MBC

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
2005 RECEIVING WATER MONITORING REPORT
RELIANT ENERGY ORMOND BEACH GENERATING STATION
VENTURA COUNTY, CALIFORNIA

2005 Survey

Prepared for:

Reliant Energy

Prepared by:

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

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March 2006

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EXECUTIVE SUMMARY

The 2005 National Pollutant Discharge Elimination System (NPDES) marine monitoring program for the Reliant Energy Ormond Beach Generating Station, Inc. (owned and operated by Houston Industries) 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 2005 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 2005 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

No thermal influence from the discharge was noted during the winter sampling in 2005. During summer, a warm water surface lens was observed near the discharge, consistent with operations on the day of sampling. Still, temperatures recorded during both seasons were among the lowest found in the last 20 years. Dissolved oxygen (DO) concentrations in winter were typical of the study area, while some DO levels in summer were among the lowest found offshore the generating station. These levels are likely related to the early morning timing of the sampling and reflect normal nighttime DO consumption. As expected, most DO concentrations were higher later in the day as a result of increased photosynthetic activity. Despite some low DO levels in summer most concentrations were in the range recorded in previous sampling. Values of pH and salinity were consistent during both seasons and appeared unaffected by the operation of the generating station.

With the exception of the warm water plume near the discharge during summer, variations in water quality parameters observed in 2005 can be attributed to natural physical and biological processes. Water quality measurements indicated that in 2005 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

Sediments in the study area in 2005 were similar among most stations, consisting primarily of sand with lesser amounts of gravel, silt, and clay. Mean grain size in the study area in 2005 was the greatest on record, a result of the very coarse sediments found upcoast of the discharge. Excluding that station, sediments in 2005 were finer than the long-term mean, but consistent with mean grain size recorded in most previous surveys. Sediment characteristics were otherwise similar at the remaining stations, with mean grain size slightly coarser at the discharge than at most other stations. A localized pattern of coarser grain size associated with the discharge plume, observed in several previous studies, was apparent in 2005. The degree of influence of the discharge on local sediments varies from year to year, suggesting a localized and transitory effect near the discharge; however, sediment composition and distribution in the study area appeared to be affected primarily by natural causes and secondarily from sand disposal activities.

Sediment Chemistry

In 2005, lowest concentrations of all metals, about one-half the concentrations at the remaining stations were, found in sediments upcoast of the discharge where sediments were coarsest. Highest metal concentrations did not appear to be related to the percent of fine material in the sediments, likely a result of similarity in sediment characteristics and relatively low metal concentrations typically found in sediments in the area. Differences between the highest and lowest levels were relatively small, and all sediment metal values were within the range of normal values in the area. As during previous surveys, all sediment metal levels were well below concentrations determined to be potentially toxic to marine organisms. Metal levels in the area vary slightly from year to year and no long-term pattern of metal concentrations relative to the discharge was apparent. Concentrations of sediment metals in 2005 did not appear to be influenced by the operation of the Ormond Beach Generating Station.

MUSSEL BIOACCUMULATION

In 2005, California mussels (*Mytilus californianus*) were collected from the Ormond Beach Generating Station discharge buoy. Mussels were returned to the laboratory for chemical analysis. Tissues from the mussels were analyzed for bioaccumulation of the metals chromium, copper, nickel, and zinc. In 2005, analytical reporting limits for bioaccumulated metals were at least one order of magnitude lower than in previous monitoring.

Three metals, chromium, copper and nickel occurred in elevated or highly elevated concentrations in 2005. Zinc levels were typical of the area and not elevated. Periodic high metal levels have been noted previously in the area, possibly related to exposure to antifouling compounds used on the discharge buoy. All metal levels exceeded concentrations found at a reference site in 2005, but were withing the range of concentrations found previously at the discharge.

Concentrations of chromium and copper in mussel tissues from the vicinity of the discharge were found at levels considered elevated by the SMWP in 2005. Nickel concentration was highly elevated. Zinc concentration at the discharge was not elevated and similar to values found previously in the area and at the reference site. Still, metal concentrations in 2005 were within ranges found previously in the area and in other surveys throughout the Southern California Bight. Although it is difficult to determine metal sources, the increased chromium values in the area are not likely to be a result of generating station operations since the characteristics of the discharge were similar to previous years.

BENTHIC INFAUNA

The infauna communities at the six stations in the study area in 2005 were composed primarily of annelid worms, arthropods, nemertean worms, small sand dollars, lancelets, and nematodes. A total of 133 species was collected, with a mean of 47 species per station. Mean density of organisms for the study area was 4,013 individuals/m^2. The communities were similar among stations, although the community immediately upcoast of the discharge was least similar to those elsewhere, with lower abundance, fewer species, and a somewhat different group of dominant species than were found elsewhere. The communities at and inshore of the discharge were similar to those downcoast of the discharge and farthest upcoast. Community abundance, species richness, and composition appear to be strongly related to sediment characteristics, as higher infaunal parameter values were found for locations where sediments were finer, indicating more stable environments. The annelids *Apoprionospio pygmaea* and *Mediomastus acutus*, occurring at all but one station, were the two most abundant species, comprising 13% and 8% of all individuals collected, respectively. Pacific sand dollar (*Dendraster excentricus*) was the most abundant species immediately upcoast of the discharge; the lancelet *Branchiostoma californiensis*, not usually found in the study area, was also abundant there.

Mean density of infaunal organisms in 2005 was slightly below the mean for 2004 and substantially below the long-term mean for summer surveys conducted in the study area since 1978. Mean species richness and diversity were similar to the means for 2004 and to the long-term means. Most of the community dominants in 2005 have been among the long-term most abundant species. Unlike 2005, abundance has usually been greatest immediately upcoast of the discharge, where sediments were coarsest, and lowest farthest downcoast. In general, species richness and diversity have been higher at the stations downcoast of the discharge than at or upcoast of the discharge area, while both parameters have been lowest inshore of the discharge. These results are consistent with the long-term sediment characteristics. No adverse effects of the discharge were observed for the infauna communities in 2005.

IMPINGEMENT

One heat treatment and 11 normal operation surveys were conducted during the 2005 monitoring year at Ormond Beach Generating Station. An estimated total of 6,216 individuals weighing 695 kg representing 47 fish species were impinged during the survey year. A total of 27,570 individuals weighing 1,904 kg representing 19 macroinvertebrate species were impinged at Ormond Beach Generating Station during one heat treatment and 11 normal operation surveys in 2005.

Fish and macroinvertebrates species collected during impingement surveys at the Ormond Beach Generating Station in 2005 were similar to those of the last 15 years, indicating a healthy, stable community in the nearshore area. Fluctuations in fish and macroinvertebrate abundance and biomass appear to be due in part to natural population variation, although recent declines in impingement catches are probably related to reductions in intake flow. There was no indication that the operation of the generating station adversely affected the core species populations.

CONCLUSIONS

The overall results of the 2005 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 2005 receiving water monitoring studies conducted for the Ormond Beach Generating Station, which is owned and operated by Reliant Energy. The 2005 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 2005 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 14 April 2005 winter survey, none of the four circulator pumps were operating. During the 14 July 2005 summer survey, the generating station operated four of four circulator pumps, discharging at the rate of 679.13 mgd. Intake temperature was 15.6°C, with an increase in water temperature across the condensers of 15.6°C, resulting in a discharge temperature of 31.2°C. During 2005, the Ormond Beach Generating Station operated at 8.46% of its total operating capacity (Norfolk 2005, 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

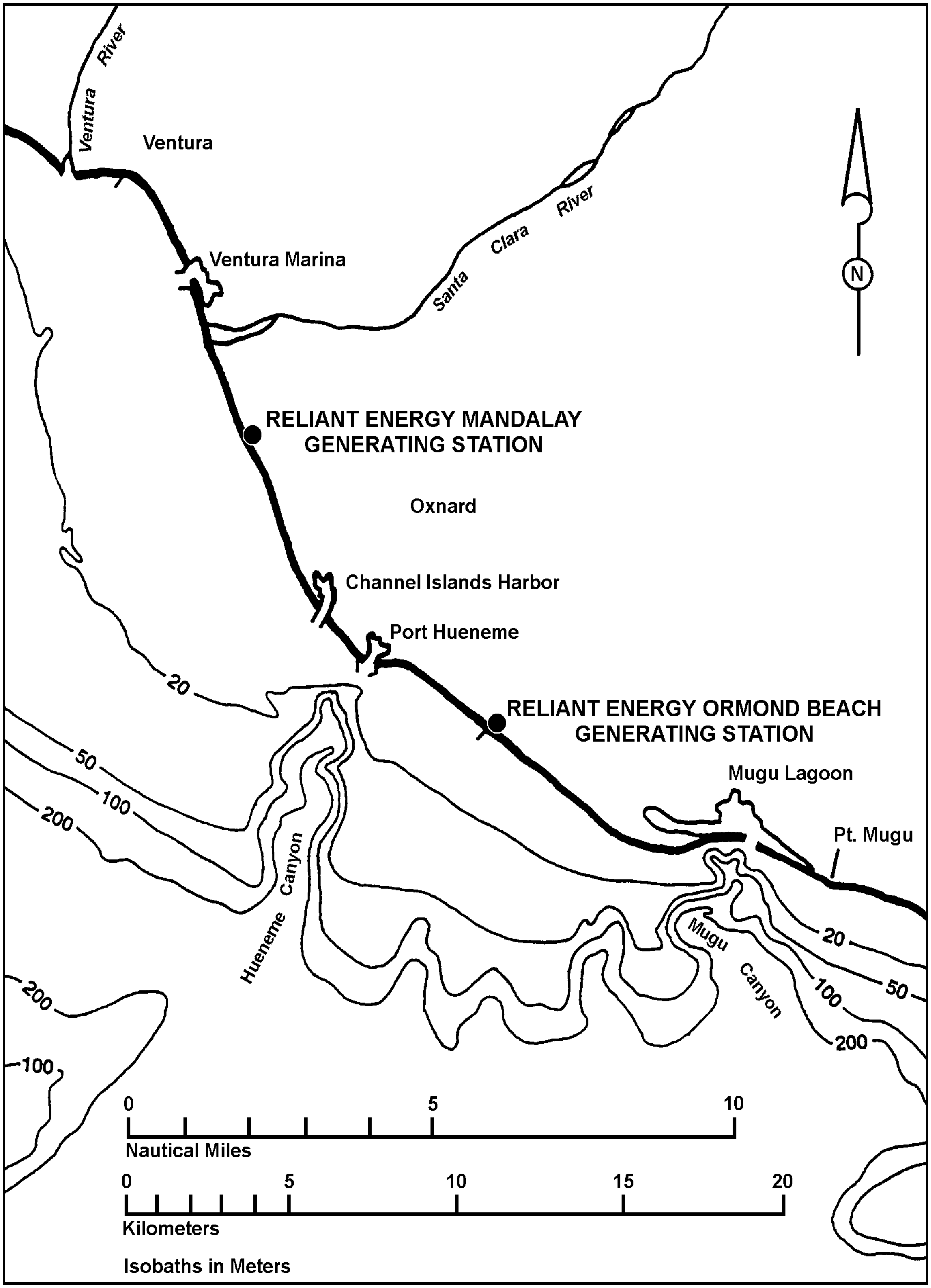


Figure 1. Location of the study area. Ormond Beach Generating Station NPDES, 2005.

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.

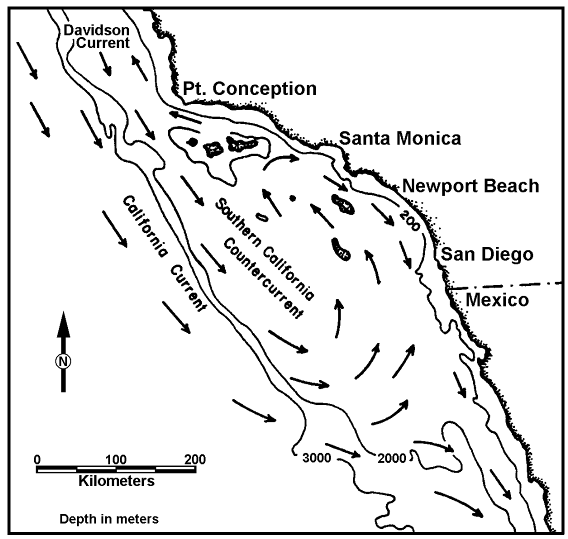


Figure 2. Surface circulation in the Southern California Bight (from Jones 1971). Ormond Beach Generating Station NPDES, 2005.

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 sports 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 2005 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 2005 monitoring program included nine water quality (RW) stations, and six sediment and benthic infauna (B) stations.

FIELD OBSERVATIONS

The NPDES water quality monitoring surveys were conducted on 14 April and 14 July, and benthic sampling was conducted on 28 June 2005. Latitude and longitude coordinates for all receiving water (RW) and benthic (B) stations are listed in Table 1.

Table 1. Latitude/longitude coordinates of sampling stations. Ormond Beach Generating Station NPDES, 2005.

Stations			
Water Quality	Benthic	Latitude	Longitude
RW1	B1	34°07.70'	119°10.98'
RW2	B2	34°07.51'	119°11.68'
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'

During the winter survey, no oil sheens, grease, floatables, or red tide (plankton bloom) were observed at any of the stations. The water was slightly turbid at Stations RW4, RW5, and RW8 on the ebb tide and slightly turbid at all receiving water stations on the flood tide. Western gulls (*Larus occidentalis*) were seen throughout the monitoring area. Forster's tern (*Sterna forsteri*) were seen at Station RW3 and cormorants (*Phalacrocorax* spp) were seen at Stations RW1 and RW2. No California brown pelicans

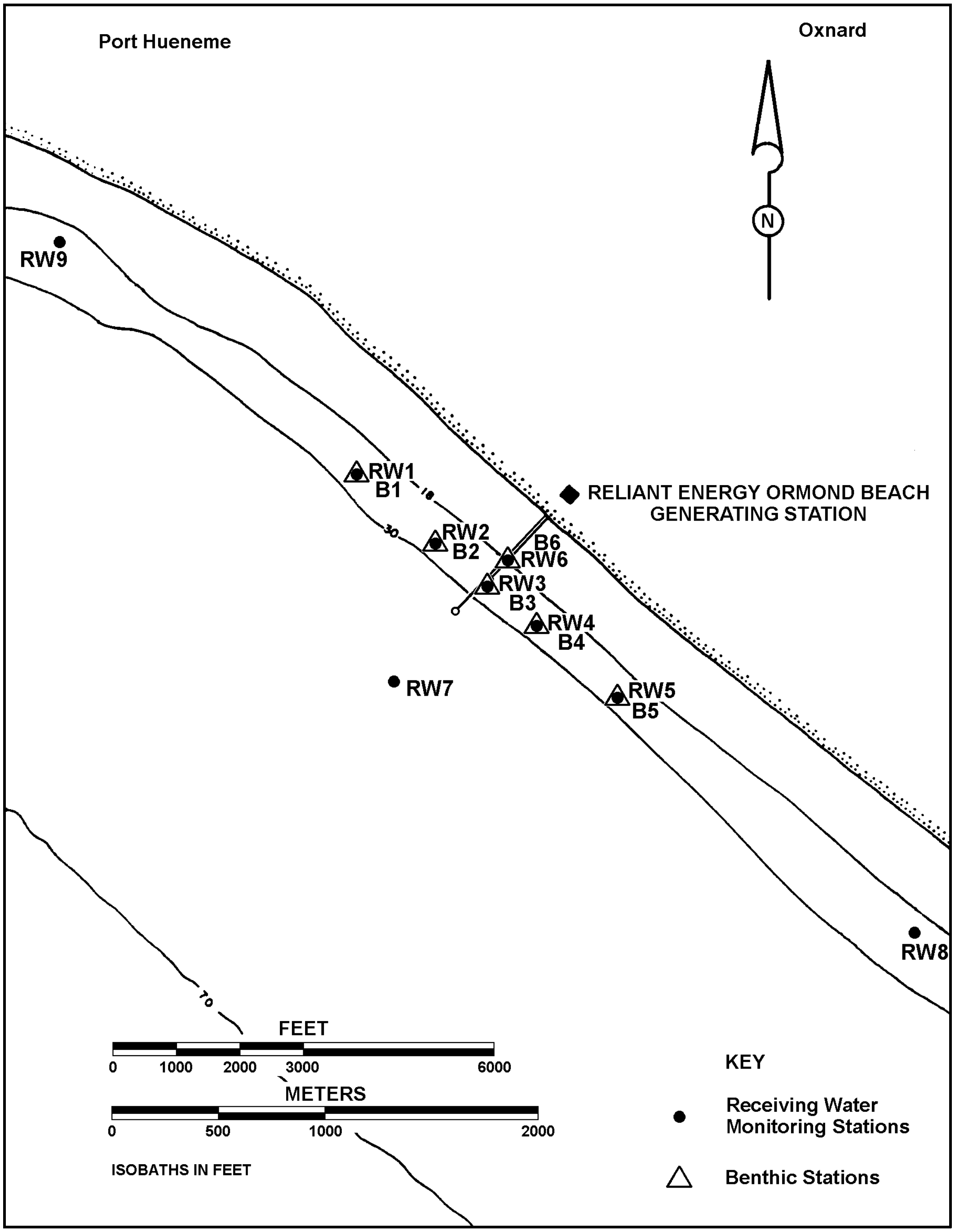


Figure 3. Location of the monitoring stations. Ormond Beach Generating Station NPDES, 2005.

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

During the summer surveys, no oil sheens, grease, or red tide were observed at any of the stations. The water was slightly turbid at Stations RW3 and RW6 on the ebb tide. Drift kelp (*Macrocystis pyrifera*) was noted at Station RW2 on the flood tide. Western gulls were observed throughout the water quality monitoring area and at most sediment core collection stations. Heermann's gulls (*Larus heermanni*) were seen at most of the receiving water stations, Forster's terns were seen at Stations RW3 and RW5 through RW7, and cormorants were seen at Stations RW3, RW4, and RW8. California brown pelicans were seen throughout the water quality monitoring area and Station B5. No California least terns were observed during the summer surveys.

STATISTICAL ANALYSES

Summary statistics developed from the biological data included the number of individuals (expressed as both trawl and 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

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

Trawl 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

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

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 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 each station during the winter and summer surveys. Sampling was conducted on both flood and ebb tides at each of the nine 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.

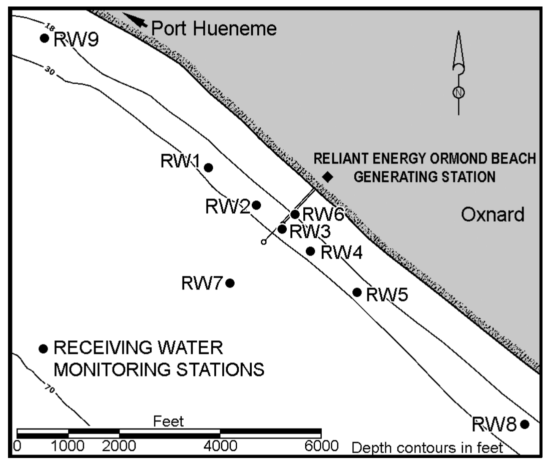


Figure 4. Location of the water column sampling stations. Ormond Beach Generating Station NPDES, 2005.

Winter water quality was monitored at Stations RW1 through RW9 on 14 April 2005 during ebb and flood tides. Ebb tide was monitored between 0614 and 0700 hours (hr) and flood tide was monitored between 1108 and 1150 hr (Figure 5). On the day of monitoring, the tide fell from a high of +4.6 ft Mean Lower Low Water (MLLW) at 0036 hr to a low of +0.5 ft MLLW at 0909 hr, then rose to a high of +4.2 ft MLLW on 15 April 2005 at 0132 hr. Skies were clear with winds that changed from northeast at 5 to 8 kn to west at 8 to 12 kn by mid-morning. Seas were west at 2 to 4 ft.

Summer water quality was monitored at Stations RW1 through RW9 on 14 July 2005 during

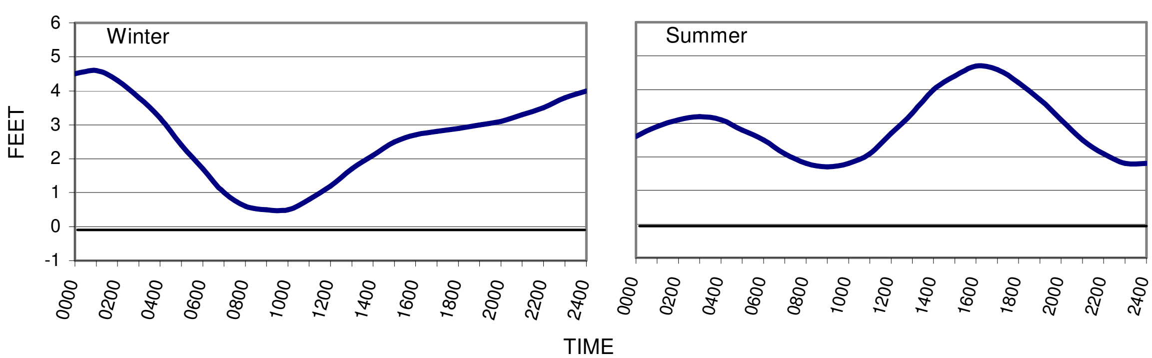


Figure 5. Tidal rhythms during water column monitoring, winter and summer surveys. Ormond Beach Generating Station NPDES, 2005.

ebb and flood tides. Ebb tide was monitored between 0623 and 0711 hr and flood tide was monitored between 1113 and 1156 hr (Figure 5). On the day of monitoring, the tide fell from a high of +3.2 ft MLLW at 0302 hr to a low of +1.7 ft MLLW at 0905 hr, then rose to a high of +4.7 ft MLLW at 1615 hr. Skies were overcast to partly cloudy with winds from the west at 2 to 8 kn. Seas were west at 4 to 7 ft.

RESULTS

Receiving water monitoring stations are shown in Figure 4. Water quality data were collected during the flood and ebb tide at each station. During both seasons, ebb tide was sampled in the early morning, while flood tide was sampled late morning. Water quality data are presented in Appendix C and summarized in Table 2.

Temperature

During winter, surface water temperatures averaged 11.18°C during ebb tide and 11.95°C during flood tide (Table 2). Surface temperatures were similar among stations and between tides in winter, varying during the survey by only about 1.5°C. During ebb tide, surface temperatures ranged from 11.02°C at Station RW9, 7,920 ft upcoast of the discharge to 11.27°C at Station RW7, the deepest station, offshore of the discharge at a depth of 40 ft. During flood tide, surface temperatures ranged from 11.23°C at Station RW9 to 12.51°C at Station RW8, 7,920 ft downcoast of the discharge. Surface temperatures at each station generally varied by 1°C or less between tides except at Station RW8 where surface temperature varied by 1.28°C (Appendix C-1). Temperatures were relatively consistent throughout the water column on both tides with no strong thermal gradients (Figure 6). The greatest surface-to-bottom difference occurred at Station RW7 (0.68°C) on ebb tide and at Station RW8 (1.63°C) on flood tide (Appendix C-1). Bottom water temperatures averaged 10.83°C during ebb tide and 11.18°C during flood tide (Table 2). Ebb tide near-bottom temperatures ranged from 10.59°C at Station RW7 to 10.93°C at Station RW6, the shallowest station, inshore of the discharge at a depth of 20 ft. During flood tide, near-bottom temperatures ranged from 10.78°C at Station RW7 to 11.62°C at Station RW6. No surface water warming associated with the discharge was noted in winter 2005.

Table 2. Summary of water quality parameters during flood and ebb tides. Ormond Beach Generating Station NPDES, 2005.

	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	11.95	11.18	7.59	6.22	8.00	7.91	33.55	33.68	11.18	10.83	6.44	5.54	7.91	7.87	33.68	33.75
Minimum	11.23	11.02	6.16	5.89	7.90	7.88	33.49	33.62	10.78	10.59	5.21	5.04	7.86	7.85	33.60	33.72
Maximum	12.51	11.27	8.61	6.54	8.07	7.92	33.66	33.75	11.62	10.93	7.45	5.94	7.98	7.89	33.75	33.78
Summer																
	Surface								Bottom							
	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb	flood	ebb
Mean	14.34	13.25	6.42	5.89	7.94	7.90	33.51	33.53	12.03	11.78	5.19	5.11	7.82	7.83	33.56	33.57
Minimum	13.27	12.58	5.95	4.97	7.90	7.83	33.50	33.48	10.87	11.64	3.55	4.60	7.66	7.81	33.52	33.56
Maximum	15.39	14.98	7.35	7.60	7.98	8.09	33.53	33.56	13.77	12.26	6.69	5.85	7.98	7.87	33.63	33.60

During the summer, surface temperatures averaged 13.25°C during ebb tide and 14.34°C during flood tide (Table 2). Surface temperatures were also relatively similar among stations and between tides in summer, varying during the survey by less than 2.2°C. Ebb tide surface temperatures ranged from 12.58°C at Station RW1, 3,000 ft upcoast of the discharge to 14.98°C

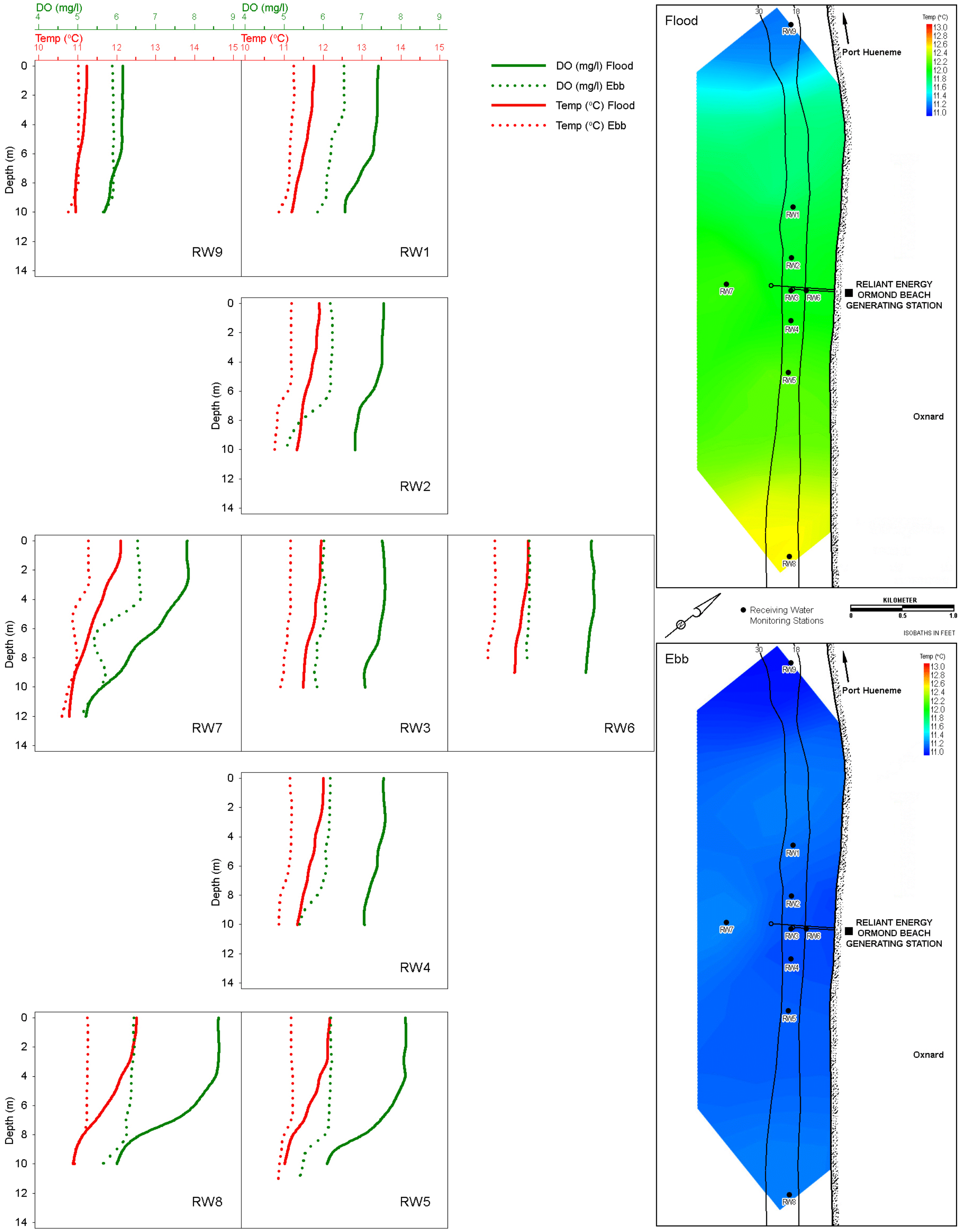


Figure 6. False color surface temperature contour plots and temperature and dissolved oxygen vertical profiles during flood and ebb tides, winter survey. Ormond Beach Generating Station NPDES, 2005.

at Station RW7. Surface temperatures during flood tide ranged from 13.27℃ at Station RW9 to 15.39℃ at Station RW6. Surface temperatures generally varied by about 2℃ between tides and were warmer on flood tide except at Station RW7 where surface temperature was 1.18°C warmer during the early morning ebb tide (Appendix C-2). During ebb tide temperatures were fairly consistent with depth throughout the water column and there were no strong thermal gradients (Figure 7). The greatest surface-to-bottom difference during ebb tide (2.72°) was found at Station RW7 (Appendix C-2). During flood tide, stronger thermal gradients occurred at most stations below a depth of 2 to 4 m, with mild thermoclines below about 8 m depth at upcoast Stations RW1 and RW2 (Figure 7). The greatest surface-to-bottom temperature difference of 3.93 °C occurred at Station RW8 on flood tide (Appendix C-2). Bottom water temperatures in 2005 averaged 11.78°C during ebb tide and 12.03°C during flood tide. Ebb tide water temperatures ranged from 11.64°C at Stations RW1 and RW2 to 12.26°C at Station RW7 (Table 2). Flood tide bottom water temperatures ranged from 10.87°C at Station RW8 to 13.77°C at Station RW6.

Dissolved Oxygen

In winter, surface dissolved oxygen (DO) concentrations during ebb tide averaged 6.22 mg/l and ranged from 5.89 mg/l at Station RW9 to 6.54 mg/l at Station RW1 (Table 2). During flood tide, surface DO concentrations averaged 7.59 mg/l and ranged from 6.16 mg/l at Station RW9 to 8.61 mg/l at Station RW8. Near-bottom DO values averaged 5.54 mg/l during ebb tide, and 6.44 mg/l during flood tide. During both tides DO was relatively consistent to about 8 m depth then decreased to the bottom (Figure 6). Dissolved oxygen concentrations in the upper water column were generally 1.5 to 2 mg/l higher during the later flood tide sampling except at Station RW9 where surface concentrations were similar to values recorded during flood tide. Maximum surface-to-bottom DO differentials occurred at Station RW7 (1.43 mg/l) during ebb tide, and at Station RW8 (2.61 mg/l) during flood tide (Appendix C-2).

In summer, surface dissolved oxygen (DO) concentrations during ebb tide averaged 5.89 mg/l and ranged from 4.97 mg/l at Station RW4, 1,000 ft downcoast of the discharge, to 7.60 mg/l at Station RW7 (Table 2). During flood tide, surface DO concentrations averaged 6.42 mg/l and ranged from 5.95 mg/l at Station RW9 to 7.35 mg/l at Station RW8. Near-bottom DO values averaged 5.11 mg/l during ebb tide, and 5.19 mg/l during flood tide. Near-bottom DO concentrations below 5 mg/l occurred at six of the nine stations during the early morning low tide and at Stations RW7 and RW8 on flood tide. Dissolved oxygen concentrations in the upper water column were generally higher during the later flood tide sampling except at Station RW7 where concentrations throughout the water column were about 1.3 mg/l higher during ebb tide. With the exception of Station RW6 DO was relatively consistent with depth on ebb tide (Figure 7). Dissolved oxygen concentrations were generally more variable with depth during the later flood tide sampling. Subsurface DO maxima were found at most stations during both tides. Maximum surface-to-bottom DO differentials occurred at Station RW5 (1.42 mg/l) during ebb tide, and at Station RW8 (3.80 mg/l) during flood tide (Appendix C-2).

Hydrogen Ion Concentration

In winter, surface hydrogen ion concentrations (pH) averaged 7.91 during ebb tide and 8.00 during flood tide (Table 2). Ebb tide pH values ranged from 7.88 at Station RW9 to 7.92 at Stations RW1, RW7 and RW8. Flood tide pH values ranged from 7.90 at Station RW9 to 8.07 at Station RW8. Bottom pH values averaged 7.87 during ebb tide and 7.91 on flood tide. Ebb tide bottom values ranged from 7.85 at Station RW2 to 7.89 at Station RW3. Flood tide bottom pH values ranged from 7.86 at Station RW7 to 7.98 at Station RW6. Hydrogen ion concentrations did not vary noticeably with depth at any station and overall ranged narrowly, varying by only 0.23 among stations and between tides in winter (Figure 8).

Surface pH values in the summer averaged 7.90 during ebb tide and 7.94 during flood tide (Table 2). Ebb tide pH values ranged from 7.83 at Station RW4 to 8.09 at Station RW7. Flood tide

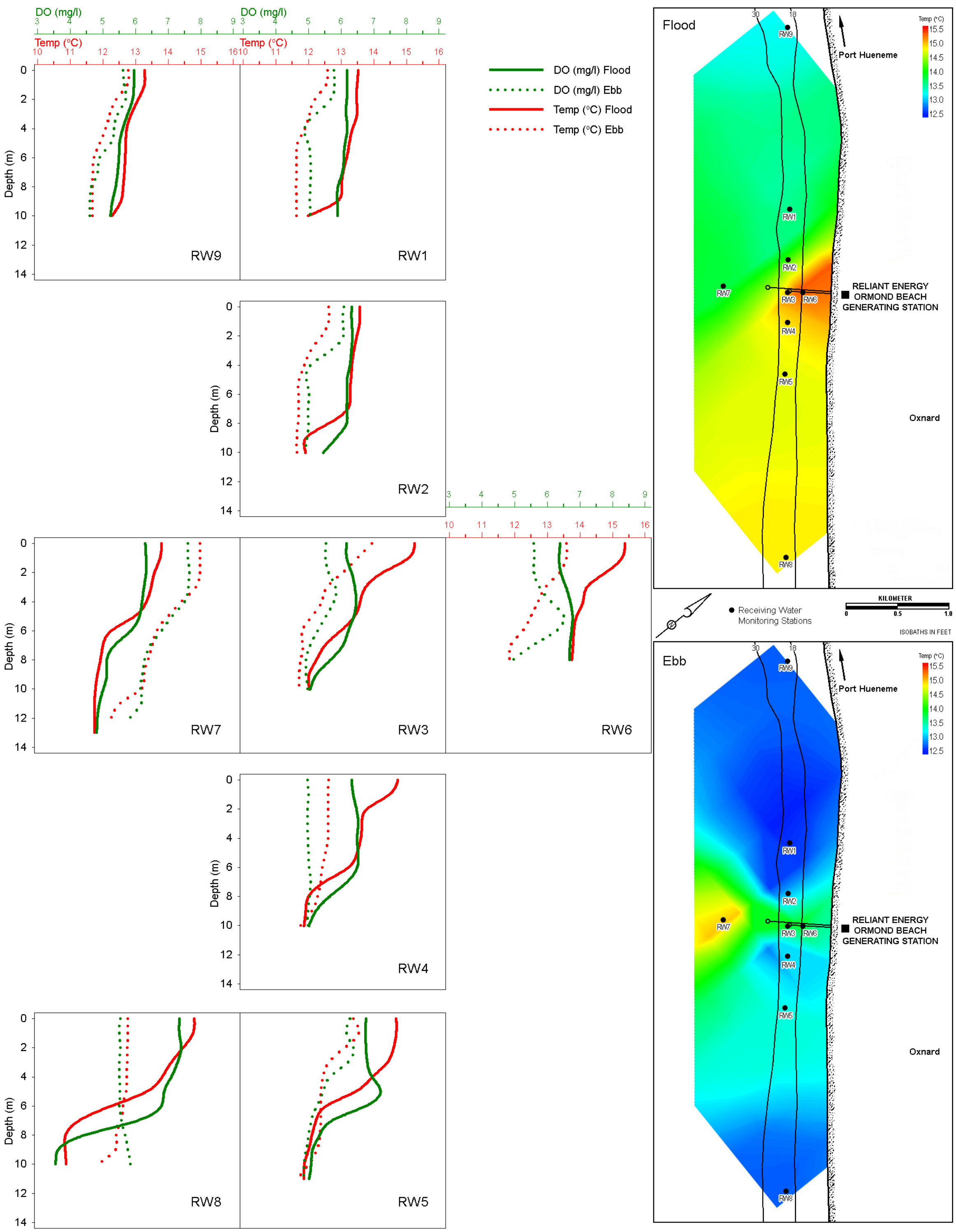


Figure 7. False color surface temperature contour plots and temperature and dissolved oxygen vertical profiles during flood and ebb tides, summer survey. Ormond Beach Generating Station NPDES, 2005.

pH values ranged from 7.90 at Station RW9 to 7.98 at Stations RW5 and RW8. Bottom pH values averaged 7.83 during ebb tide and 7.82 on flood tide. Ebb tide bottom values ranged from 7.81 at

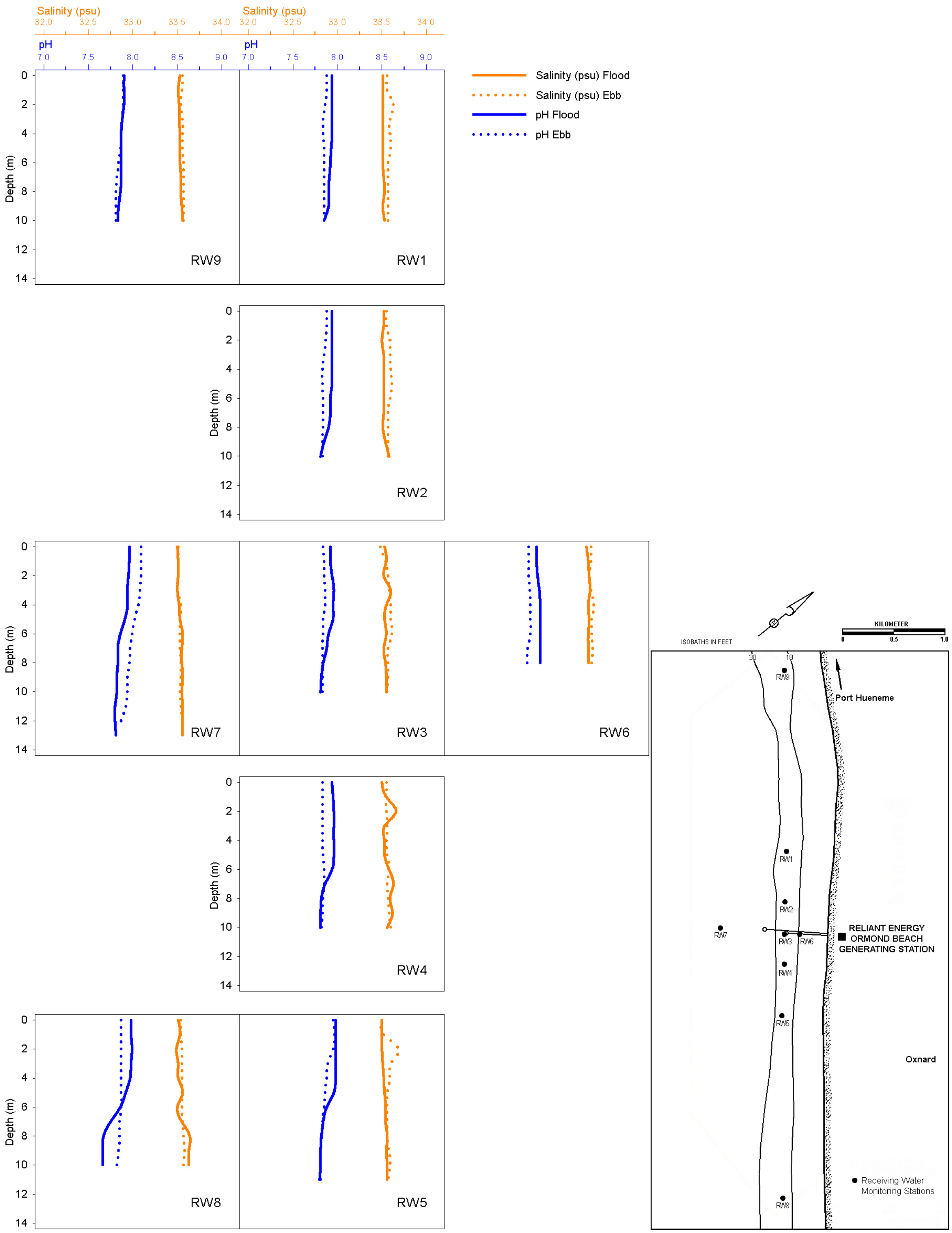


Figure 8. Hydrogen ion concentration (pH) and salinity vertical profiles during flood and ebb tides, winter survey. Ormond Beach Generating Station NPDES, 2005.

Stations RW5 and RW9 to 7.87 at Station RW7. Flood tide bottom pH values ranged from 7.66 at Station RW8 to 7.98 at Station RW6. Hydrogen ion values were relatively consistent throughout the water column, although generally higher and slightly more variable on flood tide (Figure 9). In summer, pH varied by less than 0.5 among stations and between tides.

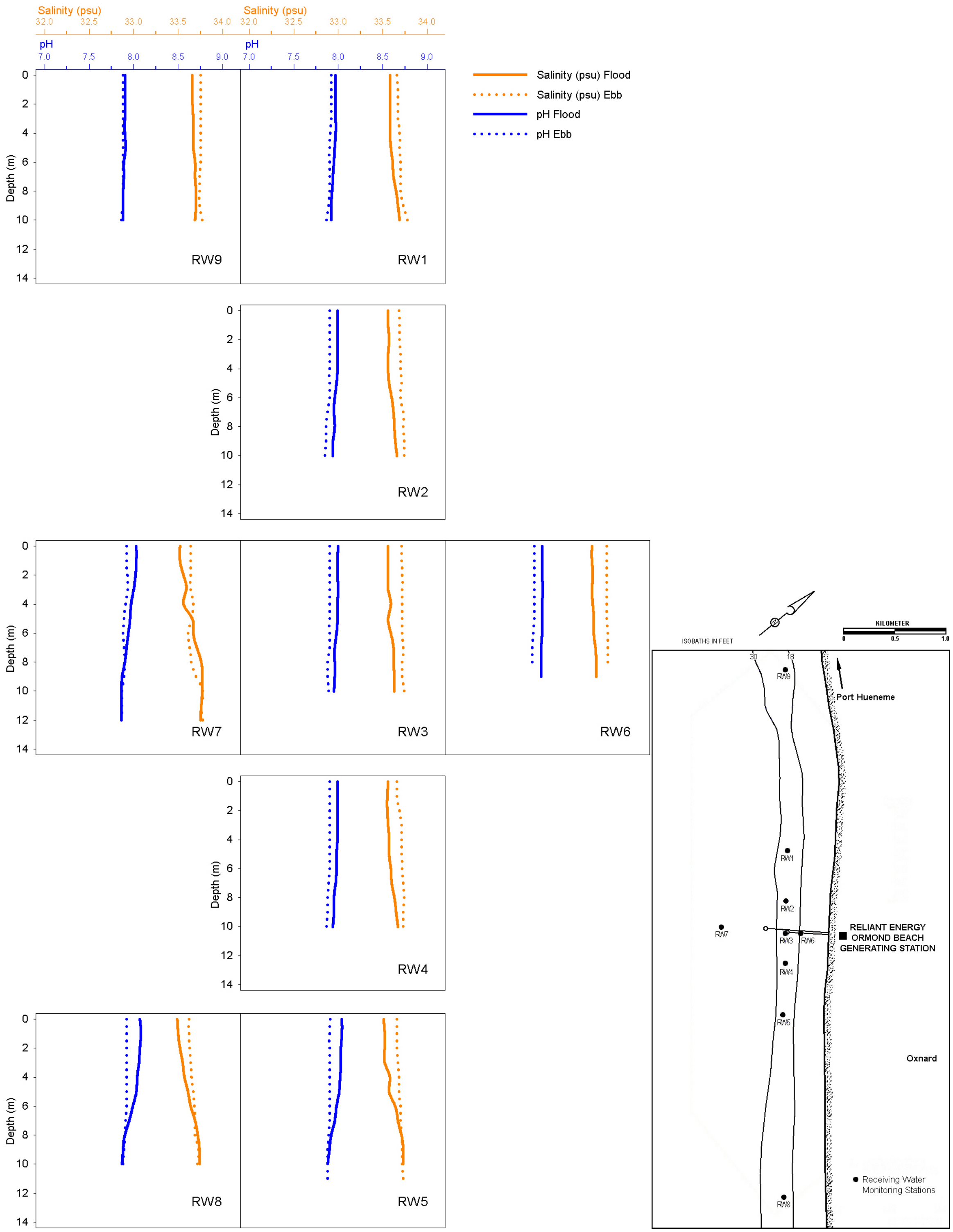


Figure 9. Hydrogen ion concentration (pH) and salinity vertical profiles during flood and ebb tides, summer survey. Ormond Beach Generating Station NPDES, 2005.

Salinity

Winter surface salinities averaged 33.68 practical salinity units (psu) during ebb tide and 33.55 psu during flood tide (Table 2). Ebb tide salinities ranged from 33.62 to 33.75 psu, while flood tide salinities ranged from 33.49 to 33.66 psu. Bottom salinities averaged 33.75 psu during ebb tide and 33.68 psu during flood tide. Salinities remained consistent with depth during both tides, although generally slightly lower and more variable during flood tide (Figure 8). In winter, salinity varied by less than 0.3 psu among stations and between tides.

Summer surface salinity averaged 33.53 psu during ebb tide and 33.51 on flood tide (Table 2). Salinities ranged from 33.48 to 33.56 psu during ebb tide and 33.50 to 33.53 psu during flood tide. Near-bottom water salinities averaged 33.57 psu on ebb tide and 33.56 psu on flood tide. Salinity values were relatively uniform on both tides and with depth at all stations, although slightly more variable at some stations on flood tide (Figure 9). In summer, salinity varied by less than 0.2 psu among stations and between tides.

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 circulator pump was in operation at the Ormond Beach Generating Station (Norfolk 2005, pers. comm.). During winter temperatures throughout most of the upper water column during late morning flood tide sampling were higher than those found on ebb tide, likely a result of solar insolation. All surface temperature values were similar, varying by 1.5°C or less among stations and between tides. Surface temperatures in 2005 were among the coolest found in the area with mean temperatures approximately 2-3°C cooler than typical in previous winter surveys (MBC 1986, 1988, 1990, 1994-1999, 2000a, 2001-2002, 2003a-2004a; Ogden 1991-1993). Temperatures decreased slightly from surface to bottom at all stations during both tides, with similar temperature gradients during both tides. Water temperatures at Station RW3, nearest the discharge, were similar to those found throughout the sampling area and no thermal influence from the Ormond Beach Generating Station discharge was evident during the 2005 winter sampling (Figure 6).

During the summer water quality sampling all four circulator pumps were in operation at the Ormond Beach Generating Station, circulating 679 mgd of cooling water with a discharge temperature of 15.6°C, (2°F) above ambient water temperature (Norfolk 2005, pers. comm.). As in winter, surface temperatures were 2-3°C cooler than typical in previous summer surveys with temperatures similar to those last seen in the area in 1999 (MBC 1986, 1988, 1990, 1994-1999, 2000a, 2001-2002, 2003a-2004a; Ogden 1991-1993). In summer, temperature gradients at the upcoast stations were similar between flood and ebb tides, while stations in the vicinity and downcoast of the discharge were more variable between tides. Surface temperatures generally varied by about 2°C between tides and were warmer on flood tide except the offshore station where surface temperature was warmer during the early morning ebb. A warm water surface lens was noted at and offshore of the discharge during the early morning ebb tide, while during flood tide, warmer near-surface water temperatures were found at, inshore and downcoast of the discharge than occurred offshore and upcoast of the discharge (Figure 7). These patterns 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 lower than typical in the area during previous surveys. Other than on flood tide at the shallowest station inshore of the discharge the thermal field did not contact the seafloor.

The concentration of dissolved oxygen 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 fluctuates 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 relative consistent during both tides to a depth of about 8 m then decreased to the bottom, with similar DO profiles between tides. Dissolved oxygen concentrations in the upper water column were generally 1.5 to 2 mg/l higher during the later flood tide sampling except at the far upcoast station where surface concentrations were similar to those recorded during flood tide. Increased DO in the water column during the later flood sampling is probably attributable to increased phytoplanktonic photosynthesis following the early morning sampling. All DO values from the winter survey were within the range normally found in the area (MBC 1986, 1988, 1990, 1994-1999, 2000a, 2001-2002, 2003a-2004a; Ogden 1991-1993) and above the level of biological concern.

In summer, DO values were more variable among stations and between tides than during the winter surveys, even though concentrations varied less throughout the water column than in winter. Dissolved oxygen concentrations in the upper water column were generally higher during the later flood tide sampling except offshore of the discharge where concentrations throughout the water column were about 1.3 mg/l higher during ebb tide. Dissolved oxygen concentrations were more variable with depth during the later flood tide sampling, however subsurface DO maxima were found at most stations during both tides. During the early morning ebb tide sampling, near-bottom DO concentrations at five stations, and DO throughout the column at the station downcoast of the discharge, were at or below concentrations considered of biological concern. These levels are likely a result of overnight consumption of DO by organisms. Dissolved oxygen levels had been replenished by photosynthetic activity at most stations by the late morning sampling, Two exceptions were offshore of the discharge, where DO values were higher during the earlier sampling, and at the station farthest downcoast where the lowest concentration of the survey (3.55 mg/l) was found near-bottom. Although not noted during the survey, DO concentrations during summer where consistent with red-tide conditions. While some DO levels in summer were among the lowest found in the area, most DO concentrations were in the range concentrations previously recorded offshore the generating station (MBC 1986, 1988, 1990, 1994-1999, 2000a, 2001-2002, 2003a-2004a; Ogden 1991-1993).

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 winter and summer, pH values varied little among stations, between tides, and with depth. The variability in pH within and between the surveys was minor, and all pH values in 2005 were consistent with those previously recorded in the study area (MBC 1986, 1988, 1990, 1994-1999, 2000a, 2001-2002, 2003a-2004a; Ogden 1991-1993).

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. In 1978, the United Nations Educational, Scientific and Cultural Organization (UNESCO) adopted the “Practical Salinity Scale, 1978" (PSS 78) based on such conductivity measurements (UNESCO 1981). Salinity, as determined by a CTD, is reported in “practical salinity units” (psu). As this report contains references to other physical parameters, the psu designation after salinity values is being used for clarity. The conversion of ppt units to the PSS 78 scale is one-to-one for temperatures typically encountered in southern California; therefore, a salinity value of 35 ppt corresponds to a PSS 78 value of 35 psu. 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, deeper, more saline waters.

During the 2005 survey, salinity values were consistent throughout the water column, among stations, and between tides and seasons. All values were typical of the nearshore waters of southern California, and did not appear to be influenced by the operation of the generating station.

CONCLUSION

With the exception of the warm water plume near the discharge during summer, variations in water quality parameters observed in 2005 can be attributed to natural physical and biological processes. Water quality measurements indicated that in 2005 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. 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 2005 (Figure 10). All samples were collected *in situ* by biologist-divers in conjunction with infauna sampling.

Sediment Grain Size

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

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

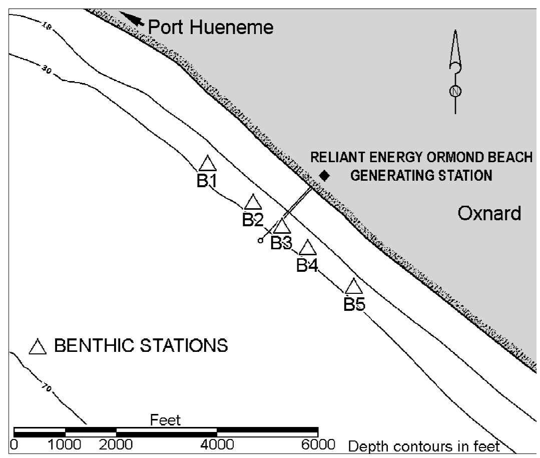


Figure 10. Location of the benthic sampling stations. Ormond Beach Generating Station NPDES, 2005.

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. Environmental Protection Agency (EPA) method 160.3 was used in determining percent solids and EPA method 6020 for metal analysis.

RESULTS

Sediment chemistry and grain size samples were collected by biologist-divers at Stations B1 through B6 on 28 June 2005 between 1306 and 1640 hours. Skies were clear with winds from the west at 5 to 8 kn. Seas were south at 4 to 5 ft.

Sediment Grain Size

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

Sediments at the six stations in 2005 were composed primarily of sand, with smaller amounts of silt (Table 3). Sediments at Stations B2 and B3, 1,000 upcoast and at the discharge, respectively, contained various amounts of gravel but no clay, while clay was found at the remaining stations, but not gravel. Overall, sediments from the six stations averaged about 6% gravel, 83% sand, 10% silt, and 2% clay, with an average mean grain size of 1.99 phi (252 µm, medium sand). Sediments were finest at Station B5, 3,000 ft downcoast of the discharge, where mean grain size was 3.47 phi (90 µm, very fine sand). Sediments were coarsest at Station B2, where mean grain size was 0.06 phi (962 µm, coarse sand).

Sorting, a measure of the spread of the particle distribution curve, averaged 1.2 phi overall,

Table 3. Sediment grain size parameters. Ormond Beach Generating Station NPDES, 2005.

	Station							
Parameter	B1	B2	B3	B4	B5	B6	Mean	S.D.
% Gravel	0.00	28.38	6.28	0.00	0.00	0.00	5.78	11.35
% Sand	87.78	70.57	84.61	80.69	77.86	94.03	82.59	8.15
% Silt	10.57	1.05	9.11	15.12	17.85	4.70	9.73	6.27
% Clay	1.65	0.00	0.00	4.19	4.29	1.27	1.90	1.93
Mean grain size								
phi	3.25	0.06	2.88	3.31	3.47	3.06	1.99	1.30
µm	105	962	136	101	90	120	252	348
Sorting(ϕ)	0.704	2.104	1.339	1.248	1.203	0.583	1.197	0.541
Skewness	0.021	-0.546	-0.431	0.292	0.370	0.027	0.178	0.180
Kurtosis	1.220	0.814	2.001	2.116	2.036	1.233	1.570	0.549

representing poorly sorted sediments (Table 3). Sorting values ranged from 0.58 phi at Station B6, inshore of the discharge at a depth of 20 ft, to 2.10 phi at Station B2. Sediments at Station B1, 3,000 ft upcoast of the discharge and Sation B6 were moderately well sorted, while sediments at Station B2 were very poorly sorted. Sediments at the remaining three stations were poorly sorted. Poorly-sorted sediments are composed of a broad range of particle size classes, while well-sorted sediments contain fewer size classes. The sediment distribution curve for Station B2 was bimodal with a primary peak in the medium-to-fine sand size category and a secondary peak in the gravel size category (Appendix D-1). The remaining stations were essentially 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 -0.55 at Station B2 to 0.37 at Station B5 (Table 3). Distribution curves were skewed toward coarse material at Stations B2 and B3 where gravel occurred, while the distribution curves at the remaining stations were skewed toward finer material.

Kurtosis is a measure of the peakedness of the particle distribution curve. A kurtosis value of 1.0 represents a normal particle distribution curve while a value greater than 1.0 indicates a leptokurtic (peaked) distribution with better sorting in the central portion of the curve than in the tails. A value less than 1.0 indicates a platykurtic (flattened) distribution and a lack of dominance by any one size category. The kurtosis value at Station B2 in 2005 was less than 1.0 suggesting that sediments were not dominated by a single size category. Kurtosis values at the remaining stations were greater than 1.0, indicating leptokurtic (excessively peaked) distributions, with dominance by a narrow range of size classes (Table 3). Kurtosis ranged from 0.81 at Station B2 to 2.12 at Station B4, 1,000 ft downcoast of the discharge, and averaged 1.57.

Sediment Chemistry

Sediment samples collected at the six benthic stations were analyzed for chromium, copper, nickel, and zinc. Values are reported as dry weight. Sediment metal concentrations are presented in Appendix E and summarized in Table 4. Metal concentrations were similar among stations, with highest values found at stations upcoast, downcoast and inshore from the generating station discharge. Lowest metal concentrations were recorded at Station B2.

Chromium. Sediment chromium concentrations averaged 6.5 mg/kg and ranged from 3.29 mg/kg at Station B2 to 8.22 mg/kg at Station B1 (Table 4).

Copper. Sediment copper concentrations averaged 3.1 mg/kg and ranged from 1.61 mg/kg at Station B2 to 3.72 mg/kg at Station B1 (Table 4).

Nickel. Sediment nickel concentrations averaged 6.0 mg/kg and ranged from 3.73 mg/kg at Station B2 to 6.76 mg/kg at Station B6 (Table 4).

Zinc. Sediment zinc concentrations averaged 19 mg/kg and ranged from 6.82 mg/kg at Station B2 to 33.9 mg/kg at Station B5 (Table 4).

Table 4. Sediment metal concentrations (mg/dry kg). Ormond Beach Generating Station NPDES, 2005.

	Station										Reporting
Metal	B1	B2	B3	B4	B5	B6	Mean	S.D.	ERL	ERM	Limits
Chromium	8.22	3.29	7.60	7.17	6.17	6.27	6.5	1.7	81	370	0.11-0.14
Copper	3.72	1.61	3.57	3.15	3.52	3.13	3.1	0.8	34	270	0.11-0.14
Nickel	6.73	3.73	6.64	6.12	6.23	6.76	6.0	1.2	21	51.6	0.11-0.14
Zinc	19.7	6.82	17.6	18.6	33.9	17.6	19	8.7	150	410	1.18-1.4

ERL = Effects Range Low
ERM = Effects Range Medium

DISCUSSION

Sediment Grain Size

In 2005, sediments were analyzed from six stations offshore the Ormond Beach Generating Station. Sediments were similar among four of the stations (Stations B1, B4, B5, and B6), consisting primarily of sand with lesser amounts of fine material (silt and clay) and mean grain sizes in the very fine sand category. Particle distribution curves at these four stations were skewed toward finer material. Sediments at the discharge (Station B3) were slightly coarser than at these stations, comprised primarily of fine sand with small percentages of gravel and silt but no clay. Mean grain size the discharge was in the fine sand category. The highest gravel content and greatest mean grain size occurred upcoast of the discharge at Station B2. Mean grain size at Station B2 was in the coarse sand category, consisting of larger grained sediments than recorded previously in monitoring surveys conducted for the Ormond Beach Generating Station (Appendix D-2).

Mean grain size in the study area in 2005 was the greatest on record, a result of the coarse sediments found at Station B2 (Figure 11). Excluding Station B2, sediments in 2005 were finer than the long-term mean, but consistent with mean grain size recorded in most previous surveys, particularly since 1998 (Appendix D-2) (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-1999, 2000a, 2001-2002, 2003a-2004a; Ogden 1991-1993). There has been great year-to-year variability in grain size off the generating station. In the 12 surveys since 1990 (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 twice, and upcoast of the discharge seven times (Appendix D-2). Coarsest sediments occurred at the discharge six times, upcoast three times, and inshore three times.

Coarse sediments at the discharge could be attributed to turbulence associated with the

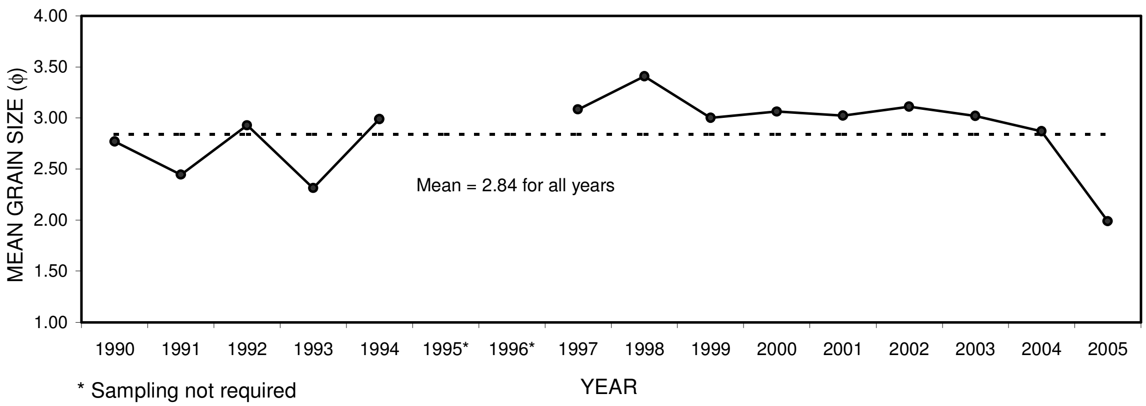
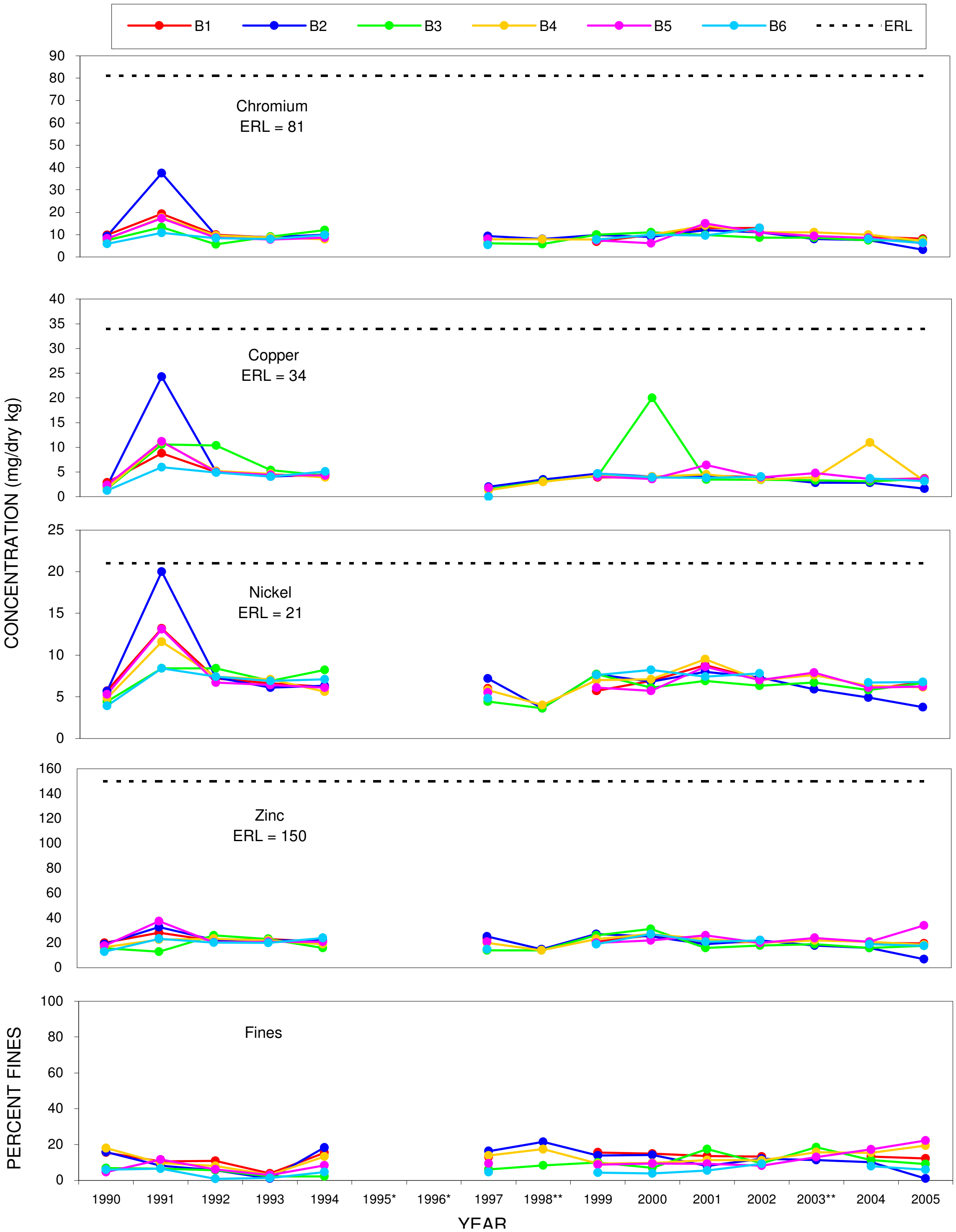


Figure 11. Comparison of sediment mean grain size, 1990 - 2005. Ormond Beach Generating Station NPDES, 2005.

cooling water discharge, which prevents finer sediments from settling. The very coarse sediments upcoast are consistent with 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 (Emory 1952, 1960; Terry et al. 1956). Occurrence of the coarse sand could be related to dredge disposal operations or sediment movement and re-exposure by current or wave conditions. Dredge and sand bypass operations 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. Aside from the localized and transitory effect near the discharge, and the potential effect from sediment disposal operations, sediment composition and distribution in the study area appear to be affected primarily by natural causes.

Sediment Chemistry

In 2005, sediments at six stations off the Ormond Beach Generating Station were analyzed for the presence and concentration of chromium, copper, nickel, and zinc. Concentrations ranged narrowly in 2005, and metal levels were relatively similar among stations. Highest chromium and copper were recorded 3,000 ft upcoast of the discharge, while highest nickel levels were recorded inshore from the discharge, and highest zinc 3,000 ft downcoast of the discharge. Lowest concentrations of all metals were recorded 1,000 ft upcoast of the discharge. Most metal concentrations were similar to values recorded in 2004 and in previous surveys (Figure 12). Copper concentration at Station B4, atypically high in 2004, was similar to values found at other stations in 2005.



*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 - 2005. Ormond Beach Generating Station NPDES, 2005.

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 upcoast of the discharge at Stations B1 and B2 (Figure 12 and Appendix E-2). This year, however, the greatest percentages of fine material were recorded at Station B1 and Station B4, downcoast from the discharge. Highest concentrations of chromium and copper were recorded at Station B1, but highest levels of nickel and zinc occurred at other stations. Because of an overall similarity in sediment characteristics at stations in the Ormond Beach area and relatively low metal concentrations typically found in sediments, metal levels in the area do not always appear to relate to the amount of fine material in the sediments (MBC 1990, 1994, 1997-1999, 2000a, 2001-2002, 2003a-2004a; Ogden 1991-1993). However, in 2005, metal concentrations about one-half the values found at the other stations were found at Station B2 where sediments were coarsest and percentage of fine material the lowest.

Historically, 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 2000a). In 2001, no pattern of metal concentrations relative to the discharge was apparent (MBC 2001). In 2002, metal concentrations were very similar among stations, but concentrations of metals were lowest at the discharge and highest inshore of the discharge (MBC 2002). In 2003 and 2004, lowest metal levels were found upcoast and at the discharge, and highest metal concentrations were found downcoast from the discharge.

Most values observed in 2005 were typical of the area and, with the exception of nickel at Station B3 and zinc at Station B5, lower than the long-term means at all stations (Appendix E-2). Zinc at Station B5 was higher than usual, but similar to values recorded in the study area in 1991. 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 2005 were 1.9 to 2.9 times less than the mean metal concentrations found in sediments at shallow (15–100 ft) coastal stations sampled in 1998 from throughout the Southern California Bight (Noblet et al. 2003).

Concentrations of metals in the study area have consistently been below levels determined to be potentially toxic to benthic organisms. Ranges of potential toxicity were developed by NOAA (NOAA 1991b) and later updated (Long et al. 1995) using data from spiked sediment bioassays, sediment-water equilibrium partitioning, and the co-occurrence of adversely affected fauna and contaminant levels in the field. Chemical concentrations believed to be associated with adverse biological effects from the various independent studies were compared for each parameter and the lower 10 percentile was designated as the "Effects Range-Low" (ERL). Concentrations below the ERL represent a minimal effects range; a range intended to estimate conditions where effects would be rarely observed (Long et al. 1995). Metal concentrations have never exceeded their respective ERLs in the study area (Figure 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, and in 2005 metal concentrations were similar among stations and to previous surveys. Although highest metal concentrations in 2005 did not appear to be related to the percent of fine material in the sediments, lowest metal concentrations were found at the station with the coarsest sediments. Metal levels in the area 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 2005 did not appear to be influenced by the operation of the Ormond Beach Generating Station.

CONCLUSION

Sediment Grain Size

In 2005, sediments were coarsest upcoast of the discharge where mean grain size was the coarsest on record for the area. Sediment characteristics were otherwise similar at the remaining stations, with mean grain size slightly coarser at the discharge than at the other stations. The degree of influence of the discharge on local sediments varies from year to year, suggesting a localized and transitory effect near the discharge. However, sediment composition and distribution in the study area appeared to be affected primarily by natural causes and not by the operations of the Ormond Beach Generating Station.

Sediment Chemistry

In 2005, highest metal concentrations did not appear to be related to the percent of fine material in the sediments, likely a result of similarity in sediment characteristics and relatively low metal concentrations typically found in sediments off Ormond Beach. Lowest metal concentrations, approximately one-half the values found at the other stations, were found at the station with the coarsest sediments. As in previous surveys, sediment metal levels were well below concentrations determined to be potentially toxic to marine organisms. Concentrations of sediment metals 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

On 28 June 2005, forty-five (45) California mussels (*Mytilus californianus*) with shell lengths averaging 60 mm were collected from the Ormond Beach Generating Station discharge buoy. Mussels were 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 (Appendix A and SWRCB 1986). The same methods were used with California mussels collected on 15 July 2005 from the Hermosa 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 cannot reliably be reported and sample results are reported as none detected (ND). In 2005, analytical reporting limits for bioaccumulated metals were lower than in most previous years (MBC 1990, 1999, 2000a, 2001-2002, 2003a-2004a; Ogden 1991-1993). As a result, concentrations of some metals may be reported at lower levels than possible during previous surveys. 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 2005, chromium, copper, nickel, and zinc were detected in all mussel tissue replicates from the generating station area and at a pier reference site (Table 5 and Appendix F).

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, 2005.

	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	3.23	3.23	5.06	3.84	1.06	0.05	**0.6**	**0.6**	**0.8**	**0.7**	0.1	0.55	1.04
Copper	8.54	12.8	12.4	11.2	2.4	0.05	**1.7**	**2.4**	**2.0**	**2.0**	0.4	1.59	2.12
Nickel	7.55	3.49	10.6	7.2	3.6	0.05	**1.5**	**0.7**	**1.7**	**1.3**	0.6	0.63	0.82
Zinc	65	95.6	86.1	82	15.7	0.05	13	18	14	15	2.9	33.64	38.87
% Solids	19.4	19.0	16.5	18	-	0.1	-	-	-	-	-	-	-
Hermosa Beach Reference Site													
Chromium	0.81	1.15	2.22	1.39	0.74	0.05	0.15	0.21	0.40	0.25	0.13	0.55	1.04
Copper	6.82	6.28	6.91	6.67	0.34	0.05	1.23	1.15	1.24	1.21	0.05	1.59	2.12
Nickel	0.67	0.59	0.67	0.64	0.05	0.05	0.12	0.11	0.12	0.12	0.01	0.63	0.82
Zinc	74.3	76.6	72.6	74.5	2.0	0.05	13.4	14.0	13.1	13.5	0.5	33.64	38.87
% Solids	18.0	18.3	18.0	18.1	-	0.1	-	-	-	-	-	-	-

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

Chromium concentrations in mussels from the discharge ranged from 3.23 to 5.06 mg/dry kg with a mean of 3.84 mg/dry kg (Table 5 and Appendix F). Copper concentrations averaged 11.2 mg/dry kg with a range from 8.54 to 12.8 mg/dry kg. Nickel levels ranged from 3.49 to 10.6 mg/dry kg with a mean of 7.2 mg/dry kg. Zinc concentrations ranged from 65 to 95.6 mg/dry kg, with a mean concentration of 82 mg/dry kg. Concentrations of chromium and copper from the discharge were about twice the levels found at the reference site in 2005. Nickel levels were more than 11 times higher at the discharge than at the reference (Table 5). Zinc was also higher at the discharge than at the reference site, although values were more similar than for the other metals, differing by about 10% between areas.

DISCUSSION

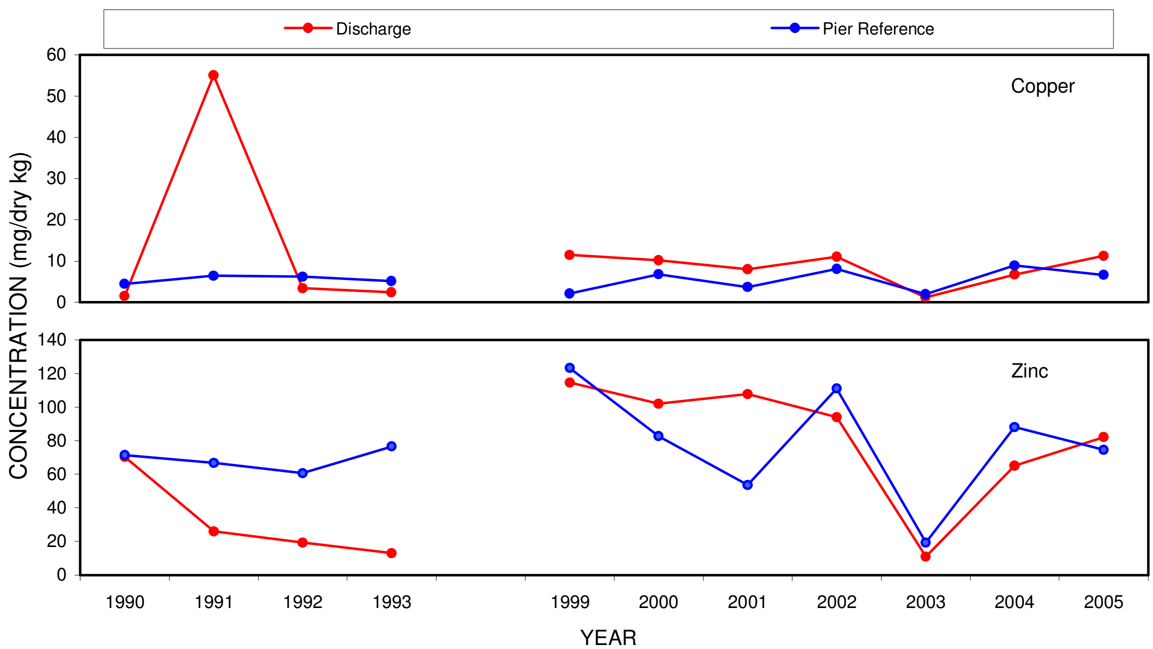
The California State Mussel Watch Program (SMWP) monitors levels of metals and organic pollutants in both native California mussels (*Mytilus californianus*) and bay mussels (*Mytilus galloprovincialis*). Bioaccumulation of pollutants by the two species was found to be comparable, although some differences were found between the mussels, likely related to habitat preference (SWRCB 1995, 2000). California mussels are preferentially used for analysis. 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 toxic chemicals, primarily 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 are highly elevated above the median. While not relatable to health concerns, 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 2005, California mussels were collected from the Ormond Beach Generating Station discharge buoy. Results were compared with those from California mussels collected from a reference site in Santa Monica Bay (the Hermosa Beach Pier).

In 2005, chromium was reported in all replicates from the discharge and the reference site. Tissue concentrations of chromium in mussels in 2005 were detected at levels near or below the reporting limits from most previous tissue sampling (Appendix F-2; MBC 1990, 1999, 2000a, 2001-2002, 2003a-2004a; Ogden 1991-1993). Chromium levels from the discharge were about twice the level found at the reference site in 2005. Chromium was detected in the discharge area at very low concentrations in 2002, at an extremely high concentration in 1991, and at levels about one-half the current results in 1990 (Appendix F-2). Chromium concentrations at the discharge exceeded 2004 reporting limits, suggesting that in 2005 chromium in the area was higher than occurred in 2004. A similar trend was noted in another monitoring program in 2005 where increased metal levels in sediments and mussel tissues appeared to be associated with record rainfall and runoff during the winter of 2004-2005 (MBC 2005a), and a general increase in chromium levels has been noted in mussel tissue monitoring programs in 2005 (MBC 2005b-d). Increased chromium concentrations in mussels from the discharge may also be related exposure to metals from the buoy where the mussels were collected. Wet-weight chromium levels for mussels from the discharge exceed the EDL 85 for resident California mussels, indicating that chromium levels were elevated in the area. Chromium levels were not elevated in mussels from the reference area. Although it is difficult to determine metal sources, the increased chromium values in the area are not likely to be a result of generating station operations since the characteristics of the discharge were similar to previous years.

Copper was detected in all replicates in 2005. Copper concentrations in mussels from the discharge were slightly higher than levels found in the area since 2000, particularly 2003, but lower than levels found in the area in 1991, and considerably lower than levels found in the area in 1991 (Figure 13 and Appendix F-2). Copper levels at the discharge were somewhat higher than values found at the reference site in 2005. Wet-weight concentrations for copper in mussel tissue approached, and in one replicate exceeded, the EDL 95 value, indicating that copper levels in mussel tissues from the discharge were elevated or highly elevated above the state-wide median. High copper values are likely a result of exposure to copper-based antifouling paint on the discharge buoy. While copper levels in 2003 and 2004 were not elevated, in 2002 and in 1999 copper concentrations were similar to 2005 results. Copper concentrations at the reference site were below levels considered elevated by the SMWP.



Sampling not required in years not shown.

Figure 13. Comparison of copper and zinc concentrations in mussel tissue, 1999 - 2005. Ormond Beach Generating Station NPDES, 2005.

In 2005, nickel was reported in all replicates from the discharge and the reference site. Tissue concentrations of nickel in mussels in 2005 were detected at levels below the reporting limits from most previous surveys (MBC 1990, 1999, 2000a, 2001-2002, 2003a-2004a; Ogden 1991-1993). Nickel concentrations at the discharge exceeded 2004 reporting limits, suggesting that in 2005 nickel in the area was higher than in at least one preceding year. Nickel was detected in mussel tissues from the discharge previously in 2002 and 1991 (Appendix F-2). Mean nickel concentration in mussels at the discharge was more than 11 times the level found at the reference site in 2005. Like chromium, nickel levels in mussel tissues appear to have generally increased in southern California in 2005 (MBC 2005a-d). Wet-weight nickel concentrations at the discharge exceeded the EDL 95 level indicating that nickel was highly elevated in the area (Table 5). Wet-weight concentration of nickel at the reference site was below the level considered elevated.

Zinc was detected in all mussel tissue replicates in 2005. Zinc concentrations from the discharge were higher than levels found in the area in the last two years, particularly in 2003, but otherwise within the range found previously at both the discharge and the reference site (Figure 13 and Appendix F-2, MBC 2005c). Wet-weight zinc concentrations from the discharge were notably lower than the EDL 85 values for resident mussels, indicating that zinc levels were not elevated near the Ormond Beach Generating Station discharge. Wet-weight concentrations of zinc at the reference site were also below levels considered elevated.

CONCLUSIONS

Concentrations of chromium and copper in mussel tissues from the vicinity of the discharge were found at levels considered elevated by the SMWP in 2005. Nickel concentration was highly elevated. Zinc concentration at the discharge was not elevated and similar to values found previously in the area and at the reference site. Still, metal concentrations in 2005 were within ranges found previously in the area and in other surveys throughout the Southern California Bight. Although it is difficult to determine metal sources, the increased chromium values in the area are not likely to be a result of generating station operations since the characteristics of the discharge were similar to previous years.

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).

MATERIALS AND METHODS

Benthic infauna sampling was conducted at six stations (Stations B1 - B6) 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 by a diver 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.

Four replicate 1.0-liter sediment samples were collected at each station. Samples were washed in the field using a 0.5-mm U.S. Standard Sieve, labeled, and fixed in buffered 10% formalin-seawater. In the laboratory, samples were transferred to 70% isopropyl alcohol, sorted to major taxonomic groups, identified to the lowest practical taxonomic level, and counted. Representative specimens were added to MBC's reference collection.

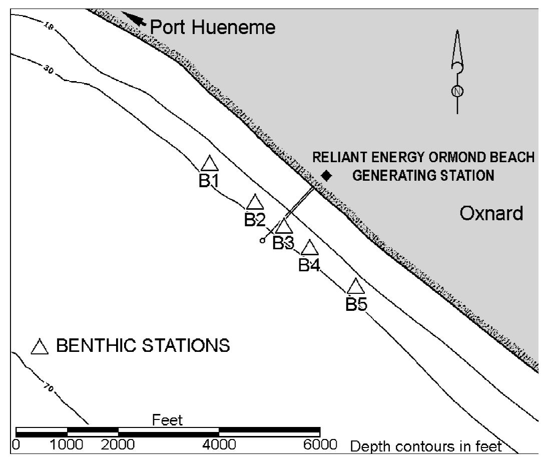


Figure 14. Location of the benthic sampling stations. Ormond Beach Generating Station NPDES, 2005.

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 which had been submersed in 70% isopropyl alcohol, blotted on a paper towel, and air-dried for five minutes. Large organisms were weighed separately.

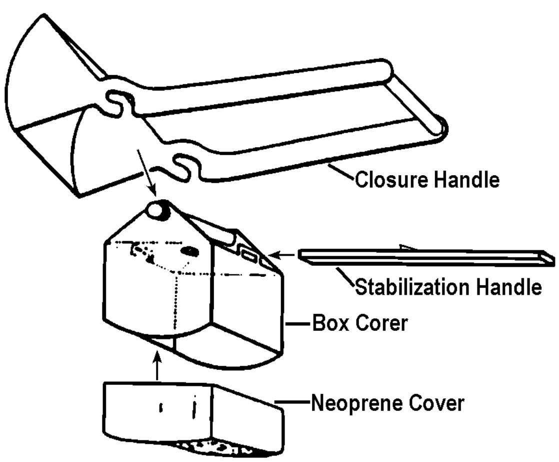


Figure 15. Diver-operated box corer used to collect infaunal samples. Ormond Beach Generating Station NPDES, 2005.

RESULTS

Benthic Infauna

Biologist-divers collected sediment cores for analysis of infauna composition at Stations B1 through B6 on 28 June 2005 between 1306 and 1640 hr. Skies were clear with winds from the west at 5 to 8 kn. Seas were south at 4 to 5 ft.

Results of the 2005 benthic infauna sampling are presented by station in Appendix G. Data are summarized in Tables 6, 7, and 8 and Figure 16.

Species Composition. A total of 963 individuals in 133 species (or taxa) and 12 phyla (major groups) were taken in the 2005 benthic infauna sampling off the Ormond Beach generating station (Table 6 and Appendix G-1). Annelids (segmented worms) were the most diverse phylum, with 63 species (47% of the total), followed by arthropods with 39 species (29%), mollusks with 12 species (9%), and nemertean worms with seven species (5%). Each of the remaining eight phyla was represented by 3% or less of the species taken. Annelids were also the most abundant phylum, with about 61% of the individuals in the samples. Arthropods were second most abundant, with 20% of the individuals, and nemerteans were third with 6%. Echinoderms were more abundant than mollusks, however, representing about 5% of the total abundance. Each of the eight remaining phyla comprised less than 4% of the abundance.

Table 6. Number of infaunal species and individuals by phylum. Ormond Beach Generating Station NPDES, 2005.

	Station								Percent
Parameter	B1	B2	B3	B4	B5	B6	Total	Mean	Total
Number of species									
Annelida	30	11	20	21	32	20	63	22.3	47.4
Arthropoda	8	7	10	17	23	15	39	13.3	29.3
Mollusca	6	2	2	3	5	2	12	3.3	9.0
Nemertea	5	2	3	3	5	5	7	3.8	5.3
Echinodermata	1	2	2	-	2	2	4	1.5	3.0
Chordata	-	1	-	-	-	1	2	0.3	1.5
Cnidaria	-	-	-	1	-	-	1	0.2	0.8
Entoprocta	-	-	-	-	-	1	1	0.2	0.8
Nematoda	1	1	1	-	1	-	1	0.7	0.8
Phorona	1	-	-	1	1	-	1	0.5	0.8
Platyhelminthes	-	1	-	-	-	-	1	0.2	0.8
Sipunculida	1	-	-	1	1	-	1	0.5	0.8
Total	53	27	38	47	70	46	133	46.8	
Number of individuals									
Annelida	132	42	120	83	143	68	588	98.0	61.1
Arthropoda	19	14	17	31	64	49	194	32.3	20.1
Nemertea	7	5	4	11	10	23	60	10.0	6.2
Echinodermata	1	38	2	-	5	5	51	8.5	5.3
Mollusca	9	7	2	3	8	4	33	5.5	3.4
Chordata	-	14	-	-	-	1	15	2.5	1.6
Nematoda	2	2	2	-	4	-	10	1.7	1.0
Phorona	2	-	-	2	2	-	6	1.0	0.6
Sipunculida	1	-	-	1	1	-	3	0.5	0.3
Cnidaria	-	-	-	1	-	-	1	0.2	0.1
Entoprocta	-	-	-	-	-	1	1	0.2	0.1
Platyhelminthes	-	1	-	-	-	-	1	0.2	0.1
Total	173	123	147	132	237	151	963	160.5	

Species Richness. Species richness averaged 47 species per station, and ranged from 27 species at Station B2, immediately upcoast of the discharge, to 70 species at Station B5, farthest downcoast (Table 7).

Table 7. Infaunal community parameters. Ormond Beach Generating Station NPDES, 2005.

	Station							
Parameter	B1	B2	B3	B4	B5	B6	Total	Mean
Number of species								
Total	53	27	38	47	70	46	133	47
Rep. Mean	20	11	15	18	29	20		19
Rep. S.D.	4	4	7	7	13	4		
Number of individuals								
Total	173	123	147	132	237	151	963	161
Rep. Mean	43	31	37	33	59	38		40
Rep. S.D.	7	16	17	14	32	6		
Density (Number/m^2)								4013
Diversity (H')								
Total	3.25	2.50	2.94	3.39	3.76	3.29	3.98	3.19
Rep. Mean	2.61	1.97	2.23	2.59	2.85	2.70		2.49
Rep. S.D.	0.35	0.28	0.55	0.33	0.33	0.31		
Biomass (g)								
Total	1.27	1.05	1.51	0.76	1.70	0.66	6.95	1.16
Rep. Mean	0.32	0.26	0.38	0.19	0.42	0.17		0.29
Rep. S.D.	0.09	0.11	0.22	0.09	0.11	0.08		

Abundance. Abundance averaged 161 individuals per station (4,013 individuals/m^2) and ranged from 123 individuals at Station B2 to 237 individuals at Station B5 (Table 7).

Species Diversity. Shannon-Wiener species diversity (H') averaged 3.19 per station and ranged from 2.50 at Station B2, where both species richness and abundance lowest, to 3.76 at Station B5, where species richness and abundance were highest (Table 7).

Biomass. Infauna biomass totaled 6.95 g for the survey and averaged 1.16 g per station (29 g/m^2) (Table 7). Values ranged from 0.66 g at Station B6, inshore of the discharge, to 1.70 g at Station B5. Annelids contributed 65% of the biomass due to their abundance, while the eight miscellaneous phyla contributed 16% of the biomass and arthropods contributed 10% (Appendices G-2 and G-4). The relatively high biomass for the miscellaneous phyla, which contained about 10% of all individuals, was due to the presence of 14 lancelets (*Branchiostoma californiensis*) at Station B2.

Community Composition. Twenty-four species each comprised 1% or more of all individuals collected; together they totaled more than 69% of the infauna collection (Table 8 and Appendix G-2). The polychaete annelid *Apoprionospio pygmaea* was the most abundant species overall, with 13% of the individuals. This species was evenly distributed among five of the six stations, but was absent from Station B2. The annelid *Mediomastus acutus* was second most abundant, with 8% of the collection, and had a distribution similar to that of *A. pygmaea*, except that it was not abundant at Station B6 and it was more abundant than *A. pygmaea* at Station B1, farthest upcoast. Pacific sand dollar (*Dendraster excentricus*) was third most abundant at 4% of the collection; it occurred primarily at Station B2, where it was the most abundant species. All of the sand dollar individuals were very small (Appendix G-4). Thirteen additional annelid species, four arthropods, two nemerteans, and one species each of chordates and nematodes were also abundant. Only three of the top 24 species occurred at all six of the stations in the study area. Two species, the annelid *Notomastus hemipodus* and *Branchiostoma californiensis*, occurred at only one station (Stations B3 and B2, respectively), and two other species, the annelids *Monticellina cryptica* and *Ampharete labrops*, both occurred only at Station B4, immediately downcoast of the discharge, and at Station B5.

Table 8. The 24 most abundant infaunal species. Ormond Beach Generating Station NPDES, 2005.

		Station							Percent	Cum.
Phylum	Species	B1	B2	B3	B4	B5	B6	Total	Total	Percent
AN	*Apoprionospio pygmaea*	30	-	33	20	22	23	128	13.29	13.29
AN	*Mediomastus acutus*	31	-	15	12	21	2	81	8.41	21.70
EC	*Dendraster excentricus*	1	35	1	-	3	2	42	4.36	26.06
AN	*Onuphis* sp 1 Pt. Loma 1983	10	2	8	3	8	4	35	3.63	29.70
AN	*Aricidea (Acmira) catherinae*	7	-	4	4	10	8	33	3.43	33.13
AR	*Diastylopsis tenuis*	6	1	1	5	18	1	32	3.32	36.45
NE	*Carinoma mutabilis*	2	1	1	7	2	16	29	3.01	39.46
AN	*Armandia brevis*	5	-	8	2	6	5	26	2.70	42.16
AN	Maldanidae	-	24	-	-	1	1	26	2.70	44.86
AR	*Stenothoe estacola*	1	5	4	-	-	15	25	2.60	47.46
AN	*Syllis (Typosyllis) farallonensis*	9	-	-	6	3	4	22	2.28	49.74
AR	*Rhepoxynius menziesi*	4	2	-	3	10	2	21	2.18	51.92
AN	*Spiophanes bombyx*	4	-	-	6	6	3	19	1.97	53.89
AN	*Glycinde armigera*	2	-	2	2	8	2	16	1.66	55.56
AN	*Notomastus hemipodus*	-	-	16	-	-	-	16	1.66	57.22
AN	*Syllis (Ehlersia) heterochaeta*	-	-	6	-	8	2	16	1.66	58.88
AN	*Monticellina cryptica*	-	-	-	9	6	-	15	1.56	60.44
AN	*Scoletoma* sp	2	-	10	-	2	-	14	1.45	61.89
AR	*Anchicolurus occidentalis*	-	2	3	1	-	8	14	1.45	63.34
CO	*Branchiostoma californiensis*	-	14	-	-	-	-	14	1.45	64.80
AN	*Nephtys caecoides*	2	2	1	-	3	4	12	1.25	66.04
NE	Lineidae	2	-	2	3	2	3	12	1.25	67.29
AN	*Ampharete labrops*	-	-	-	5	6	-	11	1.14	68.43
NT	Nematoda	2	2	2	-	4	-	10	1.04	69.47

AN = Annelida; EC = Echinodermata; AR = Arthropoda; 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). The six stations separated into three groups, based on the relative abundances of the 24 species. Station Group I included three stations that were the most typical for the study area, with similar abundances of the top species and *Apoprionospio pygmaea* and *Mediomastus acutus* as the community dominants. The two stations that clustered most closely, Stations B1 and B5 (farthest upcoast and downcoast, respectively), were in this group. Stations B3 and B6 (at and inshore of the discharge), formed Group II, clustering slightly more distantly than the stations in Group I, as several abundant species were not found at one or the other station. Group III included only Station B2 and clustered rather distantly from the other five stations. Three abundant species occurred either exclusively or primarily at that station, and several species abundant elsewhere were absent.

The most abundant species clustered into three groups, based on their occurrences (Figure 16). Species Group A included species that were generally wide spread, although most were more abundant at stations in Station Group I. Species Group B also included species that were generally wide spread, but were slightly more abundant at stations in Groups II and III. Species Group C was composed of only the two overall most abundant species, which were similarly abundant at all stations in Groups I and II but were absent from Station B2. Group C clustered quite distantly from the two other species groups.

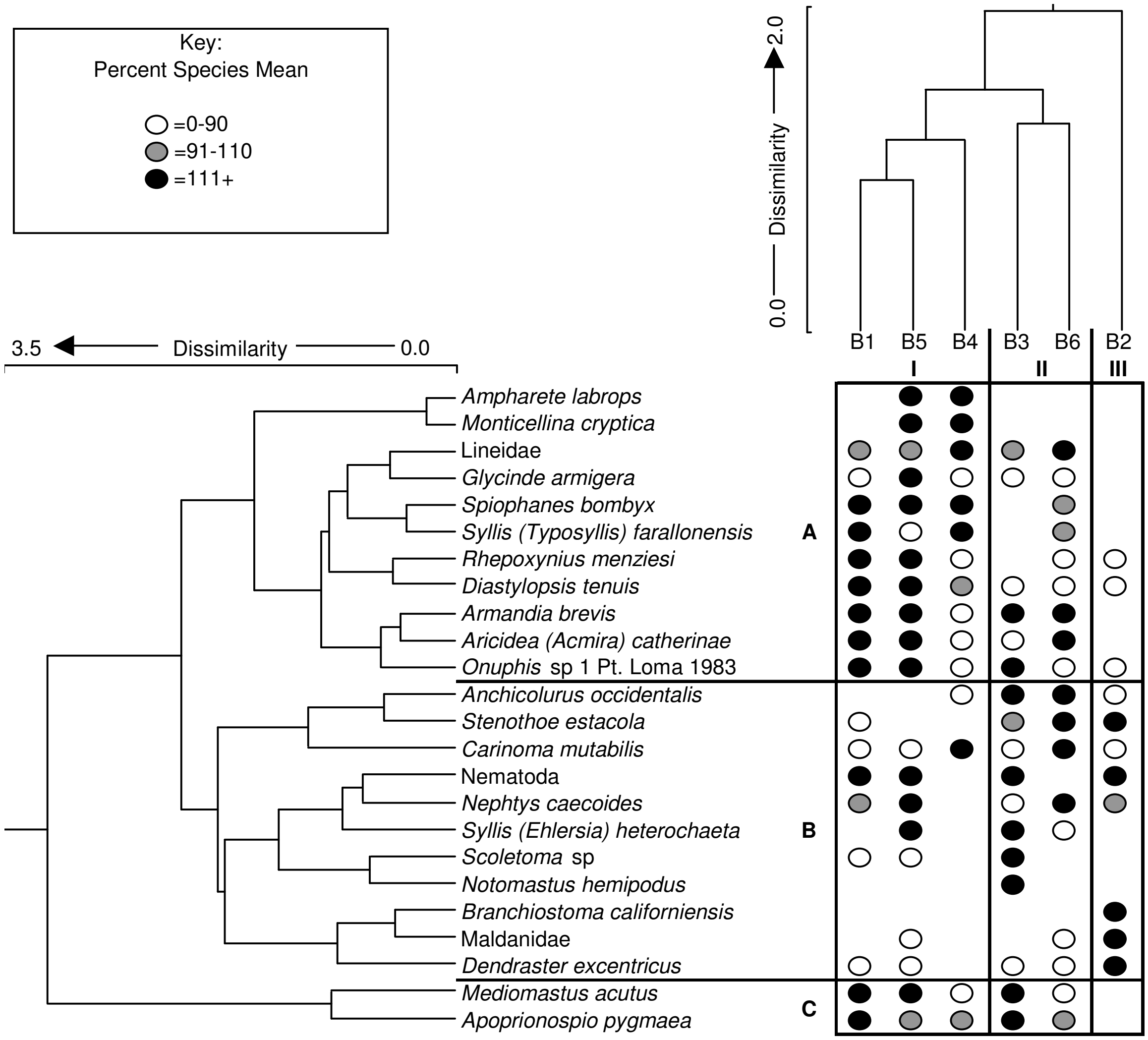


Figure 16. Two-way coincidence table resulting from normal (station) and inverse (species) classification dendrograms for the 24 most abundant infaunal species. Ormond Beach Generating Station NPDES, 2005.

DISCUSSION

Benthic Infauna

The infauna community in the study area in 2005 was composed predominantly of annelid worms, arthropods, nemertean worms, small Pacific sand dollars, lancelets, and nematode worms. A total of 133 species were collected, with an average of 47 species per station, increasing both upcoast and downcoast from the station immediately upcoast of the discharge. Density of organisms averaged 4,013 individuals/m^2 for the study area. Abundance, species richness and diversity values for the discharge area were below the study-area means, while inshore of the discharge, they were similar to the means. Immediately upcoast of the discharge, biomass was greater than would be expected based solely on abundance because of the presence of several medium-sized lancelets (*Branchistoma californiensis*). *Apoprionospio pygmaea* and *Mediomastus acutus* were the two most abundant species, occurring at all but one station, immediately upcoast of the discharge, where Pacific sand dollars were most abundant. The annelids *Onuphis* sp 1, *Aricidea catherinae*, and

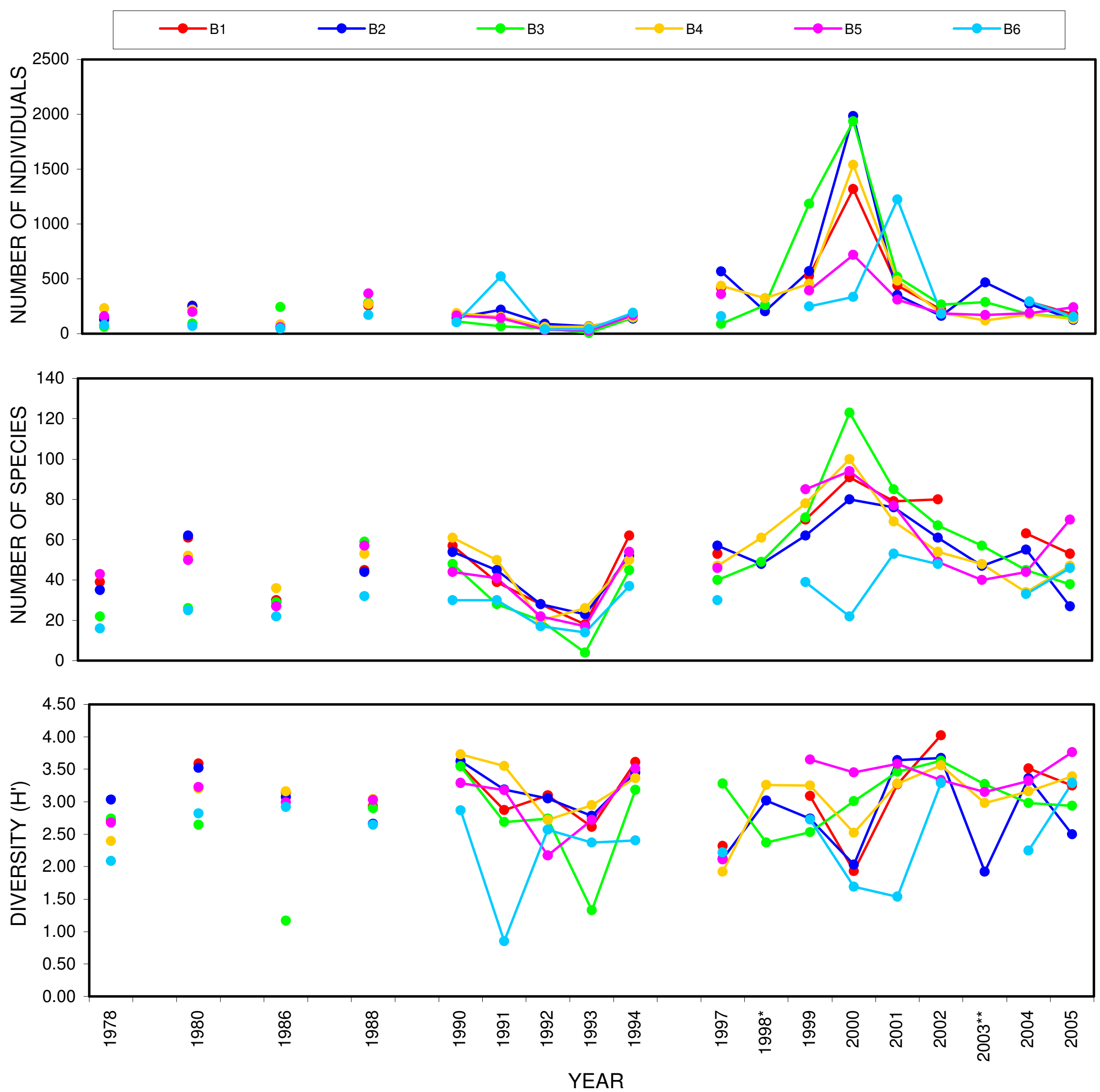
Armandia brevis, the cumacean *Diastylopsis tenuis*, the nemertean *Carinoma mutabilis*, and the amphipod *Stenothoe estacola* were also very abundant and widely distributed. The infaunal communities were relatively similar among stations except for the station immediately upcoast of the discharge, which was dominated by Pacific sand dollars, unidentified maldanids, and lancelets.

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). Species occupying this habitat are adapted to both coarse sediments and to nearly constant disruption of the substrate (Oliver et al. 1980). Although small, these species 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 annelids, can live in permanent tubes (Barnard 1963, Oliver et al. 1980).

The efficient burrowers occurring in the infauna communities in 2005 include *Carinoma mutabilis*, *Armandia brevis*, the amphipod *Rhepoxynius menziesi*, and lancelets. As a group, these species were abundant at all of the stations, suggesting the influence of substrate disturbance on the communities throughout the study area. Unlike the other burrowers, however, lancelets occurred only where sediments were coarsest. They have occasionally been found offshore of other coastal generating stations, in coarser-than-average sediments (MBC 2000b, 2004c,d). The presence of strong swimmers such as the cumaceans *Diastylopsis tenuis* and *Anchicolurus occidentalis* also indicate the effects of water motion in the nearshore environment. Along with the lancelets, Pacific sand dollars were also most abundant where sediments were coarsest, and all were small, indicating recent recruitment. Studies have suggested, however, that sediment grain size does not influence site selection by larval sand dollars (Timko 1975, Smith 1981). Other constituents of the infauna also demonstrated a relationship to sediment characteristics. Annelids were generally more abundant and diverse, and total abundance, species richness, and diversity were higher at three stations where sediments were finer. The communities at these stations were more similar to each other than to those at any of the other stations.

The infauna communities in 2005 were similar to those found in previous summer surveys conducted in the study area since 1978 (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-1999, 2000a, 2001-2002, 2003a-2004a; Ogden 1991-1993). Abundances at most of the stations were slightly lower than in 2004 and the mean for the six stations was substantially below the long-term mean (Figure 17). (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). Mean species richness and diversity in 2005 were slightly below the means for 2004 and were similar to the long-term means (Appendix G-5). Abundance was particularly high in 2000 due to the number of the annelid *Owenia collaris*, which comprised almost 42% of the infauna collection (only one individual was found in each year from 2003 to 2005). Single species contributed to high abundances in other years as well. Pacific sand dollars made up 53% of the abundance in 1997 (nematodes excluded) but only 4% in 2005, and *Apoprionospio pygmaea* comprised 29% of the community in 2001 (13% in 2005).

Since 1978, abundance has generally been slightly greatest immediately upcoast of the discharge than at the other stations and species richness has been greatest immediately downcoast of the discharge (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-1999, 2000a, 2001-2002, 2003a-2004a; Ogden 1991-1993). Lowest abundance has usually been found farthest downcoast; because of the low abundance and moderate species richness at this location, the mean species diversity value is the highest of the six stations, although it is only slightly greater than for the adjacent downcoast station. On average, both species richness and diversity have been lowest inshore of the discharge. Overall, however, values have been relatively similar among stations along the discharge isobath. All three infaunal parameters appear to have been temporally more variable at the discharge station than elsewhere, although species diversity has also been quite variable inshore of the discharge (Figure 17). These results are consistent with the long-term sediment grain size data.



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 - 2005, summer surveys. Ormond Beach Generating Station NPDES, 2005.

Composition of the infaunal community in the study area in 2005 was similar to those in prior surveys (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-1999, 2000a, 2002-2002, 2003a-2004a; Ogden 1991-1993). Six of the 24 most abundant species in 2005 were among the seven long-term most abundant species occurring in the study area since 1978 (1% or more of all individuals taken). Nine of the dominant species were among the 15 long-term most abundant (Appendix G-5). All of the 20 long-term most abundant species were present in 2005, although some of them were uncommon. In addition to the species mentioned above, several others have also been quite variable in abundance from survey to survey. These include nematodes, the annelids *Pectinaria californiensis*, *Armandia brevis*, and *Magelona sacculata*, the clam *Siliqua lucida*, and the amphipods *Photis macinerneyi*, *Aoroides inermis*, *Rhepoxynius abronius*, *P. brevipes*, and *Jassa slatteryi*, the ostracod *Euphilomedes longiseta*, and the southern moonsnail hermit crab, *Isocheles pilosus*. All but two of these species were present in 2005, in low to moderate abundance. Overall, the abundant infauna species seen in 2005 comprise a core group that has persisted in the study area, resembling the dominant communities found in similar shallow-water habitats throughout the Southern California Bight (Barnard 1963, Dexter 1978, Oliver et al. 1980).

Abundance, diversity, and composition of the infauna communities in 2005 were most likely to have been influenced primarily by sediment characteristics. Community parameter values were higher where sediments were finer, suggesting a more stable environment. Lowest values were found where sediments were coarsest, while values for the locations at and inshore of the discharge were about average for the study area. Overall, 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 in the infaunal communities.

CONCLUSION

The infauna community in the study area in 2005 was composed primarily of annelid worms, arthropods, nemertean worms, small sand dollars, lancelets, and nematodes. *Apoprionospio pygmaea* and *Mediomastus acutus* were the two most abundant species, occurring everywhere but at the station immediately upcoast of the discharge, where Pacific sand dollars were most abundant. The communities were similar among stations, although the community immediately upcoast of the discharge, where sediments were coarsest, was least similar to those elsewhere. Community parameters and composition appeared to be strongly related to sediment characteristics, with higher abundance, species richness, and diversity where sediments were finer. No pattern of infaunal parameters relating to the discharge was apparent. Mean abundance was lower than the mean for previous surveys, but richness and diversity values were similar those in the past. Overall, the communities found in 2005 were typical of the shallow subtidal habitat throughout the Southern California Bight.

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 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. The intake point is 2 m above the bottom. Seawater 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. Impinged material caught on the screens, including fish and macroinvertebrates, is washed off the screens into collection baskets. Once impinged, material is washed off the screens into collection baskets.

Fish impingement is monitored by Proteus Sea Farms, Ormond Beach, CA., during two distinct operational modes, normal operation and heat treatments. Normal operation refers to the daily operational mode of the once through cooling water system. Coastal generating stations with once through cooling water systems periodically conduct heat treatments to clear the cooling water system of fouling organisms, such as mussels, which can impair the operation of a generating station. This operational mode involves reentraining heated discharge water until the temperature of the water exceeds the critical thermal tolerances of the fouling organisms, inducing mortality and subsequent clearing of the system. In this process, fish and macroinvertebrates trapped within the system are similarly exposed to elevated seawater temperatures, often causing mortality.

MATERIALS AND METHODS

At Ormond Beach Generating Station, all heat treatments were monitored. During heat treatments, accumulated material was sorted to remove fish and macroinvertebrates. All organisms were identified to the lowest practical taxonomic level. Up to 200 individuals were measured to the nearest millimeter (mm) standard length (SL) or other appropriate length (disc width [DW] or total length [TL]), aggregate biomass (kg) recorded for measured and unmeasured individuals (if necessary). Total abundance for species with greater than 200 individuals was estimated by dividing the total weight of the unmeasured individuals by the mean individual weight of the measured samples from within each species. Macroinvertbrates were also sorted, counted and an aggregate weight taken. Specimens that are either rare or of uncertain identity were retained for later confirmation and/or inclusion into the MBC voucher collection.

In addition to heat treatment monitoring, monthly normal operation surveys were performed at Ormond Beach Generating Station. In order to assess the impingement of marine organisms at the generating station, 24-hr surveys during representative periods of operation were conducted. During such surveys, the traveling screens and collection baskets are cleared of all accumulated debris at the beginning of the 24-hr period. At the end of 24-hours all accumulated material was processed in the same fashion as during heat treatment surveys.

Due to variation in daily operating patterns, all normal operation survey fish and macroinvertebrate data was standardized to circulated water flow rates to determine the rate of impingement (catch per unit effort or CPUE) by the following equation: Impingement Rate = (Abundance/Circulated Water Volume in Million Gallons) x 100. The impingement rate, derived from this equation, established the abundance per 100 million gallons of water circulated. Volume of water circulated was based on the water flow rate during the period surveyed. Estimates of annual normal operation impingement was calculated by multiplying the total annual reported circulated water volume by the mean daily normal operation impingement rate. Rate of impingement for biomass is derived in a similar fashion. Normal operation impingement estimates are combined with recorded abundances during periodic heat treatments to determine yearly fish and macroinvertebrate intake losses.

RESULTS

Fish

One heat treatment and 11 normal operation surveys were conducted during the 2005 monitoring year at Ormond Beach Generating Station. An estimated total of 6,216 individuals weighing 695 kg representing 47 species were impinged during the survey year (Tables 9 and 10).

The heat treatment survey accounted for 2,716 individuals from 29 species while estimated abundances impinged during normal operation accounted for 3,500 individuals of 27 species (Table 9). Shiner perch (*Cymatogaster aggregata*) was the most abundant species encountered during either normal operation and the heat treatment survey, with an estimated 2,716 individuals overall. Queenfish (*Seriphus politus*) was the next most abundant species overall, second most abundant at the heat treatment and third during normal operations, with an estimated 882 individuals impinged. Northern anchovy (*Engraulis mordax*) accounted for the third highest abundance overall as well as during the heat treatment (fourth most abundant during normal operation) with 426 individuals. Bay pipefish (*Syngnathus leptorhynchus*) was the fourth most abundant species overall with 299 individuals, of which all but one individual was represented by normal operation impingement. White seaperch (*Phanerodon furcatus*) was the fifth most abundant species overall with 229 individuals, principally recorded during the monitored heat treatment. The remaining species each accounted for 3% or less of the total annual estimated impinged abundance.

Table 9. Combined heat treatment and estimated normal operations and percent totals of the 10 most abundant fish species. Ormond Beach Generating Station NPDES, 2005.

	Heat Treatment		Estimated Normal Operations*		Annual Estimated Overall		Cumulative
Species	Abundance	Percent	Abundance	Percent	Abundance	Percent	Percent
shiner perch	1,092	40.2	1,624	46.4	2,716	43.7	43.7
queenfish	645	23.7	237	6.8	882	14.2	57.9
northern anchovy	219	8.1	207	5.9	426	6.9	64.7
bay pipefish	1	0.0	298	8.5	299	4.8	69.5
white seaperch	161	5.9	68	1.9	229	3.7	73.2
Pacific sardine	28	1.0	128	3.7	156	2.5	75.7
walleye surfperch	143	5.3	-	-	143	2.3	78.0
specklefin midshipman	-	-	119	3.4	119	1.9	80.0
barred surfperch	24	0.9	94	2.7	118	1.9	81.9
California lizardfish	-	-	106	3.0	106	1.7	83.6
Survey totals							
Number of individuals	2,716		3,500		6,216		
Number of species	29		27		47		

*Estimated annual abundance derived by multiplying mean daily CPUE by total reported annual flow (88,502.561 mg) for monitoring year 2005.

A total of 158 kg of fish was recorded during the heat treatment while normal operation of the station accounted for an estimated 538 kg during the 2005 monitoring year (Table 10). Pacific electric ray (*Torpedo californica*) numerically dominated biomass with an estimated 355 kg accounting for 66% of the fish biomass impinged during normal operations and 51% of the combined biomass. Shiner perch represented the second highest biomass with 47 kg overall, 24 during the heat treatment and an estimated 23 kg during normal operation. Horn shark (*Heterodontus francisci*) and thornback (*Platyrhinoidis triseriata*) accounted for the third and fourth highest impinged biomass with and estimated 41 kg and 34 kg, respectively. Both species were exclusively impinged during normal operation surveys. Impinged queenfish biomass was the fifth highest calculated (27 kg) during the 2005 monitoring survey, with 22 recorded during the heat treatment and an estimated 6 kg impinged during normal operation of the station. The remaining 42 species contributed less than 26 kg each to impinged biomass for the survey year.

Table 10. Combined heat treatment and estimated normal operation biomass (kg) and percent totals of the 10 fish species with the greatest biomass. Ormond Beach Generating Station NPDES, 2005.

	Heat Treatment		Estimated Normal Operations*		Annual Estimated Overall	
Species	Biomass	Percent	Biomass	Percent	Biomass	Percent
Pacific electric ray	-	-	354.72	66.0	354.720	51.0
shiner perch	23.877	15.2	22.95	4.3	46.827	6.7
horn shark	-	-	40.57	7.5	40.570	5.8
thornback	-	-	33.50	6.2	33.500	4.8
queenfish	21.583	13.7	5.55	1.0	27.133	3.9
cabezon	19.714	12.5	5.63	1.0	25.344	3.6
brown rockfish	16.370	10.4	-	-	16.370	2.4
California scorpionfish	-	-	15.45	2.9	15.450	2.2
bat ray	-	-	13.40	2.5	13.400	1.9
barred sand bass	12.004	7.6	-	-	12.004	1.7
Total Biomass	157.535		537.62		695.155	

*Estimated annual biomass (kg) derived by multiplying mean daily CPUE by total reported annual flow (88,502.561 mg) for monitoring year 2005.

Length Frequency Analysis

Two fish species occurred in sufficient abundance to characterize the age structure of these impinged assemblages. Recorded standard lengths of shiner perch indicated a unimodal distribution, with a peak at 90-mm SL, with relatively high abundances in size classes from 80 to 110-mm SL (Figure 18). Impinged queenfish lengths also indicated a unimodal distribution, peaking at 130-mm SL, with relatively high abundances between 110 to 150-mm SL (Figure 19). Recorded lengths for northern anchovy were strongly unimodal with a definitive peak at 110 mm SL (Figure 20).

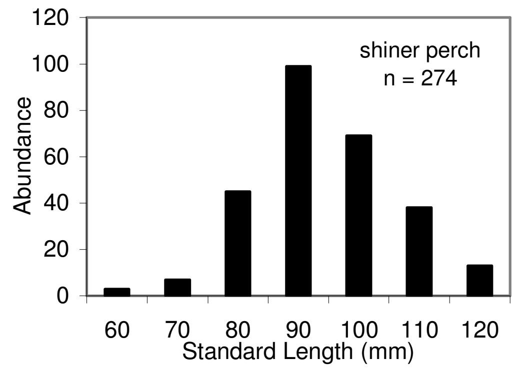


Figure 18. Length-frequency distribution of shiner perch (*Cymatogaster aggregata*) taken during impingement surveys. Ormond Beach Generating Station NPDES, 2005.

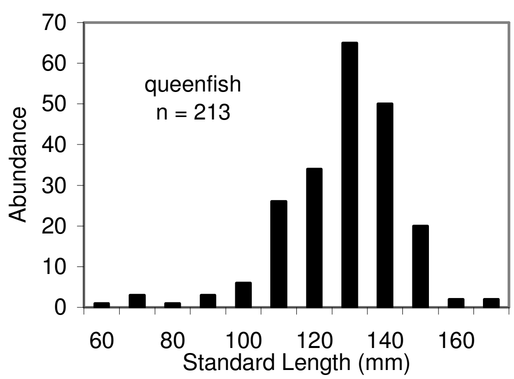


Figure 19. Length-frequency distribution of queenfish (*Seriphus politus*) taken during impingement surveys. Ormond Beach Generating Station NPDES, 2005.

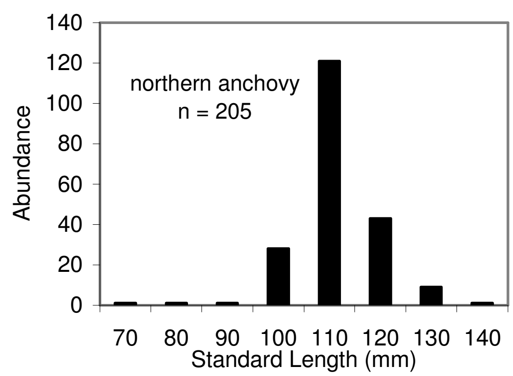


Figure 20. Length-frequency distribution of northern anchovy (*Engraulis mordax*) taken during impingement surveys. Ormond Beach Generating Station NPDES, 2005.

Macroinvertebrates

A total of 27,570 individuals weighing 1,904 kg representing 19 macroinvertebrate species were impinged at Ormond Beach Generating Station during one heat treatment and 11 normal operation surveys in 2005 (Table 11). The one heat treatment conducted during the 2005 monitoring year accounted for 633 individuals of six species weighing 51 kg. Estimated normal operation abundance was 26,937 individuals of 17 species weighing 1,852 kg representing 17 species.

Table 11. Number of individuals and biomass (kg) of macroinvertebrate species impinged during heat treatment and estimated normal operation surveys. Ormond Beach Generating Station NPDES, 2005.

	Abundance			Percent	Biomass (kg)			Percent
Species	HT	NO*	CO	Total	HT	NO*	CO	Total
Pacific rock crab	233	23,698	23,931	86.8	31.250	1,058.66	1,089.910	57.2
red rock crab	-	1,662	1,662	6.0	-	22.19	22.190	1.2
graceful crab	-	487	487	1.8	-	0.24	0.240	0.0
red rock shrimp	302	155	457	1.7	0.835	0.38	1.215	0.1
red jellyfish	-	254	254	0.9	-	588.62	588.620	30.9
hairy rock crab	-	195	195	0.7	-	1.94	1.940	0.1
blackspotted bay shrimp	-	129	129	0.5	-	0.76	0.760	0.0
sheep crab	-	117	117	0.4	-	151.26	151.260	7.9
sea star unid	75	36	111	0.4	18.250	3.05	21.300	1.1
two-spot octopus	19	38	57	0.2	0.500	1.25	1.750	0.1
striped shore crab	-	47	47	0.2	-	0.19	0.190	0.0
moss crab	-	37	37	0.1	-	3.14	3.140	0.2
California market squid	-	23	23	0.1	-	0.62	0.620	0.0
innkeeper worm	-	23	23	0.1	-	0.05	0.050	0.0
purple-striped jellyfish	-	12	12	0.0	-	19.58	19.580	1.0
sweet potatoe sea cucumber	-	12	12	0.0	-	0.85	0.850	0.0
Xantus swimming crab	-	12	12	0.0	-	0.16	0.160	0.0
giant keyhole limpet	2	-	2	0.0	0.500	-	0.500	0.0
northern kelp crab	2	-	2	0.0	0.056	-	0.056	0.0
Survey Totals								
Number of individuals	633	26,937	27,570					
Number of species	6	17	19					
Biomass					51.391	1,852.94	1,904.331	

Note: HT = Heat Treatment; NO = Normal Operation; CO = Combined; 0.0 = <0.05.

*Estimated annual abundance derived by multiplying mean daily CPUE by total reported annual flow (88,502.561 mg) for monitoring year 2005.

Impinged abundance was numerically dominated by Pacific rock crab (*Cancer antennarius*) with 233 recorded during the heat treatment and 23,698 estimated during normal operation 87% of all individuals impinged (Table 11). Red rock crab (*Cancer productus*) was the second most abundant species, with an estimated 1,662 individuals impinged during normal operation of the plant, while no individuals were impinged during the heat treatment. Graceful rock crab (*Cancer gracilis*) was the third most abundant species impinged with an estimated 487 individuals impinged during normal operation and none recorded during the heat treatment. The fifth most abundant macroinvertebrate species impinged in 2005 was the red rock shrimp (*Lysmata californica*) with a total of 457 individuals, 302 during heat treatment and an estimated 155 during normal operation. Each of the remaining species accounted for 1.0% or less of the total estimated abundance (Table 11).

Impinged biomass was numerically dominated by Pacific rock crab with an estimated 1,089 kg or 57% of the total weight (Table 11). Pacific rock crab impinged during the heat treatment accounted for 31 kg, while estimated normal operation impinged biomass was 1,059 kg. Red jellyfish (*Polyorchis penicillatus*) accounted for the second highest biomass, with an estimated 589 kg impinged during normal operation, with no observations during the heat treatment. Sheep crab (*Loxorhynchus grandis*) biomass was the third highest with an estimated 151 kg impinged during normal operation. No sheep crab were observed during the heat treatment. The remaining 16 species each accounted for less than 25 kg, or 1.3% of the annual total (Table 11).

DISCUSSION

One heat treatment and 11 normal operation surveys were conducted during the 2005 monitoring year at Ormond Beach Generating Station. An estimated total of 6,216 individual fish from 47 species weighing an estimated 695 kg were impinged over the year, based on heat treatment monitoring and estimated normal operation impingement.

Fish species composition in 2005 was similar to results found previously in the area, and other shallow nearshore areas throughout the Southern California Bight (Allen 1985). A recurring group of fish species have been observed in impingement sampling since 1990 with seven of the most abundant species in 2005 among the ten most abundant species long-term (Table 12).

Shiner perch was most abundant species in 2005 and it was third in overall abundance since 1990 (Table 12). Impingement in 2005 of shiner perch was nearly twice that of the long-term mean of 1,451 individuals/year. 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 California halibut (*Paralichthys californicus*) trawl fishery. Shiner perch are a common incidental catch in the California recreational fishery (Fritzsche and Collier 2001).

Table 12. The 10 most abundant fish species impinged during heat treatment and normal operation surveys, 1990 - 2005. Ormond Beach Generating Station NPDES, 2005.

	Year																	%
Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	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	224,754	60.3
Pacific sardine	322	86	110	1,643	362	1,056	197	2,921	21,434	24	89	295	483	107	632	156	29,916	8.0
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	23,222	6.2
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	22,259	6.0
walleye surfperch	1,506	1,521	3,942	550	126	616	10	1,353	431	-	2	611	432	266	11	143	11,519	3.1
white seaperch	1,606	987	1,054	1,019	1,169	2,454	395	926	158	-	35	36	75	86	55	229	10,285	2.8
plainfin midshipmai	1,844	1,484	999	490	336	432	11	-	-	46	58	1	172	2	-	-	5,874	1.6
Pacific pompano	1	157	72	738	22	16	4	1	1	-	5	3,350	186	280	8	30	4,871	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	3,830	1.0
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	372,577	
Total species	54	65	54	60	59	48	41	38	47	28	42	49	54	53	43	47	115	

Shiner perch size distribution was unimodal in 2005, with the predominant peak at 90 mm SL, with relatively high abundances between 80 and 110-mm SL. 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 2005 survey year are predominantly in their second to third year. 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 once through cooling water system at the generating station. Shiner perch populations were also examined in 1997, 1998, 2001, 2002, and 2004; all those years showed unimodal populations, with peaks at 60 mm, 70 mm, 80 mm (2001 and 2002), and 90-100 mm SL, respectively (MBC 1990, 1994, 1997-1999, 2000a, 2001-

2002, 2003a-2004a). In 2005, the length structure of shiner perch was similar to those in 2004, but larger than those in previous years.

Impinged abundances of queenfish were second only to shiner perch, with an estimated 882 individuals. The queenfish assemblage structure was unimodal, with size classes corresponding to Age-I to about Age-II in a close congener, white croaker (*Genyonemus lineatus*; Love et al 1984). The peak at 110 mm SL represents young Age-I individuals. Similar peaks were noted at 100 mm SL in 1993 and 2002, and at 110 mm SL in 1997, whereas bimodal distributions were seen in 2001, 2000, 1994 and 1992, with peaks at 70 and 130 mm SL, 70 and 120 mm SL, 75 and 115 mm SL, and 75 and 155 mm SL, respectively (Ogden 1991-1993; MBC 1994, 1997-1999, 2000a, 2001-2002).

Queenfish is considered a habitat generalist and is very abundant over soft substrate, such as that present offshore of Ormond Beach Generating Station (Allen 1982, Allen 1985), ranging from Baja California, Mexico to the Oregon Coast (Miller and Lea 1972). Nocturnal in nature, queenfish aggregate in dense schools during daylight hours, then disperse and actively feed on mysids and gammaridean amphipods (Hobson and Chess 1976). During day-night impingement studies at San Onofre Nuclear Generating Station, impingement of queenfish was shown to be much greater at night (SCE 1986). Allen and DeMartini (1982) observed consistently higher abundances of queenfish during night trawls than during day trawls.

Northern anchovy was the third most abundant species in 2005; it was fourth in overall abundance for the last 15 survey years (Table 12). Estimated abundance for northern anchovy in the current survey was below the long-term mean of 1,391 individuals/year. Recorded lengths for northern anchovy were predominantly within the 110-mm SL size class, or approximately 1 year-old fish (Parrish et al. 1985). Northern anchovy range from Cabo San Lucas, Baja California to British Columbia (Miller and Lea 1972) primarily in association with soft substrate habitat (Allen 1985). Live baitfish for the sportfishing community is the principal fishery for northern anchovy within southern California, with only a limited fishery currently operating (Bergen and Jacobson 2001). Adults offshore are preyed upon by marine fishes, mammals, and birds, especially California brown pelican (Bergen and Jacobson 2001). Links between breeding success of the endangered California brown pelican and northern anchovy abundance has been observed.

Estimated biomass of fish impinged during normal operation in 2005 was more than three times the biomass from heat treatments (Table 13). The pattern of impingement losses during normal operation has been consistent since 1999, and similar to reported patterns between 1979 and 1990. Prior to 1988, Ormond Beach Generating Station was a base load station, running all circulators between six and ten months of the year (SCE unpubl. flow data). Between 1988 and 2000, the generating station operated at only 8% to 36% of its rated capacity, running circulator pumps at full capacity one to three months of the year. Since 1988, annual biomass of impinged fish has been about one-tenth of the mean for the previous nine years and has ranged between about 300 and 2,700 kg per year. Biomass in 2005 was strongly influenced by relatively high numbers of larger individual species, such as Pacific electric ray, horn shark, and thornback during normal operation monitoring. In addition to operational flow differences among years, other potential influences that may determine the impingement losses each year include; variation in fish abundances, oceanographic conditions, the random impingement of large numbers of schooling species and foraging behavior of common offshore species in the vicinity of the intake.

In 2005, the most abundant macroinvertebrate taken was Pacific rock crab, followed by red jellyfish, the most abundant macroinvertebrate in 2004. Pacific rock crab and other members of the genus *Cancer* are common in the nearshore rocky environment. Red jellyfish are drifting pelagic invertebrates, which randomly encounter the intake as they are moved by the currents inshore. Both of these have been infrequently taken in large numbers at other coastal generating stations (MBC 2003b,c), but it is unlikely these occurrences have had substantial impacts on their populations.

Many of the macroinvertebrate species impinged at the station were crabs and shrimps that live in and on the fouling community in the pipes of the intake cooling structure. Strong current flows into the generating station intakes bring larvae that, once entrained, settle and grow in ideal conditions, and are typically present in the system. Species present in the environment surrounding the intake structure, as larvae or juveniles, are susceptible to entrainment into the system (Graham et al. 1977, IRC 1981). The freshly entrained individuals encounter suitable habitat and recruit to the fouling community (Graham et al. 1977, IRC 1981). With an ample food supply, these larval crabs grow until they are removed during the next heat treatment. As with the fish population, impingement monitoring suggests that a core group of recurring and abundant macroinvertebrate species continues in the area. Abundance during the periodic heat treatments has remained similar from year to year, and it is unlikely that the generating station has had any appreciable effect on the nearshore macroinvertebrate population.

The continued presence of the core species in the study area and throughout the Southern California Bight demonstrates the stability of the community and suggests that the nearshore macrofaunal marine communities in the vicinity of the intake are not unduly stressed by the relatively minor loss due to impingement.

Table 13. Fish biomass (kg) collected during heat treatment and estimated normal operation surveys, 1979 - 2005. Ormond Beach Generating Station NPDES, 2005.

Year	Normal Operation	Heat Treatment	Total
2005	537.6	157.5	695.2
2004	1,052.2	110.0	1,162.2
2003	536.1	235.2	771.3
2002	255.4	192.3	447.7
2001	2,456.4	231.6	2,688.0
2000	170.1	141.4	311.5
1999	328.1	33.7	361.8
1998	226.2	715.0	941.2
1997	561.3	543.7	1,105.0
1996	395.7	324.9	720.6
1995	548.8	931.6	1,480.4
1994	457.5	646.2	1,103.7
1993	949.7	1,731.1	2,680.9
1992	346.7	1,312.4	1,659.1
1991	1,166.4	1,543.5	2,709.9
1990	1,026.7	322.4	1,349.1
1989	1,163.4	763.8	1,927.2
1988	1,108.0	793.0	1,901.0
1987	10,606.6	769.1	11,375.7
1986	6,037.9	1,629.0	7,666.9
1985	4,018.4	433.2	4,451.6
1984	6,333.4	374.6	6,708.0
1983	16,388.1	571.0	16,959.1
1982	5,860.0	2,221.8	8,081.8
1981	13,890.5	2,074.5	15,965.0
1980	20,437.2	655.9	21,093.1
1979	36,741.7	2,375.6	39,117.3
Summary			
Total	133,600.2	21,834.1	155,434.3
Mean	4,948.2	808.7	5,756.8

CONCLUSION

Fish and macroinvertebrates species collected during impingement surveys at the Ormond Beach Generating Station in 2005 were similar to those of the last 15 years, indicating a healthy, stabele community in the nearshore area. Fluctuations in fish and macroinvertebrate abundance and biomass appear to be due in part to natural population variation, although recent declines in impingement catches are probably related to reductions in intake flow. There was no indication that the operation of the generating station adversely affected the core species populations.

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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.).

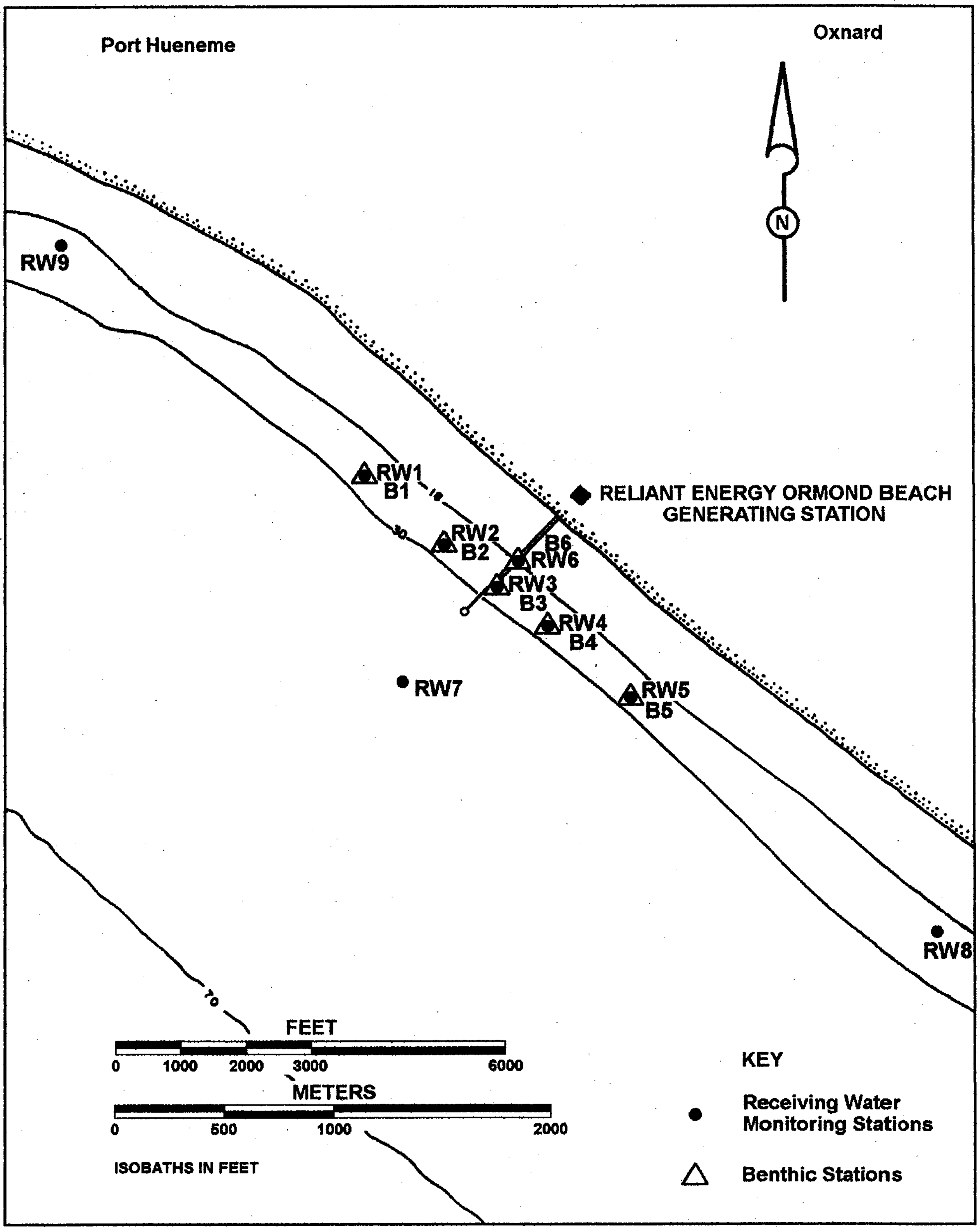

Figure 1. Location of the monitoring stations. Ormond Beach Generating Station.

APPENDIX B

Grain size techniques

Appendix B. 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).

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

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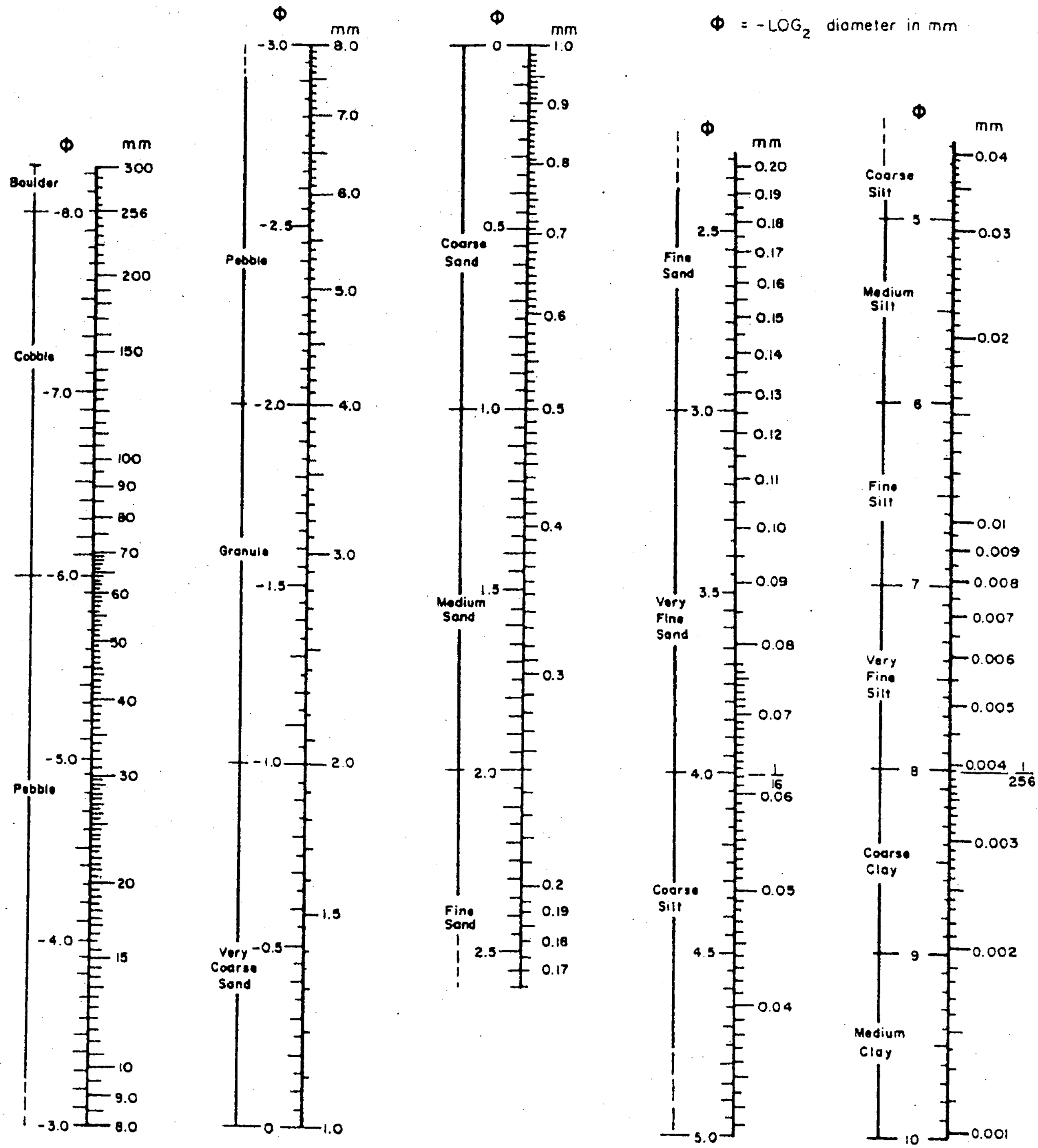
Appendix B. (Cont.).

Phi - Millimeter Conversion Figure



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

σ_I under	.35 ϕ,	very well sorted	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

Water quality parameters at each receiving water monitoring station

Appendix C-1. Water quality parameters at each receiving water monitoring station during flood and ebb tides. Ormond Beach Generating Station NPDES, winter 2005.

		Temp. (°C)		Oxygen (mg/l)		pH		Salinity (psu)	
	Depth (m)	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB	FLOOD	EBB
RW1	0	11.77	11.25	7.42	6.54	7.97	7.92	33.58	33.66
	1	11.76	11.25	7.40	6.53	7.97	7.92	33.58	33.67
	2	11.72	11.26	7.39	6.54	7.97	7.92	33.58	33.67
	3	11.71	11.23	7.39	6.54	7.97	7.92	33.58	33.67
	4	11.64	11.19	7.37	6.40	7.97	7.91	33.58	33.69
	5	11.59	11.17	7.31	6.23	7.96	7.90	33.59	33.69
	6	11.50	11.15	7.27	6.20	7.95	7.90	33.61	33.70
	7	11.43	11.14	7.03	6.14	7.94	7.90	33.62	33.70
	8	11.33	11.13	6.86	6.09	7.93	7.90	33.65	33.70
	9	11.27	11.04	6.61	6.07	7.92	7.89	33.67	33.73
	10	11.20	10.86	6.56	5.86	7.92	7.87	33.69	33.78
RW2	0	11.90	11.19	7.56	6.19	7.99	7.90	33.56	33.68
	1	11.90	11.18	7.55	6.24	7.99	7.90	33.56	33.69
	2	11.84	11.18	7.53	6.24	7.99	7.90	33.57	33.69
	3	11.83	11.18	7.51	6.24	7.99	7.90	33.56	33.70
	4	11.74	11.18	7.52	6.21	7.99	7.90	33.56	33.70
	5	11.68	11.19	7.42	6.19	7.98	7.90	33.57	33.71
	6	11.56	11.10	7.27	6.17	7.96	7.90	33.60	33.70
	7	11.48	10.86	6.98	5.91	7.95	7.88	33.62	33.73
	8	11.44	10.83	6.89	5.44	7.96	7.86	33.63	33.73
	9	11.40	10.78	6.82	5.19	7.94	7.86	33.64	33.74
	10	11.33	10.76	6.82	5.04	7.94	7.85	33.66	33.74
RW3	0	11.95	11.16	7.52	6.02	8.00	7.90	33.56	33.71
	1	11.94	11.16	7.56	6.01	7.99	7.90	33.56	33.71
	2	11.93	11.16	7.58	5.98	7.99	7.90	33.56	33.72
	3	11.90	11.16	7.59	6.06	8.00	7.90	33.56	33.72
	4	11.82	11.16	7.58	6.04	7.99	7.90	33.59	33.72
	5	11.80	11.15	7.53	6.08	7.99	7.90	33.56	33.72
	6	11.73	11.09	7.46	6.01	7.98	7.90	33.59	33.72
	7	11.60	11.07	7.40	5.85	7.96	7.90	33.62	33.73
	8	11.54	11.00	7.19	5.84	7.96	7.88	33.62	33.72
	9	11.51	10.99	7.06	5.78	7.96	7.88	33.63	33.72
	10	11.49	10.90	7.08	5.85	7.95	7.89	33.63	33.74
RW4	0	12.00	11.15	7.55	6.19	7.99	7.90	33.56	33.66
	1	12.00	11.17	7.55	6.18	7.99	7.90	33.55	33.66
	2	11.98	11.20	7.58	6.17	7.99	7.90	33.55	33.69
	3	11.90	11.19	7.59	6.16	7.99	7.90	33.56	33.71
	4	11.80	11.18	7.52	6.13	7.99	7.90	33.57	33.71
	5	11.77	11.17	7.41	6.06	7.98	7.90	33.57	33.71
	6	11.65	11.13	7.39	6.09	7.98	7.90	33.59	33.72
	7	11.59	11.04	7.26	6.01	7.97	7.89	33.60	33.73
	8	11.49	10.91	7.15	5.85	7.95	7.88	33.63	33.74
	9	11.42	10.88	7.06	5.53	7.95	7.88	33.65	33.73
	10	11.34	10.86	7.06	5.39	7.94	7.87	33.67	33.73
RW5	0	12.18	11.18	8.11	6.20	8.04	7.91	33.51	33.66
	1	12.14	11.18	8.13	6.19	8.04	7.90	33.52	33.66
	2	12.11	11.18	8.12	6.20	8.03	7.90	33.52	33.66
	3	12.10	11.19	8.07	6.22	8.03	7.90	33.52	33.67
	4	11.92	11.22	8.11	6.18	8.02	7.90	33.58	33.68
	5	11.84	11.22	7.96	6.19	8.01	7.90	33.57	33.68
	6	11.64	11.22	7.77	6.16	7.98	7.90	33.64	33.70
	7	11.51	11.18	7.47	6.15	7.96	7.90	33.67	33.70
	8	11.23	11.00	7.03	6.05	7.92	7.89	33.71	33.71
	9	11.10	10.93	6.33	5.60	7.90	7.88	33.73	33.72
	10	11.01	10.88	6.10	5.49	7.88	7.88	33.73	33.72
	11		10.85		5.39		7.88		33.73

Appendix C-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
RW6	0	11.97	11.11	7.59	5.99	7.99	7.90	33.55	33.72
	1	11.97	11.11	7.60	6.00	7.99	7.90	33.55	33.72
	2	11.95	11.12	7.66	6.01	7.99	7.90	33.56	33.72
	3	11.93	11.12	7.64	5.99	8.00	7.90	33.55	33.72
	4	11.86	11.11	7.67	6.00	7.99	7.90	33.56	33.72
	5	11.80	11.11	7.64	5.98	7.99	7.90	33.57	33.72
	6	11.75	11.06	7.56	5.97	7.99	7.89	33.57	33.73
	7	11.66	10.96	7.52	5.93	7.98	7.88	33.59	33.73
	8	11.64	10.93	7.48	5.94	7.98	7.88	33.60	33.73
	9	11.62		7.45		7.98		33.60	
RW7	0	12.10	11.27	7.81	6.53	8.03	7.92	33.52	33.64
	1	12.09	11.28	7.80	6.55	8.03	7.92	33.52	33.64
	2	11.96	11.28	7.84	6.59	8.02	7.93	33.56	33.64
	3	11.75	11.28	7.80	6.59	8.00	7.93	33.59	33.64
	4	11.63	11.05	7.57	6.60	7.97	7.91	33.56	33.67
	5	11.46	10.88	7.28	6.13	7.96	7.89	33.66	33.65
	6	11.33	10.89	7.04	5.56	7.94	7.88	33.67	33.61
	7	11.22	10.95	6.57	5.42	7.92	7.89	33.71	33.63
	8	11.09	10.98	6.31	5.57	7.90	7.90	33.76	33.65
	9	10.94	10.92	6.07	5.71	7.87	7.89	33.77	33.70
	10	10.86	10.77	5.63	5.59	7.86	7.87	33.77	33.78
	11	10.81	10.69	5.31	5.30	7.86	7.87	33.76	33.76
	12	10.78	10.59	5.21	5.10	7.86	7.86	33.75	33.78
RW8	0	12.51	11.25	8.61	6.44	8.07	7.92	33.49	33.62
	1	12.49	11.26	8.61	6.43	8.08	7.92	33.50	33.62
	2	12.42	11.26	8.63	6.46	8.07	7.92	33.52	33.63
	3	12.33	11.25	8.61	6.41	8.06	7.92	33.55	33.64
	4	12.12	11.25	8.54	6.38	8.04	7.92	33.57	33.65
	5	11.97	11.24	8.28	6.37	8.03	7.92	33.61	33.67
	6	11.73	11.23	7.99	6.34	7.99	7.92	33.64	33.68
	7	11.46	11.23	7.47	6.24	7.95	7.91	33.69	33.69
	8	11.14	11.14	6.62	6.26	7.90	7.90	33.72	33.69
	9	10.96	10.95	6.17	6.00	7.88	7.89	33.74	33.73
	10	10.88	10.92	6.00	5.64	7.87	7.88	33.74	33.72
RW9	0	11.23	11.02	6.16	5.89	7.90	7.88	33.66	33.75
	1	11.24	11.02	6.16	5.90	7.90	7.88	33.66	33.75
	2	11.21	11.03	6.15	5.91	7.90	7.88	33.66	33.75
	3	11.19	11.03	6.15	5.91	7.90	7.88	33.67	33.75
	4	11.16	11.02	6.13	5.91	7.90	7.88	33.67	33.75
	5	11.12	11.02	6.14	5.93	7.91	7.88	33.67	33.75
	6	11.04	11.02	6.10	5.90	7.89	7.88	33.69	33.75
	7	10.98	11.02	5.97	5.93	7.89	7.88	33.69	33.74
	8	10.95	11.01	5.85	5.91	7.88	7.88	33.70	33.74
	9	10.93	10.91	5.81	5.89	7.88	7.88	33.70	33.74
	10	10.95	10.76	5.68	5.65	7.88	7.86	33.69	33.77

Appendix C-2. Water quality parameters at each receiving water monitoring station during flood and ebb tides. Ormond Beach Generating Station NPDES, summer 2005.

	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
RW1	0	13.52	12.58	6.18	5.78	7.94	7.88	33.51	33.56
	1	13.49	12.53	6.19	5.79	7.94	7.88	33.51	33.56
	2	13.47	12.19	6.17	5.68	7.94	7.86	33.51	33.63
	3	13.49	12.03	6.15	5.22	7.94	7.84	33.51	33.59
	4	13.35	11.89	6.19	4.88	7.94	7.84	33.51	33.59
	5	13.25	11.66	6.12	4.99	7.93	7.85	33.51	33.60
	6	13.17	11.63	6.08	5.05	7.92	7.85	33.51	33.57
	7	13.06	11.63	6.04	5.07	7.91	7.85	33.52	33.57
	8	13.02	11.62	5.90	5.05	7.90	7.85	33.53	33.57
	9	12.88	11.63	5.88	5.04	7.90	7.85	33.51	33.57
	10	11.99	11.64	5.89	5.05	7.85	7.85	33.53	33.57
RW2	0	13.56	12.62	6.32	6.09	7.94	7.88	33.52	33.55
	1	13.57	12.61	6.32	6.05	7.94	7.88	33.52	33.55
	2	13.48	12.40	6.35	6.06	7.94	7.87	33.50	33.59
	3	13.39	12.06	6.31	5.68	7.94	7.85	33.52	33.59
	4	13.33	11.88	6.27	5.06	7.94	7.83	33.52	33.60
	5	13.30	11.71	6.18	4.94	7.94	7.83	33.52	33.61
	6	13.27	11.69	6.19	5.01	7.92	7.84	33.52	33.59
	7	13.20	11.70	6.17	4.98	7.92	7.84	33.52	33.57
	8	12.62	11.67	6.17	5.00	7.90	7.84	33.51	33.57
	9	11.92	11.64	5.85	4.95	7.85	7.83	33.54	33.57
	10	11.91	11.64	5.46	4.90	7.81	7.83	33.58	33.57
RW3	0	15.25	13.94	6.17	5.54	7.92	7.84	33.53	33.48
	1	15.06	13.49	6.17	5.52	7.92	7.85	33.55	33.54
	2	14.27	13.05	6.32	5.62	7.94	7.85	33.52	33.57
	3	13.75	12.56	6.42	5.83	7.96	7.86	33.60	33.58
	4	13.58	12.41	6.46	5.77	7.95	7.86	33.55	33.60
	5	13.41	12.10	6.39	5.53	7.95	7.84	33.53	33.60
	6	12.98	11.80	6.22	5.27	7.90	7.84	33.55	33.61
	7	12.50	11.82	6.05	5.05	7.88	7.83	33.52	33.57
	8	12.24	11.76	5.67	4.93	7.84	7.83	33.54	33.57
	9	12.01	11.71	5.24	4.93	7.82	7.83	33.55	33.57
	10	12.02	11.72	5.05	4.97	7.81	7.83	33.55	33.56
RW4	0	14.74	12.61	6.32	4.97	7.94	7.83	33.50	33.55
	1	14.47	12.60	6.37	5.00	7.95	7.83	33.55	33.55
	2	13.78	12.60	6.47	4.96	7.96	7.83	33.66	33.55
	3	13.64	12.59	6.52	4.97	7.96	7.83	33.53	33.56
	4	13.60	12.59	6.49	4.98	7.96	7.83	33.53	33.55
	5	13.49	12.52	6.52	5.00	7.96	7.84	33.53	33.56
	6	13.22	12.42	6.49	5.02	7.94	7.85	33.58	33.58
	7	12.48	12.37	6.18	5.06	7.86	7.85	33.63	33.56
	8	12.00	12.28	5.64	5.03	7.82	7.84	33.59	33.57
	9	11.91	12.10	5.22	4.98	7.81	7.83	33.62	33.58
	10	11.86	11.76	5.01	4.98	7.81	7.82	33.56	33.60
RW5	0	14.69	13.37	6.76	6.27	7.98	7.95	33.50	33.50
	1	14.69	13.54	6.74	6.16	7.98	7.97	33.50	33.52
	2	14.61	13.11	6.76	6.37	7.98	7.95	33.50	33.69
	3	14.42	12.62	6.80	6.21	7.98	7.89	33.51	33.60
	4	13.96	12.44	6.95	5.66	7.98	7.88	33.52	33.59
	5	13.45	12.38	7.21	5.45	7.96	7.86	33.53	33.56
	6	12.54	12.37	6.76	5.25	7.88	7.85	33.54	33.56
	7	12.23	12.37	5.72	5.09	7.84	7.83	33.54	33.56
	8	12.10	12.36	5.34	5.01	7.82	7.82	33.56	33.56
	9	12.00	12.26	5.12	4.93	7.81	7.81	33.55	33.58
	10	11.87	12.01	5.08	4.86	7.81	7.81	33.56	33.59
	11	11.86	11.66	5.02	4.85	7.80	7.81	33.56	33.57

Appendix C-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
RW6	0	15.39	13.60	6.41	5.60	7.94	7.85	33.50	33.55
	1	15.30	13.60	6.38	5.61	7.94	7.85	33.52	33.55
	2	14.80	13.39	6.43	5.61	7.95	7.85	33.53	33.53
	3	14.23	12.96	6.59	5.78	7.97	7.86	33.54	33.55
	4	14.11	12.73	6.72	6.14	7.98	7.87	33.52	33.58
	5	13.91	12.51	6.79	6.52	7.98	7.87	33.53	33.56
	6	13.83	12.26	6.76	6.30	7.98	7.87	33.52	33.56
	7	13.80	11.89	6.71	5.57	7.98	7.84	33.52	33.57
	8	13.77	11.86	6.69	4.96	7.98	7.83	33.52	33.56
RW7	0	13.80	14.98	6.30	7.60	7.96	8.09	33.50	33.51
	1	13.75	14.98	6.32	7.61	7.96	8.09	33.51	33.51
	2	13.58	14.97	6.32	7.65	7.95	8.09	33.51	33.51
	3	13.48	14.85	6.26	7.62	7.94	8.08	33.50	33.50
	4	13.33	14.40	6.20	7.50	7.94	8.06	33.52	33.54
	5	12.97	13.99	6.12	7.12	7.91	8.02	33.53	33.53
	6	12.25	13.64	5.85	6.79	7.86	7.99	33.56	33.53
	7	12.00	13.51	5.35	6.45	7.83	7.97	33.55	33.53
	8	11.92	13.38	5.12	6.28	7.83	7.96	33.55	33.54
	9	11.83	13.26	5.12	6.21	7.82	7.94	33.56	33.54
	10	11.77	13.17	5.01	6.15	7.82	7.94	33.55	33.53
	11	11.74	12.51	4.89	6.17	7.80	7.92	33.56	33.54
	12	11.74	12.26	4.83	5.81	7.80	7.87	33.56	33.56
	13	11.74		4.81		7.81		33.56	
RW8	0	14.80	12.76	7.35	5.53	7.98	7.87	33.51	33.54
	1	14.76	12.76	7.34	5.50	7.98	7.87	33.53	33.54
	2	14.46	12.75	7.40	5.53	7.99	7.87	33.49	33.55
	3	14.10	12.74	7.29	5.51	7.98	7.87	33.51	33.55
	4	13.82	12.73	7.10	5.51	7.97	7.87	33.51	33.55
	5	13.35	12.71	6.88	5.52	7.92	7.87	33.56	33.55
	6	12.26	12.61	6.79	5.51	7.86	7.87	33.50	33.55
	7	11.27	12.57	6.07	5.57	7.75	7.85	33.55	33.56
	8	10.85	12.40	4.44	5.68	7.67	7.85	33.64	33.57
	9	10.84	12.39	3.63	5.77	7.66	7.84	33.63	33.58
	10	10.87	11.83	3.55	5.85	7.66	7.82	33.63	33.57
RW9	0	13.27	12.77	5.95	5.61	7.90	7.89	33.53	33.56
	1	13.27	12.74	5.95	5.66	7.90	7.89	33.51	33.55
	2	13.08	12.40	5.91	5.69	7.90	7.89	33.52	33.54
	3	12.87	12.22	5.76	5.46	7.88	7.88	33.52	33.56
	4	12.73	12.08	5.61	5.34	7.87	7.87	33.53	33.56
	5	12.70	11.90	5.51	5.25	7.87	7.86	33.53	33.56
	6	12.68	11.73	5.49	4.90	7.87	7.84	33.53	33.57
	7	12.66	11.69	5.45	4.84	7.87	7.82	33.54	33.57
	8	12.62	11.68	5.39	4.65	7.86	7.81	33.54	33.57
	9	12.55	11.68	5.29	4.60	7.84	7.81	33.55	33.57
	10	12.28	11.68	5.23	4.60	7.83	7.81	33.56	33.57

APPENDIX D

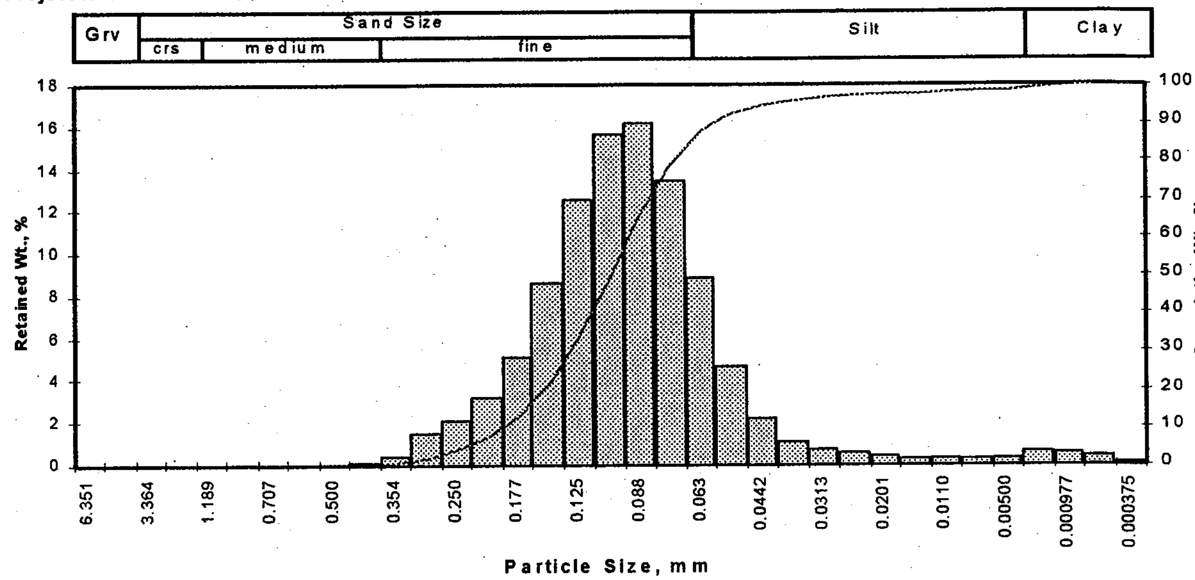
Sediment grain size distribution and statistical parameters by station

Appendix D-1. Sediment grain size distribution and statistical parameters by station. Ormond Beach Generating Station NPDES, 2005.

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience Environmental Laboratories, Inc.	**PTS File No:**	35513
Project:	N/A	**Sample ID:**	B-1
Project No:	05-08-1238	**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	0.09	0.09	0.09
0.0139	0.354	1.50	45	0.40	0.40	0.49
0.0117	0.297	1.75	50	1.44	1.44	1.93
0.0098	0.250	2.00	60	2.09	2.09	4.02
0.0083	0.210	2.25	70	3.17	3.17	7.19
0.0070	0.177	2.50	80	5.14	5.14	12.33
0.0059	0.149	2.75	100	8.65	8.65	20.97
0.0049	0.125	3.00	120	12.60	12.60	33.57
0.0041	0.105	3.25	140	15.70	15.70	49.27
0.0035	0.088	3.50	170	16.20	16.20	65.46
0.0029	0.074	3.75	200	13.50	13.50	78.96
0.0025	0.063	4.00	230	8.83	8.83	87.78
0.0021	0.053	4.25	270	4.64	4.64	92.42
0.00174	0.0442	4.50	325	2.14	2.14	94.56
0.00146	0.0372	4.75	400	1.12	1.12	95.68
0.00123	0.0313	5.00	450	0.69	0.69	96.37
0.000986	0.0250	5.32	500	0.55	0.55	96.92
0.000790	0.0201	5.64	635	0.35	0.35	97.27
0.000615	0.0156	6.00		0.27	0.27	97.54
0.000435	0.0110	6.50		0.28	0.28	97.82
0.000308	0.00781	7.00		0.24	0.24	98.06
0.000197	0.00500	7.65		0.29	0.29	98.35
0.000077	0.00195	9.00		0.64	0.64	98.99
0.000038	0.000977	10.00		0.58	0.58	99.57
0.000019	0.000488	11.00		0.39	0.39	99.96
0.000015	0.000375	11.38		0.04	0.04	100.00
TOTALS				**100.00**	**100.00**	**100.00**

Cumulative Weight Percent greater than

Weight percent	Phi Value	Particle Size: Inches	Particle Size: Millimeters
5	2.08	0.0093	0.237
10	2.39	0.0075	0.191
16	2.61	0.0065	0.164
25	2.83	0.0055	0.141
40	3.10	0.0046	0.116
50	3.26	0.0041	0.104
60	3.42	0.0037	0.094
75	3.68	0.0031	0.078
84	3.89	0.0027	0.067
90	4.12	0.0023	0.058
95	4.60	0.0016	0.041

Measure	Trask	Inman	Folk-Ward
Median, phi	3.26	3.26	3.26
Median, in.	0.0041	0.0041	0.0041
Median, mm	0.104	0.104	0.104
Mean, phi	3.19	3.25	3.25
Mean, in.	0.0043	0.0041	0.0041
Mean, mm	0.109	0.105	0.105
Sorting	1.341	0.643	0.704
Skewness	1.006	-0.018	0.021
Kurtosis	0.234	0.959	1.220

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	0.09
Fine Sand	200	78.87
Silt	>0.005 mm	19.39
Clay	<0.005 mm	1.65
	Total	**100**

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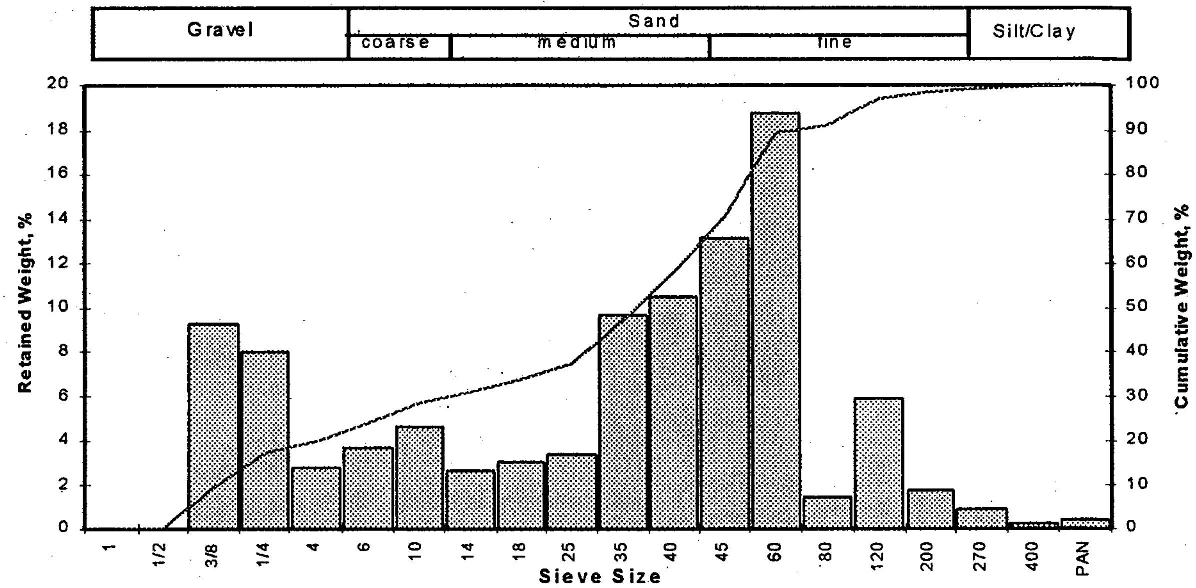
Appendix D-1. (Cont.).

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D422M

Client:	Calscience Environmental Laboratories, Inc.	**PTS File No:**	35513
Project:	N/A	**Sample ID:**	B-2
Project No:	05-08-1238	**Depth, ft:**	N/A



Opening Inches	Opening Millimeters	Phi of Screen	U.S. Sieve No.	Sample Weight grams	Incremental Weight, percent	Cumulative Weight, percent
0.9844	25.002	-4.64	1	0.00	0.00	0.00
0.4922	12.501	-3.64	1/2	0.00	0.00	0.00
0.3740	9.500	-3.25	3/8	3.90	9.25	9.25
0.2500	6.351	-2.67	1/4	3.38	8.01	17.26
0.1873	4.757	-2.25	4	1.19	2.82	20.08
0.1324	3.364	-1.75	6	1.55	3.67	23.76
0.0787	2.000	-1.00	10	1.95	4.62	28.38
0.0557	1.414	-0.50	14	1.11	2.63	31.01
0.0394	1.000	0.00	18	1.27	3.01	34.02
0.0278	0.707	0.50	25	1.44	3.41	37.43
0.0197	0.500	1.00	35	4.08	9.67	47.11
0.0166	0.420	1.25	40	4.42	10.48	57.59
0.0139	0.354	1.50	45	5.55	13.16	70.74
0.0098	0.250	2.00	60	7.88	18.68	89.43
0.0070	0.177	2.50	80	0.62	1.47	90.90
0.0049	0.125	3.00	120	2.49	5.90	96.80
0.0029	0.074	3.75	200	0.72	1.71	98.51
0.0021	0.053	4.25	270	0.37	0.88	99.38
0.0015	0.037	4.75	400	0.10	0.24	99.62
			PAN	0.16	0.38	100.00
TOTALS				42.18	100.00	100.00

Cumulative Weight Percent greater than

Weight percent	Phi Value	Particle Size Inches	Particle Size Millimeters
5	-3.43	0.4243	10.777
10	-3.19	0.3601	9.147
16	-2.76	0.2664	6.766
25	-1.55	0.1151	2.924
40	0.63	0.0254	0.645
50	1.07	0.0188	0.477
60	1.30	0.0160	0.407
75	1.61	0.0129	0.327
84	1.85	0.0109	0.276
90	2.20	0.0086	0.218
95	2.85	0.0055	0.139

Measure	Trask	Inman	Folk-Ward
Median, phi	1.07	1.07	1.07
Median, in.	0.0188	0.0188	0.0188
Median, mm	0.477	0.477	0.477
Mean, phi	-0.70	-0.45	0.06
Mean, in.	0.0640	0.0538	0.0379
Mean, mm	1.625	1.368	0.962
Sorting	2.992	2.307	2.104
Skewness	2.051	-0.659	-0.546
Kurtosis	0.145	0.361	0.814
Grain Size Description (ASTM-USCS Scale)	Medium sand (based on Mean from Trask)		

Description	Retained on Sieve #	Weight Percent
Gravel	4	20.08
Coarse Sand	10	8.30
Medium Sand	40	29.21
Fine Sand	200	40.92
Silt/Clay	<200	1.49
	Total	100

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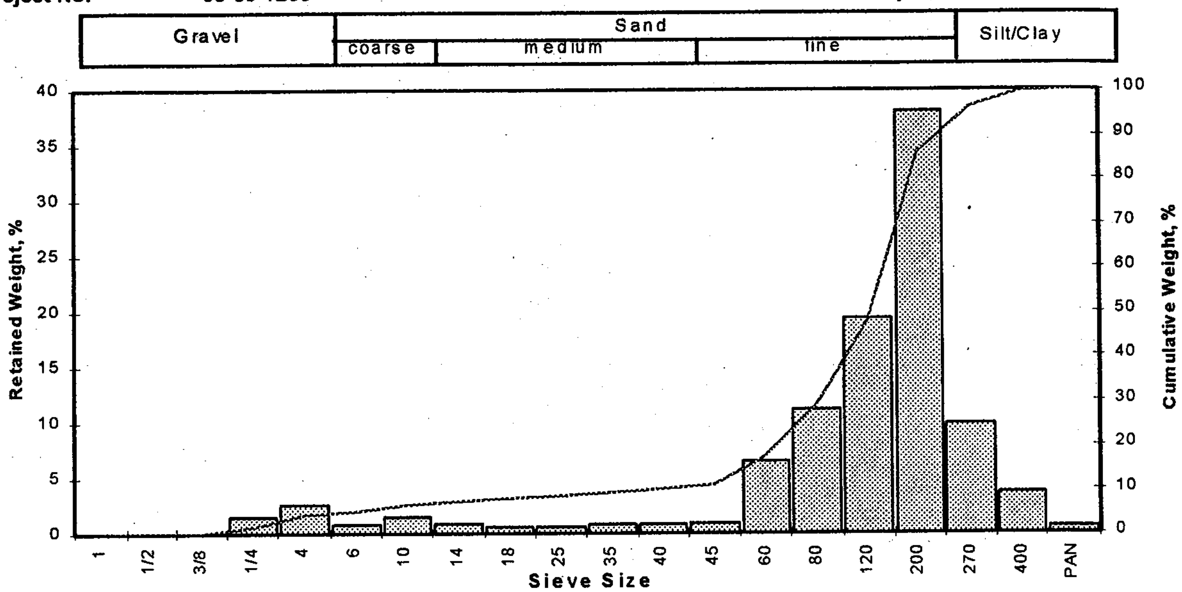
Appendix D-1. (Cont.).

PTS Laboratories, Inc. — **Particle Size Analysis - ASTM D422M**

Client:	Calscience Environmental Laboratories, Inc.	**PTS File No:**	35513
Project:	N/A	**Sample ID:**	B-3
Project No:	05-08-1238	**Depth, ft:**	N/A



Opening Inches	Opening Millimeters	Phi of Screen	U.S. Sieve No.	Sample Weight grams	Incremental Weight, percent	Cumulative Weight, percent
0.9844	25.002	-4.64	1	0.00	0.00	0.00
0.4922	12.501	-3.64	1/2	0.00	0.00	0.00
0.3740	9.500	-3.25	3/8	0.00	0.00	0.00
0.2500	6.351	-2.67	1/4	0.31	1.44	1.44
0.1873	4.757	-2.25	4	0.55	2.56	4.00
0.1324	3.364	-1.75	6	0.16	0.74	4.74
0.0787	2.000	-1.00	10	0.33	1.53	6.28
0.0557	1.414	-0.50	14	0.19	0.88	7.16
0.0394	1.000	0.00	18	0.13	0.60	7.76
0.0278	0.707	0.50	25	0.14	0.65	8.41
0.0197	0.500	1.00	35	0.16	0.74	9.16
0.0166	0.420	1.25	40	0.17	0.79	9.95
0.0139	0.354	1.50	45	0.20	0.93	10.88
0.0098	0.250	2.00	60	1.41	6.56	17.43
0.0070	0.177	2.50	80	2.41	11.20	28.64
0.0049	0.125	3.00	120	4.16	19.34	47.98
0.0029	0.074	3.75	200	8.18	38.03	86.01
0.0021	0.053	4.25	270	2.10	9.76	95.77
0.0015	0.037	4.75	400	0.79	3.67	99.44
			PAN	0.12	0.56	100.00
TOTALS				21.51	100.00	100.00

Cumulative Weight Percent greater than			
Weight percent	Phi Value	Particle Size Inches	Particle Size Millimeters
5	-1.62	0.1213	3.082
10	1.26	0.0164	0.416
16	1.89	0.0106	0.270
25	2.34	0.0078	0.198
40	2.79	0.0057	0.144
50	3.04	0.0048	0.122
60	3.24	0.0042	0.106
75	3.53	0.0034	0.086
84	3.71	0.0030	0.076
90	3.95	0.0025	0.065
95	4.21	0.0021	0.054

Measure	Trask	Inman	Folk-Ward
Median, phi	3.04	3.04	3.04
Median, in.	0.0048	0.0048	0.0048
Median, mm	0.122	0.122	0.122
Mean, phi	2.81	2.80	2.88
Mean, in.	0.0056	0.0057	0.0053
Mean, mm	0.142	0.144	0.136
Sorting	1.513	0.910	1.339
Skewness	1.075	-0.263	-0.431
Kurtosis	0.158	2.206	2.001

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

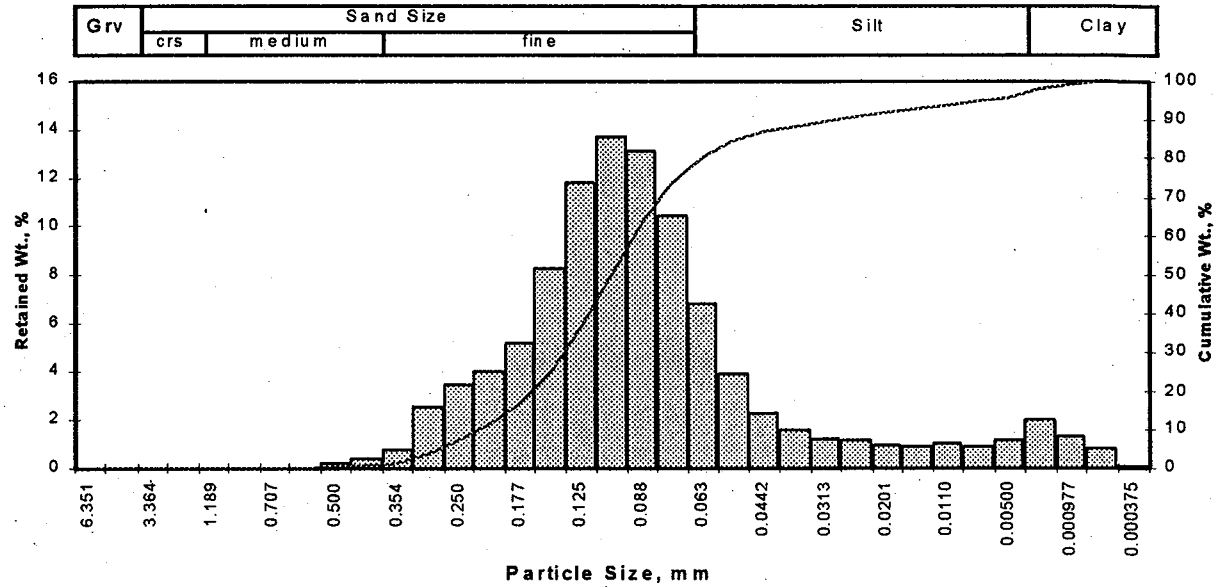
Description	Retained on Sieve #	Weight Percent
Gravel	4	4.00
Coarse Sand	10	2.28
Medium Sand	40	3.67
Fine Sand	200	76.06
Silt/Clay	<200	13.99
	Total	100

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

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience Environmental Laboratories, Inc.	**PTS File No:**	35513
Project:	N/A	**Sample ID:**	B-4
Project No:	05-08-1238	**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	0.01	0.01	0.01
0.0197	0.500	1.00	35	0.21	0.21	0.22
0.0166	0.420	1.25	40	0.44	0.44	0.66
0.0139	0.354	1.50	45	0.78	0.78	1.43
0.0117	0.297	1.75	50	2.58	2.58	4.01
0.0098	0.250	2.00	60	3.42	3.42	7.43
0.0083	0.210	2.25	70	4.01	4.01	11.44
0.0070	0.177	2.50	80	5.17	5.17	16.61
0.0059	0.149	2.75	100	8.31	8.31	24.91
0.0049	0.125	3.00	120	11.80	11.79	36.70
0.0041	0.105	3.25	140	13.70	13.69	50.40
0.0035	0.088	3.50	170	13.10	13.09	63.49
0.0029	0.074	3.75	200	10.40	10.39	73.88
0.0025	0.063	4.00	230	6.81	6.81	80.69
0.0021	0.053	4.25	270	3.90	3.90	84.59
0.00174	0.0442	4.50	325	2.31	2.31	86.89
0.00146	0.0372	4.75	400	1.62	1.62	88.51
0.00123	0.0313	5.00	450	1.21	1.21	89.72
0.000986	0.0250	5.32	500	1.17	1.17	90.89
0.000790	0.0201	5.64	635	0.95	0.95	91.84
0.000615	0.0156	6.00		0.89	0.89	92.73
0.000435	0.0110	6.50		1.02	1.02	93.75
0.000308	0.00781	7.00		0.92	0.92	94.67
0.000197	0.00500	7.65		1.14	1.14	95.81
0.000077	0.00195	9.00		1.98	1.98	97.79
0.000038	0.000977	10.00		1.28	1.28	99.07
0.000019	0.000488	11.00		0.85	0.85	99.92
0.000015	0.000375	11.38		0.08	0.08	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	1.82	0.0111	0.283
10	2.16	0.0088	0.224
16	2.47	0.0071	0.180
25	2.75	0.0058	0.148
40	3.06	0.0047	0.120
50	3.24	0.0042	0.106
60	3.43	0.0036	0.093
75	3.79	0.0028	0.072
84	4.21	0.0021	0.054
90	5.08	0.0012	0.030
95	7.19	0.0003	0.007

Measure	Trask	Inman	Folk-Ward
Median, phi	3.24	3.24	3.24
Median, in.	0.0042	0.0042	0.0042
Median, mm	0.106	0.106	0.106
Mean, phi	3.18	3.34	3.31
Mean, in.	0.0043	0.0039	0.0040
Mean, mm	0.110	0.099	0.101
Sorting	1.434	0.871	1.248
Skewness	0.980	0.113	0.292
Kurtosis	0.196	2.080	2.116

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

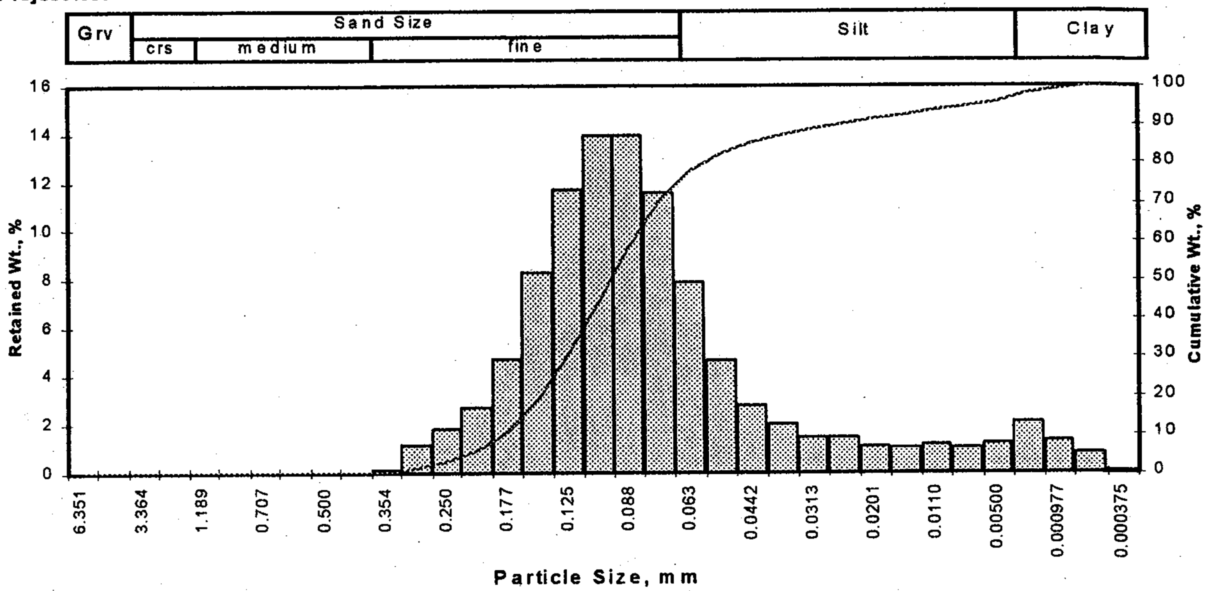
Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	0.66
Fine Sand	200	73.23
Silt	>0.005 mm	21.93
Clay	<0.005 mm	4.19
	Total	100

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

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience Environmental Laboratories, Inc.	**PTS File No:**	35513
Project:	N/A	**Sample ID:**	B-5
Project No:	05-08-1238	**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	0.17	0.17	0.17
0.0117	0.297	1.75	50	1.19	1.19	1.36
0.0098	0.250	2.00	60	1.81	1.81	3.18
0.0083	0.210	2.25	70	2.70	2.70	5.88
0.0070	0.177	2.50	80	4.66	4.66	10.54
0.0059	0.149	2.75	100	8.27	8.28	18.82
0.0049	0.125	3.00	120	11.70	11.71	30.53
0.0041	0.105	3.25	140	13.90	13.91	44.45
0.0035	0.088	3.50	170	13.90	13.91	58.36
0.0029	0.074	3.75	200	11.60	11.61	69.98
0.0025	0.063	4.00	230	7.88	7.89	77.86
0.0021	0.053	4.25	270	4.63	4.63	82.50
0.00174	0.0442	4.50	325	2.79	2.79	85.29
0.00146	0.0372	4.75	400	1.98	1.98	87.27
0.00123	0.0313	5.00	450	1.48	1.48	88.76
0.000986	0.0250	5.32	500	1.42	1.42	90.18
0.000790	0.0201	5.64	635	1.12	1.12	91.30
0.000615	0.0156	6.00		1.02	1.02	92.32
0.000435	0.0110	6.50		1.14	1.14	93.46
0.000308	0.00781	7.00		1.02	1.02	94.48
0.000197	0.00500	7.65		1.23	1.23	95.71
0.000077	0.00195	9.00		2.07	2.07	97.78
0.000038	0.000977	10.00		1.29	1.29	99.08
0.000019	0.000488	11.00		0.84	0.84	99.92
0.000015	0.000375	11.38		0.08	0.08	100.00
TOTALS				**99.90**	**100.00**	**100.00**

Cumulative Weight Percent greater than

Weight percent	Phi Value	Particle Size, Inches	Particle Size, Millimeters
5	2.17	0.0088	0.222
10	2.47	0.0071	0.180
16	2.66	0.0062	0.158
25	2.88	0.0053	0.136
40	3.17	0.0044	0.111
50	3.35	0.0039	0.098
60	3.54	0.0034	0.086
75	3.91	0.0026	0.067
84	4.38	0.0019	0.048
90	5.28	0.0010	0.026
95	7.27	0.0003	0.006

Measure	Trask	Inman	Folk-Ward
Median, phi	3.35	3.35	3.35
Median, in.	0.0039	0.0039	0.0039
Median, mm	0.098	0.098	0.098
Mean, phi	3.31	3.52	3.47
Mean, in.	0.0040	0.0034	0.0036
Mean, mm	0.101	0.087	0.090
Sorting	1.428	0.860	1.203
Skewness	0.969	0.203	0.370
Kurtosis	0.223	1.968	2.036

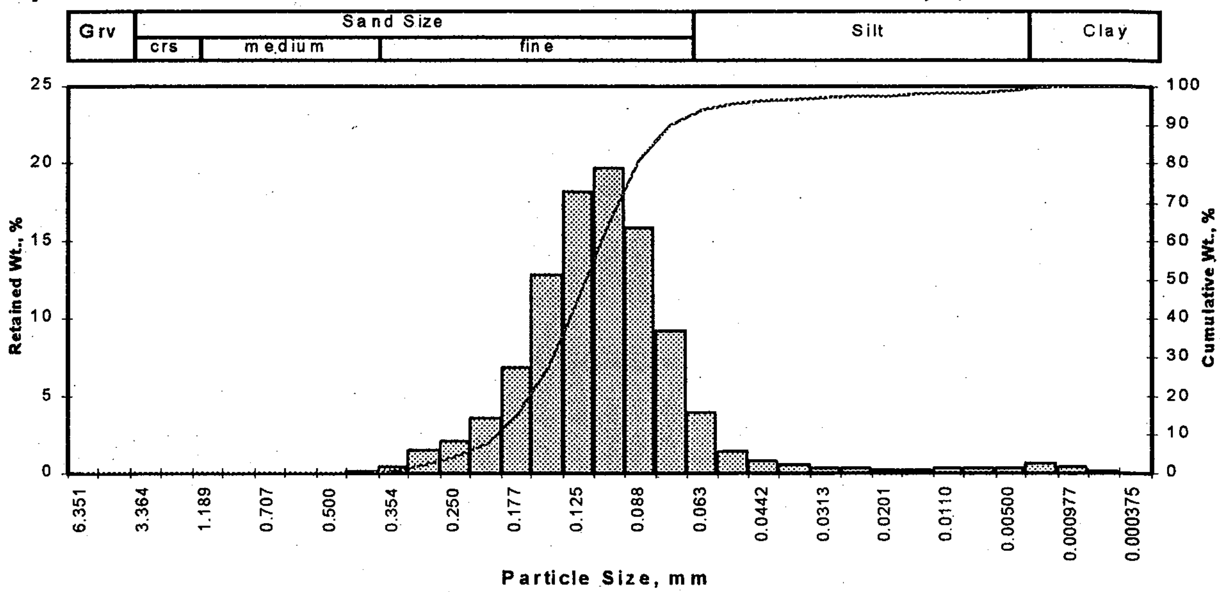
Grain Size Description (ASTM-USCS Scale)	Fine sand (based on Mean from Trask)

Description	Retained on Sieve #	Weight Percent
Gravel	4	0.00
Coarse Sand	10	0.00
Medium Sand	40	0.00
Fine Sand	200	69.97
Silt	>0.005 mm	25.74
Clay	<0.005 mm	4.29
	Total	**100**

PTS Laboratories, Inc.

Particle Size Analysis - ASTM D4464M

Client:	Calscience Environmental Laboratories, Inc.	**PTS File No:**	35513
Project:	N/A	**Sample ID:**	B-6
Project No:	05-08-1238	**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	0.13	0.13	0.13
0.0139	0.354	1.50	45	0.47	0.47	0.60
0.0117	0.297	1.75	50	1.47	1.47	2.07
0.0098	0.250	2.00	60	2.04	2.04	4.11
0.0083	0.210	2.25	70	3.52	3.52	7.63
0.0070	0.177	2.50	80	6.83	6.83	14.45
0.0059	0.149	2.75	100	12.80	12.79	27.24
0.0049	0.125	3.00	120	18.20	18.19	45.43
0.0041	0.105	3.25	140	19.70	19.69	65.12
0.0035	0.088	3.50	170	15.80	15.79	80.91
0.0029	0.074	3.75	200	9.23	9.22	90.14
0.0025	0.063	4.00	230	3.90	3.90	94.03
0.0021	0.053	4.25	270	1.42	1.42	95.45
0.00174	0.0442	4.50	325	0.74	0.74	96.19
0.00146	0.0372	4.75	400	0.53	0.53	96.72
0.00123	0.0313	5.00	450	0.36	0.36	97.08
0.000986	0.0250	5.32	500	0.30	0.30	97.38
0.000790	0.0201	5.64	635	0.24	0.24	97.62
0.000615	0.0156	6.00		0.24	0.24	97.86
0.000435	0.0110	6.50		0.30	0.30	98.16
0.000308	0.00781	7.00		0.27	0.27	98.43
0.000197	0.00500	7.65		0.30	0.30	98.73
0.000077	0.00195	9.00		0.64	0.64	99.37
0.000038	0.000977	10.00		0.47	0.47	99.84
0.000019	0.000488	11.00		0.16	0.16	100.00
0.000015	0.000375	11.38		0.00	0.00	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	2.06	0.0094	0.239
10	2.34	0.0078	0.198
16	2.53	0.0068	0.173
25	2.71	0.0060	0.153
40	2.93	0.0052	0.132
50	3.06	0.0047	0.120
60	3.18	0.0043	0.110
75	3.41	0.0037	0.094
84	3.58	0.0033	0.083
90	3.75	0.0029	0.075
95	4.17	0.0022	0.056

Measure	Trask	Inman	Folk-Ward
Median, phi	3.06	3.06	3.06
Median, in.	0.0047	0.0047	0.0047
Median, mm	0.120	0.120	0.120
Mean, phi	3.01	3.06	3.06
Mean, in.	0.0049	0.0047	0.0047
Mean, mm	0.124	0.120	0.120
Sorting	1.275	0.527	0.583
Skewness	1.001	-0.002	0.027
Kurtosis	0.239	1.000	1.233
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	0.13
Fine Sand	200	90.00
Silt	>0.005 mm	8.59
Clay	<0.005 mm	1.27
	Total	**100**

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

Appendix D-2. Yearly grain size values, 1990 - 2005. Ormond Beach Generating Station NPDES, 2005.

Year	Station	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Mean grain size phi	Mean grain size µm	Sorting*	Skewness	Kurtosis
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	-	-	-	-	-	-	-	-	-
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

Appendix D-2. (Cont.).

Year	Station	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Mean grain size phi	Mean grain size µm	Sorting*	Skewness	Kurtosis
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
1 = Silt and Clay combined

APPENDIX E

Sediment chemistry by station

Calscience Environmental Laboratories, Inc.

Analytical Report

MBC Applied Environmental Sciences		Date Received:	07/06/05
3000 Redhill Avenue		Work Order No:	05-07-0215
Costa Mesa, CA 92626-4524		Preparation:	EPA 3050B
		Method:	EPA 6020
		Units:	mg/kg

Project: OBGS 05203A

Page 1 of 1

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Date Prepared	Date Analyzed	QC Batch ID
OBGS B1 (I,II,III)	05-07-0215-19	06/28/05	Solid	07/08/05	07/08/05	050708L02

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	8.22	0.14	1.408		Nickel	6.73	0.14	1.408	
Copper	3.72	0.14	1.408		Zinc	19.7	1.4	1.408	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Date Prepared	Date Analyzed	QC Batch ID
OBGS B2 (I,II,III)	05-07-0215-20	06/28/05	Solid	07/08/05	07/08/05	050708L02

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	3.29	0.11	1.176		Nickel	3.73	0.11	1.176	
Copper	1.61	0.11	1.176		Zinc	6.82	1.18	1.176	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Date Prepared	Date Analyzed	QC Batch ID
OBGS B3 (I,II,III)	05-07-0215-21	06/28/05	Solid	07/08/05	07/09/05	050708L02

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	7.60	0.13	1.334		Nickel	6.64	0.13	1.334	
Copper	3.57	0.13	1.334		Zinc	17.6	1.3	1.334	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Date Prepared	Date Analyzed	QC Batch ID
OBGS B4 (I,II,III)	05-07-0215-22	06/28/05	Solid	07/08/05	07/09/05	050708L02

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	7.17	0.13	1.334		Nickel	6.12	0.13	1.334	
Copper	3.15	0.13	1.334		Zinc	18.6	1.3	1.334	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Date Prepared	Date Analyzed	QC Batch ID
OBGS B5 (I,II,III)	05-07-0215-23	06/28/05	Solid	07/08/05	07/09/05	050708L02

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	6.17	0.13	1.388		Nickel	6.23	0.13	1.388	
Copper	3.52	0.13	1.388		Zinc	33.9	1.3	1.388	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Date Prepared	Date Analyzed	QC Batch ID
OBGS B6 (I,II,III)	05-07-0215-24	06/28/05	Solid	07/08/05	07/09/05	050708L02

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

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Chromium	6.27	0.13	1.352		Nickel	6.76	0.13	1.352	
Copper	3.13	0.13	1.352		Zinc	17.6	1.3	1.352	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Date Prepared	Date Analyzed	QC Batch ID
Method Blank	096-10-002-526	N/A	Solid	07/08/05	07/08/05	050708L02

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:	07/06/05
3000 Redhill Avenue		Work Order No:	05-07-0215
Costa Mesa, CA 92626-4524		Preparation:	N/A
		Method:	EPA 160.3

Project: OBGS 05203A

Page 1 of 1

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Date Prepared	Date Analyzed	QC Batch ID
OBGS B1 (I,II,III)	05-07-0215-19	06/28/05	Solid	N/A	07/07/05	50707TSD1

Parameter	Result	RL	DF	Qual	Units
Solids, Total	70.6	0.1	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Date Prepared	Date Analyzed	QC Batch ID
OBGS B2 (I,II,III)	05-07-0215-20	06/28/05	Solid	N/A	07/07/05	50707TSD1

Parameter	Result	RL	DF	Qual	Units
Solids, Total	85.0	0.1	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Date Prepared	Date Analyzed	QC Batch ID
OBGS B3 (I,II,III)	05-07-0215-21	06/28/05	Solid	N/A	07/07/05	50707TSD1

Parameter	Result	RL	DF	Qual	Units
Solids, Total	74.6	0.1	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Date Prepared	Date Analyzed	QC Batch ID
OBGS B4 (I,II,III)	05-07-0215-22	06/28/05	Solid	N/A	07/07/05	50707TSD1

Parameter	Result	RL	DF	Qual	Units
Solids, Total	75.2	0.1	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Date Prepared	Date Analyzed	QC Batch ID
OBGS B5 (I,II,III)	05-07-0215-23	06/28/05	Solid	N/A	07/07/05	50707TSD1

Parameter	Result	RL	DF	Qual	Units
Solids, Total	72.3	0.1	1		%

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Date Prepared	Date Analyzed	QC Batch ID
OBGS B6 (I,II,III)	05-07-0215-24	06/28/05	Solid	N/A	07/07/05	50707TSD1

Parameter	Result	RL	DF	Qual	Units
Solids, Total	73.6	0.1	1		%

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

Calscience Environmental Laboratories, Inc.

Quality Control - Spike/Spike Duplicate

nelac

MBC Applied Environmental Sciences	Date Received:	07/06/05
3000 Redhill Avenue	Work Order No:	05-07-0215
Costa Mesa, CA 92626-4524	Preparation:	EPA 3050B
	Method:	EPA 6020

Project OBGS 05203A

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
OBGS B1 (I,II,III)	Solid	ICP/MS A	07/08/05	07/08/05	050708S02

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Chromium	110	104	80-120	4	0-20	
Copper	96	93	80-120	3	0-20	
Nickel	101	99	80-120	2	0-20	
Zinc	117	109	80-120	5	0-20	

RPD - Relative Percent Difference , CL - Control Limit

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

Calscience Environmental Laboratories, Inc.

Quality Control - Duplicate

nelac

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

Date Received:	07/06/05
Work Order No:	05-07-0215
Preparation:	N/A
Method:	EPA 160.3

Project: OBGS 05203A

Quality Control Sample ID	Matrix	Instrument	Date Prepared:	Date Analyzed:	Duplicate Batch Number
OBGS B6 (I,II,III)	Solid	N/A	N/A	07/07/05	50707TSD1

Parameter	Sample Conc	DUP Conc	RPD	RPD CL	Qualifiers
Solids, Total	73.6	71.3	3	0-25	

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

Quality Control - Laboratory Control Sample

MBC Applied Environmental Sciences		Date Received:	N/A
3000 Redhill Avenue		Work Order No:	05-07-0215
Costa Mesa, CA 92626-4524		Preparation:	EPA 3050B
		Method:	EPA 6020

Project: OBGS 05203A

Quality Control Sample ID	Matrix	Instrument	Date Analyzed	Lab File ID	LCS Batch Number
096-10-002-526	Solid	ICP/MS A	07/08/05		050708L02

Parameter	Conc Added	Conc Recovered	LCS %Rec	%Rec CL	Qualifiers
Chromium	25.0	26.6	107	80-120	
Copper	25.0	24.7	99	80-120	
Nickel	25.0	25.5	102	80-120	
Zinc	25.0	23.9	96	80-120	

RPD - Relative Percent Difference , CL - Control Limit

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Calscience Environmental Laboratories, Inc.

Glossary of Terms and Qualifiers

Work Order Number: 05-07-0215

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 or Matrix Spike Duplicate 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.

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

Appendix E-2. Yearly sediment metal concentrations, 1990 - 2004. Ormond Beach Generating Station NPDES, 2005.

Metal	Station	Year 1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	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	11
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	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	8.8
	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	10
	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	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	9
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	4.2
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	5.0
	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	5.6
	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	4.7
	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	4.5
	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	3.7
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	7.2
ERL = 21	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	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	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	6.9
	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	7.0
	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	6.9
Zinc	B1	20.0	28.1	21.8	23	21	23	-	21	26	20	21	-	20	19.7	22
ERL = 150	B2	18.9	32.5	22.5	22	22	25	15	27	25	19	22	18	16	6.82	21
	B3	15.7	13.0	25.9	23	16	14	14	26	31	16	18	19	16	17.6	19
	B4	16.7	22.6	23.4	22	19	20	14	23	27	23	20	22	21	18.6	21
	B5	17.6	37.3	20.5	21	21	21	-	20	22	26	20	24	21	33.9	23
	B6	13.0	23.3	20.3	20	24	15	-	19	27	21	22	-	19	17.6	20
Fines	B1	15.6	10.7	10.9	3.8	15.5	13.0	-	15.6	15.0	13.6	13.3	-	13.4	12.22	12.7
	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	1.05	11.3
	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	9.11	8.7
	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	19.31	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	22.14	10.1
	B6	6.0	6.6	0.9	1.3	4.7	4.7	-	4.3	4.0	5.5	9.3	-	7.9	5.97	5.1

ERL = Effects Range Low
\- = not required

APPENDIX F

Mussel tissue chemistry by station

Appendix F-1. Mussel chemistry by station. Ormond Beach Generating Station NPDES, 2005.

CRG Marine Laboratories, Inc.

2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

Trace Metals

Client: *Calscience Environmental Laboratories, Inc.* **CRG Project ID:** *25145c*

CRG ID#:	*31976*	**Sample Description:**	OBGS-I 05-10-0253	**Date Sampled:**	28-Jun-05	15:00
Replicate #:	R1			**Date Received:**	10-Oct-05	
Batch ID:	25145c-12121	**Matrix:**	Tissue	**Date Processed:**	01-Nov-05	
Instrument:	ICPMS #1 HP 4500	**Analyst:**	P. Hershelman	**Date Analyzed:**	17-Nov-05	

CONSTITUENT	FRACTION	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	ACCEPTANCE RANGE
Chromium (Cr)	NA	EPA 6020m	3.23	µg/wet g	0.025	0.05	1	NA
Copper (Cu)	NA	EPA 6020m	8.54	µg/wet g	0.025	0.05	1	NA
Nickel (Ni)	NA	EPA 6020m	7.55	µg/wet g	0.025	0.05	1	NA
Zinc (Zn)	NA	EPA 6020m	65	µg/wet g	0.025	0.05	1	NA

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable.

California ELAP Certificate # 2261
31976 R1

Appendix F-1. (Cont.).

CRG Marine Laboratories, Inc.

2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

Trace Metals

Client: *Calscience Environmental Laboratories, Inc.* **CRG Project ID:** *25145c*

CRG ID#:	*31976*	**Sample Description:**	OBGS-I 05-10-0253	**Date Sampled:**	28-Jun-05	15:00
Replicate #:	R2			**Date Received:**	10-Oct-05	
Batch ID:	25145c-12121	**Matrix:**	Tissue	**Date Processed:**	01-Nov-05	
Instrument:	ICPMS #1 HP 4500	**Analyst:**	P. Hershelman	**Date Analyzed:**	17-Nov-05	

CONSTITUENT	FRACTION	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	ACCEPTANCE RANGE
Chromium (Cr)	NA	EPA 6020m	2.8	µg/wet g	0.025	0.05	1	NA
Copper (Cu)	NA	EPA 6020m	8.02	µg/wet g	0.025	0.05	1	NA
Nickel (Ni)	NA	EPA 6020m	6.61	µg/wet g	0.025	0.05	1	NA
Zinc (Zn)	NA	EPA 6020m	60.8	µg/wet g	0.025	0.05	1	NA

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable.

California ELAP Certificate # 2261
31976 R2

Appendix F-1. (Cont.).

CRG Marine Laboratories, Inc.
2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

Trace Metals

Client: Calscience Environmental Laboratories, Inc. **CRG Project ID: 25145c**

CRG ID#:	*31977*	**Sample Description:**	OBGS-II 05-10-0253	**Date Sampled:**	28-Jun-05 15:00
Replicate #:	R1			**Date Received:**	10-Oct-05
Batch ID:	25145c-12121	**Matrix:**	Tissue	**Date Processed:**	01-Nov-05
Instrument:	ICPMS #1 HP 4500	**Analyst:**	P. Hershelman	**Date Analyzed:**	17-Nov-05

CONSTITUENT	FRACTION	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	ACCEPTANCE RANGE
Chromium (Cr)	NA	EPA 6020m	3.23	µg/wet g	0.025	0.05	1	NA
Copper (Cu)	NA	EPA 6020m	12.8	µg/wet g	0.025	0.05	1	NA
Nickel (Ni)	NA	EPA 6020m	3.49	µg/wet g	0.025	0.05	1	NA
Zinc (Zn)	NA	EPA 6020m	95.6	µg/wet g	0.025	0.05	1	NA

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable.

California ELAP Certificate # 2261
31977 R1

Appendix F-1. (Cont.).

CRG Marine Laboratories, Inc.

2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

Trace Metals

Client: ***Calscience Environmental Laboratories, Inc.*** **CRG Project ID:** ***25145c***

CRG ID#:	***31978***	**Sample Description:**	OBGS-III 05-10-0253	**Date Sampled:**	28-Jun-05	15:00
Replicate #:	R1			**Date Received:**	10-Oct-05	
Batch ID:	25145c-12121	**Matrix:**	Tissue	**Date Processed:**	01-Nov-05	
Instrument:	ICPMS #1 HP 4500	**Analyst:**	P. Hershelman	**Date Analyzed:**	17-Nov-05	

CONSTITUENT	FRACTION	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	ACCEPTANCE RANGE
Chromium (Cr)	NA	EPA 6020m	5.06	µg/wet g	0.025	0.05	1	NA
Copper (Cu)	NA	EPA 6020m	12.4	µg/wet g	0.025	0.05	1	NA
Nickel (Ni)	NA	EPA 6020m	10.6	µg/wet g	0.025	0.05	1	NA
Zinc (Zn)	NA	EPA 6020m	86.1	µg/wet g	0.025	0.05	1	NA

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable.

California ELAP Certificate # 2261
31978 R1

Appendix F-1. (Cont.).

CRG Marine Laboratories, Inc.

2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

General Chemistry

Client: *Calscience Environmental Laboratories, Inc.* **CRG Project ID:** *25145c*

CRG ID#: *31976*
Replicate #: R1

Sample Description: OBGS-I 05-10-0253
Matrix: Tissue

Date Sampled: 28-Jun-05 15:00
Date Received: 10-Oct-05

CONSTITUENT	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	DATE PROCESSED	DATE ANALYZED	BATCH ID	ANALYST
Percent Solids	EPA 160.3	19.4	Percent	0.1	0.1	1	01-Nov-05	01-Nov-05	25145c-110105	P. Hershelman

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable; NPW= No Pore Water; NES = Not Enough Sample

California ELAP Certificate # 2261
31976 R1

Appendix F-1. (Cont.).

CRG Marine Laboratories, Inc.

2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

General Chemistry

Client: *Calscience Environmental Laboratories, Inc.* **CRG Project ID:** *25145c*

CRG ID#: *31976*
Replicate #: R2

Sample Description: OBGS-I 05-10-0253
Matrix: Tissue

Date Sampled: 28-Jun-05 15:00
Date Received: 10-Oct-05

CONSTITUENT	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	DATE PROCESSED	DATE ANALYZED	BATCH ID	ANALYST
Percent Solids	EPA 160.3	19.3	Percent	0.1	0.1	1	01-Nov-05	01-Nov-05	25145c-110105	P. Hershelman

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable; NPW= No Pore Water; NES = Not Enough Sample

California ELAP Certificate # 2261
31976 R2

CRG Marine Laboratories, Inc.

2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

General Chemistry

Client: *Calscience Environmental Laboratories, Inc.* **CRG Project ID:** *25145c*

CRG ID#: *31977*
Replicate #: R1

Sample Description: OBGS-II 05-10-0253
Matrix: Tissue

Date Sampled: 28-Jun-05 15:00
Date Received: 10-Oct-05

CONSTITUENT	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	DATE PROCESSED	DATE ANALYZED	BATCH ID	ANALYST
Percent Solids	EPA 160.3	19	Percent	0.1	0.1	1	01-Nov-05	01-Nov-05	25145c-110105	P. Hershelman

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable; NPW= No Pore Water; NES = Not Enough Sample

California ELAP Certificate # 2261
31977 R1

Appendix F-1. (Cont.).

CRG Marine Laboratories, Inc.
2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

General Chemistry

Client: *Calscience Environmental Laboratories, Inc.* **CRG Project ID:** *25145c*

CRG ID#: *31978*
Replicate #: R1

Sample Description: OBGS-III 05-10-0253
Matrix: Tissue

Date Sampled: 28-Jun-05 15:00
Date Received: 10-Oct-05

CONSTITUENT	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	DATE PROCESSED	DATE ANALYZED	BATCH ID	ANALYST
Percent Solids	EPA 160.3	16.5	Percent	0.1	0.1	1	01-Nov-05	01-Nov-05	25145c-110105	P. Hershelman

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable; NPW= No Pore Water; NES = Not Enough Sample

California ELAP Certificate # 2261
31978 R1

Appendix F-1. (Cont.).

CRG Marine Laboratories, Inc.
2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

Trace Metals

Client: *Calscience Environmental Laboratories, Inc.* **CRG Project ID:** *25145c*

CRG ID#:	*31975*	**Sample Description:**	QAQC	Procedural Blank	**Date Sampled:**	
Replicate #:	B1		05-10-0253		**Date Received:**	
Batch ID:	25145c-12121	**Matrix:**	DI Water		**Date Processed:**	01-Nov-05
Instrument:	ICPMS #1 HP 4500	**Analyst:**	P. Hershelman		**Date Analyzed:**	17-Nov-05

CONSTITUENT	FRACTION	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	ACCEPTANCE RANGE
Chromium (Cr)	NA	EPA 6020m	ND	µg/wet g	0.025	0.05	1	NA
Copper (Cu)	NA	EPA 6020m	ND	µg/wet g	0.025	0.05	1	NA
Nickel (Ni)	NA	EPA 6020m	ND	µg/wet g	0.025	0.05	1	NA
Zinc (Zn)	NA	EPA 6020m	ND	µg/wet g	0.025	0.05	1	NA

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable.

California ELAP Certificate # 2261
31975 B1

Appendix F-1. (Cont.).

CRG Marine Laboratories, Inc.

2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

General Chemistry

Client: ***Calscience Environmental Laboratories, Inc.*** **CRG Project ID:** ***25145c***

CRG ID#: *31975*
Replicate #: B1

Sample Description: QAQC 05-10-0253 Procedural Blank
Matrix: DI Water

Date Sampled:
Date Received:

CONSTITUENT	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	DATE PROCESSED	DATE ANALYZED	BATCH ID	ANALYST
Percent Solids	EPA 160.3	ND	Percent	0.1	0.1	1	01-Nov-05	01-Nov-05	25145c-110105	P. Hershelman

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable; NPW= No Pore Water; NES = Not Enough Sample

California ELAP Certificate # 2261
31975 B1

Appendix F-1. (Cont.). Hermosa Beach Pier Reference Site.

CRG Marine Laboratories, Inc.

2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

Trace Metals

Client: *Calscience Environmental Laboratories, Inc.* **CRG Project ID:** *25145*

CRG ID#:	*30193*	**Sample Description:**	RGS HBP - I 05-08-1370	**Date Sampled:**	15-Jul-05 09:05
Replicate #:	R1			**Date Received:**	23-Aug-05
Batch ID:	25145-12078	**Matrix:**	Tissue	**Date Processed:**	06-Sep-05
Instrument:	ICPMS #1 HP 4500	**Analyst:**	P. Hershelman	**Date Analyzed:**	07-Sep-05

CONSTITUENT	FRACTION	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	ACCEPTANCE RANGE
Chromium (Cr)	NA	EPA 6020	0.81	µg/dry g	0.025	0.05	1	NA
Copper (Cu)	NA	EPA 6020	6.82	µg/dry g	0.025	0.05	1	NA
Nickel (Ni)	NA	EPA 6020	0.67	µg/dry g	0.025	0.05	1	NA
Zinc (Zn)	NA	EPA 6020	74.3	µg/dry g	0.025	0.05	1	NA

Reference Site

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable.

California ELAP Certificate # 2261
30193 R1

Appendix F-1. (Cont.).

CRG Marine Laboratories, Inc.

2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

Trace Metals

Client: *Calscience Environmental Laboratories, Inc.* **CRG Project ID:** *25145*

CRG ID#:	*30194*	**Sample Description:**	RGS HBP - II 05-08-1370	**Date Sampled:**	15-Jul-05	09:05
Replicate #:	R1			**Date Received:**	23-Aug-05	
Batch ID:	25145-12078	**Matrix:**	Tissue	**Date Processed:**	06-Sep-05	
Instrument:	ICPMS #1 HP 4500	**Analyst:**	P. Hershelman	**Date Analyzed:**	07-Sep-05	

CONSTITUENT	FRACTION	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	ACCEPTANCE RANGE
Chromium (Cr)	NA	EPA 6020	1.15	µg/dry g	0.025	0.05	1	NA
Copper (Cu)	NA	EPA 6020	6.28	µg/dry g	0.025	0.05	1	NA
Nickel (Ni)	NA	EPA 6020	0.59	µg/dry g	0.025	0.05	1	NA
Zinc (Zn)	NA	EPA 6020	76.6	µg/dry g	0.025	0.05	1	NA

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable.

California ELAP Certificate # 2261
30194 R1

Appendix F-1. (Cont.).

CRG Marine Laboratories, Inc.
2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

Trace Metals

Client: ***Calscience Environmental Laboratories, Inc.*** **CRG Project ID:** ***25145***

CRG ID#:	***30195***	**Sample Description:**	RGS HBP - III 05-08-1370	**Date Sampled:**	15-Jul-05 09:05
Replicate #:	R1			**Date Received:**	23-Aug-05
Batch ID:	25145-12078	**Matrix:**	Tissue	**Date Processed:**	06-Sep-05
Instrument:	ICPMS #1 HP 4500	**Analyst:**	P. Hershelman	**Date Analyzed:**	07-Sep-05

CONSTITUENT	FRACTION	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	ACCEPTANCE RANGE
Chromium (Cr)	NA	EPA 6020	2.22	µg/dry g	0.025	0.05	1	NA
Copper (Cu)	NA	EPA 6020	6.91	µg/dry g	0.025	0.05	1	NA
Nickel (Ni)	NA	EPA 6020	0.67	µg/dry g	0.025	0.05	1	NA
Zinc (Zn)	NA	EPA 6020	72.6	µg/dry g	0.025	0.05	1	NA

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable.

California ELAP Certificate # 2261
30195 R1

Appendix F-1. (Cont.).

CRG Marine Laboratories, Inc.

2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

General Chemistry

Client: *Calscience Environmental Laboratories, Inc.* **CRG Project ID:** *25145*

CRG ID#:	*30193*	**Sample Description:**	RGS HBP - I 05-08-1370	**Date Sampled:**	15-Jul-05	09:05
Replicate #:	R1			**Date Received:**	23-Aug-05	
Batch ID:	25145-12078	**Matrix:**	Tissue	**Date Processed:**	06-Sep-05	
Instrument:		**Analyst:**	D. Villegas	**Date Analyzed:**	06-Sep-05	

CONSTITUENT	FRACTION	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	ACCEPTANCE RANGE
Percent Solids	NA	EPA 160.3	18	Percent	0.1	0.1	1	NA

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable.

California ELAP Certificate # 2261

30193 R1

Appendix F-1. (Cont.).

CRG Marine Laboratories, Inc.
2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

General Chemistry

Client: *Calscience Environmental Laboratories, Inc.* **CRG Project ID:** *25145*

CRG ID#:	*30194*	**Sample Description:**	RGS HBP - II 05-08-1370	**Date Sampled:**	15-Jul-05 09:05
Replicate #:	R1			**Date Received:**	23-Aug-05
Batch ID:	25145-12078	**Matrix:**	Tissue	**Date Processed:**	06-Sep-05
Instrument:		**Analyst:**	D. Villegas	**Date Analyzed:**	06-Sep-05

CONSTITUENT	FRACTION	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	ACCEPTANCE RANGE
Percent Solids	NA	EPA 160.3	18.3	Percent	0.1	0.1	1	NA

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable.

California ELAP Certificate # 2261
30194 R1

Appendix F-1. (Cont.).

CRG Marine Laboratories, Inc.

2020 Del Amo Blvd., Suite 200, Torrance, CA 90501-1206 (310) 533-5190 FAX (310) 533-5003 crglabs@sbcglobal.net

General Chemistry

Client: *Calscience Environmental Laboratories, Inc.* **CRG Project ID:** *25145*

CRG ID#:	*30195*	**Sample Description:**	RGS HBP - III 05-08-1370	**Date Sampled:**	15-Jul-05	09:05
Replicate #:	R1			**Date Received:**	23-Aug-05	
Batch ID:	25145-12078	**Matrix:**	Tissue	**Date Processed:**	06-Sep-05	
Instrument:		**Analyst:**	D. Villegas	**Date Analyzed:**	06-Sep-05	

CONSTITUENT	FRACTION	METHOD	RESULT	UNITS	MDL	RL	DILUTION FACTOR	ACCEPTANCE RANGE
Percent Solids	NA	EPA 160.3	18	Percent	0.1	0.1	1	NA

MDL= Method Detection Limit (CFR 40 Part 136); RL= Minimum Level (SWRCB); E= Estimated Value below the RL and above the MDL; ND= Not Detected; NA= Not Applicable.

California ELAP Certificate # 2261
30195 R1

Appendix F-2. Yearly mussel tissue metal concentrations (mg/dry kg), 1990 - 2005. Ormond Beach Generating Station NPDES, 2005.

	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
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	-	-	ND	ND	ND	-	-	ND	ND	ND	-	-	70	53	59	61	8.6
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	10.1
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

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

APPENDIX G

Infauna data by station

Appendix G-1. Infaunal master species list. Ormond Beach Generating Station NPDES, 2005.

PHYLUM (Phy)
- Subphylum or Class
  - Species

- CNIDARIA (CN)
  - Anthozoa
    - Acinaria sp A MBC 2005
- PLATYHELMINTHES (PL)
  - Turbellaria
    - *Stylochoplana* sp
- NEMERTEA (NE)
  - Anopla
    - *Carinoma mutabilis*
    - Lineidae
    - *Micrura* sp
    - *Tubulanus nothus*
    - *Tubulanus polymorphus* [1]
  - Enopla
    - *Paranemertes californica* [2]
  - Uncertain
    - Nemertea
- NEMATODA (NT)
    - Nematoda
- ENTOPROCTA (EN)
    - Loxosomatidae
- MOLLUSCA (MO)
  - Gastropoda
    - *Balcis oldroyde*
    - *Caecum crebricinctum*
  - Bivalvia
    - *Cadulus aberrans*
    - *Diplodonta sericata*
    - *Macoma* sp
    - *Periploma planiusculum*
    - *Rochefortia grippi*
    - *Rochefortia tumida* [3]
    - *Siliqua lucida*
    - *Solen sicarius*
    - *Tellina modesta*
    - *Yoldia cooperii*
- SIPUNCULA (SI)
  - Sipunculidea
    - *Siphonosoma ingens*
- ANNELIDA (AN)
  - Polychaeta
    - *Amaeana occidentalis*
    - *Ampharete labrops*
    - *Ancistrosyllis hamata*
    - Annelida
    - *Aphelochaeta glandaria* [4]
    - *Aphelochaeta monilaris*

PHYLUM
- Subphylum or Class
  - Species

- ANNELIDA (cont.)
  - Polychaeta(Cont.).
    - *Apoprionospio pygmaea*
    - *Aricidea (Acmira) catherinae* [5]
    - *ArcVicidea (Aricidea) wassi*
    - *Armandia brevis* [6]
    - *Chaetozone setosa* Cmplx [7]
    - *Chone mollis*
    - *Chone* sp SD1 Pt. Loma 1997
    - *Diopatra* sp
    - *Diopatra splendidissima*
    - *Dispio uncinata*
    - *Eulalia quadrioculata*
    - Euclymeninae sp A SCAMIT 1987
    - *Eumida longicornuta*
    - *Exogone lourei*
    - *Glycera macrobranchia* [8]
    - *Glycera nana*
    - *Glycinde armigera*
    - *Goniada littorea*
    - *Hesionella mccullochae*
    - *Hesionura coineaui difficilis*
    - *Heteropodarke heteromorpha*
    - *Leitoscoloplos pugettensis* [9]
    - *Levinsenia gracilis*
    - *Lumbrineris californiensis*
    - *Magelona pitelkai*
    - *Magelona sacculata*
    - Malanidae
    - *Mediomastus acutus* [10]
    - *Mediomastus ambiseta*
    - *Monticellina cryptica*
    - *Neosabellaria cemetarium*
    - *Nephtys caecoides*
    - *Nephtys cornuta* [11]
    - *Nereiphylla castanea*
    - *Nereis procera*
    - *Notomastus hemipodus*
    - *Onuphis* sp
    - *Onuphis* sp 1 Pt. Loma 1983
    - *Owenia collaris* [12]
    - *Pectinaria californiensis*
    - *Phyllodoce hartmanae*
    - *Podarkeopsis glabrus*
    - *Prionospio (Minusplo) lighti*
    - *Protodorvillea gracilis*
    - *Scoletoma* sp
    - *Scoletoma tetraura* Cmplx [13]
    - *Scoloplos armiger* Cmplx
    - *Sgialion spinosus*
    - *Sphaerephesia similisetis*
    - *Spiochaetopterus costarum*
    - *Spiophanes berkeleyorum*
    - *Spiophanes bombyx*

Appendix G-1. (Cont.).

PHYLUM Subphylum or Class Species	PHYLUM Subphylum or Class Species
ANNELIDA (cont.)	ARTHROPODA (Cont.)
Polychaeta(Cont.).	Malacostraca (Cont.)
Spiophanes duplex [14]	*Podocerus brasiliensis*
Sthenelais tertiaglabra	*Rhepoxynius abronius*
Syllidae	*Rhepoxynius heterocuspidatus*
Syllis (Ehlersia) heterochaeta	*Rhepoxynius menziesi* [24]
Syllis (Typosyllis) farallonensis [15]	*Rheopxynius variatus*
ARTHROPODA (AR)	*Stenothoe estacola*
Malacostraca	*Tiron biocellata*
Americhelidium shoemakeri [16]	Ostracoda
Ampelisca agassizi [17]	*Asteropella slatteryi*
Anchicolurus occidentalis	*Euphilomedes longiseta*
Aoroides inermis	*Leuroleberis sharpei*
Campylaspis sp C Myers & Benedict 1974	*Parasterope hulingsi*
Cancer antennarius	*Rutiderma rostratum*
Cumella californica [18]	*Zeugophilomedes oblongata* [25]
Cyclaspis nublia	
Cyclaspis sp C SCAMIT 1986	ECHINODERMATA (EC)
Diastylopsis tenuis	Echinoidea
Edotia sublittoralis [19]	*Dendraster excentricus*
Eobrolgus spinosus	Ophiuroidea
Foxiphalus obtusidens [20]	*Amphiodia digitata*
Gibberosus myersi [21]	*Amphiodia* sp
Hemilamprops californicus	Amphiuridae
Jassa marmorata [22]	
Jassa slatteryi [22]	PHORONA (PR)
Lamprops carinatus	Phoronida
Lamprops quadriplicatus	*Phoronis* sp
Laticorophium baconi [23]	
Listriella melanica	CHORDATA (CO)
Metamysidopsis elongata	Hemichordata
Neomysis kadiakensis	Enteropneusta[26]
Pachygrapsus crassipes	Urochordata
Photis californica	*Branchiostoma californiensis*
Photis macinerneyi	

The following footnotes indicate names used in previous surveys:

1 *Tubulanus pellucidus/polymorphus, T.* sp or *T.* spp
2 *Paranemertes* sp A of SCAMIT
3 *Mysella tumida, M. cf. aleutica*
4 *Aphelochaeta* sp C Dorsey
5 *Acmira catherinae*
6 *Armandia bioculata*
7 *Chaetozone "setosa", C.* cf. *setosa*
8 *Glycera convoluta*
9 *Haploscoloplos elongatus*
10 *Mediomastus* spp (in part)
11 *Nephtys cornuta franciscana*
12 *Owenia fusiformis*
13 *Lumbrineris "tetraura"* or *L. tetraura*
14 *Spiophanes missionenesis*
15 *Typosyllis farallonensis*
16 *Synchelidium shoemakeri*
17 *Ampelisca compressa*
18 *Cumella* sp A Myers & Benedict or *C.* sp A MBC
19 *Edotea sublittorelis*
20 *Paraphoxus obtusidens*
21 *Megaluropus longimerus*
22 *Jassa falcata* (in part)
23 *Monocorophium baconi*
24 *Paraphoxus epistomus, Rhepoxynius epistomus*
25 *Zeugophilomedes oblongatus*
26 Hemichordata

Appendix G-2. Infauna results by station. Ormond Beach Generating Station NPDES, 2005.

		Station							Percent
Phylum	Species	B1	B2	B3	B4	B5	B6	Total	Total
AN	*Apoprionospio pygmaea*	30	-	33	20	22	23	128	13.29
AN	*Mediomastus acutus*	31	-	15	12	21	2	81	8.41
EC	*Dendraster excentricus*	1	35	1	-	3	2	42	4.36
AN	*Onuphis* sp 1 Pt. Loma 1983	10	2	8	3	8	4	35	3.63
AN	*Aricidea (Acmira) catherinae*	7	-	4	4	10	8	33	3.43
AR	*Diastylopsis tenuis*	6	1	1	5	18	1	32	3.32
NE	*Carinoma mutabilis*	2	1	1	7	2	16	29	3.01
AN	*Armandia brevis*	5	-	8	2	6	5	26	2.70
AN	Maldanidae	-	24	-	-	1	1	26	2.70
AR	*Stenothoe estacola*	1	5	4	-	-	15	25	2.60
AN	*Syllis (Typosyllis) farallonensis*	9	-	-	6	3	4	22	2.28
AR	*Rhepoxynius menziesi*	4	2	-	3	10	2	21	2.18
AN	*Spiophanes bombyx*	4	-	-	6	6	3	19	1.97
AN	*Glycinde armigera*	2	-	2	2	8	2	16	1.66
AN	*Notomastus hemipodus*	-	-	16	-	-	-	16	1.66
AN	*Syllis (Ehlersia) heterochaeta*	-	-	6	-	8	2	16	1.66
AN	*Monticellina cryptica*	-	-	-	9	6	-	15	1.56
AN	*Scoletoma* sp	2	-	10	-	2	-	14	1.45
AR	*Anchicolurus occidentalis*	-	2	3	1	-	8	14	1.45
CO	*Branchiostoma californiensis*	-	14	-	-	-	-	14	1.45
AN	*Nephtys caecoides*	2	2	1	-	3	4	12	1.25
NE	Lineidae	2	-	2	3	2	3	12	1.25
AN	*Ampharete labrops*	-	-	-	5	6	-	11	1.14
NT	Nematoda	2	2	2	-	4	-	10	1.04
AN	*Exogone lourei*	4	1	-	-	4	-	9	0.93
MO	*Siliqua lucida*	3	-	-	1	1	3	8	0.83
AN	*Magelona pitelkai*	2	-	-	1	3	1	7	0.73
AR	*Podocerus brasiliensis*	-	-	-	-	-	7	7	0.73
AR	*Rhepoxynius abronius*	2	-	1	1	3	-	7	0.73
AN	*Chaetozone setosa* Cmplx	3	-	-	-	3	-	6	0.62
AN	*Dispio uncinata*	1	2	1	-	-	2	6	0.62
AN	*Glycera macrobranchia*	1	-	-	2	2	1	6	0.62
AR	*Foxiphalus obtusidens*	2	-	-	4	-	-	6	0.62
AR	*Gibberosus myersi*	-	-	-	2	3	1	6	0.62
AR	*Jassa slatteryi*	-	2	3	-	-	1	6	0.62
MO	*Caecum crebricinctum*	-	6	-	-	-	-	6	0.62
MO	*Tellina modesta*	2	-	1	-	3	-	6	0.62
NE	Nemertea	1	4	-	-	1	-	6	0.62
PR	*Phoronis* sp	2	-	-	2	2	-	6	0.62
AN	*Mediomastus ambiseta*	-	-	-	-	5	-	5	0.52
AN	*Scoletoma tetraura* Cmplx	-	-	5	-	-	-	5	0.52
AR	*Aoroides inermis*	1	-	-	2	-	2	5	0.52
AR	*Jassa marmorata*	-	-	-	1	-	4	5	0.52
AR	*Photis californica*	-	-	-	1	3	1	5	0.52
EC	Amphiuridae	-	-	-	-	2	3	5	0.52
NE	*Micrura* sp	1	-	1	1	-	2	5	0.52
NE	*Tubulanus polymorphus*	-	-	-	-	4	1	5	0.52
AN	*Glycera nana*	1	-	1	2	-	-	4	0.42
AN	*Neosabellaria cementarium*	-	4	-	-	-	-	4	0.42
AN	*Sigalion spinosus*	2	-	-	1	-	1	4	0.42
AN	Syllidae	1	-	-	1	2	-	4	0.42
AR	*Americhelidium shoemakeri*	-	-	1	1	2	-	4	0.42
AR	*Cyclaspis* sp C SCAMIT 1986	-	-	-	1	3	-	4	0.42
AR	*Lamprops quadriplicatus*	-	-	-	-	2	2	4	0.42
AR	*Photis macinerneyi*	-	-	-	2	2	-	4	0.42
AN	*Chone mollis*	2	-	-	-	1	-	3	0.31
AN	*Hesionella mccullochae*	-	-	3	-	-	-	3	0.31
AN	*Hesionura coineaui difficilis*	-	3	-	-	-	-	3	0.31
AN	*Lumbrineris californiensis*	-	-	2	-	1	-	3	0.31
AN	*Sphaerephesia similisetis*	-	1	-	1	-	1	3	0.31
AN	*Spiophanes berkeleyorum*	2	-	-	-	1	-	3	0.31
AN	*Spiophanes duplex*	-	-	1	-	2	-	3	0.31
AR	*Ampelisca agassizi*	-	-	-	-	2	1	3	0.31
AR	*Cumella californica*	1	-	-	2	-	-	3	0.31
AR	*Eobrolgus spinosus*	-	-	-	2	1	-	3	0.31
AR	*Pachygrapsus crassipes*	-	-	-	1	-	2	3	0.31
AR	*Rutiderma rostratum*	-	-	-	-	3	-	3	0.31
AR	*Zeugophilomedes oblonga*	-	1	-	1	1	-	3	0.31
EC	*Amphiodia digitata*	-	3	-	-	-	-	3	0.31
MO	*Rochefortia grippi*	1	1	-	-	1	-	3	0.31
SI	*Siphonosoma ingens*	1	-	-	1	1	-	3	0.31
AN	*Chone* sp SD1 Pt. Loma 1997	2	-	-	-	-	-	2	0.21
AN	Euclymeninae sp A SCAMIT 1987	1	-	-	-	1	-	2	0.21
AN	*Goniada littorea*	1	-	-	-	-	1	2	0.21
AN	*Magelona sacculata*	1	-	-	1	-	-	2	0.21
AN	*Onuphis* sp	-	-	-	-	2	-	2	0.21
AN	*Pectinaria californiensis*	-	-	-	2	-	-	2	0.21
AN	*Sthenelais tertiaglabra*	-	-	-	-	1	1	2	0.21
AR	*Edotia sublittoralis*	-	-	1	-	1	-	2	0.21
AR	*Euphilomedes longiseta*	2	-	-	-	-	-	2	0.21

Appendix G-2. (Cont.).

Phylum	Species	B1	B2	B3	B4	B5	B6	Total	Percent Total
AR	*Leuroleberis sharpei*	-	1	-	-	1	-	2	0.21
AR	*Tiron biocellata*	-	-	-	-	2	-	2	0.21
MO	*Macoma* sp	-	-	-	-	2	-	2	0.21
MO	*Rochefortia tumida*	1	-	-	1	-	-	2	0.21
NE	*Tubulanus nothus*	1	-	-	-	1	-	2	0.21
AN	*Amaeana occidentalis*	-	-	1	-	-	-	1	0.10
AN	*Ancistrosyllis hamata*	-	-	1	-	-	-	1	0.10
AN	Annelida	1	-	-	-	-	-	1	0.10
AN	*Aphelochaeta glandaria*	-	-	-	-	1	-	1	0.10
AN	*Aphelochaeta monilaris*	1	-	-	-	-	-	1	0.10
AN	*Aricidea (Aricidea) wassi*	-	-	-	-	-	1	1	0.10
AN	*Diopatra* sp	-	-	-	1	-	-	1	0.10
AN	*Diopatra splendidissima*	-	-	-	-	1	-	1	0.10
AN	*Eulalia quadrioculata*	-	1	-	-	-	-	1	0.10
AN	*Eumida longicornuta*	-	-	-	-	1	-	1	0.10
AN	*Heteropodarke heteromorpha*	-	1	-	-	-	-	1	0.10
AN	*Leitoscoloplos pugettensis*	-	-	-	-	1	-	1	0.10
AN	*Levinsenia gracilis*	-	-	1	-	-	-	1	0.10
AN	*Nephtys cornuta*	1	-	-	-	-	-	1	0.10
AN	*Nereiphylla castanea*	-	-	-	-	1	-	1	0.10
AN	*Nereis procera*	1	-	-	-	-	-	1	0.10
AN	*Owenia collaris*	1	-	-	-	-	-	1	0.10
AN	*Phyllodoce hartmanae*	1	-	-	-	-	-	1	0.10
AN	*Podarkeopsis glabrus*	-	-	-	1	-	-	1	0.10
AN	*Prionospio (Minuspio) lighti*	-	-	1	-	-	-	1	0.10
AN	*Protodorvillea gracilis*	-	1	-	-	-	-	1	0.10
AN	*Scoloplos armiger* Cmplx	-	-	-	-	-	1	1	0.10
AN	*Spiochaetopterus costarum*	-	-	-	1	-	-	1	0.10
AR	*Asteropella slatteryi*	-	-	-	-	1	-	1	0.10
AR	*Campylaspis* sp C Myers & Benedict 1974	-	-	-	-	-	1	1	0.10
AR	*Cancer antennarius*	-	-	-	-	1	-	1	0.10
AR	*Cyclaspis nubila*	-	-	-	-	1	-	1	0.10
AR	*Hemilamprops californicus*	-	-	-	-	1	-	1	0.10
AR	*Lamprops carinatus*	-	-	-	-	1	-	1	0.10
AR	*Laticorophium baconi*	-	-	1	-	-	-	1	0.10
AR	*Listriella melanica*	-	-	-	-	1	-	1	0.10
AR	*Metamysidopsis elongata*	-	-	-	-	-	1	1	0.10
AR	*Neomysis kadiakensis*	-	-	1	-	-	-	1	0.10
AR	*Parasterope hulingsi*	-	-	-	1	-	-	1	0.10
AR	*Rhepoxynius heterocuspidatus*	-	-	1	-	-	-	1	0.10
AR	*Rhepoxynius variatus*	-	-	-	-	1	-	1	0.10
CN	*Actinaria* sp A MBC 2005	-	-	-	1	-	-	1	0.10
CO	Enteropneusta	-	-	-	-	-	1	1	0.10
EC	*Amphiodia* sp	-	-	1	-	-	-	1	0.10
EN	Loxosomatidae	-	-	-	-	-	1	1	0.10
MO	*Balcis oldroydae*	-	-	-	-	-	1	1	0.10
MO	*Cadulus aberrans*	-	-	-	-	1	-	1	0.10
MO	*Diplodonta sericata*	1	-	-	-	-	-	1	0.10
MO	*Periploma planiusculum*	-	-	1	-	-	-	1	0.10
MO	*Solen sicarius*	1	-	-	-	-	-	1	0.10
MO	*Yoldia cooperi*	-	-	-	1	-	-	1	0.10
NE	*Paranemertes californica*	-	-	-	-	-	1	1	0.10
PL	*Stylochoplana* sp	-	1	-	-	-	-	1	0.10
	Number of individuals	173	123	147	132	237	151	963	
	Number of species	53	27	38	47	70	46	133	
	Diversity (H')	3.25	2.50	2.94	3.39	3.76	3.29	3.98	

Appendix G-3. Infauna data by station and replicate. Ormond Beach Generating Station NPDES, 2005.

Station B1

Phylum	Species	Replicate B1-I	B1-II	B1-III	B1-IV	Total	Percent Composition	Density No./m²
AN	*Mediomastus acutus*	10	6	9	6	31	17.92	775.0
AN	*Apoprionospio pygmaea*	8	1	3	18	30	17.34	750.0
AN	*Onuphis* sp 1 Pt. Loma 1983	5	2	-	3	10	5.78	250.0
AN	*Syllis (Typosyllis) farallonensis*	3	3	3	-	9	5.20	225.0
AN	*Aricidea (Acmira) catherinae*	6	1	-	-	7	4.05	175.0
AR	*Diastylopsis tenuis*	-	1	5	-	6	3.47	150.0
AN	*Armandia brevis*	1	-	-	4	5	2.89	125.0
AN	*Exogone lourei*	1	-	3	-	4	2.31	100.0
AN	*Spiophanes bombyx*	3	-	1	-	4	2.31	100.0
AR	*Rhepoxynius menziesi*	1	1	2	-	4	2.31	100.0
AN	*Chaetozone setosa* Cmplx	1	-	-	2	3	1.73	75.0
MO	*Siliqua lucida*	-	3	-	-	3	1.73	75.0
AN	*Chone mollis*	-	2	-	-	2	1.16	50.0
AN	*Chone* sp SD1 Pt. Loma 1997	-	-	1	1	2	1.16	50.0
AN	*Glycinde armigera*	-	1	1	-	2	1.16	50.0
AN	*Magelona pitelkai*	-	2	-	-	2	1.16	50.0
AN	*Nephtys caecoides*	1	-	1	-	2	1.16	50.0
AN	*Scoletoma* sp	-	1	-	1	2	1.16	50.0
AN	*Sigalion spinosus*	1	-	1	-	2	1.16	50.0
AN	*Spiophanes berkeleyorum*	1	-	-	1	2	1.16	50.0
AR	*Euphilomedes longiseta*	-	-	2	-	2	1.16	50.0
AR	*Foxiphalus obtusidens*	-	-	-	2	2	1.16	50.0
AR	*Rhepoxynius abronius*	-	1	1	-	2	1.16	50.0
MO	*Tellina modesta*	1	1	-	-	2	1.16	50.0
NE	*Carinoma mutabilis*	-	2	-	-	2	1.16	50.0
NE	Lineidae	-	2	-	-	2	1.16	50.0
NT	Nematoda	1	-	1	-	2	1.16	50.0
PR	*Phoronis* sp	1	-	1	-	2	1.16	50.0
AN	Annelida	-	-	1	-	1	0.58	25.0
AN	*Aphelochaeta monilaris*	1	-	-	-	1	0.58	25.0
AN	*Dispio uncinata*	-	1	-	-	1	0.58	25.0
AN	Euclymeninae sp A SCAMIT 1987	1	-	-	-	1	0.58	25.0
AN	*Glycera macrobranchia*	1	-	-	-	1	0.58	25.0
AN	*Glycera nana*	-	-	1	-	1	0.58	25.0
AN	*Goniada littorea*	1	-	-	-	1	0.58	25.0
AN	*Magelona sacculata*	1	-	-	-	1	0.58	25.0
AN	*Nephtys cornuta*	-	-	-	1	1	0.58	25.0
AN	*Nereis procera*	-	1	-	-	1	0.58	25.0
AN	*Owenia collaris*	-	1	-	-	1	0.58	25.0
AN	*Phyllodoce hartmanae*	1	-	-	-	1	0.58	25.0
AN	Syllidae	-	-	1	-	1	0.58	25.0
AR	*Aoroides inermis*	-	-	-	1	1	0.58	25.0
AR	*Cumella californica*	-	1	-	-	1	0.58	25.0
AR	*Stenothoe estacola*	-	-	1	-	1	0.58	25.0
EC	*Dendraster excentricus*	-	-	1	-	1	0.58	25.0
MO	*Diplodonta sericata*	-	-	-	1	1	0.58	25.0
MO	*Rochefortia grippi*	-	-	1	-	1	0.58	25.0
MO	*Rochefortia tumida*	-	-	1	-	1	0.58	25.0
MO	*Solen sicarius*	-	-	1	-	1	0.58	25.0
NE	*Micrura* sp	-	-	-	1	1	0.58	25.0
NE	Nemertea	-	1	-	-	1	0.58	25.0
NE	*Tubulanus nothus*	-	-	-	1	1	0.58	25.0
SI	*Siphonosoma ingens*	-	-	-	1	1	0.58	25.0

Summary

Parameter	Replicate B1-I	B1-II	B1-III	B1-IV	Station Total	Overall Mean	S.D.
Number of individuals	51	35	43	44	173	43.3	6.6
Number of species	22	21	23	15	53	20.3	3.6
Diversity (H')	2.66	2.86	2.82	2.09	3.25	2.61	0.35

Appendix G-3. (Cont.).

Station B2

Phylum	Species	Replicate B2-I	B2-II	B2-III	B2-IV	Total	Percent Composition	Density No./m²
EC	*Dendraster excentricus*	6	7	16	6	35	28.46	875.0
AN	Maldanidae	4	14	5	1	24	19.51	600.0
CO	*Branchiostoma californiensis*	3	3	8	-	14	11.38	350.0
MO	*Caecum crebricinctum*	1	2	3	-	6	4.88	150.0
AR	*Stenothoe estacola*	-	5	-	-	5	4.07	125.0
AN	*Neosabellaria cementarium*	-	3	1	-	4	3.25	100.0
NE	Nemertea	-	1	1	2	4	3.25	100.0
AN	*Hesionura coineaui difficilis*	2	-	1	-	3	2.44	75.0
EC	*Amphiodia digitata*	1	-	-	2	3	2.44	75.0
AN	*Dispio uncinata*	1	-	1	-	2	1.63	50.0
AN	*Nephtys caecoides*	-	-	2	-	2	1.63	50.0
AN	*Onuphis* sp 1 Pt. Loma 1983	-	-	-	2	2	1.63	50.0
AR	*Anchicolurus occidentalis*	-	1	1	-	2	1.63	50.0
AR	*Jassa slatteryi*	-	2	-	-	2	1.63	50.0
AR	*Rhepoxynius menziesi*	-	-	2	-	2	1.63	50.0
NT	Nematoda	-	2	-	-	2	1.63	50.0
AN	*Eulalia quadrioculata*	-	-	-	1	1	0.81	25.0
AN	*Exogone lourei*	-	1	-	-	1	0.81	25.0
AN	*Heteropodarke heteromorpha*	-	1	-	-	1	0.81	25.0
AN	*Protodorvillea gracilis*	1	-	-	-	1	0.81	25.0
AN	*Sphaerephesia similisetis*	-	-	1	-	1	0.81	25.0
AR	*Diastylopsis tenuis*	-	-	1	-	1	0.81	25.0
AR	*Leuroleberis sharpei*	-	1	-	-	1	0.81	25.0
AR	*Zeugophilomedes oblonga*	-	-	1	-	1	0.81	25.0
MO	*Rochefortia grippi*	1	-	-	-	1	0.81	25.0
NE	*Carinoma mutabilis*	-	-	1	-	1	0.81	25.0
PL	*Stylochoplana* sp	-	1	-	-	1	0.81	25.0

Summary

Parameter	Replicate B2-I	B2-II	B2-III	B2-IV	Station Total	Overall Mean	S.D.
Number of individuals	20	44	45	14	123	30.8	16.1
Number of species	9	14	15	6	27	11.0	4.2
Diversity (H')	1.95	2.21	2.14	1.57	2.50	1.97	0.28

Appendix G-3. (Cont.).

Station B3

Phylum	Species	Replicate B3-I	B3-II	B3-III	B3-IV	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	9	4	13	7	33	22.45	825.0
AN	*Notomastus hemipodus*	-	6	1	9	16	10.88	400.0
AN	*Mediomastus acutus*	1	5	1	8	15	10.20	375.0
AN	*Scoletoma* sp	-	6	3	1	10	6.80	250.0
AN	*Armandia brevis*	-	3	-	5	8	5.44	200.0
AN	*Onuphis* sp 1 Pt. Loma 1983	1	4	2	1	8	5.44	200.0
AN	*Syllis (Ehlersia) heterochaeta*	-	6	-	-	6	4.08	150.0
AN	*Scoletoma tetraura* Cmplx	2	-	1	2	5	3.40	125.0
AN	*Aricidea (Acmira) catherinae*	-	1	3	-	4	2.72	100.0
AR	*Stenothoe estacola*	1	2	1	-	4	2.72	100.0
AN	*Hesionella mccullochae*	-	3	-	-	3	2.04	75.0
AR	*Anchicolurus occidentalis*	-	2	-	1	3	2.04	75.0
AR	*Jassa slatteryi*	1	2	-	-	3	2.04	75.0
AN	*Glycinde armigera*	-	2	-	-	2	1.36	50.0
AN	*Lumbrineris californiensis*	1	1	-	-	2	1.36	50.0
NE	Lineidae	-	1	1	-	2	1.36	50.0
NT	Nematoda	-	2	-	-	2	1.36	50.0
AN	*Amaeana occidentalis*	-	1	-	-	1	0.68	25.0
AN	*Ancistrosyllis hamata*	-	-	1	-	1	0.68	25.0
AN	*Dispio uncinata*	-	-	-	1	1	0.68	25.0
AN	*Glycera nana*	-	-	-	1	1	0.68	25.0
AN	*Levinsenia gracilis*	-	1	-	-	1	0.68	25.0
AN	*Nephtys caecoides*	-	-	1	-	1	0.68	25.0
AN	*Prionospio (Minuspio) lighti*	-	-	-	1	1	0.68	25.0
AN	*Spiophanes duplex*	-	-	1	-	1	0.68	25.0
AR	*Americhelidium shoemakeri*	-	1	-	-	1	0.68	25.0
AR	*Diastylopsis tenuis*	-	-	-	1	1	0.68	25.0
AR	*Edotia sublittoralis*	-	1	-	-	1	0.68	25.0
AR	*Laticorophium baconi*	-	1	-	-	1	0.68	25.0
AR	*Neomysis kadiakensis*	-	1	-	-	1	0.68	25.0
AR	*Rhepoxynius abronius*	-	1	-	-	1	0.68	25.0
AR	*Rhepoxynius heterocuspidatus*	-	1	-	-	1	0.68	25.0
EC	*Amphiodia* sp	-	-	1	-	1	0.68	25.0
EC	*Dendraster excentricus*	1	-	-	-	1	0.68	25.0
MO	*Periploma planiusculum*	-	-	-	1	1	0.68	25.0
MO	*Tellina modesta*	-	-	1	-	1	0.68	25.0
NE	*Carinoma mutabilis*	-	-	1	-	1	0.68	25.0
NE	*Micrura* sp	-	-	-	1	1	0.68	25.0

Summary

Parameter	Replicate B3-I	B3-II	B3-III	B3-IV	Station Total	Overall Mean	S.D.
Number of individuals	17	58	32	40	147	36.8	17.1
Number of species	8	24	15	14	38	15.3	6.6
Diversity (H')	1.59	2.94	2.17	2.20	2.94	2.23	0.55

Appendix G-3. (Cont.).

Station B4

Phylum	Species	Replicate B4-I	B4-II	B4-III	B4-IV	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	-	3	8	9	20	15.15	500.0
AN	*Mediomastus acutus*	6	2	2	2	12	9.09	300.0
AN	*Monticellina cryptica*	7	-	1	1	9	6.82	225.0
NE	*Carinoma mutabilis*	3	-	-	4	7	5.30	175.0
AN	*Spiophanes bombyx*	2	1	1	2	6	4.55	150.0
AN	*Syllis (Typosyllis) farallonensis*	2	1	1	2	6	4.55	150.0
AN	*Ampharete labrops*	-	-	5	-	5	3.79	125.0
AR	*Diastylopsis tenuis*	-	-	3	2	5	3.79	125.0
AN	*Aricidea (Acmira) catherinae*	3	-	1	-	4	3.03	100.0
AR	*Foxiphalus obtusidens*	-	-	4	-	4	3.03	100.0
AN	*Onuphis* sp 1 Pt. Loma 1983	-	2	1	-	3	2.27	75.0
AR	*Rhepoxynius menziesi*	-	1	2	-	3	2.27	75.0
NE	Lineidae	2	1	-	-	3	2.27	75.0
AN	*Armandia brevis*	1	-	1	-	2	1.52	50.0
AN	*Glycera macrobranchia*	-	-	-	2	2	1.52	50.0
AN	*Glycera nana*	-	-	2	-	2	1.52	50.0
AN	*Glycinde armigera*	1	-	-	1	2	1.52	50.0
AN	*Pectinaria californiensis*	1	-	1	-	2	1.52	50.0
AR	*Aoroides inermis*	-	-	2	-	2	1.52	50.0
AR	*Cumella californica*	-	-	2	-	2	1.52	50.0
AR	*Eobrolgus spinosus*	-	-	2	-	2	1.52	50.0
AR	*Gibberosus myersi*	-	-	1	1	2	1.52	50.0
AR	*Photis macinerneyi*	2	-	-	-	2	1.52	50.0
PR	*Phoronis* sp	-	1	1	-	2	1.52	50.0
AN	*Diopatra* sp	-	-	1	-	1	0.76	25.0
AN	*Magelona pitelkai*	-	1	-	-	1	0.76	25.0
AN	*Magelona sacculata*	-	-	1	-	1	0.76	25.0
AN	*Podarkeopsis glabrus*	1	-	-	-	1	0.76	25.0
AN	*Sigalion spinosus*	-	1	-	-	1	0.76	25.0
AN	*Sphaerephesia similisetis*	-	-	1	-	1	0.76	25.0
AN	*Spiochaetopterus costarum*	-	-	-	1	1	0.76	25.0
AN	Syllidae	1	-	-	-	1	0.76	25.0
AR	*Americhelidium shoemakeri*	-	-	1	-	1	0.76	25.0
AR	*Anchicolurus occidentalis*	1	-	-	-	1	0.76	25.0
AR	*Cyclaspis* sp C SCAMIT 1986	-	-	-	1	1	0.76	25.0
AR	*Jassa marmorata*	1	-	-	-	1	0.76	25.0
AR	*Pachygrapsus crassipes*	-	-	-	1	1	0.76	25.0
AR	*Parasterope hulingsi*	-	-	-	1	1	0.76	25.0
AR	*Photis californica*	-	-	1	-	1	0.76	25.0
AR	*Rhepoxynius abronius*	1	-	-	-	1	0.76	25.0
AR	*Zeugophilomedes oblonga*	-	-	1	-	1	0.76	25.0
CN	*Actinaria* sp A MBC 2005	-	1	-	-	1	0.76	25.0
MO	*Rochefortia tumida*	-	-	1	-	1	0.76	25.0
MO	*Siliqua lucida*	-	-	1	-	1	0.76	25.0
MO	*Yoldia cooperi*	-	-	1	-	1	0.76	25.0
NE	*Micrura* sp	-	-	-	1	1	0.76	25.0
SI	*Siphonosoma ingens*	-	1	-	-	1	0.76	25.0

Summary

Parameter	Replicate B4-I	B4-II	B4-III	B4-IV	Station Total	Overall Mean	S.D.
Number of individuals	35	16	50	31	132	33.0	14.0
Number of species	16	12	28	15	47	17.8	7.0
Diversity (H')	2.51	2.39	3.08	2.39	3.39	2.59	0.33

Appendix G-3. (Cont.).

Station B5

Phylum	Species	B5-I	B5-II	B5-III	B5-IV	Total	Percent Composition	Density No./m²
		Replicate						
AN	*Apoprionospio pygmaea*	7	3	3	9	22	9.28	550.0
AN	*Mediomastus acutus*	8	2	2	9	21	8.86	525.0
AR	*Diastylopsis tenuis*	1	5	3	9	18	7.59	450.0
AN	*Aricidea (Acmira) catherinae*	4	-	-	6	10	4.22	250.0
AR	*Rhepoxynius menziesi*	-	-	2	8	10	4.22	250.0
AN	*Glycinde armigera*	2	2	3	1	8	3.38	200.0
AN	*Onuphis* sp 1 Pt. Loma 1983	-	-	3	5	8	3.38	200.0
AN	*Syllis (Ehlersia) heterochaeta*	6	-	-	2	8	3.38	200.0
AN	*Ampharete labrops*	-	-	6	-	6	2.53	150.0
AN	*Armandia brevis*	-	5	-	1	6	2.53	150.0
AN	*Monticellina cryptica*	1	1	-	4	6	2.53	150.0
AN	*Spiophanes bombyx*	-	-	2	4	6	2.53	150.0
AN	*Mediomastus ambiseta*	-	3	-	2	5	2.11	125.0
AN	*Exogone lourei*	-	1	1	2	4	1.69	100.0
NE	*Tubulanus polymorphus*	1	2	-	1	4	1.69	100.0
NT	Nematoda	3	-	1	-	4	1.69	100.0
AN	*Chaetozone setosa* Cmplx	-	2	1	-	3	1.27	75.0
AN	*Magelona pitelkai*	-	2	-	1	3	1.27	75.0
AN	*Nephtys caecoides*	1	-	-	2	3	1.27	75.0
AN	*Syllis (Typosyllis) farallonensis*	1	1	-	1	3	1.27	75.0
AR	*Cyclaspis* sp C SCAMIT 1986	-	3	-	-	3	1.27	75.0
AR	*Gibberosus myersi*	1	1	-	1	3	1.27	75.0
AR	*Photis californica*	-	-	-	3	3	1.27	75.0
AR	*Rhepoxynius abronius*	-	1	-	2	3	1.27	75.0
AR	*Rutiderma rostratum*	-	-	-	3	3	1.27	75.0
EC	*Dendraster excentricus*	2	-	-	1	3	1.27	75.0
MO	*Tellina modesta*	-	1	2	-	3	1.27	75.0
AN	*Glycera macrobranchia*	1	1	-	-	2	0.84	50.0
AN	*Onuphis* sp	1	1	-	-	2	0.84	50.0
AN	*Scoletoma* sp	-	-	1	1	2	0.84	50.0
AN	*Spiophanes duplex*	-	-	1	1	2	0.84	50.0
AN	Syllidae	-	-	1	1	2	0.84	50.0
AR	*Americhelidium shoemakeri*	-	1	-	1	2	0.84	50.0
AR	*Ampelisca agassizi*	2	-	-	-	2	0.84	50.0
AR	*Lamprops quadriplicatus*	-	2	-	-	2	0.84	50.0
AR	*Photis macinerneyi*	-	-	-	2	2	0.84	50.0
AR	*Tiron biocellata*	-	1	1	-	2	0.84	50.0
EC	Amphiuridae	-	-	-	2	2	0.84	50.0
MO	*Macoma* sp	-	-	-	2	2	0.84	50.0
NE	*Carinoma mutabilis*	1	-	-	1	2	0.84	50.0
NE	Lineidae	-	-	1	1	2	0.84	50.0
PR	*Phoronis* sp	1	1	-	-	2	0.84	50.0
AN	*Aphelochaeta glandaria*	1	-	-	-	1	0.42	25.0
AN	*Chone mollis*	-	1	-	-	1	0.42	25.0
AN	*Diopatra splendidissima*	-	-	-	1	1	0.42	25.0
AN	Euclymeninae sp A SCAMIT 1987	-	-	-	1	1	0.42	25.0
AN	*Eumida longicornuta*	-	-	1	-	1	0.42	25.0
AN	*Leitoscoloplos pugettensis*	1	-	-	-	1	0.42	25.0
AN	*Lumbrineris californiensis*	-	-	-	1	1	0.42	25.0
AN	Maldanidae	-	-	1	-	1	0.42	25.0
AN	*Nereiphylla castanea*	-	-	1	-	1	0.42	25.0
AN	*Spiophanes berkeleyorum*	-	-	-	1	1	0.42	25.0
AN	*Sthenelais tertiaglabra*	-	-	-	1	1	0.42	25.0
AR	*Asteropella slatteryi*	-	-	-	1	1	0.42	25.0
AR	*Cancer antennarius*	-	1	-	-	1	0.42	25.0
AR	*Cyclaspis nubila*	-	-	-	1	1	0.42	25.0
AR	*Edotia sublittoralis*	-	-	-	1	1	0.42	25.0
AR	*Eobrolgus spinosus*	-	1	-	-	1	0.42	25.0
AR	*Hemilamprops californicus*	1	-	-	-	1	0.42	25.0
AR	*Lamprops carinatus*	-	-	-	1	1	0.42	25.0
AR	*Leuroleberis sharpei*	-	-	-	1	1	0.42	25.0
AR	*Listriella melanica*	-	-	-	1	1	0.42	25.0
AR	*Rhepoxynius variatus*	-	-	-	1	1	0.42	25.0
AR	*Zeugophilomedes oblonga*	-	-	-	1	1	0.42	25.0
MO	*Cadulus aberrans*	-	-	-	1	1	0.42	25.0

Appendix G-3. (Cont.).

Station B5

Phylum	Species	Replicate B5-I	B5-II	B5-III	B5-IV	Total	Percent Composition	Density No./m²
MO	*Rochefortia grippi*	-	-	-	1	1	0.42	25.0
MO	*Siliqua lucida*	-	-	-	1	1	0.42	25.0
NE	Nemertea	1	-	-	-	1	0.42	25.0
NE	*Tubulanus nothus*	1	-	-	-	1	0.42	25.0
SI	*Siphonosoma ingens*	-	-	-	1	1	0.42	25.0

Summary

Parameter	Replicate B5-I	B5-II	B5-III	B5-IV	Station Total	Overall Mean	S.D.
Number of individuals	49	45	37	106	237	59.3	31.6
Number of species	23	25	20	48	70	29.0	12.8
Diversity (H')	2.79	3.04	2.81	3.50	3.76	2.85	0.33

Appendix G-3. (Cont.).

Station B6

Phylum	Species	Replicate B6-I	B6-II	B6-III	B6-IV	Total	Percent Composition	Density No./m²
AN	*Apoprionospio pygmaea*	6	12	1	4	23	15.23	575.0
NE	*Carinoma mutabilis*	4	1	4	7	16	10.60	400.0
AR	*Stenothoe estacola*	6	4	5	-	15	9.93	375.0
AN	*Aricidea (Acmira) catherinae*	1	3	2	2	8	5.30	200.0
AR	*Anchicolurus occidentalis*	3	-	4	1	8	5.30	200.0
AR	*Podocerus brasiliensis*	3	2	1	1	7	4.64	175.0
AN	*Armandia brevis*	4	1	-	-	5	3.31	125.0
AN	*Nephtys caecoides*	-	2	-	2	4	2.65	100.0
AN	*Onuphis* sp 1 Pt. Loma 1983	1	1	1	1	4	2.65	100.0
AN	*Syllis (Typosyllis) farallonensis*	1	-	-	3	4	2.65	100.0
AR	*Jassa marmorata*	1	1	1	1	4	2.65	100.0
AN	*Spiophanes bombyx*	1	-	-	2	3	1.99	75.0
EC	Amphiuridae	1	-	-	2	3	1.99	75.0
MO	*Siliqua lucida*	-	-	2	1	3	1.99	75.0
NE	Lineidae	-	-	-	3	3	1.99	75.0
AN	*Dispio uncinata*	-	2	-	-	2	1.32	50.0
AN	*Glycinde armigera*	1	-	1	-	2	1.32	50.0
AN	*Mediomastus acutus*	1	-	-	1	2	1.32	50.0
AN	*Syllis (Ehlersia) heterochaeta*	1	-	1	-	2	1.32	50.0
AR	*Aoroides inermis*	-	-	-	2	2	1.32	50.0
AR	*Lamprops quadriplicatus*	1	-	1	-	2	1.32	50.0
AR	*Pachygapsus crassipes*	-	1	-	1	2	1.32	50.0
AR	*Rhepoxynius menziesi*	-	-	-	2	2	1.32	50.0
EC	*Dendraster excentricus*	1	-	-	1	2	1.32	50.0
NE	*Micrura* sp	1	-	-	1	2	1.32	50.0
AN	*Aricidea (Aricidea) wassi*	-	-	1	-	1	0.66	25.0
AN	*Glycera macrobranchia*	1	-	-	-	1	0.66	25.0
AN	*Goniada littorea*	-	1	-	-	1	0.66	25.0
AN	*Magelona pitelkai*	-	1	-	-	1	0.66	25.0
AN	Maldanidae	-	-	-	1	1	0.66	25.0
AN	*Scoloplos armiger* Cmplx	-	-	1	-	1	0.66	25.0
AN	*Sigalion spinosus*	-	-	1	-	1	0.66	25.0
AN	*Sphaerephesia similisetis*	1	-	-	-	1	0.66	25.0
AN	*Sthenelais tertiaglabra*	-	-	-	1	1	0.66	25.0
AR	*Ampelisca agassizi*	-	-	-	1	1	0.66	25.0
AR	*Campylaspis* sp C Myers & Benedict 1974	-	-	1	-	1	0.66	25.0
AR	*Diastylopsis tenuis*	1	-	-	-	1	0.66	25.0
AR	*Gibberosus myersi*	-	-	1	-	1	0.66	25.0
AR	*Jassa slatteryi*	-	1	-	-	1	0.66	25.0
AR	*Metamysidopsis elongata*	-	-	-	1	1	0.66	25.0
AR	*Photis californica*	-	-	-	1	1	0.66	25.0
CO	Enteropneusta	-	-	1	-	1	0.66	25.0
EN	Loxosomatidae	-	1	-	-	1	0.66	25.0
MO	*Balcis oldroydae*	-	-	1	-	1	0.66	25.0
NE	*Paranemertes californica*	1	-	-	-	1	0.66	25.0
NE	*Tubulanus polymorphus*	1	-	-	-	1	0.66	25.0

Summary

Parameter	Replicate B6-I	B6-II	B6-III	B6-IV	Station Total	Overall Mean	S.D.
Number of individuals	43	34	31	43	151	37.8	6.2
Number of species	23	15	19	24	46	20.3	4.1
Diversity (H')	2.85	2.27	2.73	2.97	3.29	2.70	0.31

Appendix G-4. Infaunal wet weight biomass data (g). Ormond Beach Generating Station NPDES, 2005.

Sta-Rep	Annelida	Arthropoda	Mollusca	Echinodermata	Misc.	Total
B1-I	0.298	<0.001	<0.001	-	0.035	0.332
B1-II	0.346	<0.001	0.043	-	0.006	0.395
B1-III	0.113	<0.001	<0.001	<0.001	0.074	0.187
B1-IV	0.265	0.026	0.031	-	0.034	0.356
Total	1.021	0.026	0.075	<0.001	0.149	1.270
B2-I	0.023	-	<0.001	0.106	<0.001	0.129
B2-II	0.026	0.017	0.009	0.015	0.267	0.334
B2-III	0.022	<0.001	0.031	<0.001	0.298	0.351
B2-IV	0.076	-	-	0.040	0.004	0.120
Total	0.147	0.017	0.040	0.161	0.569	0.934
B3-I	0.115	<0.001	-	0.015	-	0.130
B3-II	0.559	<0.001	-	-	0.050	0.609
B3-III	0.424	<0.001	0.029	0.036	0.026	0.514
B3-IV	0.220	0.031	0.009	-	<0.001	0.260
Total	1.317	0.031	0.037	0.051	0.076	1.513
B4-I	0.074	0.019	-	-	<0.001	0.093
B4-II	0.126	0.014	-	-	<0.001	0.140
B4-III	0.223	<0.001	0.061	-	<0.001	0.284
B4-IV	0.150	0.055	-	-	0.037	0.242
Total	0.573	0.088	0.061	-	0.037	0.758
B5-I	0.268	0.050	-	<0.001	0.072	0.390
B5-II	0.030	0.400	0.047	-	<0.001	0.477
B5-III	0.544	<0.001	<0.001	-	<0.001	0.544
B5-IV	0.234	<0.001	0.025	<0.001	0.030	0.288
Total	1.075	0.450	0.071	<0.001	0.102	1.698
B6-I	0.084	0.038	-	0.035	<0.001	0.157
B6-II	0.109	0.037	-	-	0.085	0.231
B6-III	0.037	0.010	0.007	-	<0.001	0.053
B6-IV	0.177	<0.001	<0.001	0.047	<0.001	0.223
Total	0.406	0.085	0.007	0.082	0.085	0.665
Grand Total	4.538	0.698	0.291	0.294	1.017	6.838

Note: - = no animals

Appendix G-5. Yearly infaunal abundance. Ormond Beach Generating Station NPDES, 2005.

Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total	% Total	Cum. %	F.O.
NT	Nematoda	7	5	-	2	6	2	-	-	5	8375	-	5	24	6	15	61	17	10	8540	22.20	22.20	14
AN	*Owenia collaris*	3	2	-	6	4	82	-	-	2	5	10	59	3275	111	2	1	1	1	3564	9.26	31.46	15
AN	*Apoprionospio pygmaea*	29	108	9	464	42	509	17	12	156	43	41	94	53	948	73	44	256	128	3026	7.87	39.33	18
EC	*Dendraster excentricus*	8	11	7	9	9	-	4	5	33	1075	31	32	118	360	62	333	88	42	2227	5.79	45.12	17
AR	*Diastylopsis tenuis*	306	110	28	80	59	23	1	19	62	67	1	391	728	136	108	10	54	32	2215	5.76	50.87	18
AN	*Mediomastus acutus*	28	30	-	-	-	-	-	2	27	66	282	86	124	94	43	44	72	81	979	2.54	53.42	13
AR	*Rhepoxynius menziesi*	32	57	27	45	44	26	14	11	50	16	24	137	256	48	31	4	31	21	874	2.27	55.69	18
MO	*Tellina modesta*	8	48	23	13	29	5	3	1	32	22	13	105	316	106	37	9	87	6	863	2.24	57.93	18
AN	*Pectinaria californiensis*	3	-	1	123	2	-	-	1	-	15	1	465	46	19	4	1	-	2	683	1.78	59.71	13
MO	*Siliqua lucida*	1	17	17	10	-	7	-	22	29	31	15	473	11	14	12	2	3	8	672	1.75	61.46	16
AN	*Spiophanes bombyx*	9	39	22	53	22	17	28	24	33	19	13	32	63	33	33	16	40	19	515	1.34	62.80	18
AN	*Armandia brevis*	1	2	-	1	-	3	-	-	3	-	1	23	3	324	9	61	18	26	475	1.23	64.03	13
AR	*Photis macinerneyi*	-	-	4	66	12	1	-	-	5	43	2	72	166	29	14	2	10	4	430	1.12	65.15	14
NE	*Carinoma mutabilis*	-	4	9	12	13	13	32	10	20	43	22	16	19	54	43	25	58	29	422	1.10	66.24	17
AN	*Magelona sacculata*	7	100	37	127	27	66	12	3	-	-	-	-	5	8	8	-	-	2	402	1.04	67.29	12
AR	*Anchicolurus occidentalis*	5	6	7	15	10	12	3	1	15	17	1	98	123	13	13	2	2	14	357	0.93	68.22	18
AR	*Gibberosus myersi*	7	3	4	9	5	18	-	-	11	11	2	31	140	37	30	3	39	6	356	0.93	69.14	16
AN	*Aricidea (Acmira) catherinae*	26	70	6	18	10	12	21	5	12	8	2	11	9	39	19	5	20	33	326	0.85	69.99	18
AR	*Aoroides inermis*	-	-	-	-	-	-	-	-	-	-	-	188	43	60	22	3	-	5	321	0.83	70.82	6
AR	*Rhepoxynius abronius*	9	24	1	8	8	28	8	-	5	6	5	14	108	65	16	-	3	7	315	0.82	71.64	16
AR	*Photis brevipes*	6	-	-	-	3	2	-	-	5	1	15	106	122	14	11	15	-	-	300	0.78	72.42	11
AN	*Scoloplos armiger* Cmplx	7	6	21	25	28	43	19	5	18	43	11	5	1	3	8	-	11	1	255	0.66	73.09	17
AN	*Goniada littorea*	42	18	9	10	24	20	4	6	15	14	12	27	17	10	15	3	6	2	254	0.66	73.75	18
AN	*Exogone lourei*	3	1	-	-	24	2	1	-	6	52	6	18	21	8	5	57	38	9	251	0.65	74.40	15
AR	*Euphilomedes longiseta*	-	10	-	-	1	-	-	-	-	-	-	63	163	-	5	-	3	2	247	0.64	75.04	7
AN	*Chaetozone setosa* Cmplx	10	14	2	6	55	16	13	2	5	8	12	-	-	5	22	8	33	6	217	0.56	75.61	16
AN	*Capitella capitata* Cmplx	-	1	191	-	-	14	-	-	-	-	-	-	1	4	-	-	-	-	211	0.55	76.15	5
AR	*Jassa slatteryi*	-	-	-	-	9	-	-	-	-	-	-	93	86	4	-	-	5	6	203	0.53	76.68	6
AR	*Isocheles pilosus*	1	4	3	9	3	-	-	-	-	-	-	1	176	-	-	-	-	-	197	0.51	77.19	7
AN	*Mediomastus* spp	2	20	-	37	34	6	3	-	-	13	46	12	6	-	-	-	-	-	179	0.47	77.66	10
AR	*Ampelisca agassizi*	-	1	1	16	64	10	2	-	4	3	-	1	5	4	45	1	7	3	167	0.43	78.09	15
AN	*Onuphis* sp 1 Pt. Loma 1983	-	-	-	-	-	-	-	-	-	35	13	7	17	24	10	8	11	35	160	0.42	78.51	9
MO	*Cooperella subdiaphana*	-	-	2	7	3	-	-	-	-	5	4	18	90	10	9	6	1	-	155	0.40	78.91	11
AN	*Nephtys caecoides*	8	7	4	10	13	8	5	2	12	4	3	18	16	6	7	7	4	12	146	0.38	79.29	18
AR	*Americhelidium shoemakeri*	25	-	2	5	-	-	-	-	1	-	-	11	77	13	5	2	1	4	146	0.38	79.67	11
AR	*Ericthonius brasiliensis*	-	-	-	-	-	-	-	-	-	-	-	130	3	6	2	1	-	-	142	0.37	80.04	5
MO	*Rochefortia tumida*	4	6	2	1	1	-	-	-	1	1	-	4	45	45	20	5	3	2	140	0.36	80.40	14
AN	*Magelona pitelkai*	1	68	-	3	9	23	4	1	3	2	-	-	3	11	3	-	-	7	138	0.36	80.76	13
NE	Nemertea	18	10	7	18	13	3	8	2	6	6	3	7	15	6	2	2	3	6	135	0.35	81.11	18
AR	*Lamprops carinatus*	1	1	-	-	1	1	-	-	-	2	-	11	63	39	9	5	-	1	134	0.35	81.46	11
AR	*Jassa marmorata*	-	-	-	-	-	-	-	-	-	-	-	25	11	-	-	70	22	5	133	0.35	81.81	5
MO	*Modiolus* sp	-	-	-	-	1	-	-	-	1	-	8	16	92	6	2	7	-	-	133	0.35	82.15	8
AR	*Uromunna ubiquita*	5	5	-	1	-	-	-	-	2	1	-	1	102	10	4	-	1	-	132	0.34	82.50	10
AN	*Spiophanes duplex*	-	31	-	52	3	4	-	7	2	1	8	-	3	5	1	1	2	3	123	0.32	82.82	14
AN	*Syllis (Typosyllis) farallonensis*	-	-	1	-	-	-	-	-	14	14	5	3	-	2	7	10	44	22	122	0.32	83.13	10
NE	Lineidae	-	-	-	4	-	-	-	-	5	9	1	3	10	12	6	8	44	12	114	0.30	83.43	11
AN	*Spiochaetopterus costarum*	15	6	-	32	-	-	-	-	6	3	1	3	11	24	-	1	9	1	112	0.29	83.72	12
AR	*Edotia sublittoralis*	3	1	3	1	2	6	-	1	10	12	1	10	35	8	1	-	6	2	102	0.27	83.99	16
AR	*Lamprops quadriplicatus*	1	1	-	1	2	3	-	-	20	8	-	19	11	5	22	-	5	4	102	0.27	84.25	13
MO	*Mysella* sp H SCAMIT 2001	2	11	11	75	-	-	-	-	-	-	-	1	-	-	-	-	-	-	100	0.26	84.51	5
AN	*Scoletoma tetraura* Cmplx	1	8	4	4	2	-	-	11	8	8	-	4	9	-	-	1	34	5	99	0.26	84.77	13
AR	*Cumella californica*	-	1	-	-	-	-	-	-	3	17	-	6	39	9	5	2	14	3	99	0.26	85.03	10
AR	*Caprella verrucosa*	-	-	-	-	-	-	-	-	-	-	-	-	96	-	-	-	-	-	96	0.25	85.27	1
PR	*Phoronis* sp	14	8	-	17	-	-	-	-	-	-	-	6	11	21	3	6	2	6	94	0.24	85.52	10
AN	*Sigalion spinosus*	5	14	4	11	4	1	5	1	10	2	3	4	4	11	9	1	-	4	93	0.24	85.76	17
AN	*Glycera macrobranchia*	3	4	1	5	4	4	5	3	6	12	4	2	5	10	6	3	8	6	91	0.24	86.00	18
NE	*Paranemertes californica*	-	3	-	4	5	-	-	-	4	6	8	5	21	18	2	-	14	1	91	0.24	86.23	12
AN	*Syllis* sp	-	2	-	22	35	12	13	3	-	-	-	-	3	-	-	-	-	-	90	0.23	86.47	7
AR	*Foxiphalus obtusidens*	1	-	-	-	1	-	-	-	4	2	-	33	20	7	5	6	4	6	89	0.23	86.70	11
NE	*Tubulanus polymorphus*	-	-	1	2	3	11	-	-	4	5	1	1	21	23	2	8	1	5	88	0.23	86.93	14
AN	*Glycinde armigera*	-	-	1	11	2	-	-	-	5	19	12	1	5	3	3	3	3	16	84	0.22	87.15	13
AR	*Rhepoxynius* sp A SCAMIT 1987	12	7	3	5	-	3	2	1	5	-	-	4	5	14	11	-	10	-	82	0.21	87.36	13
CO	Enteropneusta	10	2	-	-	8	-	-	-	-	4	2	5	23	20	2	2	2	1	81	0.21	87.57	12
AN	*Syllis (Ehlersia) heterochaeta*	-	-	-	-	-	-	-	-	-	-	12	7	8	4	2	22	9	16	80	0.21	87.78	8
AR	*Photis* sp	52	18	-	-	1	9	-	-	-	-	-	-	-	-	-	-	-	-	80	0.21	87.99	4
MO	*Macoma* sp	-	9	-	1	3	-	-	-	9	11	-	-	27	10	2	5	-	2	79	0.21	88.19	10
AN	*Dispio uncinata*	7	25	7	10	1	1	-	-	-	1	-	1	5	7	-	1	1	6	73	0.19	88.38	13
AR	*Stenothoe estacola*	-	-	-	-	1	-	-	-	-	-	-	-	3	-	-	2	35	25	66	0.17	88.55	5
AN	*Syllis (Typosyllis) aciculata*	35	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	64	0.17	88.72	2
AN	*Ampharete labrops*	5	1	-	1	-	-	-	3	5	-	10	2	4	3	8	7	-	11	60	0.16	88.87	12
CN	Actiniaria	-	1	-	-	6	6	-	-	-	-	-	-	41	5	1	-	-	-	60	0.16	89.03	6
AR	*Cyclaspis* sp C SCAMIT 1986	-	1	-	2	-	2	-	-	-	9	-	8	4	3	1	2	21	4	57	0.15	89.18	11
AR	Phoxocephalidae	-	-	-	6	1	40	10	-	-	-	-	-	-	-	-	-	-	-	57	0.15	89.33	4
PR	Phoronidae	-	3	7	-	9	3	-	-	7	19	4	-	-	-	4	-	1	-	57	0.15	89.48	9
AR	*Zeugophilomedes oblonga*	-	-	-	1	2	-	-	-	-	-	-	-	8	3	6	10	23	3	56	0.15	89.62	8

Appendix G-5. (Cont.).

Phy	Species	Year																			%	Cum.	
		1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total	Total	%	F.O.
AR	*Leuroleberis sharpei*	-	1	1	5	10	3	-	-	1	-	3	7	7	3	5	4	2	2	54	0.14	89.76	14
AR	*Balanus pacificus*	-	-	3	2	-	-	-	-	-	-	-	-	17	31	-	-	-	-	53	0.14	89.90	4
AR	*Anoropallene palpida*	-	-	-	2	-	-	-	-	-	20	-	1	24	5	-	-	-	-	52	0.14	90.03	5
AR	*Monocorophium acherusicum*	-	-	-	5	2	-	-	-	-	-	-	-	27	-	12	6	-	-	52	0.14	90.17	5
AN	*Pista disjuncta*	5	1	1	2	18	1	2	-	-	-	10	4	2	-	3	-	1	-	50	0.13	90.30	12
AR	*Campylaspis* sp C Myers & Benedict 1974	-	1	-	6	1	2	-	-	12	2	1	9	6	4	-	-	5	1	50	0.13	90.43	12
AN	*Tharyx* spp Cmplx	33	13	-	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	49	0.13	90.56	5
AN	*Phyllodoce hartmanae*	-	-	-	14	3	7	2	-	-	-	1	-	11	6	-	2	1	1	48	0.12	90.68	10
AN	*Lumbrineris* spp	4	4	-	3	4	15	11	1	-	2	2	-	-	1	-	-	-	-	47	0.12	90.80	10
AN	*Brania californiensis*	-	-	-	-	2	-	-	-	-	-	-	6	32	4	-	-	2	-	46	0.12	90.92	5
CN	*Zaolutus actius*	-	2	-	4	-	-	-	-	-	-	-	13	26	1	-	-	-	-	46	0.12	91.04	5
AN	*Polydora cirrosa*	-	-	-	-	-	-	-	-	-	-	-	17	23	3	1	-	-	-	44	0.11	91.16	4
AR	*Euphilomedes carcharodonta*	1	8	1	4	2	1	-	-	5	10	-	1	3	3	3	-	1	-	43	0.11	91.27	13
AN	*Diopatra ornata*	-	-	-	-	-	1	-	-	-	2	-	10	8	1	7	13	-	-	42	0.11	91.38	7
AR	*Cyclaspis nubila*	-	-	-	3	1	-	-	-	8	5	-	16	5	1	1	-	-	1	41	0.11	91.48	9
AN	*Chone* sp SD1 Pt. Loma 1997	-	-	-	-	-	-	-	-	-	-	3	1	6	3	17	2	6	2	40	0.10	91.59	8
AN	*Onuphis iridescens*	2	4	3	12	7	12	-	-	-	-	-	-	-	-	-	-	-	-	40	0.10	91.69	6
AR	*Podocerus brasiliensis*	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-	10	7	39	0.10	91.79	3
MO	*Protothaca staminea*	-	-	-	-	-	-	-	-	-	1	-	2	24	3	5	3	1	-	39	0.10	91.90	7
AN	Maldanidae	2	-	-	-	-	-	1	1	-	-	-	-	1	3	4	-	-	26	38	0.10	91.99	7
AN	*Monticellina cryptica*	-	-	-	-	-	-	-	-	-	2	3	6	3	4	3	1	-	15	37	0.10	92.09	8
AN	*Neosabellaria cementarium*	-	-	-	-	-	-	-	-	-	1	4	21	5	2	-	-	-	4	37	0.10	92.19	6
AR	*Cerapus tubularis* Cmplx	-	2	-	-	4	-	-	4	4	-	1	5	10	3	3	1	-	-	37	0.10	92.28	10
AN	*Notomastus hemipodus*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	16	1	16	36	0.09	92.38	5
AR	*Ischyrocerus pelagops*	-	-	-	-	-	-	-	-	-	-	-	7	29	-	-	-	-	-	36	0.09	92.47	2
MO	*Mactromeris catilliformis*	-	-	-	-	-	-	-	-	-	-	-	-	-	35	1	-	-	-	36	0.09	92.56	2
MO	*Nassarius perpinguis*	-	2	4	-	4	-	-	-	2	9	-	1	8	6	-	-	-	-	36	0.09	92.66	8
AN	*Syllides* sp	15	13	-	1	-	-	-	-	-	-	1	4	1	-	-	-	-	-	35	0.09	92.75	6
AR	*Gammaropsis thompsoni*	-	-	-	-	-	-	-	-	1	-	-	1	-	3	26	3	1	-	35	0.09	92.84	6
AN	*Onuphis eremita*	4	-	-	-	3	1	1	15	2	2	1	1	-	-	2	-	2	-	34	0.09	92.93	11
AR	*Photis bifurcata*	-	-	-	-	-	-	-	-	-	-	-	2	1	-	24	6	-	-	33	0.09	93.01	4
AR	*Rhepoxynius* sp	13	-	-	1	16	-	3	-	-	-	-	-	-	-	-	-	-	-	33	0.09	93.10	4
BC	*Glottidia albida*	4	1	3	3	5	-	-	1	3	5	1	1	3	2	-	-	-	-	32	0.08	93.18	12
MO	*Olivella baetica*	-	7	1	3	3	1	-	-	1	12	-	-	2	2	-	-	-	-	32	0.08	93.27	9
MO	*Rochefortia grippi*	-	7	-	-	1	-	-	-	-	-	-	-	13	-	-	8	-	3	32	0.08	93.35	5
AN	*Dorvillea (Schistomeringos) longicornis*	-	-	-	-	-	-	-	-	30	1	-	-	-	-	-	-	-	-	31	0.08	93.43	2
AR	*Tiron biocellata*	-	-	-	1	-	4	-	-	2	-	-	13	5	3	-	1	-	2	31	0.08	93.51	8
AR	*Hartmanodes hartmanae*	1	1	2	2	3	1	1	-	2	-	-	1	6	1	6	-	3	-	30	0.08	93.59	13
AR	*Rutiderma rostratum*	2	-	-	3	1	-	-	-	-	3	1	2	5	4	1	1	4	3	30	0.08	93.67	12
MO	*Cyclostremella dalli*	-	-	-	2	-	-	-	-	-	-	1	-	27	-	-	-	-	-	30	0.08	93.74	3
AN	Onuphidae	1	-	-	1	2	-	-	1	6	5	-	-	5	-	3	-	5	-	29	0.08	93.82	9
AR	*Hemilamprops californicus*	2	1	-	7	-	-	-	-	4	-	-	3	2	-	6	-	3	1	29	0.08	93.89	9
AN	*Sthenelais verruculosa*	6	2	3	1	1	2	-	5	1	-	-	3	2	-	2	-	-	-	28	0.07	93.97	11
CN	Limnactiniidae sp A SCAMIT 1989	-	-	-	-	1	-	-	-	3	3	3	-	3	8	3	1	3	-	28	0.07	94.04	9
EC	*Amphiodia urtica*	4	2	2	2	2	5	4	6	-	-	-	-	-	-	1	-	-	-	28	0.07	94.11	9
AN	*Phyllodoce* sp	1	19	-	1	-	1	-	-	2	-	-	1	-	1	-	-	-	-	26	0.07	94.18	7
AN	*Podarkeopsis glabrus*	-	4	-	1	6	3	2	-	1	-	1	-	2	-	2	2	1	1	26	0.07	94.25	12
AN	*Nereis latescens*	-	-	-	-	-	-	-	-	1	-	-	1	2	5	5	9	2	-	25	0.06	94.31	7
AR	*Rhepoxynius variatus*	-	-	-	1	7	1	1	2	-	-	-	2	-	1	8	-	-	1	24	0.06	94.37	9
MO	*Yoldia cooperi*	-	-	-	-	-	-	-	-	-	-	-	-	11	-	12	-	-	1	24	0.06	94.44	3
AN	*Leitoscoloplos pugettensis*	1	2	4	-	4	-	-	-	2	-	6	-	-	2	-	-	1	1	23	0.06	94.50	9
AN	*Nephtys cornuta*	-	4	-	2	2	-	-	-	1	3	-	-	-	4	2	-	4	1	23	0.06	94.56	9
AR	*Americhelidium rectipalmum*	-	-	-	3	-	-	-	-	-	-	-	2	8	3	5	-	2	-	23	0.06	94.62	6
AR	*Metharpinia jonesi*	5	6	-	-	-	-	-	-	3	8	-	-	-	-	-	1	-	-	23	0.06	94.68	5
AR	*Rhepoxynius stenodes*	-	1	-	-	1	-	-	-	-	2	3	16	-	-	-	-	-	-	23	0.06	94.74	5
AN	*Carazziella* sp A SCAMIT 1995	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-	-	22	0.06	94.79	1
AR	*Photis macrotica*	17	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	0.06	94.85	2
AN	*Prionospio (Minuspio) lighti*	-	3	-	1	1	4	-	-	-	-	-	1	-	9	1	-	-	1	21	0.05	94.91	8
AR	*Asteropella slatteryi*	-	-	-	-	-	-	-	-	1	-	1	10	4	2	-	-	2	1	21	0.05	94.96	7
AN	*Paraprionospio pinnata*	1	1	1	1	1	1	-	-	4	3	-	-	2	4	1	-	-	-	20	0.05	95.01	11
AN	*Polyophthalmus pictus*	-	-	-	-	-	17	-	-	-	2	-	-	-	-	-	-	1	-	20	0.05	95.06	3
AN	*Scoletoma* sp	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	2	-	14	20	0.05	95.12	4
AN	*Eumida longicornuta*	-	-	-	-	-	-	-	-	-	-	-	11	1	2	-	4	-	1	19	0.05	95.17	5
AR	*Monocorophium* sp	-	-	-	-	-	-	-	-	-	-	-	17	-	1	-	-	1	-	19	0.05	95.21	3
AN	*Goniada maculata*	-	-	1	2	2	-	6	-	1	-	-	1	2	-	-	-	3	-	18	0.05	95.26	8
AN	*Hesionella mccullochae*	-	-	-	-	-	-	-	-	-	2	1	1	7	-	-	-	4	3	18	0.05	95.31	6
AR	*Anoplodactylus erectus*	-	-	-	-	-	-	-	-	-	-	-	-	18	-	-	-	-	-	18	0.05	95.35	1
AR	*Eohaustorius barnardi*	13	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	0.05	95.40	2
CN	*Edwardsia californica*	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	0.05	95.45	1
EC	Amphiuridae	-	-	-	-	-	-	-	-	7	-	-	-	-	1	1	2	2	5	18	0.05	95.50	6
AN	*Amaeana occidentalis*	3	1	-	-	-	-	6	-	-	1	5	-	-	-	-	-	-	1	17	0.04	95.54	6
AN	*Chone mollis*	1	-	-	-	-	-	1	2	-	-	-	-	1	-	7	2	-	3	17	0.04	95.58	7
AN	*Metasychis disparidentatus*	1	-	-	1	-	2	-	2	4	5	1	-	1	-	-	-	-	-	17	0.04	95.63	8
AR	*Eobrolgus spinosus*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	13	-	-	3	17	0.04	95.67	3
MO	*Rictaxis punctocaelatus*	1	1	-	1	-	-	-	-	-	3	2	-	3	2	1	-	3	-	17	0.04	95.72	9

Appendix G-5. (Cont.).

Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total	% Total	Cum. %	F.O.
AN	*Eupolymnia heterobranchia*	-	-	-	-	-	-	-	-	-	-	-	3	5	3	2	3	-	-	16	0.04	95.76	5
AN	*Heteropodarke heteromorpha*	-	6	1	3	-	-	-	-	3	-	-	-	-	-	-	-	1	1	15	0.04	95.80	6
AN	*Lumbrineris californiensis*	-	-	1	1	-	-	-	-	3	4	-	-	-	1	1	-	1	3	15	0.04	95.84	8
AN	*Sphaerephesia similisetis*	-	-	-	-	-	-	-	-	1	1	-	2	2	3	2	-	1	3	15	0.04	95.87	8
AR	*Aoroides* sp	-	-	-	-	-	-	-	-	3	-	10	-	1	-	-	-	1	-	15	0.04	95.91	4
CO	*Branchiostoma californiensis*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	14	15	0.04	95.95	2
EC	*Amphiodia digitata*	-	2	-	-	-	-	-	-	-	-	-	2	1	-	6	1	-	3	15	0.04	95.99	6
MO	*Neverita reclusiana*	-	-	-	2	1	-	-	-	-	-	-	-	10	2	-	-	-	-	15	0.04	96.03	4
NE	*Zygonemertes virescens*	-	-	-	-	-	-	-	-	-	-	-	-	-	12	2	1	-	-	15	0.04	96.07	3
AN	*Diopatra splendidissima*	-	-	2	-	-	-	-	1	-	-	3	-	5	2	-	-	-	1	14	0.04	96.11	6
AN	Euclymeninae sp A SCAMIT 1987	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	10	2	14	0.04	96.14	3
EC	*Amphiodia* sp	-	-	-	-	-	1	-	-	4	1	1	3	2	-	1	-	-	1	14	0.04	96.18	8
NE	*Carinomella lactea*	-	11	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	14	0.04	96.22	2
NE	*Cerebratulus californiensis*	-	-	-	8	-	2	2	-	-	-	-	2	-	-	-	-	-	-	14	0.04	96.25	4
SI	*Siphonosoma ingens*	-	-	-	-	-	-	-	-	3	-	-	-	4	4	-	-	-	3	14	0.04	96.29	4
AN	*Malmgreniella macginitiei*	1	1	1	1	-	-	-	2	-	-	-	1	-	5	1	-	-	-	13	0.03	96.32	8
AN	*Phyllodoce longipes*	-	-	-	-	-	-	-	-	1	-	-	-	5	5	-	2	-	-	13	0.03	96.36	4
AN	*Platynereis bicanalicalata*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	10	-	-	13	0.03	96.39	4
AN	*Rhynchospio glutaea*	-	-	-	-	-	-	-	1	-	-	-	-	-	-	2	10	-	-	13	0.03	96.42	3
AR	*Metatiron tropakis*	4	1	2	-	2	-	-	-	2	1	-	1	-	-	-	-	-	-	13	0.03	96.46	7
AR	*Nymphon* sp	-	-	3	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	13	0.03	96.49	2
AR	*Rhepoxynius homocuspidatus*	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	0.03	96.52	1
EC	Echinoidea	2	3	-	-	-	1	-	7	-	-	-	-	-	-	-	-	-	-	13	0.03	96.56	4
EC	*Leptosynapta* sp	2	-	-	-	-	-	1	2	2	-	-	1	1	4	-	-	-	-	13	0.03	96.59	7
PR	*Phoronopsis* sp	-	-	-	-	-	-	-	-	-	-	-	-	9	4	-	-	-	-	13	0.03	96.63	2
AN	*Nereis procera*	1	-	-	-	1	-	-	-	1	-	3	-	-	-	1	4	-	1	12	0.03	96.66	7
AR	*Americhelidium* sp	3	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	0.03	96.69	2
EC	*Amphiodia psara*	1	1	1	-	1	-	-	-	1	-	1	1	1	2	2	-	-	-	12	0.03	96.72	10
MO	*Crepidula naticarum*	-	-	1	2	-	-	-	-	2	-	2	-	5	-	-	-	-	-	12	0.03	96.75	5
MO	Mytilidae	-	-	-	5	-	-	-	-	-	1	-	-	-	-	2	-	4	-	12	0.03	96.78	4
AN	*Aphelochaeta glandaria*	-	-	-	-	-	-	-	-	-	2	1	3	-	-	1	-	3	1	11	0.03	96.81	6
AN	*Axiothella rubrocincta*	-	-	1	-	-	-	1	-	-	-	-	-	-	-	5	4	-	-	11	0.03	96.84	4
AN	*Boccardia* sp	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	0.03	96.87	1
AN	*Glycera* sp	2	2	-	3	-	2	-	1	-	-	-	-	-	1	-	-	-	-	11	0.03	96.90	6
AN	*Magelona* sp	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	0.03	96.92	1
AN	*Nephtys* sp	-	2	-	2	-	7	-	-	-	-	-	-	-	-	-	-	-	-	11	0.03	96.95	3
AN	*Polydora cornuta*	-	-	-	-	-	-	-	1	-	-	-	-	-	9	-	-	1	-	11	0.03	96.98	3
AN	*Polydora* sp	-	-	-	10	-	-	-	-	-	-	1	-	-	-	-	-	-	-	11	0.03	97.01	2
AR	*Tritella pilimana*	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	1	-	-	11	0.03	97.04	2
MO	*Leptopecten latiauratus*	-	-	-	-	1	-	-	-	-	-	5	2	2	1	-	-	-	-	11	0.03	97.07	5
MO	*Mactrotoma californica*	-	-	-	-	-	-	-	-	-	-	-	3	8	-	-	-	-	-	11	0.03	97.10	2
MO	*Nassarius* sp	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	0.03	97.13	1
NE	*Tetrastemma* sp A SCAMIT 1995	-	-	-	-	-	-	-	-	-	-	1	7	3	-	-	-	-	-	11	0.03	97.15	3
NE	*Tubulanus nothus*	-	-	-	-	-	-	-	-	-	1	-	2	1	-	5	-	-	2	11	0.03	97.18	5
PL	*Stylochoplana* sp	-	3	-	-	-	-	-	-	1	1	2	2	-	1	-	-	-	1	11	0.03	97.21	7
SI	*Apionsoma misakianum*	-	1	1	-	6	-	-	-	-	-	-	3	-	-	-	-	-	-	11	0.03	97.24	4
AN	*Glycera nana*	-	-	1	2	-	-	-	-	-	2	-	1	-	-	-	-	-	4	10	0.03	97.27	5
AN	*Magelona californica*	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	10	0.03	97.29	1
AR	*Exosphaeroma rhomburum*	-	-	-	-	-	-	-	-	3	-	-	-	1	-	5	1	-	-	10	0.03	97.32	4
AR	Gammaridea	1	1	-	-	1	6	-	-	1	-	-	-	-	-	-	-	-	-	10	0.03	97.34	5
AR	*Ischyrocerus anguipes*	-	1	-	-	-	-	-	-	-	-	-	-	-	2	7	-	-	-	10	0.03	97.37	3
AR	*Rudilemboides stenopropodus*	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	10	0.03	97.40	1
MO	*Macoma secta*	-	-	-	2	-	-	1	-	-	1	-	3	-	-	2	-	1	-	10	0.03	97.42	6
AN	Euclymeninae	-	-	-	-	1	6	1	1	-	-	-	-	-	-	-	-	-	-	9	0.02	97.44	4
AN	*Mediomastus californiensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	3	-	-	9	0.02	97.47	2
AR	*Atylus tridens*	1	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	1	-	9	0.02	97.49	3
AR	*Metamysidopsis elongata*	-	-	-	2	-	-	-	-	-	1	-	-	1	3	-	1	-	1	9	0.02	97.52	6
AR	*Photis californica*	-	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	5	9	0.02	97.54	3
EC	Ophiuroidea	1	1	1	-	-	2	-	-	4	-	-	-	-	-	-	-	-	-	9	0.02	97.56	5
MO	*Chione* sp	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	9	0.02	97.59	2
MO	*Pandora bilirata*	-	-	-	-	-	-	-	-	-	1	-	-	3	3	1	1	-	-	9	0.02	97.61	5
NE	*Micrura* sp	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	3	5	9	0.02	97.63	3
NE	*Tetrastemma candidum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	6	-	9	0.02	97.66	2
AN	*Chone albocincta*	-	-	-	-	1	-	-	-	4	3	-	-	-	-	-	-	-	-	8	0.02	97.68	3
AN	*Glycera americana*	-	-	-	-	1	2	-	-	-	2	-	-	-	-	-	3	-	-	8	0.02	97.70	4
AN	*Spiophanes berkeleyorum*	-	1	-	-	-	-	-	-	1	-	-	-	1	1	-	1	-	3	8	0.02	97.72	6
AN	*Sthenelais tertiaglabra*	-	-	-	-	-	-	-	-	-	1	4	-	-	-	-	1	-	2	8	0.02	97.74	4
AN	*Tenonia priops*	-	-	-	3	-	-	-	-	2	-	-	1	1	-	1	-	-	-	8	0.02	97.76	5
AR	*Cancer* sp	-	-	-	-	-	-	-	-	1	-	-	4	2	1	-	-	-	-	8	0.02	97.78	4
AR	*Joeropsis lobata*	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	8	0.02	97.80	1
CN	Hydrozoa	1	2	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	8	0.02	97.82	4
MO	*Balcis oldroydae*	2	3	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	1	8	0.02	97.84	5
MO	Bivalvia	-	2	-	-	1	1	-	1	2	-	-	-	-	-	1	-	-	-	8	0.02	97.86	6
MO	*Periploma discus*	-	5	-	-	-	-	-	-	-	2	-	-	-	-	-	-	1	-	8	0.02	97.88	3
MO	*Periploma planiusculum*	1	-	-	2	-	-	-	-	-	-	-	-	1	3	-	-	-	1	8	0.02	97.90	5

Appendix G-5. (Cont.).

Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total	% Total	Cum. %	F.O.
AN	*Mediomastus ambiseta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	5	7	0.02	97.92	2
AN	*Pista elongata*	-	-	-	-	-	-	-	-	-	-	-	1	-	3	3	-	-	-	7	0.02	97.94	3
AN	*Sphaerosyllis californiensis*	-	-	-	-	-	-	-	-	-	-	1	-	4	-	-	2	-	-	7	0.02	97.96	3
AR	*Argissa hamatipes*	2	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-	1	-	7	0.02	97.98	4
AR	*Parasterope hulingsi*	-	-	-	-	-	-	-	-	-	-	-	-	2	1	1	-	2	1	7	0.02	98.00	5
CN	Anthozoa	-	2	1	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	7	0.02	98.01	4
MO	*Caecum crebricinctum*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	6	7	0.02	98.03	2
MO	*Macoma yoldiformis*	-	1	1	2	-	-	-	-	1	-	-	-	1	1	-	-	-	-	7	0.02	98.05	6
AN	*Brania brevipharyngea*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	6	0.02	98.07	1
AN	*Halosydna johnsoni*	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	3	-	-	6	0.02	98.08	3
AN	*Heteromastus* sp	-	-	1	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	6	0.02	98.10	2
AN	*Nereiphylla castanea*	-	-	-	-	-	-	-	-	1	-	-	4	-	-	-	-	-	1	6	0.02	98.11	3
AN	*Onuphis* sp	-	-	-	3	-	-	-	1	-	-	-	-	-	-	-	-	-	2	6	0.02	98.13	3
AR	*Callipallene californiensis*	4	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	6	0.02	98.14	2
AR	*Cancer antennarius*	-	-	-	-	-	-	-	-	-	1	-	-	1	2	-	1	-	1	6	0.02	98.16	5
AR	*Lepidepecreum serraculum*	-	-	-	-	1	-	-	-	1	-	-	-	3	1	-	-	-	-	6	0.02	98.18	4
AR	*Leptocuma forsmani*	-	-	-	-	2	-	-	-	1	-	-	3	-	-	-	-	-	-	6	0.02	98.19	3
AR	*Stenothoe valida*	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	6	0.02	98.21	1
MO	*Acteocina culcitella*	-	-	1	-	-	-	1	-	1	-	-	-	-	3	-	-	-	-	6	0.02	98.22	4
MO	*Ennucula tenuis*	-	-	-	-	-	-	-	-	-	2	1	-	-	3	-	-	-	-	6	0.02	98.24	3
MO	*Mytilus* sp	-	-	-	5	-	-	-	-	-	-	-	1	-	-	-	-	-	-	6	0.02	98.25	2
MO	*Solen sicarius*	-	-	-	-	-	1	-	1	-	-	2	-	-	-	1	-	-	1	6	0.02	98.27	5
NE	*Tetrastemma nigrifrons*	-	-	-	-	-	-	-	-	-	2	-	-	-	2	2	-	-	-	6	0.02	98.28	3
PL	Platyhelminthes	4	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	6	0.02	98.30	2
SI	Sipuncula	1	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	-	6	0.02	98.32	4
AN	*Arabella endonata*	-	-	-	-	1	-	-	-	2	-	-	-	1	-	-	-	1	-	5	0.01	98.33	4
AN	*Dipolydora bidentata*	-	-	-	-	1	-	-	-	3	-	-	-	1	-	-	-	-	-	5	0.01	98.34	3
AN	*Dipolydora socialis*	-	-	-	1	-	-	-	-	-	-	-	-	-	4	-	-	-	-	5	0.01	98.35	2
AN	*Eteone balboensis*	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	0.01	98.37	3
AN	*Eteone* sp	-	-	-	2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	5	0.01	98.38	2
AN	*Lumbrineris japonica*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	3	-	5	0.01	98.39	3
AN	*Protodorvillea gracilis*	-	-	-	3	-	1	-	-	-	-	-	-	-	-	-	-	-	1	5	0.01	98.41	3
AN	Syllidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	4	5	0.01	98.42	2
AR	Calanoida	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	0.01	98.43	1
AR	*Caprella californica*	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	5	0.01	98.45	1
AR	*Eochelidium* sp A SCAMIT 1996	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	5	0.01	98.46	1
AR	*Eohaustorius sawyeri*	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	5	0.01	98.47	1
AR	*Laticorophium baconi*	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	2	1	5	0.01	98.48	4
AR	*Lepidopa californica*	-	1	2	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	5	0.01	98.50	4
AR	*Listriella melanica*	-	-	-	1	-	-	-	-	-	-	-	1	-	1	-	-	1	1	5	0.01	98.51	5
AR	*Mandibulophoxus gilesi*	1	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	1	-	5	0.01	98.52	5
AR	*Paracercels* sp	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	5	0.01	98.54	1
AR	*Pinnixa* sp	2	1	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	5	0.01	98.55	4
AR	*Randallia ornata*	-	-	1	-	3	-	-	-	-	-	-	1	-	-	-	-	-	-	5	0.01	98.56	3
AR	*Rhepoxynius* sp H	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	5	0.01	98.58	1
MO	*Crepidula norrisiarum*	-	-	-	-	-	-	-	-	-	-	-	3	-	1	1	-	-	-	5	0.01	98.59	3
MO	*Crepidula* sp	-	-	-	-	1	-	-	-	-	-	-	-	-	4	-	-	-	-	5	0.01	98.60	2
MO	*Macoma nasuta*	-	-	-	3	-	-	-	-	-	-	2	-	-	-	-	-	-	-	5	0.01	98.61	2
MO	*Tellina bodegensis*	1	-	-	-	-	-	-	-	1	-	-	1	1	1	-	-	-	-	5	0.01	98.63	5
PL	*Imogine exiguus*	-	-	-	-	-	-	-	-	3	1	1	-	-	-	-	-	-	-	5	0.01	98.64	3
PL	*Stylochoplana longipenis*	-	-	-	-	-	-	-	-	1	-	-	-	2	-	2	-	-	-	5	0.01	98.65	3
SI	*Thysanocardia nigra*	-	-	-	-	-	-	-	-	2	-	-	1	2	-	-	-	-	-	5	0.01	98.67	3
AN	*Cirriformia spirabrancha*	-	-	1	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	4	0.01	98.68	4
AN	*Exogone uniformis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	4	0.01	98.69	1
AN	Polychaeta	-	-	-	-	-	-	-	1	1	-	-	-	-	2	-	-	-	-	4	0.01	98.70	3
AN	*Polycirrus* sp	-	-	1	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	4	0.01	98.71	3
AN	*Sabellaria gracilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	1	-	4	0.01	98.72	2
AR	*Balanus* sp	-	-	1	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	4	0.01	98.73	3
AR	*Caprella mendax*	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	4	0.01	98.74	1
AR	*Euphilomedes* sp	-	-	-	-	1	3	-	-	-	-	-	-	-	-	-	-	-	-	4	0.01	98.75	2
AR	*Gnathopleustes serratus*	-	-	-	-	-	2	-	-	2	-	-	-	-	-	-	-	-	-	4	0.01	98.76	2
AR	*Joeropsis dubia*	-	-	-	-	-	-	-	-	1	-	-	-	1	1	1	-	-	-	4	0.01	98.77	4
AR	*Munnogonium tillerae*	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	4	0.01	98.78	1
AR	*Neomysis kadiakensis*	-	-	-	-	-	-	-	-	1	-	-	2	-	-	-	-	-	1	4	0.01	98.79	3
AR	*Neotrypaea californiensis*	-	-	1	2	-	-	-	-	-	-	-	-	-	1	-	-	-	-	4	0.01	98.80	3
AR	*Pinnixa longipes*	-	-	-	-	-	1	-	-	-	-	-	1	-	-	2	-	-	-	4	0.01	98.81	3
AR	*Pyromaia tuberculata*	-	-	-	-	-	-	-	-	-	-	-	1	3	-	-	-	-	-	4	0.01	98.82	2
CN	*Edwardsia* sp G MEC 1992	-	1	-	1	1	-	-	-	1	-	-	-	-	-	-	-	-	-	4	0.01	98.83	4
CN	Edwardsiidae	-	1	1	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	4	0.01	98.84	4
EC	*Lovenia cordiformis*	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.01	98.85	1
MO	*Cadulus aberrans*	-	-	-	-	-	-	-	-	-	1	-	-	1	1	-	-	-	1	4	0.01	98.86	4
MO	*Epitonium sawinae*	-	-	-	-	-	-	-	-	1	1	-	-	2	-	-	-	-	-	4	0.01	98.87	3
MO	*Kellia suborbicularis*	1	-	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	4	0.01	98.88	3
MO	*Kurtziella plumbea*	-	-	-	1	1	-	-	-	1	-	-	-	1	-	-	-	-	-	4	0.01	98.90	4
MO	*Mytilus galloprovincialis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	4	0.01	98.91	1

Appendix G-5. (Cont.).

Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total	% Total	Cum. %	F.O.
MO	*Odostomia* sp D MBC 1980	-	-	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	-	4	0.01	98.92	2
MO	*Rhamphidonta retifera*	-	-	-	-	-	-	-	-	-	-	-	2	1	1	-	-	-	-	4	0.01	98.93	3
NE	*Micrura alaskensis*	-	1	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.01	98.94	3
PL	*Cryptocelis occidentalis*	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	0.01	98.95	1
AN	*Ancistrosyllis hamata*	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	1	3	0.01	98.96	3
AN	*Aphelochaeta monilaris*	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	3	0.01	98.96	2
AN	*Arabella iricolor*	-	-	-	2	-	-	-	-	-	-	-	-	-	1	-	-	-	-	3	0.01	98.97	2
AN	*Chaetozone armata*	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-	-	3	0.01	98.98	2
AN	*Chaetozone corona*	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1	-	3	0.01	98.99	3
AN	*Eteone fauchaldi*	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	3	0.01	98.99	3
AN	*Harmothoe* sp	-	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	3	0.01	99.00	2
AN	*Hesionura coineaui difficilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	0.01	99.01	1
AN	*Heterospio catalinensis*	1	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	3	0.01	99.02	2
AN	*Mooreonuphis stigmatis*	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	3	0.01	99.03	1
AN	*Paleanotus bellis*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	1	-	-	-	3	0.01	99.03	2
AN	*Polydora limicola*	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	3	0.01	99.04	1
AN	*Prionospio (Prionospio) heterobranchia*	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	1	-	-	3	0.01	99.05	3
AN	*Prionospio (Prionospio) jubata*	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	3	0.01	99.06	3
AN	*Scolelepis squamata*	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3	0.01	99.06	1
AN	*Scoloplos* sp	-	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.01	99.07	2
AR	*Acuminodeutopus heteruropus*	-	-	-	-	-	-	-	-	1	1	-	-	-	-	1	-	-	-	3	0.01	99.08	3
AR	*Blepharipoda occidentalis*	-	-	-	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	3	0.01	99.09	3
AR	Mysidacea	2	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	3	0.01	99.10	2
AR	*Nebalia daytoni*	-	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-	3	0.01	99.10	2
AR	*Nebalia pugettensis* Cmplx	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.01	99.11	2
AR	*Ogyrides* sp A Roney 1978	-	-	-	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-	3	0.01	99.12	2
AR	*Pachygapsus crassipes*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3	0.01	99.13	1
AR	*Pinnixa franciscana*	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-	3	0.01	99.13	2
AR	*Postasterope barnesi*	-	-	-	-	1	-	-	-	-	2	-	-	-	-	-	-	-	-	3	0.01	99.14	2
AR	Pycnogonida	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.01	99.15	2
AR	*Xenoleberis californica*	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.01	99.16	2
CN	*Renilla kollikeri*	-	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-	-	-	3	0.01	99.17	2
EC	*Amphipholus squamata*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	3	0.01	99.17	2
EC	Holothuroidea	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	3	0.01	99.18	1
MO	*Donax gouldii*	-	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	3	0.01	99.19	2
MO	*Doto amyra*	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	3	0.01	99.20	1
MO	*Hiatella arctica*	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	1	-	-	3	0.01	99.20	3
MO	*Lyonsia californica*	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	3	0.01	99.21	2
MO	Mactridae	-	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.01	99.22	2
MO	*Modiolus rectus*	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	3	0.01	99.23	1
MO	*Odostomia* sp	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-	-	3	0.01	99.24	2
MO	*Saxidomus nuttalli*	-	-	-	1	-	-	-	-	-	1	-	-	1	-	-	-	-	-	3	0.01	99.24	3
MO	*Turbonilla* sp	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.01	99.25	1
NE	*Anopla* sp D SCAMIT 1995	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	3	0.01	99.26	1
PL	*Notoplana* sp	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	1	-	3	0.01	99.27	3
AN	*Amastigos acutus*	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.27	1
AN	*Aricidea (Aedicira) pacifica*	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.28	1
AN	*Carazziella* sp	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.28	1
AN	*Chone minuta*	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	2	0.01	99.29	2
AN	*Chone* sp	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.29	1
AN	*Decamastus gracilis*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	0.01	99.30	2
AN	*Diopatra* sp	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	2	0.01	99.30	2
AN	*Dipolydora* sp	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	2	0.01	99.31	2
AN	*Eranno lagunae*	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	0.01	99.31	1
AN	*Eulalia quadrioculata*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	2	0.01	99.32	2
AN	*Eusyllis blomstrandi*	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2	0.01	99.32	1
AN	*Glycinde polygnatha*	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.33	1
AN	*Glycinde* sp	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.33	1
AN	*Goniada brunnea*	-	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	2	0.01	99.34	2
AN	*Hydroides uncinatus*	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	0.01	99.34	1
AN	*Laonice cirrata*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-	-	2	0.01	99.35	2
AN	*Loimia* sp A SCAMIT 2001	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	2	0.01	99.36	2
AN	*Micropodarke dubia*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2	0.01	99.36	1
AN	*Nephtys californiensis*	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	2	0.01	99.37	2
AN	Nereididae	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	2	0.01	99.37	2
AN	*Nereis* sp	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	0.01	99.38	2
AN	*Notomastus latescens*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2	0.01	99.38	1
AN	*Onuphis eremita parva*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2	0.01	99.39	1
AN	*Ophelia assimilis*	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.39	1
AN	*Poecilochaetus johnsoni*	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	0.01	99.40	2
AN	*Polydora nuchalis*	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2	0.01	99.40	1
AN	*Praxillella pacifica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2	0.01	99.41	1
AN	*Sphaerodoropsis sphaerulifer*	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	0.01	99.41	1
AR	*Ammothea hilgendorfi*	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.42	1
AR	*Aoroides exilis*	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2	0.01	99.42	1

Appendix G-5. (Cont.).

Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total	% Total	Cum. %	F.O.
		Year																					
AR	Brachyura (Megalopa)	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	2	0.01	99.43	2
AR	*Cancer gracilis*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	2	0.01	99.43	2
AR	Cumacea	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-	2	0.01	99.44	2
AR	*Haliophasma geminatum*	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	2	0.01	99.44	2
AR	*Heterocrypta occidentalis*	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	2	0.01	99.45	1
AR	*Lepidepecreum gurjanovae*	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.45	2
AR	*Mysidopsis intii*	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	2	0.01	99.46	2
AR	Oedicerotidae	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.46	1
AR	*Pachynus barnardi*	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2	0.01	99.47	1
AR	Peltidiidae	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	2	0.01	99.47	2
AR	Pinnotheridae	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.48	2
AR	*Zeuxo normani*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2	0.01	99.49	1
EC	*Amphiura arcystata*	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	0.01	99.49	1
EC	*Astropecten verrilli*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	2	0.01	99.50	2
EC	*Ophiothrix spiculata*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	2	0.01	99.50	2
EH	*Arynchite californica*	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.51	1
MO	*Alia carinata*	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2	0.01	99.51	1
MO	*Emarcusia morroensis*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.52	1
MO	*Epitonium* sp	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2	0.01	99.52	1
MO	Facelinidae	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	0.01	99.53	1
MO	Gastropoda	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2	0.01	99.53	2
MO	*Nuculana taphria*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-	2	0.01	99.54	2
MO	*Odostomia farella*	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.54	1
MO	*Parvilucina tenuisculpta*	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	2	0.01	99.55	2
MO	*Petricola* sp	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	2	0.01	99.55	1
MO	*Philine bakeri*	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2	0.01	99.56	1
MO	*Tellina nuculoides*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-	2	0.01	99.56	2
MO	*Tellina* sp B SCAMIT 1995	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2	0.01	99.57	1
MO	*Vitrinella oldroydi*	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	2	0.01	99.57	2
MO	*Volvulella cylindrica*	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.58	2
NE	*Cerebratulus* sp	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	2	0.01	99.58	2
NE	*Hoplonemertea* sp A Paquette 1988	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	2	0.01	99.59	2
NE	*Tubulanus frenatus*	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	0.01	99.59	1
NE	*Tubulanus* sp	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2	0.01	99.60	1
PL	*Kaburakia excelsa*	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.01	99.60	1
PL	*Pseudoceros* sp	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	2	0.01	99.61	2
AN	Amphinomidae	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.61	1
AN	*Ancistrosyllis groenlandica*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.62	1
AN	Annelida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00	99.62	1
AN	*Aricidea (Allia)* sp A SCAMIT 1996	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00	99.62	1
AN	*Aricidea (Aricidea) wassi*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00	99.62	1
AN	*Bispira volutacornis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00	99.63	1
AN	*Caulleriella alata*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00	99.63	1
AN	*Caulleriella bioculata*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.63	1
AN	*Caulleriella* sp	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00	99.63	1
AN	*Chaetozone hartmanae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00	99.64	1
AN	*Cossura* sp A Phillips 1987	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.00	99.64	1
AN	*Demonax* sp 1 Fitzhugh	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00	99.64	1
AN	*Dorvillea (Schistomeringos) annulata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00	99.64	1
AN	Dorvilleidae	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.65	1
AN	*Drilonereis nuda*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00	99.65	1
AN	*Drilonereis* sp	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.65	1
AN	*Ephesiella brevicapitis*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00	99.65	1
AN	*Eteone brigitteae*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00	99.66	1
AN	*Eteone californica*	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.00	99.66	1
AN	*Eteone dilatae*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.66	1
AN	*Eteone lighti*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.66	1
AN	*Eusyllis* sp	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00	99.67	1
AN	*Exogone dwisula*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.67	1
AN	Flabelligeridae	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.67	1
AN	*Goniada* sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00	99.68	1
AN	*Gyptis* sp	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.68	1
AN	*Halosydna brevisetosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00	99.68	1
AN	*Levinsenia gracilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00	99.68	1
AN	Lumbrineridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00	99.69	1
AN	*Lumbrineris cruzensis*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.69	1
AN	*Magelona hartmanae*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.69	1
AN	*Malmgreniella scriptoria*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.69	1
AN	*Megalomma pigmentum*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00	99.70	1
AN	*Monticellina serratiseta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00	99.70	1
AN	*Naineris dendritica*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.70	1
AN	*Nicomache* sp	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.70	1
AN	*Notocirrus californiensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00	99.71	1
AN	*Notomastus* sp A SCAMIT 2001	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00	99.71	1
AN	Oenonidae	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.71	1

Appendix G-5. (Cont.).

Phy	Species	1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total	% Total	Cum. %	F.O.
AN	Oligochaeta	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00	99.71	1
AN	*Ophiodromus pugettensis*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00	99.72	1
AN	*Ophryotrocha* sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.00	99.72	1
AN	*Paranaitis polynoides*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00	99.72	1
AN	*Parandalia ocularis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00	99.72	1
AN	*Pareurythoe californica*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00	99.73	1
AN	*Pherusa neopapillata*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.73	1
AN	*Phyllochaetopterus prolifica*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00	99.73	1
AN	*Phyllodoce groenlandica*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00	99.73	1
AN	*Phyllodoce pettiboneae*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00	99.74	1
AN	*Polycirrus californicus*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00	99.74	1
AN	*Polycirrus* sp 1 Banse 1980	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00	99.74	1
AN	*Polycirrus* sp A SCAMIT 1995	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00	99.75	1
AN	Polynoidae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00	99.75	1
AN	*Schistocomus* sp A SCAMIT 1987	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00	99.75	1
AN	*Scolelepis tridentata*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00	99.75	1
AN	*Scoletoma* sp A (Harris 1985)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00	99.76	1
AN	*Scoloplos acmeceps*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.76	1
AN	Sigalionidae	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.76	1
AN	Sphaerodoridae	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.76	1
AN	*Sphaerosyllis brandhorsti*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00	99.77	1
AN	Spionidae	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.77	1
AN	*Spiophanes* sp	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.77	1
AN	*Sthenelais* sp	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.77	1
AN	*Syllis (Syllis) gracilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00	99.78	1
AN	*Syllis (Typosyllis) pulchra*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00	99.78	1
AN	*Syllis (Typosyllis)* sp	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.78	1
AN	Terebellidae	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.00	99.78	1
AN	*Travisia gigas*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.79	1
AN	*Ysideria hastata*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.79	1
AR	*Acetabulastoma californica*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.79	1
•AR	*Alpheus clamator*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00	99.79	1
AR	*Ampelisca cristata cristata*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.80	1
AR	Ampeliscidae	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.80	1
AR	*Araphura cuspirostris*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.80	1
AR	Arthropoda	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.81	1
AR	*Balanus nubilus*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.81	1
AR	*Cancer jordani*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.81	1
AR	*Cancer productus*	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.81	1
AR	*Cumella* sp	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.82	1
AR	*Cumella* sp K MBC 1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.00	99.82	1
AR	*Cyclaspis* sp B SCAMIT 1989	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.82	1
AR	*Cyprideis stewarti*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00	99.82	1
AR	*Diastylis* sp	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.83	1
AR	*Emerita analoga*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00	99.83	1
AR	*Eohaustorius* sp	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.83	1
AR	Eusiridae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00	99.83	1
AR	*Exacanthomysis davisi*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00	99.84	1
AR	Flabellifera	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.84	1
AR	*Gnathia crenulatifrons*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.84	1
AR	Harpacticoida	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00	99.84	1
AR	*Heteroserolis carinata*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.85	1
AR	*Incisocalliope bairdi*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00	99.85	1
AR	*Listriella diffusa*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.85	1
AR	*Listriella eriopisa*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00	99.85	1
AR	Lysianassidae	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.00	99.86	1
AR	Natantia	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	0.00	99.86	1
AR	*Opisthopus transversus*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.86	1
AR	Ostracoda	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.86	1
AR	Paguridae	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.87	1
AR	*Photis* sp A MBC 1972	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.87	1
AR	*Photis* sp OC1 Diener 1992	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00	99.87	1
AR	*Pinnixa tubicola*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.88	1
AR	*Portunus xantusii*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00	99.88	1
AR	*Rhepoxynius heterocuspidatus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00	99.88	1
CN	*Actinaria* sp A MBC 2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00	99.88	1
CN	Pennatulacea	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00	99.89	1
CN	*Stylatula elongata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.00	99.89	1
EC	*Cucumaria piperata*	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.89	1
EC	*Pentamera populifera*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.89	1
EN	Loxosomatidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00	99.90	1
EP	*Antropora tincta*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00	99.90	1
EP	*Bowerbankia gracilis*	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	0.00	99.90	1
EP	*Caulibugula ciliata*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00	99.90	1
EP	*Celleporella hyalina*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00	99.91	1

Appendix G-5. (Cont.).

Phy	Species	Year 1978	1980	1986	1988	1990	1991	1992	1993	1994	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total	% Total	Cum. %	F.O.
EP	*Cryptoarachnidium argilla*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.91	1
EP	*Farrelia elongata*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.91	1
MO	*Acteocina harpa*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00	99.91	1
MO	*Acteocina inculta*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.92	1
MO	*Aglaja ocelligera*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.92	1
MO	*Amiantis callosa*	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.92	1
MO	Chamidae	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.92	1
MO	*Chione undatella*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00	99.93	1
MO	*Diplodonta sericata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	0.00	99.93	1
MO	*Ensis myrae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00	99.93	1
MO	*Halistylis pupoideus*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.94	1
MO	*Hermissenda crassicornis*	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00	99.94	1
MO	*Leporimetis obesa*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00	99.94	1
MO	*Lithophaga plumula*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00	99.94	1
MO	*Lucinoma annulata*	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.95	1
MO	*Macoma carlottensis*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00	99.95	1
MO	*Macoma indentata*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	0.00	99.95	1
MO	*Modiolus neglectus*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.95	1
MO	*Odostomia columbiana*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.96	1
MO	*Odostomia tenuisculpta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00	99.96	1
MO	*Ophiodermella cancellata*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.96	1
MO	*Polinices* sp	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.96	1
MO	*Polygireulima rutila*	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.97	1
MO	Pseudodorididae	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00	99.97	1
MO	*Rochefortia compressa*	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.97	1
MO	*Simomactra planulata*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00	99.97	1
MO	*Sphenia fragilis*	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	0.00	99.98	1
MO	*Sphenia luticola*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.98	1
MO	*Tellina idae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00	99.98	1
MO	*Turbonilla santarosana*	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	0.00	99.98	1
MO	*Turbonilla* sp L MBC 1975	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.99	1
MO	*Yoldia seminuda*	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	99.99	1
NE	*Monostylifera* sp SD 1 Pt. Loma 1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	0.00	99.99	1
NE	*Tetrastemma signifer*	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	99.99	1
NE	*Tetrastemma* sp	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1	0.00	99.97	1
SI	*Sipunculus nudus*	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	0.00	99.98	1
	Number of individuals	993	1267	576	1717	878	1238	312	244	933	10393	781	3373	7829	3311	1187	1095	1381	963	38471			
	Number of species	109	144	92	140	129	100	61	60	149	124	91	162	206	174	152	114	119	133	561			
	Diversity (H')	3.37	3.92	3.17	3.41	4.00	2.91	3.51	3.52	3.97	0.99	3.11	3.45	2.94	3.28	4.19	3.28	3.60	3.98	3.77			
	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				
	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				

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 H

Fish and macroinvertebrate heat treatment and normal operation data

Appendix H-1. Master species list of fish and macroinvertebrate species impinged during heat treatments and normal operations. Ormond Beach Generating Station NPDES, 2005.

PHYLUM / Class / Family / Species	Common Name
ARTHROPODA	
Malacostraca	
Cancridae	
Cancer antennarius	Pacific rock crab
Cancer gracilis	graceful crab
Cancer jordani	hairy rock crab
Cancer productus	red rock crab
Crangonidae	
Crangon nigromaculata	blackspotted bay shrimp
Grapsidae	
Pachygrapsus crassipes	striped shore crab
Hippolytidae	
Lysmata californica	red rock shrimp
Majidae	
Loxorhynchus crispatus	moss crab
Loxorhynchus grandis	sheep crab
Pugettia producta	northern kelp 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 sp	sea star unid
Holothuroidea	
Caudinidae	
Caudina arenicola	sweet potatoe sea cucumber
ECHIURA	
Echiuridea	
Urechidae	
Urechis caupo	innkeeper worm
MOLLUSCA	
Cephalopoda	
Loliginidae	
Loligo opalescens	California market squid
Octopodidae	
Octopus bimaculatus/bimaculoide	two-spot octopus
Gastropoda	
Fissurellidae	
Megathura crenulata	giant keyhole limpet
CHORDATA	
Chondrichthyes	
Triakidae	
Mustelus californicus	grey smoothhound
Triakis semifasciata	leopard shark
Chimaeridae	
Hydrolagus colliei	spotted ratfish
Heterodontidae	
Heterodontus francisci	horn shark
Myliobatidae	
Myliobatis californica	bat ray
Platyrhinidae	
Platyrhinoidis triseriata	thornback
Torpedinidae	
Torpedo californica	Pacific electric ray
Urolophidae	
Urobatis halleri	round stingray

PHYLUM / Class / Family / Species	Common Name
CHORDATA (Cont.)	
Actinopterygii	
Atherinopsidae	
Atherinopsis californiensis	jacksmelt
Batrachoididae	
Porichthys myriaster	specklefin midshipman
Blennidae	
Hypsoblennius gentilis	bay blenny
Carangidae	
Trachurus symmetricus	jack mackerel
Clupeidae	
Sardinops sagax	Pacific sardine
Cottidae	
Leptocottus armatus	staghorn sculpin
Scorpaenichthys marmoratus	cabezon
Cynoglossidae	
Symphurus atricaudus	California tonguefish
Embiotocidae	
Amphistichus argenteus	barred surfperch
Cymatogaster aggregata	shiner perch
Embiotoca jacksoni	black perch
Hyperprosopon argenteum	walleye surfperch
Hypsurus caryi	rainbow seaperch
Phanerodon furcatus	white seaperch
Rhacochilus toxotes	rubberlip seaperch
Rhacochilus vacca	pile perch
Engraulidae	
Engraulis mordax	northern anchovy
Hexagrammidae	
Hexagrammos decagrammus	kelp greenling
Labridae	
Oxyjulis californica	senorita
Ophichthidae	
Ophichthus triserialis	Pacific snake eel
Ophididae	
Chilara taylori	spotted cusk-eel
Ophidion scrippsae	basketweave cusk-eel
Paralichthyidae	
Citharichthys stigmaeus	speckled sanddab
Pleuronectidae	
Pleuronichthys ritteri	spotted turbot
Pleuronichthys verticalis	hornyhead turbot
Pomacentridae	
Chromis punctipinnis	blacksmith
Sciaenidae	
Cheilotrema saturnum	black croaker
Seriphus politus	queenfish
Umbrina roncador	yellowfin croaker
Scombridae	
Scomber japonicus	Pacific chub mackerel
Scorpaenidae	
Scorpaena guttata	California scorpionfish
Sebastes auriculatus	brown rockfish
Sebastes melanops	black rockfish
Sebastes paucispinis	bocaccio
Serranidae	
Paralabrax clathratus	kelp bass
Paralabrax nebulifer	barred sand bass
Stromateidae	
Peprilus simillimus	Pacific pompano
Syngnathidae	
Syngnathus leptorhynchus	bay pipefish
Synodontidae	
Synodus lucioceps	California lizardfish

Appendix H-2. Abundance of fish impinged during heat treatments and normal operations between 1 October 2004 and 30 September 2005. Ormond Beach Generating Station NPDES, 2005.

Species	Heat Treatment	Monitored Normal Operations	Estimated Normal Operations *	Total Abundance	Percent Total
Cymatogaster aggregata	1,092	74	1,624	2,716	43.7
Seriphus politus	645	12	237	882	14.2
Engraulis mordax	219	5	207	426	6.9
Syngnathus leptorhynchus	1	19	298	299	4.8
Phanerodon furcatus	161	4	68	229	3.7
Sardinops sagax	28	9	128	156	2.5
Hyperprosopon argenteum	143	-	-	143	2.3
Porichthys myriaster	-	6	119	119	1.9
Amphistichus argenteus	24	2	94	118	1.9
Synodus lucioceps	-	6	106	106	1.7
Torpedo californica	-	3	83	83	1.3
Scorpaenichthys marmoratus	23	2	59	82	1.3
Umbrina roncador	76	-	-	76	1.2
Sebastes auriculatus	72	-	-	72	1.2
Leptocottus armatus	-	4	68	68	1.1
Trachurus symmetricus	22	2	38	60	1.0
Heterodontus francisci	-	2	59	59	0.9
Pleuronichthys ritteri	-	1	47	47	0.8
Symphurus atricaudus	-	1	47	47	0.8
Rhacochilus toxotes	38	-	-	38	0.6
Platyrhinoidis triseriata	-	3	37	37	0.6
Hypsurus caryi	35	-	-	35	0.6
Sebastes paucispinis	-	2	31	31	0.5
Peprilus simillimus	30	-	-	30	0.5
Myliobatis californica	-	2	24	24	0.4
Chilara taylori	-	1	23	23	0.4
Scorpaena guttata	-	1	23	23	0.4
Paralabrax nebulifer	22	-	-	22	0.4
Embiotoca jacksoni	20	-	-	20	0.3
Pleuronichthys verticalis	-	1	13	13	0.2
Hydrolagus colliei	-	1	12	12	0.2
Mustelus californicus	-	1	12	12	0.2
Ophidion scrippsae	-	1	12	12	0.2
Triakis semifasciata	-	1	12	12	0.2
Cheilotrema saturnum	11	-	-	11	0.2
Paralabrax clathratus	11	-	-	11	0.2
Hexagrammos decagrammus	10	-	-	10	0.2
Atherinopsis californiensis	8	-	-	8	0.1
Oxyjulis californica	7	-	-	7	0.1
Rhacochilus vacca	5	-	-	5	0.1
Chromis punctipinnis	4	-	-	4	0.1
Hypsoblennius gentilis	3	-	-	3	0.0
Scomber japonicus	3	-	-	3	0.0
Ophichthus triserialis	1	-	-	1	0.0
Sebastes melanops	1	-	-	1	0.0
Citharichthys stigmaeus	-	1	19	19	0.3
Urobatis halleri	1	-	-	1	0.0
Survey totals	2,716	167	3,500	6,216	
Number of species	29	27	27	47	

*Estimated annual abundance derived by multiplying mean daily CPUE by total reported annual flow (88,502.561 mg) for monitor
Note: 0.0 = <0.05.

Appendix H-3. Abundance of fish impinged during heat treatments. Ormond Beach Generating Station NPDES, 2005.

Species	2005 Aug 10	Total	Percent Total	Cum. Percent
Cymatogaster aggregata	1,092	1,092	40.2	40.2
Seriphus politus	645	645	23.7	64.0
Engraulis mordax	219	219	8.1	72.0
Phanerodon furcatus	161	161	5.9	77.9
Hyperprosopon argenteum	143	143	5.3	83.2
Umbrina roncador	76	76	2.8	86.0
Sebastes auriculatus	72	72	2.7	88.7
Rhacochilus toxotes	38	38	1.4	90.1
Hypsurus caryi	35	35	1.3	91.3
Peprilus simillimus	30	30	1.1	92.5
Sardinops sagax	28	28	1.0	93.5
Amphistichus argenteus	24	24	0.9	94.4
Scorpaenichthys marmoratus	23	23	0.8	95.2
Paralabrax nebulifer	22	22	0.8	96.0
Trachurus symmetricus	22	22	0.8	96.8
Embiotoca jacksoni	20	20	0.7	97.6
Cheilotrema saturnum	11	11	0.4	98.0
Paralabrax clathratus	11	11	0.4	98.4
Hexagrammos decagrammus	10	10	0.4	98.7
Atherinopsis californiensis	8	8	0.3	99.0
Oxyjulis californica	7	7	0.3	99.3
Rhacochilus vacca	5	5	0.2	99.5
Chromis punctipinnis	4	4	0.1	99.6
Hypsoblennius gentilis	3	3	0.1	99.7
Scomber japonicus	3	3	0.1	99.9
Ophichthus triserialis	1	1	0.0	99.9
Sebastes melanops	1	1	0.0	99.9
Syngnathus leptorhynchus	1	1	0.0	100.0
Urobatis halleri	1	1	0.0	100.0
Number of individuals	2,716	2,716		
Number of species	29	29		

Appendix H-4. Abundance of fish impinged during normal operations by month. Ormond Beach Generating Station NPDES. 2005.

	2004			2005										
Species	16 Oct	30 Nov	14 Dec	5 Jan	19 Feb	20 Mar	21 May	29 Jul	3 Aug	7 Sep	29 Sep	Total	% Total	Cum. %
Cymatogaster aggregata	-	3	-	-	9	-	-	-	5	1	56	74	44.31	44.3
Syngnathus leptorhynchus	6	-	-	-	-	-	-	1	2	-	10	19	11.38	55.7
Seriphus politus	4	-	-	5	-	1	-	1	1	-	-	12	7.19	62.9
Sardinops sagax	6	1	-	-	-	-	1	-	-	-	1	9	5.39	68.3
Porichthys myriaster	-	-	1	-	-	-	-	3	1	1	-	6	3.59	71.9
Synodus lucioceps	-	-	-	-	-	-	-	-	1	-	5	6	3.59	75.4
Engraulis mordax	-	-	-	-	-	-	-	-	-	4	1	5	2.99	78.4
Leptocottus armatus	-	2	-	1	-	-	-	-	-	-	1	4	2.40	80.8
Phanerodon furcatus	-	-	-	-	-	-	-	-	1	-	3	4	2.40	83.2
Platyrhinoidis triseriata	3	-	-	-	-	-	-	-	-	-	-	3	1.80	85.0
Torpedo californica	1	-	-	1	-	-	-	-	-	1	-	3	1.80	86.8
Amphistichus argenteus	-	-	-	-	2	-	-	-	-	-	-	2	1.20	88.0
Heterodontus francisci	1	-	-	-	1	-	-	-	-	-	-	2	1.20	89.2
Myliobatis californica	2	-	-	-	-	-	-	-	-	-	-	2	1.20	90.4
Scorpaenichthys marmoratus	-	-	-	-	-	-	-	-	1	1	-	2	1.20	91.6
Sebastes paucispinis	-	-	-	-	-	-	-	1	-	-	1	2	1.20	92.8
Trachurus symmetricus	-	-	-	-	-	-	-	-	-	-	2	2	1.20	94.0
Chilara taylori	-	-	-	-	-	-	1	-	-	-	-	1	0.60	94.6
Citharichthys stigmaeus	-	-	-	-	-	-	-	-	-	-	1	1	0.60	95.2
Hydrolagus colliei	1	-	-	-	-	-	-	-	-	-	-	1	0.60	95.8
Mustelus californicus	1	-	-	-	-	-	-	-	-	-	-	1	0.60	96.4
Ophidion scrippsae	-	-	-	-	-	-	-	-	1	-	-	1	0.60	97.0
Pleuronichthys ritteri	-	-	-	-	-	-	-	-	-	1	-	1	0.60	97.6
Pleuronichthys verticalis	-	1	-	-	-	-	-	-	-	-	-	1	0.60	98.2
Scorpaena guttata	-	-	1	-	-	-	-	-	-	-	-	1	0.60	98.8
Symphurus atricaudus	-	-	-	-	-	-	-	-	-	1	-	1	0.60	99.4
Triakis semifasciata	-	-	-	-	-	-	-	-	1	-	-	1	0.60	100.0
Survey totals	25	7	2	7	12	1	2	6	14	10	81	167		
Number of species	9	4	2	3	3	1	2	4	9	7	10	27		

Appendix H-5. Fish abundance per 100 mgd impinged during normal operation by month. Ormond Beach Generating Station NPDES, 2005.

	2004			2005								Mean	Mean	Estimated
	16	30	14	5	19	20	21	29	3	7	29	Daily	Daily	Annual
Species	Oct	Nov	Dec	Jan	Feb	Mar	May	Jul	Aug	Sep	Sep	CPUE	Std Dev	Abundance*
Cymatogaster aggregata	-	0.47	-	-	5.25	-	-	-	0.73	0.58	13.14	1.83	4.05	1,624
Syngnathus leptorhynchus	0.91	-	-	-	-	-	-	0.15	0.29	-	2.35	0.34	0.72	298
Seriphus politus	0.61	-	-	1.46	-	0.58	-	0.15	0.15	-	-	0.27	0.46	237
Engraulis mordax	-	-	-	-	-	-	-	-	-	2.33	0.23	0.23	0.70	207
Sardinops sagax	0.91	0.16	-	-	-	-	0.29	-	-	-	0.23	0.14	0.28	128
Porichthys myriaster	-	-	0.29	-	-	-	-	0.46	0.15	0.58	-	0.13	0.21	119
Synodus lucioceps	-	-	-	-	-	-	-	-	0.15	-	1.17	0.12	0.35	106
Amphistichus argenteus	-	-	-	-	1.17	-	-	-	-	-	-	0.11	0.35	94
Torpedo californica	0.15	-	-	0.29	-	-	-	-	-	0.58	-	0.09	0.19	83
Leptocottus armatus	-	0.32	-	0.29	-	-	-	-	-	-	0.23	0.08	0.13	68
Phanerodon furcatus	-	-	-	-	-	-	-	-	0.15	-	0.70	0.08	0.21	68
Heterodontus francisci	0.15	-	-	-	0.58	-	-	-	-	-	-	0.07	0.18	59
Scorpaenichthys marmoratus	-	-	-	-	-	-	-	-	0.15	0.58	-	0.07	0.18	59
Pleuronichthys ritteri	-	-	-	-	-	-	-	-	-	0.58	-	0.05	0.18	47
Symphurus atricaudus	-	-	-	-	-	-	-	-	-	0.58	-	0.05	0.18	47
Trachurus symmetricus	-	-	-	-	-	-	-	-	-	-	0.47	0.04	0.14	38
Platyrhinoidis triseriata	0.45	-	-	-	-	-	-	-	-	-	-	0.04	0.14	37
Sebastes paucispinis	-	-	-	-	-	-	-	0.15	-	-	0.23	0.04	0.08	31
Myliobatis californica	0.30	-	-	-	-	-	-	-	-	-	-	0.03	0.09	24
Chilara taylori	-	-	-	-	-	-	0.29	-	-	-	-	0.03	0.09	23
Scorpaena guttata	-	-	0.29	-	-	-	-	-	-	-	-	0.03	0.09	23
Citharichthys stigmaeus	-	-	-	-	-	-	-	-	-	-	0.23	0.02	0.07	19
Pleuronichthys verticalis	-	0.16	-	-	-	-	-	-	-	-	-	0.01	0.05	13
Hydrolagus colliei	0.15	-	-	-	-	-	-	-	-	-	-	0.01	0.05	12
Mustelus californicus	0.15	-	-	-	-	-	-	-	-	-	-	0.01	0.05	12
Ophidion scrippsae	-	-	-	-	-	-	-	-	0.15	-	-	0.01	0.04	12
Triakis semifasciata	-	-	-	-	-	-	-	-	0.15	-	-	0.01	0.04	12
Total (#/100mg)	3.79	1.10	0.58	2.04	7.00	0.58	0.58	0.92	2.04	5.84	19.01	3.95	5.46	3,500

Note: numerical anomalies due to rounding.
*Estimated annual abundance derived by multiplying mean daily CPUE by total reported annual flow (88502.561 mg) for monitoring year 2005.

Appendix H-6. Biomass (kg) of fish impinged during heat treatments and normal operations between 1 October 2004 and 30 September 2005. Ormond Beach Generating Station NPDES, 2005.

Species	Heat Treatment	Monitored Normal Operations	Estimated Normal Operations *	Total	Percent
Torpedo californica	-	17.628	354.72	354.72	51.0
Cymatogaster aggregata	23.877	1.083	22.95	46.83	6.7
Heterodontus francisci	-	2.123	40.57	40.57	5.8
Platyrhinoidis triseriata	-	2.750	33.50	33.50	4.8
Seriphus politus	21.583	0.234	5.55	27.13	3.9
Scorpaenichthys marmoratus	19.714	0.303	5.63	25.34	3.6
Sebastes auriculatus	16.370	-	-	16.37	2.4
Scorpaena guttata	-	0.658	15.45	15.45	2.2
Myliobatis californica	-	1.100	13.40	13.40	1.9
Paralabrax nebulifer	12.004	-	-	12.00	1.7
Phanerodon furcatus	9.504	0.123	2.00	11.50	1.7
Rhacochilus toxotes	9.204	-	-	9.20	1.3
Hyperprosopon argenteum	9.086	-	-	9.09	1.3
Triakis semifasciata	-	0.696	8.17	8.17	1.2
Porichthys myriaster	-	0.334	7.94	7.94	1.1
Sardinops sagax	1.889	0.430	5.69	7.58	1.1
Umbrina roncador	7.093	-	-	7.09	1.0
Trachurus symmetricus	3.024	0.120	2.27	5.29	0.8
Engraulis mordax	3.030	0.047	1.93	4.96	0.7
Paralabrax clathratus	4.288	-	-	4.29	0.6
Embiotoca jacksoni	3.714	-	-	3.71	0.5
Amphistichus argenteus	1.468	0.040	1.88	3.35	0.5
Hypsurus caryi	3.270	-	-	3.27	0.5
Mustelus californicus	-	0.226	2.75	2.75	0.4
Hydrolagus colliei	-	0.224	2.73	2.73	0.4
Leptocottus armatus	-	0.150	2.21	2.21	0.3
Synodus lucioceps	-	0.122	2.17	2.17	0.3
Pleuronichthys verticalis	-	0.139	1.76	1.76	0.3
Hexagrammos decagrammus	1.243	-	-	1.24	0.2
Cheilotrema saturnum	1.187	-	-	1.19	0.2
Oxyjulis californica	1.165	-	-	1.17	0.2
Symphurus atricaudus	-	0.023	1.08	1.08	0.2
Rhacochilus vacca	1.010	-	-	1.01	0.1
Syngnathus leptorhynchus	0.009	0.063	0.89	0.90	0.1
Chilara taylori	-	0.037	0.87	0.87	0.1
Sebastes paucispinis	-	0.048	0.86	0.86	0.1
Scomber japonicus	0.840	-	-	0.84	0.1
Atherinopsis californiensis	0.764	-	-	0.76	0.1
Peprilus simillimus	0.671	-	-	0.67	0.1
Chromis punctipinnis	0.608	-	-	0.61	0.1
Urobatis halleri	0.561	-	-	0.56	0.1
Ophidion scrippsae	-	0.028	0.33	0.33	0.0
Sebastes melanops	0.321	-	-	0.32	0.0
Pleuronichthys ritteri	-	0.006	0.28	0.28	0.0
Citharichthys stigmaeus	-	0.002	0.04	0.04	0.0
Ophichthus triserialis	0.025	-	-	0.03	0.0
Hypsoblennius gentilis	0.013	-	-	0.01	0.0
Survey totals	157.535	28.737	537.62	695.155	

*Estimations derived by multiplying mean daily CPUE by total reported annual flow (152367.48 mg) for monitoring year 2004.
Note: 0.0 = <0.05.

Appendix H-7. Biomass (kg) of fish impinged during heat treatments. Ormond Beach Generating Station NPDES, 2005.

Species	2005 Aug 10	Total	Percent Total	Cum. Percent
Cymatogaster aggregata	1092	1092	40.2	40.2
Seriphus politus	645	645	23.7	64.0
Engraulis mordax	219	219	8.1	72.0
Phanerodon furcatus	161	161	5.9	77.9
Hyperprosopon argenteum	143	143	5.3	83.2
Umbrina roncador	76	76	2.8	86.0
Sebastes auriculatus	72	72	2.7	88.7
Rhacochilus toxotes	38	38	1.4	90.1
Hypsurus caryi	35	35	1.3	91.3
Peprilus simillimus	30	30	1.1	92.5
Sardinops sagax	28	28	1.0	93.5
Amphistichus argenteus	24	24	0.9	94.4
Scorpaenichthys marmoratus	23	23	0.8	95.2
Paralabrax nebulifer	22	22	0.8	96.0
Trachurus symmetricus	22	22	0.8	96.8
Embiotoca jacksoni	20	20	0.7	97.6
Cheilotrema saturnum	11	11	0.4	98.0
Paralabrax clathratus	11	11	0.4	98.4
Hexagrammos decagrammus	10	10	0.4	98.7
Atherinopsis californiensis	8	8	0.3	99.0
Oxyjulis californica	7	7	0.3	99.3
Rhacochilus vacca	5	5	0.2	99.5
Chromis punctipinnis	4	4	0.1	99.6
Hypsoblennius gentilis	3	3	0.1	99.7
Scomber japonicus	3	3	0.1	99.9
Ophichthus triserialis	1	1	0.0	99.9
Sebastes melanops	1	1	0.0	99.9
Syngnathus leptorhynchus	1	1	0.0	100.0
Urobatis halleri	1	1	0.0	100.0
Biomass (kg)	2,716	2,716		

Note: 0.0 = <0.05.

Appendix H-8. Biomass (kg) of fish impinged during normal operations by month. Ormond Beach Generating Station NPDES, 2005.

	2004			2005										
Species	16 Oct	30 Nov	14 Dec	5 Jan	19 Feb	20 Mar	21 May	29 Jul	3 Aug	7 Sep	29 Sep	Total	% Total	Cum. %
Torpedo californica	5.500	-	-	12.000	-	-	-	-	-	0.128	-	17.628	61.34	61.34
Platyrhinoidis triseriata	2.750	-	-	-	-	-	-	-	-	-	-	2.750	9.57	70.91
Heterodontus francisci	1.700	-	-	-	0.423	-	-	-	-	-	-	2.123	7.39	78.30
Myliobatis californica	1.100	-	-	-	-	-	-	-	-	-	-	1.100	3.83	82.13
Cymatogaster aggregata	-	0.058	-	-	0.122	-	-	-	0.137	0.015	0.751	1.083	3.77	85.90
Triakis semifasciata	-	-	-	-	-	-	-	-	0.696	-	-	0.696	2.42	88.32
Scorpaena guttata	-	-	0.658	-	-	-	-	-	-	-	-	0.658	2.29	90.61
Sardinops sagax	0.301	0.082	-	-	-	-	0.022	-	-	-	0.025	0.430	1.50	92.10
Porichthys myriaster	-	-	0.116	-	-	-	-	0.101	0.043	0.074	-	0.334	1.16	93.27
Scorpaenichthys marmoratu.	-	-	-	-	-	-	-	-	0.244	0.059	-	0.303	1.05	94.32
Seriphus politus	0.035	-	-	0.123	-	0.038	-	0.007	0.031	-	-	0.234	0.81	95.14
Mustelus californicus	0.226	-	-	-	-	-	-	-	-	-	-	0.226	0.79	95.92
Hydrolagus colliei	0.224	-	-	-	-	-	-	-	-	-	-	0.224	0.78	96.70
Leptocottus armatus	-	0.115	-	0.020	-	-	-	-	-	-	0.015	0.150	0.52	97.22
Pleuronichthys verticalis	-	0.139	-	-	-	-	-	-	-	-	-	0.139	0.48	97.71
Phanerodon furcatus	-	-	-	-	-	-	-	-	0.045	-	0.078	0.123	0.43	98.13
Synodus lucioceps	-	-	-	-	-	-	-	-	0.018	-	0.104	0.122	0.42	98.56
Trachurus symmetricus	-	-	-	-	-	-	-	-	-	-	0.120	0.120	0.42	98.98
Syngnathus leptorhynchus	0.031	-	-	-	-	-	-	0.006	0.007	-	0.019	0.063	0.22	99.20
Sebastes paucispinis	-	-	-	-	-	-	-	0.007	-	-	0.041	0.048	0.17	99.36
Engraulis mordax	-	-	-	-	-	-	-	-	-	0.037	0.010	0.047	0.16	99.53
Amphistichus argenteus	-	-	-	-	0.040	-	-	-	-	-	-	0.040	0.14	99.67
Chilara taylori	-	-	-	-	-	-	0.037	-	-	-	-	0.037	0.13	99.79
Ophidion scrippsae	-	-	-	-	-	-	-	-	0.028	-	-	0.028	0.10	99.89
Symphurus atricaudus	-	-	-	-	-	-	-	-	-	0.023	-	0.023	0.08	99.97
Pleuronichthys ritteri	-	-	-	-	-	-	-	-	-	0.006	-	0.006	0.02	99.99
Citharichthys stigmaeus	-	-	-	-	-	-	-	-	-	-	0.002	0.002	0.01	100.00
Survey totals	11.867	0.394	0.774	12.143	0.585	0.038	0.059	0.121	1.249	0.342	1.165	28.737		

Appendix H-9. Impinged fish biomass per 100 mgd during normal operations by month. Ormond Beach Generating Station NPDES, 2005.

	2004			2005								Mean	Mean	Estimated
Species	16 Oct	30 Nov	14 Dec	5 Jan	19 Feb	20 Mar	21 May	29 Jul	3 Aug	7 Sep	29 Sep	Daily CPUE	Daily Std Dev	Annual Biomass*
Torpedo californica	0.83	-	-	3.50	-	-	-	-	-	0.07	-	0.40	1.06	354.72
Heterodontus francisci	0.26	-	-	-	0.25	-	-	-	-	-	-	0.05	0.10	40.57
Platyrhinoidis triseriata	0.42	-	-	-	-	-	-	-	-	-	-	0.04	0.13	33.5
Cymatogaster aggregata	-	0.01	-	-	0.07	-	-	-	0.02	0.01	0.18	0.03	0.05	22.95
Scorpaena guttata	-	-	0.19	-	-	-	-	-	-	-	-	0.02	0.06	15.45
Myliobatis californica	0.17	-	-	-	-	-	-	-	-	-	-	0.02	0.05	13.4
Triakis semifasciata	-	-	-	-	-	-	-	-	0.10	-	-	0.01	0.03	8.17
Porichthys myriaster	-	-	0.03	-	-	-	-	0.02	0.01	0.04	-	0.01	0.02	7.94
Sardinops sagax	0.05	0.01	-	-	-	-	0.01	-	-	-	0.01	0.01	0.01	5.69
Scorpaenichthys marmoratu.	-	-	-	-	-	-	-	-	0.04	0.03	-	0.01	0.01	5.63
Seriphus politus	0.01	-	-	0.04	-	0.02	-	0.00	0.00	-	-	0.01	0.01	5.55
Mustelus californicus	0.03	-	-	-	-	-	-	-	-	-	-	0.00	0.01	2.75
Hydrolagus colliei	0.03	-	-	-	-	-	-	-	-	-	-	0.00	0.01	2.73
Trachurus symmetricus	-	-	-	-	-	-	-	-	-	-	0.03	0.00	0.01	2.27
Leptocottus armatus	-	0.02	-	0.01	-	-	-	-	-	-	0.00	0.00	0.01	2.21
Synodus lucioceps	-	-	-	-	-	-	-	-	0.00	-	0.02	0.00	0.01	2.17
Phanerodon furcatus	-	-	-	-	-	-	-	-	0.01	-	0.02	0.00	0.01	2
Engraulis mordax	-	-	-	-	-	-	-	-	-	0.02	0.00	0.00	0.01	1.93
Amphistichus argenteus	-	-	-	-	0.02	-	-	-	-	-	-	0.00	0.01	1.88
Pleuronichthys verticalis	-	0.02	-	-	-	-	-	-	-	-	-	0.00	0.01	1.76
Symphurus atricaudus	-	-	-	-	-	-	-	-	-	0.01	-	0.00	0.00	1.08
Syngnathus leptorhynchus	0.00	-	-	-	-	-	-	0.00	0.00	-	0.00	0.00	0.00	0.89
Chilara taylori	-	-	-	-	-	-	0.01	-	-	-	-	0.00	0.00	0.87
Sebastes paucispinis	-	-	-	-	-	-	-	0.00	-	-	0.01	0.00	0.00	0.86
Ophidion scrippsae	-	-	-	-	-	-	-	-	0.00	-	-	0.00	0.00	0.33
Pleuronichthys ritteri	-	-	-	-	-	-	-	-	-	0.00	-	0.00	0.00	0.28
Citharichthys stigmaeus	-	-	-	-	-	-	-	-	-	-	0.00	0.00	0.00	0.04
Totals (kg/100mgd)	1.80	0.06	0.23	3.54	0.34	0.02	0.02	0.02	0.18	0.20	0.27	0.61	1.10	537.62

Note: 0.000 = <0.0005; numerical anomalies due to rounding.
*Estimated annual biomass derived by multiplying mean daily CPUE by total reported annual flow (88,502.561 mg) for monitoring year 2005.

Appendix H-10. Length of impinged fish. Ormond Beach Generating Station NPDES, 2005.

	Standard Length (cm)																																								
Species	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	35	37	38	39	41	42	44	45	49	51	53	58	68
Amphistichus argenteus	-	-	-	1	1	2	7	7	2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atherinopsis californiensis	-	-	-	-	-	-	-	-	1	-	1	-	1	-	-	1	-	1	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cheilotrema saturnum	-	-	-	-	-	-	-	-	-	-	3	4	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chilara taylori	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chromis punctipinnis	-	-	1	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Citharichthys stigmaeus	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cymatogaster aggregata	-	3	7	45	99	69	38	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Embiotoca jacksoni	-	-	-	-	-	-	-	1	2	2	2	2	7	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Engraulis mordax	-	-	1	1	1	28	121	43	9	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heterodontus francisci	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Hexagrammos decagrammus	-	-	-	-	-	-	2	6	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydrolagus colliei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Hyperprosopon argenteum	-	-	-	-	-	-	8	81	43	10	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hypsoblennius gentilis	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hypsurus caryi	-	-	-	-	-	-	1	2	6	7	9	7	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leptocottus armatus	-	-	-	-	-	1	2	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
*Mustelus californicus**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
*Myliobatis californica***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
Ophichthus triserialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ophidion scrippsae	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oxyjulis californica	-	-	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-	-	2	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paralabrax clathratus	-	-	-	-	-	1	-	1	1	2	1	-	-	-	-	-	-	-	-	1	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Paralabrax nebulifer	-	-	-	-	1	-	-	-	1	1	-	-	1	-	-	-	-	-	-	-	1	1	1	5	1	6	2	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-
Peprilus simillimus	-	-	-	13	10	4	-	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phanerodon furcatus	-	-	1	-	1	5	9	37	49	43	18	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
*Platyrhinoidis triseriata**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pleuronichthys ritteri	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pleuronichthys verticalis	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Porichthys myriaster	-	-	-	-	-	-	-	-	1	1	1	-	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhacochilus toxotes	-	-	-	2	-	-	-	-	-	1	3	9	5	2	4	1	2	-	1	2	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhacochilus vacca	-	-	-	-	-	-	-	1	-	-	-	-	-	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sardinops sagax	-	-	-	-	-	-	-	1	-	8	3	11	6	6	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scomber japonicus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scorpaena guttata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Scorpaenichthys marmoratus	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	4	1	-	2	-	1	1	2	4	2	1	1	1	1	2	1	-	-	-	-	-	-	-	-	-	-	-
Sebastes auriculatus	1	-	-	-	1	1	1	2	4	5	8	10	9	2	5	4	4	8	3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sebastes melanops	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sebastes paucispinis	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Seriphus politus	-	1	3	1	3	6	26	34	65	50	20	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Symphurus atricaudus	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Syngnathus leptorhynchus	-	-	-	-	-	-	-	1	-	-	2	-	-	2	3	2	1	1	4	2	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Synodus lucioceps	-	-	-	1	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
*Torpedo californica***	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-
Trachurus symmetricus	1	-	-	-	1	-	-	-	1	-	-	1	3	2	-	2	5	4	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Triakis semifasciata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Umbrina roncador	-	-	-	-	-	-	-	-	-	4	10	16	21	14	6	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
*Urobatis halleri***	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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

Appendix H-11. Abundance and biomass (kg) of macroinvertebrates impinged during heat treatments and normal operations. Ormond Beach Generating Station NPDES, 2005.

	Heat Treatment		Monitored Normal Operations		Estimated Normal Operations *		Total	Total
Species	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass	Abundance	Biomass
Cancer antennarius	233	31.250	1,140	49.493	23,698	1,058.66	23,931	1089.910
Cancer gracilis	-	-	40	0.020	487	0.24	487	0.240
Cancer jordani	-	-	13	0.147	195	1.94	195	1.940
Cancer productus	-	-	119	1.297	1,662	22.19	1,662	22.190
Caudina arenicola	-	-	1	0.072	12	0.85	12	0.850
Chrysaora colorata	-	-	1	1.595	12	19.58	12	19.580
Crangon nigromaculata	-	-	7	0.041	129	0.76	129	0.760
Loligo opalescens	-	-	1	0.041	23	0.62	23	0.620
Loxorhynchus crispatus	-	-	3	0.255	37	3.14	37	3.140
Loxorhynchus grandis	-	-	3	3.970	117	151.26	117	151.260
Lysmata californica	302	0.835	8	0.019	155	0.38	457	1.215
Megathura crenulata	2	0.500	-	-	-	-	2	0.500
Octopus bimaculatus/bimaculoide	19	0.500	2	0.066	38	1.25	57	1.750
Pachygrapsus crassipes	-	-	1	0.004	47	0.19	47	0.190
Pisaster sp	75	18.250	2	0.158	36	3.05	111	21.300
Polyorchis penicillatus	-	-	6	14.151	254	588.62	254	588.620
Portunus xantusii	-	-	1	0.013	12	0.16	12	0.160
Pugettia producta	2	0.056	-	-	-	-	2	0.056
Urechis caupo	-	-	1	0.002	23	0.05	23	0.050
Number of individuals	633	51.391	1349	71.344	26,937	1,852.94	27,570	1904.331
Number of species	6		17		17		19	

Appendix H-12. Abundance of macroinvertebrates impinged during heat treatments. Ormond Beach Generating Station NPDES, 2004.

Species	2005 Aug 10	Total	%	Cum.
Cancer antennarius	233	233	36.8	36.8
Lysmata californica	302	302	47.7	84.5
Megathura crenulata	2	2	0.3	84.8
Octopus bimaculatus/bimaculoi	19	19	3.0	87.8
Pisaster sp	75	75	11.8	99.7
Pugettia producta	2	2	0.3	100.0
Survey totals	633	633		
Number of species	6	6		

Note: 0.0 = <0.05.

Appendix H-13. Biomass (kg) of macroinvertebrates impinged during heat treatments. Ormond Beach Generating Station NPDES, 2004.

Species	2005 Aug 10	Total	%	Cum.
Cancer antennarius	31.25	31.25	60.8	60.8
Lysmata californica	0.835	0.835	1.6	62.4
Megathura crenulata	0.5	0.5	1.0	63.4
Octopus bimaculatus/bimaculoi	0.5	0.5	1.0	64.4
Pisaster sp	18.25	18.25	35.5	99.9
Pugettia producta	0.056	0.056	0.1	100.0
Survey totals (kg)	51.391	51.391		

Appendix H-14. Abundance of macroinvertebrates impinged during normal operations by month. Ormond Beach Generating Station NPDES, 2005.

	2004			2005										
	16	30	14	5	19	20	21	29	3	7	29		%	Cum.
Species	Oct	Nov	Dec	Jan	Feb	Mar	May	Jul	Aug	Sep	Sep	Total	Total	%
Cancer antennarius	10	300	522	52	20	14	177	21	23	-	1	1,140	84.51	84.5
Cancer gracilis	40	-	-	-	-	-	-	-	-	-	-	40	2.97	87.5
Cancer jordani	-	8	-	3	-	-	-	-	2	-	-	13	0.96	88.4
Cancer productus	80	20	18	-	-	-	-	-	1	-	-	119	8.82	97.3
Caudina arenicola	-	-	-	-	-	-	-	-	1	-	-	1	0.07	97.3
Chrysaora colorata	-	-	-	-	-	-	-	1	-	-	-	1	0.07	97.4
Crangon nigromaculata	-	-	-	-	-	-	4	-	3	-	-	7	0.52	97.9
Loligo opalescens	-	-	-	1	-	-	-	-	-	-	-	1	0.07	98.0
Loxorhynchus crispatus	-	2	-	-	-	-	-	-	1	-	-	3	0.22	98.2
Loxorhynchus grandis	-	-	-	-	-	2	1	-	-	-	-	3	0.22	98.4
Lysmata californica	-	2	-	-	-	-	5	1	-	-	-	8	0.59	99.0
Octopus bimaculatus/bimaculoide.	-	-	-	-	-	-	-	-	-	-	2	2	0.15	99.2
Pachygrapsus crassipes	-	-	-	-	1	-	-	-	-	-	-	1	0.07	99.3
Pisaster sp	-	1	-	1	-	-	-	-	-	-	-	2	0.15	99.4
Polyorchis penicillatus	-	-	-	-	-	1	-	-	-	4	1	6	0.44	99.9
Portunus xantusii	-	-	-	-	-	-	-	1	-	-	-	1	0.07	99.9
Urechis caupo	-	-	-	1	-	-	-	-	-	-	-	1	0.07	100.0
Survey totals	130	333	540	58	21	17	187	24	31	4	4	1,349		
Number of species	3	6	2	5	2	3	4	4	6	1	3	17		

Note: ns = not sampled.

Appendix H-15. Impinged macroinvertebrate abundance per 100 mgd during normal operations by month. Ormond Beach Generatina Station NPDES. 2005.

	2004			2005								Mean	Mean	Estimated
	16	30	14	5	19	20	21	29	3	7	29	Daily	Daily	Annual
Species	Oct	Nov	Dec	Jan	Feb	Mar	May	Jul	Aug	Sep	Sep	CPUE	Std Dev	Abundance*
Cancer antennarius	1.51	47.27	152.31	15.17	11.67	8.17	51.65	3.20	3.36	-	0.23	26.78	45.46	23,698
Cancer gracilis	6.06	-	-	-	-	-	-	-	-	-	-	0.55	1.83	487
Cancer jordani	-	1.26	-	0.88	-	-	-	-	0.29	-	-	0.22	0.44	195
Cancer productus	12.11	3.15	5.25	-	-	-	-	-	0.15	-	-	1.88	3.81	1,662
Caudina arenicola	-	-	-	-	-	-	-	-	0.15	-	-	0.01	0.04	12
Chrysaora colorata	-	-	-	-	-	-	-	0.15	-	-	-	0.01	0.05	12
Crangon nigromaculata	-	-	-	-	-	-	1.17	-	0.44	-	-	0.15	0.36	129
Loligo opalescens	-	-	-	0.29	-	-	-	-	-	-	-	0.03	0.09	23
Loxorhynchus crispatus	-	0.32	-	-	-	-	-	-	0.15	-	-	0.04	0.10	37
Loxorhynchus grandis	-	-	-	-	-	1.17	0.29	-	-	-	-	0.13	0.35	117
Lysmata californica	-	0.32	-	-	-	-	1.46	0.15	-	-	-	0.18	0.44	155
Octopus bimaculatus/bimaculoide.	-	-	-	-	-	-	-	-	-	-	0.47	0.04	0.14	38
Pachygrapsus crassipes	-	-	-	-	0.58	-	-	-	-	-	-	0.05	0.18	47
Pisaster sp.	-	0.16	-	0.29	-	-	-	-	-	-	-	0.04	0.10	36
Polyorchis penicillatus	-	-	-	-	-	0.58	-	-	-	2.33	0.23	0.29	0.70	254
Portunus xantusii	-	-	-	-	-	-	-	0.15	-	-	-	0.01	0.05	12
Urechis caupo	-	-	-	0.29	-	-	-	-	-	-	-	0.03	0.09	23
Total (#/100mgd)	19.68	52.47	157.56	16.92	12.25	9.92	54.56	3.66	4.52	2.33	0.94	30.44	46.18	26,940

Note: Numerical anomalies due to rounding.
*Estimated annual abundance derived by multiplying mean daily CPUE by total reported annual flow (88502.561 mg) for monitoring year 2005.

Appendix H-16. Biomass (kg) of macroinvertebrates impinged during normal operations by month. Ormond Beach Generating Station NPDES, 2005.

	2004			2005										
Species	16 Oct	30 Nov	14 Dec	5 Jan	19 Feb	20 Mar	21 May	29 Jul	3 Aug	7 Sep	29 Sep	Total	% Total	Cum. %
Cancer antennarius	0.320	9.334	11.232	1.880	1.280	0.964	19.979	2.381	2.110	-	0.013	49.493	69.37	69.4
Cancer gracilis	0.020	-	-	-	-	-	-	-	-	-	-	0.020	0.03	69.4
Cancer jordani	-	0.040	-	0.015	-	-	-	-	0.092	-	-	0.147	0.21	69.6
Cancer productus	0.320	0.291	0.558	-	-	-	-	-	0.128	-	-	1.297	1.82	71.4
Caudina arenicola	-	-	-	-	-	-	-	-	0.072	-	-	0.072	0.10	71.5
Chrysaora colorata	-	-	-	-	-	-	-	1.595	-	-	-	1.595	2.24	73.8
Crangon nigromaculata	-	-	-	-	-	-	0.024	-	0.017	-	-	0.041		
Loligo opalescens	-	-	-	0.012	-	-	-	-	0.029	-	-	0.041		
Loxorhynchus crispatus	-	0.158	-	-	-	-	-	-	0.097	-	-	0.255		
Loxorhynchus grandis	-	-	-	-	-	2.473	1.497	-	-	-	-	3.970		
Lysmata californica	-	0.004	-	-	-	-	0.013	0.002	-	-	-	0.019	0.03	73.8
Octopus bimaculatus/bima	-	-	-	-	-	-	-	-	-	-	0.066	0.066	0.09	73.9
Pachygrapsus crassipes	-	-	-	-	0.004	-	-	-	-	-	-	0.004	0.01	73.9
Pisaster sp	-	0.061	-	0.097	-	-	-	-	-	-	-	0.158	0.22	74.1
Polyorchis penicillatus	-	-	-	-	-	0.751	-	-	-	10.700	2.700	14.151	19.83	93.9
Portunus xantusii	-	-	-	-	-	-	-	0.013	-	-	-	0.013	0.02	94.0
Urechis caupo	-	-	-	0.002	-	-	-	-	-	-	-	0.002	0.00	94.0
Survey totals	0.660	9.888	11.790	2.006	1.284	4.188	21.513	3.991	2.545	10.700	2.779	71.344		

Note: ns = not sampled.

Appendix H-17. Impinged macroinvertebrate biomass per 100 mgd during normal operations by month. Ormond Beach Generating Station NPDES, 2005.

	2004			2005								Mean	Mean	Estimated
Species	16 Oct	30 Nov	14 Dec	5 Jan	19 Feb	20 Mar	21 May	29 Jul	3 Aug	7 Sep	29 Sep	Daily CPUE	Daily Std Dev	Annual Biomass*
Cancer antennarius	0.048	1.471	3.277	0.549	0.747	0.563	5.830	0.363	0.308	-	0.003	1.196	1.804	1,058.66
Cancer gracilis	0.003	-	-	-	-	-	-	-	-	-	-	0.000	0.001	0.24
Cancer jordani	-	0.006	-	0.004	-	-	-	-	0.013	-	-	0.002	0.004	1.94
Cancer productus	0.048	0.046	0.163	-	-	-	-	-	0.019	-	-	0.025	0.049	22.19
Caudina arenicola	-	-	-	-	-	-	-	-	0.011	-	-	0.001	0.003	0.85
Chrysaora colorata	-	-	-	-	-	-	-	0.243	-	-	-	0.022	0.073	19.58
Crangon nigromaculata	-	-	-	-	-	-	0.007	-	0.002	-	-	0.001	0.002	0.76
Loligo opalescens	-	-	-	0.004	-	-	-	-	0.004	-	-	0.001	0.002	0.62
Loxorhynchus crispatus	-	0.025	-	-	-	-	-	-	0.014	-	-	0.004	0.008	3.14
Loxorhynchus grandis	-	-	-	-	-	1.443	0.437	-	-	-	-	0.171	0.442	151.26
Lysmata californica	-	0.001	-	-	-	-	0.004	0.000	-	-	-	0.000	0.001	0.38
Octopus bimaculatus/bima	-	-	-	-	-	-	-	-	-	-	0.015	0.001	0.005	1.25
Pachygrapsus crassipes	-	-	-	-	0.002	-	-	-	-	-	-	0.000	0.001	0.19
Pisaster sp	-	0.010	-	0.028	-	-	-	-	-	-	-	0.003	0.009	3.05
Polyorchis penicillatus	-	-	-	-	-	0.438	-	-	-	6.244	0.634	0.665	1.863	588.62
Portunus xantusii	-	-	-	-	-	-	-	0.002	-	-	-	0.000	0.001	0.16
Urechis caupo	-	-	-	0.001	-	-	-	-	-	-	-	0.000	0.000	0.05
Total (kg/100mgd)	0.10	1.56	3.44	0.59	0.75	2.44	6.28	0.61	0.37	6.24	0.65	2.09	2.29	1852.94

Note: 0.000 = <0.0005; Numerical anomalies due to rounding.
*Estimated annual biomass derived by multiplying mean daily CPUE by total reported annual flow (88,502.561 mg) for monitoring year

Appendix H-18. Total abundance of fish impinged during heat treatments and extrapolated normal operations, 1990 - 2005. Ormond Beach Generating Station NPDES, 2005.

	Year																	Percent	
Species	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total	Total	Mean
Seriphus politus	7460	43501	16697	82521	16382	24008	4218	4725	6632	161	361	3057	11089	2684	375	882	224753	60.32	14047.1
Sardinops sagax	322	86	110	1643	362	1056	197	2921	21434	24	89	295	483	107	632	156	29917	8.03	1869.8
Cymatogaster aggregata	278	270	997	1333	1023	8830	503	2423	891	8	366	542	532	1397	1113	2716	23222	6.23	1451.4
Engraulis mordax	301	365	891	631	2022	1600	2169	4329	73	177	564	1144	2095	4076	1395	426	22258	5.97	1391.1
Hyperprosopon argenteum	1506	1521	3942	550	126	616	10	1353	431	-	2	611	432	266	11	143	11520	3.09	720.0
Phanerodon furcatus	1606	987	1054	1019	1169	2454	395	926	158	-	35	36	75	86	55	229	10284	2.76	642.8
Porichthys notatus	1844	1484	999	490	336	432	11	-	-	46	58	1	172	2	-	-	5875	1.58	367.2
Peprilus simillimus	1	157	72	738	22	16	4	1	1	-	5	3350	186	280	8	30	4871	1.31	304.4
Genyonemus lineatus	14	707	149	2506	58	679	50	4	433	-	-	101	65	5	-	-	4771	1.28	298.2
Citharichthys stigmaeus	-	390	230	504	60	240	-	-	-	-	461	1330	102	454	40	19	3830	1.03	239.4
Atherinops affinis	9	105	30	49	-	44	310	1620	204	-	-	974	37	-	-	-	3382	0.91	211.4
Scomber japonicus	10	11	1848	400	451	262	5	1	54	-	-	4	1	-	-	3	3050	0.82	190.6
Paralabrax nebulifer	159	154	435	142	102	164	47	63	9	13	159	244	59	70	35	22	1877	0.50	117.3
Platyrhinoidis triseriata	46	322	33	200	76	60	2	50	72	-	29	565	21	205	61	37	1779	0.48	111.2
Leuresthes tenuis	1	593	364	83	11	-	-	-	-	-	-	127	2	347	-	-	1528	0.41	95.5
Pleuronichthys verticalis	64	118	126	268	104	99	-	99	70	-	202	219	-	74	61	13	1517	0.41	94.8
Trachurus symmetricus	194	15	8	266	275	499	-	2	11	-	-	1	-	1	64	60	1396	0.37	87.2
Leptocottus armatus	73	16	27	85	23	1	7	30	98	92	175	463	16	67	121	68	1362	0.37	85.1
Myliobatis californica	-	53	78	154	85	2	1	8	15	2	-	740	14	66	-	24	1242	0.33	77.6
Torpedo californica	38	97	18	62	60	63	105	51	1	48	29	178	-	37	204	83	1074	0.29	67.1
Porichthys myriaster	1	69	-	-	1	-	72	199	25	-	115	212	39	121	22	119	995	0.27	62.2
Sebastes auriculatus	56	69	126	82	66	66	14	30	20	18	41	33	45	120	44	72	902	0.24	56.4
Paralabrax clathratus	89	63	92	72	57	221	65	52	14	9	20	8	12	25	19	11	829	0.22	51.8
Syngnathus leptorhynchus	-	-	-	-	-	-	-	-	-	-	-	-	13	22	416	299	750	0.20	46.9
Ophidion scrippsae	101	106	57	76	48	58	1	-	-	-	29	207	-	24	-	12	719	0.19	44.9
Rhacochilus toxotes	14	33	4	43	31	15	50	173	30	4	15	17	2	105	59	38	633	0.17	39.6
Synodus lucioceps	9	7	-	-	7	-	-	-	-	-	-	143	303	-	-	106	575	0.15	35.9
Scorpaenichthys marmoratus	67	39	26	19	15	43	14	32	6	1	16	24	31	39	77	82	531	0.14	33.2
Symphurus atricaudus	10	7	16	15	28	42	200	49	-	23	-	36	-	-	24	47	497	0.13	31.0
Amphistichus argenteus	-	4	-	2	-	-	-	-	190	-	29	118	1	2	-	118	464	0.12	29.0
Paralichthys californicus	65	17	29	92	14	16	3	1	39	-	-	62	-	31	20	-	389	0.10	24.3
Pleuronichthys ritteri	-	1	2	-	-	1	-	-	-	-	-	213	87	-	-	47	351	0.09	21.9
Rhacochilus vacca	67	94	32	27	25	19	1	-	2	4	1	2	50	17	1	5	347	0.09	21.7
Syngnathus sp	-	15	-	58	1	-	-	-	-	23	175	73	-	-	-	-	345	0.09	21.6
Embiotoca jacksoni	81	56	28	20	30	30	7	10	7	2	8	11	2	11	8	20	331	0.09	20.7
Xenistius californiensis	2	26	-	38	12	111	57	11	37	-	1	1	-	-	-	-	296	0.08	18.5
Chromis punctipinnis	16	22	100	32	16	9	13	8	29	2	2	3	1	7	1	4	265	0.07	16.6
Brachyistius frenatus	18	3	6	36	20	50	17	-	28	-	-	1	1	68	-	-	248	0.07	15.5
Atherinopsis californiensis	1	28	37	118	7	15	-	-	-	-	1	-	6	19	7	8	247		15.4
Heterostichus rostratus	21	14	13	12	44	33	3	2	-	-	1	4	28	1	62	-	238	0.06	14.9
Pleuronectes vetulus	9	-	-	-	8	-	-	49	155	-	-	-	-	-	-	-	221	0.06	13.8
Acanthogobius flavimanus	-	-	-	-	-	-	-	-	190	23	-	-	-	-	-	-	213	0.06	13.3
Scorpaena guttata	7	4	2	21	33	17	3	-	5	1	1	33	30	5	4	23	189	0.05	11.8
Sebastes paucispinis	29	46	22	8	-	-	-	-	-	-	29	-	1	2	-	31	168	0.05	10.5
Oxyjulis californica	2	4	16	21	8	11	17	3	7	3	43	14	4	1	1	7	162	0.04	10.1
Pleuronichthys coenosus	1	6	1	19	57	15	1	-	-	-	-	-	-	53	-	-	153	0.04	9.6
Paralabrax maculatofasciatus	-	-	8	-	-	-	47	-	87	-	3	-	-	-	-	-	145	0.04	9.1
Rhinobatos productus	27	2	-	17	8	1	4	32	30	-	1	-	4	6	-	-	132	0.04	8.3
Pleuronichthys decurrens	-	-	-	-	-	-	-	-	-	-	-	-	-	128	-	-	128	0.03	8.0
Urobatis halleri	-	2	2	3	1	1	-	1	1	23	-	36	17	-	3	1	91	0.02	5.7

Appendix H-18. (Cont.).

Species	Year																Total	Percent	Mean
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005		Total	
Cheilotrema saturnum	1	4	1	4	17	42	-	-	4	1	1	4	-	-	-	11	90	0.02	5.6
Menticirrhus undulatus	-	10	-	-	1	-	-	-	2	-	-	71	-	-	1	-	85	0.02	5.3
Triakis semifasciata	-	-	1	-	-	-	-	-	4	-	-	66	-	-	-	12	83	0.02	5.2
Mustelus californicus	-	15	-	7	-	14	34	-	-	-	-	-	-	-	-	12	82	0.02	5.1
Hypsurus caryi	-	9	12	4	4	11	1	1	-	-	-	-	1	4	-	35	82	0.02	5.1
Umbrina roncador	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	76	76	0.02	4.8
Raja inornata	-	-	-	1	-	-	-	-	-	-	-	-	67	-	-	-	68	0.02	4.3
Heterodontus francisci	-	-	-	-	-	-	-	-	1	-	-	-	1	1	-	59	62	0.02	3.9
Medialuna californiensis	3	6	6	2	31	10	-	-	-	-	-	-	-	-	2	-	60	0.02	3.8
Squalus acanthias	-	7	8	29	-	-	1	-	12	-	-	-	-	-	-	-	57	0.02	3.6
Chilara taylori	9	22	-	1	-	-	-	-	-	-	-	-	-	-	-	23	55	0.01	3.4
Citharichthys xanthostigma	-	22	-	7	-	-	-	-	-	-	-	-	-	-	20	-	49	0.01	3.1
Oxylebius pictus	4	-	21	-	4	2	-	-	-	-	1	1	-	5	8	-	46	0.01	2.9
Syngnathus californiensis	-	-	-	-	-	-	-	-	-	-	-	-	11	35	-	-	46	0.01	2.9
Pleuronichthys guttulatus	-	8	-	-	14	-	-	-	-	23	-	-	-	-	-	-	45	0.01	2.8
Sebastes serranoides	12	-	9	1	5	-	-	-	-	-	4	-	1	10	1	-	43	0.01	2.7
Atractoscion nobilis	-	6	-	15	3	3	3	2	7	-	1	-	-	-	-	-	40	0.01	2.5
Sebastes rastrelliger	4	6	3	10	1	6	-	-	2	-	-	-	3	4	-	-	39	0.01	2.4
Cephaloscyllium ventriosum	-	7	1	23	-	-	-	-	-	-	-	-	3	-	-	-	34	0.01	2.1
Citharichthys sordidus	-	-	-	-	-	-	-	-	-	-	-	-	34	-	-	-	34	0.01	2.1
Hexagrammos decagrammus	-	3	2	-	-	-	-	-	-	-	-	-	4	11	1	10	31	0.01	1.9
Sebastes atrovirens	-	1	-	1	-	8	1	-	-	-	-	-	13	-	1	-	25	0.01	1.6
Mustelus sp	-	-	-	-	-	-	-	-	-	23	-	1	-	-	-	-	24	0.01	1.5
Merluccius productus	-	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	0.01	1.4
Mola mola	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	20	0.01	1.3
Anisotremus davidsonii	1	-	-	2	4	-	-	-	12	-	-	-	-	-	-	-	19	0.01	1.2
Girella nigricans	11	7	-	-	-	-	-	-	-	-	1	-	-	-	-	-	19	0.01	1.2
Xystreurys liolepis	10	-	1	-	7	-	-	-	-	-	-	-	-	-	-	-	18	0.00	1.1
Hypsoblennius gilberti	-	1	1	4	4	-	-	-	-	-	-	-	-	1	3	-	14	0.00	0.9
Hydrolagus colliei	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	12	0.00	0.8
Hermosilla azurea	-	7	-	-	-	-	-	1	-	-	-	-	3	-	-	-	11	0.00	0.7
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	0.5
Hypsoblennius spp	1	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	8	0.00	0.5
Ophiodon elongatus	1	-	-	-	-	-	-	-	-	-	-	1	1	5	-	-	8	0.00	0.5
Platichthys stellatus	-	7	-	-	-	-	1	-	-	-	-	-	-	-	-	-	8	0.00	0.5
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	0.4
Embiotoca lateralis	-	-	-	-	-	-	-	-	-	-	-	3	-	-	2	-	5	0.00	0.3
Gibbonsia elegans	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	4	0.00	0.3
Psettichthys melanostictus	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	4	0.00	0.3
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 serriceps	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	2	0.00	0.1
Zalembius rosaceus	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2	0.00	0.1

Appendix H-18. (Cont.).

Species	Year																Total	Percent	
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005		Total	Mean
Sebastes melanops	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	2	0.00	0.1
Agonopsis sp	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00	0.1
Agonopsis sterletus	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	0.1
Pholidae unidentified	-	-	-	-	-	-	-	-	-	-	-	-	-	-	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
Raja binoculata	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.00	0.1
Sebastes goodei	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	0.00	0.1
Sebastes sp	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	0.00	0.1
Ophichthus triserialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	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	372577		23286.0
Number of species	54	65	54	60	59	48	41	38	47	28	42	49	54	53	41	47	115		48.8

Note: 0.00 = <0.005.