NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
2007 RECEIVING WATER MONITORING REPORT
RELIANT ENERGY ORMOND BEACH GENERATING STATION
VENTURA COUNTY, CALIFORNIA

2007 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 2007 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 2007 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 2007 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 winter 2007, the Ormond Beach Generating Station circulating water pumps were not in operation during sampling. Water temperatures were similar throughout the area during the morning flood tide but slightly higher surface temperatures were found at, inshore and downcoast of the discharge on ebb tide despite no pumps in operation on the day of the sampling. In summer, a warm water surface lens was noted at and inshore of the discharge during the morning flood tide, and at, inshore and 1,000 ft up- and downcoast of the discharge during ebb tide, indicating the presence of a warm water surface lens in the vicinity of the thermal discharge. These patterns have been observed in the area in previous surveys and the resulting parameters were similar to natural conditions found commonly throughout the study area. Even in areas influenced by the thermal field, surface temperatures were typical of the area and within the range of natural variability observed during previous surveys. Dissolved oxygen (DO) concentrations were relatively consistent during both seasons, 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 during both seasons, a likely result of increased photosynthetic activity. Salinity and pH were also very consistent during both surveys at levels consistent with seasonal results observed previously and natural conditions found commonly throughout the study area.

With the exception of the warm water surface lens near the discharge in summer, variations in water quality parameters observed in 2007 can be attributed to natural physical and biological processes. Water quality measurements indicated that in 2007 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 2007, sediments were analyzed from six stations offshore the Ormond Beach Generating Station. Sediments were 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 2007 were similar to those found previously in the area and appear to be affected primarily by natural causes.

Sediment Chemistry

In 2007, sediments at six stations off the Ormond Beach Generating Station were analyzed for the presence and concentration of chromium, copper, nickel, and zinc. Highest concentrations of all metals were recorded 1,000 ft upcoast of the discharge. Lowest concentrations of chromium, nickel and zinc were recorded at the discharge, and lowest copper 1,000 ft downcoast of the discharge. Still, metal concentrations were relatively similar among stations. Sediment metal concentrations have remained relatively consistent in the area since 1990 and concentrations in 2007 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, 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 2007 did not appear to be influenced by the operation of the Ormond Beach Generating Station.

MUSSEL BIOACCUMULATION

In 2007, mussels were not found in the vicinity of the Ormond Beach Generating Station discharge. For that reason, donor mussels were purchased from a commercial supplier in Carlsbad, California and transplanted to a mooring near the Ormond Beach discharge where the mussels were allowed to acclimate for a period of 151 days. Tissues from the mussels at the discharge were analyzed for bioaccumulation of the metals chromium, copper, nickel, and zinc. Results were compared with those from mussels collected at the donor site at the time of the transplant and to mussels collected from the Manhattan Beach Pier in Santa Monica Bay, which served as the reference site.

Concentrations of chromium in mussels transplanted into the vicinity of the Ormond Beach Generating Station discharge in 2007 increased from levels reported in both 2005 and 2006. Wet-weight chromium levels in mussels from the Ormond Beach discharge exceeded the EDL 85 for bay mussels, while chromium levels in California mussel tissue from the reference site were also elevated or highly elevated in 2007, indicating that chromium was elevated in both areas. Copper concentrations in mussel tissues from the discharge declined from 2005 and 2006 levels and were lower than levels reported at either the donor or the reference site. Wet-weight copper levels at the discharge and at the donor sites were below the EDL 85 value for bay mussels, indicating that in 2007 copper concentrations were not elevated in these areas. Copper values at the reference site, however, were elevated above the EDL 85 value for native California mussels. Nickel levels in mussels from the discharge increased from 2006 levels, but were still lower than concentrations reported in 2005. Wet-weight concentrations of nickel in mussel tissues from the discharge exceeded the EDL 85 value for bay mussels in one replicate, while levels in the other two replicates and the overall replicate mean were below the EDL 85 value. As in 2006, zinc levels in tissues from the discharge area declined from concentrations reported in the previous year. Zinc levels in the tissues from the discharge were lower than levels found at either the donor or the reference site in 2007. Similarity of tissue metal levels among sites, to previous studies, and to other areas in southern California suggests that the operation of the Ormond Beach Generating Station is not elevating metal concentrations above background levels.

BENTHIC INFAUNA

The infauna community in the study area in 2007 was composed primarily of small annelid worms, arthropods, clams, and Pacific sand dollars. A total of 165 species was collected, substantially more than in 2006. Species richness averaged 67 species per station and mean species diversity (H') was 3.26; both values were greater than those in 2006 and the long-term means for summer surveys conducted in the study area since 1978. Abundance, at a mean density for the area of 10,000 individuals/m^2, was substantially greater than in 2006, but was only slightly above the long-term mean. Infaunal parameter values were similar among communities along the discharge isobath but slightly lower inshore of the discharge, a pattern that has been observed in most previous surveys. However, unlike the past, values in 2007 did not appear to be related to sediment grain-size characteristics. Southern California Benthic Response Index values averaged 19.6, similar to the mean for 2006; all values suggested that all of the communities in the study area were undisturbed, or healthy.

Composition of the infaunal communities was similar to those in the past. The polychaete annelid *Apoprionospio pygmaea* was the most abundant species, comprising 25% of the individuals in the collection. Also abundant were the annelids *Mediomastus acutus* and *Onuphis* sp 1, the clams *Siliqua lucida*, *Tellina modesta*, and *Cooperella subdiaphana*, Pacific sand dollar (*Dendraster excentricus*, all of which were small), nemertean worms, and several arthropods, including the amphipods *Ericthonius brasiliensis* and *Rhepoxynius menziesi* and the cumacean *Diastylopsis tenuis*. Tube-dwelling species such as *Ericthonius brasiliensis*, *Jassa slatteryi*, and *Podocerus brasiliensis* were most abundant at the discharge where the sediments contained a large amount shell fragments, suitable for substrate. Organic debris, primarily from surfgrass (*Phyllospadix* spp), was also abundant at the discharge, attracting detritivores such as the cumacean *Cyclaspis* sp C. Smaller amounts of shell fragments and organic debris were found inshore of the discharge, but the community dominants at that location included rapid-burrowing species such as the amphipods *R. menziesi* and *R. abronius*. Overall, the communities found in 2007 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

To evaluate fish loss at the Ormond Beach Generating Station, fish impingement was monitored during eight normal operation surveys during the 2007 monitoring year. Based on these surveys, an estimated total of 416 individuals representing 11 fish taxa and weighing 177 kg were impinged at the generating station. In addition, an estimated 2,877 individuals representing 16 macroinvertebrate species and weighing more than 347 kg were impinged during the study year.

Overall, fish species impinged in 2007 were similar to those collected in previous surveys, but were less abundant than recorded in previous annual surveys since 1990. This decline in fish abundance despite a similarity in cooling water flow volumes since 2006 suggests variability in the local fish populations, and is consistent with previous years when fish impingement abundances appeared to fluctuate independently of station operations. Macroinvertebrate composition in 2007 was similar to previous years, though abundances were also lower than typical. The similarity of species composed primarily of frequently occurring and long-term dominant species indicates a relatively stable nearshore assemblage typical of southern California. Variability in fish and macroinvertebrate communities in the area appeared to be related to natural differences in local populations and there is no indication that plant operations have adversely affected the fish or macroinvertebrate populations in the vicinity of the Ormond Beach Generating Station.

CONCLUSIONS

The overall results of the 2007 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.

INTRODUCTION

This report presents and discusses the results of the 2007 receiving water monitoring studies conducted for the Ormond Beach Generating Station, which is owned and operated by Reliant Energy. The 2007 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). Results of the 2007 surveys were compared among locations in the study area and with past physical oceanographic 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, sediments, and mussel tissue, and biological monitoring of infaunal and fish and macroinvertebrate assemblages. Fish and macroinvertebrate impingement studies were also conducted at the generating station periodically throughout the year.

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). 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 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 31 March 2007 winter survey, none of the four circulator pumps were operating. During the 28 August 2007 summer survey, the generating station operated four of four circulator pumps, discharging at the rate of 685.44 mgd. Intake temperature was 14.3°C, with an increase in water temperature across the condensers of 17.7°C, resulting in a discharge temperature of 32.0°C. During the 2007 sampling year, the Ormond Beach Generating Station operated Unit 1 and Unit 2 at 4.85% and 7.15%, respectively, of total operating capacity (Melchor 2007, 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). Prominent natural features of this portion of the Southern California Bight include the dunes along Mandalay Beach, the marshes

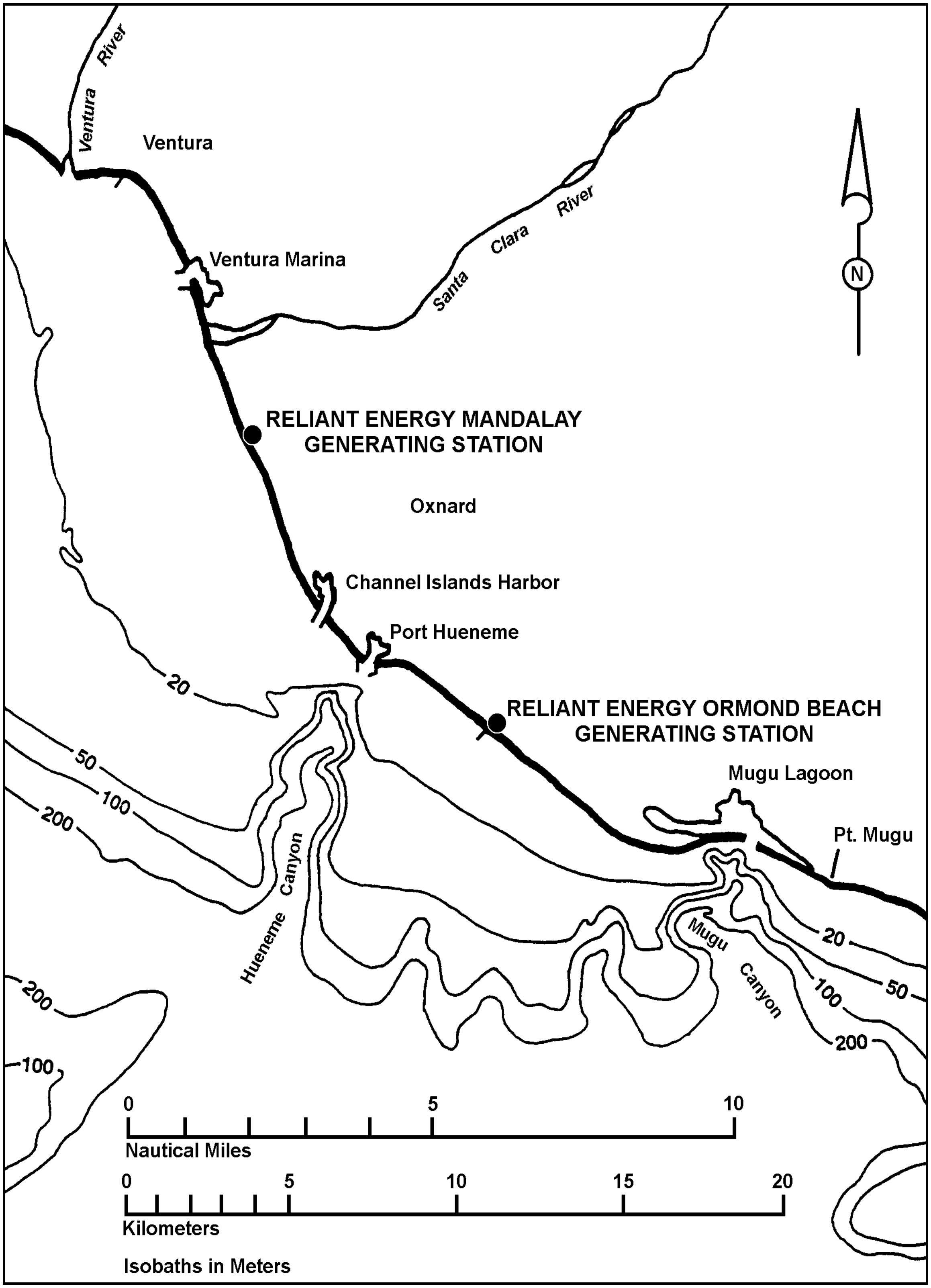


Figure 1. Location of the study area. Ormond Beach Generating Station NPDES, 2007.

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.

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 2.

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.

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.

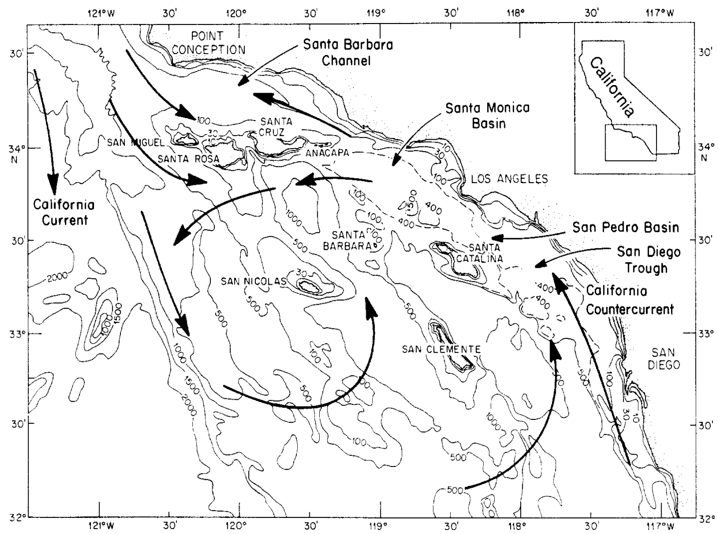


Figure 2. Surface circulation in the Southern California Bight (from Hickey 1992). Ormond Beach Generating Station NPDES, 2007.

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 meters, 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).

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 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.

Littoral 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.

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 2007 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 and Figure 3. The 2007 monitoring program included nine water quality (RW) stations, and six sediment and benthic infauna (B) stations.

Table 1. Latitude/longitude coordinates of sampling stations. Ormond Beach Generating Station NPDES, 2007.

Stations			
Water Quality	Benthic	Latitude	Longitude
RW1	B1	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	B6	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

The NPDES water quality monitoring surveys were conducted on 31 March and 28 August, and benthic sampling was conducted on 29 August 2007. Latitude and longitude coordinates for all receiving water (RW) and benthic (B) stations are listed in Table 1.

During the winter survey, no oil sheens, grease, floatables or apparent red tide (plankton bloom) were observed at any of the receiving water stations. The water appeared slightly turbid throughout the study area during the flood tide monitoring and at Stations RW2, RW3, and RW6 during the ebb tide monitoring. Western gulls (*Larus occidentalis*) were seen at Stations RW8 and RW9, Western grebes (*Aechmophorus occidentalis*) were observed at Stations RW3, RW5, RW7, and RW8, and cormorants (*Phalacrocorax* sp) were seen at Stations RW1 and RW2. No California brown pelicans (*Pelecanus occidentalis*

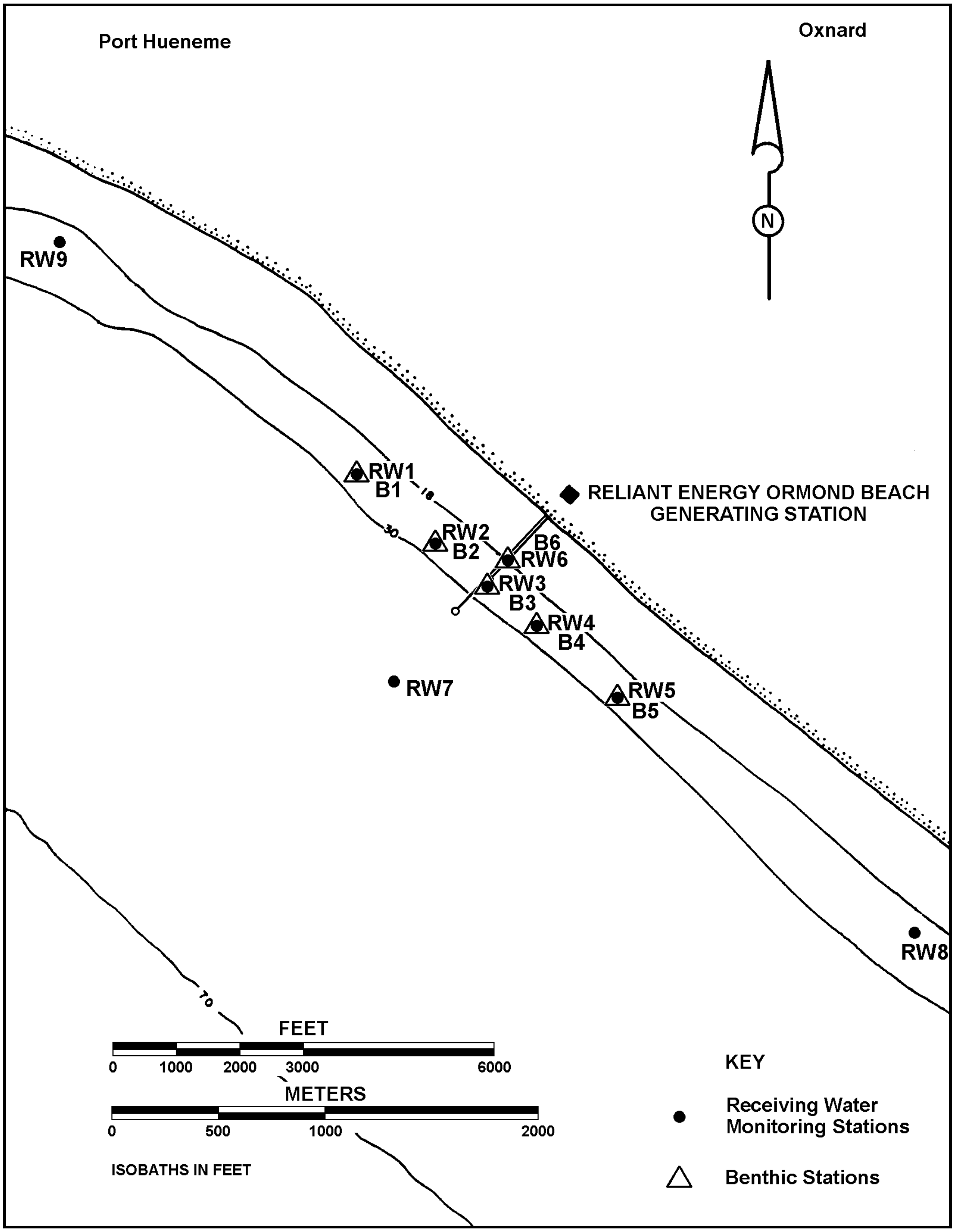


Figure 3. Location of the monitoring stations. Ormond Beach Generating Station NPDES, 2007.

californicus) or California least terns (*Sternula antillarum browni*) were observed during the winter monitoring.

During the summer surveys, no oil sheens, grease or apparent red tide were observed in the study area. The water appeared to have no turbidity during the water quality monitoring (28 August) but was slightly turbid at all stations during benthic sampling (29 August). Drift kelp (*Macrocystis pyrifera*) was noted at Stations RW9 and B2, and drift wood was noted at Station B4. Western gulls were seen throughout the study area during both surveys. Heermann's gulls (*Larus heermanni*) were seen at Stations RW1, RW2, and B6, Western Grebes were seen at Station RW4, and cormorants were seen at most of the receiving water stations and Stations B1 and B5. California brown pelicans were seen at Stations RW1, RW9, B1, B3, and B4. No California least terns were observed during any of the summer surveys.

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 4 of the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) list of invertebrate species (SCAMIT 2001).

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)].

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.

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

Temperature, DO, pH, and salinity were measured throughout the water column at nine stations during the winter and summer surveys. Sampling was conducted on both flood and ebb tides at each of the receiving water monitoring stations (Figure 4). Data were obtained *in situ* using an SBE 9/17 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.

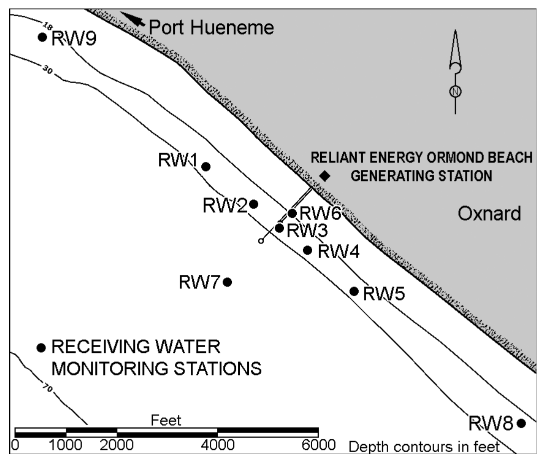


Figure 4. Location of the water column sampling stations. Ormond Beach Generating Station NPDES, 2007.

Winter water quality was monitored at Stations RW1 through RW9 on 31 March 2007 during flood and ebb tides. Flood tide was monitored between 0725 and 0815 hours (hr) and ebb tide was monitored between 1325 and 1415 hr (Figure 5). On the day of monitoring, the tide rose from a low of +0.9 ft Mean Lower Low Water (MLLW) at 0309 hr to a high of +4.8 ft MLLW at 0859 hr, then fell to a low of +0.1 ft MLLW at 1523 hr. Skies were clear in the morning and overcast by the afternoon. Winds were from the west at 2 to 7 kn and seas were west at 2 to 3 ft.

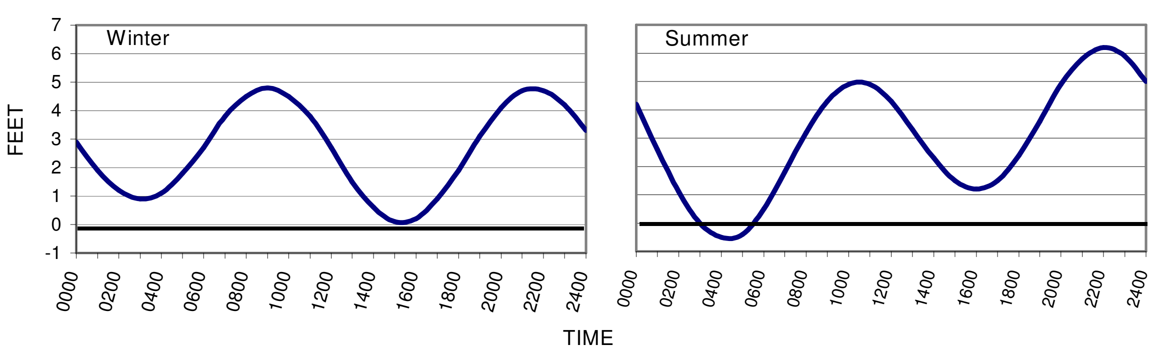


Figure 5. Tidal rhythms during water column sampling, winter and summer surveys. Ormond Beach Generating Station NPDES, 2007.

Summer water quality was monitored at Stations RW1 through RW9 on 28 August 2007 during flood and ebb tides. Flood tide was monitored between 0740 and 0830 hr and ebb tide was monitored between 1245 and 1330 hr (Figure 5). On the day of monitoring, the tide rose from a low of -0.6 ft MLLW at 0415 hr to a high of +5.0 ft MLLW at 1025 hr, then fell to a low of +1.2 ft MLLW at 1604 hr. Skies were partly to mostly cloudy with winds that changed from the northwest at 3 to 7 kn to west at 10 to 12 kn. Seas were west at 2 to 4 ft.

RESULTS

Water quality monitoring was conducted during flood and ebb tide, in winter and summer, offshore of the Ormond Beach Generating Station to determine potential effects of the generating station discharge on receiving waters. Receiving water monitoring stations are shown in Figure 4. During both seasons, flood tide was sampled in the early morning, while ebb tide was sampled early afternoon. During the winter sampling no circulating pumps were in operation (Melchor 2007, pers. comm.). On the day of the summer sampling all four circulating pumps were in operation with a flow of 685.4 mgd and a discharge temperature of 32.0°C. Seasonal water quality data for flood and ebb tides are presented in Figure 6 through 9 and summarized in Table 2. Raw data are presented in Appendix B.

Temperature

During the winter survey, surface water temperatures averaged 12.93°C during morning flood tide and 13.78°C during afternoon ebb tide (Table 2 and Figure 6). Surface temperatures were similar among stations during each tide in winter, varying by about 0.8°C or less among stations during either tidal cycle. During flood tide, surface temperatures ranged from 12.80°C at Station RW8, 7,920 ft downcoast of the discharge to 13.10°C at Station RW9, 7,920 ft upcoast of the discharge. During ebb tide, surface temperatures ranged from 13.39°C at Station RW7, the deepest station, offshore of the discharge at a depth of 40 ft, to 14.14°C at Station RW6, the shallowest station, inshore of the discharge at a depth of 20 ft. Surface temperatures at each station increased an average of about 0.9°C between the morning and afternoon tides, with the greatest difference found at Station RW6, where surface temperature was 1.29°C warmer on ebb tide (Appendix B-1). While surface temperatures were generally similar among stations on flood tide, during ebb tide highest surface temperatures (near or above 14°C) were found at Station RW3, at the discharge, Station RW4, 1,000 ft downcoast of the discharge, and Station RW6. Temperatures on flood tide were relatively consistent throughout the water column, decreasing with depth with no strong thermal gradients (Figure 6). The greatest surface-to-bottom difference on flood tide occurred at Station RW9

Table 2. Summary of water quality parameters during flood and ebb tides. Ormond Beach Generating Station NPDES, 2007.

	Temp. (°C)		D.O. (mg/l)		pH		Salinity (psu)		Temp. (°C)		D.O. (mg/l)		pH		Salinity (psu)	
Winter																
	Surface								Bottom							
	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb
Mean	12.93	13.78	7.87	8.14	7.82	7.95	33.78	33.76	12.06	12.21	7.05	7.13	7.79	7.87	33.80	33.80
Minimum	12.80	13.39	7.72	7.84	7.81	7.90	33.78	33.70	11.78	11.82	6.82	6.80	7.75	7.85	33.79	33.77
Maximum	13.10	14.14	8.23	8.29	7.85	7.98	33.80	33.82	12.37	13.24	7.25	7.99	7.81	7.91	33.82	33.87
Summer																
	Surface								Bottom							
	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb
Mean	14.60	16.65	7.36	7.53	7.91	7.97	33.67	33.64	13.08	13.56	6.77	7.38	7.87	7.95	33.66	33.70
Minimum	13.43	14.92	7.06	7.25	7.87	7.93	33.62	33.54	12.61	13.04	6.43	6.98	7.83	7.93	33.64	33.66
Maximum	15.77	19.54	7.83	7.86	7.96	8.02	33.82	33.71	13.57	14.23	7.06	7.83	7.90	7.98	33.68	33.92

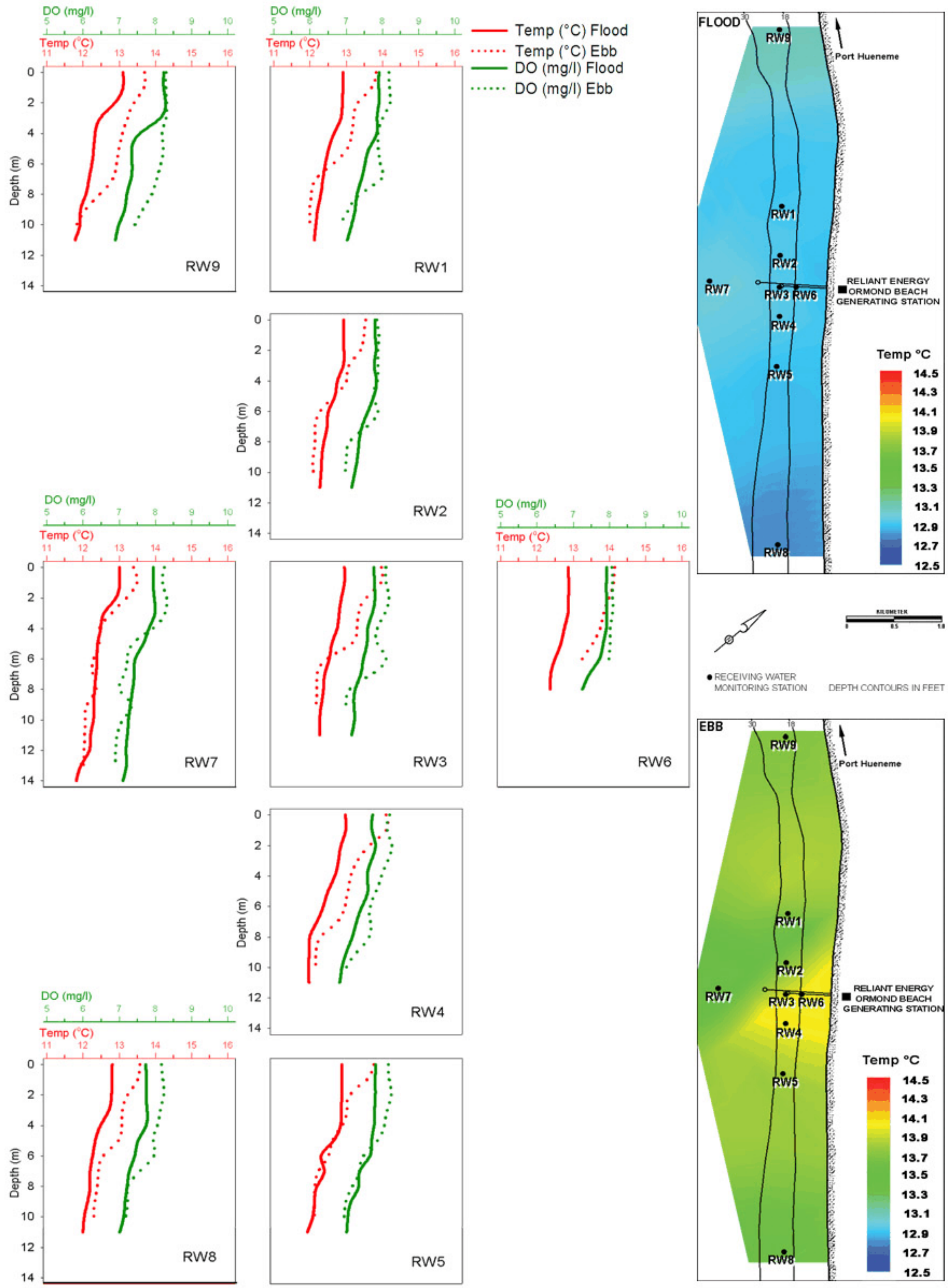


Figure 6. False color surface temperature contour plots and temperature and dissolved oxygen vertical profiles during flood and ebb tides, winter survey. Ormond Beach Generating Station NPDES, 2007.

(1.32°C) (Appendix B-1). Temperatures on ebb tide were more variable in the upper water column than during flood tide with mild thermal gradients between the surface and about 5 m depth (Figure 6). The greatest surface-to-bottom difference of 1.95°C was found at Station RW4 on ebb tide (Appendix B-1). With the exception of Station RW6, the shallowest station, near bottom temperatures at each station were similar between tides, with an average difference of less than 0.2°C. Bottom water temperatures averaged 12.06°C during flood tide and 12.21°C during ebb tide (Table 2). Flood tide near-bottom temperatures ranged from 11.78°C at Station RW9 to 12.37°C at Station RW6. During ebb tide, near-bottom temperatures ranged from 11.82°C at Station RW9 to 13.24°C at Station RW6.

During the summer survey, surface temperatures averaged 14.60°C during morning flood tide and 16.65°C during the afternoon ebb tide (Table 2 and Figure 7). Surface temperatures were relatively dissimilar among stations during each tide in summer, varying by about 2.3°C on flood tide and 4.6°C during ebb tide. Flood tide surface temperatures ranged from 13.43°C at Station RW9 to 15.77°C at Station RW3. Surface temperatures during ebb tide ranged from 14.92°C at Station RW7 to 19.54°C at Station RW3, at the point of discharge. Surface temperatures generally varied by about 2°C between tides and were warmer during the afternoon, with the greatest difference found at Station RW3 where surface temperature was 3.77°C warmer on ebb tide (Appendix B-2). Highest surface temperatures were found at and inshore of the discharge on flood tide, and at, inshore and immediately upcoast of the discharge on ebb tide. During flood tide temperatures were fairly consistent with depth throughout the water column with no strong thermal gradients, except at Station RW3, where the greatest surface-to-bottom difference of 2.26°C was found on flood tide (Figure 7 and Appendix B-1). Although temperatures were warmer throughout the water column on ebb tide at Station RW5, 3,000 ft downcoast of the discharge, and Stations RW7 through RW9, only mild thermal gradients were noted at these stations on ebb tide. At the remaining stations temperatures during ebb tide decreased rapidly in the upper water column with obvious thermal gradients in the upper four meters of the water column. Thermoclines exceeding 1°C temperature change within one meter of depth were observed between one and three meters in depth at Station RW2, 1,000 ft upcoast of the discharge, at Station RW3, where temperature declined 4.3°C between between one and three meters depth, and at Stations RW4 and RW6 (Appendix B-2). The greatest surface-to-bottom difference during flood tide (5.31°C) occurred at Station RW3. Bottom water temperatures in summer 2007 averaged 13.08°C during flood tide and 13.56°C during ebb tide. Flood tide water temperatures ranged from 12.61°C at Station RW5 to 13.57°C at Station RW6 (Table 2). Ebb tide bottom water temperatures ranged from 13.04°C at Station RW7 to 14.23°C at Station RW3.

Dissolved Oxygen

In winter, surface dissolved oxygen (DO) concentrations during flood tide averaged 7.87 mg/l and ranged from 7.72 mg/l at Station RW4 to 8.23 mg/l at Station RW9 (Table 2). During ebb tide, surface DO concentrations averaged 8.14 mg/l and ranged from 7.84 mg/l at Station RW2 to 8.29 mg/l at Station RW9. During flood tide DO was relatively consistent, decreasing below subsurface maxima with differentials of less than 1 mg/l with depth to the bottom at most stations (Figure 6). At Station RW9, reduction in DO concentration was more notable below a subsurface maximum at two meters than at the other stations, resulting in the greatest surface-to-bottom reduction of 1.34 mg/l during flood tide (Appendix B-1). During the afternoon ebb tide, dissolved oxygen concentrations in the upper water column, though generally higher, were similar to those found during the flood tide, varying by less than 0.5 mg/l from the earlier tide. Dissolved oxygen concentrations were more variable through the water column on flood tide, with subsurface maxima values found in the upper four meters at each station. Below these maxima, DO concentrations declined with depth to the bottom, with secondary DO peaks at a depth of six to eight meters at most stations (Figure 6). The maximum surface-to-bottom DO differential of 1.38 mg/l occurred at Station RW1, 3,000 ft upcoast of the discharge, on flood tide (Appendix B-1). Near-bottom DO values were similar during both tides, averaging 7.05 mg/l during flood tide, and 7.13 mg/l during ebb tide.

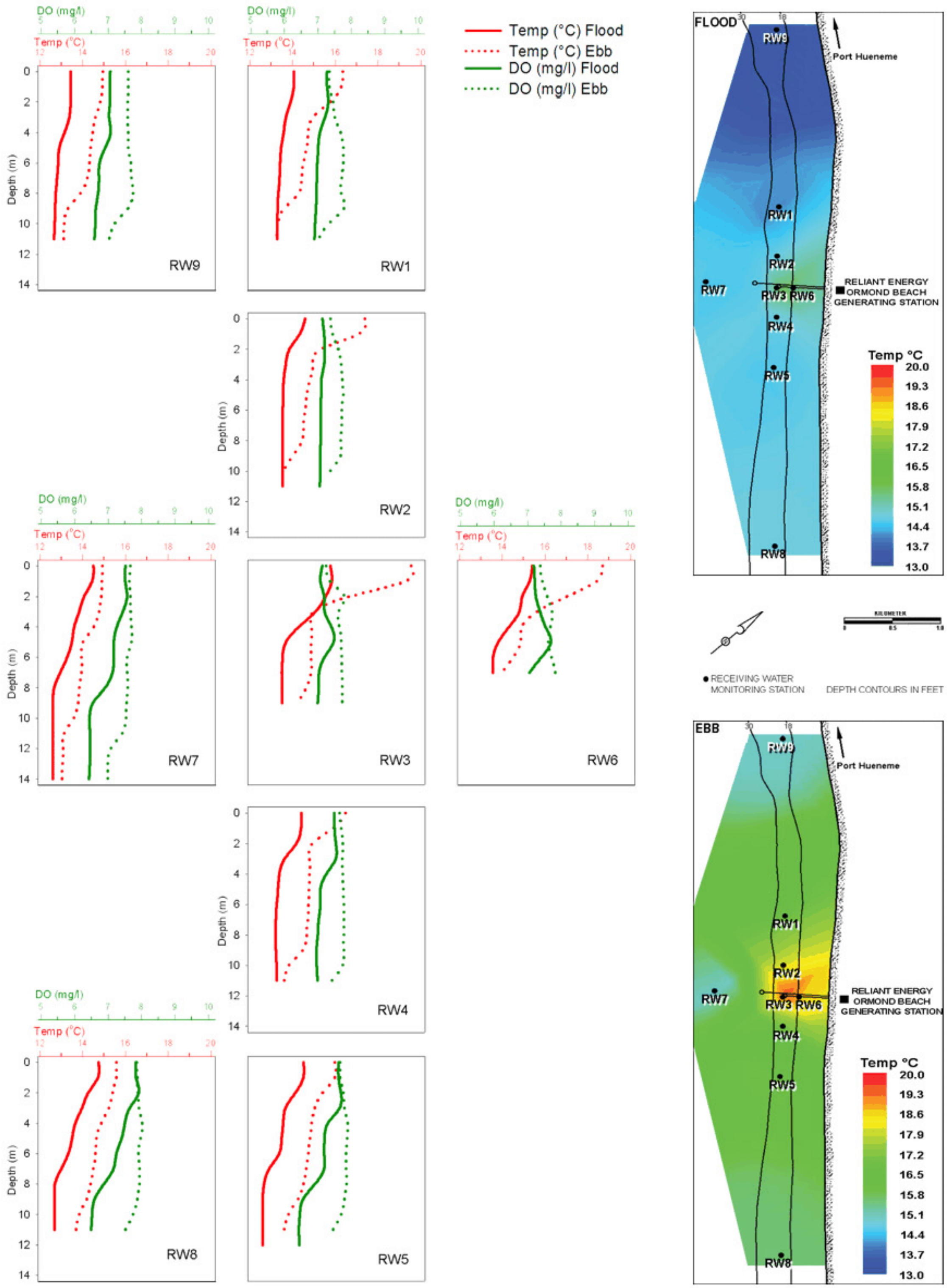


Figure 7. False color surface temperature contour plots and temperature and dissolved oxygen vertical profiles during flood and ebb tides, summer survey. Ormond Beach Generating Station NPDES, 2007.

In summer, surface DO concentrations during flood tide averaged 7.36 mg/l and ranged from 7.06 mg/l at Station RW9 to 7.83 mg/l at Station RW8 (Table 2). During ebb tide, surface DO concentrations averaged 7.53 mg/l and ranged from 7.25 mg/l at Station RW3 to 7.86 mg/l at Station RW8. Dissolved oxygen concentrations in surface waters and the upper water column were very similar to a depth of about two meters on both tides except at Station RW9 where values were consistently higher throughout the water column on ebb tide. Below a depth of about two meters at the remaining stations DO concentrations were also higher during the later ebb tide sampling (Figure 7). Dissolved oxygen concentrations were relatively consistent with depth, with slight subsurface maxima in the upper two to six meters at all stations with maxima slightly deeper on flood tide, and a general trend of moderately increasing DO with depth to about 10 m on ebb tide. Maximum surface-to-bottom DO differentials occurred at Station RW8 where DO concentration decreased by 1.34 mg/l during flood tide, at Station RW7, where DO decreased by 0.69 mg/l, and at Stations RW3 and RW6, where DO increased by almost 0.5 mg/l during ebb tide (Appendix B-2). Near-bottom DO values averaged 6.77 mg/l during flood tide, and 7.38 mg/l during ebb tide.

Hydrogen Ion Concentration

In winter, surface hydrogen ion concentrations (pH) averaged 7.82 during flood tide and 7.95 during ebb tide (Table 2). Flood tide pH values ranged from 7.81 at five of the nine stations to 7.85 at Station RW8. Ebb tide pH values ranged from 7.90 at Station RW2 to 7.98 at Station RW7. Bottom pH values averaged 7.79 during flood tide and 7.87 on ebb tide. Flood tide bottom values ranged from 7.75 at Station RW9 to 7.81 at Stations RW2 and RW3. Ebb tide bottom pH values ranged from 7.85 at Stations RW1 and RW9, to 7.91 at Station RW6. Hydrogen ion concentrations during flood tide decreased slightly with depth at all stations, but otherwise ranged narrowly, varying by about 0.1 unit or less among stations and depths during the morning tide (Appendix B-1). Hydrogen ion values were more variable, varying by 0.14 units or less during the afternoon ebb tide, with slightly higher pH values found throughout the water column at all stations (Figure 8).

Surface pH values in the summer averaged 7.91 during flood tide and 7.97 during ebb tide (Table 2). Flood tide pH values ranged from 7.87 at Station RW9 to 7.96 at Station RW8. Ebb tide pH values ranged from 7.93 at Stations RW1 and RW6 to 8.02 at Station RW8. Bottom pH values averaged 7.87 during flood tide and 7.95 on ebb tide. Flood tide bottom values ranged from 7.83 at Station RW9 to 7.90 at Stations RW3 and RW6. Ebb tide bottom pH values ranged from 7.93 at Stations RW1, RW7 and RW9 to 7.98 at Station RW1. Hydrogen ion values were relatively consistent throughout the water column, although generally slightly higher on ebb tide (Figure 9). In summer, pH varied by less than 0.2 units among stations, between tides and with depth.

Salinity

Winter surface salinities averaged 33.78 practical salinity units (psu) during flood tide and 33.76 psu during ebb tide (Table 2). Flood tide surface salinities ranged from 33.78 to 33.80 psu, while ebb tide salinities ranged from 33.70 to 33.82 psu. Bottom salinities averaged 33.80 psu during both tides. Salinities remained relatively consistent during both tides and increased slightly with increasing depth, although slightly more variable during the afternoon ebb tide (Figure 8). In winter, salinity varied by less than 0.25 psu among stations, between tides and with depth.

Summer surface salinity averaged 33.67 psu during flood tide and 33.64 on ebb tide (Table 2). Surface salinities ranged from 33.62 to 33.82 psu during flood tide and 33.54 to 33.71 psu during ebb. Salinity generally increased with depth during the survey. Near-bottom water salinities averaged 33.66 psu on flood tide and 33.70 psu on ebb tide. Salinity values were more variable at Stations RW3 through RW6 on flood tide and at Stations RW1, RW3 and RW6 on ebb tide (Figure 9). Still, salinity was relatively uniform during summer sampling, varying by less than 0.4 psu among stations, between tides and with depth.

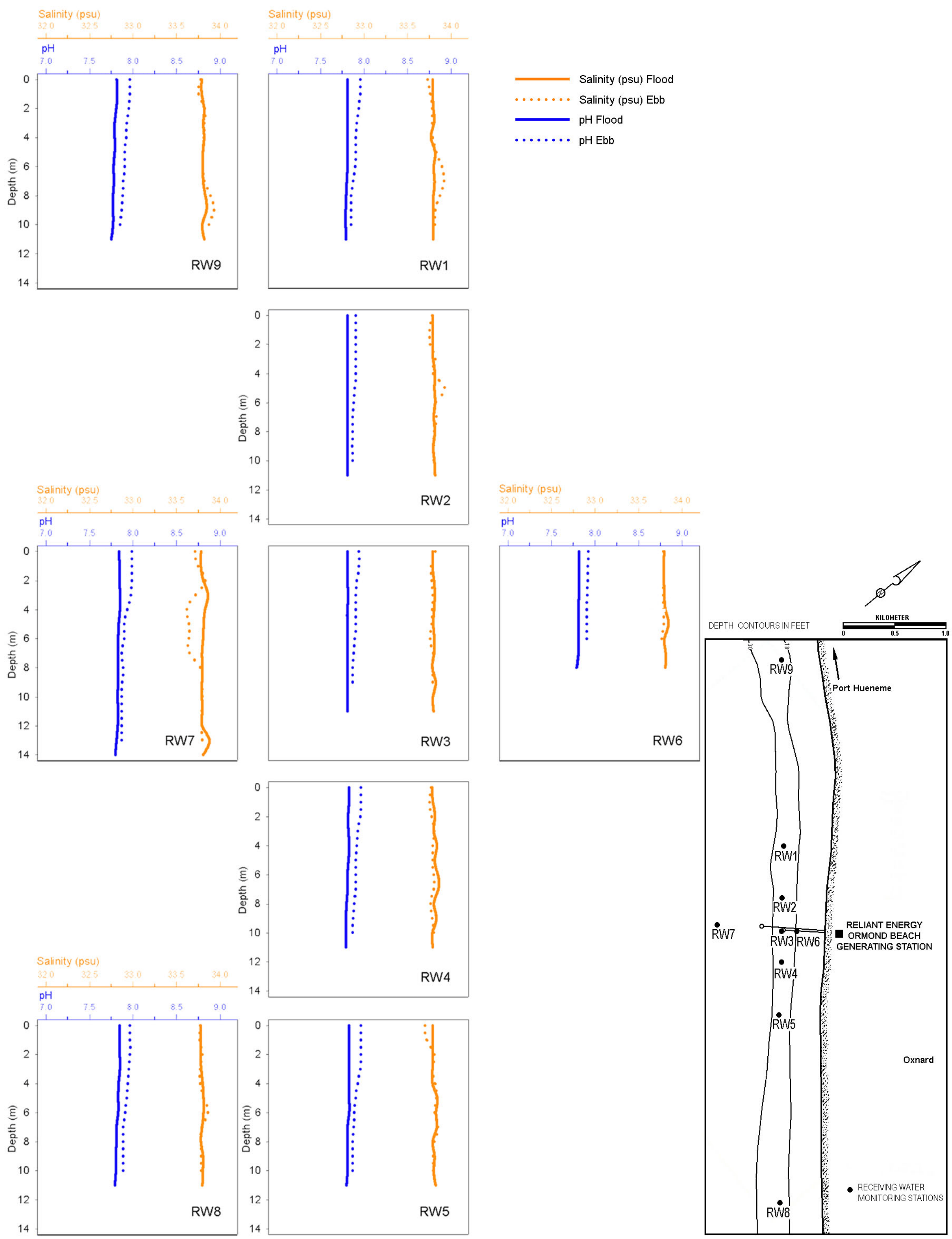


Figure 8. Hydrogen ion concentration (pH) and salinity vertical profiles during flood and ebb tides, winter survey. Ormond Beach Generating Station NPDES, 2007.

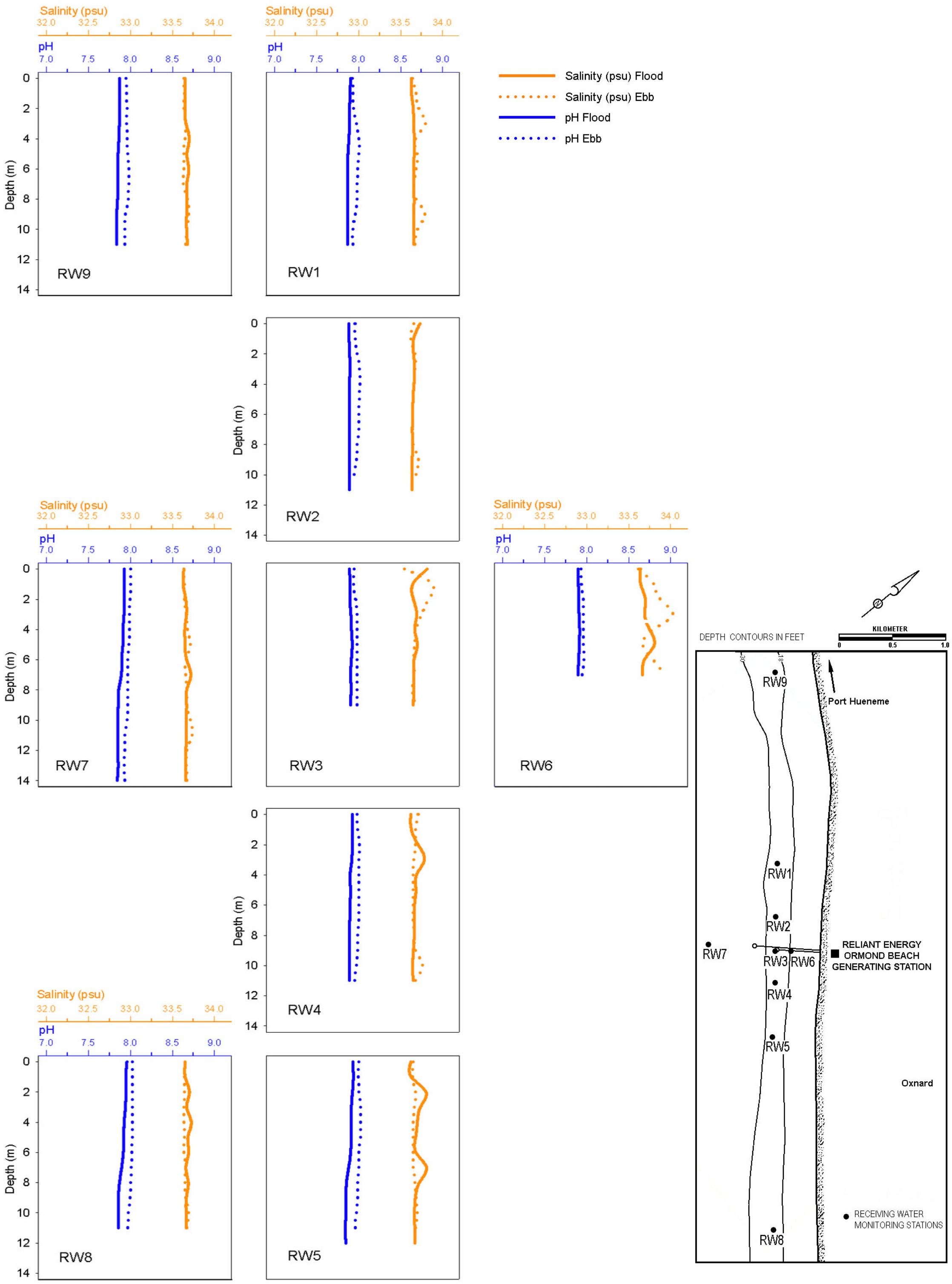


Figure 9. Hydrogen ion concentration (pH) and salinity vertical profiles during flood and ebb tides, summer survey. Ormond Beach Generating Station NPDES, 2007.

DISCUSSION

Water quality monitoring was conducted on two tides each during winter and summer to determine potential influence of the Ormond Beach Generating Station discharge on the receiving waters. During the winter sampling, no circulating pumps were in operation at the Ormond Beach Generating Station (Melchor 2007, pers. comm.). During flood tide, temperatures were relatively similar with depth at all stations, decreasing slightly from surface to bottom. Surface temperatures were similar among stations during each tide in winter, varying by about 0.8°C or less during either tidal cycle. Temperatures at each station increased an average of about 0.9°C at the surface between the morning and afternoon tides, with the greatest difference found inshore of the discharge, where surface temperature was 1.29°C warmer on ebb tide. Slightly higher surface temperatures were found at, inshore and downcoast of the discharge on ebb tide despite no pumps in operation on the day of the sampling. The warmer surface water temperatures found throughout the study area in the early afternoon were likely a result of solar insolation, resulting in more variability in the upper water column during ebb tide, with mild thermal gradients between the surface and about five meters depth. Near-bottom temperatures were similar between tides except at the shallowest station inshore of the discharge. Temperatures in 2007 were similar to temperatures found in the area in 2006 and previous surveys (MBC 1986, 1988, 1990, 1994-2001a, 2002-2004a, 2005, 2006a; Ogden 1991-1993).

During the summer water quality sampling all four circulating pumps were in operation with a flow of 685.4 mgd of cooling water with a discharge temperature of 32.0°C, or 17.7°C above intake water temperature (Melchor 2007, pers. comm.). Surface temperatures were slightly cooler than is typical of summer surveys, but warmer than occurred in the area in 2005 (MBC 1986, 1988, 1990, 1994-2001a, 2002-2004a, 2005, 2006a; Ogden 1991-1993). Temperatures during morning flood tide were fairly consistent with depth throughout the water column with no notable thermal gradients, except at and inshore of the discharge where warmer water was noted in the upper three meters. Surface temperatures generally varied by about 2°C between tides with warmer surface temperatures found during the afternoon ebb tide, likely due to solar insolation. Although temperatures were warmer throughout the water column on ebb tide, only mild thermal gradients were noted at the stations offshore or 3,000 ft or more up- and downcoast of the discharge. At the remaining stations temperatures during ebb tide decreased rapidly in the upper water column with obvious thermal gradients in the upper four meters of the water column. Thermoclines were observed between one and three meters depth at, inshore and 1,000 ft up- and downcoast of the discharge, indicating the presence of a warm water surface lens in the vicinity of the thermal discharge. Despite surface warming, near-bottom water temperatures in 2007 were similar at all stations between tides. These spatial patterns of warm surface water have been observed in previous surveys and reflect tidal influences on the thermal discharge from the generating station on the day of sampling. Even in areas influenced by the thermal field, surface temperatures were typical of the area and within the range of natural variability observed during previous surveys. Other than at the discharge on ebb tide, the thermal field did not contact the seafloor.

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.

During the winter survey, DO was relatively consistent decreasing below subsurface maxima with differentials of less than 1 mg/l with depth to the bottom at most stations on flood tide. The exception was found at the station farthest upcoast where the decline of DO concentration was more notable below a subsurface maximum at two meters than at the other stations. During the afternoon ebb tide, DO concentrations in the upper water column, though generally higher, were similar to those found during the flood tide, varying by less than 0.5 mg/l from the earlier tide. Dissolved oxygen concentrations were more variable through the water column on flood tide, with subsurface maxima recorded in the upper four meters at each station. Below these maxima, DO concentrations declined with depth to the bottom, with secondary DO peaks found at six to eight meters at most stations. The similarity of DO levels with depth suggests that during the winter sampling the water column was fairly well mixed during both tides. In 2006, a red tide in winter contributed to extreme DO fluctuations in the water column at the offshore stations, with very high DO values, up to 15.55 mg/l found near surface, and some low values near 5.00 mg/l found near bottom (MBC 2006a). All DO values from the winter survey were within the range previously found in the area and more typical of previous winter sampling than occurred in 2006 (MBC 1986, 1988, 1990, 1994-2001a, 2002-2004a, 2005, 2006a; Ogden 1991-1993).

In summer, DO concentrations in surface waters and the upper water column were very similar to a depth of about two meters on both tides except at the farthest upcoast station where values were consistently higher throughout the water column on ebb tide. Below a depth of about two meters at the remaining stations DO concentrations were also higher during the later ebb tide sampling. Dissolved oxygen concentrations were relatively consistent with depth, with slight subsurface maxima in the upper two to six meters at all stations. These maxima were slightly deeper on flood tide, with DO generally similar in the water column to a depth of about 10 m, below which DO decreased moderately to the bottom. Generally higher DO levels during the afternoon sampling were consistent with replenishment by photosynthetic activity later in the day. The similarity of DO levels with depth 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, 1994-2001a, 2002-2004a, 2005, 2006a; 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 both winter and summer, pH was very consistent throughout the water column in the survey area. Hydrogen ion values were slightly more variable in winter with slightly higher values found during ebb tide. Hydrogen ion concentrations varied by less than 0.1 units on flood tide, by 0.14 units or less during the afternoon ebb tide, and by less than 0.25 units during the winter survey. In summer pH values varied by no more than 0.2 units among stations, between tides and with depth. Hydrogen ion concentration was relatively consistent throughout the water column on both tides, although generally slightly higher on ebb tide. In 2007 all pH values were consistent with concentrations previously recorded in the study area (MBC 1986, 1988, 1990, 1994-2001a, 2002-2004a, 2005, 2006a; Ogden 1991-1993) and did not appear to be related to operation of 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. Direct measurements of salinity are impractical, however, requiring the evaporation of one kilogram of seawater to obtain a final weight of salts. The most efficient measurement of salinity is determined by the electrical conductivity of seawater, which is precisely measured through the use of a CTD (conductivity-temperature-depth) instrument and is reported in “practical salinity units” (psu) which correlates one-to-one with parts per thousand (ppt). 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 winter, salinities remained relatively consistent during both tides, increasing slightly with depth, although generally more variable during the afternoon ebb tide. Surface salinity values in winter at about 33.8 psu were slightly greater than those found during the summer survey but still varied by less than 0.3 psu among stations, between tides and with depth. During summer, surface salinity averaged about 33.6 psu. Water column concentrations were more variable downcoast of the discharge on flood tide and at, inshore and 3,000 ft upcoast of the discharge on ebb tide. Still, salinity was relatively uniform during summer sampling, varying by less than 0.4 psu among stations, between tides and with depth. All values reported in 2007 were typical of the nearshore waters of southern California and within values found previously in the area (MBC 2002-2004a, 2005, 2006a) and did not appear to be influenced by the operation of the generating station.

CONCLUSION

With the exception of the warm water surface lens near the discharge in summer, variations in water quality parameters observed in 2007 can be attributed to natural physical and biological processes. Water quality measurements indicated that in 2007 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

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

Bottom samples for sediment grain size and sediment chemistry analyses were collected at Stations B1 through B6 during the summer of 2007 (Figure 10). All samples were collected *in situ* by biologist-divers in conjunction with infauna sampling.

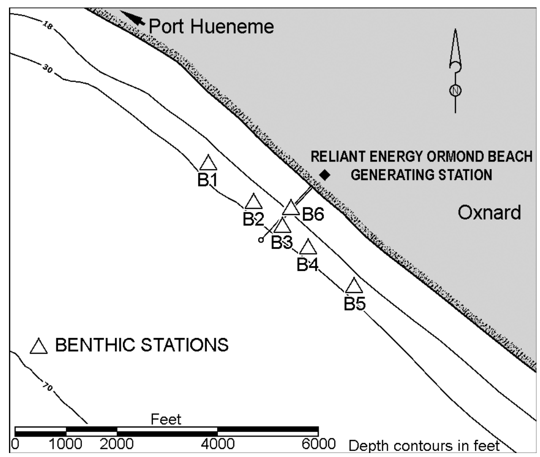


Figure 10. Location of the benthic sampling stations. Ormond Beach Generating Station NPDES, 2007.

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 B1 through B6 on 29 August 2007 between 0755 and 1015 hours. Skies were clear with winds from the northwest at 10 to 15 kn. Seas were west at 3 to 5 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. Grain size is expressed in phi (Φ) units, which are inversely related to grain diameter (Appendix C-1).

Sediments at the six stations in 2007 were composed primarily of sand, with smaller amounts of silt and clay (Table 3). Gravel was not found at any of the stations in 2007. Overall, sediments from the six stations averaged about 91% sand, 7% silt, and 2% clay, with an average mean grain size of 2.76 phi (148 µm, fine sand). Sediments were finest at Stations B1 and B5, 3,000 ft upcoast and downcoast of the discharge on the 30-ft isobath, respectively, where mean grain size was 3.11 and 3.12 phi (116 and 115 µm, very fine sand). Sediments were coarsest at Station B3, at the discharge, where mean grain size was 2.33 phi (199 µm, fine sand).

Table 3. Sediment grain size parameters. Ormond Beach Generating Station NPDES, 2007.

	Station							
Parameter	B1	B2	B3	B4	B5	B6	Mean	S.D.
% Gravel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% Sand	88.76	91.68	92.74	90.63	89.01	93.94	91.13	2.06
% Silt	8.81	6.66	5.09	7.04	8.61	4.21	6.74	1.84
% Clay	2.43	1.66	2.17	2.33	2.38	1.85	2.14	0.31
Mean grain size								
phi	3.11	2.49	2.33	2.90	3.12	2.79	2.76	0.32
µm	116	178	199	134	115	145	148	34
Sorting(ϕ)	0.839	1.251	1.167	0.890	0.762	0.844	0.959	0.200
Skewness	0.087	-0.239	0.071	0.113	0.221	-0.110	0.024	0.167
Kurtosis	1.365	0.785	1.403	1.206	1.345	1.482	1.264	0.252

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 2007, sorting averaged 0.96 phi overall, representing moderately sorted sediments (Table 3). Sorting values ranged from 0.76 phi (moderately sorted) at Station B5 to 1.25 phi (poorly sorted) at Station B2, 1,000 ft upcoast of the discharge at a depth of 30 ft. Poorly sorted sediments were also found at Station B3, while moderately sorted sediments occurred at the remaining stations. At Station B2, the distribution of sediments was bimodal, with a primary peak in the fine sand category and a secondary peak at medium sand. Sediment distribution curves at the remaining stations were unimodal, with peaks in the fine sand category and variable amounts of sediments in other size categories.

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 -0.24 at Station B2 to 0.22 at Station B5 (Table 3). Distribution curves were skewed toward coarser material at Station B2 and Station B6, inshore of the discharge on the 20-ft isobath; skewed toward finer material at Station B5 and Station B4, 1,000 ft downcoast of the discharge at 30 ft depth; and essentially symmetrical at Stations B1 and B3.

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 0.79 at Station B2 to 1.48 at Station B6 and averaged 1.26 (Table 3). Other than the platykurtic distribution at Station B2, kurtosis values in 2007 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 six benthic stations were analyzed for chromium, copper, nickel, and zinc. Sediment metal concentrations are presented in Appendix D and summarized in Table 4, with values reported as dry weight. Metal concentrations were similar among stations, with the highest values for all metals found at Station B2, upcoast of the discharge. Lowest levels for chromium, nickel and zinc were found at the discharge, while lowest copper levels occurred downcoast at Station B4.

Table 4. Sediment metal concentrations (mg/dry kg). Ormond Beach Generating Station NPDES, 2007.

	Station										Reporting
Metal	B1	B2	B3	B4	B5	B6	Mean	S.D.	ERL	ERM	Limits
Chromium	7.31	7.89	5.03	5.44	6.03	6.39	6.35	1.09	81	370	0.128 - 0.136
Copper	3.69	3.99	3.17	2.89	3.58	3.40	3.45	0.39	34	270	0.128 - 0.136
Nickel	7.17	7.75	5.93	6.51	7.09	6.93	6.90	0.62	20.9	51.6	0.128 - 0.136
Zinc	26.3	27.0	19.7	20.3	23.4	21.3	23.0	3.1	150	410	1.28 - 1.36

ERL = Effects Range Low

ERM = Effects Range Medium

Chromium. Sediment chromium concentrations averaged 6.35 mg/kg and ranged from 5.03 mg/kg at Station B3 to 7.89 mg/kg at Station B2 (Table 4).

Copper. Sediment copper concentrations averaged 3.45 mg/kg and ranged from 2.89 mg/kg at Station B4 to 3.99 mg/kg at Station B2 (Table 4).

Nickel. Sediment nickel concentrations averaged 6.90 mg/kg and ranged from 5.93 mg/kg at Station B3 to 7.75 mg/kg at Station B2 (Table 4).

Zinc. Sediment zinc concentrations averaged 23.0 mg/kg and ranged from 19.7 mg/kg at Station B3 to 27.0 mg/kg at Station B2 (Table 4).

DISCUSSION

Sediment Grain Size

In 2007, sediments were analyzed from six stations offshore the Ormond Beach Generating Station. Sediments were 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 stations nearest upcoast and inshore of the discharge, and skewed towards finer material at both stations downcoast of the discharge, while sediments were essentially symmetrical both at the discharge station and at the station farthest upcoast of the discharge. Sediments were slightly coarser at and just upcoast of the discharge, but grain sizes were relatively similar to those found at the other 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 inshore of the discharge on the 20-ft isobath, while greatest percentages of fine material (11%) occurred at the stations farthest upcoast and 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 11; Appendix C-3; MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-2001a, 2002-2004a, 2005, 2006a; Ogden 1991-1993). In 2006, however, mean grain size was consistent with that from most previous surveys, and in 2007, mean grain size was nearly identical to the long-term mean in the area (Figure 11). Coarser sediments at Station B2 in 2005 and 2006 were likely a remnant of the very coarse relict sands found in isolated patches on the Santa Barbara Shelf (AHF 1959). 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.

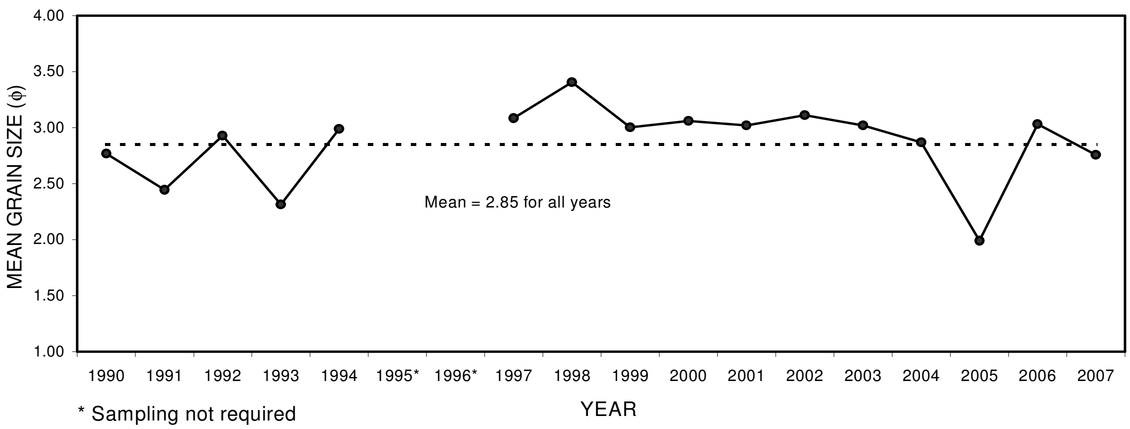


Figure 11. Comparison of sediment mean grain size, 1990 - 2007. Ormond Beach Generating Station NPDES, 2007.

In 2007, 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, 1997-2001a, 2002-2004a, 2005, 2006a; 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 2007 or commonly in previous surveys (Schiff et al. 2006; Figure 12; Appendix C-3). Despite the overall similarity in sediment characteristics found in the area in 2007, there has been year-to-year variability in grain size. In the 17 surveys since 1980 (excluding 1998 and 2003 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 four times including this year, and upcoast of the discharge ten times (Appendix C-3). Coarsest sediments occurred at the discharge seven times, including this year, upcoast seven times, and inshore three times.

In a pattern observed during some previous surveys, coarser sediments in the vicinity of the discharge in 2007 may have been influenced by turbulence (which prevents finer sediments from settling) associated with the cooling water discharge 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 2005, 2004 and 2002. However, the degree of influence varies from year to year, and in 2006, 2003 and 2001 no sediment grain size patterns relative to the discharge were apparent (MBC 2001a, 2002-2004a, 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 2007 were similar to those found previously in the area and appear to be influenced primarily by natural causes.

Sediment Chemistry

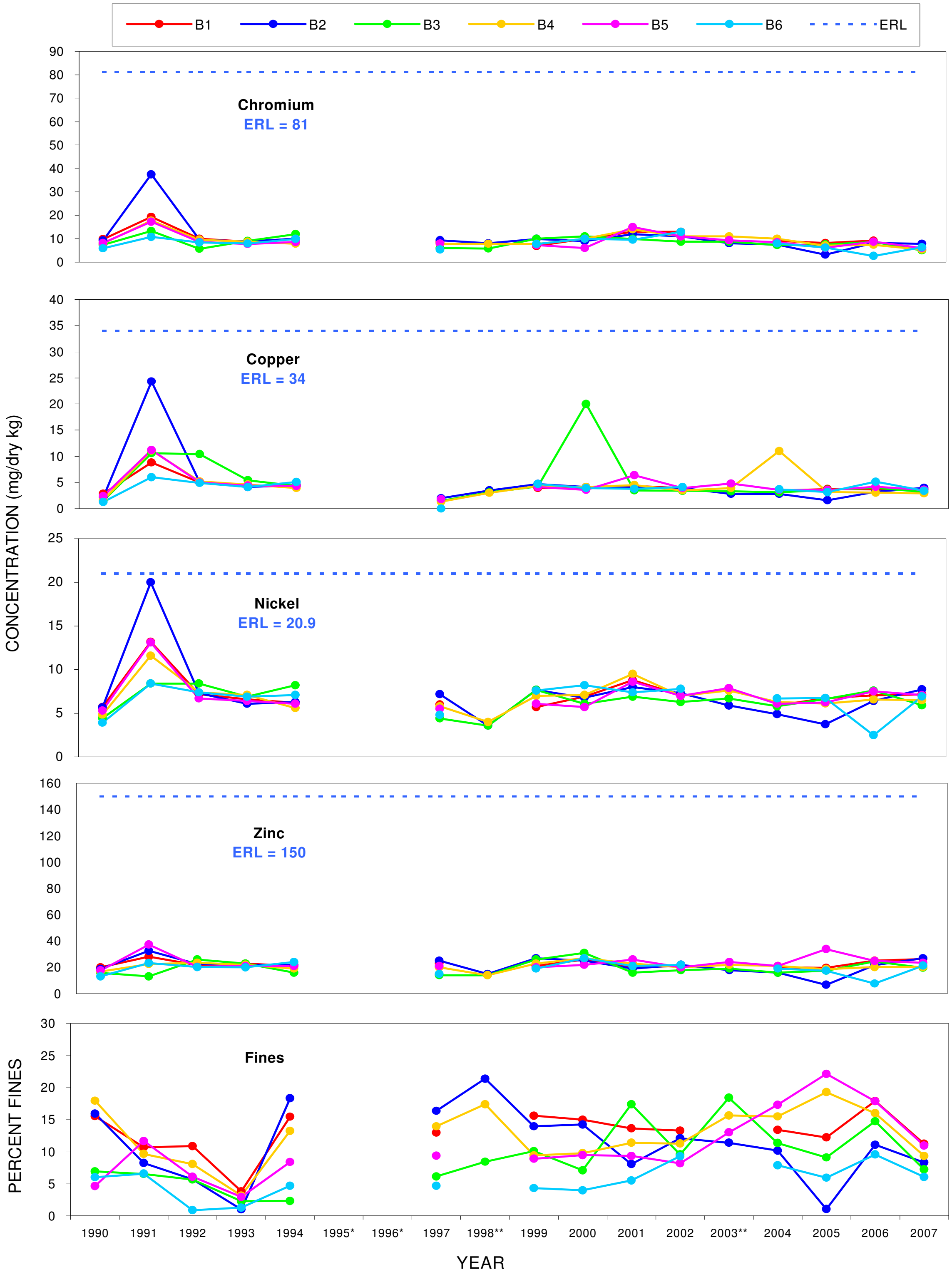
In 2007, sediments at six stations off the Ormond Beach Generating Station were analyzed for the presence and concentration of chromium, copper, nickel, and zinc. Metal levels were relatively similar among stations. Highest concentrations of all metals were recorded 1,000 ft upcoast of the discharge (Table 4 and Figure 12). Lowest concentrations of chromium, nickel and zinc were recorded at the discharge and lowest copper 1,000 ft downcoast of the discharge. Metal concentrations were similar to values recorded in previous surveys including 2006, and to their respective long-term means at each station (Figure 12 and Appendix D-2).

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 12 and Appendix D-2). Continuing this trend somewhat, this year the greatest percentage of fine material was recorded at upcoast Station B1, with a similar percentage of fine material found at Station B5 farthest downcoast of the discharge. Despite this, highest concentrations of all metals in 2007 were found at Station B2 where the percentage of fine material was intermediate in relation to the remaining stations. Consistent with previous surveys, in 2007 sediment characteristics were relatively similar among stations, and the relatively low metal concentrations did not appear to be related to the amount of fine material in the sediments (MBC 1990, 1994, 1997-2001a, 2002-2004a, 2005, 2006a; Ogden 1991-1993).

Since 1990, metal levels in the area were highest in 1991 (Figure 12). 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 2001a, 2002-2004a, 2005, 2006a).

Most metal values observed in 2007 were typical of the area and similar to the long-term means at all stations (Appendix D-2). 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 2007 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,



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

Figure 12. Comparison of sediment metal concentrations and percent fines by station, 1990 - 2007. Ormond Beach Generating Station NPDES, 2007.

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 12).

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 2007 metal concentrations were generally similar among stations and similar to results found commonly in previous surveys. Metal concentrations in 2007 were not strongly related to the percent of fine material in the sediments. 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 2007 did not appear to be influenced by the operation of the Ormond Beach Generating Station.

CONCLUSION

Sediment Grain Size

In 2007, 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 2007 were similar to those found previously in the area and appear to be affected primarily by natural causes.

Sediment Chemistry

In 2007 metal concentrations were generally similar among stations, with highest metal concentrations found at the station 1,000 ft upcoast of the generating station discharge. Lowest metal concentrations were found at or downcoast of the discharge. Sediment metal concentrations have remained relatively consistent in the area since 1990 and concentrations in 2007 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, 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 2007 did not appear to be influenced by the operation of the Ormond Beach Generating Station.

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).

MATERIALS AND METHODS

Prior to 2006, mussels for tissue analysis were collected off of the Ormond Beach Generating Station discharge buoy. Replacement of the buoy in early 2006, however, eliminated this site as a mussel source. As a result, live bay mussels (*Mytilus galloprovincialis*) were purchased from a commercial mussel distributor, Carlsbad Aquafarms, for transplant near the Ormond Beach discharge. Donor mussels were harvested from Agua Hedionda Lagoon in Carlsbad, California on 29 March 2007, cleaned and placed within protective enclosures that allowed unrestricted water flow to the mussels, and transplanted to a mooring established near the Ormond Beach discharge on 31 March 2007. Additional mussels from the donor site were frozen for later analysis and comparison with the transplanted mussels. On 29 August 2007 the transplanted mussels were retrieved and returned to the laboratory for chemical analysis.

Forty-five (45) transplanted bay mussels with shell lengths averaging 70 mm were collected from the mooring and returned to the laboratory for chemical analysis. Three replicate samples, each a composite of the tissue from 15 mussels, were analyzed for concentrations of the metals chromium, copper, nickel, and zinc according to methods used in the California State Mussel Watch Program (SMWP; Appendix A and SWRCB 1986). Standard Methods (SM) method 2540B was used in determining total percent solids, and Environmental Protection Agency (EPA) method 6020 was used for metal analysis. The same methods were used with bay mussels collected from the donor site and from a set of California mussels (*Mytilus californianus*) collected on 25 July 2007 from Manhattan Beach Pier in Santa Monica Bay, which served as a reference site.

During sample analysis, metals are detectable at very low concentrations. The level below which the analytical method will no longer detect the analyte is referred to as the method detection limit (MDL). However, concentrations are only reported when results can be confirmed by exceeding a confidence level, termed the reporting limit (RL). If metal concentrations are detected at a level below the RL the results can not reliably be reported and sample results are reported as none detected (ND). Beginning in 2005, analytical reporting limits for bioaccumulated metals were lower than in previous years (MBC 1999-2001a, 2002-2004a, 2005, 2006a). As a result, in 2005 and 2006 concentrations of some metals were reported at levels lower than possible during earlier surveys. In 2007, it was determined that the extremely low reporting limits utilized in 2005 and 2006 were more sensitive than necessary to detect bioaccumulated metals. So, while reporting limits in 2007 were higher than during the previous two years, these levels are still expected to reliably report metal concentrations commonly found in local mussel tissues without reporting ND results. For QA/QC purposes, the analytical laboratory may randomly analyze one sample twice to confirm results and provide the results from both analyses. While both replicates are usually very similar, some differences in metal concentrations are typical. When QA/QC results are provided the highest value determined during either analysis is presented in the results.

RESULTS

In 2007, chromium, copper, nickel, and zinc were detected in all mussel tissue replicates from the generating station discharge area, the donor site and at a pier reference site (Table 5 and Appendix E).

Chromium concentrations in mussels from the discharge ranged from 7.05 to 11.1 mg/dry kg with a mean of 8.6 mg/dry kg (Table 5). Mean chromium concentration at the discharge was higher than at both the donor site (6.24 mg/dry kg), and the reference site (4.65 mg/dry kg).

Table 5. Mussel tissue metal concentrations (dry weight and reporting limits, mg/dry kg; wet weight and EDL, mg/wet kg). Ormond Beach Generating Station NPDES, 2007.

	Dry Weight						Wet Weight						
	Replicate					Reporting	Replicate						
Metal	1	2	3	Mean	SD	Limits	1	2	3	Mean	SD	EDL 85	EDL 95
Discharge													
Chromium	11.1	7.05	7.53	8.56	2.21	0.667 - 0.709	**1.67**	**0.99**	**1.08**	**1.25**	0.37	0.73	1.70
Copper	5.12	4.66	4.23	4.67	0.45	1.00 - 1.06	0.77	0.66	0.60	0.68	0.08	5.30	11.93
Nickel	5.90	3.16	3.24	4.10	1.56	0.333 - 0.355	**0.89**	0.45	0.46	0.60	0.25	0.83	1.10
Zinc	76.4	58.1	81.3	71.9	12.2	6.67 - 7.09	11.5	8.2	11.6	10.4	1.9	55.78	77.84
% Solids	15.0	14.1	14.3	14.5	-	0.100	-	-	-	-	-	-	-
Donor Site													
Chromium	5.78	6.52	6.42	6.24	0.401	0.855 - 1.27	0.65	0.54	0.51	0.57	0.08	0.73	1.70
Copper	12.1	10.3	9.75	10.7	1.23	1.33 - 1.90	1.37	0.85	0.77	1.00	0.32	5.30	11.93
Nickel	3.26	2.20	2.36	2.61	0.571	0.442 - 0.633	0.37	0.18	0.19	0.25	0.11	0.83	1.10
Zinc	144	168	179	164	17.9	8.85 - 12.7	16	14	14	15	1	55.78	77.84
% Solids	11.3	8.30	7.90	9.17	-	0.100	-	-	-	-	-	-	-
Manhattan Beach Pier Reference Site													
Chromium	4.37	3.78	5.81	4.65	1.04	0.446 - 0.526	**0.93**	**0.85**	**1.10**	**0.96**	0.13	0.55	1.04
Copper	8.49	7.56	9.48	8.51	0.96	0.670 - 0.789	**1.81**	**1.69**	**1.80**	**1.77**	0.06	1.59	2.12
Nickel	2.46	1.24	1.74	1.81	0.61	0.223 - 0.263	0.52	0.28	0.33	0.38	0.13	0.63	0.82
Zinc	94.5	73.9	94.2	87.5	11.8	4.46 - 5.26	20.1	16.6	17.9	18.2	1.8	33.64	38.87
% Solids	21.3	22.4	19.0	20.9	-	0.100	-	-	-	-	-	-	-

EDL = Elevated Data Levels **Blue** values exceed EDL 85 **Red** values exceed EDL 95

Copper concentrations from the discharge averaged 4.67 mg/dry kg with a range from 4.23 to 5.12 mg/dry kg (Table 5). Copper was higher in both the donor mussels (10.7 mg/dry kg) and in mussels from the reference site (8.51 mg/dry kg).

Nickel levels in mussels from the discharge ranged from 3.16 to 5.90 mg/dry kg with a mean of 4.10 mg/dry kg (Table 5). Nickel at the discharge was about 60% higher than the mean concentration at the donor site (2.61 mg/dry kg) and more than twice the level at the reference site (1.81 mg/dry kg).

Zinc concentrations at the discharge site ranged from 58.1 to 81.3 mg/dry kg, with a mean concentration of 71.9 mg/dry kg (Table 5). Zinc concentrations were highest in the donor mussels with a mean concentration 164 mg/dry kg and second highest at the reference site with a mean of 87.5 mg/dry kg.

DISCUSSION

The SMWP monitors levels of metals and organic pollutants in both native California mussels and bay mussels. Bioaccumulation of pollutants by the two species was found to be comparable, although some differences were found between the mussels, likely related to habitat preference (SWRCB 1995, 2000). California mussels are preferentially used for analysis. However, a resident population of mussels is sometimes not available in an area, such as offshore of the Ormond Beach Generating Station. In that case, mussels are transplanted into the area for at least 90 days. All analytical results are reported on a dry weight basis; however, wet weight concentrations were calculated for comparison with evaluation criteria.

Water quality standards for evaluating bioaccumulation in mussel tissues are primarily based on human or animal health criteria, and several standards of comparison are currently available (SWRCB 1995, 2000). However, action levels for only a few organic chemicals have been determined. Because of this, the SMWP developed a method of comparison among samples based on elevated data levels (EDL). The EDL for any particular substance is based on a ranking of statewide tissue levels for that substance from the ongoing SMWP. Elevated data levels are determined for each species and may vary depending on whether the mussels are resident or transplanted. Elevated data levels are updated periodically based on recent data. In the EDL ranking system the 50th percentile corresponds to the median of all values rather than to a mean. The 85th percentile (EDL 85) indicates that a chemical is markedly elevated from the median. The 95th percentile (EDL 95) indicates values that are highly elevated above the median. While no studies have strictly compared these values, this information is useful in determining if a particular substance has been found in unusually high concentrations and in comparing local results to recent statewide results.

In 2007, mussels were not found in the vicinity of the Ormond Beach Generating Station discharge. For that reason, donor mussels were purchased from a commercial supplier in Carlsbad, California and transplanted to a mooring near the Ormond Beach discharge where the mussels were allowed to acclimate for a period of 151 days. Results were compared with those from mussels collected at the donor site at the time of the transplant and to mussels collected from the Manhattan Beach Pier in Santa Monica Bay, which served as a reference site.

All four metals were reported in all replicates from the generating station discharge, in the donor mussels, and at the reference site. Tissue concentrations of chromium in mussels at the discharge in 2007 were detected at levels about 30% than reported in 2006 and more than twice those found in the area in 2005 (Table 5, Figure 13). Previous to 2005, chromium was reported in mussels from the discharge at very low levels in 2002, at an extremely high level in 1991 and at levels about one-fifth current levels in 1990 (Figure 13 and Appendix E; MBC 1990, 1999-2001a, 2002-2004a, 2005, 2006a; Ogden 1991-1993). Chromium undoubtedly occurred in tissues during all years, but at levels which could not reliably be reported with previous analytical reporting limits. Still, most chromium concentrations at the discharge in 2005 were found at levels that exceeded previous reporting limits, suggesting that chromium in the area was higher than in preceding years. Levels were even higher in 2006 and 2007 suggesting that the chromium levels in the area have increased from pre-2005 levels. In 2005, the mean concentration of chromium in mussel tissues from the reference site was about one-third the level found at the discharge; however, in 2006 levels from the reference site (where levels were more than seven times higher than in 2005) were about 50% higher than levels in mussels from the discharge, while chromium concentrations in the donor mussels were about 20% higher than at the discharge. In 2006, higher-than-normal chromium levels were noted in mussels at the discharge, from the Agua Hedionda donor site and the Santa Monica Bay reference site, as well as from other areas of southern California in 2006 (MBC 2006a-g). In 2007, chromium in mussels from the discharge was nearly 40% higher than levels reported from mussels at the donor site, and almost twice the mean concentration from the reference site. As in 2005 and 2006, wet-weight chromium levels in mussels from the Ormond Beach discharge exceeded the EDL 85 for bay mussels, indicating that chromium was elevated in the study area (Table 5). Chromium levels in mussel tissue from the Manhattan Beach Pier reference site were also elevated or highly elevated, with replicates exceeding the EDL 85 or EDL 95 values for resident California mussels. Wet-weight concentrations of chromium in tissues from the donor site did not exceed levels considered elevated by SMWP for bay mussel.

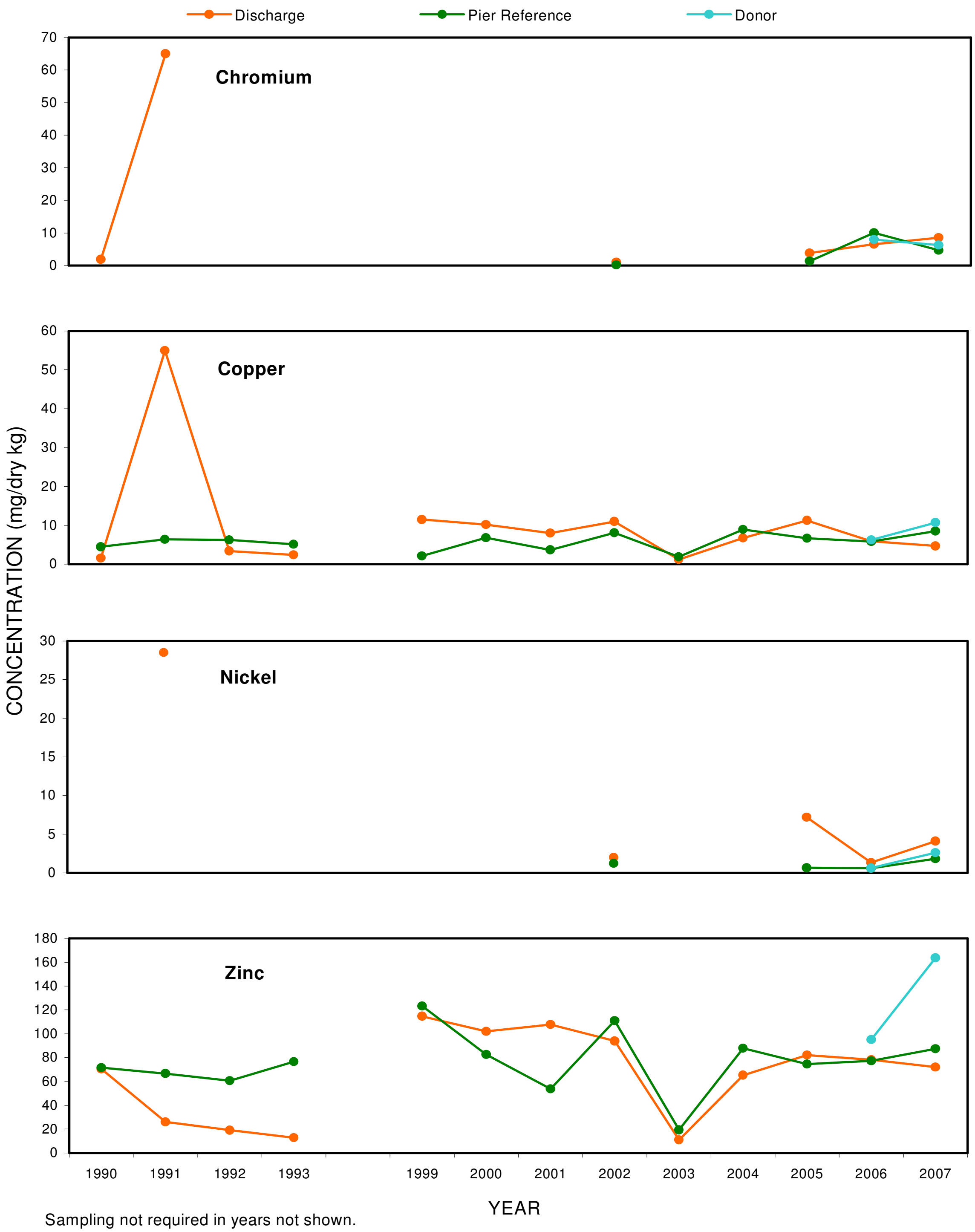


Figure 13. Comparison of mean chromium, copper, nickel, and zinc concentrations in mussel tissue at discharge and at reference sites, 1990 - 2007. Ormond Beach Generating Station NPDES, 2007.

Copper concentrations in mussels from the discharge in 2007 were 20% lower than concentrations reported in 2006, less than one-half the levels found in the area in 2005, and generally lower than levels found in the area since 1999 (except 2003) (Figure 13; Appendix E-2). Copper levels at the discharge were generally about one-half the values found in mussels from the donor and the reference sites. Wet-weight copper levels at the discharge and at the donor sites were below the EDL 85 value for bay mussels, indicating that in 2007 copper concentrations were not elevated in these areas (Table 5). Copper values at the reference site, however, were elevated above the EDL 85 value for native California mussels.

Nickel concentrations in mussels from the discharge were about three times the level reported in 2006, but more than 40% lower than levels found in the area in 2005. Previous to 2005, nickel occurred in tissues from the area in 2002 and at very high levels in 1991 (Figure 13, Appendix E). In 2005 nickel was detected in mussels from the discharge at levels that were notably higher than concentrations at the reference site, while levels at all sites were similar in 2006. In 2007, mean nickel concentration at the discharge was about 60% higher than at the donor site and more than twice the mean concentration at the reference site. Wet-weight concentrations of nickel in mussel tissues from the discharge exceeded the EDL 85 value for bay mussels in one replicate, while levels in the other two replicates and the overall replicate mean were below the EDL 85 value (Table 5). Nickel concentrations in mussel tissues collected from the donor site and from the reference site were below levels considered elevated by the SMWP for the respective mussel species.

Zinc concentrations from the discharge area were lower than in both 2005 and 2006, and while higher than levels found in 2003 and 2004, still lower than levels found between 1999 and 2002 (Appendix E-2; MBC 1990, 1999-2001a, 2002-2004a, 2005, 2006a; Ogden 1991-1993). In 2007, zinc levels at the discharge were about 20% lower than those found at the reference site and less than one-half the levels found in the donor mussels (Figure 13). Wet-weight zinc concentrations from the discharge were notably lower than the EDL 85 values for bay mussels, indicating that zinc levels were not elevated near the Ormond Beach discharge (Table 5). Wet-weight concentrations of zinc at both the donor site and the reference site were also below levels considered elevated.

CONCLUSION

In 2007, concentrations of chromium and nickel in mussels from the Ormond Beach discharge increased from 2006 levels, while copper and zinc decreased. Chromium at the discharge and at the reference site exceeded values considered elevated by the State Mussel Watch Program. Nickel levels in mussels from the discharge were lower than concentrations reported in 2005, though values in one replicate were elevated, while elevated copper was noted at the reference site but not from the discharge. The similarity of tissue metal levels among sites, to previous studies, and to other areas in southern California suggests that the operation of the Ormond Beach Generating Station is not elevating metal concentrations above background levels.

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 (four stations, two replicates each instead of four replicates as in all other surveys) (Figure 14). 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).

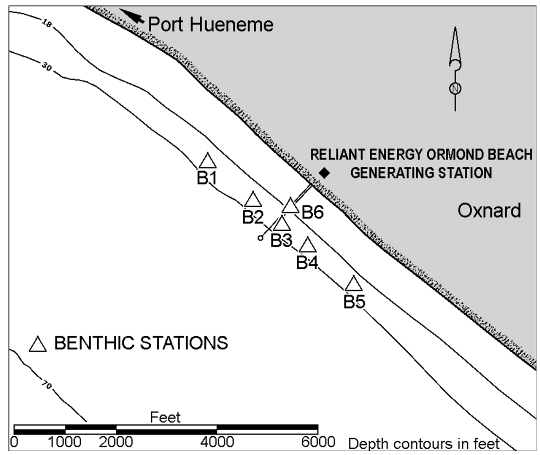


Figure 14. Location of the benthic sampling stations. Ormond Beach Generating Station NPDES, 2007.

MATERIALS AND METHODS

Biologist-divers collected sediment cores for analysis of infauna composition at Stations B1 through B6 on 29 August 2007 between 0755 and 1015 hr. Skies were clear with winds from the northwest at 10 to 15 kn, and seas were west at 3 to 5 ft. Four replicate cores were collected at each station using a hand-held, diver-operated box corer (Figure 15). 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 mesh stainless-steel screen, labeled, and fixed in buffered 10% formalin-seawater.

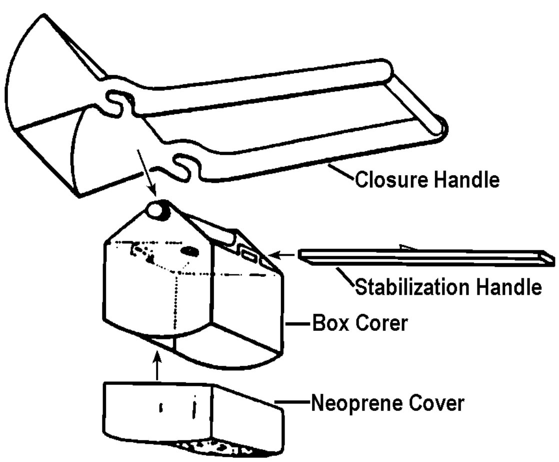


Figure 15. Diver-operated box corer used to collect infaunal samples. Ormond Beach Generating Station NPDES, 2007.

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 2001). 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 2,388 individuals in 165 species (or taxa) and 12 phyla (major groups) were taken in the 2007 benthic infauna sampling offshore of the Ormond Beach Generating Station (Table 6 and Appendix F-1). Annelids (segmented worms) were the most diverse phylum, with 65 species (39% of the total), followed by arthropods with 45 species (27%), mollusks with 24 species (14%), and nemertean (ribbon) worms with 14 species (8%). Each of the remaining eight phyla was represented by 3% or less of the species in the collection. Annelids were also the most abundant phylum, comprising about 54% of the individuals in the samples. Arthropods and mollusks were second and third most abundant, with 19% and 14% of the individuals, respectively, but nematodes (round worms) and echinoderms, with just over 6% and 4% of the abundance, respectively, were more abundant than nemerteans. Each of the seven remaining phyla comprised 1% or less of the abundance.

Table 6. Number of infaunal species and individuals by phylum. Ormond Beach Generating Station NPDES, 2007.

	Station							Percent
Parameter	B1	B2	B3	B4	B5	B6	Total	Total
Number of species								
Annelida	35	33	35	30	21	18	65	39.4
Arthropoda	18	20	22	23	21	12	45	27.3
Mollusca	10	9	10	8	6	6	24	14.5
Nemertea	7	6	4	6	5	4	14	8.5
Cnidaria	2	1	2	1	1	1	5	3.0
Echinodermata	1	3	2	2	1	2	3	1.8
Phorona	1	2	-	1	1	-	2	1.2
Platyhelminthes	-	2	-	-	-	-	2	1.2
Sipuncula	-	-	1	-	1	-	2	1.2
Brachiopoda	-	-	-	-	1	-	1	0.6
Kinorhynca	-	-	-	-	1	-	1	0.6
Nematoda	1	1	1	-	1	-	1	0.6
Total	75	77	77	71	60	43	165	
Number of individuals								
Annelida	313	335	213	144	207	70	1282	53.7
Arthropoda	46	66	129	80	76	67	464	19.4
Mollusca	68	144	25	34	32	31	334	14.0
Nematoda	8	5	9	-	3	-	155	6.5
Echinodermata	13	29	13	23	15	10	103	4.3
Nemertea	27	50	22	33	16	7	25	1.0
Cnidaria	2	2	4	1	1	1	11	0.5
Phorona	2	2	-	2	2	-	8	0.3
Platyhelminthes	-	2	-	-	-	-	2	0.1
Sipuncula	-	-	1	-	1	-	2	0.1
Brachiopoda	-	-	-	-	1	-	1	0.0
Kinorhynca	-	-	-	-	1	-	1	0.0
Total	479	635	416	317	355	186	2388	

Species Richness. Species richness averaged 67 species per station, and ranged from 43 species at Station B6, inshore of the discharge, to 77 species at both Station B2 and Station B3, immediately upcoast of the discharge and at the discharge, respectively (Table 7).

Abundance. Abundance averaged 398 individuals per station (10,000 individuals/m^2) and ranged from 186 individuals at Station B6 to 635 individuals at Station B2 (Table 7).

Species Diversity. Shannon-Wiener species diversity (H') averaged 3.26 per station and ranged from 3.07 at Station B1, farthest upcoast, to 3.60 at Station B4, immediately downcoast of the discharge (Table 7).

Table 7. Infaunal community parameters. Ormond Beach Generating Station NPDES, 2007.

	Station							
Parameter	B1	B2	B3	B4	B5	B6	Total	Mean
Number of species								
Total	75	77	77	71	60	43	165	67
Rep. Mean	33	37	35	36	31	22		32
Rep. S.D.	11	9	8	2	6	3		
Number of individuals								
Total	479	635	416	317	355	186	2,388	398
Rep. Mean	120	159	104	79	89	47		100
Rep. S.D.	57	51	35	4	28	8		
Density (Number/m^2)								10,000
Diversity (H')								
Total	3.07	3.08	3.47	3.60	3.20	3.15	3.62	3.26
Rep. Mean	2.74	2.84	2.99	3.13	2.82	2.72		2.87
Rep. S.D.	0.21	0.40	0.26	0.17	0.26	0.21		
Benthic Response Index (BRI)								
Total	19.9	21.9	22.2	18.7	19.2	15.7		19.6
Biomass (g)								
Total	1.26	1.73	2.51	2.08	0.82	1.11	9.51	1.59
Rep. Mean	0.31	0.43	0.63	0.52	0.21	0.28		0.40
Rep. S.D.	0.15	0.23	0.17	0.17	0.07	0.18		
g/m^2								40

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 station inshore of the discharge is 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 19.6 for the study area, and ranged from 15.7 at Station B6 to 22.2 at Station B3 (Table 7).

Biomass. Infauna biomass totaled 9.51 g for the survey and averaged 1.59 g per station (40 g/m^2) (Table 7). Values ranged from 0.82 g at Station B5, farthest downcoast, to 2.51 g at Station B3. Annelids contributed 69% of the biomass, a larger share than their proportion of the abundance, while arthropods and mollusks each contributed only 7% of the biomass, considerably less than their proportion of the abundance (Appendix F-4). Echinoderms contributed 6% of the biomass, slightly more than their proportion of the abundance.

Community Composition. Twenty-four species each comprised 1% or more of all individuals collected; together they totaled just under 15% of the species but more than 75% of the individuals in the infauna collection (Table 8, Appendix F-2). They included nine annelids, eight arthropods, three mollusks, two nemerteans, and one each of echinoderm and nematode. The polychaete annelid *Apoprionospio pygmaea* was the most abundant species, comprising more than 25% of the individuals. Two other annelids, *Mediomastus acutus* and *Onuphis* sp 1, were also abundant, with 5% and 4% of the individuals, respectively. Three mollusks, the clams *Siliqua lucida*, *Tellina modesta*, and *Cooperella subdiaphana*, were also very abundant, as were Pacific sand dollars (*Dendraster excentricus*), lineid nemertean worms, several arthropods, particularly the amphipods *Ericthonius brasiliensis* and *Rhepoxynius menziesi* and the cumacean *Diastylopsis tenuis*; all of the sand dollars were very small (Appendix F-4). Most of the abundant species occurred at all of the stations, although *Ericthonius* was not found at Stations B1 or B6. Several species were least abundant at or absent from Station B6, while three species, *Rhepoxynius menziesi* and two other amphipods, *R. abronius* and *Photis macinerneyi*, were most abundant at Station B6.

Table 8. The 24 most abundant infaunal species. Ormond Beach Generating Station NPDES, 2007.

		Station							Percent	Cum.
Phylum	Species	B1	B2	B3	B4	B5	B6	Total	Total	Percent
AN	*Apoprionospio pygmaea*	154	183	85	56	100	23	601	25.17	25.17
AN	*Mediomastus acutus*	30	36	5	18	24	16	129	5.40	30.57
MO	*Siliqua lucida*	20	57	4	7	7	11	106	4.44	35.01
AN	*Onuphis* sp 1 Pt. Loma 1983	29	20	28	10	9	1	97	4.06	39.07
MO	*Tellina modesta*	9	41	9	11	12	13	95	3.98	43.05
EC	*Dendraster excentricus*	13	27	11	19	15	9	94	3.94	46.98
MO	*Cooperella subdiaphana*	32	35	4	7	9	2	89	3.73	50.71
NE	Lineidae	14	25	19	16	7	1	82	3.43	54.15
AR	*Ericthonius brasiliensis*	-	1	29	8	16	-	54	2.26	56.41
AR	*Rhepoxynius menziesi*	8	6	5	5	4	21	49	2.05	58.46
AR	*Diastylopsis tenuis*	6	17	5	6	11	3	48	2.01	60.47
AN	*Armandia brevis*	5	12	4	10	5	1	37	1.55	62.02
AR	*Jassa slatteryi*	-	-	17	12	7	-	36	1.51	63.53
AN	*Spiophanes bombyx*	6	11	3	5	4	1	30	1.26	64.78
AN	*Exogone lourei*	14	-	1	1	11	1	28	1.17	65.95
AN	*Scoletoma* spp	1	9	14	-	3	-	27	1.13	67.09
AR	*Podocerus brasiliensis*	-	-	14	9	3	-	26	1.09	68.17
AR	*Rhepoxynius abronius*	2	4	4	-	3	13	26	1.09	69.26
AR	*Cyclaspis* sp C SCAMIT 1986	2	7	12	1	3	-	25	1.05	70.31
NT	Nematoda	8	5	9	-	3	-	25	1.05	71.36
NE	*Tubulanus polymorphus*	7	13	-	2	2	-	24	1.01	72.36
AN	*Goniada littorea*	6	-	3	2	8	4	23	0.96	73.32
AN	*Syllis (Typosyllis) farallonensis*	7	2	-	3	7	4	23	0.96	74.29
AR	*Photis macinerneyi*	-	2	2	4	-	15	23	0.96	75.25

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

Cluster Analyses. The 24 most abundant species were used for the normal (site-group) and inverse (species-group) cluster analyses (Figure 16). Stations B1 and B5 clustered most closely, indicating greatest similarity, with Station B2 next in similarity, forming Station Group I. The two most abundant species, *Apoprionospio pygmaea* and *Mediomastus acutus*, were more abundant at these three stations than elsewhere. Stations B3 and B4 (Group II) clustered next with the stations in Group I, while Station B6 (Group III), with fewer species and atypical abundances of some commonly occurring species clustered most distantly from the other stations.

The most abundant species clustered into three groups, based on their occurrences (Figure 16). All but one species in Group A were absent from at least one station, and three species were most abundant at Station B6. Each of the species in Groups B and C occurred at all of the stations and was most abundant at a station in Group I. However, Species Groups A and B clustered more closely together than either group did to Group C (*Apoprionospio pygmaea*), despite the similar relative proportions of abundance of *A. pygmaea* and the species in Group B.

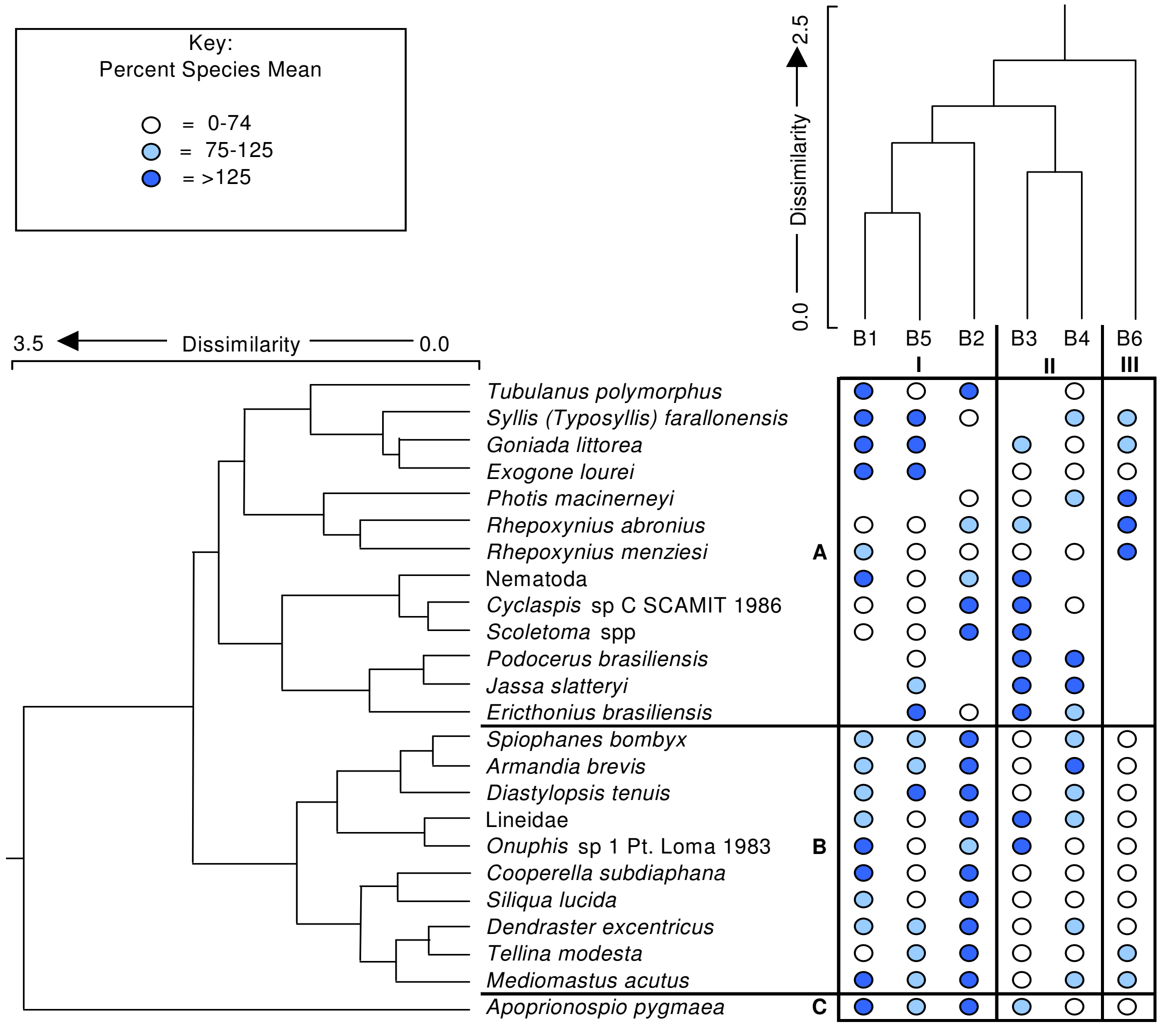


Figure 16. Two-way coincidence table resulting from normal (station) and inverse (species) classification dendrograms for the 24 most abundant infaunal species. Ormond Beach Generating Station NPDES, 2007.

DISCUSSION

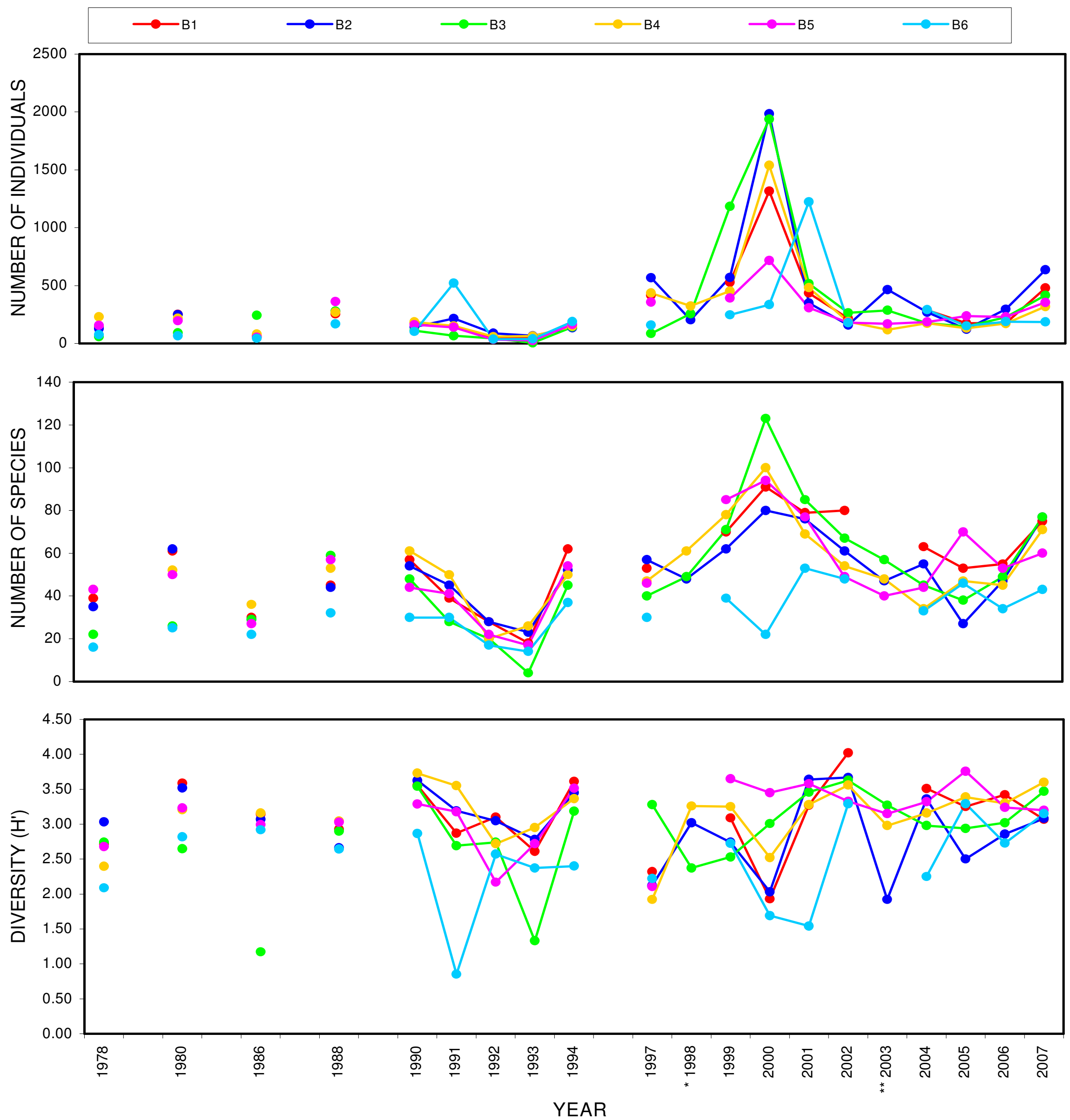
The infauna communities in the study area in 2007 were composed predominantly of small annelid worms, arthropods, clams, and Pacific sand dollars. Communities were comparable among the six stations, although those at the stations along the same isobath as the generating station discharge were more similar to each other than to the community at the station inshore of the discharge. The communities farthest upcoast and farthest downcoast were most alike, with higher-than-average abundance and species richness. However, species diversity values were lower than average, due to strong numerical dominance of the communities by one species, *Apoprionospio pygmaea*. Infaunal values were also greater than average at the discharge, and some of the abundant species were more dominant there than elsewhere, including the tube-building amphipods *Ericthonius brasiliensis*, *Jassa slatteryi*, and *Podocerus brasiliensis*, and the cumacean *Cyclaspis* sp C. Abundance and species richness were lowest inshore of the discharge, but the species diversity value was only slightly below the study-area mean because the community was not dominated by one or two species. Three species of amphipods, *Rhepoxynius menziesi*, *R. abronius*, and *Photis macinerneyi*, were more abundant there than elsewhere. 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). Values for infaunal parameters in 2007 did not appear to be related to sediment grain-size characteristics, as species diversity was generally higher where sediments were coarser, species richness was high where sediments were both coarse and fine, and abundance was highest where sediments were slightly coarser than average and lowest where they were slightly finer than average. 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*) and organic debris (mostly surfgrass, *Phyllospadix* spp). Shell fragments may provide hard substrate for tube-building annelids such as *Onuphis* sp 1 and the tube-building amphipods mentioned above (Fauchald and Jumars 1979). In addition, the organic material supports detritivores such as the *Cyclaspis* sp C. Sediments inshore of the discharge also contained moderate amounts of shell fragments and organic detritus. Two detritivores, *Rhepoxynius menziesi* and *R. abronius*, and the tube-building *Photis macinerneyi* were most abundant at that location (Word 1980).

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 2007 included the clams *Siliqua lucida*, *Tellina modesta*, and *Cooperella subdiaphana*, the annelids *Onuphis* sp 1 and *Armandia brevis*, and the amphipods *Rhepoxynius menziesi and R. abronius*. Strong swimmers such as the cumaceans *Diastylopsis tenuis* and *Cyclaspis* sp C also indicate the influence of water movement in the nearshore environment. These species were found throughout the study area, but were generally most abundant just upcoast of the discharge where sediments were coarse and poorly sorted. Pacific sand dollars were also abundant in 2007. Sand dollars frequently occur in dense aggregations; large individuals can disturb the community, thereby excluding some tube-dwelling species and reducing species richness (Smith 1981, Highsmith 1982). However, all of the Pacific sand dollars were small, indicating recent recruitment.

The infauna communities in 2007 were similar to those found in previous summer surveys conducted in the study area since 1978 (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-2001a, 2002-2004a, 2005, 2006a; Ogden 1991-1993). Abundances everywhere except inshore of the discharge were greater than in 2006, with a mean density for the area of 10,000 individuals/m^2, 86% greater than in the previous year but only slightly above the long-term mean. Abundance was particularly high in 2000, when the annelid *Owenia collaris* was very abundant everywhere except inshore of the discharge, and abundances were high at single stations in two years: Station B3 in 1999 (mostly *Siliqua lucida*) and Station B6 in 2001 (*Apoprionospio pygmaea*) (Figure 17; Appendix F-5). (As a resource exchange with RWQCB's Bight-wide programs, not all stations were sampled in 1998 and 2003, and only two replicates were collected per station in 2003; in addition, the enormous number of nematodes found in 1997 were excluded from the values shown in Figure 17). A total of 165 species was collected in 2007, compared with only 107 species in 2006; species richness values at each station were considerably greater than both in 2006 and the long-term mean. As with abundance, species richness was particularly high in 2000 everywhere except inshore of the discharge. Mean species diversity for 2007 was slightly greater than for 2006 and was substantially above the long-term mean. However, values for two stations, farthest upcoast and farthest downcoast, were equal to or below those in 2006. The BRI values were similar to those in 2006, the first year that the index was used.



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

Figure 17. Comparison of infaunal community parameters 1978 - 2007, summer surveys. Ormond Beach Generating Station NPDES, 2007.

The pattern of infaunal parameter values among stations in 2007 was comparable to that for long-term values (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-2001a, 2002-2004a, 2005, 2006a; Ogden 1991-1993). Since 1978, abundance has been greatest, on average, at the discharge, due to the high numbers of nematodes in 1997. However, abundance has frequently been greatest immediately upcoast of the discharge, and when nematodes are excluded for 1997, mean abundance has been greatest there (Figure 17). Due to consistently low abundance and high species richness, species diversity has been highest farthest downcoast from the discharge. Overall, however, values have been relatively similar among stations along the discharge isobath, even though sediments have been coarser at the discharge than elsewhere in the study area, including inshore of the discharge. Relatively low abundance, and lowest species richness and diversity have generally been found inshore of the discharge.

Composition of the infaunal community in the study area in 2007 was similar to those in prior surveys (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-2001a, 2002-2004a, 2005, 2006a; Ogden 1991-1993). Five of the top six species in 2007 were among the nine most abundant species occurring in the study area since 1978, and 15 species abundant in 2007 were among the 33 long-term community dominants (Appendix F-5). Most consistent in occurrence have been *Apoprionospio pygmaea*, *Mediomastus acutus* (one of a group of species recently split from each other), and another annelid, *Spiophanes bombyx*, *Diastylopsis tenuis*, Pacific sand dollar, *Rhepoxynius menziesi*, *Tellina modesta*, and the nemertean *Carinoma mutabilis*. Conversely, a few species have been quite variable in abundance from survey to survey. In addition to nematodes and *Owenia collaris*, 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. All but two of these species were present in 2007, and four of them were abundant. Overall, however, the majority of the infauna species seen in 2007 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

Abundance, diversity, and composition of the infauna communities in 2007 were similar among the six stations near the Ormond Beach Generating Station, with lowest abundance and species richness inshore of the discharge. Infaunal parameter values did not appear to be influenced by sediment grain size. However, other characteristics of the habitat may have been important for community composition. Prominent among the community at the discharge were several tube-dwelling species, consistent with the large amount of shell fragments in the sediment. The sediment also contained pieces of surfgrass, food for detritivores. Smaller amounts of shell fragments and organic detritus occurred inshore of the discharge, although the community at that location included few tube-dwellers and more burrowing species. 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.

IMPINGEMENT

Ormond Beach Generating Station is located approximately 3.7 km southeast of the entrance to Port Hueneme in Ventura County, California. Seawater is supplied to the once-through cooling system (OTC) through a submerged, velocity-capped intake structure. The intake structure is located 640 m offshore at a depth of -10 m Mean Low Lower Water (MLLW). The intake point is 2 m above the bottom. Seawater is drawn into the cooling system and screened for debris, first by bar racks that remove large debris followed by mesh traveling screens that remove the remaining material too large to pass through the heat exchange condensers. Impinged material caught on the screens, including fish and macroinvertebrates, is washed off the screens into collection baskets.

Fish impingement was monitored by Proteus Sea Farms International, Inc., Ojai, California during normal operation of the cooling water system. Normal operation refers to the daily operational mode of the cooling water system. 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

At the Ormond Beach Generating Station, Proteus Sea Farms International, Inc. conducted all fish impingement monitoring. Data sheets were later transmitted to MBC Applied Environmental Sciences for entry and analysis. No heat treatments were monitored during the 2007 monitoring year (1 October 2006 to 30 September 2007). In order to assess the impingement of marine organisms at the generating station during normal operation, 24-hr surveys were conducted. No surveys were conducted in October 2006, two surveys in November 2006, one survey each in December 2006 and February 2007, and monthly May through August 2007. During each survey, the traveling screens and collection baskets were cleared of all accumulated debris at the beginning of the 24-hr period. At the end of the survey period, the traveling screens were operated and accumulated material sorted to remove fish and macroinvertebrates, and all organisms were identified to the lowest practical taxonomic level. 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]), and aggregate biomass (gram [g]) recorded for measured and any additional unmeasured individuals. Length frequency distributions for those fishes examined were derived by rounding the recorded length to the nearest ten millimeters (0 to 4 = 0, 5 to 10 = 10). Abundance per size class was plotted using MS Excel. Total abundance for fish species in high abundance was estimated by dividing the total weight of the unmeasured individuals by the mean individual weight of those measured of each species. Macroinvertebrates were also sorted, counted and an aggregate weight taken.

Due to variation in daily operating patterns, normal operation survey fish and macroinvertebrate data were standardized to circulated water flow rates to determine the rate of impingement by the following equation: Impingement Rate = Number (or weight) Impinged /Circulated Water Volume for Sampling Period in million gallons, with the volume of water circulated determined based on the water flow rate during the period surveyed. For each survey, the impingement rate was multiplied by the total cooling water flow over the analysis period to derive an estimated impinged abundance and biomass (kilogram [kg]). Cooling water flows for each analysis period are presented in Appendix G-4. The estimated annual impinged abundance represents the summation of each estimated monthly abundance.

RESULTS

Eight normal operation surveys were conducted at the Ormond Beach Generating Station during the 2007 monitoring year. No heat treatments were conducted during this period. Complete survey data is available in Appendix G.

Fish

During the 2007 survey year, 43 individual fish of 11 species were collected weighing 11.8 kg (Table 9). Based on these observations, and associated impingement rates, an estimated total of 416 individuals weighing 177.3 kg were impinged during the survey year.

Table 9. Estimated abundance and biomass (kg) of fish species impinged during normal operation surveys. Ormond Beach Generating Station NPDES, 2007.

	Observed		Estimated		% Total	
Species	Abu.	Biom. (kg)	Abu.	Biom. (kg)	Abu.	Biom. (kg)
bay pipefish	6	0.014	111	0.270	26.7	0.2
white seaperch	18	2.030	78	8.828	18.8	5.0
specklefin midshipman	4	0.631	69	10.907	16.6	6.2
shiner perch	8	0.158	34	0.680	8.2	0.4
giant kelpfish	1	0.025	29	0.723	7.0	0.4
rockpool blenny	1	0.032	29	0.925	7.0	0.5
plainfin midshipman	1	0.234	26	6.138	6.3	3.5
California scorpionfish	1	0.093	17	1.607	4.1	0.9
Pacific electric ray	1	8.500	17	146.919	4.1	82.8
Pacific chub mackerel	1	0.066	4	0.287	1.0	0.2
Pacific sardine	1	0.024	2	0.048	0.5	0.0
Total Abundance	43	11.807	416	177.332		
Number of Species	11		11			

Bay pipefish (*Syngnathus leptorhynchus*) was the most abundant species impinged with an estimated 111 individuals, or 27% of the yearly total (Table 9). White seaperch (*Phanerodon furcatus*) was the second most abundant species with an estimated 78 individuals, or 19% of the total. Five species contributed an additional 5% or more to the total abundance: specklefin midshipman (*Porichthys myriaster*) with 69 individuals (17%); shiner perch (*Cymatogaster aggregata*) with 34 individuals (8%); giant kelpfish (*Heterostichus rostratus*) and rockpool blennies (*Hypsoblennius gilberti*) with 29 individuals (7%) each; and plainfin midshipman (*P. notatus*) with an additional 26 individuals (6%). The remaining four species each contributed less than 5% to the total abundance, with an estimated 17 individuals or less each.

Pacific electric ray (*Torpedo californica*) contributed the greatest estimated impinged biomass with 146.9 kg, or nearly 83% of the annual total (Table 9). Three additional species contributed more than 1% to the total biomass: specklefin midshipman with 10.9 kg, or 6% of the yearly total; white seaperch with 8.8 kg or 5%; and plainfin midshipman with 6.1 kg, or about 4% of the total. The remaining seven species cumulatively contributed an estimated 4.5 kg, or less than 3% of the annual total.

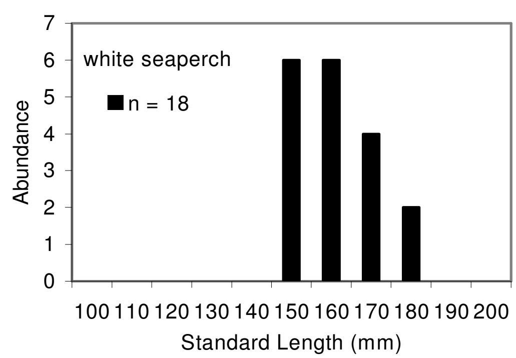


Figure 18. Length-frequency distribution of white seaperch (*Phanerodon furcatus*) taken during impingement surveys. Ormond Beach Generating Station NPDES, 2007.

Length Frequency Analysis

Length frequency analysis was conducted on the two most frequently observed species. White seaperch (n = 18) were predominantly in the 150- and 160-mm SL size classes (66%) with additional individuals in the 170- and 180-mm SL size classes (Figure 18). Standard lengths of measured shiner perch (n = 8) indicated nearly two-thirds of all individuals were in the 60- to 70-mm SL size classes, with one individual each in the 100- through 120-mm SL size classes (Figure 19).

Macroinvertebrates

In 2007, a total of 205 individuals representing 16 macroinvertebrate species weighing 17.6 kg were observed during impingement sampling at the Ormond Beach Generating Station (Table 10). Based on these observations, and the associated impingement rate, an estimated 2,877 individuals weighing 347.4 kg were impinged over the sampling year.

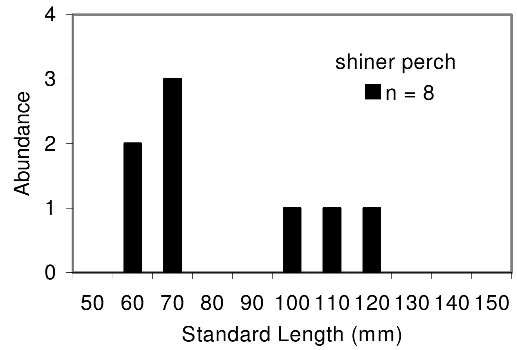


Figure 19. Length-frequency distribution of shiner perch (*Cymatogaster aggregata*) taken during impingement surveys. Ormond Beach Generating Station NPDES, 2007.

Pacific rock crab (*Cancer antennarius*) was the most abundant species, with an estimated 1,074 individuals impinged, for 37% of the yearly total (Table 10). Four additional species each contributed 5% or more to abundance: yellow crab (*Cancer anthonyi*) with 535 individuals or 19% of the total; red rock shrimp (*Lysmata californica*) with 368 individuals (13%); red rock crab (*Cancer productus*) with 234 individuals (8%); and purple-striped jellyfish (*Chrysaora colorata*) with 140 individuals (5%). The remaining 11 species each contributed 4% or less to the total annual abundance for an estimated 526 individuals cumulatively.

Table 10. Estimated abundance and biomass (kg) of macroinvertebrate species impinged during normal operation surveys. Ormond Beach Generating Station NPDES, 2007.

	Observed		Estimated		% Total	
Species	Abu.	Biom. (kg)	Abu.	Biom. (kg)	Abu.	Biom. (kg)
Pacific rock crab	84	4.572	1,074	59.745	37.3	17.2
yellow crab	19	1.880	535	43.522	18.6	12.5
red rock shrimp	66	0.165	368	1.125	12.8	0.3
red rock crab	11	1.215	234	50.303	8.1	14.5
purple-striped jellyfish	7	8.360	140	173.557	4.9	50.0
California aglaja	2	0.010	104	0.428	3.6	0.1
blackspotted bay shrimp	2	0.006	92	0.335	3.2	0.1
giant-spined sea star	1	0.001	75	0.075	2.6	0.0
graceful crab	3	0.103	62	1.529	2.2	0.4
northern kelp crab	2	0.003	58	0.075	2.0	0.0
Xantus swimming crab	2	0.030	47	0.685	1.6	0.2
sea star unid	1	0.026	26	0.682	0.9	0.2
ochre star	2	0.490	22	2.951	0.8	0.8
sheep crab	1	0.692	18	12.135	0.6	3.5
red jellyfish	1	0.001	18	0.018	0.6	0.0
California two-spot octopus	1	0.074	4	0.262	0.1	0.1
Total Abundance	205	17.628	2,877	347.428		
Number of Species	16		16			

Purple-striped jellyfish contributed the most to estimated impinged biomass with 173.6 kg, or 50% of the yearly total (Table 10). Four additional species contributed about 4% or more to the impinged biomass: Pacific rock crab with 59.7 kg, or 17% of the total; red rock crab with 50.3 kg (15%); yellow crab with 43.5 kg (13%); and sheep crab (*Loxorhynchus grandis*) with an additional 12.1 kg, or about 4% of the total. The remaining 11 species each accounted for less than 1% of the annual biomass, or 8.2 kg cumulatively.

DISCUSSION

Total estimated impingement abundance in 2007, was the lowest recorded in sampling conducted since 1990. The reduction in impingement was likely a result of reduced population densities surrounding the intake structure and unrelated to generating station operations. During the 2007 sampling year, the cooling water system circulation volume (46,814 million gallons) was similar to that recorded in 2006 (44,114 million gallons), with both years approximately one-half of the volume circulated in 2005 (88,503 million gallons) (MBC 2005, 2006a). While impingement has declined since 2005, these declines are not in direct proportion to reductions in cooling water flow. In 2006, abundance was approximately two-thirds that of the 2005 estimate with about one-half of the flow, while in 2007, abundance was less than one-tenth the annual abundance of 2006. The decline in fish abundance despite similarity in cooling water flow volumes suggests variability in local communities unrelated to plant operations and more likely reflects a natural reduction in fish abundances in the study area. A recent region-wide decline in fish population levels has been documented (Brooks et al. 2002, Jarvis et al. 2005), which undoubtedly is reflected in the general decline in fish impingement abundances.

Annual fish impingement at Ormond Beach Generating Station has been relatively variable since 1990, and much of the variability in fish abundance has been generated by the presence or absence of schooling species, such queenfish (*Seriphus politus*) and Pacific sardine *(Sardinops sagax*), the top two species taken overall, but together accounted for only two fish in 2007 (Table 11). Still, fish species composition in 2007 was generally similar to results found previously in the area, and other shallow nearshore areas throughout the Southern California Bight (Table 11, Allen 1985). A recurring group of fish species has been observed in impingement sampling since 1990 with two of the five most abundant species in 2007 among the ten most abundant species long-term.

Table 11. The 10 most abundant fish species impinged during heat treatment and normal operation surveys, 1990 - 2007. Ormond Beach Generating Station NPDES, 2007.

	Year																			%
Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	Total
queenfish	7,460	43,501	16,697	82,521	16,382	24,008	4,218	4,725	6,632	161	361	3,057	11,089	2,684	375	882	202	-	224,956	59.5
Pacific sardine	322	86	110	1,643	362	1,056	197	2,921	21,434	24	89	295	483	107	632	156	28	2	29,946	7.9
shiner perch	278	270	997	1,333	1,023	8,830	503	2,423	891	8	366	542	532	1,397	1,113	2,716	725	34	23,981	6.3
northern anchovy	301	365	891	631	2,022	1,600	2,169	4,329	73	177	564	1,144	2,095	4,076	1,395	426	578	-	22,837	6.0
walleye surfperch	1,506	1,521	3,942	550	126	616	10	1,353	431	-	2	611	432	266	11	143	80	-	11,599	3.1
white seaperch	1,606	987	1,054	1,019	1,169	2,454	395	926	158	-	35	36	75	86	55	229	204	78	10,567	2.8
plainfin midshipman	1,844	1,484	999	490	336	432	11	-	-	46	58	1	172	2	-	-	257	26	6,157	1.6
Pacific pompano	1	157	72	738	22	16	4	1	1	-	5	3,350	186	280	8	30	124	-	4,995	1.3
white croaker	14	707	149	2,506	58	679	50	4	433	-	-	101	65	5	-	-	-	-	4,771	1.3
speckled sanddab	-	390	230	504	60	240	-	-	-	-	461	1,330	102	454	40	19	921	-	4,751	1.3
Survey totals																				
Total individuals	14,680	51,860	28,796	94,602	23,403	41,996	8,664	19,266	31,545	761	3,078	15,382	16,209	11,132	4,987	6,216	4,910	416	377,903	
	54	65	54	60	59	48	41	38	47	28	42	49	54	53	43	47	41	11	120	

Bay pipefish was the most abundant fish species impinged in 2007. Though less abundant than in 2006, this continues a trend of relatively high abundances of this species in impingement sampling since 2004 (Appendix G-11, MBC 2002-2004a, 2005, 2006a). 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. 2005). All species have an upper depth limit reaching the surface extending to depths of 5 m for bay pipefish, 10 m for barcheek pipefish, and 15 m for kelp pipefish (Love et al. 2005). Ecologically, the three species exhibit two distinct habitat affinities. Allen and Pondella (2006) included bay pipefish in their southern nearshore and bay/estuary species group, while both kelp and barcheek pipefish were included in the nearshore algal bed and soft bottom species group. Kelp pipefish have been the most commonly observed of the three species in impingement sampling throughout the Los Angeles and Orange County areas, while bay pipefish has been largely limited to inshore embayments (MBC unpublished data). Barcheek pipefish has been uncommon in impingement sampling throughout the Los Angeles and Orange County areas.

Eschmeyer et al. (1983) noted bay pipefish to commonly inhabit eelgrass beds within bays, harbors, and estuaries within southern California. Two recent studies of the fish communities of bays within southern California reported bay pipefish in abundances far exceeding that of kelp pipefish (Valle et al. 1999, Allen et al. 2002). In surveys of Alamitos Bay, California, Valle et al. (1999) reported bay pipefish as the third most abundant species collected, occurring in 49% of all sampling events, while kelp pipefish was absent from the surveys. In a similar study in San Diego Bay, California, Allen et al. (2002) recorded bay pipefish as the tenth most abundant species, accounting for 0.69% of the total abundance, while kelp pipefish represented 0.01% of the total abundance.

Pipefish as a group have been reported to exhibit unique reproductive activities. Fitch and Lavenberg (1975) suggest that fertilization of the eggs occurs as the female transfers the eggs to a brood pouch located on the male's abdomen, after which the male provides all parental care and broods the eggs until hatching. The authors further report that "pregnant" male kelp pipefish have been observed from September to December in southern California. Similar patterns have been observed in the remaining pipefish species (Coleman 1999).

Little information has been reported in the primary literature regarding age and growth of southern California pipefish. Bay pipefish probably reach a maximum age of two years, while no further information is available on the remaining species (FishBase 2007). No commercial or recreational fishery currently exists for these three species of pipefish, outside of the occasional take for the aquarium trade. Other related species, such as seahorses (*Hippocampus* sp), receive much greater attention for the aquarium trade. Trends in abundance have not been derived for these pipefishes, due to the lack of either fishery dependent or independent data.

White seaperch was the second most abundant fish species impinged in 2007, and is the sixth most abundant fish species impinged at the Ormond Beach Generating Station since 1990 (Table 11). Ranging from Bahia San Carlos, Baja California, Mexico to Vancouver Island, British Columbia, Canada, white seaperch are commonly found in depths from the surfzone to 70 m (Miller and Lea 1972, Love et al. 2005). Allen and Pondella (2006) included white seaperch in their southern shallow rock sand species group. White seaperch have been commonly observed in low abundances during impingement sampling throughout the Southern California Bight (MBC unpublished data). Feder et al. (1974) noted that white seaperch tend to form loose schools in open water around the reef along the rock-sand interface. Helvey and Dorn (1981) reported white seaperch to be common around offshore cooling water structures in southern California, especially in fall and summer. Feder et al. (1974) reported that young were observed in September.

Like all surfperch, white seaperch are viviparous, producing free-swimming, fully developed young. The young are often larger than the typical 10-mm screen mesh at most coastal generating stations, preventing their entrainment and transport throughout the cooling water system. Age and growth in white seaperch have been studied in two distinct populations, one in Humboldt Bay, California and one in Anaheim Bay, California (Anderson and Bryan 1970, Eckmayer 1979). Both studies recorded individuals up to seven years old, with the northern population attaining a greater size (214 mm SL) than the southern individuals (195 mm SL), based on growth model estimations. Both populations exhibited the greatest growth over the first two years before markedly slowing. Based on these studies, the majority of impinged white seaperch were approximately three years old.

Specklefin midshipman was the third most abundant fish species taken in 2007. Specklefin midshipman is one of two species of midshipman found off the California coast. The other species, plainfin midshipman (*Porichthys notatus*) was also taken in 2007, in low abundance, but is the seventh most abundant fish species taken in impingement sampling since 1990 (Table 11). The specklefin midshipman is most commonly found in muddy and sandy areas to depths of 126 m, ranging from Point Conception, California, to Magdalena Bay, Baja California (Hubbs and Schultz 1939, Fitch and Lavenberg 1975). Although the range of the specklefin midshipman and the plainfin midshipman overlap, the specklefin prefers to live in shallower waters than the plainfin (Hubbs et al.

1939). During April to June they move off the soft bottom to rocky areas for spawning. Females will attach their eggs, 200-400, to the underside of rocks and remain with the eggs for a day or two along with the male to guard the eggs. The male will stay with the eggs for the month or more it takes them to hatch. During this time the male does not feed, and can become emaciated and diseased. Many males may succumb to the stress and die before or after the eggs hatch (Fitch and Lavenberg 1975).

Midshipmen in general are not selective feeders, and will eat anything they come across that they can get their mouth around, both alive and dead. Crustaceans, octopus, squid, and small fish make up the majority of their diet. Giant seabass, sea lions, and porpoises have been known to feed on midshipmen. During daylight hours when in muddy areas they bury themselves and emerge to feed at night (Fitch and Lavenberg 1975). At night they use photophores to display light for use in courtship (Bond 1996). They are most active at night and have been known to make humming and grunting sounds (Eschmeyer et al.1983).

There is not much documentation on the growth rate of the specklefin midshipman, but it is estimated they can grow to 508 mm (20 in) in length (Allen 1982). Males will grow much larger than females. There is no information on their maximum age, but a 457 mm (18 in) male weighing about 0.9 kg (2 lbs) was reported to be eight years old (Fitch and Lavenberg 1975).

Shiner perch was the fourth most abundant species in 2007 and is the third highest in overall abundance since 1990 (Tables 9 and 11). Impingement in 2007 of shiner perch was only about 2% of the long-term mean of 1,408 individuals per year since 1990 (Appendix G-11). Shiner perch have been somewhat variable in the area since 1990 with numbers similar to those in 2007 last reported in 1999, but still have consistently been among the most abundant species impinged (Table 11). Shiner perch are abundant in southern California, and range from San Quintin, Baja California to Alaska in depths from the surface to 480 ft (Miller and Lea 1972, Love et al. 2005). Allen (1985) observed shiner perch distribution to encompass all soft substrates throughout its range, with notably low abundances in the vicinity of kelp bed and rocky reef habitats. There is no targeted commercial fishery for shiner perch due to their small size, although they do occur as incidental catches in many of the soft-bottom fisheries, such as the California halibut (*Paralichthys californicus*) trawl fishery. Shiner perch are a common incidental catch in the California recreational fishery (Fritzsche and Collier 2001). Shiner perch abundances declined in some impingement and trawl catches in southern California after the 1970s (MBC 2001a, Stull and Tang 1996). This decline could be related to oceanic temperature regimes as there was a measurable shift from a cool water to a warmer water regime offshore of California in the 1980s and 1990s (MBC 2001b). In southern California, zooplankton (a food source for shiner perch [Allen 1982]) decreased in biomass by about 80% between 1951 and 1993, with most of the decline occurring after the 1970s (Roemmich and McGowan 1995).

Odenweller (1975) observed shiner perch in the Age-I class to average 56.8 mm SL, while Age-III class individuals averaged 100.6 mm SL in samples collected from Anaheim Bay, California. These values suggest individuals impinged at Ormond Beach Generating Station during the 2007 survey year were approximately one year old. Shiner perch are primarily planktivores, especially during the summer and fall months (Odenweller 1975) when they are most abundant in impingement samples, possibly feeding on plankton that has been entrained and passed through the cooling water system at the generating station.

Estimated biomass in 2007 was the lowest on record since 1979, after two years of nearly identical biomass estimates in 2005 and 2006, despite the reduction in operational flow between years noted above (Appendix G-12). Overall, biomass has declined markedly since 1979, with the greatest declines recorded between 1979 and 1980, 1983 and 1984, and most notably between 1987 and 1988. Annual impinged biomass between 1979 and 1987 averaged 14,602 kg while annual biomass since 1988 has been 1,244 kg, less than one-tenth of the pre-1988 annual mean. Prior to 1988, Ormond Beach Generating Station was a base load station, running all circulating pumps six to ten months per year (SCE unpublished flow data). Between 1988 and 2006, the generating station operated between 8% and 48% of its rated capacity, running circulator pumps at full capacity only one to three months of the year. This decline in operation is largely responsible for an overall decline in fish impingement from pre-1988 levels, although, as previously noted, the two factors are not exclusively related. A recent region-wide decline in fish population levels has been documented (Brooks et al. 2002, Jarvis et al. 2005), which undoubtedly is reflected in the general decline in fish impingement abundances.

Total estimated impinged macroinvertebrate abundance in 2007 was the third lowest on record since 1994 (Appendix G-13). Estimated abundance for 2007 was less than one-tenth the abundances reported for both 2005 and 2006, the two highest years on record, and about one-quarter the long-term mean reported since 1994. Macroinvertebrate numbers have been variable among years, and results in 2007 were within the range noted previously in sampling. Despite the notable reduction in abundance since 2006, macroinvertebrate biomass in 2007 was only about one-half of the weight reported in 2006 (MBC 2006a). This was due primarily to an increased number of purple-striped jellyfish reported in 2007, a large species typically more than 1 kg each, while average individual weight for yellow crab and red rock crab were both higher in 2007 than during the 2006 sampling year.

In 2007, three species of rock crab and red rock shrimp were the four most abundant species taken. These species are also among the five most abundant species reported since 1994 (Appendix G-13). Many of the macroinvertebrate species impinged at the station presumably 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 in essentially ideal conditions. These fouling communities are typically composed primarily of mollusk and arthropod species such as mussels and rock crabs, and are common in the nearshore environment, but are also frequently observed in the cooling water systems in coastal generating stations throughout southern California (Graham et al. 1977, IRC 1981). With an ample food supply brought in with the cooling water, individuals survive within the cooling water system until the community is removed during a heat treatment. With regular heat treatments most individuals taken are found at a similar small size corresponding to growth of newly settled individuals during the time period between intermittent heat treatments. When heat treatments are infrequent, however, somewhat larger individuals of some species may occur in impingement sampling, such as noted for yellow crab and red rock crab at the Ormond Beach Generating Station, which has not heat treated since 2005 (MBC 2005, 2006a).

The rock crabs (Pacific rock crab, yellow rock crab, and red rock crab) are common species in rocky subtidal habitats, while the jellyfish likely encounter the intakes during passive drifting with nearshore currents. Red rock shrimp has also been frequently encountered during impingement monitoring throughout the Southern California Bight (MBC unpublished data). Ranging from Tomales Bay, California to the Galapago, red rock shrimp is usually found south of Point Conception, California, in depths ranging from the low intertidal zone to 60 m (Jensen 1995).

CONCLUSION

Overall, fish species impinged in 2007 were similar to those collected in previous surveys, but were less abundant than recorded in previous annual surveys since 1990. This decline in fish abundance despite a similarity in cooling water flow volumes since 2006 suggests variability in the local fish populations, and is consistent with previous years when fish impingement abundances appeared to fluctuate independently of station operations. Macroinvertebrate composition in 2007 was similar to previous years, though abundances were also lower than typical. The similarity of species composed primarily of frequently occurring and long-term dominant species indicates a relatively stable nearshore assemblage typical of southern California. Variability in fish and macroinvertebrate communities in the area appeared to be related to natural differences in local populations and there is no indication that plant operations have adversely affected the fish or macroinvertebrate populations in the vicinity of the Ormond Beach Generating Station.

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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.

Appendix A. (Cont.).

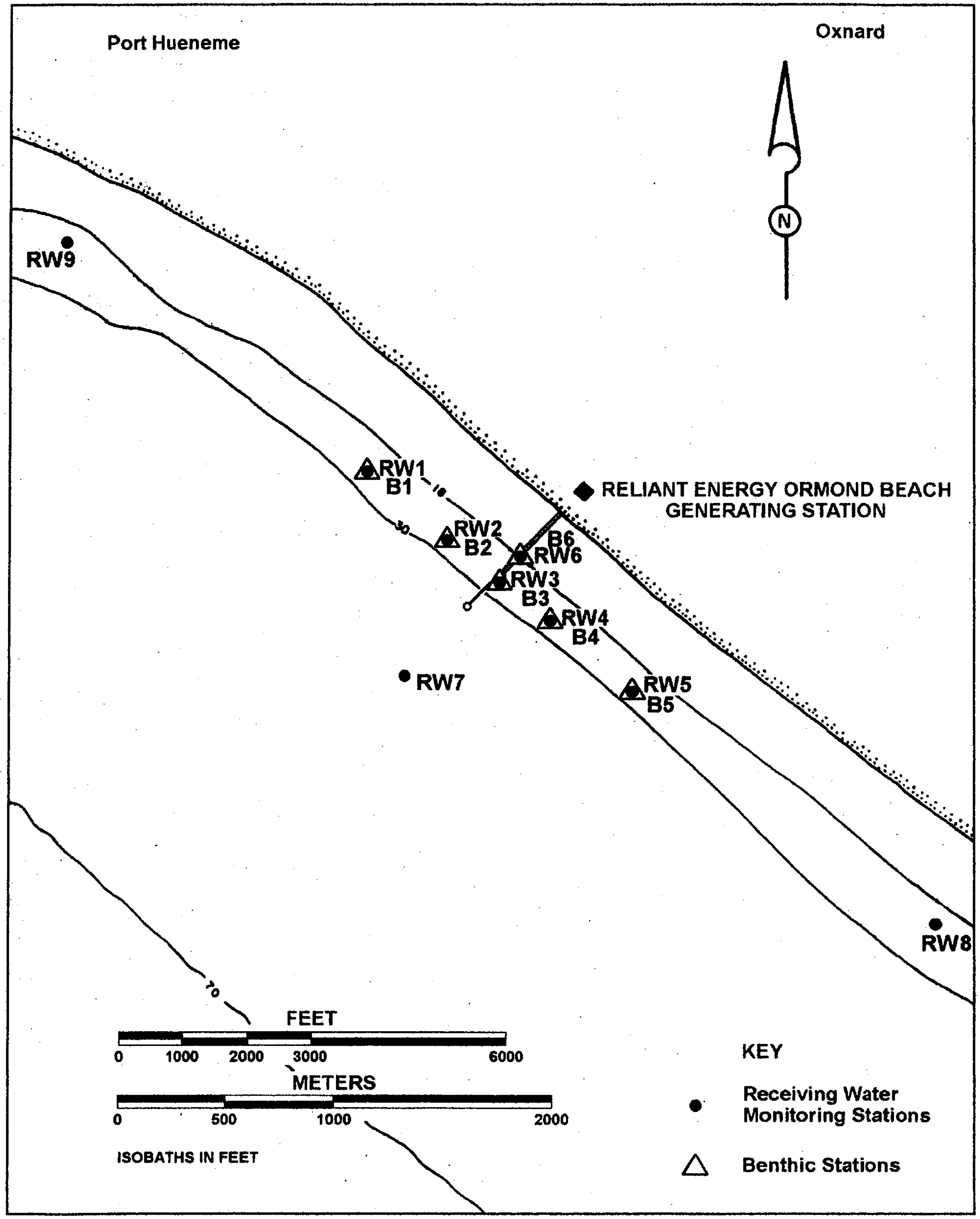


Figure 1. Location of the monitoring stations. Ormond Beach Generating Station.

APPENDIX B

Receiving water quality parameters by station

Appendix B-1. Water quality parameters at each receiving water monitoring station during flood and ebb tides. Ormond Beach Generating Station NPDES, winter 2007.

		Temp. (°C)		Oxygen (mg/l)		pH		Salinity (psu)	
	Depth (m)	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB
RW1	0	12.91	13.83	7.90	8.18	7.81	7.96	33.79	33.73
	1	12.91	13.70	7.90	8.19	7.81	7.95	33.79	33.76
	2	12.89	13.31	7.90	8.21	7.81	7.94	33.80	33.78
	3	12.85	13.20	7.85	8.00	7.81	7.92	33.80	33.78
	4	12.66	13.15	7.84	7.88	7.81	7.91	33.77	33.79
	5	12.52	13.03	7.63	7.88	7.81	7.91	33.82	33.83
	6	12.42	12.63	7.52	7.95	7.81	7.90	33.80	33.89
	7	12.35	12.16	7.42	7.96	7.80	7.88	33.81	33.92
	8	12.30	12.03	7.29	7.37	7.79	7.85	33.80	33.87
	9	12.21	11.99	7.24	7.07	7.79	7.85	33.79	33.82
	10	12.16	11.99	7.15	6.80	7.79	7.85	33.79	33.81
	11	12.11		7.03		7.79		33.80	
RW2	0	12.93	13.54	7.79	7.84	7.81	7.90	33.79	33.78
	1	12.92	13.48	7.79	7.90	7.81	7.90	33.79	33.75
	2	12.93	13.39	7.82	7.87	7.81	7.90	33.79	33.76
	3	12.92	13.07	7.77	7.88	7.81	7.91	33.79	33.82
	4	12.76	13.00	7.83	7.86	7.81	7.91	33.81	33.80
	5	12.69	12.67	7.76	7.75	7.81	7.89	33.81	33.93
	6	12.51	12.28	7.60	7.87	7.81	7.88	33.82	33.82
	7	12.47	12.14	7.43	7.57	7.81	7.87	33.80	33.83
	8	12.38	12.14	7.35	7.09	7.81	7.87	33.81	33.81
	9	12.33	12.09	7.31	7.00	7.81	7.86	33.79	33.80
	10	12.31	12.08	7.24	6.96	7.81	7.87	33.81	33.80
	11	12.27		7.15		7.81		33.81	
RW3	0	12.95	13.97	7.77	8.09	7.81	7.94	33.79	33.82
	1	12.95	13.95	7.77	8.10	7.81	7.94	33.79	33.77
	2	12.87	13.55	7.79	8.18	7.81	7.92	33.80	33.78
	3	12.80	13.34	7.72	8.06	7.82	7.91	33.81	33.79
	4	12.75	13.30	7.59	7.86	7.81	7.91	33.80	33.78
	5	12.60	13.14	7.57	7.86	7.81	7.91	33.79	33.78
	6	12.53	12.47	7.47	8.10	7.81	7.89	33.81	33.76
	7	12.41	12.19	7.40	7.71	7.81	7.88	33.80	33.79
	8	12.37	12.19	7.24	7.09	7.81	7.87	33.78	33.79
	9	12.31	12.17	7.21	6.99	7.81	7.87	33.82	33.79
	10	12.26		7.22		7.81		33.79	
	11	12.27		7.15		7.81		33.80	
RW4	0	12.97	14.10	7.72	8.19	7.83	7.96	33.78	33.77
	1	12.98	14.09	7.71	8.13	7.83	7.96	33.79	33.76
	2	12.85	13.65	7.81	8.27	7.82	7.95	33.81	33.78
	3	12.78	13.30	7.69	8.14	7.82	7.92	33.80	33.80
	4	12.68	13.13	7.58	7.97	7.83	7.92	33.84	33.79
	5	12.50	13.04	7.59	7.83	7.82	7.91	33.81	33.79
	6	12.36	12.96	7.43	7.66	7.81	7.91	33.85	33.80
	7	12.19	12.76	7.28	7.66	7.81	7.90	33.85	33.80
	8	11.99	12.29	7.17	7.64	7.80	7.89	33.80	33.76
	9	11.97	12.17	7.00	7.29	7.79	7.87	33.83	33.78
	10	11.96	12.15	6.88	7.00	7.79	7.87	33.78	33.80
	11	11.97		6.82		7.79		33.79	

Appendix B-1. (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
RW5	0	12.88	13.77	7.81	8.17	7.83	7.96	33.78	33.70
	1	12.88	13.56	7.80	8.19	7.83	7.96	33.78	33.72
	2	12.87	13.09	7.80	8.25	7.83	7.97	33.78	33.80
	3	12.87	13.02	7.78	8.14	7.83	7.96	33.78	33.79
	4	12.84	12.88	7.77	8.05	7.83	7.93	33.79	33.81
	5	12.65	12.62	7.70	7.86	7.83	7.90	33.84	33.83
	6	12.31	12.51	7.65	7.47	7.83	7.89	33.83	33.81
	7	12.40	12.23	7.37	7.36	7.81	7.88	33.84	33.85
	8	12.19	12.13	7.34	7.17	7.81	7.87	33.79	33.81
	9	12.12	12.12	7.13	6.99	7.81	7.87	33.81	33.79
	10	12.08	12.12	7.04	6.93	7.81	7.87	33.80	33.79
	11	11.92		7.01		7.80		33.82	
RW6	0	12.85	14.14	7.92	8.07	7.81	7.92	33.80	33.78
	1	12.88	14.11	7.91	8.08	7.81	7.92	33.78	33.79
	2	12.87	13.99	7.91	8.09	7.81	7.91	33.79	33.79
	3	12.85	13.85	7.92	8.09	7.81	7.91	33.80	33.78
	4	12.75	13.74	7.91	8.01	7.81	7.90	33.81	33.78
	5	12.66	13.54	7.82	8.02	7.81	7.90	33.84	33.79
	6	12.49	13.24	7.72	7.99	7.81	7.91	33.80	33.77
	7	12.38		7.44		7.81		33.81	
	8	12.37		7.25		7.79		33.81	
RW7	0	13.00	13.39	7.94	8.24	7.84	7.98	33.78	33.71
	1	13.01	13.48	7.94	8.19	7.84	7.98	33.78	33.75
	2	12.91	13.19	7.96	8.31	7.85	7.99	33.81	33.83
	3	12.58	12.79	7.98	8.26	7.85	7.97	33.86	33.71
	4	12.49	12.45	7.82	7.93	7.85	7.93	33.83	33.62
	5	12.40	12.45	7.66	7.37	7.83	7.90	33.81	33.64
	6	12.39	12.29	7.44	7.22	7.83	7.89	33.80	33.64
	7	12.36	12.28	7.41	7.15	7.83	7.87	33.79	33.65
	8	12.32	12.36	7.36	7.00	7.83	7.89	33.80	33.78
	9	12.30	12.11	7.31	7.34	7.83	7.88	33.79	33.79
	10	12.29	12.06	7.25	7.10	7.82	7.87	33.79	33.79
	11	12.21	12.04	7.22	6.94	7.83	7.87	33.80	33.79
	12	12.18	12.03	7.19	6.90	7.82	7.87	33.79	33.79
	13	11.94	12.01	7.19	6.89	7.81	7.87	33.88	33.79
	14	11.81		7.10		7.80		33.80	
RW8	0	12.80	13.57	7.74	8.15	7.85	7.96	33.78	33.77
	1	12.79	13.50	7.74	8.20	7.85	7.96	33.78	33.77
	2	12.79	13.23	7.74	8.23	7.85	7.96	33.78	33.79
	3	12.71	13.09	7.76	8.13	7.85	7.95	33.78	33.77
	4	12.48	13.07	7.74	8.05	7.83	7.94	33.80	33.77
	5	12.34	12.97	7.52	7.94	7.83	7.93	33.81	33.81
	6	12.26	12.56	7.42	7.95	7.83	7.91	33.81	33.86
	7	12.20	12.42	7.28	7.56	7.81	7.89	33.79	33.79
	8	12.19	12.40	7.22	7.25	7.81	7.89	33.78	33.78
	9	12.13	12.32	7.16	7.23	7.80	7.89	33.80	33.78
	10	12.03	12.30	7.12	7.18	7.80	7.89	33.80	33.78
	11	12.00		7.01		7.79		33.80	

Appendix B-1. (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
RW9	0	13.10	13.69	8.23	8.29	7.81	7.96	33.79	33.78
	1	13.10	13.67	8.22	8.28	7.82	7.96	33.79	33.76
	2	12.88	13.41	8.28	8.31	7.81	7.95	33.82	33.82
	3	12.47	13.23	8.13	8.28	7.79	7.93	33.81	33.82
	4	12.33	13.09	7.57	8.18	7.79	7.92	33.82	33.81
	5	12.29	12.99	7.34	8.22	7.79	7.91	33.80	33.80
	6	12.24	12.93	7.35	8.15	7.77	7.91	33.80	33.80
	7	12.16	12.82	7.32	8.03	7.78	7.89	33.80	33.82
	8	12.08	12.46	7.21	7.90	7.77	7.88	33.83	33.89
	9	11.93	12.08	7.15	7.65	7.77	7.87	33.84	33.93
	10	11.91	11.82	6.99	7.43	7.77	7.85	33.79	33.87
	11	11.78		6.89		7.75		33.82	

Appendix B-2. Water quality parameters at each receiving water monitoring station during flood and ebb tides. Ormond Beach Generating Station NPDES, summer 2007.

		Temp. (°C)		Oxygen (mg/l)		pH		Salinity (psu)	
	Depth (m)	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB
RW1	0	14.06	16.35	7.27	7.34	7.91	7.93	33.63	33.64
	1	14.06	16.29	7.27	7.34	7.90	7.93	33.63	33.69
	2	13.91	15.76	7.31	7.45	7.89	7.94	33.65	33.72
	3	13.69	14.96	7.21	7.51	7.89	7.97	33.66	33.80
	4	13.59	14.73	7.06	7.68	7.89	8.00	33.66	33.68
	5	13.47	14.67	7.01	7.75	7.87	8.00	33.66	33.70
	6	13.42	14.52	6.98	7.76	7.87	7.99	33.66	33.69
	7	13.40	14.42	6.97	7.71	7.87	7.99	33.66	33.65
	8	13.34	14.29	6.96	7.71	7.87	7.98	33.66	33.69
	9	13.30	13.61	6.94	7.78	7.87	7.96	33.66	33.79
	10	13.29	13.32	6.92	7.31	7.87	7.93	33.66	33.70
	11	13.29	13.26	6.90	7.03	7.87	7.93	33.66	33.67
RW2	0	14.59	17.38	7.14	7.37	7.89	7.96	33.73	33.66
	1	14.34	17.10	7.18	7.44	7.89	7.96	33.66	33.62
	2	13.85	15.31	7.20	7.61	7.89	7.98	33.66	33.67
	3	13.68	14.96	7.18	7.70	7.90	8.01	33.67	33.67
	4	13.59	14.82	7.10	7.73	7.89	8.02	33.66	33.66
	5	13.56	14.66	7.09	7.76	7.89	8.01	33.65	33.65
	6	13.55	14.60	7.08	7.71	7.89	8.00	33.64	33.64
	7	13.55	14.52	7.09	7.72	7.89	8.00	33.64	33.65
	8	13.54	14.46	7.09	7.68	7.89	7.98	33.64	33.65
	9	13.54	14.01	7.06	7.68	7.89	7.97	33.64	33.71
	10	13.54	13.55	7.07	7.38	7.89	7.95	33.64	33.68
	11	13.55		7.06		7.89		33.64	
RW3	0	15.77	19.54	7.13	7.25	7.89	7.94	33.82	33.54
	1	15.84	19.29	7.07	7.37	7.90	7.94	33.65	33.88
	2	15.55	16.68	7.19	7.79	7.90	7.96	33.65	33.84
	3	15.08	14.99	7.20	7.62	7.91	7.98	33.69	33.75
	4	14.30	14.87	7.41	7.65	7.91	7.98	33.67	33.68
	5	13.69	14.87	7.47	7.70	7.92	7.98	33.70	33.67
	6	13.53	14.88	7.20	7.70	7.91	7.98	33.66	33.66
	7	13.50	14.87	7.04	7.72	7.91	7.98	33.66	33.66
	8	13.50	14.66	7.02	7.74	7.91	7.98	33.66	33.64
	9	13.51	14.23	6.99	7.73	7.90	7.98	33.65	33.67
RW4	0	14.41	16.49	7.49	7.65	7.93	7.98	33.62	33.71
	1	14.40	15.90	7.50	7.69	7.93	7.99	33.63	33.68
	2	14.18	14.92	7.54	7.75	7.93	8.01	33.71	33.68
	3	13.63	14.80	7.53	7.73	7.92	8.00	33.79	33.66
	4	13.38	14.80	7.25	7.74	7.90	8.00	33.69	33.65
	5	13.32	14.78	7.07	7.76	7.90	8.00	33.68	33.65
	6	13.26	14.76	7.07	7.77	7.90	8.00	33.66	33.65
	7	13.22	14.71	7.02	7.77	7.89	8.00	33.66	33.65
	8	13.20	14.66	6.99	7.77	7.89	7.99	33.66	33.66
	9	13.22	14.49	6.96	7.77	7.89	7.99	33.65	33.68
	10	13.26	13.85	6.97	7.75	7.89	7.97	33.64	33.76
	11	13.27	13.62	6.99	7.42	7.89	7.95	33.65	33.67

Appendix B-2. (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
RW5	0	14.52	15.98	7.62	7.67	7.93	8.00	33.62	33.65
	1	14.50	15.99	7.62	7.67	7.94	8.00	33.63	33.64
	2	14.14	15.40	7.69	7.76	7.93	8.01	33.80	33.68
	3	13.67	15.04	7.65	7.80	7.91	8.02	33.74	33.66
	4	13.57	14.90	7.30	7.89	7.91	8.02	33.70	33.65
	5	13.49	14.82	7.20	7.87	7.91	8.02	33.68	33.65
	6	13.38	14.74	7.18	7.84	7.91	8.00	33.68	33.65
	7	12.91	14.65	7.18	7.85	7.88	8.00	33.81	33.65
	8	12.67	14.51	6.91	7.85	7.86	7.99	33.72	33.67
	9	12.60	14.25	6.55	7.80	7.85	7.99	33.68	33.68
	10	12.60	13.80	6.46	7.70	7.85	7.97	33.66	33.70
	11	12.60	13.60	6.43	7.46	7.84	7.96	33.67	33.68
	12	12.61		6.45		7.85		33.67	
RW6	0	15.40	18.69	7.19	7.37	7.90	7.93	33.64	33.62
	1	15.28	18.41	7.21	7.44	7.90	7.94	33.64	33.80
	2	14.94	17.03	7.24	7.58	7.90	7.96	33.70	33.88
	3	14.80	15.64	7.37	7.73	7.91	7.96	33.69	34.03
	4	14.32	14.91	7.53	7.69	7.91	7.96	33.75	33.79
	5	13.81	14.85	7.70	7.61	7.91	7.96	33.81	33.67
	6	13.57	14.51	7.41	7.72	7.91	7.97	33.69	33.79
	7	13.57	13.99	7.06	7.83	7.90	7.95	33.67	33.92
RW7	0	14.50	14.92	7.52	7.67	7.93	8.00	33.64	33.63
	1	14.44	14.91	7.51	7.64	7.93	8.00	33.63	33.64
	2	14.06	14.88	7.57	7.66	7.93	7.99	33.66	33.64
	3	13.83	14.77	7.44	7.67	7.92	7.99	33.67	33.67
	4	13.60	14.53	7.26	7.70	7.91	7.99	33.65	33.68
	5	13.49	14.03	7.17	7.69	7.91	7.98	33.65	33.72
	6	13.27	13.95	7.17	7.57	7.89	7.97	33.67	33.66
	7	12.95	13.93	7.13	7.56	7.89	7.97	33.72	33.66
	8	12.66	13.85	6.91	7.59	7.86	7.97	33.67	33.67
	9	12.60	13.78	6.55	7.55	7.85	7.97	33.67	33.67
	10	12.60	13.58	6.45	7.53	7.85	7.96	33.66	33.71
	11	12.60	13.13	6.45	7.42	7.85	7.93	33.66	33.73
	12	12.60	13.08	6.45	7.07	7.85	7.93	33.66	33.67
	13	12.60	13.05	6.45	6.99	7.85	7.92	33.66	33.67
	14	12.61	13.04	6.43	6.98	7.84	7.93	33.66	33.67
RW8	0	14.74	15.58	7.83	7.86	7.96	8.02	33.65	33.65
	1	14.71	15.57	7.83	7.87	7.95	8.02	33.65	33.64
	2	14.26	15.40	7.91	7.89	7.95	8.02	33.70	33.64
	3	13.97	15.22	7.64	7.92	7.94	8.02	33.67	33.64
	4	13.65	14.86	7.50	8.02	7.92	8.02	33.73	33.64
	5	13.50	14.64	7.40	7.97	7.92	8.02	33.68	33.64
	6	13.33	14.60	7.25	7.91	7.91	8.02	33.69	33.64
	7	13.00	14.50	7.16	7.94	7.89	8.01	33.66	33.66
	8	12.70	14.38	6.87	7.93	7.87	8.01	33.69	33.65
	9	12.69	14.18	6.59	7.87	7.86	8.00	33.67	33.66
	10	12.67	13.83	6.52	7.75	7.85	7.98	33.66	33.69
	11	12.67	13.68	6.49	7.52	7.85	7.97	33.67	33.67

Appendix B-2. (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
RW9	0	13.43	14.94	7.06	7.59	7.87	7.95	33.65	33.64
	1	13.43	14.92	7.04	7.60	7.87	7.95	33.65	33.64
	2	13.43	14.82	7.05	7.59	7.87	7.96	33.65	33.63
	3	13.37	14.60	7.03	7.58	7.87	7.96	33.66	33.66
	4	13.15	14.47	7.07	7.60	7.86	7.96	33.70	33.65
	5	12.91	14.37	6.91	7.61	7.85	7.97	33.67	33.64
	6	12.85	14.32	6.74	7.67	7.85	7.98	33.69	33.64
	7	12.80	14.23	6.73	7.70	7.85	7.98	33.67	33.63
	8	12.74	13.89	6.70	7.74	7.85	7.97	33.67	33.68
	9	12.72	13.31	6.63	7.59	7.84	7.94	33.67	33.69
	10	12.69	13.13	6.62	7.19	7.83	7.93	33.67	33.67
	11	12.66	13.11	6.59	7.03	7.83	7.93	33.68	33.66

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 ($\beta_\phi < 1$). β_ϕ = 1.00 for a normal curve. Curve category interpretations are based on Folk (1974).

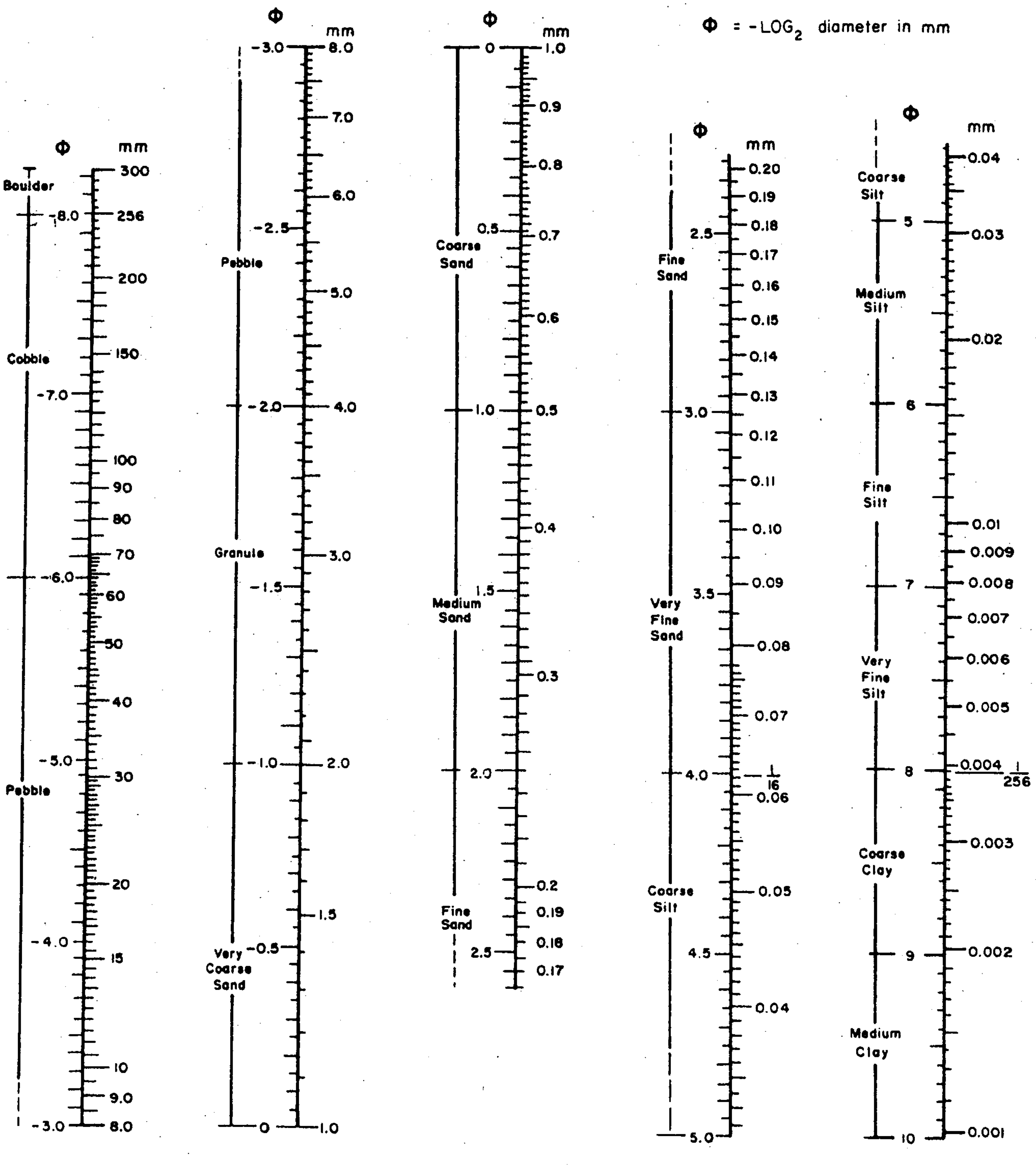
$$\beta_\phi = \frac{\phi_{95} - \phi_5}{2.44\left(\phi_{75} - \phi_{25}\right)}$$

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.

Phi - Millimeter Conversion Figure



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

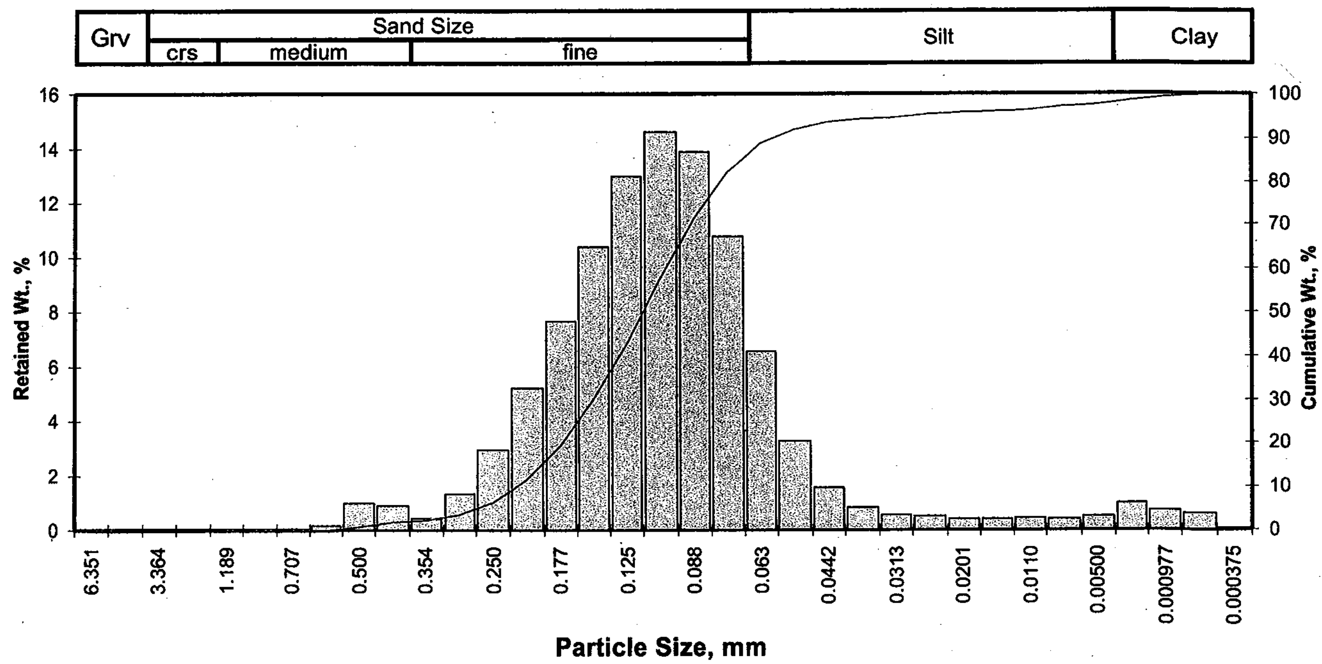
σ_I under	.35 ϕ,	very well sorted	1.0-2.0 ϕ,	poorly sorted
	.35-.50 ϕ,	well sorted	2.0-4.0 ϕ,	very poorly sorted
	.50-.71 ϕ,	moderately well sorted	over 4.0 ϕ,	extremely poorly sorted
	.71-1.0 ϕ	moderately sorted		

Appendix C-2. Sediment grain size distribution and statistical parameters by station. Ormond Beach Generating Station NPDES, 2007.

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience	**PTS File No:**	37792
Project:	N/A	**Sample ID:**	OBGS B1
Project No:	07-09-1309	**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	0.15	0.15	0.15
0.0197	0.500	1.00	35	0.98	0.98	1.13
0.0166	0.420	1.25	40	0.87	0.87	2.00
0.0139	0.354	1.50	45	0.45	0.45	2.45
0.0117	0.297	1.75	50	1.32	1.32	3.77
0.0098	0.250	2.00	60	2.92	2.92	6.69
0.0083	0.210	2.25	70	5.21	5.21	11.89
0.0070	0.177	2.50	80	7.67	7.66	19.55
0.0059	0.149	2.75	100	10.40	10.39	29.95
0.0049	0.125	3.00	120	13.00	12.99	42.93
0.0041	0.105	3.25	140	14.60	14.59	57.52
0.0035	0.088	3.50	170	13.90	13.89	71.41
0.0029	0.074	3.75	200	10.80	10.79	82.20
0.0025	0.063	4.00	230	6.57	6.56	88.76
0.0021	0.053	4.25	270	3.28	3.28	92.04
0.00174	0.0442	4.50	325	1.54	1.54	93.58
0.00146	0.0372	4.75	400	0.84	0.84	94.42
0.00123	0.0313	5.00	450	0.54	0.54	94.96
0.000986	0.0250	5.32	500	0.49	0.49	95.45
0.000790	0.0201	5.64	635	0.40	0.40	95.85
0.000615	0.0156	6.00		0.37	0.37	96.22
0.000435	0.0110	6.50		0.43	0.43	96.65
0.000308	0.00781	7.00		0.41	0.41	97.06
0.000197	0.00500	7.65		0.51	0.51	97.57
0.000077	0.00195	9.00		1.02	1.02	98.59
0.000038	0.000977	10.00		0.75	0.75	99.33
0.000019	0.000488	11.00		0.60	0.60	99.93
0.000015	0.000375	11.38		0.07	0.07	100.00
TOTALS				**100.10**	**100.00**	**100.00**

Cumulative Weight Percent greater than			
Weight percent	Phi Value	Particle Size Inches	Particle Size Millimeters
5	1.86	0.0109	0.276
10	2.16	0.0088	0.224
16	2.38	0.0075	0.192
25	2.63	0.0064	0.161
40	2.94	0.0051	0.130
50	3.12	0.0045	0.115
60	3.29	0.0040	0.102
75	3.58	0.0033	0.083
84	3.82	0.0028	0.071
90	4.09	0.0023	0.059
95	5.03	0.0012	0.031

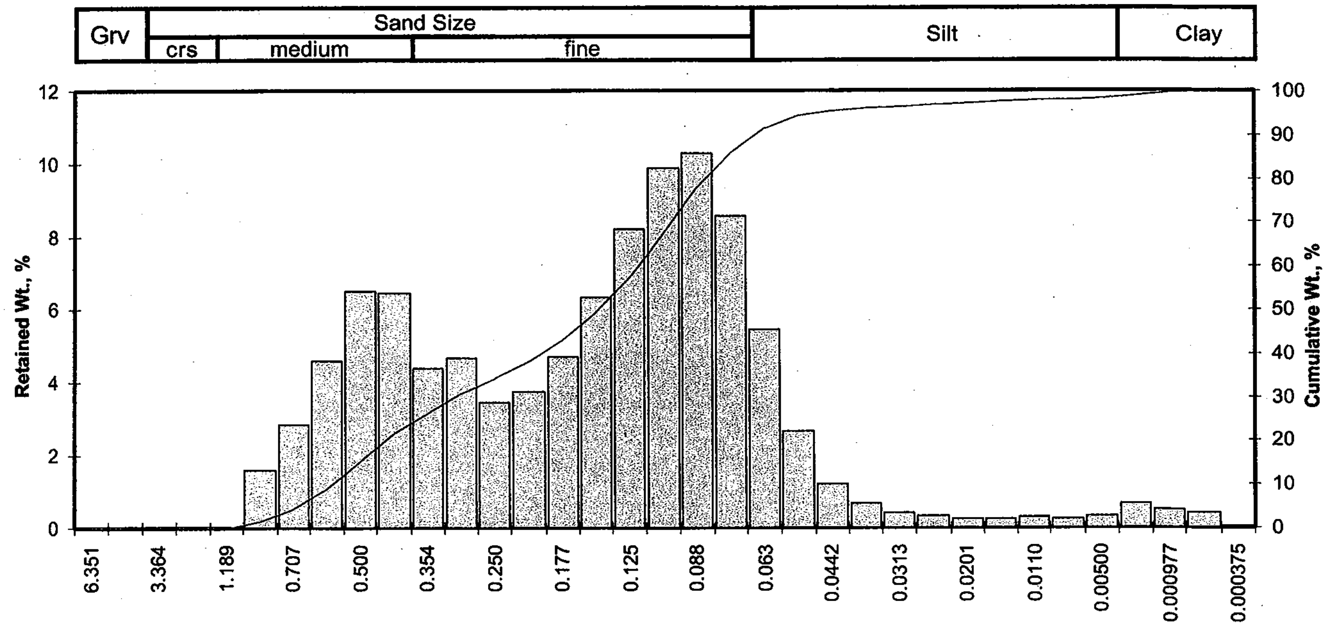
Measure	Trask	Inman	Folk-Ward
Median, phi	3.12	3.12	3.12
Median, in.	0.0045	0.0045	0.0045
Median, mm	0.115	0.115	0.115
Mean, phi	3.03	3.10	3.11
Mean, in.	0.0048	0.0046	0.0046
Mean, mm	0.122	0.117	0.116
Sorting	1.391	0.717	0.839
Skewness	1.010	-0.028	0.087
Kurtosis	0.236	1.211	1.365
Grain Size Description (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	2.00
Fine Sand	200	80.20
Silt	>0.005 mm	15.37
Clay	<0.005 mm	2.43
	Total	100

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience	**PTS File No:**	37792
Project:	N/A	**Sample ID:**	OBGS B2
Project No:	07-09-1309	**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	1.60	1.60	1.60
0.0278	0.707	0.50	25	2.85	2.85	4.45
0.0234	0.595	0.75	30	4.57	4.57	9.02
0.0197	0.500	1.00	35	6.52	6.52	15.54
0.0166	0.420	1.25	40	6.47	6.47	22.01
0.0139	0.354	1.50	45	4.36	4.36	26.37
0.0117	0.297	1.75	50	4.67	4.67	31.04
0.0098	0.250	2.00	60	3.47	3.47	34.51
0.0083	0.210	2.25	70	3.73	3.73	38.24
0.0070	0.177	2.50	80	4.69	4.69	42.93
0.0059	0.149	2.75	100	6.32	6.32	49.25
0.0049	0.125	3.00	120	8.21	8.21	57.46
0.0041	0.105	3.25	140	9.89	9.89	67.35
0.0035	0.088	3.50	170	10.30	10.30	77.65
0.0029	0.074	3.75	200	8.59	8.59	86.23
0.0025	0.063	4.00	230	5.45	5.45	91.68
0.0021	0.053	4.25	270	2.66	2.66	94.34
0.00174	0.0442	4.50	325	1.19	1.19	95.53
0.00146	0.0372	4.75	400	0.66	0.66	96.19
0.00123	0.0313	5.00	450	0.42	0.42	96.61
0.000986	0.0250	5.32	500	0.35	0.35	96.96
0.000790	0.0201	5.64	635	0.26	0.26	97.22
0.000615	0.0156	6.00		0.25	0.25	97.47
0.000435	0.0110	6.50		0.28	0.28	97.75
0.000308	0.00781	7.00		0.26	0.26	98.01
0.000197	0.00500	7.65		0.33	0.33	98.34
0.000077	0.00195	9.00		0.68	0.68	99.02
0.000038	0.000977	10.00		0.52	0.52	99.54
0.000019	0.000488	11.00		0.41	0.41	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	0.53	0.0273	0.693
10	0.79	0.0228	0.579
16	1.02	0.0194	0.494
25	1.42	0.0147	0.373
40	2.34	0.0078	0.197
50	2.77	0.0058	0.146
60	3.06	0.0047	0.120
75	3.44	0.0036	0.092
84	3.68	0.0031	0.078
90	3.92	0.0026	0.066
95	4.39	0.0019	0.048

Measure	Trask	Inman	Folk-Ward
Median, phi	2.77	2.77	2.77
Median, in.	0.0058	0.0058	0.0058
Median, mm	0.146	0.146	0.146
Mean, phi	2.10	2.35	2.49
Mean, in.	0.0092	0.0077	0.0070
Mean, mm	0.233	0.196	0.178
Sorting	2.010	1.334	1.251
Skewness	1.270	-0.316	-0.239
Kurtosis	0.274	0.446	0.785

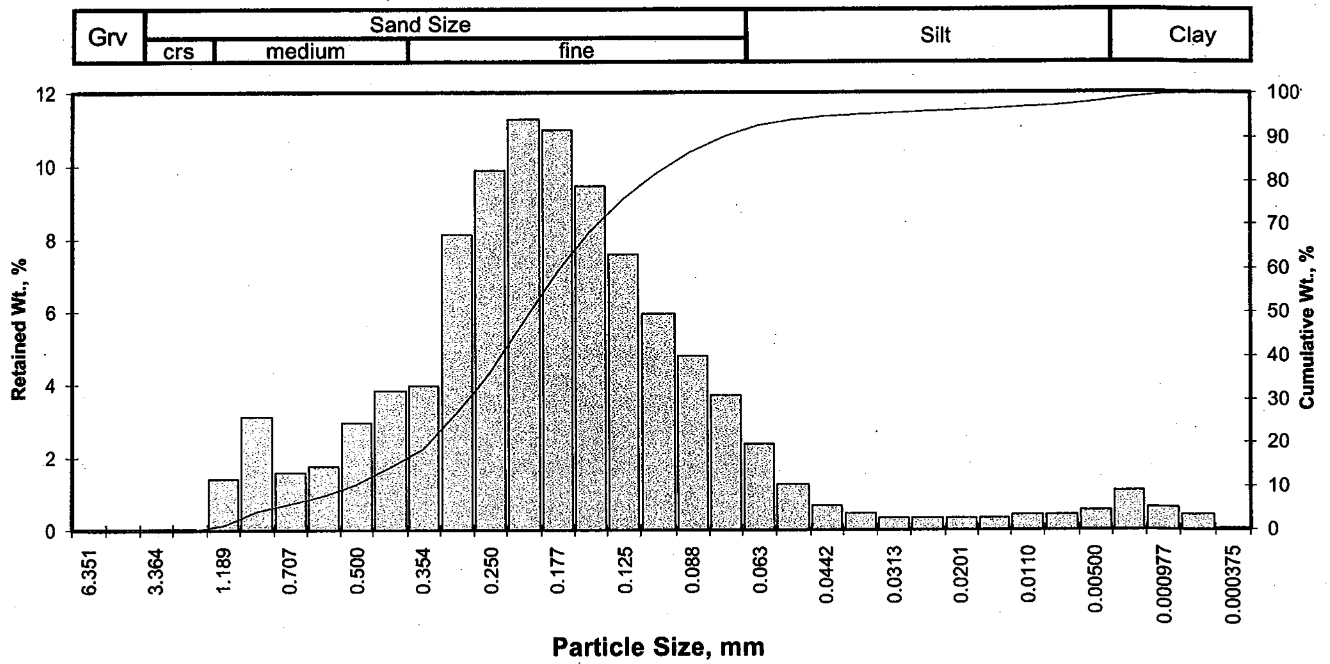
Grain Size Description (ASTM-USCS Scale)	Fine sand (based on Mean from Trask)

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	22.01
Fine Sand	200	64.23
Silt	>0.005 mm	12.11
Clay	<0.005 mm	1.66
	Total	100

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience	**PTS File No:**	37792
Project:	N/A	**Sample ID:**	OBGS B3
Project No:	07-09-1309	**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	1.40	1.40	1.40
0.0331	0.841	0.25	20	3.13	3.13	4.53
0.0278	0.707	0.50	25	1.60	1.60	6.13
0.0234	0.595	0.75	30	1.75	1.75	7.88
0.0197	0.500	1.00	35	2.96	2.96	10.83
0.0166	0.420	1.25	40	3.84	3.84	14.67
0.0139	0.354	1.50	45	3.96	3.96	18.63
0.0117	0.297	1.75	50	8.11	8.11	26.74
0.0098	0.250	2.00	60	9.86	9.85	36.59
0.0083	0.210	2.25	70	11.30	11.29	47.88
0.0070	0.177	2.50	80	11.00	10.99	58.88
0.0059	0.149	2.75	100	9.48	9.47	68.35
0.0049	0.125	3.00	120	7.57	7.57	75.92
0.0041	0.105	3.25	140	5.95	5.95	81.87
0.0035	0.088	3.50	170	4.81	4.81	86.67
0.0029	0.074	3.75	200	3.69	3.69	90.36
0.0025	0.063	4.00	230	2.38	2.38	92.74
0.0021	0.053	4.25	270	1.27	1.27	94.01
0.00174	0.0442	4.50	325	0.67	0.67	94.68
0.00146	0.0372	4.75	400	0.44	0.44	95.12
0.00123	0.0313	5.00	450	0.33	0.33	95.45
0.000986	0.0250	5.32	500	0.35	0.35	95.80
0.000790	0.0201	5.64	635	0.32	0.32	96.12
0.000615	0.0156	6.00		0.33	0.33	96.45
0.000435	0.0110	6.50		0.42	0.42	96.87
0.000308	0.00781	7.00		0.42	0.42	97.29
0.000197	0.00500	7.65		0.54	0.54	97.83
0.000077	0.00195	9.00		1.08	1.08	98.91
0.000038	0.000977	10.00		0.63	0.63	99.54
0.000019	0.000488	11.00		0.42	0.42	99.96
0.000015	0.000375	11.38		0.04	0.04	100.00
TOTALS				**100.10**	**100.00**	**100.00**

Cumulative Weight Percent greater than			
Weight percent	Phi Value	Particle Size Inches	Particle Size Millimeters
5	0.32	0.0315	0.799
10	0.93	0.0207	0.525
16	1.33	0.0156	0.397
25	1.70	0.0121	0.309
40	2.08	0.0093	0.237
50	2.30	0.0080	0.203
60	2.53	0.0068	0.173
75	2.97	0.0050	0.128
84	3.36	0.0038	0.097
90	3.73	0.0030	0.076
95	4.68	0.0015	0.039

Measure	Trask	Inman	Folk-Ward
Median, phi	2.30	2.30	2.30
Median, in.	0.0080	0.0080	0.0080
Median, mm	0.203	0.203	0.203
Mean, phi	2.20	2.35	2.33
Mean, in.	0.0086	0.0077	0.0078
Mean, mm	0.218	0.196	0.199
Sorting	1.555	1.014	1.167
Skewness	0.976	0.049	0.071
Kurtosis	0.201	1.150	1.403
Grain Size Description (ASTM-USCS Scale)			Fine sand (based on Mean from Trask)

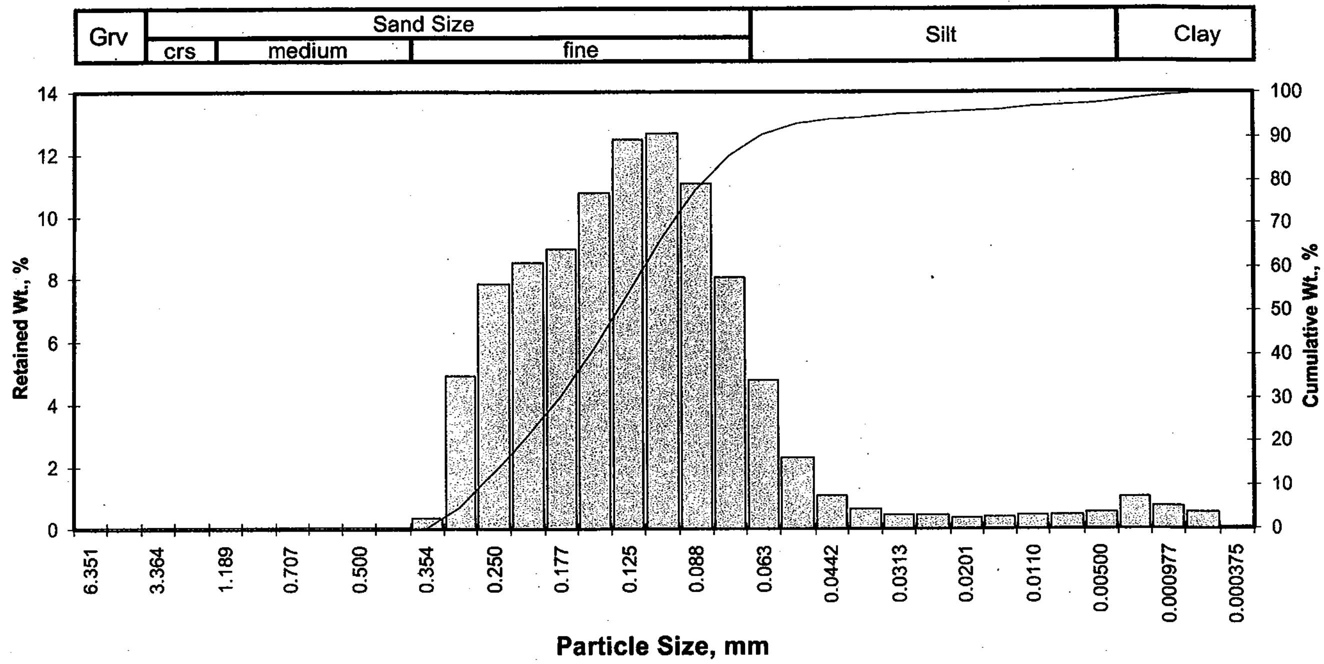
Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	14.67
Fine Sand	200	75.69
Silt	>0.005 mm	7.47
Clay	<0.005 mm	2.17
	Total	**100**

Phone: (562) 907-3607 Fax: (562) 907-3610

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience	**PTS File No:**	37792
Project:	N/A	**Sample ID:**	OBGS B4
Project No:	07-09-1309	**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	0.33	0.33	0.33
0.0117	0.297	1.75	50	4.91	4.91	5.24
0.0098	0.250	2.00	60	7.87	7.87	13.11
0.0083	0.210	2.25	70	8.57	8.57	21.69
0.0070	0.177	2.50	80	9.00	9.00	30.69
0.0059	0.149	2.75	100	10.80	10.80	41.49
0.0049	0.125	3.00	120	12.50	12.50	53.99
0.0041	0.105	3.25	140	12.70	12.70	66.70
0.0035	0.088	3.50	170	11.10	11.10	77.80
0.0029	0.074	3.75	200	8.07	8.07	85.87
0.0025	0.063	4.00	230	4.76	4.76	90.63
0.0021	0.053	4.25	270	2.28	2.28	92.91
0.00174	0.0442	4.50	325	1.06	1.06	93.97
0.00146	0.0372	4.75	400	0.64	0.64	94.61
0.00123	0.0313	5.00	450	0.46	0.46	95.07
0.000986	0.0250	5.32	500	0.44	0.44	95.51
0.000790	0.0201	5.64	635	0.36	0.36	95.87
0.000615	0.0156	6.00		0.37	0.37	96.24
0.000435	0.0110	6.50		0.46	0.46	96.70
0.000308	0.00781	7.00		0.44	0.44	97.14
0.000197	0.00500	7.65		0.53	0.53	97.67
0.000077	0.00195	9.00		1.04	1.04	98.71
0.000038	0.000977	10.00		0.71	0.71	99.42
0.000019	0.000488	11.00		0.52	0.52	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	1.74	0.0118	0.300
10	1.90	0.0105	0.268
16	2.08	0.0093	0.236
25	2.34	0.0078	0.197
40	2.72	0.0060	0.152
50	2.92	0.0052	0.132
60	3.12	0.0045	0.115
75	3.44	0.0036	0.092
84	3.69	0.0030	0.077
90	3.97	0.0025	0.064
95	4.96	0.0013	0.032

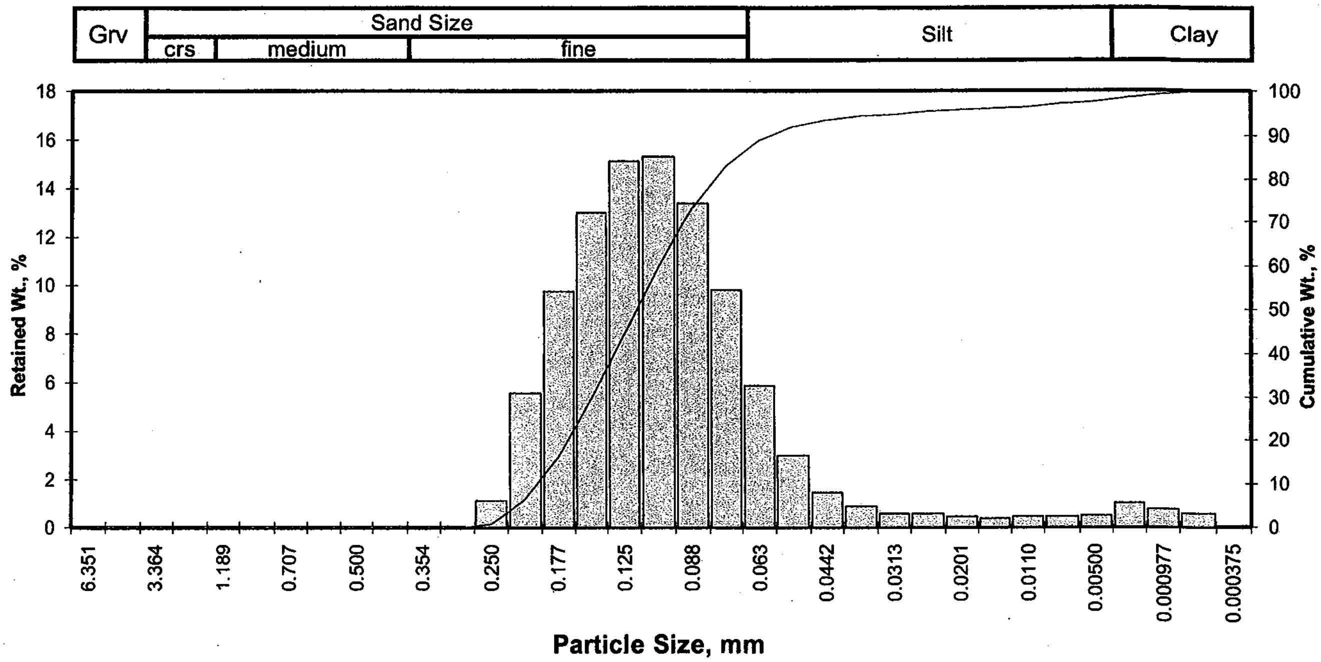
Measure	Trask	Inman	Folk-Ward
Median, phi	2.92	2.92	2.92
Median, in.	0.0052	0.0052	0.0052
Median, mm	0.132	0.132	0.132
Mean, phi	2.79	2.89	2.90
Mean, in.	0.0057	0.0053	0.0053
Mean, mm	0.145	0.135	0.134
Sorting	1.462	0.804	0.890
Skewness	1.021	-0.040	0.113
Kurtosis	0.257	1.004	1.206
Grain Size Description (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	85.87
Silt	>0.005 mm	11.80
Clay	<0.005 mm	2.33
	Total	**100**

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience	**PTS File No:**	37792
Project:	N/A	**Sample ID:**	OBGS B5
Project No:	07-09-1309	**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	0.02	0.02	0.02
0.0098	0.250	2.00	60	1.13	1.13	1.15
0.0083	0.210	2.25	70	5.54	5.54	6.69
0.0070	0.177	2.50	80	9.77	9.77	16.46
0.0059	0.149	2.75	100	13.00	13.00	29.46
0.0049	0.125	3.00	120	15.10	15.10	44.56
0.0041	0.105	3.25	140	15.30	15.30	59.86
0.0035	0.088	3.50	170	13.40	13.40	73.27
0.0029	0.074	3.75	200	9.84	9.84	83.11
0.0025	0.063	4.00	230	5.90	5.90	89.01
0.0021	0.053	4.25	270	2.98	2.98	91.99
0.00174	0.0442	4.50	325	1.46	1.46	93.45
0.00146	0.0372	4.75	400	0.86	0.86	94.31
0.00123	0.0313	5.00	450	0.59	0.59	94.90
0.000986	0.0250	5.32	500	0.54	0.54	95.44
0.000790	0.0201	5.64	635	0.42	0.42	95.86
0.000615	0.0156	6.00		0.38	0.38	96.24
0.000435	0.0110	6.50		0.44	0.44	96.68
0.000308	0.00781	7.00		0.42	0.42	97.10
0.000197	0.00500	7.65		0.52	0.52	97.62
0.000077	0.00195	9.00		1.02	1.02	98.64
0.000038	0.000977	10.00		0.74	0.74	99.38
0.000019	0.000488	11.00		0.56	0.56	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	2.17	0.0087	0.222
10	2.33	0.0078	0.198
16	2.49	0.0070	0.178
25	2.66	0.0062	0.158
40	2.92	0.0052	0.132
50	3.09	0.0046	0.118
60	3.25	0.0041	0.105
75	3.54	0.0034	0.086
84	3.79	0.0029	0.072
90	4.08	0.0023	0.059
95	5.06	0.0012	0.030

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	3.04	3.14	3.12
Mean, in.	0.0048	0.0045	0.0045
Mean, mm	0.122	0.114	0.115
Sorting	1.357	0.650	0.762
Skewness	0.989	0.076	0.221
Kurtosis	0.259	1.221	1.345

Grain Size Description (ASTM-USCS Scale)	Fine sand (based on Mean from Trask)

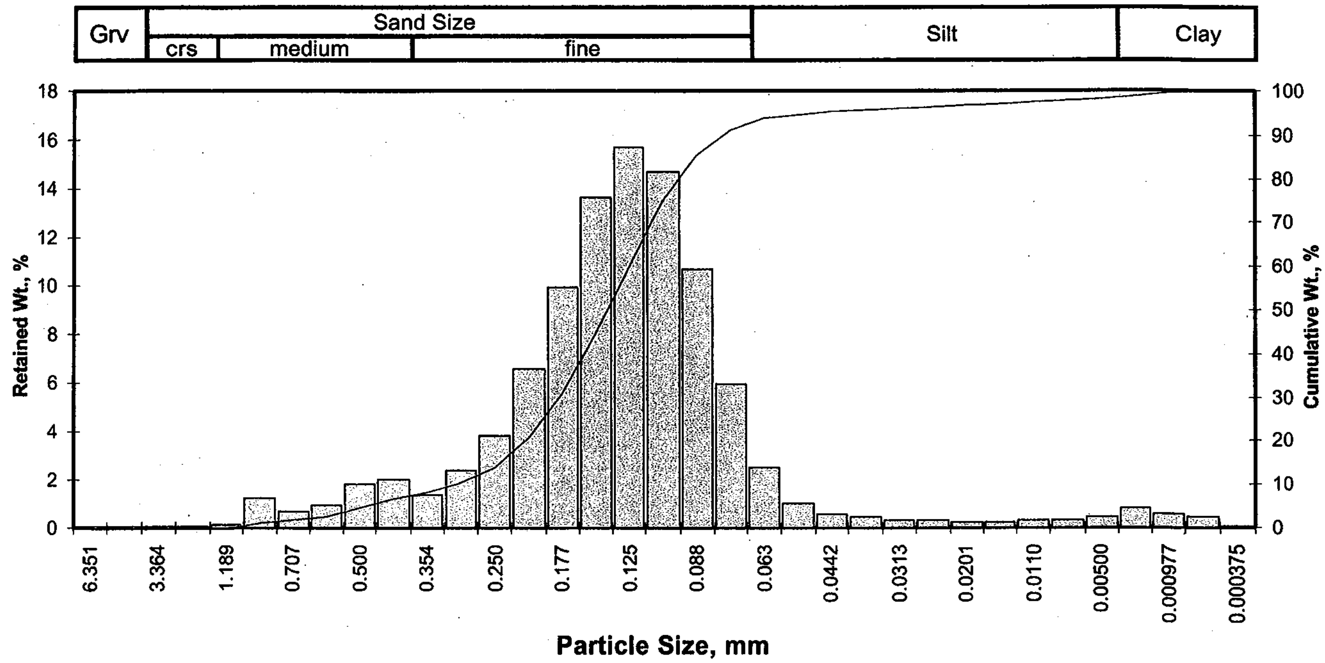
Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	0.00
Fine Sand	200	83.11
Silt	>0.005 mm	14.51
Clay	<0.005 mm	2.38
	Total	**100**

Phone: (562) 907-3607 Fax: (562) 907-3610

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience	**PTS File No:**	37792
Project:	N/A	**Sample ID:**	OBGS B6
Project No:	07-09-1309	**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	0.13	0.13	0.13
0.0331	0.841	0.25	20	1.25	1.25	1.38
0.0278	0.707	0.50	25	0.66	0.66	2.04
0.0234	0.595	0.75	30	0.91	0.91	2.95
0.0197	0.500	1.00	35	1.84	1.84	4.79
0.0166	0.420	1.25	40	2.01	2.01	6.80
0.0139	0.354	1.50	45	1.40	1.40	8.20
0.0117	0.297	1.75	50	2.37	2.37	10.57
0.0098	0.250	2.00	60	3.81	3.81	14.38
0.0083	0.210	2.25	70	6.56	6.56	20.94
0.0070	0.177	2.50	80	9.91	9.91	30.85
0.0059	0.149	2.75	100	13.60	13.60	44.46
0.0049	0.125	3.00	120	15.70	15.70	60.16
0.0041	0.105	3.25	140	14.70	14.70	74.86
0.0035	0.088	3.50	170	10.70	10.70	85.56
0.0029	0.074	3.75	200	5.91	5.91	91.47
0.0025	0.063	4.00	230	2.47	2.47	93.94
0.0021	0.053	4.25	270	0.98	0.98	94.92
0.00174	0.0442	4.50	325	0.55	0.55	95.47
0.00146	0.0372	4.75	400	0.41	0.41	95.88
0.00123	0.0313	5.00	450	0.31	0.31	96.19
0.000986	0.0250	5.32	500	0.32	0.32	96.51
0.000790	0.0201	5.64	635	0.28	0.28	96.79
0.000615	0.0156	6.00		0.28	0.28	97.07
0.000435	0.0110	6.50		0.34	0.34	97.41
0.000308	0.00781	7.00		0.33	0.33	97.74
0.000197	0.00500	7.65		0.41	0.41	98.15
0.000077	0.00195	9.00		0.80	0.80	98.95
0.000038	0.000977	10.00		0.57	0.57	99.52
0.000019	0.000488	11.00		0.43	0.43	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	1.03	0.0193	0.491
10	1.69	0.0122	0.310
16	2.06	0.0094	0.240
25	2.35	0.0077	0.196
40	2.67	0.0062	0.157
50	2.84	0.0055	0.140
60	3.00	0.0049	0.125
75	3.25	0.0041	0.105
84	3.46	0.0036	0.091
90	3.69	0.0031	0.078
95	4.28	0.0020	0.051

Measure	Trask	Inman	Folk-Ward
Median, phi	2.84	2.84	2.84
Median, in.	0.0055	0.0055	0.0055
Median, mm	0.140	0.140	0.140
Mean, phi	2.73	2.76	2.79
Mean, in.	0.0059	0.0058	0.0057
Mean, mm	0.150	0.147	0.145
Sorting	1.366	0.701	0.844
Skewness	1.025	-0.108	-0.110
Kurtosis	0.196	1.325	1.482
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	6.80
Fine Sand	200	84.67
Silt	>0.005 mm	6.68
Clay	<0.005 mm	1.85
	Total	**100**

Appendix C-3. Yearly grain size values, 1990 - 2007. Ormond Beach Generating Station NPDES, 2007.

						Mean grain size				
Year	Station	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	phi	µm	Sorting*	Skewness	Kurtosis
2007	B1	0.00	88.76	8.81	2.43	3.11	116	0.839	0.087	1.365
	B2	0.00	91.68	6.66	1.66	2.49	178	1.251	-0.239	0.785
	B3	0.00	92.74	5.09	2.17	2.33	199	1.167	0.071	1.403
	B4	0.00	90.63	7.04	2.33	2.90	134	0.890	0.113	1.206
	B5	0.00	89.01	8.61	2.38	3.12	115	0.762	0.221	1.345
	B6	0.00	93.94	4.21	1.85	2.79	145	0.844	-0.110	1.482
2006	B1	0.00	82.08	14.02	3.9	3.32	100	1.132	0.305	2.091
	B2	0.00	88.91	8.66	2.43	2.62	163	1.319	0.012	1.156
	B3	0.00	85.25	10.88	3.87	3.04	122	1.206	0.349	1.957
	B4	0.00	83.99	12.48	3.53	2.96	128	1.328	0.203	1.576
	B5	0.00	82.12	14.2	3.68	3.29	102	1.117	0.318	1.955
	B6	0.00	90.39	6.7	2.91	3.08	118	0.819	0.369	2.045
2005	B1	0.00	87.78	10.57	1.65	3.25	105	0.704	0.021	1.220
	B2	28.38	70.57	1.05	0.00	0.06	962	2.104	-0.546	0.814
	B3	6.28	84.61	9.11	0.00	2.88	136	1.339	-0.431	2.001
	B4	0.00	80.69	15.12	4.19	3.31	101	1.248	0.292	2.116
	B5	0.00	77.86	17.85	4.29	3.47	90	1.203	0.370	2.036
	B6	0.00	94.03	4.70	1.27	3.06	120	0.583	0.027	1.233
2004	B1	0.73	85.86	10.87	2.54	3.24	106	0.84	0.14	1.57
	B2	0.38	89.42	8.08	2.12	2.55	170	1.21	0.12	1.02
	B3	7.47	81.15	8.30	3.08	2.49	178	1.76	0.08	2.72
	B4	0.67	83.83	12.00	3.50	3.07	119	1.25	0.15	1.89
	B5	2.88	79.81	13.43	3.88	3.11	116	1.28	0.30	1.80
	B6	0.00	92.12	5.83	2.05	2.93	131	0.78	0.14	1.67
2003	B1	-	-	-	-	-	-	-	-	-
	B2	0.00	88.59	9.40	2.01	2.88	136	1.10	-0.18	1.07
	B3	0.00	81.58	15.15	3.27	3.04	121	1.29	0.27	1.48
	B4	0.00	84.32	12.66	3.02	3.10	117	1.18	0.03	1.65
	B5	0.00	86.99	10.30	2.71	3.09	118	1.00	0.19	1.62
	B6	-	-	-	-	-	-	-	-	-
2002	B1	0.00	86.67	11.57	1.76	3.28	103	0.73	0.11	1.36
	B2	0.00	87.86	10.65	1.49	3.17	111	0.94	-0.24	1.64
	B3	0.00	90.43	7.74	1.83	2.93	131	0.81	0.23	1.33
	B4	0.00	88.70	9.77	1.53	3.21	108	0.74	0.01	1.34
	B5	0.00	91.79	6.96	1.25	2.93	131	0.79	-0.01	1.06
	B6	0.00	90.73	7.92	1.35	3.20	109	0.61	0.09	1.32
2001	B1	0.00	86.36	10.98	2.66	3.06	120	1.25	-0.04	1.97
	B2	0.00	91.91	6.71	1.38	2.60	165	1.24	-0.34	0.97
	B3	0.00	82.61	14.79	2.60	3.39	95	0.94	0.14	1.94
	B4	0.00	88.59	9.53	1.88	3.30	102	0.66	0.03	1.35
	B5	0.00	90.64	7.75	1.61	2.91	133	0.87	-0.01	1.12
	B6	0.00	94.47	4.53	1.00	3.01	124	0.59	0.01	1.15
2000	B1	0.00	84.99	13.01	2.00	3.31	101	0.81	0.09	1.50
	B2	0.00	85.76	12.58	1.66	3.44	92	0.60	0.03	1.30
	B3	0.00	92.90	5.73	1.37	2.87	137	0.79	-0.03	1.10
	B4	0.00	90.23	8.39	1.38	3.21	108	0.67	-0.03	1.21
	B5	0.00	90.54	7.84	1.62	2.95	129	0.81	0.10	1.14
	B6	0.00	96.03	3.04	0.93	2.72	152	0.59	0.01	1.15
1999	B1	0.00	84.36	13.08	2.56	3.14	113	1.08	0.07	1.63
	B2	0.00	86.01	11.82	2.17	3.10	117	1.16	-0.13	1.82
	B3	0.00	89.90	7.87	2.23	3.24	106	0.61	0.17	1.23
	B4	0.00	90.55	7.83	1.62	2.90	134	0.92	-0.11	1.16
	B5	0.00	91.09	7.27	1.64	2.88	136	0.85	0.06	1.23
	B6	0.00	95.66	3.34	1.00	2.80	144	0.71	-0.12	1.11
1998	B1	-	-	-	-	-	-	-	-	-
	B2	0.27	78.33	19.63	1.76	3.66	79	62.10	0.02	1.45
	B3	0.41	91.15	7.08	1.36	3.13	114	60.81	0.07	1.30
	B4	0.67	81.94	15.28	2.11	3.47	90	59.27	-0.09	1.39
	B5	-	-	-	-	-	-	-	-	-
	B6	-	-	-	-	-	-	-	-	-

Appendix C-3. (Cont.).

Year	Station	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Mean grain size phi	Mean grain size µm	Sorting*	Skewness	Kurtosis
1997	B1	0.44	86.56	11.41	1.58	3.37	97	61.85	-0.01	1.26
	B2	0.00	83.63	14.79	1.58	3.57	84	63.73	-0.10	1.46
	B3	0.39	93.45	4.30	1.86	2.34	198	48.90	0.12	0.88
	B4	0.02	85.99	11.84	2.15	3.47	90	63.41	-0.06	1.33
	B5	0.29	90.33	7.75	1.63	3.09	118	58.55	0.16	1.20
	B6	0.30	95.00	3.47	1.23	3.02	124	61.02	-0.12	1.03
1994	B1	0.33	84.21	15.46	0.00	3.35	98	64.36	-0.17	1.00
	B2	0.00	81.66	18.34	0.00	3.57	84	72.11	-0.11	1.12
	B3	0.06	97.55	2.31	0.07	2.05	241	63.01	0.04	1.15
	B4	0.00	86.52	13.28	0.20	3.30	102	65.07	-0.18	1.06
	B5	3.17	88.41	7.87	0.54	2.95	129	59.27	-0.11	1.12
	B6	0.33	94.86	4.71	0.10	3.30	102	76.01	-0.06	0.92
1993	B1	0.89	95.27	3.20	0.64	2.60	165	NA	NA	NA
	B2	0.00	98.96	0.52	0.52	2.21	216	NA	NA	NA
	B3	11.45	86.26	1.64	0.65	1.93	262	NA	NA	NA
	B4	3.96	92.91	2.69	0.45	2.48	179	NA	NA	NA
	B5	0.99	96.05	2.22	0.74	2.20	217	NA	NA	NA
	B6	0.28	98.41	0.44	0.87	2.57	168	NA	NA	NA
1992	B1	0.58	88.55	10.23	0.64	3.18	110	NA	NA	NA
	B2	0.04	94.23	4.59	1.15	3.00	125	NA	NA	NA
	B3	0.73	93.57	5.13	0.57	2.98	127	NA	NA	NA
	B4	1.44	90.47	7.28	0.81	3.10	117	NA	NA	NA
	B5	2.18	91.68	5.41	0.72	2.78	146	NA	NA	NA
	B6	6.81	92.28	0.69	0.23	2.62	163	NA	NA	NA
1991	B1	1.15	88.18	9.07	1.60	2.70	154	NA	NA	NA
	B2	0.01	91.72	7.17	1.10	2.70	154	NA	NA	NA
	B3	4.97	82.31	5.53	1.01	1.38	380	NA	NA	NA
	B4	0.83	89.46	8.00	1.71	2.80	144	NA	NA	NA
	B5	0.09	88.21	9.94	1.75	2.88	136	NA	NA	NA
	B6	0.57	92.83	5.50	1.10	2.90	134	NA	NA	NA
1990	B1	1.31	82.68	15.57	0.43	3.13	114	58.38	0.09	1.25
	B2	13.65	69.89	15.93	0.53	1.95	258	35.96	-0.60	1.67
	B3	0.00	93.06	6.25	0.69	2.93	131	66.26	0.11	1.41
	B4	0.00	82.05	17.81	0.14	3.55	86	71.74	0.26	0.98
	B5	0.00	95.32	4.00	0.68	2.74	150	70.61	0.12	1.39
	B6	0.22	93.36	6.02	0.40	2.82	142	60.83	-0.14	0.99
1988	B1	0.00	71.56	28.24	0.20	3.54	87	61.67	0.28	0.87
	B2	0.00	74.34	24.86	0.80	3.48	89	57.90	0.09	1.16
	B3	0.50	94.76	3.90	0.84	2.50	177	61.77	0.17	1.42
	B4	1.14	82.27	16.59	0.00	3.36	97	66.03	0.31	1.31
	B5	0.08	83.61	15.09	1.30	3.08	118	55.51	-0.01	1.05
	B6	2.17	93.98	3.02	0.82	2.76	148	72.40	0.16	1.59
1986	B1	0.00	84.19	15.68	0.00	3.24	105	30.60	-0.42	1.04
	B2	0.00	81.71	17.78	0.00	2.97	128	12.85	-0.04	0.72
	B3	0.00	87.38	12.34	0.28	3.03	123	43.02	0.23	1.11
	B4	0.00	79.96	19.78	0.25	3.54	87	49.24	0.12	1.04
	B5	0.58	92.14	6.47	0.81	2.48	179	50.81	0.35	1.01
	B6	0.74	91.32	7.50	0.44	3.07	119	55.67	-0.21	1.17
1980	B1	0.00	96.91	2.98	0.00	2.19	218	0.93	1.62	1.03
	B2	0.00	64.87	31.14	3.92	3.64	80	0.71	0.08	2.35
	B3	0.00	95.88	2.63	1.49	2.28	205	0.45	0.07	1.40
	B4	0.00	84.08	13.59	2.25	3.39	95	0.61	0.36	1.81
	B5	0.00	83.03	14.71	2.26	3.16	111	0.87	0.34	0.67
	B6	0.00	93.05	4.89	2.06	2.93	131	0.71	-0.08	1.19
1978[1]	B1	0.00	53.4	46.6		3.92	66	1.19	0.26	NA
	B2	0.00	58.6	41.4		3.88	68	0.69	0.08	NA
	B3	0.00	94.5	5.5		2.40	190	0.69	0.09	NA
	B4	0.00	68.9	30.9		3.69	78	0.74	0.01	NA
	B5	0.50	77.0	22.5		3.23	106	1.21	0.03	NA
	B6	0.20	84.6	15.2		2.87	137	0.99	0.10	NA

NA = Not Available
- = Not Required
*Sorting values: % 1986 - 1998
ϕ 1978 & 1980, 1999 - present
1978[1] = Silt and Clay combined

APPENDIX D

Sediment chemistry by station

Calscience Environmental Laboratories, Inc.

Analytical Report

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

Project: OBGS 07203A

Date Received:	08/31/07
Work Order No:	07-08-2232
Preparation:	EPA 3050B
Method:	EPA 6020
Units:	mg/kg
	Page 1 of 1

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS-B1 (I, II, III)	**07-08-2232-19**	**08/29/07**	**Solid**	**ICP/MS A**	**09/04/07**	**09/05/07**	**070904L03**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	7.31	0.132	1		Nickel	7.17	0.132	1	
Copper	3.69	0.132	1		Zinc	26.3	1.32	1	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS-B2 (I, II, III)	**07-08-2232-20**	**08/29/07**	**Solid**	**ICP/MS A**	**09/04/07**	**09/05/07**	**070904L03**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	7.89	0.136	1		Nickel	7.75	0.136	1	
Copper	3.99	0.136	1		Zinc	27.0	1.36	1	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS-B3 (I, II, III)	**07-08-2232-21**	**08/29/07**	**Solid**	**ICP/MS A**	**09/04/07**	**09/05/07**	**070904L03**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	5.03	0.128	1		Nickel	5.93	0.128	1	
Copper	3.17	0.128	1		Zinc	19.7	1.28	1	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS-B4 (I, II, III)	**07-08-2232-22**	**08/29/07**	**Solid**	**ICP/MS A**	**09/04/07**	**09/05/07**	**070904L03**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	5.44	0.131	1		Nickel	6.51	0.131	1	
Copper	2.89	0.131	1		Zinc	20.3	1.31	1	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS-B5 (I, II, III)	**07-08-2232-23**	**08/29/07**	**Solid**	**ICP/MS A**	**09/04/07**	**09/05/07**	**070904L03**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	6.03	0.136	1		Nickel	7.09	0.136	1	
Copper	3.58	0.136	1		Zinc	23.4	1.36	1	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS-B6 (I, II, III)	**07-08-2232-24**	**08/29/07**	**Solid**	**ICP/MS A**	**09/04/07**	**09/05/07**	**070904L03**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	6.39	0.130	1		Nickel	6.93	0.130	1	
Copper	3.40	0.130	1		Zinc	21.3	1.30	1	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
Method Blank	**096-10-002-933**	**N/A**	**Solid**	**ICP/MS A**	**09/04/07**	**09/05/07**	**070904L03**

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

Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences		Date Received:	08/31/07
3000 Redhill Avenue		Work Order No:	07-08-2232
Costa Mesa, CA 92626-4524		Preparation:	N/A
		Method:	SM 2540 B

Project: OBGS 07203A

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Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS-B1 (I, II, III)	**07-08-2232-19**	**08/29/07**	**Solid**	**N/A**	**N/A**	**09/04/07**	**70904TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	75.7	0.100	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS-B2 (I, II, III)	**07-08-2232-20**	**08/29/07**	**Solid**	**N/A**	**N/A**	**09/04/07**	**70904TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	73.8	0.100	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS-B3 (I, II, III)	**07-08-2232-21**	**08/29/07**	**Solid**	**N/A**	**N/A**	**09/04/07**	**70904TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	78.4	0.100	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS-B4 (I, II, III)	**07-08-2232-22**	**08/29/07**	**Solid**	**N/A**	**N/A**	**09/04/07**	**70904TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	76.6	0.100	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS-B5 (I, II, III)	**07-08-2232-23**	**08/29/07**	**Solid**	**N/A**	**N/A**	**09/04/07**	**70904TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	73.4	0.100	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS-B6 (I, II, III)	**07-08-2232-24**	**08/29/07**	**Solid**	**N/A**	**N/A**	**09/04/07**	**70904TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	76.9	0.100	1		%

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

Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

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

Date Received: 08/31/07
Work Order No: 07-08-2232
Preparation: EPA 3050B
Method: EPA 6020

Project OBGS 07203A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
OBGS-B1 (I, II, III)	**Solid**	**ICP/MS A**	**09/04/07**	**09/05/07**	**070904S03**

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	109	97	80-120	10	0-20	
Copper	101	95	80-120	5	0-20	
Nickel	112	96	80-120	13	0-20	
Zinc	111	90	80-120	12	0-20	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - PDS / PDSD

MBC Applied Environmental Sciences	Date Received	08/31/07
3000 Redhill Avenue	Work Order N	07-08-2232
Costa Mesa, CA 92626-4524	Preparation:	EPA 3050B
	Method:	EPA 6020

Project: OBGS 07203A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	PDS/PDSD Batch Number
OBGS-B1 (I, II, III)	**Solid**	**ICP/MS A**	**09/04/07**	**09/05/07**	**070904S03**

Parameter	PDS %REC	PDSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	92	96	75-125	4	0-20	
Copper	95	93	75-125	3	0-20	
Nickel	97	97	75-125	0	0-20	
Zinc	105	88	75-125	10	0-20	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Duplicate

MBC Applied Environmental Sciences		Date Received:	08/31/07
3000 Redhill Avenue		Work Order No:	07-08-2232
Costa Mesa, CA 92626-4524		Preparation:	N/A
		Method:	SM 2540 B

Project: OBGS 07203A

Quality Control Sample ID	Matrix	Instrument	Date Prepared:	Date Analyzed:	Duplicate Batch Number
OBGS-B1 (I, II, III)	**Solid**	**N/A**	**N/A**	**09/04/07**	**70904TSD1**

Parameter	Sample Conc	DUP Conc	RPD	RPD CL	Qualifiers
Solids, Total	75.7	75.7	0	0-25	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

MBC Applied Environmental Sciences	Date Received: N/A
3000 Redhill Avenue	Work Order No: 07-08-2232
Costa Mesa, CA 92626-4524	Preparation: EPA 3050B
	Method: EPA 6020

Project: OBGS 07203A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
096-10-002-933	**Solid**	**ICP/MS A**	**09/04/07**	**09/05/07**	**070904L03**

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	111	111	80-120	0	0-20	
Copper	108	106	80-120	2	0-20	
Nickel	111	114	80-120	2	0-20	
Zinc	106	105	80-120	1	0-20	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Glossary of Terms and Qualifiers

Work Order Number: 07-08-2232

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.
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.

Appendix D-2. Yearly sediment metal concentrations, 1990 - 2007. Ormond Beach Generating Station NPDES, 2007.

		Year																
Metal	Station	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Mean
Chromium	B1	9.9	19.3	10.0	8.8	10.0	8.6	-	6.9	10.0	13	13	-	9.1	8.22	9.16	7.31	10
ERL = 81	B2	9.3	37.5	9.6	8.9	10.0	9.4	8.1	9.9	9.0	12	11	8.1	7.6	3.29	8.17	7.89	11
	B3	7.4	13.3	5.7	9.1	12.0	6.1	5.8	10.0	11.0	9.9	8.7	8.7	7.4	7.60	8.67	5.03	9
	B4	8.0	17.7	9.6	8.8	7.9	7.9	7.9	7.8	10.0	14	11	11	10	7.17	7.42	5.44	9
	B5	8.2	17.3	8.6	7.8	8.6	8.0	-	7.4	6.1	15	11	9.4	8.5	6.17	8.72	6.03	9
	B6	5.9	10.8	8.4	8.0	9.9	5.4	-	7.8	10.0	9.6	13	-	8.0	6.27	2.74	6.39	8
Copper	B1	2.9	8.8	5.0	4.2	4.3	1.6	-	3.9	3.9	4.3	3.9	-	3.5	3.72	3.67	3.69	4.1
ERL = 34	B2	2.2	24.3	5.0	4.1	4.5	2.0	3.5	4.7	4.1	4.0	3.9	2.8	2.8	1.61	3.22	3.99	4.8
	B3	1.6	10.6	10.4	5.4	4.3	1.5	3.1	4.2	20.0	3.5	3.4	3.3	3.1	3.57	3.99	3.17	5.3
	B4	1.7	11.1	5.2	4.6	3.9	1.3	3.0	4.3	4.1	4.5	3.5	3.9	11	3.15	3.05	2.89	4.4
	B5	2.4	11.2	5.0	4.4	4.3	1.8	-	4.1	3.6	6.4	3.9	4.8	3.6	3.52	4.17	3.58	4.4
	B6	1.3	6.0	4.9	4.1	5.1	0.0	-	4.7	3.9	3.8	4.1	-	3.7	3.13	5.15	3.40	3.8
Nickel	B1	5.7	13.2	7.2	6.6	6.2	6.0	-	5.7	6.9	8.8	7.1	-	5.9	6.73	7.04	7.17	7.2
ERL = 20.9	B2	5.7	20.0	7.3	6.1	6.3	7.2	3.6	7.7	6.8	8.0	7.3	5.9	4.9	3.73	6.40	7.75	7.2
	B3	4.4	8.4	8.4	6.9	8.2	4.4	3.6	7.7	6.1	6.9	6.3	6.7	5.8	6.64	7.59	5.93	6.5
	B4	4.8	11.6	7.4	7.1	5.6	5.8	4.0	7.0	7.1	9.5	7.0	7.6	6.3	6.12	6.58	6.51	6.9
	B5	5.3	13.1	6.7	6.4	6.1	5.5	-	6.1	5.7	8.6	7.0	7.9	6.1	6.23	7.52	7.09	7.0
	B6	3.9	8.4	7.4	6.9	7.1	4.8	-	7.6	8.2	7.4	7.8	-	6.7	6.76	2.50	6.93	6.6
Zinc	B1	20.0	28.1	21.8	23	21	23	-	21	26	20	21	-	20	19.7	25.0	26.3	23
ERL = 150	B2	18.9	32.5	22.5	22	22	25	15	27	25	19	22	18	16	6.82	21.8	27.0	21
	B3	15.7	13.0	25.9	23	16	14	14	26	31	16	18	19	16	17.6	24.5	19.7	19
	B4	16.7	22.6	23.4	22	19	20	14	23	27	23	20	22	21	18.6	20.2	20.3	21
	B5	17.6	37.3	20.5	21	21	21	-	20	22	26	20	24	21	33.9	24.9	23.4	24
	B6	13.0	23.3	20.3	20	24	15	-	19	27	21	22	-	19	17.6	7.74	21.3	19
Fines	B1	15.6	10.7	10.9	3.8	15.5	13.0	-	15.6	15.0	13.6	13.3	-	13.4	12.2	17.9	11.2	13.0
	B2	15.9	8.3	5.7	1.0	18.3	16.4	21.4	14.0	14.2	8.1	12.1	11.4	10.2	1.1	11.1	8.3	11.1
	B3	6.9	6.6	5.7	2.3	2.3	6.2	8.4	10.1	7.1	17.4	9.6	18.4	11.4	9.1	14.8	7.3	9.0
	B4	18.0	9.7	8.1	3.1	13.3	14.0	17.4	9.5	9.8	11.4	11.3	15.7	15.5	19.3	16.0	9.4	12.6
	B5	4.7	11.7	6.1	3.0	8.4	9.4	-	8.9	9.5	9.4	8.2	13.0	17.3	22.1	17.9	11.0	10.7
	B6	6.0	6.6	0.9	1.3	4.7	4.7	-	4.3	4.0	5.5	9.3	-	7.9	6.0	9.6	6.1	5.5

ERL = Effects Range Low

\- = not required

APPENDIX E

Mussel tissue chemistry by station

Calscience Environmental Laboratories, Inc.

Analytical Report

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

Date Received:	09/10/07
Work Order No:	07-09-0467
Preparation:	EPA 3050B
Method:	EPA 6020
Units:	mg/kg

Project: OBGS 07203A

Page 1 of 1

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS - I	**07-09-0467-1**	**08/29/07**	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920L01**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	11.1	0.667	0.5		Nickel	5.90	0.333	0.5	
Copper	5.12	1.00	0.5		Zinc	76.4	6.67	0.5	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS - II	**07-09-0467-2**	**08/29/07**	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920L01**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	7.05	0.709	0.5		Nickel	3.16	0.355	0.5	
Copper	4.66	1.06	0.5		Zinc	58.1	7.09	0.5	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS - II	**07-09-0467-3**	**08/29/07**	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920L01**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	7.53	0.699	0.5		Nickel	3.24	0.350	0.5	
Copper	4.23	1.05	0.5		Zinc	81.3	6.99	0.5	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
Method Blank	**099-12-411-3**	**N/A**	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920L01**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	ND	0.100	0.5		Nickel	ND	0.0500	0.5	
Copper	ND	0.150	0.5		Zinc	ND	1.00	0.5	

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

7440 Lincoln Way, Garden Grove, CA 92841-1427 • TEL:(714) 895-5494 • FAX: (714) 894-7501

Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences		Date Received:	09/10/07
3000 Redhill Avenue		Work Order No:	07-09-0467
Costa Mesa, CA 92626-4524		Preparation:	N/A
		Method:	SM 2540 B

Project: OBGS 07203A

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Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS - I	**07-09-0467-1**	**08/29/07**	**Tissue**	**N/A**	**N/A**	**09/19/07**	**70919TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	15.0	0.100	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS - II	**07-09-0467-2**	**08/29/07**	**Tissue**	**N/A**	**N/A**	**09/19/07**	**70919TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	14.1	0.100	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
OBGS - II	**07-09-0467-3**	**08/29/07**	**Tissue**	**N/A**	**N/A**	**09/19/07**	**70919TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	14.3	0.100	1		%

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

7440 Lincoln Way, Garden Grove, CA 92841-1427 • TEL:(714) 895-5494 • FAX: (714) 894-7501

Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

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

Date Received:	09/10/07
Work Order No:	07-09-0467
Preparation:	EPA 3050B
Method:	EPA 6020

Project OBGS 07203A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
07-09-1083-1	**Solid**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920S01**

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	111	112	80-120	1	0-20	
Copper	103	105	80-120	2	0-20	
Nickel	107	108	80-120	1	0-20	
Zinc	135	113	80-120	8	0-20	3

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Duplicate

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

Date Received:	09/10/07
Work Order No:	07-09-0467
Preparation:	N/A
Method:	SM 2540 B

Project: OBGS 07203A

Quality Control Sample ID	Matrix	Instrument	Date Prepared:	Date Analyzed:	Duplicate Batch Number
07-09-1086-3	**Solid**	**N/A**	**N/A**	**09/19/07**	**70919TSD1**

Parameter	Sample Conc	DUP Conc	RPD	RPD CL	Qualifiers
Solids, Total	18.0	17.6	2	0-25	

RPD - Relative Percent Difference , CL - Control Limit

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Quality Control - LCS/LCS Duplicate

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

Date Received: N/A
Work Order No: 07-09-0467
Preparation: EPA 3050B
Method: EPA 6020

Project: OBGS 07203A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
099-12-411-3	Tissue	ICP/MS A	09/20/07	09/20/07	070920L01

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	107	108	80-120	1	0-20	
Copper	100	100	80-120	0	0-20	
Nickel	102	103	80-120	1	0-20	
Zinc	100	104	80-120	4	0-20	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Glossary of Terms and Qualifiers

Work Order Number: 07-09-0467

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.
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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Analytical Report

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

Date Received:	09/17/07
Work Order No:	07-09-1083
Preparation:	EPA 3050B
Method:	EPA 6020
Units:	mg/kg

Project: RGS 07205A

Page 1 of 1

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
RGS MBP - I	**07-09-1083-1**	**07/25/07**	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920L01**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	4.37	0.469	0.5		Nickel	2.46	0.235	0.5	
Copper	8.49	0.704	0.5		Zinc	94.5	4.69	0.5	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
RGS MBP - II	**07-09-1083-2**	**07/25/07**	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920L01**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	3.78	0.446	0.5		Nickel	1.24	0.223	0.5	
Copper	7.56	0.670	0.5		Zinc	73.9	4.46	0.5	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
RGS MBP - III	**07-09-1083-3**	**07/25/07**	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920L01**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	5.81	0.526	0.5		Nickel	1.74	0.263	0.5	
Copper	9.48	0.789	0.5		Zinc	94.2	5.26	0.5	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
Method Blank	**099-12-411-3**	**N/A**	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920L01**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	ND	0.100	0.5		Nickel	ND	0.0500	0.5	
Copper	ND	0.150	0.5		Zinc	ND	1.00	0.5	

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

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Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences	Date Received: 09/17/07
3000 Redhill Avenue	Work Order No: 07-09-1083
Costa Mesa, CA 92626-4524	Preparation: N/A
	Method: SM 2540 B

Project: RGS 07205A

Page 1 of 1

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
RGS MBP - I	**07-09-1083-1**	**07/25/07**	**Tissue**	**N/A**	**N/A**	**09/18/07**	**70918TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	21.3	0.100	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
RGS MBP - II	**07-09-1083-2**	**07/25/07**	**Tissue**	**N/A**	**N/A**	**09/18/07**	**70918TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	22.4	0.100	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
RGS MBP - III	**07-09-1083-3**	**07/25/07**	**Tissue**	**N/A**	**N/A**	**09/18/07**	**70918TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	19.0	0.100	1		%

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:	09/17/07
3000 Redhill Avenue		Work Order No:	07-09-1083
Costa Mesa, CA 92626-4524		Preparation:	EPA 3050B
		Method:	EPA 6020

Project RGS 07205A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
RGS MBP - I	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920S01**

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	111	112	80-120	1	0-20	
Copper	103	105	80-120	2	0-20	
Nickel	107	108	80-120	1	0-20	
Zinc	135	113	80-120	8	0-20	3

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Duplicate

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

Date Received: 09/17/07
Work Order No: 07-09-1083
Preparation: N/A
Method: SM 2540 B

Project: RGS 07205A

Quality Control Sample ID	Matrix	Instrument	Date Prepared:	Date Analyzed:	Duplicate Batch Number
07-09-1039-1	**Solid**	**N/A**	**N/A**	**09/18/07**	**70918TSD1**

Parameter	Sample Conc	DUP Conc	RPD	RPD CL	Qualifiers
Solids, Total	44.8	48.6	8	0-25	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

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

Date Received: N/A
Work Order No: 07-09-1083
Preparation: EPA 3050B
Method: EPA 6020

Project: RGS 07205A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
099-12-411-3	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920L01**

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	107	108	80-120	1	0-20	
Copper	100	100	80-120	0	0-20	
Nickel	102	103	80-120	1	0-20	
Zinc	100	104	80-120	4	0-20	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences		Date Received:	09/10/07
3000 Redhill Avenue		Work Order No:	07-09-0465
Costa Mesa, CA 92626-4524		Preparation:	EPA 3050B
		Method:	EPA 6020
		Units:	mg/kg
Project: MGS / OBGS 07202/3			Page 1 of 1

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
Donor Site - I	**07-09-0465-1**	**03/29/07**	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920L01**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	5.78	0.885	0.5		Nickel	3.26	0.442	0.5	
Copper	12.1	1.33	0.5		Zinc	144	8.85	0.5	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
Donor Site - II	**07-09-0465-2**	**03/29/07**	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920L01**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	6.52	1.20	0.5		Nickel	2.20	0.602	0.5	
Copper	10.3	1.81	0.5		Zinc	168	12.0	0.5	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
Donor Site - III	**07-09-0465-3**	**03/29/07**	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920L01**

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	6.42	1.27	0.5		Nickel	2.36	0.633	0.5	
Copper	9.75	1.90	0.5		Zinc	179	12.7	0.5	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
Method Blank	**099-12-411-3**	**N/A**	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920L01**

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	ND	0.100	0.5		Nickel	ND	0.0500	0.5	
Copper	ND	0.150	0.5		Zinc	ND	1.00	0.5	

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

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Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences		Date Received:	09/10/07
3000 Redhill Avenue		Work Order No:	07-09-0465
Costa Mesa, CA 92626-4524		Preparation:	N/A
		Method:	SM 2540 B

Project: MGS / OBGS 07202/3

Page 1 of 1

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
Donor Site - I	**07-09-0465-1**	**03/29/07**	**Tissue**	**N/A**	**N/A**	**09/19/07**	**70919TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	11.3	0.100	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
Donor Site - II	**07-09-0465-2**	**03/29/07**	**Tissue**	**N/A**	**N/A**	**09/19/07**	**70919TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	8.30	0.100	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
Donor Site - III	**07-09-0465-3**	**03/29/07**	**Tissue**	**N/A**	**N/A**	**09/19/07**	**70919TSD1**

Parameter	Result	RL	DF	Qual	Units
Solids, Total	7.90	0.100	1		%

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
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received: 09/10/07
Work Order No: 07-09-0465
Preparation: EPA 3050B
Method: EPA 6020

Project MGS / OBGS 07202/3

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
07-09-1083-1	**Solid**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920S01**

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	111	112	80-120	1	0-20	
Copper	103	105	80-120	2	0-20	
Nickel	107	108	80-120	1	0-20	
Zinc	135	113	80-120	8	0-20	3

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Quality Control - Duplicate

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

Date Received: 09/10/07
Work Order No: 07-09-0465
Preparation: N/A
Method: SM 2540 B

Project: MGS / OBGS 07202/3

Quality Control Sample ID	Matrix	Instrument	Date Prepared:	Date Analyzed:	Duplicate Batch Number
07-09-1086-3	**Solid**	**N/A**	**N/A**	**09/19/07**	**70919TSD1**

Parameter	Sample Conc	DUP Conc	RPD	RPD CL	Qualifiers
Solids, Total	18.0	17.6	2	0-25	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - LCS/LCS Duplicate

MBC Applied Environmental Sciences		Date Received:	N/A
3000 Redhill Avenue		Work Order No:	07-09-0465
Costa Mesa, CA 92626-4524		Preparation:	EPA 3050B
		Method:	EPA 6020

Project: MGS / OBGS 07202/3

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
099-12-411-3	**Tissue**	**ICP/MS A**	**09/20/07**	**09/20/07**	**070920L01**

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	107	108	80-120	1	0-20	
Copper	100	100	80-120	0	0-20	
Nickel	102	103	80-120	1	0-20	
Zinc	100	104	80-120	4	0-20	

RPD - Relative Percent Difference , CL - Control Limit

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Appendix E-2. Yearly mussel tissue metal concentrations (mg/dry kg), 1990 - 2007. Ormond Beach Generating Station NPDES, 2007.

	Chromium					Copper					Nickel					Zinc				
	Rep 1	Rep 2	Rep 3	Mean	SD	Rep 1	Rep 2	Rep 3	Mean	SD	Rep 1	Rep 2	Rep 3	Mean	SD	Rep 1	Rep 2	Rep 3	Mean	SD
2007	11.1	7.05	7.53	8.56	2.21	5.12	4.66	4.23	4.67	0.45	5.90	3.16	3.24	4.10	1.56	76.4	58.1	81.3	71.9	12.2
2006	6.97	6.07	6.55	6.53	0.45	5.806	5.665	6.238	5.903	0.299	1.016	1.06	1.92	1.33	0.51	82.294	74.184	78.074	78.184	4.056
2005	3.23	3.23	5.06	3.84	1.06	8.54	12.8	12.4	11.25	2.35	7.55	3.49	10.6	7.21	3.57	65	95.6	86.1	82	15.7
2004	ND	ND	ND	-	-	6.1	8.7	5.3	6.70	1.78	ND	ND	ND	-	-	64	62	70	65	4.2
2003	ND	ND	ND	-	-	1.3	1.2	1.1	1.2	0.1	ND	ND	ND	-	-	11	11	10	11	0.6
2002	**0.99**	ND	ND	**0.99**	-	12	10	10	11	1.2	**2.6**	**1.7**	**1.8**	**2.0**	0.5	99	82	100	94	10.12
2001	ND	ND	ND	-	-	8.7	7.0	8.3	8.0	0.9	ND	ND	ND	-	-	77	96	150	108	37.9
2000	ND	ND	ND	-	-	8.8	12	9.8	10.2	1.6	ND	ND	ND	-	-	90	120	96	102	15.9
1999	ND	ND	ND	-	-	5.5	12	17	11.5	5.8	ND	ND	ND	-	-	150	94	100	115	30.7
1993	ND	NS	NS	-	-	2.4	NS	NS	2.4	-	ND	NS	NS	-	-	13	NS	NS	13	-
1992	ND	NS	NS	-	-	3.4	NS	NS	3.4	-	ND	NS	NS	-	-	19	NS	NS	19	-
1991	65.0	NS	NS	65.0	-	55.0	NS	NS	55.0	-	28.5	NS	NS	28.5	-	26	NS	NS	26	-
1990	2.24	1.73	1.57	1.85	0.35	2.2	0.9	1.5	1.5	0.7	ND	ND	ND	-	-	81	73	57	70	12.2
Donor Site																				
2007[1]	5.78	6.52	6.42	6.24	0.40	12.1	10.3	9.75	10.7	1.2	3.26	2.20	2.36	2.61	0.57	144	168	179	164	17.9
2006[1]	6.47	7.34	9.92	7.91	1.79	4.69	4.79	9.19	6.22	2.57	0.48	0.50	0.86	0.61	0.21	90.19	89.06	105.95	95.07	9.44

ND = Below the detection limit (for calculations ND = 0)
NS = Not Required
Bold = Values below reporting limit as estimated by the analytical laboratory
1 = Transplanted mussels

APPENDIX F

Infauna data by station

Appendix F-1. Infaunal master species list. Ormond Beach Generating Station NPDES, 2007.

PHYLUM (Phy)
Subphylum or Class
Species

CNIDARIA (CN)
Anthozoa
Actiniaria
Actiniaria sp A Paquette 2005 [1]
Edwardsia sp G MEC 1992
Pennatulacea
Zaolutus actius

PLATYHELMINTHES (PL)
Turbellaria
Imogine exiguus [2]
Stylochoplana sp [3]

NEMERTEA (NE)
Anopla
Carinoma mutabilis
Lineidae
Micrura sp
Tubulanus cingulatus
Tubulanus nothus
Tubulanus polymorphus [4]
Enopla
Amphiporus bimaculatus
Hoplonemertea sp A Paquette 1988
Paranemertes californica [5]
Tetrastemma candidum
Tetrastemma nigrifrons
Tetrastemma sp A SCAMIT 1995
Zygonemertes virescens
Uncertain
Nemertea

NEMATODA (NT)
Nematoda

MOLLUSCA (MO)
Gastropoda
Armina californica
Epitonium sawinae [6]
Epitonium sp
Hermissenda crassicornis
Nassarius perpinguis
Neverita reclusiana
Odostomia minutissima
Odostomia sp D MBC 1980
Olivella baetica
Ophiodermella inermis
Polygireulima rutila [7]
Bivalvia
Cooperella subdiaphana
Ensis myrae
Lyonsia californica
Macoma secta
Macoma sp
Macoma yoldiformis
Mytilidae
Periploma discus
Rochefortia compressa
Rochefortia tumida [8]
Siliqua lucida
Solen sicarius
Tellina modesta

PHYLUM
Subphylum or Class
Species

SIPUNCULA (SI)
Siphonosoma ingens
Sipuncula

ANNELIDA (AN)
Polychaeta
Apoprionospio pygmaea
Ampharete labrops
Amphicteis scaphobranchiata
Arabella endonata
Aricidea (Acmira) catherinae [9]
Armandia brevis [10]
Brania brevipharyngea
Chaetozone setosa Cmplx [11]
Chone mollis
Chone sp SD1 Pt. Loma 1997
Chrysopetalum occidentale
Demonax sp
Diopatra ornata
Dipolydora bidentata
Dipolydora socialis [12]
Dispio uncinata
Eumida longicornuta
Eupolymnia heterobranchia
Exogone lourei
Glycera macrobranchia [13]
Glycinde armigera
Goniada littorea
Goniada maculata
Hesionella mccullochae
Heteropodarke heteromorpha
Leitoscoloplos pugettensis [14]
Lumbrineris californiensis
Lumbrineris japonica
Magelona pitelkai
Magelona sacculata
Maldanidae
Mediomastus acutus [15]
Mediomastus ambiseta [15]
Monticellina cryptica [16]
Neosabellaria cementarium
Nephtys caecoides
Nephtys cornuta [17]
Nereis latescens
Notomastus hemipodus
Onuphis eremita parva
Onuphis sp 1 Pt. Loma 1983
Ophryotrocha sp
Owenia collaris [18]
Paraprionospio pinnata
Pectinaria californiensis
Phyllodoce hartmanae
Phyllodoce longipes
Pista disjuncta
Podarkeopsis glabrus
Poecilochaetus johnsoni
Prionospio (Minuspio) lighti [19]
Scolelepis squamata
Scoletoma spp
Scoletoma tetraura Cmplx [20]
Scoloplos armiger Cmplx
Sigalion spinosus [21]

Appendix F-1. (Cont.).

PHYLUM Subphylum or Class Species	PHYLUM Subphylum or Class Species
ANNELIDA (AN) (Cont.).	ARTHROPODA (AR)
Polychaeta (Cont.)	Malacostraca
Sphaerephesia similisetis	*Gammaropsis thompsoni*
Sphaerosyllis californiensis	*Gibberosus myersi* [31]
Spiochaetopterus costarum	*Hartmanodes hartmanae* [32]
Spiophanes berkeleyorum	*Incisocalliope bairdi*
Spiophanes bombyx	*Ischyrocerus pelagops*
Spiophanes duplex [22]	*Jassa slatteryi* [33]
Syllis (Ehlersia) heterochaeta	*Lamprops quadriplicatus*
Syllis (Typosyllis) farallonensis [23]	*Laticorophium baconi* [34]
Tenonia priops [24]	*Lepidopa californica*
	Oedicerotidae
ARTHROPODA (AR)	*Photis bifurcata*
Pycnogonida	*Photis brevipes*
Anoropallene palpida	*Photis macinerneyi*
Ostracoda	*Podocerus brasiliensis*
Asteropella slatteryi	*Rhepoxynius abronius*
Euphilomedes carcharodonta	*Rhepoxynius menziesi* [35]
Euphilomedes longiseta	*Rhepoxynius* sp
Parasterope hulingsi	*Rhepoxynius* sp A SCAMIT 1987
Rutiderma judayi	*Stenothoe estacola*
Rutiderma rostratum	*Uromunna ubiquita* [36]
Zeugophilomedes oblonga [25]	
Malacostraca	KINORHYNCHA (KI)
Acuminodeutopus heteruropus	Kinorhyncha
Americhelidium shoemakeri [26]	
Ampelisca agassizi [27]	ECHINODERMATA (EC)
Ampelisca cristata cristata	Echinoidea
Anchicolurus occidentalis	*Dendraster excentricus*
Aoroides inermis	Ophiuroidea
Campylaspis sp C Myers & Benedict 1974	*Amphiodia digitata*
Caprella verrucosa	*Amphiodia psara* [37]
Cerapus tubularis Cmplx	
Cumella californica [28]	PHORONA (PR)
Cyclaspis sp C SCAMIT 1986	Phoronida
Deutella californica	*Phoronis* sp
Diastylopsis tenuis	*Phoronopsis* sp
Edotia sublittoralis [29]	
Ericthonius brasiliensis	BRACHIOPODA (BC)
Foxiphalus obtusidens [30]	Inarticulata
Gammaridea	*Glottidia albida*

SCAMIT = Southern California Association of Marine Invertebrate Taxonomists

The following footnotes indicate names used in previous surveys:

1 Limnactiniidae sp A SCAMIT 1989
2 *Stylochus exiguus*
3 Platyhelminthes sp D MBC
4 *Tubulanus pellucidus/polymorphus, T.* sp or *T.* spp
5 *Paranemertes* sp A of SCAMIT
6 *Nitidiscala sawinae*
7 *Balcis rutila*
8 *Mysella tumida, M.* cf. *aleutica*
9 *Acmira catherinae*
10 *Armandia bioculata*
11 *Chaetozone "setosa", C.* cf. *setosa*
12 *Polydora socialis*
13 *Glycera convoluta*
14 *Hapolscoloplos elongatus*
15 *Mediomastus* spp (in part)
16 *Monticellina dorsobranchialis, Tharyx* sp A SCAMIT
17 *Nephtys cornuta franciscana*
18 *Owenia fusiformis*
19 *Minuspio cirrifera, Prionospio cirrifera*
20 *Lumbrineris "tetraura"* or *L. tetraura*
21 *Thalenessa spinosum*
22 *Spiophanes missionenesis*
23 *Typosyllis farallonensis*
24 *Harmothoe priops*
25 *Zeugophilomedes oblongatus, Z. oblongata*
26 *Synchelidium shoemakeri*
27 *Ampelisca compressa*
28 *Cumella* sp A Myers & Benedict or *C.* sp A MBC
29 *Edotea sublittoralis*
30 *Paraphoxus obtusidens*
31 *Megaluropus longimerus*
32 *Manoculodes hartmanae*
33 *Jassa falcata*
34 *Corophium baconi*
35 *Paraphoxus epistomus, Rhepoxynius epistomus*
36 *Munna ubiquita*
37 *Amphiodia occidentalis*

Appendix F-2. Infauna results by station. Ormond Beach Generating Station NPDES, 2007.

Phylum	Species	Station B1	B2	B3	B4	B5	B6	Total	Percent Total
AN	*Apoprionospio pygmaea*	154	183	85	56	100	23	601	25.17
AN	*Mediomastus acutus*	30	36	5	18	24	16	129	5.40
MO	*Siliqua lucida*	20	57	4	7	7	11	106	4.44
AN	*Onuphis* sp 1 Pt. Loma 1983	29	20	28	10	9	1	97	4.06
MO	*Tellina modesta*	9	41	9	11	12	13	95	3.98
EC	*Dendraster excentricus*	13	27	11	19	15	9	94	3.94
MO	*Cooperella subdiaphana*	32	35	4	7	9	2	89	3.73
NE	Lineidae	14	25	19	16	7	1	82	3.43
AR	*Ericthonius brasiliensis*	-	1	29	8	16	-	54	2.26
AR	*Rhepoxynius menziesi*	8	6	5	5	4	21	49	2.05
AR	*Diastylopsis tenuis*	6	17	5	6	11	3	48	2.01
AN	*Armandia brevis*	5	12	4	10	5	1	37	1.55
AR	*Jassa slatteryi*	-	-	17	12	7	-	36	1.51
AN	*Spiophanes bombyx*	6	11	3	5	4	1	30	1.26
AN	*Exogone lourei*	14	-	1	1	11	1	28	1.17
AN	*Scoletoma* spp	1	9	14	-	3	-	27	1.13
AR	*Podocerus brasiliensis*	-	-	14	9	3	-	26	1.09
AR	*Rhepoxynius abronius*	2	4	4	-	3	13	26	1.09
AR	*Cyclaspis* sp C SCAMIT 1986	2	7	12	1	3	-	25	1.05
NT	Nematoda	8	5	9	-	3	-	25	1.05
NE	*Tubulanus polymorphus*	7	13	-	2	2	-	24	1.01
AN	*Goniada littorea*	6	-	3	2	8	4	23	0.96
AN	*Syllis (Typosyllis) farallonensis*	7	2	-	3	7	4	23	0.96
AR	*Photis macinerneyi*	-	2	2	4	-	15	23	0.96
AN	*Pectinaria californiensis*	6	9	1	6	-	-	22	0.92
NE	*Carinoma mutabilis*	2	6	1	8	5	-	22	0.92
AN	*Chone* sp SD1 Pt. Loma 1997	1	-	8	1	4	7	21	0.88
AR	*Zeugophilomedes oblonga*	7	5	-	7	1	-	20	0.84
AN	*Monticellina cryptica*	4	2	1	-	12	-	19	0.80
AR	*Stenothoe estacola*	-	-	11	3	5	-	19	0.80
AN	*Owenia collaris*	10	1	4	2	-	1	18	0.75
AN	*Prionospio (Minuspio) lighti*	-	-	16	-	-	-	16	0.67
AN	*Mediomastus ambiseta*	9	3	-	2	-	-	14	0.59
AN	*Syllis (Ehlersia) heterochaeta*	-	7	1	5	-	1	14	0.59
AN	*Glycera macrobranchia*	5	3	1	1	3	-	13	0.54
AN	*Chaetozone setosa* Cmplx	1	2	2	2	5	-	12	0.50
AR	*Laticorophium baconi*	-	-	7	3	2	-	12	0.50
AN	*Spiophanes duplex*	1	3	2	1	4	-	11	0.46
NE	*Paranemertes californica*	1	4	-	4	-	2	11	0.46
AN	*Ampharete labrops*	1	5	3	-	-	1	10	0.42
AR	*Acuminodeutopus heteruropus*	-	1	-	1	8	-	10	0.42
AR	*Foxiphalus obtusidens*	1	-	6	2	-	-	9	0.38
MO	*Rochefortia tumida*	1	-	1	4	1	2	9	0.38
AR	*Americhelidium shoemakeri*	-	1	3	-	1	3	8	0.34
AR	*Ampelisca agassizi*	1	2	-	2	3	-	8	0.34
AR	*Cumella californica*	-	7	-	1	-	-	8	0.34
EC	*Amphiodia psara*	-	1	2	4	-	1	8	0.34
MO	*Macoma* sp	1	3	-	2	2	-	8	0.34
AN	*Chone mollis*	2	4	1	-	-	-	7	0.29
AN	*Scoletoma tetraura* Cmplx	-	-	7	-	-	-	7	0.29
AR	*Edotia sublittoralis*	3	1	1	1	1	-	7	0.29
PR	*Phoronis* sp	2	1	-	2	2	-	7	0.29
AN	*Leitoscoloplos pugettensis*	1	2	-	1	2	-	6	0.25
AN	*Phyllodoce hartmanae*	1	-	4	-	1	-	6	0.25
AN	*Spiochaetopterus costarum*	2	2	1	1	-	-	6	0.25
AR	*Aoroides inermis*	6	-	-	-	-	-	6	0.25
AR	*Photis brevipes*	1	-	4	1	-	-	6	0.25
AN	*Notomastus hemipodus*	-	-	5	-	-	-	5	0.21
AN	*Pista disjuncta*	1	-	-	2	-	2	5	0.21
AR	*Anchicolurus occidentalis*	1	-	-	4	-	-	5	0.21
AR	*Uromunna ubiquita*	2	-	2	-	-	1	5	0.21
CN	Actiniaria sp A Paquette 2005	1	2	-	1	-	1	5	0.21
AN	*Brania brevipharyngea*	4	-	-	-	-	-	4	0.17
AN	*Demonax* sp	-	-	1	2	1	-	4	0.17
AN	*Magelona pitelkai*	-	2	1	1	-	-	4	0.17

Appendix F-2. Infauna results by station. Ormond Beach Generating Station NPDES, 2007.

Phylum	Species	Station B1	B2	B3	B4	B5	B6	Total	Percent Total
AN	*Podarkeopsis glabrus*	-	1	2	-	1	-	4	0.17
AN	*Sigalion spinosus*	1	-	-	3	-	-	4	0.17
AN	*Sphaerephesia similisetis*	-	2	-	2	-	-	4	0.17
AN	*Spiophanes berkeleyorum*	1	2	1	-	-	-	4	0.17
AR	*Campylaspis* sp C Myers & Benedict 1974	-	1	1	2	-	-	4	0.17
AR	*Euphilomedes carcharodonta*	1	2	-	1	-	-	4	0.17
AR	*Gammaropsis thompsoni*	-	-	-	3	1	-	4	0.17
AR	*Hartmanodes hartmanae*	-	1	1	-	1	1	4	0.17
AR	*Lamprops quadriplicatus*	1	1	1	-	1	-	4	0.17
AN	*Glycinde armigera*	-	1	1	-	1	-	3	0.13
AN	*Nephtys caecoides*	-	2	-	1	-	-	3	0.13
AN	*Scoloplos armiger* Cmplx	-	1	-	1	-	1	3	0.13
AR	*Ampelisca cristata cristata*	-	3	-	-	-	-	3	0.13
AR	*Euphilomedes longiseta*	-	-	-	-	-	3	3	0.13
AR	*Rhepoxynius* sp A SCAMIT 1987	-	-	-	-	-	3	3	0.13
AR	*Rutiderma rostratum*	1	1	-	-	1	-	3	0.13
MO	*Macoma secta*	-	2	-	-	1	-	3	0.13
MO	*Macoma yoldiformis*	-	3	-	-	-	-	3	0.13
MO	*Olivella baetica*	-	1	2	-	-	-	3	0.13
NE	Nemertea	-	1	-	2	-	-	3	0.13
NE	*Tetrastemma candidum*	-	-	-	-	-	3	3	0.13
AN	*Dipolydora socialis*	1	-	1	-	-	-	2	0.08
AN	*Dispio uncinata*	-	-	-	-	-	2	2	0.08
AN	*Eumida longicornuta*	2	-	-	-	-	-	2	0.08
AN	*Goniada maculata*	1	-	-	1	-	-	2	0.08
AN	*Heteropodarke heteromorpha*	-	1	-	1	-	-	2	0.08
AN	*Lumbrineris californiensis*	-	-	-	-	-	2	2	0.08
AN	*Magelona sacculata*	1	1	-	-	-	-	2	0.08
AN	*Neosabellaria cementarium*	1	-	-	1	-	-	2	0.08
AN	*Nephtys cornuta*	-	1	-	1	-	-	2	0.08
AN	*Tenonia priops*	-	2	-	-	-	-	2	0.08
AR	*Anoropallene palpida*	-	2	-	-	-	-	2	0.08
AR	*Asteropella slatteryi*	-	1	-	-	1	-	2	0.08
AR	*Caprella verrucosa*	-	-	-	2	-	-	2	0.08
AR	*Deutella californica*	-	-	-	-	2	-	2	0.08
AR	*Gibberosus myersi*	-	-	-	-	-	2	2	0.08
AR	*Parasterope hulingsi*	-	-	1	-	-	1	2	0.08
AR	*Rutiderma judayi*	1	-	-	-	1	-	2	0.08
CN	Actiniaria	-	-	2	-	-	-	2	0.08
CN	*Zaolutus actius*	-	-	2	-	-	-	2	0.08
MO	*Rochefortia compressa*	1	-	-	1	-	-	2	0.08
MO	*Solen sicarius*	-	-	-	-	-	2	2	0.08
NE	Hoplonemertea sp A Paquette 1988	1	-	-	-	1	-	2	0.08
NE	*Micrura* sp	-	-	-	1	1	-	2	0.08
AN	*Amphicteis scaphobranchiata*	-	1	-	-	-	-	1	0.04
AN	*Arabella endonata*	-	-	-	-	1	-	1	0.04
AN	*Aricidea (Acmira) catherinae*	-	-	1	-	-	-	1	0.04
AN	*Chrysopetalum occidentale*	-	-	-	1	-	-	1	0.04
AN	*Diopatra ornata*	-	-	1	-	-	-	1	0.04
AN	*Dipolydora bidentata*	-	-	-	-	1	-	1	0.04
AN	*Eupolymnia heterobranchia*	1	-	-	-	-	-	1	0.04
AN	*Hesionella mccullochae*	-	-	1	-	-	-	1	0.04
AN	*Lumbrineris japonica*	1	-	-	-	-	-	1	0.04
AN	Maldanidae	-	1	-	-	-	-	1	0.04
AN	*Nereis latescens*	-	-	1	-	-	-	1	0.04
AN	*Onuphis eremita parva*	-	-	-	-	-	1	1	0.04
AN	*Ophryotrocha* sp	-	-	1	-	-	-	1	0.04
AN	*Paraprionospio pinnata*	-	1	-	-	-	-	1	0.04
AN	*Phyllodoce longipes*	-	-	-	-	-	1	1	0.04
AN	*Poecilochaetus johnsoni*	1	-	-	-	-	-	1	0.04
AN	*Scolelepis squamata*	-	-	1	-	-	-	1	0.04
AN	*Sphaerosyllis californiensis*	1	-	-	-	-	-	1	0.04
AR	*Cerapus tubularis* Cmplx	-	-	-	1	-	-	1	0.04
AR	Gammaridea	-	-	1	-	-	-	1	0.04
AR	*Incisocalliope bairdi*	1	-	-	-	-	-	1	0.04

Appendix F-2. Infauna results by station. Ormond Beach Generating Station NPDES, 2007.

Phylum	Species	Station B1	B2	B3	B4	B5	B6	Total	Percent Total
AR	*Ischyrocerus pelagops*	-	-	-	1	-	-	1	0.04
AR	*Lepidopa californica*	-	-	-	-	-	1	1	0.04
AR	Oedicerotidae	-	-	1	-	-	-	1	0.04
AR	*Photis bifurcata*	1	-	-	-	-	-	1	0.04
AR	*Rhepoxynius* sp	-	-	1	-	-	-	1	0.04
BC	*Glottidia albida*	-	-	-	-	1	-	1	0.04
CN	*Edwardsia* sp G MEC 1992	-	-	-	-	1	-	1	0.04
CN	Pennatulacea	1	-	-	-	-	-	1	0.04
EC	*Amphiodia digitata*	-	1	-	-	-	-	1	0.04
KI	Kinorhyncha	-	-	-	-	1	-	1	0.04
MO	*Armina californica*	-	1	-	-	-	-	1	0.04
MO	*Ensis myrae*	-	1	-	-	-	-	1	0.04
MO	*Epitonium sawinae*	-	-	-	1	-	-	1	0.04
MO	*Epitonium* sp	-	-	1	-	-	-	1	0.04
MO	*Hermissenda crassicornis*	-	-	1	-	-	-	1	0.04
MO	*Lyonsia californica*	1	-	-	-	-	-	1	0.04
MO	Mytilidae	-	-	1	-	-	-	1	0.04
MO	*Nassarius perpinguis*	-	-	1	-	-	-	1	0.04
MO	*Neverita reclusiana*	-	-	-	-	-	1	1	0.04
MO	*Odostomia minutissima*	-	-	1	-	-	-	1	0.04
MO	*Odostomia* sp D MBC 1980	1	-	-	-	-	-	1	0.04
MO	*Ophiodermella inermis*	1	-	-	-	-	-	1	0.04
MO	*Periploma discus*	-	-	-	1	-	-	1	0.04
MO	*Polygireulima rutila*	1	-	-	-	-	-	1	0.04
NE	*Amphiporus bimaculatus*	-	-	-	-	-	1	1	0.04
NE	*Tetrastemma nigrifrons*	-	1	-	-	-	-	1	0.04
NE	*Tetrastemma* sp A SCAMIT 1995	-	-	1	-	-	-	1	0.04
NE	*Tubulanus cingulatus*	1	-	-	-	-	-	1	0.04
NE	*Tubulanus nothus*	1	-	-	-	-	-	1	0.04
NE	*Zygonemertes virescens*	-	-	1	-	-	-	1	0.04
PL	*Imogine exiguus*	-	1	-	-	-	-	1	0.04
PL	*Stylochoplana* sp	-	1	-	-	-	-	1	0.04
PR	*Phoronopsis* sp	-	1	-	-	-	-	1	0.04
SI	*Siphonosoma ingens*	-	-	1	-	-	-	1	0.04
SI	Sipuncula	-	-	-	-	1	-	1	0.04
	Number of individuals	479	635	416	317	355	186	2388	
	Number of species	75	77	77	71	60	43	165	
	Diversity (H')	3.07	3.08	3.47	3.60	3.20	3.15	3.62	

Appendix F-3. Infauna data by station and replicate. Ormond Beach Generating Station NPDES, 2007.

Station B1

Phylum	Species	Replicate B1-I	B1-II	B1-III	B1-IV	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	28	25	17	84	154	32.15	3850.0
MO	*Cooperella subdiaphana*	7	9	3	13	32	6.68	800.0
AN	*Mediomastus acutus*	11	7	8	4	30	6.26	750.0
AN	*Onuphis* sp 1 Pt. Loma 1983	7	8	4	10	29	6.05	725.0
MO	*Siliqua lucida*	3	9	4	4	20	4.18	500.0
AN	*Exogone lourei*	1	12	-	1	14	2.92	350.0
NE	Lineidae	3	4	2	5	14	2.92	350.0
EC	*Dendraster excentricus*	-	8	2	3	13	2.71	325.0
AN	*Owenia collaris*	1	5	-	4	10	2.09	250.0
AN	*Mediomastus ambiseta*	6	1	1	1	9	1.88	225.0
MO	*Tellina modesta*	3	-	1	5	9	1.88	225.0
AR	*Rhepoxynius menziesi*	2	3	-	3	8	1.67	200.0
NT	Nematoda	-	3	3	2	8	1.67	200.0
AN	*Syllis (Typosyllis) farallonensis*	2	1	2	2	7	1.46	175.0
AR	*Zeugophilomedes oblonga*	-	2	1	4	7	1.46	175.0
NE	*Tubulanus polymorphus*	-	4	-	3	7	1.46	175.0
AN	*Goniada littorea*	3	1	1	1	6	1.25	150.0
AN	*Pectinaria californiensis*	-	3	1	2	6	1.25	150.0
AN	*Spiophanes bombyx*	1	-	4	1	6	1.25	150.0
AR	*Aoroides inermis*	-	-	-	6	6	1.25	150.0
AR	*Diastylopsis tenuis*	1	2	-	3	6	1.25	150.0
AN	*Armandia brevis*	-	1	1	3	5	1.04	125.0
AN	*Glycera macrobranchia*	-	-	2	3	5	1.04	125.0
AN	*Brania brevipharyngea*	-	-	-	4	4	0.84	100.0
AN	*Monticellina cryptica*	3	-	1	-	4	0.84	100.0
AR	*Edotia sublittoralis*	-	3	-	-	3	0.63	75.0
AN	*Chone mollis*	-	-	-	2	2	0.42	50.0
AN	*Eumida longicornuta*	-	-	-	2	2	0.42	50.0
AN	*Spiochaetopterus costarum*	1	-	-	1	2	0.42	50.0
AR	*Cyclaspis* sp C SCAMIT 1986	-	2	-	-	2	0.42	50.0
AR	*Rhepoxynius abronius*	-	1	-	1	2	0.42	50.0
AR	*Uromunna ubiquita*	1	1	-	-	2	0.42	50.0
NE	*Carinoma mutabilis*	1	1	-	-	2	0.42	50.0
PR	*Phoronis* sp	1	1	-	-	2	0.42	50.0
AN	*Ampharete labrops*	-	-	-	1	1	0.21	25.0
AN	*Chaetozone setosa* Cmplx	-	-	-	1	1	0.21	25.0
AN	*Chone* sp SD1 Pt. Loma 1997	-	-	1	-	1	0.21	25.0
AN	*Dipolydora socialis*	-	-	-	1	1	0.21	25.0
AN	*Eupolymnia heterobranchia*	-	-	-	1	1	0.21	25.0
AN	*Goniada maculata*	-	1	-	-	1	0.21	25.0
AN	*Leitoscoloplos pugettensis*	1	-	-	-	1	0.21	25.0
AN	*Lumbrineris japonica*	-	1	-	-	1	0.21	25.0
AN	*Magelona sacculata*	-	1	-	-	1	0.21	25.0
AN	*Neosabellaria cementarium*	-	-	-	1	1	0.21	25.0
AN	*Phyllodoce hartmanae*	-	1	-	-	1	0.21	25.0
AN	*Pista disjuncta*	1	-	-	-	1	0.21	25.0
AN	*Poecilochaetus johnsoni*	-	-	1	-	1	0.21	25.0
AN	*Scoletoma* sp	-	-	-	1	1	0.21	25.0
AN	*Sigalion spinosus*	-	1	-	-	1	0.21	25.0
AN	*Sphaerosyllis californiensis*	-	-	-	1	1	0.21	25.0
AN	*Spiophanes berkeleyorum*	-	1	-	-	1	0.21	25.0
AN	*Spiophanes duplex*	-	-	1	-	1	0.21	25.0
AR	*Ampelisca agassizi*	-	-	1	-	1	0.21	25.0
AR	*Anchicolurus occidentalis*	1	-	-	-	1	0.21	25.0
AR	*Euphilomedes carcharodonta*	-	1	-	-	1	0.21	25.0
AR	*Foxiphalus obtusidens*	-	-	-	1	1	0.21	25.0
AR	*Incisocalliope bairdi*	-	-	-	1	1	0.21	25.0
AR	*Lamprops quadriplicatus*	-	1	-	-	1	0.21	25.0
AR	*Photis bifurcata*	-	-	-	1	1	0.21	25.0
AR	*Photis brevipes*	-	-	-	1	1	0.21	25.0

Appendix F-3. Infauna data by station and replicate. Ormond Beach Generating Station NPDES, 2007.

Station B1

Phylum	Species	Replicate B1-I	B1-II	B1-III	B1-IV	Total	Percent Composition	Density No./m²
AR	*Rutiderma judayi*	1	-	-	-	1	0.21	25.0
AR	*Rutiderma rostratum*	-	-	-	1	1	0.21	25.0
CN	Actiniaria sp A Paquette 2005	-	-	1	-	1	0.21	25.0
CN	Pennatulacea	-	1	-	-	1	0.21	25.0
MO	*Lyonsia californica*	-	-	-	1	1	0.21	25.0
MO	*Macoma* sp	-	-	-	1	1	0.21	25.0
MO	*Odostomia* sp D MBC 1980	-	-	-	1	1	0.21	25.0
MO	*Ophiodermella inermis*	-	1	-	-	1	0.21	25.0
MO	*Polygireulima rutila*	-	-	-	1	1	0.21	25.0
MO	*Rochefortia compressa*	1	-	-	-	1	0.21	25.0
MO	*Rochefortia tumida*	-	-	-	1	1	0.21	25.0
NE	Hoplonemertea sp A Paquette 1988	-	-	1	-	1	0.21	25.0
NE	*Paranemertes californica*	-	-	-	1	1	0.21	25.0
NE	*Tubulanus cingulatus*	-	1	-	-	1	0.21	25.0
NE	*Tubulanus nothus*	-	1	-	-	1	0.21	25.0

Summary

Parameter	Replicate B1-I	B1-II	B1-III	B1-IV	Station Total	Overall Mean	S.D.
Number of individuals	91	129	64	195	479	119.8	56.8
Number of species	25	37	24	46	75	33.0	10.5
Diversity (H')	2.57	3.05	2.70	2.66	3.07	2.74	0.21

Appendix F-3. (Cont.).

Station B2

Phylum	Species	Replicate B2-I	B2-II	B2-III	B2-IV	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	10	26	39	108	183	28.82	4575.0
MO	*Siliqua lucida*	9	15	22	11	57	8.98	1425.0
MO	*Tellina modesta*	13	8	10	10	41	6.46	1025.0
AN	*Mediomastus acutus*	10	7	13	6	36	5.67	900.0
MO	*Cooperella subdiaphana*	6	7	9	13	35	5.51	875.0
EC	*Dendraster excentricus*	3	7	11	6	27	4.25	675.0
NE	Lineidae	3	8	7	7	25	3.94	625.0
AN	*Onuphis* sp 1 Pt. Loma 1983	4	8	5	3	20	3.15	500.0
AR	*Diastylopsis tenuis*	7	1	3	6	17	2.68	425.0
NE	*Tubulanus polymorphus*	-	7	1	5	13	2.05	325.0
AN	*Armandia brevis*	-	8	1	3	12	1.89	300.0
AN	*Spiophanes bombyx*	3	3	4	1	11	1.73	275.0
AN	*Pectinaria californiensis*	1	-	-	8	9	1.42	225.0
AN	*Scoletoma* spp	3	2	2	2	9	1.42	225.0
AN	*Syllis (Ehlersia) heterochaeta*	2	2	2	1	7	1.10	175.0
AR	*Cumella californica*	2	4	-	1	7	1.10	175.0
AR	*Cyclaspis* sp C SCAMIT 1986	-	-	7	-	7	1.10	175.0
AR	*Rhepoxynius menziesi*	4	1	1	-	6	0.94	150.0
NE	*Carinoma mutabilis*	-	1	2	3	6	0.94	150.0
AN	*Ampharete labrops*	-	4	1	-	5	0.79	125.0
AR	*Zeugophilomedes oblonga*	-	-	4	1	5	0.79	125.0
NT	Nematoda	-	1	2	2	5	0.79	125.0
AN	*Chone mollis*	-	2	-	2	4	0.63	100.0
AR	*Rhepoxynius abronius*	2	-	-	2	4	0.63	100.0
NE	*Paranemertes californica*	-	1	1	2	4	0.63	100.0
AN	*Glycera macrobranchia*	-	1	1	1	3	0.47	75.0
AN	*Mediomastus ambiseta*	-	1	2	-	3	0.47	75.0
AN	*Spiophanes duplex*	-	3	-	-	3	0.47	75.0
AR	*Ampelisca cristata cristata*	1	-	1	1	3	0.47	75.0
MO	*Macoma* sp	-	-	1	2	3	0.47	75.0
MO	*Macoma yoldiformis*	2	-	1	-	3	0.47	75.0
AN	*Chaetozone setosa* Cmplx	-	1	1	-	2	0.31	50.0
AN	*Leitoscoloplos pugettensis*	-	-	1	1	2	0.31	50.0
AN	*Magelona pitelkai*	1	1	-	-	2	0.31	50.0
AN	*Monticellina cryptica*	-	-	1	1	2	0.31	50.0
AN	*Nephtys caecoides*	-	-	2	-	2	0.31	50.0
AN	*Sphaerephesia similisetis*	-	-	2	-	2	0.31	50.0
AN	*Spiochaetopterus costarum*	-	2	-	-	2	0.31	50.0
AN	*Spiophanes berkeleyorum*	-	1	1	-	2	0.31	50.0
AN	*Syllis (Typosyllis) farallonensis*	2	-	-	-	2	0.31	50.0
AN	*Tenonia priops*	-	1	-	1	2	0.31	50.0
AR	*Ampelisca agassizi*	-	-	1	1	2	0.31	50.0
AR	*Anoropallene palpida*	-	1	1	-	2	0.31	50.0
AR	*Euphilomedes carcharodonta*	2	-	-	-	2	0.31	50.0
AR	*Photis macinerneyi*	-	1	1	-	2	0.31	50.0
CN	Actiniaria sp A Paquette 2005	1	-	1	-	2	0.31	50.0
MO	*Macoma secta*	-	-	-	2	2	0.31	50.0
AN	*Amphicteis scaphobranchiata*	-	-	1	-	1	0.16	25.0
AN	*Glycinde armigera*	-	-	-	1	1	0.16	25.0
AN	*Heteropodarke heteromorpha*	-	1	-	-	1	0.16	25.0
AN	*Magelona sacculata*	-	-	-	1	1	0.16	25.0
AN	Maldanidae	-	1	-	-	1	0.16	25.0
AN	*Nephtys cornuta*	-	-	-	1	1	0.16	25.0
AN	*Owenia collaris*	-	-	1	-	1	0.16	25.0
AN	*Paraprionospio pinnata*	1	-	-	-	1	0.16	25.0
AN	*Podarkeopsis glabrus*	-	-	1	-	1	0.16	25.0
AN	*Scoloplos armiger* Cmplx	-	-	-	1	1	0.16	25.0
AR	*Acuminodeutopus heteruropus*	-	-	1	-	1	0.16	25.0
AR	*Americhelidium shoemakeri*	-	-	1	-	1	0.16	25.0
AR	*Asteropella slatteryi*	-	-	1	-	1	0.16	25.0

Appendix F-3. (Cont.).

Station B2

Phylum	Species	Replicate B2-I	B2-II	B2-III	B2-IV	Total	Percent Composition	Density No./m²
AR	*Campylaspis* sp C Myers & Benedict 1974	-	1	-	-	1	0.16	25.0
AR	*Edotia sublittoralis*	1	-	-	-	1	0.16	25.0
AR	*Ericthonius brasiliensis*	-	-	-	1	1	0.16	25.0
AR	*Hartmanodes hartmanae*	-	-	1	-	1	0.16	25.0
AR	*Lamprops quadriplicatus*	-	-	1	-	1	0.16	25.0
AR	*Rutiderma rostratum*	-	1	-	-	1	0.16	25.0
EC	*Amphiodia digitata*	-	1	-	-	1	0.16	25.0
EC	*Amphiodia psara*	1	-	-	-	1	0.16	25.0
MO	*Armina californica*	-	1	-	-	1	0.16	25.0
MO	*Ensis myrae*	1	-	-	-	1	0.16	25.0
MO	*Olivella baetica*	-	1	-	-	1	0.16	25.0
NE	Nemertea	-	1	-	-	1	0.16	25.0
NE	*Tetrastemma nigrifrons*	-	1	-	-	1	0.16	25.0
PL	*Imogine exiguus*	-	1	-	-	1	0.16	25.0
PL	*Stylochoplana* sp	-	1	-	-	1	0.16	25.0
PR	*Phoronis* sp	-	-	1	-	1	0.16	25.0
PR	*Phoronopsis* sp	-	1	-	-	1	0.16	25.0

Summary

Parameter	Replicate B2-I	B2-II	B2-III	B2-IV	Station Total	Overall Mean	S.D.
Number of individuals	95	148	174	218	635	158.8	51.4
Number of species	26	43	45	35	77	37.3	8.7
Diversity (H')	2.91	3.18	3.02	2.27	3.08	2.84	0.40

Appendix F-3. (Cont.).

Station B3

Phylum	Species	Replicate B3-I	B3-II	B3-III	B3-IV	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	10	15	23	37	85	20.43	2125.0
AR	*Ericthonius brasiliensis*	5	9	9	6	29	6.97	725.0
AN	*Onuphis* sp 1 Pt. Loma 1983	9	6	1	12	28	6.73	700.0
NE	Lineidae	5	2	7	5	19	4.57	475.0
AR	*Jassa slatteryi*	-	-	6	11	17	4.09	425.0
AN	*Prionospio (Minuspio) lighti*	-	15	-	1	16	3.85	400.0
AN	*Scoletoma* spp	10	-	1	3	14	3.37	350.0
AR	*Podocerus brasiliensis*	-	4	7	3	14	3.37	350.0
AR	*Cyclaspis* sp C SCAMIT 1986	6	1	3	2	12	2.88	300.0
AR	*Stenothoe estacola*	-	3	4	4	11	2.64	275.0
EC	*Dendraster excentricus*	2	-	4	5	11	2.64	275.0
MO	*Tellina modesta*	-	1	5	3	9	2.16	225.0
NT	Nematoda	1	-	1	7	9	2.16	225.0
AN	*Chone* sp SD1 Pt. Loma 1997	1	1	2	4	8	1.92	200.0
AN	*Scoletoma tetraura* Cmplx	-	3	3	1	7	1.68	175.0
AR	*Laticorophium baconi*	-	1	-	6	7	1.68	175.0
AR	*Foxiphalus obtusidens*	-	-	6	-	6	1.44	150.0
AN	*Mediomastus acutus*	2	1	1	1	5	1.20	125.0
AN	*Notomastus hemipodus*	-	1	-	4	5	1.20	125.0
AR	*Diastylopsis tenuis*	1	1	2	1	5	1.20	125.0
AR	*Rhepoxynius menziesi*	1	-	3	1	5	1.20	125.0
AN	*Armandia brevis*	-	1	2	1	4	0.96	100.0
AN	*Owenia collaris*	-	-	2	2	4	0.96	100.0
AN	*Phyllodoce hartmanae*	1	1	-	2	4	0.96	100.0
AR	*Photis brevipes*	-	-	-	4	4	0.96	100.0
AR	*Rhepoxynius abronius*	1	-	3	-	4	0.96	100.0
MO	*Cooperella subdiaphana*	-	-	2	2	4	0.96	100.0
MO	*Siliqua lucida*	1	-	-	3	4	0.96	100.0
AN	*Ampharete labrops*	1	-	2	-	3	0.72	75.0
AN	*Goniada littorea*	1	1	-	1	3	0.72	75.0
AN	*Spiophanes bombyx*	1	-	1	1	3	0.72	75.0
AR	*Americhelidium shoemakeri*	-	1	2	-	3	0.72	75.0
AN	*Chaetozone setosa* Cmplx	2	-	-	-	2	0.48	50.0
AN	*Podarkeopsis glabrus*	-	2	-	-	2	0.48	50.0
AN	*Spiophanes duplex*	-	1	-	1	2	0.48	50.0
AR	*Photis macinerneyi*	-	1	-	1	2	0.48	50.0
AR	*Uromunna ubiquita*	-	-	2	-	2	0.48	50.0
CN	Actiniaria	1	-	-	1	2	0.48	50.0
CN	*Zaolutus actius*	-	-	2	-	2	0.48	50.0
EC	*Amphiodia psara*	1	-	1	-	2	0.48	50.0
MO	*Olivella baetica*	1	-	-	1	2	0.48	50.0
AN	*Aricidea (Acmira) catherinae*	1	-	-	-	1	0.24	25.0
AN	*Chone mollis*	1	-	-	-	1	0.24	25.0
AN	*Demonax* sp	1	-	-	-	1	0.24	25.0
AN	*Diopatra ornata*	-	-	1	-	1	0.24	25.0
AN	*Dipolydora socialis*	-	-	1	-	1	0.24	25.0
AN	*Exogone lourei*	-	1	-	-	1	0.24	25.0
AN	*Glycera macrobranchia*	1	-	-	-	1	0.24	25.0
AN	*Glycinde armigera*	-	-	1	-	1	0.24	25.0
AN	*Hesionella mccullochae*	-	-	-	1	1	0.24	25.0
AN	*Magelona pitelkai*	-	1	-	-	1	0.24	25.0
AN	*Monticellina cryptica*	-	-	-	1	1	0.24	25.0
AN	*Nereis latescens*	-	-	1	-	1	0.24	25.0
AN	*Ophryotrocha* sp	-	-	-	1	1	0.24	25.0
AN	*Pectinaria californiensis*	-	1	-	-	1	0.24	25.0
AN	*Scolelepis squamata*	-	-	1	-	1	0.24	25.0
AN	*Spiochaetopterus costarum*	-	-	1	-	1	0.24	25.0
AN	*Spiophanes berkeleyorum*	-	-	1	-	1	0.24	25.0
AN	*Syllis (Ehlersia) heterochaeta*	-	-	1	-	1	0.24	25.0
AR	*Campylaspis* sp C Myers & Benedict 1974	-	-	1	-	1	0.24	25.0
AR	*Edotia sublittoralis*	-	-	-	1	1	0.24	25.0
AR	Gammaridea	-	-	1	-	1	0.24	25.0
AR	*Hartmanodes hartmanae*	-	-	-	1	1	0.24	25.0
AR	*Lamprops quadriplicatus*	1	-	-	-	1	0.24	25.0
AR	Oedicerotidae	1	-	-	-	1	0.24	25.0

Appendix F-3. (Cont.).

Station B3

Phylum	Species	Replicate B3-I	B3-II	B3-III	B3-IV	Total	Percent Composition	Density No./m²
AR	*Parasterope hulingsi*	-	1	-	-	1	0.24	25.0
AR	*Rhepoxynius* sp	1	-	-	-	1	0.24	25.0
MO	*Epitonium* sp	-	-	1	-	1	0.24	25.0
MO	*Hermissenda crassicornis*	-	1	-	-	1	0.24	25.0
MO	Mytilidae	-	-	1	-	1	0.24	25.0
MO	*Nassarius perpinguis*	-	-	1	-	1	0.24	25.0
MO	*Odostomia minutissima*	-	-	-	1	1	0.24	25.0
MO	*Rochefortia tumida*	-	-	1	-	1	0.24	25.0
NE	*Carinoma mutabilis*	-	-	1	-	1	0.24	25.0
NE	*Tetrastemma* sp A SCAMIT 1995	-	-	1	-	1	0.24	25.0
NE	*Zygonemertes virescens*	-	-	1	-	1	0.24	25.0
SI	*Siphonosoma ingens*	1	-	-	-	1	0.24	25.0

Summary

Parameter	Replicate B3-I	B3-II	B3-III	B3-IV	Station Total	Overall Mean	S.D.
Number of individuals	72	77	124	143	416	104.0	35.0
Number of species	30	27	45	38	77	35.0	8.1
Diversity (H')	2.93	2.70	3.32	2.99	3.47	2.99	0.26

Appendix F-3. (Cont.).

Station B4

Phylum	Species	Replicate B4-I	B4-II	B4-III	B4-IV	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	5	19	6	26	56	17.67	1400.0
EC	*Dendraster excentricus*	11	2	3	3	19	5.99	475.0
AN	*Mediomastus acutus*	4	2	8	4	18	5.68	450.0
NE	Lineidae	1	9	1	5	16	5.05	400.0
AR	*Jassa slatteryi*	9	-	1	2	12	3.79	300.0
MO	*Tellina modesta*	1	1	7	2	11	3.47	275.0
AN	*Armandia brevis*	4	1	3	2	10	3.15	250.0
AN	*Onuphis* sp 1 Pt. Loma 1983	4	5	-	1	10	3.15	250.0
AR	*Podocerus brasiliensis*	4	3	1	1	9	2.84	225.0
AR	*Ericthonius brasiliensis*	3	1	4	-	8	2.52	200.0
NE	*Carinoma mutabilis*	2	1	2	3	8	2.52	200.0
AR	*Zeugophilomedes oblonga*	1	2	2	2	7	2.21	175.0
MO	*Cooperella subdiaphana*	2	-	3	2	7	2.21	175.0
MO	*Siliqua lucida*	1	2	3	1	7	2.21	175.0
AN	*Pectinaria californiensis*	1	3	1	1	6	1.89	150.0
AR	*Diastylopsis tenuis*	1	2	3	-	6	1.89	150.0
AN	*Spiophanes bombyx*	1	1	-	3	5	1.58	125.0
AN	*Syllis (Ehlersia) heterochaeta*	-	1	3	1	5	1.58	125.0
AR	*Rhepoxynius menziesi*	-	-	4	1	5	1.58	125.0
AR	*Anchicolurus occidentalis*	2	-	1	1	4	1.26	100.0
AR	*Photis macinerneyi*	1	-	3	-	4	1.26	100.0
EC	*Amphiodia psara*	1	-	2	1	4	1.26	100.0
MO	*Rochefortia tumida*	-	2	-	2	4	1.26	100.0
NE	*Paranemertes californica*	1	1	-	2	4	1.26	100.0
AN	*Sigalion spinosus*	1	-	1	1	3	0.95	75.0
AN	*Syllis (Typosyllis) farallonensis*	1	-	2	-	3	0.95	75.0
AR	*Gammaropsis thompsoni*	1	1	1	-	3	0.95	75.0
AR	*Laticorophium baconi*	3	-	-	-	3	0.95	75.0
AR	*Stenothoe estacola*	1	1	-	1	3	0.95	75.0
AN	*Chaetozone setosa* Cmplx	-	1	-	1	2	0.63	50.0
AN	*Demonax* sp	1	-	1	-	2	0.63	50.0
AN	*Goniada littorea*	-	-	2	-	2	0.63	50.0
AN	*Mediomastus ambiseta*	-	1	-	1	2	0.63	50.0
AN	*Owenia collaris*	-	-	-	2	2	0.63	50.0
AN	*Pista disjuncta*	-	-	1	1	2	0.63	50.0
AN	*Sphaerephesia similisetis*	-	1	-	1	2	0.63	50.0
AR	*Ampelisca agassizi*	-	-	-	2	2	0.63	50.0
AR	*Campylaspis* sp C Myers & Benedict 1974	2	-	-	-	2	0.63	50.0
AR	*Caprella verrucosa*	1	-	1	-	2	0.63	50.0
AR	*Foxiphalus obtusidens*	-	1	1	-	2	0.63	50.0
MO	*Macoma* sp	-	-	1	1	2	0.63	50.0
NE	Nemertea	-	2	-	-	2	0.63	50.0
NE	*Tubulanus polymorphus*	-	-	1	1	2	0.63	50.0
PR	*Phoronis* sp	-	2	-	-	2	0.63	50.0
AN	*Chone* sp SD1 Pt. Loma 1997	-	-	-	1	1	0.32	25.0
AN	*Chrysopetalum occidentale*	1	-	-	-	1	0.32	25.0
AN	*Exogone lourei*	-	1	-	-	1	0.32	25.0
AN	*Glycera macrobranchia*	-	1	-	-	1	0.32	25.0
AN	*Goniada maculata*	-	-	-	1	1	0.32	25.0
AN	*Heteropodarke heteromorpha*	-	-	1	-	1	0.32	25.0
AN	*Leitoscoloplos pugettensis*	-	-	-	1	1	0.32	25.0
AN	*Magelona pitelkai*	-	-	-	1	1	0.32	25.0
AN	*Neosabellaria cementarium*	-	-	1	-	1	0.32	25.0
AN	*Nephtys caecoides*	-	1	-	-	1	0.32	25.0
AN	*Nephtys cornuta*	1	-	-	-	1	0.32	25.0
AN	*Scoloplos armiger* Cmplx	-	-	-	1	1	0.32	25.0
AN	*Spiochaetopterus costarum*	1	-	-	-	1	0.32	25.0
AN	*Spiophanes duplex*	-	-	-	1	1	0.32	25.0
AR	*Acuminodeutopus heteruropus*	1	-	-	-	1	0.32	25.0
AR	*Cerapus tubularis* Cmplx	-	-	1	-	1	0.32	25.0

Appendix F-3. (Cont.).

Station B4

Phylum	Species	Replicate B4-I	B4-II	B4-III	B4-IV	Total	Percent Composition	Density No./m²
AR	*Cumella californica*	1	-	-	-	1	0.32	25.0
AR	*Cyclaspis* sp C SCAMIT 1986	-	1	-	-	1	0.32	25.0
AR	*Edotia sublittoralis*	-	1	-	-	1	0.32	25.0
AR	*Euphilomedes carcharodonta*	-	-	1	-	1	0.32	25.0
AR	*Ischyrocerus pelagops*	1	-	-	-	1	0.32	25.0
AR	*Photis brevipes*	1	-	-	-	1	0.32	25.0
CN	*Actiniaria* sp A Paquette 2005	-	1	-	-	1	0.32	25.0
MO	*Epitonium sawinae*	-	-	1	-	1	0.32	25.0
MO	*Periploma discus*	-	1	-	-	1	0.32	25.0
MO	*Rochefortia compressa*	-	-	-	1	1	0.32	25.0
NE	*Micrura* sp	-	-	1	-	1	0.32	25.0

Summary

Parameter	Replicate B4-I	B4-II	B4-III	B4-IV	Station Total	Overall Mean	S.D.
Number of individuals	78	75	79	85	317	79.3	4.2
Number of species	36	33	36	38	71	35.8	2.1
Diversity (H')	3.22	2.96	3.33	3.02	3.60	3.13	0.17

Appendix F-3. (Cont.).

Station B5

Phylum	Species	Replicate B5-I	B5-II	B5-III	B5-IV	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	17	28	16	39	100	28.17	2500.0
AN	*Mediomastus acutus*	13	4	4	3	24	6.76	600.0
AR	*Ericthonius brasiliensis*	3	2	1	10	16	4.51	400.0
EC	*Dendraster excentricus*	2	2	2	9	15	4.23	375.0
AN	*Monticellina cryptica*	1	3	6	2	12	3.38	300.0
MO	*Tellina modesta*	3	2	1	6	12	3.38	300.0
AN	*Exogone lourei*	4	3	1	3	11	3.10	275.0
AR	*Diastylopsis tenuis*	1	6	3	1	11	3.10	275.0
AN	*Onuphis* sp 1 Pt. Loma 1983	1	2	5	1	9	2.54	225.0
MO	*Cooperella subdiaphana*	2	2	3	2	9	2.54	225.0
AN	*Goniada littorea*	2	2	2	2	8	2.25	200.0
AR	*Acuminodeutopus heteruropus*	-	1	1	6	8	2.25	200.0
AN	*Syllis (Typosyllis) farallonensis*	1	1	3	2	7	1.97	175.0
AR	*Jassa slatteryi*	4	1	-	2	7	1.97	175.0
MO	*Siliqua lucida*	-	-	-	7	7	1.97	175.0
NE	Lineidae	4	-	-	3	7	1.97	175.0
AN	*Armandia brevis*	2	1	-	2	5	1.41	125.0
AN	*Chaetozone setosa* Cmplx	-	1	1	3	5	1.41	125.0
AR	*Stenothoe estacola*	5	-	-	-	5	1.41	125.0
NE	*Carinoma mutabilis*	-	3	2	-	5	1.41	125.0
AN	*Chone* sp SD1 Pt. Loma 1997	-	1	2	1	4	1.13	100.0
AN	*Spiophanes bombyx*	1	-	1	2	4	1.13	100.0
AN	*Spiophanes duplex*	2	-	1	1	4	1.13	100.0
AR	*Rhepoxynius menziesi*	4	-	-	-	4	1.13	100.0
AN	*Glycera macrobranchia*	1	-	-	2	3	0.85	75.0
AN	*Scoletoma* spp	2	1	-	-	3	0.85	75.0
AR	*Ampelisca agassizi*	-	-	-	3	3	0.85	75.0
AR	*Cyclaspis* sp C SCAMIT 1986	-	1	-	2	3	0.85	75.0
AR	*Podocerus brasiliensis*	2	-	-	1	3	0.85	75.0
AR	*Rhepoxynius abronius*	-	-	2	1	3	0.85	75.0
NT	Nematoda	1	-	-	2	3	0.85	75.0
AN	*Leitoscoloplos pugettensis*	1	1	-	-	2	0.56	50.0
AR	*Deutella californica*	2	-	-	-	2	0.56	50.0
AR	*Laticorophium baconi*	2	-	-	-	2	0.56	50.0
MO	*Macoma* sp	1	-	1	-	2	0.56	50.0
NE	*Tubulanus polymorphus*	1	-	1	-	2	0.56	50.0
PR	*Phoronis* sp	-	1	1	-	2	0.56	50.0
AN	*Arabella endonata*	-	-	1	-	1	0.28	25.0
AN	*Demonax* sp	1	-	-	-	1	0.28	25.0
AN	*Dipolydora bidentata*	-	-	-	1	1	0.28	25.0
AN	*Glycinde armigera*	-	-	-	1	1	0.28	25.0
AN	*Phyllodoce hartmanae*	-	1	-	-	1	0.28	25.0
AN	*Podarkeopsis glabrus*	-	-	-	1	1	0.28	25.0
AR	*Americhelidium shoemakeri*	-	-	1	-	1	0.28	25.0
AR	*Asteropella slatteryi*	1	-	-	-	1	0.28	25.0
AR	*Edotia sublittoralis*	-	-	-	1	1	0.28	25.0
AR	*Gammaropsis thompsoni*	1	-	-	-	1	0.28	25.0
AR	*Hartmanodes hartmanae*	-	-	-	1	1	0.28	25.0
AR	*Lamprops quadriplicatus*	-	-	-	1	1	0.28	25.0
AR	*Rutiderma judayi*	1	-	-	-	1	0.28	25.0
AR	*Rutiderma rostratum*	-	1	-	-	1	0.28	25.0
AR	*Zeugophilomedes oblonga*	1	-	-	-	1	0.28	25.0
BC	*Glottidia albida*	-	-	-	1	1	0.28	25.0
CN	*Edwardsia* sp G MEC 1992	-	-	1	-	1	0.28	25.0
KI	Kinorhyncha	1	-	-	-	1	0.28	25.0

Appendix F-3. (Cont.).

Station B5

Phylum	Species	Replicate B5-I	B5-II	B5-III	B5-IV	Total	Percent Composition	Density No./m²
MO	*Macoma secta*	-	-	-	1	1	0.28	25.0
MO	*Rochefortia tumida*	-	-	1	-	1	0.28	25.0
NE	Hoplonemertea sp A Paquette 1988	-	-	-	1	1	0.28	25.0
NE	*Micrura* sp	-	-	1	-	1	0.28	25.0
SI	Sipuncula	-	-	-	1	1	0.28	25.0

Summary

Parameter	Replicate B5-I	B5-II	B5-III	B5-IV	Station Total	Overall Mean	S.D.
Number of individuals	91	71	65	128	355	88.8	28.4
Number of species	34	24	27	37	60	30.5	6.0
Diversity (H')	3.07	2.46	2.86	2.89	3.20	2.82	0.26

Appendix F-3. (Cont.).

Station B6

Phylum	Species	Replicate B6-I	B6-II	B6-III	B6-IV	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	9	4	7	3	23	12.37	575.0
AR	*Rhepoxynius menziesi*	1	9	3	8	21	11.29	525.0
AN	*Mediomastus acutus*	1	10	4	1	16	8.60	400.0
AR	*Photis macinerneyi*	5	1	4	5	15	8.06	375.0
AR	*Rhepoxynius abronius*	4	4	1	4	13	6.99	325.0
MO	*Tellina modesta*	1	2	5	5	13	6.99	325.0
MO	*Siliqua lucida*	-	1	4	6	11	5.91	275.0
EC	*Dendraster excentricus*	2	1	5	1	9	4.84	225.0
AN	*Chone* sp SD1 Pt. Loma 1997	1	1	2	3	7	3.76	175.0
AN	*Goniada littorea*	2	-	1	1	4	2.15	100.0
AN	*Syllis (Typosyllis) farallonensis*	1	1	1	1	4	2.15	100.0
AR	*Americhelidium shoemakeri*	1	-	1	1	3	1.61	75.0
AR	*Diastylopsis tenuis*	-	-	2	1	3	1.61	75.0
AR	*Euphilomedes longiseta*	-	-	1	2	3	1.61	75.0
AR	*Rhepoxynius* sp A SCAMIT 1987	-	-	-	3	3	1.61	75.0
NE	*Tetrastemma candidum*	1	-	1	1	3	1.61	75.0
AN	*Dispio uncinata*	-	-	1	1	2	1.08	50.0
AN	*Lumbrineris californiensis*	-	-	1	1	2	1.08	50.0
AN	*Pista disjuncta*	-	-	2	-	2	1.08	50.0
AR	*Gibberosus myersi*	-	1	-	1	2	1.08	50.0
MO	*Cooperella subdiaphana*	1	-	1	-	2	1.08	50.0
MO	*Rochefortia tumida*	-	1	1	-	2	1.08	50.0
MO	*Solen sicarius*	-	-	1	1	2	1.08	50.0
NE	*Paranemertes californica*	1	1	-	-	2	1.08	50.0
AN	*Ampharete labrops*	-	1	-	-	1	0.54	25.0
AN	*Armandia brevis*	-	-	1	-	1	0.54	25.0
AN	*Exogone lourei*	-	-	1	-	1	0.54	25.0
AN	*Onuphis eremita parva*	-	1	-	-	1	0.54	25.0
AN	*Onuphis* sp 1 Pt. Loma 1983	1	-	-	-	1	0.54	25.0
AN	*Owenia collaris*	-	1	-	-	1	0.54	25.0
AN	*Phyllodoce longipes*	-	-	1	-	1	0.54	25.0
AN	*Scoloplos armiger* Cmplx	-	-	-	1	1	0.54	25.0
AN	*Spiophanes bombyx*	-	1	-	-	1	0.54	25.0
AN	*Syllis (Ehlersia) heterochaeta*	-	-	-	1	1	0.54	25.0
AR	*Hartmanodes hartmanae*	1	-	-	-	1	0.54	25.0
AR	*Lepidopa californica*	1	-	-	-	1	0.54	25.0
AR	*Parasterope hulingsi*	1	-	-	-	1	0.54	25.0
AR	*Uromunna ubiquita*	1	-	-	-	1	0.54	25.0
CN	Actiniaria sp A Paquette 2005	-	-	1	-	1	0.54	25.0
EC	*Amphiodia psara*	-	1	-	-	1	0.54	25.0
MO	*Neverita reclusiana*	-	1	-	-	1	0.54	25.0
NE	*Amphiporus bimaculatus*	-	1	-	-	1	0.54	25.0
NE	Lineidae	-	-	1	-	1	0.54	25.0

Summary

Parameter	Replicate B6-I	B6-II	B6-III	B6-IV	Station Total	Overall Mean	S.D.
Number of individuals	36	44	54	52	186	46.5	8.2
Number of species	19	20	26	22	43	21.8	3.1
Diversity (H')	2.58	2.53	2.99	2.79	3.15	2.72	0.21

Appendix F-4. Infaunal wet weight biomass data (g). Ormond Beach Generating Station NPDES, 2007.

Sta-Rep	Annelida	Arthropoda	Mollusca	Echinodermata	Misc.	Total
B1-I	0.4433	0.0287	0.0115	-	0.0430	0.5265
B1-II	0.1182	<0.0001	0.0533	<0.0001	<0.0001	0.1715
B1-III	0.2081	0.0095	<0.0001	0.0388	0.0422	0.2986
B1-IV	0.1756	0.0297	0.0576	<0.0001	<0.0001	0.2629
Total	0.9452	0.0679	0.1224	0.0388	0.0852	1.2595
B2-I	0.0353	0.0155	0.1624	0.0701	<0.0001	0.2833
B2-II	0.5506	<0.0001	0.0337	0.0605	0.1220	0.7668
B2-III	0.3469	<0.0001	<0.0001	0.0210	0.0192	0.3871
B2-IV	0.1709	<0.0001	<0.0001	<0.0001	0.1225	0.2934
Total	1.1037	0.0155	0.1961	0.1516	0.2637	1.7306
B3-I	0.7261	0.0102	0.0159	<0.0001	0.0329	0.7851
B3-II	0.4480	<0.0001	0.0049	-	0.0057	0.4586
B3-III	0.4087	0.0546	0.0108	0.0691	0.2197	0.7629
B3-IV	0.4561	0.0227	0.0078	0.0182	<0.0001	0.5048
Total	2.0389	0.0875	0.0394	0.0873	0.2583	2.5114
B4-I	0.4295	<0.0001	0.0310	<0.0001	<0.0001	0.4605
B4-II	0.4945	<0.0001	0.0559	<0.0001	0.0910	0.6414
B4-III	0.0992	0.1034	0.0187	0.0209	0.0715	0.3137
B4-IV	0.2252	0.0270	0.0263	0.3109	0.0793	0.6687
Total	1.2484	0.1304	0.1319	0.3318	0.2418	2.0843
B5-I	0.0613	0.1164	0.0219	<0.0001	0.0207	0.2203
B5-II	0.0522	0.0456	<0.0001	<0.0001	<0.0001	0.0978
B5-III	0.0724	0.0348	<0.0001	<0.0001	0.1388	0.2460
B5-IV	0.1200	0.0947	0.0433	<0.0001	<0.0001	0.2580
Total	0.3059	0.2915	0.0652	-	0.1595	0.8221
B6-I	0.1232	0.0383	0.0246	<0.0001	0.0352	0.2213
B6-II	0.0287	<0.0001	<0.0001	0.0055	0.0145	0.0487
B6-III	0.3607	<0.0001	0.0428	<0.0001	<0.0001	0.4035
B6-IV	0.3972	<0.0001	0.0353	<0.0001	<0.0001	0.4325
Total	0.9098	0.0383	0.1027	0.0055	0.0497	1.1060
Grand Total	6.5519	0.6311	0.6577	0.6150	1.0582	9.5139

Note: - = no animals

Appendix F-5. Yearly infaunal abundance. Ormond Beach Generating Station NPDES, 2007.

		Year																					%
Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	Total
NT	Nematoda	7	5	-	2	6	2	-	-	5	8375	-	5	24	6	15	61	17	10	8	25	8573	20.34
AN	*Apoprionospio pygmaea*	29	108	9	464	42	509	17	12	156	43	41	94	53	948	73	44	256	128	120	601	3747	8.89
AN	*Owenia collaris*	3	2	-	6	4	82	-	-	2	5	10	59	3275	111	2	1	1	1	2	18	3584	8.50
AR	*Diastylopsis tenuis*	306	110	28	80	59	23	1	19	62	67	1	391	728	136	108	10	54	32	209	48	2472	5.87
EC	*Dendraster excentricus*	8	11	7	9	9	-	4	5	33	1075	31	32	118	360	62	333	88	42	51	94	2372	5.63
AN	*Mediomastus acutus*	28	30	-	-	-	-	-	2	27	66	282	86	124	94	43	44	72	81	106	129	1214	2.88
MO	*Tellina modesta*	8	48	23	13	29	5	3	1	32	22	13	105	316	106	37	9	87	6	39	95	997	2.37
AR	*Rhepoxynius menziesi*	32	57	27	45	44	26	14	11	50	16	24	137	256	48	31	4	31	21	50	49	973	2.31
MO	*Siliqua lucida*	1	17	17	10	-	7	-	22	29	31	15	473	11	14	12	2	3	8	7	106	785	1.86
AN	*Pectinaria californiensis*	3	-	1	123	2	-	-	1	-	15	1	465	46	19	4	1	-	2	-	22	705	1.67
AN	*Spiophanes bombyx*	9	39	22	53	22	17	28	24	33	19	13	32	63	33	33	16	40	19	10	30	555	1.32
AN	*Armandia brevis*	1	2	-	1	-	3	-	-	3	-	1	23	3	324	9	61	18	26	5	37	517	1.23
NE	*Carinoma mutabilis*	-	4	9	12	13	13	32	10	20	43	22	16	19	54	43	25	58	29	69	22	513	1.22
AR	*Photis macinerneyi*	-	-	4	66	12	1	-	-	5	43	2	72	166	29	14	2	10	4	15	23	468	1.11
AN	*Magelona sacculata*	7	100	37	127	27	66	12	3	-	-	-	-	5	8	8	-	-	2	-	2	404	0.96
AR	*Gibberosus myersi*	7	3	4	9	5	18	-	-	11	11	2	31	140	37	30	3	39	6	19	2	377	0.89
AR	*Anchicolurus occidentalis*	5	6	7	15	10	12	3	1	15	17	1	98	123	13	13	2	2	14	4	5	366	0.87
AR	*Rhepoxynius abronius*	9	24	1	8	8	28	8	-	5	6	5	14	108	65	16	-	3	7	19	26	360	0.85
AN	*Aricidea (Acmira) catherinae*	26	70	6	18	10	12	21	5	12	8	2	11	9	39	19	5	20	33	15	1	342	0.81
AR	*Aoroides inermis*	-	-	-	-	-	-	-	-	-	-	-	188	43	60	22	3	-	5	-	6	327	0.78
AN	*Exogone lourei*	3	1	-	-	24	2	1	-	6	52	6	18	21	8	5	57	38	9	37	28	316	0.75
AR	*Photis brevipes*	6	-	-	-	3	2	-	-	5	1	15	106	122	14	11	15	-	-	3	6	309	0.73
AN	*Onuphis* sp 1 Pt. Loma 1983	-	-	-	-	-	-	-	-	-	35	13	7	17	24	10	8	11	35	49	97	306	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	292	0.69
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	0.60
MO	*Cooperella subdiaphana*	-	-	2	7	3	-	-	-	-	5	4	18	90	10	9	6	1	-	5	89	249	0.59
AN	*Chaetozone setosa* Cmplx	10	14	2	6	55	16	13	2	5	8	12	-	-	5	22	8	33	6	11	12	240	0.57
AR	*Jassa slatteryi*	-	-	-	-	9	-	-	-	-	-	-	93	86	4	-	-	5	6	-	36	239	0.57
NE	Lineidae	-	-	-	4	-	-	-	-	5	9	1	3	10	12	6	8	44	12	20	82	216	0.51
AN	*Capitella capitata* Cmplx	-	1	191	-	-	14	-	-	-	-	-	-	1	4	-	-	-	-	-	-	211	0.50
AR	*Isocheles pilosus*	1	4	3	9	3	-	-	-	-	-	-	1	176	-	-	-	-	-	-	-	197	0.47
AR	*Ericthonius brasiliensis*	-	-	-	-	-	-	-	-	-	-	-	130	3	6	2	1	-	-	-	54	196	0.47
AN	*Mediomastus* spp	2	20	-	37	34	6	3	-	-	13	46	12	6	-	-	-	-	-	-	-	179	0.42
AR	*Ampelisca agassizi*	-	1	1	16	64	10	2	-	4	3	-	1	5	4	45	1	7	3	2	8	177	0.42
AN	*Syllis (Typosyllis) farallonensis*	-	-	1	-	-	-	-	-	14	14	5	3	-	2	7	10	44	22	28	23	173	0.41
AR	*Americhelidium shoemakeri*	25	-	2	5	-	-	-	-	1	-	-	11	77	13	5	2	1	4	6	8	160	0.38
AN	*Nephtys caecoides*	8	7	4	10	13	8	5	2	12	4	3	18	16	6	7	7	4	12	3	3	152	0.36
MO	*Rochefortia tumida*	4	6	2	1	1	-	-	-	1	1	-	4	45	45	20	5	3	2	3	9	152	0.36
AN	*Magelona pitelkai*	1	68	-	3	9	23	4	1	3	2	-	-	3	11	3	-	-	7	-	4	142	0.34
NE	Nemertea	18	10	7	18	13	3	8	2	6	6	3	7	15	6	2	2	3	6	3	3	141	0.33
AR	*Uromunna ubiquita*	5	5	-	1	-	-	-	-	2	1	-	1	102	10	4	-	1	-	-	5	137	0.33
AN	*Spiophanes duplex*	-	31	-	52	3	4	-	7	2	1	8	-	3	5	1	1	2	3	2	11	136	0.32
AR	*Lamprops carinatus*	1	1	-	-	1	1	-	-	-	2	-	11	63	39	9	5	-	1	2	-	136	0.32
AR	*Jassa marmorata*	-	-	-	-	-	-	-	-	-	-	-	25	11	-	-	70	22	5	-	-	133	0.32
MO	*Modiolus* sp	-	-	-	-	1	-	-	-	1	-	8	16	92	6	2	7	-	-	-	-	133	0.32
AN	*Scoletoma tetraura* Cmplx	1	8	4	4	2	-	-	11	8	8	-	4	9	-	-	1	34	5	25	7	131	0.31
AN	*Spiochaetopterus costarum*	15	6	-	32	-	-	-	-	6	3	1	3	11	24	-	1	9	1	5	6	123	0.29
AN	*Glycera macrobranchia*	3	4	1	5	4	4	5	3	6	12	4	2	5	10	6	3	8	6	18	13	122	0.29
NE	*Tubulanus polymorphus*	-	-	1	2	3	11	-	-	4	5	1	1	21	23	2	8	1	5	9	24	121	0.29
AR	*Cumella californica*	-	1	-	-	-	-	-	-	3	17	-	6	39	9	5	2	14	3	6	8	113	0.27
NE	*Paranemertes californica*	-	3	-	4	5	-	-	-	4	6	8	5	21	18	2	-	14	1	11	11	113	0.27
AR	*Lamprops quadriplicatus*	1	1	-	1	2	3	-	-	20	8	-	19	11	5	22	-	5	4	5	4	111	0.26
AR	*Edotia sublittoralis*	3	1	3	1	2	6	-	1	10	12	1	10	35	8	1	-	6	2	-	7	109	0.26
AR	*Foxiphalus obtusidens*	1	-	-	-	1	-	-	-	4	2	-	33	20	7	5	6	4	6	6	9	104	0.25
AN	*Chone* sp SD1 Pt. Loma 1997	-	-	-	-	-	-	-	-	-	-	3	1	6	3	17	2	6	2	41	21	102	0.24
AN	*Syllis (Ehlersia) heterochaeta*	-	-	-	-	-	-	-	-	-	-	12	7	8	4	2	22	9	16	7	14	101	0.24
AR	*Zeugophilomedes oblonga*	-	-	-	1	2	-	-	-	-	-	-	-	8	3	6	10	23	3	25	20	101	0.24
PR	*Phoronis* sp	14	8	-	17	-	-	-	-	-	-	-	6	11	21	3	6	2	6	-	7	101	0.24
MO	*Mysella* sp H SCAMIT 2001	2	11	11	75	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	100	0.24
AR	*Cyclaspis* sp C SCAMIT 1986	-	1	-	2	-	2	-	-	-	9	-	8	4	3	1	2	21	4	17	25	99	0.23
AN	*Sigalion spinosus*	5	14	4	11	4	1	5	1	10	2	3	4	4	11	9	1	-	4	1	4	98	0.23
AR	*Caprella verrucosa*	-	-	-	-	-	-	-	-	-	-	-	-	96	-	-	-	-	-	-	2	98	0.23
AN	*Glycinde armigera*	-	-	1	11	2	-	-	-	5	19	12	1	5	3	3	3	3	16	7	3	94	0.22
AN	*Monticellina cryptica*	-	-	-	-	-	-	-	-	-	2	3	6	3	4	3	1	-	15	37	19	93	0.22
AN	*Syllis* sp	-	2	-	22	35	12	13	3	-	-	-	-	3	-	-	-	-	-	-	-	90	0.21
AR	*Rhepoxynius* sp A SCAMIT 1987	12	7	3	5	-	3	2	1	5	-	-	4	5	14	11	-	10	-	3	3	88	0.21
MO	*Macoma* sp	-	9	-	1	3	-	-	-	9	11	-	-	27	10	2	5	-	2	-	8	87	0.21
AR	*Stenothoe estacola*	-	-	-	-	1	-	-	-	-	-	-	-	3	-	-	2	35	25	-	19	85	0.20
CO	Enteropneusta	10	2	-	-	8	-	-	-	-	4	2	5	23	20	2	2	2	1	-	-	81	0.19

Appendix F-5. (Cont.).

Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	% Total
		Year																					
AR	*Photis* sp	52	18	-	-	1	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	80	0.19
AN	*Dispio uncinata*	7	25	7	10	1	1	-	-	-	1	-	1	5	7	-	1	1	6	-	2	75	0.18
AN	*Ampharete labrops*	5	1	-	1	-	-	-	3	5	-	10	2	4	3	8	7	-	11	-	10	70	0.17
AR	*Podocerus brasiliensis*	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-	10	7	-	26	65	0.15
AN	*Scoletoma* spp	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	2	-	14	17	27	64	0.15
AN	*Syllis (Typosyllis) aciculata*	35	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	64	0.15
CN	Actiniaria	-	1	-	-	6	6	-	-	-	-	-	-	41	5	1	-	-	-	2	2	64	0.15
AR	*Campylaspis* sp C Myers&Benedict 1974	-	1	-	6	1	2	-	-	12	2	1	9	6	4	-	-	5	1	6	4	60	0.14
PR	Phoronidae	-	3	7	-	9	3	-	-	7	19	4	-	-	-	4	-	1	-	1	-	58	0.14
AR	Phoxocephalidae	-	-	-	6	1	40	10	-	-	-	-	-	-	-	-	-	-	-	-	-	57	0.14
AN	*Phyllodoce hartmanae*	-	-	-	14	3	7	2	-	-	-	1	-	11	6	-	2	1	1	1	6	55	0.13
AN	*Pista disjuncta*	5	1	1	2	18	1	2	-	-	-	10	4	2	-	3	-	1	-	-	5	55	0.13
AR	*Anoropallene palpida*	-	-	-	2	-	-	-	-	-	20	-	1	24	5	-	-	-	-	1	2	55	0.13
AR	*Leuroleberis sharpei*	-	1	1	5	10	3	-	-	1	-	3	7	7	3	5	4	2	2	1	-	55	0.13
AR	*Balanus pacificus*	-	-	3	2	-	-	-	-	-	-	-	-	17	31	-	-	-	-	-	-	53	0.13
AR	*Monocorophium acherusicum*	-	-	-	5	2	-	-	-	-	-	-	-	27	-	12	6	-	-	-	-	52	0.12
AR	*Euphilomedes carcharodonta*	1	8	1	4	2	1	-	-	5	10	-	1	3	3	3	-	1	-	4	4	51	0.12
AN	*Tharyx* spp Cmplx	33	13	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	49	0.12
CN	*Zaolutus actius*	-	2	-	4	-	-	-	-	-	-	-	13	26	1	-	-	-	-	-	2	48	0.11
AN	*Lumbrineris* spp	4	4	-	3	4	15	11	1	-	2	2	-	-	1	-	-	-	-	-	-	47	0.11
AN	*Brania californiensis*	-	-	-	-	2	-	-	-	-	-	-	6	32	4	-	-	2	-	-	-	46	0.11
AN	*Notomastus hemipodus*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	16	1	16	4	5	45	0.11
AN	*Polydora cirrosa*	-	-	-	-	-	-	-	-	-	-	-	17	23	3	1	-	-	-	1	-	45	0.11
AN	*Diopatra ornata*	-	-	-	-	-	1	-	-	-	2	-	10	8	1	7	13	-	-	-	1	43	0.10
AR	*Cyclaspis nubila*	-	-	-	3	1	-	-	-	8	5	-	16	5	1	1	-	-	1	2	-	43	0.10
AN	*Onuphis iridescens*	2	4	3	12	7	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	40	0.09
MO	*Protothaca staminea*	-	-	-	-	-	-	-	-	-	1	-	2	24	3	5	3	1	-	1	-	40	0.09
AN	Maldanidae	2	-	-	-	-	-	1	1	-	-	-	-	1	3	4	-	-	26	-	1	39	0.09
AN	*Neosabellaria cementarium*	-	-	-	-	-	-	-	-	-	1	4	21	5	2	-	-	-	4	-	2	39	0.09
AR	*Gammaropsis thompsoni*	-	-	-	-	-	-	-	-	1	-	-	1	-	3	26	3	1	-	-	4	39	0.09
AR	*Hartmanodes hartmanae*	1	1	2	2	3	1	1	-	2	-	-	1	6	1	6	-	3	-	5	4	39	0.09
AR	*Rhepoxynius* sp	13	-	-	1	16	-	8	-	-	-	-	-	-	-	-	-	-	-	-	1	39	0.09
AN	*Prionospio (Minuspio) lighti*	-	3	-	1	1	4	-	-	-	-	-	1	-	9	1	-	-	1	1	16	38	0.09
AR	*Cerapus tubularis* Cmplx	-	2	-	-	4	-	-	4	4	-	1	5	10	3	3	1	-	-	-	1	38	0.09
AR	*Ischyrocerus pelagops*	-	-	-	-	-	-	-	-	-	-	-	7	29	-	-	-	-	-	1	1	38	0.09
MO	*Nassarius perpinguis*	-	2	4	-	4	-	-	-	2	9	-	1	8	6	-	-	-	-	-	1	37	0.09
AR	*Rutiderma rostratum*	2	-	-	3	1	-	-	-	-	3	1	2	5	4	1	1	4	3	3	3	36	0.09
MO	*Mactromeris catilliformis*	-	-	-	-	-	-	-	-	-	-	-	-	-	35	1	-	-	-	-	-	36	0.09
AN	*Syllides* sp	15	13	-	1	-	-	-	-	-	-	1	4	1	-	-	-	-	-	-	-	35	0.08
CN	Actiniaria sp A Paquette 2005	-	-	-	-	1	-	-	-	3	3	3	-	3	8	3	1	3	1	1	5	35	0.08
MO	*Olivella baetica*	-	7	1	3	3	1	-	-	1	12	-	-	2	2	-	-	-	-	-	3	35	0.08
AN	*Onuphis eremita*	4	-	-	-	3	1	1	15	2	2	1	1	-	-	2	-	2	-	-	-	34	0.08
AR	*Photis bifurcata*	-	-	-	-	-	-	-	-	-	-	-	2	1	-	24	6	-	-	-	1	34	0.08
BC	*Glottidia albida*	4	1	3	3	5	-	-	1	3	5	1	1	3	2	-	-	-	-	-	1	33	0.08
AR	*Tiron biocellata*	-	-	-	1	-	4	-	-	2	-	-	13	5	3	-	1	-	2	1	-	32	0.08
MO	*Rochefortia grippi*	-	7	-	-	1	-	-	-	-	-	-	-	13	-	-	8	-	3	-	-	32	0.08
AN	*Dorvillea (Schistomeringos) longicornis*	-	-	-	-	-	-	-	-	30	1	-	-	-	-	-	-	-	-	-	-	31	0.07
AN	*Podarkeopsis glabrus*	-	4	-	1	6	3	2	-	1	-	1	-	2	-	2	2	1	1	1	4	31	0.07
MO	*Cyclostremella dalli*	-	-	-	2	-	-	-	-	-	-	1	-	27	-	-	-	-	-	-	-	30	0.07
AN	*Leitoscoloplos pugettensis*	1	2	4	-	4	-	-	-	2	-	6	-	-	2	-	-	1	1	-	6	29	0.07
AN	Onuphidae	1	-	-	1	2	-	-	1	6	5	-	-	5	-	3	-	5	-	-	-	29	0.07
AR	*Hemilamprops californicus*	2	1	-	7	-	-	-	-	4	-	-	3	2	-	6	-	3	1	-	-	29	0.07
AN	*Sthenelais verruculosa*	6	2	3	1	1	2	-	5	1	-	-	3	2	-	2	-	-	-	-	-	28	0.07
EC	*Amphiodia urtica*	4	2	2	2	2	5	4	6	-	-	-	-	-	-	1	-	-	-	-	-	28	0.07
AN	*Nereis latescens*	-	-	-	-	-	-	-	-	1	-	-	1	2	5	5	9	2	-	-	1	26	0.06
AN	*Phyllodoce* sp	1	19	-	1	-	1	-	-	2	-	-	1	-	1	-	-	-	-	-	-	26	0.06
AN	*Nephtys cornuta*	-	4	-	2	2	-	-	-	1	3	-	-	-	4	2	-	4	1	-	2	25	0.06
AN	*Chone mollis*	1	-	-	-	-	-	1	2	-	-	-	-	1	-	7	2	-	3	-	7	24	0.06
AR	*Asteropella slatteryi*	-	-	-	-	-	-	-	-	1	-	1	10	4	2	-	-	2	1	1	2	24	0.06
AR	*Rhepoxynius variatus*	-	-	-	1	7	1	1	2	-	-	-	2	-	1	8	-	-	1	-	-	24	0.06
EC	*Amphiodia* sp	-	-	-	-	-	1	-	-	4	1	1	3	2	-	1	-	-	1	10	-	24	0.06
MO	*Yoldia cooperi*	-	-	-	-	-	-	-	-	-	-	-	-	11	-	12	-	-	1	-	-	24	0.06
AN	*Mediomastus ambiseta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	5	2	14	23	0.05
AN	*Paraprionospio pinnata*	1	1	1	1	1	1	-	-	4	3	-	-	2	4	1	-	-	-	2	1	23	0.05
AR	*Americhelidium rectipalmum*	-	-	-	3	-	-	-	-	-	-	-	2	8	3	5	-	2	-	-	-	23	0.05
AR	*Metharpinia jonesi*	5	6	-	-	-	-	-	-	3	8	-	-	-	-	-	1	-	-	-	-	23	0.05
AR	*Rhepoxynius stenodes*	-	1	-	-	1	-	-	-	-	2	3	16	-	-	-	-	-	-	-	-	23	0.05
AN	*Carazziella* sp A SCAMIT 1995	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-	-	-	-	22	0.05
AN	*Goniada maculata*	-	-	1	2	2	-	6	-	1	-	-	1	2	-	-	-	3	-	2	2	22	0.05
AN	*Hesionella mccullochae*	-	-	-	-	-	-	-	-	-	2	1	1	7	-	-	-	4	3	3	1	22	0.05

Appendix F-5. (Cont.).

		Year																					%
Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	Total
AN	*Polyophthalmus pictus*	-	-	-	-	-	17	-	-	-	2	-	-	-	-	-	-	1	-	2	-	22	0.05
AR	*Photis macrotica*	17	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	0.05
AN	*Eumida longicornuta*	-	-	-	-	-	-	-	-	-	-	-	11	1	2	-	4	-	1	-	2	21	0.05
AN	*Sphaerephesia similisetis*	-	-	-	-	-	-	-	-	1	1	-	2	2	3	2	-	1	3	1	4	20	0.05
EC	*Amphiodia psara*	1	1	1	-	1	-	-	-	1	-	1	1	1	2	2	-	-	-	-	8	20	0.05
AR	*Monocorophium* sp	-	-	-	-	-	-	-	-	-	-	-	17	-	1	-	-	1	-	-	-	19	0.05
AR	*Anoplodactylus erectus*	-	-	-	-	-	-	-	-	-	-	-	-	18	-	-	-	-	-	-	-	18	0.04
AR	*Eohaustorius barnardi*	13	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	0.04
CN	*Edwardsia californica*	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	0.04
EC	Amphiuridae	-	-	-	-	-	-	-	-	7	-	-	-	-	1	1	2	2	5	-	-	18	0.04
AN	*Amaeana occidentalis*	3	1	-	-	-	-	6	-	-	1	5	-	-	-	-	-	-	1	-	-	17	0.04
AN	*Eupolymnia heterobranchia*	-	-	-	-	-	-	-	-	-	-	-	3	5	3	2	3	-	-	-	1	17	0.04
AN	*Heteropodarke heteromorpha*	-	6	1	3	-	-	-	-	3	-	-	-	-	-	-	-	1	1	-	2	17	0.04
AN	*Lumbrineris californiensis*	-	-	1	1	-	-	-	-	3	4	-	-	-	1	1	-	1	3	-	2	17	0.04
AN	*Metasychis disparidentatus*	1	-	-	1	-	2	-	2	4	5	1	-	1	-	-	-	-	-	-	-	17	0.04
AR	*Americhelidium* sp	3	9	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	0.04
AR	*Eobrolgus spinosus*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	13	-	-	3	-	-	17	0.04
AR	*Laticorophium baconi*	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	2	1	-	12	17	0.04
EC	*Amphiodia digitata*	-	2	-	-	-	-	-	-	-	-	-	2	1	-	6	1	-	3	1	1	17	0.04
MO	*Rictaxis punctocaelatus*	1	1	-	1	-	-	-	-	-	3	2	-	3	2	1	-	3	-	-	-	17	0.04
CO	*Branchiostoma californiense*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	14	1	-	16	0.04
MO	Mytilidae	-	-	-	5	-	-	-	-	-	1	-	-	-	-	2	-	4	-	3	1	16	0.04
MO	*Neverita reclusiana*	-	-	-	2	1	-	-	-	-	-	-	-	10	2	-	-	-	-	-	1	16	0.04
NE	*Zygonemertes virescens*	-	-	-	-	-	-	-	-	-	-	-	-	-	12	2	1	-	-	-	1	16	0.04
AR	*Aoroides* sp	-	-	-	-	-	-	-	-	3	-	10	-	1	-	-	-	1	-	-	-	15	0.04
PL	*Stylochoplana* sp	-	3	-	-	-	-	-	-	1	1	2	2	-	1	-	-	-	1	3	1	15	0.04
SI	*Siphonosoma ingens*	-	-	-	-	-	-	-	-	3	-	-	-	4	4	-	-	-	3	-	1	15	0.04
AN	*Diopatra splendidissima*	-	-	2	-	-	-	-	1	-	-	3	-	5	2	-	-	-	1	-	-	14	0.03
AN	Euclymeninae sp A SCAMIT 1987	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	10	2	-	-	14	0.03
AN	*Phyllodoce longipes*	-	-	-	-	-	-	-	-	1	-	-	-	5	5	-	2	-	-	-	1	14	0.03
NE	*Carinomella lactea*	-	11	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	14	0.03
NE	*Cerebratulus californiensis*	-	-	-	8	-	2	2	-	-	-	-	2	-	-	-	-	-	-	-	-	14	0.03
NE	*Micrura* sp	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	3	5	3	2	14	0.03
NE	*Tubulanus nothus*	-	-	-	-	-	-	-	-	-	1	-	2	1	-	5	-	-	2	2	1	14	0.03
PR	*Phoronopsis* sp	-	-	-	-	-	-	-	-	-	-	-	-	9	4	-	-	-	-	-	1	14	0.03
AN	*Malmgreniella macginitiei*	1	1	1	1	-	-	-	2	-	-	-	1	-	5	1	-	-	-	-	-	13	0.03
AN	*Platynereis bicanalicalata*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	10	-	-	-	-	13	0.03
AN	*Rhynchospio glutaea*	-	-	-	-	-	-	-	1	-	-	-	-	-	-	2	10	-	-	-	-	13	0.03
AN	*Spiophanes berkeleyorum*	-	1	-	-	-	-	-	-	1	-	-	-	1	1	-	1	-	3	1	4	13	0.03
AR	*Acuminodeutopus heteruropus*	-	-	-	-	-	-	-	-	1	1	-	-	-	-	1	-	-	-	-	10	13	0.03
AR	*Metatiron tropakis*	4	1	2	-	2	-	-	-	2	1	-	1	-	-	-	-	-	-	-	-	13	0.03
AR	*Nymphon* sp	-	-	3	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	13	0.03
AR	*Parasterope hulingsi*	-	-	-	-	-	-	-	-	-	-	-	-	2	1	1	-	2	1	4	2	13	0.03
AR	*Rhepoxynius homocuspidatus*	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	0.03
EC	Echinoidea	2	3	-	-	-	1	-	7	-	-	-	-	-	-	-	-	-	-	-	-	13	0.03
EC	*Leptosynapta* sp	2	-	-	-	-	-	1	2	2	-	-	1	1	4	-	-	-	-	-	-	13	0.03
MO	*Macoma secta*	-	-	-	2	-	-	1	-	-	1	-	3	-	-	2	-	1	-	-	3	13	0.03
AN	*Aphelochaeta glandaria*	-	-	-	-	-	-	-	-	-	2	1	3	-	-	1	-	3	1	1	-	12	0.03
AN	*Nereis procera*	1	-	-	-	1	-	-	-	1	-	3	-	-	-	1	4	-	1	-	-	12	0.03
AN	*Polydora cornuta*	-	-	-	-	-	-	-	1	-	-	-	-	-	9	-	-	1	-	1	-	12	0.03
MO	*Crepidula naticarum*	-	-	1	2	-	-	-	-	2	-	2	-	5	-	-	-	-	-	-	-	12	0.03
NE	*Tetrastemma candidum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	6	-	-	3	12	0.03
NE	*Tetrastemma* sp A SCAMIT 1995	-	-	-	-	-	-	-	-	-	-	1	7	3	-	-	-	-	-	-	1	12	0.03
SI	*Apionsoma misakianum*	-	1	1	-	6	-	-	-	-	-	-	3	-	-	-	-	-	-	1	-	12	0.03
AN	*Axiothella rubrocincta*	-	-	1	-	-	-	1	-	-	-	-	-	-	-	5	4	-	-	-	-	11	0.03
AN	*Boccardia* sp	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	0.03
AN	*Glycera nana*	-	-	1	2	-	-	-	-	-	2	-	1	-	-	-	-	-	4	1	-	11	0.03
AN	*Glycera* sp	2	2	-	3	-	2	-	1	-	-	-	-	-	1	-	-	-	-	-	-	11	0.03
AN	*Magelona* sp	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	0.03
AN	*Nephtys* sp	-	2	-	2	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	0.03
AN	*Polydora* sp	-	-	-	10	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	11	0.03
AR	Gammaridea	1	1	-	-	1	6	-	-	1	-	-	-	-	-	-	-	-	-	-	1	11	0.03
AR	*Metamysidopsis elongata*	-	-	-	2	-	-	-	-	-	1	-	-	1	3	-	1	-	1	2	-	11	0.03
AR	*Tritella pilimana*	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	1	-	-	-	-	11	0.03
MO	*Leptopecten latiauratus*	-	-	-	-	1	-	-	-	-	-	5	2	2	1	-	-	-	-	-	-	11	0.03
MO	*Mactrotoma californica*	-	-	-	-	-	-	-	-	-	-	-	3	8	-	-	-	-	-	-	-	11	0.03
MO	*Nassarius* sp	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	0.03
AN	*Brania brevipharyngea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	4	10	0.02
AN	*Magelona californica*	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	10	0.02
AN	*Tenonia priops*	-	-	-	3	-	-	-	-	2	-	-	1	1	-	1	-	-	-	-	2	10	0.02

Appendix F-5. (Cont.).

		Year																					%
Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	Total
AR	*Exosphaeroma rhomburum*	-	-	-	-	-	-	-	-	3	-	-	-	1	-	5	1	-	-	-	-	10	0.02
AR	*Ischyrocerus anguipes*	-	1	-	-	-	-	-	-	-	-	-	-	-	2	7	-	-	-	-	-	10	0.02
AR	*Rudilemboides stenopropodus*	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	0.02
MO	Bivalvia	-	2	-	-	1	1	-	1	2	-	-	-	-	-	1	-	-	-	2	-	10	0.02
MO	*Cadulus aberrans*	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	1	6	-	10	0.02
MO	*Macoma yoldiformis*	-	1	1	2	-	-	-	-	1	-	-	-	1	1	-	-	-	-	-	3	10	0.02
AN	Euclymeninae	-	-	-	-	1	6	1	1	-	-	-	-	-	-	-	-	-	-	-	-	9	0.02
AN	*Mediomastus californiensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	3	-	-	-	-	9	0.02
AN	*Onuphis* sp	-	-	-	3	-	-	-	1	-	-	-	-	-	-	-	-	-	2	3	-	9	0.02
AN	*Sphaerosyllis californiensis*	-	-	-	-	-	-	-	-	-	-	1	-	4	-	-	2	-	-	1	1	9	0.02
AR	*Atylus tridens*	1	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	9	0.02
AR	*Photis californica*	-	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	5	-	-	9	0.02
EC	Ophiuroidea	1	1	1	-	-	2	-	-	4	-	-	-	-	-	-	-	-	-	-	-	9	0.02
MO	*Chione* sp	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	9	0.02
MO	*Pandora bilirata*	-	-	-	-	-	-	-	-	-	1	-	-	3	3	1	1	-	-	-	-	9	0.02
MO	*Periploma discus*	-	5	-	-	-	-	-	-	-	2	-	-	-	-	-	-	1	-	-	1	9	0.02
MO	*Periploma planiusculum*	1	-	-	2	-	-	-	-	-	-	-	-	1	3	-	-	-	1	1	-	9	0.02
AN	*Chone albocincta*	-	-	-	-	1	-	-	-	4	3	-	-	-	-	-	-	-	-	-	-	8	0.02
AN	*Glycera americana*	-	-	-	-	1	2	-	-	-	2	-	-	-	-	-	3	-	-	-	-	8	0.02
AN	*Sthenelais tertiaglabra*	-	-	-	-	-	-	-	-	-	1	4	-	-	-	-	1	-	2	-	-	8	0.02
AR	*Cancer* sp	-	-	-	-	-	-	-	-	1	-	-	4	2	1	-	-	-	-	-	-	8	0.02
AR	*Joeropsis lobata*	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	8	0.02
CN	Hydrozoa	1	2	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0.02
MO	*Balcis oldroydae*	2	3	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	8	0.02
MO	*Solen sicarius*	-	-	-	-	-	1	-	1	-	-	2	-	-	-	1	-	-	1	-	2	8	0.02
AN	*Arabella endonata*	-	-	-	-	1	-	-	-	2	-	-	-	1	-	-	-	1	-	1	1	7	0.02
AN	*Dipolydora socialis*	-	-	-	1	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	2	7	0.02
AN	*Pista elongata*	-	-	-	-	-	-	-	-	-	-	-	1	-	3	3	-	-	-	-	-	7	0.02
AR	*Argissa hamatipes*	2	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	7	0.02
CN	Anthozoa	-	2	1	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	0.02
MO	*Caecum crebricinctum*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	6	-	-	7	0.02
NE	*Tetrastemma nigrifrons*	-	-	-	-	-	-	-	-	-	2	-	-	-	2	2	-	-	-	-	1	7	0.02
SI	Sipuncula	1	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	-	1	7	0.02
AN	*Dipolydora bidentata*	-	-	-	-	1	-	-	-	3	-	-	-	1	-	-	-	-	-	-	1	6	0.01
AN	*Halosydna johnsoni*	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	3	-	-	-	-	6	0.01
AN	*Heteromastus* sp	-	-	1	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	6	0.01
AN	*Lumbrineris japonica*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	3	-	-	1	6	0.01
AN	*Nereiphylla castanea*	-	-	-	-	-	-	-	-	1	-	-	4	-	-	-	-	-	1	-	-	6	0.01
AR	*Callipallene californiensis*	4	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	0.01
AR	*Cancer antennarius*	-	-	-	-	-	-	-	-	-	1	-	-	1	2	-	1	-	1	-	-	6	0.01
AR	*Lepidepecreum serraculum*	-	-	-	-	1	-	-	-	1	-	-	-	3	1	-	-	-	-	-	-	6	0.01
AR	*Lepidopa californica*	-	1	2	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	6	0.01
AR	*Leptocuma forsmani*	-	-	-	-	2	-	-	-	1	-	-	3	-	-	-	-	-	-	-	-	6	0.01
AR	*Stenothoe valida*	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	0.01
MO	*Acteocina culcitella*	-	-	1	-	-	-	1	-	1	-	-	-	-	3	-	-	-	-	-	-	6	0.01
MO	*Ennucula tenuis*	-	-	-	-	-	-	-	-	-	2	1	-	-	3	-	-	-	-	-	-	6	0.01
MO	*Mytilus* sp	-	-	-	5	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	6	0.01
MO	*Odostomia* sp D MBC 1980	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	-	1	1	6	0.01
PL	*Imogine exiguus*	-	-	-	-	-	-	-	-	3	1	1	-	-	-	-	-	-	-	-	1	6	0.01
PL	Platyhelminthes	4	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	6	0.01
AN	*Eteone balboensis*	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	0.01
AN	*Eteone* sp	-	-	-	2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	0.01
AN	*Protodorvillea gracilis*	-	-	-	3	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	5	0.01
AN	Syllidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	4	-	-	5	0.01
AR	*Caprella californica*	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	5	0.01
AR	*Eohaustorius sawyeri*	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	5	0.01
AR	*Listriella melanica*	-	-	-	1	-	-	-	-	-	-	-	1	-	1	-	-	1	1	-	-	5	0.01
AR	*Mandibulophoxus gilesi*	1	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	1	-	-	-	5	0.01
AR	*Paracerceis* sp	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	5	0.01
AR	*Pinnixa* sp	2	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	0.01
AR	*Randallia ornata*	-	-	1	-	3	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	5	0.01
CN	*Edwardsia* sp G MEC 1992	-	1	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	5	0.01
MO	*Crepidula norrisiarum*	-	-	-	-	-	-	-	-	-	-	-	3	-	1	1	-	-	-	-	-	5	0.01
MO	*Crepidula* sp	-	-	-	-	1	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	5	0.01
MO	*Epitonium sawinae*	-	-	-	-	-	-	-	-	1	1	-	-	2	-	-	-	-	-	-	1	5	0.01
MO	*Macoma nasuta*	-	-	-	3	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	5	0.01
MO	*Tellina bodegensis*	1	-	-	-	-	-	-	-	1	-	-	1	1	1	-	-	-	-	-	-	5	0.01
PL	*Stylochoplana longipenis*	-	-	-	-	-	-	-	-	1	-	-	-	2	-	2	-	-	-	-	-	5	0.01
SI	*Thysanocardia nigra*	-	-	-	-	-	-	-	-	2	-	-	1	2	-	-	-	-	-	-	-	5	0.01
AN	*Cirriformia spirabrancha*	-	-	1	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	-	4	0.01

Appendix F-5. (Cont.).

Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	% Total
AN	*Demonax* sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	0.01
AN	*Exogone uniformis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	4	0.01
AN	Polychaeta	-	-	-	-	-	-	-	1	1	-	-	-	-	2	-	-	-	-	-	-	4	0.01
AN	*Polycirrus* sp	-	-	1	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	4	0.01
AN	*Sabellaria gracilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	1	-	-	-	4	0.01
AN	*Scolelepis squamata*	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1	4	0.01
AR	*Ampelisca cristata cristata*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	4	0.01
AR	*Balanus* sp	-	-	1	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	4	0.01
AR	*Blepharipoda occidentalis*	-	-	-	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	1	-	4	0.01
AR	*Caprella mendax*	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	4	0.01
AR	*Euphilomedes* sp	-	-	-	-	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.01
AR	*Gnathopleustes serratus*	-	-	-	-	-	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-	4	0.01
AR	*Joeropsis dubia*	-	-	-	-	-	-	-	-	1	-	-	-	1	1	1	-	-	-	-	-	4	0.01
AR	*Munnogonium tillerae*	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.01
AR	*Neomysis kadiakensis*	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-	-	-	1	-	-	4	0.01
AR	*Neotrypaea californiensis*	-	-	1	2	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	4	0.01
AR	*Pinnixa longipes*	-	-	-	-	-	1	-	-	-	-	-	1	-	-	2	-	-	-	-	-	4	0.01
AR	*Pyromaia tuberculata*	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-	-	-	-	-	-	4	0.01
CN	Edwardsiidae	-	1	1	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	4	0.01
EC	*Lovenia cordiformis*	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.01
MO	*Kellia suborbicularis*	1	-	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	4	0.01
MO	*Kurtziella plumbea*	-	-	-	1	1	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	4	0.01
MO	*Lyonsia californica*	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	1	4	0.01
MO	*Mytilus galloprovincialis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	4	0.01
MO	*Rhamphidonta retifera*	-	-	-	-	-	-	-	-	-	-	-	2	1	1	-	-	-	-	-	-	4	0.01
NE	Hoplonemertea sp A Paquette 1988	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	2	4	0.01
NE	*Micrura alaskensis*	-	1	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.01
PL	*Cryptocelis occidentalis*	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.01
AN	*Ancistrosyllis hamata*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1	-	-	3	0.01
AN	*Aphelochaeta monilaris*	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-	3	0.01
AN	*Arabella iricolor*	-	-	-	2	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	3	0.01
AN	*Chaetozone armata*	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-	3	0.01
AN	*Chaetozone corona*	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1	-	-	-	3	0.01
AN	*Eteone fauchaldi*	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	3	0.01
AN	*Harmothoe* sp	-	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	3	0.01
AN	*Hesionura coineaui difficilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3	0.01
AN	*Heterospio catalinensis*	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	3	0.01
AN	*Mooreonuphis stigmatis*	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	3	0.01
AN	*Onuphis eremita parva*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	1	3	0.01
AN	*Ophiodromus pugettensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	-	3	0.01
AN	*Paleanotus bellis*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	3	0.01
AN	*Poecilochaetus johnsoni*	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	3	0.01
AN	*Polydora limicola*	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	3	0.01
AN	*Praxillella pacifica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-	3	0.01
AN	*Prionospio (Prionospio) heterobranchia*	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	1	-	-	-	-	3	0.01
AN	*Prionospio (Prionospio) jubata*	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	3	0.01
AN	*Scoloplos* sp	-	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.01
AR	Mysidacea	2	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	3	0.01
AR	*Nebalia daytoni*	-	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	3	0.01
AR	*Nebalia pugettensis* Cmplx	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.01
AR	Oedicerotidae	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	0.01
AR	*Ogyrides* sp A Roney 1978	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3	0.01
AR	*Pachygapsus crassipes*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3	0.01
AR	*Pinnixa franciscana*	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	3	0.01
AR	*Postasterope barnesi*	-	-	-	-	1	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	3	0.01
AR	Pycnogonida	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.01
AR	*Xenoleberis californica*	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.01
CN	*Renilla kollikeri*	-	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	3	0.01
EC	*Amphipholus squamata*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	3	0.01
EC	Holothuroidea	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	3	0.01
MO	*Donax gouldii*	-	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	3	0.01
MO	*Doto amyra*	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	3	0.01
MO	*Epitonium* sp	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	1	3	0.01
MO	*Hiatella arctica*	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	3	0.01
MO	Mactridae	-	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.01
MO	*Modiolus rectus*	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	3	0.01
MO	*Odostomia* sp	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-	3	0.01
MO	*Rochefortia compressa*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	3	0.01
MO	*Saxidomus nuttalli*	-	-	-	1	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	3	0.01
MO	*Turbonilla* sp	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.01

Appendix F-5. (Cont.).

Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	% Total
NE	*Anopla* sp D SCAMIT 1995	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3	0.01
NE	*Cerebratulus* sp	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	1	-	3	0.01
PL	*Notoplana* sp	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	1	-	-	-	3	0.01
AN	*Amastigos acutus*	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00
AN	*Aricidea (Aedicira) pacifica*	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00
AN	*Carazziella* sp	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00
AN	*Chone minuta*	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	2	0.00
AN	*Chone* sp	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00
AN	*Decamastus gracilis*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	0.00
AN	*Diopatra* sp	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	2	0.00
AN	*Dipolydora* sp	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	2	0.00
AN	*Eranno lagunae*	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2	0.00
AN	*Eteone californica*	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	2	0.00
AN	*Eulalia quadrioculata*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	2	0.00
AN	*Eusyllis blomstrandi*	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	0.00
AN	*Glycinde polygnatha*	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00
AN	*Glycinde* sp	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00
AN	*Goniada brunnea*	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	2	0.00
AN	*Hydroides uncinatus*	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2	0.00
AN	*Laonice cirrata*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	0.00
AN	*Loimia* sp A SCAMIT 2001	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	2	0.00
AN	*Micropodarke dubia*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	0.00
AN	*Nephtys californiensis*	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	2	0.00
AN	Nereididae	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	2	0.00
AN	*Nereis* sp	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	0.00
AN	*Notomastus latescens*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	0.00
AN	*Ophelia assimilis*	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00
AN	*Ophryotrocha* sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	2	0.00
AN	*Polycirrus* sp A SCAMIT 1995	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	2	0.00
AN	*Polydora nuchalis*	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2	0.00
AN	*Sphaerodoropsis sphaerulifer*	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2	0.00
AR	*Ammothea hilgendorfi*	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00
AR	*Aoroides exilis*	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	0.00
AR	Brachyura (Megalopa)	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	2	0.00
AR	*Cancer gracilis*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	2	0.00
AR	Cumacea	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	2	0.00
AR	*Cyclaspis* sp B SCAMIT 1989	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	0.00
AR	*Deutella californica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	0.00
AR	*Haliophasma geminatum*	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	2	0.00
AR	*Heterocrypta occidentalis*	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	0.00
AR	*Incisocalliope bairdi*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	2	0.00
AR	*Lepidepecreum gurjanovae*	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00
AR	*Mysidopsis intii*	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	2	0.00
AR	*Pachynus barnardi*	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2	0.00
AR	Peltidiidae	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	2	0.00
AR	Pinnotheridae	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00
AR	*Rutiderma judayi*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	0.00
AR	*Zeuxo normani*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	0.00
CN	Pennatulacea	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	2	0.00
EC	*Amphiura arcystata*	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2	0.00
EC	*Astropecten verrilli*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	2	0.00
EC	*Ophiothrix spiculata*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	-	2	0.00
EH	*Arynchite californica*	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00
KI	Kinorhyncha	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	2	0.00
MO	*Alia carinata*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	0.00
MO	*Emarcusia morroensis*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00
MO	*Ensis myrae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	2	0.00
MO	Facelinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2	0.00
MO	Gastropoda	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2	0.00
MO	*Hermissenda crassicornis*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	2	0.00
MO	*Nuculana taphria*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	2	0.00
MO	*Odostomia farella*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00
MO	*Parvilucina tenuisculpta*	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	0.00
MO	*Petricola* sp	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	0.00
MO	*Philine bakeri*	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2	0.00
MO	*Polygireulima rutila*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	0.00
MO	*Tellina nuculoides*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	2	0.00
MO	*Tellina* sp B SCAMIT 1995	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2	0.00
MO	*Vitrinella oldroydi*	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	0.00
MO	*Volvulella cylindrica*	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00

Appendix F-5. (Cont.).

		Year																					%
Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	Total
NE	*Tubulanus frenatus*	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2	0.00
NE	*Tubulanus* sp	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2	0.00
PL	*Kaburakia excelsa*	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.00
PL	*Pseudoceros* sp	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	2	0.00
AN	*Amphicteis scaphobranchiata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00
AN	Amphinomidae	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Ancistrosyllis groenlandica*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	Annelida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00
AN	*Aricidea (Allia)* sp A SCAMIT 1996	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Aricidea (Aricidea) wassi*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00
AN	*Bispira volutacornis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00
AN	*Caulleriella alata*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Caulleriella bioculata*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Caulleriella* sp	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00
AN	*Chaetozone hartmanae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00
AN	*Chrysopetalum occidentale*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00
AN	*Cossura* sp A Phillips 1987	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00
AN	*Demonax* sp 1 Fitzhugh	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Dorvillea (Schistomeringos) annulata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00
AN	Dorvilleidae	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
AN	*Drilonereis nuda*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00
AN	*Drilonereis* sp	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Ephesiella brevicapitis*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00
AN	*Eteone brigitteae*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00
AN	*Eteone dilatae*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Eteone lighti*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Eusyllis* sp	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00
AN	*Exogone dwisula*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	Flabelligeridae	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Goniada* sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00
AN	*Gyptis* sp	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Halosydna brevisetosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00
AN	*Levinsenia gracilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00
AN	Lumbrineridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00
AN	*Lumbrineris cruzensis*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Magelona hartmanae*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Malmgreniella scriptoria*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
AN	*Megalomma pigmentum*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00
AN	*Monticellina serratiseta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00
AN	*Naineris dendritica*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
AN	*Nicomache* sp	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Notocirrus californiensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00
AN	*Notomastus* sp A SCAMIT 2001	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	Oenonidae	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	Oligochaeta	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Paranaitis polynoides*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Parandalia ocularis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00
AN	*Pareurythoe californica*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Pherusa neopapillata*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
AN	*Phyllochaetopterus prolifica*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Phyllodoce groenlandica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00
AN	*Phyllodoce pettiboneae*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Polycirrus californicus*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00
AN	*Polycirrus* sp 1 Banse 1980	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00
AN	Polynoidae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00
AN	*Schistocomus* sp A SCAMIT 1987	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00
AN	*Scolelepis tridentata*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Scoletoma* sp A (Harris 1985)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00
AN	*Scoloplos acmeceps*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	Sigalionidae	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	Sphaerodoridae	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Sphaerosyllis brandhorsti*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00
AN	Spionidae	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Spiophanes* sp	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Sthenelais* sp	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
AN	*Syllis (Syllis) gracilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00
AN	*Syllis (Typosyllis) pulchra*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00
AN	*Syllis (Typosyllis)* sp	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
AN	Terebellidae	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AN	*Travisia gigas*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00

Appendix F-5. (Cont.).

Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	% Total
AN	*Ysideria hastata*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
AR	*Acetabulastoma californica*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
AR	*Alpheus clamator*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00
AR	Ampeliscidae	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Araphura cuspirostris*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	Arthropoda	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Balanus nubilus*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Caecognathia crenulatifrons*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
AR	*Cancer jordani*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Cancer productus*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	Caridea	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Cumella* sp	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Cumella* sp K MBC 1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00
AR	*Cyprideis stewarti*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Diastylis* sp	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Elasmopus bampo*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.00
AR	*Emerita analoga*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Eohaustorius* sp	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
AR	Eusiridae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00
AR	*Exacanthomysis davisi*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00
AR	Flabellifera	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	Harpacticoida	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00
AR	*Heteroserolis carinata*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Listriella diffusa*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Listriella eriopisa*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	Lysianassidae	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Opisthopus transversus*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	Ostracoda	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	Paguridae	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Photis* sp A MBC 1972	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Photis* sp OC1 Diener 1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00
AR	*Pinnixa tubicola*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
AR	*Portunus xantusii*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00
AR	*Rhepoxynius heterocuspidatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00
CN	*Stylatula elongata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00
EC	*Astropecten* sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.00
EC	*Cucumaria piperata*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
EC	*Pentamera populifera*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
EN	Loxosomatidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00
EP	*Antropora tincta*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.00
EP	*Bowerbankia gracilis*	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00
EP	*Caulibugula ciliata*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00
EP	*Celleporella hyalina*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.00
EP	*Cryptoarachnidium argilla*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
EP	*Farrella elongata*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Acteocina harpa*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Acteocina inculta*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Aglaja ocelligera*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Amiantis callosa*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Armina californica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00
MO	Chamidae	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
MO	*Chione undatella*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Diplodonta sericata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00
MO	*Euspira* sp	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Halistylis pupoideus*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Leporimetis obesa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00
MO	*Lithophaga plumula*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Lucinoma annulatum*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Macoma carlottensis*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Macoma indentata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00
MO	*Modiolus neglectus*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Odostomia columbiana*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
MO	*Odostomia minutissima*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00
MO	*Odostomia tenuisculpta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00
MO	*Ophiodermella cancellata*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Ophiodermella inermis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00
MO	*Petricola carditoides*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.00
MO	Pseudodoridoidae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00
MO	*Simomactra planulata*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00
MO	*Sphenia fragilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00

Appendix F-5. (Cont.).

Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	% Total
MO	*Sphenia luticola*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Tellina idae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00
MO	*Turbonilla santarosana*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Turbonilla* sp L MBC 1975	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
MO	*Yoldia seminuda*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00
NE	*Amphiporus bimaculatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00
NE	*Monostylifera* sp SD 1 Pt. Loma 1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00
NE	*Tetrastemma signifer*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00
NE	*Tetrastemma* sp	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00
NE	*Tubulanus cingulatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00
SI	*Sipunculus nudus*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.00
Number of individuals		988	1267	576	1717	878	1238	312	244	933	10393	781	3373	7829	3311	1187	1095	1381	963	1289	2388	42143	
Number of species		108	144	92	140	129	100	60	60	149	124	91	162	206	174	152	114	119	133	107	165	571	
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	3.84	
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		
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		

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

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, 2007.

Phylum / Class / Family / Species	Common name
Arthropoda	
Malacostraca	
Cancridae	
Cancer antennarius	Pacific rock crab
Cancer anthonyi	yellow crab
Cancer gracilis	graceful crab
Cancer productus	red rock crab
Crangonidae	
Crangon nigromaculata	blackspotted bay shrimp
Epialtidae	
Pugettia producta	northern kelp crab
Hippolytidae	
Lysmata californica	red rock shrimp
Majidae	
Loxorhynchus grandis	sheep crab
Portunidae	
Portunus xantusii	Xantus swimming crab
Cnidaria	
Hydrozoa	
Polyorchidae	
Polyorchis penicillatus	red jellyfish
Scyphozoa	
Pelagiidae	
Chrysaora colorata	purple-striped jellyfish
Echinodermata	
Asteroidea	
Asterinidae	
Pisaster giganteus	giant-spined sea star
Pisaster ochraceus	ochre star
Pisaster sp	sea star unid
Mollusca	
Cephalopoda	
Octopodidae	
Octopus bimaculatus/bimaculoides	California two-spot octopus
Gastropoda	
Aglajidae	
Navanax inermis	California aglaja
Chordata	
Chondrichthyes	
Torpedinidae	
Torpedo californica	Pacific electric ray
Actinopterygii	
Batrachoididae	
Porichthys myriaster	specklefin midshipman
Porichthys notatus	plainfin midshipman
Blennidae	
Hypsoblennius gilberti	rockpool blenny
Clinidae	
Heterostichus rostratus	giant kelpfish
Clupeidae	
Sardinops sagax	Pacific sardine
Embiotocidae	
Cymatogaster aggregata	shiner perch
Phanerodon furcatus	white seaperch
Scombridae	
Scomber japonicus	Pacific chub mackerel
Scorpaenidae	
Scorpaena guttata	California scorpionfish
Syngnathidae	
Syngnathus leptorhynchus	bay pipefish

Appendix G-2. Abundance of fish impinged during normal operations by survey date. Ormond Beach Generating Station NPDES, 2007.

Species	11/1/2006	11/15/2006	12/26/2006	2/20/2007	5/19/2007	6/5/2007	7/12/2007	8/14/2007	Total Abundance
Phanerodon furcatus	18	-	-	-	-	-	-	-	18
Cymatogaster aggregata	7	1	-	-	-	-	-	-	8
Syngnathus leptorhynchus	-	1	-	-	1	2	1	1	6
Porichthys myriaster	-	-	-	-	-	-	4	-	4
Heterostichus rostratus	-	-	-	-	-	-	-	1	1
Hypsoblennius gilberti	-	-	-	-	-	-	-	1	1
Porichthys notatus	-	-	-	-	1	-	-	-	1
Sardinops sagax	-	-	1	-	-	-	-	-	1
Scomber japonicus	1	-	-	-	-	-	-	-	1
Scorpaena guttata	-	-	-	-	-	-	1	-	1
Torpedo californica	-	-	-	-	-	-	1	-	1
Total Abundance	26	2	1	-	2	2	7	3	43
Number of Taxa	3	2	1	0	2	1	4	3	11

Appendix G-3. Biomass (kg) of fish impinged during normal operations by survey date. Ormond Beach Generating Station NPDES, 2007.

Species	11/1/2006	11/15/2006	12/26/2006	2/20/2007	5/19/2007	6/5/2007	7/12/2007	8/14/2007	Total Biomass (kg)
Torpedo californica	-	-	-	-	-	-	8.500	-	8.500
Phanerodon furcatus	2.030	-	-	-	-	-	-	-	2.030
Porichthys myriaster	-	-	-	-	-	-	0.631	-	0.631
Porichthys notatus	-	-	-	-	0.234	-	-	-	0.234
Cymatogaster aggregata	0.152	0.006	-	-	-	-	-	-	0.158
Scorpaena guttata	-	-	-	-	-	-	0.093	-	0.093
Scomber japonicus	0.066	-	-	-	-	-	-	-	0.066
Hypsoblennius gilberti	-	-	-	-	-	-	-	0.032	0.032
Heterostichus rostratus	-	-	-	-	-	-	-	0.025	0.025
Sardinops sagax	-	-	0.024	-	-	-	-	-	0.024
Syngnathus leptorhynchus	-	0.003	-	-	0.001	0.003	0.002	0.005	0.014
Total Biomass (kg)	2.248	0.009	0.024	-	0.235	0.003	9.226	0.062	11.807

Appendix G-4. Estimated monthly abundance of fish impinged during normal operations. Ormond Beach Generating Station NPDES, 2007.

	2006		2007					Total
Species	Nov	Dec	Feb	May	Jun	Jul	Aug	Abundance
Syngnathus leptorhynchus	4	-	-	26	35	17	29	111
Phanerodon furcatus	78	-	-	-	-	-	-	78
Porichthys myriaster	-	-	-	-	-	69	-	69
Cymatogaster aggregata	34	-	-	-	-	-	-	34
Heterostichus rostratus	-	-	-	-	-	-	29	29
Hypsoblennius gilberti	-	-	-	-	-	-	29	29
Porichthys notatus	-	-	-	26	-	-	-	26
Scorpaena guttata	-	-	-	-	-	17	-	17
Torpedo californica	-	-	-	-	-	17	-	17
Scomber japonicus	4	-	-	-	-	-	-	4
Sardinops sagax	-	2	-	-	-	-	-	2
Total Abundance	120	2	-	52	35	120	87	416
Number of Species	4	1	0	2	1	4	3	11
Analysis Flow (mg)	1,214	96	233	3,686	6,010	6,010	19,816	

Appendix G-5. Estimated monthly biomass (kg) of fish impinged during normal operations. Ormond Beach Generating Station NPDES, 2007.

	2006		2007					Total
Species	Nov	Dec	Feb	May	Jun	Jul	Aug	Biomass (kg)
Torpedo californica	-	-	-	-	-	146.919	-	146.919
Porichthys myriaster	-	-	-	-	-	10.907	-	10.907
Phanerodon furcatus	8.828	-	-	-	-	-	-	8.828
Porichthys notatus	-	-	-	6.138	-	-	-	6.138
Scorpaena guttata	-	-	-	-	-	1.607	-	1.607
Hypsoblennius gilberti	-	-	-	-	-	-	0.925	0.925
Heterostichus rostratus	-	-	-	-	-	-	0.723	0.723
Cymatogaster aggregata	0.680	-	-	-	-	-	-	0.680
Scomber japonicus	0.287	-	-	-	-	-	-	0.287
Syngnathus leptorhynchus	0.011	-	-	0.026	0.053	0.035	0.145	0.270
Sardinops sagax	-	0.048	-	-	-	-	-	0.048
Total Biomass (kg)	9.806	0.048	-	6.164	0.053	159.468	1.793	177.332
Analysis Flow (mg)	1,214	96	233	3,686	6,010	6,010	19,816	

Appendix G-6. Length frequency of impinged fish measured during normal operation surveys. Ormond Beach Generating Station NPDES, 2007.

	Size Class (cm)																			Total
Species	6	7	10	11	12	13	14	15	16	17	18	19	20	21	23	26	27	29	77	Measured
Phanerodon furcatus	-	-	-	-	-	-	-	6	6	4	2	-	-	-	-	-	-	-	-	18
Cymatogaster aggregata	2	3	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8
Syngnathus leptorhynchus	-	-	-	-	-	-	-	-	-	1	-	1	2	1	1	-	-	-	-	6
Porichthys myriaster	-	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	1	1	-	4
Heterostichus rostratus	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Hypsoblennius gilberti	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Porichthys notatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
Sardinops sagax	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
Scomber japonicus	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1
Scorpaena guttata	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
*Torpedo californica**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1

Note: * = total length

Appendix G-7. Abundance of macroinvertebrates impinged during normal operations by survey date. Ormond Beach Generating Station NPDES, 2007.

Species	11/1/2006	11/15/2006	12/26/2006	2/20/2007	5/19/2007	6/5/2007	7/12/2007	8/14/2007	Total Abundance
Cancer antennarius	8	40	4	1	-	3	4	24	84
Lysmata californica	1	61	-	1	1	1	-	1	66
Cancer anthonyi	-	2	-	3	-	9	-	5	19
Cancer productus	5	-	-	1	3	-	-	2	11
Chrysaora colorata	-	-	-	-	2	5	-	-	7
Cancer gracilis	1	-	-	-	-	-	-	2	3
Crangon nigromaculata	-	-	-	1	-	-	1	-	2
Navanax inermis	-	-	-	1	-	-	-	1	2
Pisaster ochraceus	1	-	-	-	-	1	-	-	2
Portunus xantusii	-	-	-	-	-	1	-	1	2
Pugettia producta	-	-	-	-	-	-	-	2	2
Loxorhynchus grandis	-	-	-	-	-	1	-	-	1
Octopus bimaculatus/bimaculoides	-	1	-	-	-	-	-	-	1
Pisaster giganteus	-	-	-	1	-	-	-	-	1
Pisaster sp	-	-	-	-	1	-	-	-	1
Polyorchis penicillatus	-	-	-	-	-	1	-	-	1
Total Abundance	16	104	4	9	7	22	5	38	205
Number of Species	5	4	1	7	4	8	2	8	16

Appendix G-8. Biomass (kg) of macroinvertebrates impinged during normal operations by survey date. Ormond Beach Generating Station NPDES, 2007.

Species	11/1/2006	11/15/2006	12/26/2006	2/20/2007	5/19/2007	6/5/2007	7/12/2007	8/14/2007	Total Biomass (kg)
Chrysaora colorata	-	-	-	-	3.100	5.260	-	-	8.360
Cancer antennarius	0.242	2.199	0.262	0.152	-	0.300	0.621	0.796	4.572
Cancer anthonyi	-	0.164	-	0.220	-	1.481	-	0.015	1.880
Cancer productus	0.301	-	-	0.510	0.380	-	-	0.024	1.215
Loxorhynchus grandis	-	-	-	-	-	0.692	-	-	0.692
Pisaster ochraceus	0.420	-	-	-	-	0.070	-	-	0.490
Lysmata californica	0.002	0.146	-	0.004	0.003	0.006	-	0.004	0.165
Cancer gracilis	0.059	-	-	-	-	-	-	0.044	0.103
Octopus bimaculatus/bimaculoides	-	0.074	-	-	-	-	-	-	0.074
Portunus xantusii	-	-	-	-	-	0.016	-	0.014	0.030
Pisaster sp	-	-	-	-	0.026	-	-	-	0.026
Navanax inermis	-	-	-	0.003	-	-	-	0.007	0.010
Crangon nigromaculata	-	-	-	0.004	-	-	0.002	-	0.006
Pugettia producta	-	-	-	-	-	-	-	0.003	0.003
Pisaster giganteus	-	-	-	0.001	-	-	-	-	0.001
Polyorchis penicillatus	-	-	-	-	-	0.001	-	-	0.001
Total Biomass (kg)	1.024	2.583	0.262	0.894	3.509	7.826	0.623	0.907	17.628

Appendix G-9. Estimated monthly abundance of macroinvertebrates impinged during normal operations. Ormond Beach Generating Station NPDES, 2007.

	2006		2007					Total
Species	Nov	Dec	Jan	May	Jun	Jul	Aug	Abundance
Cancer antennarius	175	8	75	-	53	69	694	1,074
Cancer anthonyi	7	-	225	-	158	-	145	535
Lysmata californica	220	-	75	26	18	-	29	368
Cancer productus	22	-	75	79	-	-	58	234
Chrysaora colorata	-	-	-	52	88	-	-	140
Navanax inermis	-	-	75	-	-	-	29	104
Crangon nigromaculata	-	-	75	-	-	17	-	92
Pisaster giganteus	-	-	75	-	-	-	-	75
Cancer gracilis	4	-	-	-	-	-	58	62
Pugettia producta	-	-	-	-	-	-	58	58
Portunus xantusii	-	-	-	-	18	-	29	47
Pisaster sp	-	-	-	26	-	-	-	26
Pisaster ochraceus	4	-	-	-	18	-	-	22
Loxorhynchus grandis	-	-	-	-	18	-	-	18
Polyorchis penicillatus	-	-	-	-	18	-	-	18
Octopus bimaculatus/bimaculoides	4	-	-	-	-	-	-	4
Total Abundance	436	8	675	183	389	86	1,100	2,877
Number of species	7	1	7	4	8	2	8	16
Analysis Flow (mg)	1,214	96	233	3,686	6,010	6,010	19,816	

Appendix G-10. Estimated monthly biomass (kg) of macroinvertebrates impinged during normal operations. Ormond Beach Generating Station NPDES, 2007.

	2006		2007					Total
Species	Nov	Dec	Jan	May	Jun	Jul	Aug	Biomass (kg)
Chrysaora colorata	-	-	-	81.313	92.244	-	-	173.557
Cancer antennarius	8.790	0.523	11.425	-	5.261	10.734	23.012	59.745
Cancer productus	1.309	-	38.333	9.967	-	-	0.694	50.303
Cancer anthonyi	0.581	-	16.536	-	25.972	-	0.434	43.522
Loxorhynchus grandis	-	-	-	-	12.135	-	-	12.135
Pisaster ochraceus	1.723	-	-	-	1.228	-	-	2.951
Cancer gracilis	0.257	-	-	-	-	-	1.272	1.529
Lysmata californica	0.525	-	0.301	0.079	0.105	-	0.116	1.125
Portunus xantusii	-	-	-	-	0.281	-	0.405	0.685
Pisaster sp	-	-	-	0.682	-	-	-	0.682
Navanax inermis	-	-	0.225	-	-	-	0.202	0.428
Crangon nigromaculata	-	-	0.301	-	-	0.035	-	0.335
Octopus bimaculatus/bimaculoides	0.262	-	-	-	-	-	-	0.262
Pisaster giganteus	-	-	0.075	-	-	-	-	0.075
Pugettia producta	-	-	0.075	-	-	-	-	0.075
Polyorchis penicillatus	-	-	-	-	0.018	-	-	0.018
Total Biomass (kg)	13.447	0.523	67.270	92.042	137.243	10.768	26.134	347.428
Analysis Flow (mg)	1,214	96	233	3,686	6,010	6,010	19,816	

Appendix G-11. Total abundance of fish impinged during heat treatments and extrapolated normal operations, 1990 - 2007. Ormond Beach Generating Station NPDES, 2007.

	Year																			Percent	
Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	Total	Mean
Seriphus politus	7460	43501	16697	82521	16382	24008	4218	4725	6632	161	361	3057	11089	2684	375	882	202	-	224955	59.53	12497.5
Sardinops sagax	322	86	110	1643	362	1056	197	2921	21434	24	89	295	483	107	632	156	28	2	29947	7.92	1663.7
Cymatogaster aggregata	278	270	997	1333	1023	8830	503	2423	891	8	366	542	532	1397	1113	2716	725	34	23981	6.35	1332.3
Engraulis mordax	301	365	891	631	2022	1600	2169	4329	73	177	564	1144	2095	4076	1395	426	578	-	22836	6.04	1268.7
Hyperprosopon argenteum	1506	1521	3942	550	126	616	10	1353	431	-	2	611	432	266	11	143	80	-	11600	3.07	644.4
Phanerodon furcatus	1606	987	1054	1019	1169	2454	395	926	158	-	35	36	75	86	55	229	204	78	10566	2.80	587.0
Porichthys notatus	1844	1484	999	490	336	432	11	-	-	46	58	1	172	2	-	-	257	26	6158	1.63	342.1
Peprilus simillimus	1	157	72	738	22	16	4	1	1	-	5	3350	186	280	8	30	124	-	4995	1.32	277.5
Genyonemus lineatus	14	707	149	2506	58	679	50	4	433	-	-	101	65	5	-	-	-	-	4771	1.26	265.1
Citharichthys stigmaeus	-	390	230	504	60	240	-	-	-	-	461	1330	102	454	40	19	921	-	4751	1.26	264.0
Atherinops affinis	9	105	30	49	-	44	310	1620	204	-	-	974	37	-	-	-	228	-	3610	0.96	200.6
Scomber japonicus	10	11	1848	400	451	262	5	1	54	-	-	4	1	-	-	3	45	4	3099	0.82	172.2
Platyrhinoidis triseriata	46	322	33	200	76	60	2	50	72	-	29	565	21	205	61	37	127	-	1906	0.50	105.9
Paralabrax nebulifer	159	154	435	142	102	164	47	63	9	13	159	244	59	70	35	22	-	-	1877	0.50	104.3
Syngnathus leptorhynchus	-	-	-	-	-	-	-	-	-	-	-	-	13	22	416	299	301	111	1162	0.31	64.6
Pleuronichthys verticalis	64	118	126	268	104	99	-	99	70	-	202	219	-	74	61	13	101	-	1618	0.43	89.9
Leuresthes tenuis	1	593	364	83	11	-	-	-	-	-	-	127	2	347	-	-	-	-	1528	0.40	84.9
Leptocottus armatus	73	16	27	85	23	1	7	30	98	92	175	463	16	67	121	68	98	-	1460	0.39	81.1
Trachurus symmetricus	194	15	8	266	275	499	-	2	11	-	-	1	-	1	64	60	-	-	1396	0.37	77.5
Myliobatis californica	-	53	78	154	85	2	1	8	15	2	-	740	14	66	-	24	103	-	1345	0.36	74.7
Porichthys myriaster	1	69	-	-	1	-	72	199	25	-	115	212	39	121	22	119	88	69	1152	0.30	64.0
Torpedo californica	38	97	18	62	60	63	105	51	1	48	29	178	-	37	204	83	39	17	1130	0.30	62.8
Sebastes auriculatus	56	69	126	82	66	66	14	30	20	18	41	33	45	120	44	72	21	-	923	0.24	51.3
Paralabrax clathratus	89	63	92	72	57	221	65	52	14	9	20	8	12	25	19	11	-	-	829	0.22	46.1
Ophidion scrippsae	101	106	57	76	48	58	1	-	-	-	29	207	-	24	-	12	42	-	761	0.20	42.3
Symphurus atricaudus	10	7	16	15	28	42	200	49	-	23	-	36	-	-	24	47	140	-	637	0.17	35.4
Rhacochilus toxotes	14	33	4	43	31	15	50	173	30	4	15	17	2	105	59	38	-	-	633	0.17	35.2
Synodus lucioceps	9	7	-	-	7	-	-	-	-	-	-	143	303	-	-	106	37	-	612	0.16	34.0
Scorpaenichthys marmoratus	67	39	26	19	15	43	14	32	6	1	16	24	31	39	77	82	16	-	547	0.14	30.4
Amphistichus argenteus	-	4	-	2	-	-	-	-	190	-	29	118	1	2	-	118	-	-	464	0.12	25.8
Paralichthys californicus	65	17	29	92	14	16	3	1	39	-	-	62	-	31	20	-	10	-	399	0.11	22.2
Pleuronichthys ritteri	-	1	2	-	-	1	-	-	-	-	-	213	87	-	-	47	-	-	351	0.09	19.5
Rhacochilus vacca	67	94	32	27	25	19	1	-	2	4	1	2	50	17	1	5	-	-	347	0.09	19.3
Syngnathus sp	-	15	-	58	1	-	-	-	-	23	175	73	-	-	-	-	-	-	345	0.09	19.2
Embiotoca jacksoni	81	56	28	20	30	30	7	10	7	2	8	11	2	11	8	20	-	-	331	0.09	18.4
Xenistius californiensis	2	26	-	38	12	111	57	11	37	-	1	1	-	-	-	-	-	-	296	0.08	16.4
Heterostichus rostratus	21	14	13	12	44	33	3	2	-	-	1	4	28	1	62	-	-	29	267	0.07	14.8
Chromis punctipinnis	16	22	100	32	16	9	13	8	29	2	2	3	1	7	1	4	-	-	265	0.07	14.7
Parophrys vetulus	9	-	-	-	8	-	-	49	155	-	-	-	-	-	-	-	40	-	261	0.07	14.5
Brachyistius frenatus	18	3	6	36	20	50	17	-	28	-	-	1	1	68	-	-	-	-	248	0.07	13.8
Atherinopsis californiensis	1	28	37	118	7	15	-	-	-	-	1	-	6	19	7	8	-	-	247	0.07	13.7
Acanthogobius flavimanus	-	-	-	-	-	-	-	-	190	23	-	-	-	-	-	-	-	-	213	0.06	11.8
Scorpaena guttata	7	4	2	21	33	17	3	-	5	1	1	33	30	5	4	23	-	17	206	0.05	11.4
Oxyjulis californica	2	4	16	21	8	11	17	3	7	3	43	14	4	1	1	7	19	-	181	0.05	10.1
Rhinobatos productus	27	2	-	17	8	1	4	32	30	-	1	-	4	6	-	-	45	-	177	0.05	9.8

Appendix G-11. (Cont.).

Species	Year 1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	Percent Total	Mean
Pleuronichthys coenosus	1	6	1	19	57	15	1	-	-	-	-	-	-	53	-	-	23	-	176	0.05	9.8
Sebastes paucispinis	29	46	22	8	-	-	-	-	-	-	29	-	1	2	-	31	1	-	169	0.04	9.4
Pleuronichthys decurrens	-	-	-	-	-	-	-	-	-	-	-	-	-	128	-	-	21	-	149	0.04	8.3
Paralabrax maculatofasciatus	-	-	8	-	-	-	47	-	87	-	3	-	-	-	-	-	-	-	145	0.04	8.1
Hypsurus caryi	-	9	12	4	4	11	1	1	-	-	-	-	1	4	-	35	24	-	106	0.03	5.9
Urobatis halleri	-	2	2	3	1	1	-	1	1	23	-	36	17	-	3	1	-	-	91	0.02	5.1
Cheilotrema saturnum	1	4	1	4	17	42	-	-	4	1	1	4	-	-	-	11	-	-	90	0.02	5.0
Raja inornata	-	-	-	1	-	-	-	-	-	-	-	-	67	-	-	-	18	-	86	0.02	4.8
Menticirrhus undulatus	-	10	-	-	1	-	-	-	2	-	-	71	-	-	1	-	-	-	85	0.02	4.7
Triakis semifasciata	-	-	1	-	-	-	-	-	4	-	-	66	-	-	-	12	-	-	83	0.02	4.6
Mustelus californicus	-	15	-	7	-	14	34	-	-	-	-	-	-	-	-	12	-	-	82	0.02	4.6
Squalus acanthias	-	7	8	29	-	-	1	-	12	-	-	-	-	-	-	-	22	-	79	0.02	4.4
Umbrina roncador	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	76	-	-	76	0.02	4.2
Oxylebius pictus	4	-	21	-	4	2	-	-	-	-	1	1	-	5	8	-	19	-	65	0.02	3.6
Heterodontus francisci	-	-	-	-	-	-	-	-	1	-	-	-	1	1	-	59	-	-	62	0.02	3.4
Medialuna californiensis	3	6	6	2	31	10	-	-	-	-	-	-	-	-	2	-	-	-	60	0.02	3.3
Chilara taylori	9	22	-	1	-	-	-	-	-	-	-	-	-	-	-	23	-	-	55	0.01	3.1
Hexagrammos decagrammus	-	3	2	-	-	-	-	-	-	-	-	-	4	11	1	10	21	-	52	0.01	2.9
Citharichthys xanthostigma	-	22	-	7	-	-	-	-	-	-	-	-	-	-	20	-	-	-	49	0.01	2.7
Pleuronichthys guttulatus	-	8	-	-	14	-	-	-	-	23	-	-	-	-	-	-	1	-	46	0.01	2.6
Syngnathus californiensis	-	-	-	-	-	-	-	-	-	-	-	-	11	35	-	-	-	-	46	0.01	2.6
Sebastes miniatus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45	-	45	0.01	2.5
Sebastes serranoides	12	-	9	1	5	-	-	-	-	-	4	-	1	10	1	-	-	-	43	0.01	2.4
Hypsoblennius gilberti	-	1	1	4	4	-	-	-	-	-	-	-	-	1	3	-	-	29	43	0.01	2.4
Atractoscion nobilis	-	6	-	15	3	3	3	2	7	-	1	-	-	-	-	-	-	-	40	0.01	2.2
Ophichthus zophochir	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	39	-	39	0.01	2.2
Sebastes rastrelliger	4	6	3	10	1	6	-	-	2	-	-	-	3	4	-	-	-	-	39	0.01	2.2
Cephaloscyllium ventriosum	-	7	1	23	-	-	-	-	-	-	-	-	3	-	-	-	-	-	34	0.01	1.9
Citharichthys sordidus	-	-	-	-	-	-	-	-	-	-	-	-	34	-	-	-	-	-	34	0.01	1.9
Sebastes atrovirens	-	1	-	1	-	8	1	-	-	-	-	-	13	-	1	-	-	-	25	0.01	1.4
Mustelus sp	-	-	-	-	-	-	-	-	-	23	-	1	-	-	-	-	-	-	24	0.01	1.3
Merluccius productus	-	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	0.01	1.2
Mola mola	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	20	0.01	1.1
Anisotremus davidsonii	1	-	-	2	4	-	-	-	12	-	-	-	-	-	-	-	-	-	19	0.01	1.1
Girella nigricans	11	7	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	19	0.01	1.1
Hyperprosopon ellipticum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	-	19	0.01	1.1
Phanerodon atripes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	-	19	0.01	1.1
Xeneretmus latifrons	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	-	19	0.01	1.1
Xystreurys liolepis	10	-	1	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	18	0.00	1.0
Hydrolagus colliei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	12	0.00	0.7
Hermosilla azurea	-	7	-	-	-	-	-	1	-	-	-	-	3	-	-	-	-	-	11	0.00	0.6
Halichoeres semicinctus	2	-	2	-	-	-	-	-	-	-	-	2	2	2	-	-	-	-	10	0.00	0.6
Sphyraena argentea	-	-	-	8	-	1	-	-	1	-	-	-	-	-	-	-	-	-	10	0.00	0.6
Anchoa compressa	-	-	-	7	1	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0.00	0.4
Hypsoblennius spp	1	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0.00	0.4

Appendix G-11. (Cont.).

Species	Year 1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	Percent Total	Mean
Ophiodon elongatus	1	-	-	-	-	-	-	-	-	-	-	1	1	5	-	-	-	-	8	0.00	0.4
Platichthys stellatus	-	7	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	8	0.00	0.4
Eopsetta jordani	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	7	0.00	0.4
Icichthys lockingtoni	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	7	0.00	0.4
Sebastes caurinus	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	7	0.00	0.4
Hypsoblennius gentilis	-	-	-	1	-	-	-	-	-	2	-	-	-	-	-	3	-	-	6	0.00	0.3
Embiotoca lateralis	-	-	-	-	-	-	-	-	-	-	-	3	-	-	2	-	-	-	5	0.00	0.3
Gibbonsia elegans	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	4	0.00	0.2
Psettichthys melanostictus	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	4	0.00	0.2
Cottidae unidentified	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	3	0.00	0.2
Sebastes flavidus	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	3	0.00	0.2
Semicossyphus pulcher	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-	3	0.00	0.2
Amphistichus koelzi	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	0.00	0.1
Sebastes melanops	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	2	0.00	0.1
Sebastes serriceps	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	0.00	0.1
Zalembius rosaceus	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2	0.00	0.1
Agonopsis sp	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00	0.1
Agonopsis sterletus	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00	0.1
Artedius corallinus	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	0.1
Aulorhynchus flavidus	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00	0.1
Balistes polylepis	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	0.1
Clinocottus sp	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00	0.1
Gibbonsia montereyensis	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	0.1
Neoclinus blanchardi	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	0.1
Ophichthus triserialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00	0.1
Pholidae unidentified	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00	0.1
Raja binoculata	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	0.1
Sebastes goodei	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00	0.1
Sebastes sp	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00	0.1
Syngnathus exilis	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	0.1
Number of individuals	14680	51860	28796	94602	23403	41996	8664	19266	31545	761	3078	15382	16209	11132	4987	6216	4910	416	377903		20994.6
Number of species	54	65	54	60	59	48	41	38	47	28	42	49	54	53	41	47	41	11	120		48.8

Note: 0.00 = <0.005.

Appendix G-12. Fish biomass (kg) collected during heat treatment and estimated normal operation surveys, 1979-2007. Ormond Beach Generating Station

Year	Normal Operation	Heat Treatment	Total
1979	36,741.7	2,375.6	39,117.3
1980	20,437.2	655.9	21,093.1
1981	13,890.5	2,074.5	15,965.0
1982	5,860.0	2,221.8	8,081.8
1983	16,388.1	571.0	16,959.1
1984	6,333.4	374.6	6,708.0
1985	4,018.4	433.2	4,451.6
1986	6,037.9	1,629.0	7,666.9
1987	10,606.6	769.1	11,375.7
1988	1,108.0	793.0	1,901.0
1989	1,163.4	763.8	1,927.2
1990	1,026.7	322.4	1,349.1
1991	1,166.4	1,543.5	2,709.9
1992	346.7	1,312.4	1,659.1
1993	949.7	1,731.1	2,680.9
1994	457.5	646.2	1,103.7
1995	548.8	931.6	1,480.4
1996	395.7	324.9	720.6
1997	561.3	543.7	1,105.0
1998	226.2	715.0	941.2
1999	328.1	33.7	361.8
2000	170.1	141.4	311.5
2001	2,456.4	231.6	2,688.0
2002	255.4	192.3	447.7
2003	536.1	235.2	771.3
2004	1,052.2	110.0	1,162.2
2005	537.6	157.5	695.2
2006	696.4	0.0	696.4
2007	177.3	0.0	177.3
Summary			
Total	134,473.9	21,834.1	156,308.0
Mean	4,637.0	752.9	5,389.9

Appendix G-13. Total abundance of macroinvertebrates impinged during heat treatments and estimated normal operations, 1994 - 2007. Ormond Beach Generating Station NPDES, 2007.

	YEAR														Percent	Cum.
Species	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total	Mean	Total	Percent
Cancer antennarius	138	4434	571	377	5184	5687	79	255	8590	23931	3566	1,074	53886	4490.5	34.39	34.4
Thetys vagina	14	-	-	11488	145	387	9599	29	40	-	3621	-	25323	2110.3	16.16	50.6
Cancer anthonyi	15636	55	-	-	-	-	-	29	-	-	1591	535	17846	1487.2	11.39	61.9
Cancer productus	42	-	-	-	11	-	4559	28	4767	1662	4364	234	15667	1305.6	10.00	71.9
Lysmata californica	353	510	90	22	64	4	371	14	17	457	7265	368	9535	794.6	6.09	78.0
Crangon nigromaculata	35	-	-	417	144	3060	916	58	1236	129	348	92	6435	536.3	4.11	82.1
Cancer gracilis	708	-	-	-	-	1201	1	14	1587	487	2258	62	6318	526.5	4.03	86.2
Portunus xantusii	2352	99	560	730	235	194	355	43	20	12	127	47	4774	397.8	3.05	89.2
Chrysaora colorata	304	77	24	2	1823	-	489	202	-	12	5	140	3079	256.5	1.96	91.2
Farfantepenaeus californiensis	7	-	1	-	29	39	-	-	-	-	2220	-	2296	191.3	1.47	92.6
Pachygrapsus crassipes	1447	-	88	9	5	5	6	2	351	47	221	-	2181	181.8	1.39	94.0
Pisaster giganteus	1	1233	-	-	9	-	-	-	-	-	20	75	1338	111.5	0.85	94.9
Loligo opalescens	80	26	-	23	203	232	59	101	44	23	445	-	1236	103.0	0.79	95.7
Polyorchis penicillata	35	-	-	23	-	1	-	29	433	254	83	18	876	73.0	0.56	96.2
Cancer jordani	-	-	-	75	316	-	-	-	2	195	112	-	700	58.3	0.45	96.7
Anthopleura xanthogrammica	-	-	-	-	-	-	-	-	-	-	691	-	691	57.6	0.44	97.1
Pisaster sp	35	-	3	15	-	15	391	45	49	111	-	26	690	57.5	0.44	97.6
Pyromaia tuberculata	483	-	12	1	-	-	1	-	-	-	171	-	668	55.7	0.43	98.0
Octopus bimaculatus/bimaculoides	14	39	7	73	27	27	28	209	55	57	118	4	658	54.8	0.42	98.4
Loxorhynchus crispatus	2	-	-	-	269	208	1	31	61	37	-	-	609	50.8	0.39	98.8
Loxorhynchus grandis	33	31	5	-	-	1	2	9	90	117	100	18	406	33.8	0.26	99.1
Pugettia producta	21	-	-	30	-	-	-	-	2	2	205	58	318	26.5	0.20	99.3
Panulirus interruptus	3	1	6	3	69	82	2	61	-	-	-	-	227	18.9	0.14	99.4
Caudina arenicola	-	-	-	-	202	1	-	-	-	12	-	-	215	17.9	0.14	99.5
Strongylocentrotus purpuratus	14	-	-	-	5	1	34	30	-	-	42	-	126	10.5	0.08	99.6
Navanax inermis	12	-	-	-	-	-	-	-	-	-	-	104	116	9.7	0.07	99.7
Parastichopus sp	7	1	1	24	-	39	-	-	-	-	-	-	72	6.0	0.05	99.7
Salpa maxima	-	-	-	-	-	-	63	-	-	-	-	-	63	5.3	0.04	99.8
Heptacarpus palpator	-	-	-	-	-	-	-	-	-	-	62	-	62	5.2	0.04	99.8
Megathura crenulata	-	-	-	-	-	41	2	1	1	2	-	-	47	3.9	0.03	99.8
Pisaster ochraceus	-	18	-	-	6	-	-	-	-	-	-	22	46	3.8	0.03	99.9
Heptacarpus pictus	-	-	-	-	-	-	-	-	-	-	44	-	44	3.7	0.03	99.9
Urechis caupo	-	-	-	-	-	-	-	-	20	23	-	-	43	3.6	0.03	99.9
Pelia tumida	-	-	-	-	-	-	-	-	-	-	28	-	28	2.3	0.02	100.0
Parastichopus parvimensis	-	-	-	-	-	-	-	-	-	-	19	-	19	1.6	0.01	100.0
Cancer sp	-	-	-	-	18	-	-	-	-	-	-	-	18	1.5	0.01	100.0
Protothaca tenerrima	-	-	-	-	-	-	-	-	-	-	10	-	10	0.8	0.01	100.0
Taliepus nuttallii	-	-	-	-	-	-	-	-	-	-	10	-	10	0.8	0.01	100.0
Pleuroncodes planipes	7	-	-	-	-	-	-	-	-	-	-	-	7	0.6	0.00	100.0
Hemigrapsus nudus	-	-	-	-	-	-	-	6	-	-	-	-	6	0.5	0.00	100.0
Chorilia longipes	-	-	-	-	-	-	-	-	3	-	-	-	3	0.3	0.00	100.0
Pisaster brevispinus	2	-	-	-	-	-	-	-	-	-	-	-	2	0.2	0.00	100.0
Number of individuals	21785	6524	1368	13312	8764	11225	16958	1196	17368	27570	27746	2877	156693	13057.8		
Number of species	26	12	12	16	19	19	19	20	19	19	27	16	42	18.7		

Note: 0.00 = <0.005.