NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
2008 RECEIVING WATER MONITORING REPORT
RELIANT ENERGY ORMOND BEACH GENERATING STATION
VENTURA COUNTY, CALIFORNIA

2008 Survey

Prepared for:

Reliant Energy

Prepared by:

MBC *Applied Environmental Sciences*
3000 Red Hill Avenue
Costa Mesa, California 92626

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EXECUTIVE SUMMARY

The 2008 National Pollutant Discharge Elimination System (NPDES) marine monitoring program for the Ormond Beach Generating Station owned and operated by Reliant Energy was conducted in accordance with specifications set forth by the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) in NPDES Permit No. CA0001198 dated 28 June 2001. The 2008 NPDES program was modified to facilitate the generating station's participation in the fourth comprehensive regional survey of coastal ocean waters in the Southern California Bight (Bight '08). The 2008 studies included physical monitoring of the receiving waters and underlying sediments and biological sampling of benthic infaunal assemblages and mussels. Fish and macroinvertebrate impingement studies were also conducted periodically throughout the year. Results of the 2008 surveys were compared among stations and with previous studies to determine if the beneficial uses of the receiving waters continue to be protected.

WATER COLUMN MONITORING

In summer 2008, water quality characteristics indicated a well mixed water column in the survey area. Water column temperature profiles were similar throughout the area during both tides, with slightly higher temperatures found during the later ebb tide sampling period. Temperatures in the survey area did not appear to be related to the thermal discharge, and highest surface water temperatures were noted at the station farthest downcoast of the discharge on both tides. Water column temperatures were typical of the area and within the range of natural variability observed during previous surveys. Dissolved oxygen (DO) concentrations were consistent during both tides, with values similar to those found commonly in previous studies and well above the level of biological concern. Higher DO concentrations in the study area later in the day were noted, a likely result of increased photosynthetic activity. Salinity and pH were also very consistent during the survey at levels consistent with seasonal results observed previously and natural conditions found commonly throughout the study area.

Variations in water quality parameters can be attributed to natural physical and biological processes, and no thermal influence in the vicinity of the discharge was noted. Water quality measurements indicated that in 2008 the cooling water discharge from the Ormond Beach Generating Station did not have an adverse effect on receiving waters in the study area.

SEDIMENT CHARACTERISTICS

Sediment Grain Size

In 2008, sediments were analyzed from four stations offshore the Ormond Beach Generating Station. Sediment composition was similar among stations, consisting primarily of sand with lesser amounts of fine material (silt and clay) and mean grain sizes in the fine and very fine sand categories. Slightly coarser sediments found at the discharge may have been influenced by turbulence associated with the cooling water discharge, a pattern noted during some previous surveys. The degree of influence of the discharge on local sediments varies from year to year, suggesting a localized and transitory effect near the discharge. Other than the coarser sediments found in the discharge area, sediment characteristics offshore of the Ormond Beach Generating Station discharge in 2008 were similar to those found previously in the area and appear to be affected primarily by natural causes.

Sediment Chemistry

In 2008, sediments at four stations off the Ormond Beach Generating Station were analyzed for the presence and concentration of chromium, copper, nickel, and zinc. Highest metal concentrations were found at the stations 1,000 ft upcoast and 3,000 ft downcoast of the generating station discharge where percentages of fine material in the sediments were greatest. Lowest concentrations of all metals were recorded at the discharge. Still, metal levels were similar among stations in 2008 and within the range of values recorded in previous surveys. Concentrations of chromium, copper and nickel at stations sampled in 2008 were below their respective long-term means, while zinc levels were generally slightly higher than the long-term means. Sediment metal concentrations have remained relatively consistent in the area since 1990 and have been consistently lower than mean metal concentrations found in sediments at shallow coastal stations throughout southern California. While metal levels typically vary slightly from year to year, and metal concentrations in 2008 appeared to be somewhat related to the percentage of fine material in the sediments, no long-term patterns of metal concentrations relative to the discharge were apparent. As in previous surveys, sediment metal levels were well below concentrations determined to be potentially toxic to marine organisms. Concentrations of sediment metals in 2008 did not appear to be adversely influenced by the operation of the Ormond Beach Generating Station.

MUSSEL BIOACCUMULATION

As part of the resource exchange for participation in the Bight ‘08 Regional Monitoring Program, mussel bioaccumulation analysis was required only if resident mussels were located in the discharge area. No mussels were located in the study area in 2008. Mussel tissue bioaccumulation studies, including transplantation of mussels into the area, if necessary, will continue in 2009.

BENTHIC INFAUNA

The infauna community in the study area in 2008 was composed primarily of small arthropods, annelids worms, clams, and nemertean (ribbon) worms. As part of the resource exchange for the Bight ‘08 Regional Monitoring Program, only four stations were sampled, with only two replicates taken at each station. A total of 78 species was collected, with species richness averaging 35 species per station (23 per replicate, fewer than in 2007). Species diversity (H’) averaged 3.15 per station (2.83 per replicate, very similar to 2007). Abundance, at a mean density for the area of 4,500 individuals/m^2, was less than one-half that in 2007, and was also considerably below the long-term mean for the four stations for summer surveys conducted since 1978. Mean species richness was similar to the long-term mean, while species diversity was above the long-term mean. Infaunal parameter values were similar among stations, although, unlike most previous years, abundance was highest near the generating station discharge. Community parameters appeared only somewhat related to sediment characteristics. Species richness was highest where sediments were finest, but abundance was highest where they were coarsest and best sorted. The presence of shell fragments near the discharge may have contributed to the abundance of several species dependent on attachment substrates. Southern California Benthic Response Index values averaged 2.3, below the mean for 2007; all values suggested that the communities in the study area were undisturbed, or healthy.

Composition of the infaunal communities was similar to those in the past. The clam *Tellina modesta* was the most abundant species overall, even though it was most abundant only at the station upcoast of the generating station. The polychaete annelids *Apoprionospio pygmaea* and *Mediomastus acutus*, the cumacean *Diastylopsis tenuis*, and the amphipod *Rhepoxynius menziesi* were also abundant and occurred at all of the stations. Community constituents included many rapid-burrowing species, such as *R. menziesi*, that are well adapted to the nearshore sandy habitat. Overall, the communities found in 2008 were typical of the shallow subtidal habitat throughout the Southern California Bight. No adverse effects of the generating station discharge on the infauna were apparent.

IMPINGEMENT

Twelve normal operation impingement surveys were completed at Ormond Beach Generating Station in 2008. No heat treatments were conducted in 2008. Based on these surveys, an estimated total of 1,206 fish representing 16 species and weighing 219 kg were impinged during the operation of the cooling water system with abundance dominated by bay pipefish and queenfish. In addition, an estimated 3,259 macroinvertebrates representing 16 species and weighing 632 kg were impinged during the study year. Yellow crab and Pacific rock crab combined to account for 58% of the total macroinvertebrate impingement.

Overall, fish species impinged in 2008 were similar to those collected in recent surveys, but were less abundant than recorded in most annual surveys since 1990. Macroinvertebrate composition in 2008 was also similar to previous years, although, as with fish, abundances were less than average. The similarity of species composed primarily of frequently occurring and long-term dominant species indicates a relatively stable nearshore assemblage typical of southern California.

CONCLUSIONS

The overall results of the 2008 NPDES monitoring program indicated that operation of the Ormond Beach Generating Station had no detectable adverse effects on the beneficial uses of the receiving waters.

CHAPTER 1 — INTRODUCTION

This report presents and discusses the results of the 2008 receiving water monitoring studies conducted for the Ormond Beach Generating Station, which is owned and operated by Reliant Energy. The 2008 monitoring program was conducted in accordance with specifications set forth in National Pollutant Discharge Elimination System (NPDES) Monitoring and Reporting Program No. 5619 (Permit No. CA0001198) issued by the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) on 28 June 2001 (Appendix A). The 2008 NPDES program was modified to facilitate the generating station's participation in the fourth comprehensive regional survey of coastal ocean waters in the Southern California Bight (Bight '08) (Appendix A). Results of the 2008 surveys were compared among locations in the study area and with past physical and biological studies to determine any effects the generating station discharge is having on the marine environment, and if the beneficial uses of the receiving waters are being protected. Sampling included physical and chemical monitoring of receiving waters and sediments, and biological monitoring of infaunal and fish and macroinvertebrate assemblages. Sufficient numbers of resident mussels for tissue analysis were not found in the survey area in 2008.

DESCRIPTION OF THE GENERATING STATION

The Ormond Beach Generating Station is located on the coast of California, approximately 3.7 kilometers (km) southeast of the entrance to Port Hueneme in Ventura County (Figure 1-1). The station consists of two steam-electric, gas-fueled generating units, rated at 750 megawatts (Mw) each. At full load, the boiler of each unit produces 2.6 million kilograms (kg) of steam per hour which is supplied to tandem compound turbines at a temperature of 555.6°C.

Cooling water is supplied to the station through a 4.0-meter (m) inside-diameter (ID) concrete conduit at a maximum flow rate of about 475,000 gallons per minute (gpm). The intake structure is located 640 m offshore at a water depth of about 10 m Mean Low Lower Water (MLLW); the port is 2 m above the bottom and is covered by a raised velocity cap. Seawater enters the conduit at a velocity of about 82 centimeters per second (cm/s) and passes through a screening facility in the plant to remove marine life, trash, and other debris.

After passing through the screenwell, cooling water is pumped to two condensers (one per unit), where its temperature is elevated approximately 16.7°C when the plant is operating at full capacity. The heated effluent is returned to the ocean through a 4.3-m-ID conduit which terminates 457 m offshore at a bottom depth of 9 m (MLLW). The discharge water is directed vertically upward and exits the conduit at a depth of 6 m (MLLW) at a speed of about 87 cm/s.

Approximately 20,000 gpm of the main flow is diverted to three auxiliary heat exchangers that cool treated distilled water for other plant equipment. The temperature of this water is elevated approximately 5.6°C before it is returned to join the main stream in the discharge conduit.

During the 17 September 2008 survey, the generating station operated two of four circulator pumps, discharging at the rate of 187.054 mgd. Intake temperature was 17.6°C, with an increase in water temperature across the condensers of 0.7°C, resulting in a discharge temperature of 18.3°C. During the 2008 sampling year, the Ormond Beach Generating Station operated at 6.1% of total operating capacity (Melchor 2008, pers. comm.).

DESCRIPTION OF THE STUDY AREA

The Ormond Beach Generating Station is located on the coastal plain of the Ventura Basin which is defined by two coastal features: the barrier beaches at Point Mugu (11.3 km to the south) and the delta of the Ventura River (20.9 km to the north) (Figure 1-1). Prominent natural features of this portion of the Southern California Bight include the dunes along Mandalay Beach, the marshes

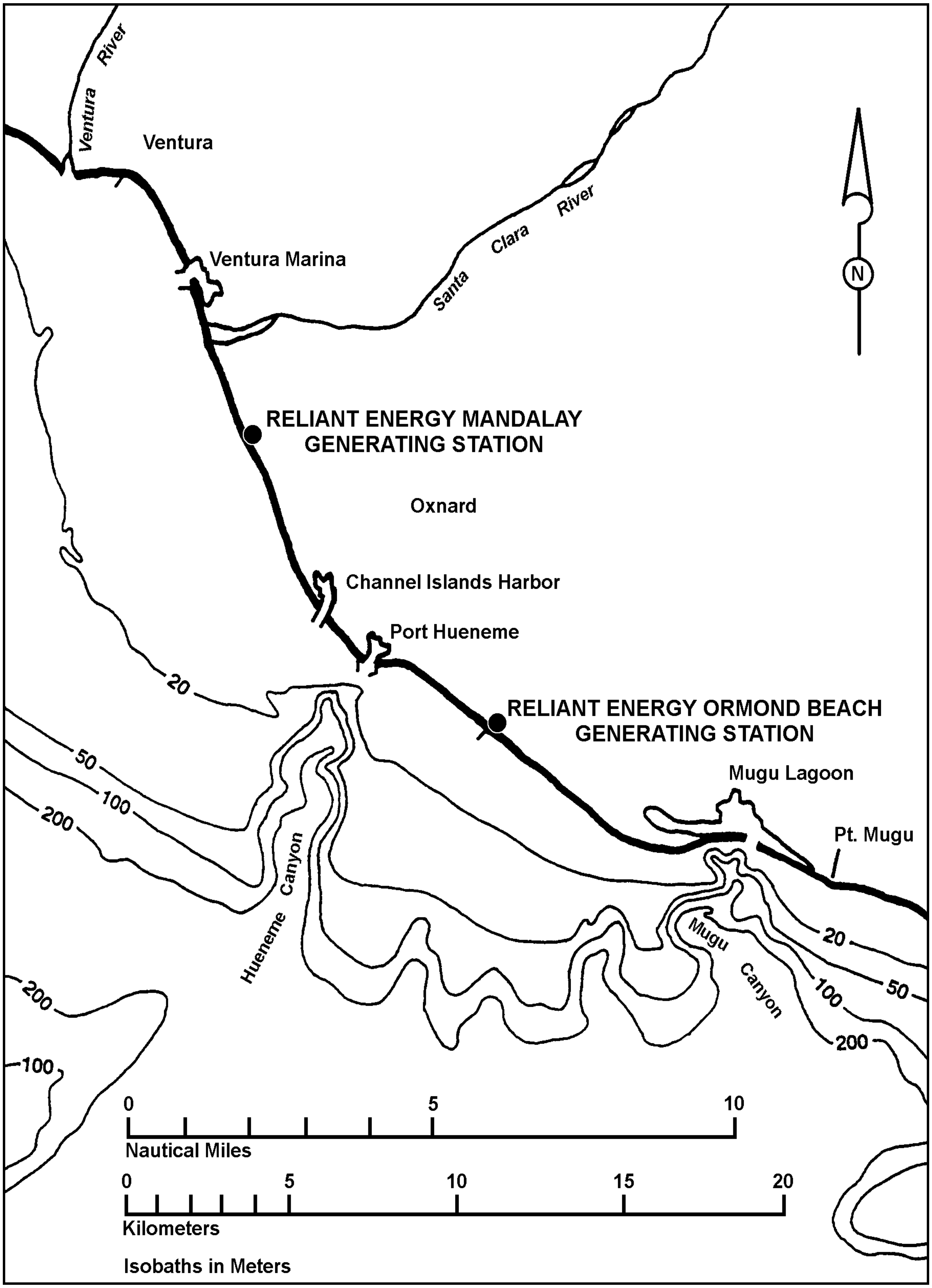


Figure 1-1. Location of the study area. Ormond Beach Generating Station NPDES, 2008.

and lagoon on the naval reservation near Point Mugu, and the straight, sandy beaches interrupted by the Ventura Marina, Channel Islands Harbor, and the harbor at Port Hueneme.

The physiography, climate, and general oceanography of the southern California coastal region all contribute to the general character of the study area. The fate of any thermal discharges into coastal waters is influenced by the complex interactions of the above factors. The plume in turn may alter the nature of the biota present in the area. All of these factors have long- and short-term cycles as well as non-periodic components. Winds, tides, and currents are particularly important since they determine to the greatest extent the actual fate of the thermal effluent.

Physiography

The general orientation of the coast from Point Conception to the Mexican border is northwest to southeast. The continental margin has been slowly emerging over geological time, resulting in a predominantly cliffed coastline, although it is broken by coastal plains in the vicinity of Oxnard-Ventura, Los Angeles, and San Diego.

The eight islands offshore from the southern California mainland strongly influence water circulation and oceanographic conditions throughout the Bight. The mainland shelf along the coast is narrow, ranging from less than two to almost 20 km in width, but averaging about 7 km. Seaward of the shelf is an irregular and geologically complex region known as the continental borderland. The bottom here comprises a series of basins and ridges which extend in depth from near-surface to depths in excess of 2,400 m.

Hydrography

The ocean floor of the Ventura Basin is characterized by three distinct areas: a broad and gently sloping area directly in front of the Ormond Beach Generating Station, and two submarine canyons (Hueneme and Mugu) at either edge (Figure 1-1 and IRC 1973). At Ormond Beach, the 20 fathom contour is within 7 km of shore, while to the north at Mandalay it is no closer than 13 km.

General nearshore circulation in the area is affected by the two canyons, Port Hueneme, Channel Islands Harbor, the Ventura Marina, and the Santa Clara River. However, there is little evidence that these features significantly affect circulation in the immediate study area.

Climate

Southern California is a climatic regime defined broadly as Mediterranean, which is characterized by short, mild winters and warm, dry summers. Monthly mean air temperatures along the coast range from 8°C in winter to 21°C in summer, with daily minima dropping slightly below freezing and maxima reaching above 37°C.

Annual precipitation near the coast averages about 46 cm, 90% of which occurs between November and April. Drainage of the coastal region is largely by way of many short streams which normally flow only during rainstorms. Only a small part of the storm runoff actually reaches the ocean, most being impounded by dams and used for other purposes.

Sea breezes, which develop from differences in heating between land and sea, combine with prevailing coastal winds (which blow out of the northwest in summer) to produce strong onshore winds. In summer the sea breezes usually begin at mid-day and may continue through the late afternoon, with speeds reaching 37 km/hour. In late fall and winter, reverse pressure systems frequently develop. Coastal winds tend to be from the southeast from November through February and typically blow from early afternoon to 2000 hours (hr).

Currents

Water in the northern Pacific Ocean is driven eastward by prevailing winds until it impinges on the western coast of North America where it divides and flows both north and south. The southern component is the California Current, a diffuse and meandering water mass which generally flows to the southeast. There is no fixed western boundary to this current, but more than 90% of its transport is within 725 km of the California coast.

South of Point Conception the California Current diverges. One branch turns northward and flows inshore of the Channel Islands, forming the Southern California Countercurrent. Surface speed in the countercurrent ranges between 5 and 10 cm/s. The general flow pattern is complicated by eddies in the Channel Islands region and it fluctuates seasonally. It is more strongly developed in summer and autumn and weak or occasionally absent in winter and spring. Generalized surface water circulation off southern California is shown in Figure 1-2.

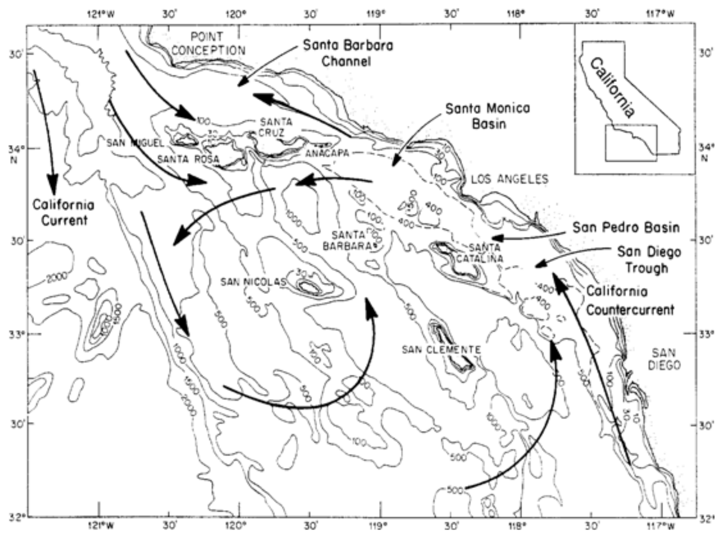


Figure 1-2. Surface circulation in the Southern California Bight (from Hickey 1992). Ormond Beach Generating Station NPDES, 2008.

Nearshore, coastal currents are strongly influenced by a combination of wind, tides, and local topography. When wind-driven currents are superimposed on tidal motions, a strong diurnal pattern is usually apparent. Therefore, short-term observations of currents near the coast often vary in both direction and speed.

Longshore Drift

In response to longshore currents, sand typically moves parallel to shore, then into the heads of submarine canyons. In the Hueneme area, the net littoral sediment transport is downcoast in the range of 600,000 to 900,000 m^3 per year. The construction of the harbor entrance effectively trapped much of the normal supply to Ormond Beach; that which was not trapped was diverted into the head of Hueneme Canyon. Erosion downstream of the harbor-entrance jetties is about 900,000 m^3 per year. To offset these losses, slightly more than 1,500,000 m^3 are dredged biannually and deposited to intertidal and subtidal habitats at Ormond Beach. This deposition can have a detrimental impact on the nearshore biota. Erosion southeast of the jetties continues at the rate of 1,500,000 m^3 per year.

Tides

Tides along the California coast are mixed, with two unequal highs and two unequal lows during each 25 hr period. The tide is a long-period wave that is a combination of semidiurnal components (each having nearly 12 hr periods) and diurnal components with nearly 25 hr periods. In the eastern North Pacific Ocean, the tide wave rotates in a counterclockwise direction so that tidal extremes occur progressively later in the day northwards along the coast. As a result, flood tide currents flow upcoast and ebb tide currents flow downcoast.

Upwelling

The predominant northwesterly winds are responsible for large scale upwelling along the California coast. From about February to October, these winds induce offshore movement of surface water which is replaced by the upwelling of deeper ocean waters. The upwelled water is colder, more saline, lower in oxygen, and higher in nutrient concentrations than surface waters. Thus, upwelling not only alters the physical properties of the surface waters but also affects biological productivity.

RECEIVING WATER CHARACTERISTICS

The capacity of the marine environment to assimilate waste heat depends on its ability to dilute and disperse it. The assimilation capacity depends on the ambient water temperature as well as the amount and temperature of the thermal discharge. Dispersion is largely determined by local wind, wave, tide, and current patterns. The following summary concerns general patterns of natural ocean temperatures off southern California as well as other physical characteristics of the nearshore water mass.

Temperature

Natural seawater temperature fluctuates throughout the year as a result of seasonal and diurnal variations in meteorological conditions such as wind, air temperature, insolation, cloud cover, and relative humidity as well as oceanographic conditions such as currents, tides, turbulence, and vertical mixing. The California State Water Resource Control Board defines natural temperature as "the temperature of the receiving water at locations, depths, and times which represent conditions unaffected by any elevated temperature waste discharge" (SWRCB 1975).

Previous studies have shown that natural surface temperatures may vary several degrees in a single day, depending upon time of day, time of year, and prevailing oceanographic and meteorological conditions. Temperatures offshore Ormond Beach range from monthly means of 13.3°C in February and March to 16.7°C in August. Mean maximum natural surface temperatures are 14.4°C during the winter and 22.2°C in the summer (MBC 1975).

When there are large differences between surface and bottom temperatures, a thermocline may develop (a thermocline is an area of rapid temperature change between two layers of water). Natural thermoclines are formed when absorption of solar radiation at the surface produces a heated surface layer which is not mixed vertically. Artificial thermoclines may result from the discharge of warm water above cooler waters and the lack of vertical mixing. Off southern California, a reasonably sharp thermocline usually develops in summer at depths up to 30 m. Only very weak thermoclines appear in winter.

Salinity

Salinity is a measure of the concentration of salts in water which can be expressed as a weight of salts dissolved in a volume of water. Typically, the concentration of salts in the ocean is roughly 35 grams per kilogram of water and can be expressed as 35 parts per thousand (ppt). Although relatively constant in the open ocean, salinity varies in the nearshore as a result of freshwater runoff and evaporation. Mean surface salinities at the Ventura Marina between 1965 and 1971 ranged from 24.1 ppt during a period of high storm runoff to a high of 33.9 ppt (IRC 1973). Yearly averages were about 33.5 ppt.

Dissolved Oxygen

Dissolved oxygen (DO) is used by plants and animals in normal respiration and metabolic processes. It is replenished in seawater by gaseous exchange with the atmosphere and through photosynthesis by plants. Concentrations in surface waters off Ormond Beach between July 1970 and January 1973 ranged from 7.3 to 11.0 mg/l (IRC 1973). The high values were probably a result of active photosynthetic processes and the low values a result of mixing with oxygen-depleted subsurface water.

Hydrogen Ion Concentration

The hydrogen ion concentration (pH) in southern California surface waters varies narrowly around a mean of approximately 8.1 and decreases slightly as the water becomes more acidic with depth. However, values will naturally approach 8.6 during phytoplankton blooms, which rapidly metabolize carbonates in the surface waters. Values can also drop below 7.9, although this generally occurs in waters below 100 m, or in confined water ways such as harbors, where organic decomposition and reduced circulation will lead to an accumulation of acidic byproducts. Maximum pH values recorded during four quarterly surveys offshore Ormond Beach between December 1973 and September 1974 were 8.0 to 8.6 (EQA/MBC 1975).

BENEFICIAL USES OF RECEIVING WATERS

The Water Quality Control Plan for the Santa Clara River Basin adopted by the California Regional Water Quality Control Board (1994) lists beneficial uses of waters in the nearshore and offshore zones of the Santa Clara-Calleguas Hydrographic Unit, which includes Ormond Beach and the study area. These uses are:

Industrial Service Supply (IND) - Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.

Navigation (NAV) - Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

Water Contact Recreation (REC-1) - Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

Non-contact Water Recreation (REC-2) - Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Commercial and Sport Fishing (COMM) - Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

Marine Habitat (MAR) - Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

Wildlife Habitat (WILD) - Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

Preservation of Biological Habitats (BIOL) - Uses of water that support designated areas or habitats, such as Areas of Special Biological Significance (ASBS), established refuges, parks, sanctuaries, ecological reserves, or other areas where the preservation or enhancement of natural resources requires special protection.

Rare, Threatened, or Endangered Species (RARE) - Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

Migration of Aquatic Organisms (MIGR) - Uses of water that support habitats necessary for migration, acclimatization between fresh and salt water, or other temporary activities by aquatic organisms, such as anadromous fish.

Spawning, Reproduction, and/or Early Development (SPWN) - Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

Shellfish Harvesting (SHELL) - Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sport purposes.

Although all of the above are not directly associated with the receiving waters of the Ormond Beach Generating Station at all times, they may be reasonably assumed to constitute occasional beneficial uses of the nearshore waters in the study area.

SCOPE OF THE MONITORING PROGRAM

The 2008 monitoring program for the Ormond Beach Generating Station was conducted by MBC Applied Environmental Sciences (MBC) in accordance with specifications set forth in the NPDES Monitoring and Reporting Program (Appendix A). The monitoring program included winter and summer water column profiling, summer sediment sampling for grain size and chemistry, mussel sampling for bioaccumulation, summer biological sampling for benthic infauna, and periodic impingement sampling of fish and macroinvertebrates.

STATION LOCATIONS

The locations of the monitoring stations are described in Appendix A and shown in Table 1-1 and Figure 1-3. The 2008 monitoring program included nine water quality (RW) stations, and four sediment and benthic infauna (B) stations.

Table 1-1. Latitude/longitude coordinates of sampling stations. Ormond Beach Generating Station NPDES, 2008.

Stations			
Water Quality	Benthic	Latitude	Longitude
RW1		34°07.70'	119°10.98'
RW2	B2	34°07.51'	119°10.68'
RW3	B3	34°07.44'	119°10.46'
RW4	B4	34°07.33'	119°10.34'
RW5	B5	34°07.10'	119°10.06'
RW6		34°07.50'	119°10.38'
RW7		34°07.17'	119°10.72'
RW8		34°06.52'	119°09.34'
RW9		34°08.16'	119°11.78'

FIELD OBSERVATIONS

As part of the resource exchange for participation in the Bight ‘08 Regional Monitoring Program, winter receiving water surveys were eliminated from 2008 monitoring program requirements (Appendix A). The NPDES water quality monitoring summer survey was conducted on 17 September and benthic sampling was conducted on 18 September 2008. Latitude and longitude coordinates for all receiving water (RW) and benthic (B) stations are listed in Table 1-1.

During the summer surveys, no oil sheens, grease or red tide (plankton bloom) were observed at any of the stations. The water appeared relatively clear with no turbidity noted during either the water quality survey or the benthic sampling. Drift algae was noted only at receiving water Station RW6 during the flood tide water quality monitoring.

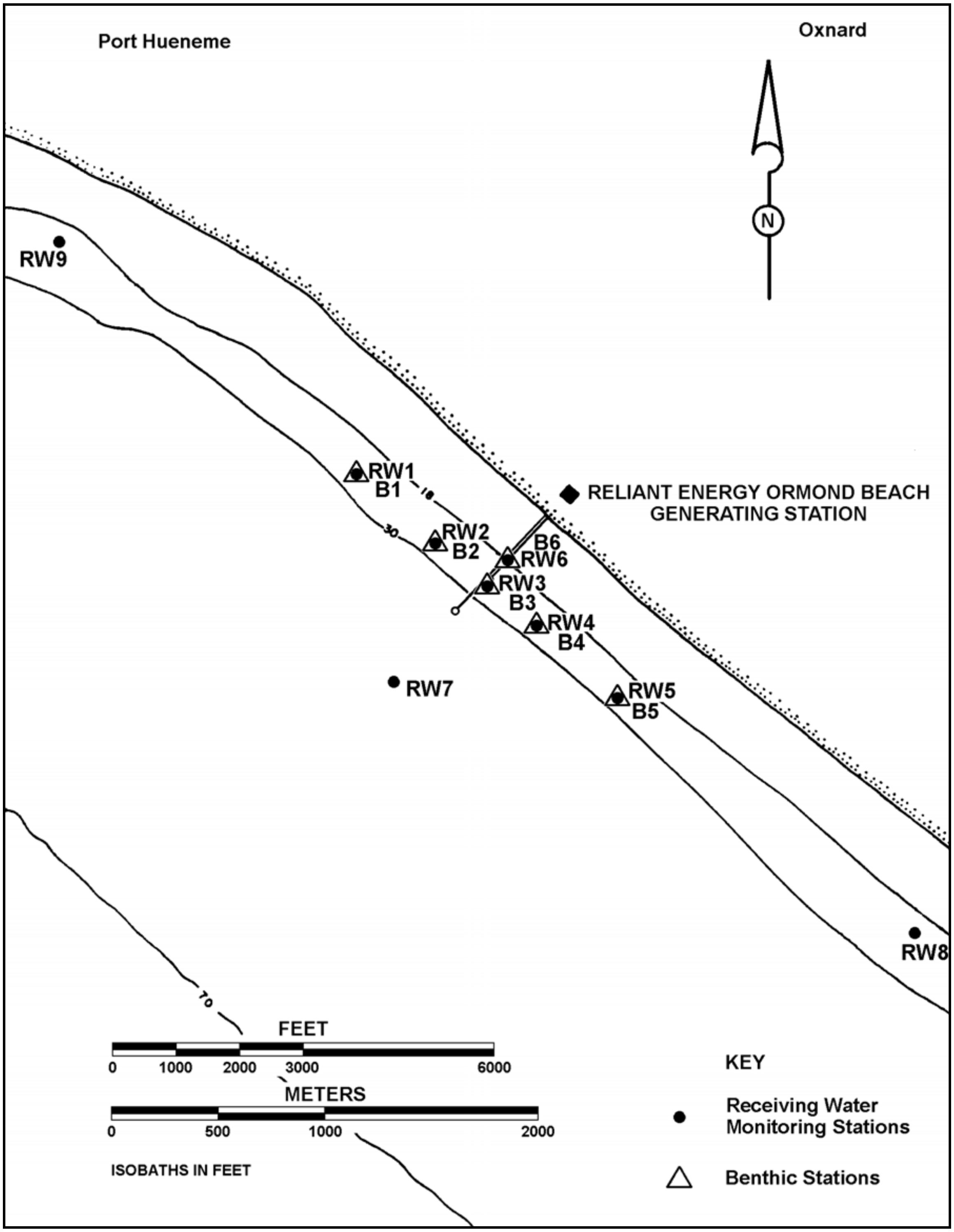


Figure 1-3. Location of the monitoring stations. Ormond Beach Generating Station NPDES, 2008.

Western gulls (*Larus occidentalis*) and cormorants (*Phalacrocorax* spp) were observed at most of the water quality stations as well as at most of the benthic stations. Terns (Laridae) were seen during the water quality sampling at Stations RW5 and RW8 during flood tide, at Stations RW2 and RW8 during ebb tide, and at benthic Stations B2 and B5. California brown pelicans (*Pelecanus occidentalis californicus*) were observed during flood tide water quality monitoring at Station RW5 and during ebb tide at Stations RW5 through RW7, and RW9. No California least terns (*Sternula antillarum browni*) were observed during either survey days.

STATISTICAL ANALYSES

Summary statistics developed from the biological data included the number of individuals (expressed as per standard area), number of species and Shannon-Wiener (Shannon and Weaver 1962) species diversity (H') index. The diversity equation is as follows:

Shannon-Wiener

$$H' = -\sum_{j=1}^{s} \frac{n_j}{N} \ln \frac{n_j}{N}$$

where: H' = species diversity
n_j = number of individuals in the j^{th} species
S = total number of species
N = number of individuals

The Southern California Benthic Response Index (BRI) is an abundance-weighted average pollution tolerance of species occurring in a sample, and is a measure of the condition of marine and estuarine benthic communities (Smith et al. 2003). It classifies benthic communities as “reference” (i.e. undisturbed) or one of four levels of response to increased disturbance. The index formula is:

Benthic Response

$$BRI_s = \frac{\sum_{i=1}^{n} \sqrt[3]{a_{si}}\; p_i}{\sum_{i=1}^{n} \sqrt[3]{a_{si}}}$$

where: BRI_s = BRI value for sampling unit s_i
n = number of species with pollution tolerance scores in s_i
p_i = pollution tolerance of species *i*
a_{si} = abundance of species *i* in *s*

Species pollution tolerances p_i were determined during BRI development as the position of the abundance distribution of species *i* on a gradient between the most and least disturbed sites. Species without pollution tolerance values are not included in the calculation. Pollution tolerance values were not assigned to species if the data were insufficient to assign a value. The index was developed for benthic samples that were sieved through a 1-mm mesh screen. Pollution tolerance scores were derived for coastal shelf samples for shallow (10-30 m deep), mid-depth (>30-120 m deep), and deep (>120-324 m deep) habitats, and for bay and harbor habitat samples, northern (Point Conception to Newport Bay) and southern (Dana Point to the U.S.-Mexico border). The species names for which scores are available are based on Edition 5 of the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) list of invertebrate species (SCAMIT 2008).

Evenness (J’) is a measure of the degree to which a sampled community is dominated by one or a few species. Values of evenness range from 1.0 (all species with identical abundances) to 0 (Pielou 1977). The evenness equation is as follows:

$$J' = \frac{H'}{\ln S}$$

where: J' = Evenness
H' = Shannon-Wiener Index
S = number of species within the community

Infauna data were subjected to log transformations (when necessary) and classified (clustered) using NCSS 2000 Hierarchial Clustering (Hintze 1998). Cluster analysis provides a graphic representation of the relationship between species, their individual abundance, and spatial occurrence among the stations sampled. In theory, if physical conditions were identical at all stations, the biological community would be expected to be identical as well. In practice this is never the case, but it is expected that the characteristics of adjacent stations would be more similar than those distant from one another. The dendrogram shows graphically the degree of similarity (and dissimilarity) between observed characteristics and the expected average. The two-way analysis utilized in this study illustrates groupings of species and stations, as well as their relative abundance, expressed as a percent of the overall mean. Two classification analyses are performed on each set; in one (normal analysis) the sites are grouped on the basis of the species which occurred in each, and in the other (inverse analysis) the species are grouped according to their distribution among the sites. Each analysis involves three steps. The first is the calculation of an inter-entity distance (dissimilarity) matrix using Euclidean distance (Clifford and Stephenson 1975) as the measure of dissimilarity.

Euclidean distance
$$D = \left[\sum_{1}^{n} \left(x_1 - x_2 \right) \right]^{1/2}$$

where: D = Euclidean distance between two entities
x_1 = score for one entity
x_2 = score for other entity
n = number of attributes

The second procedure, referred to as sorting, clusters the entities into a dendrogram based on their dissimilarity. The group average sorting strategy is used in construction of the dendrogram (Boesch 1977). In step three, the dendrograms from both the site and species classifications are combined into a two-way coincidence table. The relative abundance values of each species are replaced by symbols (Smith 1976) and entered into the table. In the event of extreme high abundance of a single species, abundance data are transformed using a natural log transformation [ln(x)].

Community importance for benthic infaunal species and trawled fish and macroinvertebrates was tested using the Index of Relative Importance (IRI): IRI = Rank(Rank of abundance + Rank of Frequency of Occurrence) (Stephens and Zerba 1981). Spearman's rank correlation was used to test for similarities in the distribution of IRI ranks between the annual surveys.

DETECTION / REPORTING LIMITS

Detection/reporting limits used in reporting chemistry results are interpreted as the smallest amount of a given analyte that can be measured above the random noise inherent in any analytical tool. Thus, any value below the detection/reporting limits cannot be considered a reliable estimate of analyte concentration. Therefore, where a test for a given analyte results in a level below the detection/reporting limit, a "none detected" (ND) value has been assigned. The complication of what numerical value to substitute for ND in statistical calculations is addressed by the Environmental Protection Agency (EPA 1989, Section 5.3.3). When values for a given analyte are ND for all stations, then means and standard deviations will also be considered ND. However, when an analyte is detected at some stations and not at others, statistical calculations can be made by substituting ND values with either (a) zero, (b) one-half the average detection limit, or (c) the average detection limit (EPA 1989). Determining which substitution to use is based on whether or not substantial information exists to support the historical presence or absence of a given analyte at the station location. Since chemistry analyses have repeatedly resulted in ND values at the same stations through past surveys, ND values have been replaced with zeros in performing statistical calculations. As the ability to detect chemicals in increasingly smaller concentrations has improved greatly with time, detection/reporting limits differ in virtually all past surveys; this would confound any yearly comparison if options (b) or (c) from above were used. Historical raw data are presented in the appendices for possible supplementary study.

CHAPTER 2 — WATER COLUMN MONITORING

Water column measurements of physical and chemical characteristics of seawater such as temperature, dissolved oxygen (DO), hydrogen ion concentration (pH), and salinity are important components of a discharge monitoring program. Because biological communities exist in equilibrium in the marine environment, changes in seawater characteristics can result in potentially adverse impacts to these communities. As the physical/chemical properties of the receiving waters can vary naturally on a relatively small scale, water quality sampling is designed to assess these parameters in a way that helps determine the scale of seasonal and tidally driven oceanographic influences with respect to the point of discharge. Long-term monitoring of these parameters can help determine whether deviations from expected patterns exist that may indicate impacts from the discharge on local biological communities and to determine whether the beneficial uses of the receiving water remain protected.

MATERIALS AND METHODS

As part of the resource exchange for participation in the Bight '08 Regional Monitoring Program, winter water quality sampling was not required in 2008 (Appendix A). Winter surveys will resume during the 2009 monitoring year. During the summer survey, temperature, DO, pH, and salinity were measured throughout the water column on both flood and ebb tides at each of the nine receiving water monitoring stations (Figure 2-1). Data were obtained *in situ* using an SBE 25 water quality profiling system (Sea-Bird), and averaged at 1.0-m intervals. In the field, the data were transferred from the Sea-Bird to floppy disk for storage. In the laboratory, data were processed using Sea-Bird proprietary software (SeaSoft). The resulting information was imported into Microsoft Excel spreadsheets for reduction and analysis.

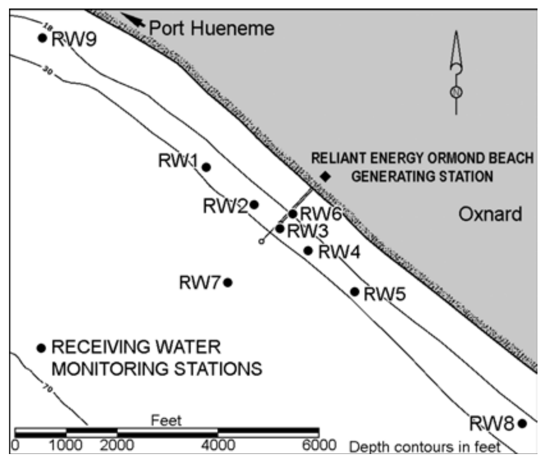


Figure 2-1. Location of the water column sampling stations. Ormond Beach Generating Station NPDES, 2008.

Summer water quality was monitored at Stations RW1 through RW9 on 17 September 2008 during flood and ebb tides. Flood tide was monitored between 0815 and 0930 hours (hr) and ebb tide was monitored between 1345 and 1445 hr. On the day of monitoring, the tide rose from a low of +1.0 ft Mean Lower Low Water (MLLW) at 0449 hr to a high of +5.9 ft MLLW at 1056 hr, then fell to a low of +0.3 ft MLLW 1739 hr (Figure 2-2). Skies were mostly cloudy (90% cloud coverage) with winds from the west at 2 to 3 knots during the morning flood tide monitoring. By the afternoon ebb tide monitoring, skies were clear with winds from the west at 10 to 12 knots. Seas were from the west at 2 to 3 ft.

RESULTS

Water quality monitoring was conducted offshore of the Ormond Beach Generating Station in summer during flood and ebb tide to determine potential effects of the generating station discharge on receiving waters. Receiving water monitoring stations are shown in Figure 2-1. Flood tide was sampled in the early morning, while ebb tide was sampled early afternoon. On the day of sampling two of four circulating pumps were in operation with a flow of 187.1 mgd and a discharge

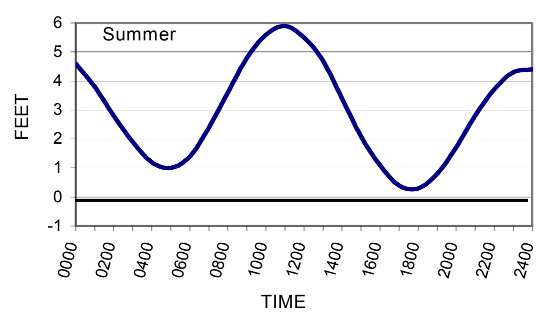


Figure 2-2. Tidal rhythms during water quality sampling, summer survey. Ormond Beach Generating Station NPDES, 2008.

temperature of 18.3°C, approximately 0.7°C above the intake temperature (Melchor 2008, pers. comm.). Water quality data for flood and ebb tides are presented in Figures 2-3 and 2-4 and summarized in Table 2-1. Raw data are presented in Appendix B.

Temperature

During the summer survey, surface temperatures averaged 16.77°C during morning flood tide and 18.08°C during the later ebb tide (Table 2-1 and Figure 2-3). Surface temperatures were more dissimilar among stations during flood tide, varying by about 2.1°C, than on ebb tide which varied by 0.7°C among stations. Flood tide surface temperatures ranged from 15.11°C at Station RW9, farthest upcoast of the discharge, to 17.23°C at Station RW8, farthest downcoast. Surface temperatures during ebb tide ranged from 17.60°C at Station RW9 to 18.30°C at Station RW8. Surface temperatures generally varied by about 1.3°C between tides and were warmer during the later ebb sampling, with the greatest difference found at Station RW9 where surface temperature was 2.5°C warmer on ebb tide (Appendix B). Highest surface temperatures were found farthest downcoast on both tides. During flood tide, temperatures were fairly consistent with depth throughout the water column. On flood tide, the greatest surface-to-bottom difference of 2.65°C was found at Station RW1, 3,000 ft upcoast of the discharge (Figure 2-3 and Appendix B). Temperatures were warmer throughout the water column on ebb tide at all stations, with the greatest surface-to-bottom difference of 2.69°C found at Station RW7, offshore of the discharge at a depth of 40 ft. Thermoclines exceeding 1°C temperature change within one meter of depth were not observed during the summer sampling, and only mild thermal gradients were noted during either tide. Bottom water temperatures in 2008 averaged 15.31°C during flood tide and 16.80°C during ebb tide. Flood tide water temperatures ranged from 14.06°C at Station RW9 to 16.48°C at Station RW6, inshore of the discharge at a depth of 20 ft (Table 2-1). Ebb tide bottom water temperatures ranged from 15.42°C at Station RW7 to 17.75°C at Station RW8.

Table 2-1. Summary of water quality parameters during flood and ebb tides. Reliant Energy Ormond Beach Generating Station NPDES, 2008.

	Temp. (°C)		D.O. (mg/l)		pH		Salinity (psu)		Temp. (°C)		D.O. (mg/l)		pH		Salinity (psu)	
	Summer															
	Surface								Bottom							
	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb
Mean	16.77	18.08	8.43	8.45	8.24	8.27	33.37	33.41	15.31	16.80	8.31	8.65	8.20	8.26	33.37	33.40
Minimum	15.11	17.60	8.12	8.33	8.17	8.27	33.33	33.38	14.06	15.42	8.16	8.50	8.16	8.24	33.33	33.37
Maximum	17.23	18.30	8.54	8.62	8.26	8.28	33.39	33.42	16.48	17.75	8.48	8.76	8.24	8.28	33.40	33.43

Dissolved Oxygen

Surface DO concentrations during flood tide averaged 8.43 mg/l and ranged from 8.12 mg/l at Station RW9 to 8.54 mg/l at Station RW6 (Table 2-1and Appendix B). During ebb tide, surface DO concentrations averaged 8.45 mg/l and ranged from 8.33 mg/l at Station RW5, 3,000 downcoast of the discharge to 8.62 mg/l at Station RW9. Dissolved oxygen concentrations were very similar between tides at all stations except Station RW9, where ebb tide values exceeded flood tide levels by about 0.5 mg/l throughout the water column (Figure 2-3). Dissolved oxygen concentrations were also relatively consistent with depth, with a general trend of moderately decreasing DO with depth during flood tide sampling and a trend of moderately increasing DO with depth during ebb tide (Figure 2-3 and Appendix B). Maximum surface-to-bottom DO differentials occurred at Station RW1 where DO concentration decreased by 0.31 mg/l during flood tide and at Stations RW7, 1,000 ft upcoast of the discharge, where DO increased by 0.38 mg/l during ebb tide (Appendix B). Near-bottom DO values averaged 8.31 mg/l during flood tide, and 8.65 mg/l during ebb tide.

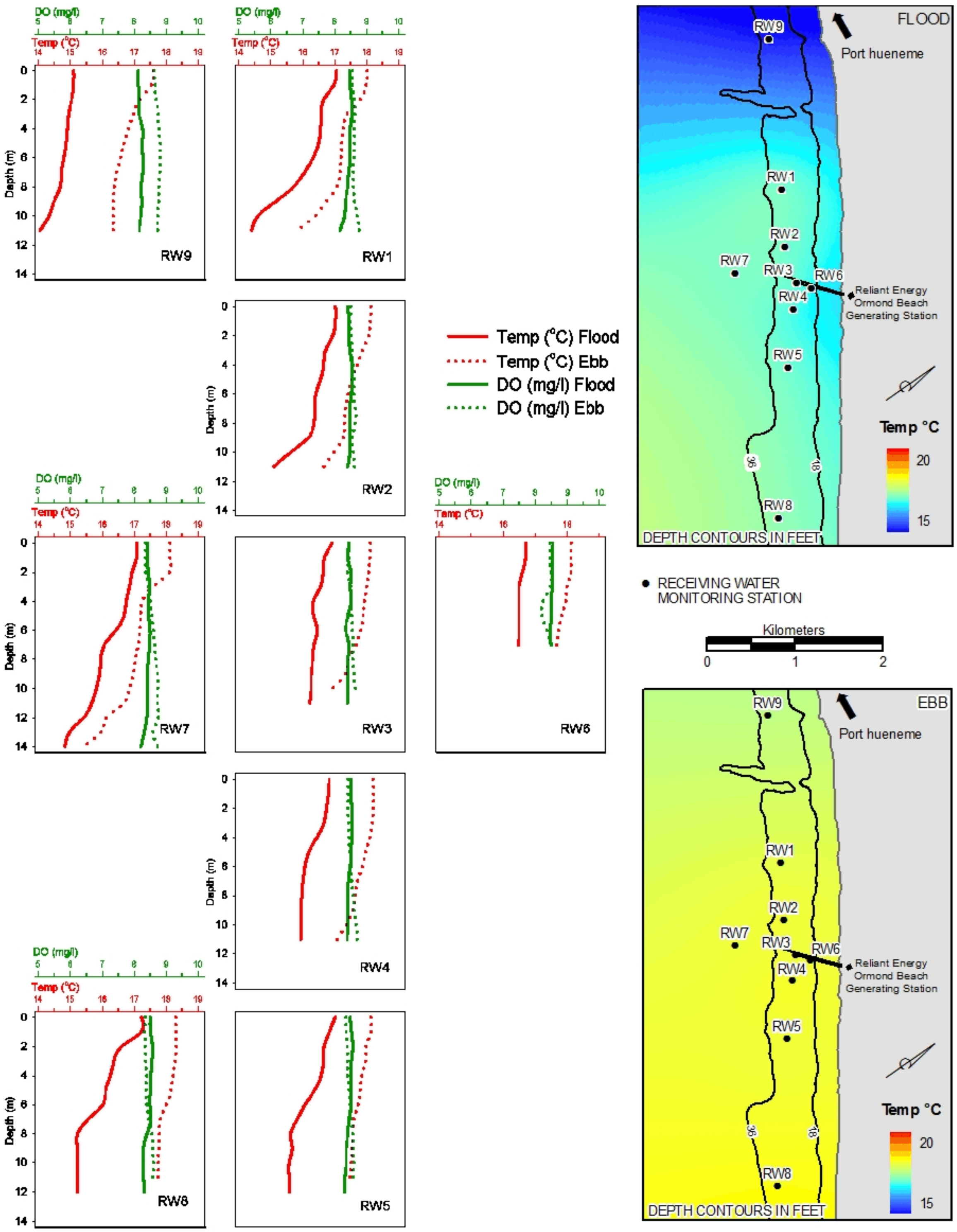


Figure 2-3. False color surface temperature contour plots and temperature and dissolved oxygen vertical profiles during flood and ebb tides, summer survey. Ormond Beach Generating Station NPDES, 2008.

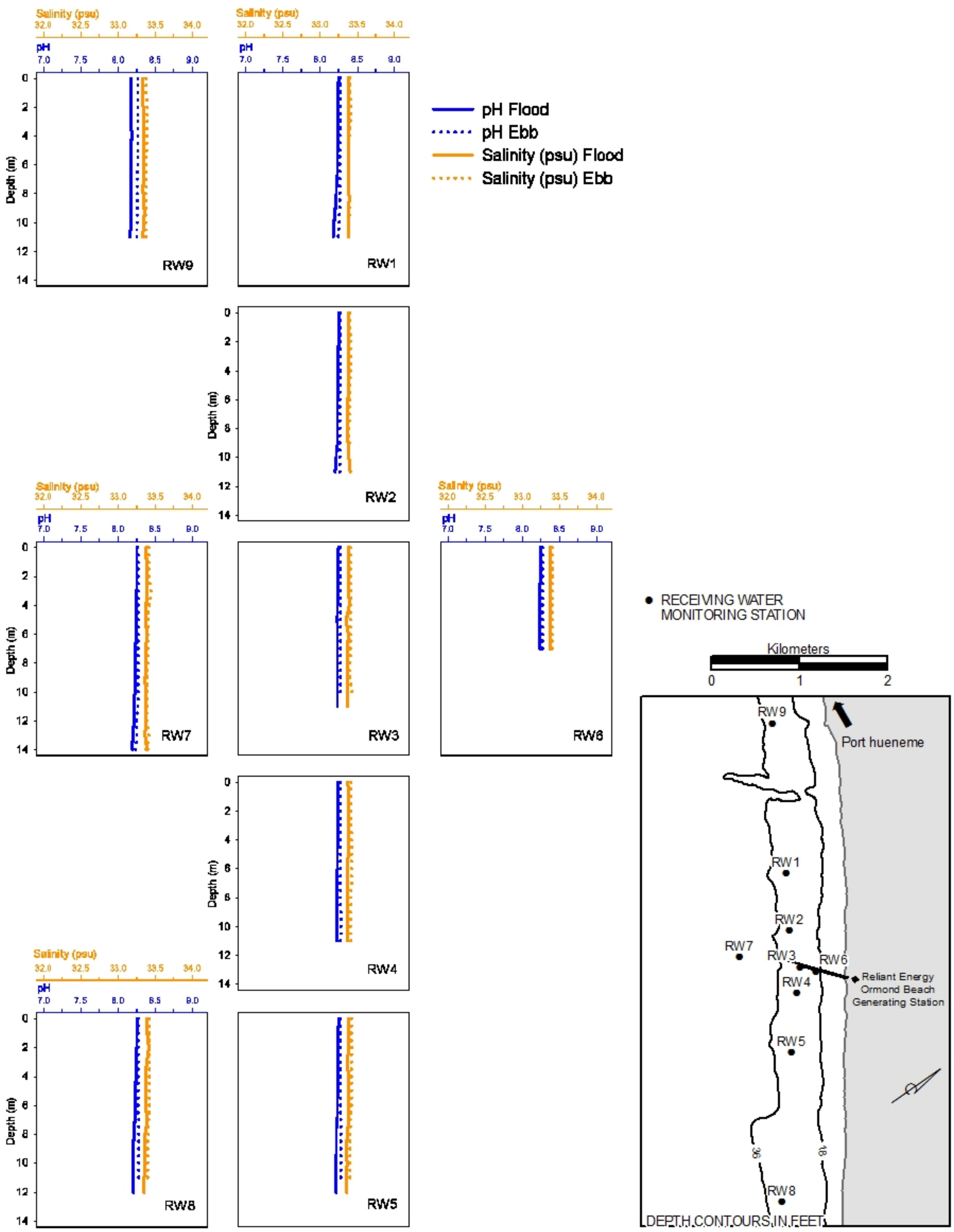


Figure 2-4. Hydrogen ion concentration (pH) and salinity vertical profiles during flood and ebb tides, summer survey. Ormond Beach Generating Station NPDES, 2008.

Hydrogen Ion Concentration

Surface pH values in the summer averaged 8.24 during flood tide and 8.27 during ebb tide (Table 2-1). Flood tide pH values ranged from 8.17 at Station RW9 to 8.26 at Station RW8. Ebb tide pH values ranged from 8.27 at eight of the nine stations to 8.28 at Station RW1 (Figure 2-4 and Appendix B). Bottom pH values averaged 8.20 during flood tide and 8.26 on ebb tide (Table 2-1). Flood tide bottom values ranged from 8.16 at Station RW9 to 8.24 at Station RW6. Ebb tide bottom pH values ranged from 8.24 at Station RW7 to 8.28 at Station RW4, 1,000 ft downcoast of the discharge, Station RW5, 3,000 ft downcoast of the discharge, and Station RW8 (Figure 2-4 and Appendix B). Hydrogen ion values were relatively consistent throughout the water column, although slightly higher on ebb tide (Figure 2-4). In summer, pH varied by less than 0.2 units among stations, between tides and with depth.

Salinity

Surface salinity averaged 33.37 practical salinity units (psu - which correlates one-to-one with parts per thousand [ppt]) during flood tide and 33.41 psu on ebb tide (Table 2-1). Surface salinities ranged from 33.33 to 33.39 psu during flood tide and 33.38 to 33.42 psu during ebb. Near-bottom water salinities averaged 33.37 psu ranging from 33.33 to 33.40 psu on flood tide and averaging 33.40 psu, ranging from 33.37 to 33.43 psu on ebb tide. In general, salinity was slightly higher throughout the water column during the later ebb tide sampling period (Figure 2-4 and Appendix B). Salinity was very uniform during summer sampling, varying by only about 0.1 psu among stations, between tides and with depth.

DISCUSSION

Water quality monitoring was conducted on two tides during summer to determine potential influence of the Ormond Beach Generating Station discharge on the receiving waters. During the summer water quality sampling two of four circulating pumps were in operation with a flow of 187.1 mgd and a discharge temperature of 18.3°C, approximately 0.7°C above the intake temperature (Melchor 2008, pers. comm.). Surface temperatures were slightly warmer than is typical of summer surveys, but cooler than occurred in the area in 2004 (MBC 1986, 1988, 1990, 1994-2004a, 2005, 2006a, 2007a; Ogden 1991-1993). Temperatures during morning flood tide were fairly consistent to a depth of about 4 to 8 m, then decreased with increasing depth to the bottom, with no notable thermal gradients. Surface temperatures generally varied by less than 1.5°C between tides, with warmer surface temperatures found during the late morning/early afternoon ebb tide, likely due to solar insolation. The greatest difference in surface temperature between tides was noted at the station farthest upcoast of the generating station discharge. Although temperatures were warmer throughout the water column on ebb tide, profiles of temperature differences with depth were similar between tides at most stations. Although thermoclines have commonly been observed in the upper water column in previous summer surveys, temperatures in 2008 indicated a fairly well-mixed water column throughout the study area. In addition, warm surface water influence from the thermal discharge observed in previous surveys was not apparent during the 2008 survey, likely a result of low thermal input from the generating station on the day of sampling. Highest temperatures were noted at the station farthest downcoast of the discharge on both tides which did not appear to be related to the thermal discharge. In 2008, water column temperatures were typical of the area and within the range of natural variability observed during previous surveys.

The concentration of DO in seawater is affected by physical, chemical, and biological variables. High DO levels may be the result of cool water temperatures (solubility of oxygen in water inversely correlates with temperature), active photosynthesis, and/or mixing at the air-water interface (Sverdrup et al. 1942). Conversely, low concentrations may result from high water temperatures, high rates of organic decomposition, and/or extensive mixing of surface waters with oxygen-poor subsurface waters. Dissolved oxygen concentrations typically fluctuate in the nearshore temperate environment around 7.5 mg/l (Kennish 2001), with a threshold of biological concern of 5 mg/l.

In summer, DO concentrations were consistent with depth at all stations during both tides, and with the exception of the station farthest upcoast, nearly identical between tides. Dissolved oxygen levels generally decreased slightly with depth during the morning flood tide and increased slightly with depth during the late morning/early afternoon ebb tide. This, along with the generally higher DO levels (particularly at the upcoast station) during the later sampling were consistent with replenishment by photosynthetic activity later in the day. The similarity of DO levels with depth also suggests that during the summer sampling the water column was fairly well mixed during both tides. Dissolved oxygen concentrations were in the range previously recorded offshore the generating station (MBC 1986, 1988, 1990, 1994-2004a, 2005, 2006a, 2007a; Ogden 1991-1993) and were well above the level of biological concern.

In the open ocean, pH remains fairly constant due to the buffering capacity of sea water (Sverdrup et al. 1942). However, in nearshore areas, pH may vary due to physical, chemical, and biological influences. For instance, in areas with a large organic influx, such as bays, estuaries, and near river mouths, microbial decomposition can alter pH levels. Along with a reduction in DO, decomposition also results in the production of humic acids, which reduces pH (Duxbury and Duxbury 1984). Decreased pH values may also occur in areas of fresh water influx, since fresh water generally has a lower pH than salt water. In contrast, phytoplankton blooms, which are often associated with nearshore upwelling, may initially cause an increase in pH. High photosynthetic rates increase the removal of carbon dioxide from water, thus reducing the bicarbonate concentration, resulting in an increase in pH.

In summer, pH was very consistent throughout the water column in the survey area. Hydrogen ion values were slightly more variable during flood tide, with slightly higher values found during ebb tide. Hydrogen ion concentrations varied by less than 0.2 units among stations, between tides and with depth. In 2008 all pH values were consistent with concentrations previously recorded in the study area (MBC 1986, 1988, 1990, 1994-2004a, 2005, 2006a, 2007a; Ogden 1991-1993) and did not appear to be related to the thermal discharge.

Salinity in the open ocean is generally 35 psu (ppt). However, in nearshore areas subjected to freshwater influx, salinity is usually slightly lower. In southern California, salinity values of nearshore waters are generally between 33 and 34 ppt (Dailey et al. 1993). Reductions in nearshore salinity usually result from freshwater input, while slight increases are often associated with upwelling of colder, more saline waters.

In 2008 summer, surface salinity averaged about 33.4 psu, with slightly lower values noted at the station farthest upcoast on flood tide. Salinity was very uniform during the summer sampling, varying by only about 0.1 psu among stations, between tides and with depth. In general, salinity was slightly lower throughout the water column during morning flood tide sampling period. All values reported in 2008 were typical of the nearshore waters of southern California and within values found previously in the area (MBC 2002-2004a, 2005, 2006a, 2007a) and did not appear to be influenced by the operation of the generating station.

CONCLUSION

Water quality characteristics found during the 2008 summer monitoring indicate a well mixed water column in the survey area. Variations in water quality parameters can be attributed to natural physical and biological processes, and no thermal influence in the vicinity of the discharge was noted. Water quality measurements indicated that in 2008 the cooling water discharge from the Ormond Beach Generating Station did not have an adverse effect on receiving waters in the study area.

CHAPTER 3 — SEDIMENT CHARACTERISTICS

Marine sediment characteristics are affected by both natural and anthropogenic influences. Tides, currents, and wave action all influence sediment grain size by suspending and transporting fine-grained material, resulting in coarser sediments in dynamic areas and finer sediments in areas of reduced currents and wave action. Coastal streams and rivers contribute sediments as well as contaminants to the marine environment, with variable influence from year-to-year depending on yearly rain amounts. In coastal environments, man-made structures such as jetties and breakwaters alter water movement and may result in changes in local sediment characteristics and deposition patterns, while sand replenishment projects can influence sediment characteristics over large intertidal and subtidal areas. In addition to influencing grain size, anthropogenic inputs may contribute contaminants, including metals, to the environment which can bind to sediments. Sediment grain size and sediment chemistry trends are useful in characterizing year-to-year differences that may be related to either natural or anthropogenic influences.

MATERIALS AND METHODS

As part of the resource exchange for participation in the Bight '08 Regional Monitoring Program, the number of sediment stations sampled in 2008 was reduced from six to four (Appendix A). Stations sampled in 2008 were the same as those sampled during the Bight '03 Regional Monitoring Program, which also reduced monitoring effort in exchange for participation in the regional monitoring program. Sediment studies at all six stations will recommence in 2009.

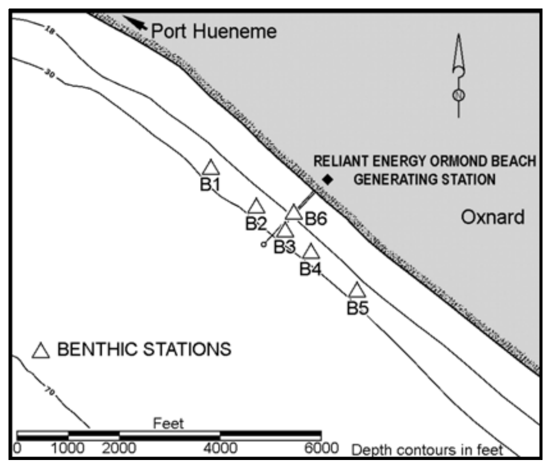


Figure 3-1. Location of the benthic sampling stations. Ormond Beach Generating Station NPDES, 2008.

Bottom samples for sediment grain size and sediment chemistry analyses were collected at Stations B2 through B5 during the summer of 2008 (Figure 3-1). All samples were collected *in situ* by biologist-divers in conjunction with infauna sampling.

Sediment Grain Size

A sample of sediments for grain size analysis was taken at each station using a 3.5-centimeter (cm)-diameter, 15-cm-long plastic core tube. The sample was transferred to a plastic bag for laboratory analysis.

The size distributions of sediment particles were determined using two techniques: laser light diffraction to measure the amount and patterns of light scattered by a particle's surface for the sand/silt/clay fraction, and standard sieving for the gravel fraction. Laboratory data from the two methods were combined and presented in tabular format. Resulting analyses include mean and median grain size, standard deviation of the grain size, sorting, skewness, and kurtosis. Data were plotted as size-distribution curves. Additional details are provided in Appendix C-1.

Sediment Chemistry

Samples for sediment chemistry analysis were taken from the upper 2 cm of the sediments at each station. Collection jars were filled with seawater and taken to the sea floor by biologist-divers where sediment samples were collected directly with the glass jars.

Sediments were kept on ice while in the field, and maintained at approximately 4°C until laboratory procedures began. Replicate sediment samples were composited by the analytical laboratory prior to analysis and reported as station results. Sediment was analyzed for total percent solids and four metals: chromium, copper, nickel, and zinc. Standard Methods (SM) method 2540 B was used in determining total percent solids, and Environmental Protection Agency (EPA) method 6020 was used for metal analysis.

RESULTS

Sediment chemistry and grain size samples were collected by biologist-divers at Stations B2 through B5 on 18 September 2008 between 0730 and 0930 hours. Skies were mostly clear (15% cloud coverage) with winds from the northwest at 2 to 3 knots. Seas were from the west at 2 to 3 ft.

Sediment Grain Size

Sediment distribution curves and parameters describing sediment grain size characteristics for each station are presented in Appendix C and are summarized in Table 3-1. Grain size is expressed in phi (Φ) units, which are inversely related to grain diameter (Appendix C-1).

Sediments at the four stations in 2008 were composed primarily of sand, with smaller amounts of silt and clay (Table 3-1). Gravel was not found at any of the stations in 2008. Overall, sediments from the six stations averaged about 91% sand, 7% silt, and 2% clay, with an average mean grain size of 2.94 phi (131 µm, fine sand). Sediments were finest at Station B2, 1,000 ft upcoast of the discharge on the 30-ft isobath, where mean grain size was 3.20 phi (109 µm, very fine sand). Sediments were coarsest at Station B3, at the discharge, where mean grain size was 2.60 phi (165 µm, fine sand).

Table 3-1. Sediment grain size parameters. Ormond Beach Generating Station NPDES, 2008.

Parameter	B2	B3	B4	B5	Mean	S.D.
% Gravel	0.00	0.00	0.00	0.00	0.00	0.00
% Sand	89.88	93.62	91.35	89.80	91.16	1.79
% Silt	8.41	4.81	6.82	8.05	7.02	1.62
% Clay	1.71	1.57	1.83	2.15	1.82	0.25
Mean grain size						
phi	3.20	2.60	2.91	3.10	2.94	0.26
µm	109	165	133	116	131	25
Sorting(ϕ)	0.813	0.961	0.894	0.722	0.848	0.103
Skewness	-0.169	-0.024	-0.093	0.145	-0.035	0.134
Kurtosis	1.606	1.242	1.222	1.224	1.324	0.189

Sorting is a measure of the spread of the particle distribution curve, with poorly-sorted sediments composed of a broad range of particle size classes, while well-sorted sediments contain fewer size classes. In 2008, sorting averaged 0.85 phi overall, representing moderately sorted sediments (Table 3-1). Sorting values ranged from 0.72 phi at Station B5, 3,000 ft downcoast of the discharge at a depth of 30 ft, to 0.96 phi at Station B3. Moderately sorted sediments occurred at all stations. Sediment distribution curves at all stations were essentially unimodal, with a peak in the fine sand category at all stations, and variable amounts of sediments in other size categories (Appendix C-2). Small secondary peaks in the medium sand category also occurred at Stations B2, B3 and B4, 1,000 ft downcoast of the discharge at a depth of 30 ft.

Skewness and kurtosis tell how closely the grain size distribution approaches the normal Gaussian probability curve. More extreme skewness and kurtosis values indicate non-normal distributions. Skewness is a measure of the symmetry of the particle distribution curve; a value of zero indicates a symmetrical distribution of fine and coarse materials around the median of the curve, while a value greater then zero (positive) indicates an excess of fine material, and a negative value indicates an excess of coarse material. Skewness ranged from -0.02 at Station B3 to 0.15 at Station B5 (Table 3-1). Distribution curves were skewed toward coarser material at Stations B2, B3 and B4, while sediments at Station B5 skewed toward finer material.

Kurtosis is a measure of the peakedness of the particle distribution curve. A kurtosis value of 1.0 represents a normal particle distribution curve while a value greater than 1.0 indicates a leptokurtic (peaked) distribution with better sorting in the central portion of the curve than in the tails. A value less than 1.0 indicates a platykurtic (flattened) distribution and a lack of dominance by any one size category. Kurtosis ranged from 1.22 at Stations B4 and B5 to 1.61 at Station B2 and averaged 1.32 (Table 3-1). Kurtosis values at all stations in 2008 were greater than 1.0, indicating leptokurtic (excessively peaked) distributions, with dominance by a narrow range of size classes.

Sediment Chemistry

Sediment samples collected at the four benthic stations were analyzed for chromium, copper, nickel, and zinc. Sediment metal concentrations are presented in Appendix D and summarized in Table 3-2 with values reported as dry weight. Metal concentrations were similar among stations, with the highest values for all metals found at Stations B2 and B5, upcoast of the discharge. Lowest levels for all metals were found at the discharge.

Chromium. Sediment chromium concentrations averaged 7.42 mg/kg and ranged from 6.45 mg/kg at Station B3 to 8.24 mg/kg at Station B2 (Table 3-2).

Copper. Sediment copper concentrations averaged 3.60 mg/kg and ranged from 3.05 mg/kg at Station B3 to 3.94 mg/kg at Station B5 (similarly, 3.93 mg/kg at Station B2) (Table 3-2).

Nickel. Sediment nickel concentrations averaged 6.46 mg/kg and ranged from 5.85 mg/kg at Station B3 to 6.90 mg/kg at Station B2 (Table 3-2).

Zinc. Sediment zinc concentrations averaged 23.2 mg/kg and ranged from 19.8 mg/kg at Station B3 to 26.0 mg/kg at Station B2 (Table 3-2).

Table 3-2. Sediment metal concentrations (mg/dry kg). Ormond Beach Generating Station NPDES, 2008.

Metal	B2	B3	B4	B5	Mean	S.D.	ERL	ERM	Reporting Limits
Chromium	8.24	6.45	7.73	7.24	7.42	0.76	81	370	0.130 - 0.140
Copper	3.93	3.05	3.47	3.94	3.60	0.43	34	270	0.130 - 0.140
Nickel	6.90	5.85	6.54	6.55	6.46	0.44	20.9	51.6	0.130 - 0.140
Zinc	26.0	19.8	23.6	23.3	23.2	2.6	150	410	1.30 - 1.40

ERL = Effects Range Low

ERM = Effects Range Medium

DISCUSSION

Sediment Grain Size

In 2008, sediments were analyzed from four stations offshore the Ormond Beach Generating Station. (Station B1, farthest upcoast of the discharge point and Station B6, inshore of the discharge were not sampled in 2008, but will be included in the 2009 sampling program). Sediment composition was similar among stations, consisting primarily of sand with lesser amounts of fine material (silt and clay) and mean grain sizes in the fine and very fine sand categories. Particle distribution curves were skewed toward coarser material at the station farthest downcoast of the discharge, and skewed towards finer material at the stations 1,000 ft upcoast and downcoast of the discharge. Sediment distribution was essentially symmetrical at the discharge station. Sediments were coarsest at the discharge and finest at the nearest upcoast station, though still relatively similar among stations. The percent contribution to the sediments by fine material (silt and clay) was similar among all stations, with lowest percentage of fines (6%) found at the discharge, while greatest percentages of fine material (10%) occurred at the stations nearest upcoast and farthest downcoast of the discharge.

In 2005, mean grain size in the study area was the greatest on record, a result of the coarse sediments found at Station B2 (Figure 3-2; Appendix C-3; MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-2004a, 2005, 2006a; Ogden 1991-1993). The coarse sediments found at Station B2 in 2005 and 2006 were likely a remnant of very coarse relict sands found in isolated patches on the Santa Barbara Shelf (AHF 1959; MBC 2005, 2006a). Relict sands represent poorly-weathered sediments historically deposited as beaches or dunes during periods of lower sea level (Emery 1952, 1960; Terry et al. 1956). Occurrence of the coarse sands during these years may also have been related to dredge and sand bypass operations that were conducted at Channel Islands Harbor in late 2004, with sand discharged just downcoast from Port Hueneme (Ryan 2006, pers. comm.), although disposal operations would likely also have affected sediments at Station B1, which was not indicated during those surveys (MBC 2005, 2006a). Since 2006, however, mean grain size has been consistent with most previous surveys; mean values were slightly finer than the long-term average in 2006 and 2008, and nearly identical to the long-term mean in 2007 (Figure 3-2).

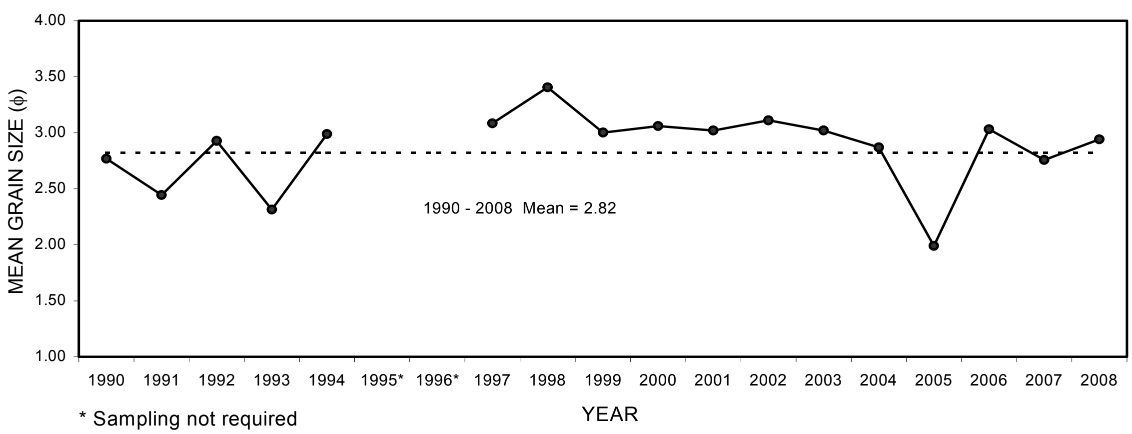
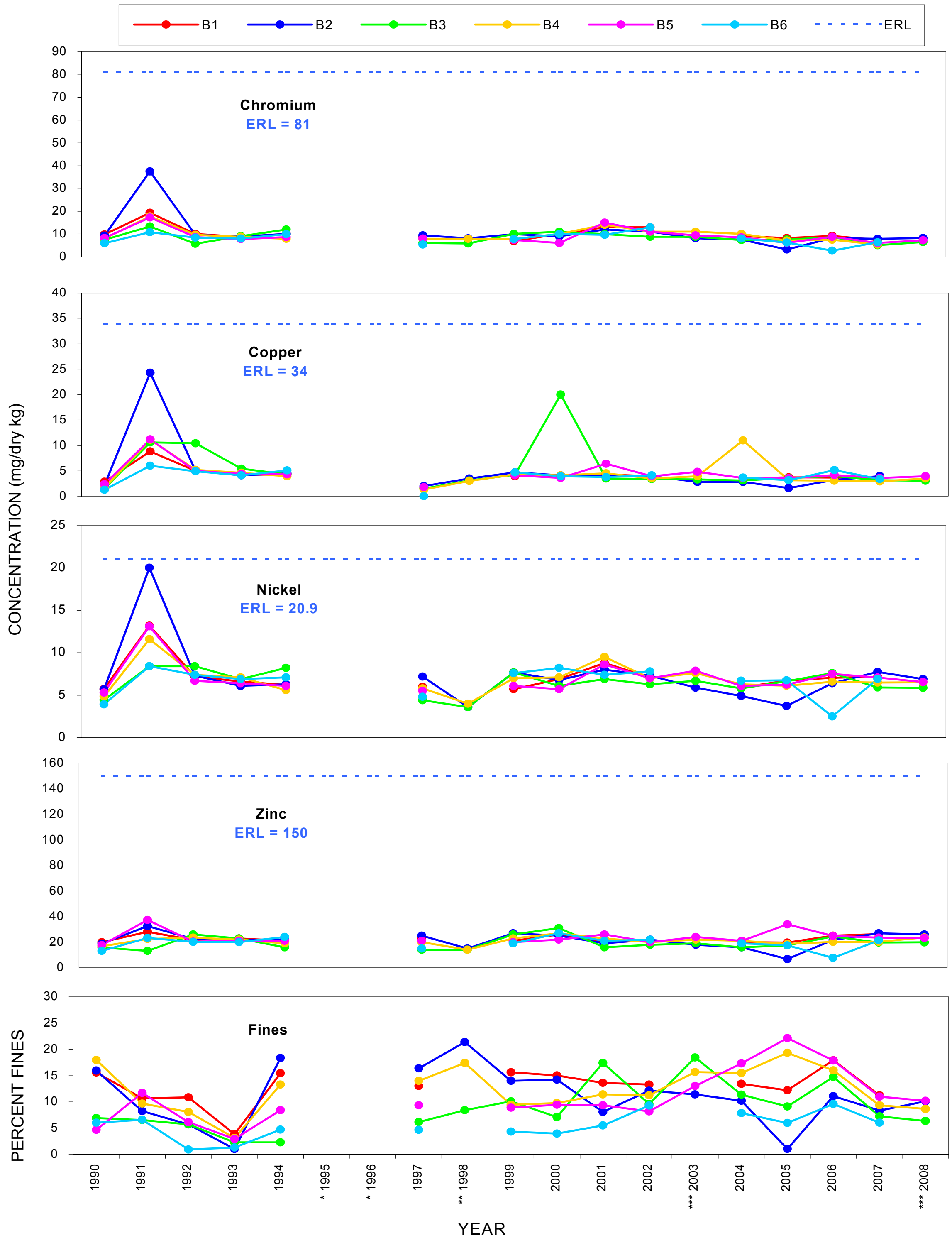


Figure 3-2. Comparison of sediment mean grain size, 1990 - 2008. Ormond Beach Generating Station NPDES, 2008.

In 2008, sediment grain sizes in the fine to very fine sand categories were typical of those commonly found offshore of the generating station (MBC 1990, 1994, 1997-2004a, 2005, 2006a, 2007a; Ogden 1991-1993). In regional sampling conducted in 2003, sediments from shallow (5-30 m) coastal stations throughout the Southern California Bight averaged 31% fines overall, considerably higher than found in the survey area in 2008 or commonly in previous surveys (Schiff et al. 2006; Figure 3-3; Appendix C-3). Despite the overall similarity in sediment characteristics found in the area in 2008, there has been year-to-year variability in grain size. In the 14 surveys since 1990 (excluding 1998, 2003 and this year when the sampling program was limited to three or four stations), sediments were finest at the discharge twice, inshore of the discharge once, downcoast of the discharge three times, and upcoast of the discharge eight times (MBC 1990, 1994, 1997-2004a, 2005, 2006a, 2007a; Ogden 1991-1993). During the same surveys coarsest sediments occurred at the discharge seven times, upcoast four times, and inshore three times. In 2008, sediments were finest upcoast, with similar, though slightly coarser characteristics at the station farthest downcoast, and coarsest at the discharge (Table 3-1)



*No sampling required; ** 1998 - only three stations required; *** 2003 and 2008 only four stations required.

Figure 3-3. Comparison of sediment metal concentrations and percent fines by station, 1990 - 2008. Ormond Beach Generating Station NPDES, 2008.

In a pattern observed during some previous surveys, coarser sediments in the vicinity of the discharge in 2008 may have been influenced by turbulence associated with the cooling water discharge (which prevents finer sediments from settling) in addition to normal nearshore processes which influence grain size, such as currents, waves and sand movement. This localized influence on sediment characteristics was recently noted in 2007, 2004 and 2002 (MBC 2002, 2004a, 2007a). However, the degree of influence varies from year to year, and in 2006, 2005, 2003 and 2001 no sediment grain size patterns relative to the discharge were apparent (MBC 2001, 2003, 2004a, 2005, 2006a). The similarity of grain size characteristics at the remaining stations station suggests that outside of the immediate influence of the discharge sediment distribution was primarily influenced by natural causes. Aside from a possible localized and transitory effect near the discharge, sediment characteristics offshore of the Reliant Energy Ormond Beach Generating Station discharge in 2008 were similar to those found previously in the area and appear to be influenced primarily by natural causes.

Sediment Chemistry

In 2008, sediments at four stations off the Ormond Beach Generating Station were analyzed for the presence and concentration of chromium, copper, nickel, and zinc. Similar to 2007, highest concentrations of chromium, nickel, and zinc were recorded 1,000 ft upcoast of the discharge, and copper at that station was nearly identical to the highest level detected farthest downcoast (Table 3-2). Lowest concentrations of all metals were recorded at the discharge. Still, metal levels were similar among stations in 2008 and within the range of values recorded in previous surveys (Figure 3-3). Concentrations of chromium, copper, and nickel were below their respective long-term means at each station in 2008, while zinc levels were equivalent to or slightly higher than long-term means (MBC 1990, 1994, 1997-2004a, 2005-2006a, 2007a; Ogden 1991-1993).

Differences in metal concentrations among sites are often directly related to the amount of fine-grained material in the sediment. Fine-grained sediments may contain higher amounts of metals due to the greater available surface area (Ackermann 1980, de Groot et al. 1982). Comparisons should take into account the relative amounts of fine and coarse sediments. Sediments in the study area have consistently been sandy. In previous years, the largest percentages of fines (silt and clay combined) were usually recorded at the upcoast stations or Station B4 downcoast from the discharge (Figure 3-3). Continuing this trend somewhat, the greatest percentage of fine material was recorded farthest downcoast at Station B5, with a similar percentage of fine material found upcoast of the discharge at Station B2. Not unexpectedly, highest concentrations of all metals in 2008 were found at these stations where the percentage of fine material was highest. Still, consistent with previous surveys, sediment metal levels were similar among stations with relatively low concentrations throughout the study area (MBC 1990, 1994, 1997-2004a, 2005-2006a, 2007a; Ogden 1991-1993).

Since 1990, metal levels in the area were highest in 1991 (Figure 3-3). In 1992, concentrations of most metals decreased substantially, and by 1993 metal concentrations were similar to levels detected in 1990. A similar pattern was recorded in sediment metal concentrations offshore the Mandalay Generating Station, located upcoast from Channel Islands Harbor (MBC 2004b). Since 1993, metal concentrations in the study area have been relatively consistent with the exception of an anomalously high copper concentration detected in 2000 at the discharge. In 2000, levels of chromium, copper, and zinc were all highest at the discharge, even though the amount of fine material there was low, suggesting the generating station as a possible source (MBC 2000). Starting in 2001, no consistent pattern of distribution of metals in sediments has been apparent in the study area (MBC 2001-2004a, 2005, 2006a, 2007a).

Most metal values observed in 2008 were typical of the area and similar to the long-term means at all stations (Figure 3-3). Metal levels throughout the Ormond Beach study area were within the range found in sediments within the Southern California Bight and were lower than or comparable to levels found by the National Oceanographic and Atmospheric Administration (NOAA) at other sandy, offshore sites in southern California (NOAA 1991a). Mean concentrations of metals off the generating station in 2008 were about two to four times less than the mean metal concentrations found in sediments at shallow (5-30 m) coastal stations sampled in 2003 from throughout the Southern California Bight (Schiff et al. 2006).

Concentrations of metals in the study area have consistently been below levels determined to be potentially toxic to aquatic organisms. Ranges of potential toxicity were developed by NOAA (NOAA 1991b) and later updated (Long et al. 1995) using data from spiked sediment bioassays, sediment-water equilibrium partitioning, and the co-occurrence of adversely affected fauna and contaminant levels in the field. Chemical concentrations believed to be associated with adverse biological effects from the various independent studies were compared for each parameter and the lower 10 percentile was designated as the “Effects Range-Low” (ERL). Concentrations below the ERL represent a minimal effects range; a range intended to estimate conditions where effects would be rarely observed (Long et al. 1995). Metal concentrations have never exceeded their respective ERLs in the study area (Figure 3-3).

Pollutants come from a variety of sources of both industrial and domestic origin. Oil and gasoline combustion releases many substances, including cadmium, copper, chromium, lead, mercury, and zinc. These and other metals are also used in paints, pigments, batteries, manufacturing, and protective coatings. Aerial fallout is a diffuse and potentially large source of contaminants derived from other sources, and may include metals, chlorinated hydrocarbons, and PAHs (SCCWRP 1973, 1986). As these contaminants accumulate on the ground, they are washed into rivers by rainfall, and are eventually deposited in the ocean.

Sediment metal concentrations have remained relatively consistent in the area since 1990. In 2008 concentrations of chromium, copper, and zinc were lower than their long-term means at the respective stations, while zinc was only slightly higher. Metal concentrations in 2008 appeared to be somewhat related to the percent of fine material in the sediments, with lowest levels found near the discharge and highest at the stations with the most fine material. Still, metal concentrations were similar among stations and to results found commonly in previous surveys, and lower than levels found in similar habitats throughout southern California. Metal levels typically vary slightly from year to year and no long-term patterns of metal concentrations relative to the discharge were apparent. Concentrations of sediment metals in 2008 did not appear to be adversely influenced by the operation of the Ormond Beach Generating Station.

CONCLUSION

Sediment Grain Size

In 2008, slightly coarser sediments found at the discharge station appeared to have been influenced by turbulence associated with the cooling water discharge, a pattern noted during some previous surveys. The degree of influence of the discharge on local sediments varies from year to year, suggesting a localized and transitory effect near the discharge. Other than the coarser sediments found in the discharge area, sediment characteristics offshore of the Ormond Beach Generating Station discharge in 2008 were similar to those found previously in the area and appear to be affected primarily by natural causes.

Sediment Chemistry

In 2008 metal concentrations were generally similar among stations, with highest metal concentrations found at the station 1,000 ft upcoast and at the station 3,000 ft downcoast of the generating station discharge, where percentages of fine material in the sediments were greatest. Lowest metal concentrations were found at the discharge. Sediment metal concentrations have remained relatively consistent in the area since 1990 and concentrations in 2008 were lower than mean values found in regional monitoring of sediments in shallow coastal waters of southern California. While metal levels typically vary slightly from year to year, and metal concentrations in 2008 appeared to be somewhat related to the percent of fine material in the sediments, no long-term patterns of metal concentrations relative to the discharge were apparent. As in previous surveys, sediment metal levels were well below concentrations determined to be potentially toxic to marine organisms. Concentrations of sediment metals in 2008 did not appear to be adversely influenced by the operation of the Ormond Beach Generating Station.

CHAPTER 4 — MUSSEL BIOACCUMULATION

Concentrations of many toxic substances in water are often too low or transitory to be reliably detected through the analysis of water samples. Also, many toxic substances are not water-soluble, but are instead associated with sediments or organic tissues. Tissues from aquatic organisms are preferably sampled because they accumulate and concentrate toxic substances to levels which may be hundreds of times the levels found in water samples, thus facilitating the detection of pollutants. Mussels are excellent subjects for this purpose because they 1) are sessile, 2) are long-lived, 3) can be transplanted and maintained in areas were they do not occur, and 4) reliably concentrate toxic pollutants from the water (SWRCB 1995, 2000).

As part of the resource exchange for participation in the Bight ‘08 Regional Monitoring Program, mussel bioaccumulation analysis was required only if resident mussels were located in the discharge area (Appendix A). On 18 September 2008, biologist-divers searched in the vicinity of the discharge. No resident mussels and were found on the discharge or intake buoys, the usual source of mussels in the area. Additional searching located only seven resident mussels on a mooring located offshore. These were collected but later were determined to be of insufficient size and number to be consistent with previous methods (SWRCB 1995, 2000); no analysis for tissue metal concentrations was performed.

CHAPTER 5 — BENTHIC INFAUNA

The benthic infauna, invertebrates that live in the bottom sediments, are an important part of the marine ecosystem. These animals are a major food source for fish and other larger invertebrates, and contribute to nutrient recycling. Some species are highly sensitive to effects of human activities, while others thrive under altered conditions. The assessment of the benthic community is, therefore, a major component of many marine monitoring programs, which document both existing conditions and trends over time.

The benthic infaunal community offshore of the Ormond Beach Generating Station has been sampled as part of the NPDES environmental monitoring program since 1978. Benthic samples were collected in both winter and summer from 1978 to 1988, and only in summer since 1990. Six stations were sampled in all surveys except 1998 (only three stations) and 2003 and 2008 (four stations) (Figure 5-1). New in 2006 was inclusion of the Southern California Benthic Response Index (BRI), which was developed to provide a scientifically valid criterion or threshold that can be used to distinguish "healthy" and "unhealthy" benthic communities (Smith et al. 2003).

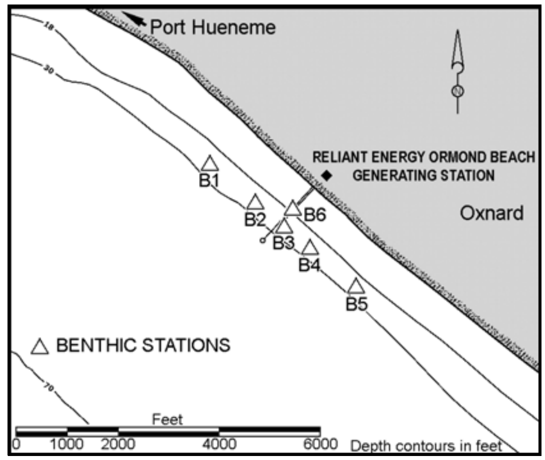


Figure 5-1 Location of the benthic sampling stations. Ormond Beach Generating Station NPDES, 2008.

MATERIALS AND METHODS

As part of the resource exchange for participation in the Bight '08 Regional Monitoring Program, the number of stations sampled for infauna was decreased from six to four (Station B1, farthest upcoast, and Station B6, inshore of the discharge, were dropped), and the number of replicates collected at each station was reduced (Appendix A). The stations sampled were the same as during the Bight '03 Regional Monitoring Program. Sampling at all six stations will resume in 2009. Biologist-divers collected sediment cores for analysis of infauna composition at Stations B2 through B5 on 18 September 2008 between 0730 and 0930 hr. Skies were mostly clear with winds from the northwest at 2 to 3 kn, and seas were from the west at 2 to 3 ft. Two replicate cores were collected at each station using a hand-held, diver-operated box corer (Figure 5-2). The box corer collects a uniform sample of 100.0 cm^2 surface area to a depth of 10.0 cm for a total sample volume of 1.0 liter. The box corer is pushed into the sediments and a closing blade is swung across the mouth of the box. Upon withdrawal from the sediments, the sample is sealed in the box by a neoprene lid for transport to the surface. Samples were washed in the field using a 0.5-mm U.S. Standard Sieve, labeled, and fixed in buffered 10% formalin-seawater.

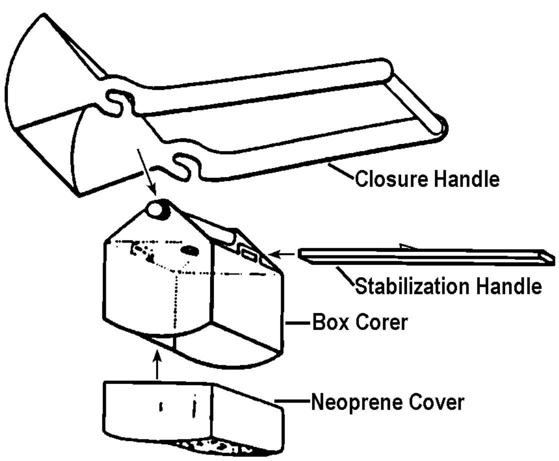


Figure 5-2. Diver-operated box corer used to collect infaunal samples. Ormond Beach Generating Station NPDES, 2008.

In the laboratory, samples were transferred to 70% isopropyl alcohol, sorted to major taxonomic groups, identified to the lowest practical taxonomic level, and counted. Identifications and nomenclature followed the usage accepted by the Southern California Association of Marine

Invertebrate Taxonomists (SCAMIT 2008). Representative specimens were added to MBC's reference collection. Following identification, the weight of organisms for each major taxonomic group in each replicate was obtained. Specimens were placed on small, pre-weighed mesh screens that had been immersed in 70% isopropyl alcohol, blotted on a paper towel, and air-dried for five minutes. Large organisms, if any, were weighed separately. Data are presented by station and replicate in Appendix F.

RESULTS

Species Composition. A total of 361 individuals in 78 species (or taxa) and nine phyla (major groups) were taken in the 2008 benthic infauna sampling offshore of the Ormond Beach Generating Station (Table 5-1 and Appendix F-1). Annelids (segmented worms) were the most diverse phylum, with 30 species (more than 38% of the total), followed by arthropods with 26 species (33%), mollusks with nine species (12%), and nemertean (ribbon) worms with six species (8%). Each of the remaining five phyla was represented by less than 3% of the species in the collection. Arthropods were the most abundant phylum, comprising about 42% of the individuals in the samples. Annelids, mollusks, and nemerteans were next most abundant, with 35%, 13%, and 6% of the individuals, respectively. Each of the remaining phyla comprised less than 2% of the abundance.

Table 5-1. Number of infaunal species and individuals by phylum. Ormond Beach Generating Station NPDES, 2008.

Parameter	B2	B3	B4	B5	Total	Percent Total
Number of species						
Annelida	15	9	16	15	30	38.5
Arthropoda	14	15	7	9	26	33.3
Mollusca	3	4	1	5	9	11.5
Nemertea	4	4	3	2	6	7.7
Cnidaria	-	1	-	1	2	2.6
Echinodermata	1	1	-	2	2	2.6
Chordata	1	1	-	-	1	1.3
Nematoda	-	1	1	1	1	1.3
Phorona	1	-	-	-	1	1.3
Total	39	36	28	35	78	
Number of individuals						
Arthropoda	37	60	28	26	151	41.8
Annelida	31	38	27	30	126	34.9
Mollusca	24	8	3	12	47	13.0
Nemertea	6	5	5	4	20	5.5
Nematoda	-	3	1	2	6	1.7
Echinodermata	2	1	-	2	5	1.4
Chordata	2	1	-	-	3	0.8
Cnidaria	-	1	-	1	2	0.6
Phorona	1	-	-	-	1	0.3
Total	103	117	64	77	361	

Species Richness. Species richness averaged 35 species per station (23 species per replicate), and ranged from 28 species at Station B4, immediately downcoast of the generating station discharge, to 39 species at Station B2, immediately upcoast of the discharge (Table 5-2). Species richness near the discharge was very similar to the mean for the study area.

Abundance. Abundance averaged 90 individuals per station (a density of 4,500 individuals/m^2) and ranged from 64 individuals at Station B4 to 117 individuals at Station B3, near the discharge (Table 5-2).

Table 5-2. Infaunal community parameters. Ormond Beach Generating Station NPDES, 2008.

Parameter	B2	B3	B4	B5	Total	Mean
Number of species						
Total	39	36	28	35	78	35
Rep. Mean	25	24	18	24		23
Rep. S.D.	1	3	1	1		
Number of individuals						
Total	103	117	64	77	361	90
Rep. Mean	52	59	32	39		23
Rep. S.D.	1	12	1	4		
Density (Number/m^2)						2,256
Diversity (H')						
Total	3.20	3.08	3.04	3.26		3.15
Rep. Mean	2.86	2.81	2.71	2.95		2.83
Rep. S.D.	0.02	0.26	0.00	0.05		
Benthic Response Index (BRI)						
Total	2.3	2.8	1.9	2.0		2.3
Biomass (g)						
Total	0.27	0.74	1.65	0.51	3.16	0.79
Rep. Mean	0.13	0.37	0.83	0.25		0.40
Rep. S.D.	0.06	0.26	0.45	0.03		
g/m^2						40

Species Diversity. Shannon-Wiener species diversity (H') averaged 3.15 per station and ranged from 3.04 at Station B4 to 3.26 at Station B5, farthest downcoast (Table 5-2).

Benthic Response Index. The Southern California Benthic Response Index (BRI) is the abundance-weighted average pollution tolerance of species occurring in a sample. The pollution tolerance scores (p_i) for shallow coastal shelf habitat (10 to 30 m) were used in the computations, even though the stations are slightly shallower than the depth range recommended for application of the index. In addition, the screen mesh size used for sieving the samples from the study area (0.5 mm) was smaller than the mesh size used for the samples from which the BRI was developed. BRI values averaged 2.3 for the study area, and ranged from 1.9 at Station B4 to 2.8 at Station B3 (Table 5-2).

Biomass. Infauna biomass totaled 3.16 g for the survey and averaged 0.79 g per station (40 g/m^2) (Table 5-2). Values ranged from 0.27 g at Station B2 to 1.65 g at Station B4. Annelids contributed 66% to the biomass, a larger share than their proportion of the abundance due to occurrence of a few large individuals in three samples. Arthropods contributed only 4% to the biomass even though they were the most abundant group (Appendix F-4).

Community Composition. Thirty species each comprised 1% or more of all individuals collected; together they totaled about 38% of the species but 80% of the individuals in the infauna collection (Table 5-3, Appendix F-2). They included 15 arthropods, 10 annelids, 2 nemerteans, and one each of mollusk, nematode (round worm), and echinoderm. The clam *Tellina modesta* was the most abundant species overall, comprising about 10% of all individuals collected, but it was the top species only at Station B2. The polychaete annelid *Apoprionospio pygmaea* and the cumacean *Diastylopsis tenuis* were next most abundant, each with 8% of the individuals overall, but *A. pygmaea* was the numerically dominant species at Station B3 while *D. tenuis* was more evenly distributed among the four stations. The amphipod *Rhepoxynius menziesi* and the annelid *Mediomastus acutus* were also abundant. These top five species were found at all four stations. Other abundant species were absent from one or more stations, and four arthropods (the amphipods *Caprella* cf. *verrucosa*, *Laticorophium baconi*, *Photis* sp, and *Stenothoe estacola*) were abundant only at Station B3.

Table 5-3. The 30 most abundant infaunal species. Ormond Beach Generating Station NPDES, 2008.

Phylum	Species	B2	B3	B4	B5	Total	Percent Total	Cum. Percent
MO	*Tellina modesta*	22	4	3	8	37	10.25	10.25
AN	*Apoprionospio pygmaea*	2	22	2	4	30	8.31	18.56
AR	*Diastylopsis tenuis*	4	8	10	8	30	8.31	26.87
AR	*Rhepoxynius menziesi*	4	5	8	7	24	6.65	33.52
AN	*Mediomastus acutus*	9	1	2	2	14	3.88	37.40
AR	*Caprella cf verrucosa*	-	9	4	-	13	3.60	41.00
AN	*Scoletoma tetraura* Cmplx	4	5	2	-	11	3.05	44.04
AR	*Laticorophium baconi*	-	9	-	1	10	2.77	46.81
AR	*Photis* sp	-	8	-	-	8	2.22	49.03
AR	*Stenothoe estacola*	-	7	1	-	8	2.22	51.25
AN	*Aricidea (Acmira) catherinae*	2	2	3	-	7	1.94	53.19
AN	*Glycera macrobranchia*	-	-	3	4	7	1.94	55.12
AN	*Spiophanes bombyx*	3	-	3	1	7	1.94	57.06
AR	*Americhelidium shoemakeri*	4	1	-	2	7	1.94	59.00
AR	*Zeugophilomedes oblongus*	1	1	3	2	7	1.94	60.94
NE	Lineidae	1	2	3	1	7	1.94	62.88
NE	*Carinoma mutabilis*	2	-	1	3	6	1.66	64.54
NT	Nematoda	-	3	1	2	6	1.66	66.20
AN	*Onuphis* sp A SCAMIT 1992	-	1	1	3	5	1.39	67.59
AR	*Photis brevipes*	5	-	-	-	5	1.39	68.98
AN	*Chaetozone setosa* Cmplx	-	-	-	4	4	1.11	70.08
AN	Euclymeninae sp A SCAMIT 1987	1	-	-	3	4	1.11	71.19
AN	*Goniada littorea*	1	2	1	-	4	1.11	72.30
AR	*Ampelisca agassizi*	2	-	1	1	4	1.11	73.41
AR	*Anchicolurus occidentalis*	3	1	-	-	4	1.11	74.52
AR	*Foxiphalus obtusidens*	3	-	1	-	4	1.11	75.62
AR	*Gammaropsis thompsoni*	-	4	-	-	4	1.11	76.73
AR	*Gibberosus myersi*	3	-	-	1	4	1.11	77.84
AR	*Rhepoxynius abronius*	4	-	-	-	4	1.11	78.95
EC	*Dendraster excentricus*	2	1	-	1	4	1.11	80.06

AN = Annelida; EC = Echinodermata; AR = Arthropoda; MO = Mollusca; NE = Nemertea; NT = Nematoda

Cluster Analyses. The 30 most abundant species were used for the normal (site-group) and inverse (species-group) cluster analyses (Figure 5-3). Stations B4 and B5 (Group III) clustered most closely, indicating greatest similarity of their communities. Station B3 (Group II) was next in similarity, while the community at Station B2 was least similar to the other communities. Several species were more abundant at Stations B2 and B3 than elsewhere, including *Tellina modesta* at Station B2 and *Apoprionospio pygmaea* at Station B3. However, all of the stations clustered at a relatively low level of dissimilarity, indicating a considerable degree of similarity among their communities.

The most abundant species clustered into four groups, based on their occurrences (Figure 5-3). Group A included species that were most abundant at Station B3, while Group B included species that were most abundant at stations in Group III. The species in Group C were most abundant at Station B2 and clustered more closely together than any other species group. Group D included the four most abundant species overall; this group clustered together at a relatively high level of dissimilarity and also was the least similar to the other three groups.

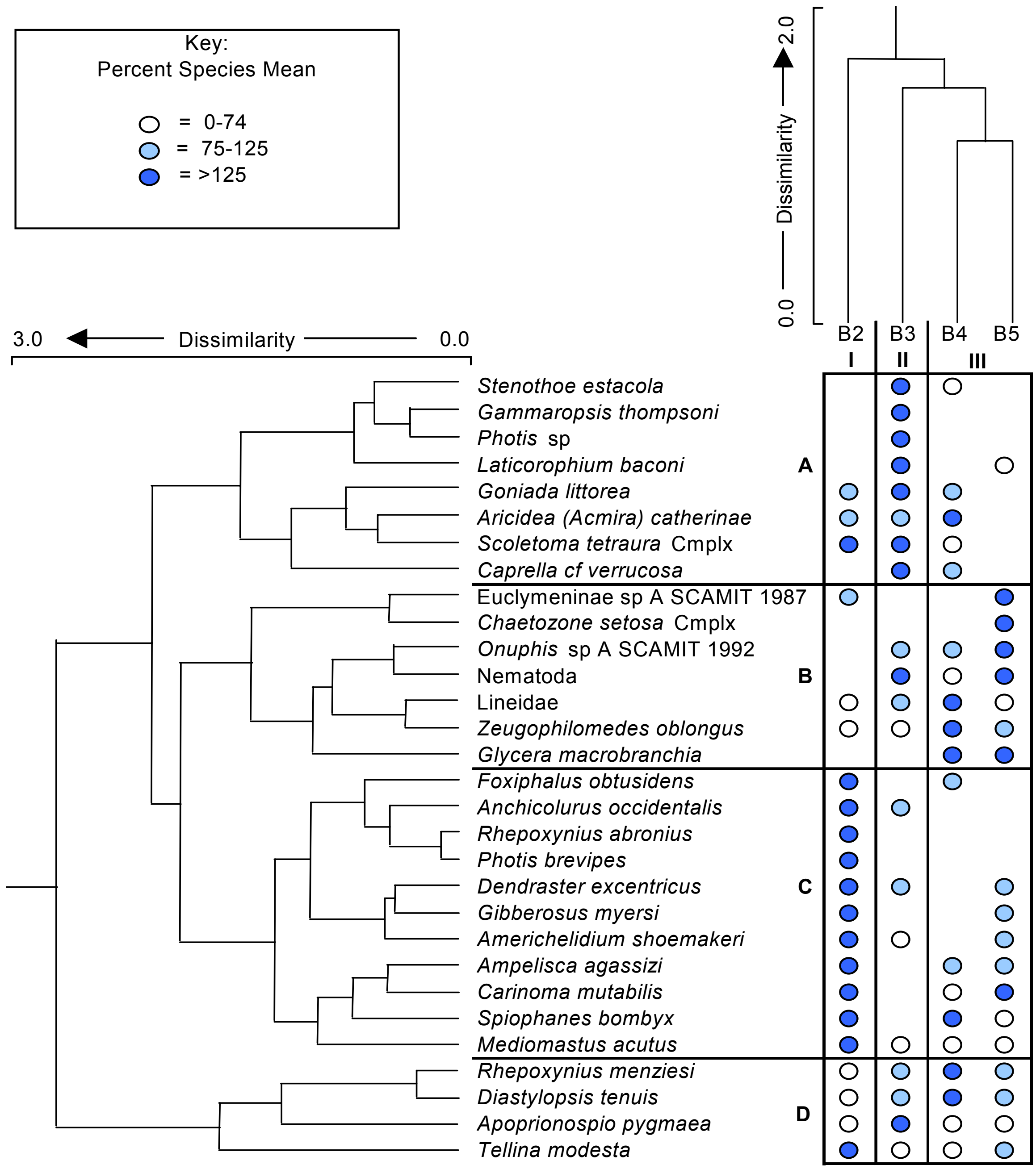


Figure 5-3. Two-way coincidence table resulting from normal (station) and inverse (species) classification dendrograms for the 30 most abundant infaunal species. Ormond Beach Generating Station NPDES, 2008.

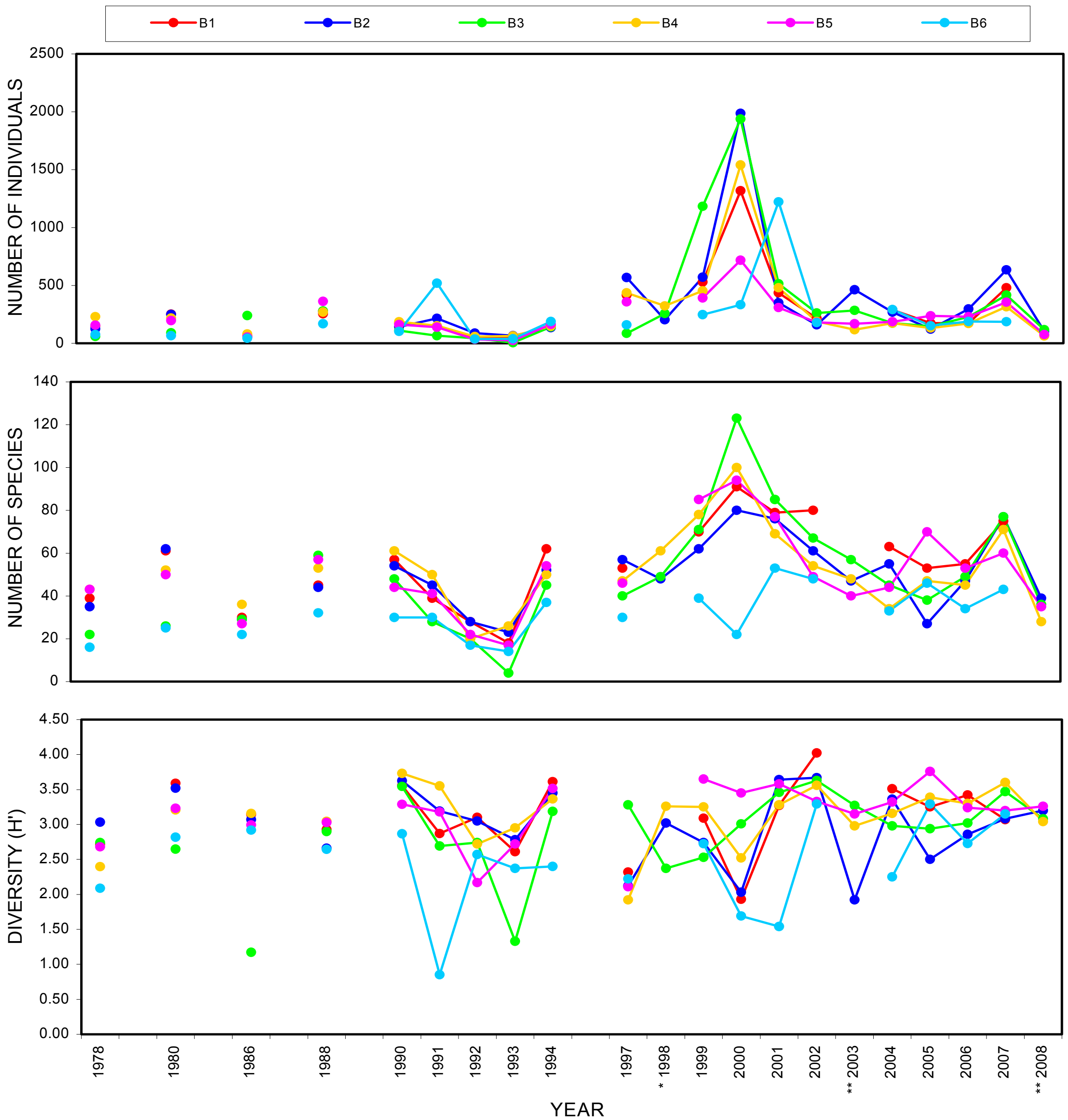
DISCUSSION

The infauna communities in the study area in 2008 were composed predominantly of small arthropods, annelid worms, clams, and nemertean worms. Community composition was comparable among the four stations, although the two communities downcoast of the generating station were most alike, while the community upcoast of the generating station was least similar to those elsewhere. Abundance was highest near the generating station, and *Apoprionospio pygmaea* and four species of amphipods were most abundant there than elsewhere. Values for most other infaunal parameters at that location were about average for the study area. Species richness was highest upcoast of the generating station, but species diversity was highest farthest downcoast because the community was not strongly dominated by a single species. All of the abundant species found in the study area are typical of sandy habitats on the shallow coastal shelf. The Benthic Response Index values for all of the stations were low, within the range of 0 to 25 (Reference category), indicating that the communities were undisturbed, or healthy.

Composition of the infauna community reflects the substrate in which it lives (Gray 1974). Particle size and sorting affect sediment stability and cohesiveness, influencing the ability of infaunal animals to burrow. The coastline at the Ormond Beach Generating Station is exposed to swell from both the south and west, and the nearshore subtidal sediments are strongly affected by both storms and normal wave activity. Sediments are relatively coarse, due to the winnowing effect of moving water, and there is little organic matter. Generally, nearshore sand faunas tend to be impoverished when compared to siltier offshore sands (Barnard 1963). Infaunal parameters in 2008 appeared to be only somewhat related to sediment grain-size characteristics. Species richness was highest where sediments were finest, but abundance was highest where sediments were coarsest and best sorted. However, other factors relating to the habitat may have been relevant. Samples from the discharge area contained large amounts of shell fragments, primarily bay mussel (*Mytilus galloprovincialis*), that may provide hard substrate for tube-building animals such as the amphipods *Laticorophium baconi*, *Photis* sp, and *Gammaropsis thompsoni* and the annelid *Onuphis* sp A, and *Caprella* cf. *verrucosa* which needs a substrate to which it attaches while feeding (Fauchald and Jumars 1979).

Species occupying the nearshore habitat are adapted to the relatively coarse sediments and to nearly constant disruption of the substrate (Oliver et al. 1980). Although small, these organisms are capable of reburying themselves quickly after the upper layers of sediment in which they live are disturbed by a passing wave or swell, or they tend to burrow deeper into the sediment and are therefore less affected by disturbance. Many of these species' life history strategies, including frequent and abundant production of young, also allow them to rapidly repopulate a habitat severely disrupted during winter storms. When conditions are calm, the environment is more stable and finer sediments accumulate, in which deposit-feeding species, such as some annelids and amphipods, can live in permanent tubes (Barnard 1963, Oliver et al. 1980). The efficient burrowers abundant in the infauna communities in 2008 included the clam *Tellina modesta*, the amphipods *Rhepoxynius menziesi*, *Americhelidium shoemakeri*, *Foxiphalus obtusidens*, and *R. abronius*, the annelids *Scoletoma tetraura* and *Glycera macrobranchia*, the ostracod *Zeugophilomedes oblongus*, and the nemertean *Carinoma mutabilis*. Strong swimmers such as the cumaceans *Diastylopsis tenuis* and *Anchicolurus occidentalis* and the amphipod *Gibberosus myersi* also indicate the influence of water movement in the nearshore environment.

The infauna communities in 2008 were similar to those found in previous summer surveys conducted in the study area since 1978 (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-2004a, 2005, 2006a, 2007a; Ogden 1991-1993). Mean abundance for the four stations was less than one-half the mean abundance for the same four stations in both 2007 and the long-term mean since 1978. In 1997, nematodes were extremely abundant near the discharge. Excluding those individuals (as shown in Figure 5-4), mean abundance in 2008 was still only 59% of the long-term abundance. Abundance was particularly high in 2000, due to the high numbers of the annelid *Owenia collaris* at most of the stations, and it was high at individual stations in 1999 and 2001 (high numbers of the clam *Siliqua lucida* at the discharge and of *Apoprionospio pygmaea* inshore of the discharge, respectively) (Figure 5-4; Appendix F-5). (As a resource exchange during previous Bight-wide programs, not all stations were sampled in 1998 and 2003, and, as in 2008, only two replicates were collected per station in 2003). Because of the program reduction, only 78 infauna species were taken in 2008, compared with 165 species for all stations and replicates in 2007. Comparing replicate species richness values, mean species richness in 2008 was still below that in 2007. However, it was almost identical to the long-term mean for the same four stations. As with abundance, species richness was particularly high in 2000 (except inshore of the discharge, which was not sampled in 2008). Mean species diversity for 2008 was slightly lower than for 2007, but was above the long-term mean. The BRI values in 2008 were below both those in 2007 and the mean since 2006, the first year that the index was used.



No sampling required in years not shown; * 1998 - only three stations required; ** 2003 and 2008 only four stations required.

Figure 5-4. Comparison of infaunal community parameters 1978 - 2008, summer surveys. Ormond Beach Generating Station NPDES, 2008.

The pattern of infaunal parameter values among stations in 2008 was somewhat different from that for 2007 and also for long-term values. Since 1978, abundance has been greatest, on average, immediately upcoast of the discharge (excluding the high numbers of nematodes in 1997) (Figure 5-4). Long-term abundance has been second highest at the discharge, even though it has rarely been highest there, as it was in 2008. Generally, among the four stations sampled in 2008, abundance has been lowest farthest downcoast, but among the normal six-station array, it has been lowest inshore of the discharge. On average, differences in species richness among the four stations sampled in 2008 have been minor, although richness has usually been slightly lower at the discharge; during normal sampling surveys, species richness (and, as a result, species diversity) has rather consistently been lowest inshore of the discharge. Due to consistently low abundance and near-average species richness, species diversity has been highest farthest downcoast from the discharge, as it was in 2008. Among the four stations, diversity has been lowest, on average, at the discharge, due to higher-than-average abundance and lower species richness. Diversity was particularly low at the discharge in 1993 due to extremely low species richness, and in 1997, due to high numbers of nematodes (Ogden 1993, MBC 1997). In 2008, diversity for the discharge station was very near the study area mean. The means of BRI values since 2006 have been similar among stations, as they were in 2008 (MBC 2006a, 2007a). Overall, values have been relatively similar among stations along the discharge isobath (which includes the four stations sampled in 2008), even though sediments have been coarser at the discharge than elsewhere in the study area.

Composition of the infaunal community in the study area in 2008 was similar to those in prior surveys. The five most abundant species have been among the eight most abundant species occurring in the study area since 1978, and 19 species abundant in 2008 were among the 35 long-term community dominants (Appendix F-5). The Index of Relative Importance and Spearman rank correlation indicate that the communities have been similar among years, particularly from 2001 to 2008 (Appendix F-6). The species most consistent in occurrence have been *Apoprionospio pygmaea*, *Diastylopsis tenuis*, *Mediomastus acutus* (one of a group of species recently split from each other), *Tellina modesta*, *Rhepoxynius menziesi*, *Spiophanes bombyx*, and *Carinoma mutabilis*. Conversely, a few species have been quite variable in abundance from survey to survey. In addition to nematodes, *Owenia collaris*, and *Siliqua lucida*, mentioned above, the annelids *Pectinaria californiensis*, *Armandia brevis*, and *Capitella capitata*, the ostracod *Euphilomedes longiseta*, the amphipods *Jassa slatteryi* and *Ericthonius brasiliensis*, and the southern moonsnail hermit crab, *Isocheles pilosus* have occurred only sporadically but occasionally have been very abundant. Most of these species were not found in 2008, and none was abundant. Overall, however, the majority of the infauna species seen in 2008 are part of a core group that has persisted in the study area, resembling communities found in similar shallow-water habitats throughout the Southern California Bight (Barnard 1963, Dexter 1978, Oliver et al. 1980).

CONCLUSION

Species richness, diversity, and composition of the infauna communities in 2008 were similar among the four stations near the Ormond Beach Generating Station, while abundance was somewhat higher than average near the discharge, probably due to the presence of shell fragments in the substrate which provided additional habitat. Infaunal parameter values appeared to be only somewhat influenced by sediment characteristics, as species richness was highest where sediments were finest, but abundance was highest where sediments were coarsest and best sorted. The Benthic Response Index values suggested that all of the communities were undisturbed, or healthy. The communities were similar to those found in the study area since 1978, and were typical of the shallow, nearshore environment. No adverse effects of the generating station discharge were apparent.

CHAPTER 6 — IMPINGEMENT

Once through cooling water systems are commonly used by electric power generating stations sited adjacent to large water bodies (e.g., lake, river, bay, coastal ocean). Such systems may potentially entrap organisms present in the source water entrained into the cooling system. Cooling water is typically screened prior to entering the condensers to remove material that may interfere with the proper operation of the system.

Ormond Beach Generating Station is located approximately 3.7 km southeast of the entrance to Port Hueneme in Ventura County, California. The facility withdraws seawater through a submerged, velocity-capped intake structure located 640 m offshore at a depth of -10 m Mean Low Lower Water (MLLW). Water enters through a riser standing 2 m above the bottom. Seawater was screened by bar racks to remove large debris followed by mesh traveling screens that remove the remaining material. Material, including fish and macroinvertebrates, impinged on the screens was washed off the screens into collection baskets. Impingement sampling was conducted by Proteus Sea Farms International, Inc., Ojai, California. This report summarizes these observations and subsequent analysis over the monitoring period to determine the interaction between the operation of the cooling water system and the general assemblage and stability of the source water community.

MATERIALS AND METHODS

Proteus Sea Farms International, Inc. conducted all field data collection and transmitted the data sheets to MBC Applied Environmental Sciences for entry and analysis. No heat treatments were monitored during the 2008 monitoring year (1 October 2007 to 30 September 2008). Total impingement at the facility was monitored monthly during normal operation of the cooling water system, usually over 24 hours. During these surveys, the traveling screens and collection baskets were cleared of all accumulated debris at the start of the sampling period. At the end of the survey period all accumulated material was processed. Up to 50 individuals of each fish species were measured to the nearest millimeter (mm) standard length (SL) or other appropriate length (disc width [DW] or total length [TL]), aggregate biomass (kg) was recorded for all measured and unmeasured individuals. Total abundance for species with greater than 50 individuals was estimated by dividing the total weight of the unmeasured individuals by the mean weight of the measured individuals of that species. Macroinvertebrates were also sorted to the lowest possible taxonomic category, counted and an aggregate weight (kg) taken. Individual fish lengths were rounded to the nearest 10 mm, (i.e., 35-44 mm SL = 40 mm SL). Abundance per size class was plotted using MS Excel.

Due to variation in daily operating patterns, all normal operation survey fish and macroinvertebrate data was extrapolated over reported circulated water volumes, in millions (10^6) of gallons, to determine the estimated monthly impingement by the equation: Estimated Impingement = (Abundance/Survey water volume) x Monthly water volume. Annual abundances represent the summation of all estimated monthly impingement abundances. Biomass values were analyzed in the same fashion.

RESULTS

Twelve normal operation surveys were conducted at the Ormond Beach during the 2008 monitoring year. No heat treatments were conducted during this period. Complete survey data is presented in Appendix G.

Fish

An estimated total of 1,206 fish weighing 218.9 kg representing 16 species were impinged at Ormond Beach in 2008 (Table 6-1). Bay pipefish (*Syngnathus leptorhynchus*) was the most abundant species with an estimated 632 individuals followed by 287 queenfish (*Seriphus politus*). Combined, these two species accounted for 76% of the total impinged abundance. Each of the remaining species accounted for less than 6% of the total biomass, or a cumulative of 287 fish impinged. Biomass was also principally influenced by two species, Pacific electric ray (*Torpedo californica*) and queenfish, which combined for 88% of the total biomass. Pacific electric ray ranked first with an estimated 179.2 kg followed by queenfish with 13.6 kg. Each of the remaining 14 species accounted for less than 10 kg, or 5%, to the annual total. Combined, these species contributed 12%, or 26.1 kg, to the annual total.

Table 6-1. Estimated abundance and biomass (kg) of fish species impinged during normal operation surveys. Ormond Beach Generating Station NPDES, 2008.

	Observed		Estimated		% Total	
Species	Abu.	Biom. (kg)	Abu.	Biom. (kg)	Abu.	Biom. (kg)
bay pipefish	67	0.203	632	1.735	52	1
queenfish	18	0.799	287	13.640	24	6
jack mackerel	3	0.102	55	1.861	5	1
plainfin midshipman	2	0.094	36	1.715	3	1
Pacific electric ray	3	24.875	28	179.201	2	82
Pacific sardine	1	0.015	25	0.369	2	<1
cabezon	1	0.038	19	0.737	2	<1
olive rockfish	1	0.044	19	0.815	2	<1
shiner perch	1	0.020	18	0.365	1	<1
northern anchovy	1	0.019	18	0.347	1	<1
thornback	2	0.692	18	7.485	1	3
specklefin midshipman	4	0.081	18	0.356	1	<1
speckled sanddab	1	0.008	14	0.114	1	<1
horn shark	2	1.399	9	6.175	1	3
kelp perch	1	0.009	6	0.053	<1	<1
bat ray	1	0.897	4	3.959	<1	2
Total Abundance	109	29.295	1,206	218.927		
Number of Species	16		16			

Length Frequency Analysis

The impinged bay pipefish represented 13 size classes, with most ranging between the 170- and 280-mm SL size classes (Figure 6-1). Their unimodal distribution was centered in the 220-mm SL size class. Impinged queenfish were distributed among eight size classes peaking at 140 mm SL (Figure 6-2).

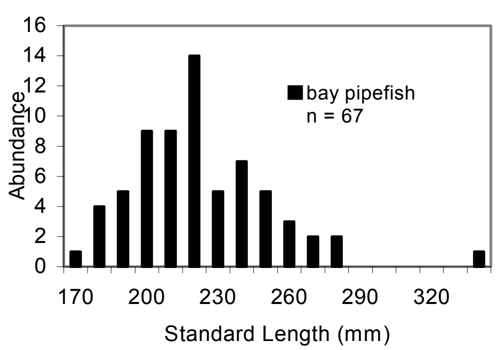


Figure 6-1. Length frequency histogram for bay pipefish (*Syngnathus leptorhynchus*) taken during impingement surveys. Ormond Beach Generating Station NPDES, 2008.

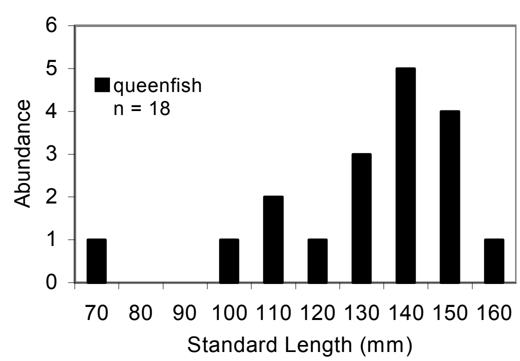


Figure 6-2. Length frequency histogram for queenfish (*Seriphus politus*) taken during impingement surveys. Ormond Beach Generating Station NPDES, 2008.

Macroinvertebrates

Operation of the cooling water system in 2008 at Ormond Beach impinged an estimated 3,259 macroinvertebrates weighing 631.9 kg and representing 16 species (Table 6-2). Seventy-eight percent of the abundance was contributed by the combination of an estimated 1,204 yellow crab (*Metacarcinus anthonyi*), 688 Pacific rock crab (*Romaleon antennarius*), and 657 moon jellies (*Aurelia labiata*). Each of the remaining species contributed less than 10%, or 326, to the total number of individuals, for a cumulative total of 710 macroinvertebrates. The 540.2 kg of moon jelly impinged accounted for 85% of the estimated annual total, followed by Pacific rock crab (41.0 kg) and yellow crab (26.9 kg). Each of the remaining 13 species accounted for 1% or less of the annual total, or 23.9 kg, cumulatively.

Table 6-2. Estimated abundance and biomass (kg) of macroinvertebrate species impinged during normal operation surveys. Ormond Beach Generating Station NPDES, 2008.

	Observed		Estimated		% Total	
Species	Abu.	Biom. (kg)	Abu.	Biom. (kg)	Abu.	Biom. (kg)
yellow crab	79	1.850	1,204	26.936	37	4
Pacific rock crab	57	3.522	688	40.950	21	6
moon jelly	36	29.600	657	540.194	20	85
blackspotted bay shrimp	17	0.064	260	0.937	8	<1
red rock crab	8	0.176	145	3.001	4	<1
hairy rock crab	4	0.080	98	1.966	3	<1
common salp	7	0.295	58	2.234	2	<1
California two-spot octopus	2	0.031	37	0.574	1	<1
giant-spined sea star	1	0.188	25	4.620	1	1
Monterey jelly	1	0.022	25	0.541	1	<1
red rock shrimp	1	0.002	14	0.029	<1	<1
graceful crab	1	0.007	13	0.089	<1	<1
warty sea cucumber	1	0.127	13	1.622	<1	<1
purple-striped jellyfish	2	1.316	12	7.793	<1	1
California market squid	1	0.045	6	0.266	<1	<1
Xantus swimming crab	1	0.044	4	0.194	<1	<1
Total Abundance	219	37.369	3,259	631.946		
Number of Species	16		16			

DISCUSSION

Fish impingement in 2008 was among the lowest recorded since 1990, but consistent with the lower abundances recorded over the last four years (Figure 6-3). Circulated cooling water volume declined nearly each year between 1990 and 1999, but heat treatment abundances did not exhibit corresponding declines, but rather fluctuated independent of the flow (Figure 6-4). Estimated normal operation impingement generally followed cooling water flow volumes due to the inherent correlation between the two, as flow volumes are included in the estimate equation. Queenfish, typically the most abundant species impinged, was present in greatly reduced numbers in 2008. The general decline in queenfish abundance mirrors the pattern observed throughout the Southern California Bight (Miller et al. in review [a]). Of those species impinged in 2008, only bay pipefish increased in abundance in relation to its historic numbers, recording its highest annual total since 1990 (Figure 6-5). Bay pipefish were not recorded in annual surveys at Ormond Beach from 1990 through 2001, with the first collection made during the 2002 sampling year. Since then, they have been regularly collected in varying abundances each year, including ranking first in overall abundance in both 2007 and 2008. All of the fish impinged in 2008 were common to the Southern California Bight (Love et al. 2005, Allen and Pondella 2006).

Three species of pipefish commonly occur throughout the nearshore waters of southern California, including; kelp pipefish (*Syngnathus californiensis*), bay pipefish (*S. leptorhynchus*), and barcheek pipefish (*S. exilis*) (Love et al. 2005). As a group, these three species generally range from at least central Baja California, Mexico to northern California, with varying depth ranges (Love et al.

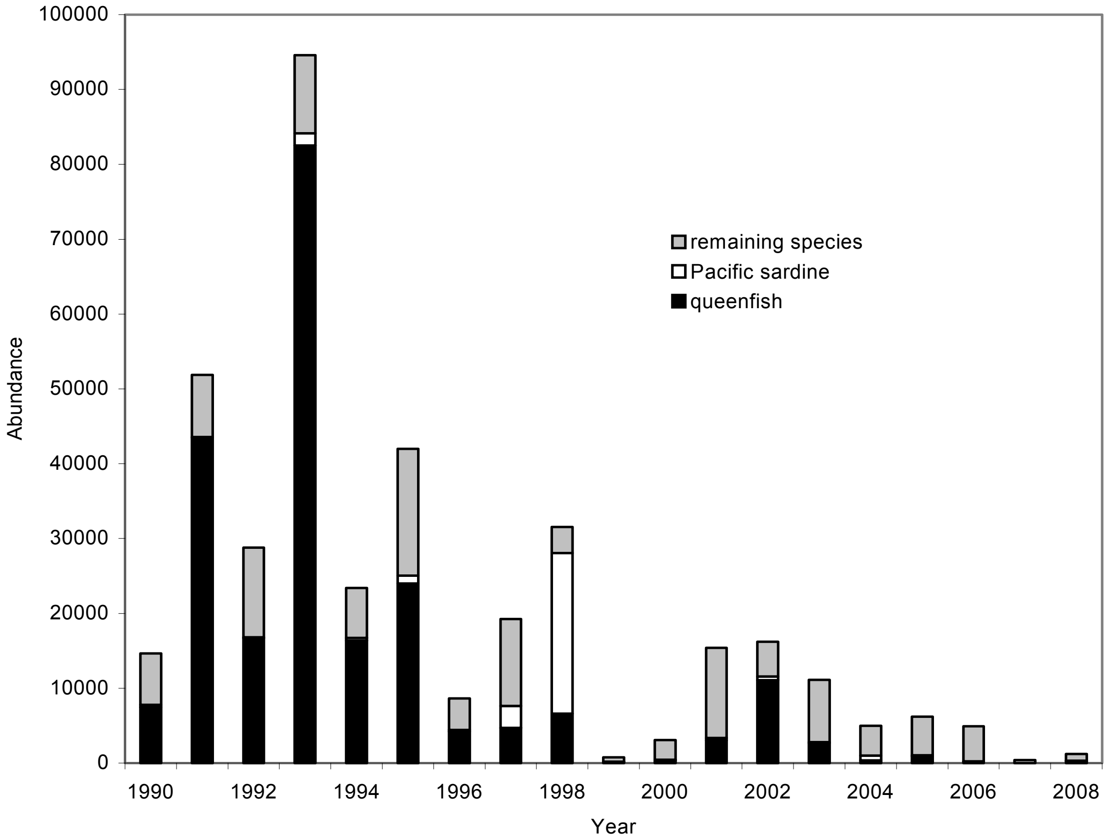


Figure 6-3. Total impinged abundance (heat treatment + estimated normal operation) of queenfish, Pacific sardine, and all remaining fish species, 1990-2008. Ormond Beach Generating Station NPDES, 2008.

2005). Eschmeyer et al. (1983) noted that bay pipefish commonly inhabit eelgrass beds within bays, harbors, and estuaries within southern California. Pipefish, typically kelp or bay, commonly occur during impingement sampling, especially at facilities withdrawing from bays or harbors (MBC 2006b,c). Barcheek pipefish has been uncommon in impingement sampling from Ventura through Northern San Diego County. Bay pipefish life history information is generally scarce, but they generally live two years to a maximum size of 385 mm TL, indicating that those impinged at Ormond Beach Generating Station were one year old, or less (MBC 2007a).

Queenfish historically rank among the most frequently impinged species, typically ranking first at southern California generating stations with cooling water intakes located along the open coast, similarly, queenfish are frequently the most abundant nearshore demersal fish caught in trawl and midwater gill net surveys in southern California (Allen and DeMartini 1983, Pondella and Allen 2000, Allen et al. 2007, MBC 2007a-d, Miller et al. in review [a]). Their abundance has been highly variable over time at Ormond Beach Generating Station, with reduced numbers taken over the last four years, including 2008. Queenfish impinged in 2008 at the generating station were largely four to five years old (Miller et al. in review [b]).

Total estimated macroinvertebrate impinged abundance in 2008 was consistent with that recorded in 2007 and within the historic range, but still among the lowest on record since 1994 (Figure 6-6). Estimated abundance for 2008 was approximately 11% of the abundances reported for either 2005 or 2006, the two highest years on record. In 2008, yellow crab and Pacific rock crab were the most abundant species, consistent with historic occurrence at Ormond Beach Generating Station. Moon jelly, third in abundance and first in contribution to biomass during the survey were collected for the first time in 2008, with all individuals taken during a single survey in May 2008.

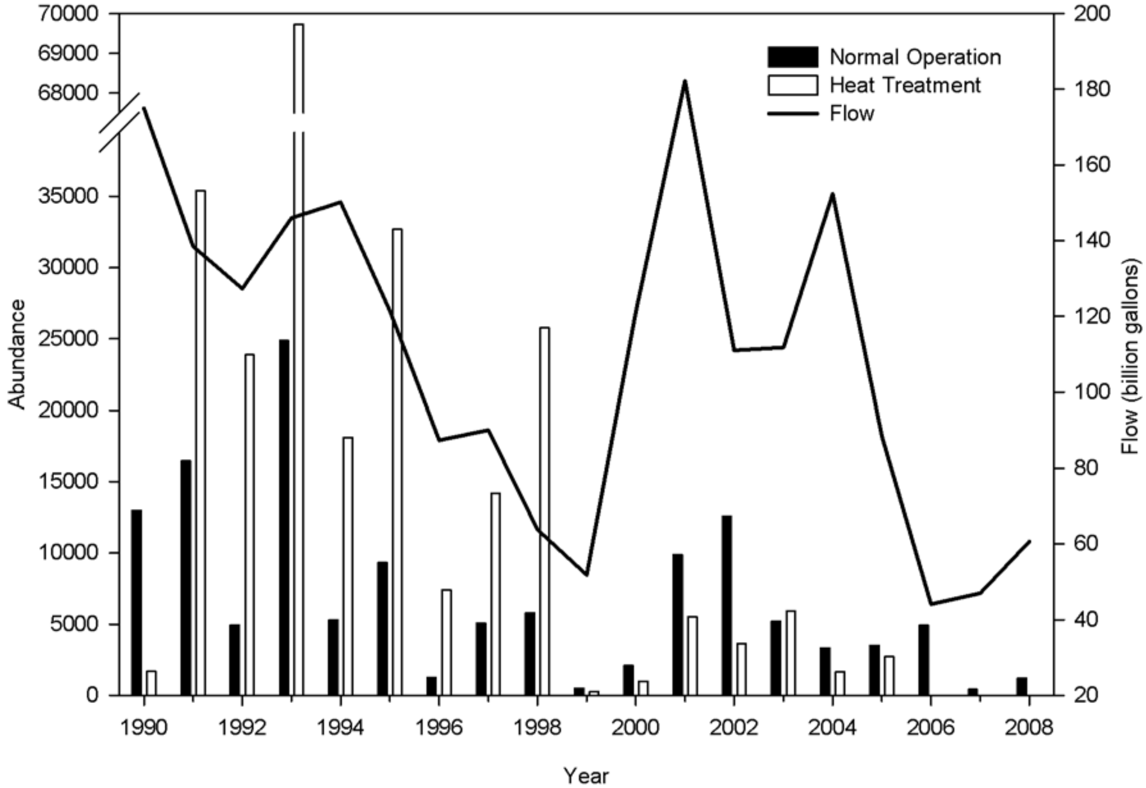


Figure 6-4. Annual estimated normal operation and heat treatment abundances with annual total cooling water volume 1990-2008. Ormond Beach Generating Station NPDES, 2008.

Many of the macroinvertebrate species impinged at the station may live in and on the pipes of the cooling water intake structure, while others, such as jellyfish, are drawn from the water column. Strong current flows into the generating station intake bring larvae of some species that, once entrained, can settle and grow within the conduits. These fouling communities are typically composed primarily of mollusk and arthropod species common to the area. With an ample food supply brought in with the cooling water, individuals may survive within the cooling water system until the community is removed during a heat treatment (Graham et al. 1977). With regular heat treatments most individuals taken are a similar age and are generally found at a small size, corresponding to growth of newly settled individuals during the time period between heat treatments. When heat treatments were infrequent, however, somewhat larger individuals may occur in impingement sampling, as observed for yellow crab and red rock crab in 2008. For example, the average weight of Pacific rock crab observed during the 2008 surveys was 0.062 kg compared to a mean of 0.030 kg in 1998, a year when four heat treatments were conducted (Table 6-2). In 2008, mean weight of Pacific rock crab increased by 0.008 kg compared to

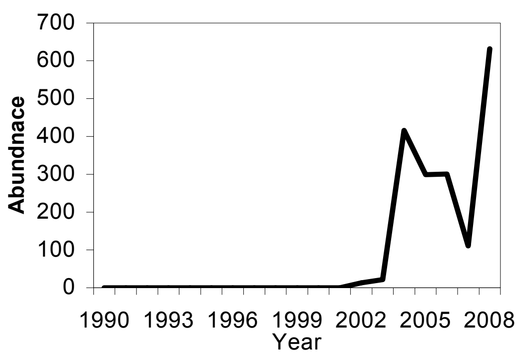


Figure 6-5. Total impinged abundance (heat treatment + estimated normal operation) of bay pipefish, 1990-2008. Ormond Beach Generating Station NPDES, 2008.

the 2007 monitoring results, while yellow crab size declined by 0.076 kg (MBC 2007a). Parker (2001) reports each rock crab species to prefer differing habitats: yellow crab prefer open sand and soft bottom habitat while Pacific rock crabs are more common near rocky reefs. Both species, however, have supported a commercial fishery, collectively landed as “rock crab,” since at least 1926. Their commercial landings began to appreciably increase after 1950, peaking in the mid-1980s.

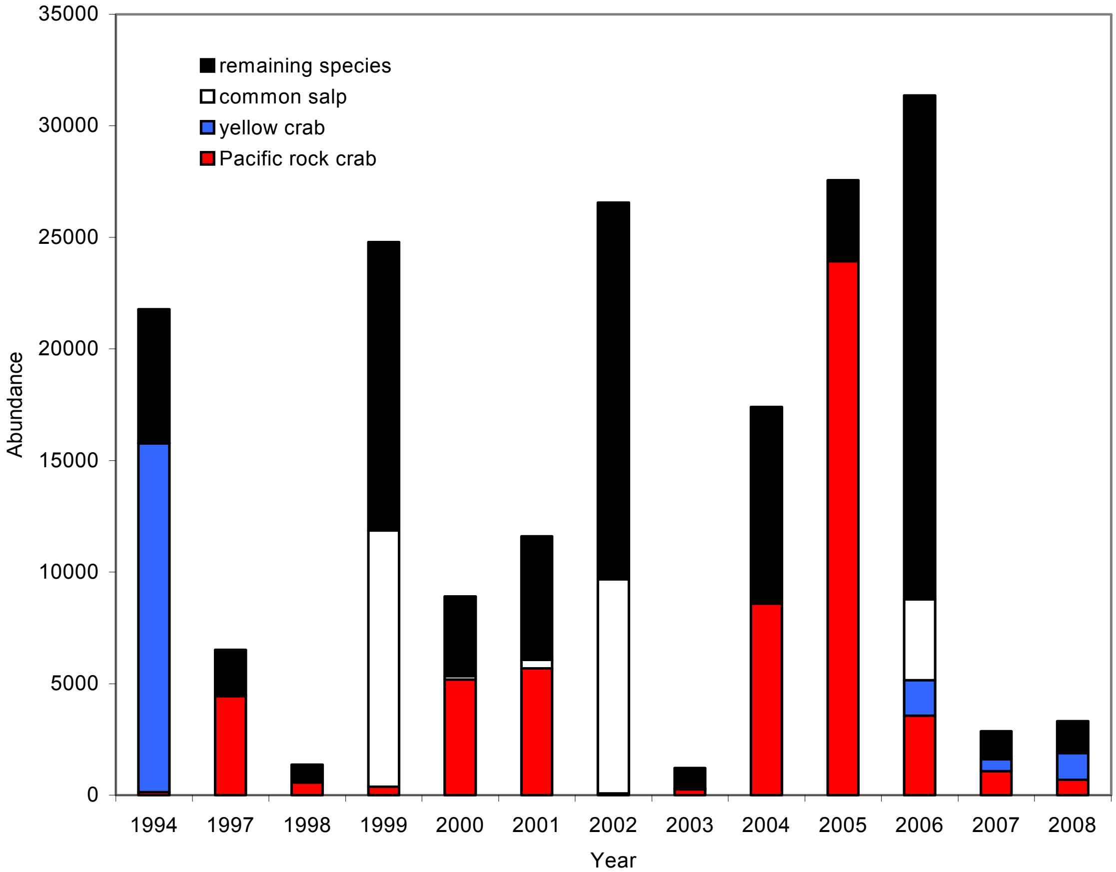


Figure 6-6. Total impinged abundance (heat treatment + estimated normal operation) of Pacific rock crab, yellow crab, common salp, and all remaining macroinvertebrate species, 1990-2008. Ormond Beach Generating Station NPDES, 2008.

CONCLUSION

Overall, fish species impinged in 2008 were similar to those collected in recent previous surveys, but were less abundant than recorded in most surveys since 1990. The decline in queenfish, a core member of the impinged assemblage at Ormond Beach Generating Station, mirrored a wider decline throughout the Southern California Bight. Macroinvertebrate composition in 2008 was generally similar to previous years, although abundances were also below average. The similarity of species composed primarily of frequently occurring and long-term dominant species indicates a relatively stable nearshore assemblage typical of southern California.

CHAPTER 7 — LITERATURE CITED

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APPENDIX A

Receiving water monitoring specifications

V. RECEIVING WATER MONITORING

A. Receiving Water

1. Pursuant to the Code of Federal Regulations [40 CFR § 122.41(j) and §122.48(b)], the monitoring program for a discharger receiving a NPDES permit must determine compliance with NPDES permit conditions, and demonstrate that State water quality standards are met.

2. Since compliance monitoring focuses on the effects of point source discharge, it is not designed to assess impacts from other sources of pollution (e.g., nonpoint source runoff, aerial fallout) nor to evaluate the current status of important ecological resources on a regional basis.

B. Regional Database

1. Several efforts are underway to develop and implement a comprehensive regional monitoring program for the Southern California Bight. These efforts

have the support and participation from regulatory agencies, dischargers, and environmental groups. The goal is to establish a regional program to address public health concerns, monitor trends in natural resources and nearshore habitats, and assess regional impacts from all contaminant sources.

2. Two pilot regional monitoring programs were conducted; one during the summer of 1994 and another in 1998. The purpose of the pilot programs were to test an alternative sampling design that combines elements of compliance monitoring with a broader regional assessment approach. The pilot program was designed by USEPA, the State Board, and three regional Boards (Los Angeles, Santa Ana, and San Diego) in conjunction with the Southern California Coastal Water Research Project and participating discharger agencies.

   The pilot regional monitoring programs included the following components: microbiology; water quality; sediment chemistry; sediment toxicity testing; benthic infauna; demersal fish; and bioaccumulation.

3. The two pilot regional monitoring programs were funded primarily by resource exchanges with the participating discharger agencies. During the year when the pilot regional monitoring was scheduled, USEPA and this Regional Board eliminated portions of the routine compliance monitoring programs for that year, while retaining certain critical compliance monitoring elements. A certain percentage of the traditional sampling sites were also retained to maintain continuity of the historical record and to allow comparison of different sampling designs. The exchanged resources were redirected to complete sampling within the regional monitoring program design. Thus, the Discharger's overall level of effort for the 1994 and 1998 pilot programs remained approximately the same as the compliance monitoring programs.

4. Given the apparent benefits realized by the first two regional monitoring programs, it is probable that similar comprehensive sampling efforts will be repeated for the California Bight at periodic intervals (perhaps every four or five years). At the present time, it appears likely that the next regional monitoring program will be attempted during the summer of 2002 - 2003.

5. We anticipate that future regional monitoring programs will be funded in a similar manner. Revisions to the routine compliance monitoring program will be made under the direction of the USEPA and this Regional Board as necessary to accomplish this goal; and may include resource exchanges in the number of parameters to be monitored, the frequency of monitoring, or the number, type, and location of samples collected.

6. The compliance monitoring programs for the Mandalay Generating Station, and other major ocean dischargers will serve as the framework for the regional monitoring program. However, substantial changes to these programs may be required to fulfill the goals of regional monitoring, while retaining the compliance monitoring component required to evaluate the potential impacts from NPDES discharges. Revisions to the existing program will be made under the direction of the USEPA and this Regional Board as necessary to accomplish this goal; and may include a reduction or increase in the number of parameters to be monitored, the frequency of monitoring, or the number, type, and location of samples collected.

C. Receiving Water Monitoring

The receiving water monitoring program shall consist of periodic biological surveys of the area surrounding the discharge, and shall include studies of those physical-chemical characteristics of the receiving water which may be impacted by the discharge.

Location of Sampling Stations (see Attached Figure 1):

1. Receiving water stations in the surf zone shall be located as follows:

   a. Station RW1 – 3000 feet upcoast of the discharge terminus, at a depth of 30 feet.

   b. Station RW2 - 1000 feet upcoast of the discharge terminus, at a depth of 30 feet.

   c. Station RW3 - At the point of discharge.

   d. Station RW4 - 1000 feet downcoast of the discharge terminus, at a depth of 30 feet.

   e. Station RW5 - 3000 feet downcoast of the discharge terminus, at a depth of 30 feet.

   f. Station RW6 – along the centerline of the discharge conduit, at a depth of 20 feet.

   g. Station RW7 – along the centerline of the discharge conduit, at a depth of 40 feet.

h. Station RW8 – 7,920 feet downcoast of the discharge terminus, at a depth of 30 feet.

i. Station RW9 – 7,920 feet upcoast of the discharge terminus, at a depth of 30 feet.

2. Benthic stations shall be located as follows:

   Stations B1 through B6 shall be located directly beneath Stations RW1 through RW6, respectively.

D. Type and Frequency of Sampling:

1. Temperature profiles shall be measured semiannually (summer and winter) each year at Stations RW1 through RW9 from surface to bottom at a minimum of one-meter intervals. Dissolved oxygen levels and pH shall be measured semiannually at least at the surface, mid-depth and bottom at each station. All stations shall be sampled during both a flooding tide and an ebbing tide during each semiannual survey.

2. Impingement sampling for fish and commercially important macroinvertebrates shall be conducted at least once every two months at Intake Serial No. 001. Impingement sampling shall coincide with heat treatments.

   Fish and macroinvertebrates shall be identified to the lowest possible taxon. For each intake point, data reported shall include numerical abundance of each fish and macroinvertebrate species, wet weight of each species (when combined weight of individuals in each species exceeds 0.2 kg), number of individuals in each 1-centimeter size class (based on standard length) for each species and total number of species collected. When large numbers of given species are collected, length/weight data need only be recorded for 50 individuals and total number and total weight may be estimated based on aliquots samples. Total fish impinged per heat treatment or sampling event shall be reported and data shall be expressed per unit volume water entrained.

3. Native California mussels (Mytilus Californianus) shall be collected during the summer from the discharge conduit, as close to the point of discharge as possible, for bioaccumulation monitoring. The mussels shall be collected and analyzed as described in Appendix A of the *California State Mussel Watch Marine Water Quality Monitoring Program 1985-86* (Water Quality Monitoring Report No. 87-2WQ). Mussel tissue shall be analyzed for copper, chromium, nickel, and zinc at a minimum.

6. Benthic sampling shall be conducted annually during the summer at Stations B1 through B6.

   a. One liter sediment core samples shall be collected by divers at each of the benthic stations for biological examination and determination of biomass and diversity, and for sediment analyses. Four replicates shall be obtained at each station for benthic analyses, and each shall be analyzed separately. A fifth sample shall be taken at each station for sediment analyses and general description.

   b. Each benthic replicate sample shall be sieved through a 0.5 mm standard mesh screen. All organisms recovered shall be enumerated an identified to the lowest taxon possible. Infaunal organisms shall be reported as concentrations per liter for each replicate and each station. Total abundance, number of species and Shannon-Weiner diversity indices shall be calculated (using natural logs) for each replicate and each station.

      Biomass shall be determined as the wet weight in grams or milligrams retained on a 0.5 millimeter screen per unit volume (e.g., 1 liter) of sediment. Biomass shall be reported for each major taxonomic group (e.g., polychaetes, crustaceans, mollusks) for each replicate and each station.

   c. Sediment grain size analyses shall be performed on each sediment sample (sufficiently detailed to calculate percent weight in relation to the size). Sub-samples (upper tow centimeters) shall be taken from each sediment sample and analyzed for copper, chromium, nickel and zinc.

7. The following general observations or measurement at receiving water, benthic and trawl stations shall be reported:

   a. Tidal stage, time, and date of monitoring.
   b. General water conditions.
   c. Color of the water.
   d. Appearance of oil films or greases, or floatable materials.
   e. Extent of visible turbidity or color patches.
   f. Direction of tidal flow.
   g. Description of odor, if any, of the receiving water.
   h. Depth at each station for each sampling period.

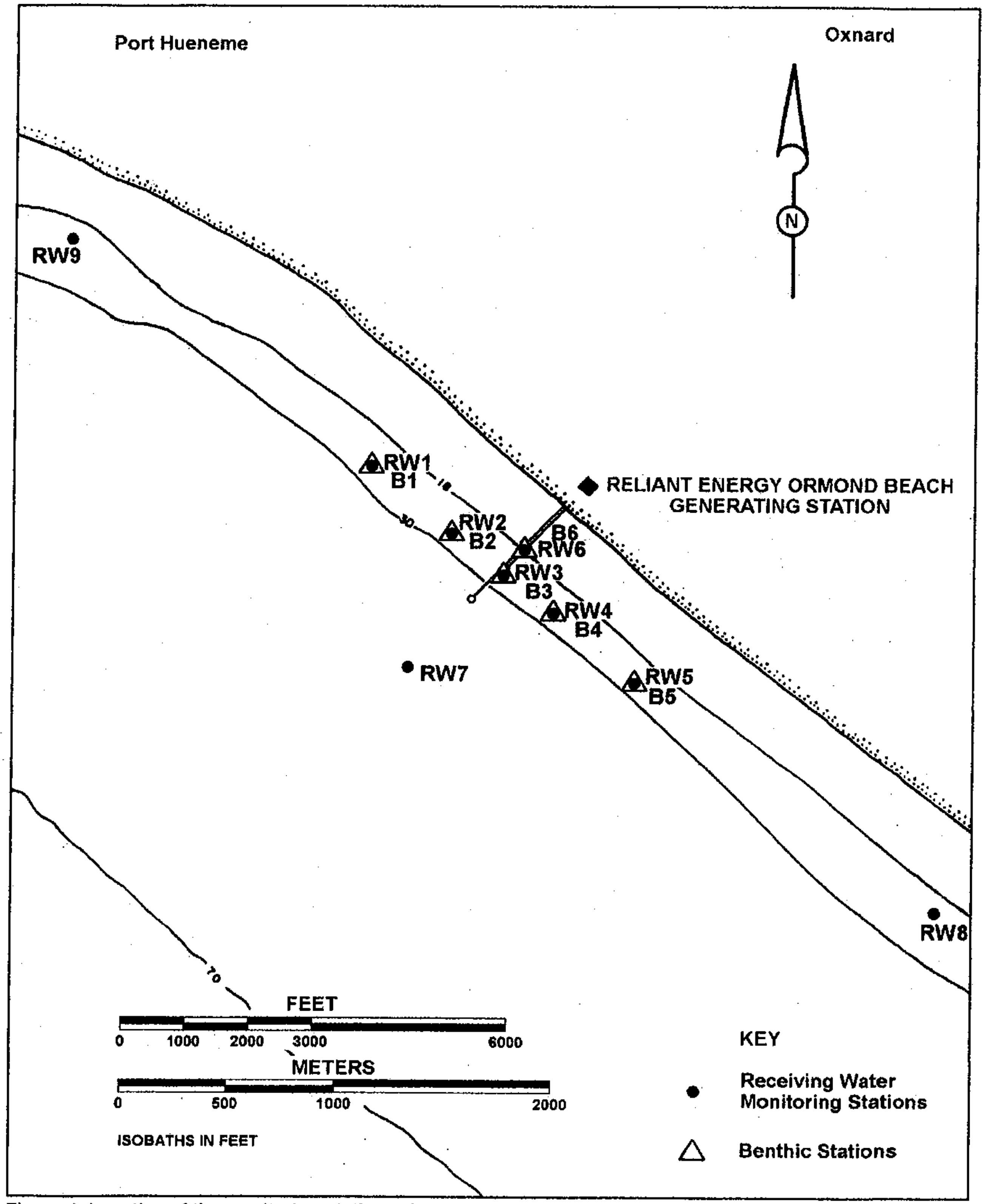

Figure 1. Location of the monitoring stations. Ormond Beach Generating Station.

California Regional Water Quality Control Board
Los Angeles Region

Linda S. Adams
Cal/EPA Secretary

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Arnold Schwarzenegger
Governor

February 7, 2008

Ms. Julie Babcock
Environmental, Western Region Operations
Reliant Energy
7251 S. Amigo St., Suite 120
Las Vegas, NV 89119

PARTICIPATION IN BIGHT'08 REGIONAL MONITORING OF COASTAL OCEAN WATERS MANDALAY GENERATING STATION (NPDES PERMIT NO. CA0001180, CI2093) ORMOND BEACH GENERATING STATION (NPDES PERMIT NO. CA0001198, CI5619)

Dear Ms. Babcock:

As you know, planning is underway for the fourth comprehensive regional survey of coastal ocean waters in the Southern California Bight (Bight'08). As we have done in the past, the Los Angeles Regional Board and the United States Environmental Protection Agency plan to facilitate your agency's participation in the Bight'08 study through a resource exchange by diverting a portion of the routine compliance monitoring into this program. As before, our goal is to implement the regional monitoring program without significantly increasing the total cost of your monitoring requirements. Your letter of January 21, 2008, outlined a reduced monitoring program for 2008, which you are directed to implement as specified below:

1. Reliant Mandalay Generating Station

   a. Eliminate 2008 winter receiving water monitoring surveys that normally would be conducted as part of compliance monitoring.

   b. For the 2008 summer receiving water monitoring survey, retain water quality sampling at all receiving water stations for compliance monitoring purposes and retain four benthic infaunal sampling stations (B1, B2, B3 and B4) with sediment chemistry and grain size analyses at each station; however, reduce benthic sampling to collection of only two replicate samples. Retain trawling at all sampling stations (10-minute trawls, one replicate per station). Retain mussel bioaccumulation monitoring (if resident mussels are located in the discharge area) and fish impingement monitoring as normally required.

2. Reliant Ormond Beach Generating Station

   a. Eliminate 2008 winter receiving water monitoring surveys that normally would be conducted as part of compliance monitoring.

   b. For the 2008 summer receiving water monitoring survey, retain water quality sampling at all receiving water stations for compliance monitoring purposes and retain four benthic infaunal sampling stations (B2, B3, B4 and B5) with sediment chemistry and grain size analyses at each station; however, reduce benthic sampling to collection of only two replicate samples. * Retain trawling at all sampling stations (10-minute trawls, one replicate per station). Retain mussel bioaccumulation monitoring (if resident mussels are located in the discharge area) and fish impingement monitoring as normally required. ** Trawling not required for Ormond Beach Generating Station. M. Lyons 2/20/2008*

In exchange for the reduced monitoring program commitments outlined above, Reliant Energy has agreed to direct MBC Applied Environmental Sciences (MBC) to act on their behalf and perform services valued at $17,300 in exchange for the reduced sampling at the Mandalay Generating Station and $22,100 for the Ormond Beach Generating Station. The Bight'08 survey will be administered by the Southern California Coastal Water Research Project (SCCWRP), which will coordinate the distribution of assignments and project effort. MBC will coordinate with SCCWRP directly to most efficiently and effectively provide services to the Bight'08 program. We understand that Reliant Energy would prefer to see their effort distributed into marinas, estuaries and nearshore zones within the northern project area of the Bight, particularly within Channel Islands Harbor. However, as Reliant Energy realizes, the actual locations and types of sampling to be performed will be determined by SCCWRP. The normal receiving water monitoring program should be resumed beginning in 2009.

We appreciate your interest and cooperation in participating in this valuable regional monitoring survey. If you have any questions, please contact Michael Lyons at (213) 576-6718, as he is the staff person most familiar with this project.

Sincerely,

Tracy J. Egoscue
Executive Officer

Cc: Terry Fleming, U.S. Environmental Protection Agency, Region IX (WTR-2)
David Vilas, MBC Applied Environmental Sciences, Carlsbad
Ken Schiff, Southern California Coastal Water Research Project

APPENDIX B

Receiving water quality parameters by station

Appendix B. Water quality parameters at each receiving water monitoring station during flood and ebb tides. Reliant Energy Ormond Beach generating station NPDES, summer 2008.

		Temp. (°C)		Oxygen (mg/l)		pH		Salinity (psu)	
	Depth (m)	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB
RW1	0	17.05	18.01	8.47	8.54	8.25	8.28	33.38	33.40
	1	16.97	17.99	8.48	8.55	8.25	8.27	33.38	33.40
	2	16.65	17.79	8.53	8.61	8.24	8.27	33.38	33.41
	3	16.58	17.38	8.54	8.62	8.24	8.27	33.38	33.41
	4	16.55	17.25	8.48	8.61	8.24	8.27	33.37	33.39
	5	16.50	17.21	8.47	8.61	8.24	8.27	33.38	33.39
	6	16.33	17.19	8.49	8.59	8.23	8.27	33.38	33.39
	7	16.06	17.16	8.44	8.58	8.23	8.27	33.38	33.39
	8	15.71	17.07	8.40	8.58	8.22	8.27	33.39	33.39
	9	15.15	16.73	8.34	8.61	8.20	8.27	33.39	33.39
	10	14.59	16.38	8.30	8.70	8.18	8.26	33.38	33.39
	11	14.40	15.84	8.16	8.76	8.18	8.25	33.37	33.39
RW2	0	17.03	18.13	8.41	8.50	8.25	8.27	33.38	33.40
	1	17.02	18.11	8.44	8.49	8.25	8.27	33.38	33.40
	2	16.93	18.06	8.46	8.51	8.25	8.27	33.39	33.41
	3	16.70	17.85	8.47	8.55	8.25	8.28	33.38	33.41
	4	16.65	17.70	8.54	8.57	8.24	8.27	33.38	33.41
	5	16.55	17.53	8.54	8.61	8.24	8.27	33.38	33.40
	6	16.41	17.42	8.52	8.59	8.24	8.27	33.37	33.40
	7	16.40	17.32	8.47	8.65	8.23	8.27	33.37	33.39
	8	16.35	17.29	8.48	8.63	8.23	8.27	33.37	33.39
	9	16.17	17.26	8.48	8.55	8.23	8.27	33.37	33.39
	10	15.63	16.98	8.48	8.58	8.22	8.27	33.39	33.39
	11	15.09	16.65	8.41	8.62	8.20	8.26	33.40	33.41
RW3	0	16.92	18.11	8.46	8.44	8.25	8.27	33.38	33.41
	1	16.68	18.10	8.41	8.45	8.24	8.27	33.38	33.41
	2	16.63	18.05	8.51	8.41	8.24	8.27	33.38	33.41
	3	16.55	18.00	8.48	8.49	8.24	8.27	33.38	33.41
	4	16.34	17.93	8.51	8.50	8.24	8.28	33.39	33.41
	5	16.34	17.89	8.41	8.52	8.23	8.28	33.36	33.41
	6	16.45	17.80	8.34	8.56	8.24	8.28	33.38	33.41
	7	16.36	17.67	8.45	8.58	8.23	8.28	33.37	33.41
	8	16.31	17.42	8.41	8.57	8.23	8.27	33.37	33.40
	9	16.27	17.33	8.42	8.59	8.23	8.27	33.37	33.40
	10	16.27	16.93	8.41	8.65	8.23	8.27	33.37	33.43
	11	16.21		8.41		8.23		33.37	
RW4	0	16.82	18.19	8.49	8.42	8.25	8.27	33.37	33.41
	1	16.80	18.21	8.50	8.42	8.25	8.27	33.37	33.41
	2	16.73	18.20	8.53	8.42	8.25	8.27	33.38	33.41
	3	16.66	18.17	8.53	8.43	8.25	8.27	33.38	33.41
	4	16.44	18.09	8.52	8.45	8.24	8.27	33.39	33.42
	5	16.18	17.97	8.52	8.47	8.23	8.28	33.38	33.42
	6	16.07	17.86	8.48	8.51	8.23	8.28	33.37	33.42
	7	16.00	17.71	8.43	8.53	8.23	8.28	33.37	33.42
	8	15.97	17.64	8.41	8.58	8.22	8.28	33.37	33.41
	9	15.96	17.57	8.40	8.59	8.22	8.28	33.36	33.41
	10	15.94	17.36	8.40	8.67	8.22	8.28	33.36	33.41
	11	15.94	17.07	8.38	8.69	8.22	8.28	33.36	33.41
RW5	0	17.01	18.13	8.48	8.33	8.25	8.27	33.38	33.42
	1	16.83	18.12	8.52	8.36	8.25	8.27	33.38	33.42
	2	16.66	17.99	8.57	8.38	8.25	8.28	33.38	33.42
	3	16.64	17.96	8.52	8.40	8.25	8.28	33.37	33.42
	4	16.57	17.83	8.49	8.41	8.24	8.28	33.38	33.42
	5	16.37	17.80	8.50	8.46	8.24	8.28	33.38	33.42
	6	16.07	17.72	8.51	8.48	8.23	8.28	33.38	33.42

Appendix B. (Cont.).

	Depth (m)	Temp. (°C) FLOOD	Temp. (°C) EBB	Oxygen (mg/l) FLOOD	Oxygen (mg/l) EBB	pH FLOOD	pH EBB	Salinity (psu) FLOOD	Salinity (psu) EBB
	7	15.83	17.60	8.45	8.52	8.23	8.28	33.38	33.41
	8	15.61	17.57	8.40	8.57	8.22	8.28	33.37	33.40
	9	15.66	17.55	8.36	8.57	8.22	8.28	33.36	33.40
	10	15.57	17.52	8.36	8.59	8.21	8.28	33.36	33.40
	11	15.57	17.48	8.31	8.58	8.21	8.28	33.36	33.40
	12	15.58		8.30		8.21		33.36	
RW6	0	16.70	18.12	8.54	8.45	8.25	8.27	33.37	33.40
	1	16.70	18.11	8.52	8.44	8.24	8.27	33.37	33.40
	2	16.60	18.11	8.52	8.48	8.24	8.27	33.38	33.40
	3	16.49	17.99	8.53	8.47	8.24	8.27	33.37	33.40
	4	16.48	17.95	8.48	8.24	8.24	8.27	33.37	33.40
	5	16.48	17.83	8.49	8.21	8.24	8.27	33.37	33.40
	6	16.48	17.72	8.46	8.36	8.24	8.27	33.37	33.40
	7	16.48	17.68	8.48	8.50	8.24	8.27	33.37	33.40
RW7	0	17.08	18.11	8.40	8.35	8.25	8.27	33.38	33.41
	1	17.07	18.11	8.41	8.35	8.25	8.27	33.38	33.42
	2	16.93	18.09	8.44	8.36	8.25	8.27	33.39	33.42
	3	16.85	17.57	8.48	8.44	8.25	8.27	33.38	33.44
	4	16.76	17.26	8.44	8.49	8.25	8.27	33.38	33.42
	5	16.68	17.20	8.45	8.55	8.25	8.27	33.38	33.41
	6	16.42	17.17	8.49	8.59	8.24	8.27	33.39	33.40
	7	16.07	17.11	8.47	8.64	8.23	8.27	33.38	33.40
	8	15.95	17.04	8.44	8.67	8.23	8.28	33.37	33.40
	9	15.91	16.97	8.40	8.72	8.22	8.27	33.37	33.39
	10	15.82	16.85	8.42	8.74	8.22	8.28	33.37	33.39
	11	15.68	16.68	8.40	8.72	8.22	8.27	33.37	33.39
	12	15.41	16.13	8.39	8.75	8.21	8.25	33.38	33.38
	13	14.98	15.97	8.32	8.57	8.20	8.25	33.37	33.41
	14	14.83	15.42	8.22	8.73	8.19	8.24	33.40	33.38
RW8	0	17.23	18.30	8.49	8.35	8.26	8.27	33.39	33.42
	1	17.22	18.31	8.50	8.33	8.26	8.27	33.39	33.42
	2	16.60	18.31	8.57	8.34	8.25	8.27	33.41	33.42
	3	16.36	18.28	8.55	8.36	8.24	8.27	33.39	33.42
	4	16.25	18.20	8.52	8.38	8.24	8.27	33.38	33.42
	5	16.11	18.15	8.50	8.37	8.23	8.27	33.38	33.42
	6	16.01	18.00	8.49	8.39	8.23	8.27	33.37	33.42
	7	15.56	17.82	8.52	8.46	8.22	8.28	33.39	33.41
	8	15.23	17.78	8.40	8.55	8.21	8.28	33.37	33.40
	9	15.22	17.76	8.29	8.57	8.21	8.28	33.36	33.40
	10	15.23	17.75	8.28	8.60	8.21	8.28	33.35	33.40
	11	15.23	17.75	8.29	8.58	8.21	8.28	33.35	33.40
	12	15.23		8.31		8.21		33.35	
RW9	0	15.11	17.60	8.12	8.62	8.17	8.27	33.33	33.38
	1	15.11	17.54	8.12	8.64	8.17	8.27	33.33	33.38
	2	15.04	17.17	8.15	8.68	8.17	8.27	33.34	33.39
	3	14.95	16.96	8.15	8.76	8.18	8.27	33.34	33.39
	4	14.91	16.83	8.27	8.77	8.18	8.27	33.35	33.39
	5	14.87	16.68	8.26	8.82	8.18	8.26	33.34	33.38
	6	14.80	16.57	8.28	8.80	8.18	8.26	33.35	33.38
	7	14.72	16.45	8.27	8.80	8.17	8.26	33.34	33.38
	8	14.69	16.37	8.22	8.77	8.17	8.26	33.34	33.37
	9	14.49	16.35	8.24	8.77	8.17	8.26	33.35	33.37
	10	14.33	16.35	8.20	8.73	8.17	8.26	33.35	33.37
	11	14.06	16.34	8.16	8.73	8.16	8.26	33.33	33.37

APPENDIX C

Sediment grain size techniques and statistical parameters by station

Appendix C-1. Grain size techniques.

Sediment Grain Size Analysis

Analysis of sediment samples for size distribution characteristics are performed using two techniques. Sediments in the gravel size range (> 2.0 mm in diameter) are analyzed using a series of standard sieves having screen openings of 0.5 phi increments (diameter in phi units = -$\log_2$ diameter in mm, or = -ln diameter in mm ÷ ln 2). The sand-silt-clay fraction of sediments [-1 phi through 4 phi (2.0 mm through 0.0625 mm) for sand], [4 phi through 8 phi (0.0625 mm through 0.004 mm) for silt, 8 phi and greater for clay (0.0039 mm and smaller)] is analyzed by laser light diffraction. The sample is suspended in a suspension column and continuously circulated through the laser beam. The laser beam passes through the sample where the suspended particles scatter incident light. Fourier optics collect diffracted light and focus it on to three sets of detectors. A composite, time-averaged diffraction pattern is measured by 126 detectors. Sizes are computed and summed into normal distribution classifications.

Laboratory data from the two methods are mathematically combined and entered into a computer program which calculates and prints size-distribution characteristics and plots both interval and cumulative frequency distribution curves.

Analysis of the plotted cumulative size frequency curves is performed as described by Inman (1952). The median, 5th, 16th, 84th, and 95th percentiles (converted to phi notation) of the sediment distribution curve is used to calculate mean grain size diameter, sorting coefficient, and measures of skewness and kurtosis. Where sediment distribution coincides with a normal distribution curve, the 16th and 84th percentiles represent diameters one standard deviation on either side of the mean. The following formulas are used in the calculations:

1. Mean Diameter (M_ϕ) is the average particle size in the central 68% of the distribution.

$$M_\phi = \left(\phi_{16} + \phi_{50} + \phi_{84}\right) / 3$$

2. Sorting (σ_ϕ) measures the uniformity (or non-uniformity) of particle quantities in each size category of the sediment distribution. A σ_ϕ value under 0.35ϕ indicates that particles are very well sorted (i.e. sediments are primarily composed of a narrow range of size classes, or a single size class), while a value of over 4.0ϕ indicates that the sediments are extremely poorly sorted, or evenly distributed among size classes.

$$\sigma_\phi = \frac{\phi_{84} - \phi_{16}}{4} + \frac{\phi_{95} - \phi_5}{6.6}$$

3. Skewness (α_ϕ) is a measure of the direction and extent of departure of the mean from the median (in a normal or symmetrical curve they coincide). In symmetrical curves, α_ϕ=0.00 with limits of -1.00 and +1.00. Negative values indicate the particle distribution is skewed toward larger particle diameters, while positive values indicate the distribution is skewed toward smaller particle diameters.

$$\alpha_\phi = \frac{\phi_{16} + \phi_{84} - 2\phi_{50}}{2\left(\phi_{84} - \phi_{16}\right)} + \frac{\phi_5 + \phi_{95} - 2\phi_{50}}{2\left(\phi_{95} - \phi_5\right)}$$

4. Kurtosis (β_ϕ) is a measure of how far the sediment distribution curve departs from a normal Gaussian shape at its peak. Curves with greater than normal amounts of sediment at their modes will be sharp or leptokurtic ($\beta_\phi > 1$). Those with fatter tails and lower peaks than expected are termed platykurtic ($\beta_\phi < 1$). $\beta_\phi = 1.00$ for a normal curve. Curve category interpretations are based on Folk (1974).

$$\beta_\phi = \frac{\phi_{95} - \phi_5}{2.44\left(\phi_{75} - \phi_{25}\right)}$$

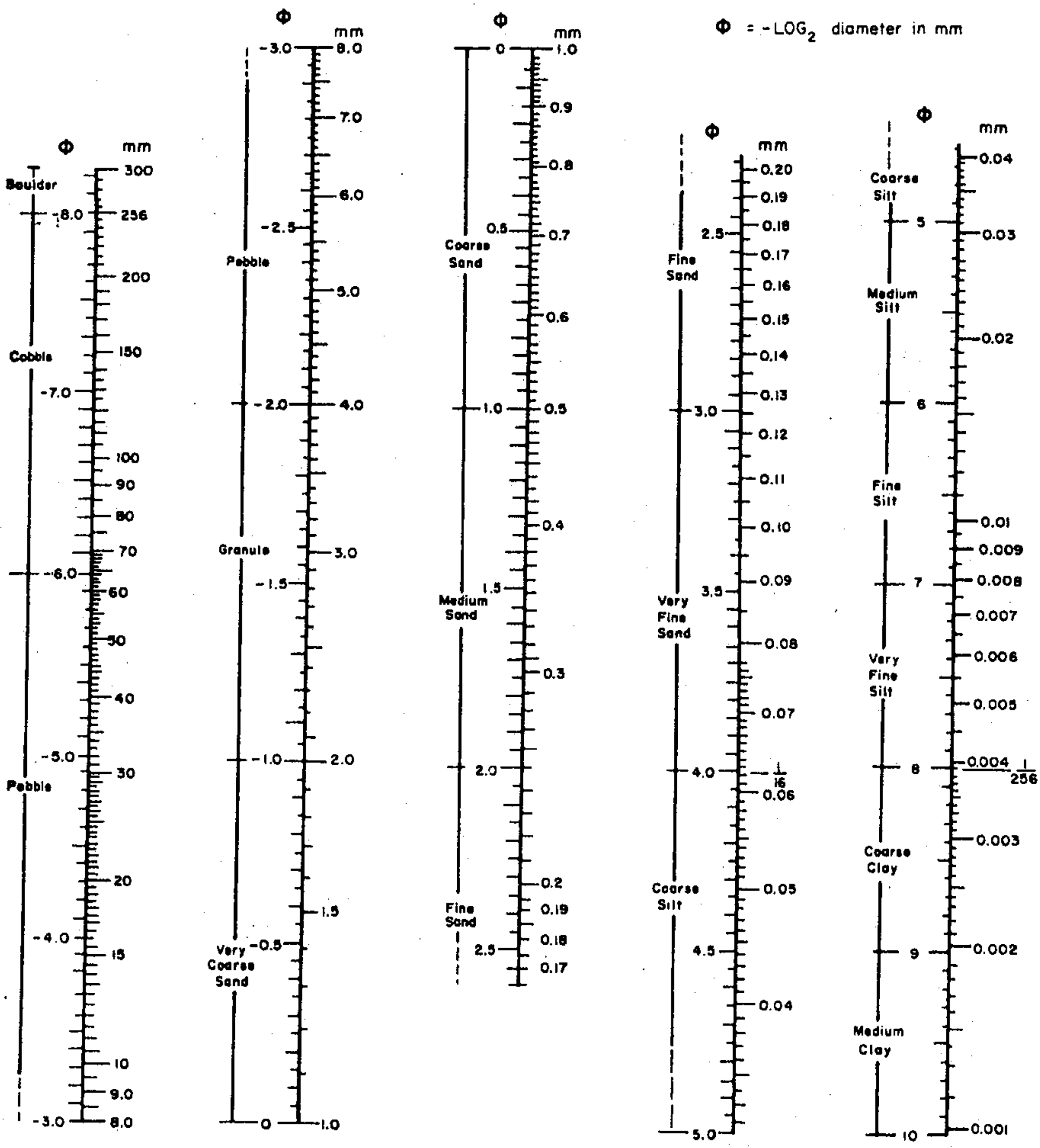
LITERATURE CITED

Folk, R. L. 1974. Petrology of sedimentary rocks. Hemphill Publishing Co., Austin, TX. 182 p.

Inman, D. L. 1952. Measures for describing the size distribution of sediments. J. Sed. Pet. 22:125-145.

Appendix C-1. (Cont.).

Phi - Millimeter Conversion Figure



Measurement sorting values for a large number of sediments has suggested the following verbal classification scale for sorting:

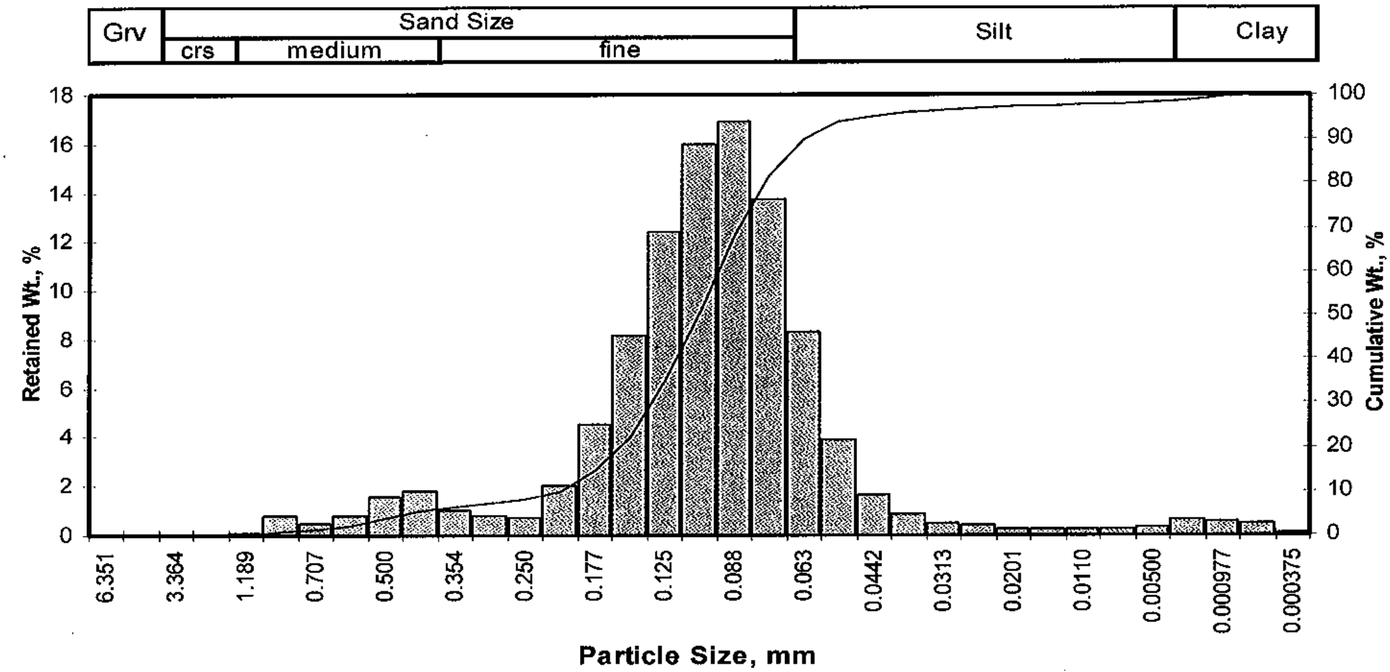
σ_I under	.35 φ,	very well sorted
	.35-.50 φ,	well sorted
	.50-.71 φ,	moderately well sorted
	.71-1.0 φ	moderately sorted
	1.0-2.0 φ,	poorly sorted
	2.0-4.0 φ,	very poorly sorted
	over 4.0 φ,	extremely poorly sorted

Appendix C-2. Sediment grain size distribution and statistical parameters by station. Ormond Beach Generating Station NPDES, 2008.

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience	**PTS File No:**	38922
Project:	N/A	**Sample ID:**	OBGS B2
Project No:	08-10-1028	**Depth, ft:**	N/A



Opening Inches	Opening Millimeters	Phi of Screen	U.S. No.	Sample Weight, grams	Increment Weight, percent	Cumulative Weight, percent
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	0.07	0.07	0.07
0.0331	0.841	0.25	20	0.80	0.80	0.87
0.0278	0.707	0.50	25	0.49	0.49	1.36
0.0234	0.595	0.75	30	0.77	0.77	2.13
0.0197	0.500	1.00	35	1.59	1.59	3.72
0.0166	0.420	1.25	40	1.77	1.77	5.49
0.0139	0.354	1.50	45	1.04	1.04	6.53
0.0117	0.297	1.75	50	0.75	0.75	7.28
0.0098	0.250	2.00	60	0.71	0.71	7.99
0.0083	0.210	2.25	70	1.99	1.99	9.97
0.0070	0.177	2.50	80	4.49	4.49	14.46
0.0059	0.149	2.75	100	8.15	8.15	22.61
0.0049	0.125	3.00	120	12.40	12.39	35.00
0.0041	0.105	3.25	140	16.00	15.99	51.00
0.0035	0.088	3.50	170	16.90	16.89	67.89
0.0029	0.074	3.75	200	13.70	13.69	81.58
0.0025	0.063	4.00	230	8.30	8.30	89.88
0.0021	0.053	4.25	270	3.88	3.88	93.76
0.00174	0.0442	4.50	325	1.64	1.64	95.40
0.00146	0.0372	4.75	400	0.84	0.84	96.24
0.00123	0.0313	5.00	450	0.49	0.49	96.73
0.000986	0.0250	5.32	500	0.36	0.36	97.09
0.000790	0.0201	5.64	635	0.23	0.23	97.32
0.000615	0.0156	6.00		0.20	0.20	97.52
0.000435	0.0110	6.50		0.24	0.24	97.76
0.000308	0.00781	7.00		0.23	0.23	97.99
0.000197	0.00500	7.65		0.30	0.30	98.29
0.000077	0.00195	9.00		0.61	0.61	98.90
0.000038	0.000977	10.00		0.57	0.57	99.47
0.000019	0.000488	11.00		0.48	0.48	99.95
0.000015	0.000375	11.38		0.05	0.05	100.00
TOTALS				**100.00**	**100.00**	**100.00**

Cumulative Weight Percent greater than

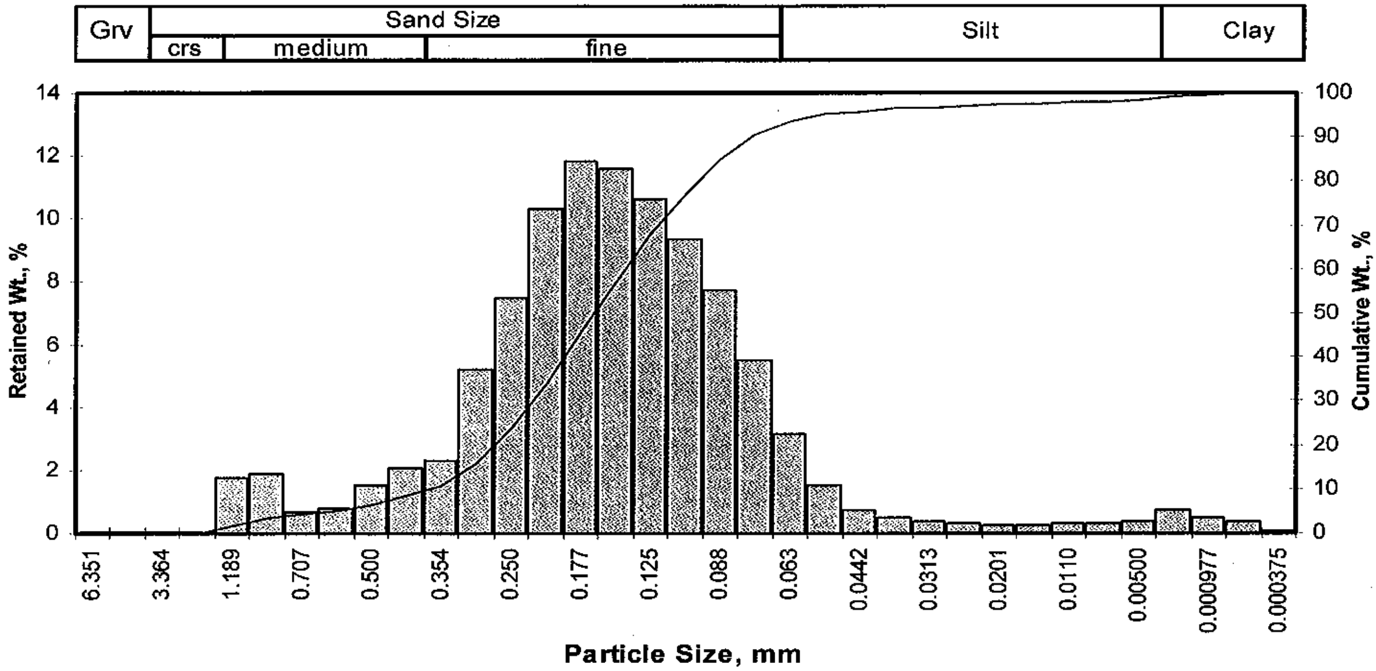
Weight percent	Phi Value	Particle Size Inches	Particle Size Millimeters
5	1.18	0.0174	0.441
10	2.25	0.0083	0.210
16	2.55	0.0067	0.171
25	2.80	0.0057	0.144
40	3.08	0.0047	0.118
50	3.23	0.0042	0.106
60	3.38	0.0038	0.096
75	3.63	0.0032	0.081
84	3.82	0.0028	0.071
90	4.01	0.0024	0.062
95	4.44	0.0018	0.046

Measure	Trask	Inman	Folk-Ward
Median, phi	3.23	3.23	3.23
Median, in.	0.0042	0.0042	0.0042
Median, mm	0.106	0.106	0.106
Mean, phi	3.15	3.18	3.20
Mean, in.	0.0044	0.0043	0.0043
Mean, mm	0.112	0.110	0.109
Sorting	1.334	0.638	0.813
Skewness	1.014	-0.078	-0.169
Kurtosis	0.213	1.554	1.606
Grain Size Description (ASTM-USCS Scale)		Fine sand (based on Mean from Trask)	

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	5.49
Fine Sand	200	76.10
Silt	>0.005 mm	16.70
Clay	<0.005 mm	1.71
	Total	100

PTS Laboratories, Inc. **Particle Size Analysis - ASTM D4464M**

Client:	Calscience	**PTS File No:**	38922
Project:	N/A	**Sample ID:**	OBGS B3
Project No:	08-10-1028	**Depth, ft:**	N/A



Opening		Phi of	U.S.	Sample Weight,	Increment Weight,	Cumulative Weight,
Inches	Millimeters	Screen	No.	grams	percent	percent
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	1.72	1.72	1.72
0.0331	0.841	0.25	20	1.88	1.88	3.60
0.0278	0.707	0.50	25	0.68	0.68	4.28
0.0234	0.595	0.75	30	0.79	0.79	5.07
0.0197	0.500	1.00	35	1.49	1.49	6.56
0.0166	0.420	1.25	40	2.08	2.08	8.64
0.0139	0.354	1.50	45	2.27	2.27	10.91
0.0117	0.297	1.75	50	5.18	5.18	16.09
0.0098	0.250	2.00	60	7.51	7.51	23.60
0.0083	0.210	2.25	70	10.30	10.30	33.90
0.0070	0.177	2.50	80	11.80	11.80	45.71
0.0059	0.149	2.75	100	11.60	11.60	57.31
0.0049	0.125	3.00	120	10.60	10.60	67.91
0.0041	0.105	3.25	140	9.34	9.34	77.25
0.0035	0.088	3.50	170	7.72	7.72	84.97
0.0029	0.074	3.75	200	5.50	5.50	90.47
0.0025	0.063	4.00	230	3.15	3.15	93.62
0.0021	0.053	4.25	270	1.50	1.50	95.12
0.00174	0.0442	4.50	325	0.75	0.75	95.87
0.00146	0.0372	4.75	400	0.48	0.48	96.35
0.00123	0.0313	5.00	450	0.34	0.34	96.69
0.000986	0.0250	5.32	500	0.30	0.30	96.99
0.000790	0.0201	5.64	635	0.23	0.23	97.22
0.000615	0.0156	6.00		0.23	0.23	97.45
0.000435	0.0110	6.50		0.29	0.29	97.74
0.000308	0.00781	7.00		0.30	0.30	98.04
0.000197	0.00500	7.65		0.39	0.39	98.43
0.000077	0.00195	9.00		0.70	0.70	99.13
0.000038	0.000977	10.00		0.47	0.47	99.60
0.000019	0.000488	11.00		0.36	0.36	99.96
0.000015	0.000375	11.38		0.04	0.04	100.00
TOTALS				**100.00**	**100.00**	**100.00**

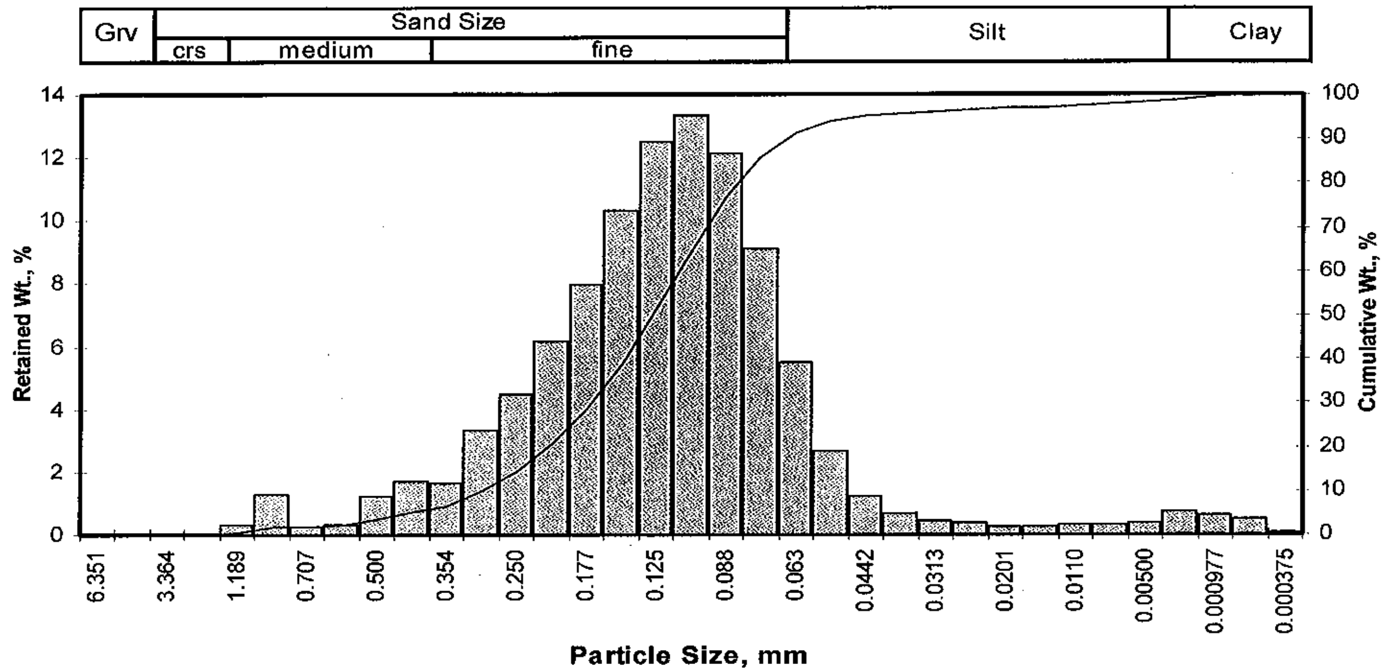
Cumulative Weight Percent greater than			
Weight percent	Phi Value	Particle Size Inches	Particle Size Millimeters
5	0.73	0.0238	0.604
10	1.40	0.0149	0.379
16	1.75	0.0117	0.298
25	2.03	0.0096	0.244
40	2.38	0.0076	0.192
50	2.59	0.0065	0.166
60	2.81	0.0056	0.142
75	3.19	0.0043	0.110
84	3.47	0.0036	0.090
90	3.73	0.0030	0.075
95	4.23	0.0021	0.053

Measure	Trask	Inman	Folk-Ward
Median, phi	2.59	2.59	2.59
Median, in.	0.0065	0.0065	0.0065
Median, mm	0.166	0.166	0.166
Mean, phi	2.50	2.61	2.60
Mean, in.	0.0070	0.0065	0.0065
Mean, mm	0.177	0.164	0.165
Sorting	1.493	0.862	0.961
Skewness	0.987	0.017	-0.024
Kurtosis	0.222	1.033	1.242
Grain Size Description (ASTM-USCS Scale)		Fine sand (based on Mean from Trask)	

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	8.64
Fine Sand	200	81.83
Silt	>0.005 mm	7.96
Clay	<0.005 mm	1.57
	Total	100

PTS Laboratories, Inc. **Particle Size Analysis - ASTM D4464M**

Client:	Calscience	**PTS File No:**	38922
Project:	N/A	**Sample ID:**	OBGS B4
Project No:	08-10-1028	**Depth, ft:**	N/A



Opening Inches	Opening Millimeters	Phi of Screen	U.S. No.	Sample Weight, grams	Increment Weight, percent	Cumulative Weight, percent
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	0.29	0.29	0.29
0.0331	0.841	0.25	20	1.25	1.25	1.54
0.0278	0.707	0.50	25	0.25	0.25	1.79
0.0234	0.595	0.75	30	0.30	0.30	2.09
0.0197	0.500	1.00	35	1.19	1.19	3.28
0.0166	0.420	1.25	40	1.69	1.69	4.97
0.0139	0.354	1.50	45	1.63	1.63	6.61
0.0117	0.297	1.75	50	3.32	3.32	9.93
0.0098	0.250	2.00	60	4.46	4.46	14.39
0.0083	0.210	2.25	70	6.13	6.14	20.53
0.0070	0.177	2.50	80	7.96	7.97	28.50
0.0059	0.149	2.75	100	10.30	10.31	38.80
0.0049	0.125	3.00	120	12.50	12.51	51.32
0.0041	0.105	3.25	140	13.30	13.31	64.63
0.0035	0.088	3.50	170	12.10	12.11	76.74
0.0029	0.074	3.75	200	9.12	9.13	85.87
0.0025	0.063	4.00	230	5.48	5.48	91.35
0.0021	0.053	4.25	270	2.66	2.66	94.01
0.00174	0.0442	4.50	325	1.19	1.19	95.21
0.00146	0.0372	4.75	400	0.65	0.65	95.86
0.00123	0.0313	5.00	450	0.42	0.42	96.28
0.000986	0.0250	5.32	500	0.36	0.36	96.64
0.000790	0.0201	5.64	635	0.27	0.27	96.91
0.000615	0.0156	6.00		0.26	0.26	97.17
0.000435	0.0110	6.50		0.32	0.32	97.49
0.000308	0.00781	7.00		0.30	0.30	97.79
0.000197	0.00500	7.65		0.38	0.38	98.17
0.000077	0.00195	9.00		0.74	0.74	98.91
0.000038	0.000977	10.00		0.58	0.58	99.49
0.000019	0.000488	11.00		0.46	0.46	99.95
0.000015	0.000375	11.38		0.05	0.05	100.00
TOTALS				**99.90**	**100.00**	**100.00**

Cumulative Weight Percent greater than			
Weight percent	**Phi Value**	**Particle Size Inches**	**Particle Size Millimeters**
5	1.25	0.0165	0.419
10	1.75	0.0117	0.296
16	2.07	0.0094	0.239
25	2.39	0.0075	0.191
40	2.77	0.0058	0.146
50	2.97	0.0050	0.127
60	3.16	0.0044	0.112
75	3.46	0.0036	0.091
84	3.70	0.0030	0.077
90	3.94	0.0026	0.065
95	4.46	0.0018	0.046

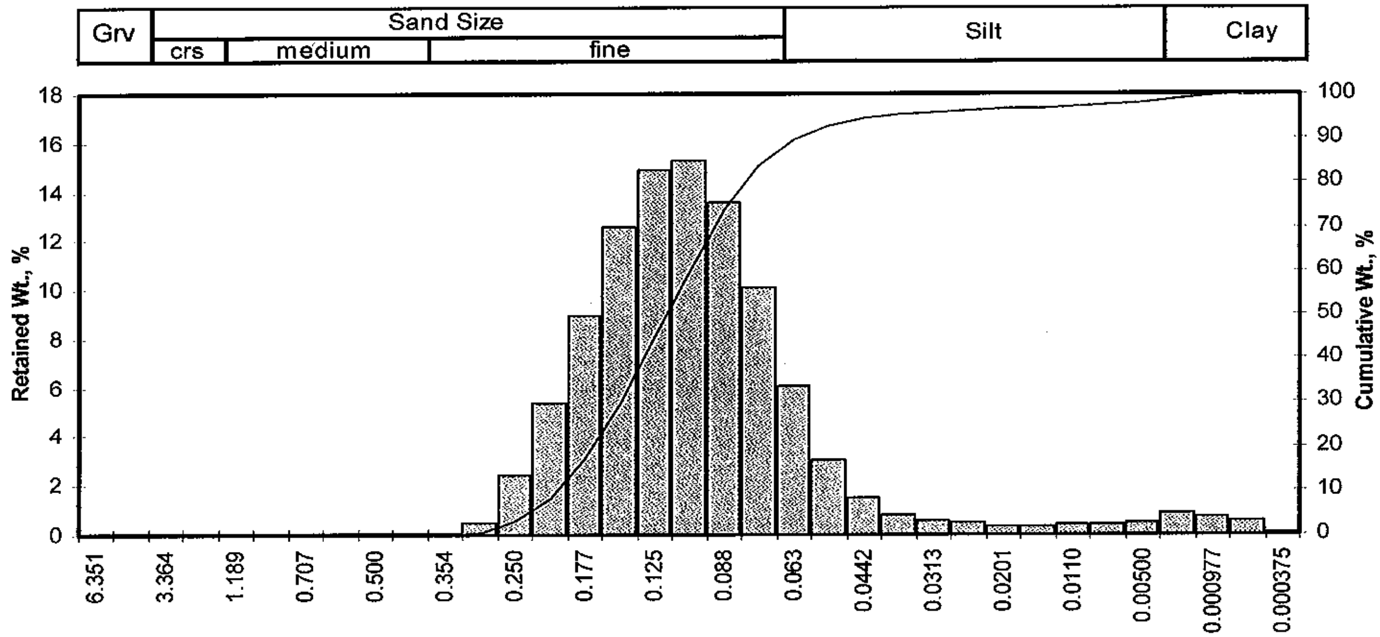
Measure	Trask	Inman	Folk-Ward
Median, phi	2.97	2.97	2.97
Median, in.	0.0050	0.0050	0.0050
Median, mm	0.127	0.127	0.127
Mean, phi	2.83	2.88	2.91
Mean, in.	0.0055	0.0053	0.0052
Mean, mm	0.141	0.136	0.133
Sorting	1.451	0.817	0.894
Skewness	1.033	-0.112	-0.093
Kurtosis	0.216	0.961	1.222
Grain Size Description (ASTM-USCS Scale)	Fine sand (based on Mean from Trask)		

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	4.97
Fine Sand	200	80.89
Silt	>0.005 mm	12.30
Clay	<0.005 mm	1.83
	Total	100

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience	**PTS File No:**	38922
Project:	N/A	**Sample ID:**	OBGS B5
Project No:	08-10-1028	**Depth, ft:**	N/A



Opening Inches	Opening Millimeters	Phi of Screen	U.S. No.	Sample Weight, grams	Increment Weight, percent	Cumulative Weight, percent
0.2500	6.351	-2.67	1/4	0.00	0.00	0.00
0.1873	4.757	-2.25	4	0.00	0.00	0.00
0.1324	3.364	-1.75	6	0.00	0.00	0.00
0.0787	2.000	-1.00	10	0.00	0.00	0.00
0.0468	1.189	-0.25	16	0.00	0.00	0.00
0.0331	0.841	0.25	20	0.00	0.00	0.00
0.0278	0.707	0.50	25	0.00	0.00	0.00
0.0234	0.595	0.75	30	0.00	0.00	0.00
0.0197	0.500	1.00	35	0.00	0.00	0.00
0.0166	0.420	1.25	40	0.00	0.00	0.00
0.0139	0.354	1.50	45	0.00	0.00	0.00
0.0117	0.297	1.75	50	0.50	0.50	0.50
0.0098	0.250	2.00	60	2.37	2.37	2.87
0.0083	0.210	2.25	70	5.38	5.38	8.25
0.0070	0.177	2.50	80	8.96	8.96	17.22
0.0059	0.149	2.75	100	12.60	12.60	29.82
0.0049	0.125	3.00	120	14.90	14.90	44.72
0.0041	0.105	3.25	140	15.30	15.30	60.02
0.0035	0.088	3.50	170	13.60	13.60	73.62
0.0029	0.074	3.75	200	10.10	10.10	83.72
0.0025	0.063	4.00	230	6.08	6.08	89.80
0.0021	0.053	4.25	270	3.03	3.03	92.83
0.00174	0.0442	4.50	325	1.44	1.44	94.27
0.00146	0.0372	4.75	400	0.81	0.81	95.08
0.00123	0.0313	5.00	450	0.52	0.52	95.60
0.000986	0.0250	5.32	500	0.44	0.44	96.04
0.000790	0.0201	5.64	635	0.32	0.32	96.36
0.000615	0.0156	6.00		0.30	0.30	96.66
0.000435	0.0110	6.50		0.37	0.37	97.03
0.000308	0.00781	7.00		0.36	0.36	97.39
0.000197	0.00500	7.65		0.46	0.46	97.85
0.000077	0.00195	9.00		0.88	0.88	98.73
0.000038	0.000977	10.00		0.67	0.67	99.40
0.000019	0.000488	11.00		0.54	0.54	99.94
0.000015	0.000375	11.38		0.06	0.06	100.00
TOTALS				**100.00**	**100.00**	**100.00**

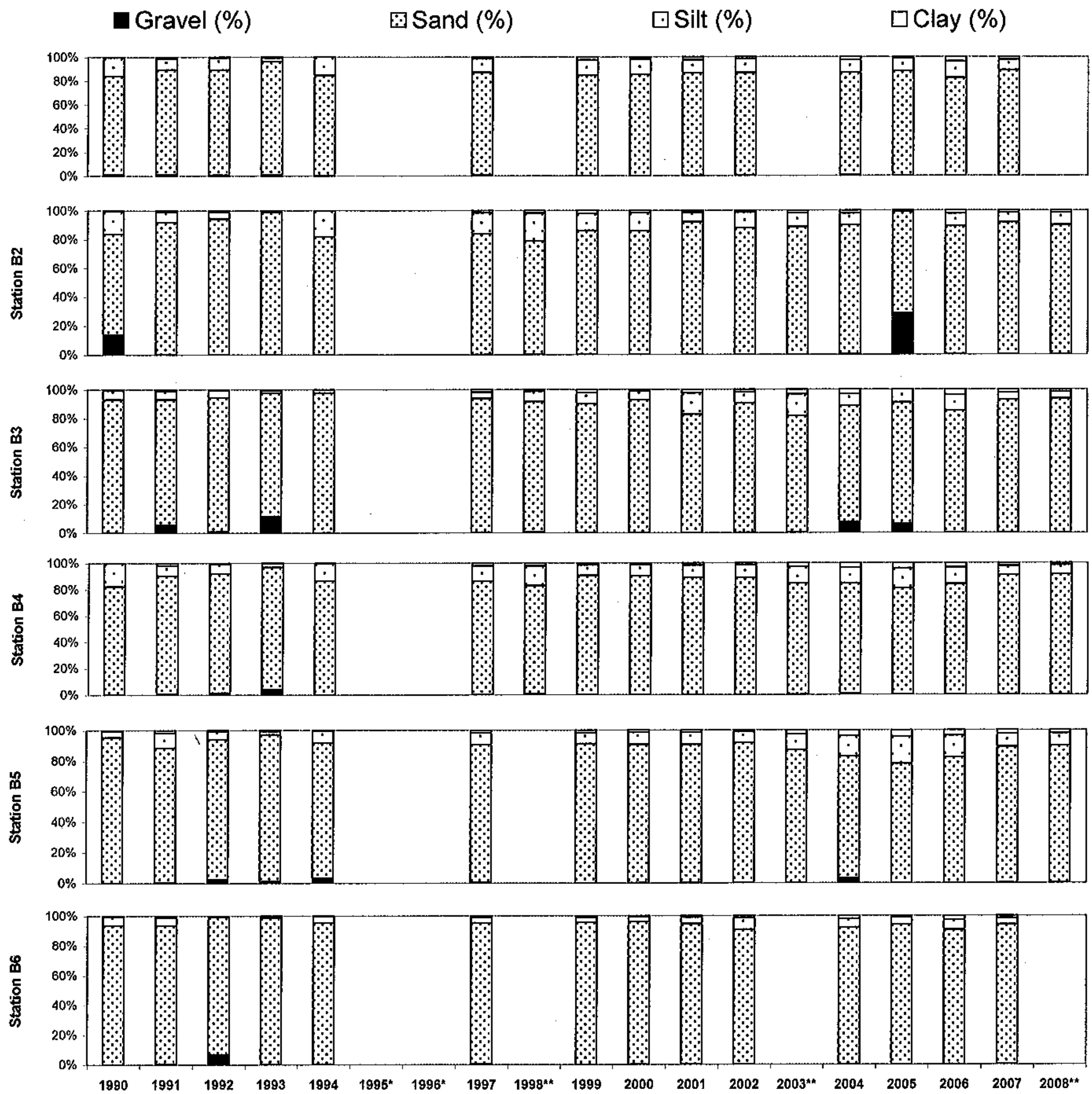
Cumulative Weight Percent greater than

Weight percent	Phi Value	Particle Size Inches	Particle Size Millimeters
5	2.10	0.0092	0.233
10	2.30	0.0080	0.203
16	2.47	0.0071	0.181
25	2.65	0.0063	0.159
40	2.92	0.0052	0.132
50	3.09	0.0046	0.118
60	3.25	0.0041	0.105
75	3.53	0.0034	0.086
84	3.76	0.0029	0.074
90	4.02	0.0024	0.062
95	4.73	0.0015	0.038

Measure	Trask	Inman	Folk-Ward
Median, phi	3.09	3.09	3.09
Median, in.	0.0046	0.0046	0.0046
Median, mm	0.118	0.118	0.118
Mean, phi	3.03	3.11	3.10
Mean, in.	0.0048	0.0045	0.0046
Mean, mm	0.123	0.116	0.116
Sorting	1.356	0.648	0.722
Skewness	0.994	0.042	0.145
Kurtosis	0.256	1.027	1.224
Grain Size Description (ASTM-USCS Scale)	Fine sand (based on Mean from Trask)		

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	0.00
Fine Sand	200	83.72
Silt	>0.005 mm	14.13
Clay	<0.005 mm	2.15
	Total	**100**

Appendix C-3. Long-term sediment composition by size catagory, 1990 - 2008. Ormond Beach Generating Station NPDES, 2008.



* No sampling required.

** Regional Monitoring Year; 1998 only three stations required; 2003 and 2008 only four stations required.

APPENDIX D

Sediment chemistry by station

Calscience Environmental Laboratories, Inc.

Analytical Report

nelac

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Project: OBGS 08207A

Date Received:	09/22/08
Work Order No:	08-09-1989
Preparation:	EPA 3050B
Method:	EPA 6020
Units:	mg/kg

Page 1 of 1

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
OBGS B2-(1,2,3)	08-09-1989-13-A	09/18/08 00:00	Solid	ICP/MS A	09/23/08	09/24/08 16:39	080923L01

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	8.24	0.139	1		Nickel	6.90	0.139	1	
Copper	3.93	0.139	1		Zinc	26.0	1.39	1	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
OBGS B3-(1,2,3)	08-09-1989-14-A	09/18/08 00:00	Solid	ICP/MS A	09/23/08	09/24/08 16:43	080923L01

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	6.45	0.130	1		Nickel	5.85	0.130	1	
Copper	3.05	0.130	1		Zinc	19.8	1.30	1	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
OBGS B4-(1,2,3)	08-09-1989-15-A	09/18/08 00:00	Solid	ICP/MS A	09/23/08	09/24/08 16:47	080923L01

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	7.73	0.132	1		Nickel	6.54	0.132	1	
Copper	3.47	0.132	1		Zinc	23.6	1.32	1	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
OBGS B5-(1,2,3)	08-09-1989-16-A	09/18/08 00:00	Solid	ICP/MS A	09/23/08	09/24/08 16:51	080923L01

Comment(s): -Results are reported on a dry weight basis.

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	7.24	0.140	1		Nickel	6.55	0.140	1	
Copper	3.94	0.140	1		Zinc	23.3	1.40	1	

Client Sample Number	Lab Sample Number	Date /Time Collected	Matrix	Instrument	Date Prepared	Date/Time Analyzed	QC Batch ID
Method Blank	096-10-002-1,229	N/A	Solid	ICP/MS A	09/23/08	09/23/08 12:07	080923L01

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	ND	0.100	1		Nickel	ND	0.100	1	
Copper	ND	0.100	1		Zinc	ND	1.00	1	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

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Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences		Date Received:	09/22/08
3000 Redhill Avenue		Work Order No:	08-09-1989
Costa Mesa, CA 92626-4524			

Project: OBGS 08207A

Client Sample Number	Lab Sample Number	Date Collected	Matrix
OBGS B2-(1,2,3)	08-09-1989-13	09/18/08	Solid

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	71.9	0.100	1		%	N/A	09/24/08	SM 2540 B

Client Sample Number	Lab Sample Number	Date Collected	Matrix
OBGS B3-(1,2,3)	08-09-1989-14	09/18/08	Solid

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	76.9	0.100	1		%	N/A	09/24/08	SM 2540 B

Client Sample Number	Lab Sample Number	Date Collected	Matrix
OBGS B4-(1,2,3)	08-09-1989-15	09/18/08	Solid

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	75.8	0.100	1		%	N/A	09/24/08	SM 2540 B

Client Sample Number	Lab Sample Number	Date Collected	Matrix
OBGS B5-(1,2,3)	08-09-1989-16	09/18/08	Solid

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	71.3	0.100	1		%	N/A	09/24/08	SM 2540 B

Client Sample Number	Lab Sample Number	Date Collected	Matrix
Method Blank		N/A	Solid

Parameter	Result	RL	DF	Qual	Units	Date Prepared	Date Analyzed	Method
Solids, Total	ND	0.100	1		%	N/A	09/24/08	SM 2540 B

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

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Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

MBC Applied Environmental Sciences		Date Received:	09/22/08
3000 Redhill Avenue		Work Order No:	08-09-1989
Costa Mesa, CA 92626-4524		Preparation:	EPA 3050B
		Method:	EPA 6020

Project OBGS 08207A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
08-09-0501-6	Solid	ICP/MS A	09/23/08	09/23/08	080923S01

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	105	97	80-120	4	0-20	
Copper	73	53	80-120	5	0-20	3
Nickel	107	101	80-120	5	0-20	
Zinc	4X	4X	80-120	4X	0-20	Q

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Quality Control - PDS / PDSD

MBC Applied Environmental Sciences
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received: 09/22/08
Work Order No: 08-09-1989
Preparation: EPA 3050B
Method: EPA 6020

Project: OBGS 08207A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	PDS/PDSD Batch Number
08-09-0501-6	Solid	ICP/MS A	09/23/08	09/23/08	080923S01

Parameter	PDS %REC	PDSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	99	99	75-125	0	0-20	
Copper	105	99	75-125	1	0-20	
Nickel	102	103	75-125	1	0-20	
Zinc	4X	4X	75-125	4X	0-20	Q

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Quality Control - Duplicate

nelac

MBC Applied Environmental Sciences	Date Received:		N/A
3000 Redhill Avenue	Work Order No:		08-09-1989
Costa Mesa, CA 92626-4524			

Project: OBGS 08207A

Matrix: Solid

Parameter	Method	QC Sample ID	Date Analyzed	Sample Conc	DUP Conc	RPD	RPD CL	Qualifiers
Solids, Total	SM 2540 B	08-09-1990-16	09/24/08	76.5	76.3	0	0-25	

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

MBC Applied Environmental Sciences		Date Received:	N/A
3000 Redhill Avenue		Work Order No:	08-09-1989
Costa Mesa, CA 92626-4524		Preparation:	EPA 3050B
		Method:	EPA 6020

Project: OBGS 08207A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
096-10-002-1,229	Solid	ICP/MS A	09/23/08	09/23/08	080923L01

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	103	103	80-120	0	0-20	
Copper	109	109	80-120	0	0-20	
Nickel	106	105	80-120	0	0-20	
Zinc	105	103	80-120	2	0-20	

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Glossary of Terms and Qualifiers

Work Order Number: 08-09-1989

Qualifier	Definition
*	See applicable analysis comment.
1	Surrogate compound recovery was out of control due to a required sample dilution, therefore, the sample data was reported without further clarification.
2	Surrogate compound recovery was out of control due to matrix interference. The associated method blank surrogate spike compound was in control and, therefore, the sample data was reported without further clarification.
3	Recovery of the Matrix Spike (MS) or Matrix Spike Duplicate (MSD) compound was out of control due to matrix interference. The associated LCS and/or LCSD was in control and, therefore, the sample data was reported without further clarification.
4	The MS/MSD RPD was out of control due to matrix interference. The LCS/LCSD RPD was in control and, therefore, the sample data was reported without further clarification.
5	The PDS/PDSD associated with this batch of samples was out of control due to a matrix interference effect. The associated batch LCS/LCSD was in control and, hence, the associated sample data was reported with no further corrective action required.
A	Result is the average of all dilutions, as defined by the method.
B	Analyte was present in the associated method blank.
C	Analyte presence was not confirmed on primary column.
E	Concentration exceeds the calibration range.
H	Sample received and/or analyzed past the recommended holding time.
J	Analyte was detected at a concentration below the reporting limit and above the laboratory method detection limit. Reported value is estimated.
ME	LCS Recovery Percentage is within LCS ME Control Limit range.
N	Nontarget Analyte.
ND	Parameter not detected at the indicated reporting limit.
Q	Spike recovery and RPD control limits do not apply resulting from the parameter concentration in the sample exceeding the spike concentration by a factor of four or greater.
U	Undetected at the laboratory method detection limit.
X	% Recovery and/or RPD out-of-range.
Z	Analyte presence was not confirmed by second column or GC/MS analysis.

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APPENDIX E

Mussel tissue chemistry by station

Appendix E

As part of the resource exchange for participation in the Bight '08 Regional Monitoring Program, mussel bioaccumulation analysis was required only if resident mussels were located in the discharge area (Appendix A). On 18 September 2008, biologist-divers searched in the vicinity of the discharge. No resident mussels and were found on the discharge or intake buoys, the usual source of mussels in the area. Additional searching located only seven resident mussels on a mooring located offshore. These were collected but later were determined to be of insufficient size and number to be consistent with previous methods (SWRCB 1995, 2000); no analysis for tissue metal concentrations was performed.

APPENDIX F

Infauna data by station

Appendix F-1. Infaunal master species list. Ormond Beach Generating Station NPDES, 2008.

PHYLUM (Phy)
- Subphylum or Class
  - Species

CNIDARIA (CN)
- Anthozoa
  - Actiniaria sp A Paquette 2005[1]
  - *Zaolutus actius*

NEMERTEA (NE)
- Anopla
  - *Carinoma mutabilis*
  - Lineidae
- Enopla
  - Hoplonemertea sp A Paquette 1988
  - *Paranemertes californica*[2]
  - *Tetrastemma nigrifrons*
  - *Tetrastemma* sp

NEMATODA (NT)
- Nematoda

MOLLUSCA (MO)
- Gastropoda
  - *Odostomia* sp D MBC 1980
- Bivalvia
  - *Cooperella subdiaphana*
  - *Modiolus* sp
  - Mytilidae
  - *Petricola carditoides*
  - *Rochefortia compressa*
  - *Rochefortia tumida*[3]
  - *Tellina modesta*
  - *Yoldia cooperii*

ANNELIDA (AN)
- Polychaeta
  - *Ampharete labrops*
  - *Aphelochaeta glandaria* Cmplx[4]
  - *Apoprionospio pygmaea*
  - *Aricidea (Acmira) catherinae*[5]
  - *Chaetozone setosa* Cmplx[6]
  - *Chone eiffelturris*[7]
  - *Diopatra splendidissima*
  - Euclymeninae sp A SCAMIT 1987
  - *Exogone lourei*
  - *Glycera americana*
  - *Glycera macrobranchia*[8]
  - *Glycinde armigera*
  - *Goniada littorea*
  - *Goniada maculata*
  - *Hesionella mccullochae*
  - *Magelona berkeleyi*
  - *Magelona sacculata*
  - *Mediomastus acutus*[9]
  - *Mediomastus californiensis*[9]
  - *Monticellina cryptica*[10]
  - *Nephtys caecoides*
  - *Nephtys cornuta*[11]

PHYLUM
- Subphylum or Class
  - Species

ANNELIDA (AN) cont.
- Polychaeta
  - *Notomastus hemipodus*
  - *Onuphis eremita parva*
  - *Onuphis* sp A SCAMIT 1992[12]
  - *Podarkeopsis glabrus*
  - *Scoletoma tetraura* Cmplx[13]
  - *Spiophanes bombyx*
  - *Typosyllis farallonensis*[14]
  - *Typosyllis heterochaeta*[15]

ARTHROPODA (AR)
- Ostracoda
  - *Asteropella slatteryi*
  - *Parasterope hulingsi*
  - *Rutiderma rostratum*
  - *Zeugophilomedes oblongus*[16]
- Malacostraca
  - *Americhelidium shoemakeri*[17]
  - *Ampelisca agassizi*[18]
  - *Anchicolurus occidentalis*
  - *Caprella* cf *verrucosa*
  - *Caprella mendax*
  - *Cyclaspis* sp B SCAMIT 1989
  - *Diastylopsis tenuis*
  - *Foxiphalus obtusidens*[19]
  - *Gammaropsis thompsoni*
  - *Gibberosus myersi*[20]
  - *Hartmanodes hartmanae*[21]
  - *Hippolyte clarki*
  - *Incisocalliope newportensis*
  - *Jassa slatteryi*[22]
  - *Laticorophium baconi*[23]
  - *Monocorophium* spp
  - *Photis brevipes*
  - *Photis* sp
  - *Podocerus* spp
  - *Rhepoxynius abronius*[24]
  - *Rhepoxynius menziesi*[25]
  - *Stenothoe estacola*

ECHINODERMATA (EC)
- Echinoidea
  - *Dendraster excentricus*
- Holothuroidea
  - *Leptosynapta* sp[26]

PHORONA (PR)
- Phoronida
  - Phoronidae

CHORDATA (CO)
- Hemichordata
  - Enteropneusta[27]

Appendix F-1. (Cont.).

PHYLUM Subphylum or Class Species	PHYLUM Subphylum or Class Species

SCAMIT = Southern California Association of Marine Invertebrate Taxonomists

The following footnotes indicate names used in previous surveys:

1 Limnactiniidae sp A SCAMIT 1989
2 *Paranemertes* sp A of SCAMIT
3 *Mysella tumida, M. cf. aleutica*
4 *Aphelochaeta* sp C Dorsey
5 *Acmira catherinae*
6 *Chaetozone "setosa", C.* cf. *setosa*
7 *Chone* sp SD1 Pt. Loma 1997
8 *Glycera convoluta*
9 *Mediomastus* spp (in part)
10 *Monticellina dorsobranchialis, Tharyx* sp A SCAMIT
11 *Nephtys cornuta franciscana*
12 *Onuphis* sp SD1 Pt. Loma 1997
13 *Lumbrineris "tetraura"* or *L. tetraura*
14 *Syllis (Typosyllis) farallonensis*
15 *Syllis (Ehlersia) heterochaeta*
16 *Zeugophilomedes oblongatus, Z. oblongata*
17 *Synchelidium shoemakeri*
18 *Ampelisca compressa*
19 *Paraphoxus obtusidens*
20 *Megaluropus longimerus*
21 *Monoculodes hartmanae*
22 *Jassa falcata*
23 *Corophium baconi*
24 *Paraphoxus abronius*
25 *Paraphoxus epistomus, Rhepoxynius epistomus*
26 *Leptosynapta* sp B Benedict or of MBC
27 Hemichordata

Appendix F-2. Infauna results by station. Ormond Beach Generating Station NPDES, 2008.

Phylum	Species	B2	B3	B4	B5	Total	Percent Total
MO	*Tellina modesta*	22	4	3	8	37	10.25
AN	*Apoprionospio pygmaea*	2	22	2	4	30	8.31
AR	*Diastylopsis tenuis*	4	8	10	8	30	8.31
AR	*Rhepoxynius menziesi*	4	5	8	7	24	6.65
AN	*Mediomastus acutus*	9	1	2	2	14	3.88
AR	*Caprella* cf *verrucosa*	-	9	4	-	13	3.60
AN	*Scoletoma tetraura* Cmplx	4	5	2	-	11	3.05
AR	*Laticorophium baconi*	-	9	-	1	10	2.77
AR	*Photis* sp	-	8	-	-	8	2.22
AR	*Stenothoe estacola*	-	7	1	-	8	2.22
AN	*Aricidea (Acmira) catherinae*	2	2	3	-	7	1.94
AN	*Glycera macrobranchia*	-	-	3	4	7	1.94
AN	*Spiophanes bombyx*	3	-	3	1	7	1.94
AR	*Americhelidium shoemakeri*	4	1	-	2	7	1.94
AR	*Zeugophilomedes oblongus*	1	1	3	2	7	1.94
NE	Lineidae	1	2	3	1	7	1.94
NE	*Carinoma mutabilis*	2	-	1	3	6	1.66
NT	Nematoda	-	3	1	2	6	1.66
AN	*Onuphis* sp A SCAMIT 1992	-	1	1	3	5	1.39
AR	*Photis brevipes*	5	-	-	-	5	1.39
AN	*Chaetozone setosa* Cmplx	-	-	-	4	4	1.11
AN	Euclymeninae sp A SCAMIT 1987	1	-	-	3	4	1.11
AN	*Goniada littorea*	1	2	1	-	4	1.11
AR	*Ampelisca agassizi*	2	-	1	1	4	1.11
AR	*Anchicolurus occidentalis*	3	1	-	-	4	1.11
AR	*Foxiphalus obtusidens*	3	-	1	-	4	1.11
AR	*Gammaropsis thompsoni*	-	4	-	-	4	1.11
AR	*Gibberosus myersi*	3	-	-	1	4	1.11
AR	*Rhepoxynius abronius*	4	-	-	-	4	1.11
EC	*Dendraster excentricus*	2	1	-	1	4	1.11
AN	*Exogone lourei*	1	-	-	2	3	0.83
AN	*Hesionella mccullochae*	-	3	-	-	3	0.83
AN	*Magelona sacculata*	1	-	2	-	3	0.83
AN	*Monticellina cryptica*	2	-	-	1	3	0.83
AN	*Typosyllis heterochaeta*	1	-	2	-	3	0.83
AR	*Rutiderma rostratum*	-	-	-	3	3	0.83
CO	Enteropneusta	2	1	-	-	3	0.83
NE	*Tetrastemma* sp	2	1	-	-	3	0.83
AN	*Chone eiffelturris*	-	-	1	1	2	0.55
AN	*Magelona berkeleyi*	-	-	1	1	2	0.55
AN	*Nephtys caecoides*	1	1	-	-	2	0.55
AR	*Hippolyte clarki*	-	2	-	-	2	0.55
AR	*Jassa slatteryi*	-	2	-	-	2	0.55
MO	*Modiolus* sp	1	1	-	-	2	0.55
MO	*Petricola carditoides*	-	2	-	-	2	0.55
NE	Hoplonemertea sp A Paquette 1988	1	1	-	-	2	0.55
AN	*Ampharete labrops*	1	-	-	-	1	0.28
AN	*Aphelochaeta glandaria* Cmplx	-	-	1	-	1	0.28
AN	*Diopatra splendidissima*	-	-	1	-	1	0.28
AN	*Glycera americana*	-	-	1	-	1	0.28
AN	*Glycinde armigera*	1	-	-	-	1	0.28
AN	*Goniada maculata*	-	-	-	1	1	0.28
AN	*Mediomastus californiensis*	-	-	-	1	1	0.28
AN	*Nephtys cornuta*	1	-	-	-	1	0.28
AN	*Notomastus hemipodus*	-	1	-	-	1	0.28
AN	*Onuphis eremita parva*	-	-	-	1	1	0.28
AN	*Podarkeopsis glabrus*	-	-	1	-	1	0.28
AN	*Typosyllis farallonensis*	-	-	-	1	1	0.28
AR	*Asteropella slatteryi*	-	-	-	1	1	0.28
AR	*Caprella mendax*	-	1	-	-	1	0.28
AR	*Cyclaspis* sp B SCAMIT 1989	1	-	-	-	1	0.28
AR	*Hartmanodes hartmanae*	-	1	-	-	1	0.28
AR	*Incisocalliope newportensis*	1	-	-	-	1	0.28
AR	*Monocorophium* spp	1	-	-	-	1	0.28
AR	*Parasterope hulingsi*	1	-	-	-	1	0.28

Appendix F-2. (Cont.).

Phylum	Species	B2	B3	B4	B5	Total	Percent Total
AR	*Podocerus* spp	-	1	-	-	1	0.28
CN	Actiniaria sp A Paquette 2005	-	-	-	1	1	0.28
CN	*Zaolutus actius*	-	1	-	-	1	0.28
EC	*Leptosynapta* sp	-	-	-	1	1	0.28
MO	*Cooperella subdiaphana*	1	-	-	-	1	0.28
MO	Mytilidae	-	1	-	-	1	0.28
MO	*Odostomia* sp D MBC 1980	-	-	-	1	1	0.28
MO	*Rochefortia compressa*	-	-	-	1	1	0.28
MO	*Rochefortia tumida*	-	-	-	1	1	0.28
MO	*Yoldia cooperii*	-	-	-	1	1	0.28
NE	*Paranemertes californica*	-	1	-	-	1	0.28
NE	*Tetrastemma nigrifrons*	-	-	1	-	1	0.28
PR	Phoronidae	1	-	-	-	1	0.28
	Number of individuals	103	117	64	77	361	
	Number of species	39	36	28	35	78	
	Diversity (H')	3.20	3.08	3.04	3.26	3.73	

Appendix F-3. Infauna data by station and replicate. Ormond Beach Generating Station NPDES, 2008.

Station B2

Phylum	Species	Replicate B2-I	B2-II	Total	Percent Composition	Density No./m²
MO	*Tellina modesta*	12	10	22	21.36	550.0
AN	*Mediomastus acutus*	3	6	9	8.74	225.0
AR	*Photis brevipes*	-	5	5	4.85	125.0
AN	*Scoletoma tetraura* Cmplx	4	-	4	3.88	100.0
AR	*Americhelidium shoemakeri*	2	2	4	3.88	100.0
AR	*Diastylopsis tenuis*	1	3	4	3.88	100.0
AR	*Rhepoxynius abronius*	2	2	4	3.88	100.0
AR	*Rhepoxynius menziesi*	4	-	4	3.88	100.0
AN	*Spiophanes bombyx*	2	1	3	2.91	75.0
AR	*Anchicolurus occidentalis*	-	3	3	2.91	75.0
AR	*Foxiphalus obtusidens*	-	3	3	2.91	75.0
AR	*Gibberosus myersi*	-	3	3	2.91	75.0
AN	*Apoprionospio pygmaea*	1	1	2	1.94	50.0
AN	*Aricidea (Acmira) catherinae*	2	-	2	1.94	50.0
AN	*Monticellina cryptica*	2	-	2	1.94	50.0
AR	*Ampelisca agassizi*	1	1	2	1.94	50.0
CO	Enteropneusta	2	-	2	1.94	50.0
EC	*Dendraster excentricus*	1	1	2	1.94	50.0
NE	*Carinoma mutabilis*	1	1	2	1.94	50.0
NE	*Tetrastemma* sp	2	-	2	1.94	50.0
AN	*Ampharete labrops*	1	-	1	0.97	25.0
AN	Euclymeninae sp A SCAMIT 1987	1	-	1	0.97	25.0
AN	*Exogone lourei*	1	-	1	0.97	25.0
AN	*Glycinde armigera*	1	-	1	0.97	25.0
AN	*Goniada littorea*	1	-	1	0.97	25.0
AN	*Magelona sacculata*	-	1	1	0.97	25.0
AN	*Nephtys caecoides*	-	1	1	0.97	25.0
AN	*Nephtys cornuta*	-	1	1	0.97	25.0
AN	*Typosyllis heterochaeta*	1	-	1	0.97	25.0
AR	*Cyclaspis* sp B SCAMIT 1989	-	1	1	0.97	25.0
AR	*Incisocalliope newportensis*	-	1	1	0.97	25.0
AR	*Monocorophium* spp	-	1	1	0.97	25.0
AR	*Parasterope hulingsi*	-	1	1	0.97	25.0
AR	*Zeugophilomedes oblongus*	1	-	1	0.97	25.0
MO	*Cooperella subdiaphana*	-	1	1	0.97	25.0
MO	*Modiolus* sp	1	-	1	0.97	25.0
NE	Hoplonemertea sp A Paquette 1988	1	-	1	0.97	25.0
NE	Lineidae	-	1	1	0.97	25.0
PR	Phoronidae	-	1	1	0.97	25.0

Summary

Parameter	Replicate B2-I	B2-II	Station Total	Overall Mean	S.D.
Number of individuals	51	52	103	51.5	0.7
Number of species	25	24	39	24.5	0.7
Diversity (H')	2.87	2.84	3.20	2.86	0.02

Appendix F-3. (Cont.).

Station B3

Phylum	Species	Replicate B3-I	Replicate B3-II	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	8	14	22	18.80	550.0
AR	*Caprella* cf *verrucosa*	6	3	9	7.69	225.0
AR	*Laticorophium baconi*	5	4	9	7.69	225.0
AR	*Diastylopsis tenuis*	6	2	8	6.84	200.0
AR	*Photis* sp	2	6	8	6.84	200.0
AR	*Stenothoe estacola*	5	2	7	5.98	175.0
AN	*Scoletoma tetraura* Cmplx	4	1	5	4.27	125.0
AR	*Rhepoxynius menziesi*	4	1	5	4.27	125.0
AR	*Gammaropsis thompsoni*	3	1	4	3.42	100.0
MO	*Tellina modesta*	4	-	4	3.42	100.0
AN	*Hesionella mccullochae*	-	3	3	2.56	75.0
NT	Nematoda	2	1	3	2.56	75.0
AN	*Aricidea (Acmira) catherinae*	2	-	2	1.71	50.0
AN	*Goniada littorea*	2	-	2	1.71	50.0
AR	*Hippolyte clarki*	1	1	2	1.71	50.0
AR	*Jassa slatteryi*	2	-	2	1.71	50.0
MO	*Petricola carditoides*	1	1	2	1.71	50.0
NE	Lineidae	-	2	2	1.71	50.0
AN	*Mediomastus acutus*	-	1	1	0.85	25.0
AN	*Nephtys caecoides*	-	1	1	0.85	25.0
AN	*Notomastus hemipodus*	-	1	1	0.85	25.0
AN	*Onuphis* sp A SCAMIT 1992	1	-	1	0.85	25.0
AR	*Americhelidium shoemakeri*	-	1	1	0.85	25.0
AR	*Anchicolurus occidentalis*	1	-	1	0.85	25.0
AR	Caprella mendax	1	-	1	0.85	25.0
AR	*Hartmanodes hartmanae*	1	-	1	0.85	25.0
AR	*Podocerus* spp	-	1	1	0.85	25.0
AR	*Zeugophilomedes oblongus*	1	-	1	0.85	25.0
CN	*Zaolutus actius*	1	-	1	0.85	25.0
CO	Enteropneusta	-	1	1	0.85	25.0
EC	*Dendraster excentricus*	1	-	1	0.85	25.0
MO	*Modiolus* sp	1	-	1	0.85	25.0
MO	Mytilidae	1	-	1	0.85	25.0
NE	*Hoplonemertea* sp A Paquette 1988	1	-	1	0.85	25.0
NE	*Paranemertes californica*	-	1	1	0.85	25.0
NE	*Tetrastemma* sp	-	1	1	0.85	25.0

Summary

Parameter	Replicate B3-I	Replicate B3-II	Station Total	Overall Mean	Overall S.D.
Number of individuals	67	50	117	58.5	12.0
Number of species	26	22	36	24.0	2.8
Diversity (H')	2.99	2.63	3.08	2.81	0.26

Appendix F-3. (Cont.).

Station B4

Phylum	Species	Replicate B4-I	Replicate B4-II	Total	Percent Composition	Density No./m²
AR	*Diastylopsis tenuis*	3	7	10	15.63	250.0
AR	*Rhepoxynius menziesi*	4	4	8	12.50	200.0
AR	*Caprella* cf *verrucosa*	2	2	4	6.25	100.0
AN	*Aricidea (Acmira) catherinae*	3	-	3	4.69	75.0
AN	*Glycera macrobranchia*	1	2	3	4.69	75.0
AN	*Spiophanes bombyx*	1	2	3	4.69	75.0
AR	*Zeugophilomedes oblongus*	2	1	3	4.69	75.0
MO	*Tellina modesta*	3	-	3	4.69	75.0
NE	Lineidae	2	1	3	4.69	75.0
AN	*Apoprionospio pygmaea*	-	2	2	3.13	50.0
AN	*Magelona sacculata*	2	-	2	3.13	50.0
AN	*Mediomastus acutus*	1	1	2	3.13	50.0
AN	*Scoletoma tetraura* Cmplx	2	-	2	3.13	50.0
AN	*Typosyllis heterochaeta*	-	2	2	3.13	50.0
AN	*Aphelochaeta glandaria* Cmplx	-	1	1	1.56	25.0
AN	*Chone eiffelturris*	1	-	1	1.56	25.0
AN	*Diopatra splendidissima*	-	1	1	1.56	25.0
AN	*Glycera americana*	1	-	1	1.56	25.0
AN	*Goniada littorea*	-	1	1	1.56	25.0
AN	*Magelona berkeleyi*	1	-	1	1.56	25.0
AN	*Onuphis* sp A SCAMIT 1992	-	1	1	1.56	25.0
AN	*Podarkeopsis glabrus*	1	-	1	1.56	25.0
AR	*Ampelisca agassizi*	-	1	1	1.56	25.0
AR	*Foxiphalus obtusidens*	-	1	1	1.56	25.0
AR	*Stenothoe estacola*	-	1	1	1.56	25.0
NE	*Carinoma mutabilis*	-	1	1	1.56	25.0
NE	*Tetrastemma nigrifrons*	-	1	1	1.56	25.0
NT	Nematoda	1	-	1	1.56	25.0

Summary

Parameter	Replicate B4-I	Replicate B4-II	Station Total	Overall Mean	Overall S.D.
Number of individuals	31	33	64	32.0	1.4
Number of species	17	19	28	18.0	1.4
Diversity (H')	2.71	2.71	3.04	2.71	0.00

Appendix F-3. (Cont.).

Station B5

Phylum	Species	Replicate B5-I	Replicate B5-II	Total	Percent Composition	Density No./m²
AR	*Diastylopsis tenuis*	5	3	8	10.39	200.0
MO	*Tellina modesta*	1	7	8	10.39	200.0
AR	*Rhepoxynius menziesi*	5	2	7	9.09	175.0
AN	*Apoprionospio pygmaea*	-	4	4	5.19	100.0
AN	*Chaetozone setosa* Cmplx	2	2	4	5.19	100.0
AN	*Glycera macrobranchia*	1	3	4	5.19	100.0
AN	Euclymeninae sp A SCAMIT 1987	1	2	3	3.90	75.0
AN	*Onuphis* sp A SCAMIT 1992	2	1	3	3.90	75.0
AR	*Rutiderma rostratum*	1	2	3	3.90	75.0
NE	*Carinoma mutabilis*	2	1	3	3.90	75.0
AN	*Exogone lourei*	1	1	2	2.60	50.0
AN	*Mediomastus acutus*	1	1	2	2.60	50.0
AR	*Americhelidium shoemakeri*	-	2	2	2.60	50.0
AR	*Zeugophilomedes oblongus*	1	1	2	2.60	50.0
NT	Nematoda	2	-	2	2.60	50.0
AN	*Chone eiffelturris*	1	-	1	1.30	25.0
AN	*Goniada maculata*	1	-	1	1.30	25.0
AN	*Magelona berkeleyi*	-	1	1	1.30	25.0
AN	*Mediomastus californiensis*	-	1	1	1.30	25.0
AN	*Monticellina cryptica*	-	1	1	1.30	25.0
AN	*Onuphis eremita parva*	1	-	1	1.30	25.0
AN	*Spiophanes bombyx*	-	1	1	1.30	25.0
AN	*Typosyllis farallonensis*	-	1	1	1.30	25.0
AR	*Ampelisca agassizi*	1	-	1	1.30	25.0
AR	*Asteropella slatteryi*	1	-	1	1.30	25.0
AR	*Gibberosus myersi*	1	-	1	1.30	25.0
AR	*Laticorophium baconi*	1	-	1	1.30	25.0
CN	*Actiniaria* sp A Paquette 2005	-	1	1	1.30	25.0
EC	*Dendraster excentricus*	-	1	1	1.30	25.0
EC	*Leptosynapta* sp	1	-	1	1.30	25.0
MO	*Odostomia* sp D MBC 1980	1	-	1	1.30	25.0
MO	*Rochefortia compressa*	-	1	1	1.30	25.0
MO	*Rochefortia tumida*	1	-	1	1.30	25.0
MO	*Yoldia cooperii*	1	-	1	1.30	25.0
NE	Lineidae	-	1	1	1.30	25.0

Summary

Parameter	Replicate B5-I	Replicate B5-II	Station Total	Overall Mean	Overall S.D.
Number of individuals	36	41	77	38.5	3.5
Number of species	24	23	35	23.5	0.7
Diversity (H')	2.98	2.92	3.26	2.95	0.05

Appendix F-4. Infaunal wet weight biomass data (g). Ormond Beach Generating Station NPDES, 2008.

Sta-Rep	Annelida	Arthropoda	Mollusca	Echinodermata	Misc.	Total
B2-I	0.0264	0.0066	0.0072	0.0088	0.0390	0.0880
B2-II	0.0218	0.0049	0.0512	0.0147	0.0851	0.1777
Total	0.0482	0.0115	0.0584	0.0235	0.1241	0.2657
B3-I	0.0545	0.0442	0.0119	0.0128	0.0632	0.1866
B3-II	0.4294	0.0172	0.0580	-	0.0452	0.5498
Total	0.4839	0.0614	0.0699	0.0128	0.1084	0.7364
B4-I	0.2832	0.0075	0.2141	-	<0.0001	0.5048
B4-II	1.1157	0.0107	-	-	0.0214	1.1478
Total	1.3989	0.0182	0.2141	-	0.0214	1.6526
B5-I	0.0780	0.0128	0.0569	0.1269	<0.0001	0.2746
B5-II	0.0839	0.0147	0.0384	0.0149	0.0791	0.2310
Total	0.1619	0.0275	0.0953	0.1418	0.0791	0.5056
Grand Total	2.0929	0.1186	0.4377	0.1781	0.3330	3.1603

Note: - = no animals

Appendix F-5. Yearly abundance of the top 40 infaunal species. Ormond Beach Generating Station NPDES, 2008.

Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total	% Total
		Year																						
NT	Nematoda	7	5	-	2	6	2	-	-	5	8375	-	5	24	6	15	61	17	10	8	25	6	8579	20.18
AN	*Apoprionospio pygmaea*	29	108	9	464	42	509	17	12	156	43	41	94	53	948	73	44	256	128	120	601	30	3777	8.89
AN	*Owenia collaris*	3	2	-	6	4	82	-	-	2	5	10	59	3275	111	2	1	1	1	2	18	-	3584	8.43
AR	*Diastylopsis tenuis*	306	110	28	80	59	23	1	19	62	67	1	391	728	136	108	10	54	32	209	48	30	2502	5.89
EC	*Dendraster excentricus*	8	11	7	9	9	-	4	5	33	1075	31	32	118	360	62	333	88	42	51	94	4	2376	5.59
AN	*Mediomastus acutus*	28	30	-	-	-	-	-	2	27	66	282	86	124	94	43	44	72	81	106	129	14	1228	2.89
MO	*Tellina modesta*	8	48	23	13	29	5	3	1	32	22	13	105	316	106	37	9	87	6	39	95	37	1034	2.43
AR	*Rhepoxynius menziesi*	32	57	27	45	44	26	14	11	50	16	24	137	256	48	31	4	31	21	50	49	24	997	2.35
MO	*Siliqua lucida*	1	17	17	10	-	7	-	22	29	31	15	473	11	14	12	2	3	8	7	106	-	785	1.85
AN	*Pectinaria californiensis*	3	-	1	123	2	-	-	1	-	15	1	465	46	19	4	1	-	2	-	22	-	705	1.66
AN	*Spiophanes bombyx*	9	39	22	53	22	17	28	24	33	19	13	32	63	33	33	16	40	19	10	30	7	562	1.32
NE	*Carinoma mutabilis*	-	4	9	12	13	13	32	10	20	43	22	16	19	54	43	25	58	29	69	22	6	519	1.22
AN	*Armandia brevis*	1	2	-	1	-	3	-	-	3	-	1	23	3	324	9	61	18	26	5	37	-	517	1.22
AR	*Photis macinerneyi*	-	-	4	66	12	1	-	-	5	43	2	72	166	29	14	2	10	4	15	23	-	468	1.10
AN	*Magelona sacculata*	7	100	37	127	27	66	12	3	-	-	-	-	5	8	8	-	-	2	-	2	3	407	0.96
AR	*Gibberosus myersi*	7	3	4	9	5	18	-	-	11	11	2	31	140	37	30	3	39	6	19	2	4	381	0.90
AR	*Anchicolurus occidentalis*	5	6	7	15	10	12	3	1	15	17	1	98	123	13	13	2	2	14	4	5	4	370	0.87
AR	*Rhepoxynius abronius*	9	24	1	8	8	28	8	-	5	6	5	14	108	65	16	-	3	7	19	26	4	364	0.86
AN	*Aricidea (Acmira) catherinae*	26	70	6	18	10	12	21	5	12	8	2	11	9	39	19	5	20	33	15	1	7	349	0.82
AR	*Aoroides inermis*	-	-	-	-	-	-	-	-	-	-	-	188	43	60	22	3	-	5	-	6	-	327	0.77
AN	*Exogone lourei*	3	1	-	-	24	2	1	-	6	52	6	18	21	8	5	57	38	9	37	28	3	319	0.75
AR	*Photis brevipes*	6	-	-	-	3	2	-	-	5	1	15	106	122	14	11	15	-	-	3	6	5	314	0.74
AN	*Onuphis* sp 1 Pt. Loma 1983	-	-	-	-	-	-	-	-	-	35	13	7	17	24	10	8	11	35	49	97	5	311	0.73
AN	*Goniada littorea*	42	18	9	10	24	20	4	6	15	14	12	27	17	10	15	3	6	2	15	23	4	296	0.70
AN	*Scoloplos armiger* Cmplx	7	6	21	25	28	43	19	5	18	43	11	5	1	3	8	-	11	1	-	3	-	258	0.61
AR	*Euphilomedes longiseta*	-	10	-	-	1	-	-	-	-	-	-	63	163	-	5	-	3	2	1	3	-	251	0.59
MO	*Cooperella subdiaphana*	-	-	2	7	3	-	-	-	-	5	4	18	90	10	9	6	1	-	5	89	1	250	0.59
AN	*Chaetozone setosa* Cmplx	10	14	2	6	55	16	13	2	5	8	12	-	-	5	22	8	33	6	11	12	4	244	0.57
AR	*Jassa slatteryi*	-	-	-	-	9	-	-	-	-	-	-	93	86	4	-	-	5	6	-	36	2	241	0.57
NE	Lineidae	-	-	-	4	-	-	-	-	5	9	1	3	10	12	6	8	44	12	20	82	7	223	0.52
AN	*Capitella capitata* Cmplx	-	1	191	-	-	14	-	-	-	-	-	-	1	4	-	-	-	-	-	-	-	211	0.50
AR	*Isocheles pilosus*	1	4	3	9	3	-	-	-	-	-	-	1	176	-	-	-	-	-	-	-	-	197	0.46
AR	*Ericthonius brasiliensis*	-	-	-	-	-	-	-	-	-	-	-	130	3	6	2	1	-	-	-	54	-	196	0.46
AR	*Ampelisca agassizi*	-	1	1	16	64	10	2	-	4	3	-	1	5	4	45	1	7	3	2	8	4	181	0.43
AN	*Mediomastus* spp	2	20	-	37	34	6	3	-	-	13	46	12	6	-	-	-	-	-	-	-	-	179	0.42
Number of individuals		988	1267	576	1717	878	1238	312	244	933	10393	781	3373	7829	3311	1187	1095	1381	963	1289	2388	361	42504	
Number of species		108	144	92	140	129	100	60	60	149	124	91	162	206	174	152	114	119	133	107	165	78	575	
Diversity (H')		3.35	3.92	3.17	3.41	4.00	2.91	3.49	3.52	3.97	0.99	3.11	3.45	2.94	3.28	4.19	3.28	3.60	3.98	3.54	3.62	3.73	3.85	
Number of stations/reps		7/4	7/4	7/4*	7/4	6/4	6/4	6/4	6/4	6/4	6/4	3/4	6/4	6/4	6/4	6/4	4/2	6/4	6/4	6/4	6/4	4/2		
Total biomass		NR	NR	28.0	1.43	75.3	2.71	21.4	16.1	12.7	7.96	6.02	78.9	437	16.6	28.9	6.3	6.2	6.8	7.3	9.5	3.2		

NR = Not Reported
F.O. = Frequency of Occurrence
Note: 0.00 = <0.005
* = Samples screened on 1.0 mm screen, all other years on 0.5 mm screen.

Appendix F-6. Index of Relative Importance for the top 25 infaunal organisms observed during infaunal sampling and contigency table of Spearman rank correlation coefficients by year, 1990 - 2008. Ormond Beach Generating Station NPDES, 2008.

Species	1990	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Apoprionospio pygmaea	1	1	7	2	3	11	1	2	5	1	1	15	1	3
Mediomastus acutus	20	8	4	1	7	7	8	5	2	3	2	1	2	5
Diastylopsis tenuis	3	2	2	18	1	2	3	1	9	6	4	20	6	1
Dendraster excentricus	14	4	1	4	14	5	2	4	1	5	4	6	4	11
Tellina modesta	4	9	10	7	5	4	10	6	10	2	16	4	3	2
Rhepoxynius menziesi	1	5	16	5	2	2	8	7	13	9	9	13	7	3
Spiophanes bombyx	5	3	9	6	12	9	11	8	8	7	8	5	9	6
Carinoma mutabilis	10	6	5	3	16	16	7	3	7	4	6	2	14	7
Anchicolurus occidentalis	11	11	15	18	8	10	18	13	17	19	10	2	19	13
Aricidea (Acmira) catherinae	11	13	18	15	21	21	12	8	11	11	3	8	24	9
Nematoda	14	15	2	22	22	15	23	17	2	12	11	9	13	8
Goniada littorea	5	12	13	9	14	17	18	11	14	16	19	16	11	12
Exogone lourei	9	16	6	13	19	18	21	23	5	10	12	14	12	16
Siliqua lucida	20	6	11	8	5	20	17	16	17	17	15	21	5	19
Gibberosus myersi	16	14	17	15	17	6	13	10	14	8	14	18	22	13
Rhepoxynius abronius	13	18	19	13	17	12	5	12	22	17	13	23	10	13
Armandia brevis	20	19	22	18	20	23	6	18	2	12	7	21	7	19
Photis macinerneyi	20	16	11	15	10	8	14	13	17	15	18	24	15	19
Owenia collaris	17	21	20	12	9	1	4	24	20	20	22	16	17	19
Scoloplos armiger Cmplx	7	10	8	11	23	24	24	18	22	14	22	6	20	19
Pectinaria californiensis	19	22	13	18	3	13	16	22	20	21	19	9	16	19
Photis brevipes	18	19	21	9	12	13	20	21	11	21	24	24	18	16
Aoroides inermis	20	22	22	22	10	18	14	15	14	21	17	19	21	19
Magelona sacculata	8	22	22	22	24	22	21	20	22	21	19	9	22	18
Onuphis sp A SCAMIT 1992	20	22	22	22	24	25	25	25	22	21	24	12	25	10
1990	-	**0.57**	0.35	0.32	0.17	0.26	0.19	**0.48**	0.13	**0.48**	0.28	0.39	0.27	**0.60**
1994	-	-	**0.72**	**0.70**	**0.45**	**0.43**	**0.47**	**0.82**	**0.50**	**0.81**	**0.68**	**0.68**	**0.67**	**0.66**
1997	-	-	-	**0.48**	0.27	0.35	0.22	**0.55**	**0.58**	**0.71**	**0.52**	**0.55**	**0.59**	**0.48**
1998	-	-	-	-	0.39	0.40	**0.48**	**0.56**	**0.40**	**0.64**	0.38	**0.46**	**0.64**	**0.41**
1999	-	-	-	-	-	**0.67**	**0.49**	**0.43**	0.14	0.25	0.24	0.24	**0.57**	0.26
2000	-	-	-	-	-	-	**0.61**	**0.50**	0.24	**0.44**	0.27	0.38	**0.45**	**0.42**
2001	-	-	-	-	-	-	-	**0.66**	**0.41**	**0.57**	**0.63**	**0.63**	**0.60**	**0.37**
2002	-	-	-	-	-	-	-	-	**0.51**	**0.81**	**0.76**	**0.81**	**0.57**	**0.74**
2003	-	-	-	-	-	-	-	-	-	**0.72**	**0.73**	**0.67**	**0.60**	**0.50**
2004	-	-	-	-	-	-	-	-	-	-	**0.76**	**0.85**	**0.66**	**0.71**
2005	-	-	-	-	-	-	-	-	-	-	-	**0.90**	**0.56**	**0.59**
2006	-	-	-	-	-	-	-	-	-	-	-	-	**0.56**	**0.76**
2007	-	-	-	-	-	-	-	-	-	-	-	-	-	**0.45**

APPENDIX G

Fish and macroinvertebrate heat treatment and normal operation data

Appendix G-1. Species list of impinged fish and macroinvertebrate species. Ormond Beach Generating Station NPDES, 2008.

Phylum / Class / Family / *Species*	Common name
Arthropoda	
Malacostraca	
Cancridae	
Metacarcinus anthonyi	yellow crab
Metacarcinus gracilis	graceful crab
Romaleon antennarius	Pacific rock crab
Romaleon jordani	hairy rock crab
Cancer productus	red rock crab
Crangonidae	
Crangon nigromaculata	blackspotted bay shrimp
Hippolytidae	
Lysmata californica	red rock shrimp
Portunidae	
Portunus xantusii	Xantus swimming crab
Chordata	
Thaliacea	
Salpidae	
Thetys vagina	common salp
Cnidaria	
Hydrozoa	
Polyorchidae	
Polyorchis montereyensis	Monterey jelly
Scyphozoa	
Pelagiidae	
Chrysaora colorata	purple-striped jellyfish
Ulmaridae	
Aurelia labiata	moon jelly
Echinodermata	
Asteroidea	
Asterinidae	
Pisaster giganteus	giant-spined sea star
Holothuroidea	
Stichopodidae	
Parastichopus parvimensis	warty sea cucumber
Mollusca	
Cephalopoda	
Loliginidae	
Loligo opalescens	California market squid
Octopodidae	
Octopus bimaculatus/bimaculoides	California two-spot octopus
Chordata	
Chondrichthyes	
Heterodontidae	
Heterodontus francisci	horn shark
Myliobatidae	
Myliobatis californica	bat ray
Platyrhinidae	
Platyrhinoidis triseriata	thornback
Torpedinidae	
Torpedo californica	Pacific electric ray
Actinopterygii	
Batrachoididae	
Porichthys notatus	plainfin midshipman
Porichthys myriaster	specklefin midshipman
Carangidae	
Trachurus symmetricus	jack mackerel
Clupeidae	
Sardinops sagax	Pacific sardine
Cottidae	
Scorpaenichthys marmoratus	cabezon
Embiotocidae	
Cymatogaster aggregata	shiner perch
Brachyistius frenatus	kelp perch
Engraulidae	
Engraulis mordax	northern anchovy
Paralichthyidae	
Citharichthys stigmaeus	speckled sanddab
Sciaenidae	
Seriphus politus	queenfish
Scorpaenidae	
Sebastes serranoides	olive rockfish
Syngnathidae	
Syngnathus leptorhynchus	bay pipefish

Appendix G-2. Abundance of fish impinged during normal operations by survey date. Ormond Beach Generating Station NPDES, 2008.

Species	10/16/2007	11/2/2007	12/13/2007	1/25/2008	2/28/2008	3/2/2008	4/2/2008	5/16/2008	6/19/2008	7/2/2008	8/19/2008	9/16/2008	Total Abundance
Syngnathus leptorhynchus	1	4	1	5	31	15	2	-	2	4	1	1	67
Seriphus politus	-	-	-	-	3	-	-	15	-	-	-	-	18
Porichthys myriaster	-	-	-	-	4	-	-	-	-	-	-	-	4
Torpedo californica	-	-	1	-	1	-	-	1	-	-	-	-	3
Trachurus symmetricus	-	-	-	-	-	-	-	3	-	-	-	-	3
Heterodontus francisci	-	-	-	2	-	-	-	-	-	-	-	-	2
Platyrhinoidis triseriata	-	-	-	-	1	1	-	-	-	-	-	-	2
Porichthys notatus	-	-	-	-	-	-	-	2	-	-	-	-	2
Brachyistius frenatus	-	-	1	-	-	-	-	-	-	-	-	-	1
Citharichthys stigmaeus	-	-	-	-	-	1	-	-	-	-	-	-	1
Cymatogaster aggregata	-	-	-	-	-	-	-	1	-	-	-	-	1
Engraulis mordax	-	-	-	-	-	-	-	1	-	-	-	-	1
Myliobatis californica	-	-	-	1	-	-	-	-	-	-	-	-	1
Sardinops sagax	1	-	-	-	-	-	-	-	-	-	-	-	1
Scorpaenichthys marmoratus	-	-	-	-	-	-	-	-	-	-	1	-	1
Sebastes serranoides	-	-	-	-	-	-	-	-	-	1	-	-	1
Total Abundance	2	4	3	8	40	17	2	23	2	5	2	1	109
Number of Taxa	2	1	3	3	5	3	1	6	1	2	2	1	16

Appendix G-3. Biomass (kg) of fish impinged during normal operations by survey date. Ormond Beach Generating Station NPDES, 2008.

Species	10/16/2007	11/2/2007	12/13/2007	1/25/2008	2/28/2008	3/2/2008	4/2/2008	5/16/2008	6/19/2008	7/2/2008	8/19/2008	9/16/2008	Total Biomass (kg)
Torpedo californica	-	-	11.500	-	9.600	-	-	3.775	-	-	-	-	24.875
Heterodontus francisci	-	-	-	1.399	-	-	-	-	-	-	-	-	1.399
Myliobatis californica	-	-	-	0.897	-	-	-	-	-	-	-	-	0.897
Seriphus politus	-	-	-	-	0.068	-	-	0.731	-	-	-	-	0.799
Platyrhinoidis triseriata	-	-	-	-	0.243	0.449	-	-	-	-	-	-	0.692
Syngnathus leptorhynchus	0.002	0.014	0.003	0.030	0.093	0.037	0.002	-	0.007	0.007	0.005	0.003	0.203
Trachurus symmetricus	-	-	-	-	-	-	-	0.102	-	-	-	-	0.102
Porichthys notatus	-	-	-	-	-	-	-	0.094	-	-	-	-	0.094
Porichthys myriaster	-	-	-	-	0.081	-	-	-	-	-	-	-	0.081
Sebastes serranoides	-	-	-	-	-	-	-	-	-	0.044	-	-	0.044
Scorpaenichthys marmoratus	-	-	-	-	-	-	-	-	-	-	0.038	-	0.038
Cymatogaster aggregata	-	-	-	-	-	-	-	0.020	-	-	-	-	0.020
Engraulis mordax	-	-	-	-	-	-	-	0.019	-	-	-	-	0.019
Sardinops sagax	0.015	-	-	-	-	-	-	-	-	-	-	-	0.015
Brachyistius frenatus	-	-	0.009	-	-	-	-	-	-	-	-	-	0.009
Citharichthys stigmaeus	-	-	-	-	-	0.008	-	-	-	-	-	-	0.008
Total Biomass (kg)	0.017	0.014	11.512	2.326	10.085	0.494	0.002	4.741	0.007	0.051	0.043	0.003	29.295

Appendix G-4. Estimated monthly abundance of fish impinged during normal operations. Ormond Beach Generating Station NPDES, 2008.

	2007			2008									Total
Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Abundance
Syngnathus leptorhynchus	25	51	6	22	136	214	38	-	25	74	19	22	632
Seriphus politus	-	-	-	-	13	-	-	274	-	-	-	-	287
Trachurus symmetricus	-	-	-	-	-	-	-	55	-	-	-	-	55
Porichthys notatus	-	-	-	-	-	-	-	36	-	-	-	-	36
Torpedo californica	-	-	6	-	4	-	-	18	-	-	-	-	28
Sardinops sagax	25	-	-	-	-	-	-	-	-	-	-	-	25
Scorpaenichthys marmoratus	-	-	-	-	-	-	-	-	-	-	19	-	19
Sebastes serranoides	-	-	-	-	-	-	-	-	-	19	-	-	19
Cymatogaster aggregata	-	-	-	-	-	-	-	18	-	-	-	-	18
Engraulis mordax	-	-	-	-	-	-	-	18	-	-	-	-	18
Platyrhinoidis triseriata	-	-	-	-	4	14	-	-	-	-	-	-	18
Porichthys myriaster	-	-	-	-	18	-	-	-	-	-	-	-	18
Citharichthys stigmaeus	-	-	-	-	-	14	-	-	-	-	-	-	14
Heterodontus francisci	-	-	-	9	-	-	-	-	-	-	-	-	9
Brachyistius frenatus	-	-	6	-	-	-	-	-	-	-	-	-	6
Myliobatis californica	-	-	-	4	-	-	-	-	-	-	-	-	4
Total Abundance	50	51	18	35	175	242	38	419	25	93	38	22	1,206
Number of Species	2	1	3	3	5	3	1	6	1	2	2	1	16

Appendix G-5. Estimated monthly biomass (kg) of fish impinged during normal operations. Ormond Beach Generating Station NPDES, 2008.

	2007			2008									Total
Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Biomass (kg)
Torpedo californica	-	-	68.101	-	42.207	-	-	68.893	-	-	-	-	179.201
Seriphus politus	-	-	-	-	0.299	-	-	13.341	-	-	-	-	13.640
Platyrhinoidis triseriata	-	-	-	-	1.068	6.417	-	-	-	-	-	-	7.485
Heterodontus francisci	-	-	-	6.175	-	-	-	-	-	-	-	-	6.175
Myliobatis californica	-	-	-	3.959	-	-	-	-	-	-	-	-	3.959
Trachurus symmetricus	-	-	-	-	-	-	-	1.861	-	-	-	-	1.861
Syngnathus leptorhynchus	0.049	0.179	0.018	0.132	0.409	0.529	0.038	-	0.089	0.130	0.097	0.065	1.735
Porichthys notatus	-	-	-	-	-	-	-	1.715	-	-	-	-	1.715
Sebastes serranoides	-	-	-	-	-	-	-	-	-	0.815	-	-	0.815
Scorpaenichthys marmoratus	-	-	-	-	-	-	-	-	-	-	0.737	-	0.737
Sardinops sagax	0.369	-	-	-	-	-	-	-	-	-	-	-	0.369
Cymatogaster aggregata	-	-	-	-	-	-	-	0.365	-	-	-	-	0.365
Porichthys myriaster	-	-	-	-	0.356	-	-	-	-	-	-	-	0.356
Engraulis mordax	-	-	-	-	-	-	-	0.347	-	-	-	-	0.347
Citharichthys stigmaeus	-	-	-	-	-	0.114	-	-	-	-	-	-	0.114
Brachyistius frenatus	-	-	0.053	-	-	-	-	-	-	-	-	-	0.053
Total Biomass (kg)	0.418	0.179	68.172	10.266	44.339	7.060	0.038	86.522	0.089	0.945	0.834	0.065	218.927

Appendix G-6. Length frequency of impinged fish measured during normal operation surveys. Ormond Beach Generating Station NPDES, 2008.

	Size Class (cm)																														
Species	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	31	34	41	43	49	61	83	94	Total Measured
Brachyistius frenatus	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Citharichthys stigmaeus	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Cymatogaster aggregata	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Engraulis mordax	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
*Heterodontus francisci**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	2
*Myliobatis californica***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
*Platyrhinoidis triseriata**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	2
Porichthys myriaster	-	1	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Porichthys notatus	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Sardinops sagax	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Scorpaenichthys marmoratus	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Sebastes serranoides	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Seriphus politus	1	-	-	1	2	1	3	5	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18
Syngnathus leptorhynchus	-	-	-	-	-	-	-	-	-	-	1	4	5	9	9	14	5	7	5	3	2	2	-	1	-	-	-	-	-	-	67
*Torpedo californica**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	3
Trachurus symmetricus	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3

Note: * = Total Length, ** = Disc Width

Appendix G-7. Abundance of macroinvertebrates impinged during normal operations by survey date. Ormond Beach Generating Station NPDES, 2008.

Species	10/16/2007	11/2/2007	12/13/2007	1/25/2008	2/28/2008	3/2/2008	4/2/2008	5/16/2008	6/19/2008	7/2/2008	8/19/2008	9/16/2008	Total Abundance
Metacarcinus anthonyi	16	62	-	-	-	-	-	-	-	-	1	-	79
Romaleon antennarius	6	14	6	11	6	3	2	1	2	-	1	5	57
Aurelia labiata	-	-	-	-	-	-	-	36	-	-	-	-	36
Crangon nigromaculata	-	-	-	-	2	2	-	5	3	5	-	-	17
Cancer productus	2	2	-	-	-	-	3	-	1	-	-	-	8
Thetys vagina	-	-	6	-	-	-	-	-	-	-	-	1	7
Romaleon jordani	4	-	-	-	-	-	-	-	-	-	-	-	4
Chrysaora colorata	-	-	2	-	-	-	-	-	-	-	-	-	2
Octopus bimaculatus/bimaculoides	-	-	-	-	-	-	-	1	-	-	1	-	2
Loligo opalescens	-	-	1	-	-	-	-	-	-	-	-	-	1
Lysmata californica	-	-	-	-	-	1	-	-	-	-	-	-	1
Metacarcinus gracilis	-	-	-	-	-	-	-	-	1	-	-	-	1
Parastichopus parvimensis	-	1	-	-	-	-	-	-	-	-	-	-	1
Pisaster giganteus	1	-	-	-	-	-	-	-	-	-	-	-	1
Polyorchis montereyensis	1	-	-	-	-	-	-	-	-	-	-	-	1
Portunus xantusii	-	-	-	1	-	-	-	-	-	-	-	-	1
Total Abundance	30	79	15	12	8	6	5	43	7	5	3	6	219
Number of Species	6	4	4	2	2	3	2	4	4	1	3	2	16

Appendix G-8. Biomass (kg) of macroinvertebrates impinged during normal operations by survey date. Ormond Beach Generating Station NPDES, 2008.

Species	10/16/2007	11/2/2007	12/13/2007	1/25/2008	2/28/2008	3/2/2008	4/2/2008	5/16/2008	6/19/2008	7/2/2008	8/19/2008	9/16/2008	Total Biomass (kg)
Aurelia labiata	-	-	-	-	-	-	-	29.600	-	-	-	-	29.600
Romaleon antennarius	0.327	0.753	0.257	0.753	0.465	0.237	0.155	0.238	0.170	-	0.015	0.152	3.522
Metacarcinus anthonyi	0.269	1.561	-	-	-	-	-	-	-	-	0.020	-	1.850
Chrysaora colorata	-	-	1.316	-	-	-	-	-	-	-	-	-	1.316
Thetys vagina	-	-	0.264	-	-	-	-	-	-	-	-	0.031	0.295
Pisaster giganteus	0.188	-	-	-	-	-	-	-	-	-	-	-	0.188
Cancer productus	0.049	0.019	-	-	-	-	0.029	-	0.079	-	-	-	0.176
Parastichopus parvimensis	-	0.127	-	-	-	-	-	-	-	-	-	-	0.127
Romaleon jordani	0.080	-	-	-	-	-	-	-	-	-	-	-	0.080
Crangon nigromaculata	-	-	-	-	0.009	0.008	-	0.021	0.014	0.012	-	-	0.064
Loligo opalescens	-	-	0.045	-	-	-	-	-	-	-	-	-	0.045
Portunus xantusii	-	-	-	0.044	-	-	-	-	-	-	-	-	0.044
Octopus bimaculatus/bimaculoides	-	-	-	-	-	-	-	0.024	-	-	0.007	-	0.031
Polyorchis montereyensis	0.022	-	-	-	-	-	-	-	-	-	-	-	0.022
Metacarcinus gracilis	-	-	-	-	-	-	-	-	0.007	-	-	-	0.007
Lysmata californica	-	-	-	-	-	0.002	-	-	-	-	-	-	0.002
Total Biomass (kg)	0.935	2.460	1.882	0.797	0.474	0.247	0.184	29.883	0.270	0.012	0.042	0.183	37.369

Appendix G-9. Estimated monthly abundance of macroinvertebrates impinged during normal operations. Ormond Beach Generating Station NPDES, 2008.

	2007			2008									Total
Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Abundance
Metacarcinus anthonyi	393	792	-	-	-	-	-	-	-	-	19	-	1,204
Romaleon antennarius	147	179	36	49	26	43	38	18	25	-	19	108	688
Aurelia labiata	-	-	-	-	-	-	-	657	-	-	-	-	657
Crangon nigromaculata	-	-	-	-	9	29	-	91	38	93	-	-	260
Cancer productus	49	26	-	-	-	-	57	-	13	-	-	-	145
Romaleon jordani	98	-	-	-	-	-	-	-	-	-	-	-	98
Thetys vagina	-	-	36	-	-	-	-	-	-	-	-	22	58
Octopus bimaculatus/bimaculoides	-	-	-	-	-	-	-	18	-	-	19	-	37
Pisaster giganteus	25	-	-	-	-	-	-	-	-	-	-	-	25
Polyorchis montereyensis	25	-	-	-	-	-	-	-	-	-	-	-	25
Lysmata californica	-	-	-	-	-	14	-	-	-	-	-	-	14
Metacarcinus gracilis	-	-	-	-	-	-	-	-	13	-	-	-	13
Parastichopus parvimensis	-	13	-	-	-	-	-	-	-	-	-	-	13
Chrysaora colorata	-	-	12	-	-	-	-	-	-	-	-	-	12
Loligo opalescens	-	-	6	-	-	-	-	-	-	-	-	-	6
Portunus xantusii	-	-	-	4	-	-	-	-	-	-	-	-	4
Total Abundance	737	1,010	90	53	35	86	95	784	89	93	57	130	3,259
Number of species	6	4	4	2	2	3	2	4	4	1	3	2	16

Appendix G-10. Estimated monthly biomass (kg) of macroinvertebrates impinged during normal operations. Ormond Beach Generating Station NPDES, 2008.

	2007			2008									Total
Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Biomass (kg)
Aurelia labiata	-	-	-	-	-	-	-	540.194	-	-	-	-	540.194
Romaleon antennarius	8.036	9.618	1.522	3.324	2.044	3.387	2.932	4.343	2.163	-	0.291	3.290	40.950
Metacarcinus anthonyi	6.610	19.938	-	-	-	-	-	-	-	-	0.388	-	26.936
Chrysaora colorata	-	-	7.793	-	-	-	-	-	-	-	-	-	7.793
Pisaster giganteus	4.620	-	-	-	-	-	-	-	-	-	-	-	4.620
Cancer productus	1.204	0.243	-	-	-	-	0.549	-	1.005	-	-	-	3.001
Thetys vagina	-	-	1.563	-	-	-	-	-	-	-	-	0.671	2.234
Romaleon jordani	1.966	-	-	-	-	-	-	-	-	-	-	-	1.966
Parastichopus parvimensis	-	1.622	-	-	-	-	-	-	-	-	-	-	1.622
Crangon nigromaculata	-	-	-	-	0.040	0.114	-	0.383	0.178	0.222	-	-	0.937
Octopus bimaculatus/bimaculoides	-	-	-	-	-	-	-	0.438	-	-	0.136	-	0.574
Polyorchis montereyensis	0.541	-	-	-	-	-	-	-	-	-	-	-	0.541
Loligo opalescens	-	-	0.266	-	-	-	-	-	-	-	-	-	0.266
Portunus xantusii	-	-	-	0.194	-	-	-	-	-	-	-	-	0.194
Metacarcinus gracilis	-	-	-	-	-	-	-	-	0.089	-	-	-	0.089
Lysmata californica	-	-	-	-	-	0.029	-	-	-	-	-	-	0.029
Total Biomass (kg)	22.977	31.421	11.144	3.518	2.084	3.530	3.481	545.358	3.435	0.222	0.815	3.961	631.946

Appendix G-11. Total abundance of the top 20 fish impinged during heat treatments and extrapolated normal operations, 1990 - 2008. Ormond Beach Generating Station NPDES, 2008.

	Year																				Percent	
Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total	Total	Mean
Seriphus politus	7460	43501	16697	82521	16382	24008	4218	4725	6632	161	361	3057	11089	2684	375	882	202	-	287	225242	59.41	11854.9
Sardinops sagax	322	86	110	1643	362	1056	197	2921	21434	24	89	295	483	107	632	156	28	2	25	29972	7.91	1577.5
Cymatogaster aggregata	278	270	997	1333	1023	8830	503	2423	891	8	366	542	532	1397	1113	2716	725	34	18	23999	6.33	1263.1
Engraulis mordax	301	365	891	631	2022	1600	2169	4329	73	177	564	1144	2095	4076	1395	426	578	-	18	22854	6.03	1202.8
Hyperprosopon argenteum	1506	1521	3942	550	126	616	10	1353	431	-	2	611	432	266	11	143	80	-	-	11600	3.06	610.5
Phanerodon furcatus	1606	987	1054	1019	1169	2454	395	926	158	-	35	36	75	86	55	229	204	78	-	10566	2.79	556.1
Porichthys notatus	1844	1484	999	490	336	432	11	-	-	46	58	1	172	2	-	-	257	26	36	6194	1.63	326.0
Peprilus simillimus	1	157	72	738	22	16	4	1	1	-	5	3350	186	280	8	30	124	-	-	4995	1.32	262.9
Genyonemus lineatus	14	707	149	2506	58	679	50	4	433	-	-	101	65	5	-	-	-	-	-	4771	1.26	251.1
Citharichthys stigmaeus	-	390	230	504	60	240	-	-	-	-	461	1330	102	454	40	19	921	-	14	4765	1.26	250.8
Atherinops affinis	9	105	30	49	-	44	310	1620	204	-	-	974	37	-	-	-	228	-	-	3610	0.95	190.0
Scomber japonicus	10	11	1848	400	451	262	5	1	54	-	-	4	1	-	-	3	45	4	-	3099	0.82	163.1
Platyrhinoidis triseriata	46	322	33	200	76	60	2	50	72	-	29	565	21	205	61	37	127	-	18	1924	0.51	101.2
Paralabrax nebulifer	159	154	435	142	102	164	47	63	9	13	159	244	59	70	35	22	-	-	-	1877	0.50	98.8
Syngnathus leptorhynchus	-	-	-	-	-	-	-	-	-	-	-	-	13	22	416	299	301	111	632	1794	0.47	94.4
Pleuronichthys verticalis	64	118	126	268	104	99	-	99	70	-	202	219	-	74	61	13	101	-	-	1618	0.43	85.1
Leuresthes tenuis	1	593	364	83	11	-	-	-	-	-	-	127	2	347	-	-	-	-	-	1528	0.40	80.4
Leptocottus armatus	73	16	27	85	23	1	7	30	98	92	175	463	16	67	121	68	98	-	-	1460	0.39	76.9
Trachurus symmetricus	194	15	8	266	275	499	-	2	11	-	-	1	-	1	64	60	-	-	55	1451	0.38	76.3
Myliobatis californica	-	53	78	154	85	2	1	8	15	2	-	740	14	66	-	24	103	-	4	1349	0.36	71.0
Number of individuals	14680	51860	28796	94602	23403	41996	8664	19266	31545	761	3078	15382	16209	11132	4987	6216	4910	416	1206	379109		19953.1
Number of species	54	65	54	60	59	48	41	38	47	28	42	49	54	53	41	47	41	11	16	120		44.6

Note: 0.00 = <0.005.

No Heat Treatments in 2008

Appendix G-12. Total abundance of the top 20 macroinvertebrates impinged during heat treatments and estimated normal operations, 1994 - 2008. Ormond Beach Generating Station NPDES, 2008.

	YEAR															Percent	Cum.
Species	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total	Mean	Total	Percent
Romaleon antennarius	138	4434	571	377	5184	5687	79	255	8590	23931	3566	1,074	688	54574	4198.0	34.12	34.1
Thetys vagina	14	-	-	11488	145	387	9599	29	40	-	3621	-	58	25381	1952.4	15.87	50.0
Metacarcinus anthonyi	15636	55	-	-	-	-	-	29	-	-	1591	535	1,204	19050	1465.4	11.91	61.9
Cancer productus	42	-	-	-	11	-	4559	28	4767	1662	4364	234	145	15812	1216.3	9.89	71.8
Lysmata californica	353	510	90	22	64	4	371	14	17	457	7265	368	14	9549	734.5	5.97	77.8
Crangon nigromaculata	35	-	-	417	144	3060	916	58	1236	129	348	92	260	6695	515.0	4.19	81.9
Metacarcinus gracilis	708	-	-	-	-	1201	1	14	1587	487	2258	62	13	6331	487.0	3.96	85.9
Portunus xantusii	2352	99	560	730	235	194	355	43	20	12	127	47	4	4778	367.5	2.99	88.9
Chrysaora colorata	304	77	24	2	1823	-	489	202	-	12	5	140	12	3091	237.7	1.93	90.8
Farfantepenaeus californiensis	7	-	1	-	29	39	-	-	-	-	2220	-	-	2296	176.6	1.44	92.3
Pachygrapsus crassipes	1447	-	88	9	5	5	6	2	351	47	221	-	-	2181	167.8	1.36	93.6
Pisaster giganteus	1	1233	-	-	9	-	-	-	-	-	20	75	25	1363	104.8	0.85	94.5
Loligo opalescens	80	26	-	23	203	232	59	101	44	23	445	-	6	1242	95.5	0.78	95.2
Polyorchis penicillata	35	-	-	23	-	1	-	29	433	254	83	18	-	876	67.4	0.55	95.8
Romaleon jordani	-	-	-	75	316	-	-	-	2	195	112	-	98	798	61.4	0.50	96.3
Octopus bimaculatus/bimaculoides	14	39	7	73	27	27	28	209	55	57	118	4	37	695	53.5	0.43	96.7
Anthopleura xanthogrammica	-	-	-	-	-	-	-	-	-	-	691	-	-	691	53.2	0.43	97.2
Pisaster sp	35	-	3	15	-	15	391	45	49	111	-	26	-	690	53.1	0.43	97.6
Pyromaia tuberculata	483	-	12	1	-	-	1	-	-	-	171	-	-	668	51.4	0.42	98.0
Aurelia labiata	-	-	-	-	-	-	-	-	-	-	-	-	657	657	50.5	0.41	98.4
Number of individuals	21785	6524	1368	13312	8764	11225	16958	1196	17368	27570	27746	2877	3259	159952	13057.8		
Number of species	26	12	12	16	19	19	19	20	19	19	27	16	16	44	18.7		

Note: 0.00 = <0.005.