001	0.001	0.002	0.002	0.006	0.035	0.125	0.002			0.001	0.002			0.094
	Cancer gracilis	0.002			0.040	0.105	0.009		0.047			0.026	0.010	0.003					
Echinoderm	*Astropecten armatus*											0.080							
	Asterina miniata															0.120			
	Pisaster brevispinus					4.500						0.700							
	Pisaster giganteus			6.000	8.000														3.000
	Ophiothrix spiculata						0.001												
	Parastichopus parvimensis															0.059			0.039
Mollusca	*Polinices lewisii*											0.170							
	Neverita reclusiana													0.011					
	Pteropurpura festiva															0.003			
	Kelletia kelletti			0.200															
	Philine auriformis		0.030	0.028	0.015	0.055	0.002		0.003						0.010				
	Navanax inermis									0.015	0.120								
	Bulla gouldiana		0.175																
	Aplysia californica									10.500	1.100								
	Octopus sp								0.070	0.011									

	Total Weight - Day	0.014	0.246	6.261	10.649	4.703	0.018	0.015	0.129	10.568	1.347	11.798	3.300	0.053	0.181	0.184	0.000	0.000	4.353

February 2000
25' Otter Trawl Macroinvertebrate Biomass (kg/haul)

GROUP	*NAME*	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
	Penaeus californiensis				0.250	0.195							0.023	0.039				0.270	
	Heptacarpus stimpsoni														0.001				
	Heptacarpus palpator															0.001			
	Lysmata californica								0.001										
	Crangon nigromaculata		0.065	0.048	0.090	0.072	0.055	0.026	0.016	0.051	0.018	0.060	0.050	0.057	0.430	0.031	0.280	0.125	0.105
	Panulirus interruptus				1.350							2.600		0.500				0.750	2.250
Crustacean	*Pagurus spilocarpus*											0.425	0.070	0.085	0.001		0.070		0.125
	Randallia ornata					0.067													
	Loxorhynchus crispatus				1.800														
	Loxorhynchus grandis							2.100	1.350							1.500			
	Pyromaia tuberculata		0.027				0.030	0.008	0.046			0.020		0.027	0.060	0.030	0.075		0.200
	Cancer gracilis				0.035	0.076				0.017		0.005	0.120		0.001		0.021		
	Portunus xantusii		0.195	1.900	0.650	0.900	0.054						0.080	0.090					
	Asterina miniata															0.225			
Echinoderm	*Pisaster giganteus*		2.250	4.000	2.350	5.800													
	Ophiothrix spiculata																0.001		
	Lytechinus pictus			0.004							0.009								
Minor Phyla	*Strongylocentrotus purpuratus*															0.010			
	Parastichopus californicus																0.140	0.110	
	Parastichopus parvimensis																	0.107	
	Polinices lewisii						0.395												
	Neverita reclusiana			0.095								0.018							
	Philine sp A (SCAMIT)								0.001										
Mollusca	*Philine auriformis*		0.054	0.024						0.007	0.002						0.002		
	Navanax inermis															0.013			0.055
	Bulla gouldiana			0.240															
	Aplysia californica									2.100	3.200								
	Octopus sp								0.050	0.082									
	Total Weight - Night	0.000	2.591	6.311	6.525	7.110	0.534	2.134	1.464	2.257	3.229	3.128	0.343	0.798	0.493	1.810	0.589	1.362	2.735

May 2000
25' Otter Trawl Macroinvertebrate Biomass (kg/haul)

GROUP	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Day Samples																			
	Penaeus californiensis				0.025												0.033		
	Sicyonia penicillata				0.025														
	Crangon nigromaculata	0.007			0.001							0.024		0.001	0.019		0.007	0.100	0.024
	Panulirus interruptus									2.200									
	Neotrypaea californiensis							0.001											
Crustacean	*Pagurus spilocarpus*											0.006							
	Pyromaia tuberculata			0.010	0.005	0.007	0.010		0.004	0.002	0.015	0.036		0.010	0.060	0.015	0.005		0.120
	Heterocrypta occidentalis			0.006															
	Cancer anthonyi													0.005					
	Cancer jordani		0.075																
	Portunus xantusii				0.030		0.007												
	Astropecten armatus												0.057	0.130					
	Asterina miniata															0.365			
	Ophiothrix spiculata						0.002										0.001		
	Lytechinus pictus															0.003			
Echinoderm	*Strongylocentrotus fransciscanus*															0.009			
	Strongylocentrotus purpuratus										0.005					0.038			
	Cucumaria pseudocurata	0.005															0.003		
	Parastichopus californicus																0.110		
	Parastichopus parvimensis						0.290									0.115	0.045		
	Neverita reclusiana	0.045	0.009																
	Pteropurpura festiva							0.012	0.005										
	Nassarius perpinguis					0.001							0.001				0.001	0.001	
	Philine auriformis		0.003		0.001	0.005									0.010	0.001		0.001	
Mollusc	*Navanax inermis*									0.065									0.030
	Aplysia californica				2.400					1.900									
	Diaulula sandiegensis															0.003			
	Dendronotus iris				0.055		0.038			0.005	0.005								
	Octopus bimaculoides																		0.098
Minor Phyla	*Prosthiostomidae*															0.001			
Total Weight - Day		0.057	0.086	0.016	2.542	0.013	0.347	0.013	0.009	4.172	0.025	0.066	0.058	0.146	0.089	0.549	0.205	0.102	0.272

May 2000
25' Otter Trawl Macroinvertebrate Biomass (kg/haul)

GROUP	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
Night Samples																			
	Penaeus californiensis															0.011			
	Sicyonia penicillata																0.037		
	Crangon nigricauda	0.018																	
	Crangon nigromaculata				0.014	0.011	0.012	0.010	0.001			0.050		0.031	0.013		0.061	1.159	0.033
Crustacean	*Panulirus interruptus*													0.246					
	Neotrypaea californiensis																		0.001
	Pagurus spilocarpus						0.004						0.036	0.022				0.025	
	Randallia ornata	0.001																	
	Pyromaia tuberculata	0.001	0.002	0.006	0.011	0.003	0.010	0.040	0.015	0.001	0.014		0.001		0.017	0.002	0.014	0.009	0.018
	Portunus xantusii	0.001		0.047	0.052	0.003	0.020	0.051					0.027			0.007			
	Asterina miniata								0.035										
	Pisaster brevispinus																	1.250	
Echinoderm	*Ophiothrix spiculata*						0.001	0.009										0.005	
	Parastichopus californicus																	0.115	
	Parastichopus parvimensis																	0.125	
	Aphrodita sp															0.016			
	Neverita reclusiana	0.029					0.005						0.008	0.009					
	Pteropurpura festiva						0.030		0.001										
	Nassarius fossatus														0.003				
	Nassarius perpinguis																0.001	0.001	
Mollusc	*Conus californicus*						0.011												
	Philine auriformis	0.001			0.001		0.001			0.002	0.003	0.001	0.006		0.005		0.005	0.021	0.001
	Navanax inermis									0.205	0.120								
	Bulla gouldiana			0.200															
	Discodoris sandiegensis						0.002								0.002				
	Laevicardium substriatum									0.001									
Total Weight - Night		0.051	0.002	0.253	0.078	0.017	0.096	0.110	0.052	0.209	0.137	0.051	0.078	0.308	0.040	0.036	0.118	2.710	0.053

August 2000
25' Otter Trawl Macroinvertebrate Biomass (kg/haul)

GROUP	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
	Day Samples																		
Crustaceans	*Penaeus californiensis*																	0.040	
	Sicyonia penicillata							0.032											
	Crangon alaskensis							0.001											
	Crangon nigromaculata						0.001	0.002	0.003			0.014		0.006				0.055	0.021
	Panulirus interruptus										0.700					1.200			
	Pagurus spilocarpus											0.025	0.300	0.082					0.074
	Loxorhynchus grandis							1.300											
	Pyromaia tuberculata		0.001	0.001	0.022	0.006	0.011	0.021	0.014	0.006	0.026	0.020		0.001	0.037		0.021	0.086	0.034
	Cancer gracilis									0.014									
	Hemigrapsus oregonensis								0.002										
Echinoderms	*Astropecten armatus*											0.240	0.032						
	Pisaster brevispinus			3.050	2.500														
	Ophiothrix spiculata						0.001	0.001											
	Parastichopus californicus						0.002									0.045			0.300
Molluscs	*Tegula gallina*																		0.002
	Pteropurpura festiva		0.010	0.285															
	Philine auriformis				0.001		0.002		0.007									0.001	
	Navanax inermis									0.040								0.024	
	Bulla gouldiana			0.007															
	Tellina modesta			0.001															
	Lyonsia californica									0.001									
	Octopus sp									0.086									
Total weight - Day		0.000	0.011	3.344	2.523	0.006	0.017	1.357	0.026	0.147	0.726	0.299	0.332	0.089	0.037	1.245	0.021	0.206	0.431

August 2000
25' Otter Trawl Macroinvertebrate Biomass (kg/haul)

GROUP	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
	Night Samples																		
Crustaceans	*Penaeus californiensis*																0.032		
	Crangon nigromaculata	0.011	0.010		0.034	0.017	0.018	0.005	0.009	0.011		0.059			0.021		0.015	0.065	0.065
	Panulirus interruptus									0.400									
	Pagurus spilocarpus												0.350	0.020					0.009
	Pyromaia tuberculata	0.005		0.002	0.013	0.012	0.019	0.004	0.025	0.003	0.028	0.050	0.005	0.008	0.010	0.007	0.007	0.013	0.077
	Cancer gracilis										0.002								
	Portunus xantusii				0.010								0.004						
Echinoderms	*Asterina miniata*															0.113			
	Pisaster brevispinus				1.450					1.550									
	Parastichopus californicus																0.665		
Molluscs	*Neverita reclusiana*	0.007													0.019				
	Pteropurpura festiva								0.012										
	Nassarius perpinguis																0.004		
	Olivella baetica			0.002															
	Philine auriformis		0.001		0.006	0.003	0.008		0.017	0.003							0.001		0.009
	Navanax inermis										0.026								
	Bulla gouldiana			0.028															
	Aplysia californica										1.000								
	Octopus sp															0.650			
Total weight - Night		0.023	0.011	0.032	1.513	0.032	0.045	0.009	0.063	1.967	1.056	0.109	0.359	0.028	0.050	0.770	0.724	0.078	0.160

November 2000
25' Otter Trawl Macroinvertebrate Biomass (kg/haul)

GROUP	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
	Day Samples																		
Crustaceans	*Sicyonia ingentis*	0.001																	
	Crangon nigromaculata	0.001	0.001	0.001	0.001							0.015		0.003	0.051		0.017	0.150	0.103
	Panulirus interruptus											5.000			0.300				
	Neotrypaea californiensis																		0.001
	Pagurus spilocarpus											0.041	0.015						0.004
	Loxorhynchus crispatus		0.550																
	Pyromaia tuberculata	0.071		0.001		0.001	0.004	0.004	0.007		0.014	0.008	0.001		0.105		0.002	0.004	0.800
	Portunus xantusii	0.002			0.007					0.001	0.003				0.011				
Echinoderms	*Patiria miniata*															0.073			
	Pisaster brevispinus		2.900	2.150							0.002								
	Lytechinus pictus										0.001								
	Strongylocentrotus purpuratus															0.034			
	Parastichopus californicus																		0.240
Molluscs	*Aphrodita sp*																		0.003
	Nassarius sp			0.135															
	Nassarius tiarula					0.001													
	Navanax inermis							0.067	0.020										
	Diaulula sandiegensis						0.003												
	Laevicardium substriatum			0.003															
	Solen rosaceus			0.016															
	Compsomyax subdiaphana							0.007											0.013
	Periploma discus																		0.003
	Philine auriformis				0.002	0.001	0.001	0.001	0.001						0.001		0.009		0.015
Total weight - Day		0.075	3.451	2.306	0.010	0.003	0.008	0.079	0.028	0.001	0.020	5.064	0.016	0.003	0.468	0.107	0.028	0.154	1.182

November 2000
25' Otter Trawl Macroinvertebrate Biomass (kg/haul)

GROUP	NAME	LA1	LA2A	LA2B	LA3A	LA3B	LA4	LA5	LA6	LA7A	LA7B	LB1	LB2A	LB2B	LB3	LB4	LB5	LB6	LB7
	Night Samples																		
Crustaceans	*Penaeus californiensis*									0.043									
	Sicyonia penicillata						0.003												
	Crangon alaskensis	0.004			0.001			0.001							0.001				
	Crangon nigromaculata	0.025	0.003	0.004	0.033	0.026	0.010	0.001	0.012	0.002		0.023	0.003		0.092	0.001	0.045	0.265	0.028
	Panulirus interruptus											0.400							
	Pyromaia tuberculata		0.008		0.007	0.028	0.009	0.004	0.022	0.010	0.004		0.001		0.010	0.002	0.022	0.009	0.039
	Cancer anthonyi								0.550										
	Portunus xantusii	0.010	0.004	0.001	0.056	0.066				0.032	0.005		0.015	0.003	0.001			0.045	
Echinoderms	*Patiria miniata*															0.180			
	Pisaster brevispinus																		2.150
	Ophiothrix spiculata							0.001	0.001										
	Lytechinus pictus			0.001	0.002											0.002			
	Parastichopus californicus															0.080			
	Parastichopus parvimensis								0.160										
Molluscs	*Nassarius sp*			0.012															
	Octopus sp			0.195						0.025									
	Neverita reclusiana												0.046						
	Navanax inermis									0.078	0.102							0.014	
	Diaulula sandiegensis															0.022			
	Philine auriformis					0.001	0.004		0.014	0.019					0.010		0.002		
Total weight - Night		0.039	0.015	0.213	0.099	0.121	0.026	0.007	0.759	0.209	0.111	0.423	0.065	0.003	0.114	0.287	0.069	0.333	2.217

16' Trawl Invertebrate Catch

Total Abundance

Area	February 2000			May 2000			August 2000			November 2000			Annual Mean		
	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean
Deepwater Basin															
LA6	48	38	43	NS	NS	NS	10	10	20	2	1	3	20	16	22
Deepwater Channel															
LA4	15	18	17	NS	NS	NS	45	32	77	11	18	29	24	23	41
LB7	43	16	30	NS	NS	NS	25	39	64	36	68	104	35	41	66
Deepwater Open															
LA1	3	0	2	NS	NS	NS	7	5	12	6	23	29	5	9	14
LB1	2	5	4	NS	NS	NS	8	125	133	17	41	58	9	57	65
Deepwater Slip															
LB4	18	15	17	NS	NS	NS	9	15	24	3	4	7	10	11	16
Survey Mean	22	15	18				17	38	55	13	26	38	17	26	37

Total Biomass (kg/haul)

Area	February 2000			May 2000			August 2000			November 2000			Annual Mean		
	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Mean	Day	Night	Combined
Deepwater Basin															
LA6	0.06	0.04	0.05	NS	NS	NS	0.02	1.41	0.71	0.01	0.18	0.09	0.03	0.54	0.28
Deepwater Channel															
LA4	0.02	0.03	0.02	NS	NS	NS	0.01	0.83	0.42	0.04	0.04	0.04	0.02	0.30	0.16
LB7	0.24	0.63	0.44	NS	NS	NS	0.03	0.03	0.03	0.04	0.09	0.06	0.10	0.25	0.18
Deepwater Open															
LA1	0.05	0.00	0.02	NS	NS	NS	0.02	0.00	0.01	0.00	0.97	0.48	0.02	0.32	0.17
LB1	2.05	2.00	2.03	NS	NS	NS	0.71	1.57	1.14	0.54	0.13	0.33	1.10	1.23	1.17
Deepwater Slip															
LB4	0.65	0.15	0.40	NS	NS	NS	0.15	0.01	0.08	0.02	0.11	0.06	0.27	0.09	0.18
Survey Mean	0.51	0.47	0.49				0.16	0.64	0.40	0.11	0.25	0.18	0.26	0.46	0.36

Number of Species

Area	February 2000			May 2000			August 2000			November 2000			Annual Mean			Annual
	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Total
Deepwater Basin																
LA6	1	2	2	NS	NS	NS	1	3	4	2	1	3	1	2	3	5
Deepwater Channel																
LA4	1	3	3	NS	NS	NS	2	6	6	6	4	7	3	4	5	13
LB7	3	3	4	NS	NS	NS	5	2	5	2	3	3	3	3	4	8
Deepwater Open																
LA1	2	0	2	NS	NS	NS	3	2	4	1	3	3	2	2	3	8
LB1	1	3	3	NS	NS	NS	2	5	6	4	5	6	2	4	5	7
Deepwater Slip																
LB4	5	3	6	NS	NS	NS	7	3	8	2	3	5	5	3	6	14
Survey Mean	2	2	3				3	4	6	3	3	5	3	3	4	
															Annual Total	32

NS - Not Sampled

16' Trawl Invertebrate Catch

Shannon-Wiener Diversity

Area	February 2000			May 2000			August 2000			November 2000			Annual Mean		
	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Basin															
LA6	NA	0.34	0.19	NS	NS	NS	NA	0.64	1.01	0.69	NA	1.10	0.69	0.49	0.77
Deepwater Channel															
LA4	NA	0.65	0.44	NS	NS	NS	0.24	0.96	0.60	1.64	1.04	1.50	0.94	0.88	0.85
LB7	0.70	0.60	0.73	NS	NS	NS	1.38	0.68	1.05	0.62	0.76	0.73	0.90	0.68	0.84
Deepwater Open															
LA1	0.64	NA	0.64	NS	NS	NS	0.80	0.50	0.84	NA	0.36	0.30	0.72	0.43	0.59
LB1	NA	0.95	1.00	NS	NS	NS	0.38	0.49	0.52	0.89	0.83	1.21	0.63	0.76	0.91
Deepwater Slip															
LB4	1.19	0.49	1.07	NS	NS	NS	1.83	0.85	1.49	0.64	1.04	1.55	1.22	0.79	1.37
Survey Mean	0.84	0.61	0.68				0.92	0.69	0.92	0.89	0.80	1.07	0.85	0.67	0.89

Margalef Diversity

Area	February 2000			May 2000			August 2000			November 2000			Annual Mean		
	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Basin															
LA6	NA	0.27	0.22	NS	NS	NS	NA	0.87	1.00	1.44	NA	1.82	1.44	0.57	1.02
Deepwater Channel															
LA4	NA	0.69	0.57	NS	NS	NS	0.26	1.44	1.15	2.09	1.04	1.78	1.17	1.06	1.17
LB7	0.53	0.72	0.74	NS	NS	NS	1.24	0.27	0.96	0.28	0.47	0.43	0.68	0.49	0.71
Deepwater Open															
LA1	0.91	NA	0.91	NS	NS	NS	1.03	0.62	1.21	NA	0.64	0.59	0.97	0.63	0.90
LB1	NA	1.24	1.03	NS	NS	NS	0.48	0.83	1.02	1.06	1.08	1.23	0.77	1.05	1.09
Deepwater Slip															
LB4	1.38	0.74	1.43	NS	NS	NS	2.73	0.74	2.20	0.91	1.44	2.06	1.67	0.97	1.90
Survey Mean	0.94	0.73	0.82				1.15	0.80	1.26	1.16	0.93	1.32	1.12	0.80	1.13

Dominance Index

Area	February 2000			May 2000			August 2000			November 2000			Annual Mean		
	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined	Day	Night	Combined
Deepwater Basin															
LA6	1	1	1	NS	NS	NS	1	1	2	2	1	3	1	1	2
Deepwater Channel															
LA4	1	1	1	NS	NS	NS	1	2	1	4	2	3	2	2	2
LB7	1	1	1	NS	NS	NS	2	2	2	2	2	2	2	2	2
Deepwater Open															
LA1	2	1	2	NS	NS	NS	2	1	1	1	1	1	2	1	1
LB1	1	2	2	NS	NS	NS	1	1	1	2	1	2	1	1	2
Deepwater Slip															
LB4	2	1	2	NS	NS	NS	5	2	2	2	2	4	3	2	3
Survey Mean	1	1	2				2	2	2	2	2	3	2	1	2

NS - Not Sampled

February 2000 - 16' Otter Trawls

Day Samples

Abundance

Group	Scientific Name	LA1	LA4	LA6	LB1	LB4	LB7
Crustaceans	*Penaeus californiensis*						5
	Crangon nigromaculata						5
	Panulirus interruptus				2		
	Pyromaia tuberculata	2	15	48		9	33
Echinoderms	*Astropecten armatus*	1					
	Asterina miniata					6	
	Lytechinus pictus					1	
	Strongylocentrotus fransciscanus					1	
	Parastichopus californicus					1	
	Total Catch - Day	3	15	48	2	18	43
	Number of Species - Day	2	1	1	1	5	3

Biomass

Group	Scientific Name	LA1	LA4	LA6	LB1	LB4	LB7
Crustaceans	*Penaeus californiensis*						0.190
	Crangon nigromaculata						0.011
	Panulirus interruptus				2.050		
	Pyromaia tuberculata	0.004	0.022	0.058		0.008	0.041
Echinoderms	*Astropecten armatus*	0.042					
	Asterina miniata					0.430	
	Lytechinus pictus					0.019	
	Strongylocentrotus fransciscanus					0.063	
	Parastichopus californicus					0.130	
	Total Biomass (kg)- Day	0.046	0.022	0.058	2.050	0.650	0.242

Night Samples

Abundance

Group	Scientific Name	LA1	LA4	LA6	LB1	LB4	LB7
Crustaceans	*Crangon nigromaculata*			4	3		2
	Panulirus interruptus				1		1
	Pyromaia tuberculata		14	34		13	13
Echinoderms	*Asterina miniata*		1				
	Pisaster brevispinus				1		
	Parastichopus californicus					1	
Molluscs	*Pteropurpura festiva*		3				
	Diaulula sandiegensis					1	
	Total Catch - Night	0	18	38	5	15	16
	Number of Species - Night	0	3	2	3	3	3

Biomass

Group	Scientific Name	LA1	LA4	LA6	LB1	LB4	LB7
Crustaceans	*Crangon nigromaculata*			0.005	0.002		0.003
	Panulirus interruptus				1.550		0.625
	Pyromaia tuberculata		0.018	0.031		0.018	0.006
Echinoderms	*Asterina miniata*		0.003				
	Pisaster brevispinus				0.450		
	Parastichopus californicus					0.124	
Molluscs	*Pteropurpura festiva*		0.005				
	Diaulula sandiegensis					0.005	
	Total Biomass (kg)- Night	0.000	0.026	0.036	2.002	0.147	0.634

August 2000 - 16' Otter Trawls

Day Samples

Abundance

Group	Scientific Name	LA1	LA4	LA6	LB1	LB4	LB7
Crustaceans	*Heptacarpus sp*						3
	Crangon nigromaculata	5	42		7	3	10
	Panulirus interruptus				1		
	Randallia ornata	1					
	Pugettia producta						1
	Pyromaia tuberculata		3	10		1	9
	Cancer sp	1					1
	Cancer antennarius						1
Echinoderms	*Asterina miniata*					1	
	Strongylocentrotus purpuratus					1	
Molluscs	*Philine auriformis*					1	
	Navanax inermis					1	
	Anisodoris sp					1	
	Total Catch - Day	7	45	10	8	9	25
	Number of Species - Day	3	2	1	2	7	6

Biomass

Group	Scientific Name	LA1	LA4	LA6	LB1	LB4	LB7
Crustaceans	*Heptacarpus sp*						0.012
	Crangon nigromaculata	0.006	0.007		0.005	0.001	0.002
	Panulirus interruptus				0.700		
	Randallia ornata	0.015					
	Pugettia producta						0.001
	Pyromaia tuberculata		0.002	0.015		0.001	0.015
	Cancer sp	0.001					0.001
	Cancer antennarius						0.002
Echinoderms	*Asterina miniata*					0.080	
	Strongylocentrotus purpuratus					0.020	
Molluscs	*Philine auriformis*					0.001	
	Navanax inermis					0.042	
	Anisodoris sp					0.007	
	Total Biomass (kg)- Day	0.022	0.009	0.015	0.705	0.152	0.021

Night Samples

Abundance

Group	Scientific Name	LA1	LA4	LA6	LB1	LB4	LB7
Crustaceans	*Crangon nigromaculata*	4	23	8	110	9	17
	Panulirus interruptus			1			
	Pagurus spilocarpus				8		
	Loxorhynchus crispatus		1				
	Pyromaia tuberculata		5		5	5	22
	Cancer sp		1			1	
	Portunus xantusii		1				
Echinoderms	*Astropecten armatus*				1		
	Pisaster brevispinus				1		
Molluscs	*Pteropurpura festiva*			1			
	Acanthodoris brunnea	1					
	Octopus rubescens		1				
	Total Catch - Night	5	32	10	125	15	39
	Number of Species - Night	2	6	3	5	3	2

Biomass

Group	Scientific Name	LA1	LA4	LA6	LB1	LB4	LB7
Crustaceans	*Crangon nigromaculata*	0.001	0.006	0.003	0.050	0.002	0.003
	Panulirus interruptus			1.400			
	Pagurus spilocarpus				0.125		
	Loxorhynchus crispatus		0.650				
	Pyromaia tuberculata		0.004		0.004	0.003	0.029
	Cancer sp		0.001			0.001	
	Portunus xantusii		0.008				
Echinoderms	*Astropecten armatus*				0.045		
	Pisaster brevispinus				1.350		
Molluscs	*Pteropurpura festiva*			0.003			
	Acanthodoris brunnea	0.001					
	Octopus rubescens		0.165				
	Total Biomass (kg)- Night	0.002	0.834	1.406	1.574	0.006	0.032

November 2000 - 16' Otter Trawls

Day Samples

Abundance

Group	Scientific Name	LA1	LA4	LA6	LB1	LB4	LB7
Crustaceans	*Crangon alaskensis*		2				
	Crangon nigromaculata	3	1		12		25
	Panulirus interruptus				1		
	Pagurus spilocarpus				3		
	Pyromaia tuberculata		4	1	1	2	11
Echinoderms	*Patiria miniata*		1				
	Ophiothrix spiculata		1				
Molluscs	*Pteropurpura sp*			1			
	Philine auriformis		2				
	Navanax inermis					1	
	Total Catch - Day	3	11	2	17	3	36
	Number of Species - Day	1	6	2	4	2	2

Biomass

Group	Scientific Name	LA1	LA4	LA6	LB1	LB4	LB7
Crustaceans	*Crangon alaskensis*		0.001				
	Crangon nigromaculata	0.001	0.001		0.004		0.022
	Panulirus interruptus				0.500		
	Pagurus spilocarpus				0.031		
	Pyromaia tuberculata		0.004	0.001	0.001	0.004	0.013
Echinoderms	*Patiria miniata*		0.032				
	Ophiothrix spiculata		0.001				
Molluscs	*Pteropurpura sp*			0.006			
	Philine auriformis		0.001				
	Navanax inermis					0.015	
	Total Biomass (kg)- Day	0.001	0.040	0.007	0.536	0.019	0.035

Night Samples

Abundance

Group	Scientific Name	LA1	LA4	LA6	LB1	LB4	LB7
Crustaceans	*Crangon nigromaculata*	21	9		2	2	33
	Panulirus interruptus	1					
	Pagurus spilocarpus				2		
	Pyromaia tuberculata		7		32		34
	Portunus xantusii	1			3		
Echinoderms	*Astropecten armatus*				2		
	Patiria miniata					1	
Molluscs	*Aphrodita sp*					1	
	Philine auriformis		1				1
	Diaulula sandiegensis		1				
	Octopus sp			1			
	Total Catch - Night	23	18	1	41	4	68
	Number of Species - Night	3	4	1	5	3	3

Biomass

Group	Scientific Name	LA1	LA4	LA6	LB1	LB4	LB7
Crustaceans	*Crangon nigromaculata*	0.014	0.016		0.003	0.001	0.032
	Panulirus interruptus	0.950					
	Pagurus spilocarpus				0.026		
	Pyromaia tuberculata		0.026		0.025		0.053
	Portunus xantusii	0.001			0.011		
Echinoderms	*Astropecten armatus*				0.063		
	Patiria miniata					0.095	
Molluscs	*Aphrodita sp*					0.010	
	Philine auriformis		0.001				0.001
	Diaulula sandiegensis		0.001				
	Octopus sp			0.180			
	Total Biomass (kg)- Night	0.965	0.044	0.180	0.128	0.106	0.086

APPENDIX F

Riprap Data

F.1 Master Species List

Rip rap species

Quadrat and Diver Observations

Crustaceans

	Species
	Achelia echinata
	Achelia sp
	Acidostoma sp
	Allorchestes angusta
	Ammothea hilgendorfi
	Ammothella bi-unguiculata
	Ammothella sp
	Amphilochus sp
	Amphipod, unid.
	Ampithoe sp
?	Aoroides cf secunda
	Aoroides sp
	Atylus tridens
	Balanus amphitrite amphitrite
	Balanus glandula
	Balanus hesperius
	Balanus sp
	Balanus trigonus
	Calanoida (copepod)
	Caprella augusta
	Caprella californica
	Caprella mendax
	Caprella natalenis
	Caprella sp
?	Caprella sp A
	Caprella verrucosa
	Caprellidae
	Chthalamus sp
	Chthalmus fissus
	Cirolana diminuta
	Cirolana sp
	Cirripedia
	Corophiidae
	Corophium sp
	Cumella californica
	Cyclopoida
	Desdimelita desdichada
	Deutella californica
	Dynamenella sp
	Elasmopus sp
	Ericthonius brasiliensis
	Gammaropsis thompsoni
	Gitanopsis vilordes
	Harpacticoida
	Hemigrapsus nudus
	Hemigrapsus sp
?	Hemiproto sp
	Heptacarpus sp
	Heptacarpus taylori
	Hyale sp
	Ischyrocerus sp
	Isopoda
	Janiralata sp
	Jassa slatteryi
	Joeropsis sp
	Laticorophium baconi
	Leptochelia dubia
	Leucothoe aluta
	Leucothoe sp
	Leucothoe spinicarpa
	Liljeborgia sp
	Loxorhynchus grandis
	Lysianassidae
	Maera simile
	Megabalanus californicus
	Melita dentata
	Melita sp
	Microcerberidae
	Monocorophium insidiosum
	Mysidopsis sp
	Najna sp
	Opisthopus transversus
	Pachycheles pubescens
	Pachycheles rudis
	Pachycheles sp
	Pachygrapsus crassipes
	Paguridae
	Panilurus interruptus
	Paracerceis sp
?	Paradexamine sp A
	Paramicrodeutopus schmitti
	Paranthura elegans
	Petrolisthes sp
	Photis lacia
	Photis parvidons
	Photis sp
	Pinnixa sp
	Podocerus brasiliensis
	Podocerus cristatus
	Podocerus sp
	Pontogeneia sp
	Porcellanidae
	Postasterope sp
	Pycnogonum stearnsi
	Stenothoe estacola
	Stenothoe sp
	Tanaidae
	Tetraclita rubescens
	Tetraclita sp
	Tritella pilimana
	Uromunna ubiquita

* Non-indigenous
? Status unclear

Rip rap species
Quadrat and Diver Observations

Echinoderms Species Name
Amphioplus sp
Amphipholis sp
Amphipholis squamata
Amphiuridae
Asterina miniata
Brisaster sp
Echinoid
Henricia sp
Holothuroidea
Lytechinus pictus
Ophiactis simplex
Ophiuroidea
Parastichopus sp
Pisaster giganteus
Pisaster sp
Strongylocentrotus franciscanus
Strongylocentrotus purpuratus

* Non-indigenous
? Status unclear

Rip rap species
Quadrat and Diver Observations

Polychaetes

	Species Name
?	Arabella iricolor
	Arabella sp
	Autolytus sp
?	Autolytus sp 2
	Axiothella sp
	Boccardia basilaria
	Boccardia probosoidea
	Boccardia sp
*	Boccardiella hamata
	Brania brevipharyngea
	Brania californiensis
	Brania sp
	Capitella "capitata"
	Capitellidae
	Caulleriella sp
	Chone ecaudata
	Chone sp
	Chrysopetalum occidentale
	Cirratulidae
	Cirratulus sp
	Cirriformia sp
?	Cirriformia sp SD 2
	Cirriformia spirabrancha
	Cossura sp
?	Ctenodrilus serratus
	Diopatra sp
*	Dipolydora giardi
*	Dipolydora socialis
?	Dodecaceria concharum
	Dodecaceria fewkesi
	Dorvillea (Schistomeringos) longicornis
	Eulalia quadrioculata
	Eusyllis sp
	Exogone lourei
	Exogone sp
?	Exogone verugera
	Halosydna brevisetosa
	Halosydna johnsoni
?	Hydroides pacificus
	Hydroides sp
	Maldanidae
	Naineris dendritica
	Naineris sp
*	Neanthes acuminata
	Neanthes sp
	Nereididae
	Nereis latescens
	Nereis mediator
	Nereis procera
	Nereis sp
*	Nicolea gracilibranchis

	Species Name
	Odontosyllis sp
	Oenonidae
	Oligochaeta
	Orbiniidae
	Paleanotus bellis
	Perinereis montera
	Pionosyllis sp
	Platynereis bicanaliculata
	Polychaeta
	Polycirrus sp
?	Polydora armata
*	Polydora cornuta
*	Polydora ligni
*	Polydora limicola
	Polydora sp
*	Polydora websteri
	Polynoidae
?	Polyophthalmus pictus
	Protocirrineris sp
*	Pseudopolydora paucibranchiata
	Pseudopotamilla socialis
	Sabellidae
	Serpulidae
	Sphaerosyllis californiensis
	Spionidae
	Syllidae
	Syllis(Syllis) elongata
*	Syllis(Syllis) gracilis
*	Syllis(Typosyllis) fasciata
*	Syllis(Typosyllis) nipponica
*	Syllis(Typosyllis) orientalis
	Syllis(Typosyllis) pulchra
	Syllis(Typosyllis) sp
	Terebellidae
	Trypanosyllis gemmipara
	Trypanosyllis intermedia

* Non-indigenous
? Status unclear

Rip rap species
Quadrat and Diver Observations

Molluscs

	Species Name	Species Name
	Acanthina spinata	Norrisia norrisi
	Aeolidoidea	Notoacmea dipicta
	Alia carinata	Nudibranchia
	Ancula pacifica	Octopus sp
	Astraea undosa	Odostomia sp
	Barleeia californica	Ostrea sp
	Barleeia sp	Ostrea conchaphila
	Bivalvia	Ostreidae
	Brachidontes adamisianus	Pectinidae
	Chaetopleura sp	Philobrya setosa
	Chama arcana	Pollicipes polymerus
	Collisella digitalis	Polyplacophora
	Collisella limatula	Pteropurpura festiva
	Collisella ochracea	Puncturella sp
	Collisella scabra	Rimula sinezoides
	Collisella sp	Rimula sp
	Collisella strigatella	Roperia poulsoni
	Crassedoma giganteum	Rupellaria tellimyalis
*	Crassostrea gigas	Serpulorbis squamiger
	Crepidula dorsata	Sinezona rinoloides
	Crepidula onyx	Sinezona sp
	Crepidula sp	Tegula brunnea
	Doridoidea	Tegula funebralis
	Fissurella volcano	Tegula gallina
	Gastropoda	Vermetidae
	Haminaea vesicula	
	Hiatella arctica	
	Hypsurus caryi	
	Iselica ovoidea	
	Kelletia kelletii	
	Kellia suborbicularis	
	Lasaea adansoni	
	Lasaea subviridis	
	Lithophaga plumula	
	Lithopoma undosum	
	Littorina planaxis	
	Littorina scutulata	
	Littorina sp	
	Lottia gigentea	
	Lucapinella callomarginata	
	Maxwellia gemma	
	Megathura crenulata	
	Modiolus sp	
	Mopalia muscosa	
	Mopalia sp	
	Mytilidae	
*	Mytilus galloprovincialis	
	Mytilus sp	
	Nassarina penicillata	
	Navanax inermis	
	Neoloricata	

* Non-indigenous
? Status unclear

Rip rap species
Quadrat and Diver Observations

Minor Phyla

Species Name	Species Name
Acanthoptilum sp	Tetrastemma sp
Actiniidae	Thysanocardia nigra
Alcyonidium sp (colonial)	Triticella sp
Amathia sp (colonial)	Urochordata
Amphiporus sp	Zygonemertes virescens
Anthopleura elegantissima	
Anthopleura sp	
Ascidiacea sp	
Bugula pacifica (colonial)	
Celleporina sp (colonial)	
Chironomidae	
Ciona sp	
Crisia sp (colonial)	
Dendrostoma petraeum	
Diadumenidae	
Dolichopodidae	
Ectoprocta (colonial)	
Ectoprota sp	
Emplectonema gracilis	
Entoprocta (colonial)	
Epiactis prolifera	
Gobiesox rhessodon	
Gorgonia sp	
Hydrozoa	
Leucosolenia sp	
Lineidae	
Micrura wilsoni	
Molgula sp	
Nematoda	
Nemertea	
Nemertopsis gracilis	
Nolella sp (colonial)	
Notoplana sp	
Pachycerianthus fimbriatus	
Paleonemertea	
Platyhelminthes	
Plumularia alicia (colonial)	
Plumularia sp (colonial)	
Porifera	
Solitary green anemone	
Spinicirrus inequalis	
Spinicirrus sp	
Styela clara	
Styela monteryensis	
Styela sp	
Styela truncata	
Stylochus franciscanus	
Stylochus sp	
Syncoryne eximia	

* Non-indigenous
? Status unclear

F.2 Summary Tables by Season

Riprap Quadrats

Abundance per 0.01125 m^2

Tidal zone / Habitat / Station		March 2000	May 2000	August 2000	November 2000	Annual Mean	Annual Total
Upper Intertidal							
Open Water	LA1	185	100	330	141	189	755
	LA4	167	146	556	900	442	1769
	LB1	54	87	193	141	118	474
Channel	LB2	144	41	53	66	76	303
Basin	LA2	140	117	37	187	120	480
	LA3	4	3	1	4	3	11
	LB3	51	73	89	73	71	285
	LB4	122	131	139	172	141	563
Tidal Zone Mean		108	87	174	210	145	580
Lower Intertidal							
Open Water	LA1	240	450	435	137	315	1261
	LA4	86	187	181	303	189	756
	LB1	58	382	247	211	224	897
Channel	LB2	45	40	32	42	40	159
Basin	LA2	45	80	209	208	135	541
	LA3	7	5	14	2	7	27
	LB3	112	79	139	55	96	384
	LB4	47	88	164	180	120	478
Tidal ZoneMean		80	164	177	142	141	563
Subtidal							
Open Water	LA1	109	297	195	99	175	698
	LA4	19	22	102	55	49	197
	LB1	139	248	688	196	317	1270
Channel	LB2	57	122	32	137	87	347
Basin	LA2	51	46	103	50	62	249
	LA3	4	3	42	4	13	52
	LB3	256	295	206	99	214	855
	LB4	154	67	115	295	158	631
Tidal Zone Total		98	137	185	116	134	537
Overall Mean		95	129	179	156	140	560

Notes:
Values based on the mean of the two replicates, rounded to the nearest whole number
Algae not included

Riprap Quadrats
Biomass (g)

Tidal zone / Habitat / Station		March 2000	May 2000	August 2000	November 2000	Annual Mean	Annual Total
Upper Intertidal							
Open Water	LA1	43.48	14.83	43.75	27.43	32.37	129.49
	LA4	19.80	7.52	45.79	22.50	23.90	95.61
	LB1	5.07	8.57	11.91	6.97	8.13	32.52
Channel	LB2	19.72	9.41	11.44	8.60	12.29	49.17
Basin	LA2	26.83	23.42	6.08	76.18	33.13	132.51
	LA3	12.95	1.02	0.76	93.85	27.15	108.58
	LB3	17.85	10.07	13.81	7.70	12.36	49.43
	LB4	9.24	6.59	40.47	13.31	17.40	69.61
Tidal Zone Mean		19.37	10.18	21.75	32.07	20.84	83.37
Lower Intertidal							
Open Water	LA1	64.13	103.96	111.41	53.91	83.35	333.41
	LA4	54.76	44.87	80.74	81.35	65.43	261.72
	LB1	85.52	105.25	81.96	24.21	74.24	296.94
Channel	LB2	153.57	29.27	12.87	56.74	63.11	252.45
Basin	LA2	107.39	31.68	19.78	2.57	40.36	161.42
	LA3	116.95	37.22	16.97	1.28	43.11	172.42
	LB3	100.96	36.93	183.16	83.69	101.19	404.74
	LB4	51.05	9.15	40.32	83.66	46.05	184.18
Tidal Zone Mean		91.79	49.79	68.40	48.43	64.60	258.41
Subtidal							
Open Water	LA1	22.58	26.02	31.79	32.34	28.18	112.73
	LA4	69.82	35.01	41.25	26.65	43.18	172.73
	LB1	195.56	77.38	42.61	19.09	83.66	334.64
Channel	LB2	145.65	148.84	98.07	106.82	124.85	499.38
Basin	LA2	52.93	54.22	22.11	28.36	39.41	157.62
	LA3	0.30	0.76	47.30	63.99	28.09	112.35
	LB3	202.97	410.09	117.00	144.27	218.58	874.33
	LB4	46.85	84.92	130.17	157.87	104.95	419.81
Tidal Zone Mean		92.08	104.66	66.29	72.42	83.86	335.45
Overall Mean		67.75	54.88	52.15	50.97	56.44	225.74

Notes:
Values based on the mean of the two replicates

Riprap Quadrats
Number of species

Tidal zone / Habitat	Station	March 2000	May 2000	August 2000	November 2000	Annual Mean	Annual Total
Upper Intertidal							
Open Water	LA1	18	4	10	7	10	25
	LA4	8	8	8	10	9	18
	LB1	8	8	5	8	7	14
Channel	LB2	14	4	6	5	7	18
Basin	LA2	6	8	5	7	7	14
	LA3	4	3	1	4	3	10
	LB3	14	6	7	7	9	17
	LB4	9	4	11	9	8	17
Tidal Zone Mean		10	6	7	7	7	17
Lower Intertidal							
Open Water	LA1	40	19	14	15	22	53
	LA4	19	11	16	36	21	47
	LB1	28	15	17	27	22	51
Channel	LB2	14	7	7	12	10	22
Basin	LA2	15	10	6	13	11	30
	LA3	7	2	5	4	5	16
	LB3	13	9	14	14	13	30
	LB4	12	6	12	14	11	23
Tidal Zone Mean		19	10	11	17	14	34
Subtidal							
Open Water	LA1	49	51	26	35	40	95
	LA4	20	12	14	27	18	47
	LB1	51	38	33	36	40	96
Channel	LB2	32	38	13	22	26	70
Basin	LA2	23	19	18	16	19	45
	LA3	8	5	9	6	7	26
	LB3	51	42	27	32	38	88
	LB4	46	24	18	40	32	79
Tidal Zone Mean		35	29	20	27	28	68
Overall Mean		21	15	13	17	16	40

Notes:
Values based on the two replicates, rounded to the nearest whole number

Riprap Quadrats
Shannon-Wiener Diversity

Tidal zone / Habitat / Station		March 2000	May 2000	August 2000	November 2000	Annual Mean
Upper Intertidal						
Open Water	LA1	1.63	0.99	1.48	1.33	1.36
	LA4	1.39	1.07	1	0.53	1.00
	LB1	1.47	1.24	0.83	0.97	1.13
Channel	LB2	1.1	0.79	1.15	1.18	1.06
Basin	LA2	0.34	0.87	1.25	1.05	0.88
	LA3	1.32	0.95	0	1.28	0.89
	LB3	1.73	1.15	1.51	1.55	1.49
	LB4	1.2	0.46	1.39	1.11	1.04
Lower Intertidal						
Open Water	LA1	2.44	1.97	1.62	2.06	2.02
	LA4	2.28	1.03	1.41	2.39	1.78
	LB1	2.79	1.25	1.5	2.64	2.05
Channel	LB2	1.75	1.19	1.33	1.77	1.51
Basin	LA2	1.23	0.95	0.86	1.47	1.13
	LA3	1.52	1.06	1.55	1.39	1.38
	LB3	1.49	1.65	1.72	2.14	1.75
	LB4	1.98	1.14	1.64	1.16	1.48
Subtidal						
Open Water	LA1	3.11	2.75	2.52	3.03	2.85
	LA4	2.27	1.53	1.46	2.95	2.05
	LB1	3.54	2.41	1.71	2.81	2.62
Channel	LB2	2.61	3.05	1.74	1.94	2.34
Basin	LA2	2.12	1.93	2	1.77	1.96
	LA3	1.91	1.61	1.1	1.75	1.59
	LB3	2.98	2.73	1.87	3.07	2.66
	LB4	3.21	2.83	1.74	2.67	2.61

Notes:
Values based on the mean of the two replicates, rounded to the nearest whole number
Algae not included

Riprap Quadrats
Margalef Diversity

Tidal zone / Habitat / Station		March 2000	May 2000	August 2000	November 2000	Annual Mean
Upper Intertidal						
Open Water	LA1	2.87	0.65	1.55	1.21	1.57
	LA4	1.37	1.4	1.11	1.32	1.30
	LB1	1.76	1.57	0.76	1.42	1.38
Channel	LB2	2.62	0.81	1.26	0.95	1.41
Basin	LA2	0.81	1.47	1.11	1.15	1.14
	LA3	2.16	2.18	0	2.39	1.68
	LB3	3.06	1.17	1.34	1.4	1.74
	LB4	1.67	0.62	2.03	1.56	1.47
Lower Intertidal						
Open Water	LA1	5.66	2.46	2.14	2.85	3.28
	LA4	4.05	1.91	2.89	5.78	3.66
	LB1	5.91	2.36	2.91	4.86	4.01
Channel	LB2	3.42	1.63	1.73	2.94	2.43
Basin	LA2	2.9	1.83	0.94	2.25	1.98
	LA3	3.21	0.66	1.52	4.33	2.43
	LB3	2.54	1.83	2.64	3.25	2.57
	LB4	2.86	1.12	2.16	2.5	2.16
Subtidal						
Open Water	LA1	8.53	8.26	4.55	7.41	7.19
	LA4	4.8	2.28	2.38	6.5	3.99
	LB1	9.53	6.17	4.9	6.63	6.81
Channel	LB2	5.95	7.71	3.46	4.27	5.35
Basin	LA2	4.58	4.18	3.24	3.59	3.90
	LA3	3.61	4.37	2.15	3.99	3.53
	LB3	8.48	6.68	3.94	6.54	6.41
	LB4	8.93	5.48	3.58	6.86	6.21

Notes:
Values based on the mean of the two replicates, rounded to the nearest whole number
Algae not included

Riprap Quadrats
Dominance Index

Tidal zone / Habitat / Station		March 2000	May 2000	August 2000	November 2000	Annual Mean
Upper Intertidal						
Open Water	LA1	3	2	3	2	3
	LA4	3	2	2	1	2
	LB1	3	2	2	2	2
Channel	LB2	2	2	2	2	2
Basin	LA2	1	2	3	2	2
	LA3	3	2	1	3	2
	LB3	3	2	3	3	3
	LB4	2	1	2	2	2
Lower Intertidal						
Open Water	LA1	7	4	3	4	5
	LA4	5	2	3	6	4
	LB1	10	2	2	8	6
Channel	LB2	3	2	2	3	3
Basin	LA2	2	1	2	2	2
	LA3	4	2	4	3	3
	LB3	3	3	4	5	4
	LB4	4	2	3	2	3
Subtidal						
Open Water	LA1	14	11	8	11	11
	LA4	6	3	2	12	6
	LB1	19	5	3	9	9
Channel	LB2	9	11	3	4	7
Basin	LA2	5	5	4	5	5
	LA3	5	4	2	5	4
	LB3	10	7	3	12	8
	LB4	13	10	3	7	8

Notes:
Values based on the mean of the two replicates, rounded to the nearest whole number
Algae not included

F.3 Summary Tables by Species

Riprap Quadrats
Mean abundance by species across tidal zones

		Open Water			Channel	Basin				Annual	Annual
Group	Species	LA1	LA4	LB1	LB2	LA2	LA3	LB3	LB4	Mean	Total
	Achelia echinata	0.1								0.02	1
	Achelia sp								0.1	0.02	1
	Acidostoma sp				0.5					0.06	2
	Allorchestes angusta	1.5	1.8	0.1		0.1	0.3			0.47	15
	Ammothea hilgendorfi	0.1		0.1						0.03	1
	Ammothella bi-unguiculata								0.3	0.03	1
	Ammothella sp								0.1	0.02	1
	Amphilochus sp				0.1		0.1		0.9	0.14	5
	Amphipod, unid.	0.3								0.03	1
	Ampithoe sp	0.4		0.3	3.4	1.3		1.9	0.3	0.92	30
	Aoroides cf secunda			0.3						0.03	1
	Aoroides sp	2.9	0.4	9.0	6.9	1.5	0.3	2.6	4.6	3.52	113
	Atylus tridens				0.4			0.8		0.14	5
	Balanus amphitrite amphitrite		0.1		1.3	5.4	0.3			0.88	28
	Balanus glandula	195.4	135.9	123.8	62.9	159.4	0.3	45.3	78.4	100.14	3205
	Balanus hesperius			0.8						0.09	3
	Balanus sp				0.1		0.1			0.03	1
	Balanus trigonus				0.3	0.1			0.1	0.06	2
	Calanoida (copepod)			0.1				0.1		0.03	1
	Caprella augusta	2.8		0.1				0.3		0.39	13
	Caprella californica			0.4	0.4			0.4		0.14	5
	Caprella mendax				1.0			0.8		0.22	7
	Caprella natalenis	0.5		0.5	2.1			4.0		0.89	29
	Caprella sp			0.8			0.1	0.1		0.13	4
	Caprella sp A	0.1	0.1							0.03	1
	Caprella verrucosa			0.1						0.02	1
	Caprellidae			0.1						0.02	1
	Chthalmus fissus	63.4	377.6	195.1	47.0	91.1	0.3	38.4	139.3	119.02	3809
	Cirolana diminuta	0.3								0.03	1
	Cirolana sp	0.8				0.3		0.3	0.1	0.17	6
	Cirripedia		0.3							0.03	1
	Corophiidae	0.1		0.3						0.05	2
	Corophium sp	0.5		0.1		0.1			0.9	0.20	7
	Cumella californica			0.3				0.1		0.05	2
	Cyclopoida				0.6			0.1		0.09	3
	Desdimelita desdichada				3.5	0.4				0.48	16
	Deutella californica								0.3	0.03	1
	Dynamenella sp	20.8	4.4	8.3	1.4	6.6	0.9	2.0		5.53	177
Crustaceans	Elasmopus sp	1.0	0.5		4.1				0.4	0.75	24
	Ericthonius brasiliensis			1.5				0.3	0.1	0.23	8
	Gammaropsis thompsoni	0.3	0.1	1.9				0.1	1.9	0.53	17
	Gitanopsis vilordes	0.1		0.3	0.9			0.3	0.3	0.22	7
	Harpacticoida	0.5	1.5	0.8	0.3	2.0		1.3	0.4	0.83	27
	Hemiproto sp							0.4		0.05	2
	Heptacarpus sp			0.1						0.02	1
	Heptacarpus taylori							0.3		0.03	1
	Hyale sp	17.1	5.0	1.1		1.6	1.1	6.0	3.6	4.45	143
	Ischyrocerus sp	0.4		2.8				0.1		0.41	13
	Janiralata sp					0.1				0.02	1
	Jassa slatteryi	4.8	0.4	0.3			0.1	0.4	2.5	1.05	34
	Joeropsis sp	9.1	1.0	4.1	7.4	0.8	0.3	19.3	13.1	6.88	220
	Laticorophium baconi	0.1						0.1		0.03	1
	Leptochelia dubia	1.5	4.0	2.0	0.5		0.4	1.8	1.5	1.45	47
	Leucothoe aluta	0.1			0.5			0.1	0.3	0.13	4
	Leucothoe sp	1.0								0.13	4
	Leucothoe spinicarpa						0.1			0.02	1
	Liljeborgia sp				0.3				0.4	0.08	3
	Lysianassidae					0.1				0.02	1
	Maera simile	1.1				0.9				0.25	8
	Megabalanus californicus			1.4		0.1				0.19	6
	Melita dentata			0.3						0.03	1
	Melita sp		0.3		3.5	0.1				0.48	16
	Microcerberidae	2.3								0.28	9
	Monocorophium insidiosum					2.3				0.28	9
	Mysidopsis sp							0.1		0.02	1
	Najna sp	0.1								0.02	1
	Opisthopus transversus					0.1				0.02	1
	Pachycheles pubescens	0.4								0.05	2
	Pachycheles rudis	1.3								0.16	5
	Pachycheles sp								0.1	0.02	1
	Pachygrapsus crassipes	0.4	0.4	0.3	0.1		0.3			0.17	6
	Paracerceis sp	1.1			2.0	3.3		1.9		1.03	33
	Paradexamine sp A							0.1		0.02	1
	Paramicrodeutopus schmitti	0.1		2.1			7.9	27.8	15.9	6.72	215
	Paranthura elegans	0.4			0.1	0.5		0.1		0.14	5
	Postasterope sp							7.3		0.91	29
	Petrolisthes sp							0.1		0.02	1

Riprap Quadrats
Mean abundance by species across tidal zones

Group	Species	Open Water			Channel	Basin				Annual	Annual
		LA1	LA4	LB1	LB2	LA2	LA3	LB3	LB4	Mean	Total
Crustaceans	Photis lacia		0.1							0.02	1
	Photis parvidons	21.8	1.4	7.4	0.9			1.1	16.4	6.11	196
	Photis sp				0.3				0.1	0.05	2
	Pinnixa sp	0.1						0.3		0.05	2
	Podocerus brasiliensis		0.1							0.02	1
	Podocerus cristatus		0.1							0.02	1
	Podocerus sp	2.0		0.5						0.31	10
	Pontogeneia sp			0.1						0.02	1
	Porcellanidae		0.1	0.6						0.09	3
	Pycnogonum stearnsi	0.9				0.1				0.13	4
	Stenothoe estacola	2.0		1.3					0.1	0.42	14
	Stenothoe sp		0.1	0.4						0.06	2
	Tanaidae	36.8	15.3	103.8	6.6	6.6	1.6	15.4	7.8	24.22	775
	Tetraclita rubescens	7.8	4.9	4.5				0.1	1.4	2.33	75
	Tritella pilimana			1.0						0.13	4
	Uromunna ubiquita	0.8		1.3				0.4	0.3	0.33	11
	Subtotal abundance	404.9	555.8	479.9	159.1	284.9	14.3	181.9	291.6	296.5	9490
	Subtotal number of taxa	45	25	44	30	25	17	40	31		94
Echinoderms	Amphioplus sp				0.3			12.9		1.64	53
	Amphipholis sp			0.3	1.0			12.6	8.0	2.73	88
	Amphipholis squamata				1.6		0.5	14.4	9.9	3.30	106
	Amphiuridae				0.1		0.3	6.0	5.3	1.45	47
	Echinoid	1.6		0.1				0.1	0.1	0.25	8
	Henricia sp			0.1						0.02	1
	Lytechinus pictus	0.3								0.03	1
	Ophiactis simplex	4.9	0.6		0.1			1.9	4.4	1.48	48
	Ophiuroidea				0.3			7.1	0.5	0.98	32
	Strongylocentrotus purpuratus	0.3	0.5	0.6				0.1	0.8	0.28	9
	Subtotal abundance	7.0	1.1	1.1	3.4	0.0	0.8	55.1	28.9	12.2	390
	Subtotal number of taxa	4	2	4	6		2	8	7		10
Molluscs	Acanthina spinata							0.3		0.03	1
	Aeolidoidea						0.1			0.02	1
	Alia carinata			1.4				0.1	0.1	0.20	7
	Ancula pacifica					0.1				0.02	1
	Astraea undosa				0.1				0.1	0.03	1
	Barleeia californica	6.6	0.1		0.6			1.3		1.08	35
	Barleeia sp							0.8	0.4	0.14	5
	Bivalvia							0.1		0.02	1
	Brachidontes adamisianus	0.3								0.03	1
	Chaetopleura sp	0.8								0.09	3
	Chama arcana	0.1					0.3	0.1		0.06	2
	Collisella digitalis			0.1						0.02	1
	Collisella limatula	1.0	4.5	1.0	3.1	5.1		2.8	2.6	2.52	81
	Collisella ochracea			0.8					1.6	0.30	10
	Collisella scabra	28.5	32.3	16.4	6.6	6.9		14.4	21.3	15.78	505
	Collisella sp	5.1	1.5	4.9	1.0	1.1		2.3	2.6	2.31	74
	Collisella strigatella				0.3					0.03	1
	Crassedoma giganteum			0.1						0.02	1
	Crassostrea gigas						2.1			0.27	9
	Crepidula dorsata	1.6		0.1	0.3			0.3		0.28	9
	Crepidula onyx			0.3	1.0	1.6			0.6	0.44	14
	Crepidula sp	0.3	0.1	0.1						0.06	2
	Doridoidea								0.4	0.05	2
	Fissurella volcano	0.3	0.3		0.1			0.6	0.1	0.17	6
	Gastropoda	0.5		0.1						0.08	3
	Haminaea vesicula				0.3					0.03	1
	Hiatella arctica	0.9	0.1	0.1						0.14	5
	Iselica ovoidea		2.8	0.4	1.3	0.4		1.8	0.5	0.88	28
	Kellia suborbicularis	0.1								0.02	1
	Lasaea adansoni	4.1	1.0		0.9	1.4		5.1	1.3	1.72	55
	Lasaea subviridis	78.4	3.4		1.1	1.0		29.6	12.0	15.69	502
	Lithophaga plumula	0.1								0.02	1
	Lithopoma undosum								0.1	0.02	1
	Littorina planaxis	2.0	10.0	2.1				0.6	10.0	3.09	99
	Littorina scutulata	1.3	5.0	0.3	1.0	0.1			2.8	1.30	42
	Lottia gigentea	0.1						1.1		0.16	5
	Lucapinella callomarginata	0.3	0.1		0.1			0.3	0.1	0.11	4
	Modiolus sp		0.1	0.3				0.1		0.06	2
	Mopalia muscosa	1.4	0.4							0.22	7
	Mopalia sp	5.1	0.9	2.5	1.0	0.4		0.1	0.8	1.34	43
	Mytilidae			0.1			0.1			0.03	1
	Mytilus galloprovincialis	62.3	43.3	72.1	11.1	3.9	0.1	41.1	11.3	30.64	981
	Mytilus sp			1.8						0.22	7
	Nassarina penicillata	0.1		0.3	0.1			2.5		0.38	12
	Navanax inermis								0.1	0.02	1
	Neoloricata	1.1	0.1	0.1				0.1		0.19	6
	Norrisia norrisi			0.3						0.03	1

Riprap Quadrats
Mean abundance by species across tidal zones

Group	Species	Open Water			Channel	Basin				Annual	Annual
		LA1	LA4	LB1	LB2	LA2	LA3	LB3	LB4	Mean	Total
	Notoacmea dipicta			0.1						0.02	1
	Octopus sp			0.1						0.02	1
	Odostomia sp	3.3				0.4		3.8	0.5	0.98	32
	Ostrea sp					0.1	1.3			0.17	6
	Ostreola conchaphila						0.5			0.06	2
	Philobrya setosa	0.8								0.09	3
	Pollicipes polymerus			0.1						0.02	1
	Polyplacophora	4.0								0.50	16
	Pteropurpura festiva	0.4				0.1	0.1	0.6		0.16	5
	Puncturella sp	0.5						0.4		0.11	4
Molluscs	Rimula sinezoides							0.1		0.02	1
	Rimula sp							0.1	0.3	0.05	2
	Roperia poulsoni	0.1		1.1						0.16	5
	Rupellaria tellimyalis					0.1				0.02	1
	Serpulorbis squamiger	0.4	0.1		0.1				0.1	0.09	3
	Sinezona rinoloides			0.9						0.11	4
	Sinezona sp							0.6		0.08	3
	Tegula brunnea				0.1					0.02	1
	Tegula gallina							0.6		0.08	3
	Subtotal abundance	211.6	106.0	107.9	30.3	22.8	4.6	111.6	69.6	83.0	2657
	Subtotal number of taxa	32	19	27	20	15	8	29	23		65
	Arabella iricolor			0.3					0.1	0.05	2
	Arabella sp	0.1	0.1	0.1						0.05	2
	Autolytus sp	0.5							0.3	0.09	3
	Autolytus sp 2	0.1								0.02	1
	Axiothella sp							0.5	2.3	0.34	11
	Boccardia basilaria	0.1								0.02	1
	Boccardia probosoidea	0.8	0.6	1.4					0.6	0.42	14
	Boccardia sp					0.1				0.02	1
	Boccardiella hamata	0.1								0.02	1
	Brania brevipharyngea	0.1	0.5	0.5	0.3	1.5			0.1	0.38	12
	Brania californiensis			2.6		0.3		3.3		0.77	25
	Brania sp		0.1	0.4				0.4		0.11	4
	Capitella "capitata"					0.1				0.02	1
	Capitellidae		0.1							0.02	1
	Caulleriella sp					0.3	0.1			0.05	2
	Chone ecaudata			0.1				0.4	0.5	0.13	4
	Chone sp		0.1							0.02	1
	Chrysopetalum occidentale					0.1				0.02	1
	Cirratulidae							0.1		0.02	1
	Cirratulus sp	0.1		0.3		0.1		0.9	0.5	0.23	8
	Cirriformia sp				0.1	0.3				0.05	2
	Cirriformia sp SD 2					0.3				0.03	1
	Cirriformia spirabrancha				0.4					0.05	2
	Cossura sp		0.1							0.02	1
	Ctenodrilus serratus	0.1								0.02	1
	Dipolydora giardi	0.1								0.02	1
	Dipolydora socialis						0.1			0.02	1
	Dodecaceria concharum	3.0							2.5	0.69	22
	Dodecaceria fewkesi	2.8								0.34	11
	Dorvillea (Schistomeringos) longicornis					0.3				0.03	1
Polychaetes	Eulalia quadrioculata			0.1						0.02	1
	Eusyllis sp	0.1								0.02	1
	Exogone lourei	0.5	3.3	1.0	0.5	4.5	0.1	4.0	0.9	1.84	59
	Exogone sp	0.1	0.5		0.1		0.1			0.11	4
	Exogone verugera	0.1								0.02	1
	Halosydna brevisetosa		0.5					0.3		0.09	3
	Halosydna johnsoni	0.3		0.5				0.4	0.3	0.17	6
	Hydroides pacificus			5.5	0.4				0.9	0.84	27
	Hydroides sp		0.1							0.02	1
	Maldanidae	0.1		0.1				0.4		0.08	3
	Naineris dendritica	0.1							0.3	0.05	2
	Naineris sp		0.3							0.03	1
	Neanthes acuminata			0.1						0.02	1
	Neanthes sp							0.3		0.03	1
	Nereididae	0.1		0.3	0.1					0.06	2
	Nereis grubei		0.4	1.1						0.19	6
	Nereis latescens			0.3						0.03	1
	Nereis mediator	1.3		1.0				0.1	0.1	0.31	10
	Nereis procera			0.1						0.02	1
	Nereis sp			0.3						0.03	1
	Nicolea gracilibranchis	1.0	1.3	1.0	0.3			7.0	0.8	1.41	45
	Odontosyllis sp		0.1	0.1						0.03	1
	Oenonidae				0.1					0.02	1
	Oligochaeta					0.4				0.05	2
	Orbiniidae				0.1					0.02	1
	Paleanotus bellis	0.1		0.6					0.1	0.11	4
	Perinereis montera	0.1		0.9					0.3	0.16	5
	Pionosyllis sp					0.1				0.02	1
	Platynereis bicanaliculata	0.1								0.02	1
	Polycirrus sp								0.1	0.02	1
	Polydora armata								0.1	0.02	1

Riprap Quadrats
Mean abundance by species across tidal zones

Group	Species	Open Water			Channel	Basin				Annual	Annual
		LA1	LA4	LB1	LB2	LA2	LA3	LB3	LB4	Mean	Total
Polychaetes	Polydora cornuta				0.1		0.1			0.03	1
	Polydora giardi	1.8		0.4		0.1		0.3	1.1	0.45	15
	Polydora ligni		0.1							0.02	1
	Polydora limicola	14.1		21.8				0.1	2.0	4.75	152
	Polydora sp	0.8	0.3	2.3			0.1	0.1		0.44	14
	Polydora websteri	0.1		0.6				0.3		0.13	4
	Polynoidae	0.4		0.1				0.1	0.1	0.09	3
	Polyophthalmus pictus		0.1	1.3						0.17	6
	Protocirrineris sp	1.6			1.9				1.4	0.61	20
	Pseudopolydora paucibranchiata				0.1					0.02	1
	Pseudopotamilla socialis	0.9							1.6	0.31	10
	Sabellidae				0.4			0.1		0.06	2
	Serpulidae	0.1	0.1	0.1	0.4					0.09	3
	Sphaerosyllis californiensis			0.3		0.9			0.3	0.17	6
	Spionidae			0.4						0.05	2
	Syllidae	0.4		0.1	0.1					0.08	3
	Syllis(Syllis) elongata			2.0					0.8	0.34	11
	Syllis(Syllis) gracilis	0.1			0.4			0.9	1.3	0.33	11
	Syllis(Typosyllis) fasciata		1.9	4.1						0.75	24
	Syllis(Typosyllis) nipponica				0.1	0.1		7.8		1.00	32
	Syllis(Typosyllis) orientalis							0.1		0.02	1
	Syllis(Typosyllis) pulchra	4.5	0.1	4.1	0.4			0.8	1.5	1.42	46
	Syllis(Typosyllis) sp	2.5	0.9	3.8	0.1			1.1	0.9	1.16	37
	Terebellidae			0.1						0.02	1
	Trypanosyllis gemmipara	0.1								0.02	1
	Trypanosyllis intermedia	0.1	0.5		0.1			0.1		0.11	4
	Subtotal abundance	39.6	12.1	60.0	6.5	9.4	0.8	29.6	21.5	22.4	718
	Subtotal number of taxa	39	23	39	21	16	6	25	28		87
Other Minor Phyla	Acanthoptilum sp			0.3						0.03	1
	Actiniidae			1.1						0.14	5
	Alcyonidium sp (colonial)			0.1						0.02	1
	Amathia sp (colonial)								0.1	0.02	1
	Amphiporus sp			0.6	0.1			0.1	0.1	0.13	4
	Anthopleura elegantissima	12.3	0.3	1.6						1.77	57
	Bugula pacifica (colonial)								0.1	0.02	1
	Celleporina sp (colonial)				0.1		0.3	0.1		0.06	2
	Chironomidae	0.9	0.6						0.1	0.20	7
	Ciona sp							0.1		0.02	1
	Crisia sp (colonial)						0.1			0.02	1
	Dendrostoma petraeum	0.8								0.09	3
	Diadumenidae						0.3			0.03	1
	Dolichopodidae	0.3						0.1		0.05	2
	Ectoprocta (colonial)	0.1				0.3	0.4			0.09	3
	Emplectonema gracilis		0.3	0.5	0.3				0.3	0.16	5
	Entoprocta (colonial)				0.1					0.02	1
	Epiactis prolifera	0.4								0.05	2
	Gobiesox rhessodon			0.4						0.05	2
	Hydrozoa (colonial)		0.1				0.1			0.03	1
	Leucosolenia sp							0.1	0.1	0.03	1
	Lineidae		0.1	0.1	0.1		0.1	0.1		0.08	3
	Micrura wilsoni				0.1					0.02	1
	Molgula sp			0.1						0.02	1
	Nematoda		2.8	0.6						0.42	14
	Nemertea	0.1	0.5	0.3	0.6				0.4	0.23	8
	Nemertopsis gracilis			1.0					2.8	0.47	15
	Nolella sp (colonial)							0.3		0.03	1
	Notoplana sp								0.1	0.02	1
	Paleonemertea							0.1		0.02	1
	Platyhelminthes			0.6	0.1			0.1	0.1	0.13	4
	Plumularia alicia (colonial)			0.1						0.02	1
	Plumularia sp (colonial)			0.1						0.02	1
	Porifera (colonial)	0.3			0.3		0.1			0.08	3
	Spinicirrus inequalis		0.4	2.1				0.3	0.4	0.39	13
	Spinicirrus sp	0.3	0.1						1.0	0.17	6
	Styela clara					0.1	0.1			0.03	1
	Styela sp		0.1		0.3					0.05	2
	Styela truncata			0.1			0.3			0.05	2
	Stylochus franciscanus			0.1						0.02	1
	Stylochus sp				0.1			0.3	0.5	0.11	4
	Syncoryne eximia				0.1					0.02	1
	Tetrastemma sp							0.4		0.05	2
	Thysanocardia nigra						0.1			0.02	1
	Triticella sp				0.1					0.02	1
	Urochordata			0.1	0.1					0.03	1
	Zygonemertes virescens			0.9						0.11	4
	Subtotal abundance	15.3	5.3	11.0	2.6	0.4	1.9	2.1	6.1	5.6	180
	Subtotal number of taxa	9	10	21	14	2	10	13	13		49

Riprap Quadrats
Mean abundance by species across tidal zones

		Open Water			Channel	Basin				Annual	Annual
Group	**Species**	**LA1**	**LA4**	**LB1**	**LB2**	**LA2**	**LA3**	**LB3**	**LB4**	**Mean**	**Total**
	Bryopsis hypnoides				P						P
	Ceramium taylorii	P									P
	Chaetomorpha californica	P									P
	Chonria arcuata	P									P
	Colonial diatoms		P		P						P
	Colpomenia sinuosa	P	P	P	P	P	P	P			P
	Corallina pinnatifolia	P		P	P			P			P
	Corallina vancouveriensis	P	P		P		P	P			P
	Dictyota flabellata				P			P			P
	Ectpcarpus parvus				P						P
	Enteromorpha compressa	P						P			P
	Enteromorpha linza	P		P		P					P
	Enteromorpha sp					P					P
	Giffordia granulosa							P			P
Algae	Gigantia canaliculata	P		P							P
	Gigantia sp		P								P
	Gigantia tepida	P									P
	Laminaria farlowii		P								P
	Macrocystis pyrifera		P								P
	Polysiphonia brodiaei					P					P
	Polysiphonia pacifica					P					P
	Rhizoclonium riparium	P									P
	Rhodoglossum affine		P								P
	Sargassum muticum							P			P
	Tiffaniella snyderiae	P		P				P			P
	Ulothrix flacca	P									P
	Ulva californica	P		P		P					P
	Ulva lactuca		P			P					P
	Subtotal number of taxa	14	8	6	7	7	2	8			28

P - Present

Riprap Quadrats
Mean annual abundance
Upper intertidal zone

Group	Species	Open Water			Channel	Basins				**Annual**	**Annual**
		LA1	LA4	LB1	LB2	LA2	LA3	LB3	LB4	**Mean**	**Total**
Crustaceans	Allorchestes angusta	0.8	0.5			0.1	0.3			0.20	7
	Aoroides sp			0.3						0.03	1
	Balanus amphitrite amphitrite				0.1	4.9	0.3			0.66	21
	Balanus glandula	90.4	114.8	31.5	45.3	81.8	0.1	27.8	42.9	54.30	1738
	Balanus hesperius			0.8						0.09	3
	Chthalmus fissus	44.9	283.0	72.0	21.0	25.3	0.3	21.8	76.5	68.08	2179
	Dynamenella sp	1.5	0.1		0.3	2.4		0.3		0.56	18
	Gitanopsis vilordes	0.1								0.02	1
	Hyale sp	11.6	3.5	0.4				3.8	0.4	2.45	79
	Janiralata sp					0.1				0.02	1
	Jassa slatteryi							0.1		0.02	1
	Joeropsis sp								0.3	0.03	1
	Leptochelia dubia			0.3	0.1					0.05	2
	Megabalanus californicus					0.1				0.02	1
	Najna sp	0.1								0.02	1
	Pachygrapsus crassipes						0.1			0.02	1
	Paracerceis sp				1.1			1.0		0.27	9
	Paramicrodeutopus schmitti	0.1								0.02	1
	Photis lacia		0.1							0.02	1
	Photis parvidons			0.8						0.09	3
	Photis sp				0.3				0.1	0.05	2
	Tanaidae		0.4						0.1	0.06	2
	Tetraclita rubescens	0.5	0.3							0.09	3
Echinoderms	Amphioplus sp				0.3					0.03	1
	Amphiuridae								0.1	0.02	1
	Ophiuroidea				0.3					0.03	1
Molluscs	Alia carinata								0.1	0.02	1
	Barleeia californica				0.1					0.02	1
	Barleeia sp								0.1	0.02	1
	Brachidontes adamisianus	0.1								0.02	1
	Chama arcana						0.3			0.03	1
	Collisella digitalis			0.1						0.02	1
	Collisella limatula	0.6	0.1	0.8	0.4	1.3		2.4	0.3	0.72	23
	Collisella scabra	7.5	20.3	7.4	3.3	2.9		9.1	5.9	7.03	225
	Collisella sp	1.0	1.0	2.0				0.1	0.4	0.56	18
	Crassostrea gigas						0.5			0.06	2
	Iselica ovoidea					0.1			0.3	0.05	2
	Lasaea adansoni	4.0	0.4		0.8	0.8		2.9	1.3	1.25	40
	Lasaea subviridis	15.6	2.1		1.0	0.1		0.1	1.5	2.56	82
	Littorina planaxis	2.0	10.0	1.6				0.4	8.6	2.83	91
	Littorina scutulata	1.3	5.0	0.3	1.0	0.1			1.8	1.17	38
	Lottia gigentea	0.1						1.0		0.14	5
	Lucapinella callomarginata							0.1		0.02	1
	Mopalia muscosa	0.1								0.02	1
	Mytilus galloprovincialis	4.5	0.1					0.1		0.59	19
	Nassarina penicillata			0.1	0.1					0.03	1
	Ostrea sp						0.4			0.05	2
	Ostreola conchaphila						0.4			0.05	2
Polychaetes	Boccardia probosoidea		0.3							0.03	1
	Cossura sp		0.1							0.02	1
	Exogone sp						0.1			0.02	1
	Oenonidae				0.1					0.02	1
	Trypanosyllis intermedia	0.1								0.02	1
Other Minor Phyla	Acanthoptilum sp			0.3						0.03	1
	Anthopleura elegantissima	0.5								0.06	2
	Chironomidae	0.9							0.1	0.13	4
	Dolichopodidae	0.3						0.1		0.05	2
	Hydrozoa (colonial)		0.1							0.02	1
	Nemertea				0.1					0.02	1
	Platyhelminthes							0.1		0.02	1
	Triticella sp				0.1					0.02	1
Algae	Colpomenia sinuosa					P					
	Corallina pinnatifolia	P									
	Enteromorpha compressa	P						P			
	Total	189	442	118	76	120	3	71	141	144.9	4636

Notes:
P = Present
Values based on the mean of the two replicates, rounded to the nearst whole number

Riprap Quadrats
Mean annual abundance
Subtidal zone

Group	Species	Open Water			Channel	Basins				Annual	Annual
		LA1	LA4	LB1	LB2	LA2	LA3	LB3	LB4	Mean	Total
	Achelia echinata	0.1								0.02	1
	Achelia sp								0.1	0.02	1
	Acidostoma sp				0.5					0.06	2
	Ammothea hilgendorfi	0.1								0.02	1
	Ammothella bi-unguiculata								0.3	0.03	1
	Ammothella sp								0.1	0.02	1
	Amphilochus sp				0.1		0.1		0.9	0.14	5
	Amphipod, unid.	0.3								0.03	1
	Ampithoe sp	0.4		0.3	3.4	1.1		1.9	0.3	0.91	29
	Aoroides cf secunda			0.3						0.03	1
	Aoroides sp	2.9	0.4	8.6	6.8	1.5	0.3	2.6	4.6	3.45	111
	Atylus tridens				0.4			0.8		0.14	5
	Balanus amphitrite amphitrite				0.1	0.3				0.05	2
	Balanus glandula	12.3	2.3	40.9	0.8	20.6		0.5	5.1	10.30	330
	Balanus sp						0.1			0.02	1
	Balanus trigonus				0.3	0.1			0.1	0.06	2
	Calanoida (copepod)			0.1				0.1		0.03	1
	Caprella augusta	2.8						0.3		0.38	12
	Caprella californica			0.4	0.4			0.4		0.14	5
	Caprella mendax				1.0			0.8		0.22	7
	Caprella natalenis	0.5		0.5	2.1			4.0		0.89	29
	Caprella sp			0.8			0.1	0.1		0.13	4
	Caprella sp A	0.1	0.1							0.03	1
	Caprella verrucosa			0.1						0.02	1
	Caprellidae			0.1						0.02	1
	Chthalmus fissus	5.5	14.5	42.5	16.9	8.9		2.9	14.5	13.20	423
	Cirolana sp	0.5						0.1	0.1	0.09	3
	Cirripedia		0.3							0.03	1
	Corophiidae	0.1		0.3						0.05	2
	Corophium sp	0.5		0.1		0.1			0.9	0.20	7
	Cumella californica			0.3				0.1		0.05	2
	Cyclopoida				0.1					0.02	1
	Desdimelita desdichada				3.5	0.4				0.48	16
	Deutella californica								0.3	0.03	1
	Dynamenella sp	2.9		0.3	0.4	1.4				0.61	20
	Elasmopus sp	1.0	0.5		4.1				0.4	0.75	24
	Ericthonius brasiliensis			1.5				0.3	0.1	0.23	8
	Gammaropsis thompsoni	0.3	0.1	1.9				0.1	1.9	0.53	17
Crustaceans	Gitanopsis vilordes			0.3	0.9			0.3	0.3	0.20	7
	Harpacticoida	0.5	1.0	0.5	0.3	1.4		0.9	0.1	0.58	19
	Hemiproto sp							0.4		0.05	2
	Heptacarpus sp			0.1						0.02	1
	Heptacarpus taylori							0.3		0.03	1
	Hyale sp	2.4				1.6			0.1	0.52	17
	Ischyrocerus sp	0.4		2.8				0.1		0.41	13
	Jassa slatteryi	4.8	0.4	0.3			0.1	0.3	2.5	1.03	33
	Joeropsis sp	8.1	1.0	1.5	7.4	0.8	0.3	19.1	12.9	6.38	204
	Laticorophium baconi	0.1						0.1		0.03	1
	Leptochelia dubia	1.5	0.5	0.6	0.4		0.4	1.8	1.4	0.81	26
	Leucothoe aluta	0.1			0.5			0.1	0.3	0.13	4
	Leucothoe sp	1.0								0.13	4
	Leucothoe spinicarpa						0.1			0.02	1
	Liljeborgia sp				0.3				0.4	0.08	3
	Lysianassidae					0.1				0.02	1
	Maera simile	1.1				0.9				0.25	8
	Megabalanus californicus			1.4						0.17	6
	Melita dentata			0.3						0.03	1
	Melita sp				3.5					0.44	14
	Monocorophium insidiosum					2.3				0.28	9
	Mysidopsis sp							0.1		0.02	1
	Opisthopus transversus					0.1				0.02	1
	Pachycheles pubescens	0.4								0.05	2
	Pachycheles rudis	1.3								0.16	5
	Pachycheles sp								0.1	0.02	1
	Pachygrapsus crassipes	0.1		0.1						0.03	1
	Paracerceis sp	1.1			0.1					0.16	5
	Paradexamine sp A							0.1		0.02	1
	Paramicrodeutopus schmitti			2.0			7.4	27.8	15.9	6.63	212
	Paranthura elegans	0.4			0.1	0.4		0.1		0.13	4
	Postasterope sp							7.3		0.91	29
	Photis parvidons	21.8	1.1	5.9	0.9			1.1	16.4	5.89	189
	Pinnixa sp	0.1						0.3		0.05	2
	Podocerus brasiliensis		0.1							0.02	1
	Podocerus sp	2.0		0.5						0.31	10
	Pontogeneia sp			0.1						0.02	1
	Porcellanidae			0.1						0.02	1
	Pycnogonum stearnsi	0.5								0.06	2
	Stenothoe estacola	2.0		1.3					0.1	0.42	14
	Tanaidae	34.3	2.0	95.0	6.4	6.6	1.1	15.4	7.6	21.05	674
Crustaceans	Tetraclita rubescens	2.5	1.0	1.6					1.3	0.80	26
	Tritella pilimana			1.0						0.13	4
	Uromunna ubiquita	0.8		1.3				0.4	0.3	0.33	11
	Amphioplus sp							12.9		1.61	52
	Amphipholis sp			0.3	1.0			12.6	8.0	2.73	88
	Amphipholis squamata				1.6			14.4	9.9	3.23	104

Riprap Quadrats
Mean annual abundance
Subtidal zone

Group	Species	Open Water			Channel	Basins				**Annual**	**Annual**
		LA1	LA4	LB1	LB2	LA2	LA3	LB3	LB4	**Mean**	**Total**
Echinoderms	Amphiuridae				0.1			6.0	5.1	1.41	45
	Echinoid	1.6		0.1				0.1	0.1	0.25	8
	Henricia sp			0.1						0.02	1
	Lytechinus pictus	0.3								0.03	1
	Ophiactis simplex	4.6	0.6		0.1			1.9	4.4	1.45	47
	Ophiuroidea							7.1	0.5	0.95	31
	Strongylocentrotus purpuratus	0.3	0.5	0.6				0.1	0.8	0.28	9
Molluscs	Acanthina spinata							0.3		0.03	1
	Alia carinata			1.4				0.1		0.19	6
	Ancula pacifica					0.1				0.02	1
	Astraea undosa				0.1				0.1	0.03	1
	Barleeia californica	0.4			0.5			1.3		0.27	9
	Barleeia sp							0.8	0.3	0.13	4
	Chama arcana	0.1						0.1		0.03	1
	Collisella limatula	0.3	1.9		1.8	1.3		0.1	0.9	0.77	25
	Collisella ochracea			0.5					1.6	0.27	9
	Collisella scabra	4.1	1.4	1.0	2.1	0.3		1.9	2.0	1.59	51
	Collisella sp	1.3	0.5	1.5	0.8	0.6		1.9	2.3	1.09	35
	Collisella strigatella				0.3					0.03	1
	Crassedoma giganteum			0.1						0.02	1
	Crassostrea gigas						0.8			0.09	3
	Crepidula dorsata	1.6		0.1	0.3			0.3		0.28	9
	Crepidula onyx			0.1	1.0	1.5			0.6	0.41	13
	Crepidula sp	0.3	0.1	0.1						0.06	2
	Doridoidea								0.4	0.05	2
	Fissurella volcano	0.3	0.3		0.1			0.5	0.1	0.16	5
	Gastropoda	0.5		0.1						0.08	3
	Hiatella arctica	0.6	0.1	0.1						0.11	4
	Iselica ovoidea		0.5	0.4	1.1			1.8	0.3	0.50	16
	Lasaea adansoni		0.1		0.1			0.1		0.05	2
	Lasaea subviridis	0.1						0.3		0.05	2
	Lithophaga plumula	0.1								0.02	1
	Lithopoma undosum								0.1	0.02	1
	Lottia gigentea							0.1		0.02	1
	Lucapinella callomarginata		0.1		0.1			0.1	0.1	0.06	2
	Modiolus sp			0.3						0.03	1
	Mopalia muscosa	0.5	0.1							0.08	3
	Mopalia sp	2.8	0.3	1.3	0.3	0.4		0.1	0.5	0.69	22
	Mytilus galloprovincialis	5.9	13.0	37.0	5.9	1.0		19.9	6.5	11.14	357
	Mytilus sp			1.8						0.22	7
	Nassarina penicillata	0.1		0.1				2.5		0.34	11
	Navanax inermis								0.1	0.02	1
	Neoloricata		0.1	0.1						0.03	1
	Norrisia norrisi			0.1						0.02	1
	Notoacmea dipicta			0.1						0.02	1
	Octopus sp			0.1						0.02	1
	Odostomia sp	0.8						3.8	0.5	0.63	20
	Ostreola conchaphila						0.1			0.02	1
	Philobrya setosa	0.8								0.09	3
	Pteropurpura festiva	0.4				0.1		0.6		0.14	5
	Puncturella sp	0.5						0.4		0.11	4
	Rimula sinezoides							0.1		0.02	1
	Rimula sp							0.1	0.3	0.05	2
	Roperia poulsoni	0.1		1.0						0.14	5
	Rupellaria tellimyalis					0.1				0.02	1
	Serpulorbis squamiger	0.4	0.1		0.1				0.1	0.09	3
	Sinezona rinoloides			0.9						0.11	4
	Sinezona sp							0.6		0.08	3
	Tegula gallina							0.6		0.08	3

Riprap Quadrats
Mean annual abundance
Subtidal zone

		Open Water			Channel	Basins				Annual	Annual
Group	Species	LA1	LA4	LB1	LB2	LA2	LA3	LB3	LB4	Mean	Total
Polychaetes	Arabella iricolor			0.3					0.1	0.05	2
	Arabella sp			0.1						0.02	1
	Autolytus sp	0.3							0.3	0.06	2
	Autolytus sp 2	0.1								0.02	1
	Axiothella sp							0.5	2.3	0.34	11
	Boccardia basilaria	0.1								0.02	1
	Boccardia probosoidea	0.1		1.4					0.3	0.22	7
	Brania brevipharyngea	0.1	0.3	0.5	0.3	1.3			0.1	0.31	10
	Brania californiensis			2.6		0.1		3.3		0.75	24
	Brania sp			0.4				0.4		0.09	3
	Capitella "capitata"					0.1				0.02	1
	Caulleriella sp					0.3	0.1			0.05	2
	Chone ecaudata			0.1				0.4	0.5	0.13	4
	Chrysopetalum occidentale					0.1				0.02	1
	Cirratulidae							0.1		0.02	1
	Cirratulus sp	0.1		0.1		0.1		0.8	0.5	0.20	7
	Cirriformia sp				0.1	0.1				0.03	1
	Cirriformia sp SD 2					0.3				0.03	1
	Cirriformia spirabrancha				0.4					0.05	2
	Ctenodrilus serratus	0.1								0.02	1
	Dipolydora giardi	0.1								0.02	1
	Dodecaceria concharum	3.0							2.5	0.69	22
	Dodecaceria fewkesi	2.8								0.34	11
	Dorvillea (Schistomeringos) longicornis					0.3				0.03	1
	Eulalia quadrioculata			0.1						0.02	1
	Eusyllis sp	0.1								0.02	1
	Exogone lourei	0.5	1.1	1.0	0.5	3.9	0.1	4.0	0.9	1.50	48
	Exogone sp	0.1			0.1					0.03	1
	Halosydna brevisetosa		0.5					0.3		0.09	3
	Halosydna johnsoni	0.3		0.5				0.4	0.3	0.17	6
	Hydroides pacificus			4.6	0.3				0.5	0.67	22
	Hydroides sp		0.1							0.02	1
	Maldanidae			0.1				0.4		0.06	2
	Naineris dendritica	0.1							0.3	0.05	2
	Naineris sp		0.1							0.02	1
	Neanthes acuminata			0.1						0.02	1
	Neanthes sp							0.3		0.03	1
	Nereididae	0.1		0.1	0.1					0.05	2
	Nereis grubei			0.8						0.09	3
	Nereis latescens			0.1						0.02	1
	Nereis mediator	0.9		0.8				0.1	0.1	0.23	8
	Nereis procera			0.1						0.02	1
	Nereis sp			0.3						0.03	1
	Nicolea gracilibranchis	1.0	1.1	1.0	0.3			7.0	0.8	1.39	45
	Odontosyllis sp			0.1						0.02	1
	Oligochaeta					0.4				0.05	2
	Orbiniidae				0.1					0.02	1
	Paleanotus bellis			0.6					0.1	0.09	3
	Perinereis montera			0.1						0.02	1
	Pionosyllis sp					0.1				0.02	1
	Platynereis bicanaliculata	0.1								0.02	1
	Polycirrus sp								0.1	0.02	1
	Polydora armata								0.1	0.02	1
	Polydora cornuta				0.1					0.02	1
	Polydora giardi	1.4				0.1		0.3	1.1	0.36	12
	Polydora limicola	6.4		18.0				0.1	2.0	3.31	106
	Polydora sp	0.3	0.3	1.1			0.1	0.1		0.23	8
	Polydora websteri	0.1								0.02	1
	Polynoidae	0.4		0.1				0.1	0.1	0.09	3
	Polyophthalmus pictus			0.9						0.11	4
	Protocirrineris sp	1.6			1.9				1.4	0.61	20
	Pseudopolydora paucibranchiata				0.1					0.02	1
	Pseudopotamilla socialis	0.9							1.6	0.31	10
	Sabellidae				0.4			0.1		0.06	2
	Serpulidae		0.1	0.1	0.4					0.08	3
	Sphaerosyllis californiensis			0.3		0.9			0.3	0.17	6
	Spionidae			0.4						0.05	2
	Syllidae	0.3			0.1					0.05	2
	Syllis(Syllis) elongata			0.3						0.03	1
	Syllis(Syllis) gracilis	0.1			0.4			0.9	1.3	0.33	11
	Syllis(Typosyllis) fasciata			2.5						0.31	10
	Syllis(Typosyllis) nipponica				0.1	0.1		7.8		1.00	32
	Syllis(Typosyllis) pulchra	2.9		3.4	0.4				1.4	1.00	32
	Syllis(Typosyllis) sp	0.6		3.4	0.1			1.0	0.8	0.73	24
	Terebellidae			0.1						0.02	1
	Trypanosyllis gemmipara	0.1								0.02	1

Riprap Quadrats
Mean annual abundance
Subtidal zone

Group	Species	Open Water			Channel	Basins				Annual	Annual
		LA1	LA4	LB1	LB2	LA2	LA3	LB3	LB4	**Mean**	**Total**
Other Minor Phyla	Actiniidae			1.1						0.14	5
	Alcyonidium sp (colonial)			0.1						0.02	1
	Amathia sp (colonial)								0.1	0.02	1
	Amphiporus sp			0.4						0.05	2
	Anthopleura elegantissima	2.4	0.3	0.5						0.39	13
	Bugula pacifica (colonial)								0.1	0.02	1
	Celleporina sp (colonial)				0.1		0.3	0.1		0.06	2
	Ciona sp							0.1		0.02	1
	Crisia sp (colonial)						0.1			0.02	1
	Dendrostoma petraeum	0.8								0.09	3
	Diadumenidae						0.1			0.02	1
	Ectoprocta (colonial)	0.1				0.1	0.3			0.06	2
	Entoprocta (colonial)				0.1					0.02	1
	Gobiesox rhessodon			0.4						0.05	2
	Hydrozoa (colonial)						0.1			0.02	1
	Leucosolenia sp							0.1	0.1	0.03	1
	Lineidae			0.1			0.1			0.03	1
	Micrura wilsoni				0.1					0.02	1
	Molgula sp			0.1						0.02	1
	Nematoda		0.1							0.02	1
	Nemertea			0.3	0.4				0.4	0.13	4
	Nemertopsis gracilis			0.1					0.9	0.13	4
	Nolella sp (colonial)							0.3		0.03	1
	Platyhelminthes			0.4	0.1				0.1	0.08	3
	Plumularia alicia (colonial)			0.1						0.02	1
	Plumularia sp (colonial)			0.1						0.02	1
	Porifera (colonial)	0.3			0.3		0.1			0.08	3
	Spinicirrus inequalis			2.0				0.3	0.4	0.33	11
	Spinicirrus sp	0.1							1.0	0.14	5
	Styela clara					0.1	0.1			0.03	1
	Styela sp		0.1		0.3					0.05	2
	Styela truncata			0.1			0.3			0.05	2
	Stylochus franciscanus			0.1						0.02	1
	Stylochus sp				0.1			0.1	0.4	0.08	3
	Syncoryne eximia				0.1					0.02	1
	Tetrastemma sp							0.4		0.05	2
	Thysanocardia nigra						0.1			0.02	1
	Urochordata			0.1	0.1					0.03	1
Algae	Bryopsis hypnoides				P						
	Ceramium taylorii	P									
	Chonria arcuata	P									
	Colonial diatoms		P		P						
	Colpomenia sinuosa	P	P	P	P		P	P			
	Corallina pinnatifolia	P		P	P			P			
	Corallina vancouveriensis	P	P		P		P	P			
	Dictyota flabellata				P			P			
	Ectpcarpus parvus				P						
	Enteromorpha linza			P							
	Enteromorpha sp					P					
	Giffordia granulosa							P			
	Gigantia canaliculata	P									
	Gigantia sp		P								
	Gigantia tepida	P									
	Laminaria farlowii		P								
	Macrocystis pyrifera		P								
	Polysiphonia brodiaei					P					
	Polysiphonia pacifica					P					
	Rhodoglossum affine		P								
	Sargassum muticum							P			
	Tiffaniella snyderiae	P						P			
	Ulothrix flacca	P									
	Ulva californica			P							
	Ulva lactuca		P			P					
	Total	174.5	49.1	317.4	86.6	62.3	12.9	213.6	157.6	134.3	4296

Notes:
P = Present
Values based on the mean of the two replicates, rounded to the nearst whole number

Riprap Quadrats

Mean annual abundance

Lower intertidal zone

Group	Species	Open Water			Channel	Basins				**Annual**	**Annual**
		LA1	LA4	LB1	LB2	LA2	LA3	LB3	LB4	**Mean**	**Total**
	Allorchestes angusta	0.8	1.3	0.1						0.27	9
	Ammothea hilgendorfi			0.1						0.02	1
	Ampithoe sp					0.1				0.02	1
	Aoroides sp			0.1	0.1					0.03	1
	Balanus amphitrite amphitrite		0.1		1.0	0.3				0.17	6
	Balanus glandula	92.8	18.9	51.4	16.9	57.0	0.1	17.0	30.4	35.55	1138
	Balanus sp				0.1					0.02	1
	Caprella augusta			0.1						0.02	1
	Chthalmus fissus	13.0	80.1	80.6	9.1	57.0		13.8	48.3	37.73	1208
	Cirolana diminuta	0.3								0.03	1
	Cirolana sp	0.3				0.3		0.1		0.08	3
	Cyclopoida				0.5			0.1		0.08	3
	Dynamenella sp	16.4	4.3	8.0	0.8	2.9	0.9	1.8		4.36	140
	Harpacticoida		0.5	0.3		0.6		0.4	0.3	0.25	8
	Hyale sp	3.1	1.5	0.8			1.1	2.3	3.1	1.48	48
Crustaceans	Joeropsis sp	1.0		2.6				0.1		0.47	15
	Leptochelia dubia		3.5	1.1					0.1	0.59	19
	Melita sp		0.3			0.1				0.05	2
	Microcerberidae	2.3								0.28	9
	Pachygrapsus crassipes	0.3	0.4	0.1	0.1		0.1			0.13	4
	Paracerceis sp				0.8	3.3		0.9		0.61	20
	Paramicrodeutopus schmitti			0.1			0.5			0.08	3
	Paranthura elegans					0.1				0.02	1
	Petrolisthes sp							0.1		0.02	1
	Photis parvidons		0.3	0.8						0.13	4
	Podocerus cristatus		0.1							0.02	1
	Porcellanidae		0.1	0.5						0.08	3
	Pycnogonum stearnsi	0.4				0.1				0.06	2
	Stenothoe sp		0.1	0.4						0.06	2
	Tanaidae	2.5	12.9	8.8	0.3		0.5			3.11	100
	Tetraclita rubescens	4.8	3.6	2.9				0.1	0.1	1.44	46
	Amphipholis squamata						0.5			0.06	2
Echinoderms	Amphiuridae						0.3			0.03	1
	Ophiactis simplex	0.3								0.03	1
	Aeolidoidea						0.1			0.02	1
	Barleeia californica	6.3	0.1							0.80	26
	Bivalvia							0.1		0.02	1
	Brachidontes adamisianus	0.1								0.02	1
	Chaetopleura sp	0.8								0.09	3
	Collisella limatula	0.1	2.5	0.3	1.0	2.6		0.3	1.5	1.03	33
	Collisella ochracea			0.3						0.03	1
	Collisella scabra	16.9	10.6	8.0	1.3	3.8		3.4	13.4	7.16	229
	Collisella sp	2.9		1.4	0.3	0.5		0.3		0.66	21
	Crassostrea gigas						0.9			0.11	4
	Crepidula onyx			0.1		0.1				0.03	1
	Fissurella volcano							0.1		0.02	1
	Haminaea vesicula				0.3					0.03	1
	Hiatella arctica	0.3								0.03	1
	Iselica ovoidea		2.3		0.1	0.3				0.33	11
	Kellia suborbicularis	0.1								0.02	1
	Lasaea adansoni	0.1	0.5			0.6		2.1		0.42	14
Molluscs	Lasaea subviridis	62.6	1.3		0.1	0.9		29.3	10.5	13.08	419
	Littorina planaxis			0.5				0.3	1.4	0.27	9
	Littorina scutulata								1.0	0.13	4
	Lucapinella callomarginata	0.3								0.03	1
	Modiolus sp		0.1					0.1		0.03	1
	Mopalia muscosa	0.8	0.3							0.13	4
	Mopalia sp	2.4	0.6	1.3	0.8				0.3	0.66	21
	Mytilidae			0.1			0.1			0.03	1
	Mytilus galloprovincialis	51.9	30.1	35.1	5.3	2.9	0.1	21.1	4.8	18.91	605
	Neoloricata	1.1						0.1		0.16	5
	Norrisia norrisi			0.1						0.02	1
	Odostomia sp	2.5				0.4				0.36	12
	Ostrea sp					0.1	0.9			0.13	4
	Pollicipes polymerus			0.1						0.02	1
	Polyplacophora	4.0								0.50	16
	Pteropurpura festiva						0.1			0.02	1
	Roperia poulsoni			0.1						0.02	1
	Tegula brunnea				0.1					0.02	1
	Arabella sp	0.1	0.1							0.03	1
	Autolytus sp	0.3								0.03	1
	Boccardia probosoidea	0.6	0.4						0.4	0.17	6
	Boccardia sp					0.1				0.02	1
	Boccardiella hamata	0.1								0.02	1
Polychaetes	Brania brevipharyngea		0.3			0.3				0.06	2
	Brania californiensis					0.1				0.02	1
	Brania sp		0.1							0.02	1
	Capitellidae		0.1							0.02	1
	Chone sp		0.1							0.02	1
	Cirratulus sp			0.1				0.1		0.03	1
	Cirriformia sp					0.1				0.02	1
	Dipolydora socialis						0.1			0.02	1
	Exogone lourei		2.1			0.6				0.34	11
	Exogone sp		0.5							0.06	2
	Exogone verugera	0.1								0.02	1
	Hydroides pacificus			0.9	0.1				0.4	0.17	6
	Maldanidae	0.1								0.02	1
	Naineris sp		0.1							0.02	1

Riprap Quadrats
Mean annual abundance
Lower intertidal zone

Group	Species	Open Water			Channel	Basins				Annual	Annual
		LA1	LA4	LB1	LB2	LA2	LA3	LB3	LB4	Mean	Total
Polychaetes	Nereididae			0.1						0.02	1
	Nereis grubei		0.4	0.4						0.09	3
	Nereis latescens			0.1						0.02	1
	Nereis mediator	0.4		0.3						0.08	3
	Nicolea gracilibranchis		0.1							0.02	1
	Odontosyllis sp		0.1							0.02	1
	Paleanotus bellis	0.1								0.02	1
	Perinereis montera	0.1		0.8					0.3	0.14	5
	Polydora cornuta						0.1			0.02	1
	Polydora giardi	0.4		0.4						0.09	3
	Polydora ligni		0.1							0.02	1
	Polydora limicola	7.8		3.8						1.44	46
	Polydora sp	0.5		1.1						0.20	7
	Polydora websteri			0.6				0.3		0.11	4
	Polyophthalmus pictus		0.1	0.4						0.06	2
	Serpulidae	0.1								0.02	1
	Syllidae	0.1		0.1						0.03	1
	Syllis(Syllis) elongata			1.8					0.8	0.31	10
	Syllis(Typosyllis) fasciata		1.9	1.6						0.44	14
	Syllis(Typosyllis) orientalis							0.1		0.02	1
	Syllis(Typosyllis) pulchra	1.6	0.1	0.8				0.8	0.1	0.42	14
	Syllis(Typosyllis) sp	1.9	0.9	0.4				0.1	0.1	0.42	14
	Trypanosyllis intermedia		0.5		0.1			0.1		0.09	3
Other Minor Phyla	Amphiporus sp			0.3	0.1			0.1	0.1	0.08	3
	Anthopleura elegantissima	9.4		1.1						1.31	42
	Chironomidae		0.6							0.08	3
	Diadumenidae						0.1			0.02	1
	Ectoprocta (colonial)					0.1	0.1			0.03	1
	Emplectonema gracilis		0.3	0.5	0.3				0.3	0.16	5
	Epiactis prolifera	0.4								0.05	2
	Lineidae		0.1		0.1			0.1		0.05	2
	Nematoda		2.6	0.6						0.41	13
	Nemertea	0.1	0.5		0.1					0.09	3
	Nemertopsis gracilis			0.9					1.9	0.34	11
	Notoplana sp								0.1	0.02	1
	Paleonemertea							0.1		0.02	1
	Platyhelminthes			0.3						0.03	1
	Spinicirrus inequalis		0.4	0.1						0.06	2
	Spinicirrus sp	0.1	0.1							0.03	1
	Stylochus sp							0.1	0.1	0.03	1
	Zygonemertes virescens			0.9						0.11	4
Algae	Ceramium taylorii	P									
	Chaetomorpha californica	P									
	Colpomenia sinuosa		P	P							
	Corallina vancouveriensis	P	P								
	Enteromorpha compressa	P									
	Enteromorpha linza	P				P					
	Enteromorpha sp					P					
	Gigantia canaliculata			P							
	Gigantia tepida	P									
	Rhizoclonium riparium	P									
	Tiffaniella snyderiae			P							
	Ulothrix flacca	P									
	Ulva californica	P				P					
	Ulva lactuca					P					
	Total	315	189	224	40	135	7	96	120	138	4502

Notes:
P = Present
Values based on the mean of the two replicates, rounded to the nearst whole number

F.4 Raw Data – Quadrats

March 2000
Riprap Quadrat Invertebrate Data (2 replicates)

	LA1		LA2		LA3		LA4		LB1		LB2		LB3		LB4	
	Upper intertidal															
CRUSTACEANS																
Allorchestes angusta	3	3			2											
Balanus glandula	109	88	97	161			33	68	39		51	138	35	3	23	79
Balanus hesperius										6						
Chthalmus fissus	1	9	8	2			29	101	4	26	6	61	10	22	9	88
Dynamenella sp	4	8														
Gitanopsis vilordes	1															
Hyale sp													2			
Jassa slatteryi													1			
Joeropsis sp															1	
Leptochelia dubia												1				
Paracerceis sp												6	2			
Photis sp												2				
Tetraclita rubescens	1	3														
ECHINODERMS																
Amphioplus sp											2					
Ophiuroidea											2					
MINOR PHYLA																
Acanthoptilum sp										2						
Chironomidae	7														1	
Dolichopodidae	2												1			
Hydrozoa (colonial)							1									
Nemertea											1					
Platyhelminthes													1			
Triticella sp											1					
anthopleura elegantissima	1	3														
MOLLUSCS																
Alia carinata															1	
Barleeia californica											1					
Brachidontes adamisianus	1															
Chama arcana					1	1										
Collisella limatula			5	4					1			2	3	3		
Collisella scabra	12	14	1				28	14	18	8		3	4	2		
Collisella sp	1	1														1
Iselica ovoidea			1												2	
Lasaea subviridis	48	10										8			4	
Littorina planaxis							2	51	1	1			2		19	15
Littorina scutulata							3									
Lottia gigentea	1												1	7		
Lucapinella callomarginata													1			
Mopalia muscosa		1														
Mytilus galloprovincialis	20	16											1			
Nassarina penicillata										1	1					
Ostrea sp					2	1										
POLYCHAETES																
Boccardia probosoidea							2									
Cossura sp							1									
Exogone sp						1										
Oenonidae											1					
Trypanosyllis intermedia		1														

March 2000
Riprap Quadrat Invertebrate Data (2 replicates)

	LA1		LA2		LA3		LA4		LB1		LB2		LB3		LB4	
	Lower intertidal															
CRUSTACEANS																
Allorchestes angusta	4	2					2	1								
Ammothea hilgendorfi										1						
Aoroides sp											1					
Balanus glandula	64	98	35	26	1		10	18	6		12	26	4	21	5	16
Chthalmus fissus							3	4	3		1	3	1	8		6
Cirolana diminuta	1	1														
Dynamenella sp	16						11	4	6							
Harpacticoida				3						2				2	2	
Hyale sp							3							1		
Joeropsis sp		2								3						
Leptochelia dubia									7							
Pachygrapsus crassipes						1	1	1		1	1					
Paracerceis sp				1							1					
Paramicrodeutopus schmitti										1						
Photis parvidons										5						
Pycnogonum stearnsi		1														
Stenothoe sp										3						
Tanaidae	9	2						1		9						
Tetraclita rubescens	3	4					11	5	3						1	
ECHINODERMS																
Ophiactis simplex		2														
MINOR PHYLA																
Chironomidae							5									
Ectoprocta (colonial)			1		1											
Emplectonema gracilis							1			1					1	
Epiactis prolifera	3															
Lineidae														1		
Linuchidae													1			
Nematoda										5						
Nemertea		1					2				1					
Nemertopsis gracilis															15	
Platyhelminthes										1						
Spinicirrus sp		1					1									
anthopleura elegantissima		6								5						
MOLLUSCS																
Barleeia californica		50														
Collisella limatula								2	1		1	2			4	
Collisella scabra		14					16	2	2		1	8	2	12		1
Collisella sp	6	7														
Crepidula onyx			1													
Haminaea vesicula												2				
Hiatella arctica		2														
Lasaea subviridis							2				1		10	91		22
Littorina planaxis														2		2
Lucapinella callomarginata		2														
Mopalia muscosa							2									
Mopalia sp	4	5						1				3			2	
Mytilidae									1							
Mytilus galloprovincialis	4	46	3	8	1		19	35	10	20	15	9	21	44	13	3
Neoloricata		9											1			
Odostomia sp		20														
Ostrea sp			1		5	2										
POLYCHAETES																
Arabella sp	1															
Autolytus sp	1	1														
Boccardia probosoidea	1	4														
Boccardia sp				1												
Brania brevipharyngea				2												
Brania californiensis				1												
Brania sp								1								
Cirratulus sp									1							
Cirriformia sp				1												
Dipolydora socialis					1											
Exogone lourei			1	4												
Exogone verugera		1														
Hydroides pacificus											1					
Maldanidae		1														
Nereis mediator	1	2								1						
Paleanotus bellis		1														
Polydora cornuta						1										
Polydora giardi		3								3						
Polydora limicola	14	46								6						
Polydora sp		3								8						
Serpulidae		1														
Syllidae									1							
Syllis(Typosyllis) sp	5	4					3							1		
Trypanosyllis intermedia							1	3			1			1		

March 2000
Riprap Quadrat Invertebrate Data (2 replicates)

	LA1		LA2		LA3		LA4		LB1		LB2		LB3		LB4	
	Subtidal															
CRUSTACEANS																
Ammothea hilgendorfi		1														
Amphipod, unid.	1	1														
Ampithoe sp			1								2		3		1	
Aoroides sp			5	5	1				2	4	9	18		5	20	4
Balanus glandula														1		
Balanus sp					1											
Balanus trigonus			1													
Caprella californica										3	2	1	2			
Caprella sp									2	4			1			
Chthalmus fissus									5							
Corophium sp			1													1
Cumella californica									1	1						
Ericthonius brasiliensis									4	4				2	1	
Gammaropsis thompsoni									4	8					6	
Gitanopsis vilordes										2	3	4		2	1	1
Harpacticoida			3	2					1	2	1			7		
Heptacarpus sp										1						
Ischyrocerus sp									7	15						
Jassa slatteryi							1									
Joeropsis sp	3		1				1		3	4	5	20	6	25	24	
Leptochelia dubia	4	1					1		1	4				2	2	
Leucothoe sp	1															
Liljeborgia sp															2	1
Melita dentata										2						
Pachycheles pubescens	2	1														
Paramicrodeutopus schmitti														4	5	3
Paranthura elegans			1									1	1			
Parasterope sp													50	8		
Photis parvidons	31	4					1		4	15	2	2	3	2	26	1
Pinnixa sp														1		
Podocerus sp	3								3	1						
Pycnogonum stearnsi	3															
Stenothoe estacola									1	2						
Tanaidae	25	5	11	21			3		5	9	1	2	2	1	25	15
Tritella pilimana									2	6						
Uromunna ubiquita		2								10			2			
ECHINODERMS																
Amphioplus sp													93	1		
Amphipholis sp										2	1	3				
Echinoid										1						
Ophiactis simplex	2	2											5	3	2	
Ophiuroidea													53	2		
Strongylocentrotus purpuratus		1					2	1	2	3						3
MINOR PHYLA																
Alcyonidium sp (colonial)									1							
Amathia sp (colonial)															1	
Artemita sp									1							
Celleporina sp (colonial)					1	1						1	1			
Ciona sp														1		
Colonial diatoms							1				1					
Crisia sp (colonial)					1											
Dendrosomata petraeum	6															
Ectoprocta (colonial)					1											
Gobiesox rhessodon									2	1						
Hydrozoa (colonial)					1											
Leucosolenia sp														1	1	
Linuchidae														1		
Micrura wilsoni												1				
Molgula sp									1							
Nemertea										2						
Nolella sp (colonial)													1	1		
Plumularia alicia (colonial)									1							
Porifera (colonial)		1														
Spinicirrus sp	1														8	
Stylochus sp														1	2	
Syncoryne eximia												1				
Tetrastemma sp													3			
anthopleura elegantissima	2															

March 2000
Riprap Quadrat Invertebrate Data (2 replicates)

	LA1		LA2		LA3		LA4		LB1		LB2		LB3		LB4	
	Subtidal															
MOLLUSCS																
Alia carinata									8	3				1		
Astraea undosa												1				1
Barleeia californica		3									3					
Collisella limatula			1								3	1		1		
Collisella scabra									1			3				
Collisella sp												3			2	
Collisella strigatella											1	1				
Crassedoma giganteum									1							
Crepidula dorsata										1						
Crepidula onyx			2	4						1	2	4			5	
Crepidula sp							1			1						
Doridoidea															3	
Gastropoda	3									1						
Hiatella arctica	3															
Iselica ovoidea							1		2		2		3	1		
Lasaea subviridis		1														
Lucapinella callomarginata								1				1		1	1	
Mopalia sp	2			1												
Mytilus galloprovincialis	10	1	1	2			3	7	13	7	3	2	12	34	13	1
Mytilus sp									2	12						
Nassarina penicillata		1							1				12			
Navanax inermis																1
Neoloricata								1		1						
Odostomia sp													2	19	1	
Philobrya setosa	3															
Pteropurpura festiva													5			
Rimula sinezoides														1		
Roperia poulsoni	1								4							
Serpulorbis squamiger	1															1
Sinezona rinoloides									3	4						
Sinezona sp													1	1		
Tegula gallina													1			
POLYCHAETES																
Arabella iricolor															1	
Autolytus sp	1															
Autolytus sp 2	1															
Axiothella sp														4	16	2
Brania brevipharyngea			7	3					2						1	
Brania californiensis			1							21			21	2		
Brania sp									2	1			1	2		
Chone ecaudata										1					2	2
Chrysopetalum occidentale			1													
Cirratulus sp	1		1										4		4	
Cirriformia sp											1					
Dodecaceria concharum	18	1													20	
Exogone lourei	2		20	4	1		3	5		8	1		16	2	3	1
Exogone sp	1															
Halosydna johnsoni	1								1					1	2	
Hydroides pacificus									4	2						
Maldanidae									1				1			
Naineris dendritica	1														2	
Neanthes sp													2			
Nereididae										1						
Nereis mediator	3														1	
Nicolea gracilibranchis	8						2	1	1	2			16	6	4	
Orbiniidae											1					
Pionosyllis sp			1													
Platynereis bicanaliculata	1															
Polycirrus sp															1	
Polydora armata															1	
Polydora giardi	1	10		1									2		9	
Polydora limicola	1	20												1	9	6
Polydora sp		1						1								
Polynoidae		2							1				1			
Protocirrineris sp	1														11	
Pseudopotamilla socialis	1	3													13	
Sabellidae														1		
Serpulidae							1		1							
Sphaerosyllis californiensis									2							
Syllis(Syllis) gracilis		1												1	9	
Syllis(Typosyllis) nipponica													10	19		
Syllis(Typosyllis) sp	4	1												6	3	
Terebellidae										1						

May 2000

Riprap Quadrat Invertebrate Data (2 replicates)

	LA1		LA2		LA3		LA4		LB1		LB2		LB3		LB4	
	Upper Intertidal															
CRUSTACEANS																
Allorchestes angusta				1			2	2								
Aoroides sp										2						
Balanus amphitrite amphitrite			16	13							1					
Balanus glandula	81	38	91	80		1	11	11	43	12	41	12	23	54	11	1
Chthalmus fissus	47	12	22	5			68	144	73	17	14	11	1	38	162	70
Janiralata sp			1													
Leptochelia dubia										2						
Paracerceis sp													1	2		
Photis parvidons										6						
Tetraclita rubescens							1									
MOLLUSCS																
Collisella limatula													2	2		
Collisella scabra	8	4	1	1			6	12	14				8	7	1	2
Collisella sp		1					2	1	1							
Crassostrea gigas					3											
Lasaea subviridis		8		1				5						1		
Littorina planaxis							3	16	2						8	7
Littorina scutulata				1			6	2	1			2				
	Lower Intertidal															
CRUSTACEANS																
Allorchestes angusta							2	5		1						
Aoroides sp									1							
Balanus amphitrite amphitrite				2							1					
Balanus glandula	171	89	27	94			3	35	222	32	41	9	20	5	6	30
Balanus sp												1				
Chthalmus fissus	75	8	1	9			32	241	143	261	5	10	41	5	80	21
Cyclopoida												4	1			
Dynamenella sp	22		2					1	6	16	1	1		5		
Leptochelia dubia										2						
Pachygrapsus crassipes	1						1									
Paracerceis sp				13												
Photis parvidons							1									
Porcellanidae									1							
Pycnogonum stearnsi	1		1													
Tanaidae	2						1				1					
Tetraclita rubescens	18						3	6	2	7				1		
ECHINODERMS																
Amphipholis squamata					4											
Amphiuridae					2											
MINOR PHYLA																
Nemertopsis gracilis										1						
Platyhelminthes										1						
Zygonemertes virescens										7						
anthopleura elegantissima	32															
MOLLUSCS																
Collisella limatula							1	1					2			1
Collisella ochracea										2						
Collisella scabra	35			1			1	20	3	17			4	3	21	9
Collisella sp	5	3							1	2						
Crassostrea gigas					1	2										
Kellia suborbicularis	1															
Lasaea subviridis	16	252		7									46	4		2
Littorina planaxis										4					4	2
Mopalia muscosa	2	4														
Mytilus galloprovincialis	45	62	2				16	3	6	25	3	2	14	6		
Polyplacophora	32															
POLYCHAETES																
Boccardiella hamata	1															
Polydora limicola	2															
Polydora sp	1															
Syllidae	1															
Syllis(Typosyllis) pulchra	13															
Syllis(Typosyllis) sp	6															

May 2000
Riprap Quadrat Invertebrate Data (2 replicates)

	LA1		LA2		LA3		LA4		LB1		LB2		LB3		LB4	
	Subtidal															
CRUSTACEANS																
Acidostoma sp											4					
Ammothella bi-unguiculata																2
Ampithoe sp	3									2	8	17		5		1
Aoroides cf secunda										2						
Aoroides sp	14	1				1			4	39	23	4	1	7	1	
Atylus tridens											2	1	4	2		
Balanus glandula	1	3	1	46				4	122	2						25
Balanus trigonus											1	1				
Calanoida (copepod)										1						
Caprella californica													1			
Caprella mendax											8		3	3		
Caprella natalenis	3	1							4		14		5	8		
Caprella verrucosa									1							
Chthalmus fissus		1		6				19	80	1						6
Cirolana sp	1	3														
Corophium sp	2	2								1						
Cumella californica													1			
Cyclopoida											1					
Deutella californica															2	
Dynamenella sp										1	1					
Elasmopus sp	5	3									3					1
Ericthonius brasiliensis									2	2						
Gammaropsis thompsoni										3				1		
Harpacticoida	1	1		1							1					
Hemiproto sp													1	2		
Heptacarpus taylori													2			
Hyale sp		4														
Ischyrocerus sp	2	1														
Jassa slatteryi	28									2						
Joeropsis sp	15	3							1	2	13	3	23	55	5	1
Leptochelia dubia	3	1									1			6	3	
Leucothoe sp	7															
Liljeborgia sp											2					
Maera simile	9															
Pachycheles rudis	10															
Pachygrapsus crassipes		1														
Photis parvidons	122	7								20	3			1	3	
Pinnixa sp		1												1		
Podocerus sp	12															
Pontogeneia sp									1							
Stenothoe estacola	12									3					1	
Tanaidae	66	108		1					46	1	21	26	4	16	7	1
Tetraclita rubescens								2	1	1					1	
Uromunna ubiquita	4															
ECHINODERMS																
Amphipholis sp											3		18	83		
Amphipholis squamata											11		26	79	2	
Amphiuridae											1		8	29		
Echinoid	6	7												1	1	
Ophiactis simplex	16										1		3	3		
Strongylocentrotus purpuratus	1													1	1	
MINOR PHYLA																
Ectoprocta (colonial)		1			1											
Entoprocta (colonial)											1					
Nemertea											3					3
Nemertopsis gracilis									1							7
Platyhelminthes									3		1					1
Plumularia sp (colonial)									1							
Porifera (colonial)											1					
Styela clara				1		1										
Styela sp											2					
Stylochus sp																1
Urochordata										1	1					

May 2000
Riprap Quadrat Invertebrate Data (2 replicates)

	LA1		LA2		LA3		LA4		LB1		LB2		LB3		LB4	
	Subtidal															
MOLLUSCS																
Collisella limatula			1													
Collisella ochracea										4					9	4
Collisella scabra	4							3				8			2	5
Collisella sp	4								1			1	3	6	11	
Crepidula dorsata	13										2			2		
Crepidula onyx				6							2					
Fissurella volcano	1						1						1	1	1	
Gastropoda	1															
Hiatella arctica	1															
Iselica ovoidea													5	1		
Lasaea subviridis													1	1		
Mopalia muscosa	4						1									
Mopalia sp	1												1			4
Mytilus galloprovincialis	2			2			3	9	7	12	4	9	30	42	7	9
Nassarina penicillata													1	4		
Norrisia norrisi										1						
Odostomia sp	6												7			
Philobrya setosa	1															
Pteropurpura festiva	3															
Puncturella sp	4												2	1		
Roperia poulsoni									2	1						
Serpulorbis squamiger	1	1					1					1				
Tegula gallina													3			
POLYCHAETES																
Boccardia probosoidea									4							2
Brania brevipharyngea									1	1	2					
Brania californiensis													2	1		
Capitella "capitata"				1												
Caulleriella sp				2		1										
Chone ecaudata													2	1		
Cirratulidae													1			
Cirratulus sp										1				2		
Cirriformia sp				1												
Cirriformia sp SD 2				2												
Dipolydora giardi		1														
Dodecaceria concharum	5															
Dorvillea (Schistomeringos) longicornis				2												
Eusyllis sp	1															
Exogone lourei	2			7							3		9	3		
Exogone sp											1					
Halosydna johnsoni	1									2			1	1		
Hydroides pacificus										1		1				
Maldanidae													1	1		
Nereididae											1					
Nereis mediator	1	3							2	3						
Nicolea gracilibranchis										1	1		9	20		
Oligochaeta				3												
Polydora cornuta											1					
Polydora limicola	21								55	32						
Polydora sp						1				5				1		
Polynoidae	1															
Protocirrineris sp	12											11				
Pseudopotamilla socialis	2	1														
Sabellidae											2	1				
Serpulidae											3					
Sphaerosyllis californiensis				7												
Syllidae	2										1					
Syllis(Syllis) gracilis											3		1	4		
Syllis(Typosyllis) nipponica				1							1		8	6		
Syllis(Typosyllis) pulchra																3
Syllis(Typosyllis) sp										9		1				
Trypanosyllis gemmipara	1															

August 2000
Riprap Quadrat Invertebrate Data (2 replicates)

	LA1		LA2		LA3		LA4		LB1		LB2		LB3		LB4	
	Upper Intertidal															
CRUSTACEANS																
Balanomorpha	1						10	2								
Balanus amphitrite amphitrite			3													
Balanus glandula	96	178	17	6			260	406	68	35	38	11	23	45	61	88
Chthamalidae sp	42	160	30			1	120	225	144	116	37	5	18	25	17	50
Dynamenella sp			16								2			1		
Hyale sp	14	65					6	3					13	5	1	1
Joeropsis sp															1	
Najna sp		1														
Paracerceis sp														3		
Paramicrodeutopus schmitti		1														
Photis lacia								1								
Photis sp															1	
Tanaidae															1	
MOLLUSCS																
Collisella limatula	1	4	1						1			1	8	1	2	
Collisella scabra	10	5					5	21	5	9	5		19	16	12	13
Collisella sp							1	3							2	
Lasaea subviridis	15	44					12								5	3
Littorina planaxis	6	8					8		5	3					10	1
Littorina scutulata	6	3					20	9			6					8
	Lower Intertidal															
CRUSTACEANS																
Ampithoe sp				1												
Balanus glandula	141	128	132	49			26	25	41	15	20	14		71	68	77
Chthalmus fissus	12	9	165	56			79	137	61	136	14	3		48	10	21
Cirolana sp													1			
Dynamenella sp	14	23	2			7	3	7		3						
Hyale sp	13	10				9			2	1			6		2	21
Joeropsis sp													1			
Leptochelia dubia																1
Melita sp								2								
Paracerceis sp			10	2								5	4			
Paramicrodeutopus schmitti						4										
Petrolisthes sp													1			
Photis parvidons									1							
Pollicipes polymerus										1						
Porcellanidae								1	3							
Tanaidae	4					4		1		1						
Tetraclita rubescens	2	1						4	3	5						
MINOR PHYLA																
Nemertea							1									
Paleonemertea														1		
MOLLUSCS																
Brachidontes adamisianus		1														
Chaetopleura sp	6															
Collisella limatula		1		1			1	1	1		3					3
Collisella scabra	16	5					13	21	9	14		1	1	2	27	21
Collisella sp	2								2	3	1	1				
Crassostrea gigas					3	1										
Fissurella volcano													1			
Lasaea subviridis	105	128					1	7						83	50	10
Littorina planaxis																3
Littorina scutulata															1	7
Mopalia sp	1	2					1	1	2	1	1					
Mytilus galloprovincialis	135	109					11	15	149	31			30	20		
Norrisia norrisi									1							
Tegula brunnea												1				
POLYCHAETES																
Boccardia probosoidea																3
Cirratulus sp														1		
Naineris sp							1									
Nereis mediator										1						
Nicolea gracilibranchis							1									
Perinereis montera	1															1
Polydora limicola										1						
Syllis(Typosyllis) pulchra							1			6			5	1		1

August 2000
Riprap Quadrat Invertebrate Data (2 replicates)

	LA1		LA2		LA3		LA4		LB1		LB2		LB3		LB4	
	Subtidal															
CRUSTACEANS																
Ammothella sp															1	
Amphilochus sp						1										6
Ampithoe sp			8										4			
Aoroides sp		3	2							1			8			2
Balanus amphitrite amphitrite				2												
Balanus glandula	23	71	16	47			2	10	91	43			3		2	9
Caprella natalenis												3	19			
Caprella sp						1										
Caprellidae										1						
Chthalmus fissus	38	5	6	52			2	95	205	32			3	6	42	68
Cirolana sp													1			
Corophiidae		1							1	1						
Dynamenella sp	2	20		5												
Hyale sp	11	4		13											1	
Joeropsis sp	1	33	1			2				1			39		2	52
Ischyrocerus sp													1			
Jassa slatteryi						1							2			1
Leptochelia dubia						3						1	6			1
Leucothoe spinicarpa						1										
Maera simile			7													
Megabalanus californicus									6	1						
Melita sp												28				
Monocorophium insidiosum			17	1												
Mysidopsis sp													1			
Paracerceis sp	7	2										1				
Paradexamine sp A													1			
Paramicrodeutopus schmitti						59							186			
Paranthura elegans		3														
Photis parvidons										2						
Porcellanidae									1							
Pycnogonum stearnsi		1														
Stenothoe estacola									2	1						
Tanaidae	4	45	15	2		9			460	200		1	84			5
Tetraclita rubescens	5	4						3	4	7					2	1
ECHINODERMS																
Amphipholis squamata												1	1			
Amphiuridae													1			
Henricia sp									1							
Lytechinus pictus	1															
Ophiactis simplex	1															
MINOR PHYLA																
Actiniidae									9							
Bugula pacifica (colonial)																1
Ectoprocta (colonial)			1													
Porifera (colonial)	1															
Spinicirrus inequalis									3				1	1		
Styela sp							1									
Stylochus franciscanus									1							
anthopleura elegantissima		15					1	1								
MOLLUSCS																
Ancula pacifica			1													
Chama arcana													1			
Collisella limatula	1	1	2				4	6			4					
Collisella scabra	8	17					1	7	4	3			1	11		9
Collisella sp	2	2	5					2	5	4						
Crassostrea gigas					1	5										
Fissurella volcano							1					1	2			
Mopalia sp	1	7		1				2		1	1	1				
Mytilus galloprovincialis	13	9	1				40	24	113	75	7	10	4	17	1	11
Notoacmea dipicta										1						
Octopus sp									1							
Odostomia sp																2
Roperia poulsoni									1							

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Riprap Quadrat Invertebrate Data (2 replicates)

	LA1		LA2		LA3		LA4		LB1		LB2		LB3		LB4	
	Subtidal															
POLYCHAETES																
Arabella sp									1							
Autolytus sp		1														2
Boccardia probosoidea		1							6	1						
Exogone lourei																1
Hydroides pacificus										1						
Hydroides sp							1									
Naineris sp							1									
Nereididae		1														
Nereis latescens										1						
Nereis mediator									1					1		
Nereis procera									1							
Nereis sp									1	1						
Nicolea gracilibranchis										1		1				
Paleanotus bellis									1	1						
Perinereis montera									1							
Polydora limicola		1							20	19						
Pseudopolydora paucibranchiata												1				
Spionidae									2	1						
Syllis(Typosyllis) nipponica													7			
Syllis(Typosyllis) pulchra		23							12	15		3				8
Syllis(Typosyllis) sp									3	3						

November 2000
Riprap Quadrat Invertebrate Data (2 replicates)

	LA1		LA2		LA3		LA4		LB1		LB2		LB3		LB4	
	Upper Intertidal															
CRUSTACEANS																
Balanus amphitrite amphitrite			7		2											
Balanus glandula	77	56	115	87			45	84	43	12	55	16	9	30	42	38
Chthalmus fissus	25	62	78	57			458	1107	101	95	27	7	3	51	118	98
Dynamenella sp			3					1					1			
Hyale sp	7	7						19	1	2				10		1
Megabalanus californicus				1												
Pachygrapsus crassipes					1											
Paracerceis sp											3					
Tanais sp							1	2								
Tetraclita rubescens								1								
ECHINODERMS																
Amphiuridae															1	
MOLLUSCS																
Barleeia sp															1	
Collisella digitalis										1						
Collisella limatula								1	4							
Collisella scabra	4	3	12	8			44	32	5		18		17		9	10
Collisella sp	5						1			15			1			
Crassostrea gigas					1											
Lasaea adansoni	10	22		6			1	2			6		23		2	8
Littorina planaxis		2							1				1		9	
Littorina scutulata		1							1							6
Mytilus galloprovincialis							1									
Ostreola conchaphila					1	2										
	Lower Intertidal															
CRUSTACEANS																
Balanus amphitrite amphitrite							1				7					
Balanus glandula	24	27	10	83			28	6	53	42	11	2	1	14	30	11
Caprella augusta										1						
Chthalmus fissus			14	211			101	43	12	30	22	15	2	5	227	21
Cirolana sp		2		2												
Dynamenella sp	6	50	1	18			7	1	18	15	4			9		
Harpacticoida				2			1	3					1			
Hyale sp		2					8	1		3				11	2	
Joeropsis sp		6							18							
Leptochelia dubia							11	17								
Melita sp				1												
Microcerberidae	3	15														
Pachygrapsus crassipes	1															
Paracerceis sp														3		
Paranthura elegans				1												
Photis parvidons								1								
Podocerus cristatus								1								
Pycnogonum stearnsi	1															
Stenothoe sp								1								
Tanaidae		3					70	30	53	7	1					
Tetraclita rubescens	5	5							2	1						
MINOR PHYLA																
Amphiporus sp									2		1		1			1
Diadumenidae						1										
Emplectonema gracilis							1		3		2					1
Lineidae								1			1					
Nematoda								21								
Nemertea								1								
Nemertopsis gracilis										6						
Notoplana sp																1
Spinicirrus inequalis							2	1	1							
Stylochus sp														1	1	
Anthopleura elegantissima	12	25							4							
MOLLUSCS																
Aeolidoidea						1										
Barleeia californica								1								
Bivalvia													1			
Collisella limatula			6	14			11	3			2				2	2
Collisella scabra	36	29	8	21			12		8	11			1	2	22	6
Collisella sp				4					3				1	1		
Crepidula onyx										1						
Iselica ovoidea				2			4	14				1				
Lasaea adansoni		1		5			2	2					17			
Modiolus sp							1							1		
Mopalia sp	6	1					1	1	4	3	2					
Mytilidae						1										
Mytilus galloprovincialis	13	1		10			48	94	32	8	7	6	23	11	7	15
Odostomia sp				3												
Pteropurpura festiva					1											
Roperia poulsoni										1						

November 2000
Riprap Quadrat Invertebrate Data (2 replicates)

	LA1		LA2		LA3		LA4		LB1		LB2		LB3		LB4	
	Lower Intertidal															
POLYCHAETES																
Arabella sp							1									
Boccardia probosoidea							3									
Brania brevipharyngea								2								
Capitellidae								1								
Chone sp								1								
Exogone lourei								17								
Exogone sp								4								
Hydroides pacificus									7							3
Nereididae									1							
Nereis grubei							2	1	3							
Nereis latescens									1							
Odontosyllis sp							1									
Perinereis montera									5	1						1
Polydora ligni							1									
Polydora limicola									22	1						
Polydora sp									1							
Polydora websteri									2	3			2			
Polyophthalmus pictus								1	3							
Syllis(Syllis) elongata									13	1						6
Syllis(Typosyllis) fasciata							15		11	2						
Syllis(Typosyllis) orientalis													1			
Syllis(Typosyllis) sp							3	1	3							1
	Subtidal															
CRUSTACEANS																
Achelia echinata	1															
Achelia sp															1	
Amphilochus sp											1					1
Ampithoe sp													3			
Aoroides sp	3	2					2	1		19					2	8
Balanus amphitrite amphitrite												1				
Balanus glandula			30	25				2	46	23	2	4			3	2
Balanus trigonus																1
Calanoida (copepod)													1			
Caprella augusta	10	12											2			
Caprella sp A	1						1									
Chthalmus fissus			7				2		6	11	76	59	1	13		
Cirolana sp																1
Corophium sp															4	2
Desdimelita desdichada			3								28					
Dynamenella sp		1	2	4						1	1	1				
Elasmopus sp							1	3			29	1			2	
Gammaropsis thompsoni	2						1								8	1
Harpacticoida	2		3	2			8			1					1	
Jassa slatteryi	6	4					2								13	6
Joeropsis sp	2	8	4				5	2	1		18		5		13	6
Laticorophium baconi		1											1			
Leptochelia dubia	2	1					2	1			1					5
Leucothoe aluta	1										4		1		1	1
Lysianassidae			1													
Megabalanus californicus									4							
Pachycheles sp															1	
Pachygrapsus crassipes										1						
Paramicrodeutopus schmitti									12	4			30	2	27	92
Paranthura elegans			1	1												
Photis parvidons	2	8					3	5	3	3				3	83	18
Podocerus brasiliensis							1									
Podocerus sp		1														
Stenothoe estacola		4								1						
Tanaidae	11	10	3				12	1	1	38			10	6	3	5
Tetraclita rubescens		11						3							6	
Uromunna ubiquita													1		2	
ECHINODERMS																
Amphioplus sp													9			
Amphipholis sp											1				56	8
Amphipholis squamata											1		9		57	20
Amphiuridae													9	1	36	5
Lytechinus pictus		1														
Ophiactis simplex	15	1					4	1					1		30	3
Ophiuroidea													2			4
Strongylocentrotus purpuratus							1								2	
MINOR PHYLA																
Amphiporus sp										3						
Diadumenidae					1											
Lineidae					1				1							
Nematoda							1									
Porifera (colonial)						1					1					
Spinicirrus inequalis									3	10						3
Styela truncata					1	1			1							
Stylochus sp												1				
Thysanocardia nigra					1											
anthopleura elegantissima		2								4						

November 2000
Riprap Quadrat Invertebrate Data (2 replicates)

	LA1		LA2		LA3		LA4		LB1		LB2		LB3		LB4	
	Subtidal															
MOLLUSCS																
Acanthina spinata													2			
Barleeia californica											1		10			
Barleeia sp														6	2	
Chama arcana	1															
Collisella limatula			1	5				5			5	1			5	2
Collisella scabra		4	2								2	4	1	2		
Collisella sp		2						2		2		2	1	5	5	
Crepidula sp		2														
Fissurella volcano		1														
Hiatella arctica	1						1		1							
Iselica ovoidea							2	1	1		7		4		2	
Lasaea adansoni								1			1		1			
Lithophaga plumula	1															
Lithopoma undosum																1
Lottia gigentea														1		
Modiolus sp									1	1						
Mopalia sp	9	2		1					5	4						
Mytilus galloprovincialis	6	6	1	1			10	8	33	36	9	3	8	12	4	6
Nassarina penicillata													2	1		
Odostomia sp													2			1
Ostreola conchaphila					1											
Philobrya setosa		2														
Pteropurpura festiva			1													
Rimula sp														1	2	
Rupellaria tellimyalis				1												
Sinezona sp													3			
Tegula gallina														1		
POLYCHAETES																
Arabella iricolor									1	1						
Boccardia basilaria		1														
Brania brevipharyngea		1					2									
Cirriformia spirabrancha											3					
Ctenodrilus serratus		1														
Dodecaceria fewkesi		22														
Eulalia quadrioculata									1							
Exogone lourei								1					2		1	1
Halosydna brevisetosa							2	2					1	1		
Halosydna johnsoni									1							
Hydroides pacificus									26	3	1				2	2
Neanthes acuminata										1						
Nereis grubei									3	3						
Nicolea gracilibranchis							1	5	3				4	1		2
Odontosyllis sp										1						
Paleanotus bellis									3						1	
Polydora limicola		8							2	16						1
Polydora sp		1						1	1	3						
Polydora websteri		1														
Polynoidae																1
Polyophthalmus pictus									7							
Protocirrineris sp											4					
Sphaerosyllis californiensis																2
Syllis(Syllis) elongata									1	1						
Syllis(Syllis) gracilis													1			1
Syllis(Typosyllis) fasciata										20						
Syllis(Typosyllis) nipponica													4	8		
Syllis(Typosyllis) sp									3	9			2		1	2

F.5 Raw Data – Diver Observations

MARCH 2000
Riprap Field Observations (A=Abundant, C=Common, F=Few)

SPECIES	LARR1	LARR2	LARR3	LARR4	LBRR1	LBRR2	LBRR3	LBRR4
Upper Intertidal								
Balanus sp	C	C		A	C	C	C	C
Chthalamus	A	C	A	A		F	C	C
Littorina sp	C	C		C	C	F	C	C
Mytilus sp							F	
Ostreidae			C					
Lower Intertidal								
Anthopleura sp	A					F		
Ascidiacea			F					
Corallina sp			C					
Pollicipes polymerus					C			
Chlorophyta	C							
Norrisia norrisi					F			
Polyplacophora sp				F	C	F		
Porphyra sp			F					
Vermetidae						F		
Balanus sp	A	C		C		C	C	C
Chthalamus sp	C	C	A				C	C
Littorina sp		C		F	A		C	C
Mytilus sp		C		A	A	A	A	C
Tetraclita sp	A			C	A			C
Subtidal								
Anthopleura sp				C		F		F
Ascidiacea, unid	F	F				F	F	F
Asterina miniata		F	F			F		F
Astrea undosa	C						C	F
Balanus sp		F				C	C	C
Brisaster sp							F	
Chthalamus sp		F	A				C	
Colpomenia sp						F	C	
Corallina sp	A						F	F
Gigartina sp		F						
Gorgonia sp	F							
Kelletia kelletii							F	F
Littorina sp	C	F					C	C
Loxorhyncus grandis							F	
Macrocystis pyrifera							C	
Megathura crenulata	F				F		F	
Mytilus sp		C		A	A	A	A	A
Nudibranchia		F						
Pachycerianthus fimbriatus				F				F
Panulirus interruptus	F							
Parastichopus sp.				F	F	F		F
Pectinidae sp	F			F		F	F	F
Pisaster sp				F	C			F
Polychaeta								C
Polyplacophora sp						F		
Porphyra sp			F					
Saragassum sp		F				F	C	
Strongylocentrus franciscanus	F			F		F	F	F
Strongylocentrus purpuratus	C			C	C	F	C	A
Styela montereyensis			C					
Tetraclita sp								C
Ulva sp		F						
Vermetidae	F					F		
Zostera sp						F		

MAY 2000
Riprap Field Observations (A=Abundant, C=Common, F=Few)

SPECIES	LARR1	LARR2	LARR3	LARR4	LBRR1	LBRR2	LBRR3	LBRR4
Upper Intertidal								
Balanus sp	A	A	A	A	A	A	A	A
Chthalamus sp	A	A		A	A	F	A	A
Isopoda sp						F		
Littorina sp	A			F	A		A	A
Ostreidae			F					
Polyplacophora sp		F						
Tetraclita sp				F				
Lower Intertidal								
Anthopleura sp	A							F
Balanus sp	A	A	F		A	A	A	A
Chthalamus sp	A	A		A		A	A	A
Hemigrapsus sp				F				
Littorina sp	F	F		F	A	F	A	F
Mytilus sp	A	F		A	A	F	A	A
Ostreidae		F	A					
Pollicipes polymerus					F			
Polyplacophora sp	F	F		F	F	F		
Tetraclita sp		A		A	A		F	A
Ulva sp	A	F						
Subtidal								
Anthopleura sp	A	F		F		F		F
Asterina miniata								F
Astrea undosa	A					F		
Balanus sp			F		A		A	A
Chthalamus sp		A		A			A	
Colpomenia sp	F			F	A		A	
Corallina sp	A							
Diopatra sp		F						
Egregia sp	F			F				
Gastropoda	F				F			
Hemigrapsus nudus								F
Holothuroidea	F		F				F	
Kelletia kelletii	F							
Littorina sp	F			A	F			F
Macrocystis pyrifera							A	
Megathura crenulata	F				F		F	
Mytilus sp		A		A	A	A	A	A
Norrisia norrisi					F			
Pachycerianthus fimbriatus	F							
Pectinidae								F
Pisaster sp	F			F	F			
Polyplacophora sp	F			F		F		
Red algal turf		F						
Saragassum sp							A	
Strongylocentrus franciscanus	F			F				F
Strongylocentrus purpuratus	A			A	F	F	F	A
Styela montereyensis			A					
Tegula funebralis								F
Tetraclita sp				F				
Ulva sp		A			A			
Vermetidae	F				A	A		F

AUGUST 2000
Riprap Field Observations (A=Abundant, C=Common, F=Few)

SPECIES	LARR1	LARR2	LARR3	LARR4	LBRR1	LBRR2	LBRR3	LBRR4
Upper Intertidal								
Balanus sp	A	F	F	A	C	C	A	A
Chthalamus sp	C	F		C	A	C	A	C
Littorina sp		A		C	C	C	C	C
Paguridae		F						
Lower Intertidal								
Anthopleura sp	C							
Balanus sp	A	A	C	A	A	A	A	A
Chthalamus sp				A	C			A
Littorina sp		F			C	C		F
Mytilus sp	A	F		A	C	F	A	A
Ostreidae		F	F					
Pollicipes polymeres				F	C			
Polyplacophora sp	F			F	F		F	
Tegula funebralis							C	F
Tetraclita sp	F			F	F			F
Subtidal								
Anthopleura sp	A			F		F	F	F
Ascidiacea sp								F
Asterina miniata						F		F
Astrea undosa	F			F		F		F
Atherinops attinis							F	
Balanus sp		A	F	C	F	C	A	F
Chronis punctipinnis	F							
Colpomenia sp				C			C	
Corallina sp	C				F		C	
Damalichthys vacca					F			
Dictyolus sp				F			F	
Egregia sp	C				F	F		
Embioticidae		C		C			F	
Embiotoca jacksoni	F				F			
Girella nigricans							F	F
Gorgonia sp	F							
Hypsoblennius gentilis				C				
Hypsoblennius gilberti					F			
Hypsurus caryi							F	
Hypsypops rubincundua	F							
Kelletia kelletii	F							
Littorina sp		F		F				
Loxorhynchus grandis							F	
Macrocystis pyrifera							C	
Maxwellia gemma					F			
Megathura crenulata					F		F	F
Myliobatis californicus								F
Mytilus sp		F		A	C		A	A
Norrisia norrisi				F	F			
Ostreidae			C					
Pachycerianthus fimbriatus		F						
Paralabrax clathratus	F							
Paralabrax nebulifer			F					F
Phanerodon furcatus	F							
Pisaster sp					F			
Polyplacophora sp	C	F		F		F		F
Porifera							F	
Saragassum sp							F	
Stiobia nana								F
Strongylocentrus franciscanus	F			F				F
Strongylocentrus purpuratus	A			C	C	C		A
Tegula funebralis								C
Tetraclita sp	F							F
Ulva sp		F			F			

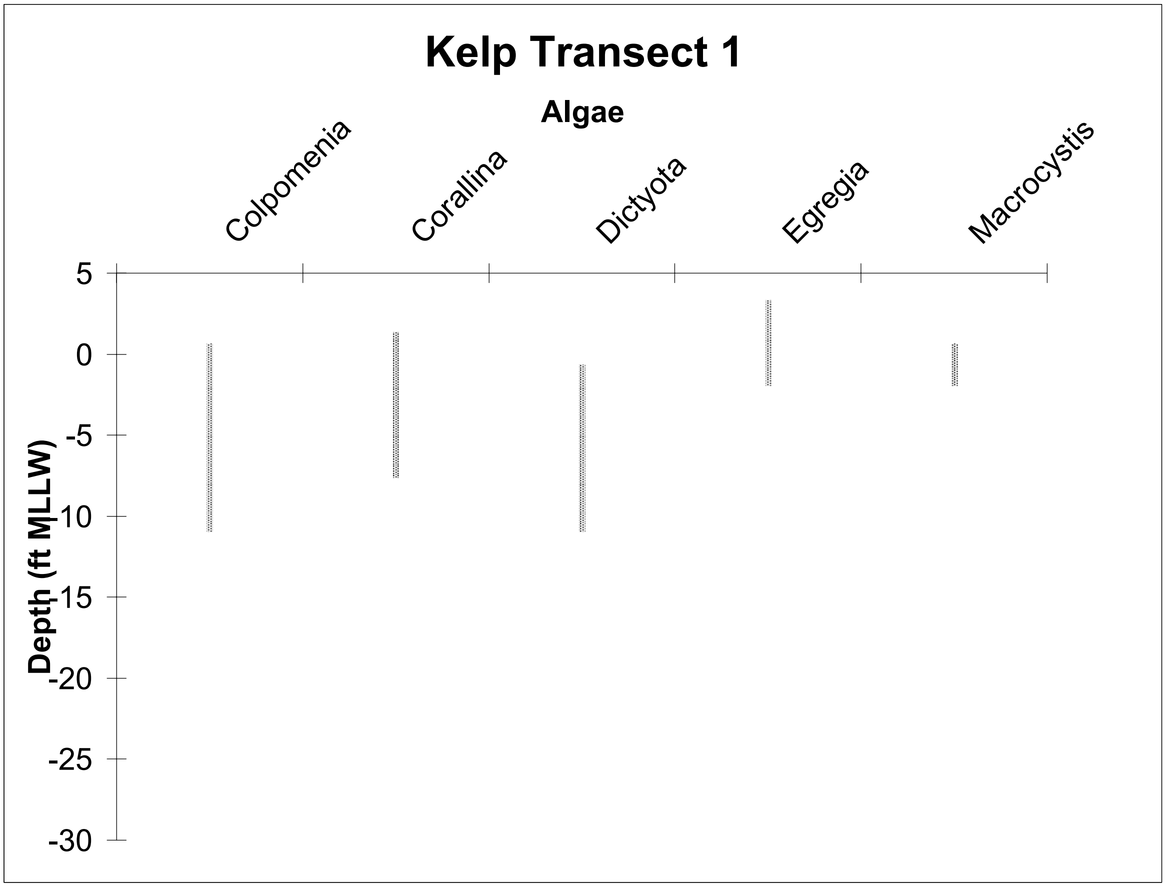
NOVEMBER 2000
Riprap Field Observations (A=Abundant, C=Common, F=Few)

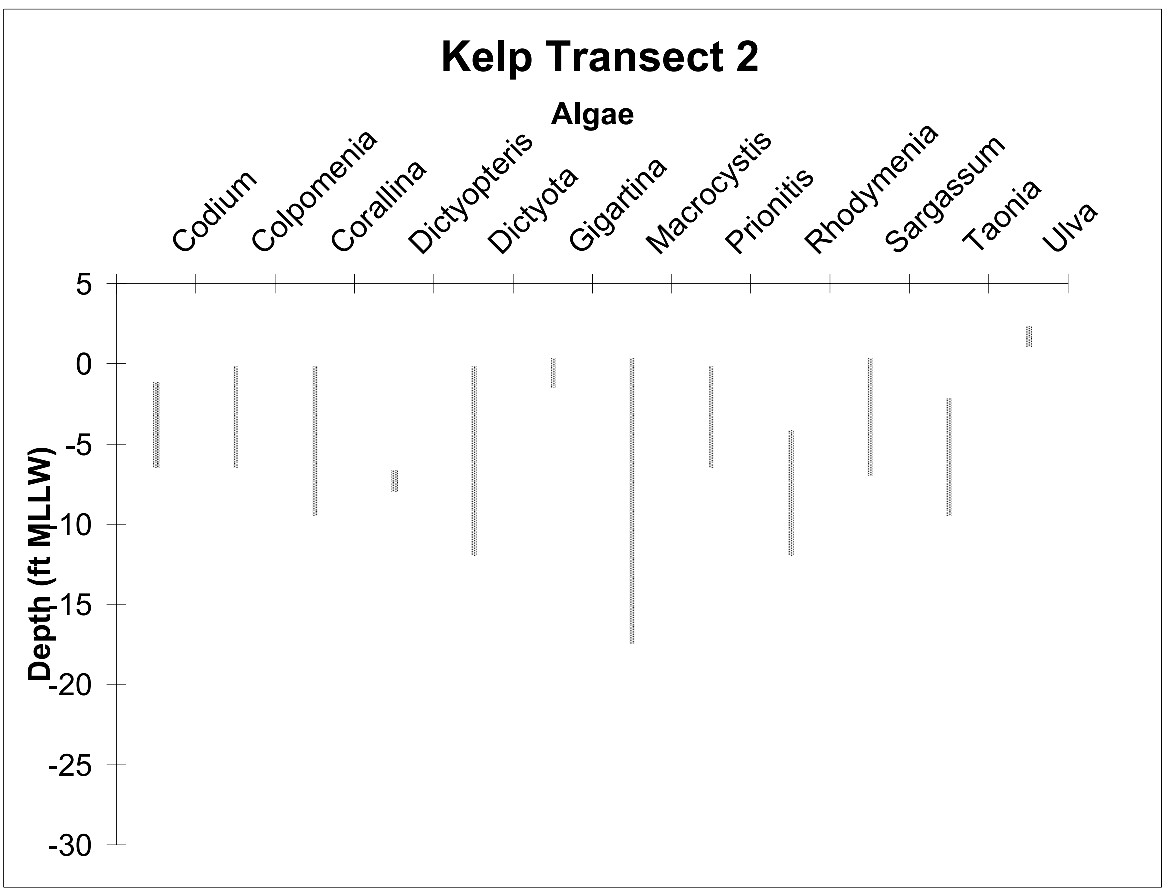
SPECIES	LARR1	LARR2	LARR3	LARR4	LBRR1	LBRR2	LBRR3	LBRR4
Upper Intertidal								
Balanus sp.	A	A	A	C	A	A	C	A
Chthalamus sp.	A	C		A	A	A	F	A
Isopoda						F		
Littorina sp.	C	F		F	C	F	C	C
Ostreidae			A					
Pachygrapsus crassipes					F			
Lower Intertidal								
Anthopleura sp.	C							
Balanus sp.	A	C	A	C	A	C	C	A
Chthalamus sp.					A			A
Corallina sp.	C			F				
Lepas anatifera					F			
Littorina sp.	C	F		C	C	C		C
Maxwellia gemma					F			
Mytilus sp.	C	C		A	C	A	A	A
Ostreidae		F	C					
Pachycerianthus fimbriatus						F		
Polyplacophora sp.	F	F			F	F		
Tegula funebralis							F	
Tetraclita sp.	F			C	C			C
Subtidal								
Anthopleura sp.	F	F		F				
Anthopleura xanthogrammica						F		
Ascidiacea sp.							F	
Asterina miniata			F			F		
Astrea undosa	F				C	F	F	F
Balanus sp.		A	A	F			C	C
Chronis punctipinnis	F							
Chthalamus sp.					C			
Colpomenia sp.	C	F				F	C	
Corallina sp.	A	F			A		F	
Diopatra sp.					F			C
Ectoprota	A							
Egregia	F						F	
Embioticidae					F			
Girella nigricans	F							C
Hydrozoa								F
Littorina sp.		C		F	C			F
Macrocystis pyrifera							F	
Maxwellia gemma	F	F						
Megathura crenulata	F					F		
Mytilus sp.		C		A		A	A	A
Norrisia norrisi					F			F
Nudibranchia		F	F					
Ostreidae		F						
Pectinidae							F	
Pisaster giganteus					F			F
Pisaster sp.					F			F
Polyplacophora sp.		F				F		
Porifera sp.			C				F	
Red algal turf		F						
Saragassum sp.		F					F	
Strongylocentrotus franciscanus	F			F	F			
Strongylocentrus purpuratus	C			C	C	F	F	C
Styela monteryensis		F	C			F		
Tegula funebralis								F
Tetraclita sp.								C
Ulva sp.		F						
Vermetidae	F					C	F	

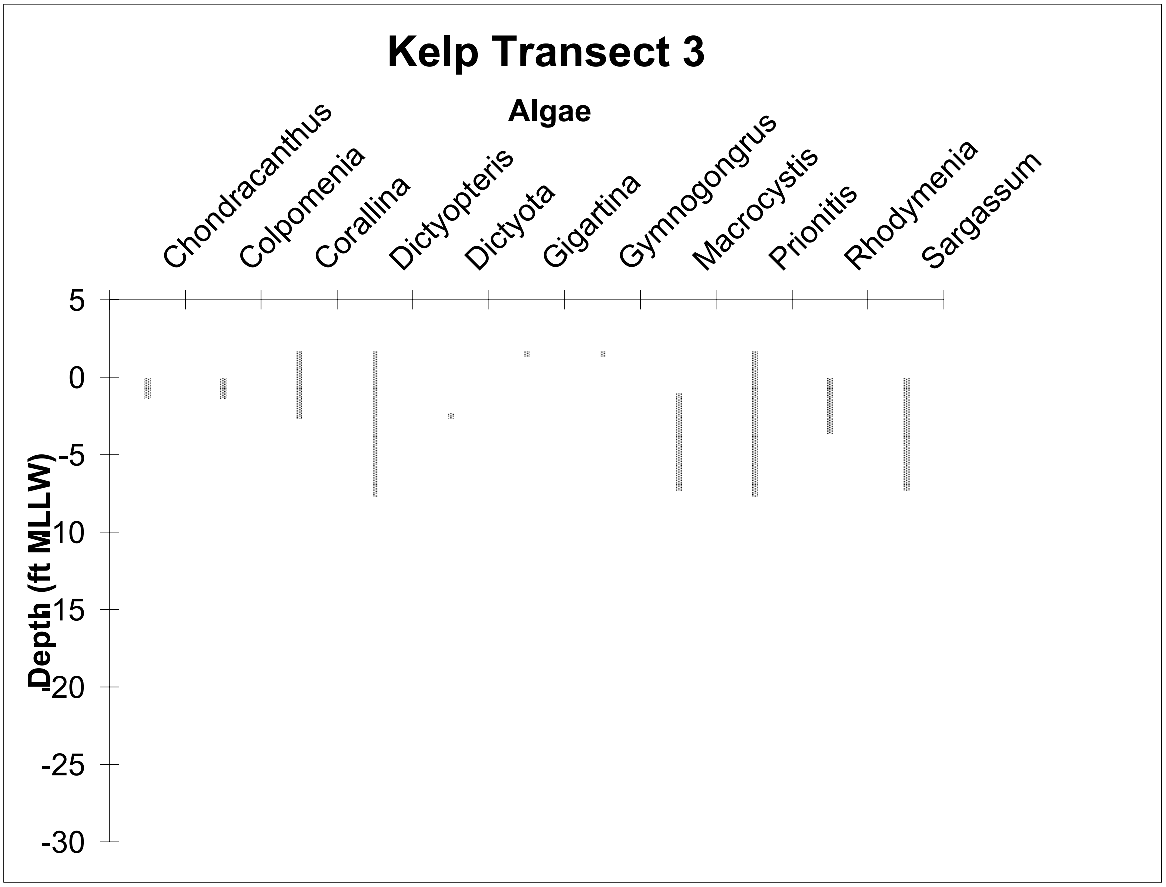
APPENDIX G

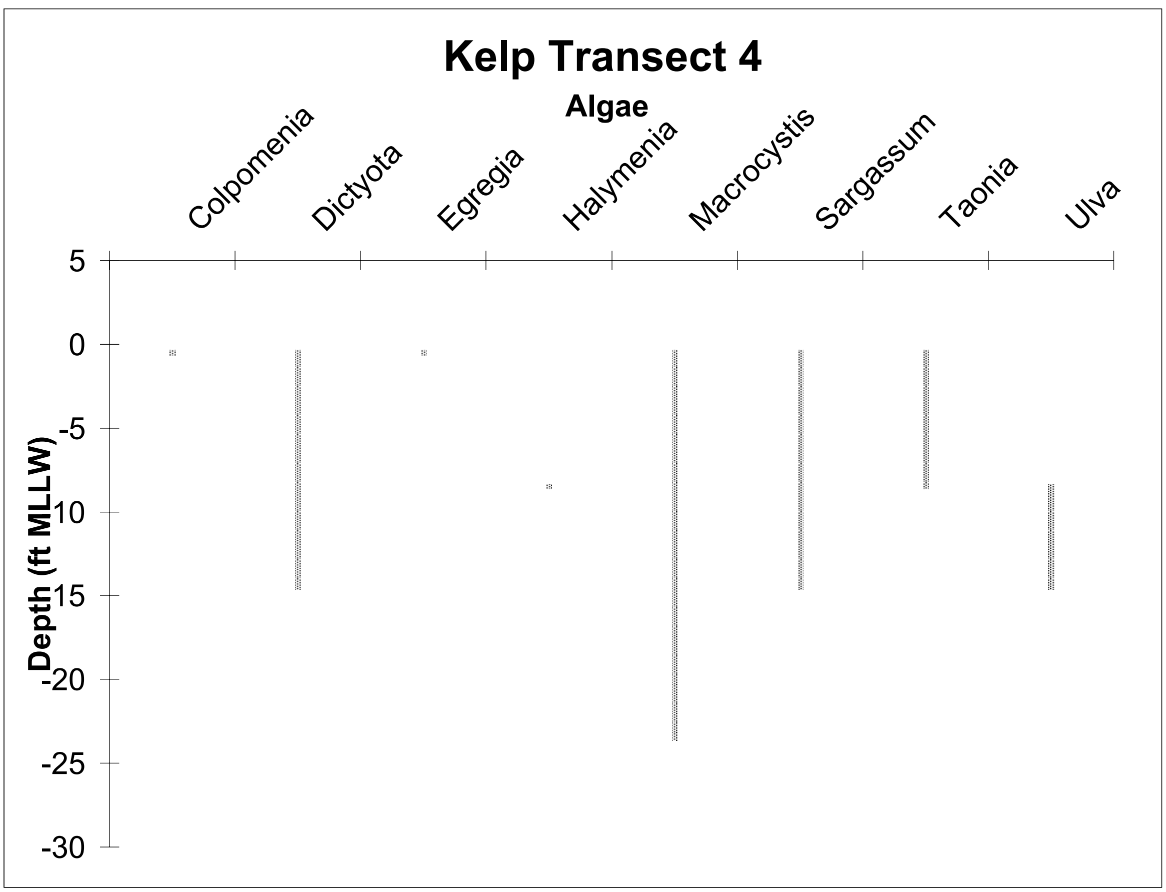
Kelp Data

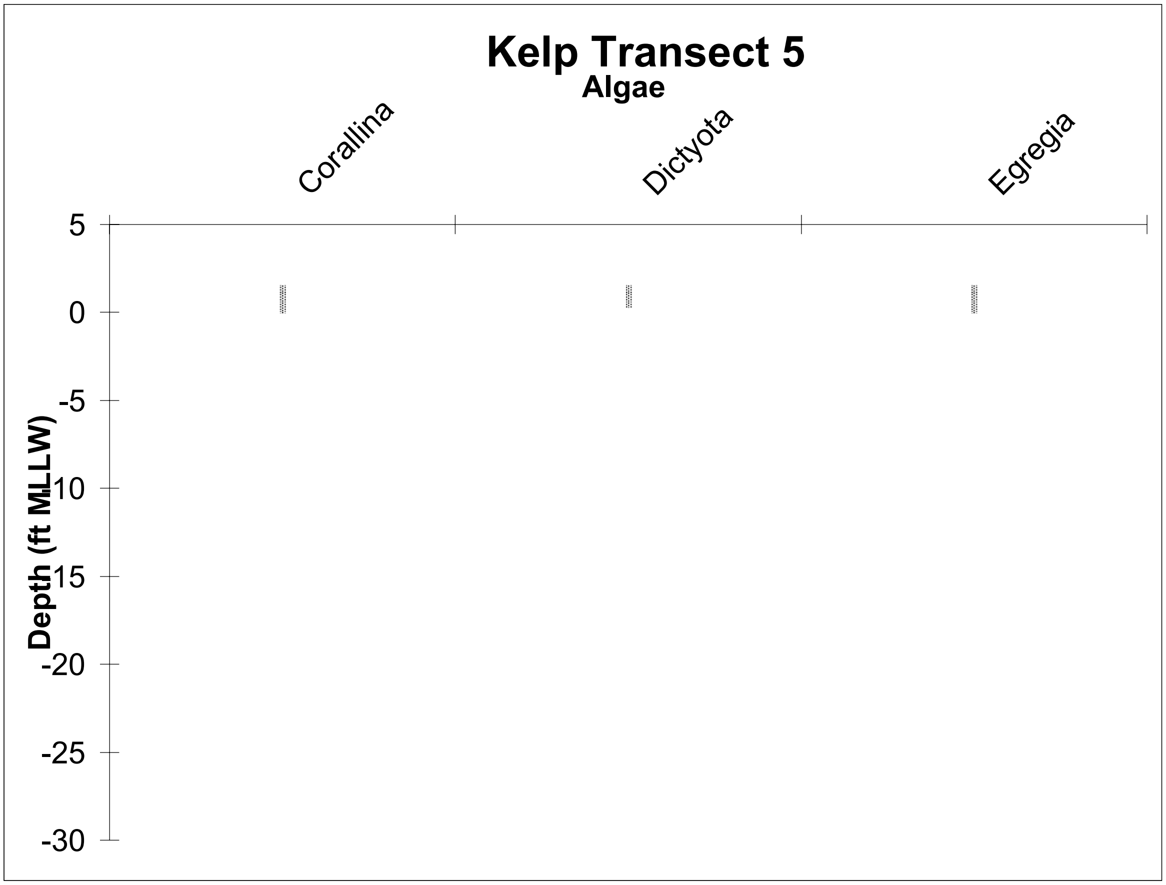
G.1 Transect Plots

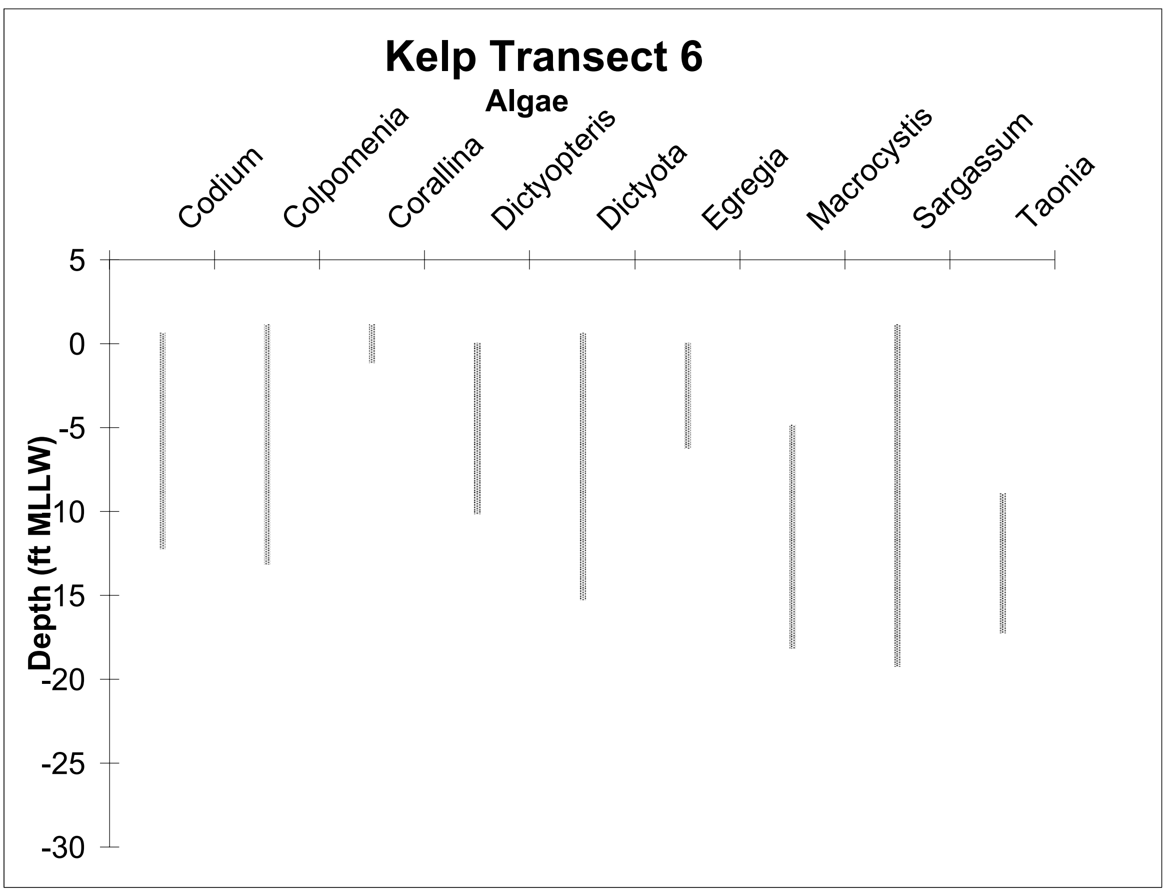

Kelp Transect 1
Algae
Colpomenia
Corallina
Dictyota
Egregia
Macrocystis
Depth (ft MLLW)
5
0
-5
-10
-15
-20
-25
-30

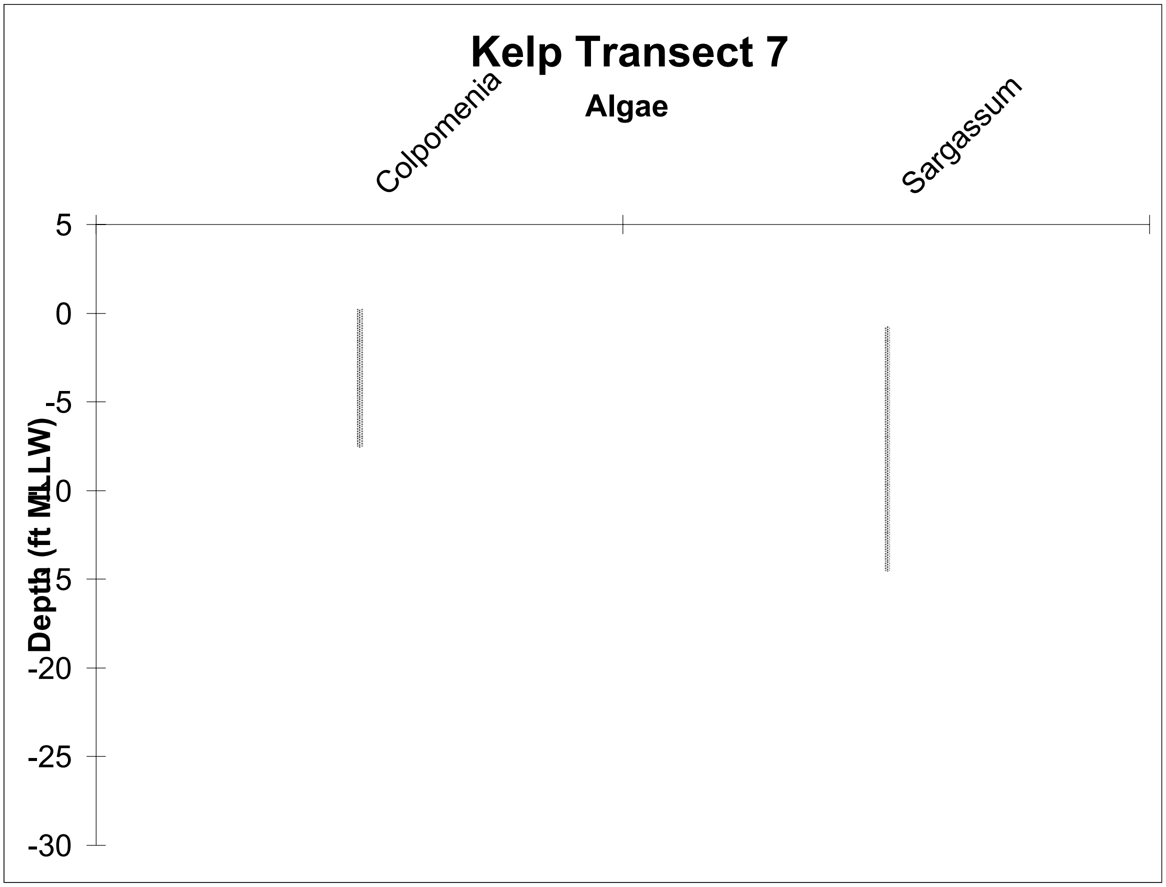

Kelp Transect 2
Algae
Codium
Colpomenia
Corallina
Dictyopteris
Dictyota
Gigartina
Macrocystis
Prionitis
Rhodymenia
Sargassum
Taonia
Ulva
Depth (ft MLLW)
5
0
-5
-10
-15
-20
-25
-30

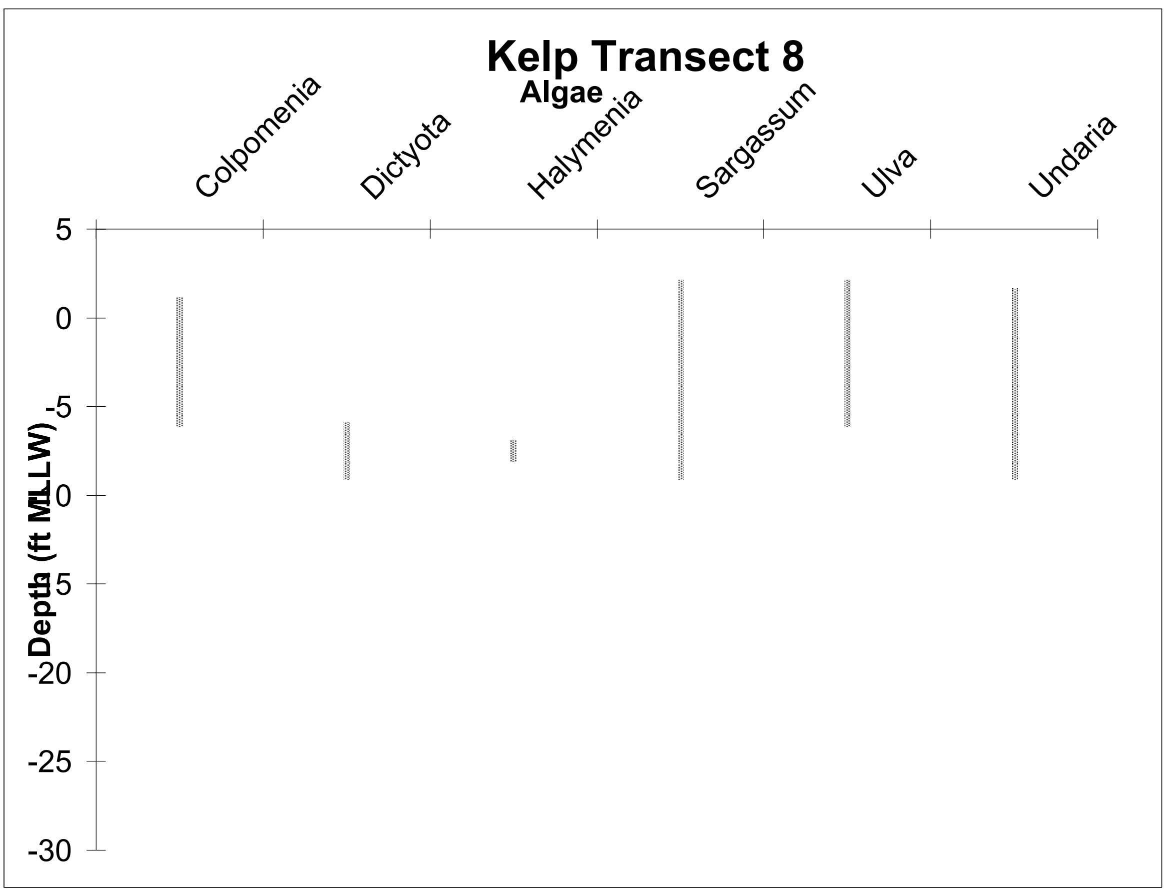

Kelp Transect 3
Algae
Chondracanthus
Colpomenia
Corallina
Dictyopteris
Dictyota
Gigartina
Gymnogongrus
Macrocystis
Prionitis
Rhodymenia
Sargassum
5
0
-5
-10
-15
-20
-25
-30
Depth (ft MLLW)

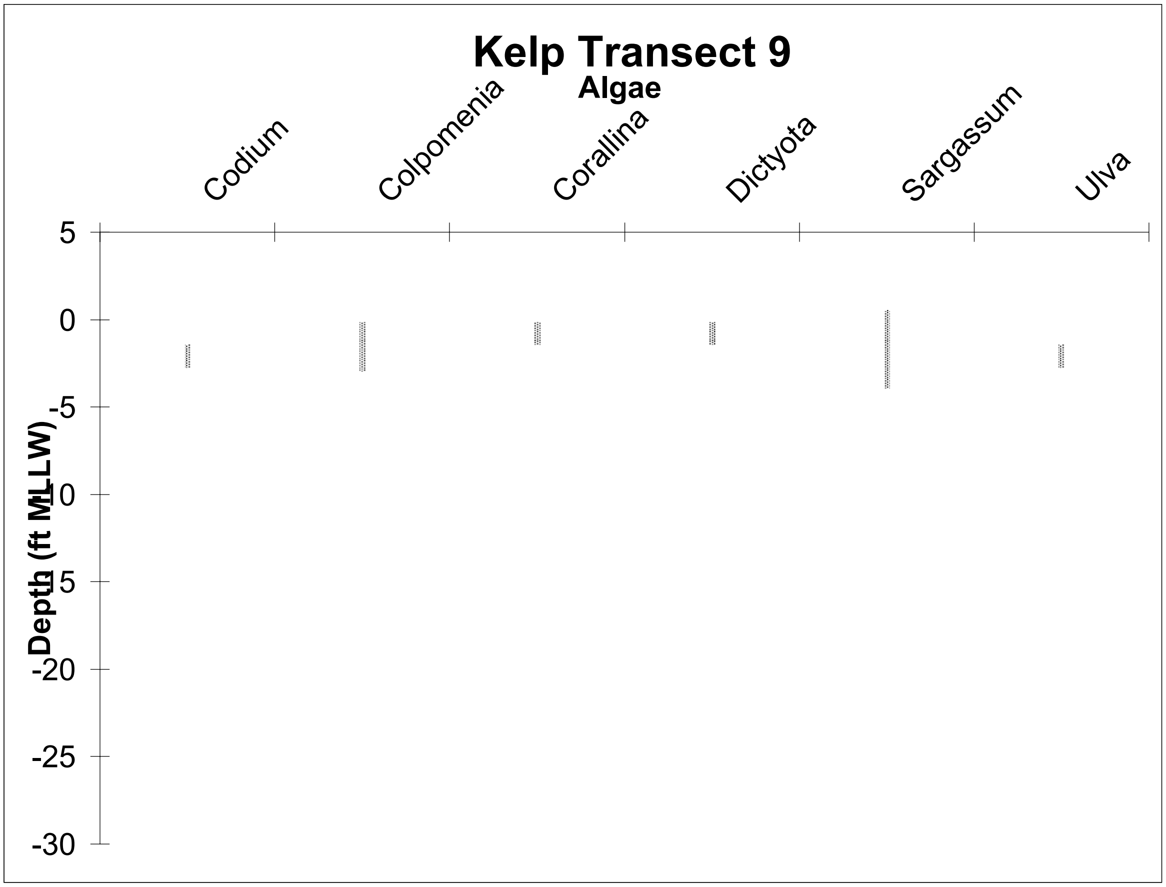

Kelp Transect 4
Algae
Colpomenia
Dictyota
Egregia
Halymenia
Macrocystis
Sargassum
Taonia
Ulva
5
0
-5
-10
-15
-20
-25
-30
Depth (ft MLLW)

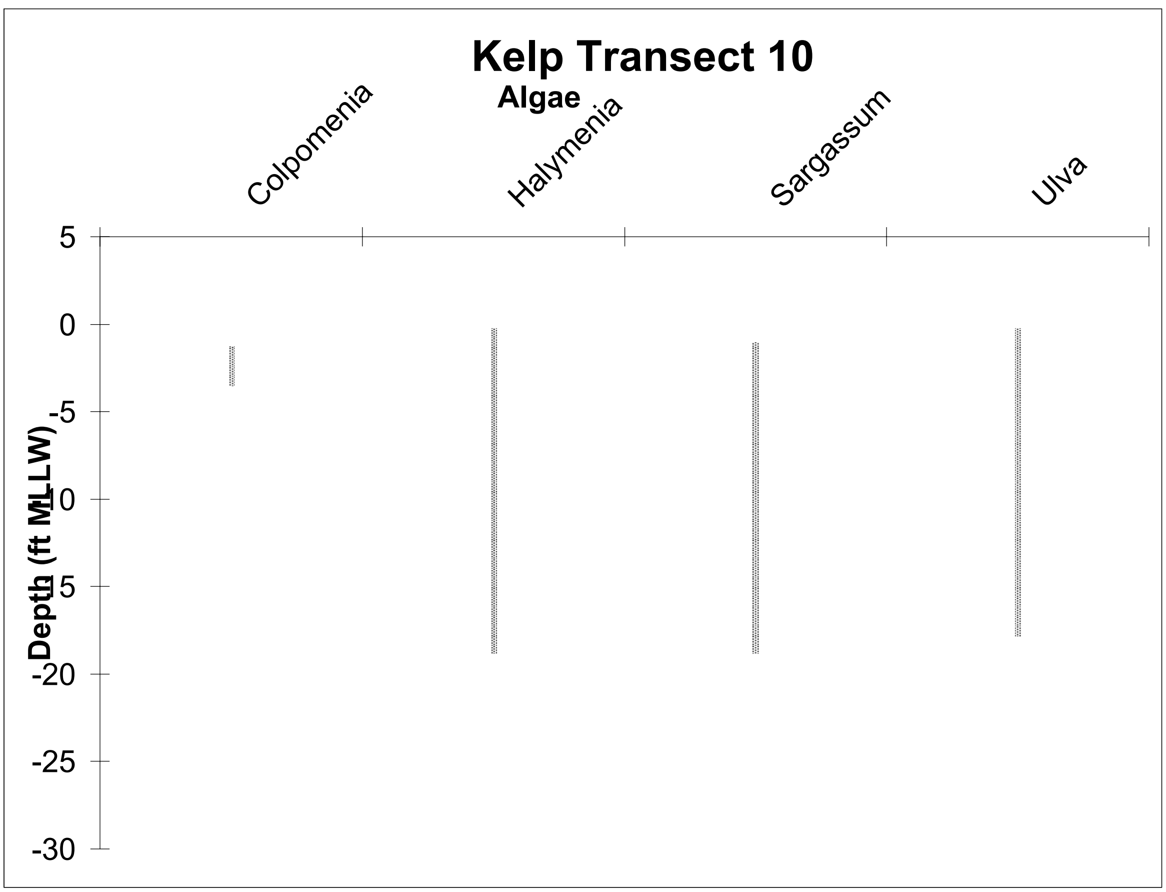

Kelp Transect 5
Algae
Corallina
Dictyota
Egregia
Depth (ft MLLW)
5
0
-5
-10
-15
-20
-25
-30

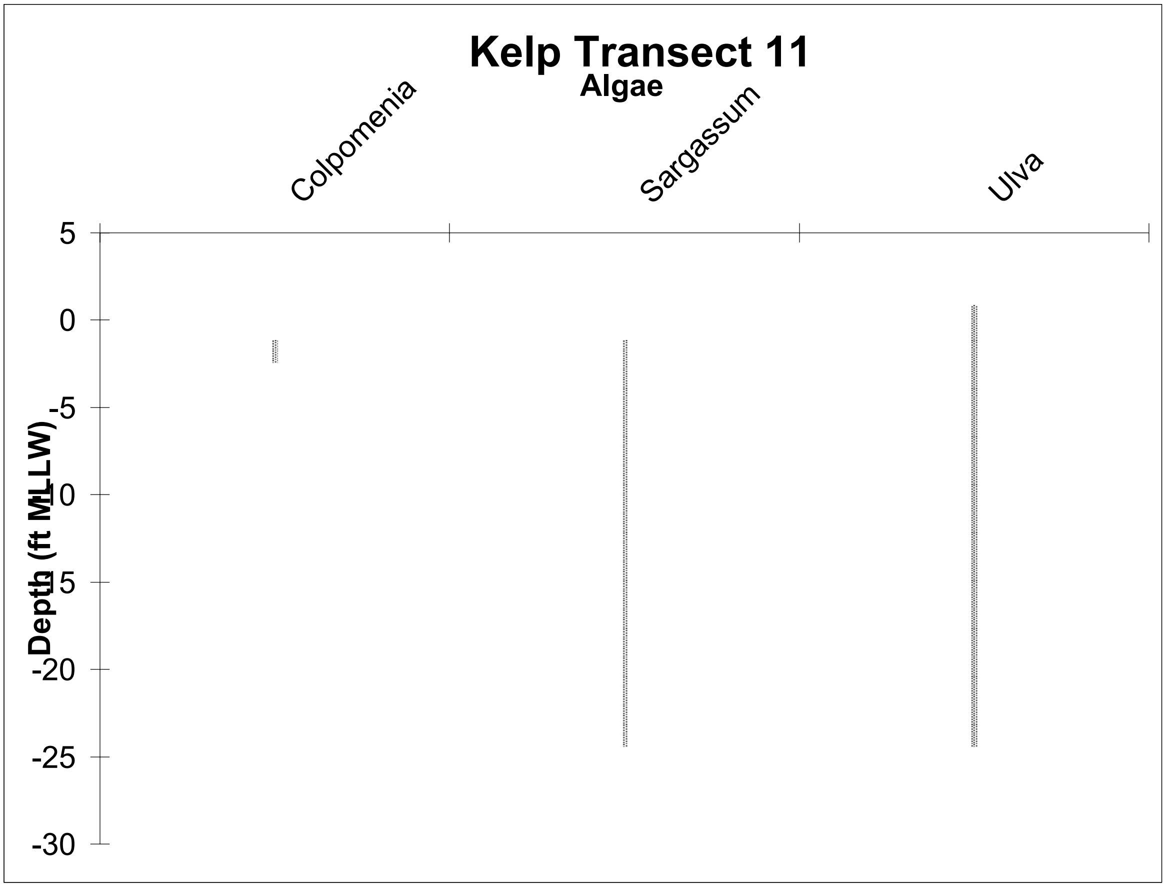

Kelp Transect 6
Algae
Codium
Colpomenia
Corallina
Dictyopteris
Dictyota
Egregia
Macrocystis
Sargassum
Taonia
Depth (ft MLLW)
5
0
-5
-10
-15
-20
-25
-30

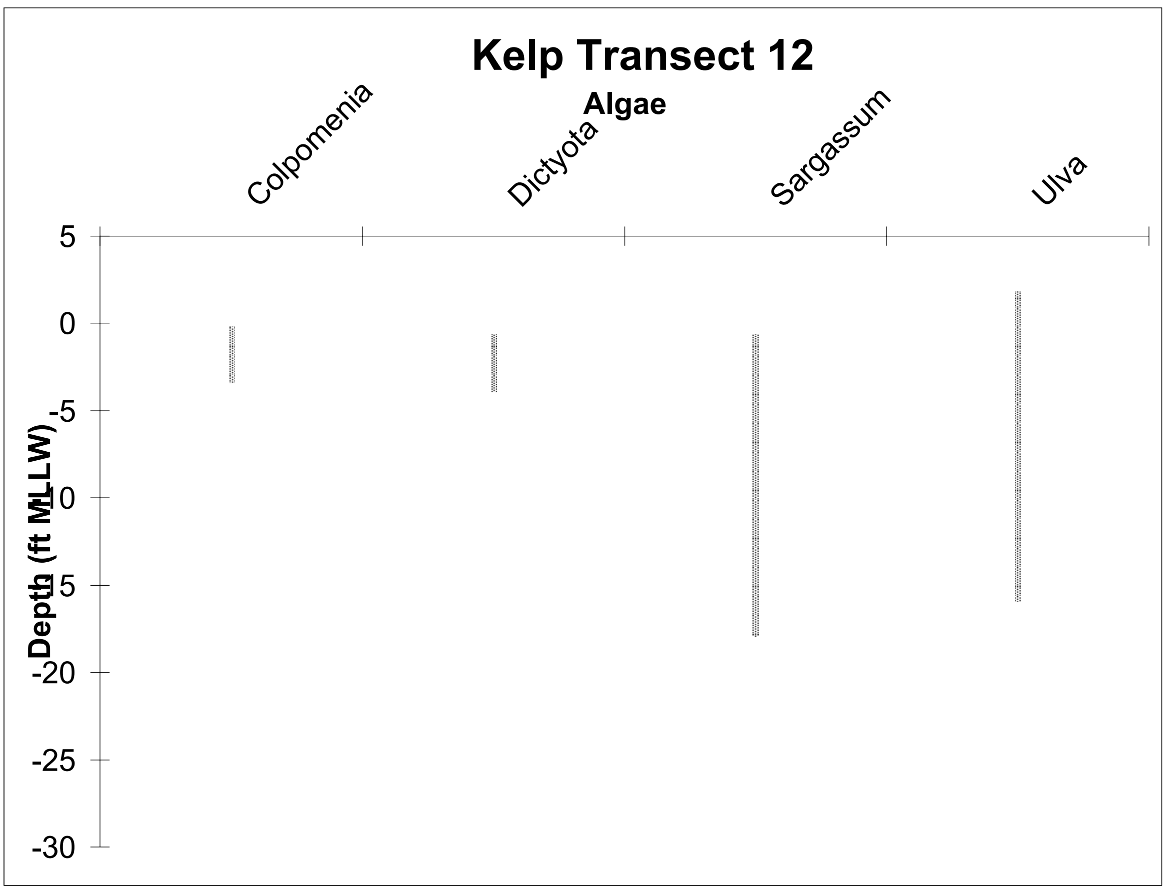

Kelp Transect 7
Algae
Colpomenia
Sargassum
Depth (ft MLLW)
5
0
-5
-10
-15
-20
-25
-30

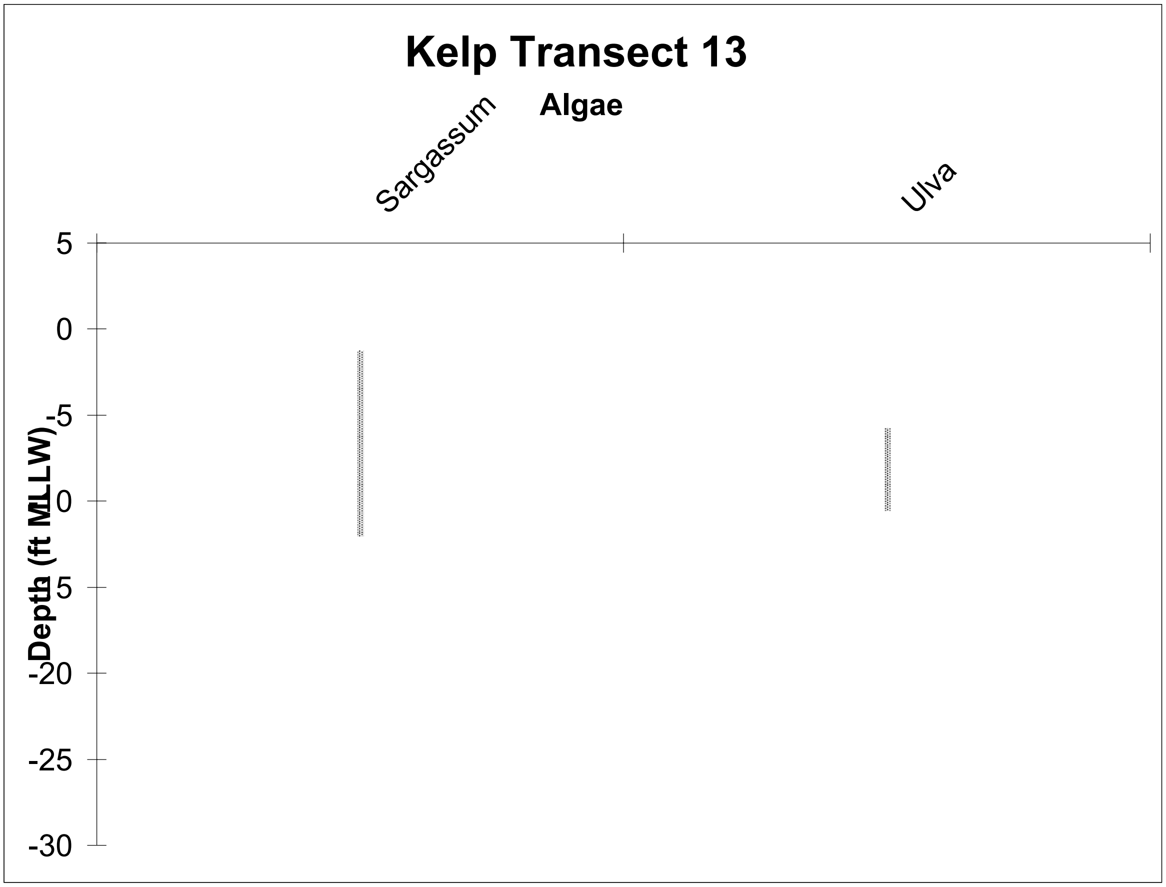

Kelp Transect 8
Algae
Colpomenia
Dictyota
Halymenia
Sargassum
Ulva
Undaria
Depth (ft MLLW)
5
0
-5
-10
-15
-20
-25
-30

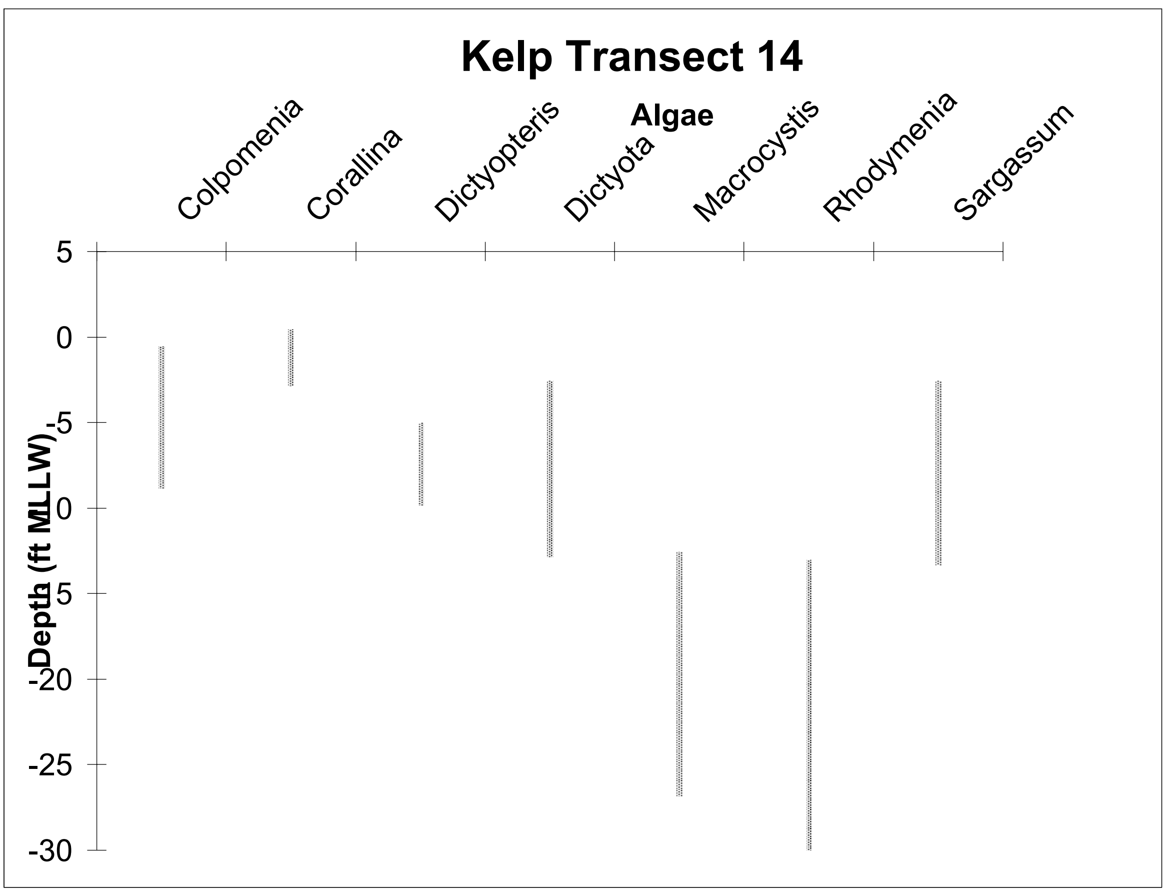

Kelp Transect 9
Algae
Codium
Colpomenia
Corallina
Dictyota
Sargassum
Ulva
Depth (ft MLLW)
5
0
-5
-10
-15
-20
-25
-30

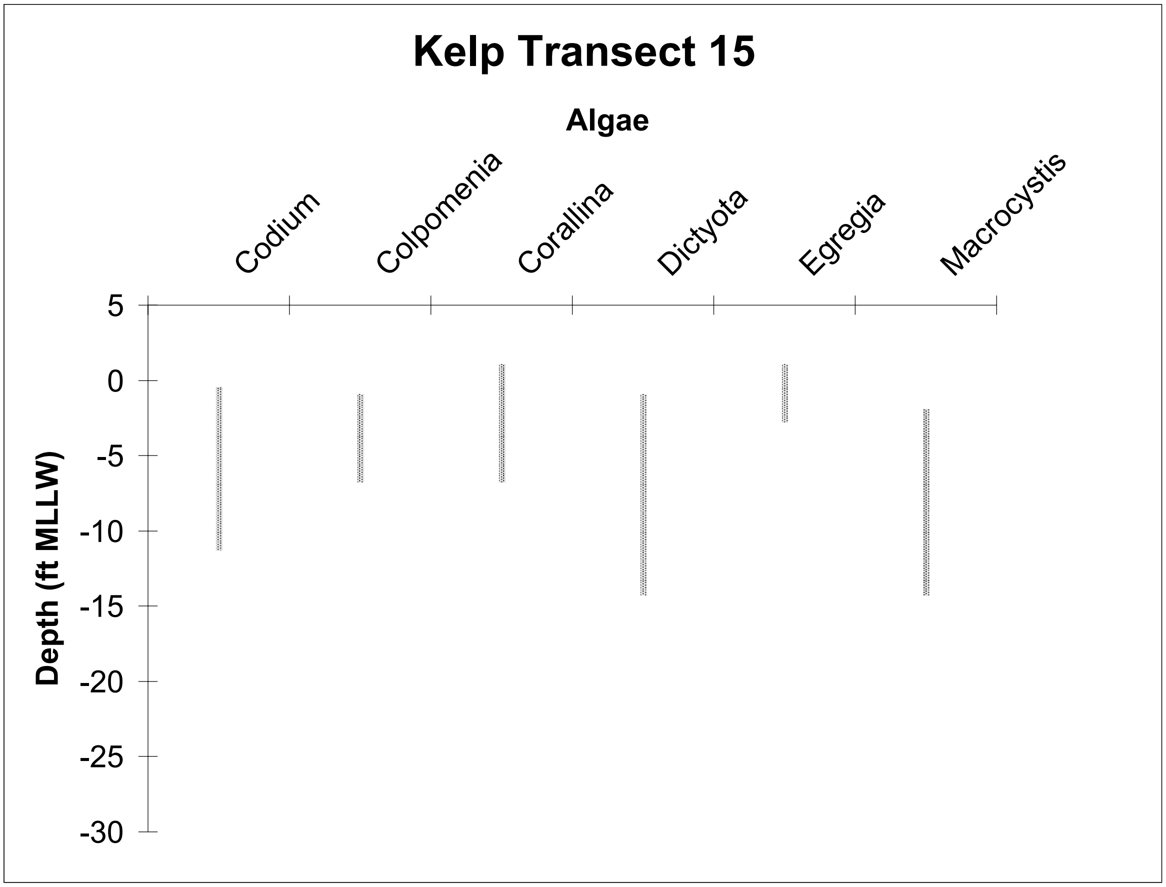

Kelp Transect 10
Algae
Colpomenia
Halymenia
Sargassum
Ulva
Depth (ft MLLW)
5
0
-5
-10
-15
-20
-25
-30

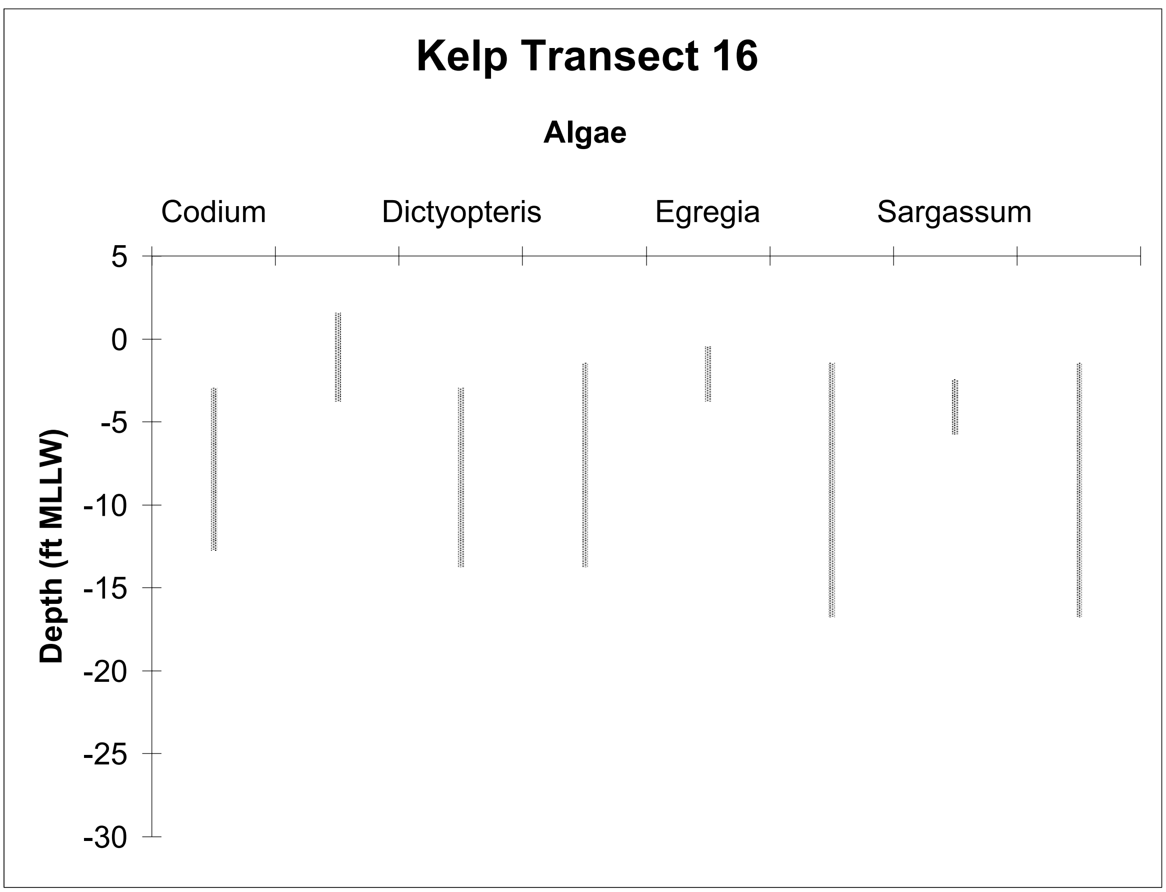

Kelp Transect 11
Algae
Colpomenia
Sargassum
Ulva
5
0
-5
-10
-15
-20
-25
-30
Depth (ft MLLW)

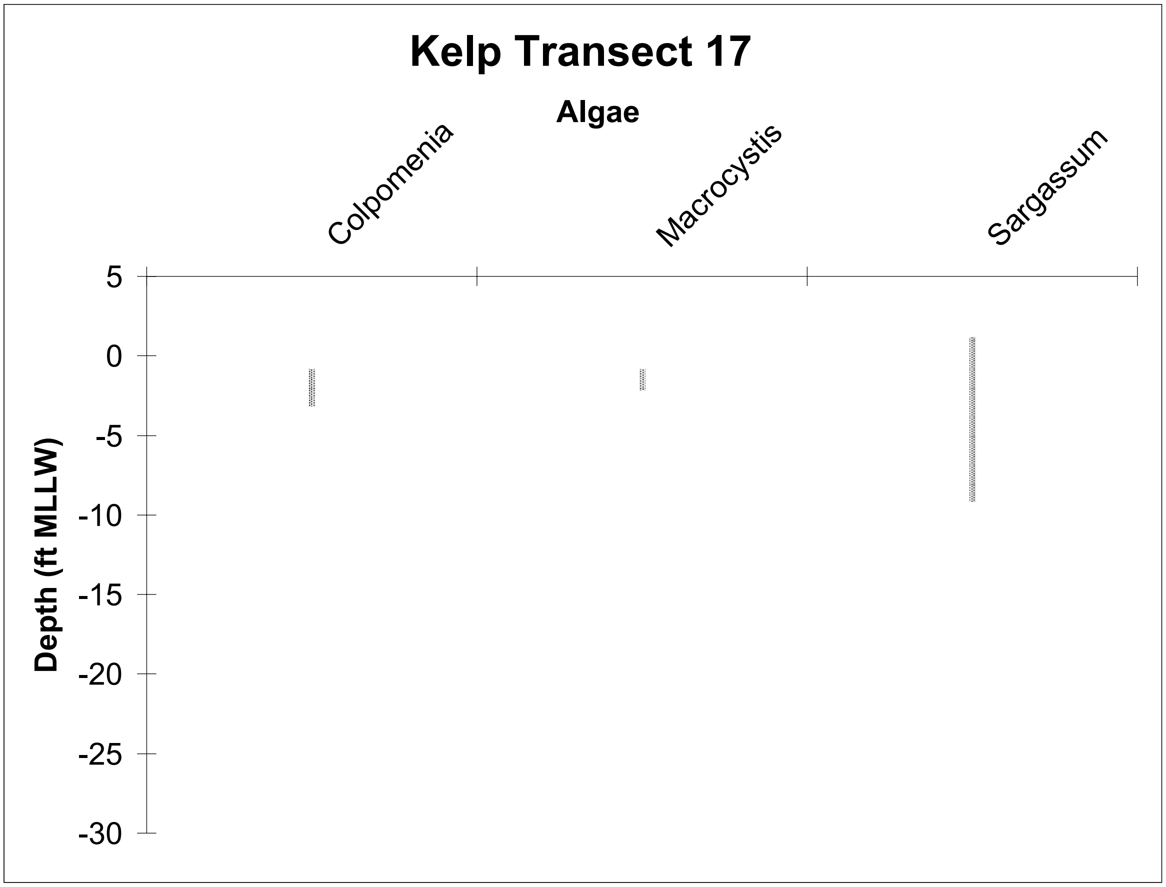

Kelp Transect 12
Algae
Colpomenia
Dictyota
Sargassum
Ulva
5
0
-5
-10
-15
-20
-25
-30
Depth (ft MLLW)

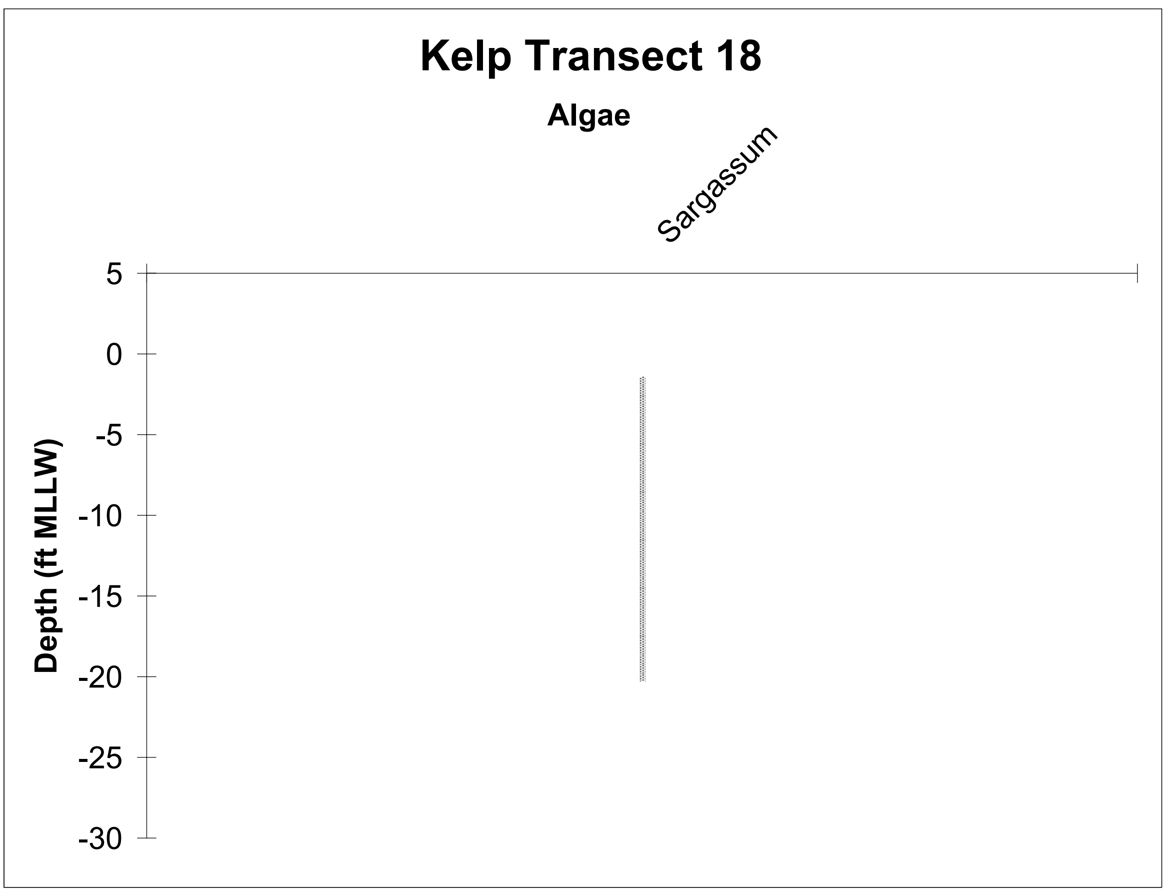

Kelp Transect 13
Algae
Sargassum
Ulva
5
0
-5
-10
-15
-20
-25
-30
Depth (ft MLLW)

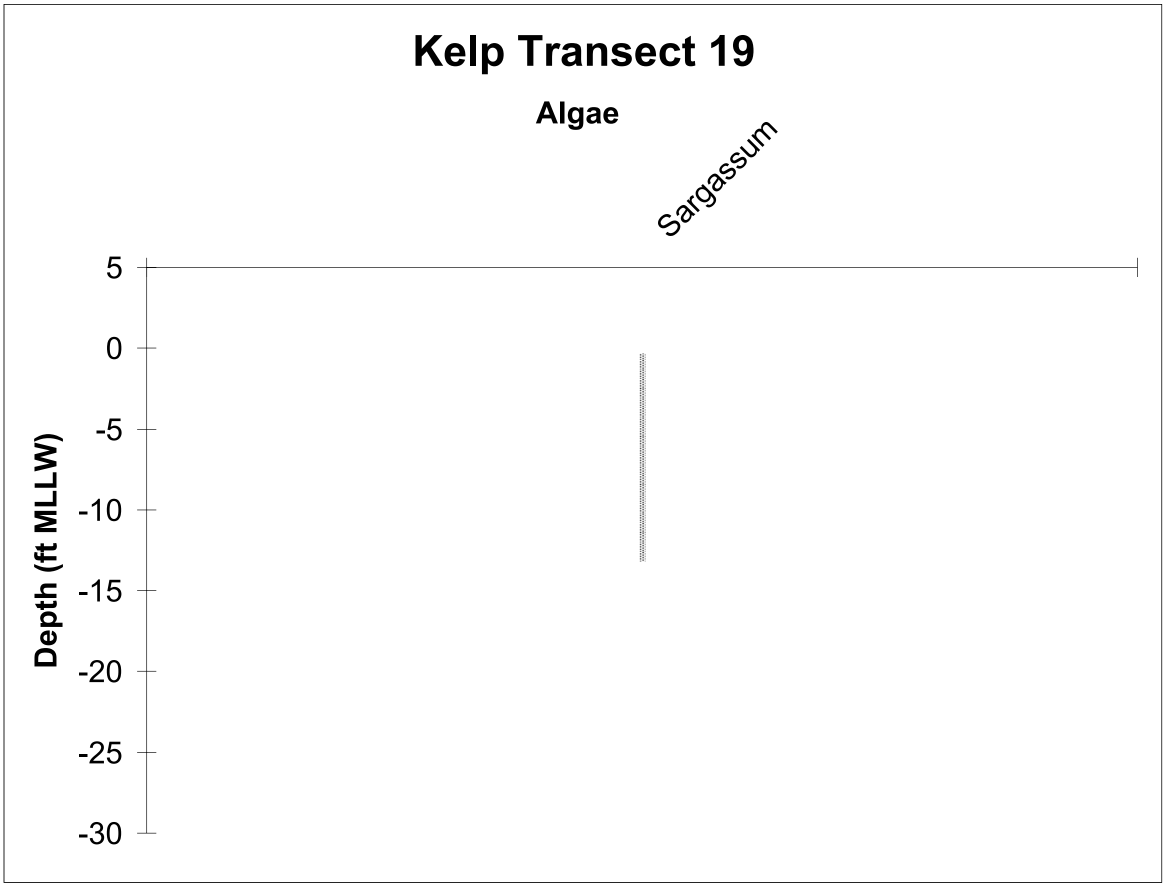

Kelp Transect 14
Algae
Colpomenia
Corallina
Dictyopteris
Dictyota
Macrocystis
Rhodymenia
Sargassum
5
0
-5
-10
-15
-20
-25
-30
Depth (ft MLLW)

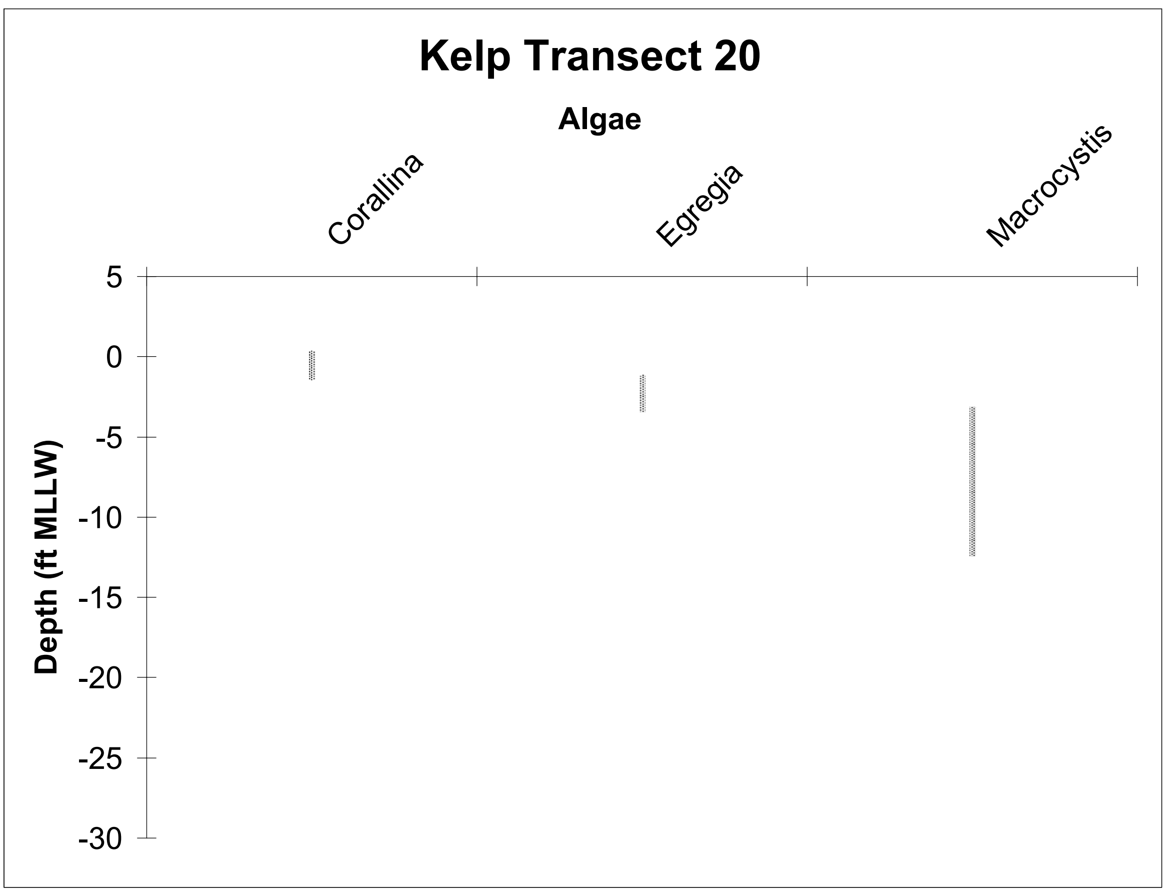

Kelp Transect 15
Algae
Codium
Colpomenia
Corallina
Dictyota
Egregia
Macrocystis
Depth (ft MLLW)
5
0
-5
-10
-15
-20
-25
-30


Kelp Transect 16
Algae
Codium
Dictyopteris
Egregia
Sargassum
Depth (ft MLLW)
5
0
-5
-10
-15
-20
-25
-30


Kelp Transect 17
Algae
Colpomenia
Macrocystis
Sargassum
Depth (ft MLLW)
5
0
-5
-10
-15
-20
-25
-30


Kelp Transect 18
Algae
Sargassum
Depth (ft MLLW)
5
0
-5
-10
-15
-20
-25
-30


Kelp Transect 19
Algae
Sargassum
5
0
-5
-10
-15
-20
-25
-30
Depth (ft MLLW)


Kelp Transect 20
Algae
Corallina
Egregia
Macrocystis
5
0
-5
-10
-15
-20
-25
-30
Depth (ft MLLW)

APPENDIX H

Bird Data

H.1 Avian Guilds
H.2 Raw Data
H.3 Mammals

Avian Ecological Guilds

Avian ecological guilds observed February 2000 to January 2001 in the Port of Long Beach and Port of Los Angeles

GUILD 1 - SMALL SHOREBIRDS

Charadriidae (Plovers and Relatives)

Black-bellied Plover	*Pluvialis squatarola*
Semipalmated Plover	*Charadrius semipalmatus*
Killdeer	*Charadrius vociferus*

Scolopacidae (Sandpipers and Relatives)

Spotted Sandpiper	*Actitis macularia*
Surfbird	*Aphriza virgata*
Ruddy Turnstone	*Arenaria interpress*
Black Turnstone	*Arenaria melanocephala*
Sanderling	*Calidris alba*
Western Sandpiper	*Calidris mauri*
Least Sandpiper	*Calidris minutilla*
Dunlin	*Calidris alpina*
Short-billed Dowitcher	*Limnodromus griseus*
Long-billed Dowitcher	*Limnodromus scolopaceus*

GUILD 2 - LARGE SHOREBIRDS

Haematopodidae (Oystercatchers)

Black Oystercatcher	*Haematopus bachmani*
American Oystercatcher	*Haematopus palliatus*

Recurvirostridae (Avocets and Stilts)

American Avocet	*Recurvirostra americana*

Scolopacidae (Sandpipers and Relatives)

Willet	*Catoptrophorus semipalmatus*
Wandering Tattler	*Heteroscelus incanus*
Marbled Godwit	*Limosa fedoa*
Whimbrel	*Numenius phaeopus*
Long-billed Curlew	*Numenius americanus*
Lesser Yellowlegs	*Tringa flavipes*
Greater Yellowlegs	*Tringa melanoleuca*

GUILD 3 - WADING/MARSHBIRDS

Ardeidae (Herons and Bitterns)

Snowy Egret	*Egretta thula*
Great Egret	*Casmerodius albus*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides striatus*
Black-crowned Night Heron	*Nycticorax nycticorax*

Threskiornithidae (Ibises and Spoonbills)

White-faced Ibis	*Plegadis chihi*

GUILD 4 - AERIAL FISH FORAGERS

Pelecanidae (Pelicans)

California Brown Pelican	*Pelecanus occidentalis californicus*

Laridae (Terns)

Common Tern	*Sterna hirundo*
Forster's Tern	*Sterna forsteri*
Caspian Tern	*Sterna caspia*
Elegant Tern	*Sterna elegans*
Royal Tern	*Sterna maxima*
California Least Tern	*Sterna antillarum browni*
Parasitic Jaeger	*Stercorarius parasiticus*
Black Skimmer	*Rynchops niger*

Alcedinidae (Kingfishers)

Belted Kingfisher	*Ceryle alcyon*

Avian Ecological Guilds

Avian ecological guilds observed February 2000 to January 2001 in the Port of Long Beach and Port of Los Angeles

GUILD 5 - WATERFOWL

Gaviidae (Loons)

Common Loon	*Gavia immer*
Pacific Loon	*Gavia pacifica*

Podicipedidae (Grebes)

Pied-billed Grebe	*Podilymbus podiceps*
Horned Grebe	*Podiceps auritus*
Eared Grebe	*Podiceps nigricollis*
Western Grebe	*Aechmophorus occidentalis*
Clark's Grebe	*Aechmophorus clarkii*

Phalacrocoracidae (Cormorants)

Double-crested Cormorant	*Phalacrocorax auritus*
Pelagic Cormorant	*Phalacrocorax pelagicus*
Brant's Cormorant	*Phalacrocorax penicillatus*

Anatidae (Swans, Geese, and Ducks)

Mallard	*Anas platyrhynchos*
American Green-winged Teal	*Anas crecca*
Cinnamon Teal	*Anas cyanoptera*
American Wigeon	*Anas americana*
Domestic Goose	*Anser domesticus*
Black Brant	*Branta bernicla*
Lesser Scaup	*Aythya affinis*
Greater Scaup	*Aythya marila*
Ruddy Duck	*Oxyura jamaicensis*
Bufflehead	*Bucephala albeola*
Red-breasted Merganser	*Mergus serrator*
Surf Scoter	*Melanitta perspicillata*

Rallidae (Rails, Gallinules, and Coots)

American Coot	*Fulica americana*

Alcids

Tuffed Puffin	*Fratercula cirrhata*
Cassin's Auklet	*Ptychoramphus aleuticus*

GUILD 6 - GULLS

Laridae (Gulls)

Herring Gull	*Larus argentatus*
California Gull	*Larus californicus*
Mew Gull	*Larus canus*
Ring-billed Gull	*Larus delawarensis*
Glaucous-winged Gull	*Larus glaucescens*
Heermann's Gull	*Larus hermanni*
Western Gull	*Larus occidentalis*

GUILD 7 - RAPTORS

Accipitridae (Hawk, Old World Vultures, and Harriers)

Osprey	*Pandion haliaetus*
Red-tailed Hawk	*Buteo jamaicensis*
Red-shouldered Hawk	*Buteo lineatus*

Falconidae (Caracaras and Falcons)

American Kestrel	*Falco sparverius*
Peregrine Falcon	*Falco peregrinus anatum*

Strigidae (Typical Owls)

Burrowing Owl	*Athene cunicularia hypugea*

Avian Ecological Guilds

Avian ecological guilds observed February 2000 to January 2001 in the Port of Long Beach and Port of Los Angeles

GUILD 8 - UPLAND BIRDS

Columbidae (Pigeons and Doves)	
Rock Dove	*Columba livia*
Spotted Dove	*Streptopelia chinensis*
Mourning Dove	*Zenaida macroura*
Trochilidae (Hummingbirds)	
Anna's Hummingbird	*Calypte anna*
Emberizidae (Warblers, Sparrows, Blackbirds and Relatives)	
Yellow-rumped Warbler	*Dendroica coronata auduboni*
Song Sparrow	*Melospiza melodia*
House Sparrow	*Passer domesticus*
Great-tailed Grackel	*Quiscalus quiscula*
Western Meadowlark	*Sturnella magna*
White-crowned Sparrow	*Zonotrichia leucophrys*
Fringillidae (Finches)	
House Finch	*Carpodacus mexicanus*
Lesser Goldfinch	*Carduelis psaltria*
American Goldfinch	*Carduelis tristis*

GUILD 8 (CONTINUED)

Tyrannidae (Tyrant Flycatchers)	
Black Phoebe	*Sayornis nigricans*
Say's Phoebe	*Sayornis saya*
Laniidae	
Loggerhead Shrike	*Lanius ludovicianus*
Hirundinidae (Swallows)	
Barn Swallow	*Hirundo rustica*
Rough-winged Swallow	*Stelgidopteryx serripennis*
Violet-green Swallow	*Tachycineta thalassina*
Motacillidae (Pipits and Wagtails)	
American Pipit	*Anthus rubescens*
Mimidae (Mockingbirds and Thrashers)	
Northern Mockingbird	*Mimus polyglottos*
Sturnidae (Starlings)	
European Starling	*Sturnus vulgaris*
Corvidae (Jays, Magpies, and Crows)	
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corax*

February 2000 A Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Coot	2																1								1							
American Crow	38	20									1						2		1	1	4	3	5				1					
Belted Kingfisher	4					1																1		1	1							
Black Oystercatcher	26		2							2			8			14																
Black Phoebe	3				1						1						1															
Black Skimmer	8	8																														
Black Turnstone	35							2		2	12		5			14																
Black-bellied Plover	75												75																			
Black-crowned Night Heron	4																				4											
Brandt's Cormorant	1873								4	11	9	555	34	1	3	1	12		1	3	1229	1	3	1					3		2	
Brown Pelican	201	3	16	27	26	3	1		1	50			2		3	10	2	1	1	3	3						2					47
Bufflehead	48	30				4	3																							4	7	
California Gull	139	8		1	26		3	12	1		17	2	7		1	6					3	9	2	2	1		3	4		10	15	6
Caspian Tern	4	3																					1									
Clark's Grebe	6					1			3																2							
Common Loon	3		2																													1
Domestic Goose	5																								5							
Double-crested Cormorant	335	32	4	8	13	1	15	5	23	6	11		16	2		5	9		1	5	133			6	10	1	1	2	8		6	12
Dunlin	1															1																
Eared Grebe	58	8	1	4	1	4	18		2		8		1			2	2				3			1	2				1			
European Starling	2																				2											
Forster's Tern	62	41	1	1					1		11	2				1					4											
Glaucous-winged Gull	15												3						10	2												
Great Blue Heron	57	1	1		4		2	14	3		12						2		1	1	9		2	1	1				2		1	
Great Egret	1																												1			
Heermann's Gull	75	8	5	4	6		1		2	8			5		1	1				2	10			3								19
Herring Gull	17								3						1	5			1	1	2											4
Horned Grebe	6	4					1																								1	
House Finch	3																						2	1								
Least Sandpiper	67												1			2									64							
Lesser Scaup	12						9																								3	
Mallard	4																							1	3							
Marbled Godwit	8					5	3																									
Mew Gull	27	3	1										2								14			2	4		1					
Mourning Dove	1																						1									
Pacific Loon	2																								1			1				
Pelagic Cormorant	3		1																	2												
Peregrine Falcon	2								1															1								
Pied-billed Grebe	9	3																						1	3				1			1
Red-breasted Merganser	14										3						1					6			4							
Ring-billed Gull	170	37	1		8		2	1									1			17	2	1	5	2	17	1	2		1	3	68	1
Rock Dove	211	3	17		2	1														22	23		17	7	94	2	5	3	8	1	5	1
Royal Tern	80	80																														
Ruddy Turnstone	6												1			5																
Sanderling	51						15		15				1			20																
Snowy Egret	2																1								1							
Spotted Sandpiper	5								1										3					1								
Surf Scoter	526		46	100	4	30	120	3	24		82	18					11				88											
Surfbird	49		27								10		9			1	2															
Unidentified Cormorant	8								6	1	1																					
Unidentified Gull	319		15	2	208		3	52	2	1			6							2	3	1	7		1			4		1		11
Unidentified Sandpiper	29						14													1											14	
Wandering Tattler	6								1	1	2		2																			
Western Grebe	389	8	1	6	3	4	6	11	46	4	102	40	3	24	4		22	5	7	9	59	8	4				2			2	8	1
Western Gull	1203	97	29	55	232	4	25	188	52	12	22	6	9	2	3	33	12		19	29	44	52	11	23	49	4	8	5	1	27	14	136
Western Sandpiper	124		16			27	81																									
Whimbrel	14		1				1				4		6			1	1															
Willet	112	1	2		2	18	4	50		4	8		7			6	8		1										1			

February 2000 B Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Coot	1																						1									
American Crow	39		4		1	5					2									1	10										13	3
Belted Kingfisher	8	1				1					1									2											3	
Black Oystercatcher	13			6												7																
Black Phoebe	1	1																														
Black Skimmer	53	52				1																										
Black Turnstone	15			2				2	2	2	3		1			3																
Black-bellied Plover	53												53																			
Black-crowned Night Heron	2																				2											
Brandt's Cormorant	901		1	2					5		850	15		2			1			2	13		2	1				1		1	1	4
Brown Pelican	474	1	40	111	125	1		5	5	34	1		41			64	3	1		6	1					1		1	1		1	31
Bufflehead	28	22					1																								5	
California Gull	229	40	1				1	2	9	6	6	9	21	5	4	2		1	17	26	1	1		3	48	2			3	2	8	11
Caspian Tern	15	14		1																												
Clark's Grebe	10											1							1		4				4							
Common Loon	8	1	3						1		1														1			1				
Common Raven	1																													1		
Double-crested Cormorant	282	25	28	11	37	1	11	5	10	2	10		2	4		4	1		1	1	50	2	3	2	28			2	4	5	21	12
Eared Grebe	80	2			2	11	39	2	4		6		1						1	1	8		2								1	
Elegant Tern	8	8																														
European Starling	14		1																10		2		1									
Forster's Tern	102	66	16	2	2	1			3		3				1	6		1			1											
Glaucous-winged Gull	9		1		3														2		3											
Great Blue Heron	57		1	1	4	2		10	4		9			2							14		1	2	2			1	1	2		1
Green-backed Heron	4																						2		1			1				
Heermann's Gull	98	34	9	14	3				1	2			1			5				2	6		1	3								17
Herring Gull	41	2	1		11		8	5	3	2			1	1						1				1								5
Horned Grebe	3																			1											2	
House Finch	48							1			40								4	3												
Killdeer	1	1																														
Least Sandpiper	57												3			3									38				4		9	
Lesser Scaup	8	5																													3	
Mallard	3																								3							
Marbled Godwit	10					10																										
Mew Gull	50	2	1																		40					3	4					
Mourning Dove	2								2																							
Pacific Loon	1																									1						
Pelagic Cormorant	3										2							1														
Peregrine Falcon	1																							1								
Pied-billed Grebe	9	3																			4		1					1				
Red-breasted Merganser	10					2	1				2									1		3									1	
Ring-billed Gull	69	2	7				1													5		1	1		5	1	1			19	25	1
Rock Dove	209	13	31		30	2														24	18	1	1		40	8		11	8	4	6	12
Royal Tern	2	2																														
Ruddy Turnstone	6			1												5																
Sanderling	48	4					18			4			8		1	13																
Snowy Egret	1																														1	
Spotted Sandpiper	10				1			2											1	1	1		2	1							1	
Surf Scoter	420		92	142	1	39	14	2	4		33	1				1					91											
Surfbird	11			4					2	2	3																					
Violet-green Swallow	6		3						3																							
Wandering Tattler	6				2				2							1			1													
Western Grebe	270			2	1	5	11	15	25		58	17		1	3	4		4	2	2	97	2	3		7		1	1		1	7	1
Western Gull	1585	92	68	84	313	7	99	95	29	30	9	2	43	4		27	3	5	20	75	41	16	41	32	59	5	12	8	3	30	19	314
Western Sandpiper	7																														7	
Whimbrel	15	1	1			2	1		1		1		2	2		4																
White-crowned Sparrow	4																														4	
Willet	106	5	1	3	4	24		23			15		14	3		6	1		6												1	

March 2000 A Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Avocet	1							1																								
American Crow	30	3	12																		7		4		1							3
Belted Kingfisher	3				1	1															1											
Black Oystercatcher	14												10			3	1															
Black Skimmer	58	58																														
Black Turnstone	62		11			13		2		1	5		19			11																
Black-bellied Plover	2												2																			
Brandt's Cormorant	684								39		7	1	166			30					431		1	2					1		5	1
Brown Pelican	577		7	13	68			1	2		3		134	2	1	245	17	19	1	7	3					1						53
Bufflehead	20	19																													1	
Burrowing Owl	1										1																					
California Gull	277	5			12		16	3	3		1	1		1		7	4			8	3	1	4	7	121	6	1		1	7	65	
Caspian Tern	22	16	1					1	2		1									1												
Clark's Grebe	5										3										2											
Common Loon	6		1								1							2									1	1				
Common Raven	4		1								2															1						
Domestic Goose	2																								2							
Double-crested Cormorant	225	32	18	8	16	1	11	24	12		4		8		3	5	16	2		5	14		7	5	10			3	1		10	10
Eared Grebe	78	3			2	7	38	3	2		3							2			11		2		3						2	
Elegant Tern	14	11	1										2																			
European Starling	12																				6		6									
Forster's Tern	59	34	7			2		2	1		2				2			6			3											
Glaucous-winged Gull	9		1		2						1									1	2				1					1		
Great Blue Heron	65	1			3	3	7	9	2		1						3	1			29				1		1		3		1	
Heermann's Gull	187	3	8	3	3				3				24	1	1	97	11	25		3				1								4
Herring Gull	16			2	2			7	4							1																
Horned Grebe	3	1															1														1	
House Finch	28					1	4		2		6										5	3	7									
Least Sandpiper	44							8					6			2									28							
Lesser Scaup	4	3																													1	
Mallard	9										5										2										2	
Marbled Godwit	6					4	2																									
Mew Gull	6	1																			3										2	
Mourning Dove	3																				2		1									
Pacific Loon	1																												1			
Pelagic Cormorant	3										2												1									
Pied-billed Grebe	21	2					1										4						2	5				2			5	
Red-breasted Merganser	2								1												1											
Ring-billed Gull	45	13	2			1														2	1		1	1	3	1				10	10	
Rock Dove	232	5	35		32	14														7	51	15	19		8	10	4	6	9		4	13
Royal Tern	2	2																														
Ruddy Turnstone	23		6						2				4			11																
Sanderling	68	4					29	10	8				9			8																
Snowy Egret	6				1												1								3						1	
Song Sparrow	1	1																														
Spotted Sandpiper	7	1					1		2													1	1								1	
Surf Scoter	434		86	25	1	94	21	1	5		30						9	34			128											
Surfbird	25		1				4						16			4																
Tufted Puffin	1			1																												
Unidentified Cormorant	60			60																												
Unidentified Falcon	1								1																							
Unidentified Gull	55				49																								1			5
Unidentified Sandpiper	5																1				1										3	
Wandering Tattler	5												2			3																
Western Grebe	501	6		1		2	9	15	30	1	109	56		2	9	1	93	4	5	3	127		4	1	11				2		9	1
Western Gull	1570	55	60	22	300		88	150	54	1	38		39	9	16	96	16	75		39	72	20	35	22	58	11	10	3	2	47	7	225
Western Sandpiper	34					3	18	2					1												10							
Whimbrel	14		1			1		1	2		3		1	3		1					1											
White-crowned Sparrow	1																				1											
Willet	60		1	2	2	2	9	15			1		7	4		6	5	1	4												1	

March 2000 B Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Crow	26	2	3				2				4						3			6	3	1										2
Barn Swallow	9		4																							2					2	1
Belted Kingfisher	1					1																										
Black Brant	6		1				5																									
Black Oystercatcher	24		1	1						6			10			6																
Black Skimmer	73	73																														
Black Turnstone	32		6							12	7		1	2		4																
Black-bellied Plover	2	1											1																			
Black-crowned Night Heron	5																				5											
Brandt's Cormorant	117									2	4	1	4		54	4		4	7		31		1								2	3
Brown Pelican	334	5	47	45	42	1			10	22	2		14	1		30	10	14	12		9		2		3							65
Bufflehead	5	4																													1	
California Gull	163	15	9		3		11		1			1			3	2	1		7	1	1	3		6	89	3			3	1	3	
Caspian Tern	92	27	2			7	51	3												1								1				
Clark's Grebe	7										1						3		1						2							
Common Loon	1		1																													
Common Raven	2																				1								1			
Domestic Goose	2																								2							
Double-crested Cormorant	205	22	10	5	20	2	22	2	25		5					4	10		4	7	25		5	9	9			1		1	10	7
Eared Grebe	63	2			2	5	31	1	1		12						2				3				2						2	
Elegant Tern	15		2	1				2	3	1								6														
European Starling	15	1																	5		4		3								2	
Forster's Tern	71	7	7			3	17	2	6				1	3			3		9	2	5	3	2								1	
Glaucous-winged Gull	10				1														2		4											3
Great Blue Heron	42		4		3	5	1				1							1	1		20		1	2	1			1	1			
Great-tailed Grackle	1										1																					
Heermann's Gull	110	37	11					1	1	1	1	3	2	1	3	11	4	1	21		5		1									6
Herring Gull	5						1									1			3													
Horned Grebe	1																												1			
Killdeer	2					1			1																							
Least Sandpiper	16							5		3										1											7	
Lesser Scaup	4	2				2																										
Mallard	4																		2					1	1							
Mew Gull	1																								1							
Mourning Dove	3								3																							
Pelagic Cormorant	1																			1												
Peregrine Falcon	2							1																1								
Pied-billed Grebe	1	1																														
Red-breasted Merganser	2								1		1																					
Ring-billed Gull	21	14	1														1												1		3	1
Rock Dove	311	2	34		13	12					6			2					4	9	49		3	7	77	12	7	11		11	8	44
Royal Tern	1																		1													
Ruddy Turnstone	10		1							3			1			5																
Sanderling	14		4						7							3																
Semipalmated Plover	4																														4	
Snowy Egret	14																			1				2	10						1	
Spotted Sandpiper	8							2											2	1			1							1	1	
Surf Scoter	555	1	207	4	1	32	88	1	2		90						7				122											
Surfbird	519		3	3						25	134		6	213		23	112															
Unidentified Sandpiper	13																								13							
Wandering Tattler	7									2			2			3																
Western Grebe	1480	2	5	3		9	2	15	123		121	396		7	86		271		303	2	111	4			6		3			1	10	
Western Gull	1798	165	214	61	341	4	71	242	32	14	20	11	9	1	20	12	7	12	32	48	44	43	36	38	34	2	2	6	12	18	10	237
Western Sandpiper	33		1				31	1																								
Whimbrel	15	1			1		5			2	1			3		1															1	
Willet	68	1	3	3	3	4	7	10		2	6		6	2		4	8		1	1	6											1

April 2000 A Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Crow	22	2			3														1	5	7					1						3
American Kestrel	1																															1
Barn Swallow	45		10		5	2															5		14		2		2			3	2	
Black Brant	1		1																													
Black Oystercatcher	30		1							4	2		8			15																
Black Skimmer	58	39			6										13																	
Black Turnstone	42			3		4			4	5			20			6																
Black-crowned Night Heron	21	4			6	1															10											
Brandt's Cormorant	509								7	7	4	7	3		7	3					469			2								
Brown Pelican	268		25	7	31	3		2		64			44		8	42	1	1		1	2	1								1	1	34
California Gull	53	37					10						1						2						1					1	1	
Caspian Tern	117	28	1		1	6	41	4	3				2				5	2	4			2	4	2	8		1			2	1	
Clark's Grebe	2																				1				1							
Common Loon	3		3																													
Common Raven	2																1				1											
Domestic Goose	2																								2							
Double-crested Cormorant	147	33	2	4	21			4	1		7				2	2	3			5	23	2	3		17	1	7		2	3	4	1
Eared Grebe	40	3	1		1	1	18	1			8						1				2			1	2						1	
Elegant Tern	15										4	1	4		4			2														
European Starling	23	3	1																2	1	1		6		4			3				2
Forster's Tern	48	1									6		2		9					5	12		7	1					4		1	
Glaucous-winged Gull	2						1														1											
Great Blue Heron	45		2		1	2	1	8			3								2	1	15		1	8							1	
Great-tailed Grackle	4																				4											
Green-backed Heron	3																							1		1		1				
Heermann's Gull	69	12	10		1			2		8		1	1		6	5		3	1													19
House Finch	6					1																	1		4							
House Sparrow	6		1																				4									1
Killdeer	2							1	1																							
Least Sandpiper	3												2																		1	
Least Tern	12								4		6										2											
Loggerhead Shrike	1					1																										
Long-billed Curlew	1					1																										
Mallard	9								1											3	1			1	2		1					
Mourning Dove	1								1																							
Pacific Loon	3		2															1														
Peregrine Falcon	2																							2								
Pied-billed Grebe	1																1															
Ring-billed Gull	9	8	1																													
Rock Dove	356	7	36		30	17													4	10	51	2	21	16	72	10	2	20		13	13	32
Rough-winged Swallow	2																		1												1	
Ruddy Turnstone	10								2	1			1			6																
Sanderling	14		8				1			5																						
Snowy Egret	1																														1	
Spotted Sandpiper	6		1																		1			1				1			2	
Surf Scoter	73		23				11		2		21	4			2						10											
Surfbird	58			15						2	14		10	15		2																
Wandering Tattler	11								1				2	1		7																
Western Grebe	588			3	4	13	1	32	45	1	100	59			178		1	3	1	1	112	24	1	1	1			1			6	
Western Gull	1084	114	97	49	88	5	25	30	68	21	19	11	26	7	4	26	7	39	20	13	75	20	37	11	16	15	1	6	2	28	7	197
Western Sandpiper	74					74																										
Whimbrel	12					1	1		1				3	3		2													1			
Willet	33	2	2			6		6	1	1	6		1	1		3	2				1										1	

May 2000 A Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Crow	13	3															1				3				6							
Barn Swallow	34	11	4		4											1	2				2		2		2	2		3			1	
Black Brant	2	2																														
Black Oystercatcher	20		4							1			9			6																
Black Skimmer	4		4																													
Black Turnstone	4															4																
Black-bellied Plover	1												1																			
Black-crowned Night Heron	51		3			1	1				1						9		1	2	32											1
Brandt's Cormorant	114		1		1						7										105											
Brown Pelican	239		3	27	6		3		1	30	49	16	41	2	3	32	18	3		1	1			1					1			1
Caspian Tern	51		3	1	4			2	4	1		1	1	2	2		7		1		1	2	11	2	1		1		1		2	1
Clark's Grebe	3																1				2											
Common Loon	8	3	4								1																					
Common Raven	3		1				2																									
Double-crested Cormorant	107	7	3		2		5	2	1	2	8	2		1			2		1		34		5	8	8						11	5
Eared Grebe	6		2			1			2		1																					
Elegant Tern	288		14	11	2			10	72	2			6	4	17	7	3	139														1
European Starling	8				1												1		4		1							1				
Forster's Tern	48									5		1	19		2	5	8	3	5													
Glaucous-winged Gull	1																															1
Great Blue Heron	35	1			1		1	1											3	3	16			7								2
Great-tailed Grackle	5																				5											
Green-backed Heron	1																									1						
Heermann's Gull	102	22	13	8					1	7	6	3	2			6	4		14		2			5								9
Horned Grebe	3							3																								
House Finch	14					3																	2	6	1						2	
Killdeer	2								1									1														
Least Tern	104	9	2	21	2	6	18	2	26	1	5		1					9	2													
Mallard	11																2		1		2		2		4							
Mourning Dove	5							1	3														1									
Osprey	1					1																										
Pacific Loon	1		1																													
Peregrine Falcon	2																				2											
Pied-billed Grebe	1					1																										
Ring-billed Gull	1						1																									
Rock Dove	282	4	15		16	23		1									2		1	1	36		3		93	30	4	14	4	5	16	14
Rough-winged Swallow	1		1																													
Royal Tern	13									1								12														
Snowy Egret	5																				4				1							
Surf Scoter	6						1				1										4											
Surfbird	1															1																
Unidentified Cormorant	5			3			2																									
Wandering Tattler	3												3																			
Western Grebe	159			1	1	1	5	4	14	3	10	18			3	1	9			1	80	6									1	1
Western Gull	1756	624	200	83	85	1	33	28	7	32	47	2	36	3	1	28	245	33	19	11	40	12	8	9	23		1	2	5	12	25	101
Whimbrel	1																	1														

June 2000 A Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Crow	11		1								2											1	2		5							
Anna's Hummingbird	1												1																			
Barn Swallow	39		13		3						1										2		9		8			1				2
Black Oystercatcher	30									4			15			11																
Black Skimmer	1			1																												
Black-bellied Plover	1		1																													
Black-crowned Night Heron	58		4		1						16						9		1	1	24		1								1	
Brandt's Cormorant	4				1					1											2											
Brown Pelican	346		22	48	3	3	40	11		96	6	1	54			20	7		2		16							1			1	15
Caspian Tern	70		4				3		43		2				2	1	2	3	1				5	3								1
Common Loon	1		1																													
Domestic Goose	1																								1							
Double-crested Cormorant	111		4		5	1	8	2	1		7			2		1	4			5	43	1	3	9	1			1	2		8	3
Elegant Tern	1026		86	17	11	3		102	557		1	29	5	13	29	9	81	70	5		1					1	1					5
Great Blue Heron	78		3	2	2	2	2	6			24						2	1		2	16	2	1	8	1						1	3
Great-tailed Grackle	6										4										2											
Green-backed Heron	1																					1										
Heermann's Gull	871	73	141	289	1		2	55	51	7	5		19	1		46	30		71	6	16	5	4		4	2				1	1	41
Horned Grebe	1		1																													
House Finch	18						15		3																							
House Sparrow	1																						1									
Least Tern	94	2	21	5		1	6	4	23		4			3	5		2	2	3		7	1			2						3	
Mallard	9																		8					1								
Mourning Dove	5							2	3																							
Northern Mockingbird	1																								1							
Pelagic Cormorant	1										1																					
Peregrine Falcon	1																							1								
Ring-billed Gull	2	1					1																									
Rock Dove	278		20		16	6														2	20	8	21	3	95	33	3	10	15	6	12	8
Royal Tern	35		1					1	33																							
Ruddy Turnstone	2												1			1																
Surf Scoter	8		4				1														3											
Wandering Tattler	1									1																						
Western Grebe	452		3		16		46	7	2		223	1		3					126		21	3									1	
Western Gull	1534	97	178	88	147	2	28	129	8	2	12	3	16	4		45	370		85	57	30	18	17	9	33	2	3	1	1	10	2	137
Willet	14						2		4				7			1																

July 2000 A Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Crow	7	4																			3											
Barn Swallow	31		16														1				1		7		1	1						4
Black Oystercatcher	26				1					2			18			5																
Black Skimmer	65								62			3																				
Black Turnstone	23									10			9			4																
Black-bellied Plover	3					1				2																						
Black-crowned Night Heron	41	12	9		2												1				12		4				1					
Brandt's Cormorant	15										2		1			5					6				1							
Brown Pelican	1181	1	1	17	13		167	16	1	213	10		326		3	205	49	15	5		61	3	3					1			26	45
California Gull	19			1			2										15							1								
Caspian Tern	57						20	3	28	1			1		1		1	2														
Clark's Grebe	42						1				11								14		14										2	
Domestic Goose	8																								8							
Double-crested Cormorant	95	1	3		5		6				3		1	1			2	1		2	47		1	15			1	1	1		4	
Dowitcher species	6						6																									
Eared Grebe	1			1																												
Elegant Tern	4550	2	74	30		2	12	2360	1895	16		8	26		21	1	19	75								2						7
European Starling	3																												3			
Forster's Tern	3																										3					
Great Blue Heron	87	3	1		2	1	4	37			9		1				1	2	1	1	12	1	1	2			1	2	1		2	2
Great Egret	1																				1											
Green-backed Heron	4																										1	1	1			1
Heermann's Gull	2813	59	233	138	5		19	239	466	326	11		418		9	282	428	5	66	2	3	12	37	1	15	5	2			8		24
Least Tern	88	1		6		6	29	1	33	3								7	2													
Long-billed Curlew	3					1																									2	
Mallard	12																							1	11							
Pelagic Cormorant	1																			1												
Pied-billed Grebe	3					1																									2	
Red-shouldered Hawk	1																														1	
Rock Dove	287	23	15		6	7		2									1			6	15	5	11		119	27	1	23		19	3	4
Royal Tern	15						2	10	1		2																					
Ruddy Turnstone	6									1			4			1																
Snowy Egret	4																				3										1	
Surf Scoter	8		4				1														3											
Surfbird	84			5						22			51			6																
Wandering Tattler	8			2									2			4																
Western Grebe	284		1		10		48	7	14		121						1		70		11										1	
Western Gull	1869	99	239	45	231	8	36	94	11	12	60		39		22	59	465	1	65	81	46	12	38	19	48	1	3	4		8	7	116
Whimbrel	1							1																								
Willet	25		1		1	3			2	4	3		4			6			1													

August 2000 A Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Crow	8		1			1					2						2		1				1									
Barn Swallow	40		7		1																4		19		2			1				6
Belted Kingfisher	6						1														3			1			1					
Black Oystercatcher	36									1			13			22																
Black Skimmer	183						5		176								2															
Black Turnstone	23		2						7	2			11			1																
Black-bellied Plover	12		1				4			2			5																			
Black-crowned Night Heron	16		2					1			7										2	1	2						1			
Brandt's Cormorant	30		2							1	3	3			6	2	1	1			11											
Brown Pelican	1038		21	25	2		104	10	46	190	5	2	145		3	218	84	7	29		59	1	8							2	49	28
California Gull	9		1				5		1															1						1		
Caspian Tern	48		2			1	15	1	22						1		3						2	1								
Clark's Grebe	42										12								15		14										1	
Common Loon	1																															1
Domestic Goose	7																								7							
Double-crested Cormorant	104	1	7		1		10				14	1	1				2			2	41		1	9	5			1			8	
Elegant Tern	2431		33	8	2			2052	237	23	2	15			23		7	21									2					6
European Starling	4																		1		3											
Forster's Tern	1								1																							
Great Blue Heron	78		5		8	4	2	8	5		14		2				2		2		8	3	4	3	1			3		1	3	
Great-tailed Grackle	4										4																					
Green-backed Heron	6		1																				1	1		1		1	1			
Heermann's Gull	1989	49	127	67	13		1	170	506	105	2	2	183	1	4	96	356		192	3	4	5	2	2	3	31	2	1		9		53
Herring Gull	1						1																									
Least Sandpiper	1												1																			
Least Tern	8								7	1																						
Loggerhead Shrike	1																						1									
Long-billed Curlew	1					1																										
Mallard	12																								10		1				1	
Marbled Godwit	1					1																										
Mourning Dove	1																				1											
Northern Mockingbird	1																								1							
Pelagic Cormorant	2																				2											
Pied-billed Grebe	4																				1										3	
Ring-billed Gull	4	2	1					1																								
Rock Dove	261	21	17		21	11											3			1	44	1	12	15	51	20	3	13		13	3	12
Ruddy Turnstone	9									2	1		3			3																
Snowy Egret	1																				1											
Spotted Sandpiper	4					1													2				1									
Surf Scoter	6		3																		3											
Surfbird	23		2							1	3		6			9			2													
Unidentified Gull	1			1																												
Unidentified Hummingbird	1									1																						
Wandering Tattler	12		2				1		2				3	1		3																
Western Grebe	300				3		48				117								96		35										1	
Western Gull	2269	215	411	60	160	2	59	201	83	29	30	25	83	18	6	42	313	5	56	66	55	26	54	36	66	3	5	2		34	7	117
Whimbrel	8			1		2				2	1								1		1											
Willet	32	3	2			2	8		2	1	1		5			6			1												1	

August 2000 B Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Crow	14	3	1																	1	1				1						6	1
Barn Swallow	18																2						13		3							
Belted Kingfisher	14	1	2		2			1			1										3		2		1			1				
Black Oystercatcher	26								3	6			6			11																
Black Phoebe	3				2																1											
Black Skimmer	147						78		64		1						1	3														
Black Turnstone	19									9			3			7																
Black-bellied Plover	30	1				1	2			7			19																			
Black-crowned Night Heron	14	4	2		1			1													2	1							2			1
Brandt's Cormorant	49								6		7					1	1				33			1								
Brown Pelican	1115	7	18	27	7		19	10	60	180	21	1	212			334	81	9	10		41	1						3			22	52
California Gull	25		1				21																		3							
Caspian Tern	32	1					6	4	19							1		1														
Clark's Grebe	46							3	6		11								19		6										1	
Domestic Goose	3																								3							
Double-crested Cormorant	164	1	6	1	6	1	16	1	3	1	30						1	1	1		40	1	1	18	8			1	2		17	7
Elegant Tern	279	3	5	8				175	41	5		1						40					1									
Forster's Tern	5		1				2										1				1											
Glaucous-winged Gull	1																			1												
Great Blue Heron	74	6	5		3	2	3	8	2		13						10				6	2	2	1	2	1		1	2	2	2	1
Great-tailed Grackle	5																				4				1							
Green-backed Heron	2																								1	1						
Heermann's Gull	1468	49	59	101	7		1	10	31	47	18		59			104	775	1	51	6	24	12	15	12	6	18	24	1	1	10		26
House Finch	4						3	1																								
Least Sandpiper	1												1																			
Mallard	21	5																						1	15							
Marbled Godwit	11	2				1	4									4																
Mourning Dove	1																								1							
Pelagic Cormorant	7										2									1	1	2						1				
Pied-billed Grebe	4	1				1																			2							
Ring-billed Gull	10	2				1	7																									
Rock Dove	315	19	22		6	6											1			38	12	7	11	8	115	27	1	17	11	1	4	9
Ruddy Turnstone	5									3			1			1																
Snowy Egret	1																														1	
Spotted Sandpiper	6		1				1												2					2								
Surf Scoter	8		4				1														3											
Surfbird	13								1	3			2			6	1															
Unidentified Sandpiper	1							1																								
Wandering Tattler	5						1		2	1						1																
Western Grebe	285							27	9		96			2					112	2	35	1									1	
Western Gull	2247	296	247	118	288	4	83	135	36	11	55	4	21	1	1	25	326	7	55	105	77	35	55	47	52	4	23	1	3	24	9	99
Western Sandpiper	18								18																							
Whimbrel	9		1	1			3									3			1													
Willet	43	9	1			4	3	2		2	4		6			7	2		1	1											1	
Yellowlegs species	1		1																													

September 2000 A Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Coot	1																				1											
American Crow	11		7								1									1	1							1				
Barn Swallow	1																									1						
Belted Kingfisher	17	1	2			1		1												3		1	4		1			2				1
Black Oystercatcher	75		3							3						67	2															
Black Skimmer	31					21	10																									
Black Turnstone	50								5	12			4			29																
Black-bellied Plover	7	1				5				1																						
Black-crowned Night Heron	5		1																		2		1									1
Brandt's Cormorant	225									1	5	2			1			1		3	209		2									1
Brown Pelican	1136	6	68	8	25	3	388	46	9	62	54	3	8		2	129	23	26		4	100		17		2		2	1		1	24	125
California Gull	6	1																		1					3					1		
Caspian Tern	3								3																							
Clark's Grebe	36										16								12		8											
Domestic Goose	10																								10							
Double-crested Cormorant	199	3	1	2	12		21	5		3	13					1	7	5	1	6	55	2	3	19	10	1	1	2	7		7	12
Eared Grebe	2																		2													
Elegant Tern	185	8					4		123	4	1	13			16			14			1	1										
Forster's Tern	33	3				2	2			4					10		1				1	1	8								1	
Great Blue Heron	83	3	18		7	5	6	4	2		11						5	1	2		9	2	1		1			2	1	1	1	1
Green-backed Heron	2																								1				1			
Heermann's Gull	694	32	62	5	24		3	7	116	24	57	15		1		83	92	3	11	13	24	13	34	1	6		6	1	1	9		51
Long-billed Curlew	1					1																										
Mallard	16																								16							
Marbled Godwit	3					3																										
Pelagic Cormorant	2																			1					1							
Peregrine Falcon	1						1																									
Pied-billed Grebe	4	3																													1	
Ring-billed Gull	2	2																														
Rock Dove	269	9	18		9	26														13	6	7	11	16	75	12	4	8	3	4	29	19
Rough-winged Swallow	1																1															
Ruddy Turnstone	7									1						6																
Spotted Sandpiper	5	1									2												1								1	
Surf Scoter	3						1				2																					
Surfbird	35								4	7						24																
Unidentified Cormorant	2										2																					
Unidentified Falcon	1								1																							
Unidentified Gull	2													2																		
Unidentified Sandpiper	11							11																								
Wandering Tattler	6						1			1						4																
Western Grebe	235						20	8			156	2							39		10											
Western Gull	1938	204	234	56	251	6	42	127	35	12	59	15	9		4	35	128	36	48	65	43	120	76	45	114	11	8	2	5	10	25	113
Western Sandpiper	9													1																	8	
Whimbrel	9	1	1						2	2						2						1										
Willet	36	4	1		1	12	4			5				1		2	3		2										1			

September 2000 B Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Coot	1																							1								
American Crow	17		5					1						5									3		1			1			1	
Barn Swallow	4										4																					
Belted Kingfisher	20		2			2								2						1		2	3		3			1		2		2
Black Oystercatcher	33									3			1			28	1															
Black Phoebe	2				1															1												
Black Skimmer	14						14																									
Black Turnstone	2															2																
Black-bellied Plover	6					1	1			2			1			1																
Black-crowned Night Heron	9	1	4																		2											2
Brandt's Cormorant	95		8	1					2		26					2					52	1			1	1					1	
Brown Pelican	901	17	58	133	112	3		23	1	104	10	1	33	10		189	15	8	1	5	27	2	5					3			14	127
California Gull	18	2					3																1	1	11							
Caspian Tern	5						3		1												1											
Clark's Grebe	21	1	1		1	1		1			2						1		10	1	1									1		
Double-crested Cormorant	203	8	2	1	7		7	11		1	34		1	5		3	3			2	50	5	1		13			3		1	23	22
Eared Grebe	4		3		1																											
Elegant Tern	1										1																					
European Starling	19					18								1																		
Forster's Tern	11	1	2	1	1														1		4		1									
Great Blue Heron	94	2	14	1	4	2	1	5	14	2	15		2	1			8				8		2		2	2		2		2	2	3
Green-backed Heron	6		1																	1		1	1		2							
Heermann's Gull	592	31	90	110	15			12	9	11	13		3	2		54	13	13	9	27	9	15	11		15	18	17	4		9	14	68
Herring Gull	1		1																													
Mallard	11																								11							
Marbled Godwit	4						4																									
Pacific Loon	1		1																													
Pelagic Cormorant	3										1										1		1									
Pied-billed Grebe	7	3					1																		2						1	
Red-tailed Hawk	1																							1								
Ring-billed Gull	3	1									1																				1	
Rock Dove	243	30	42		16	6															15	3	5	8	56	20	6	12	16	4	1	3
Royal Tern	2										1				1																	
Ruddy Turnstone	1															1																
Say's Phoebe	2								2																							
Snowy Egret	1																								1							
Spotted Sandpiper	2				1		1																									
Surf Scoter	5										5																					
Wandering Tattler	3			1						1							1															
Western Grebe	308	14	8	9	23	7		8	25	1	124			3			3		39	4	25			3	8				1	2	1	
Western Gull	1538	178	186	223	126	3	28	36	39	12	19	8	22	2	2	70	52	6	10	38	42	36	53	47	201	3	8	4	1	5	11	67
Whimbrel	2						1									1																
White Faced Ibis	1															1																
Willet	33	1			1		14			3						10			2												2	

October 2000 A Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Coot	2																						2									
American Crow	8	3				2																	3									
American Oystercatcher	1															1																
American Wigeon	1																													1		
Belted Kingfisher	14		3			1	1	1											1	1	1	1	1		1							2
Black Oystercatcher	63												2			61																
Black Turnstone	21												18			3																
Black-bellied Plover	105						5						99			1																
Black-crowned Night Heron	7																				1	1	2		3							
Brandt's Cormorant	70		16	4	1			1	3		8	4	1	4	8			1		2	13		1	2	1							
Brown Pelican	541	3	85	4	72		2	7	11	17	13	3	114			106	11	7	2		1	3	6	1	1			4				68
California Gull	34		1		2	1	3					1										1			25							
Caspian Tern	9	1					4			4																						
Clark's Grebe	11			1		1	1	1	1								3				2				1							
Common Raven	3	2																						1								
Double-crested Cormorant	230	10	21		20		1	4			22	3	13	2		1	18		6	1	46	2	5	9	13			1	10		9	13
Eared Grebe	32						22	4			1			1			2				1		1									
Elegant Tern	77	5					2		1		2		35		2	29							1									
European Starling	1		1																													
Forster's Tern	19	5				1	5						2				4				1								1			
Great Blue Heron	62	3	2	5	5	1	4	3	1		8		1	1		2	2		3	1	3	2	5	1	1			2	3	1		2
Heermann's Gull	471	11	33	1	61			17	37	14	2	1	38	2		70	7		10	26	2	16	31	13	13	10	15	2	6		1	32
Herring Gull	1																				1											
Mallard	18																						1		17							
Mourning Dove	1																								1							
Northern Mockingbird	1																								1							
Osprey	1					1																										
Pacific Loon	1		1																													
Parisitic Jaeger	2									1		1																				
Pelagic Cormorant	5										1									2	2											
Pied-billed Grebe	8	2																							1				4		1	
Ring-billed Gull	3																						2									1
Rock Dove	201	10	45	5	6																8	3	7		59	16	9	23	10			
Royal Tern	1							1																								
Ruddy Turnstone	5												3			2																
Snowy Egret	1																														1	
Spotted Sandpiper	2										1						1															
Surfbird	13												10			3																
Wandering Tattler	3												2			1																
Western Grebe	1260	9	21	60	17	5	11	105	131		462	13	7	6	6		148		20	17	163	16	1	15	7					6	10	4
Western Gull	1555	93	76	13	348	4	29	311	14	8	17	21	17	7	9	50	16	1	34	24	46	26	45	25	157	5	10	3	8	1	8	129
Whimbrel	7						3						1			3																
Willet	41		1		2		12	2		1	2		11			9	1															

October 2000 B Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Coot	6	1								1													1							3		
American Crow	13		3		1		2														3									1		3
American Kestrel	1																												1			
American Oystercatcher	1															1																
Belted Kingfisher	12		2				1													1	2		2		2						2	
Black Oystercatcher	20		1							1						18																
Black Phoebe	1																				1											
Black Skimmer	2						2																									
Black Turnstone	11		1	1		1			2		1		1	2		2																
Black-bellied Plover	48		2	6		8			1				31																			
Black-crowned Night Heron	13	1	7																		4				1							
Brandt's Cormorant	124		45	5	2					3	6	1	9	4	2	2			1	7	25		1	2	2			4				3
Brown Pelican	297		43	20	53	1		1	8	52	3	4	15		3	22	3	1		5	22	1	16	2				8			4	10
Bufflehead	3																				3											
California Gull	106		2				1														1	1	1	24	58			1	1	1	13	2
Caspian Tern	1														1																	
Clark's Grebe	14					5	3	1				1									1				2						1	
Common Loon	2		1						1																							
Common Raven	4																							2					2			
Domestic Goose	5																								5							
Double-crested Cormorant	169	9	8	2	16		5	8		3	17	1		3		3	21			3	25		8	4	6			2			10	15
Eared Grebe	12			6		3					1														2							
Elegant Tern	4		1	3																												
European Starling	3													3																		
Forster's Tern	15		1					1				4	2		1						6											
Great Blue Heron	72	1	8		5	4	1	13	2	1	9		1				3		1	2	5		2		5			1	1	1	3	3
Great-tailed Grackle	1																				1											
Green-backed Heron	3																								1	1		1				
Heermann's Gull	573	23	28	37	51	2	9	7	98	24	20	27	5	4	16	9	26	2	7	21	2	13	32	14	4	15	9	11	10			47
Herring Gull	6	1																				1	3		1							
House Finch	2																					2										
Mallard	8																								8							
Marbled Godwit	3						3																									
Mew Gull	1																						1									
Mourning Dove	1										1																					
Pacific Loon	1		1																													
Pelagic Cormorant	1																										1					
Pied-billed Grebe	10	3			1			1																1							4	
Ring-billed Gull	14	1	2				6																2							2	1	
Rock Dove	203	1	18		13	7					1								1		6	2	4		115	8		8	6		2	11
Royal Tern	1										1																					
Ruddy Duck	4	3					1																									
Ruddy Turnstone	1												1																			
Sanderling	31	17					9				4					1																
Say's Phoebe	1					1																										
Semipalmated Plover	4																														4	
Snowy Egret	1																														1	
Spotted Sandpiper	7		1			1								2					3													
Surf Scoter	98		1	17			28	1			51																					
Surfbird	10		2	3							1		1			3																
Unidentified Cormorant	2								2																							
Unidentified Sandpiper	1															1																
Unidentified Scaup	11						11																									
Wandering Tattler	1			1																												
Western Grebe	1213	11	35	5	42	84	35	50	54		114	248	1	7			255		27	32	94	10	52	14	14					2	20	7
Western Gull	1890	35	65	177	423	5	44	37	20	24	28	25	17	9	13	25	10	16	6	120	107	45	170	24	292	5	25	2	4	27	9	81
Western Meadowlark	11					10																								1		
Western Sandpiper	29	5					8				8																				8	
Whimbrel	14		1				7		1		1			2		2																
Willet	44	1	1	3	2	2	17	6		2	4					3	1		1												1	

November 2000 A Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Crow	22	4					1													5								1			11	
Belted Kingfisher	11					1					1								1	1		1	1		2					1	1	1
Black Oystercatcher	26												12			14																
Black Skimmer	5	2					3																									
Black Turnstone	14									2			10			2																
Black-bellied Plover	25					1	4			5			12			2															1	
Black-crowned Night Heron	11		3																		1	1	3		1						1	1
Brandt's Cormorant	161		12						2	16	25	2	33	1	6					2	49			6	2	1		1			3	
Brown Pelican	317	4	6	11	41	1		42	5	39	2		7			4		2	1	2	28	1	1	2	2	1		3	1		5	106
Bufflehead	33	16				4	3																		5						5	
California Gull	184	12	4	4	2		7	32						1	1	1			4	1	2	3	1	10	76	1		1		2	11	8
Caspian Tern	3	3																														
Clark's Grebe	30	1				1					22										1	1		1	1						2	
Common Loon	2																		1							1						
Common Raven	1																														1	
Double-crested Cormorant	174	3	4	3	14	1	20	1	1	2	15		1	4	1	4	8		2	8	32		1	5	12			5	2	1	11	13
Eared Grebe	68	12	5		2	9	20	6	5		3										1			4	1							
Elegant Tern	1	1																														
European Starling	1																															1
Forster's Tern	46	13	1							2	5	8			9	8																
Glaucous-winged Gull	2				1		1																									
Great Blue Heron	69		8	1	4	1	1	10	3		7		3	1			1		1	3	7	1	5	1	3		1	3	2		2	
Great Egret	1																														1	
Great-tailed Grackle	1										1																					
Green-backed Heron	1																													1		
Heermann's Gull	581	16	46	3	18	7	4	13	2	5	9	5	2	10	42	20	8	1	18	27	31	19	36	19	16	17	9	6		14	3	155
Herring Gull	11										4									2			1									4
House Finch	8								4		4																					
Least Sandpiper	2												1																		1	
Lesser Goldfinch	5	5																														
Loggerhead Shrike	2																						1	1								
Long-billed Curlew	1					1																										
Mallard	15	4																						2	9							
Marbled Godwit	4					1	3																									
Mew Gull	33	16																		1	16											
Northern Mockingbird	1																								1							
Pelagic Cormorant	3																				2				1							
Peregrine Falcon	1																													1		
Pied-billed Grebe	13	4																					3		1			1			3	1
Ring-billed Gull	69	9	3				12													5		2	5								19	14
Rock Dove	204	12	23		1	7					3									3	5	3	4		51	7	4	15	38	11	6	11
Ruddy Duck	61	58																													3	
Ruddy Turnstone	2												2																			
Sanderling	11		7				4																									
Say's Phoebe	2																						1		1							
Semipalmated Plover	8																														8	
Snowy Egret	1																														1	
Spotted Sandpiper	6				1		2							1					1													1
Surf Scoter	408	3	1	21		28	85	12			253				1			3	1													
Surfbird	41												41																			
Western Grebe	748	17	4	2	13	14	8	16	23		461	4	1	4	3		26		9	7	62	21	15	4	18			3		1	8	4
Western Gull	1310	66	99	21	151	13	19	119	1	30	19	6	23	4	12	65	13		4	22	46	25	85	55	82	7	12	5	1	19	6	280
Western Sandpiper	48																														48	
Whimbrel	9							1			2		2			4																
White-crowned Sparrow	2																								2							
Willet	47		1	1	1	3	12	5			3		7			9	2		1												2	

November 2000 B Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Crow	22	2																								1	2				15	2
American Goldfinch	4						4																									
American Green-winged Teal	1																														1	
American Oystercatcher	1															1																
Belted Kingfisher	9		1											1						1	2		1								2	1
Black Oystercatcher	11									4						7																
Black Phoebe	1							1																								
Black Skimmer	2						2																									
Black Turnstone	13								4	1			7			1																
Black-bellied Plover	75			2		1	50			3			14			4															1	
Black-crowned Night Heron	12	1	4																		3		1		3							
Brandt's Cormorant	141		1		3				4	8	8		16	9		3	7			13	47		2	6	4						5	5
Brown Pelican	566	3	16	51	30	2	4	29	6	63	9	2	129	1	2	91	1	2	1	1	13	1	1	1	2			7	1			97
Bufflehead	28	22					4																								2	
California Gull	144	8	2										2			1	2			2	2		6	17	84		2	7		5	4	
Caspian Tern	5	2					2		1																							
Cassin's Auklet	1									1																						
Clark's Grebe	7		1														2				2	1								1		
Common Loon	3		1																						1						1	
Common Raven	1		1																													
Domestic Goose	4																								4							
Double-crested Cormorant	213	5	6	8	15	7	7	5		3	14			1		4	12		3	5	62			3	14			5			13	21
Eared Grebe	22	4	1		3	1	9				2						1								1							
Forster's Tern	61	15	1			2	2				38							3														
Glaucous-winged Gull	11	1			1													1		2			1		2							3
Great Blue Heron	59	1	6	1	6	3	4	4	5		9		1	1		1	1			1	3		4	1	1			1		1	2	2
Great-tailed Grackle	3																				3											
Heermann's Gull	1016	101	102	27	42	1	5	8	15	16	20	6	102	4	1	51	20	67	3	10	30	15	33	23	14	8	4	26		10	1	251
Herring Gull	11												1			2				3	1	4										
House Finch	31						1				30																					
Killdeer	1						1																									
Long-billed Curlew	1						1																									
Mallard	21																								6						15	
Marbled Godwit	1						1																									
Mew Gull	30																				24			4							2	
Mourning Dove	1																								1							
Northern Mockingbird	1																								1							
Pacific Loon	1							1																								
Pelagic Cormorant	1				1																											
Pied-billed Grebe	10	3																					2		3			1			1	
Red-tailed Hawk	2																						1		1							
Ring-billed Gull	106	75	3		2		3	1			1								2	1		4	2	1	1	1				1	5	3
Rock Dove	223	15	26		16	3					3										2	2	2	5	71	24	7	19		8	13	7
Ruddy Duck	86	86																														
Ruddy Turnstone	2												2																			
Sanderling	19						14				3		1			1																
Snowy Egret	2																								2							
Spotted Sandpiper	3						1										1						1									
Surf Scoter	364	3	20	40	3	30	90	60			116						1					1										
Surfbird	55		1	1					6	2			29	2		13			1													
Unidentified Cormorant	2								1		1																					
Western Grebe	372	19	7	2	4		42	13	42		95	30	3	3	1		7	3	8	13	40	13	5	3	14		1			1	3	
Western Gull	1700	141	66	62	237	6	20	130	1	17	8	10	42	6	3	47	7	33	7	41	123	54	120	31	207	3	5	7		6	6	254
Western Sandpiper	1						1																									
Whimbrel	10						4						2	1		2			1													
White-crowned Sparrow	3							3																								
Willet	43	2	2	6			12	3		3			7			7															1	

December 2000 A Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Coot	1																						1									
American Crow	7		1			1															1		1		2					1		
Belted Kingfisher	12		1			1														1	1	2	3		1					1	1	
Black Oystercatcher	6															6																
Black Phoebe	2						1																		1							
Black Skimmer	3						3																									
Black Turnstone	2									1			1																			
Black-bellied Plover	122						64			1			56																		1	
Black-crowned Night Heron	14		4																		4				5							1
Brandt's Cormorant	140			3				1			18	2	24	5	25	1	1		1	2	43		4	1	3							6
Brown Pelican	540	1	2	69	97	2	1	32	12	143	4	2	26		1	4	1	1		3	12	1	5		4	1		4	1			111
Bufflehead	38	29					4				2																				3	
California Gull	325	15	79	7			25		2		5	8	2	4	2	3	4			5	10		2	3	148		1					
Caspian Tern	5	3																			2											
Clark's Grebe	9							1			5			1					1	1												
Common Loon	1		1																													
Common Tern	2												1				1															
Domestic Goose	8																								8							
Double-crested Cormorant	195	9	3	7	18	2	4	3		5	3		2		1	1	12		5	6	50	1		10	18	1		4	6	1	8	15
Eared Grebe	33	5			4	3	8	7	3		1										2											
European Starling	13										4										9											
Forster's Tern	43	28	5				2					2		1	3	2																
Glaucous-winged Gull	24		2		3														3						12							4
Great Blue Heron	69	1	8	2	2	2	3	3	11		10			1		1			2		5	1	6		4			1	1	2	3	
Great Egret	1																														1	
Great-tailed Grackle	2																				1				1							
Green-backed Heron	1																															1
Heermann's Gull	865	100	130	69	55		1	11	2	20	9	4	5	1	11	2	12		4	36	34	24	32	24	16	20	10	8		10		215
Herring Gull	19		8										4			1			1	1		1	2									1
Horned Grebe	1						1																									
House Finch	235					5	27		120		83																					
Lesser Scaup	2	2																														
Mallard	29																								23						6	
Marbled Godwit	4						4																									
Mew Gull	63	7																			52	1		3								
Northern Mockingbird	1																								1							
Pacific Loon	3										1								1									1				
Pelagic Cormorant	11							1			1						1			1	4			1				1		1		
Peregrine Falcon	1																			1												
Pied-billed Grebe	6	2																			1		1	1							1	
Red-breasted Merganser	6																					6										
Red-tailed Hawk	1																						1									
Ring-billed Gull	109	5	29		1			2		1	1		1			2	2		4	14	2	6	3	6	3				1	13	3	10
Rock Dove	359		38		14	4					35										20	3	10	5	159	25		13	12	7	7	7
Ruddy Duck	76	76																														
Sanderling	4						2						2																			
Say's Phoebe	1					1																										
Snowy Egret	1																														1	
Spotted Dove	1																							1								
Spotted Sandpiper	6				1									2					2		1											
Surf Scoter	402		38	28	1	12	204	29			76	1									13											
Surfbird	13												13																			
Western Grebe	409	15	5	3	9	4	35	11	34		121	5		2	1			1	8	13	78	25	6		19				1	12		1
Western Gull	1701	62	56	77	305	3	19	137	1	20	8	15	32	2	7	37	7		11	16	44	31	14	20	335	4	6	3	4	27	3	395
Western Sandpiper	51												1																		50	
Whimbrel	12						4						1			3	4															
Willet	45		4	5			24	3					3			4	1														1	

December 2000 B Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Coot	1																						1									
American Crow	5				1															1	2											1
Belted Kingfisher	8										1									2		1	1			1					1	1
Black Phoebe	3													2									1									
Black Skimmer	2						2																									
Black Turnstone	1															1																
Black-bellied Plover	74	2					72																									
Black-crowned night heron	6																				5		1									
Brandt's Cormorant	710	1	4	1				2	1	2	25	1	23	5	11				1		618		2	2	5						3	3
Brown Pelican	327	9	4	32	78	1		19	8	19	2	1	13	1		5				3	14		1	3			1	1		1	2	109
Bufflehead	46	7	36	1			2																									
California Gull	142	4	1		3	1			13		6	1	6	2		3	1			23	9	5		1	54		1				2	6
Caspian Tern	8	4														2	1	1														
Clark's Grebe	20						4	2	6		1	1							1			2			1					1	1	
Common Loon	2																1										1					
Common Raven	4						2														2											
Domestic Goose	2																								2							
Double-crested Cormorant	227	5	2	1	15	4	8	6	2		6		5	4		6	15		10	5	67	1	5	3	18			8			7	24
Eared Grebe	35	3	2	2	2	7	6				9										2										1	1
Elegant Tern	1																				1											
European Starling	5					1					2								1		1											
Forster's Tern	64	56	2																													6
Glaucous-winged Gull	18	2			3			1					1			1			2	1		1	2	1	3							
Great Blue Heron	56	1	2		3	1		15	8		1			2			1		1		5		7	1	2			1	2		3	
Great-tailed Grackle	1																				1											
Green-backed Heron	1																											1				
Heermann's Gull	447	8	29	8	28		3	11	48		4		4			1	6	8	8	21	26	16	17	8	10	1	13	10		7	2	150
Herring Gull	17		1		1		1	1	7						1	5																
Horned Grebe	3	1			1		1																									
House Finch	145							16	75		38										16											
Mallard	4																								4							
Marbled Godwit	4						4																									
Mew Gull	66								10												53	2	1									
Pelagic Cormorant	8													1						2	2	1						1			1	
Peregrine Falcon	1									1																						
Pied-billed Grebe	4	1			1																		1				1					
Red-breasted Merganser	4																					4										
Red-tailed Hawk	1					1																										
Ring-billed Gull	140	24	9		3		2		2							1	1		1	20	4	3	2	6	3		2	1		12	20	24
Rock Dove	199	3	19		2	4														9	1	2	10	17	82	4		7	9	6	7	17
Ruddy Duck	75	75																														
Ruddy Turnstone	1									1																						
Sanderling	5		4													1																
Say's Phoebe	1																				1											
Snowy Egret	1							1																								
Spotted Sandpiper	4					1											1		2													
Surf Scoter	489		52	66		32	161	15			109				5			4			45											
Unidentified Scaup	35						35																									
Western Grebe	523	13	2	5	4	4	50	13	48		153	28			4	2	52	6	12	18	63	18	3	2	14						4	5
Western Gull	1576	60	52	43	155	4	41	106	65	18	2	12	58	1	2	37	13	4	5	58	39	35	63	41	316	5	10	3	2	41	7	278
Whimbrel	6						6																									
Willet	36	2	1		1		29						1				1														1	

January 2001 A Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Coot	4																		1		1		2									
American Crow	4		1																	1					2							
Belted Kingfisher	4					1					1											1				1						
Black Oystercatcher	2										1		1																			
Black Phoebe	1				1																											
Black Skimmer	4	2					2																									
Black Turnstone	4										1		2			1																
Black-bellied Plover	107	1					84						14			8																
Black-crowned Night Heron	6		2																		3				1							
Brandt's Cormorant	175		2	1	3				3	1	8	1	90	20	8	8	3			3	11	1	3	4	3							2
Brown Pelican	454	2	11	21	124	1		7	41	18	4	2	2	4	1	9	3		1	1	9	2	4		1		1	2		1		182
Bufflehead	38	23				1	12																								2	
California Gull	790	70	10		3	32	15	1	2	4		1	13	3		10	7	1	6	277	2			11	209			1		66	46	
Caspian Tern	8	6	2																													
Cinnamon Teal	5																											5				
Clark's Grebe	25	1						1				13		1				2	1		3				1						2	
Common Loon	3		1																					1								1
Common Raven	2																2															
Domestic Goose	3																								3							
Double-crested Cormorant	220	11	5	2	17	2	15	1	1	4	1		2	14		5	6		1	3	56		13	7	7		1	3	4	1	9	29
Eared Grebe	33	5			2	6	10		2		2									1	1				1			1			2	
European Starling	7																7															
Forster's Tern	46	29	11	1					1			2						2														
Glaucous-winged Gull	20							1			1		2			3			5	2					3							3
Great Blue Heron	48	1	2		2	3	1	2	5		13					1			2	1	2	1	5		2			1			3	1
Great-tailed Grackle	9																			1	2	6										
Greater Scaup	39						33																								6	
Grebe-unidentified	33											33																				
Heermann's Gull	543	69	74	59	47		3	16	1	6	7	2	2	12	5	3	13	2	6	6	5	8	10	27	9	25		15	3	6	2	100
Herring Gull	7								3							2			1	1												
Horned Grebe	5	1					4																									
House Finch	157						4		151		2																					
House Sparrow	1																						1									
Least Sandpiper	8												2												6							
Long-billed Curlew	1						1																									
Mallard	20																								6						14	
Marbled Godwit	5						5																									
Mew Gull	49	21								1											21			1	1						4	
Mourning Dove	1																														1	
Northern Mockingbird	2																								1						1	
Pelagic Cormorant	12				1									1		1				1	6	1						1				
Pied-billed Grebe	4	3																													1	
Red-breasted Merganser	6																			5		1										
Red-tailed Hawk	1								1																							
Ring-billed Gull	111	17	1		1		5	5								3	2		2	14	3	5	2	3	14	3				1	17	13
Rock Dove	171	2	10		8	7											4		2	2	13	6	11		57	1		29	14		2	3
Royal Tern	3			1														2														
Ruddy Duck	49	49																														
Ruddy Turnstone	1												1																			
Sanderling	87	20	7			7	34			2			3		3	11																
Semipalmated Plover	4																														4	
Snowy Egret	1																														1	
Spotted Sandpiper	6				1	1													2				2									
Surf Scoter	165		54	2	3	13	42				10	5									36											
Surfbird	5										4		1																			
Western Grebe	313	16	4		6	9	13	6	26	1	14	60		11	5	6	3	5	4	23	34	19	7	1	22	1					10	7
Western Gull	2306	100	76	318	326	5	55	96	11	58	22	12	77	13	8	76	16	2	20	73	52	71	63	29	243	48	9	8	7	119		293
Western Sandpiper	54	17							1																						36	
Whimbrel	3													1		1	1															
Willet	51	2	3		3	2	15	2			9		1	1			5		3		2								3			
Yellow-rumped Warbler	1																				1											

January 2001 B Survey
Number of Individuals in Each Zone

Species	Totals	ZONES																														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
American Coot	3																						1									2
American Crow	14				2		1				5						1		1		2	1										1
American Pipit	3																				3											
Belted Kingfisher	7		2			1																1				1			1		1	
Black Oystercatcher	1		1																													
Black Phoebe	2																				2											
Black Skimmer	1						1																									
Black-bellied Plover	74					1	73																									
Black-crowned night heron	24	1	5																		6	2	2		7			1				
Brandt's Cormorant	304		1		1	1		1	3	11	20	3	205	5	5	20		1		1	10	1	4	2	1			1			2	5
Brown Pelican	616	2	10	125	67	1		3	137	76	2		30	1		32	3	1		1	1							1				123
Bufflehead	37	32				1	1																								3	
California Gull	270	8	2	2			26		6	7	1	2	39		2	14		7	2				2	8	121	3	4			3	10	1
Caspian Tern	6	3	1				2																									
Clark's Grebe	57	1					2		44		5	2											1				1				1	
Common Loon	2																			1												1
Double-crested Cormorant	188	10	2	5	18	4	3	5	3	3	5			3	1	3	3	1	5	3	47		13	5	15	1		4		3	6	17
Eared Grebe	28	4			3	8	7				1								1		1				2		1					
Elegant Tern	1	1																														
European Starling	5																			3	2											
Forster's Tern	63	44	4	7						3								5														
Glaucous-winged Gull	24	2			1											1			4	6					7							3
Great Blue Heron	68	4	5		2	2	9	10	2		2			1					1	2	16		4		1			2	1		3	1
Great Egret	1																														1	
Great-tailed Grackle	2																				2											
Greater Scaup	10						10																									
Heermann's Gull	380	53	81	15	48		1	1	5	2	3	1	6		5		10	11	5	20	7	6	5	8	5	9	5	3		2		63
Herring Gull	5	1	1				1												1			1										
Horned Grebe	2						2																									
House Finch	91					2	12		74		2						1															
House Sparrow	1																				1											
Least Sandpiper	5																														5	
Lesser Scaup	11	11																														
Loggerhead Shrike	1																								1							
Long-billed Curlew	2						1																								1	
Mallard	28	28																														
Marbled Godwit	4					1	3																									
Mew Gull	88	42	1																		32	3		6	1							3
Mourning Dove	1																														1	
Northern Mockingbird	1																								1							
Pacific Loon	1											1																				
Pelagic Cormorant	6													2							2								1			1
Pied-billed Grebe	9	4			1		1																1		1					1		
Red-breasted Merganser	8																			2		3	2		1							
Red-tailed Hawk	1					1																										
Ring-billed Gull	113	35	1		1	1	16									1	7		1	6		4	3		4					3	4	26
Rock Dove	357	2	31		19	8														1	9	3	6	11	154	14	4	37		29	2	27
Royal Tern	1	1																														
Ruddy Duck	27	27																														
Sanderling	36	25				2	8			1																						
Snowy Egret	2	1																							1							
Spotted Sandpiper	3										1																	1				1
Surf Scoter	359		78	29	5	11	159	3			28	4	2								40											
Western Grebe	227	11	7		3		19	13	6		48	11		9	4		1	5		11	23	9	8	1	28	1	1		1		6	1
Western Gull	1739	69	66	103	128	2	53	101	19	57	33	8	126	10	6	73	40	37	23	43	50	46	40	26	203	4	7	6	1	30	5	324
Western Sandpiper	29																								10						19	
Whimbrel	9							1			1			3		2					2											
Willet	29		1	2	2	2		4			9			3			4			1											1	
Yellow-rumped Warbler	7						1										2			3	1											

Marine Mammals Sighted During POLA/POLB Bird Surveys- Feb 2000- Jan 2001

Date	Zone	Number	Species	Comments
17-Feb-00	20	3	Ca. Sea Lion	swimming
17-Feb-00	2	1	Harbor Seal	near bait barge
17-Feb-00	4	3	Ca. Sea Lion	2 male, 1 female near fish dock
18-Feb-00	14	1	Grey Whale	small
18-Feb-00	8	2	Ca. Sea Lion	both male
07-Mar-00	8	1	Harbor Seal	in kelp
07-Mar-00	20	1	Ca. Sea Lion	on channel buoy
07-Mar-00	2	2	Ca. Sea Lion	on channel buoy
07-Mar-00	4	3	Ca. Sea Lion	being fed off a boat
07-Mar-00	34	7	Ca. Sea Lion	near fish plant
15-Mar-00	34	4	Ca. Sea Lion	near fish plant
16-Mar-00	20	3	Ca. Sea Lion	1 male in water, 2 females on buoy
16-Mar-00	10	2	Ca. Sea Lion	on buoy
16-Mar-00	2	1	Grey Whale	in shallow water habitat
29-Mar-00	21	1	Ca. Sea Lion	female
29-Mar-00	20	3	Ca. Sea Lion	3 females on buoy
29-Mar-00	10	1	Ca. Sea Lion	male
30-Mar-00	2	1	Ca. Sea Lion	male
30-Mar-00	5	1	Harbor Seal	
30-Mar-00	6	1	Grey Whale	in shallow water habitat
30-Mar-00	4	2	Ca. Sea Lion	1 male, 1 female
30-Mar-00	4	1	Ca. Sea Lion	male
30-Mar-00	34	2	Ca. Sea Lion	males
18-Apr-00	25	1	Ca. Sea Lion	male
19-Apr-00	14	1	Ca. Sea Lion	
19-Apr-00	2	1	Ca. Sea Lion	male
19-Apr-00	5	1	Harbor Seal	
19-Apr-00	4	1	Ca. Sea Lion	male
19-Apr-00	4	3	Ca. Sea Lion	on buoy
19-Apr-00	34	2	Ca. Sea Lion	males
20-Apr-00	8	2	Ca. Sea Lion	
20-Apr-00	8	3	Harbor Seal	loafing on rip rap
20-Apr-00	8	1	Grey Whale	DEAD, gulls foraging on it
20-Apr-00	24	4	Ca. Sea Lion	on buoy
30-May-00	20	1	Harbor Seal	

Marine Mammals Sighted During POLA/POLB Bird Surveys- Feb 2000- Jan 2001

Date	Zone	Number	Species	Comments
30-May-00	25	1	Ca. Sea Lion	female on buoy
31-May-00	2	1	Ca. Sea Lion	
31-May-00	20	1	Ca. Sea Lion	male on buoy
31-May-00	4	1	Ca. Sea Lion	
31-May-00	34	6	Ca. Sea Lion	near fish plant 2 male, 4 female
31-May-00	31	1	Ca. Sea Lion	
31-May-00	18	1	Bottle Nosed Dolphin	
31-May-00	23	3	Ca. Sea Lion	on bouy
26-Jul-00	20	1	Ca. Sea Lion	male on buoy
26-Jul-00	10	4	Ca. Sea Lion	3 female, 1 male on buoy
27-Jul-00	4	1	Ca. Sea Lion	1 male on water
27-Jul-00	20	2	Ca. Sea Lion	1 male, 1 female
27-Jyly-00	34	3	Ca. Sea Lion	3 males near fish plant
9--Aug-00	8	1	Ca. Sea Lion	male on buoy
10-Aug-00	3	1	Ca. Sea Lion	female in water
10-Aug-00	34	1	Ca. Sea Lion	female
10-Aug-00	34	4	Ca. Sea Lion	3 female, 1 male
23-Aug-00	20	1	Ca. Sea Lion	male on buoy
23-Aug-00	10	2	Ca. Sea Lion	2 males on buoy
23-Aug-00	22	1	Harbor Seal	DEAD
23-Aug-00`	23	4	Ca. Sea Lion	4 males on buoy
24-Aug-00	4	1	Ca. Sea Lion	male devouring big fish
24-Aug-00	34	6	Ca. Sea Lion	all male
12-Sep-00	10	1	Ca. Sea Lion	male
12-Sep-00	23	2	Ca. Sea Lion	2 male, 1 female
13-Sep-00	3	2	Harbor Seal	
13-Sep-00	4	1	Ca. Sea Lion	1 male
13-Sep-00	34	7	Ca. Sea Lion	at fish plant
25-Sep-00	9	1	Harbor Seal	on rip rap
26-Sep-00	3	1	Ca. Sea Lion	on dredge pipe
26-Sep-00	1	1	Ca. Sea Lion	on buoy
26-Sep-00	34	5	Ca. Sea Lion	
17-Oct-00	23	1	Ca. Sea Lion	on buoy
17-Oct-00	24	1	Ca. Sea Lion	
18-Oct-00	3	1	Ca. Sea Lion	

Marine Mammals Sighted During POLA/POLB Bird Surveys- Feb 2000- Jan 2001

Date	Zone	Number	Species	Comments
18-Oct-00	2	1	Ca. Sea Lion	
18-Oct-00	11	2	Ca. Sea Lion	on buoy
18-Oct-00	7	2	Ca. Sea Lion	on buoy
18-Oct-00	4	1	Ca. Sea Lion	on buoy
18-Oct-00	34	1	Ca. Sea Lion	bull out of water
18-Oct-00	34	3	Ca. Sea Lion	in water
17-Nov-00	20	1	Ca. Sea Lion	male
29-Nov-00	23	1	Harbor Seal	
30-Nov-00	3	1	Ca. Sea Lion	female
30-Nov-00	2	1	Ca. Sea Lion	female
30-Nov-00	1	1	Harbor Seal	DEAD on beach by boy scout camp
30-Nov-00	4	1	Ca. Sea Lion	male
30-Nov-00	34	4	Ca. Sea Lion	2 female, 2 male
14-Dec-00	20	2	Ca. Sea Lion	males in water
14-Dec-00	25	1	Ca. Sea Lion	female
29-Dec-00	4	1	Ca. Sea Lion	
29-Dec-00	34	1	Ca. Sea Lion	male
17-Jan-01	20	1	Ca. Sea Lion	bull on buoy
17-Jan-01	24	4	Ca. Sea Lion	4 females
18-Jan-01	2	1	Ca. Sea Lion	female in water
18-Jan-01	4	1	Ca. Sea Lion	male
18-Jan-01	4	1	Ca. Sea Lion	female on buoy
18-Jan-01	34	3	Ca. Sea Lion	3 males
31-Jan-01	11	3	Ca. Sea Lion	on buoy
1-Feb-01	4	1	Ca. Sea Lion	BIG male
1-Feb-01	34	1	Ca. Sea Lion	
1-Feb-01	34	3	Ca. Sea Lion	2 male 2 female

APPENDIX I

Changes in Los Angeles and Long Beach Harbors – Personal Reflections of Dr. Donald J. Reish

LOS ANGELES–LONG BEACH HARBORS—PERSONAL REFLECTIONS

Donald J. Reish

PREFACE

Emeritus Professor, California State University, Long Beach

I first saw what was then the murky waters of Los Angeles Harbor in September 1949. I had just enrolled at the University of Southern California to pursue my PhD studies. The late Bob Menzies and I drove to Wilmington to meet with Carrol Wakeman, Chief Engineer of the Port of Los Angeles. I had just come along for the ride with Bob. He was also initiating his PhD studies which was on the marine wood boring isopod *Limnoria*. Little did I realize at the time what a role Los Angeles–Long Beach Harbors would play in my professional life and has continued to play a role to this date.

The purpose of writing these personal reflections is to record the history on the environmental conditions and events which transformed a highly polluted harbor into one which is much less today. The environmental conditions and events which has occurred in Los Angeles–Long Beach Harbors is a mirror of what has occurred in many parts of the world as a result of the ecological awakening. Most of the people who played a role in the early ecological and engineering studies in Los Angeles–Long Beach Harbors are dead. I was present at the beginning and have witnessed the changes which have occurred in the harbors, and it is hoped that my personal reflections will give the reader some perspective that only time offers. I have also tried to convey some idea of the thinking of that time, again to give the reader some perspective of the evolution of the changes that took place.

EVENTS LEADING TO THE FIRST ECOLOGICAL STUDY OF THE HARBORS

There were two levels of government which were concerned about the condition of the harbors, one at the local level, the other at the state level. These two agencies came together in 1951 which affected me and some others at the University of Southern California. For a number of years various governmental agencies received complaints from the local people regarding the polluted waters of the harbor. Some of these complaints predated World War II. In fact the water quality was so poor during World War II in the inner Los Angeles Harbor that ship yard workers were unable to work because the emission of sulfide gas from the water caused conjunctivitis. So much waste was emptied into the waters that the dissolved oxygen was depleted resulting in the formation of sulfides. A technical committee was formed under the chairmanship of Carrol Wakeman. This committee issued two reports; the second of which recommended that studies should be conducted which covered the entire harbor area. They recommended three studies: (1) detail the sources of waste discharges into the harbor, (2) biological studies [what type (s) of biological studies were never specified], and (3) bacterial studies at bathing beaches within the harbors. Unfortunately, none of these studies was initiated, but a few years later a program of water quality measurements, consisting of dissolved oxygen, pH, temperature, and transparency (Secchi) was initiated and continued for an unknown period [see further comments below].

The California legislature passed a bill in 1949 which established the State Water Pollution Control Board [later renamed California Water Quality Control Board]. The State was divided into nine regional boards of which Los Angeles was one. Following a series of meetings, the Los Angeles Regional Water Pollution Control Board recommended the following laboratory and field investigations: (1) detail the sources of pollution, (2) determine the existing conditions, and (3) determine the existing uses of the harbor waters. It was further recommended that these recommendations be implemented in the 1951-1952 fiscal year.

Events were occurring on the USC campus which were to interface with the governmental happenings. As part of his doctoral dissertation on *Limnoria*, Bob Menzies proposed a year survey of these animals in the harbors. His major professor, Dr. John L. Mohr, expanded Bob's proposal to include the teredinids and fouling organism that attached to the test panels. Mohr and Menzies enlisted the help of Carrol Wakeman (Port of Los Angeles), Harold Schiller (Baxter Creosoting Co.) and graduate students at USC: Charles Horvath (teredinids), Jerry Barnard (amphipods), John Soule (bryozoans), a student interested in tunicates, and me (polychaetes). This group formed what was to become known as the Southern California Marine Wood Borers Council which met periodically in the home of John Mohr. At these meetings we planned the year survey for wood borers and associated organisms in the harbors. The primary purpose of this group was to learn further of the interrelations of the biological, chemical, and physical factors governing the occurrence and distribution of marine wood borers and associated organisms. The survey began in April 1950 and was completed in March 1951. Douglas fir wood blocks measuring 5.1 X 5.1 X 15.2 cm were suspend at three different water depths (whenever possible) for a 28 day period. The fouling organisms were scraped from the blocks, presereved, and the wood blocks examined from the presence of wood borers. We were amazed of the quantity of fouling organisms which attached to the blocks in such a short period of time. Some of the results of this study were presented at the wood borers conference held in Port Hueneme in the summer of 1951 and was published (U. S. Naval Civil Engineering Laboratory, 1951). Other publications from this study include the papers by Menzies, Mohr, and Wakeman (1963), Barnard (1955, 1958), Barnard and Reish (1957, 1960), and Reish (1954, 1971b).

All of the above described events came together in June 1951 as a series of circumstances. Presumably as a result of the action on water pollution by the State of California, Curtis Newcombe, U. S. Public Health Service, San Francisco office, organized a symposium on water pollution, which was held on the campus of the University of Southern California, in conjunction with the annual meeting of the Pacific Division of the American Association for the Advancement of Science [Note: The governmental agency, Environmental Protection Agency did not exist at this time; environmental pollution regulations were largely handled at the federal level by the U. S. Public Health Service.]. John Mohr was a replacement speaker at this symposium. Robert Paul, California Department of Fish and Game, Sacramento office, was also a speaker. The proceedings of this symposium were published in 1951 in Scientific American.

Since the State Water Pollution Control Board did not have the authorization to conduct such investigations, they contacted the appropriate state agency. California Department of Fish and Game (CF&G) was contacted to do the biological surveys. Robert Paul was the CF&G

administrator for the biological studies. However, CF&G did not have the personnel to do this type of biological work. Robert Paul and John Mohr became acquainted at this June 1951 symposium, and Paul learned about the recently completed wood borer survey. Agreement was reached between CF&G and the group at USC; Bob Menzies, Charles Horvath, and Howard Winter were hired as CF&G seasonal aids. These three plus John Mohr conducted the first benthic survey of Los Angeles–Long Beach Harbors, August 24-25, 1951. Other areas sampled included San Diego Bay, Newport Bay, and Avalon Bay. Lower San Gabriel River was sampled in 1952 by Charles Horvath. Howard Winter and I [I became a seasonal aid in May 1952] sampled Alamitos Bay in June 1952. I identified the polychaetes from all these surveys. Reports of Los Angeles–Long Beach Harbors (1952) and San Diego Bay (1952) were published by the respective Regional Water Pollution Control Boards. The results of the Alamitos Bay and Lower San Gabriel River were published in the quarterly of CF&G (Reish and Winter, 1954; Reish 1956).

The data were summarized in the 1952 publication as to the character of the benthic samples, final sorting of the benthic samples, and a listing of the number of species and specimens of polychaetes. No other organisms were identified. It is important to view these results in the time frame of the period. No guidelines existed on how to conduct a survey especially a marine benthic one. While a benthic survey had been done in the San Francisco Bay in 1914, nothing had been done since and it was doubtful that we were aware of that publication at the time. A size one Hayward orange peel bucket was borrowed from the geology department at Scripps Institute of Oceanography. It was not fitted with a skirt, a modification which was later added (Reish, 1959b). Sediment and organisms were often lost while raising the sampler to the surface. Even with the primitive sampling procedures, the results excited Olga Hartman which resulted in her initiating the first offshore benthic program in Southern California in 1953. Sampling devices and sediment processing have improved over the years in Southern California, but it all began with the initial study in Los Angeles–Long Beach Harbors.

The publication in 1952 of the Los Angeles–Long Beach Harbor Pollution Survey listed the sources and specific locations of the waste discharges entering the harbors. There were 267 separate dischargers in Los Angeles Harbor plus an additional 17 sources entering from Dominguez Channel into the Consolidated Slip. Long Beach Harbor received wastes from 38 point sources. Because of military restrictions samples were not taken in the U. S. Naval Shipyard nor were the sources of any waste discharges in this area documented. Waste discharged into the harbors included storm drains, oil well brines and refinery wastes, ballast water, cooling waters, fish cannery wastes, unspecified industrial wastes, raw sewage, and primary treated domestic wastes from the Terminal Island sewage treatment plant. The majority of the wastes were discharged into the inner harbor areas. Bacteriological and water quality measurements were included in the 1952 publication. The species and number of specimens of polychaetes were listed by station. As indicated above, the collecting and processing techniques did not yield the number of species or specimens of later surveys.

The water quality survey by a governmental agency, which was initiated in August 1951, was continued at monthly intervals by the Port of Los Angeles and the Los Angeles Department of Water and Power. Samples were taken in both harbors. Water analysis included dissolved oxygen or dissolved sulfide, pH, and turbidity (Secchi). I do not know how long these two agencies continued to take these monthly samples, but I participated in this program for a year from the fall of 1953 to the fall of 1954. I took bottom to surface plankton hauls to determine the usefulness of this type of biological sampling in pollution studies. My results were of limited value and I did not publish the results of this plankton survey of the harbors.

Dissolved Oxygen. The measurement of the dissolved oxygen content of the water mass is a frequently used measure of water quality because of its importance for the survival of fish and aquatic life. It is easy to measure and the results are obtained rapidly. Dissolved oxygen was measured in the pollution study of August 1951 and the data were published in the 1952 report (Los Angeles Regional Water Pollution Control Board, 1952). Dissolved oxygen data were taken in the year long wood borer study of 1950-51 and published in Reish (1971b) and the benthic study in 1954 (Reish 1959a). The data were similar in all these studies and conditions remained the same through 1969 (see below). Little or no dissolved oxygen was present in the inner harbor areas especially in West Basin, Slips 1, 5, Consolidated Slip and sometimes in Fish Harbor. Dissolved sulfide measurements over 1.0 mg/L were often measured in Consolidate Slip especially where Dominguiz Channel enters the harbor at the Ford Avenue Bridge. Dissolved oxygen measured over 5.0 mg/L or higher throughout Long Beach Harbor except in the inner reaches of Channels 2 and 3 where reduced levels were noted. The outer harbor areas had dissolved oxygen over 5.0 mg/L except during the peak of fish cannery activity when readings near 0.0 mg/L were measured.

Wood Borers. Marine wood borers played an important role in the early studies of Los Angeles–Long Beach Harbors especially for some people associated with USC, as noted above. Carrol Wakeman as chief engineer for the Port of Los Angeles was very interested in the USC proposed study of wood borers since most of the pilings in the port were treated or untreated wood pilings. He made the necessary arrangements for the use of a boat for this one year study. The principal wood borers in the harbors are the isopods *Limnoria tripunctata* and *L. quadripunctata*, the pelecypod borers *Teredo diegensis [=Lyrodus pedicellatus]* and *Bankia setacea*. Of lesser economic importance is the amphipod *Chelura terebrans* and the copepod *Tisbe gracilis*.

Test panels, as described earlier, were suspended for a 28 day period from April 1950 through March 1951. Both species of *Limnoria* were present throughout the year with greater numbers present during the warmer months. *Limnoria tripunctata*, which is capable of boring through creosoted wood, was present at all stations except Consolidated Slip where the dissolved oxygen averaged 0.12 mg/L for the year and at the entrance to the harbor where the temperature ranged from 12.2^{o} to 18.3^{o} C. *Limnoria quadripunctata* was present at all stations except in Consolidated Slip but in fewer numbers than *L. tripunctata*. There are three species of *Limnoria* known from the Eastern Pacific Ocean. *Limnoria tripunctata* is a warmer water species, *L. lignorum* is a colder water species and is not known south of Morro Bay, and *L. quadripunctata* is intermediate between these two species with regards to water temperature requirements.

Neither species of pelecypod borer was encountered on test panels exposed in West Basin, Slips 1 and 5, Consolidated Slip or the main channel of Los Angeles Harbor. *Lyrodus pedicellatus* was found primarily in Long Beach Harbor, Fish Harbor, and at the entrance to the harbors. *Bankia setacea*, primarily a colder water species, was collected only at the entrance of the harbors and at the station located at the Pontoon Bridge [=Desmond Bridge location] in Long Beach Harbor.

The amphipod *Chelura terebrans* is present only within the burrows made by *Limnoria.*

While it is capable of burrowing into wood, as shown by laboratory cultures (Barnard, 1955), it is unable to excavate a protective burrow in a short period of time and therefore would be subject to predation before it could bury itself. *Tisbe gracilis* is able to eat wood and reproduce under laboratory conditions (Barnard and Reish, 1957, 1960), but its role in the field is unknown. No survey of the wood borers in the harbors has been conducted since March 1951; however, I have collected *Limnoria tripunctata* from Los Angeles Harbor for use in laboratory studies over the years with the last specimens collected in 1986. *Limnoria tripunctata* caused a critical economic problem following the initiation of pollution abatement in 1968 which will be discussed below.

I had described above the relationship between CF&G and some of the graduate students at USC. CF&G hired the initial personnel as seasonal aids which limited employment by law to a nine month period. Time ran out with this initial group, and I took over in May 1952. It was my responsibility to complete the reports of Lower San Gabriel River, Newport Bay, and Avalon Bay. Howard Winter, who was rehired as a seasonal aid after the mandatory three months layoff, and I conducted the survey of Alamitos Bay. The American Red Cross furnished a boat and operator for the two day collection. During my employment as a seasonal aid, I was invited by U. S. Public Health Service and CF&G to present a seminar on the Berkeley campus on the methods and equipment used in the surveys of southern California. I met Curtis Newcombe at this seminar, and I spent the next day with him. He suggested that I apply for a research grant from the U. S. Public Health Service to conduct additional studies in Los Angeles–Long Beach Harbors. When I returned to Los Angeles, I talked with John Mohr about such a grant proposal, and he offered to serve as the principal investigator. I could not be the principal investigator since I did not have an academic position at the university [I was completing my PhD dissertation at the time.]. I wrote a proposal emphasizing the importance of polychaetes in the benthic environment. The first response from the U. S. Public Health Service was to explain why are polychaetes important and why should this proposal be supported.. [This was the first of several responses that I received from granting agencies requesting information as to why polychaetes are important.]. It is important to note that the major marine benthic work up to 1950 had been done by Petersen in the Danish seas. They had used a large mesh screen to wash their benthic samples and therefore had washed most of the polychaetes back into the ocean. I explained the importance of polychaetes by stating that they play a similar role in the marine benthos as earthworms do on land. The proposal was then approved but lacked the necessary funds to support it. This response coincided with the end of my nine months as a seasonal aid. I had just completed my PhD and was unemployed [Academic positions were non-existent in 1952-53.]. Dr. Olga Hartman secured funds for me from the Allan Hancock Foundation to assist her in initiating the off shore benthic program in early 1953. Late spring 1953 U. S. Public Health Service secured the funds, but I had already committed myself to accompany John Mohr to Point Barrow, Alaska, for two months. I initiated the three year study in September 1953; two additional years were added later. The five year grant budget was $35,000.

THE BENTHIC SURVEY OF 1954

With grant support assured, I began planning for sampling the harbors in September 1953. I purchased a small orange peel bucket and had it modified and devised a method of attaching a canvas skirt to minimize the loss of sediment and organisms while bringing it to the surface (Reish, 1959b). As indicated above, I participated with the Port of Los Angeles in their monthly survey of water quality as described above. It also afforded me the opportunity to become more familiar with the harbors.

I conducted three benthic surveys in 1954: January, June, and November. A different boat was used each time; one supplied by the Port of Los Angeles, one by CF&G and the third belonging to Richard Linsley, a graduate student at USC. Funds were not available to pay for assistance in the field collection. The following people helped me: Jerry Barnard, Keith Woodwick, Charles Horvath, Reginald White, Richard Linsley, and my brother Gene. This was typical for that time; you helped people, they helped you, all without remuneration.

The results of the three benthic surveys were published (Reish, 1959a). An abbreviated form of this study appeared earlier (Reish, 1955). This publication by the Allan Hancock Foundation was unique in many ways in that all the data were published. Because of the space limitations and expense involved, the data from most ecological surveys are only summarized. The number of specimens and the species occurrence by station were detailed in six tables. This presentation of data was so unique that years later Donald Boesch (1977) utilized these data as the basis of his publication of the application of numerical classification in ecological studies of pollution.

Chemical, geological, and physical data included dissolved oxygen, pH, chlorinity, transparency (Secchi), substrate characteristics, organic carbon composition of the sediments, temperature of the air and water, rainfall, and tidal fluctuations. As I have indicated, guidelines did not exist as to what environmental measurements are important and which are not so all the possible measurements which could be made were included. I wanted to give as complete environmental description of the harbors that I could. As will be described below, dissolved oxygen and organic carbon content of the sediment were especially useful in characterizing a polluted harbor.

Biological Characterization of the Harbors in 1954. A total of 13,817 specimens comprising 141 species of animals was collected during the three bottom surveys. Slightly more than 50 percent of the species were polychaetes. There were 40 species of mollusks. 18 species of crustaceans with the remaining species belonging to cnidarians, nematods, nemerteans, phoronids, oligochaetes, echinoderms, and an arrow goby fish.

The distribution of the polychaetes were plotted and correlated with bottom conditions. On this basis the harbors were divided into five ecological areas: healthy zone, semi-healthy zones I and II, polluted zone, and very polluted zone which lacked macroinvertebrate life. This terminology was adapted from the fresh water studies of Patrick (1949). Specific species of polychaetes were used as indicators of these zones. The biological and physical characteristics of these five zones are summarized in Table 1. It is of interest to note that this table has been cited and reproduced in publications both here and abroad. Donald Boesch stated in his publications on numerical classification that the results of my analysis and his cluster analysis were nearly identical. This indicated to me that a human which is knowledgeable of the area and of the organisms is just as capable as the computer in evaluating the data.

Harbor Related Studies. The results and experience gained from the 1954 study were used in different ways and stimulated me to initiate other studies. It is important to note that funds from the U. S. Public Health Service were in the form of a grant, not a contract, which at least at the time, allowed flexibility in pursuing potentially promising leads. This I did as I describe below.

A large area of East Basin and Consolidated Slip were dredged in 1953. As noted above, the biological sampling in 1951 indicated an area devoid of macroscopic animal life. As a result of dredging, animals characteristic of the semi-healthy bottom I were present in January 1954 and only the inner reaches of Consolidated Slip were devoid of benthic animals. There was a reduction in the number of species in June and November 1954 and by December 1955 only two species were found. The results of this study indicated that animal settlement can be rapid following the removal of contaminated sediments by dredging, but if the source of the contamination continues, the area will return to its former state. It took one year. The results of this study were published including my picture (Reish, 1957a)!

I came across an earlier paper by a German (Wilhelmi, 1916) who stated that *Capitella capitata* played a similar role in marine waters as *Tubifex* does in fresh waters of Germany. This paper had and has been overlooked; it might not have been widely distributed because of World War I. As a result I looked further into the distribution of *Capitella* in the harbors and found it to be present in Fish Harbor, around the discharge point of Terminal Island outfall sewer, Slip 5 (location of former fish canneries), and Slip 2 in Long Beach harbor (wastes from fisheries and domestic sewage). *Capitella capitata* was also abundant at the location of the former fish canneries in Newport Bay (Barnard and Reish, 1959). Samples were taken at and away from the Terminal Island outfall in December 1955 to determine if there was an intermediate zone between the polluted zone of *C. capitata* and the healthy zone which covered much of the outer harbors. No intermediate zone existed. I concluded that *C. capitata* is an indicator of wastes of biological origin. I presented these results at a biological pollution symposium in Cincinnati in 1956 (Reish, 1957b). My papers written in the 1954-1959 period played an important role in the *Capitella*-indicator species controversy.

In the 1940s and 1950s a creosote company stored their untreated logs in the middle of West Basin. They hired Charles Horvath to monitor their logs for the presence of wood borers. I took over monitoring in the fall of 1953 when he went off to the Arctic Ocean under a contract to John Mohr. The company requested additional monitoring sites. I used gallon jars as weights. Wood blocks were suspended on rope which was tied to a buoy and to a wire loop attached to the gallon jar (see figure l in Reish 1961b). While removing the test blocks in December 1953, I saw some nereid polychaetes in the sediment of one jar. These worms were identified as *Neanthes caudata* [later referred to as *N. arenaceodentata* a few years later by Pettibone]. The flexibility of the grant allowed me to pursue culturing this species through several generations and lead to a publication (Reish 1957c). The discovery of the nereids in the jar lead me to develop two paths of research and later a third. Many different species of polychaetes were present in the gallon jar which I either maintained or was able to complete its life cycle in the laboratory. *Capitella capitata* was one of these species. All cultures of polychaetes were destroyed before I joined the faculty at California State University, Long Beach in 1958.

The second path was the use of the sediment bottle collector as a monitoring tool (Reish 1961a, b). Over a two year period from December 1955 through December 1957 jars were suspended for a 28 day period in the three different ecological zones as defined by the 1954 benthic study. The healthy zone stations were at the entrance to the main channels of both harbors. The semi-healthy stations were mid-way up the main channel of Los Angeles Harbor, and the polluted stations were located at the ends of Slip 1, 5 and East Basin. A total of 45 different species was identified of which 44 occurred in the healthy zone {one specimen of one species was lacking) for an average of 10.7 species per collection. The average was 6.5 for the semi-healthy zone and 4.6 for the polluted zone. *Capitella capitata* was present in most of the jars at all stations throughout the year and was the dominate species at the semi-healthy and polluted zones. Dissolved oxygen and organic carbon content of the sediment were the only chemical measurements made. Dissolved oxygen was higher and organic carbon lower at the healthy zone stations. The reverse occurred at the polluted zone stations. To my knowledge, no one has utilized this technique as a monitoring tool.

Having spent several years around the harbors, I noted a difference in the organisms attached to the floating boat docks. One of my graduate students, Robert Crippen, conducted a monthly quantitative survey of the polychaetes from October 1966 through January 1968 (Crippen and Reish, 1969). Many of the same stations were occupied as those in the sediment bottle collector study with the addition of a station in the inner reaches of Consolidated Slip. Data published included the number of species and species of polychaetes, qualitative occurrence of the other organisms, dissolved oxygen, turbidity, chlorinity, and nutrients. The number of species declined from the outer to the inner harbor with no polychaetes taken during the year at Consolidated Slip. The species occurrence was different from the benthos with two cirratulids, *Cirriformia luxuriosa* and *Cirratulus cirratus*, the most common species from the cleaner water stations. *Capitella capitata* was the dominant species from the two polluted stations.

This difference in the species composition of fouling organisms as one moved from outer to inner harbor that, on more than one occasion, I collected organisms from boat floats from different areas of the harbor to demonstrate the effect of pollution to classes. The differences were so striking that students with a minimum background in biology could visually see the effects of pollution.

Jerry Barnard and I worked in the same laboratory in the basement of Allan Hancock Foundation; I was supported by the U. S. Public Health Service grant and he by a U. S. Air Force contract studying Arctic Ocean crustaceans. We thought it would be fun to work on each other's speciality. We worked together with the wood boring copepod. I had established a colony of *Capitella capitata*, and I thought it would be productive to conduct a field bioassay in the harbor using this species. We selected Consolidated Slip–East Basin region to conduct this test because of the variation of the dissolved oxygen concentration from 0.0 to over 5.0 mg/L. No one had previously conducted a bioassay with a polychaete. We placed an adult male and female in a plastic tube together with *Enteromorpha* as food. Nylon mesh was attached to the ends of the tube which permitted the circulation of water. Animals were examined and fed 2-3 times a week for 50 days. Results were grouped into three levels: (1) worm lived for several days, did not feed, and died in an environment with a median dissolved oxygen concentration of 0.0-1.6 mg/L, (2) an intermediate level where 50 per cent of the animals lived and fed but did not reproduce where the median dissolved oxygen was 2.9 mg/L, and (3) an environment with a median dissolved oxygen concentration of 3.5 mg/l or higher where the animals lived, ate, reproduced, and the young survived and grew (Reish and Barnard, 1960). It would be nearly a decade until I conducted my next toxicity test. And 15 years until I became interested in sublethal toxicity. Routine marine toxicity tests by governmental agencies and consulting firms did not begin until around 1980.

Summarizing the environmental state in the harbors in the 1949-1968 period saw little or no improvements in the biological or physical conditions. While no benthic samples were taken between 1956 and 1973, visual observations and dissolved oxygen measurements were indicative that the benthos was at it was in the 1951-1955 period.

POLLUTION ABATEMENT

On February 21, 1968, the Regional Water Quality Control Board [The phrase "Water Quality" had replaced "Pollution" by now.], Los Angeles Region, issued an order prohibiting the discharge of oil refinery wastes from the Dominguez Channel into the Consolidated Slip. Following this directive, the 18 major oil companies either ceased emptying their wastes into the Dominguez Channel or eliminated by treatment the oxygen depleting wastes from their discharge. The last company to comply was on September 25, 1970. The changes were dramatic, but there is an interesting story leading up to the abatement order.

Near the end of his term in office Governor Edmund "Pat" Brown appointed a Beverly Hills housewife, Ellen Harris, as a member of the advisory board of the Los Angeles Regional Water Quality Control Board in early 1966. She represented the people of the State on this board. She became an active member and hosted a meeting complete with television coverage in the auditorium of the Los Angeles Department of Water and Power with the purpose of learning about pollution in Los Angeles–Long Beach Harbors. I was invited to be one of the speakers. Following this meeting, she spoke in favor of pollution abatement before several groups including California State University, Long Beach. [It is important to note that Rachael Carson's book "Silent Spring" was published four years earlier in 1962.] The result of her actions lead to the February 21, 1968, ban on discharging oil refinery wastes into Dominguez Channel and Consolidated Slip.

At the time of these events, I wasn't conducting any research in the harbor, but I heard that things were changing in the Consolidated Slip. As I had described earlier, Bob Crippen studied the fouling organisms attached to boat floats; his last collection was made in October 1967 just before the ban was initiated. Again, I took advantage of the opportunity to demonstrate the biological effects of pollution abatement using both the fouling and benthic organisms as the measures. Dissolved oxygen, which was nearly always absent, now measured 3.9 mg/L at the inner most station. Fouling organisms, which previously consisted of blue green algae, rat tail maggot, and an oligochaete, now were home to 13 species including such animals as *Mytilus edulis*, *Balanus amphitrite*, polychaetes, amphipods, and tunicates. The benthos, which had lacked animals for years, now was populated with clams, polychaetes, phoronids, and other invertebrates. Similar biological changes were noted at nearby stations. Harbor seals were even seen swimming in the inner reaches of Consolidated Slip.

Pollution abatement was essentially an unheard of event in those days. In fact, I was featured on the Channel 7 evening news program. I had finished handwriting the manuscript on a flight to Rome, Italy, in December 1970, to attend a FAO meeting on pollution. Bob Clark, the editor of Marine Pollution Bulletin, wanted to take my handwritten manuscript back with him to England to published it in the next issue of Marine Pollution Bulletin. He said it was important because we do not have any published information of the effects of pollution abatement on the marine environment. I said no at the time, but after returning home, I edited and typed the manuscript, sent it to Clark, and it was published (Reish, 1971a). California Cooperative Oceanic Fisheries Investigations asked me to present my results at their annual meeting (Reish, 1972).

Undoubtably contributing to the rapid recovery of the biota was the extended or year round reproduction of many of the organisms in Southern California. However, at the time the prevailing thinking was that recovery would take years if ever. While the environment of Consolidated Slip in not pristine, its conditions has greatly improved since the days of zero dissolved oxygen and conjunctivitis caused by emissions of sulfide gas.

At lease two problem arose, one serious, the other amusing, as a result of pollution abatement in the harbors. As I described earlier, the pilings in Los Angeles Harbor are primarily protected by treatment with creosote. These pilings not only support docks but also many warehouses as well. *Limnoria tripunctata*, which was discovered by Menzies, is able to burrow through creosoted pilings. Once it burrows through the 2-3 cm creosote layer of preserved wood, *Limnoria* can destroy a piling quickly. With adequate dissolved oxygen now present in the inner harbor, *Limnoria* migrated into these areas and began attacking the creosoted pilings. Carrol Wakeman and others devised a method to protect the pilings from *Limnoria*. Each piling was wrapped with a thick (~5 mm), heavy plastic sheeting. Each piling had to be wrapped individually by hard hat divers. This was an expensive remedy, but is was successful in excluding *Limnoria* and killing any of those which may have been present. Long Beach Harbor did not have this problem because it is a newer harbor and used concrete pilings.

The amusing incident involved the pleasure boat owners of outer harbor and elsewhere. Since their boats were berthed in cleaner waters, fouling organisms were attached to the side of their boats. They would then move their boat into Consolidated Slip for a few days and the absence of dissolved oxygen would kill the fouling organisms. With the clean up on the inner harbor area, the boat owners had to find some other method of ridding their boat of fouling organisms.

Long Beach U. S. Naval Station

When the Port of Los Angeles Harbor Department initiated their water quality studies*of* both harbors in conjunction with the marine wood borer survey, the U. S. navy would not allow sampling within the base. Lee Hill enrolled in the graduate program at CSULB and I survey as his major professor. However before he had begun to start on his research, he was drafted into the U. S. Navy. After he completed boot camp, he was stationed at the Long Beach Naval Base.

His arrival in Long Beach coincided with a recent directive by President Nixon that the environmental conditions at the U. S. military bases by assessed. Since Lee had a knowledge of marine biology, the commander requested that Lee be a member of the environmental committee. He was then able to initiate a one year study of the benthic and fouling organisms within the base. This was the only study made within the base until it was discommissioned in the 1990s.

Lee's study consisted of monthly collections of the fouling and benthic polychaetes from September 1970 through September 1971. Chemical and physical measurements consisted of dissolved oxygen, temperature, and nutrients. This research resulted in Lee's master's degree thesis and was published (Lee and Reish, 1975). Benthic condidtions were similar to what was known in the other regions of the harbors. The inner reaches of the bases were considered to be polluted and dominated by *Capitella capitata.* There was an intermediate semi-healthy zone and a healthy zone located at the entrance of the base which were similar to what was found throughout much of the outer harbors in 1954-1955. The number of benthic species in the fouling community ranged from 22 to 27 going from the inner to the outer regions of the base. *Capitella capitata* was the dominant fouling species in the inner reaches of the base. Members of Families Syllidae and Nereidae were limited to the outer most stations of the base.

The biological conditions within the base were similar to what was found in the other reaches of the harbors in the post-pollution abatement period.

Environmental Impact Studies

Beginning in the early 1970s and extending to this date, many environmental impact studies have been undertaken. Some of these are limited in scope and may or may not have added any new information, others more extensive, such at Harbor Projects (see below). No complete inventory exists of what has been by different consulting firms or public agencies.

HARBOR PROJECTS

It became apparent in the early 1970s that shipping to and from the harbors was increasing and would continue to increase in the future. The harbors needed to be improved and expanded. Dorothy and John Soule and Mikihiko Oguri established harbor Projects at the Allan Hancock Foundation on the USC campus. The underlying purpose as to detail the state of the environmental conditions of the harbors which would form the scientific basis for the now required environmental impact reports. Funding was from several sources including the U. S. Army Corps of Engineers, Sea Grant, Tuna Canneries and different governmental agencies. Biological studies included benthic collections, fouling organisms, monthly settlement on test panels, algae, plankton, fish, bird and mammals population counts. Many students from CSULB participated in Harbor Projects which gave them their initial experience in marine research. The results of the Harbor Projects studies were issued in a series of publications issued by the Allan Hancock Foundation and published in scientific journals. The benthic animals present in 1973 were compared to those present in 1954. The healthy zone in 1973 extended throughout much of the harbors as a result of pollution abatement. The semi-healthy and polluted sones were limited to the blind ends of slips and Fish Harbor. Benthic animals were present in all areas of the harbors including Dominguez Channel (Reish, et al., 1980).

In summarizing the biological conditions of the 1951-1973 period, we saw the initial biological studies characterizing the environment of a polluted industrialized harbor improving as a result of pollution abatement. These findings served to indicate that benthic biological conditions are not lost forever as a result of pollution, but can be restored to better conditions of pollution abatement.

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