# NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
# 2005 RECEIVING WATER MONITORING REPORT
# RELIANT ENERGY MANDALAY 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 Mandalay Generating Station was conducted in accordance with specifications set forth by the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) in NPDES Permit No. CA0001180 dated 26 April 2001. The 2005 studies included physical monitoring of the receiving waters and underlying sediments, and biological sampling of the benthic infaunal, fish, and macroinvertebrate assemblages. 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

Water quality monitoring was conducted on ebbing and flooding tides during winter and summer surveys, within the surrounding waters of the Mandalay Generating Station discharge channel to determine potential influence on the receiving waters. Measured water quality parameters, water temperature, dissolved oxygen (DO) concentrations, hydrogen ion concentrations (pH), and salinity, were monitored at five surf-zone and 12 offshore stations. Elevated temperatures were found at the discharge channel and the nearest downcoast surf-zone station. The nearshore thermal plume appeared to be highly localized and did not have an affect on any other stations. Reduced DO values were recorded at the surf-zone station nearest the discharge channel were likely related to the increased water temperature. Otherwise, dissolved oxygen concentrations fluctuated between surveys, likely resulting from seasonal water temperature differences or other natural influences. Hydrogen ion concentrations and salinity values at surf-zone stations were similar to those recorded at offshore stations. All water quality parameters were within ranges recorded previously in the study area and were similar to those observed in the Southern California Bight in past studies. Only minor, localized effects could be attributed to the generating station discharge.

## 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 silt and clay. Mean grain size in the study area in 2005 was the smallest since 1997. A localized pattern of coarser grain size associated with the discharge plume, observed in several previous studies, was not apparent in 2005, as sediments at stations upcoast and downcoast of the discharge were measurably larger, while only the sediments from the furthest point upcoast of the discharge exhibited a smaller grain size. 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, highest metal concentrations did appear to be loosely related to 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 typically 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 Mandalay Generating Station.

## MUSSEL BIOACCUMULATION

In 2005 no mussels were found in the vicinity of the Mandalay Generating Station discharge. Mussels were then collected from a donor site, the Ormond Beach Generating Station discharge buoy, placed within protective enclosures that allowed unrestricted water flow to the mussels, and transplanted to the Mandalay mooring and allowed to acclimate for 93 days. Tissues from the mussels at the discharge, the donor site and a reference site were analyzed for bioaccumulation of the metals chromium, copper, nickel, and zinc. In 2005, analytical reporting limits for bioaccumulated metals were lower than determined in previous monitoring. As a result concentrations of two of the four metals were detected at reportable levels for the first time since sampling began in 2001.

Metal concentrations in mussel tissues from the vicinity of the discharge were lower than metal levels in mussels from the donor site, suggesting that the transplanted mussels had acclimated to the area and that tissue metal concentrations accurately represented values in the area of the discharge. Chromium was detected at levels below the reporting limits of previous sampling. Copper levels in 2005 were slightly higher than found previously in the area except in 2001. Nickel was reported for the first time since sampling began in 2001 at a level below previous reporting limits. Zinc concentrations were higher than found in the last two years, but higher than occurred in 2001 and 2002. Metal concentrations in tissues from the discharge were lower than levels detected in mussels from the donor site, but with the exception of zinc higher than levels found at a reference site in 2005. Wet-weight concentrations of all metals in mussel tissues from the discharge were lower than values considered elevated for transplanted mussels by the California State Mussel Watch Program in 2005. The comparatively low tissue metal levels and similarity of tissue metal levels to previous studies, at a reference site, and other areas in southern California suggests that the operation of the Mandalay Generating Station is not elevating metal levels above background levels.

**BENTHIC INFAUNA**

The infaunal community in 2005 was comprised primarily of small annelid worms and arthropods. Abundance averaged 345 individuals per station (8,630 individuals/$m^2$), with a mean of 28 species per station. Density in 2005 was almost twice that in 2004 and was higher than the long-term mean for the study area, while species richness was similar to the long-term mean and species diversity was lower than the mean. Infaunal parameter values appeared to show little relationship to sediment characteristics. Values for the community nearest the discharge were similar to those both upcoast and downcoast. Abundance was highest immediately upcoast of the discharge. Infaunal community composition was similar among stations, although the most abundant species, the annelid *Apoprionospio pygmaea*, was most abundant immediately upcoast of the discharge, and the cumacean *Diastylopsis tenuis*, second in abundance, was most abundant immediately downcoast of the discharge. The annelid *Armandia brevis*, unusually abundant in 2005 at other sandy-bottom, nearshore locations in southern California, was most abundant where sediments were coarsest, farthest downcoast.

The infaunal communities in the nearshore shallow subtidal environment off the generating station in 2005 were similar to those found in previous studies conducted since 1978 and typical of those in the Southern California Bight. No pattern of abundance, species richness, diversity or biomass related to the discharge was apparent. All infaunal community parameters in 2005 were typical of the area and within the range of values found previously throughout the study area.

**DEMERSAL FISH AND MACROINVERTEBRATES**

In 2005, fish and macroinvertebrate communities were more abundant than has been recorded in recent surveys. Analyses between seasonal sampling indicated a significant difference in abundance between winter and summer, as would be expected with schooling fishes that exhibit seasonal migration and activity patterns. No significant differences were detected between the reference stations. Macroinvertebrate communities exhibited similar patterns as were recorded for fish, with no significant difference between the reference stations and those adjacent to the discharge. Based on the available data, both current and historical, the operation of Mandalay Generating Station had no detectable deleterious effects on the fish and macroinvertebrate communities within the receiving waters. The results of this investigation suggest that all applicable beneficial uses of the receiving waters, i. e. commercial and recreational fishing, maintenance of all applicable habitat, migration of aquatic organisms, spawning, reproduction, and early development of fish species common to the area are being maintained.

**IMPINGEMENT**

To evaluate fish loss at the Mandalay Generating Station, fish impingement was monitored during two heat treatments and seven normal operation surveys in 2005. Based on these surveys, an estimated total of 53,598 individuals representing 20 fish species and weighing more than 1,200 kg were impinged at the generating station in 2005. Overall impinged abundance and biomass estimates for the 2005 monitoring year represent the second highest since 2002. In addition, an estimated 199 individuals representing three macroinvertebrate species and weighing greater than 18 kg were impinged during the study year, the highest total since recent monitoring begin 2001.

Abundance and biomass of fish impinged in 2005 was higher than in 2004, but less than in 2002. Abundance and biomass of macroinvertebrates impinged in 2005 was the highest in recent years. Impinged fish abundances in 2005 indicate an increasing trend, which, in light of the declining circulated water volume, suggests local fish assemblages have been increasing since 2002. All fish and macroinvertebrate species collected were typical of the bay/nearshore environment from which the generating station withdraws its cooling water. There was no indication that plant operations are adversely affecting the local marine macrofaunal community.

**CONCLUSIONS**

The overall results of the 2005 NPDES monitoring program indicated that operation of the Mandalay 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 Mandalay 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. 2093 (Permit No. CA0001180) issued by the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB) on 26 April 2001 (Appendix A). Results of the 2005 surveys were compared among stations and with past physical oceanographic and biological studies to determine if the generating station discharge is having an adverse effect 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, fish, and macroinvertebrate assemblages.

## DESCRIPTION OF THE GENERATING STATION

The Mandalay Generating Station is located on the California coast, approximately 4.8 kilometers (km) west of the City of Oxnard in Ventura County. The generating station consists of two steam-electric generating units, each rated at 215 megawatts (Mw), and one gas turbine unit rated at 147 Mw. Steam is supplied to the steam-electric units by two oil- or gas-fired boilers, each rated at 707,600 kilograms (kg) of steam per hour.

Cooling water is supplied to the station at a rate of approximately 176,000 gallons per minute (gpm), which comes from the ocean via the Edison Canal from Channel Islands Harbor, 4.8 km downcoast. Water enters the station through a screening facility which removes large marine organisms, trash, and other debris. Cooling water is pumped to the two steam condensers where its temperature is elevated approximately 12.2°C when the units are operating at full load. The warmed effluent is returned to the ocean across the beach via a rock-lined canal (Figure 1).

Approximately 9,800 gpm (6%) of the main cooling water is diverted before it reaches the steam condensers and is directed to an auxiliary heat exchanger which is used to cool distilled water used in auxiliary station equipment. The temperature of this seawater is elevated approximately 5°C before it joins the main cooling-water flow in the discharge conduit. An additional 3,200 gpm (2%) is diverted to an auxiliary cooling-water heat exchanger for the gas turbine unit where its temperature is raised a maximum of 9°C. The turbine unit is operated approximately 250 hours per year.

Two of the four circulator pumps were operating during the winter survey on 14 April 2005, discharging 137.4 mgd. The intake temperature was 16.1°C and the discharge temperature was 18.3°C, for a 2.2°C temperature increase. During the summer survey, 14 July 2005, four circulator pumps were operating, discharging 217.2 mgd. The intake temperature was 22.8°C and the discharge temperature 30.0°C, for a temperature increase of 7.2°C for the water flowing across the condensers. During 2005, the Mandalay Generating Station steam plants operated at 10.95% of their total operating capacity (Norfolk 2005, pers. comm.).

## DESCRIPTION OF THE STUDY AREA

The physiography, climate, and hydrography of the southern California coastal region contribute to the character of the study area and, therefore, affect the influence of thermal discharges in coastal waters. Oceanographic, biological, and meteorological elements are all characterized by short- and long-period cyclical variations as well as non-periodic trends. Winds, tides, and currents are particularly important since they have the greatest impact on the fate of the thermal plume itself.

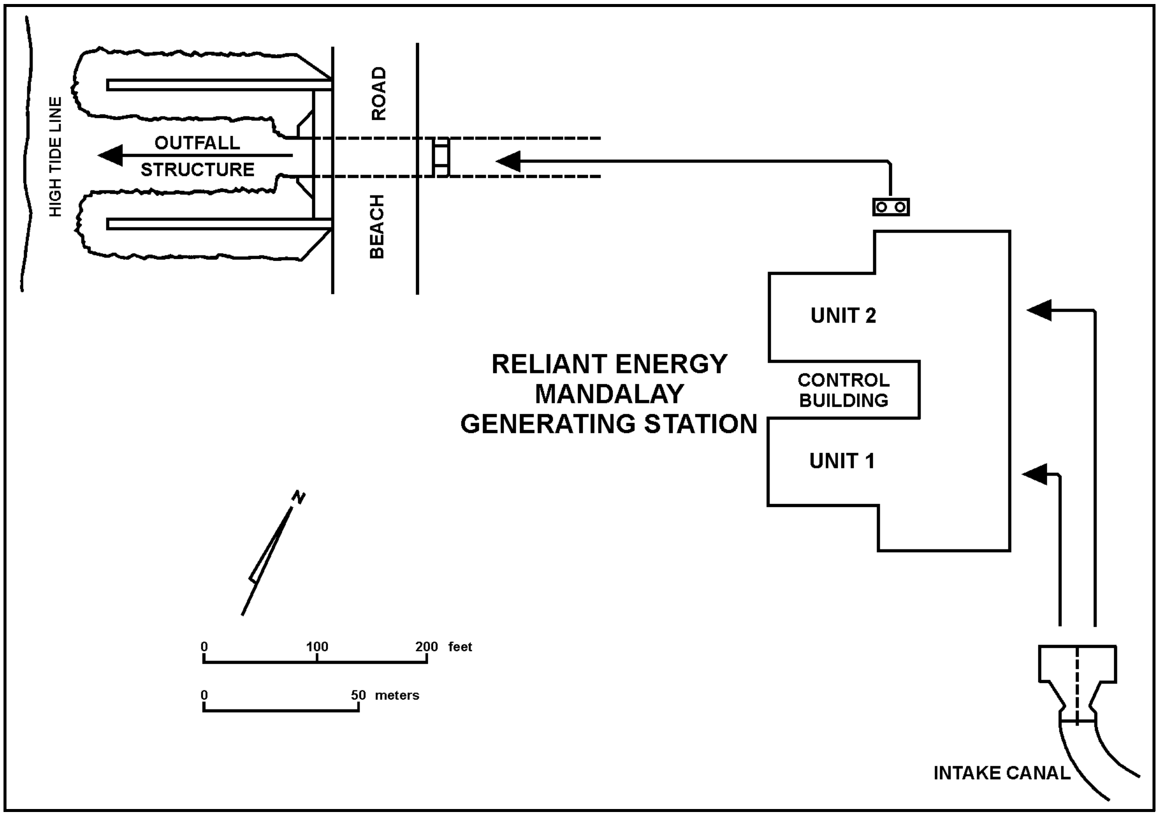



**Figure 1. Diagram of the Mandalay Generating Station cooling water system. Mandalay Generating Station NPDES, 2005.**

## Physiography

The general orientation of the coastline between Point Conception and the Mexican border is from northwest to southeast. The continental margin has been slowly emerging over time, resulting in a predominantly cliffed coastline, broken by coastal plains in the Oxnard-Ventura, Los Angeles, and San Diego areas. Drainage of the coastal region is by many relatively short streams which normally flow only during rain storms. Only a small part of the storm drainage actually reaches the ocean because most is impounded by dams and diverted for other uses.

The Mandalay Generating Station is situated on the coastal plain of the Ventura Basin, approximately 30 km northwest of Point Mugu and 3 km south of the mouth of the Santa Clara River (Figure 2). The Ventura Basin is defined by the Ventura River delta to the north and the barrier beaches at Point Mugu to the south. Prominent natural features of this stretch of coast include straight sandy beaches, the dunes along Mandalay Beach, and the marshes and lagoon in the naval reservation near Point Mugu.

The eight islands offshore southern California strongly influence water circulation and general oceanographic characteristics of the entire Southern California Bight. The mainland shelf is narrow along the coast, ranging in width from less than 1.6 to more than 19 km, averaging approximately 7 km. Seaward of the shelf is an irregular and geologically complex region known as the continental borderland, which consists of numerous ridges and basins extending from near the surface to depths in excess of 2,400 meters (m).

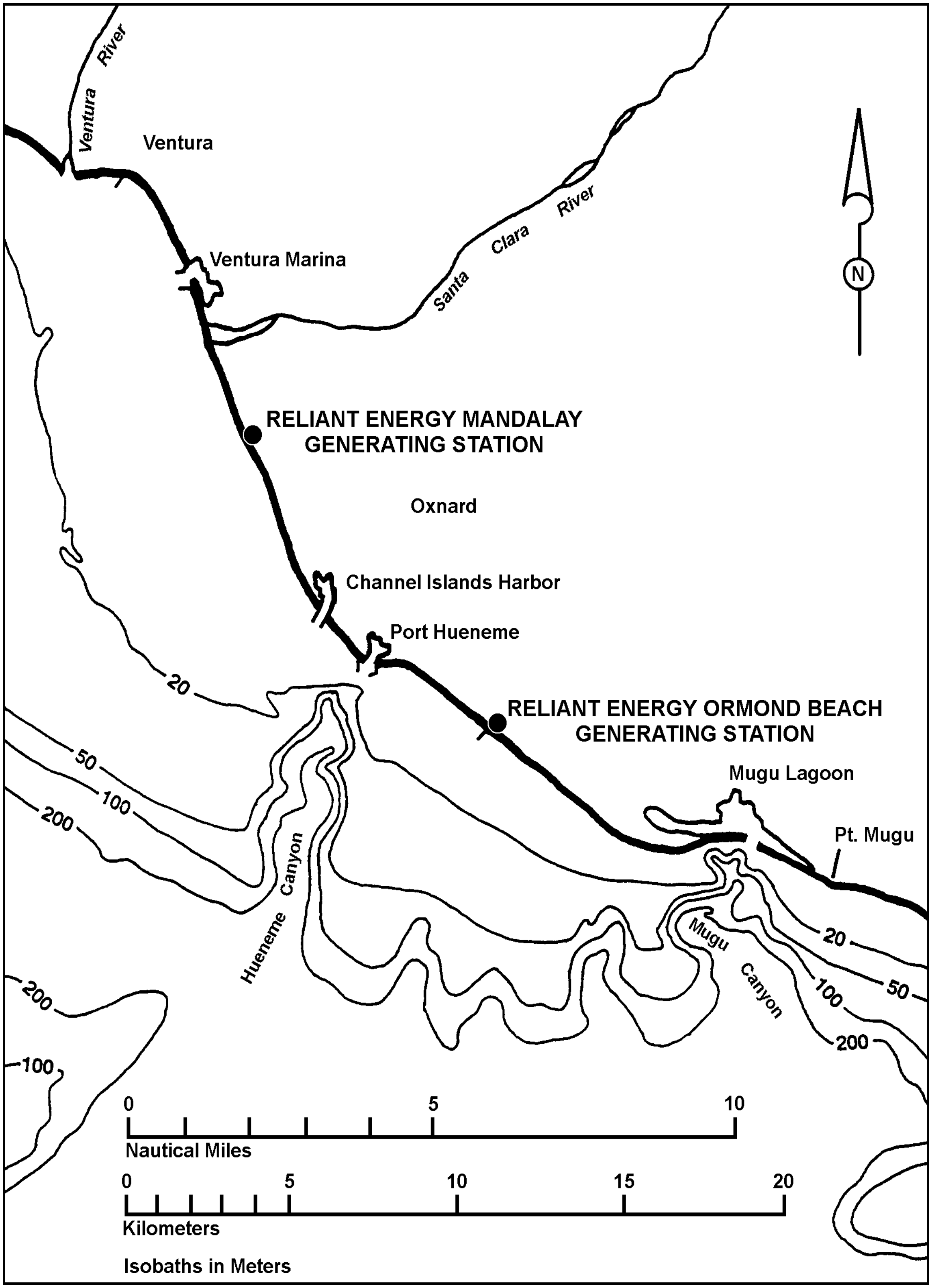



**Figure 2. Location of the study area. Mandalay Generating Station NPDES, 2005.**

**Submarine Physiography**

The submarine physiography of the Ventura Basin is characterized by two distinct areas divided by the Hueneme Canyon (IRC 1973). To the northwest of the Hueneme Canyon is a broad gently sloping sea floor and to the southeast a narrower, steeper slope (Figure 2). Mugu Canyon cuts into the slope near the southeastern boundary of the basin.

Offshore at Mandalay Beach, the 20 fathom (fm) contour is 12.8 to 16.0 km from shore while further south in the basin, it is closer (3.2 to 6.4 km) to shore. The head of Hueneme Submarine Canyon approaches the shoreline so closely that the 20 fm isobath is within 100 m of the jetties at Port Hueneme. There are no major irregularities in bathymetry between Hueneme Canyon and the mouth of the Ventura River.

Marked changes in bottom topography close to shore can result in irregular current patterns and variable current velocities. Nearshore circulation in the study area is affected by Hueneme and Mugu Canyons, Port Hueneme, Channel Islands Harbor, the Ventura Marina, and the mouth of the Santa Clara River. None of the studies conducted at the Mandalay Generating Station indicated that the tidal prism from the harbors and marinas in the area significantly influence current speed and direction near the generating station.

**Climate**

Southern California is in a climatic regime broadly defined as Mediterranean, which is characterized by short, mild winters and warm, dry summers. Long-term annual precipitation near the coast averages about 46 centimeters (cm), of which 90% occurs between November and April. Monthly mean air temperatures along the coast range from 8.3°C in winter to 20.6°C in summer, with daily minima dropping slightly below freezing and maxima reaching above 37°C.

Sea breezes, which develop from differential heating between land and sea masses, combine with the prevailing winds from the northwest during summer months to produce strong onshore winds. Summer sea breezes typically start at about noon and may continue through late afternoon, with speeds reaching 37 km/hour (hr). In late fall and winter, reverse pressure systems frequently develop; coastal winds tend to be from the southeast and the sea breezes typically blow from 1300 hr to as late as 2000 hr.

**Ocean 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 comprises the California Current, a diffuse and meandering water mass which generally flows to the southeast, following the coast. 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 generally flows along the Patton Escarpment (160 km offshore) and approaches the coast again near Cape Colnett, Baja California (Figure 3). Off Baja California part of the California Current turns north forming a counter-current in the Southern California Bight known as the Southern California Countercurrent. Part of this countercurrent flows through the Santa Barbara Channel and then rejoins the California Current while the rest turns and flows south nearshore. Nearshore, coastal currents are strongly influenced by a combination of wind, tides, and local physiography. Therefore, short-term observations of currents near the coast often vary in both direction and speed.

Surface speed in the countercurrent ranges between 5.5 and 11 centimeters per second (cm/s). The general flow pattern is complicated by eddies in the Channel Islands region and fluctuates seasonally, being more strongly developed in summer and autumn, and weak or occasionally absent in winter and spring.

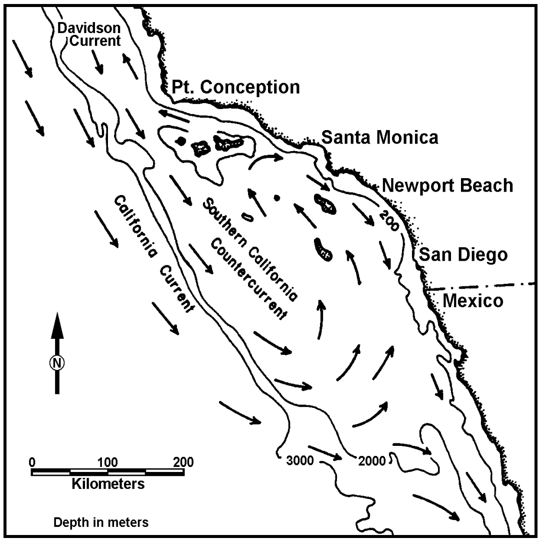



**Figure 3. Surface circulation in the Southern California Bight (from Jones 1971). Mandalay Generating Station NPDES, 2005.**

### Longshore Drift

Longshore currents typically move sand parallel to shore and thus toward the heads of submarine canyons either upcoast or downcoast. In the Hueneme area southeast of Mandalay, the net littoral sediment transport, or longshore drift, is downcoast at the rate of 600,000 to 900,000 $m^3$ per year. When the entrance to Port Hueneme was constructed, the upcoast jetty effectively trapped or diverted the natural sand supply that was formerly available to beaches in the Ormond Beach area. That portion of sediment not trapped by the jetty was lost into deep water at the head of the Hueneme Canyon. Approximately 900,000 $m^3$ per year are eroded downcoast of the jetties. Slightly more than 1,500,000 $m^3$ of sediment are dredged and bypassed biannually around the trap. Erosion southeast of the harbor continues, however, at a rate of approximately 1,500,000 $m^3$ per year.

Channel Islands Harbor was designed to prevent sediment loss into Hueneme Canyon. The detached breakwater at the harbor entrance provides a shadow zone which traps sediment upcoast of the northwest jetty. In 1960-61, dredging of the sand trap, the entrance channel, and the first phase of development at Channel Islands Harbor provided about 4,120,000 $m^3$ of sand which were used for beach nourishment (IRC 1973). To the northwest of the Mandalay Generating Station the normal southeasterly movement of sediment from the Ventura River area is interrupted by the trap effect of Ventura Marina breakwater and jetties.

### Tides

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

### Upwelling

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

## RECEIVING WATER CHARACTERISTICS

The capacity of the marine environment to assimilate heated cooling water depends on its ability to dilute and disperse the thermal discharge. The extent to which these functions are accomplished depends on the quantity and temperature of the thermal effluent relative to normal ocean temperatures and ocean current patterns as well as other characteristics of the receiving waters. These factors are the primary determinants of the fate and effect of thermal effluent discharge. The following discussion focuses on natural physical and chemical oceanographic characteristics that influence the local marine biota.

**Temperature**

Natural water temperatures fluctuate throughout the year in response to seasonal and diurnal variations in currents; meteorological conditions such as wind, air temperature, relative humidity, and cloud cover; and parameters such as ocean waves and turbulence. Natural temperature is defined by the California State Water Resources Control Board (SWRCB 1972) as "the temperature of the receiving water at locations, depths, and times which represent conditions unaffected by any elevated temperature waste discharge or irrigation return waters."

Daily surface water temperatures may be expected to vary 1°C to 2°C in summer and 0.3°C to 1°C in winter on the average. Factors contributing to rapid daytime warming of the sea surface are weak winds, clear skies, and warm air temperatures; factors that limit diurnal temperature ranges are overcast skies, moderate air temperatures, and mixing of the surface waters by winds and waves.

Between July 1970 and January 1973 natural surface water temperatures at nearby Ormond Beach ranged from 11.4°C in December 1971 to 22.0°C in August of the same year. During 1971-1972 minimum and maximum surface water temperatures at a control station offshore from the Mandalay Generating Station were 11.6°C and 22.7°C, respectively (IRC 1973).

When there is a large difference between surface and bottom water temperatures, a steep temperature gradient between adjacent water layers of different temperatures (i.e., a thermocline) may develop. Natural thermoclines are formed when absorption of solar radiation at the sea surface develops a stable stratification, separating surface from subsurface layers. Off southern California, a reasonably sharp thermocline is normally found in summer in the upper 30 m of the water column; in winter thermoclines are weakly defined. Artificial thermoclines may result when warm water from a thermal discharge overlies cooler receiving waters.

**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 fluctuates in coastal environments as a result of the introduction of freshwater runoff and direct rainfall, and through the evaporation of freshwater. Between 1965 and 1971 surface salinity at the Ventura Marina ranged from a minimum of 24.1 ppt, which was associated with rainfall runoff, to a maximum of approximately 33.9 ppt (IRC 1973).

**Dissolved Oxygen**

Dissolved oxygen (DO) is utilized by aquatic plants and animals in their metabolic processes; it is replenished by gaseous exchange with the atmosphere and as a byproduct of photosynthesis. High values generally result from photosynthetic activity and low values from mixing of surface waters with oxygen-depleted subsurface waters. Between July 1970 and January 1973, concentrations in surface waters offshore Ormond Beach ranged from 7.3 milligrams per liter (mg/l) to 11.0 mg/l (IRC 1973).

**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 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 conducted offshore Ormond Beach between December 1973 and September 1974 were 8.0 to 8.6 (EQA/MBC 1975).

**BENEFICIAL USES OF RECEIVING WATERS**

The Water Quality Control Plan for the Santa Clara River Basin (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 Mandalay 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.

**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 uses may not directly apply to the generating station's receiving waters at all times, they may be reasonably assumed to constitute occasional beneficial uses of nearshore waters in the study area.

## SCOPE OF THE MONITORING PROGRAM

The 2005 monitoring program for the Mandalay 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 winter and summer trawling for fish and macroinvertebrates.

## STATION LOCATIONS

The locations of the monitoring stations are described in Appendix A and shown on Figure 4. The 2005 monitoring program included 17 water quality (RW) stations, four trawl (T) stations, and five sediment and benthic infauna (B) stations.

## FIELD OBSERVATIONS

The NPDES trawl surveys were conducted on 7 April and 29 June, receiving 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), trawl (T), and benthic (B) stations are listed in Table 1.

During the winter surveys, no oil sheens, grease, or red tide (plankton bloom) were observed at any of the stations. The water was turbid throughout the trawl sampling area and at all receiving water stations. Drift wood was noted at Station RW6 on the ebb tide. Western gulls (*Larus occidentalis*) were seen at all trawl stations and most of the receiving water stations. Forster's tern (*Sterna forsteri*) were seen at Station RW13, Western grebes (*Aechmophorus occidentalis*) were seen at Stations RW6 through RW9, and RW15, and cormorants (*Phalacrocorax* spp) were seen at Stations RW6, RW7, and RW11. Sanderlings (*Calidris alba*) were seen at most of the surf-zone

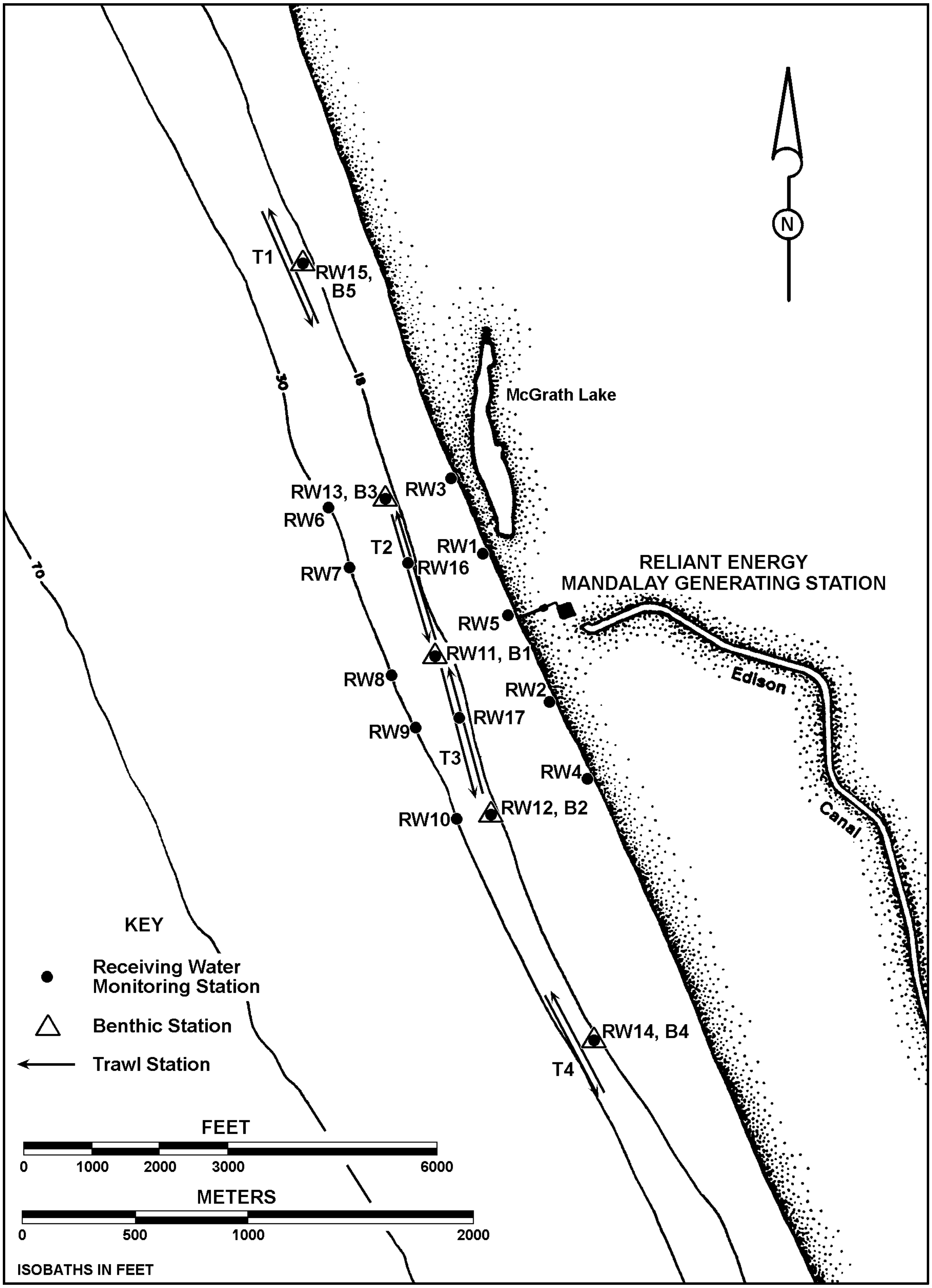



**Figure 4. Location of the monitoring stations. Mandalay Generating Station NPDES, 2005.**

stations. California brown pelicans (*Pelecanus occidentalis californicus*) were seen at Stations T3, T4, and at most receiving water stations. No California least terns (*Sterna antillarum browni*) were observed during any of the winter surveys.

**Table 1. Latitude/longitude coordinates of sampling stations. Mandalay Generating Station NPDES, 2005.**

| Stations | | | |
|---|---|---|---|
| Water Quality | Benthic | Latitude | Longitude |
| RW6 | | 34°12.58' | 119°15.81' |
| RW7 | | 34°12.40' | 119°15.73' |
| RW8 | | 34°12.22' | 119°15.59' |
| RW9 | | 34°12.06' | 119°15.50' |
| RW10 | | 34°11.88' | 119°15.35' |
| RW11 | B1 | 34°12.30' | 119°15.40' |
| RW12 | B2 | 34°11.94' | 119°15.20' |
| RW13 | B3 | 34°12.65' | 119°15.58' |
| RW14 | B4 | 34°11.40' | 119°14.92' |
| RW15 | B5 | 34°13.17' | 119°15.93' |
| RW16 | | 34°12.47' | 119°15.51' |
| RW17 | | 34°12.11' | 119°15.31' |
| Trawl Stations | Heading | Latitude | Longitude |
| T1 | 130° | 34°13.37' | 119°15.98' |
| T2 | 138° | 34°12.62' | 119°15.61' |
| T3 | 130° | 34°12.12' | 119°15.33' |
| T4 | 150° | 34°11.52' | 119°15.05' |

During the summer surveys, no oil sheens or grease were observed at any of the stations. The water was slightly turbid at Station T2, slightly to moderately turbid at all receiving water stations, and turbid at Stations B2. Red tide was observed at Station RW14. Drift kelp (*Macrocystis pyrifera*) was noted at Stations T2, T3, and B5. Western gulls were seen throughout the sediment core collection stations, trawl sampling area, and at most receiving water stations. Heermann's gull (*Larus heermanni*) were seen at Stations RW1 through RW3, RW11, RW12, RW14, and RW16. Forster's terns were seen at Station RW16, Western grebes were seen at Station B3, and cormorants were seen at Stations B1, B4, T2,T4, RW3, RW5 through RW7, and RW10. Sanderlings and western sandpipers (*Calidris mauri*) were seen at Station RW1 and whimbrels (*Numenius phaeopus*) were seen at most surf-zone stations. California sea lions (*Zalophus californianus*) were seen at Stations B2, B3, B5, and T2. A small pod of bottlenose dolphins were seen at Station B1. California brown pelicans were seen at Stations RW1 through RW3, RW10 through RW11, RW15, RW16, at most of sediment core collection stations, and throughout the trawl sampling area. No California least terns were observed during any of the summer surveys.

## STATISTICAL ANALYSES

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

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

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

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

**DETECTION / REPORTING LIMITS**

Detection/reporting limits used in reporting chemistry results are interpreted as the smallest amount of a given analyte that can be measured above the random noise inherent in any analytical tool. Thus, any value below the detection/reporting limits cannot be considered a reliable estimate of analyte concentration. Therefore, where a test for a given analyte results in a level below the detection/reporting limit, a “none detected” (ND) value has been assigned. The complication of what numerical value to substitute for ND in statistical calculations is addressed by 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 such as water temperature, dissolved oxygen concentration, hydrogen ion concentration, and salinity are important components of a discharge monitoring program. Because biological communities exist in equilibrium within the marine environment, changes in the properties of these characteristics can result in potentially adverse impacts to these communities. As the properties within the receiving waters can vary naturally on a relatively small scale, water quality monitoring 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 waters remain protected.

Receiving water monitoring stations for the Mandalay Generating Station are shown in Figure 5. Seasonal water quality profiles for ebb and flood tides are presented in the following figures and summarized in Tables 2 and 3. Raw data are provided in Appendix C.

## MATERIALS AND METHODS

Water quality monitoring was conducted at 17 receiving water (RW) stations located within the surrounding waters of the discharge channel. Stations RW1 through RW5 are positioned along the beach within the surf-zone. Stations RW6 through RW10 are positioned along the 30-foot (ft) isobath and Stations RW11 through RW17 are positioned along the 20-ft isobath. Water temperature, dissolved oxygen concentration, hydrogen ion concentration, and salinity were recorded during ebbing and flooding tides, during winter and summer surveys.

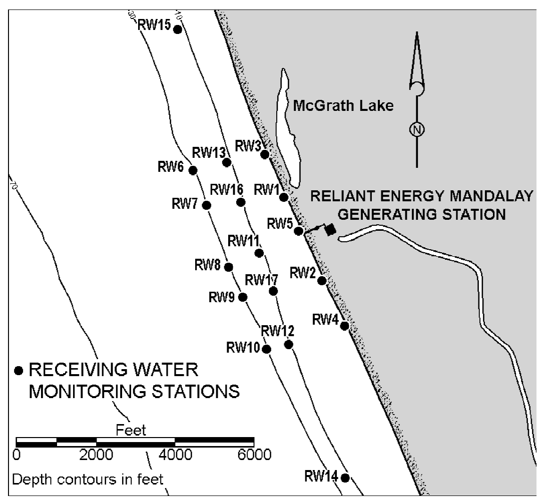



**Figure 5. Location of the water column sampling stations. Mandalay Generating Station NPDES, 2005.**

Winter water quality was monitored on 14 April 2005 during ebb and flood tides. At surf-zone Stations RW1 through RW5, ebb tide was monitored between 0643 and 0815 hours (hr) and flood tide was monitored between 0955 and 1111 hr. At offshore Stations RW6 through RW17, ebb tide was monitored between 0741 and 0835 hr and flood tide was monitored between 0934 and 1032 hr (Figure 6). 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 at surf-zone stations were partly cloudy with winds that changed from northeast to west at 1 to 7 knots (kn). Seas were west at 1 to 3 ft. At offshore stations, skies were clear with winds that changed from northeast to west at 2 to 5 kn. Seas were west at 4 to 6 ft. During the water quality monitoring, two circulator pumps were in operation at the Mandalay Generating Station, with a discharge temperature of 2.2°C (4.0°F) warmer than ambient water temperature (Norfolk 2005, pers. comm.).

Summer water quality was monitored on 14 July 2005 during ebb and flood tides. At surf-zone stations, ebb tide was monitored between 0650 and 0755 hr and flood tide was monitored between 1000 and 1107 hr. At offshore stations, ebb tide was monitored between 0757 and 0859 hr and flood tide was monitored between 0942 and 1047 hr (Figure 6). 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 at surf-zone stations were overcast to mostly cloudy with winds from the west at 1 to 5 kn. Seas were west at 2 to 4 ft. At offshore stations, skies were overcast with winds from the west at 2 to 5 kn. Seas were west at 4 to 7 ft. During water quality monitoring, four circulator pumps were in operation at the Mandalay Generating Station, with a discharge temperature of 10.6°C (19.0°F) warmer than ambient water temperature (Norfolk 2005, pers. comm.).

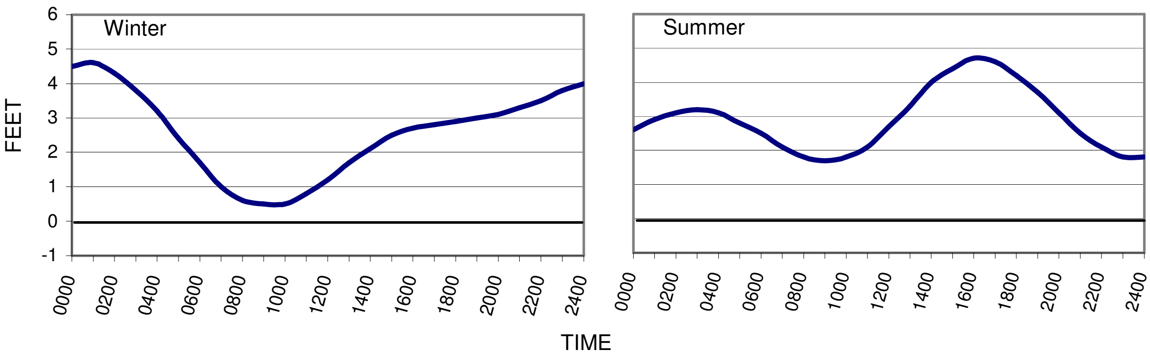



**Figure 6. Tidal rhythms during water column monitoring, winter and summer surveys. Mandalay Generating Station NPDES, 2005.**

Water quality monitoring at surf-zone stations was conducted by collecting surface water samples from within the surf-zone. Water samples were analyzed in the field using a YSI 556 Multi-Probe System water quality analyzer. Monitoring at offshore stations was conducted using a Sea-Bird Water Quality Monitoring System (SBE 9/17). Data were processed using the Sea-Bird proprietary software (SeaSoft). The resulting data was imported into Microsoft Office Excel 2000 spreadsheets for further reduction and analysis. Vertical water quality profiles were constructed with SigmaPlot version 9. Color contour images depicting sea surface temperatures were constructed with TecPlot version 9.

## RESULTS

### Water Temperature

During winter monitoring, offshore surface water temperatures during ebb tide averaged 11.06°C and ranged from 10.78°C at Station RW16, upcoast of the discharge on the 20-ft isobath, to 11.31°C at Station RW10, furthest downcoast of the discharge on the 30-ft isobath (Table 2 and Figure 7). Surface water temperatures during flood tide averaged 11.43°C and ranged from 10.98°C

**Table 2. Summary of water quality parameters during flood and ebb tides at offshore stations. Mandalay 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 | 11.43 | 11.06 | 7.60 | 6.84 | 7.88 | 7.91 | 32.73 | 33.39 | 10.43 | 10.60 | 3.94 | 4.39 | 7.76 | 7.78 | 33.80 | 33.78 |
| Minimum | 10.98 | 10.78 | 6.98 | 5.21 | 7.84 | 7.84 | 31.91 | 32.91 | 10.36 | 10.40 | 3.76 | 3.69 | 7.75 | 7.75 | 33.76 | 33.73 |
| Maximum | 11.93 | 11.31 | 8.12 | 8.48 | 7.92 | 7.99 | 33.55 | 33.69 | 10.71 | 10.87 | 4.49 | 5.35 | 7.78 | 7.83 | 33.82 | 33.81 |
| **Summer** | | | | | | | | | | | | | | | | |
| | Surface | | | | | | | | Bottom | | | | | | | |
| | flood | ebb | flood | ebb | flood | ebb | flood | ebb | flood | ebb | flood | ebb | flood | ebb | flood | ebb |
| Mean | 15.00 | 15.33 | 7.14 | 7.10 | 8.01 | 8.04 | 33.47 | 33.43 | 12.78 | 12.82 | 5.06 | 5.11 | 7.83 | 7.84 | 33.57 | 33.55 |
| Minimum | 14.52 | 14.85 | 6.52 | 6.30 | 7.93 | 7.97 | 33.37 | 33.37 | 12.54 | 12.52 | 4.88 | 4.86 | 7.81 | 7.81 | 33.54 | 33.54 |
| Maximum | 15.60 | 15.85 | 7.69 | 7.58 | 8.09 | 8.11 | 33.52 | 33.49 | 13.19 | 13.21 | 5.43 | 5.36 | 7.85 | 7.87 | 33.63 | 33.57 |

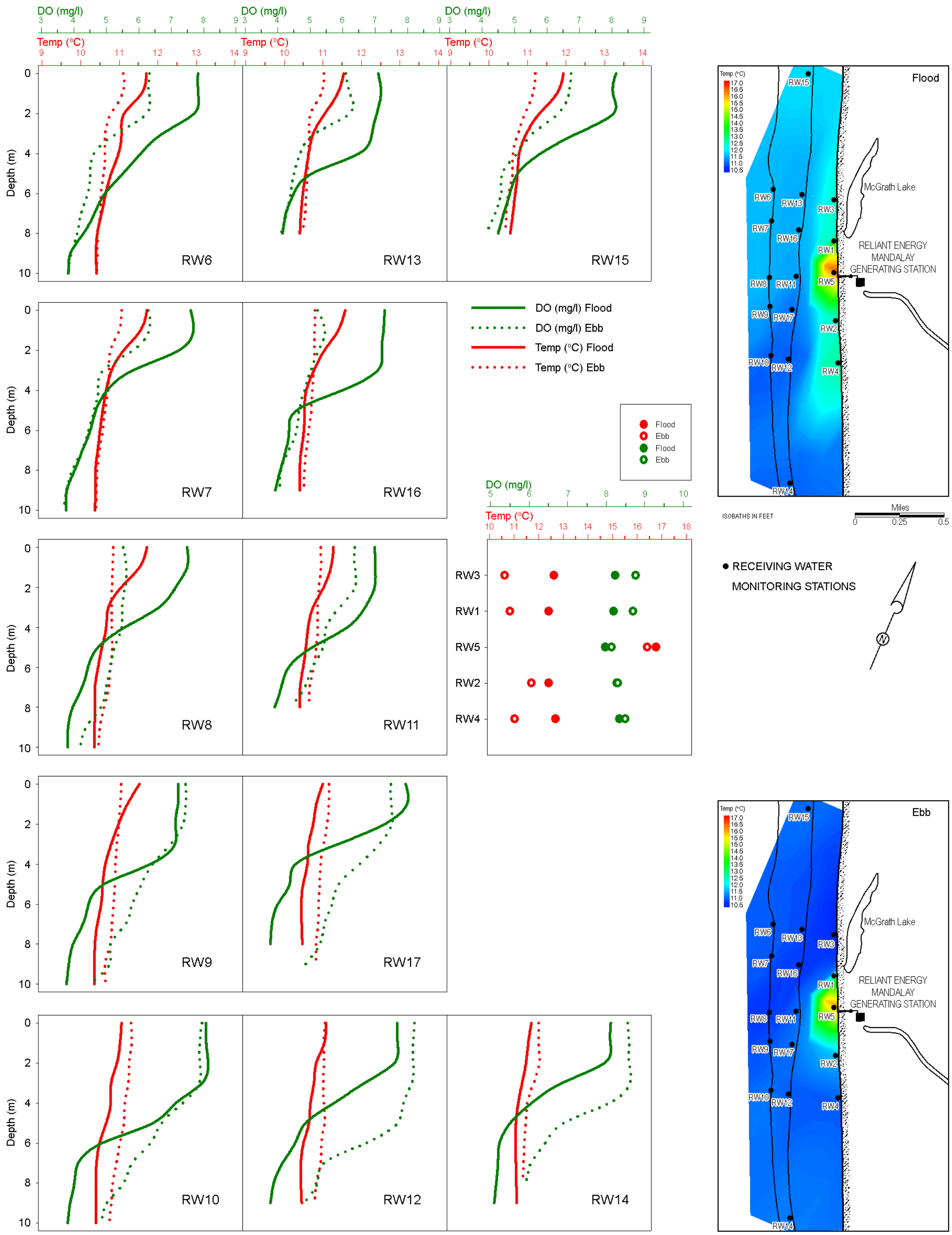



**Figure 7. False color surface temperature contour plots, surf zone water quality, and temperature and dissolved oxygen vertical profiles during flood and ebb tides, winter survey. Mandalay Generating Station NPDES, 2005.**

at Station RW17, downcoast of the discharge on the 20-ft isobath, to 11.93°C at Station RW15, furthest upcoast of the discharge on the 20-ft isobath. At most stations, surface temperatures during flood tide monitoring were slightly higher than ebb tide monitoring (Figure 7). Temperature decreased from surface to bottom at all stations during both tides. The water column was fairly well-mixed and no thermocline was apparent at any of the stations. Average bottom water temperatures were 10.60°C during ebb tide and 10.43°C during flood tide (Table 2). Coolest bottom water temperatures were recorded at stations along the 30-ft isobath and warmest bottom temperature was recorded at Station RW14, furthest downcoast of the discharge on the 20-ft isobath.

At surf-zone stations, surface water temperatures during ebb tide averaged 12.12°C and ranged from 10.62°C at Station RW3, furthest upcoast of the discharge, to 16.41°C at Station RW5, at the discharge channel (Table 3 and Figure 7). Surface water temperatures during flood tide averaged 13.37°C and ranged from 12.40°C at Station RW1, upcoast of the discharge, to 16.76°C at Station RW5. Water temperatures recorded at the discharge channel were 4 to 6°C higher than temperatures recorded at the other stations during both tides.

**Table 3. Summary of water quality parameters during flood and ebb tides at surf-zone stations. Mandalay Generating Station NPDES, 2005.**

| | Temp. (°C) | | D.O. (mg/l) | | pH | | Salinity (psu) | | Temp. (°C) | | D.O. (mg/l) | | pH | | Salinity (psu) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Winter** | | | | | | | | **Summer** | | | | | | | |
| | flood | ebb | flood | ebb | flood | ebb | flood | ebb | flood | ebb | flood | ebb | flood | ebb | flood | ebb |
| Mean | 13.37 | 12.12 | 8.19 | 8.47 | 7.91 | 7.88 | 32.32 | 32.82 | 17.32 | 17.14 | 7.02 | 6.82 | 7.99 | 7.96 | 32.66 | 32.68 |
| Minimum | 12.40 | 10.62 | 7.97 | 8.13 | 7.88 | 7.85 | 31.24 | 31.69 | 14.84 | 15.78 | 6.27 | 6.45 | 7.97 | 7.92 | 32.39 | 32.39 |
| Maximum | 16.76 | 16.41 | 8.33 | 8.76 | 7.95 | 7.97 | 32.74 | 33.33 | 21.48 | 19.63 | 7.46 | 7.14 | 8.01 | 8.00 | 32.87 | 32.89 |

During summer monitoring, offshore surface water temperature during ebb tide averaged 15.33°C and ranged from 14.85°C at Station RW15 to 15.85°C at Station RW7, upcoast of the discharge on the 30-ft isobath (Table 2 and Figure 8). Surface water temperatures during flood tide averaged 15.00°C and ranged from 14.52°C at Station RW13, upcoast of the discharge on the 20-ft isobath, to 15.60°C at Station RW7. At most stations, surface temperatures during ebb tide monitoring were slightly higher than flood tide monitoring (Figure 8). Temperature decreased from surface to bottom at all stations during both tides. A thermocline was apparent between the depths of one to four meters at most stations along the 30-ft isobath and between the depths of one to three meters at most stations along the 20-ft isobath. Average bottom water temperatures were 12.82°C during ebb tide and 12.78°C during flood tide (Table 2). Coolest bottom water temperature was recorded at Station RW6, furthest upcoast of the discharge on the 30-ft isobath, and warmest bottom temperature was recorded at Station RW12, downcoast of the discharge on the 20-ft isobath.

At surf-zone stations, surface water temperatures during ebb tide averaged 17.14°C and ranged from 15.78°C at Stations RW1, upcoast of the discharge, to 19.63°C at Station RW2, downcoast of the discharge channel (Table 3 and Figure 8). Surface water temperatures during flood tide averaged 17.32°C and ranged from 14.84°C at Station RW1 to 21.48°C at Station RW5. Temperatures recorded at Stations RW5 and RW2 were 2 to 6°C higher than temperatures recorded at the other stations during both tides.

### Dissolved Oxygen

During winter monitoring, offshore surface dissolved oxygen (DO) concentration during ebb tide averaged 6.84 mg/l and ranged from 5.21 mg/l at Station RW16 to 8.48 mg/l at Station RW14 (Table 2 and Figure 7). Surface DO concentrations during flood tide averaged 7.60 mg/l and ranged from 6.98 mg/l at Station RW11, directly offshore of the discharge on the 20-ft isobath, to 8.12 mg/l

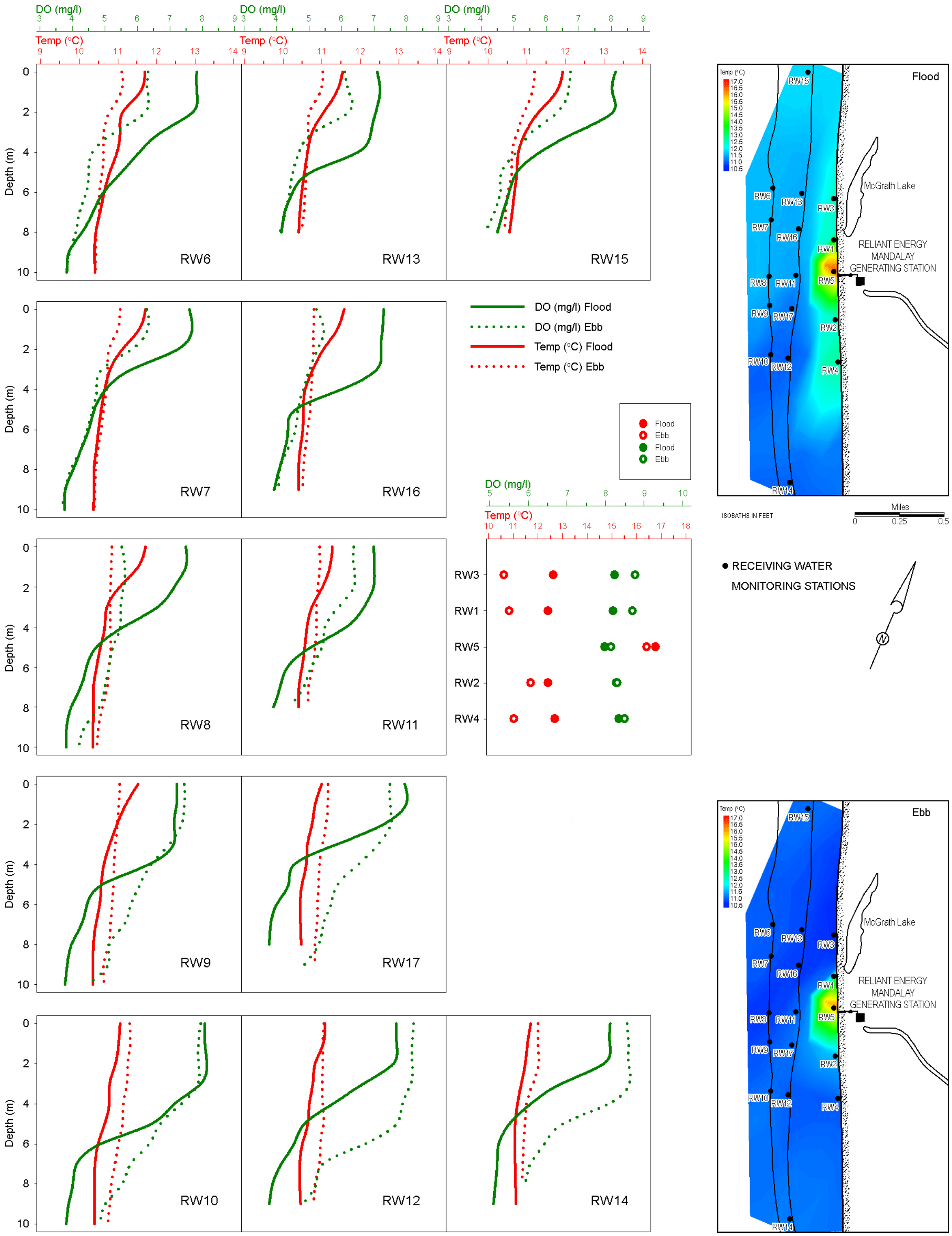



**Figure 8. False color surface temperature contour plots, surf zone water quality, and temperature and dissolved oxygen vertical profiles during flood and ebb tides, summer survey. Mandalay Generating Station NPDES, 2005.**

at Station RW15. Maximum DO concentrations were recorded within the upper two to three meters of the water column at all stations (Figure 7). Dissolved oxygen concentrations rapidly declined between the depths of two and five meters at most stations prior to gradually declining with depth. Average bottom DO values were 4.39 mg/l during ebb tide and 3.94 mg/l during flood tide (Table 2). Lowest bottom DO value was recorded at Station RW7 and the highest value was recorded at Sation RW14.

At surf-zone stations, surface DO concentrations during ebb tide averaged 8.47 mg/l and ranged from 8.13 mg/l at Station RW5 to 8.76 mg/l at Station RW3 (Table 3 and Figure 7). Surface DO concentrations during flood tide averaged 8.19 mg/l and ranged from 7.97 mg/l at Stations RW5 to 8.33 mg/l at Station RW4, furthest downcoast of the discharge.

During summer monitoring, offshore surface DO concentration during ebb tide averaged 7.10 mg/l and ranged from 6.30 mg/l at Station RW15 to 7.58 mg/l at Station RW7 (Table 2 and Figure 8). Surface DO concentrations during flood tide averaged 7.14 mg/l and ranged from 6.52 mg/l at Station RW9, downcoast of the discharge on the 30-ft isobath, to 7.69 mg/l at Station RW7. Maximum DO concentrations were recorded within the upper two meters of the water column at all stations (Figure 8). Dissolved oxygen concentrations rapidly declined between the depths of two and four meters at most stations prior to gradually declining with depth. Profiles were relatively similar between tides at all stations. Average bottom DO values were 5.11 mg/l during ebb tide and 5.06 mg/l during flood tide (Table 2). Lowest bottom DO value was recorded at Station RW6 and the highest value was recorded at Sation RW12.

At surf-zone stations, surface DO concentrations during ebb tide averaged 6.82 mg/l and ranged from 6.45 mg/l at Station RW2 to 7.14 mg/l at Station RW1 (Table 3 and Figure 8). Surface DO concentrations during flood tide averaged 7.02 mg/l and ranged from 6.27 mg/l at Station RW5 to 7.46 mg/l at Station RW1.

**Hydrogen Ion Concentration**

During winter monitoring, offshore surface hydrogen ion concentrations (pH) averaged 7.91 during ebb tide and 7.88 during flood tide (Table 2). Profiles were similar among stations and between tides, and fluctuated little throughout the water column (Figure 9). Average bottom pH values were 7.78 during ebb tide and 7.76 during flood tide (Table 2). The maximum surface-to-bottom difference was 0.20 at Stations RW9 and RW10.

At surf-zone stations, surface pH values averaged 7.88 during ebb tide and 7.91 during flood tide (Table 3). Hydrogen ion concentrations varied by less than 0.15 units among stations and between tides. Highest pH values were recorded at Station RW5 (Figure 9).

During summer monitoring, offshore surface pH values averaged 8.04 during ebb tide and 8.01 during flood tide (Table 2). Values throughout the water column varied little among stations and between tides (Figure 10). Average bottom pH values were 7.84 during ebb tide and 7.83 during flood tide (Table 2). The maximum surface-to-bottom difference was 0.30 at Station RW6.

At surf-zone stations, surface pH values averaged 7.96 during ebb tide and 7.99 during flood tide (Table 3). Hydrogen ion concentrations varied by less than 0.10 units among stations and between tides. Highest pH value was recorded at Station RW3 (Figure 10).

**Salinity**

During winter monitoring, offshore surface salinity readings averaged 33.39 practical salinity units (psu) during ebb tide and 32.73 psu during flood tide (Table 2). Lower salinity values were

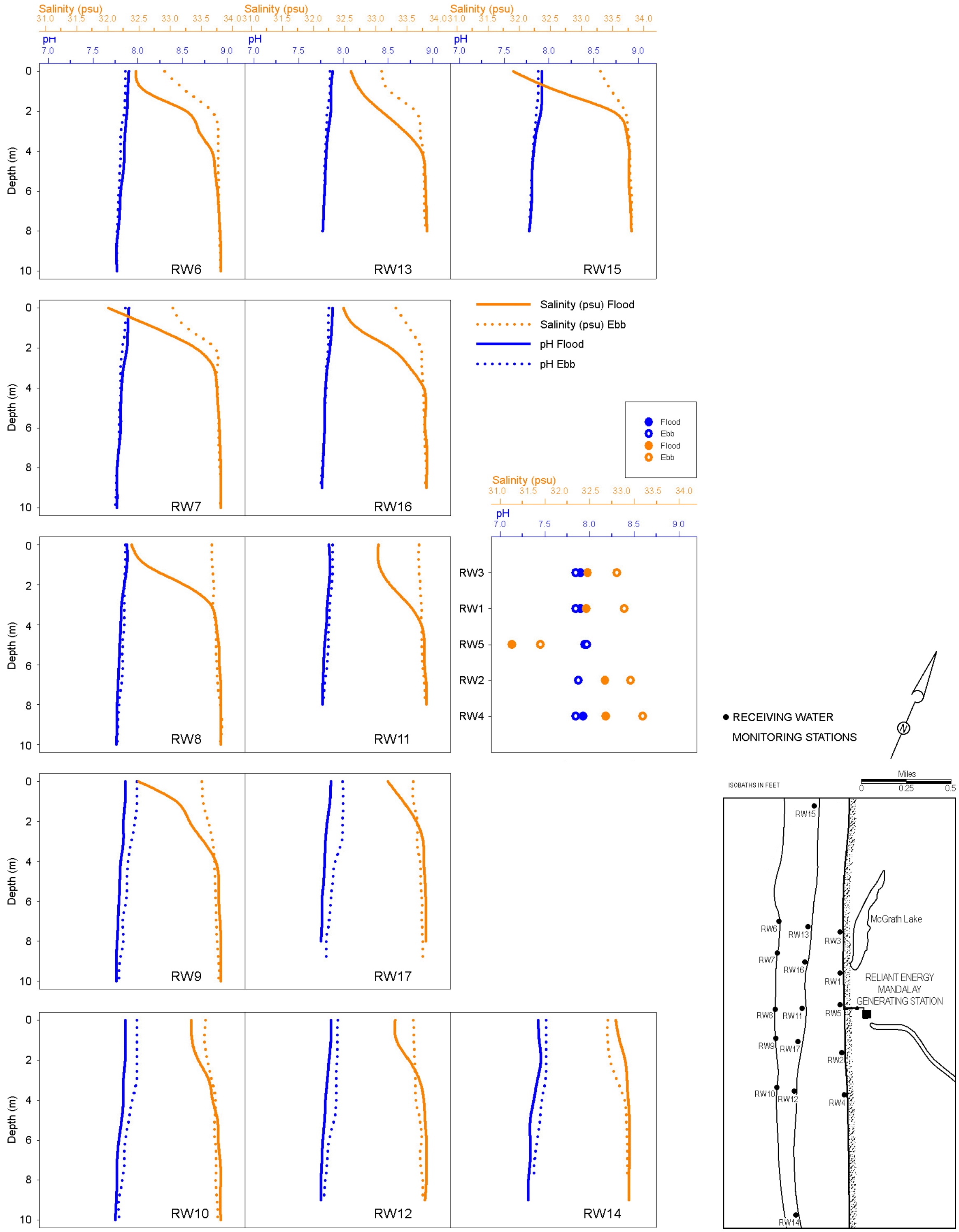



**Figure 9. Surf zone water quality parameters, and hydrogen ion concentration (pH) and salinity vertical profiles during flood and ebb tides, winter survey. Mandalay Generating Station NPDES, 2005.**

recorded within the upper four meters at most stations off of and upcoast of the discharge channel during flood than those recorded during ebb tide (Figure 9). Average bottom salinity values were

33.78 psu during ebb tide and 33.80 psu during flood tide (Table 2). The maximum surface-to-bottom differences were 0.89 at Station RW6 during ebb tide and 1.89 psu at Station RW15 during flood tide.

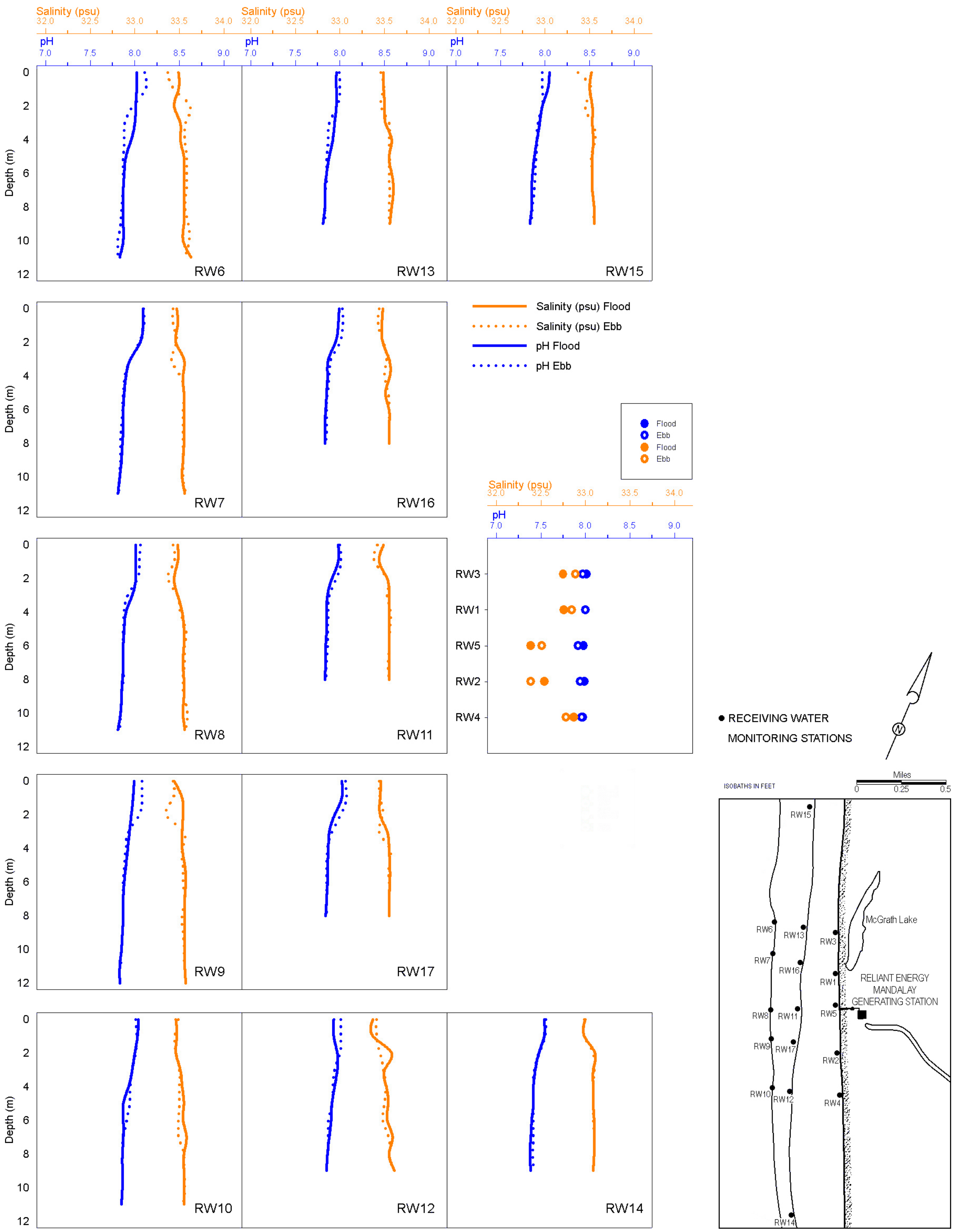



**Figure 10. Surf zone water quality parameters, and hydrogen ion concentration (pH) and salinity vertical profiles during flood and ebb tides, summer survey. Mandalay Generating Station NPDES, 2005.**

At surf-zone stations, surface salinity readings averaged 32.82 psu during ebb tide and 32.32 psu during flood tide (Table 3). Salinity varied by 1.64 psu during ebb tide and 1.50 psu during flood tide. Lowest salinity values were recorded at Station RW5 and highest salinity values were recorded at Station RW4 (Figure 9).

During summer monitoring, offshore surface salinity readings averaged 33.43 psu during ebb tide and 33.47 psu during flood tide (Table 2). Salinity values throughout the water column varied by less than 0.30 psu among stations and between tides (Figure 10). Average bottom salinity values were 33.55 psu during ebb tide and 33.57 psu during flood tide (Table 2). The maximum surface-to-bottom difference was less than 0.25 psu at Station RW12.

At surf-zone stations, surface salinity readings averaged 32.68 psu during ebb tide and 32.66 psu during flood tide (Table 3). Salinity varied by 0.50 psu or less during both tides. Lowest salinity values were recorded at Station RW2 during the ebb tide and Station RW5 during the flood tide. Highest salinity values were recorded at Station RW3 during ebb tide and RW4 during flood tide (Figure 10).

## DISCUSSION

### Water Temperature

Water temperature monitoring was conducted on ebbing and flooding tides during winter and summer surveys, within the receiving waters of the Mandalay Generating Station discharge to document the dispersion of the thermal inputs within the receiving waters. During winter water quality monitoring, a highly localized thermal plume was detected at Station RW5, at the discharge channel, and quickly dissipated in all directions. Surface water temperatures recorded at Station RW5 were 4 to 6°C higher than surface water temperatures recorded at all other stations during both tides. Surface water temperatures at offshore stations were similar, within 0.5°C, among stations, and varied by less than 1.2°C between tides. The water column was fairly well-mixed with slight decreases in temperature with depth. On the day of monitoring, winter water temperatures were within the range considered normal, and were similar to temperatures previously reported for the coastal waters off of the generating station (MBC 1979, 1981, 1986, 1988, 1990, 1994-2000, 2001a-2002a, 2003, 2004a; Ogden 1991-1993).

During summer water quality monitoring, a nearshore thermal plume extended downcoast from Station RW5 to Station RW2 but was not detected at any of the other surf-zone or offshore stations. Surface water temperatures recorded at Station RW5 and RW2 were 2 to 6°C higher than surface water temperatures recorded at all other stations during both tides. Surface water temperatures at offshore stations were similar, within 1.1°C, among stations, and varied by less than 1.5°C between tides. A thermocline was recorded at subsurface depths at most offshore stations. Summer temperature profiles had greater surface-to-bottom differences than winter profiles. This pattern is a typical seasonal occurrence that can result from increased solar insolation and reduced surface water mixing. On the day of monitoring, summer water temperatures were within the range considered normal, and were similar to temperatures previously reported for the coastal waters off of the generating station (MBC 1979, 1981, 1986, 1988, 1990, 1994-2000, 2001a-2002a, 2003, 2004a; Ogden 1991-1993).

### Dissolved Oxygen

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

During winter monitoring, surface DO values on average were higher at surf-zone stations than at offshore stations. This pattern could be associated with wave action along the shoreline. The lowest DO value recorded among surf-zone stations was at RW5, which also had the warmest water temperature recorded. Surface DO concentrations varied by as much as 3.3 mg/l among stations and between tides. The lowest surface DO value recorded among offshore stations was at RW16, which in contrast had the coolest surface water temperature. Maximum DO concentrations were recorded within the upper two to three meters of the water column. Below this surface layer, DO concentrations declined with depth suggesting that subsurface waters were less oxygenated. It was noted that the waters within and surrounding the offshore monitoring area appeared to be turbid.

During the summer survey, surface DO values were less variable, 1.5 mg/l or less among all stations and between tides, than during the winter survey. The lowest surface DO value was recorded at the discharge channel, 6.27 mg/l, where water temperatures were the warmest. At offshore stations, most of the DO profiles generally followed the inverse of the temperature profiles, with maximum DO concentrations occurring within the upper two meters of the water column. Below this surface layer, DO concentrations declined gradually with depth. All bottom DO values were above or within 0.15 mg/l the level of biological concern. All DO concentrations were within the range of previously reported values for the area (MBC 1979, 1981, 1986, 1988, 1990, 1994-2000, 2001a-2002a, 2003, 2004a; Ogden 1991-1993).

**Hydrogen Ion Concentration**

In the open ocean, hydrogen ion concentrations (pH) remains fairly constant due to the buffering capacity of seawater (Sverdrup et al. 1942). However, in nearshore areas, pH may vary due to physical, chemical, and biological influences. For instance, in areas with large organic influx, such as bays, estuaries, and river mouths, microbial decomposition is greater and can alter pH levels. Along with a reduction in dissolved oxygen, decomposition also results in the production of humic acids, which decreases pH levels (Duxbury and Duxbury 1984). Reduced pH values may also occur in areas of freshwater influx, since freshwater usually has a lower pH than saltwater. In contrast, phytoplankton blooms, which are often associated with nearshore upwelling, may cause an increase in pH levels. High photosynthetic rates increase the removal of carbon dioxide from water, thus reducing the carbonic acid concentration and raising pH.

During winter and summer water quality monitoring, pH varied little among stations, between tides, and with depth. Winter surface pH values at offshore stations were slightly lower than those recorded during the summer survey. Reduced surface salinity values were also recorded at most of the offshore stations during the winter survey and could be associated with the lower pH levels. Winter of 2005 was an unusually wet season with a near record amount of precipitation. All pH values were within the ranges of variation previously recorded within the study area (MBC 1979, 1981, 1986, 1988, 1990, 1994-2000, 2001a-2002a, 2003, 2004a; Ogden 1991-1993).

**Salinity**

The concentration of dissolved salts, salinity, in the open ocean is generally 35 practical salinity units (psu). 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). These numbers are determined by ion ratios (similar to the method of determining pH), and are without units. However, since 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; therefore, a salinity value of 35 ppt corresponds to a PSS 78 value of 35 psu. In southern California, salinity of nearshore waters is generally between 33 and 34 ppt (Dailey et al. 1993). Reductions in nearshore salinity usually result from freshwater input, while slight increases are often associated with upwelling of colder, more saline bottom waters.

During winter monitoring, salinity values at offshore stations were lower than those recorded during the summer survey, varying as much as 1.9 psu throughout the water column among stations and between tides. Summer salinity values at offshore stations were less variable, 0.3 psu or less, throughout the water column among stations and between tides. Variation within the surf-zone monitoring was greater during the winter survey, as much as 2.1 psu, than during the summer monitoring, 0.5 psu or less. These variations are likely the result of natural seasonal fluctuations. Winter of 2005 was an unusually wet season with a near record amount of precipitation. All salinity values were typical of the nearshore waters within the area (MBC 1979, 1981, 1986, 1988, 1990, 1994-2000, 2001a-2002a, 2003, 2004a; Ogden 1991-1993).

## CONCLUSION

In 2005, there was a slight elevation of surface water temperatures at the surf-zone stations in the vicinity and slightly downcoast of the discharge channel. The nearshore thermal plume was highly localized and was not detected at the furthest downcoast surf-zone station, any of the upcoast surf-zone stations or offshore stations. Reduced DO values at the surf-zone station nearest the discharge were likely related to the increased temperatures at the discharge channel. Otherwise, differences in dissolved oxygen concentration between surveys was likely the result of differences in natural seasonal fluctuations of water temperatures or other natural outside influences. Hydrogen ion concentrations and salinity values were within ranges recorded in the study area and within the Southern California Bight in past studies. There were only minor effects, localized to the discharge channel, on recorded water quality parameters from the Mandalay Generating Station that were detected during the 2005 NPDES surveys.

## 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 embayments, reduced water movement allows finer material to settle out of the water column, leading to fine-grained, soft-bottom sediments. In harbor and port areas, however, propeller wash, ship wakes, and discharge streams from industrial sources can suspend and redistribute sediments, while dredging may cause long-term changes in sediment characteristics over a large area. 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 11). 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 from a grab at each station using a 3.5-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.

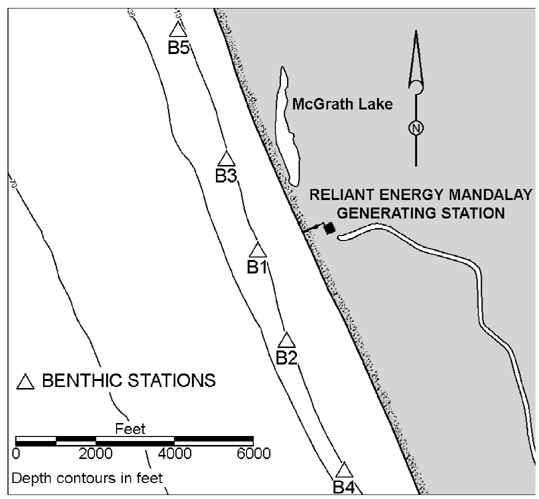



**Figure 11. Location of the benthic sampling stations. Mandalay Generating Station NPDES, 2005.**

#### Sediment Chemistry

Samples for sediment chemistry analysis were taken from the upper two centimeters of the sediments at each station. To ensure that sediments were not contaminated by contact with metal, glass collection jars were filled with seawater and taken to the sea floor by biologist-divers where sediment samples were collected directly with the jars.

On the surface 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 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 4. Grain size is expressed in phi (Φ) units, which are inversely related to grain diameter (Appendix B).

**Table 4. Sediment grain size parameters. Mandalay Generating Station NPDES, 2005.**

| | Station | | | | | | |
|---|---|---|---|---|---|---|---|
| Parameter | B1 | B2 | B3 | B4 | B5 | Mean | S.D. |
| % Gravel | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| % Sand | 88.15 | 89.87 | 91.09 | 94.18 | 83.27 | 89.31 | 4.03 |
| % Silt | 10.27 | 8.54 | 7.04 | 5.02 | 14.12 | 9.00 | 3.45 |
| % Clay | 1.58 | 1.59 | 1.87 | 0.80 | 2.61 | 1.69 | 0.65 |
| Mean grain size | | | | | | | |
| phi | 3.24 | 3.15 | 3.06 | 2.65 | 3.40 | 3.08 | 0.28 |
| µm | 106 | 113 | 120 | 159 | 94 | 118 | 25 |
| Sorting (ϕ) | 0.651 | 0.734 | 0.714 | 0.810 | 0.754 | 0.733 | 0.058 |
| Skewness | 0.130 | -0.001 | 0.112 | 0.041 | 0.237 | 0.130 | 0.081 |
| Kurtosis | 1.166 | 1.350 | 1.371 | 1.079 | 1.555 | 1.304 | 0.187 |

Sediments at the six stations in 2005 were composed primarily of sand, with smaller amounts of silt and clay (Table 4). Gravel was not collected at any station in 2005. Overall, sediments from the five stations sampled averaged about 89% sand, 9% silt, and 2% clay, with an average mean grain size of 3.08 phi (118 µm, medium sand). Sediments were finest at Station B5, 5,910 ft upcoast of the discharge, where mean grain size was 3.40 phi (94 µm, very fine sand). Sediments were coarsest at Station B4, downcoast of the discharge, where mean grain size was 2.65 phi (159 µm, coarse sand).

Sorting, a measure of the spread of the particle distribution curve, averaged 0.733 phi overall, representing poorly sorted sediments (Table 4). Sorting values ranged from 0.651 phi at Station B1, offshore of the discharge at a depth of 20 ft, to 0.810 phi at Station B4. Sediments at Stations B2, B3, and B5 were moderately sorted. Sediment distribution curves 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 -0.001 at Station B2 to 0.237 at Station B5 (Table 4).

Kurtosis is a measure of the peakedness of the particle distribution curve. A kurtosis value of 1.0 represents a normal particle distribution curve while a value greater than 1.0 indicates a leptokurtic (peaked) distribution with better sorting in the central portion of the curve than in the tails. A value less than 1.0 indicates a platykurtic (flattened) distribution and a lack of dominance by any one size category. Kurtosis values were greater than 1.0, indicating leptokurtic (excessively peaked) distributions, with dominance by a narrow range of size classes (Table 4). Kurtosis ranged from 1.079 at Station B4 to 1.555 at Station B5, and averaged 1.304.

## Sediment Chemistry

Sediment samples collected at the five 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 5. Metal concentrations were similar among stations, with highest values generally found at stations upcoast from the generating station discharge. Observed metal concentrations were all below both the metal-specific ERL and ERM.

**Table 5. Sediment metal concentrations (mg/dry kg). Mandalay Generating Station NPDES, 2005.**

| | Station | | | | | | | | | Reporting |
|---|---|---|---|---|---|---|---|---|---|---|
| Metal | B1 | B2 | B3 | B4 | B5 | Mean | S.D. | ERL | ERM | Limits |
| Chromium | 7.23 | 6.31 | 7.17 | 7.78 | 8.15 | 7.3 | 0.7 | 81 | 370 | 0.13-0.14 |
| Copper | 6.49 | 5.54 | 6.91 | 5.31 | 6.77 | 6.2 | 0.7 | 34 | 270 | 0.13-0.14 |
| Nickel | 8.53 | 7.32 | 8.34 | 7.53 | 8.51 | 8.0 | 0.6 | 21 | 51.6 | 0.13-0.14 |
| Zinc | 24.6 | 22.0 | 25.4 | 21.1 | 26.3 | 24 | 2.2 | 150 | 410 | 1.3-1.4 |

ERL = Effects Range Low
ERM = Effects Range Medium

**Chromium.** Sediment chromium concentrations averaged 7.3 mg/kg and ranged from 6.31 mg/kg at Station B2 to 8.15 mg/kg at Station B5 (Table 5).

**Copper.** Sediment copper concentrations averaged 6.2 mg/kg and ranged from 5.31 mg/kg at Station B4 to 6.91 mg/kg at Station B3 (Table 5).

**Nickel.** Sediment nickel concentrations averaged 8.0 mg/kg and ranged from 7.32 mg/kg at Station B2 to 8.53 mg/kg at Station B1 (Table 5).

**Zinc.** Sediment zinc concentrations averaged 24 mg/kg and ranged from 21.1 mg/kg at Station B4 to 26.3 mg/kg at Station B5 (Table 5).

## DISCUSSION

## Sediment Grain Size

In 2005, sediments were analyzed from five stations offshore the Mandalay Generating Station. Sediments were similar among four of the stations (Stations B1 through B3), consisting primarily of sand with lesser amounts of fine material (silt and clay) and mean grain sizes in the very fine sand category. Sampling at Station B4 recorded primarily larger grained sand, while Station B5 was still principally sand, but a higher proportion of silt was detected. Particle distribution curves at all four stations were skewed toward finer material. Mean grain size the discharge was in the very fine sand category.

Mean grain size in the study area in 2005 was the smallest since 1997, a result of the higher proportions of silt than has been recorded in recent years (Figure 12).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), coarsest sediments occurred at the discharge five times, with no annual surveys recording the finest sediments at the discharge.

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

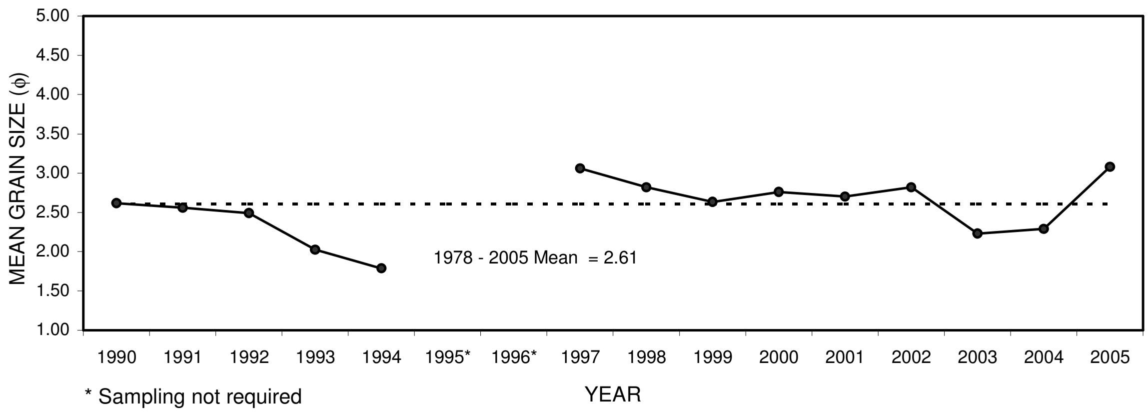


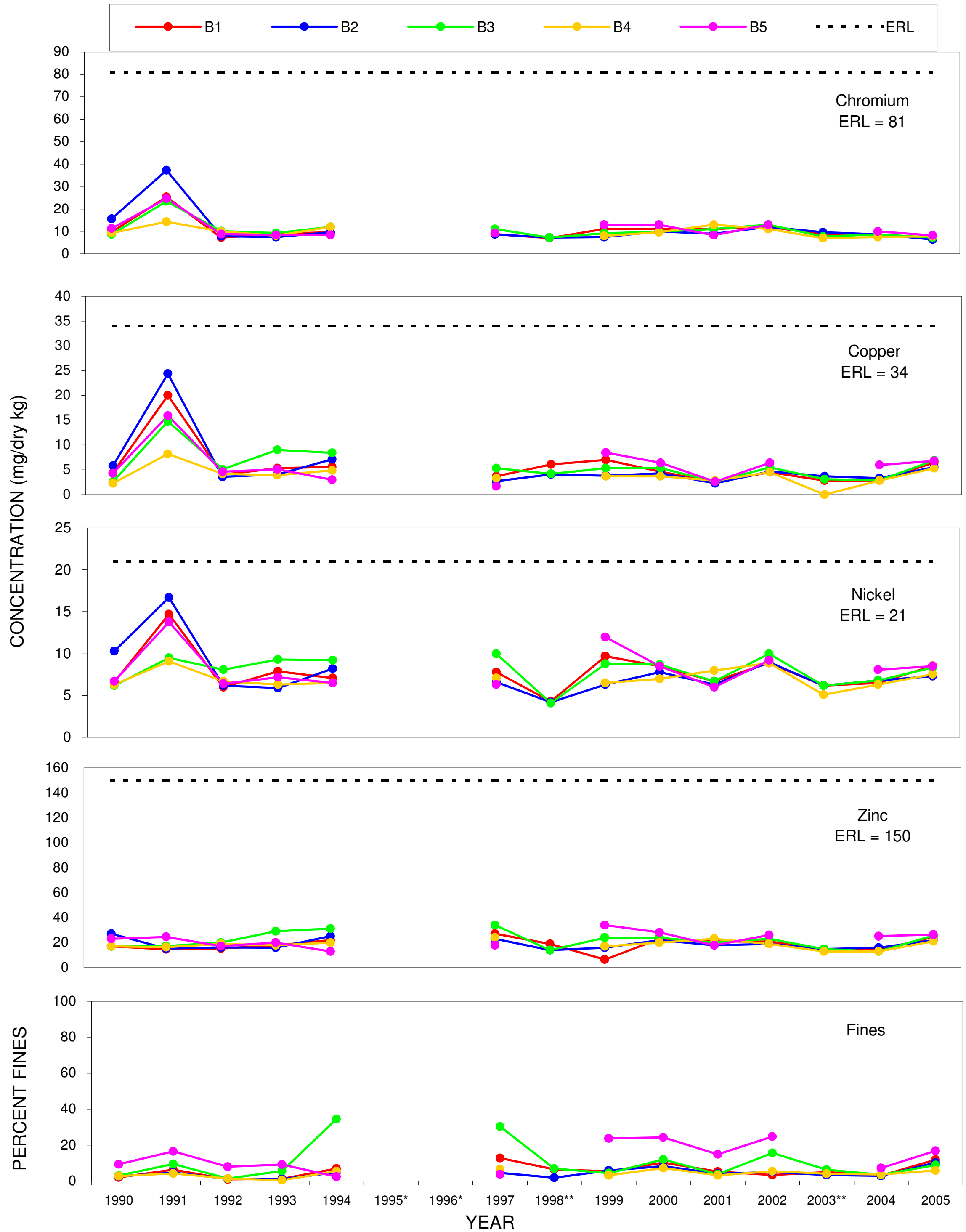

**Figure 12. Comparison of sediment mean grain size, 1990 - 2005. Mandalay Generating Station NPDES, 2005.**

## Sediment Chemistry

In 2005, sediments at five stations off the Mandalay 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 zinc levels were detected over 5,900 ft upcoast of the discharge, while copper concentrations peaked just upcoast of the discharge, and nickel levels were highest near the discharge. Lowest concentrations of metals were generally recorded 2,360 ft downcoast of the discharge. Most metal concentrations were similar to values recorded in 2004 and in previous surveys (Figure 13).

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, as in 2005, the largest percentages of fines (silt and clay combined) were usually recorded upcoast of the discharge at Station B5 (Figure 16). Highest concentrations of chromium and zinc were recorded at Station B5, but highest levels of nickel and zinc occurred at other stations. Because of an overall similarity in sediment characteristics at stations in the Mandalay 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, 1997-2000, 2001a-2002a, 2003, 2004a; Ogden 1991-1993).

Most values observed in 2005 were typical of the area, but higher than the station-specific long-term mean for most stations for all metals except chromium, which was below the long-term mean across all stations. Metal levels throughout the Mandalay 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 stations in 2005 were 1.9 to 2.9 times less than the mean metal concentrations found in sediments at shallow (5–30 m) coastal stations sampled in 1998 from throughout the Southern California Bight (Noblet et al. 2003).




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

**Figure 13. Comparison of sediment metal concentrations and percent fines by station, 1990 - 2005. Mandalay Generating Station NPDES, 2005.**

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 13).

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 percent of fine material in the sediments, lowest metal concentrations, were found at the station with the coarsest sediments. Metal levels in the area typically vary slightly from year to year and no long-term patterns of metal concentrations relative to the discharge were apparent. Concentrations of sediment metals in 2005 did not appear to be influenced by the operation of the Mandalay Generating Station.

## CONCLUSION

### Sediment Grain Size

In 2005, sediments were coarsest downcoast of the discharge. 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 Mandalay Generating Station.

### Sediment Chemistry

In 2005, highest metal concentrations did not appear to be related to 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 vicinity of the Mandalay Generating Station. 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 Mandalay 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 biologist-divers searched a mooring located offshore of the Mandalay Generating Station discharge and found no available mussels. Mussels were collected from a donor site, the Ormond Beach Generating Station discharge buoy, placed within protective enclosures that allowed unrestricted water flow to the mussels, and transplanted to the Mandalay mooring. Donor site mussels were also collected at this time and frozen for later analysis and comparison with the transplanted mussels. On 29 September 2005, the transplanted mussels were retrieved and returned to the laboratory for chemical analysis.

Forty-five (45) transplanted California mussels (*Mytilus californianus*) with shell lengths averaging 59 mm were collected from the mooring and returned to the laboratory for chemical analysis. Three replicate samples, each a composite of the tissue from 15 mussels, were analyzed for concentrations of the metals chromium, copper, nickel, and zinc according to methods used in the California State Mussel Watch Program (Appendix A and SWRCB 1986). The same methods were used with California mussels collected from the donor site and from another set of 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 previous years (MBC 2001a- 2002a, 2003-2004a). 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, the donor site and at a pier reference site (Table 6 and Appendix F).

Chromium concentrations in mussels from the generating station ranged from 2.46 to 4.6 mg/dry kg with a mean of 3.3 mg/dry kg (Table 6). Mean chromium concentration at the discharge was slightly lower than at the donor site (3.84 mg/dry kg), but more than twice the concentration found at the reference site (1.39 mg/dry kg).

Copper concentrations from the discharge averaged 8.2 mg/dry kg with a range from 4.9 to 13.6 mg/dry kg (Table 6). Copper was relatively similar among sites, with the highest mean concentration found at the donor site (11.2 mg/dry kg) and the lowest at the reference site (6.67 mg/dry kg).

**Table 6. Mussel tissue metal concentrations (dry weight and reporting limits, mg/dry kg; wet weight and EDL, mg/wet kg). Mandalay 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 | 4.6 | 2.91 | 2.46 | 3.3 | 1.1 | 0.05 | 0.7 | 0.6 | 0.5 | 0.6 | 0.1 | 0.73 | 1.70 |
| Copper | 13.6 | 6.0 | 4.9 | 8.2 | 4.7 | 0.05 | 2.1 | 1.2 | 1.0 | 1.4 | 0.6 | 5.3 | 11.93 |
| Nickel | 2.98 | 1.39 | 0.93 | 1.77 | 1.08 | 0.05 | 0.5 | 0.3 | 0.2 | 0.3 | 0.1 | 0.83 | 1.1 |
| Zinc | 83.1 | 64.8 | 37 | 62 | 23.2 | 0.05 | 13 | 12 | 8 | 11 | 3.0 | 55.78 | 77.84 |
| % Solids | 15.5 | 19.2 | 20.4 | 18 | | 0.1 | - | - | - | - | - | - | - |
| Ormond Beach Donor Site | | | | | | | | | | | | | |
| 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 | 12.6 | 18.2 | 14.2 | 15.0 | 2.9 | 33.64 | 38.87 |
| % Solids | 19.4 | 19 | 16.5 | 18 | - | 0.1 | - | - | - | - | - | - | - |
| Pier Reference Site (Hermosa Beach Pier) | | | | | | | | | | | | | |
| 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 | 18.3 | 18 | 18 | - | 0.1 | - | - | - | - | - | - | - |

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

Nickel levels in mussels from the discharge station ranged from 0.93 to 2.98 mg/dry kg with a mean of 1.77 mg/dry kg (Table 6). While nickel at the discharge was nearly three time the mean concentration at the reference site (0.64 mg/dry kg), nickel at both sites were notably lower than levels found at the donor site (7.2 mg/dry kg).

Zinc concentrations at the discharge site ranged from 37 to 83.1mg/dry kg, with a mean concentration of 62 mg/dry kg (Table 6). Like copper, zinc concentrations were relatively similar among the sites, with mean concentrations at both the donor site (82 mg/dry kg) and the reference site (74.5 mg/dry kg) slightly higher than levels found at the discharge station.

## 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. However, a resident population of mussels is sometimes not available in an area, such as offshore of the Mandalay Generating Station discharge. In that case, mussels are transplanted into the area for at least 90 days. All analytical results are reported on a dry weight basis; however, wet weight concentrations were calculated for comparison with evaluation criteria.

Water quality standards for evaluating bioaccumulation in mussel tissues are primarily based on human or animal health criteria, and several standards of comparison are currently available (SWRCB 1995, 2000). However, action levels for only a few 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 50$^{th}$ percentile corresponds to the median of all values rather than to a mean. The 85$^{th}$ percentile (EDL 85) indicates that a chemical is markedly elevated from the median. The 95$^{th}$ 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, mussels were not found in the vicinity of the Mandalay Generating Station discharge channel. For that reason, mussels were collected from a donor site near the Ormond Beach Generating Station and transplanted to a mooring offshore of the Mandalay discharge where the mussels were allowed to acclimate for a period of 93 days. Results were compared with those from mussels collected at the donor site at the time of the transplant and to mussels collected from the Hermosa Beach Pier in Santa Monica Bay, which served as a reference site.

In 2005, chromium was reported in all replicates from the discharge, the donor site and the reference site. Tissue concentrations of chromium in mussels in 2005 were detected at levels near or below the reporting limits from previous tissue sampling (MBC 2001a- 2002a, 2003-2004a). Chromium has not been detected in mussel tissues from the discharge or the donor site in previous surveys (Appendix F-2). Still, most chromium concentrations at the discharge and at the donor site were found at levels that exceeded recent reporting limits, suggesting that chromium in the area in 2005 was higher than in preceding years. 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 tissues monitoring programs in 2005 (MBC 2005b-d). 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, which are similar to previous years. Previously, chromium was detected at the reference site in 1990 at a level similar to concentrations found in mussels from the discharge in 2005 (MBC 2002b). Mean concentration of chromium in mussel tissues from the discharge area in 2005 were about twice the level found at the reference site, but lower than levels found at the donor site (Table 5). Wet-weight chromium levels at the generating station were below the EDL 85 value for transplanted mussels, indicating that levels were not elevated in the survey area. Wet-weight chromium levels for mussels from the donor site did exceed the EDL 85 for California mussels, indicating that chromium levels were elevated in the donor area. Chromium levels were not elevated in mussels from the reference area.

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 2002, particularly 2003, but lower than levels found in the area in 2001, the first year of mussel tissue monitoring (Figure 14; Appendix F-2). Copper levels were relatively similar among sites in 2005, with the highest mean concentration found at the donor site and the lowest at the Hermosa Beach reference site. Wet-weight copper levels at the discharge were below the EDL 85 value for transplanted mussels, indicating that levels were not elevated, however, concentrations of copper were elevated or highly elevated in resident mussels from the donor site (likely a result of exposure to copper-based antifouling paint on the donor-site buoy). Copper concentrations at the reference site were below levels considered elevated by the SMWP.

In 2005, nickel was reported in all replicates from the discharge, the donor site and the reference site. Tissue concentrations of nickel in mussels in 2005 were detected at levels below the reporting limits from most previous tissue sampling (MBC 2001a- 2002a, 2003-2004a). Nickel levels at the donor site, however, appear to be higher than in previous years. Nickel has not been detected in mussel tissues from the discharge or the donor site in previous surveys (Appendix F-2). Like chromium, nickel levels in mussel tissues appear to have generally increased in southern California in 2005 (MBC 2005a-d). Previously, nickel was detected at the reference site in 1990 and in 2002 at levels similar to those near the discharge in 2005 (MBC 2002b). While mean nickel concentrations at the discharge was nearly three times the mean concentration at the reference site in 2005, nickel concentrations at both sites were notably lower than levels found at the donor site where wet-weight concentrations exceeded the EDL 95 level indicating that nickel was highly elevated in the area (Table 6). Wet-weight concentration of nickel at both the discharge and the reference site were below levels considered elevated.

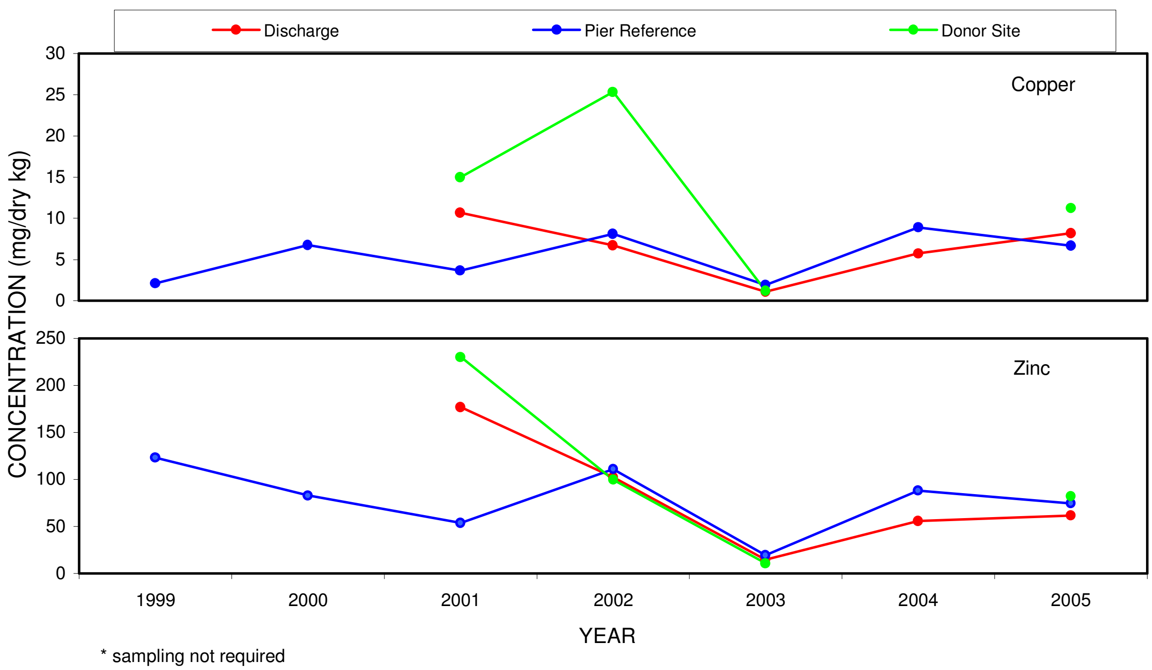



**Figure 14. Comparison of mean copper and zinc concentrations in mussel tissue at discharge and at reference sites, 1999 - 2005. Mandalay Generating Station NPDES, 2005.**

Zinc was detected in all mussel tissue replicates in 2005. Zinc concentrations from the discharge area were higher than levels found in the area in the last two years, particularly in 2003, but otherwise lower than concentrations found in the area in 2001 and 2002 (Figure 14). Zinc levels at the discharge were lower than levels found at both the donor site and the reference site, although, in general, concentrations were similar among samples (Table 6). Wet-weight zinc concentrations from the discharge were notably lower than the EDL 85 values for transplant mussels, indicating that zinc levels were not elevated near the Mandalay Generating Station discharge channel. Wet-weight concentrations of zinc at both the donor site and the reference site were also below levels considered elevated.

## CONCLUSIONS

Metal concentrations in mussel tissues transplanted into the vicinity of the discharge were lower than metal levels in source mussels at the time of the transplant. This suggests that the transplanted mussels had acclimated to the area and that tissue metal concentrations accurately represented values in the area of the discharge. Concentrations of copper, nickel and zinc at the discharge were similar to values found previously in the area and at the reference site. Chromium levels at the discharge reflected a general increase in chromium noted throughout southern California in 2005. No metal concentrations in mussels from the discharge exceeded levels considered elevated for transplanted mussels by the SMWP. The comparatively low tissue metal levels and similarity of tissue metal levels to previous studies, at a reference site, and other areas in southern California suggests that the operation of the Mandalay Generating Station is not elevating metal concentrations above background levels.

## BENTHIC INFAUNA

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

The benthic infaunal community offshore of the Mandalay 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. Five stations have been sampled in all surveys except in 1998 (only three stations) and 2003 (four stations, with only two replicates each, one-half the number of replicates in all other surveys).

### MATERIALS AND METHODS

Benthic infaunal sampling was conducted at the five benthic stations (Stations B1 - B5), using a hand-held, diver-operated box corer (Figures 15 and 16). 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 (l). The box corer is pushed into the sediments by a diver. Upon withdrawal from the sediments, the sample is sealed in the box by a neoprene cover for transport to the surface.

Four replicate cores were collected at each station. Samples were washed in the field using a 0.5-mm screen, 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.

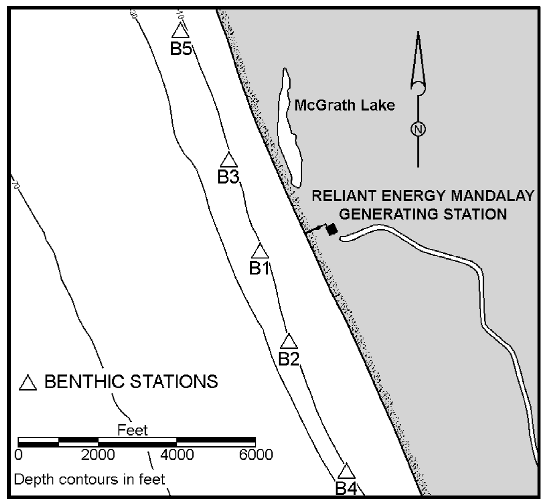



**Figure 15. Location of the benthic sampling stations. Mandalay Generating Station NPDES, 2005.**

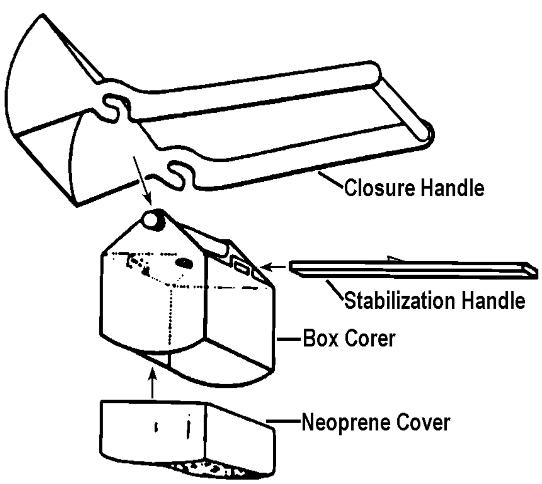



**Figure 16. Diver-operated box corer used to collect infaunal samples. Mandalay Generating Station NPDES, 2005.**

### RESULTS

Biologist-divers collected sediment cores for analysis of infauna composition at Stations B1 through B5 on 28 June 2005 between 0818 and 1042 hr. Skies were clear with winds changing from the northeast at 3 kn to west at 3 to 5 kn. Seas were west at 2 to 3 ft and south at 3 ft.

Results of the infauna sampling in 2004 are presented by station in Appendix G. Data are summarized in Tables 7 through 9 and Figure 17.

**Species Composition.** In 2005, the infauna samples from the five benthic stations offshore of the Mandalay Generating Station contained a total of 1,726 individuals representing 60 species in seven phyla (major taxonomic groups) (Table 7). Annelids (segmented worms) and arthropods were the most abundant phyla, comprising 61% and 35% of the individuals, respectively. However, annelids were the most abundant group at only three of the stations (comprising as much as 95% of the individuals at Station B5, farthest upcoast), while arthropods were most abundant at Stations B1 and B2, at and immediately downcoast of the generating station discharge, respectively. Each of the other five phyla represented less than 3% of the total abundance. Annelids and arthropods were also the most diverse phyla, with annelids accounting for 45% of the species collected, while another 30% of the species were arthropods, 10% were nemertean worms, and 8% were mollusks. The other three phyla comprised less than 4% of the species. Annelids represented the greatest proportion of species at all stations, with the highest proportion, 71%, at Station B5.

**Table 7. Number of infaunal species and individuals by phylum. Mandalay Generating Station NPDES, 2005.**

| | Station | | | | | | Percent |
|---|---|---|---|---|---|---|---|
| Parameter | B1 | B2 | B3 | B4 | B5 | Total | Total |
| Number of species | | | | | | | |
| Annelida | 13 | 14 | 13 | 13 | 15 | 27 | 45.0 |
| Arthropoda | 11 | 10 | 8 | 9 | 2 | 18 | 30.0 |
| Nemertea | 5 | 4 | 4 | 1 | 2 | 6 | 10.0 |
| Mollusca | 3 | 3 | - | 2 | 1 | 5 | 8.3 |
| Echinodermata | - | 1 | 1 | 1 | - | 2 | 3.3 |
| Nematoda | - | - | - | 1 | 1 | 1 | 1.7 |
| Phorona | 1 | 1 | - | - | - | 1 | 1.7 |
| Total | 33 | 33 | 26 | 27 | 21 | 60 | |
| Number of individuals | | | | | | | |
| Annelida | 107 | 96 | 488 | 161 | 204 | 1056 | 61.2 |
| Arthropoda | 111 | 337 | 112 | 39 | 4 | 603 | 34.9 |
| Nemertea | 12 | 13 | 5 | 4 | 3 | 37 | 2.1 |
| Mollusca | 3 | 8 | - | 4 | 3 | 18 | 1.0 |
| Nematoda | - | - | - | 5 | 1 | 6 | 0.3 |
| Echinodermata | - | 1 | 1 | 2 | - | 4 | 0.2 |
| Phorona | 1 | 1 | - | - | - | 2 | 0.1 |
| Total | 234 | 456 | 606 | 215 | 215 | 1726 | |

**Abundance.** Abundance averaged 345 individuals per station (86 individuals per replicate, or 8,630 individuals/m$^2$), ranging from 215 individuals at both Station B4, farthest upcoast, and Station B5 to 606 individuals at Station B3, immediately upcoast of the discharge (Table 8). Abundance at the discharge (234 individuals) was below the area mean.

**Species Richness.** The number of species averaged 28 per station, or 14 species per replicate (Table 8). Values ranged from 21 species at Station B5 to 33 species at both Stations B1 and B2. The 26 species taken at Station B1 was slightly less than the study-area mean.

**Species Diversity (H').** Shannon-Weiner species diversity averaged 1.84 per station and ranged from 1.40 at Station B3 to 2.30 at Station B1 (Table 8). Mean replicate diversity was 1.69.

**Biomass.** Biomass averaged 1.48 g per station (37 g/m$^2$) and ranged from 0.85 g at Station B2 to 2.76 g at Station B4 (Table 8). About 60% of the total biomass was contributed by annelids because they were so numerous, while two small Pacific sand dollars (*Dendraster excentricus*), found at Station B4, contributed another 30% of the total survey biomass (Appendix G-4).

**Table 8. Infaunal community parameters. Mandalay Generating Station NPDES, 2005.**

| | Station | | | | | | |
|---|---|---|---|---|---|---|---|
| Parameter | B1 | B2 | B3 | B4 | B5 | Total | Mean |
| Number of species | | | | | | | |
| Total | 33 | 33 | 26 | 27 | 21 | 60 | 28 |
| Rep. Mean | 16 | 17 | 13 | 14 | 11 | | 14 |
| Rep. S.D. | 2 | 3 | 2 | 3 | 1 | | |
| Number of individuals | | | | | | | |
| Total | 234 | 456 | 606 | 215 | 215 | 1726 | 345 |
| Rep. Mean | 59 | 114 | 152 | 54 | 54 | | 86 |
| Rep. S.D. | 9 | 64 | 35 | 12 | 22 | | |
| Density (#/m$^2$) | | | | | | | 8,630 |
| Diversity (H') | | | | | | | |
| Total | 2.30 | 1.71 | 1.40 | 2.12 | 1.64 | 2.09 | 1.84 |
| Rep. Mean | 1.96 | 1.66 | 1.35 | 1.88 | 1.57 | | 1.69 |
| Rep. S.D. | 0.12 | 0.30 | 0.28 | 0.28 | 0.37 | | |
| Biomass (g) | | | | | | | |
| Total | 1.11 | 0.85 | 1.71 | 2.76 | 0.99 | 7.42 | 1.48 |
| Rep. Mean | 0.28 | 0.21 | 0.43 | 0.69 | 0.25 | | 0.37 |
| Rep. S.D. | 0.10 | 0.13 | 0.15 | 0.82 | 0.08 | | 0.26 |
| g/m$^2$ | | | | | | | 37.10 |

**Community Composition.** Eleven species each represented 1% or more of the individuals in the infauna collection (Table 9 and Appendix G-2). These 11 species together were only 18% of the number of species in the collection but contributed almost 90% of the individuals. Six of these abundant species occurred at all stations, and one, the isopod *Edotia sublittoralis*, occurred at only two stations. Four of the species were not found at Station B5. Six of the 11 most abundant species were annelids and five were arthropods. The two most abundant species, the annelid *Apoprionospio pygmaea* and the cumacean *Diastylopsis tenuis*, comprised 43% and 25% of all individuals collected, respectively, and were more than five times as abundant as any other species. *Apoprionospio* was most abundant at Station B3 and *D. tenuis*, at Station B2.

**Table 9. The 11 most abundant infaunal species. Mandalay Generating Station NPDES, 2005.**

| | | Station | | | | | | Percent | Cum. |
|---|---|---|---|---|---|---|---|---|---|
| Phylum | Species | B1 | B2 | B3 | B4 | B5 | Total | Total | Percent |
| AN | *Apoprionospio pygmaea* | 70 | 49 | 405 | 99 | 121 | 744 | 43 | 43 |
| AR | *Diastylopsis tenuis* | 72 | 277 | 60 | 13 | 2 | 424 | 25 | 68 |
| AN | *Spiophanes bombyx* | 7 | 23 | 18 | 6 | 22 | 76 | 4 | 72 |
| AN | *Spiophanes duplex* | 2 | 1 | 34 | - | 33 | 70 | 4 | 76 |
| AR | *Photis macinerneyi* | 13 | 17 | 25 | 1 | 2 | 58 | 3 | 79 |
| AN | *Armandia brevis* | 2 | 1 | 7 | 32 | 4 | 46 | 3 | 82 |
| AR | *Rhepoxynius menziesi* | 4 | 19 | 2 | 11 | - | 36 | 2 | 84 |
| AR | *Anchicolurus occidentalis* | 10 | 12 | 7 | 6 | - | 35 | 2 | 86 |
| AN | *Onuphis* sp 1 Pt. Loma 1983 | 2 | 3 | 11 | 1 | 7 | 24 | 1 | 88 |
| AN | *Syllis (Typosyllis) farallonensis* | 6 | 4 | - | 8 | - | 18 | 1 | 89 |
| AR | *Edotia sublittoralis* | 4 | - | 14 | - | - | 18 | 1 | 90 |

AN = Annelida; AR = Arthropoda

**Cluster Analyses.** Normal (station) and inverse (species) cluster analyses were performed on the 11 most abundant species in the infauna collection (Table 9). The five study-area stations clustered into two groups, based on their relative abundances of the 11 most abundant species (Figure 17). The communities in Station Group I (Stations B1, B2, and B4, the three stations at and downcoast of the discharge) were more similar to each other than to the communities upcoast of the discharge at Stations B3 and B5 (Group II). Stations B1 and B2 clustered most closely because of the similarity of community composition, even though *Diastylopsis tenuis*, the dominant species at both stations, was much more abundant at Station B2. Station B4, dominated by *Apoprionospio pygmaea* and the annelid *Armandia brevis*, clustered next with Stations B1 and B2 in Group I. Stations B3 and B5 clustered together rather distantly. Those two communities were dominated by *A. pygmaea*, and the annelids *Spiophanes bombyx* and *S. duplex* were also important.

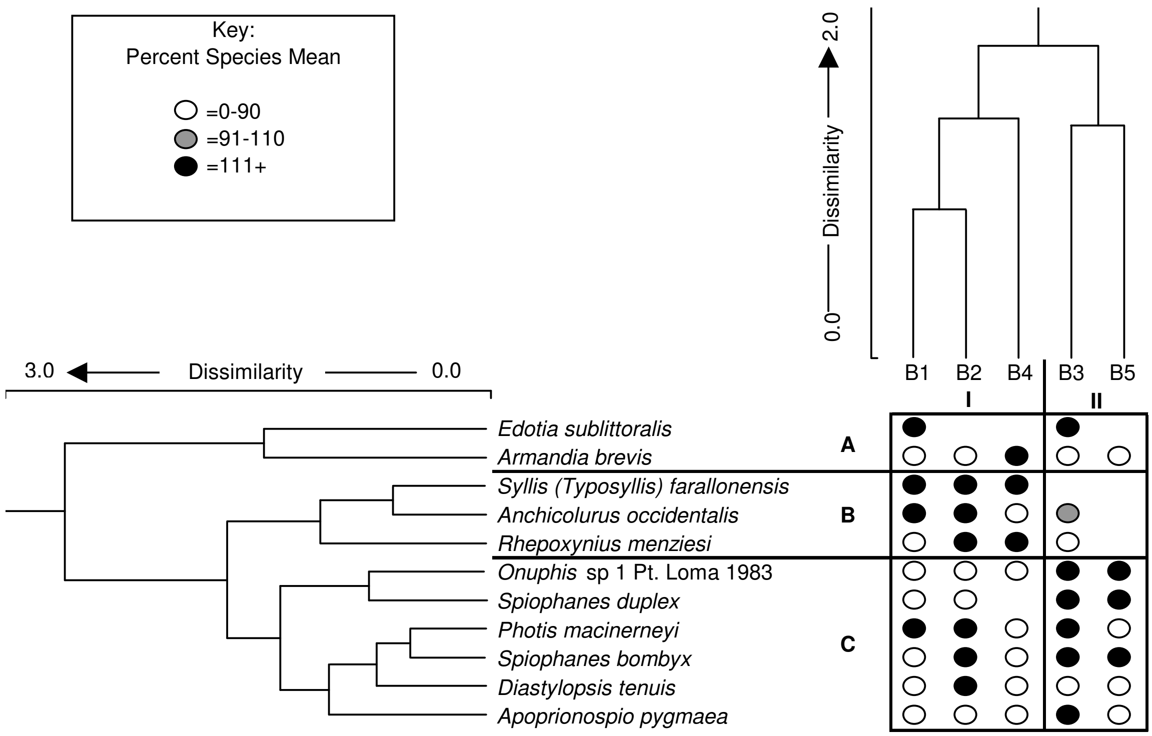



**Figure 17. Two-way coincidence table resulting from normal (station) and inverse (species) classification dendrograms for the 11 most abundant infaunal species. Mandalay Generating Station NPDES, 2005.**

The 11 most abundant species separated into three groups, based on their similarity of occurrence (Figure 17). Species Group A included two species, *Edotia sublittoralis* and *Armandia brevis*, which had the most uneven distribution among the five stations. Group B included three moderately abundant species that were absent from Station B5. Group C contained the species that were more evenly distributed among stations, including the top five species. The amphipod *Photis macinerneyi* and *Spiophanes bombyx* clustered most closely.

## DISCUSSION

The infauna community in the study area in 2005 was comprised primarily of small annelid worms and arthropods. Abundance averaged 345 individuals per station (8,630 individuals/m$^2$), with a mean of 28 species per station. Abundance was higher immediately upcoast and downcoast of the discharge, species richness was higher at and immediately downcoast of the discharge, species diversity was higher nearest the discharge, and biomass (excluding two small Pacific sand dollars) was highest where abundance was highest, immediately upcoast of the discharge. Values for all four parameters were generally lower farthest upcoast and downcoast. The relatively high diversity value for the discharge was due to the high species richness, lower-than-average abundance, and the absence of strong numerical domination by a single species. Biomass at the discharge was slightly lower than the area mean. The low diversity value for the community immediately upcoast of the discharge resulted from high total abundance, moderate species richness, and extremely high abundance of *Apoprionospio pygmaea*, which was almost seven times that of the next most abundant species at that location. Although *A. pygmaea* was the most abundant species overall, another species, *Diastylopsis tenuis*, was slightly more abundant at the discharge and was more than five times more abundant than *A. pygmaea* immediately downcoast of the discharge. In general, the communities at the three stations at and downcoast of the discharge were composed of similar species, particularly those that prefer somewhat coarser sediments, while the communities at the two upcoast stations included a slightly different mix of abundant species that are usually associated with finer sediments. Overall, however, the communities were comparable throughout the study area.

Infaunal organisms reflect the substrate in which they live (Johnson 1970, Gray 1974). The coastline at the generating station is exposed to ocean swell from both the south and west, and the shallow subtidal sediments are routinely subject to disturbance from normal wave activity and infrequent severe disturbance during storms. Sediments are generally coarse, due to the winnowing effect of moving water, with little organic matter. Usually, coarse sediments support smaller and less diverse infaunal communities than do finer sediments (Barnard 1963). Particle sorting also plays a role, with well-sorted sediments providing fewer ecological niches. The species occupying the nearshore habitat are adapted to both coarse sediment and nearly constant disruption of the substrate (Oliver et al. 1980). Although small, they are capable of reburying themselves quickly if dislodged. Their life history strategies, such as frequent and abundant production of young, allow them to rapidly repopulate habitat severely disrupted by winter storms.

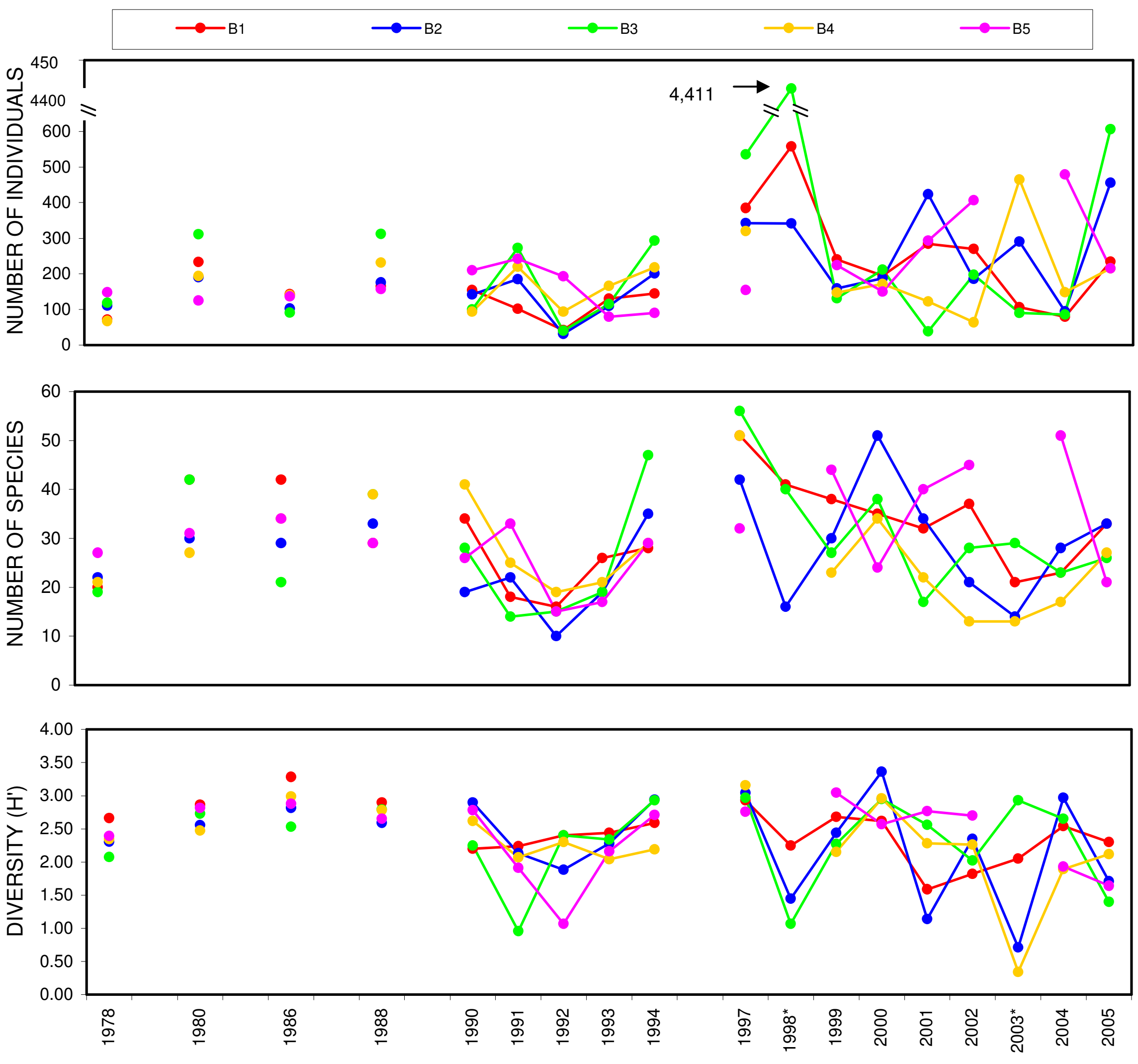
In the study area, abundance, biomass, and community composition appeared to relate somewhat to sediment characteristics, while other community parameters, such as species richness and diversity showed little connection. All parameter values were low where sediments were finest, while none of the parameters were highest where sediments were coarsest. However, several species that are normally associated with coarse sediments, such as *Armandia brevis*, were far more abundant farthest downcoast where sediments were coarsest, and the cumaceans *Diastylopsis tenuis* and *Anchicolurus occidentalis* and the amphipod *Rhepoxynius menziesii*, which are either strong swimmers or burrowers, were most abundant where sediments were moderately coarse. Sediment sorting was probably not an important factor in determining community characteristics, as differences in sorting values among the stations were negligible.

Species that comprised the infauna communities in 2005 are typical of the shallow nearshore environment (Barnard 1963, Dexter 1978). The pattern of species dominance relating to sediment characteristics was similar to those observed in several previous surveys (MBC 1999- 2000, 2001a-2002a, 2003, 2004a). *Apoprionospio pygmaea,* the most abundant species, is a generalist, living in tubes built below the shifting surface layer of sediment, and is wide-spread in sandy shallow-water habitats along the coast of southern California (MBC 2004b-d). Other common species included *Diastylopsis tenuis*, *Rhepoxynius menziesii*, *Spiophanes bombyx* and *S. duplex*. In addition, *Armandia brevis*, which was very abundant farthest downcoast from the discharge, was also extraordinarily abundant both inside King Harbor and outside the harbor in shallow water offshore of Redondo Beach and offshore of the Scattergood and El Segundo Generating Stations (MBC 2004d,e). This unusual occurrence of *A. brevis* may be an example of a particularly successful and wide-spread recruitment in 2005.

Most of the abundant species in the 2005 infaunal collection have been among the core group of species found in the study area in the past (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-2000, 2001a-2002a, 2003, 2004a; Ogden 1991-1993). Four of the 11 most abundant species were among the 16 overall long-term dominant species (those that each comprised 1% or more of all individuals collected since 1978) (Appendix G-5). These include *Apoprionospio pygmaea*, *Diastylopsis tenuis*, *Spiophanes bombyx* (the top three in 2005) and *Rhepoxynius menziesii*. Eight of the top species, *A. pygmaea* (the long-term most abundant species), *D. tenuis*, *S. bombyx*, *Photis macinerneyi*, *Armandia brevis*, *Anchicolurus occidentalis*, *Onuphis* sp 1, and *Syllis farallonensis*, were more abundant in 2005 than in any previous survey. Typically common species, such the annelids *Mediomastus acutus*, *Scoloplos armiger*, Pacific sand dollars, and *Tellina modesta*, were present in 2005 but were not abundant, while *Owenia collaris*, normally quite abundant, did not occur in 2005. Two species which sporadically have been extremely abundant, Gould beanclam (*Donax gouldi*) and the ostracod *Euphilomedes carcharodonta*, were also absent or very uncommon in 2005, and the most abundant species in 2004, the feather-duster worm *Chone* sp SD 1, was also uncommon.

Despite these differences, comparison of the communities observed since 1978 shows that a number of species have persisted.

In 2005, mean abundance for the study area was almost twice that in 2004, with values for each station greater than the long-term mean and, for four of the five stations, greater than in 2004 (Figure 18) (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-2000, 2001a-2002a, 2003, 2004a; Ogden 1991-1993). The high abundance immediately upcoast of the discharge was the second highest value for the area since 1978 (exceeded by extreme numbers of Gould beanclam at the same location in 1998). Mean density of individuals (particularly *Apoprionspio pygmaea*) was higher farthest downcoast in 2003 also, when only two replicates were collected. Mean species richness in 2005 was similar to that in previous years, however. The number of species seen farthest upcoast was lower than the number in most recent surveys but was similar to that in the early 1990s. Because of the relatively high abundance and moderate species richness, species diversity in 2005 was lower than



Sampling was not required in years not shown, * 1998 - only three stations required, 2003 - only four stations required.

**Figure 18. Comparison of infaunal community parameters, 1978 - 2005. Mandalay Generating Station NPDES, 2005.**

in 2004 at all but one station (farthest downcoast), and values for all stations were below their long-term means.

In general, mean values for infauna community parameter values from 1978 to 2005 have not differed much among the stations in the study area (MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-2000, 2001a-2002a, 2003, 2004a; Ogden 1991-1993). On average, abundance has been greatest immediately upcoast of the discharge because of extremely high abundance of Gould beanclam in one year. However, abundance has usually been highest immediately downcoast of the discharge. With the high number of beanclams excluded, mean abundance was highest for that location, and the difference in mean abundance among stations was minimal. Mean density of organisms for the study area as a whole has been about 6,440 individuals/$m^2$ (5,270 individuals/$m^2$, excluding Gould beanclam); mean density for the discharge area (about 5,066 individuals/$m^2$), although lowest of the study area, was not substantially different from the area-wide mean. On average, species richness and diversity have both been highest at the discharge, although, as with abundance, the long-term differences among stations have been small. This suggests that the infaunal community is rather homogeneous throughout the study area. However, biological events such as settlement of new recruits, competition, or failure to reproduce, combined with natural oceanographic events result in occasionally large spatial or temporal changes in abundance and community composition.

The infaunal communities in the nearshore shallow subtidal environment off the generating station in 2005 were similar to those found in previous studies conducted since 1978 and were typical of those in the Southern California Bight. Unlike in previous years, the pattern of infaunal parameter values appeared to have little relationship to sediment characteristic, and values at the discharge were similar to those seen elsewhere in the study area.

## CONCLUSION

The infauna communities in the study area in 2005 were similar to those found in previous studies conducted since 1978. Infaunal parameters appeared to have little relationship to sediment characteristics, other than the presence of particular species where sediments were coarsest, farthest downcoast. Abundance, species richness and diversity values for the discharge area were similar to those elsewhere. No pattern related to the discharge was apparent. The infaunal communities in 2005 were typical of the southern California nearshore habitat, and were similar to those seen previously in the study area.

## DEMERSAL FISH AND MACROINVERTEBRATES

In recent years, demersal fish and macroinvertebrate communities have come under greater scrutiny due to their close proximity to potentially impacted sediments. Numerous sites associated with discharges, either from municipal wastewater treatment plants or power plant once through cooling water systems, are the subject of ongoing monitoring within the Southern California Bight (Cross and Allen 1993). Trawl surveys of the demersal fish and macroinvertebrate assemblages within the receiving waters of Mandalay Generating Station began in 1971, with a total of eight surveys from 1971 to 1988. Beginning in 1990, surveys were conducted annually during winter and summer, as dictated by National Pollutant Discharge Elimination System permits. The goal of this monitoring is to assess the effects of the heated seawater discharged from the station on the local marine fauna. Intra-annual and inter-annual variation was examined to assess the composition and stability of the populations within the receiving waters.

### MATERIALS AND METHODS

Two trawl surveys were conducted in 2005 (7 April and 29 June) to sample the demersal fish and macroinvertebrate communities at four sites offshore of Mandalay Generating Station (Figure 19). During April sampling, skies were partly cloudy to overcast with winds initially out of the east at 3 knots (kn) before switching to the west at 4 to 6 kn. Seas were west at 2 to 3 feet (ft). June sampling occurred under overcast skies with winds out of the west at 1 to 8 kn with a west swell at 2 to 4 ft. No red tides or petroleum residue on the water's surface were observed during either seasonal survey.

Trawl paths for all four stations were parallel to the shoreline. All four stations followed the 20-ft isobath (Figure 19). Stations T2 (upcoast discharge) and T3 (downcoast discharge) were centered 1,180 ft upcoast and downcoast of the discharge, with portions of the trawl path directly offshore the discharge. Stations T1 and T4 acted as reference sites and were centered approximately 5,910 ft upcoast and downcoast of the discharge. Two replicate tows were made at each station with a 25-ft wide semi-balloon otter trawl net. The headrope was equipped with regularly spaced floats, while the footrope was weighted with chain and equipped with plastic rollers to reduce fouling. The body of the net consisted of 1.5-inch (in.) bar mesh with a 0.5-in. bar mesh liner in the cod end.

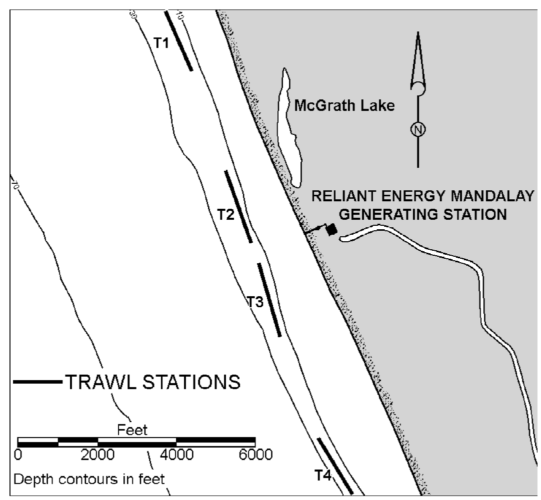



**Figure 19. Location of the trawl sampling stations. Mandalay Generating Station NPDES, 2005.**

During each replicate, the otter trawl was towed at 2.0 to 2.5 knots for ten minutes. Time was measured from the point at which the net began fishing at the bottom to the time retrieval began. Each catch was immediately separated from debris and sorted to the lowest possible taxonomic category. Fishes were identified, up to 200 individuals were measured to the nearest millimeter (mm) standard length (SL), [disc width (DW) or total length (TL) where appropriate], and examined for external parasites, anatomical anomalies, or other abnormalities. Aggregate weight, in kilograms (kg), was recorded by species, divided between measured and unmeasured samples when appropriate. Species represented by 200 individuals or less were enumerated, those in excess of 200 were weighed with their abundance estimated based on the weight of the measured 200 by the following equation: Estimated abundance = (Unmeasured Weight)/(Mean Weight of Measured Individuals). Macroinvertebrates were counted and aggregate weights recorded. In cases of high abundance (> 200 individuals), the total abundance was estimated in the same fashion as was used for fish.

Specimens were returned to the sea after processing, except in cases of rare occurrence or uncertain identity. These individuals were retained for later confirmation and inclusion in the MBC voucher collection.

All field data was recorded on preprinted data sheets and later entered into Microsoft Excel 2000 spreadsheets. In-house quality assurance/quality control (QA/QC) protocols were followed to ensure accurate transcribing into digital format. Checked data was archived in the MBC trawl database in Microsoft Access 2000. Parametric and non-parametric analytical statistics were performed using Number Cruncher Statistical Software 2000 (Hintze 1998). Descriptive (summary) statistics were performed using Microsoft Excel 2000. Summary statistics included abundance, abundance per 100 meters (m) trawled, biomass, number of species, the Shannon-Wiener species diversity index (H'; Shannon and Weaver 1962), and the evenness index (J'; Pielou 1977). Fish abundance and macroinvertebrate densities were derived by dividing the raw abundance by the distance sampled (m) and multiplying by 100 to determine the number of fish or macroinvertebrates per 100 m.

Due to the non-normal distribution of the data, as indicated by high skewness and kurtosis values, of the data, all comparisons were made with a Kruskall-Wallis non-parametric analysis of variance (H) at the $p = 0.05$ significance level (Sokal and Rohlf 1995). Species and station relationships within seasons were graphically derived through hierarchical clustering analysis and two-way coincidence tables. A minimum of 10 individuals per species in each season was used as the criterion for inclusion in the cluster analysis. Abundance was natural log (ln) transformed before the calculation of the inter-entity distance (dissimilarity) matrix. Cluster diagrams were drawn based on these dissimilarities. In this analysis, a dissimilarity value of 1.5 was determined *a priori* as the minimal value indicating a significant separation between faunal groups.

Species length was represented by length frequency histograms to examine potential age structure of the sampled assemblage. Two species with greater than 500 individuals collected were analyzed. Species-specific lengths were rounded to the nearest 10-mm bin by season, i.e., 35-44 mm SL = 40 mm SL bin.

## RESULTS

### Fish

A total of 7,062 individuals representing 33 fish species weighing 73.91 kg was collected during the 2005 monitoring year (Tables 10 and 11). Overall species diversity (H') was 1.28 while evenness (J') was 0.37, indicating a high number of species collected with a relatively few species numerically dominating the overall catch (Table 10). Winter fish assemblages were significantly denser than summer assemblages (Kruskall-Wallis, df = 1, $H = 5.56$, $p = 0.015$). No significant differences were detected between stations ($p > 0.05$); fish density for the year peaked at Station T1 while the least dense assemblage was recorded at Station T2 (Figure 20).

White croaker (*Genyonemus lineatus*) numerically dominated the overall sample with 65.6% of the total abundance, or 4,632 individuals (Table 10). Queenfish (*Seriphus politus*) was the next most abundant species with 15.7% of the annual total, or 1,106 individuals. Of the remaining 31 species, only kelp pipefish (*Syngathus californiensis*), speckled sanddab (*Citharichthys stigmaeus*), northern anchovy (*Engraulis mordax*), and shiner perch (*Cymatogaster aggregata*) accounted for greater than 1.0% of the total abundance, or greater than 71 individuals. Ten species of the remaining 29 were represented by a single individual over the year (Table 10).

**Table 10. Abundance and catch parameters for fish species taken by trawl. Mandalay Generating Station NPDES, 2005.**

| | Winter | | | | | Summer | | | | | Grand | Percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | T1 | T2 | T3 | T4 | Total | T1 | T2 | T3 | T4 | Total | Total | Total |
| white croaker | 1,822 | 916 | 1,164 | 698 | 4,600 | 2 | - | - | 30 | 32 | 4,632 | 65.6 |
| queenfish | 17 | 9 | 289 | 789 | 1,104 | - | - | 1 | 1 | 2 | 1,106 | 15.7 |
| kelp pipefish | 94 | 52 | 83 | 66 | 295 | 25 | 13 | 8 | 5 | 51 | 346 | 4.9 |
| speckled sanddab | 8 | 180 | 1 | 41 | 230 | 19 | 46 | 22 | 8 | 95 | 325 | 4.6 |
| northern anchovy | 98 | 4 | 5 | 54 | 161 | - | - | 41 | - | 41 | 202 | 2.9 |
| shiner perch | 6 | 6 | 8 | 18 | 38 | 1 | - | 40 | 56 | 97 | 135 | 1.9 |
| barred surfperch | 3 | 16 | 2 | 3 | 24 | 2 | 21 | 3 | 17 | 43 | 67 | 0.9 |
| walleye surfperch | - | 1 | - | - | 1 | 7 | 5 | 30 | 10 | 52 | 53 | 0.8 |
| spiny dogfish | - | - | 10 | 31 | 41 | - | - | - | - | - | 41 | 0.6 |
| specklefin midshipman | - | 1 | 15 | 11 | 27 | - | - | - | - | - | 27 | 0.4 |
| thornback | 7 | 10 | 1 | 3 | 21 | 1 | 2 | - | - | 3 | 24 | 0.3 |
| white seaperch | - | - | - | - | - | - | 15 | 7 | 1 | 23 | 23 | 0.3 |
| basketweave cusk-eel | - | 1 | - | 17 | 18 | - | - | - | - | - | 18 | 0.3 |
| English sole | - | 2 | 1 | - | 3 | - | 2 | 6 | 2 | 10 | 13 | 0.2 |
| bat ray | - | 5 | 3 | 1 | 9 | - | - | - | - | - | 9 | 0.1 |
| California lizardfish | - | - | - | - | - | - | 5 | 3 | 1 | 9 | 9 | 0.1 |
| California corbina | 2 | 3 | - | - | 5 | - | 1 | - | - | 1 | 6 | 0.1 |
| black perch | 2 | - | - | - | 2 | - | - | - | 2 | 2 | 4 | 0.1 |
| hornyhead turbot | - | - | - | - | - | - | - | 1 | 2 | 3 | 3 | 0.0 |
| Pacific sardine | 2 | - | - | - | 2 | - | - | 1 | - | 1 | 3 | 0.0 |
| white seabass | - | - | - | 2 | 2 | - | - | - | - | - | 2 | 0.0 |
| Pacific pompano | - | - | 2 | - | 2 | - | - | - | - | - | 2 | 0.0 |
| leopard shark | - | - | 1 | 1 | 2 | - | - | - | - | - | 2 | 0.0 |
| Pacific staghorn sculpin | - | - | - | - | - | 1 | - | - | - | 1 | 1 | 0.0 |
| pygmy poacher | - | 1 | - | - | 1 | - | - | - | - | - | 1 | 0.0 |
| California halibut | - | - | - | 1 | 1 | - | - | - | - | - | 1 | 0.0 |
| diamond turbot | - | - | - | 1 | 1 | - | - | - | - | - | 1 | 0.0 |
| spotted turbot | - | - | - | - | - | - | - | - | 1 | 1 | 1 | 0.0 |
| rubberlip seaperch | - | - | - | - | - | - | - | - | 1 | 1 | 1 | 0.0 |
| shovelnose guitarfish | - | - | - | - | - | - | - | - | 1 | 1 | 1 | 0.0 |
| brown rockfish | - | 1 | - | - | 1 | - | - | - | - | - | 1 | 0.0 |
| Pacific angel shark | - | - | - | - | - | 1 | - | - | - | 1 | 1 | 0.0 |
| fantail sole | - | - | - | - | - | - | - | 1 | - | 1 | 1 | 0.0 |
| Total Abundance | 2,061 | 1,208 | 1,585 | 1,737 | 6,591 | 59 | 110 | 164 | 138 | 471 | 7,062 | |
| Number of Species | 11 | 16 | 14 | 16 | 24 | 9 | 9 | 13 | 15 | 22 | 33 | |
| Diversity (H') | 0.52 | 0.89 | 0.86 | 1.29 | 1.05 | 1.49 | 1.67 | 1.94 | 1.83 | 1.96 | 1.28 | |
| Evenness (J') | 0.22 | 0.32 | 0.33 | 0.46 | 0.33 | 0.68 | 0.76 | 0.76 | 0.68 | 0.63 | 0.37 | |

Note: 0.0 = < 0.05

Spiny dogfish (*Squalus acanthias*), rather than white croaker, numerically dominated the recorded biomass during the 2005 monitoring year with 16.15 kg, or 21.9% of the total biomass (Table 11). White croaker accounted for the second highest biomass with 12.77 kg, followed closely by bat ray (*Myliobatis californica*) with 12.31 kg and queenfish with 10.16 kg. The remaining fish species collected each accounted for 9.0% or less of the total biomass.

Winter sampling collected 6,591 individuals from 24 species with a overall seasonal species diversity of 1.05 and evenness of 0.33 (Table 10). Sampling at Station T1 accounted for the greatest total abundance with 2,061 individuals, but the lowest species richness, species diversity, and evenness during winter sampling with 11, 0.52, and 0.22, respectively. Peak species richness was shared between the assemblages at Station T2 and T4, each with 16 species. Species diversity and evenness each reached seasonal maximums in the observed assemblages at Station T4 with 1.29 and 0.46, respectively (Table 10). Station-specific abundance peaked at Station T1, principally attributed to abundance of white croaker, followed by the community at Station T4, which was strongly influenced by the abundance of queenfish (Figure 21). Abundance of queenfish was relatively low at Stations T1 and T2 (<20 individuals). Cluster analysis of the faunal associations indicate three distinct groups separated by their presence and relative abundances at each station. White croaker and queenfish immediately separate from the remaining species (Group III) due to their numerical dominance, especially at Stations T1 and T4 (Figure 22). Species Group II is comprised of those species collected in relatively high abundances, while those in Group I were collected in minimal abundances.

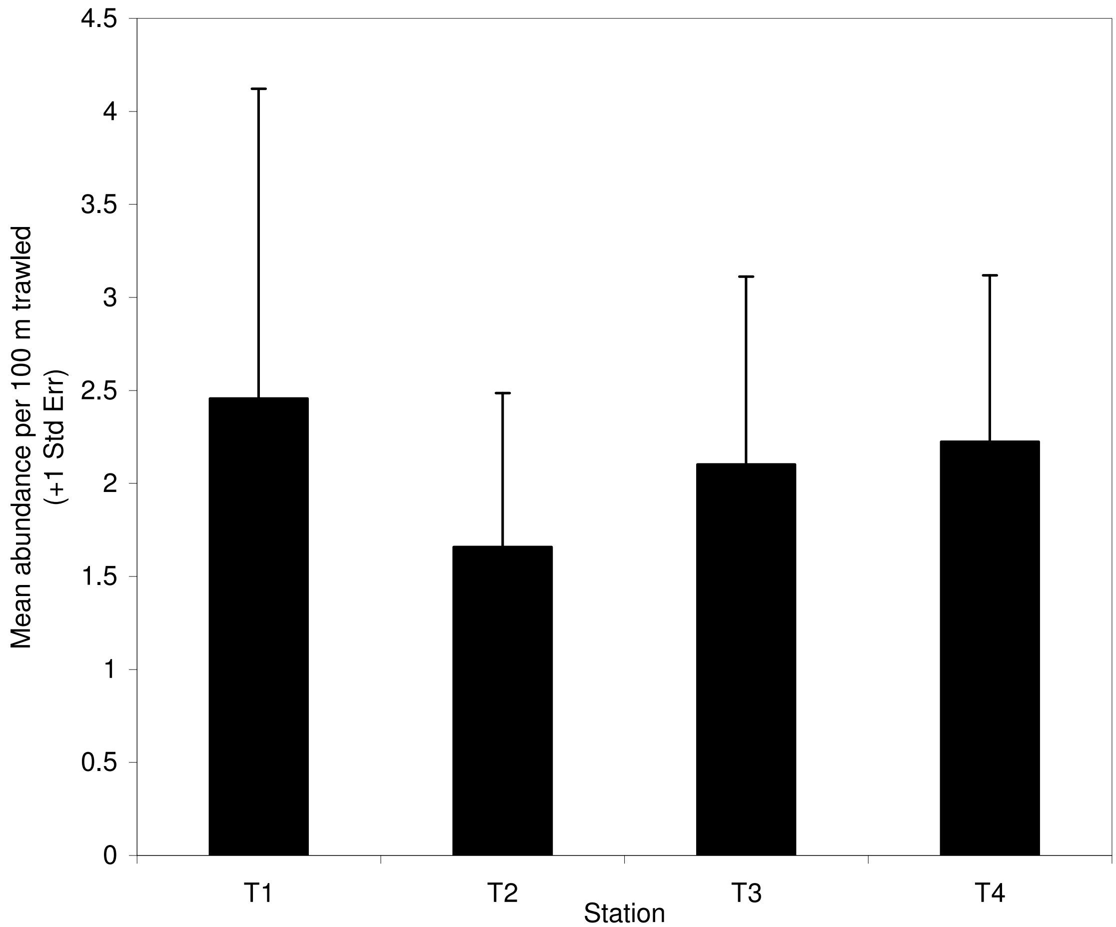



**Figure 20. Mean fish abundance per 100 m distance sampled by otter trawl by station. Mandalay Generating Station NPDES, 2005.**

Stations separated between upcoast of the discharge (Groups A and B) and downcoast of the discharge (Group C), with a further distinction made between the upcoast stations (Figure 22). Group A (Station T1) was distinguished by relatively high abundances of white croaker and Species Group II. The assemblage at Station T2 comprised Group B and diverged from the other stations due to low abundances of all species except a few from Species Group I. Group C represented both stations located downcoast of the discharge and was comprised of relatively high abundances of Species Group II (Figure 23).

Winter seasonal biomass totaled 62.06 kg, with the Station T4 community accounting for nearly one-half of the total survey biomass (28.61 kg), principally composed of white croaker,

**Table 11. Biomass (kg) of fish species taken by trawl. Mandalay Generating Station NPDES, 2005.**

| | Winter | | | | | Summer | | | | | Grand | Percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | T1 | T2 | T3 | T4 | Total | T1 | T2 | T3 | T4 | Total | Total | Total |
| spiny dogfish | - | - | 3.50 | 12.65 | 16.15 | - | - | - | - | - | 16.15 | 21.9 |
| white croaker | 2.04 | 1.12 | 5.07 | 4.20 | 12.42 | 0.00 | - | - | 0.35 | 0.35 | 12.77 | 17.3 |
| bat ray | - | 7.00 | 4.31 | 1.00 | 12.31 | - | - | - | - | - | 12.31 | 16.7 |
| queenfish | 0.08 | 0.04 | 2.27 | 7.74 | 10.13 | - | - | 0.01 | 0.02 | 0.03 | 10.16 | 13.8 |
| thornback | 1.37 | 3.23 | 0.04 | 1.52 | 6.16 | 0.15 | 0.37 | - | - | 0.52 | 6.68 | 9.0 |
| shovelnose guitarfish | - | - | - | - | - | - | - | - | 4.73 | 4.73 | 4.73 | 6.4 |
| barred surfperch | 0.08 | 0.67 | 0.07 | 0.09 | 0.90 | 0.07 | 0.25 | 0.06 | 0.82 | 1.20 | 2.10 | 2.8 |
| shiner perch | 0.06 | 0.04 | 0.05 | 0.11 | 0.26 | 0.02 | - | 0.63 | 1.02 | 1.67 | 1.92 | 2.6 |
| speckled sanddab | 0.02 | 0.62 | 0.00 | 0.10 | 0.74 | 0.20 | 0.42 | 0.24 | 0.05 | 0.91 | 1.65 | 2.2 |
| northern anchovy | 0.67 | 0.01 | 0.02 | 0.08 | 0.77 | - | - | 0.20 | - | 0.20 | 0.97 | 1.3 |
| Pacific angel shark | - | - | - | - | - | 0.80 | - | - | - | 0.80 | 0.80 | 1.1 |
| English sole | - | 0.13 | 0.07 | - | 0.20 | - | 0.10 | 0.39 | 0.07 | 0.56 | 0.76 | 1.0 |
| leopard shark | - | - | 0.05 | 0.45 | 0.50 | - | - | - | - | - | 0.50 | 0.7 |
| kelp pipefish | 0.10 | 0.07 | 0.10 | 0.07 | 0.34 | 0.06 | 0.03 | 0.02 | 0.01 | 0.13 | 0.47 | 0.6 |
| California corbina | 0.26 | 0.15 | - | - | 0.40 | - | 0.01 | - | - | 0.01 | 0.41 | 0.6 |
| basketweave cusk-eel | - | 0.00 | - | 0.25 | 0.25 | - | - | - | - | - | 0.25 | 0.3 |
| spotted turbot | - | - | - | - | - | - | - | - | 0.21 | 0.21 | 0.21 | 0.3 |
| diamond turbot | - | - | - | 0.20 | 0.20 | - | - | - | - | - | 0.20 | 0.3 |
| walleye surfperch | - | 0.00 | - | - | 0.00 | 0.02 | 0.01 | 0.10 | 0.04 | 0.17 | 0.17 | 0.2 |
| specklefin midshipman | - | 0.00 | 0.07 | 0.07 | 0.14 | - | - | - | - | - | 0.14 | 0.2 |
| hornyhead turbot | - | - | - | - | - | - | - | 0.05 | 0.06 | 0.10 | 0.10 | 0.1 |
| white seaperch | - | - | - | - | - | - | 0.04 | 0.03 | 0.00 | 0.08 | 0.08 | 0.1 |
| California lizardfish | - | - | - | - | - | - | 0.04 | 0.02 | 0.01 | 0.08 | 0.08 | 0.1 |
| white seabass | - | - | - | 0.06 | 0.06 | - | - | - | - | - | 0.06 | 0.1 |
| brown rockfish | - | 0.05 | - | - | 0.05 | - | - | - | - | - | 0.05 | 0.1 |
| Pacific sardine | 0.02 | - | - | - | 0.02 | - | - | 0.02 | - | 0.02 | 0.04 | 0.1 |
| fantail sole | - | - | - | - | - | - | - | 0.04 | - | 0.04 | 0.04 | 0.1 |
| Pacific pompano | - | - | 0.03 | - | 0.03 | - | - | - | - | - | 0.03 | 0.0 |
| Pacific staghorn sculpin | - | - | - | - | - | 0.03 | - | - | - | 0.03 | 0.03 | 0.0 |
| California halibut | - | - | - | 0.02 | 0.02 | - | - | - | - | - | 0.02 | 0.0 |
| black perch | 0.00 | - | - | - | 0.00 | - | - | - | 0.01 | 0.01 | 0.02 | 0.0 |
| rubberlip seaperch | - | - | - | - | - | - | - | - | 0.01 | 0.01 | 0.01 | 0.0 |
| pygmy poacher | - | 0.00 | - | - | 0.00 | - | - | - | - | - | 0.00 | 0.0 |
| Total Biomass (kg) | 4.69 | 13.12 | 15.64 | 28.61 | 62.06 | 1.35 | 1.29 | 1.80 | 7.42 | 11.85 | 73.91 | |

Note: 0.0 = < 0.05

queenfish, and spiny dogfish (Table 11 and Figure 24). The Station T3 ichthyofauna exhibited similar species-specific biomass distributions, while the biomass composition of the samples collected at Stations T1 and T2 was strongly influenced by white croaker, bat ray and thornback (*Platyrhinoidis triseriata*).

The summer survey recorded 471 individuals representing 22 species weighing 11.85 kg (Tables 10 and 11). No significant differences ($p > 0.05$) were detected between the fish densities at each station. Overall species diversity was relatively high at 1.96, as was evenness at 0.63, indicating a diverse community with several species collected in relatively even abundances (Table 10). Species richness peaked with the Station T4 community, while diversity was highest among fishes at Station T3, and evenness reached the seasonal maximum in collections at Stations T2 and T3. Seasonal minimums in diversity and evenness were recorded at Stations T1 and T4 (J'), with a tie in minimum species richness between the fauna of Stations T1 and T2 (Table 10).

Unlike winter surveys, white croaker and queenfish were collected in low abundances during the summer surveys (Figure 21). Abundance in the summer was numerically dominated by shiner perch with 97 individuals, followed closely by speckled sanddab with 95 individuals (Table 10). Faunal assemblages segregated into four groups based on common abundance/station occurrences (Figure 23). Shiner perch comprised Species Group IV due to relatively high abundances downcoast of the discharge and its comparative absence upcoast of discharge. Barred surfperch (*Amphistichus argenteus*) and white croaker were collected in relatively similar abundances overall, each with relatively high abundances downcoast of the discharge, although barred surfperch were also abundant at Station T2. Species forming Group II were collected in similar abundances, approximately 50 individuals, while Group I species were collected in relatively low abundances (Figure 23). As was seen in winter, the stations separated into three groups. Both stations located upcoast of the discharge clustered into one group (A), while downcoast stations separated by distance from the discharge with Species Group I principally abundant at Station T3 (Group B) and Species Groups III and IV principally abundant at Station T4 (Group C).

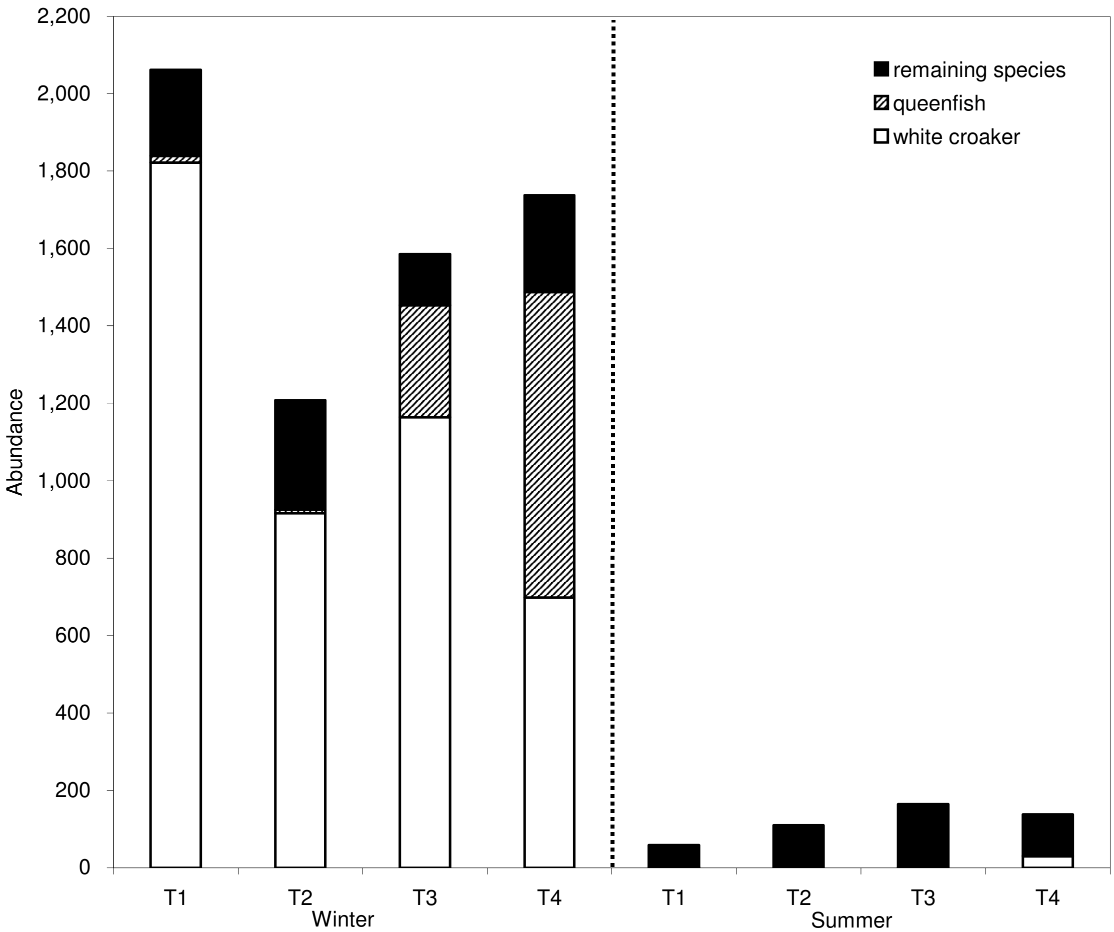



**Figure 21. Fish abundance sampled by trawl by station and season. Mandalay Generating Station NPDES, 2005.**

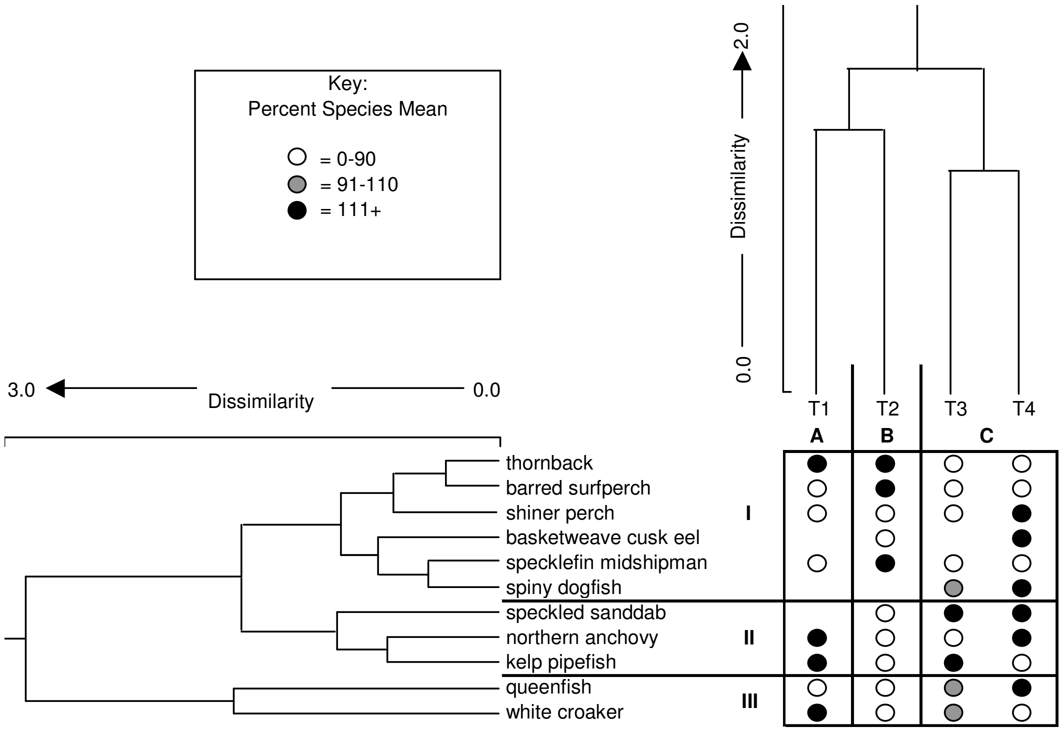



**Figure 22. Two-way coincidence table resulting from normal (station) and inverse (species) classification dendrograms for fish taken by trawl, winter survey. Mandalay Generating Station NPDES, 2005.**

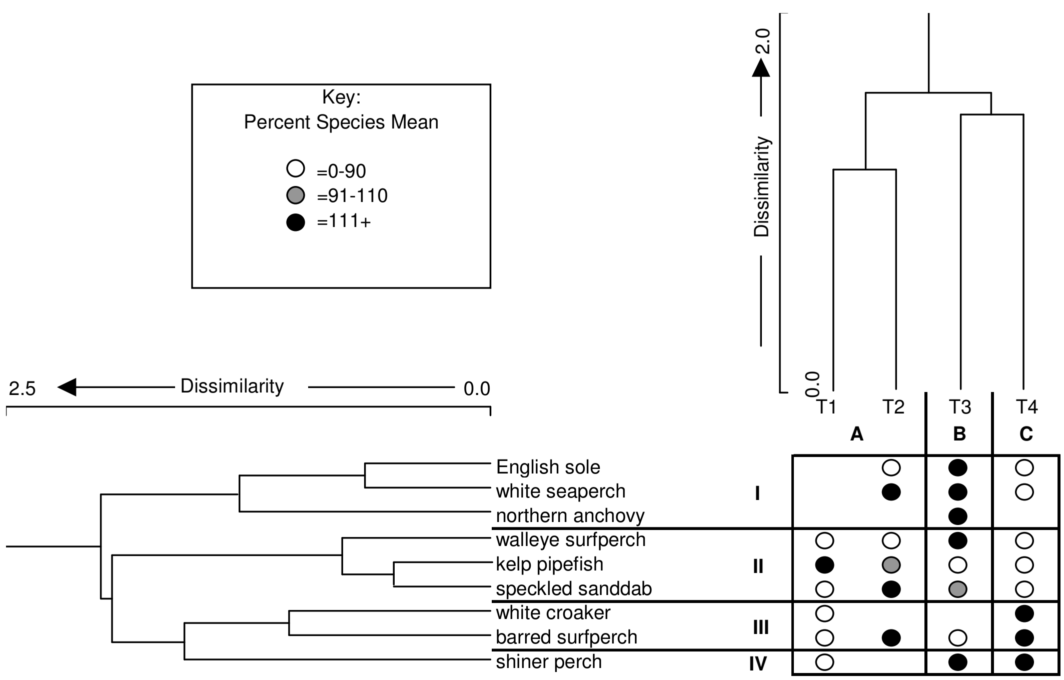



**Figure 23. Two-way coincidence table resulting from normal (station) and inverse (species) classification dendrograms for fish taken by trawl, summer survey. Mandalay Generating Station NPDES, 2005.**

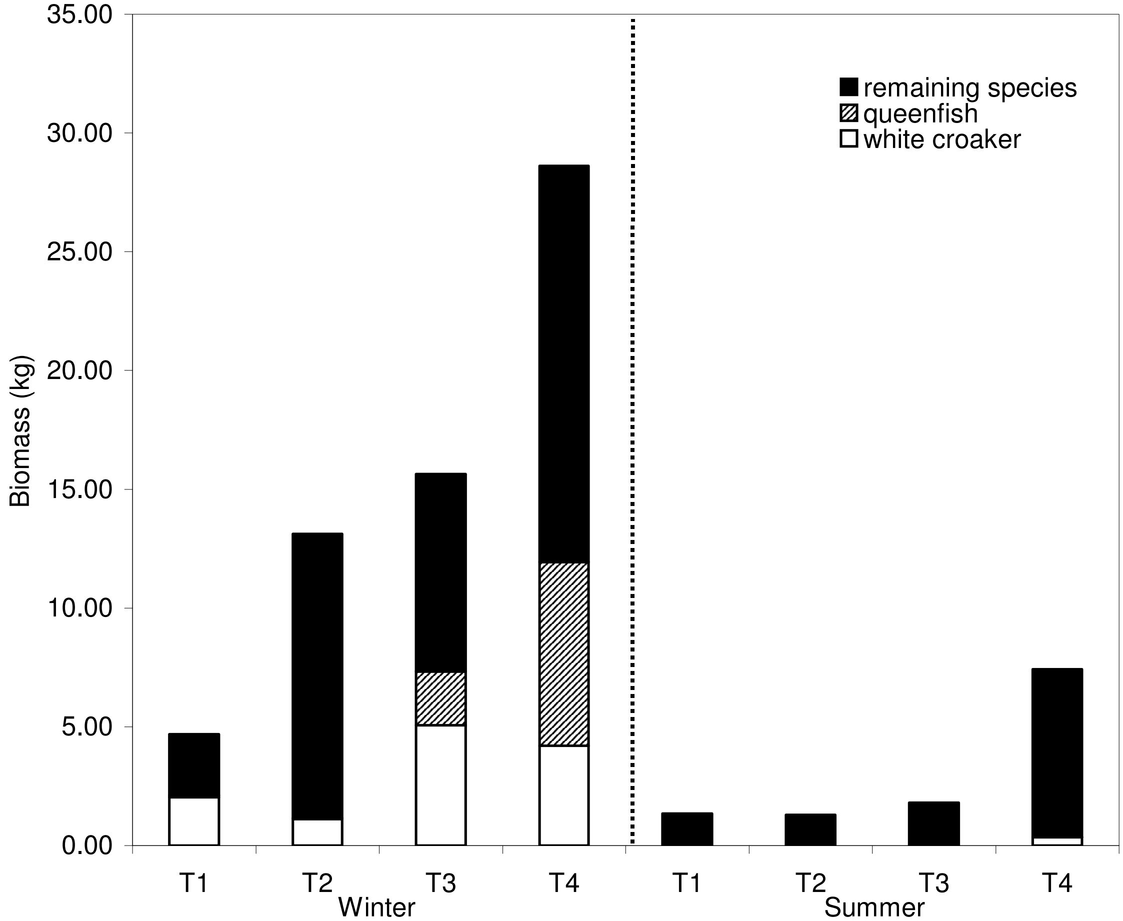



**Figure 24. Fish biomass (kg) sampled by trawl by station and season. Mandalay Generating Station NPDES, 2005.**

Biomass data closely resembled abundance data, with the exception of a single large shovelnose guitarfish (*Rhinobatos productus*) accounting for nearly one-half of the seasonal biomass (Table 11). Other than the shovelnose guitarfish, shiner perch and barred surfperch were the only species with a recorded biomass greater than 1.00 kg each. The remaining 19 species' biomass was less than 1.0 kg (Table 11). No fish species were recorded with abnormalities or fish parasites during the annual surveys.

### Fish Length

Fish lengths for the annual survey ranged from a 29-mm SL speckled sanddab to a 1,020-mm TL shovelnose guitarfish (Table 12). Length frequency analysis for white croaker indicates a bimodal distribution, with a principal peak at 40 mm SL and a secondary peak at 60 mm SL during winter sampling (Figure 25). Most of the individuals collected in summer were between 70 to 90 mm SL. Winter sampled queenfish indicate a unimodal distribution between 70 to 90 mm SL (Figure 26). Queenfish abundances recorded during summer sampling were too low to warrant an analysis of the summer assemblage.

**Table 12. Measured length (mm) of fish species taken by trawl. Mandalay Generating Station NPDES, 2005.**

| | Winter | | | | | Summer | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Species | Number | Min | Max | Mean | SD | Number | Min | Max | Mean | SD |
| barred surfperch | 24 | 82 | 150 | 105.2 | 18.0 | 43 | 59 | 132 | 91.2 | 24.9 |
| basketweave cusk-eel | 18 | 78 | 235 | 122.2 | 36.4 | - | - | - | - | - |
| bat ray* | 9 | 363 | 480 | 442.0 | 35.5 | - | - | - | - | - |
| black perch | 2 | 47 | 48 | 47.5 | 0.7 | 2 | 52 | 55 | 53.5 | 2.1 |
| brown rockfish | 1 | 116 | 116 | 116.0 | - | - | - | - | - | - |
| California corbina | 5 | 142 | 211 | 170.4 | 29.9 | 1 | 95 | 95 | 95.0 | - |
| California halibut | 1 | 121 | 121 | 121.0 | - | - | - | - | - | - |
| California lizardfish | - | - | - | - | - | 9 | 82 | 118 | 103.3 | 13.0 |
| diamond turbot | 1 | 203 | 203 | 203.0 | - | - | - | - | - | - |
| English sole | 3 | 154 | 183 | 170.7 | 15.0 | 10 | 111 | 195 | 147.5 | 25.6 |
| fantail sole | - | - | - | - | - | 1 | 123 | 123 | 123.0 | - |
| hornyhead turbot | - | - | - | - | - | 3 | 120 | 145 | 131.7 | 12.6 |
| kelp pipefish | 295 | 80 | 291 | 167.5 | 29.1 | 51 | 137 | 253 | 194.1 | 25.5 |
| leopard shark** | 2 | 230 | 235 | 232.5 | 3.5 | - | - | - | - | - |
| northern anchovy | 161 | 41 | 117 | 73.6 | 19.6 | 41 | 47 | 89 | 76.8 | 6.8 |
| Pacific angel shark | - | - | - | - | - | 1 | 175 | 175 | 175.0 | - |
| Pacific pompano | 2 | 82 | 92 | 87.0 | 7.1 | - | - | - | - | - |
| Pacific sardine | 2 | 102 | 116 | 109.0 | 9.9 | 1 | 118 | 118 | 118.0 | - |
| Pacific staghorn sculpin | - | - | - | - | - | 1 | 106 | 106 | 106.0 | - |
| pygmy poacher | 1 | 70 | 70 | 70.0 | - | - | - | - | - | - |
| queenfish | 673 | 47 | 139 | 78.5 | 12.3 | 2 | 92 | 110 | 101.0 | 12.7 |
| rubberlip seaperch | - | - | - | - | - | 1 | 73 | 73 | 73.0 | - |
| shiner perch | 38 | 57 | 101 | 66.4 | 7.6 | 97 | 47 | 112 | 85.5 | 9.4 |
| shovelnose guitarfish** | - | - | - | - | - | 1 | 1020 | 1020 | 1020.0 | - |
| speckled sanddab | 230 | 29 | 99 | 60.3 | 11.4 | 95 | 32 | 107 | 70.6 | 23.4 |
| specklefin midshipman | 27 | 56 | 145 | 79.1 | 19.4 | - | - | - | - | - |
| spiny dogfish** | 41 | 354 | 660 | 464.5 | 64.8 | - | - | - | - | - |
| spotted turbot | - | - | - | - | - | 1 | 217 | 217 | 217.0 | - |
| thornback** | 21 | 140 | 555 | 346.3 | 101.8 | 3 | 273 | 312 | 291.7 | 19.6 |
| walleye surfperch | 1 | 45 | 45 | 45.0 | - | 52 | 38 | 62 | 51.2 | 4.4 |
| white croaker | 1599 | 30 | 154 | 49.8 | 14.3 | 32 | 34 | 132 | 74.7 | 18.8 |
| white seabass | 2 | 106 | 145 | 125.5 | 27.6 | - | - | - | - | - |
| white seaperch | - | - | - | - | - | 23 | 41 | 62 | 54.3 | 4.1 |

* = Disc Width , ** = Total Length

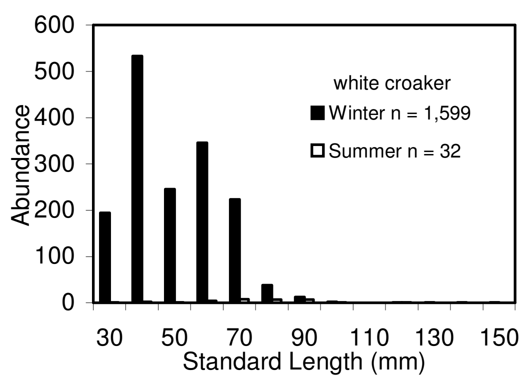



**Figure 25. Length frequency histogram of white croaker (*Genyonemus lineatus*) collected by trawl. Mandalay Generating Station NPDES, 2005.**

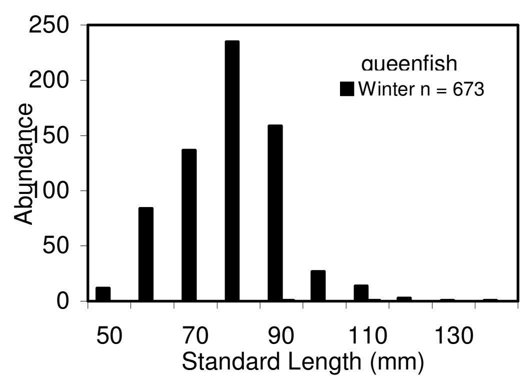



**Figure 26. Length frequency histogram of queenfish (*Seriphus politus*) collected by trawl. Mandalay Generating Station NPDES, 2005.**

**Macroinvertebrates**

A total of 8,101 individuals representing seven macroinvertebrate species weighing 31.67 kg were collected during the 2005 monitoring year (Table 13). Overall species diversity was 0.31 and evenness was 0.16, both indices reflecting a low species richness with overall abundance numerically dominated by only one or two species. Macroinvertebrate density peaked at Station T2 for the year, with the remaining three stations relatively similar (Figure 27).

**Table 13. Abundance and catch parameters for macroinvertebrate species taken by trawl. Mandalay Generating Station NPDES, 2005.**

| | Winter | | | | | Summer | | | | | Grand | Percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | T1 | T2 | T3 | T4 | Total | T1 | T2 | T3 | T4 | Total | Total | Total |
| blackspotted bay shrimp | 827 | 3,033 | 1,285 | 1,424 | 6,569 | 684 | 162 | 52 | 18 | 916 | 7,485 | 92.4 |
| Pacific sand dollar | 3 | 87 | 53 | 181 | 324 | - | 67 | 1 | 137 | 205 | 529 | 6.5 |
| graceful crab | - | 5 | 4 | 20 | 29 | 6 | 6 | 6 | 29 | 47 | 76 | 0.9 |
| tuberculate pear crab | - | - | - | - | - | 2 | 2 | 2 | - | 6 | 6 | 0.1 |
| Xantus swimming crab | 1 | 1 | - | 1 | 3 | - | - | - | - | - | 3 | 0.0 |
| mottled pea crab | - | 1 | - | - | 1 | - | - | - | - | - | 1 | 0.0 |
| sheep crab | - | - | - | - | - | - | 1 | - | - | 1 | 1 | 0.0 |
| Abundance | 831 | 3,127 | 1,342 | 1,626 | 6,926 | 692 | 238 | 61 | 184 | 1,175 | 8,101 | |
| Number of species | 3 | 5 | 3 | 4 | 5 | 3 | 5 | 4 | 3 | 5 | 7 | |
| Diversity (H') | 0.03 | 0.14 | 0.19 | 0.42 | 0.22 | 0.07 | 0.77 | 0.54 | 0.74 | 0.66 | 0.31 | |
| Evennes (J') | 0.03 | 0.09 | 0.17 | 0.30 | 0.14 | 0.06 | 0.48 | 0.39 | 0.67 | 0.41 | 0.16 | |
| Biomass (kg) | 2.63 | 9.91 | 4.21 | 6.42 | 23.18 | 2.20 | 4.73 | 0.39 | 1.18 | 8.49 | 31.67 | |
| Fish parasites (not included above): | | | | | | | | | | | | |
| fish louse | - | - | - | - | 1 | - | 7 | 12 | 4 | 23 | 24 | |

Note: 0.0 = < 0.05

Blackspotted bay shrimp (*Crangon nigromaculata*) numerically dominated the annual abundance with 92.4% or 7,485 individuals (Table 13 and Figure 28). Of the remaining six species, only Pacific sand dollar (*Dendraster excentricus*) accounted for greater than 1.0 % of the total annual abundance. The remaining five species were each represented by less than 1.0%, or 77 individuals.

Winter sampling recorded a total of 6,926 individuals from 5 species weighing 23.18 kg (Table 13). Blackspotted bay shrimp accounted for nearly 95% of the total seasonal abundance with 6,569 individuals and nearly one-half was recorded at Station T2. Abundances at Station T2 were nearly twice that of the station with the second highest abundance (Station T4), with blackspotted bay shrimp as the principal species across all stations with only Pacific sand dollar appreciably present at Stations T2 -T4 (Figure 28).

Species diversity and evenness indices reflected the numerical dominance of blackspotted bay shrimp, with the survey minimums in each recorded at Station T1 where blackspotted bay shrimp accounted for nearly 100% of the total abundance (Figure 28). Peak diversity and evenness in winter were recorded for the macroinvertebrate community at Station T4 with 0.42 and 0.30, respectively, principally due to the relatively high abundances of Pacific sand dollar and graceful crab (*Cancer gracilis*). Macroinvertebrate biomass peaked with the assemblage at Station T2 (9.91 kg), while minimal biomass was recorded in the Station T1 communities (Table 13).

Abundance during summer surveys was greatly reduced in comparison to the winter survey (Table 13). A total of 1,175 individuals representing five species weighing 8.494 kg was recorded during summer sampling. Overall species diversity during summer sampling was 0.66 while evenness was 0.41, indicating a more diverse community than was encountered during the winter survey.

Blackspotted bay shrimp was the most abundant macroinvertebrate species in summer with 916 individuals, followed by Pacific sand dollar with 205 individuals and graceful crab with 47

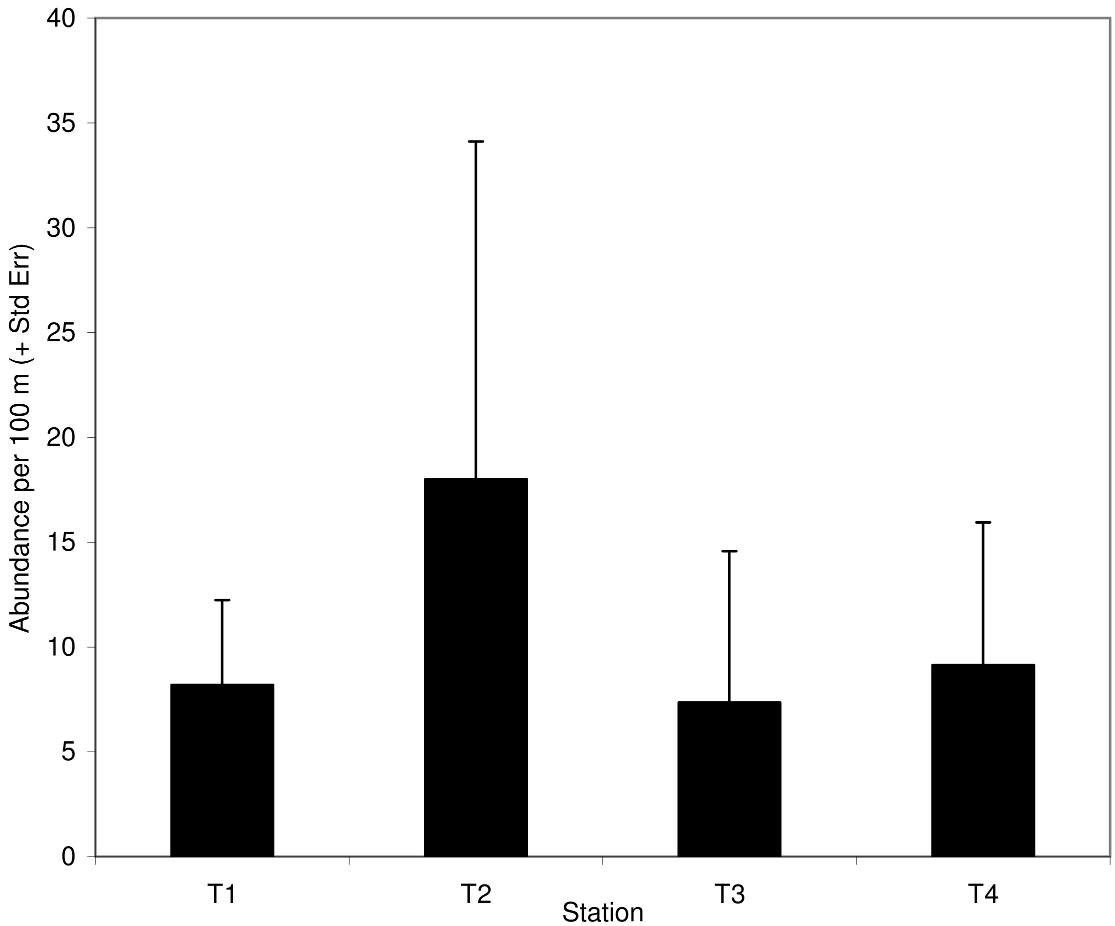



**Figure 27. Mean macroinvertebrate abundance per 100 m distance sampled by otter trawl by station. Mandalay Generating Station NPDES, 2005.**

individuals (Table 13). Abundances at Station T1 were the greatest during the summer surveys, again with blackspotted bay shrimp comprising nearly the entire macroinvertebrate sample (Figure 28). Surveys at Station T3 recorded the least abundance during the annual surveys, while abundances at Station T4 displayed a different trend with Pacific sand dollar as the most abundant species (Figure 28).

Macroinvertebrate biomass peaked during summer sampling at Station T2, principally due to the presence of one large sheep crab (*Loxorhynchus grandis*), followed by the assemblages at Station T1 and T4 with 2.20 and 1.18 kg, respectively (Table 13). Survey minimum biomass was recorded during sampling at Station T3 with 0.39 kg.

Several fish lice were collected free from host species during the annual surveys (Table 13). One individual was recorded during winter surveys at Station T3, while 23 individuals were observed during summer sampling.

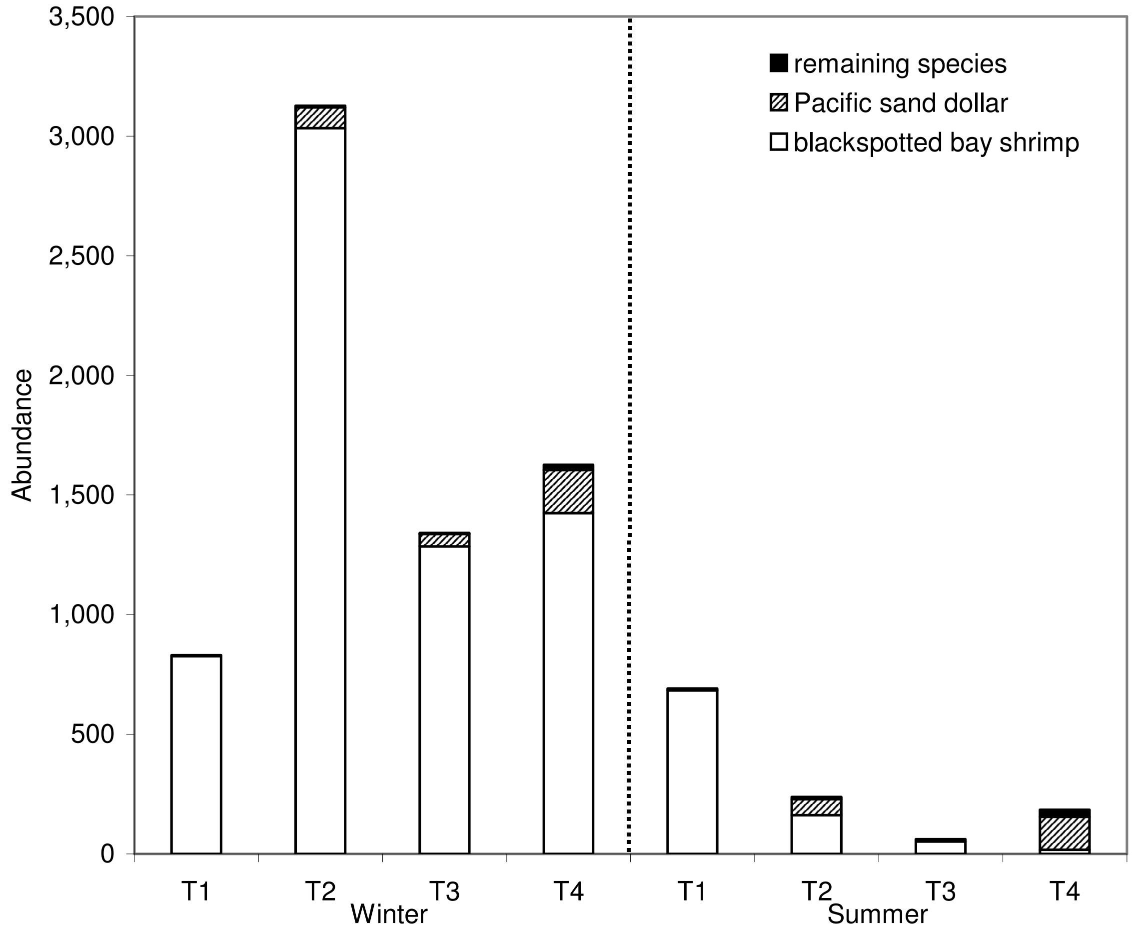



**Figure 28. Macroinvertebrate abundance sampled by otter trawl by station and season. Mandalay Generating Station NPDES, 2005.**

## DISCUSSION

In 2005, 7,062 individual fish from 33 species weighing 73.91 kg were collected during trawl surveys of the demersal community in the receiving waters of Mandalay Generating Station. Significant seasonal variation in the abundance of observed fish species was recorded. However, no such difference was noted between stations, indicating a fish community fluctuating with seasonal migration or activity patterns, rather than anthropogenic impacts. Recorded abundances in 2005 were consistent with the long-term mean (Figure 29). Demersal fish abundances observed in the 2005 annual survey were the highest since 2002, and rose for the second straight year, suggesting a stable, but slightly increasing fish community within the receiving waters. Annual surveys during 2005 recorded a return to the conventional species distribution, with white croaker and queenfish as the most abundant species observed (Figure 29). During the previous two years, northern anchovy and speckled sanddab comprised the majority of the recorded abundance while white croaker and queenfish abundances were greatly reduced (Figure 29). Species richness was consistent with previous surveys, and appreciably higher than records in 2003 and 2004 (Table 14).

White croaker and queenfish were the most abundant species collected in the 2005 demersal trawl surveys (Figure 29). These are two of the three most abundant species (northern anchovy, *Engraulis mordax*, being the third species) collected since monitoring began in 1978

(Figure 29; MBC 1979, 1981, 1986, 1988, 1990, 1994, 1997-2000, 2001a-2002a, 2003, 2004a; Ogden 1991-1993). All three have been collected in all but one annual survey, with varied abundances (Table 14). Northern anchovy, a substantial member of the fish community in 11 of the past 17 surveys, was present in noticeably reduced abundances in 2005. Known as a schooling species, the greatly reduced abundances of northern anchovy may indicate a lack of polarized schools in the area due to random migration patterns, rather than anthropogenic effects.

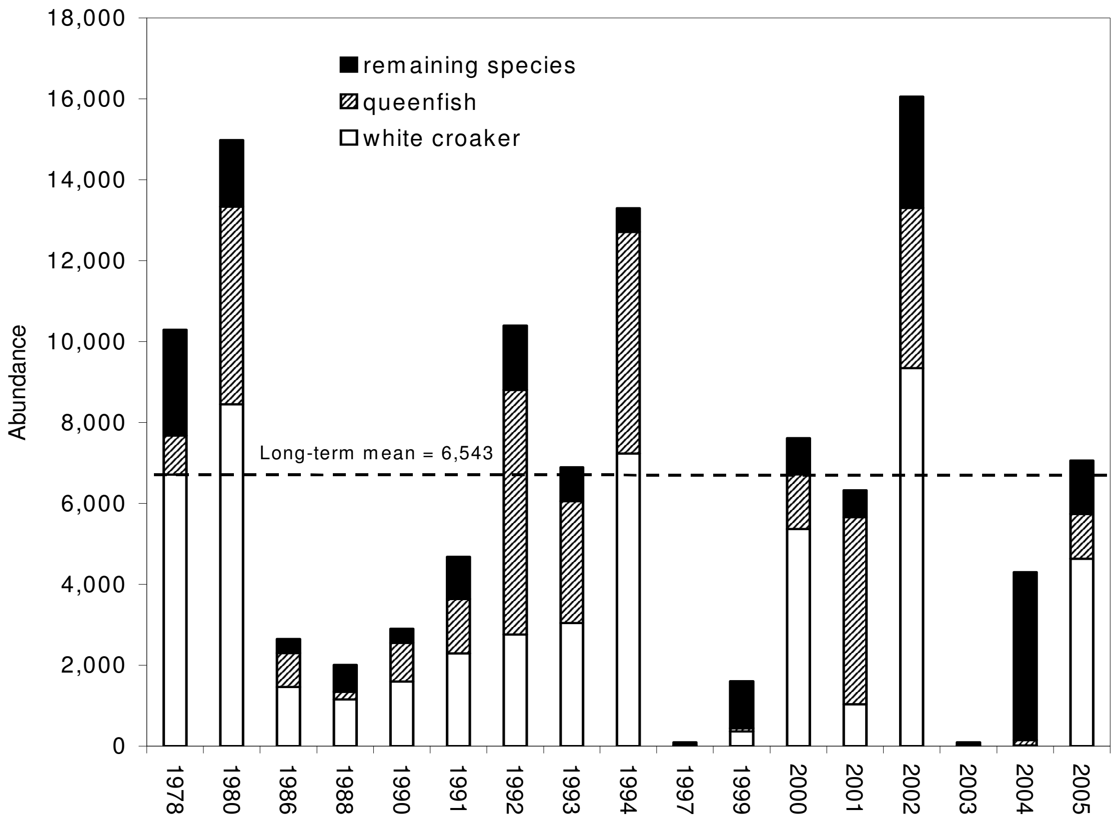



**Figure 29. Macroinvertebrate abundance sampled by otter trawl during annual surveys 1978 - 2005. Mandalay Generating Station NPDES, 2005.**

White croaker was the most abundant fish collected in 2005 and has been such over the length of the sampling period (Table 14). In 2005, 4,632 individuals accounted for 65.6% of the total catch, principally occurring during winter surveys. During the winter, white croaker was taken at all stations, but was absent from collections at Stations T2 and T3 during summer sampling. White croaker was the most abundant fish collected during the 1998 Bight-wide demersal fish survey, accounting for 28% of the total fish catch and 26% of the total biomass (Allen et al. 2002).

White croaker is typically abundant over sandy nearshore areas (Hobson and Chess 1976, Allen and DeMartini 1983) at depths of 15 to 22 m (Love et al. 1984), and is an important sport fish commonly caught from piers and jetties throughout the Southern California Bight (Eschmeyer et al. 1983). Most of the commercial catch is sold as fresh fish, although a small amount is used for live bait. White croaker are common from British Columbia to Baja California in loose schools from the surf zone to depths of 600 ft, and in shallow bays, sloughs, and lagoons (Love et al. 1984, Moore and Wild 2001). They are primarily nocturnal and tend to occur inshore during the day in resting schools, remaining nearshore at night to feed on bottom-dwelling polychaetes and crustaceans (Ware 1979, Allen 1982). Juveniles (less than 130 mm SL) are usually limited to shallow nearshore areas and embayments, which they may use as nursery grounds.

**Table 14. The 20 most abundant fish species taken during trawl surveys, 1978 - 2005. Mandalay Generating Station NPDES, 2005.**

| | Year | | | | | | | | | | | | | | | | | Grand | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 1978 | 1980 | 1986 | 1988 | 1990 | 1991 | 1992 | 1993 | 1994 | 1997 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | Total | Total |
| white croaker | 6713 | 8446 | 1464 | 1150 | 1592 | 2291 | 2756 | 3043 | 7237 | 20 | 363 | 5363 | 1033 | 9342 | - | 16 | 4632 | 50829 | 45.7 |
| queenfish | 966 | 4889 | 830 | 195 | 957 | 1341 | 6049 | 3009 | 5483 | - | 76 | 1352 | 4630 | 3971 | 8 | 138 | 1106 | 33894 | 30.5 |
| northern anchovy | 1476 | 494 | 2 | 52 | 88 | 359 | 1469 | 159 | 115 | - | 640 | 256 | 383 | 1216 | 9 | 3322 | 202 | 10040 | 9.0 |
| speckled sanddab | 36 | 8 | 40 | 64 | 76 | 217 | 4 | 75 | 16 | 7 | 143 | 219 | 38 | 224 | 51 | 476 | 325 | 1694 | 1.5 |
| shiner perch | 107 | 24 | - | 4 | 33 | 63 | 4 | 58 | 88 | 17 | 190 | 42 | 11 | 529 | 18 | 118 | 135 | 1306 | 1.2 |
| barred surfperch | 210 | 172 | 46 | 223 | 38 | 95 | 29 | 115 | 41 | 18 | 1 | 33 | 9 | 42 | - | 20 | 67 | 1092 | 1.0 |
| white seaperch | 245 | 321 | 2 | 17 | 18 | 26 | 5 | 5 | 80 | 12 | 25 | - | 1 | 225 | - | - | 23 | 982 | 0.9 |
| walleye surfperch | 335 | 340 | 8 | 18 | - | 50 | 5 | 26 | 28 | 1 | 1 | 16 | 37 | 28 | 1 | 9 | 53 | 903 | 0.8 |
| kelp pipefish | - | - | - | - | - | - | - | - | - | - | 80 | 149 | 104 | 179 | 3 | 118 | 346 | 633 | 0.6 |
| thornback | 27 | 21 | 12 | 16 | 6 | 56 | 4 | 167 | 2 | 3 | 13 | 14 | 6 | 52 | - | 2 | 24 | 401 | 0.4 |
| California halibut | 25 | 54 | 66 | 58 | 21 | 27 | 1 | 8 | 11 | - | 2 | 5 | 1 | 4 | - | - | 1 | 283 | 0.3 |
| California corbina | 15 | 3 | 79 | - | - | 3 | 2 | 33 | 19 | - | 2 | 73 | 24 | 9 | - | 8 | 6 | 270 | 0.2 |
| California lizardfish | 17 | 5 | - | - | 8 | - | 1 | 2 | 4 | - | 1 | 1 | 26 | 115 | - | 1 | 9 | 181 | 0.2 |
| yellowfin croaker | 2 | - | 11 | 1 | - | 1 | - | 79 | 50 | - | - | - | 3 | - | - | - | - | 147 | 0.1 |
| barcheek pipefish | 3 | - | - | 77 | 5 | - | - | - | 58 | - | - | - | - | - | - | - | - | 143 | 0.1 |
| fantail sole | - | 10 | 17 | 10 | 1 | 3 | 1 | 1 | 5 | 1 | 39 | 27 | 1 | 16 | - | - | 1 | 132 | 0.1 |
| English sole | 22 | 8 | 5 | 49 | 7 | - | - | 1 | 4 | 1 | 7 | - | - | 15 | - | 1 | 13 | 120 | 0.1 |
| basketweave cusk-eel | 1 | 3 | 9 | - | 8 | 45 | - | 28 | 4 | - | 1 | 5 | - | - | - | - | 18 | 104 | 0.1 |
| shovelnose guitarfish | 6 | 11 | 6 | 22 | 13 | 18 | - | 19 | 2 | - | 1 | 2 | - | 2 | - | - | 1 | 102 | 0.1 |
| Pacific butterfish | 2 | 23 | - | 6 | - | 1 | 7 | - | 3 | - | - | 30 | 2 | 20 | - | 1 | 2 | 95 | 0.1 |
| Survey totals | | | | | | | | | | | | | | | | | | | |
| Number of individuals | 10299 | 14986 | 2648 | 2009 | 2896 | 4674 | 10399 | 6892 | 13296 | 89 | 1597 | 7616 | 6324 | 16056 | 91 | 4304 | 6964 | 111140 | |
| Number of species | 41 | 35 | 29 | 24 | 23 | 30 | 21 | 28 | 33 | 10 | 25 | 22 | 24 | 27 | 7 | 23 | 33 | 65 | |

Although white croaker spawning can occur throughout the year, distinct seasonal peaks are generally found in January through April (Love et al. 1984, Goldberg 1976). White croaker individuals typically mature at approximately one year at a length of 120 to 130 mm SL (Love et al. 1984). In winter, white croaker averaged 50 mm SL, ranging in length from 30 to 154 mm SL. Summer collections averaged 75 mm SL, with a range of 34 to 132 mm SL. Length frequency analysis indicates the majority of the community were young of the year (YOY) or within their first year. Proportionally few individuals were mature, based on Love et al. (1984).

Queenfish, the second most abundant fish taken in 2005, accounted for 15.7% of the total fish abundance and contributed 13.8% to the overall annual biomass. Like white croaker, queenfish abundances were substantially higher during winter surveys, with 1,104 in winter surveys and only two individuals collected in summer sampling. Collections at Stations T3 and T4 during winter surveys accounted for nearly all queenfish in 2005. Queenfish is overall the second most abundant fish species collected offshore of the generating station and has been taken during all but one annual survey since 1978 (Table 14).

Queenfish is an inner and middle shelf species found commonly in bays and harbors of southern California. In the 1998 Bight-wide survey, 3,854 individual queenfish were caught, accounting for 6% of the total abundance and 4% of the total biomass of fish collected at depths between 2 to 202 m, with queenfish accounting for 20% of the abundance of those species collected on the inner shelf (Allen et al. 2002). Abundance of queenfish in the survey area has varied between seasons and among years, with numbers ranging from zero in 1997 to 6,049 in 1992 (Figure 28). Most queenfish are found over sandy bottoms from the surf line out to about 23 m (75 ft) and in bays, sloughs, and around pilings (Eschmeyer et al. 1983). Queenfish school by day and disperse to deeper water at night where they actively feed on crustaceans and small fish.

Queenfish mature at about one year and approximately 110 mm SL, though mature fish as small as 100 mm SL are occasionally found (DeMartini and Fountain 1981). Off Los Angeles, spawning occurs from April into August (Goldberg 1976). In 2005, queenfish averaged 78.5 mm SL in winter, with only two individuals (92 and 110 mm SL) collected during the summer surveys. Length frequency analysis indicates a community principally comprised of YOY, with lesser numbers of one-year-old fish.

In 2005, speckled sanddab was the fourth most abundant fish species collected with 325 individuals recorded. Speckled sanddab was present at all four stations over the year, with distinctly greater abundances just upcoast of the discharge. It is the fourth most abundant long-term species in the area and has been taken during every survey year. In 2005, speckled sanddab abundances were the second highest on record for the area (Table 14). Speckled sanddab is a non-schooling species commonly associated with soft-bottom habitats throughout the shallow nearshore environment of southern California (Allen 1982, Allen 1985). A sandy-bottom species that feeds mainly during the day, speckled sanddab hunts primarily by sight on epifaunal invertebrates (Ford 1965, Allen 1982). This typically small sanddab has not been an important part of the commercial catch, although present in some of the commercial landings, speckled sanddab are frequently sought by recreational anglers (Allen and Leos 2001). Speckled sanddab is a non-schooling species and similarity of abundances among years of this species suggests that the fish assemblage of the nearshore, soft-bottom community remains stable in the area.

In 2005, 8,101 macroinvertebrate individuals were collected from 7 species. Macroinvertebrate abundance in 2005 exceeded the long-term mean of 4,341 individuals, and was the highest recorded since 2001 (Figure 30). Two species (blackspotted bay shrimp and Pacific sand dollar) accounted for 99% of the total abundance. Winter abundances were substantially greater than those recorded during summer surveys.

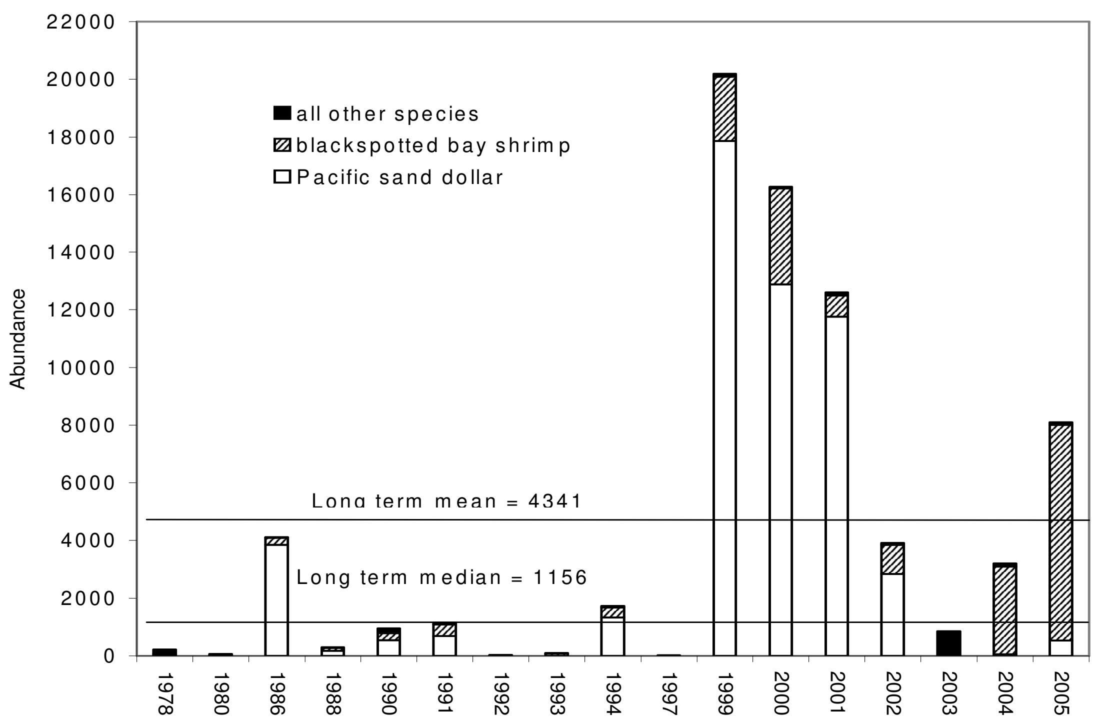



**Figure 30. Fish abundance sampled by otter trawl during annual surveys 1978 - 2005. Mandalay Generating Station NPDES, 2005.**

Surveys during 2005 continued a trend beginning with the summer 2002 survey, with blackspotted bay shrimp replacing Pacific sand dollar as the numerically dominant macroinvertebrate species in the area (Figure 30; MBC 1990, 1994, 1997-2000, 2001a-2002a, 2003, 2004a; Ogden 1991-1993). This species is also common in trawl surveys at other locations in southern California, and plays an important role in the coastal food web. Blackspotted bay shrimp prefers mud and sand bottoms, feeding on small epibenthic and benthic fauna. In turn, blackspotted bay shrimp are preyed on by a number of fish, including Pacific staghorn sculpin (*Leptocottus armatus*), brown smoothhound (*Mustelus henlei*) and white croaker (Ware 1979, Siegfried 1989). Annual abundance off some areas of California has varied widely, sometimes by more than tenfold (Siegfried 1989). Ovigerous females (those with eggs) are found in coastal embayments in summer but are uncommon in winter. Seasonal migrations of some crangonid shrimp have been linked to changing seawater temperatures (Siegfried 1989).

## CONCLUSION

In 2005, fish and macroinvertebrate communities were more abundant than has been recorded in recent surveys. Analyses between seasonal sampling indicated a significant difference in abundance between the two seasons, as would be expected with schooling fishes that exhibit seasonal migration and activity patterns. No significant differences were detected between the reference stations. Macroinvertebrate communities exhibited similar patterns as were recorded for fish, with no significant difference between the reference stations and those adjacent to the discharge. Based on the available data, both current and historical, the operation of Mandalay Generating Station had no detectable deleterious effects on the fish and macroinvertebrate communities within the receiving waters. The results of this investigation suggest that all applicable beneficial uses of the receiving waters, i.e., commercial and recreational fishing, maintenance of all applicable habitat, migration of aquatic organisms, spawning, reproduction, and early development of fish species common to the area are being maintained.

# IMPINGEMENT

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

Mandalay Generating Station is located on the coast of approximately 4.8 km west of the City of Oxnard, California. Seawater is supplied to the once through cooling system via Edison Canal, which connects to Channel Islands Harbor, located approximately 4.8 km downcoast of the generating station. Withdrawn seawater is screened for debris, first by bar racks that remove large debris followed by mesh traveling screens that remove the remaining material, such as fish and macroinvertebrates. 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. 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 system of fouling organisms, such as mussels, which could impair the operation of a generating station. Heat treatments involve 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 unable to escape the intake area are similarly exposed to elevated seawater temperatures, often causing mortality.

## MATERIALS AND METHODS

At Mandalay Generating Station, all heat treatments were monitored. During heat treatments, accumulated material was sorted and processed. Fish and macroinvertebrates were identified to the lowest practical taxonomic category. 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), and sex of select species. Total abundance for species with greater than 200 individuals was estimated by dividing the total weight of the unmeasured individuals by the mean weight of the measured individuals from within each species. Specimens that are either rare or of uncertain identity were retained for later confirmation and/or inclusion into the MBC voucher collection.

Macroinvertbrates were also sorted to the lowest possible taxonomic category, counted and an aggregate weight taken. California spiny lobster (*Panulirus interruptus*) were counted, measured to the nearest mm carapace length (CL), sexed, and an aggregate weight recorded.

In addition to heat treatment monitoring, monthly normal operation surveys were performed at Mandalay Generating Station. In order to assess the impingement of marine organisms during representative periods of normal operation at the generating station, 24-hr surveys during representative periods of operation were conducted. During such surveys, the traveling screens and collection baskets were cleared of all accumulated debris prior to the collection of a sample. At the end of a 24-hour period 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 is 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. This impingement rate, derived from this equation, establishes the abundance per 100 million gallons of water circulated. Volume of water circulated is based on the water flow rate corresponding to the time period surveyed. Estimates of annual normal operation impingement is 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. Annual impingement losses are calculated by combining abundance (biomass) during heat treatments with estimated normal operation impingement.

Data was recorded in the field on preprinted data sheets and entered into formatted MS Excel 2000 spreadsheets. In house QA/QC measures were followed to ensure accurate transcription into digital format. Corrected data was uploaded to the MBC fish impingement database for archiving. All descriptive (summary) statistics were computed with Microsoft Excel 2000. Summary statistics include mean and standard deviation. Length frequency distributions for those fishes examined were derived by rounding (1 to 4 = 0, 5 to 9 = 10) the recorded length to the nearest ten mm of each measurement type (SL or DW). Abundance per size class was plotted using MS Excel 2000. Species examined were limited to those with greater than 30 individual lengths available. Data from both survey types were utilized for length frequency analysis.

## RESULTS

### Fish

Two heat treatments and seven normal operation surveys were conducted during the 2005 monitoring year at Mandalay Generating Station. An estimated 53,598 individuals weighing 1,235.567 kg representing 20 fish species were impinged during the 2005 monitoring year (Table 15). Of these, California grunion (*Leuresthes tenuis*) numerically dominated both abundance and biomass with 74.5% of the total abundance, with an 39,910 individuals, and 79.2% of the total biomass, or 979.113 kg. Shiner perch (*Cymatogaster aggregata*) impinged abundance and biomass was the second highest recorded for both parameters, with an estimated 8,883 individuals weighing 85.402 kg. The third highest impinged abundance and biomass was northern

**Table 15. Estimated abundance and biomass (kg) of fish species impinged during heat treatment and normal operation surveys. Mandalay Generating Station NPDES, 2005.**

| | | | Percent | | Cumulative Percent | |
|---|---|---|---|---|---|---|
| Common Name | Abundance | Biomass | Abundance | Biomass | Abundance | Biomass |
| California grunion | 39,910 | 979.113 | 74.5 | 79.2 | 74.5 | 79.2 |
| shiner perch | 8,883 | 85.402 | 16.6 | 6.9 | 91.0 | 86.2 |
| northern anchovy | 3,137 | 66.826 | 5.9 | 5.4 | 96.9 | 91.6 |
| diamond turbot | 444 | 20.755 | 0.8 | 1.7 | 97.7 | 93.2 |
| Pacific sardine | 260 | 5.527 | 0.5 | 0.4 | 98.2 | 93.7 |
| bat ray | 179 | 20.723 | 0.3 | 1.7 | 98.5 | 95.4 |
| California halibut | 174 | 6.491 | 0.3 | 0.5 | 98.9 | 95.9 |
| deepbody anchovy | 127 | 1.200 | 0.2 | 0.1 | 99.1 | 96.0 |
| staghorn sculpin | 113 | 1.247 | 0.2 | 0.1 | 99.3 | 96.1 |
| bay goby | 79 | 1.789 | 0.1 | 0.1 | 99.5 | 96.2 |
| black perch | 77 | 5.977 | 0.1 | 0.5 | 99.6 | 96.7 |
| queenfish | 44 | 0.210 | 0.1 | 0.0 | 99.7 | 96.7 |
| spotted kelpfish | 41 | 0.721 | 0.1 | 0.1 | 99.8 | 96.8 |
| bay pipefish | 26 | 0.028 | 0.0 | 0.0 | 99.8 | 96.8 |
| thornback | 23 | 32.046 | 0.0 | 2.6 | 99.8 | 99.4 |
| white seabass | 22 | 3.018 | 0.0 | 0.2 | 99.9 | 99.6 |
| white seaperch | 20 | 0.182 | 0.0 | 0.0 | 99.9 | 99.7 |
| fantail sole | 19 | 2.172 | 0.0 | 0.2 | 100.0 | 99.8 |
| jack mackerel | 19 | 2.107 | 0.0 | 0.2 | 100.0 | 100.0 |
| Pacific pompano | 1 | 0.034 | 0.0 | 0.0 | 100.0 | 100.0 |
| Survey Totals | 53,598 | 1,235.567 | | | | |
| Total Species | 20 | | | | | |

Note: 0.0 = <0.05.

anchovy (*Engraulis mordax*) with an estimated 3,137 individuals weighing 66.826 kg. Each of the remaining 17 species individually accounted for less than 1.0% of the abundance. With regards to biomass, thornback (*Platyrhinoidis triseriata*) accounted for 2.6% of the total estimated biomass, while diamond turbot (*Pleuronichthys guttulatus*) and bat ray (*Myliobatis californica*) each represented 1.7% of the total estimated biomass (Table 15). The remaining 13 species cumulatively represented 2.5% of the calculated impinged biomass for the 2005 monitoring year.

### Length Frequency Analysis

Lengths of three impinged fish species were analyzed for length frequency to estimate the age structure of the impinged assemblage. Impinged shiner perch exhibited a bimodal distribution with peaks at 60-mm SL and 90-mm SL (Figure 31). California grunion exhibited a unimodal distribution among impinged individuals peaking at 120-mm SL, with relatively high abundances in size classes ranging from 90-mm SL to 160-mm SL (Figure 32). Recorded lengths of northern anchovy indicate a unimodal distribution dominated by the 60-mm SL size classes (Figure 33).

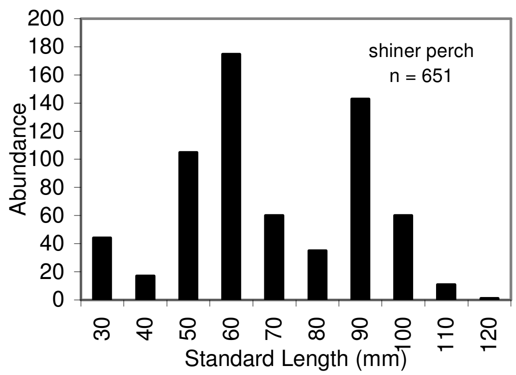



**Figure 31. Length frequency of shiner perch (*Cymatogaster aggregata*) impinged during heat treatment and normal operation surveys. Mandalay Generating Station NPDES, 2005.**

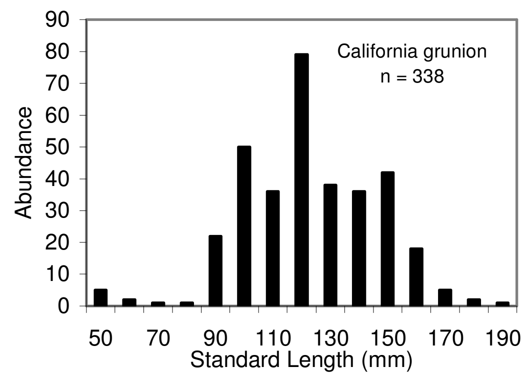



**Figure 32. Length frequency of California grunion (*Leuresthes tenuis*) impinged during heat treatment and normal operation surveys. Mandalay Generating Station NPDES, 2005.**

### Macroinvertebrates

An estimated total of 199 individuals weighing 18.514 kg representing three macroinvertebrate species were impinged during the 2005 monitoring year at Mandalay Generating Station (Table 16). Striped shore crab (*Pachygrapsus crassipes*) numerically dominated the impinged macroinvertebrate abundance with 156 individuals, but accounted for the second highest impinged biomass with 2.802 kg. California seahare (*Aplysia californica*) represented the second most abundant impinged macroinvertebrate species with an estimated 40 individuals, but contributed the highest biomass with 14.468 kg. Exclusively collected during heat treatments, three impinged California spiny lobster (*Panulirus interruptus*) were recorded weighing 1.244 kg (Table 16).

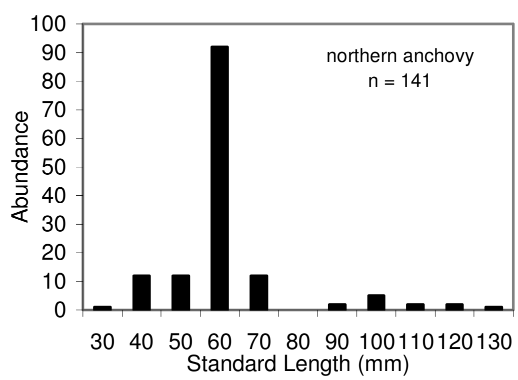



**Figure 33. Length frequency of northern anchovy (*Engraulis mordax*) impinged during heat treatment and normal operation surveys. Mandalay Generating Station NPDES, 2005.**

**Table 16. Estimated abundance and biomass (kg) of macroinvertebrate species impinged during heat treatment and normal operation surveys. Mandalay Generating Station NPDES, 2005.**

| | | | Percent | | Cumulative Percent | |
|---|---|---|---|---|---|---|
| Common Name | Abundance | Biomass | Abundance | Biomass | Abundance | Biomass |
| striped shore crab | 156 | 2.802 | 78.6 | 15.1 | 78.6 | 15.1 |
| California seahare | 40 | 14.468 | 19.9 | 78.1 | 98.5 | 93.3 |
| California spiny lobster | 3 | 1.244 | 1.5 | 6.7 | 100.0 | 100.0 |
| Survey Totals | 199 | 18.514 | | | | |
| Total Species | 3 | | | | | |

## DISCUSSION

To evaluate fish loss at the Mandalay Generating Station, fish impingement was monitored during two heat treatments and seven normal operation surveys in 2005. Based on these surveys, an estimated total of 53,598 individuals representing 20 fish species and weighing more than 1,200 kg were impinged at the generating station in 2005. Overall impinged abundance and biomass estimates for the 2005 monitoring year were nearly twice that reported for 2004, and represent the second highest since 2002 (Figure 34; MBC 2001a-2002a, 2003, 2004a). In addition, an estimated 199 individuals representing three macroinvertebrate species and weighing greater than 18 kg were impinged during the study year, the highest total since recent monitoring begin 2001.

Estimates of impinged California grunion exhibit a nearly ten-fold increase in abundance and greater than a fifteen-fold increase in biomass over the values reported for the 2004 monitoring year, but well below the reported high of 114,883 individuals reported in 2002 (MBC 2002).The estimated number of California grunion impinged in 2005 (39,910), 2004 (4,273), 2003 (6,502 individuals), and 2002 (114,872 individuals) was very high compared to the average annual abundance of 200 individuals impinged in a two-year impingement survey from October 1978 to September 1980 (Herbinson 1981; MBC 2002a, 2003, 2004a). California grunion are top-water fish, commonly found within six to eight feet of the water's surface, and are usually found one to two miles from shore (Walker 1949). They are common in kelp beds and are also found in larger bays, including Newport Bay and San Diego Bay, ranging from southern Baja California to San Francisco Bay, California (Walker 1949; Miller and Lea 1972). California grunion grow rapidly during their first year, males reaching an average length of 100 mm SL, and females 119 mm SL (Clark 1925). The unimodal size distribution of grunion impinged in 2005 suggest a population predominantly composed of young-of-the-year and Age-I fish, with some Age-II class fish represented in the higher size classes.

Spawning of California grunion is consistently correlated with the time of full or new moon phases, and although the primary spawning season is from early March through June, they do spawn before and after this event. California grunion leave the water to spawn in wet beaches where they can be caught by hand during a limited fishing season in California.

Shiner perch was the next most abundant fish species impinged during the 2005 monitoring year. The estimated number of shiner perch impinged in 2005 represent a decrease in overall abundance from those values reported for 2004, but still only the third highest annual abundance over the last five years (MBC 2001a-2002a, 2003, 2004a). The 2005 total represented only a small fraction of the average annual number impinged in a two-year impingement survey from October 1978 to September 1980 (105,942 individuals) (Herbinson 1981). The size of the shiner perch impinged in 2005 indicates three year classes were impinged, with most in the 60-mm and 90-mm size classes, or Age-I and Age-II class fish (Anderson and Bryan 1970, Odenweller 1975, Eckmayer 1979). Shiner perch range from northern Baja California to Sitka, Alaska in depths ranging from the surfzone to 146 m (Love et al. 2005).

Shiner perch abundances declined in some impingement and trawl catches in southern California after the 1970s (MBC 2001b, Stull and Tang 1996). This decline could be related to oceanic temperature regimes as there was a measurable shift from a cool water to a warmer water regime offshore of California in the 1980s and 1990s (MBC 2001c). In southern California, zooplankton (a food source for shiner perch [Allen 1982]) decreased in biomass by about 80% between 1951 and 1993, with most of the decline occurring after the 1970s (Roemmich and McGowan 1995).

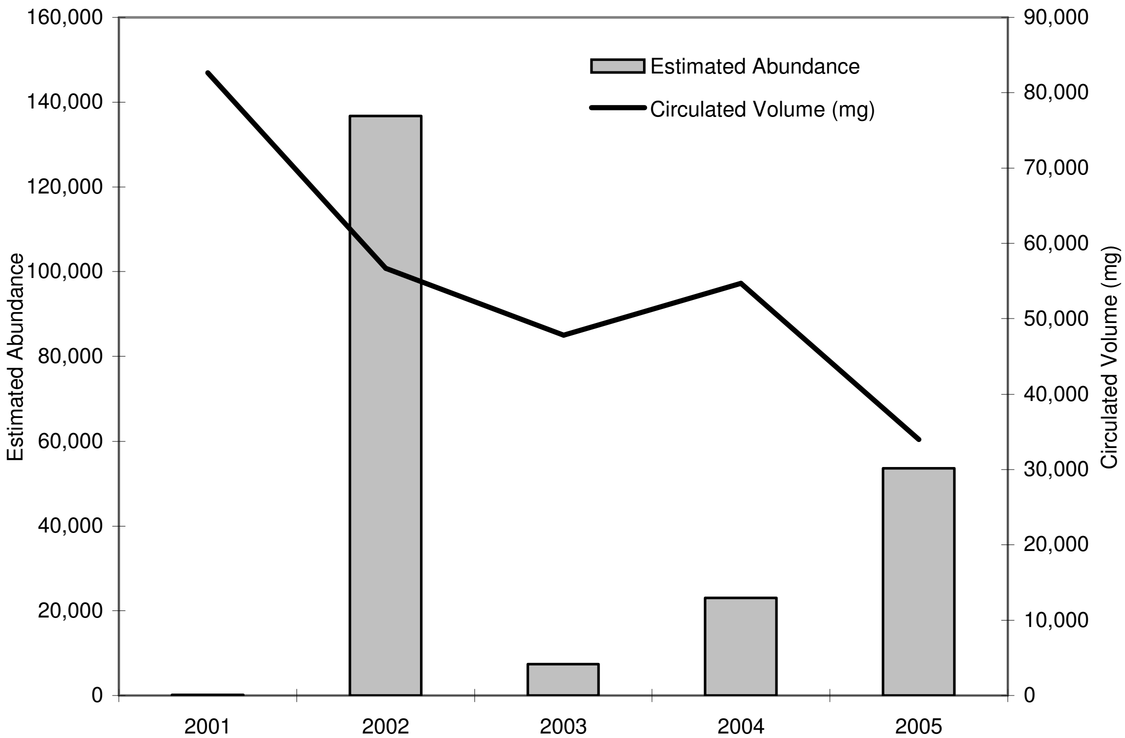



**Figure 34. Annual estimated abundance of fish impinged during heat treatment and normal operation surveys and annual reported circuating water volume (mg). Mandalay Generating Station NPDES, 2005.**

Northern anchovy was the third most abundant species in 2005. Recorded lengths for northern anchovy were predominantly within the 60-mm SL size class, or young of the year (YOY; 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 principle fishery for northern anchovy within southern California, with only a limited reduction 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.

The most abundant macroinvertebrate species during the 2005 impingement survey, striped shore crab abundance in 2005 was the highest recorded within the last five years and the highest since 2001(MBC 2001a-2002a, 2003, 2004a). Common to southern California, striped shore crab regularly occur in crevices, tidepools, and mussel beds (Morris et al. 1980). Noted to occupy the mid to high-intertidal zone, striped shore crabs have been reported to have adapted to a semi-terrestrial lifestyle, feeding on the algae and diatoms often left exposed at low tide (Morris et al. 1980).

California seahare, the second most abundant macroinvertebrate species in 2005, was recorded for the first time since 2002 in impingement sampling at Mandalay Generating Station (MBC 2002a, 2003, 2004a). Morris et al. (1980) report the California seahare is common to the nearshore waters of southern California, from the deep intertidal zone to 18 m. Principally diurnal, California seahares are commonly observed grazing on algae, specifically eelgrass (*Zostera* sp).

A commercially important macroinvertebrate, California spiny lobster was collected in low abundances exclusively during heat treatments. California spiny lobster has been a consistent member of the impinged macroinvertebrate community at Mandalay Generating Station since 2002, with peak abundances in 2003 and 2005 at three individuals (MBC 2002a, 2003, 2004a). Since the mid-1970s, California spiny lobster abundances appear to be generally increasing, based on commercial landings, within the Southern California Bight (Barsky 2001). This highly valued crustacean is commonly found within caves and crevices of rocky substrate throughout its range from Monterey Bay, California to Manzanillo, Mexico (Barsky 2001). Fishing, both recreational and commercial, within State of California waters is highly regulated by the California Department of Fish and Game, with a limited harvest season from early October to mid-March (Barsky 2001).

Fish abundance in 2005 was dominated by California grunion and shiner perch, the two most common species collected in heat treatment and normal operation surveys. Only three macroinvertebrate species were collected during impingement surveys, striped shore crab, California seahare, and California spiny lobster. Overall, fish and macroinvertebrate species impinged in 2005 are common inhabitants of nearshore and/or bay and harbor environments.

**CONCLUSION**

Abundance and biomass of fish impinged in 2005 was higher than in 2004, but less than in 2002. Abundance and biomass of macroinvertebrates impinged in 2005 was the highest in recent years. Impinged fish abundances in 2005 indicate an increasing trend, which, in light of the declining circulated water volume, suggests local fish assemblages have been increasing since 2002. All fish and macroinvertebrate species collected were typical of the bay/nearshore environment from which the generating station withdraws its cooling water. There was no indication that plant operations are adversely affecting the local marine macrofaunal community.

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**PERSONAL COMMUNICATION**

Norfolk, G. 2005. Reliant Energy Mandalay Generating Station.

# 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 frpm 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 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 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 discretion 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 discretion 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. Monitoring for Algicide Spraying

The Discharger periodically sprays the banks of the Mandalay Intake Canal with an algicide to control algal growth in the intake canal. The Discharger shall notify the Regional Board at least two weeks prior to each application of algicide. Water samples shall be collected at a minimum of three locations (Wooley Road, 5th Street and Unocal Bridge, or other locations subject to approval by the Executive Officer) and analyzed for total residual oxidant concentrations. The Discharger also shall conduct visual observations of the canal following algicide applications to assess the effectiveness of the spraying program in controlling algal growth and to observe any unusual mortality of fish or invertebrates. The Discharger shall report the results of sample analysis and visual observations, as well as a description of the amounts and locations of all algicide applications, in the appropriate monthly monitoring report to the Regional Board.

D. 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 - 1180 feet upcoast of the discharge channel.

    b. Station RW2 - 1180 feet downcoast of the discharge channel.

    c. Station RW3 - 2360 feet upcoast of the discharge channel.

    d. Station RW4 - 2360 feet downcoast of the discharge channel.

    e. Station RW5 - At the discharge channel.

2. Receiving water stations offshore of the discharge area shall be located as follows:

   a. Station RW6 - directly offshore of station RW13 at a depth of 30 feet.

   b. Station RW7 - directly offshore of station RW16 at a depth of 30 feet.

   c. Station RW8 – directly offshore of station RW11 at a depth of 30 feet.

   d. Station RW9 – directly offshore of station RW17 at a depth of 30 feet.

   e. Station RW10 – directly offshore of station RW12 at a depth of 30 feet.

   f. Station RW11 – directly offshore of station RW5 at a depth of 20 feet.

   g. Station RW12 – directly offshore of station RW4 at a depth of 20 feet.

   h. Station RW13 – directly offshore of station RW3 at a depth of 20 feet.

   i. Station RW14 – 5,910 feet downcoast of the discharge channel at a depth of 20 feet.

   j. Station RW15 – 5,910 feet upcoast of the discharge channel at a depth of of 20 feet.

   k. Station RW16 – directly offshore of station RW1 at a depth of 20 feet.

   l. Station RW17 – directly offshore of station RW2 at a depth of 20 feet.

3. Benthic stations shall be located as follows:

   a. Station B1 shall be located directly beneath Station RW11.

   b. Station B2 shall be located directly beneath Station RW12.

   c. Station B3 shall be located directly beneath Station RW13.

   d. Station B4 shall be located directly beneath Station RW14.

   e. Station B5 shall be located directly beneath Station RW15.

4. Trawling stations shall be located as follows:

   a. Station T1 – Parallel to the shore at a depth of 20 feet, extending equidistant to either side of Station RW15.

   b. Station T2 – Parallel to the shore at a depth of 20 feet, extending equidistant to either side of Station RW16.

   c. Station T3 – Parallel to the shore at a depth of 20 feet, extending equidistant to either side of Station RW17.

   d. Station T4 – Parallel to the shore at a depth of 20 feet, extending equidistant to either side of Station RW14.

E. Type and Frequency of Sampling:

1. Surface temperatures, dissolved oxygen levels and pH shall be measured semiannually (summer and winter) each year at Stations RW1 through RW5. All stations shall be sampled on both a flooding tide and an ebbing tide during each semiannual survey.

2. Temperature profiles shall be measured semiannually (summer and winter) each year at Stations RW6 through RW17 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 on both a flooding tide and an ebbing tide during each semiannual survey.

3. Impingement sampling for fish and commercially important macroinvertebrates shall be conducted at least once every two months at intake Serial No. 002. Impingement sampling shall coincide with heat treatments for at least three of the six sampling events during the year.

   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.

4. 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.

5. Sampling by otter trawl shall be conducted semiannually (summer and winter) each year along transects at Stations T1 through T4. Trawls are specialized gear used in large open water areas of reservoirs, lakes, large rivers, estuaries, and offshore marine areas. They are used to gain information on a particular species of fish rather than on overall fish populations. The otter trawl is used to capture near-bottom and bottom fishes.

   a. Trawl net dimensions shall be as follows:

      1. At least a 25 ft throat width.

      2. 1.5 in mesh-size (body).

      3. 0.5 in mesh-size (linear in the cod end).

   b. Two replicate trawls shall be conducted at each station for a duration of 10 minutes each at a uniform speed between 2.0 and 2.5 knots.

   c. The identity, size (standard length), wet weight, and number of fish in each trawl shall be reported. The number of fish affected by abnormal growth or disease, such as fin erosion, lesions, and papillomas, shall be reported. Fish species shall be reported in rank order of abundance and frequency of occurrence for each trawl. The Shannon-Wiener diversity index shall also be computed for each trawl.

   d. All commercially important macroinvertibrates shall be identified, enumerated, and reported in the same manner as fish species.

6. Benthic sampling shall be conducted annually during the summer at Stations B1 through B5.

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.

i. Presence or absence of red tide.

j. Presence and activity of marine life.

k. Presence of the California Least Tern and California Brown Pelican.

8. During the discharge of calcareous material (excluding heat treatment discharge) to the receiving waters, the following observations or measurements shall be recorded and reported in the next monitoring report:

a. Date and times of discharge(s).

b. Estimate of volume and weigh of discharge(s).

c. Composition of discharge(s).

d. General water conditions and weather conditions.

e. Appearance and extent of any oil films or grease, floatable material or odors.

f. Appearance and extent of visible turbidity or color patches.

g. Presence of marine life.

h. Presence and activity of the California least tern and the California brown pelican.

Reliant Energy Incorporated
Mandalay Generating Station
Monitoring and Reporting Program No. CI-2093

CA0001180

SUMMARY OF RECEIVING WATER MONITORING PROGRAM

| Constituent | Units | Stations | Type of Sample | Minimum Frequency of Analysis |
|---|---|---|---|---|
| Temperature | °C | RW1-RW5 | surface | semiannually (flood, ebb) |
| Temperature | °C | RW6-RW17 | vertical profile | semiannually (flood, ebb) |
| Dissolved oxygen | mg/L | RW1-RW5 | surface | semiannually (flood, ebb) |
| Dissolved oxygen | mg/L | RW6-RW17 | vertical profile | semiannually (flood, ebb) |
| pH | pH Units | RW1-RW5 | surface | semiannually (flood, ebb) |
| pH | pH Units | RW6-RW17 | vertical profile | semiannually (flood, ebb) |
| Fish and macro Invertebrates | ---- | T1-T4 | trawl | semiannually |
| Fish and macro Invertebrates | ---- | Intake Serial No. 002 | impingement | bimonthly |
| Benthic Infauna | ---- | B1-B5 | grab | annually |
| Sediments | ---- | B1-B5 | grab | annually |
| Mussels | ---- | Discharge Serial No. 001 | tissue | annually |

The receiving water monitoring report containing the results of semiannual and annual monitoring shall be received at the Regional Board on March 1 of each year following the calendar year of data collection.

Reliant Energy Incorporated
Mandalay Generating Station
Monitoring and Reporting Program No. CI-2093

CA0001180

## VI. STORM WATER MONITORING AND REPORTING

The Discharger shall implement the Monitoring and Reporting Requirements for individual dischargers contained in the general permit for *Dischargers of Storm Water Associated with Industrial Activities* (State Board Order No. 97-030-DWQ) adopted on April 17, 1997. The monitoring reports shall be received at the Regional Board by July 1 of each year. Indicate in the report the Compliance File CI-2093.

Ordered by: ________________________ Date: April 26, 2001
Dennis A. Dickinson
Executive Officer

/COD

Reliant Energy Incorporated
Mandalay Generating Station
Monitoring and Reporting Program No. CI-2093

CA0001180

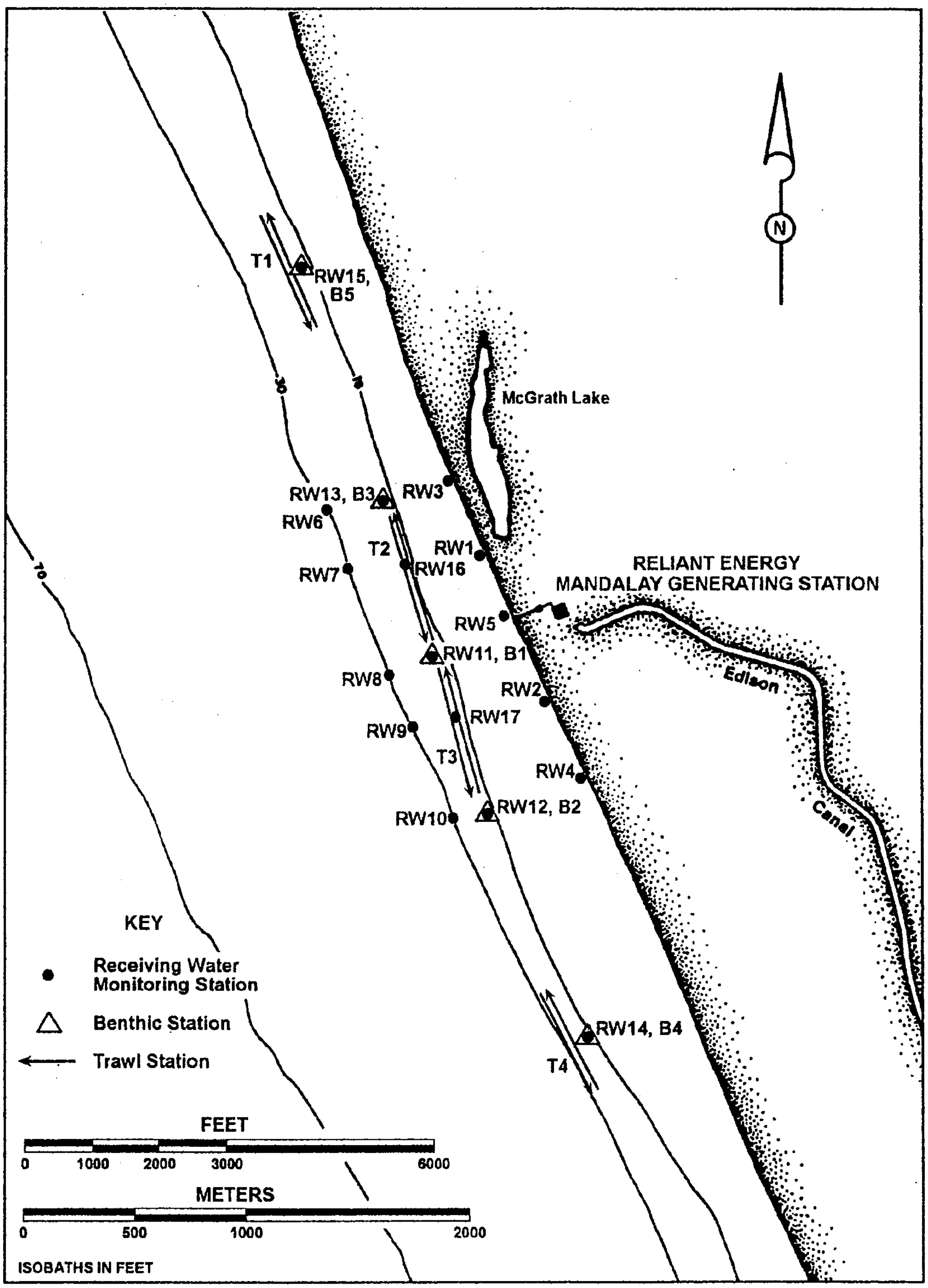



Figure 1. Locations of the sampling stations. Reliant Energy Mandalay Generating Station.

# 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 ($M_\phi$) 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 ($\sigma_\phi$) measures the uniformity (or non-uniformity) of particle quantities in each size category of the sediment distribution. A $\sigma_\phi$ value under 0.35$\phi$ 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 4.0$\phi$ 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 ($\alpha_\phi$) 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, $\alpha_\phi$=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 ($\beta_\phi$) is a measure of how far the sediment distribution curve departs from a normal Gaussian shape at its peak. Curves with greater than normal amounts of sediment at their modes will be sharp or leptokurtic ($\beta_\phi > 1$). Those with fatter tails and lower peaks than expected are termed platykurtic ($\beta_\phi < 1$). $\beta_\phi$ = 1.00 for a normal curve. Curve category interpretations are based on Folk (1974).

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

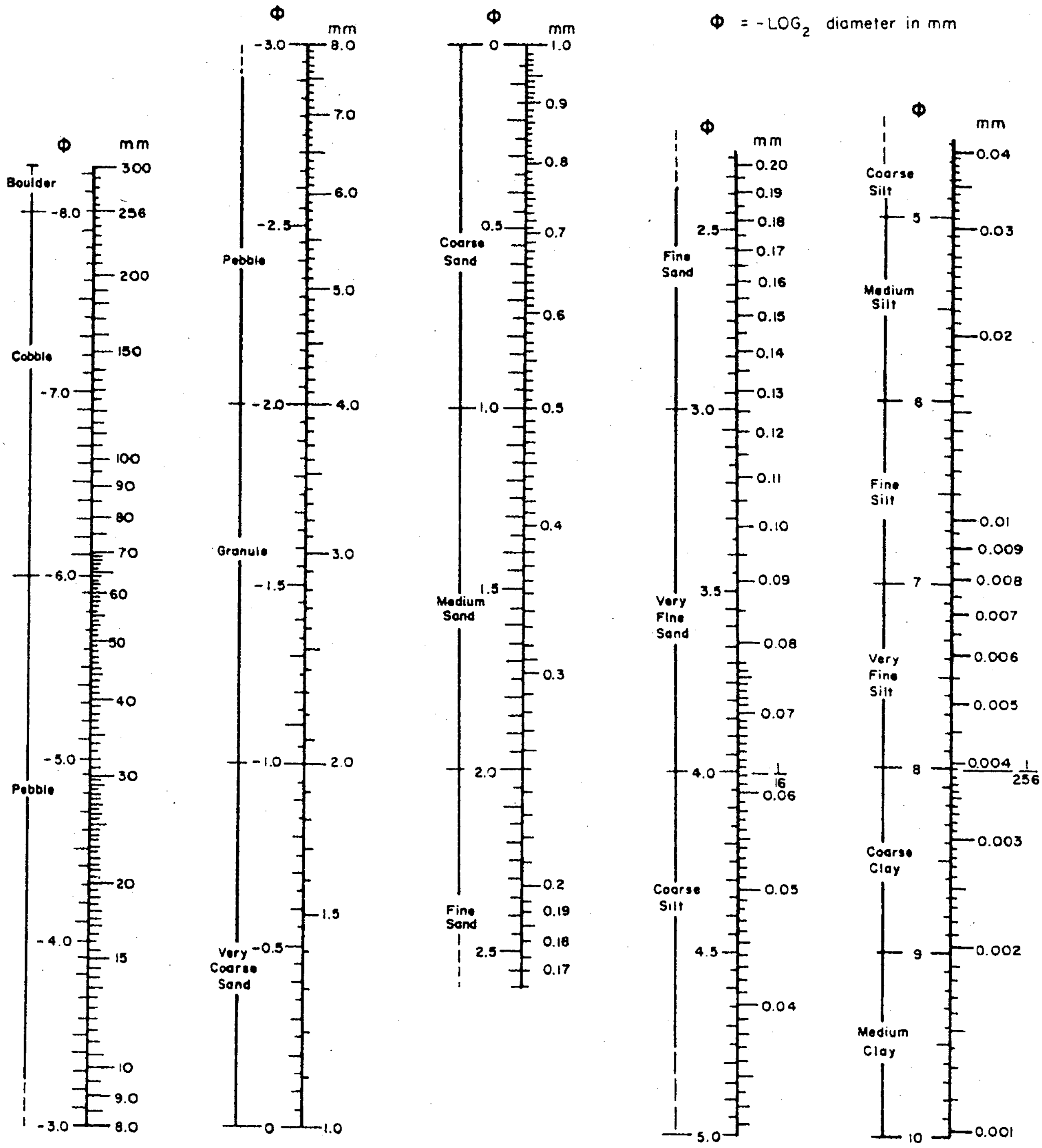
## LITERATURE CITED

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

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

Appendix B. (Cont.).

## Phi - Millimeter Conversion Figure




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

| | | | | |
|---|---|---|---|---|
| $\sigma_I$ 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. Mandalay Generating Station NPDES, winter 2005.**

| | | Temp. (°C) | | Oxygen (mg/l) | | pH | | Salinity (psu) | |
|---|---|---|---|---|---|---|---|---|---|
| | Depth (m) | FLOOD | EBB | FLOOD | EBB | FLOOD | EBB | FLOOD | EBB |
| **Surf Zone** | | | | | | | | | |
| RW1 | 0 | 12.40 | 10.83 | 8.18 | 8.68 | 7.90 | 7.85 | 32.43 | 33.04 |
| RW2 | 0 | 12.41 | 11.71 | 8.26 | 8.29 | 7.88 | 7.88 | 32.73 | 33.14 |
| RW3 | 0 | 12.61 | 10.62 | 8.23 | 8.76 | 7.90 | 7.85 | 32.45 | 32.92 |
| RW4 | 0 | 12.68 | 11.03 | 8.33 | 8.48 | 7.93 | 7.85 | 32.74 | 33.33 |
| RW5 | 0 | 16.76 | 16.41 | 7.97 | 8.13 | 7.95 | 7.97 | 31.24 | 31.69 |
| **Offshore** | | | | | | | | | |
| RW6 | 0 | 11.70 | 11.10 | 7.82 | 6.33 | 7.90 | 7.86 | 32.45 | 32.91 |
| | 1 | 11.58 | 11.09 | 7.83 | 6.31 | 7.89 | 7.86 | 32.60 | 33.26 |
| | 2 | 11.13 | 10.79 | 7.71 | 6.25 | 7.88 | 7.85 | 33.26 | 33.67 |
| | 3 | 11.06 | 10.64 | 6.74 | 5.33 | 7.86 | 7.81 | 33.46 | 33.77 |
| | 4 | 10.98 | 10.63 | 6.06 | 4.62 | 7.85 | 7.81 | 33.67 | 33.77 |
| | 5 | 10.79 | 10.60 | 5.51 | 4.50 | 7.84 | 7.80 | 33.72 | 33.77 |
| | 6 | 10.65 | 10.53 | 4.96 | 4.43 | 7.81 | 7.79 | 33.76 | 33.78 |
| | 7 | 10.54 | 10.52 | 4.63 | 4.22 | 7.80 | 7.78 | 33.78 | 33.78 |
| | 8 | 10.43 | 10.44 | 4.29 | 4.10 | 7.78 | 7.77 | 33.80 | 33.79 |
| | 9 | 10.40 | 10.43 | 3.89 | 3.92 | 7.76 | 7.77 | 33.81 | 33.80 |
| | 10 | 10.41 | 10.42 | 3.83 | 3.80 | 7.77 | 7.77 | 33.81 | 33.80 |
| RW7 | 0 | 11.72 | 11.06 | 7.60 | 6.30 | 7.90 | 7.86 | 32.01 | 33.04 |
| | 1 | 11.55 | 11.00 | 7.68 | 6.32 | 7.89 | 7.86 | 32.76 | 33.27 |
| | 2 | 11.11 | 10.77 | 7.23 | 5.82 | 7.88 | 7.83 | 33.41 | 33.72 |
| | 3 | 10.80 | 10.74 | 5.82 | 4.90 | 7.84 | 7.81 | 33.70 | 33.75 |
| | 4 | 10.66 | 10.71 | 5.02 | 4.75 | 7.82 | 7.81 | 33.75 | 33.76 |
| | 5 | 10.57 | 10.64 | 4.67 | 4.62 | 7.81 | 7.80 | 33.77 | 33.77 |
| | 6 | 10.50 | 10.57 | 4.50 | 4.46 | 7.81 | 7.79 | 33.79 | 33.78 |
| | 7 | 10.44 | 10.49 | 4.26 | 4.25 | 7.79 | 7.79 | 33.80 | 33.78 |
| | 8 | 10.38 | 10.43 | 4.02 | 3.95 | 7.77 | 7.77 | 33.81 | 33.80 |
| | 9 | 10.38 | 10.41 | 3.78 | 3.77 | 7.77 | 7.76 | 33.81 | 33.81 |
| | 10 | 10.37 | 10.40 | 3.76 | 3.69 | 7.77 | 7.75 | 33.81 | 33.80 |
| RW8 | 0 | 11.72 | 10.84 | 7.49 | 5.52 | 7.88 | 7.86 | 32.38 | 33.67 |
| | 1 | 11.52 | 10.83 | 7.49 | 5.62 | 7.88 | 7.86 | 32.61 | 33.67 |
| | 2 | 11.05 | 10.81 | 7.14 | 5.58 | 7.85 | 7.85 | 33.23 | 33.70 |
| | 3 | 10.72 | 10.81 | 6.63 | 5.48 | 7.82 | 7.85 | 33.65 | 33.69 |
| | 4 | 10.66 | 10.81 | 5.57 | 5.47 | 7.81 | 7.85 | 33.74 | 33.73 |
| | 5 | 10.55 | 10.82 | 4.74 | 5.25 | 7.80 | 7.83 | 33.78 | 33.73 |
| | 6 | 10.45 | 10.77 | 4.43 | 5.13 | 7.79 | 7.83 | 33.79 | 33.75 |
| | 7 | 10.37 | 10.73 | 4.25 | 4.99 | 7.78 | 7.82 | 33.81 | 33.76 |
| | 8 | 10.37 | 10.61 | 3.96 | 4.83 | 7.77 | 7.79 | 33.81 | 33.80 |
| | 9 | 10.36 | 10.50 | 3.82 | 4.37 | 7.77 | 7.78 | 33.81 | 33.83 |
| | 10 | 10.36 | 10.46 | 3.80 | 4.20 | 7.76 | 7.77 | 33.81 | 33.80 |
| RW9 | 0 | 11.52 | 11.05 | 7.21 | 7.45 | 7.86 | 7.99 | 32.49 | 33.51 |
| | 1 | 11.21 | 11.03 | 7.21 | 7.45 | 7.86 | 7.99 | 33.10 | 33.53 |
| | 2 | 10.98 | 10.99 | 7.13 | 7.36 | 7.84 | 7.97 | 33.31 | 33.61 |
| | 3 | 10.79 | 10.94 | 7.11 | 6.98 | 7.84 | 7.93 | 33.54 | 33.68 |
| | 4 | 10.64 | 10.90 | 6.36 | 6.43 | 7.81 | 7.89 | 33.73 | 33.71 |
| | 5 | 10.57 | 10.89 | 4.93 | 6.08 | 7.80 | 7.88 | 33.78 | 33.72 |
| | 6 | 10.53 | 10.85 | 4.45 | 5.80 | 7.79 | 7.87 | 33.78 | 33.73 |
| | 7 | 10.43 | 10.81 | 4.27 | 5.59 | 7.78 | 7.83 | 33.80 | 33.74 |
| | 8 | 10.37 | 10.76 | 3.97 | 5.13 | 7.77 | 7.84 | 33.81 | 33.75 |
| | 9 | 10.36 | 10.63 | 3.84 | 5.11 | 7.76 | 7.80 | 33.81 | 33.78 |
| | 10 | 10.36 | 10.64 | 3.77 | 4.48 | 7.76 | 7.79 | 33.81 | 33.78 |

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 |
|---|---|---|---|---|---|---|---|---|---|
| RW10 | 0 | 11.06 | 11.31 | 8.07 | 7.95 | 7.86 | 7.99 | 33.34 | 33.57 |
| | 1 | 11.02 | 11.32 | 8.08 | 7.88 | 7.86 | 7.99 | 33.35 | 33.55 |
| | 2 | 10.94 | 11.26 | 8.14 | 7.88 | 7.86 | 7.99 | 33.45 | 33.60 |
| | 3 | 10.79 | 11.24 | 7.96 | 7.86 | 7.84 | 7.99 | 33.62 | 33.67 |
| | 4 | 10.78 | 11.14 | 7.14 | 7.36 | 7.84 | 7.94 | 33.68 | 33.73 |
| | 5 | 10.66 | 11.13 | 6.44 | 6.70 | 7.82 | 7.90 | 33.76 | 33.71 |
| | 6 | 10.49 | 11.01 | 4.88 | 6.37 | 7.79 | 7.86 | 33.77 | 33.72 |
| | 7 | 10.41 | 10.93 | 4.13 | 5.79 | 7.77 | 7.85 | 33.80 | 33.74 |
| | 8 | 10.39 | 10.83 | 4.01 | 5.54 | 7.77 | 7.83 | 33.81 | 33.73 |
| | 9 | 10.39 | 10.79 | 3.88 | 5.01 | 7.76 | 7.79 | 33.80 | 33.75 |
| | 10 | 10.39 | 10.74 | 3.81 | 4.84 | 7.75 | 7.79 | 33.81 | 33.76 |
| RW11 | 0 | 11.26 | 10.93 | 6.98 | 6.36 | 7.84 | 7.88 | 33.04 | 33.69 |
| | 1 | 11.19 | 10.93 | 6.99 | 6.36 | 7.85 | 7.88 | 33.05 | 33.69 |
| | 2 | 11.00 | 10.88 | 6.97 | 6.37 | 7.84 | 7.87 | 33.23 | 33.71 |
| | 3 | 10.73 | 10.85 | 6.68 | 5.89 | 7.82 | 7.85 | 33.53 | 33.73 |
| | 4 | 10.60 | 10.85 | 6.13 | 5.48 | 7.81 | 7.84 | 33.73 | 33.73 |
| | 5 | 10.54 | 10.81 | 5.05 | 5.39 | 7.79 | 7.83 | 33.78 | 33.74 |
| | 6 | 10.47 | 10.75 | 4.32 | 5.05 | 7.78 | 7.82 | 33.78 | 33.75 |
| | 7 | 10.39 | 10.64 | 4.09 | 4.82 | 7.77 | 7.79 | 33.81 | 33.78 |
| | 8 | 10.38 | 10.62 | 3.89 | 4.39 | 7.77 | 7.78 | 33.81 | 33.78 |
| RW12 | 0 | 11.06 | 11.03 | 7.66 | 8.20 | 7.86 | 7.94 | 33.31 | 33.60 |
| | 1 | 11.02 | 11.01 | 7.68 | 8.16 | 7.86 | 7.93 | 33.33 | 33.61 |
| | 2 | 10.81 | 11.01 | 7.58 | 8.16 | 7.84 | 7.93 | 33.53 | 33.62 |
| | 3 | 10.75 | 10.99 | 6.66 | 8.12 | 7.82 | 7.92 | 33.70 | 33.63 |
| | 4 | 10.66 | 11.01 | 5.72 | 7.86 | 7.80 | 7.92 | 33.77 | 33.64 |
| | 5 | 10.62 | 11.03 | 4.84 | 7.68 | 7.79 | 7.90 | 33.79 | 33.71 |
| | 6 | 10.48 | 10.94 | 4.52 | 6.71 | 7.77 | 7.84 | 33.81 | 33.73 |
| | 7 | 10.41 | 10.93 | 4.13 | 5.41 | 7.76 | 7.82 | 33.81 | 33.71 |
| | 8 | 10.41 | 10.81 | 3.86 | 5.21 | 7.75 | 7.80 | 33.81 | 33.75 |
| | 9 | 10.43 | 10.78 | 3.76 | 4.79 | 7.75 | 7.78 | 33.79 | 33.75 |
| RW13 | 0 | 11.54 | 11.02 | 7.10 | 6.11 | 7.88 | 7.85 | 32.60 | 33.09 |
| | 1 | 11.38 | 10.96 | 7.19 | 6.23 | 7.86 | 7.85 | 32.76 | 33.22 |
| | 2 | 11.05 | 10.68 | 7.06 | 6.23 | 7.86 | 7.82 | 33.09 | 33.64 |
| | 3 | 10.75 | 10.65 | 6.91 | 5.15 | 7.83 | 7.81 | 33.46 | 33.71 |
| | 4 | 10.63 | 10.61 | 6.51 | 4.70 | 7.81 | 7.80 | 33.73 | 33.76 |
| | 5 | 10.55 | 10.60 | 5.06 | 4.50 | 7.80 | 7.79 | 33.79 | 33.77 |
| | 6 | 10.48 | 10.57 | 4.50 | 4.40 | 7.79 | 7.79 | 33.80 | 33.78 |
| | 7 | 10.43 | 10.54 | 4.25 | 4.27 | 7.78 | 7.78 | 33.81 | 33.78 |
| | 8 | 10.40 | 10.48 | 4.15 | 4.10 | 7.77 | 7.77 | 33.82 | 33.80 |
| RW14 | 0 | 11.09 | 11.28 | 7.95 | 8.48 | 7.88 | 7.97 | 33.55 | 33.42 |
| | 1 | 11.01 | 11.28 | 7.94 | 8.52 | 7.89 | 7.97 | 33.61 | 33.42 |
| | 2 | 10.95 | 11.30 | 7.76 | 8.53 | 7.91 | 7.97 | 33.70 | 33.46 |
| | 3 | 10.85 | 11.15 | 6.45 | 8.55 | 7.87 | 7.96 | 33.73 | 33.57 |
| | 4 | 10.75 | 10.99 | 5.51 | 7.92 | 7.83 | 7.92 | 33.75 | 33.69 |
| | 5 | 10.69 | 10.95 | 4.85 | 6.50 | 7.79 | 7.90 | 33.77 | 33.72 |
| | 6 | 10.68 | 10.91 | 4.52 | 5.93 | 7.79 | 7.87 | 33.77 | 33.73 |
| | 7 | 10.69 | 10.89 | 4.47 | 5.49 | 7.79 | 7.84 | 33.77 | 33.74 |
| | 8 | 10.70 | 10.87 | 4.42 | 5.35 | 7.77 | 7.83 | 33.76 | 33.73 |
| | 9 | 10.71 | | 4.36 | | 7.77 | | 33.76 | |

**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 |
|---|---|---|---|---|---|---|---|---|---|
| RW15 | 0 | 11.93 | 11.20 | 8.12 | 6.74 | 7.92 | 7.88 | 31.91 | 33.30 |
| | 1 | 11.76 | 11.14 | 8.03 | 6.67 | 7.92 | 7.88 | 32.63 | 33.49 |
| | 2 | 11.31 | 10.94 | 8.05 | 6.35 | 7.91 | 7.86 | 33.50 | 33.70 |
| | 3 | 10.97 | 10.75 | 6.93 | 5.56 | 7.86 | 7.84 | 33.72 | 33.75 |
| | 4 | 10.78 | 10.62 | 5.80 | 5.07 | 7.83 | 7.82 | 33.77 | 33.78 |
| | 5 | 10.74 | 10.61 | 5.09 | 4.61 | 7.81 | 7.81 | 33.76 | 33.78 |
| | 6 | 10.68 | 10.51 | 4.85 | 4.58 | 7.81 | 7.80 | 33.77 | 33.80 |
| | 7 | 10.62 | 10.45 | 4.66 | 4.39 | 7.80 | 7.79 | 33.79 | 33.80 |
| | 8 | 10.55 | 10.42 | 4.49 | 4.12 | 7.78 | 7.78 | 33.80 | 33.81 |
| RW16 | 0 | 11.56 | 10.78 | 7.28 | 5.21 | 7.88 | 7.84 | 32.48 | 33.32 |
| | 1 | 11.38 | 10.77 | 7.25 | 5.44 | 7.87 | 7.83 | 32.70 | 33.54 |
| | 2 | 11.02 | 10.76 | 7.20 | 5.25 | 7.85 | 7.83 | 33.24 | 33.72 |
| | 3 | 10.75 | 10.74 | 7.07 | 5.00 | 7.82 | 7.81 | 33.55 | 33.74 |
| | 4 | 10.55 | 10.71 | 5.97 | 4.81 | 7.80 | 7.81 | 33.77 | 33.76 |
| | 5 | 10.50 | 10.68 | 4.57 | 4.64 | 7.79 | 7.79 | 33.80 | 33.77 |
| | 6 | 10.49 | 10.62 | 4.33 | 4.57 | 7.79 | 7.79 | 33.79 | 33.78 |
| | 7 | 10.42 | 10.56 | 4.23 | 4.32 | 7.78 | 7.78 | 33.82 | 33.79 |
| | 8 | 10.38 | 10.50 | 4.06 | 4.08 | 7.77 | 7.76 | 33.82 | 33.81 |
| | 9 | 10.38 | 10.49 | 3.91 | 4.04 | 7.76 | 7.75 | 33.81 | 33.79 |
| RW17 | 0 | 10.98 | 11.14 | 7.93 | 7.47 | 7.86 | 7.99 | 33.19 | 33.60 |
| | 1 | 10.81 | 11.14 | 7.97 | 7.48 | 7.85 | 8.00 | 33.44 | 33.60 |
| | 2 | 10.73 | 11.09 | 7.28 | 7.50 | 7.82 | 7.99 | 33.65 | 33.67 |
| | 3 | 10.61 | 11.00 | 5.83 | 7.11 | 7.80 | 7.98 | 33.76 | 33.66 |
| | 4 | 10.58 | 10.92 | 4.53 | 6.50 | 7.79 | 7.91 | 33.77 | 33.71 |
| | 5 | 10.47 | 10.90 | 4.35 | 5.86 | 7.78 | 7.88 | 33.79 | 33.72 |
| | 6 | 10.42 | 10.87 | 3.98 | 5.66 | 7.76 | 7.86 | 33.80 | 33.74 |
| | 7 | 10.43 | 10.86 | 3.80 | 5.42 | 7.76 | 7.84 | 33.80 | 33.74 |
| | 8 | 10.45 | 10.80 | 3.76 | 5.29 | 7.75 | 7.81 | 33.80 | 33.75 |
| | 9 | | 10.81 | | 4.84 | | 7.81 | | 33.75 |

**Appendix C-2. Water quality parameters at each receiving water monitoring station during flood and ebb tides. Mandalay 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 |
|---|---|---|---|---|---|---|---|---|---|
| **Surf Zone** | | | | | | | | | |
| RW1 | 0 | 14.84 | 15.78 | 7.46 | 7.14 | 8.00 | 8.00 | 32.76 | 32.85 |
| RW2 | 0 | 20.05 | 19.63 | 6.60 | 6.45 | 7.99 | 7.94 | 32.54 | 32.39 |
| RW3 | 0 | 14.85 | 15.81 | 7.40 | 7.06 | 8.01 | 7.97 | 32.75 | 32.89 |
| RW4 | 0 | 15.38 | 16.17 | 7.38 | 6.89 | 7.97 | 7.96 | 32.87 | 32.78 |
| RW5 | 0 | 21.48 | 18.29 | 6.27 | 6.57 | 7.98 | 7.92 | 32.39 | 32.51 |
| **Offshore** | | | | | | | | | |
| RW6 | 0 | 15.29 | 15.68 | 6.96 | 6.87 | 8.02 | 8.11 | 33.49 | 33.37 |
| | 1 | 15.29 | 15.66 | 6.96 | 7.38 | 8.02 | 8.12 | 33.49 | 33.44 |
| | 2 | 15.00 | 14.11 | 7.01 | 7.77 | 8.01 | 7.98 | 33.44 | 33.62 |
| | 3 | 14.36 | 13.40 | 6.96 | 6.48 | 8.00 | 7.89 | 33.51 | 33.57 |
| | 4 | 13.86 | 13.23 | 6.65 | 5.47 | 7.96 | 7.88 | 33.51 | 33.56 |
| | 5 | 13.39 | 13.19 | 6.14 | 5.35 | 7.90 | 7.87 | 33.55 | 33.58 |
| | 6 | 13.28 | 13.11 | 5.57 | 5.37 | 7.88 | 7.87 | 33.55 | 33.58 |
| | 7 | 13.22 | 12.96 | 5.41 | 5.31 | 7.87 | 7.87 | 33.55 | 33.58 |
| | 8 | 13.17 | 12.91 | 5.39 | 5.25 | 7.87 | 7.85 | 33.55 | 33.56 |
| | 9 | 13.08 | 12.79 | 5.34 | 5.13 | 7.87 | 7.84 | 33.55 | 33.60 |
| | 10 | 12.98 | 12.57 | 5.26 | 4.97 | 7.87 | 7.81 | 33.54 | 33.61 |
| | 11 | 12.69 | 12.52 | 5.22 | 4.86 | 7.83 | 7.81 | 33.63 | 33.56 |
| RW7 | 0 | 15.60 | 15.85 | 7.69 | 7.58 | 8.09 | 8.10 | 33.47 | 33.43 |
| | 1 | 15.54 | 15.83 | 7.71 | 7.59 | 8.09 | 8.10 | 33.48 | 33.43 |
| | 2 | 14.77 | 14.91 | 7.92 | 7.76 | 8.06 | 8.05 | 33.46 | 33.47 |
| | 3 | 13.89 | 14.12 | 7.21 | 6.75 | 7.95 | 7.95 | 33.55 | 33.41 |
| | 4 | 13.44 | 13.35 | 6.11 | 5.92 | 7.90 | 7.89 | 33.54 | 33.51 |
| | 5 | 13.28 | 13.08 | 5.64 | 5.48 | 7.88 | 7.87 | 33.55 | 33.55 |
| | 6 | 13.15 | 13.02 | 5.44 | 5.34 | 7.87 | 7.86 | 33.55 | 33.54 |
| | 7 | 13.06 | 12.94 | 5.32 | 5.21 | 7.87 | 7.85 | 33.55 | 33.54 |
| | 8 | 12.96 | 12.84 | 5.27 | 5.16 | 7.86 | 7.84 | 33.55 | 33.54 |
| | 9 | 12.89 | 12.81 | 5.21 | 5.04 | 7.85 | 7.84 | 33.54 | 33.54 |
| | 10 | 12.64 | 12.70 | 5.13 | 5.03 | 7.83 | 7.83 | 33.53 | 33.54 |
| | 11 | 12.54 | 12.57 | 4.88 | 4.95 | 7.81 | 7.82 | 33.56 | 33.57 |
| RW8 | 0 | 15.03 | 15.49 | 7.17 | 7.07 | 8.01 | 8.06 | 33.48 | 33.43 |
| | 1 | 15.02 | 15.45 | 7.17 | 7.01 | 8.01 | 8.05 | 33.48 | 33.44 |
| | 2 | 14.89 | 14.93 | 7.15 | 7.04 | 8.01 | 8.03 | 33.44 | 33.37 |
| | 3 | 13.78 | 13.78 | 7.14 | 6.53 | 7.97 | 7.92 | 33.48 | 33.48 |
| | 4 | 13.29 | 13.25 | 6.11 | 5.75 | 7.90 | 7.88 | 33.53 | 33.51 |
| | 5 | 13.17 | 13.01 | 5.51 | 5.60 | 7.88 | 7.87 | 33.55 | 33.57 |
| | 6 | 13.09 | 13.01 | 5.41 | 5.28 | 7.87 | 7.87 | 33.55 | 33.56 |
| | 7 | 13.07 | 12.97 | 5.31 | 5.27 | 7.87 | 7.87 | 33.54 | 33.56 |
| | 8 | 12.98 | 12.96 | 5.23 | 5.22 | 7.86 | 7.87 | 33.55 | 33.54 |
| | 9 | 12.91 | 12.89 | 5.20 | 5.19 | 7.85 | 7.85 | 33.55 | 33.55 |
| | 10 | 12.73 | 12.71 | 5.12 | 5.14 | 7.84 | 7.84 | 33.54 | 33.59 |
| | 11 | 12.61 | 12.69 | 4.89 | 5.00 | 7.81 | 7.83 | 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 |
|---|---|---|---|---|---|---|---|---|---|
| RW9 | 0 | 14.54 | 15.72 | 6.52 | 7.47 | 7.99 | 8.08 | 33.44 | 33.43 |
| | 1 | 14.24 | 15.70 | 6.91 | 7.49 | 7.98 | 8.08 | 33.53 | 33.43 |
| | 2 | 13.98 | 14.70 | 6.66 | 7.71 | 7.96 | 8.05 | 33.54 | 33.35 |
| | 3 | 13.91 | 13.75 | 6.30 | 6.74 | 7.94 | 7.93 | 33.53 | 33.55 |
| | 4 | 13.83 | 13.67 | 6.06 | 5.72 | 7.92 | 7.90 | 33.53 | 33.53 |
| | 5 | 13.63 | 13.49 | 5.85 | 5.63 | 7.90 | 7.88 | 33.56 | 33.54 |
| | 6 | 13.43 | 13.22 | 5.62 | 5.48 | 7.88 | 7.87 | 33.57 | 33.54 |
| | 7 | 13.13 | 13.03 | 5.53 | 5.41 | 7.87 | 7.87 | 33.56 | 33.56 |
| | 8 | 13.02 | 13.00 | 5.38 | 5.25 | 7.87 | 7.87 | 33.56 | 33.53 |
| | 9 | 12.97 | 12.91 | 5.26 | 5.22 | 7.86 | 7.86 | 33.56 | 33.54 |
| | 10 | 12.85 | 12.82 | 5.21 | 5.18 | 7.85 | 7.85 | 33.56 | 33.55 |
| | 11 | 12.81 | 12.76 | 5.11 | 5.10 | 7.83 | 7.84 | 33.56 | 33.55 |
| | 12 | 12.78 | | 5.02 | | 7.83 | | 33.57 | |
| RW10 | 0 | 15.19 | 15.07 | 7.31 | 6.84 | 8.04 | 8.01 | 33.46 | 33.49 |
| | 1 | 15.00 | 15.10 | 7.51 | 6.90 | 8.03 | 8.02 | 33.47 | 33.45 |
| | 2 | 14.54 | 14.80 | 7.24 | 6.93 | 8.00 | 8.01 | 33.46 | 33.46 |
| | 3 | 14.31 | 14.47 | 6.72 | 6.61 | 7.97 | 7.97 | 33.51 | 33.50 |
| | 4 | 14.20 | 14.42 | 6.32 | 6.23 | 7.93 | 7.95 | 33.53 | 33.50 |
| | 5 | 13.83 | 14.33 | 5.75 | 6.14 | 7.87 | 7.94 | 33.55 | 33.50 |
| | 6 | 13.37 | 14.24 | 5.40 | 5.94 | 7.87 | 7.91 | 33.54 | 33.49 |
| | 7 | 13.16 | 13.68 | 5.41 | 5.89 | 7.87 | 7.87 | 33.58 | 33.49 |
| | 8 | 13.00 | 13.53 | 5.34 | 5.56 | 7.86 | 7.86 | 33.55 | 33.55 |
| | 9 | 12.96 | 13.11 | 5.28 | 5.40 | 7.86 | 7.86 | 33.55 | 33.55 |
| | 10 | 12.91 | 13.10 | 5.23 | 5.27 | 7.86 | 7.86 | 33.55 | 33.56 |
| | 11 | 12.87 | 12.99 | 5.21 | 5.24 | 7.85 | 7.85 | 33.55 | 33.54 |
| RW11 | 0 | 14.60 | 15.02 | 6.74 | 6.69 | 7.98 | 8.00 | 33.49 | 33.42 |
| | 1 | 14.33 | 14.93 | 6.83 | 6.95 | 7.98 | 8.01 | 33.44 | 33.39 |
| | 2 | 13.23 | 13.64 | 6.49 | 7.06 | 7.91 | 7.96 | 33.53 | 33.53 |
| | 3 | 13.01 | 13.15 | 5.43 | 6.03 | 7.86 | 7.88 | 33.55 | 33.53 |
| | 4 | 12.93 | 13.00 | 5.21 | 5.30 | 7.85 | 7.87 | 33.55 | 33.57 |
| | 5 | 12.85 | 12.95 | 5.13 | 5.28 | 7.85 | 7.86 | 33.55 | 33.56 |
| | 6 | 12.82 | 12.93 | 5.08 | 5.23 | 7.84 | 7.86 | 33.55 | 33.55 |
| | 7 | 12.81 | 12.84 | 5.02 | 5.17 | 7.84 | 7.85 | 33.55 | 33.54 |
| | 8 | 12.80 | 12.80 | 4.95 | 5.04 | 7.83 | 7.84 | 33.55 | 33.55 |
| RW12 | 0 | 15.46 | 15.40 | 6.73 | 7.30 | 7.93 | 8.01 | 33.37 | 33.41 |
| | 1 | 15.42 | 15.33 | 6.82 | 7.37 | 7.93 | 8.01 | 33.37 | 33.41 |
| | 2 | 14.49 | 14.66 | 6.90 | 7.37 | 7.97 | 8.00 | 33.58 | 33.45 |
| | 3 | 14.34 | 14.13 | 6.76 | 6.66 | 7.97 | 7.94 | 33.50 | 33.49 |
| | 4 | 14.20 | 14.06 | 6.63 | 6.01 | 7.94 | 7.92 | 33.52 | 33.51 |
| | 5 | 13.98 | 13.95 | 6.11 | 5.86 | 7.91 | 7.91 | 33.54 | 33.50 |
| | 6 | 13.82 | 13.59 | 5.85 | 5.66 | 7.90 | 7.87 | 33.53 | 33.48 |
| | 7 | 13.45 | 13.26 | 5.77 | 5.38 | 7.88 | 7.87 | 33.59 | 33.55 |
| | 8 | 13.20 | 13.21 | 5.52 | 5.36 | 7.86 | 7.87 | 33.55 | 33.56 |
| | 9 | 13.19 | | 5.43 | | 7.85 | | 33.61 | |
| RW13 | 0 | 14.52 | 14.97 | 7.38 | 7.05 | 7.96 | 7.99 | 33.49 | 33.46 |
| | 1 | 14.52 | 14.80 | 7.38 | 7.11 | 7.96 | 8.00 | 33.49 | 33.49 |
| | 2 | 14.46 | 14.02 | 7.42 | 7.02 | 7.96 | 7.97 | 33.50 | 33.46 |
| | 3 | 14.43 | 13.13 | 7.31 | 5.99 | 7.94 | 7.88 | 33.51 | 33.55 |
| | 4 | 14.05 | 13.02 | 7.22 | 5.26 | 7.92 | 7.87 | 33.58 | 33.55 |
| | 5 | 13.21 | 12.97 | 6.69 | 5.20 | 7.88 | 7.85 | 33.55 | 33.56 |
| | 6 | 12.91 | 12.85 | 5.53 | 5.19 | 7.85 | 7.85 | 33.58 | 33.55 |
| | 7 | 12.78 | 12.82 | 5.18 | 5.10 | 7.83 | 7.84 | 33.60 | 33.56 |
| | 8 | 12.74 | 12.83 | 5.03 | 5.02 | 7.83 | 7.83 | 33.58 | 33.55 |
| | 9 | 12.72 | 12.79 | 5.03 | 5.02 | 7.81 | 7.83 | 33.56 | 33.55 |

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 |
|---|---|---|---|---|---|---|---|---|---|
| RW14 | 0 | 14.83 | 14.96 | 7.27 | 6.93 | 7.99 | 8.01 | 33.45 | 33.44 |
| | 1 | 14.78 | 14.93 | 7.25 | 6.90 | 7.99 | 8.00 | 33.44 | 33.44 |
| | 2 | 13.72 | 14.23 | 7.11 | 6.64 | 7.93 | 7.94 | 33.56 | 33.54 |
| | 3 | 13.41 | 13.47 | 5.72 | 5.73 | 7.89 | 7.88 | 33.54 | 33.55 |
| | 4 | 13.38 | 13.27 | 5.53 | 5.41 | 7.87 | 7.87 | 33.54 | 33.54 |
| | 5 | 13.35 | 13.08 | 5.45 | 5.48 | 7.87 | 7.87 | 33.54 | 33.54 |
| | 6 | 13.13 | 13.06 | 5.41 | 5.38 | 7.85 | 7.87 | 33.55 | 33.54 |
| | 7 | 12.95 | 12.99 | 5.13 | 5.36 | 7.84 | 7.87 | 33.55 | 33.55 |
| | 8 | 12.79 | 12.93 | 5.11 | 5.35 | 7.83 | 7.86 | 33.55 | 33.55 |
| | 9 | 12.76 | 12.93 | 5.03 | 5.27 | 7.84 | 7.87 | 33.54 | 33.54 |
| RW15 | 0 | 14.98 | 14.85 | 7.18 | 6.30 | 8.05 | 7.97 | 33.52 | 33.37 |
| | 1 | 14.62 | 14.73 | 7.37 | 6.45 | 8.03 | 7.97 | 33.50 | 33.52 |
| | 2 | 14.09 | 14.27 | 7.04 | 6.54 | 7.97 | 7.97 | 33.53 | 33.45 |
| | 3 | 13.90 | 13.90 | 6.47 | 6.12 | 7.94 | 7.92 | 33.53 | 33.53 |
| | 4 | 13.63 | 13.68 | 6.14 | 5.91 | 7.91 | 7.91 | 33.54 | 33.56 |
| | 5 | 13.42 | 13.59 | 5.69 | 5.79 | 7.88 | 7.90 | 33.53 | 33.52 |
| | 6 | 13.25 | 13.47 | 5.43 | 5.61 | 7.86 | 7.89 | 33.53 | 33.53 |
| | 7 | 13.03 | 13.36 | 5.21 | 5.49 | 7.85 | 7.88 | 33.53 | 33.53 |
| | 8 | 12.94 | 13.15 | 5.04 | 5.40 | 7.85 | 7.86 | 33.55 | 33.55 |
| | 9 | 12.84 | 12.87 | 5.02 | 5.32 | 7.83 | 7.85 | 33.55 | 33.54 |
| RW16 | 0 | 14.88 | 15.35 | 7.24 | 7.51 | 7.99 | 8.03 | 33.48 | 33.44 |
| | 1 | 14.70 | 15.37 | 7.32 | 7.51 | 7.98 | 8.03 | 33.47 | 33.43 |
| | 2 | 13.77 | 14.30 | 7.38 | 7.67 | 7.95 | 8.00 | 33.48 | 33.49 |
| | 3 | 13.13 | 13.41 | 6.19 | 6.64 | 7.87 | 7.90 | 33.55 | 33.52 |
| | 4 | 13.07 | 13.27 | 5.25 | 5.59 | 7.86 | 7.88 | 33.56 | 33.50 |
| | 5 | 12.98 | 12.98 | 5.25 | 5.40 | 7.85 | 7.86 | 33.51 | 33.54 |
| | 6 | 12.77 | 12.88 | 5.15 | 5.22 | 7.84 | 7.85 | 33.55 | 33.55 |
| | 7 | 12.74 | 12.81 | 4.99 | 5.14 | 7.83 | 7.85 | 33.55 | 33.55 |
| | 8 | 12.73 | 12.78 | 4.92 | 5.06 | 7.83 | 7.84 | 33.55 | 33.55 |
| RW17 | 0 | 15.03 | 15.55 | 7.46 | 7.56 | 8.02 | 8.06 | 33.46 | 33.44 |
| | 1 | 14.86 | 15.52 | 7.54 | 7.58 | 8.02 | 8.07 | 33.45 | 33.45 |
| | 2 | 13.62 | 14.52 | 7.55 | 7.76 | 7.94 | 8.01 | 33.45 | 33.48 |
| | 3 | 13.11 | 13.33 | 6.25 | 6.81 | 7.88 | 7.91 | 33.53 | 33.44 |
| | 4 | 13.01 | 13.02 | 5.47 | 5.51 | 7.87 | 7.86 | 33.55 | 33.56 |
| | 5 | 12.94 | 12.99 | 5.33 | 5.16 | 7.86 | 7.85 | 33.56 | 33.55 |
| | 6 | 12.89 | 12.96 | 5.30 | 5.15 | 7.86 | 7.85 | 33.56 | 33.55 |
| | 7 | 12.86 | 12.95 | 5.23 | 5.11 | 7.85 | 7.85 | 33.55 | 33.55 |
| | 8 | 12.85 | 12.94 | 5.09 | 5.12 | 7.84 | 7.85 | 33.55 | 33.55 |

# APPENDIX D

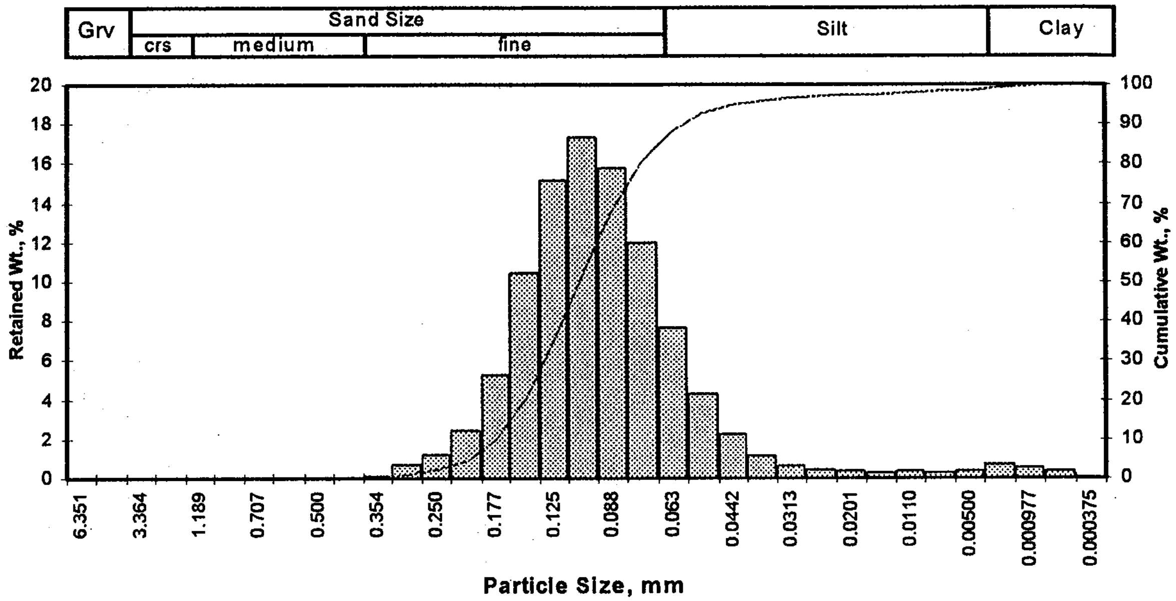
## Sediment grain size distribution and statistical parameters by station

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

# **PTS** Laboratories, Inc.

**Particle Size Analysis - ASTM D4464M**

| | | | |
|---|---|---|---|
| **Client:** | Calscience Environmental Laboratories, Inc. | **PTS File No:** | 35518 |
| **Project:** | N/A | **Sample ID:** | B-1 |
| **Project No:** | 05-08-1237 | **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 | 0.10 | 0.10 | 0.10 |
| 0.0117 | 0.297 | 1.75 | 50 | 0.70 | 0.70 | 0.80 |
| 0.0098 | 0.250 | 2.00 | 60 | 1.24 | 1.24 | 2.04 |
| 0.0083 | 0.210 | 2.25 | 70 | 2.43 | 2.43 | 4.47 |
| 0.0070 | 0.177 | 2.50 | 80 | 5.26 | 5.26 | 9.73 |
| 0.0059 | 0.149 | 2.75 | 100 | 10.40 | 10.40 | 20.13 |
| 0.0049 | 0.125 | 3.00 | 120 | 15.20 | 15.20 | 35.33 |
| 0.0041 | 0.105 | 3.25 | 140 | 17.30 | 17.30 | 52.64 |
| 0.0035 | 0.088 | 3.50 | 170 | 15.80 | 15.80 | 68.44 |
| 0.0029 | 0.074 | 3.75 | 200 | 12.00 | 12.00 | 80.44 |
| 0.0025 | 0.063 | 4.00 | 230 | 7.71 | 7.71 | 88.15 |
| 0.0021 | 0.053 | 4.25 | 270 | 4.33 | 4.33 | 92.48 |
| 0.00174 | 0.0442 | 4.50 | 325 | 2.20 | 2.20 | 94.68 |
| 0.00146 | 0.0372 | 4.75 | 400 | 1.14 | 1.14 | 95.82 |
| 0.00123 | 0.0313 | 5.00 | 450 | 0.62 | 0.62 | 96.44 |
| 0.000986 | 0.0250 | 5.32 | 500 | 0.46 | 0.46 | 96.90 |
| 0.000790 | 0.0201 | 5.64 | 635 | 0.31 | 0.31 | 97.21 |
| 0.000615 | 0.0156 | 6.00 | | 0.27 | 0.27 | 97.48 |
| 0.000435 | 0.0110 | 6.50 | | 0.32 | 0.32 | 97.80 |
| 0.000308 | 0.00781 | 7.00 | | 0.29 | 0.29 | 98.09 |
| 0.000197 | 0.00500 | 7.65 | | 0.33 | 0.33 | 98.42 |
| 0.000077 | 0.00195 | 9.00 | | 0.65 | 0.65 | 99.07 |
| 0.000038 | 0.000977 | 10.00 | | 0.54 | 0.54 | 99.61 |
| 0.000019 | 0.000488 | 11.00 | | 0.35 | 0.35 | 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 | 2.28 | 0.0081 | 0.207 |
| 10 | 2.51 | 0.0069 | 0.176 |
| 16 | 2.65 | 0.0063 | 0.159 |
| 25 | 2.83 | 0.0055 | 0.141 |
| 40 | 3.07 | 0.0047 | 0.119 |
| 50 | 3.21 | 0.0042 | 0.108 |
| 60 | 3.37 | 0.0038 | 0.097 |
| 75 | 3.64 | 0.0032 | 0.080 |
| 84 | 3.87 | 0.0027 | 0.069 |
| 90 | 4.11 | 0.0023 | 0.058 |
| 95 | 4.57 | 0.0017 | 0.042 |

| Measure | Trask | Inman | Folk-Ward |
|---|---|---|---|
| Median, phi | 3.21 | 3.21 | 3.21 |
| Median, in. | 0.0042 | 0.0042 | 0.0042 |
| Median, mm | 0.108 | 0.108 | 0.108 |
| Mean, phi | 3.18 | 3.26 | 3.24 |
| Mean, in. | 0.0044 | 0.0041 | 0.0042 |
| Mean, mm | 0.111 | 0.105 | 0.106 |
| Sorting | 1.323 | 0.607 | 0.651 |
| Skewness | 0.985 | 0.076 | 0.130 |
| Kurtosis | 0.255 | 0.889 | 1.166 |
| **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 | 80.44 |
| Silt | >0.005 mm | 17.98 |
| Clay | <0.005 mm | 1.58 |
| | **Total** | **100** |

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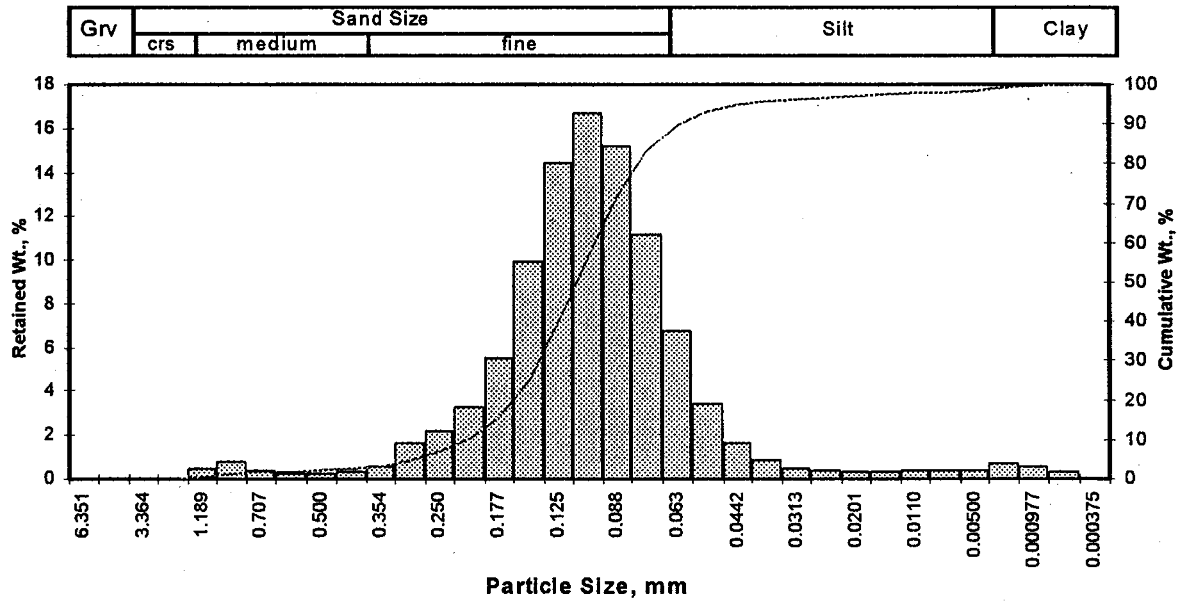
Appendix D-1. (Cont.).

**PTS** Laboratories, Inc.

**Particle Size Analysis - ASTM D4464M**

| | | | |
|---|---|---|---|
| **Client:** | Calscience Environmental Laboratories, Inc. | **PTS File No:** | **35518** |
| **Project:** | N/A | **Sample ID:** | **B-2** |
| **Project No:** | 05-08-1237 | **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 | 0.50 | 0.50 | 0.50 |
| 0.0331 | 0.841 | 0.25 | 20 | 0.76 | 0.76 | 1.26 |
| 0.0278 | 0.707 | 0.50 | 25 | 0.41 | 0.41 | 1.67 |
| 0.0234 | 0.595 | 0.75 | 30 | 0.25 | 0.25 | 1.92 |
| 0.0197 | 0.500 | 1.00 | 35 | 0.21 | 0.21 | 2.13 |
| 0.0166 | 0.420 | 1.25 | 40 | 0.33 | 0.33 | 2.46 |
| 0.0139 | 0.354 | 1.50 | 45 | 0.58 | 0.58 | 3.04 |
| 0.0117 | 0.297 | 1.75 | 50 | 1.65 | 1.65 | 4.69 |
| 0.0098 | 0.250 | 2.00 | 60 | 2.20 | 2.20 | 6.90 |
| 0.0083 | 0.210 | 2.25 | 70 | 3.24 | 3.24 | 10.14 |
| 0.0070 | 0.177 | 2.50 | 80 | 5.50 | 5.51 | 15.65 |
| 0.0059 | 0.149 | 2.75 | 100 | 9.93 | 9.94 | 25.59 |
| 0.0049 | 0.125 | 3.00 | 120 | 14.40 | 14.41 | 40.00 |
| 0.0041 | 0.105 | 3.25 | 140 | 16.70 | 16.72 | 56.72 |
| 0.0035 | 0.088 | 3.50 | 170 | 15.20 | 15.21 | 71.93 |
| 0.0029 | 0.074 | 3.75 | 200 | 11.20 | 11.21 | 83.14 |
| 0.0025 | 0.063 | 4.00 | 230 | 6.72 | 6.73 | 89.87 |
| 0.0021 | 0.053 | 4.25 | 270 | 3.43 | 3.43 | 93.30 |
| 0.00174 | 0.0442 | 4.50 | 325 | 1.60 | 1.60 | 94.90 |
| 0.00146 | 0.0372 | 4.75 | 400 | 0.83 | 0.83 | 95.73 |
| 0.00123 | 0.0313 | 5.00 | 450 | 0.49 | 0.49 | 96.22 |
| 0.000986 | 0.0250 | 5.32 | 500 | 0.42 | 0.42 | 96.64 |
| 0.000790 | 0.0201 | 5.64 | 635 | 0.33 | 0.33 | 96.98 |
| 0.000615 | 0.0156 | 6.00 | | 0.31 | 0.31 | 97.29 |
| 0.000435 | 0.0110 | 6.50 | | 0.38 | 0.38 | 97.67 |
| 0.000308 | 0.00781 | 7.00 | | 0.35 | 0.35 | 98.02 |
| 0.000197 | 0.00500 | 7.65 | | 0.39 | 0.39 | 98.41 |
| 0.000077 | 0.00195 | 9.00 | | 0.71 | 0.71 | 99.12 |
| 0.000038 | 0.000977 | 10.00 | | 0.52 | 0.52 | 99.64 |
| 0.000019 | 0.000488 | 11.00 | | 0.33 | 0.33 | 99.97 |
| 0.000015 | 0.000375 | 11.38 | | 0.03 | 0.03 | 100.00 |
| **TOTALS** | | | | **99.90** | **100.00** | **100.00** |

**Cumulative Weight Percent greater than**

| Weight percent | Phi Value | Particle Size Inches | Particle Size Millimeters |
|---|---|---|---|
| 5 | 1.78 | 0.0114 | 0.290 |
| 10 | 2.24 | 0.0083 | 0.212 |
| 16 | 2.51 | 0.0069 | 0.176 |
| 25 | 2.74 | 0.0059 | 0.150 |
| 40 | 3.00 | 0.0049 | 0.125 |
| 50 | 3.15 | 0.0044 | 0.113 |
| 60 | 3.30 | 0.0040 | 0.101 |
| 75 | 3.57 | 0.0033 | 0.084 |
| 84 | 3.78 | 0.0029 | 0.073 |
| 90 | 4.01 | 0.0024 | 0.062 |
| 95 | 4.53 | 0.0017 | 0.043 |

| Measure | Trask | Inman | Folk-Ward |
|---|---|---|---|
| Median, phi | 3.15 | 3.15 | 3.15 |
| Median, in. | 0.0044 | 0.0044 | 0.0044 |
| Median, mm | 0.113 | 0.113 | 0.113 |
| Mean, phi | 3.09 | 3.15 | 3.15 |
| Mean, in. | 0.0046 | 0.0044 | 0.0044 |
| Mean, mm | 0.117 | 0.113 | 0.113 |
| Sorting | 1.335 | 0.636 | 0.734 |
| Skewness | 0.998 | -0.007 | -0.001 |
| Kurtosis | 0.220 | 1.156 | 1.350 |
| **Grain Size Description** (ASTM-USCS Scale) | Fine sand (based on Mean from Trask) | | |

| Description | Retained on Sieve # | Weight Percent |
|---|---|---|
| Gravel | 4 | 0.00 |
| Coarse Sand | 10 | 0.00 |
| Medium Sand | 40 | 2.46 |
| Fine Sand | 200 | 80.68 |
| Silt | >0.005 mm | 15.26 |
| Clay | <0.005 mm | 1.59 |
| | **Total** | **100** |

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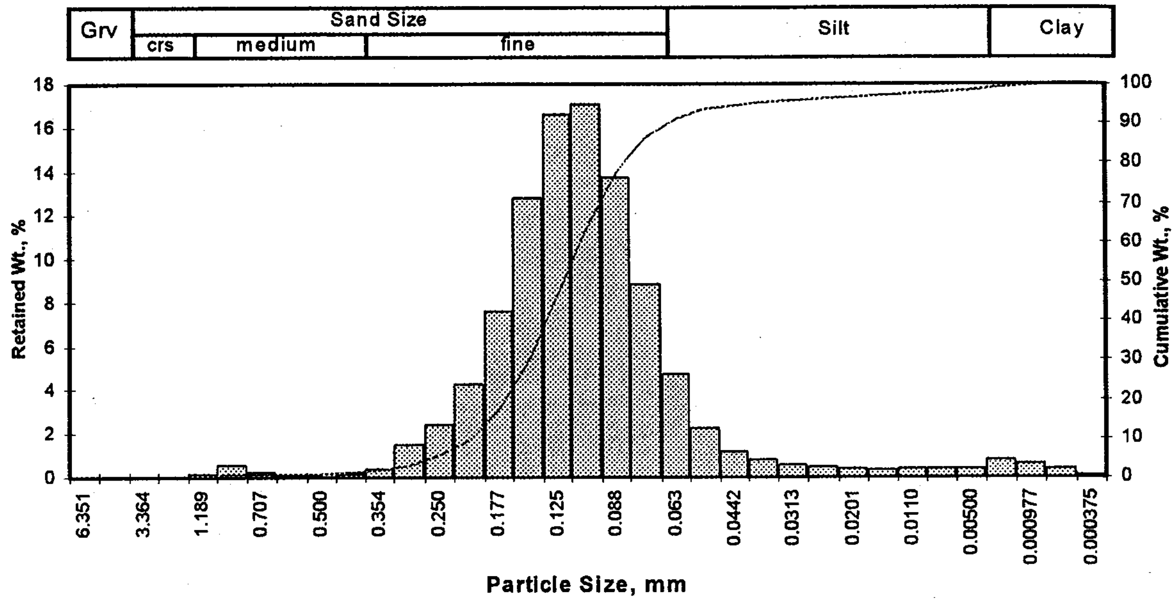
**PTS Laboratories, Inc.** **Particle Size Analysis - ASTM D4464M**

| | | | |
|---|---|---|---|
| **Client:** | Calscience Environmental Laboratories, Inc. | **PTS File No:** | 35518 |
| **Project:** | N/A | **Sample ID:** | B-3 |
| **Project No:** | 05-08-1237 | **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 | 0.18 | 0.18 | 0.18 |
| 0.0331 | 0.841 | 0.25 | 20 | 0.55 | 0.55 | 0.73 |
| 0.0278 | 0.707 | 0.50 | 25 | 0.23 | 0.23 | 0.96 |
| 0.0234 | 0.595 | 0.75 | 30 | 0.06 | 0.06 | 1.02 |
| 0.0197 | 0.500 | 1.00 | 35 | 0.03 | 0.03 | 1.05 |
| 0.0166 | 0.420 | 1.25 | 40 | 0.14 | 0.14 | 1.19 |
| 0.0139 | 0.354 | 1.50 | 45 | 0.39 | 0.39 | 1.58 |
| 0.0117 | 0.297 | 1.75 | 50 | 1.44 | 1.44 | 3.02 |
| 0.0098 | 0.250 | 2.00 | 60 | 2.39 | 2.39 | 5.41 |
| 0.0083 | 0.210 | 2.25 | 70 | 4.26 | 4.26 | 9.67 |
| 0.0070 | 0.177 | 2.50 | 80 | 7.62 | 7.62 | 17.29 |
| 0.0059 | 0.149 | 2.75 | 100 | 12.80 | 12.80 | 30.09 |
| 0.0049 | 0.125 | 3.00 | 120 | 16.60 | 16.60 | 46.69 |
| 0.0041 | 0.105 | 3.25 | 140 | 17.10 | 17.10 | 63.79 |
| 0.0035 | 0.088 | 3.50 | 170 | 13.70 | 13.70 | 77.49 |
| 0.0029 | 0.074 | 3.75 | 200 | 8.88 | 8.88 | 86.37 |
| 0.0025 | 0.063 | 4.00 | 230 | 4.72 | 4.72 | 91.09 |
| 0.0021 | 0.053 | 4.25 | 270 | 2.28 | 2.28 | 93.37 |
| 0.00174 | 0.0442 | 4.50 | 325 | 1.19 | 1.19 | 94.56 |
| 0.00146 | 0.0372 | 4.75 | 400 | 0.75 | 0.75 | 95.31 |
| 0.00123 | 0.0313 | 5.00 | 450 | 0.51 | 0.51 | 95.82 |
| 0.000986 | 0.0250 | 5.32 | 500 | 0.46 | 0.46 | 96.28 |
| 0.000790 | 0.0201 | 5.64 | 635 | 0.36 | 0.36 | 96.64 |
| 0.000615 | 0.0156 | 6.00 | | 0.33 | 0.33 | 96.97 |
| 0.000435 | 0.0110 | 6.50 | | 0.39 | 0.39 | 97.36 |
| 0.000308 | 0.00781 | 7.00 | | 0.35 | 0.35 | 97.71 |
| 0.000197 | 0.00500 | 7.65 | | 0.42 | 0.42 | 98.13 |
| 0.000077 | 0.00195 | 9.00 | | 0.81 | 0.81 | 98.94 |
| 0.000038 | 0.000977 | 10.00 | | 0.62 | 0.62 | 99.56 |
| 0.000019 | 0.000488 | 11.00 | | 0.40 | 0.40 | 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 | 1.96 | 0.0101 | 0.258 |
| 10 | 2.26 | 0.0082 | 0.209 |
| 16 | 2.46 | 0.0072 | 0.182 |
| 25 | 2.65 | 0.0063 | 0.159 |
| 40 | 2.90 | 0.0053 | 0.134 |
| 50 | 3.05 | 0.0048 | 0.121 |
| 60 | 3.19 | 0.0043 | 0.109 |
| 75 | 3.45 | 0.0036 | 0.091 |
| 84 | 3.68 | 0.0031 | 0.078 |
| 90 | 3.94 | 0.0026 | 0.065 |
| 95 | 4.65 | 0.0016 | 0.040 |

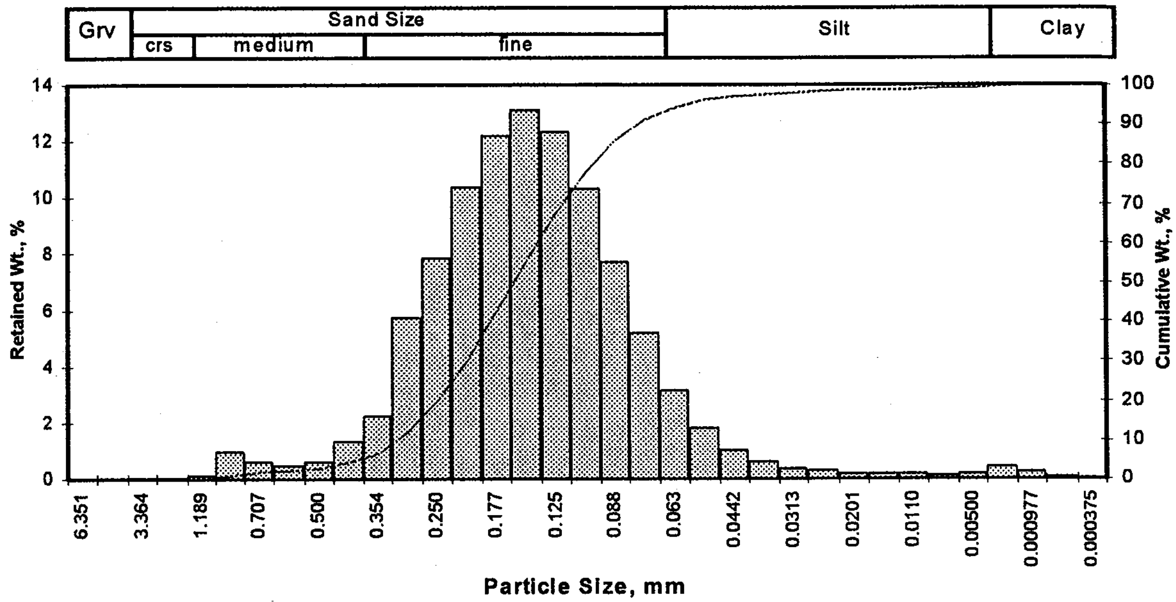
| Measure | Trask | Inman | Folk-Ward |
|---|---|---|---|
| Median, phi | 3.05 | 3.05 | 3.05 |
| Median, in. | 0.0048 | 0.0048 | 0.0048 |
| Median, mm | 0.121 | 0.121 | 0.121 |
| Mean, phi | 3.00 | 3.07 | 3.06 |
| Mean, in. | 0.0049 | 0.0047 | 0.0047 |
| Mean, mm | 0.125 | 0.119 | 0.120 |
| Sorting | 1.321 | 0.613 | 0.714 |
| Skewness | 0.997 | 0.036 | 0.112 |
| Kurtosis | 0.237 | 1.194 | 1.371 |
| **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 | 1.19 |
| Fine Sand | 200 | 85.18 |
| Silt | >0.005 mm | 11.76 |
| Clay | <0.005 mm | 1.87 |
| | **Total** | **100** |

Appendix D-1. (Cont.).

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

| | | | |
|---|---|---|---|
| **Client:** | Calscience Environmental Laboratories, Inc. | **PTS File No:** | 35518 |
| **Project:** | N/A | **Sample ID:** | B-4 |
| **Project No:** | 05-08-1237 | **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 | 0.10 | 0.10 | 0.10 |
| 0.0331 | 0.841 | 0.25 | 20 | 0.97 | 0.97 | 1.07 |
| 0.0278 | 0.707 | 0.50 | 25 | 0.62 | 0.62 | 1.69 |
| 0.0234 | 0.595 | 0.75 | 30 | 0.47 | 0.47 | 2.16 |
| 0.0197 | 0.500 | 1.00 | 35 | 0.61 | 0.61 | 2.77 |
| 0.0166 | 0.420 | 1.25 | 40 | 1.34 | 1.34 | 4.11 |
| 0.0139 | 0.354 | 1.50 | 45 | 2.23 | 2.23 | 6.34 |
| 0.0117 | 0.297 | 1.75 | 50 | 5.74 | 5.74 | 12.07 |
| 0.0098 | 0.250 | 2.00 | 60 | 7.82 | 7.81 | 19.89 |
| 0.0083 | 0.210 | 2.25 | 70 | 10.40 | 10.39 | 30.28 |
| 0.0070 | 0.177 | 2.50 | 80 | 12.20 | 12.19 | 42.47 |
| 0.0059 | 0.149 | 2.75 | 100 | 13.10 | 13.09 | 55.56 |
| 0.0049 | 0.125 | 3.00 | 120 | 12.30 | 12.29 | 67.86 |
| 0.0041 | 0.105 | 3.25 | 140 | 10.30 | 10.29 | 78.15 |
| 0.0035 | 0.088 | 3.50 | 170 | 7.71 | 7.70 | 85.85 |
| 0.0029 | 0.074 | 3.75 | 200 | 5.18 | 5.18 | 91.03 |
| 0.0025 | 0.063 | 4.00 | 230 | 3.15 | 3.15 | 94.18 |
| 0.0021 | 0.053 | 4.25 | 270 | 1.79 | 1.79 | 95.97 |
| 0.00174 | 0.0442 | 4.50 | 325 | 1.01 | 1.01 | 96.98 |
| 0.00146 | 0.0372 | 4.75 | 400 | 0.61 | 0.61 | 97.59 |
| 0.00123 | 0.0313 | 5.00 | 450 | 0.39 | 0.39 | 97.98 |
| 0.000986 | 0.0250 | 5.32 | 500 | 0.32 | 0.32 | 98.30 |
| 0.000790 | 0.0201 | 5.64 | 635 | 0.21 | 0.21 | 98.51 |
| 0.000615 | 0.0156 | 6.00 | | 0.17 | 0.17 | 98.68 |
| 0.000435 | 0.0110 | 6.50 | | 0.18 | 0.18 | 98.86 |
| 0.000308 | 0.00781 | 7.00 | | 0.15 | 0.15 | 99.01 |
| 0.000197 | 0.00500 | 7.65 | | 0.19 | 0.19 | 99.20 |
| 0.000077 | 0.00195 | 9.00 | | 0.45 | 0.45 | 99.65 |
| 0.000038 | 0.000977 | 10.00 | | 0.27 | 0.27 | 99.92 |
| 0.000019 | 0.000488 | 11.00 | | 0.09 | 0.08 | 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 | 1.35 | 0.0154 | 0.392 |
| 10 | 1.66 | 0.0125 | 0.317 |
| 16 | 1.88 | 0.0107 | 0.273 |
| 25 | 2.12 | 0.0090 | 0.230 |
| 40 | 2.45 | 0.0072 | 0.183 |
| 50 | 2.64 | 0.0063 | 0.160 |
| 60 | 2.84 | 0.0055 | 0.140 |
| 75 | 3.17 | 0.0044 | 0.111 |
| 84 | 3.44 | 0.0036 | 0.092 |
| 90 | 3.70 | 0.0030 | 0.077 |
| 95 | 4.11 | 0.0023 | 0.058 |

| Measure | Trask | Inman | Folk-Ward |
|---|---|---|---|
| Median, phi | 2.64 | 2.64 | 2.64 |
| Median, in. | 0.0063 | 0.0063 | 0.0063 |
| Median, mm | 0.160 | 0.160 | 0.160 |
| Mean, phi | 2.55 | 2.66 | 2.65 |
| Mean, in. | 0.0067 | 0.0062 | 0.0063 |
| Mean, mm | 0.170 | 0.158 | 0.159 |
| Sorting | 1.439 | 0.782 | 0.810 |
| Skewness | 0.997 | 0.018 | 0.041 |
| Kurtosis | 0.248 | 0.767 | 1.079 |
| **Grain Size Description** (ASTM-USCS Scale) | Fine sand (based on Mean from Trask) | | |

| Description | Retained on Sieve # | Weight Percent |
|---|---|---|
| Gravel | 4 | 0.00 |
| Coarse Sand | 10 | 0.00 |
| Medium Sand | 40 | 4.11 |
| Fine Sand | 200 | 86.92 |
| Silt | >0.005 mm | 8.16 |
| Clay | <0.005 mm | 0.80 |
| | **Total** | **100** |

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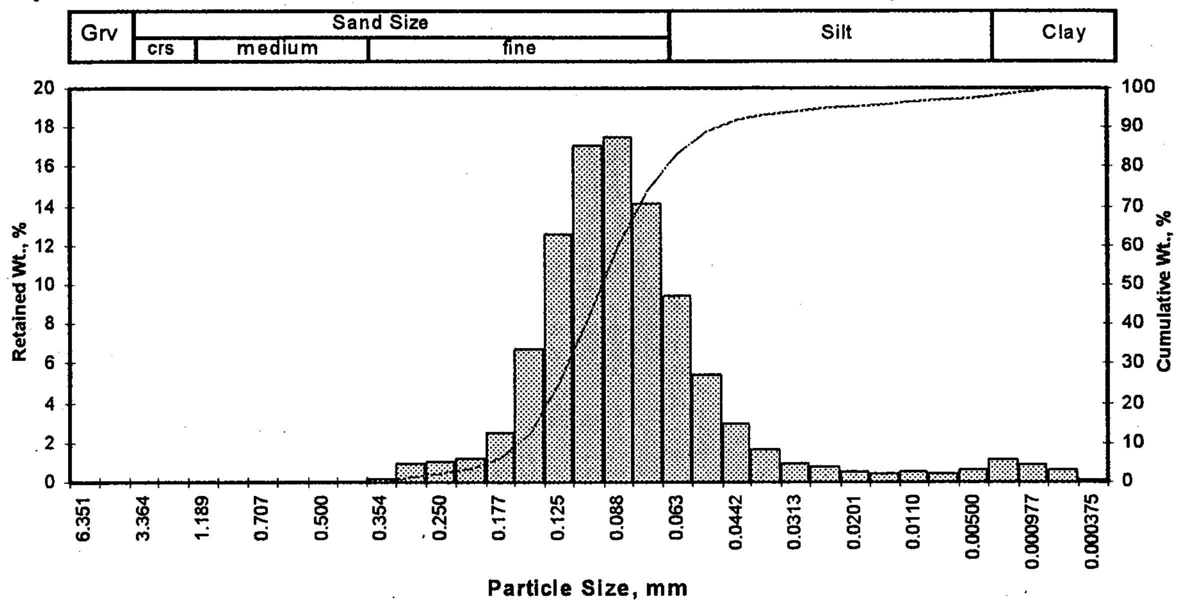
**PTS Laboratories, Inc.**

**Particle Size Analysis - ASTM D4464M**

| | | | |
|---|---|---|---|
| **Client:** | Calscience Environmental Laboratories, Inc. | **PTS File No:** | 35518 |
| **Project:** | N/A | **Sample ID:** | B-5 |
| **Project No:** | 05-08-1237 | **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 | 0.91 | 0.91 | 1.09 |
| 0.0098 | 0.250 | 2.00 | 60 | 1.03 | 1.03 | 2.12 |
| 0.0083 | 0.210 | 2.25 | 70 | 1.18 | 1.18 | 3.30 |
| 0.0070 | 0.177 | 2.50 | 80 | 2.53 | 2.53 | 5.83 |
| 0.0059 | 0.149 | 2.75 | 100 | 6.75 | 6.75 | 12.58 |
| 0.0049 | 0.125 | 3.00 | 120 | 12.60 | 12.60 | 25.18 |
| 0.0041 | 0.105 | 3.25 | 140 | 17.10 | 17.11 | 42.29 |
| 0.0035 | 0.088 | 3.50 | 170 | 17.50 | 17.51 | 59.79 |
| 0.0029 | 0.074 | 3.75 | 200 | 14.10 | 14.10 | 73.90 |
| 0.0025 | 0.063 | 4.00 | 230 | 9.37 | 9.37 | 83.27 |
| 0.0021 | 0.053 | 4.25 | 270 | 5.42 | 5.42 | 88.69 |
| 0.00174 | 0.0442 | 4.50 | 325 | 2.91 | 2.91 | 91.61 |
| 0.00146 | 0.0372 | 4.75 | 400 | 1.61 | 1.61 | 93.22 |
| 0.00123 | 0.0313 | 5.00 | 450 | 0.93 | 0.93 | 94.15 |
| 0.000986 | 0.0250 | 5.32 | 500 | 0.74 | 0.74 | 94.89 |
| 0.000790 | 0.0201 | 5.64 | 635 | 0.52 | 0.52 | 95.41 |
| 0.000615 | 0.0156 | 6.00 | | 0.45 | 0.45 | 95.86 |
| 0.000435 | 0.0110 | 6.50 | | 0.49 | 0.49 | 96.35 |
| 0.000308 | 0.00781 | 7.00 | | 0.46 | 0.46 | 96.81 |
| 0.000197 | 0.00500 | 7.65 | | 0.58 | 0.58 | 97.39 |
| 0.000077 | 0.00195 | 9.00 | | 1.08 | 1.08 | 98.47 |
| 0.000038 | 0.000977 | 10.00 | | 0.86 | 0.86 | 99.33 |
| 0.000019 | 0.000488 | 11.00 | | 0.61 | 0.61 | 99.94 |
| 0.000015 | 0.000375 | 11.38 | | 0.06 | 0.06 | 100.00 |
| **TOTALS** | | | | **100.00** | **100.00** | **100.00** |

**Cumulative Weight Percent greater than**

| Weight percent | Phi Value | Particle Size Inches | Particle Size Millimeters |
|---|---|---|---|
| 5 | 2.42 | 0.0074 | 0.187 |
| 10 | 2.65 | 0.0063 | 0.159 |
| 16 | 2.82 | 0.0056 | 0.142 |
| 25 | 3.00 | 0.0049 | 0.125 |
| 40 | 3.22 | 0.0042 | 0.108 |
| 50 | 3.36 | 0.0038 | 0.097 |
| 60 | 3.50 | 0.0035 | 0.088 |
| 75 | 3.78 | 0.0029 | 0.073 |
| 84 | 4.03 | 0.0024 | 0.061 |
| 90 | 4.36 | 0.0019 | 0.049 |
| 95 | 5.39 | 0.0009 | 0.024 |

| Measure | Trask | Inman | Folk-Ward |
|---|---|---|---|
| Median, phi | 3.36 | 3.36 | 3.36 |
| Median, in. | 0.0038 | 0.0038 | 0.0038 |
| Median, mm | 0.097 | 0.097 | 0.097 |
| Mean, phi | 3.34 | 3.43 | 3.40 |
| Mean, in. | 0.0039 | 0.0037 | 0.0037 |
| Mean, mm | 0.099 | 0.093 | 0.094 |
| Sorting | 1.312 | 0.608 | 0.754 |
| Skewness | 0.981 | 0.108 | 0.237 |
| Kurtosis | 0.238 | 1.444 | 1.555 |

| | |
|---|---|
| **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 | 73.89 |
| Silt | >0.005 mm | 23.49 |
| Clay | <0.005 mm | 2.61 |
| | Total | 100 |

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**Appendix D-2. Yearly grain size values, 1990 - 2005. Mandalay Generating Station NPDES, 2005.**

| | | | | | | Mean grain size | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Station | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | phi | µm | Sorting* | Skewness | Kurtosis |
| 2005 | B1 | 0.00 | 88.15 | 10.27 | 1.58 | 3.24 | 106 | 0.651 | 0.130 | 1.166 |
| | B2 | 0.00 | 89.87 | 8.54 | 1.59 | 3.15 | 113 | 0.734 | -0.001 | 1.350 |
| | B3 | 0.00 | 91.09 | 7.04 | 1.87 | 3.06 | 120 | 0.714 | 0.112 | 1.371 |
| | B4 | 0.00 | 94.18 | 5.02 | 0.80 | 2.65 | 159 | 0.810 | 0.041 | 1.079 |
| | B5 | 0.00 | 83.27 | 14.12 | 2.61 | 3.40 | 94 | 0.754 | 0.237 | 1.555 |
| 2004 | B1 | 1.22 | 95.73 | 2.15 | 0.90 | 2.16 | 224 | 0.74 | -0.08 | 1.28 |
| | B2 | 0.00 | 97.09 | 2.16 | 0.75 | 2.27 | 207 | 0.59 | 0.08 | 1.06 |
| | B3 | 0.71 | 95.89 | 2.48 | 0.92 | 2.14 | 226 | 0.74 | 0.06 | 1.15 |
| | B4 | 1.48 | 94.91 | 2.61 | 1.00 | 2.18 | 221 | 0.80 | -0.12 | 1.51 |
| | B5 | 0.00 | 92.76 | 5.38 | 1.86 | 2.82 | 142 | 0.77 | 0.08 | 1.39 |
| 2003 | B1 | 0.00 | 95.01 | 3.53 | 1.46 | 2.28 | 207 | 0.81 | 0.09 | 1.32 |
| | B2 | 0.00 | 96.63 | 2.48 | 0.89 | 2.19 | 220 | 0.75 | 0.04 | 1.22 |
| | B3 | 0.00 | 93.67 | 4.66 | 1.67 | 2.58 | 168 | 0.84 | 0.10 | 1.28 |
| | B4 | 0.00 | 96.02 | 2.89 | 1.09 | 1.94 | 260 | 0.89 | 0.06 | 1.28 |
| | B5 | - | - | - | - | - | - | - | - | - |
| 2002 | B1 | 0.00 | 96.73 | 2.58 | 0.69 | 2.46 | 182 | 0.63 | -0.01 | 1.20 |
| | B2 | 0.00 | 94.97 | 4.08 | 0.95 | 2.64 | 161 | 0.71 | -0.02 | 1.33 |
| | B3 | 0.00 | 84.43 | 12.83 | 2.74 | 3.07 | 119 | 1.23 | 0.14 | 2.17 |
| | B4 | 0.00 | 94.60 | 4.40 | 1.00 | 2.62 | 162 | 0.76 | -0.03 | 1.35 |
| | B5 | 0.00 | 75.25 | 22.21 | 2.54 | 3.54 | 86 | 0.97 | 0.34 | 1.47 |
| 2001 | B1 | 0.00 | 94.78 | 4.52 | 0.70 | 2.47 | 180 | 0.71 | 0.18 | 1.23 |
| | B2 | 0.00 | 95.96 | 3.44 | 0.60 | 2.61 | 163 | 0.61 | 0.10 | 1.18 |
| | B3 | 0.00 | 96.21 | 2.90 | 0.89 | 2.64 | 161 | 0.61 | 0.00 | 1.13 |
| | B4 | 0.00 | 96.92 | 2.41 | 0.67 | 2.63 | 162 | 0.57 | 0.02 | 1.13 |
| | B5 | 0.00 | 85.18 | 13.15 | 1.67 | 3.28 | 103 | 0.79 | 0.11 | 1.46 |
| 2000 | B1 | 0.00 | 92.10 | 6.40 | 1.50 | 2.55 | 171 | 0.93 | 0.16 | 1.24 |
| | B2 | 0.00 | 93.42 | 4.97 | 1.61 | 2.71 | 153 | 0.73 | 0.16 | 1.36 |
| | B3 | 0.00 | 90.14 | 7.69 | 2.17 | 2.70 | 154 | 0.98 | 0.23 | 1.72 |
| | B4 | 0.00 | 94.23 | 4.09 | 1.68 | 2.65 | 160 | 0.65 | 0.23 | 1.26 |
| | B5 | 0.00 | 83.51 | 14.01 | 2.48 | 3.34 | 99 | 0.86 | 0.28 | 1.68 |
| 1999 | B1 | 0.00 | 94.55 | 4.41 | 1.04 | 2.67 | 158 | 0.72 | 0.01 | 1.31 |
| | B2 | 0.00 | 94.21 | 4.89 | 0.90 | 2.41 | 188 | 0.87 | 0.13 | 1.14 |
| | B3 | 0.00 | 95.60 | 3.57 | 0.83 | 2.56 | 169 | 0.75 | 0.00 | 1.06 |
| | B4 | 0.00 | 96.79 | 2.53 | 0.68 | 2.27 | 207 | 0.75 | 0.02 | 1.16 |
| | B5 | 0.00 | 76.32 | 21.05 | 2.63 | 3.55 | 85 | 0.84 | 0.28 | 1.48 |
| 1998 | B1 | 0.12 | 93.37 | 5.33 | 1.17 | 3.01 | 124 | 65.30 | 0.16 | 1.23 |
| | B2 | 0.01 | 98.14 | 1.82 | 0.02 | 2.59 | 166 | 71.18 | -0.12 | 1.09 |
| | B3 | 0.25 | 92.88 | 5.70 | 1.17 | 2.89 | 135 | 58.93 | 0.10 | 1.14 |
| | B4 | - | - | - | - | - | - | - | - | - |
| | B5 | - | - | - | - | - | - | - | - | - |
| 1997 | B1 | 2.14 | 85.05 | 10.34 | 2.47 | 3.31 | 101 | 60.14 | 0.10 | 1.30 |
| | B2 | 1.82 | 93.66 | 3.06 | 1.45 | 2.79 | 145 | 61.12 | -0.10 | 1.11 |
| | B3 | 0.16 | 69.54 | 28.49 | 1.82 | 3.80 | 72 | 60.25 | 0.14 | 1.15 |
| | B4 | 0.28 | 93.28 | 5.68 | 0.76 | 3.08 | 119 | 65.17 | 0.08 | 1.12 |
| | B5 | 0.12 | 96.07 | 3.34 | 0.47 | 2.62 | 163 | 59.24 | -0.03 | 0.98 |
| 1994 | B1 | 0.00 | 6.89 | 91.74 | 1.37 | 3.05 | 121 | 65.76 | -0.01 | 1.16 |
| | B2 | 0.38 | 4.45 | 46.64 | 48.53 | 0.12 | 920 | 39.76 | -0.37 | 0.50 |
| | B3 | 1.15 | 33.34 | 65.31 | 0.20 | 3.93 | 66 | 61.17 | 0.25 | 1.17 |
| | B4 | 0.00 | 5.40 | 89.57 | 5.04 | 2.61 | 164 | 55.63 | -0.25 | 1.96 |
| | B5 | 0.13 | 2.23 | 97.43 | 0.21 | 2.48 | 179 | 66.01 | 0.02 | 1.11 |
| 1993 | B1 | 20.44 | 78.30 | 0.84 | 0.42 | 1.07 | 480 | N.A. | N.A. | N.A. |
| | B2 | 0.23 | 98.66 | 0.74 | 0.37 | 2.47 | 180 | N.A. | N.A. | N.A. |
| | B3 | 0.80 | 93.69 | 5.09 | 0.42 | 2.48 | 179 | N.A. | N.A. | N.A. |
| | B4 | 0.59 | 98.95 | 0.00 | 0.46 | 2.23 | 213 | N.A. | N.A. | N.A. |
| | B5 | 0.05 | 90.83 | 8.72 | 0.40 | 2.50 | 177 | N.A. | N.A. | N.A. |
| 1992 | B1 | 1.37 | 97.68 | 0.71 | 0.24 | 2.45 | 183 | N.A. | N.A. | N.A. |
| | B2 | 0.00 | 98.80 | 0.60 | 0.60 | 2.48 | 179 | N.A. | N.A. | N.A. |
| | B3 | 5.05 | 93.59 | 0.91 | 0.45 | 2.37 | 193 | N.A. | N.A. | N.A. |
| | B4 | 8.84 | 89.79 | 0.69 | 0.69 | 2.58 | 167 | N.A. | N.A. | N.A. |
| | B5 | 0.54 | 91.55 | 7.01 | 0.90 | 2.57 | 168 | N.A. | N.A. | N.A. |
| 1991 | B1 | 0.33 | 93.39 | 5.23 | 1.05 | 2.58 | 167 | N.A. | N.A. | N.A. |
| | B2 | 0.24 | 95.14 | 3.60 | 1.03 | 2.42 | 186 | N.A. | N.A. | N.A. |
| | B3 | 1.11 | 89.44 | 8.40 | 1.05 | 2.40 | 190 | N.A. | N.A. | N.A. |
| | B4 | 0.20 | 95.54 | 3.20 | 1.07 | 2.38 | 192 | N.A. | N.A. | N.A. |
| | B5 | 0.00 | 83.57 | 14.73 | 1.70 | 3.13 | 114 | N.A. | N.A. | N.A. |
| 1990 | B1 | 1.84 | 96.28 | 1.88 | 0.00 | 2.35 | 196 | 68.62 | -0.04 | 1.33 |
| | B2 | 0.60 | 98.86 | 2.53 | 0.01 | 2.68 | 156 | 72.52 | -0.07 | 1.48 |
| | B3 | 1.11 | 95.87 | 3.01 | 0.01 | 2.54 | 173 | 74.10 | -0.07 | 1.47 |
| | B4 | 4.88 | 92.48 | 2.64 | 0.01 | 2.37 | 193 | 66.20 | -0.31 | 2.95 |
| | B5 | 0.15 | 90.52 | 9.33 | 0.00 | 3.38 | 96 | 76.64 | 0.11 | 1.34 |

Appendix D-2 (Cont.).

| Year | Station | Gravel (%) | Sand (%) | Silt (%) | Clay (%) | Mean grain size phi | Mean grain size µm | Sorting* | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|---|---|
| 1988 | B1 | 4.56 | 87.93 | 6.86 | 0.64 | 2.57 | 168 | 58.77 | -0.18 | 2.22 |
| | B2 | 1.46 | 95.19 | 3.05 | 0.29 | 2.53 | 174 | 71.58 | 0.17 | 1.57 |
| | B3 | 3.50 | 92.18 | 4.16 | 0.16 | 2.32 | 200 | 66.75 | -0.09 | 2.44 |
| | B4 | 0.71 | 92.82 | 5.10 | 1.37 | 3.16 | 111 | 66.85 | 0.32 | 1.63 |
| | B5 | 4.34 | 90.91 | 2.95 | 1.81 | 2.80 | 144 | 64.47 | -0.13 | 2.05 |
| 1986 | B1 | 0.09 | 85.65 | 14.23 | 0.00 | 3.26 | 104 | 42.05 | 0.38 | 1.22 |
| | B2 | 0.00 | 94.40 | 4.94 | 0.66 | 3.16 | 111 | 58.88 | 0.31 | 1.57 |
| | B3 | 0.00 | 91.15 | 8.22 | 0.00 | 3.09 | 118 | 30.23 | 0.14 | 1.43 |
| | B4 | 0.11 | 89.76 | 9.88 | 0.26 | 3.18 | 110 | 49.68 | 0.38 | 1.55 |
| | B5 | 0.38 | 80.31 | 18.93 | 0.38 | 3.40 | 95 | 47.90 | 0.11 | 1.59 |
| 1980 | B1 | 0.00 | 67.77 | 25.78 | 6.03 | 3.77 | 73 | 0.80 | 0.37 | 3.32 |
| | B2 | 0.00 | 86.09 | 10.95 | 2.95 | 3.11 | 116 | 0.58 | 0.35 | 2.71 |
| | B3 | 0.00 | 74.46 | 22.80 | 2.74 | 3.61 | 82 | 0.60 | 0.40 | 2.00 |
| | B4 | 6.00 | 81.23 | 10.36 | 2.36 | 3.10 | 117 | 0.53 | 0.13 | 5.71 |
| | B5 | 0.00 | 68.28 | 29.51 | 2.18 | 3.69 | 78 | 0.73 | 0.42 | 1.32 |
| 1978 | B1 | 0.52 | 96.44 | 3.04 | 0.00 | 2.46 | 182 | 0.57 | 0.10 | NA |
| | B2 | 0.08 | 97.77 | 2.15 | 0.00 | 2.64 | 161 | 0.46 | -0.04 | NA |
| | B3 | 0.10 | 80.00 | 19.90 | 0.00 | 3.39 | 95 | 0.61 | 0.05 | NA |
| | B4 | 0.21 | 99.42 | 0.37 | 0.00 | 2.37 | 193 | 0.54 | -0.20 | NA |
| | B5 | 0.03 | 80.46 | 19.51 | 0.00 | 3.45 | 92 | 0.56 | 0.00 | NA |

N.A. = Not Available
\- = not required
*Sorting values: % 1986-1998; $\phi$ 1978 & 1980, 1999-present

# 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: 05-07-0218 |
| Costa Mesa, CA 92626-4524 | Preparation: EPA 3050B |
| | Method: EPA 6020 |
| | Units: mg/kg |
| Project: MGS 05204A | Page 1 of 1 |

| Client Sample Number | Lab Sample Number | Date Collected | Matrix | Date Prepared | Date Analyzed | QC Batch ID |
|---|---|---|---|---|---|---|
| **MGS B1 (I,II,III)** | **05-07-0218-16** | **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 | 7.23 | 0.13 | 1.37 | | Nickel | 8.53 | 0.13 | 1.37 | |
| Copper | 6.49 | 0.13 | 1.37 | | Zinc | 24.6 | 1.3 | 1.37 | |

| Client Sample Number | Lab Sample Number | Date Collected | Matrix | Date Prepared | Date Analyzed | QC Batch ID |
|---|---|---|---|---|---|---|
| **MGS B2 (I,II,III)** | **05-07-0218-17** | **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 | 6.31 | 0.13 | 1.388 | | Nickel | 7.32 | 0.13 | 1.388 | |
| Copper | 5.54 | 0.13 | 1.388 | | Zinc | 22.0 | 1.3 | 1.388 | |

| Client Sample Number | Lab Sample Number | Date Collected | Matrix | Date Prepared | Date Analyzed | QC Batch ID |
|---|---|---|---|---|---|---|
| **MGS B3 (I,II,III)** | **05-07-0218-18** | **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 | 0.14 | 1.408 | | Nickel | 8.34 | 0.14 | 1.408 | |
| Copper | 6.91 | 0.14 | 1.408 | | Zinc | 25.4 | 1.4 | 1.408 | |

| Client Sample Number | Lab Sample Number | Date Collected | Matrix | Date Prepared | Date Analyzed | QC Batch ID |
|---|---|---|---|---|---|---|
| **MGS B4 (I,II,III)** | **05-07-0218-19** | **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 | 7.78 | 0.14 | 1.408 | | Nickel | 7.53 | 0.14 | 1.408 | |
| Copper | 5.31 | 0.14 | 1.408 | | Zinc | 21.1 | 1.4 | 1.408 | |

| Client Sample Number | Lab Sample Number | Date Collected | Matrix | Date Prepared | Date Analyzed | QC Batch ID |
|---|---|---|---|---|---|---|
| **MGS B5 (I,II,III)** | **05-07-0218-20** | **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 | 8.15 | 0.13 | 1.388 | | Nickel | 8.51 | 0.13 | 1.388 | |
| Copper | 6.77 | 0.13 | 1.388 | | Zinc | 26.3 | 1.3 | 1.388 | |

| 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
3000 Redhill Avenue
Costa Mesa, CA 92626-4524

Date Received: 07/06/05
Work Order No: 05-07-0218
Preparation: N/A
Method: EPA 160.3

Project: MGS 05204A

Page 1 of 1

| Client Sample Number | Lab Sample Number | Date Collected | Matrix | Date Prepared | Date Analyzed | QC Batch ID |
|---|---|---|---|---|---|---|
| MGS B1 (I,II,III) | 05-07-0218-16 | 06/28/05 | Solid | N/A | 07/07/05 | 50707TSD2 |

| Parameter | Result | RL | DF | Qual | Units |
|---|---|---|---|---|---|
| Solids, Total | 72.8 | 0.1 | 1 | | % |

| Client Sample Number | Lab Sample Number | Date Collected | Matrix | Date Prepared | Date Analyzed | QC Batch ID |
|---|---|---|---|---|---|---|
| MGS B2 (I,II,III) | 05-07-0218-17 | 06/28/05 | Solid | N/A | 07/07/05 | 50707TSD2 |

| Parameter | Result | RL | DF | Qual | Units |
|---|---|---|---|---|---|
| Solids, Total | 72.2 | 0.1 | 1 | | % |

| Client Sample Number | Lab Sample Number | Date Collected | Matrix | Date Prepared | Date Analyzed | QC Batch ID |
|---|---|---|---|---|---|---|
| MGS B3 (I,II,III) | 05-07-0218-18 | 06/28/05 | Solid | N/A | 07/07/05 | 50707TSD2 |

| Parameter | Result | RL | DF | Qual | Units |
|---|---|---|---|---|---|
| Solids, Total | 70.9 | 0.1 | 1 | | % |

| Client Sample Number | Lab Sample Number | Date Collected | Matrix | Date Prepared | Date Analyzed | QC Batch ID |
|---|---|---|---|---|---|---|
| MGS B4 (I,II,III) | 05-07-0218-19 | 06/28/05 | Solid | N/A | 07/07/05 | 50707TSD2 |

| Parameter | Result | RL | DF | Qual | Units |
|---|---|---|---|---|---|
| Solids, Total | 71.1 | 0.1 | 1 | | % |

| Client Sample Number | Lab Sample Number | Date Collected | Matrix | Date Prepared | Date Analyzed | QC Batch ID |
|---|---|---|---|---|---|---|
| MGS B5 (I,II,III) | 05-07-0218-20 | 06/28/05 | Solid | N/A | 07/07/05 | 50707TSD2 |

| Parameter | Result | RL | DF | Qual | Units |
|---|---|---|---|---|---|
| Solids, Total | 72.4 | 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: 05-07-0218 |
| Costa Mesa, CA 92626-4524 | Preparation: EPA 3050B |
| | Method: EPA 6020 |

Project MGS 05204A

| Quality Control Sample ID | Matrix | Instrument | Date Prepared | Date Analyzed | MS/MSD Batch Number |
|---|---|---|---|---|---|
| 05-07-0215-19 | 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

**Calscience Environmental Laboratories, Inc.**

## Quality Control - Duplicate

nelac

| | | |
|---|---|---|
| MBC Applied Environmental Sciences | Date Received: | 07/06/05 |
| 3000 Redhill Avenue | Work Order No: | 05-07-0218 |
| Costa Mesa, CA 92626-4524 | Preparation: | N/A |
| | Method: | EPA 160.3 |

Project: MGS 05204A

| Quality Control Sample ID | Matrix | Instrument | Date Prepared: | Date Analyzed: | Duplicate Batch Number |
|---|---|---|---|---|---|
| **MGS B5 (I,II,III)** | **Solid** | **N/A** | **N/A** | **07/07/05** | **50707TSD2** |

| Parameter | Sample Conc | DUP Conc | RPD | RPD CL | Qualifiers |
|---|---|---|---|---|---|
| Solids, Total | 72.4 | 71.8 | 1 | 0-25 | |

RPD - Relative Percent Difference , CL - Control Limit

Calscience Environmental Laboratories, Inc.

# Quality Control - Laboratory Control Sample

nelac

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

| | |
|---|---|
| Date Received: | N/A |
| Work Order No: | 05-07-0218 |
| Preparation: | EPA 3050B |
| Method: | EPA 6020 |

Project: MGS 05204A

| 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

Calscience Environmental Laboratories, Inc.

## Glossary of Terms and Qualifiers

Work Order Number: 05-07-0218

| 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 - 2005. Mandalay Generating Station NPDES, 2005.**

| | | Year | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metal | Station | 1990 | 1991 | 1992 | 1993 | 1994 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | Mean |
| Chromium | B1 | 9.7 | 25.3 | 7.2 | 8.9 | 9.6 | 8.8 | 7.0 | 11 | 11 | 11 | 12 | 8.7 | 8.3 | 7.23 | 10 |
| ERL = 81 | B2 | 15.6 | 37.2 | 7.8 | 7.4 | 9.6 | 8.7 | 7.2 | 7.5 | 10 | 8.9 | 12 | 9.6 | 8.6 | 6.31 | 11 |
| | B3 | 8.7 | 23.4 | 10.1 | 9.3 | 12 | 11 | 7.2 | 9.1 | 9.9 | 11 | 13 | 7.7 | 8.6 | 7.17 | 11 |
| | B4 | 9.3 | 14.3 | 10.0 | 8.1 | 12 | 9.2 | - | 7.9 | 9.6 | 13 | 11 | 7.0 | 7.5 | 7.78 | 10 |
| | B5 | 11.3 | 24.6 | 8.8 | 8.4 | 8.4 | 9.2 | - | 13 | 13 | 8.3 | 13 | - | 10 | 8.15 | 11 |
| Copper | B1 | 4.4 | 20.0 | 4.0 | 5.3 | 5.6 | 3.7 | 6.1 | 7.0 | 4.6 | 2.5 | 4.5 | 2.8 | 2.9 | 6.49 | 5.7 |
| ERL = 34 | B2 | 5.8 | 24.4 | 3.6 | 4.1 | 7.1 | 2.7 | 4.1 | 3.8 | 4.3 | 2.3 | 4.7 | 3.7 | 3.3 | 5.54 | 5.7 |
| | B3 | 2.6 | 14.8 | 5.1 | 9.0 | 8.4 | 5.3 | 4.2 | 5.3 | 5.3 | 2.6 | 5.5 | 3.1 | 2.9 | 6.91 | 5.8 |
| | B4 | 2.3 | 8.2 | 4.2 | 3.9 | 4.9 | 3.3 | - | 3.7 | 3.7 | 2.8 | 4.5 | ND | 2.8 | 5.31 | 3.8 |
| | B5 | 4.3 | 15.9 | 4.6 | 5.1 | 3.0 | 1.7 | - | 8.5 | 6.4 | 2.6 | 6.4 | - | 6.0 | 6.77 | 5.9 |
| Nickel | B1 | 6.6 | 14.7 | 6.0 | 7.9 | 7.1 | 7.8 | 4.3 | 9.7 | 8.5 | 6.7 | 8.9 | 6.2 | 6.5 | 8.53 | 7.8 |
| ERL = 21 | B2 | 10.3 | 16.7 | 6.2 | 5.9 | 8.2 | 6.6 | 4.2 | 6.3 | 7.8 | 6.3 | 9.0 | 6.2 | 6.8 | 7.32 | 7.7 |
| | B3 | 6.2 | 9.5 | 8.1 | 9.3 | 9.2 | 10 | 4.1 | 8.8 | 8.7 | 6.7 | 10.0 | 6.2 | 6.8 | 8.34 | 8.0 |
| | B4 | 6.3 | 9.1 | 6.7 | 6.3 | 6.5 | 7.1 | - | 6.5 | 7.0 | 8.0 | 8.9 | 5.1 | 6.3 | 7.53 | 7.0 |
| | B5 | 6.7 | 13.8 | 6.4 | 7.2 | 6.5 | 6.3 | - | 12.0 | 8.5 | 6.0 | 9.2 | - | 8.1 | 8.51 | 8.3 |
| Zinc | B1 | 17 | 14.7 | 15.4 | 18 | 22 | 27 | 19 | 6.4 | 23 | 21 | 21 | 15 | 14 | 24.6 | 18 |
| ERL = 150 | B2 | 27 | 15.4 | 16.2 | 16 | 25 | 23 | 14 | 16 | 22 | 18 | 19 | 15 | 16 | 22.0 | 19 |
| | B3 | 17 | 17.2 | 20.0 | 29 | 31 | 34 | 14 | 24 | 24 | 20 | 23 | 15 | 13 | 25.4 | 22 |
| | B4 | 17 | 16.4 | 19.0 | 18 | 20 | 24 | - | 17 | 20 | 23 | 19 | 13 | 13 | 21.1 | 19 |
| | B5 | 23 | 24.6 | 17.3 | 20 | 13 | 18 | - | 34 | 28 | 18 | 26 | - | 25 | 26.3 | 23 |
| Percent | B1 | 1.9 | 6.3 | 1.0 | 1.3 | 6.9 | 12.8 | 6.5 | 5.5 | 7.9 | 5.2 | 3.3 | 5.0 | 3.1 | 11.85 | 5.6 |
| Fines | B2 | 2.5 | 4.6 | 1.2 | 1.1 | 4.8 | 4.5 | 1.8 | 5.8 | 6.6 | 4.0 | 5.0 | 3.4 | 2.9 | 10.13 | 4.2 |
| | B3 | 3.0 | 9.5 | 1.4 | 5.5 | 34.5 | 30.3 | 6.9 | 4.4 | 9.9 | 3.8 | 15.6 | 6.3 | 3.4 | 8.91 | 10.2 |
| | B4 | 2.7 | 4.3 | 1.4 | 0.5 | 5.4 | 6.4 | - | 3.2 | 5.8 | 3.1 | 5.4 | 4.0 | 3.6 | 5.82 | 4.0 |
| | B5 | 9.3 | 16.4 | 7.9 | 9.1 | 2.4 | 3.8 | - | 23.7 | 16.5 | 14.8 | 24.8 | - | 7.2 | 16.73 | 12.7 |

ERL = Effects Range Low
- = not required
ND = below the detection limit (for calcuations ND = 0)

# APPENDIX F

## Mussel tissue chemistry by station

Appendix F-1. Mussel chemistry by station. Mandalay 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:** *25145d*

| | | | | | | |
|---|---|---|---|---|---|---|
| **CRG ID#:** | *31980* | **Sample Description:** | MGS-I | **Date Sampled:** | 29-Sep-05 | 12:00 |
| **Replicate #:** | R1 | | 05-10-0254 | **Date Received:** | 10-Oct-05 | |
| **Batch ID:** | 25145d-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 | 4.6 | µg/wet g | 0.025 | 0.05 | 1 | NA |
| Copper (Cu) | NA | EPA 6020m | 13.6 | µg/wet g | 0.025 | 0.05 | 1 | NA |
| Nickel (Ni) | NA | EPA 6020m | 2.91 | µg/wet g | 0.025 | 0.05 | 1 | NA |
| Zinc (Zn) | NA | EPA 6020m | 80.5 | 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
31980 R1

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:** *25145d*

| | | | | | |
|---|---|---|---|---|---|
| **CRG ID#:** | *31980* | **Sample Description:** | MGS-I 05-10-0254 | **Date Sampled:** | 29-Sep-05 12:00 |
| **Replicate #:** | R2 | | | **Date Received:** | 10-Oct-05 |
| **Batch ID:** | 25145d-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 | 4.12 | µg/wet g | 0.025 | 0.05 | 1 | NA |
| Copper (Cu) | NA | EPA 6020m | 13.6 | µg/wet g | 0.025 | 0.05 | 1 | NA |
| Nickel (Ni) | NA | EPA 6020m | 2.98 | µg/wet g | 0.025 | 0.05 | 1 | NA |
| Zinc (Zn) | NA | EPA 6020m | 83.1 | 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.

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31980 R2

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# Trace Metals

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

| | | | | | |
|---|---|---|---|---|---|
| **CRG ID#:** | *31981* | **Sample Description:** | MGS-II 05-10-0254 | **Date Sampled:** | 29-Sep-05 12:00 |
| **Replicate #:** | R1 | | | **Date Received:** | 10-Oct-05 |
| **Batch ID:** | 25145d-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 | 2.91 | µg/wet g | 0.025 | 0.05 | 1 | NA |
| Copper (Cu) | NA | EPA 6020m | 6.02 | µg/wet g | 0.025 | 0.05 | 1 | NA |
| Nickel (Ni) | NA | EPA 6020m | 1.39 | µg/wet g | 0.025 | 0.05 | 1 | NA |
| Zinc (Zn) | NA | EPA 6020m | 64.8 | 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.**

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**31981 R1**

Appendix F-1. (Cont.).


**CRG Marine Laboratories, Inc.**

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## Trace Metals

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

| | | | | | |
|---|---|---|---|---|---|
| **CRG ID#:** | *31982* | **Sample Description:** | MGS-III 05-10-0254 | **Date Sampled:** | 29-Sep-05 12:00 |
| **Replicate #:** | R1 | | | **Date Received:** | 10-Oct-05 |
| **Batch ID:** | 25145d-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 | 2.46 | µg/wet g | 0.025 | 0.05 | 1 | NA |
| Copper (Cu) | NA | EPA 6020m | 4.93 | µg/wet g | 0.025 | 0.05 | 1 | NA |
| Nickel (Ni) | NA | EPA 6020m | 0.93 | µg/wet g | 0.025 | 0.05 | 1 | NA |
| Zinc (Zn) | NA | EPA 6020m | 37 | 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.

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31982 R1

Appendix F-1. (Cont.).


# CRG Marine Laboratories, Inc.

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## General Chemistry

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

**CRG ID#:** *31980*
**Replicate #:** R1

**Sample Description:** MGS-I 05-10-0254
**Matrix:** Tissue

**Date Sampled:** 29-Sep-05 12:00
**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 | 15.3 | 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

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31980 R1

**CRG Marine Laboratories, Inc.**

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## General Chemistry

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

**CRG ID#:** *31980*
**Replicate #:** R2

**Sample Description:** MGS-I 05-10-0254
**Matrix:** Tissue

**Date Sampled:** 29-Sep-05 12:00
**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 | 15.5 | 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

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31980 R2

Appendix F-1. (Cont.).


# CRG Marine Laboratories, Inc.

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## General Chemistry

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

**CRG ID#:** *31981*
**Replicate #:** R1

**Sample Description:** MGS-II 05-10-0254
**Matrix:** Tissue

**Date Sampled:** 29-Sep-05 12:00
**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 | 19.2 | 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
31981 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:** *25145d*

**CRG ID#:** *31982*
**Replicate #:** R1

**Sample Description:** MGS-III 05-10-0254
**Matrix:** Tissue

**Date Sampled:** 29-Sep-05 12:00
**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 | 20.4 | 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
31982 R1

Appendix F-1. (Cont.).

CRG Marine Laboratories, Inc.
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# Trace Metals

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

**CRG ID#:** 31979
**Replicate #:** B1
**Batch ID:** 25145d-12121
**Instrument:** ICPMS #1 HP 4500

**Sample Description:** QAQC 05-10-0254 Procedural Blank
**Matrix:** DI Water
**Analyst:** P. Hershelman

**Date Sampled:**
**Date Received:**
**Date Processed:** 01-Nov-05
**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
31979 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: *25145d***

**CRG ID#:** *31979*
**Replicate #:** B1

**Sample Description:** QAQC 05-10-0254 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**
**31979 B1**

Appendix F-1. (Cont.). Ormond Beach 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:** *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 |

# Donor 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
31976 R1

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 | Date Sampled: | 28-Jun-05 | 15:00 |
| Replicate #: | R2 | | 05-10-0253 | 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.**

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## Trace Metals

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

**CRG ID#:** *31977*
**Replicate #:** R1
**Batch ID:** 25145c-12121
**Instrument:** ICPMS #1 HP 4500

**Sample Description:** OBGS-II 05-10-0253
**Matrix:** Tissue
**Analyst:** P. Hershelman

**Date Sampled:** 28-Jun-05 15:00
**Date Received:** 10-Oct-05
**Date Processed:** 01-Nov-05
**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
**Replicate #:** R1
**Batch ID:** 25145c-12121
**Instrument:** ICPMS #1 HP 4500

**Sample Description:** OBGS-III 05-10-0253
**Matrix:** Tissue
**Analyst:** P. Hershelman

**Date Sampled:** 28-Jun-05 15:00
**Date Received:** 10-Oct-05
**Date Processed:** 01-Nov-05
**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.

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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

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31976 R1

Appendix F-1. (Cont.).

**CRG Marine Laboratories, Inc.**

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## 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

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#:** *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**

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.). 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.

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30193 R1

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## Trace Metals

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

**CRG ID#:** *30194*
**Replicate #:** R1
**Batch ID:** 25145-12078
**Instrument:** ICPMS #1 HP 4500

**Sample Description:** RGS HBP - II 05-08-1370
**Matrix:** Tissue
**Analyst:** P. Hershelman

**Date Sampled:** 15-Jul-05 09:05
**Date Received:** 23-Aug-05
**Date Processed:** 06-Sep-05
**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.**

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**30194 R1**

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## 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.**

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**30195 R1**

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## 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.**

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**CRG Marine Laboratories, Inc.**

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## General Chemistry

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

| | | | | | | |
|---|---|---|---|---|---|---|
| **CRG ID#:** | ***30194*** | **Sample Description:** | RGS HBP - II<br>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.**
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## 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). Mandalay 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 |
| Mussel Mooring | | | | | | | | | | | | | | | | | | | | |
| 2005 | 4.6 | 2.91 | 2.46 | 3.3 | 1.1 | 13.6 | 6.02 | 4.93 | 8.2 | 4.7 | 2.98 | 1.39 | 0.93 | 1.77 | 1.08 | 83.1 | 64.8 | 37 | 62 | 23.2 |
| 2004[1] | ND | ND | ND | - | - | 4.9 | 6.3 | 6.0 | 5.7 | 0.7 | ND | ND | ND | - | - | 54 | 58 | 55 | 56 | 2.1 |
| 2003[2] | ND | ND | ND | - | - | 1.1 | 1.2 | 1.0 | 1.1 | 0.1 | ND | ND | ND | - | - | 13 | 18 | 13 | 15 | 2.9 |
| 2002[2] | ND | ND | ND | - | - | 6.6 | 6.4 | 7.1 | 6.7 | 0.4 | ND | ND | ND | - | - | 100 | 97 | 110 | 102 | 6.8 |
| 2001[2] | ND | ND | ND | - | - | 12 | 13 | 7.0 | 10.7 | 3.2 | ND | ND | ND | - | - | 130 | 260 | 140 | 177 | 72.3 |
| Donor Site | | | | | | | | | | | | | | | | | | | | |
| 2005 | 3.23 | 3.23 | 5.06 | 3.8 | 1.1 | 8.54 | 12.8 | 12.4 | 11.2 | 2.4 | 7.55 | 3.49 | 10.6 | 7.2 | 3.6 | 65 | 95.6 | 86.1 | 82 | 15.7 |
| 2004* | NS | NS | NS | - | - | NS | NS | NS | - | - | NS | NS | NS | - | - | NS | NS | NS | - | - |
| 2003 | ND | ND | ND | - | - | 1.3 | 1.2 | 1.1 | 1.2 | 0.1 | ND | ND | ND | - | - | 11 | 11 | 10 | 11 | 0.6 |
| 2002 | ND | ND | ND | - | - | 16 | 20 | 40 | 25 | 12.9 | ND | ND | ND | - | - | 87 | 92 | 120 | 100 | 17.8 |
| 2001 | ND | ND | ND | - | - | 13 | 16 | 16 | 15 | 1.7 | ND | ND | ND | - | - | 270 | 170 | 250 | 230 | 52.9 |

ND = Below the detection limit (for calculations ND = 0)
NS = Not required
1 = Resident mussels
2 = Transplanated mussels
* = Transplant mussel source not required

# APPENDIX G

## Infauna data by station

**Appendix G-1. Infaunal master species list. Mandalay Generating Station NPDES, 2005.**

PHYLUM (Phy)
- Subphylum or Class
  - Species

NEMERTEA (NE)
- Anopla
  - *Carinoma mutabilis*
  - Lineidae
- Enopla
  - *Amphiporus* sp
  - *Paranemertes californica*[1]
  - *Tetrastemma candidum*
  - *Zygonemertes virescens*

NEMATODA (NT)
- Nematoda

MOLLUSCA (MO)
- Bivalvia
  - *Donax gouldii*
  - *Macoma* sp
  - *Mactromeris catilliformis*[2]
  - *Siliqua lucida*
  - *Tellina modesta*

ANNELIDA (AN)
- Polychaeta
  - *Ampharete labrops*
  - *Apoprionospio pygmaea*
  - *Aricidea (Aedicira) pacifica*
  - *Armandia brevis*[3]
  - *Chone* sp
  - *Chone* sp SD1 Pt. Loma 1997
  - *Dispio unicata*
  - *Glycera macrobranchia*[4]
  - *Glycinde armigera*
  - *Goniadia littorea*
  - *Goniadia maculata*
  - *Hesionella mccullochae*
  - *Magelona pitelkai*
  - *Mediomastus acutus*
  - *Mediomastus ambiseta*[5]
  - *Nephtys caecoides*
  - *Nephtys cornuta*
  - *Onuphis* sp I Pt Loma 1983
  - *Phyllodoce hartmanae*

PHYLUM
- Subphylum or Class
  - Species

ANNELIDA (AN) Cont
- Polychaeta (cont)
  - *Prionospio (Minuspio) lighti*
  - *Scoloplos armiger* Cmplx[6]
  - *Spiochaetopterus costarum*
  - *Spiophanes berkeleyorum*
  - *Spiophanes bombyx*
  - *Spiophanes duplex*
  - Syllidae
  - *Syllis (Typosyllis) farallonensis*

ARTHROPODA (AR)
- Ostracoda
  - *Euphilomedes longiseta*
- Copepoda
  - Harpacticoida
- Malacostraca
  - *Americhelidium shoemakeri*[7]
  - *Anchicolurus occidentalis*
  - *Campylaspis* sp C Myers & Benedict 1974
  - *Diastylopsis tenuis*
  - *Edotia sublittoralis*
  - Gammaridea
  - *Gibberosus myersi*
  - *Lamprops carinatus*
  - *Leptocuma forsmani*
  - *Listriella melanica*
  - *Neomysis kadiakensis*
  - *Photis macinerneyi*
  - *Rhepoxynius abronius*
  - *Rhepoxynius menziesi*[8]
  - *Rhepoxynius* sp A SCAMIT 1987
  - *Uromunna ubiquita*[9]

ECHINODERMATA (EC)
- Ophiuroidea
  - Ophiuroidea
- Echinoidea
  - *Dendraster excentricus*

PHORONA (PR)
- *Phoronis* sp

The following footnotes indicate names used in previous surveys:

1 *Paranemertes* sp A of SCAMIT
2 *Spisula catilliformis*
3 *Armandia bioculata*
4 *Glycera convoluta*
5 *Mediomastus* spp (in part)
6 *Scoloplos "armiger", S. armiger*
7 *Synchelidium shoemakeri*
8 *Paraphoxus epistomus, Rhepoxynius epistomus*
9 *Munna ubiquita*

**Appendix G-2. Infauna results by station. Mandalay Generating Station NPDES, 2005.**

| Phylum | Species | Station B1 | B2 | B3 | B4 | B5 | Total | Percent Total |
|---|---|---|---|---|---|---|---|---|
| AN | *Apoprionospio pygmaea* | 70 | 49 | 405 | 99 | 121 | 744 | 43.11 |
| AR | *Diastylopsis tenuis* | 72 | 277 | 60 | 13 | 2 | 424 | 24.57 |
| AN | *Spiophanes bombyx* | 7 | 23 | 18 | 6 | 22 | 76 | 4.40 |
| AN | *Spiophanes duplex* | 2 | 1 | 34 | - | 33 | 70 | 4.06 |
| AR | *Photis macinerneyi* | 13 | 17 | 25 | 1 | 2 | 58 | 3.36 |
| AN | *Armandia brevis* | 2 | 1 | 7 | 32 | 4 | 46 | 2.67 |
| AR | *Rhepoxynius menziesi* | 4 | 19 | 2 | 11 | - | 36 | 2.09 |
| AR | *Anchicolurus occidentalis* | 10 | 12 | 7 | 6 | - | 35 | 2.03 |
| AN | *Onuphis* sp 1 Pt. Loma 1983 | 2 | 3 | 11 | 1 | 7 | 24 | 1.39 |
| AN | *Syllis (Typosyllis) farallonensis* | 6 | 4 | - | 8 | - | 18 | 1.04 |
| AR | *Edotia sublittoralis* | 4 | - | 14 | - | - | 18 | 1.04 |
| AN | *Dispio uncinata* | 3 | - | 4 | 2 | 3 | 12 | 0.70 |
| MO | *Siliqua lucida* | 1 | 5 | - | 3 | 3 | 12 | 0.70 |
| AN | *Goniada littorea* | 6 | 3 | 1 | 1 | - | 11 | 0.64 |
| NE | *Carinoma mutabilis* | 3 | 3 | 1 | 4 | - | 11 | 0.64 |
| AN | *Chone* sp SD1 Pt. Loma 1997 | 5 | 3 | 1 | - | 1 | 10 | 0.58 |
| NE | Lineidae | 3 | 5 | 2 | - | - | 10 | 0.58 |
| NE | *Paranemertes californica* | 4 | 3 | 1 | - | 2 | 10 | 0.58 |
| AR | *Lamprops carinatus* | 1 | 6 | 2 | - | - | 9 | 0.52 |
| AN | *Glycera macrobranchia* | 1 | 1 | - | 2 | 2 | 6 | 0.35 |
| AN | *Mediomastus acutus* | - | 2 | 2 | 2 | - | 6 | 0.35 |
| AR | *Euphilomedes longiseta* | - | 2 | - | 4 | - | 6 | 0.35 |
| NT | Nematoda | - | - | - | 5 | 1 | 6 | 0.35 |
| AN | *Mediomastus ambiseta* | - | 3 | - | - | 2 | 5 | 0.29 |
| AN | *Scoloplos armiger* Cmplx | - | 1 | - | 3 | - | 4 | 0.23 |
| AR | *Rhepoxynius* sp A SCAMIT 1987 | 3 | - | 1 | - | - | 4 | 0.23 |
| NE | *Tetrastemma candidum* | - | 2 | 1 | - | 1 | 4 | 0.23 |
| AN | *Hesionella mccullochae* | - | - | - | 3 | - | 3 | 0.17 |
| AN | *Magelona pitelkai* | - | - | 2 | 1 | - | 3 | 0.17 |
| AN | *Phyllodoce hartmanae* | - | - | 1 | - | 2 | 3 | 0.17 |
| AN | *Spiophanes berkeleyorum* | - | - | - | - | 3 | 3 | 0.17 |
| EC | *Dendraster excentricus* | - | - | 1 | 2 | - | 3 | 0.17 |
| MO | *Tellina modesta* | 1 | 2 | - | - | - | 3 | 0.17 |
| AN | *Glycinde armigera* | - | 1 | 1 | - | - | 2 | 0.12 |
| AN | *Nephtys caecoides* | - | 1 | - | 1 | - | 2 | 0.12 |
| AR | *Americhelidium shoemakeri* | 1 | - | - | 1 | - | 2 | 0.12 |
| AR | *Gibberosus myersi* | 1 | - | - | 1 | - | 2 | 0.12 |
| AR | *Leptocuma forsmani* | 1 | 1 | - | - | - | 2 | 0.12 |
| PR | *Phoronis* sp | 1 | 1 | - | - | - | 2 | 0.12 |
| AN | *Ampharete labrops* | 1 | - | - | - | - | 1 | 0.06 |
| AN | *Aricidea (Aedicira) pacifica* | 1 | - | - | - | - | 1 | 0.06 |
| AN | *Chone* sp | - | - | 1 | - | - | 1 | 0.06 |
| AN | *Goniada maculata* | - | - | - | - | 1 | 1 | 0.06 |
| AN | *Nephtys cornuta* | - | - | - | - | 1 | 1 | 0.06 |
| AN | *Prionospio (Minuspio) lighti* | - | - | - | - | 1 | 1 | 0.06 |
| AN | *Spiochaetopterus costarum* | - | - | - | - | 1 | 1 | 0.06 |
| AN | Syllidae | 1 | - | - | - | - | 1 | 0.06 |
| AR | *Campylaspis* sp C Myers & Benedict 1974 | - | - | - | 1 | - | 1 | 0.06 |
| AR | Gammaridea | - | - | 1 | - | - | 1 | 0.06 |
| AR | Harpacticoida | 1 | - | - | - | - | 1 | 0.06 |
| AR | *Listriella melanica* | - | - | - | 1 | - | 1 | 0.06 |
| AR | *Neomysis kadiakensis* | - | 1 | - | - | - | 1 | 0.06 |
| AR | *Rhepoxynius abronius* | - | 1 | - | - | - | 1 | 0.06 |
| AR | *Uromunna ubiquita* | - | 1 | - | - | - | 1 | 0.06 |
| EC | Ophiuroidea | - | 1 | - | - | - | 1 | 0.06 |
| MO | *Donax gouldii* | - | 1 | - | - | - | 1 | 0.06 |
| MO | *Macoma* sp | - | - | - | 1 | - | 1 | 0.06 |
| MO | *Mactromeris catilliformis* | 1 | - | - | - | - | 1 | 0.06 |
| NE | *Amphiporus* sp | 1 | - | - | - | - | 1 | 0.06 |
| NE | *Zygonemertes virescens* | 1 | - | - | - | - | 1 | 0.06 |
| | Number of individuals | 234 | 456 | 606 | 215 | 215 | 1726 | |
| | Number of species | 33 | 33 | 26 | 27 | 21 | 60 | |
| | Diversity (H') | 2.30 | 1.71 | 1.40 | 2.12 | 1.64 | 2.09 | |

**Appendix G-3. Infaunal data by station and replicate. Mandalay Generating Station NPDES, 2005.**

**Station B1**

| Phylum | Species | Replicate B1-I | B1-II | B1-III | B1-IV | Total | Percent Composition | Density No./m² |
|---|---|---|---|---|---|---|---|---|
| AR | *Diastylopsis tenuis* | 6 | 31 | 24 | 11 | 72 | 30.77 | 1800.0 |
| AN | *Apoprionospio pygmaea* | 26 | 14 | 9 | 21 | 70 | 29.91 | 1750.0 |
| AR | *Photis macinerneyi* | 5 | 6 | 2 | - | 13 | 5.56 | 325.0 |
| AR | *Anchicolurus occidentalis* | 1 | 1 | 7 | 1 | 10 | 4.27 | 250.0 |
| AN | *Spiophanes bombyx* | 3 | - | 2 | 2 | 7 | 2.99 | 175.0 |
| AN | *Goniada littorea* | 2 | 2 | 1 | 1 | 6 | 2.56 | 150.0 |
| AN | *Syllis (Typosyllis) farallonensis* | - | 1 | 1 | 4 | 6 | 2.56 | 150.0 |
| AN | *Chone* sp SD1 Pt. Loma 1997 | 2 | - | 1 | 2 | 5 | 2.14 | 125.0 |
| AR | *Edotia sublittoralis* | 3 | 1 | - | - | 4 | 1.71 | 100.0 |
| AR | *Rhepoxynius menziesi* | 4 | - | - | - | 4 | 1.71 | 100.0 |
| NE | *Paranemertes californica* | 1 | - | 2 | 1 | 4 | 1.71 | 100.0 |
| AN | *Dispio uncinata* | - | 2 | - | 1 | 3 | 1.28 | 75.0 |
| AR | *Rhepoxynius* sp A SCAMIT 1987 | 3 | - | - | - | 3 | 1.28 | 75.0 |
| NE | *Carinoma mutabilis* | 1 | 1 | - | 1 | 3 | 1.28 | 75.0 |
| NE | Lineidae | - | 1 | 2 | - | 3 | 1.28 | 75.0 |
| AN | *Armandia brevis* | - | 1 | 1 | - | 2 | 0.85 | 50.0 |
| AN | *Onuphis* sp 1 Pt. Loma 1983 | - | 1 | - | 1 | 2 | 0.85 | 50.0 |
| AN | *Spiophanes duplex* | - | 2 | - | - | 2 | 0.85 | 50.0 |
| AN | *Ampharete labrops* | 1 | - | - | - | 1 | 0.43 | 25.0 |
| AN | *Aricidea (Aedicira) pacifica* | - | - | 1 | - | 1 | 0.43 | 25.0 |
| AN | *Glycera macrobranchia* | - | - | - | 1 | 1 | 0.43 | 25.0 |
| AN | Syllidae | - | - | 1 | - | 1 | 0.43 | 25.0 |
| AR | *Americhelidium shoemakeri* | - | - | - | 1 | 1 | 0.43 | 25.0 |
| AR | *Gibberosus myersi* | - | 1 | - | - | 1 | 0.43 | 25.0 |
| AR | Harpacticoida | - | 1 | - | - | 1 | 0.43 | 25.0 |
| AR | *Lamprops carinatus* | 1 | - | - | - | 1 | 0.43 | 25.0 |
| AR | *Leptocuma forsmani* | - | - | 1 | - | 1 | 0.43 | 25.0 |
| MO | *Mactromeris catilliformis* | 1 | - | - | - | 1 | 0.43 | 25.0 |
| MO | *Siliqua lucida* | - | 1 | - | - | 1 | 0.43 | 25.0 |
| MO | *Tellina modesta* | - | - | 1 | - | 1 | 0.43 | 25.0 |
| NE | *Amphiporus* sp | - | 1 | - | - | 1 | 0.43 | 25.0 |
| NE | *Zygonemertes virescens* | - | 1 | - | - | 1 | 0.43 | 25.0 |
| PR | *Phoronis* sp | 1 | - | - | - | 1 | 0.43 | 25.0 |

**Summary**

| Parameter | Replicate B1-I | B1-II | B1-III | B1-IV | Station Total | Replicate Mean | S.D. |
|---|---|---|---|---|---|---|---|
| Number of individuals | 61 | 69 | 56 | 48 | 234 | 58.5 | 8.8 |
| Number of species | 16 | 18 | 15 | 13 | 33 | 15.5 | 2.1 |
| Diversity (H') | 2.12 | 1.94 | 1.97 | 1.82 | 2.30 | 1.96 | 0.12 |

## Appendix G-3. (Cont.).

### Station B2

| Phylum | Species | Replicate B2-I | B2-II | B2-III | B2-IV | Total | Percent Composition | Density No./m² |
|---|---|---|---|---|---|---|---|---|
| AR | *Diastylopsis tenuis* | 16 | 40 | 87 | 134 | 277 | 60.75 | 6925.0 |
| AN | *Apoprionospio pygmaea* | 11 | 7 | 24 | 7 | 49 | 10.75 | 1225.0 |
| AN | *Spiophanes bombyx* | 3 | 8 | 4 | 8 | 23 | 5.04 | 575.0 |
| AR | *Rhepoxynius menziesi* | 3 | 2 | 8 | 6 | 19 | 4.17 | 475.0 |
| AR | *Photis macinerneyi* | 1 | 1 | 5 | 10 | 17 | 3.73 | 425.0 |
| AR | *Anchicolurus occidentalis* | 6 | 4 | 2 | - | 12 | 2.63 | 300.0 |
| AR | *Lamprops carinatus* | - | - | 2 | 4 | 6 | 1.32 | 150.0 |
| MO | *Siliqua lucida* | 1 | - | - | 4 | 5 | 1.10 | 125.0 |
| NE | Lineidae | 1 | 3 | - | 1 | 5 | 1.10 | 125.0 |
| AN | *Syllis (Typosyllis) farallonensis* | - | 1 | 2 | 1 | 4 | 0.88 | 100.0 |
| AN | *Chone* sp SD1 Pt. Loma 1997 | - | 1 | 1 | 1 | 3 | 0.66 | 75.0 |
| AN | *Goniada littorea* | 2 | - | - | 1 | 3 | 0.66 | 75.0 |
| AN | *Mediomastus ambiseta* | - | - | 3 | - | 3 | 0.66 | 75.0 |
| AN | *Onuphis* sp 1 Pt. Loma 1983 | - | 2 | 1 | - | 3 | 0.66 | 75.0 |
| NE | *Carinoma mutabilis* | 1 | 1 | 1 | - | 3 | 0.66 | 75.0 |
| NE | *Paranemertes californica* | 1 | 1 | - | 1 | 3 | 0.66 | 75.0 |
| AN | *Mediomastus acutus* | - | - | 1 | 1 | 2 | 0.44 | 50.0 |
| AR | *Euphilomedes longiseta* | - | - | - | 2 | 2 | 0.44 | 50.0 |
| MO | *Tellina modesta* | - | 1 | 1 | - | 2 | 0.44 | 50.0 |
| NE | *Tetrastemma candidum* | 1 | - | 1 | - | 2 | 0.44 | 50.0 |
| AN | *Armandia brevis* | - | - | 1 | - | 1 | 0.22 | 25.0 |
| AN | *Glycera macrobranchia* | - | 1 | - | - | 1 | 0.22 | 25.0 |
| AN | *Glycinde armigera* | - | 1 | - | - | 1 | 0.22 | 25.0 |
| AN | *Nephtys caecoides* | - | - | - | 1 | 1 | 0.22 | 25.0 |
| AN | *Scoloplos armiger* Cmplx | - | 1 | - | - | 1 | 0.22 | 25.0 |
| AN | *Spiophanes duplex* | 1 | - | - | - | 1 | 0.22 | 25.0 |
| AR | *Leptocuma forsmani* | - | - | - | 1 | 1 | 0.22 | 25.0 |
| AR | *Neomysis kadiakensis* | - | - | 1 | - | 1 | 0.22 | 25.0 |
| AR | *Rhepoxynius abronius* | - | - | - | 1 | 1 | 0.22 | 25.0 |
| AR | *Uromunna ubiquita* | - | - | - | 1 | 1 | 0.22 | 25.0 |
| EC | Ophiuroidea | - | - | - | 1 | 1 | 0.22 | 25.0 |
| MO | *Donax gouldii* | - | - | - | 1 | 1 | 0.22 | 25.0 |
| PR | *Phoronis* sp | - | - | - | 1 | 1 | 0.22 | 25.0 |

### Summary

| Parameter | Replicate B2-I | B2-II | B2-III | B2-IV | Station Total | Replicate Mean | S.D. |
|---|---|---|---|---|---|---|---|
| Number of individuals | 48 | 75 | 145 | 188 | 456 | 114.0 | 64.1 |
| Number of species | 13 | 16 | 17 | 21 | 33 | 16.8 | 3.3 |
| Diversity (H') | 2.01 | 1.79 | 1.51 | 1.34 | 1.71 | 1.66 | 0.30 |

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* | 139 | 60 | 92 | 114 | 405 | 66.83 | 10125.0 |
| AR | *Diastylopsis tenuis* | 17 | 15 | 16 | 12 | 60 | 9.90 | 1500.0 |
| AN | *Spiophanes duplex* | 10 | 4 | 9 | 11 | 34 | 5.61 | 850.0 |
| AR | *Photis macinerneyi* | 9 | 6 | 5 | 5 | 25 | 4.13 | 625.0 |
| AN | *Spiophanes bombyx* | 5 | - | 7 | 6 | 18 | 2.97 | 450.0 |
| AR | *Edotia sublittoralis* | 5 | 7 | 1 | 1 | 14 | 2.31 | 350.0 |
| AN | *Onuphis* sp 1 Pt. Loma 1983 | 3 | 2 | 6 | - | 11 | 1.82 | 275.0 |
| AN | *Armandia brevis* | - | 3 | 4 | - | 7 | 1.16 | 175.0 |
| AR | *Anchicolurus occidentalis* | 3 | 3 | 1 | - | 7 | 1.16 | 175.0 |
| AN | *Dispio uncinata* | - | - | 3 | 1 | 4 | 0.66 | 100.0 |
| AN | *Magelona pitelkai* | - | 2 | - | - | 2 | 0.33 | 50.0 |
| AN | *Mediomastus acutus* | - | 1 | 1 | - | 2 | 0.33 | 50.0 |
| AR | *Lamprops carinatus* | 1 | 1 | - | - | 2 | 0.33 | 50.0 |
| AR | *Rhepoxynius menziesi* | - | - | - | 2 | 2 | 0.33 | 50.0 |
| NE | Lineidae | - | 1 | 1 | - | 2 | 0.33 | 50.0 |
| AN | *Chone* sp | - | 1 | - | - | 1 | 0.17 | 25.0 |
| AN | *Chone* sp SD1 Pt. Loma 1997 | - | - | - | 1 | 1 | 0.17 | 25.0 |
| AN | *Glycinde armigera* | - | 1 | - | - | 1 | 0.17 | 25.0 |
| AN | *Goniada littorea* | 1 | - | - | - | 1 | 0.17 | 25.0 |
| AN | *Phyllodoce hartmanae* | - | - | - | 1 | 1 | 0.17 | 25.0 |
| AR | Gammaridea | - | 1 | - | - | 1 | 0.17 | 25.0 |
| AR | *Rhepoxynius* sp A SCAMIT 1987 | 1 | - | - | - | 1 | 0.17 | 25.0 |
| EC | *Dendraster excentricus* | - | - | - | 1 | 1 | 0.17 | 25.0 |
| NE | *Carinoma mutabilis* | - | 1 | - | - | 1 | 0.17 | 25.0 |
| NE | *Paranemertes californica* | - | - | 1 | - | 1 | 0.17 | 25.0 |
| NE | *Tetrastemma candidum* | - | - | - | 1 | 1 | 0.17 | 25.0 |

**Summary**

| Parameter | Replicate B3-I | B3-II | B3-III | B3-IV | Station Total | Replicate Mean | S.D. |
|---|---|---|---|---|---|---|---|
| Number of individuals | 194 | 109 | 147 | 156 | 606 | 151.5 | 34.9 |
| Number of species | 11 | 16 | 13 | 12 | 26 | 13.0 | 2.2 |
| Diversity (H') | 1.15 | 1.70 | 1.44 | 1.10 | 1.40 | 1.35 | 0.28 |

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* | 22 | 20 | 20 | 37 | 99 | 46.05 | 2475.0 |
| AN | *Armandia brevis* | 12 | 7 | 5 | 8 | 32 | 14.88 | 800.0 |
| AR | *Diastylopsis tenuis* | 3 | 2 | 4 | 4 | 13 | 6.05 | 325.0 |
| AR | *Rhepoxynius menziesi* | 1 | 1 | 4 | 5 | 11 | 5.12 | 275.0 |
| AN | *Syllis (Typosyllis) farallonensis* | 4 | 1 | 2 | 1 | 8 | 3.72 | 200.0 |
| AN | *Spiophanes bombyx* | 1 | 1 | 3 | 1 | 6 | 2.79 | 150.0 |
| AR | *Anchicolurus occidentalis* | - | 1 | 4 | 1 | 6 | 2.79 | 150.0 |
| NT | Nematoda | 4 | - | - | 1 | 5 | 2.33 | 125.0 |
| AR | *Euphilomedes longiseta* | 2 | - | 2 | - | 4 | 1.86 | 100.0 |
| NE | *Carinoma mutabilis* | 1 | - | - | 3 | 4 | 1.86 | 100.0 |
| AN | *Hesionella mccullochae* | - | 3 | - | - | 3 | 1.40 | 75.0 |
| AN | *Scoloplos armiger* Cmplx | - | 1 | 2 | - | 3 | 1.40 | 75.0 |
| MO | *Siliqua lucida* | - | - | 1 | 2 | 3 | 1.40 | 75.0 |
| AN | *Dispio uncinata* | 1 | - | - | 1 | 2 | 0.93 | 50.0 |
| AN | *Glycera macrobranchia* | 1 | - | 1 | - | 2 | 0.93 | 50.0 |
| AN | *Mediomastus acutus* | - | - | 2 | - | 2 | 0.93 | 50.0 |
| EC | *Dendraster excentricus* | 1 | - | 1 | - | 2 | 0.93 | 50.0 |
| AN | *Goniada littorea* | - | - | - | 1 | 1 | 0.47 | 25.0 |
| AN | *Magelona pitelkai* | - | - | 1 | - | 1 | 0.47 | 25.0 |
| AN | *Nephtys caecoides* | 1 | - | - | - | 1 | 0.47 | 25.0 |
| AN | *Onuphis* sp 1 Pt. Loma 1983 | 1 | - | - | - | 1 | 0.47 | 25.0 |
| AR | *Americhelidium shoemakeri* | - | - | - | 1 | 1 | 0.47 | 25.0 |
| AR | *Campylaspis* sp C Myers & Benedict 1974 | - | - | - | 1 | 1 | 0.47 | 25.0 |
| AR | *Gibberosus myersi* | 1 | - | - | - | 1 | 0.47 | 25.0 |
| AR | *Listriella melanica* | - | 1 | - | - | 1 | 0.47 | 25.0 |
| AR | *Photis macinerneyi* | - | - | 1 | - | 1 | 0.47 | 25.0 |
| MO | *Macoma* sp | - | - | - | 1 | 1 | 0.47 | 25.0 |

Summary

| Parameter | Replicate B4-I | B4-II | B4-III | B4-IV | Station Total | Replicate Mean | S.D. |
|---|---|---|---|---|---|---|---|
| Number of individuals | 56 | 38 | 53 | 68 | 215 | 53.8 | 12.3 |
| Number of species | 15 | 10 | 15 | 15 | 27 | 13.8 | 2.5 |
| Diversity (H') | 2.00 | 1.58 | 2.21 | 1.74 | 2.12 | 1.88 | 0.28 |

## Appendix G-3. (Cont.).

### Station B5

| Phylum | Species | Replicate B5-I | B5-II | B5-III | B5-IV | Total | Percent Composition | Density No./m² |
|---|---|---|---|---|---|---|---|---|
| AN | *Apoprionospio pygmaea* | 17 | 47 | 47 | 10 | 121 | 56.28 | 3025.0 |
| AN | *Spiophanes duplex* | 4 | 10 | 10 | 9 | 33 | 15.35 | 825.0 |
| AN | *Spiophanes bombyx* | 4 | 8 | 4 | 6 | 22 | 10.23 | 550.0 |
| AN | *Onuphis* sp 1 Pt. Loma 1983 | 1 | 2 | 2 | 2 | 7 | 3.26 | 175.0 |
| AN | *Armandia brevis* | 2 | 1 | - | 1 | 4 | 1.86 | 100.0 |
| AN | *Dispio uncinata* | - | - | 3 | - | 3 | 1.40 | 75.0 |
| AN | *Spiophanes berkeleyorum* | 1 | 1 | - | 1 | 3 | 1.40 | 75.0 |
| MO | *Siliqua lucida* | - | - | 1 | 2 | 3 | 1.40 | 75.0 |
| AN | *Glycera macrobranchia* | 1 | - | 1 | - | 2 | 0.93 | 50.0 |
| AN | *Mediomastus ambiseta* | 1 | - | 1 | - | 2 | 0.93 | 50.0 |
| AN | *Phyllodoce hartmanae* | 1 | - | 1 | - | 2 | 0.93 | 50.0 |
| AR | *Diastylopsis tenuis* | - | 1 | - | 1 | 2 | 0.93 | 50.0 |
| AR | *Photis macinerneyi* | 1 | - | - | 1 | 2 | 0.93 | 50.0 |
| NE | *Paranemertes californica* | - | 2 | - | - | 2 | 0.93 | 50.0 |
| AN | *Chone* sp SD1 Pt. Loma 1997 | - | - | - | 1 | 1 | 0.47 | 25.0 |
| AN | *Goniada maculata* | - | - | - | 1 | 1 | 0.47 | 25.0 |
| AN | *Nephtys cornuta* | - | - | 1 | - | 1 | 0.47 | 25.0 |
| AN | *Prionospio (Minuspio) lighti* | 1 | - | - | - | 1 | 0.47 | 25.0 |
| AN | *Spiochaetopterus costarum* | - | - | 1 | - | 1 | 0.47 | 25.0 |
| NE | *Tetrastemma candidum* | - | 1 | - | - | 1 | 0.47 | 25.0 |
| NT | Nematoda | - | - | - | 1 | 1 | 0.47 | 25.0 |

### Summary

| Parameter | Replicate B5-I | B5-II | B5-III | B5-IV | Station Total | Replicate Mean | S.D. |
|---|---|---|---|---|---|---|---|
| Number of individuals | 34 | 73 | 72 | 36 | 215 | 53.8 | 21.7 |
| Number of species | 11 | 9 | 11 | 12 | 21 | 10.8 | 1.3 |
| Diversity (H') | 1.74 | 1.23 | 1.30 | 2.02 | 1.64 | 1.57 | 0.37 |

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

| Sta-Rep | Annelida | Arthropoda | Mollusca | Echinodermata | Misc. | Total |
|---|---|---|---|---|---|---|
| B1-I | 0.265 | <0.001 | 0.044 | - | 0.016 | 0.325 |
| B1-II | 0.197 | <0.001 | 0.023 | - | <0.001 | 0.219 |
| B1-III | 0.374 | <0.001 | <0.001 | - | 0.022 | 0.396 |
| B1-IV | 0.158 | <0.001 | - | - | 0.009 | 0.167 |
| Total | 0.994 | <0.001 | 0.066 | - | 0.047 | 1.107 |
| B2-I | 0.098 | 0.033 | <0.001 | - | <0.001 | 0.132 |
| B2-II | 0.368 | <0.001 | 0.009 | - | 0.002 | 0.379 |
| B2-III | 0.051 | 0.041 | <0.001 | - | <0.001 | 0.092 |
| B2-IV | 0.057 | 0.061 | 0.130 | <0.001 | <0.001 | 0.249 |
| Total | 0.574 | 0.136 | 0.140 | <0.001 | 0.002 | 0.852 |
| B3-I | 0.446 | <0.001 | - | - | - | 0.446 |
| B3-II | 0.156 | 0.064 | - | - | <0.001 | 0.220 |
| B3-III | 0.463 | 0.093 | - | - | <0.001 | 0.556 |
| B3-IV | 0.487 | <0.001 | <0.001 | - | 0.003 | 0.490 |
| Total | 1.553 | 0.156 | <0.001 | - | 0.003 | 1.712 |
| B4-I | 0.196 | 0.011 | - | 1.598 | 0.026 | 1.832 |
| B4-II | <0.001 | 0.033 | - | - | - | 0.033 |
| B4-III | 0.102 | <0.001 | <0.001 | 0.643 | - | 0.744 |
| B4-IV | 0.152 | <0.001 | <0.001 | - | <0.001 | 0.152 |
| Total | 0.450 | 0.043 | <0.001 | 2.241 | 0.026 | 2.760 |
| B5-I | 0.316 | 0.047 | - | - | - | 0.363 |
| B5-II | 0.147 | 0.030 | - | - | 0.034 | 0.211 |
| B5-III | 0.177 | - | <0.001 | - | - | 0.177 |
| B5-IV | 0.228 | <0.001 | <0.001 | - | 0.011 | 0.239 |
| Total | 0.867 | 0.077 | <0.001 | - | 0.045 | 0.989 |
| Grand Total | 4.439 | 0.412 | 0.206 | 2.241 | 0.122 | 7.420 |

Note: - = no animals

## Appendix G-5. Yearly infaunal abundance, 1978 - 2005. Mandalay Generating Station NPDES, 2005.

| | | Year | | | | | | | | | | | | | | | | | | | Percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Phy | Species | 1978 | 1980 | 1986 | 1988 | 1990 | 1991 | 1992 | 1993 | 1994 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | Total | Total |
| AN | *Apoprionospio pygmaea* | 86 | 213 | 17 | 175 | 52 | 490 | 170 | 128 | 203 | 100 | 658 | 28 | 143 | 569 | 354 | 719 | 86 | 744 | 4935 | 22.87 |
| MO | *Donax gouldii* | - | - | - | - | - | - | - | - | - | - | 3064 | - | 2 | - | - | 6 | - | 1 | 3073 | 14.24 |
| AN | *Mediomastus acutus* | 5 | 1 | - | - | - | - | - | 1 | 58 | 35 | 1026 | 28 | 12 | 103 | 83 | 3 | 40 | 6 | 1401 | 6.49 |
| AR | *Diastylopsis tenuis* | 123 | 163 | 75 | 33 | 12 | 9 | 5 | 11 | 88 | 45 | 2 | 51 | 56 | 7 | 19 | - | 4 | 424 | 1127 | 5.22 |
| AR | *Rhepoxynius menziesi* | 17 | 25 | 20 | 61 | 43 | 14 | 18 | 14 | 34 | - | 35 | 270 | 84 | 67 | 71 | 64 | 85 | 36 | 958 | 4.44 |
| AN | *Scoloplos armiger* Cmplx | 61 | 28 | 20 | 111 | 187 | 149 | 55 | 69 | 43 | 71 | 16 | 10 | 10 | 20 | 12 | 18 | 33 | 4 | 917 | 4.25 |
| AN | *Spiophanes bombyx* | 14 | 51 | 92 | 46 | 17 | 2 | 3 | 154 | 60 | 15 | 13 | 8 | 43 | 4 | 2 | - | 12 | 76 | 612 | 2.84 |
| EC | *Dendraster excentricus* | 12 | 1 | 43 | 17 | 87 | 14 | 14 | - | 10 | 103 | 52 | 75 | 34 | 41 | 15 | 7 | 4 | 3 | 532 | 2.46 |
| AN | *Owenia collaris* | 5 | 40 | - | 2 | 10 | 88 | 9 | 44 | 2 | 130 | 8 | 31 | 111 | 5 | 29 | 1 | 1 | - | 516 | 2.39 |
| AR | *Euphilomedes carcharodonta* | - | 1 | 1 | 3 | - | - | - | - | 47 | 333 | - | - | - | - | 2 | - | - | - | 387 | 1.79 |
| MO | *Siliqua lucida* | - | 17 | 9 | 112 | - | 4 | - | - | 82 | 62 | 22 | 31 | 6 | 17 | 11 | - | 1 | 12 | 386 | 1.79 |
| AN | *Chone* sp SD1 Pt. Loma 1997 | - | - | - | - | - | - | - | - | - | - | 14 | 1 | 20 | 7 | 25 | 5 | 290 | 10 | 372 | 1.72 |
| NE | *Carinoma mutabilis* | - | 3 | 16 | 18 | 7 | 18 | 28 | 19 | 25 | 24 | 78 | 17 | 18 | 29 | 28 | 7 | 14 | 11 | 360 | 1.67 |
| AN | *Magelona pitelkai* | 9 | 131 | - | 38 | 13 | 21 | 14 | 24 | 20 | 5 | - | 1 | - | 8 | 6 | 5 | 1 | 3 | 299 | 1.39 |
| MO | *Tellina modesta* | 2 | 18 | 29 | 2 | 4 | - | - | 1 | 11 | 101 | 2 | 19 | 46 | 20 | 8 | 1 | 23 | 3 | 290 | 1.34 |
| AN | *Goniada littorea* | 21 | 26 | 6 | - | 6 | 2 | - | 3 | 6 | 11 | 36 | 74 | 37 | 5 | 9 | - | 4 | 11 | 257 | 1.19 |
| AN | *Pectinaria californiensis* | - | 1 | 9 | 60 | 3 | - | - | - | 4 | 112 | - | 1 | 6 | - | 2 | - | 1 | - | 199 | 0.92 |
| AR | *Americhelidium shoemakeri* | 4 | - | - | 1 | 7 | - | - | - | 8 | 3 | - | 5 | 23 | 68 | 25 | 13 | 18 | 2 | 177 | 0.82 |
| CN | *Zaolutus actius* | - | 4 | - | - | - | - | - | - | - | 99 | 4 | 7 | 40 | 4 | 17 | - | - | - | 175 | 0.81 |
| AN | *Nephtys caecoides* | 6 | 4 | 8 | 5 | 9 | 24 | 8 | 11 | 14 | 3 | 3 | 6 | 11 | 9 | 19 | 21 | 8 | 2 | 171 | 0.79 |
| AR | *Rhepoxynius* sp A SCAMIT 1987 | 2 | 5 | 9 | 12 | 26 | 11 | - | - | 23 | 37 | - | 4 | 11 | 12 | 12 | - | 2 | 4 | 170 | 0.79 |
| AR | *Photis macinerneyi* | - | - | 13 | 45 | - | - | - | - | 4 | 20 | 2 | 5 | 10 | 6 | 1 | - | - | 58 | 164 | 0.76 |
| AN | *Mediomastus* spp | - | 9 | 16 | 17 | 12 | 7 | 4 | - | - | - | 91 | 2 | 1 | 2 | - | - | - | - | 161 | 0.75 |
| MO | *Mactromeris catilliformis* | - | - | - | - | - | - | - | - | - | 12 | - | - | - | 14 | 120 | - | 1 | 1 | 148 | 0.69 |
| AR | *Euphilomedes longiseta* | - | - | - | 2 | 10 | 22 | - | - | - | - | 3 | - | 3 | 5 | 54 | 12 | 12 | 6 | 129 | 0.60 |
| AN | *Magelona sacculata* | 2 | 23 | 47 | 22 | 16 | 4 | - | - | - | - | - | - | - | 2 | 6 | - | - | - | 122 | 0.57 |
| AN | *Spiophanes duplex* | 4 | 17 | - | 11 | - | - | - | 4 | 3 | 1 | 1 | - | 5 | 1 | - | - | - | 70 | 117 | 0.54 |
| AR | *Mandibulophoxus gilesi* | 14 | - | - | - | - | 36 | 15 | - | 4 | 15 | - | - | 3 | - | - | 4 | 23 | - | 114 | 0.53 |
| AN | *Onuphis eremita* | - | - | - | - | 11 | 9 | - | 45 | 1 | 1 | 17 | - | 1 | - | 1 | 19 | - | - | 105 | 0.49 |
| AN | *Armandia brevis* | - | 7 | - | 5 | - | 1 | - | - | 7 | 3 | 6 | 9 | - | 6 | 3 | - | 11 | 46 | 104 | 0.48 |
| AN | *Chone albocincta* | - | - | - | - | 5 | 14 | - | 5 | 9 | 62 | - | - | - | - | 1 | - | - | - | 96 | 0.44 |
| MO | *Solen sicarius* | 2 | - | 9 | 16 | 3 | 5 | 2 | 5 | 3 | 20 | 20 | 3 | 6 | - | - | 1 | - | - | 95 | 0.44 |
| AR | *Isocheles pilosus* | 12 | 1 | - | 75 | 1 | - | - | - | - | 1 | - | - | 2 | 1 | - | - | - | - | 93 | 0.43 |
| NE | Lineidae | - | - | - | 1 | - | - | - | - | - | 9 | 22 | 13 | 5 | 4 | 2 | 1 | 24 | 10 | 91 | 0.42 |
| AN | *Dispio uncinata* | 9 | 20 | 10 | 6 | 2 | - | - | - | 1 | 4 | - | 4 | 9 | 7 | - | 1 | - | 12 | 85 | 0.39 |
| AN | *Mediomastus ambiseta* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 13 | - | 61 | 5 | 79 | 0.37 |
| AR | *Anchicolurus occidentalis* | - | - | - | 2 | - | 3 | - | 1 | 2 | 4 | - | 19 | 4 | 1 | 1 | 1 | 4 | 35 | 77 | 0.36 |
| AR | *Eohaustorius barnardi* | 17 | 12 | 9 | 4 | 1 | - | - | - | 5 | 11 | 1 | 1 | 4 | 7 | 2 | - | - | - | 74 | 0.34 |
| AR | *Edotia sublittoralis* | 1 | 7 | - | 1 | - | - | - | - | 1 | 35 | 1 | - | 2 | - | 3 | - | - | 18 | 69 | 0.32 |
| AN | *Glycera macrobranchia* | 1 | 1 | - | 1 | 13 | 3 | 4 | 3 | 3 | 6 | 4 | 1 | 1 | 4 | 8 | 2 | 6 | 6 | 67 | 0.31 |
| AN | *Ampharete labrops* | 1 | - | 3 | 5 | - | 4 | - | - | 6 | - | 5 | 3 | 6 | 5 | 24 | - | 2 | 1 | 65 | 0.30 |
| NE | Nemertea | 3 | 4 | 3 | 4 | 4 | 1 | - | 10 | 2 | 4 | 16 | - | 1 | - | - | 3 | 2 | - | 57 | 0.26 |
| AN | *Spiochaetopterus costarum* | - | 1 | 1 | 5 | 7 | 2 | - | 12 | 7 | 4 | - | - | 10 | 5 | - | - | 1 | 1 | 56 | 0.26 |
| AR | *Uromunna ubiquita* | - | - | - | 1 | - | - | - | - | - | 33 | 2 | 4 | 1 | 3 | 6 | 1 | 3 | 1 | 55 | 0.25 |
| AR | *Photis* sp | 17 | 30 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 47 | 0.22 |
| NE | *Paranemertes californica* | - | 4 | 1 | 6 | 2 | - | - | - | 4 | 11 | 1 | 1 | 3 | - | 1 | 2 | 1 | 10 | 47 | 0.22 |
| AR | *Eohaustorius sawyeri* | - | - | - | - | 8 | - | - | - | - | - | - | 4 | - | - | 28 | 5 | 1 | - | 46 | 0.21 |
| AR | Calanoida | 6 | 39 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 45 | 0.21 |
| AN | Onuphidae | 1 | - | - | - | 1 | - | 1 | - | 1 | 1 | - | - | 3 | - | 35 | - | - | - | 43 | 0.20 |
| AR | *Jassa slatteryi* | - | - | - | - | - | - | - | - | - | - | - | 38 | - | - | - | 3 | 2 | - | 43 | 0.20 |
| MO | *Macoma nasuta* | - | - | 8 | - | 35 | - | - | - | - | - | - | - | - | - | - | - | - | - | 43 | 0.20 |
| NT | Nematoda | - | - | - | - | 1 | - | 1 | - | 2 | 4 | - | 2 | - | 1 | - | 6 | 15 | 6 | 38 | 0.18 |
| AR | *Leptocuma forsmani* | 1 | - | - | - | - | - | 14 | 3 | 1 | 5 | 1 | 2 | 2 | 2 | - | - | 4 | 2 | 37 | 0.17 |
| AN | *Aricidea (Acmira) catherinae* | - | 7 | 9 | 1 | 5 | 2 | - | - | 3 | 2 | - | - | - | 1 | 3 | - | 3 | - | 36 | 0.17 |
| AN | *Amastigos acutus* | - | 35 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 35 | 0.16 |
| AN | *Onuphis* sp 1 Pt. Loma 1983 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 6 | - | 3 | 24 | 33 | 0.15 |
| MO | *Cooperella subdiaphana* | - | 1 | 1 | 6 | - | - | - | - | - | 7 | 2 | 3 | 2 | 6 | 2 | 1 | 2 | - | 33 | 0.15 |
| AN | *Onuphis* sp | - | - | - | 1 | - | - | - | - | - | 11 | - | - | 15 | 5 | - | - | - | - | 32 | 0.15 |
| AN | *Amaeana occidentalis* | 1 | - | - | - | - | - | 1 | - | - | - | 28 | 1 | - | - | - | - | - | - | 31 | 0.14 |
| AR | *Gibberosus myersi* | 2 | - | 1 | 1 | - | - | - | - | 2 | 8 | - | 3 | 4 | 5 | - | 2 | - | 2 | 30 | 0.14 |
| AR | *Campylaspis* sp C M & B 1974 | - | - | - | - | - | - | - | 1 | 1 | 1 | - | 8 | 12 | 1 | 2 | - | 1 | 1 | 28 | 0.13 |
| MO | *Mysella pedroana* | - | 1 | - | 27 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 28 | 0.13 |
| PR | Phoronidae | - | 2 | - | - | 1 | 1 | - | 2 | 3 | 7 | 1 | - | 5 | 2 | 1 | - | 3 | - | 28 | 0.13 |
| AN | *Neosabellaria cementarium* | - | - | - | - | - | - | - | - | - | - | - | 27 | - | - | - | - | - | - | 27 | 0.13 |
| MO | *Tellina bodegensis* | - | - | 1 | 2 | 2 | - | - | - | 13 | 1 | - | 3 | 1 | 2 | 2 | - | - | - | 27 | 0.13 |

## 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 | Percent Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AN | *Polydora limicola* | - | - | - | - | - | - | - | - | 26 | - | - | - | - | - | - | - | - | - | 26 | 0.12 |
| AN | *Syllis (Typosyllis) farallonensis* | - | - | 1 | - | - | - | - | - | 6 | - | - | - | - | - | - | - | - | 18 | 25 | 0.12 |
| AN | *Polydora* sp | 1 | 1 | 1 | 14 | 1 | 2 | - | 1 | - | - | - | - | - | 3 | - | - | - | - | 24 | 0.11 |
| AN | *Prionospio (Minuspio) lighti* | 1 | 1 | 1 | - | 4 | - | - | - | 5 | 7 | - | - | - | - | - | - | 3 | 1 | 23 | 0.11 |
| AN | *Syllis* spp | - | - | - | 3 | 13 | 5 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | 23 | 0.11 |
| AR | Phoxocephalidae | - | - | - | - | - | 16 | 7 | - | - | - | - | - | - | - | - | - | - | - | 23 | 0.11 |
| MO | *Macoma* sp | - | - | 6 | - | - | - | - | 1 | 2 | - | - | 2 | 7 | - | 1 | 2 | 1 | 1 | 23 | 0.11 |
| AR | *Lepidopa californica* | 2 | 1 | 5 | 3 | - | - | 4 | 3 | - | - | - | 1 | - | - | - | - | 3 | - | 22 | 0.10 |
| AR | *Photis macrotica* | 13 | 9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 22 | 0.10 |
| AN | *Notomastus tenuis* | - | - | - | 1 | - | - | - | - | 2 | - | 10 | 6 | 1 | - | - | - | - | - | 20 | 0.09 |
| AR | *Anoropallene palpida* | - | - | - | - | - | - | - | - | - | 17 | - | 3 | - | - | - | - | - | - | 20 | 0.09 |
| MO | Mactridae | 1 | 5 | 14 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 20 | 0.09 |
| AR | *Hemilamprops californica* | - | - | - | - | - | - | - | - | - | 17 | - | 2 | - | - | - | - | - | - | 19 | 0.09 |
| AN | *Sthenelais verruculosa* | - | 1 | 2 | - | - | 1 | 1 | 2 | - | - | 2 | - | 5 | 2 | 1 | - | - | - | 17 | 0.08 |
| AR | *Lamprops carinatus* | - | - | - | - | - | - | - | - | - | - | - | - | 5 | - | 2 | - | 1 | 9 | 17 | 0.08 |
| AN | *Polydora cornuta* | - | - | 16 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 16 | 0.07 |
| MO | *Macoma secta* | - | 2 | - | 1 | - | 3 | - | - | - | 1 | - | - | 1 | - | - | - | 8 | - | 16 | 0.07 |
| AN | *Hesionella mccullochae* | - | - | - | - | - | - | - | - | - | 1 | 3 | 1 | 5 | 1 | - | - | 1 | 3 | 15 | 0.07 |
| MO | *Mactrotoma californica* | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 13 | - | - | - | - | - | 15 | 0.07 |
| PL | *Stylochoplana* sp | - | - | - | 3 | 2 | - | - | - | - | 7 | 2 | - | 1 | - | - | - | - | - | 15 | 0.07 |
| AN | *Chaetozone setosa* Cmplx | - | - | - | - | 13 | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 14 | 0.06 |
| AR | *Cyclaspis nubila* | - | - | - | - | - | - | - | - | 5 | 7 | - | - | 1 | - | 1 | - | - | - | 14 | 0.06 |
| AR | *Rhepoxynius* sp | 10 | - | - | - | - | - | 4 | - | - | - | - | - | - | - | - | - | - | - | 14 | 0.06 |
| EC | Amphiuridae | - | - | - | - | 2 | - | - | - | 6 | - | - | 3 | - | 3 | - | - | - | - | 14 | 0.06 |
| AN | *Nephtys cornuta* | - | 8 | - | - | - | - | - | - | - | - | 2 | - | - | 1 | - | - | 1 | 1 | 13 | 0.06 |
| MO | *Crepidula naticarum* | - | 4 | 9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 13 | 0.06 |
| PR | *Phoronis* sp | - | 3 | - | 8 | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 13 | 0.06 |
| AN | *Aricidea (Allia) hartleyi* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 12 | - | 12 | 0.06 |
| AN | *Onuphis iridescens* | - | 5 | - | 7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 12 | 0.06 |
| AN | *Spiophanes berkeleyorum* | 2 | - | - | 7 | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 12 | 0.06 |
| AN | *Sthenelais tertiaglabra* | - | - | - | - | - | - | - | - | 2 | 6 | - | 4 | - | - | - | - | - | - | 12 | 0.06 |
| AR | *Balanus pacificus* | - | 4 | 2 | - | - | - | - | - | - | - | - | 2 | - | 4 | - | - | - | - | 12 | 0.06 |
| MO | *Cyclostremella dalli* | - | - | - | - | - | - | - | - | - | 12 | - | - | - | - | - | - | - | - | 12 | 0.06 |
| MO | *Olivella baetica* | 1 | 1 | 1 | 2 | - | - | - | - | - | - | 1 | 1 | - | 2 | 2 | - | 1 | - | 12 | 0.06 |
| NE | *Tubulanus polymorphus* | - | - | 2 | - | - | - | - | - | 4 | - | 1 | - | 1 | 2 | 1 | - | 1 | - | 12 | 0.06 |
| AN | *Carraziella* sp A SCAMIT 1995 | - | - | - | - | - | - | - | - | - | - | - | - | - | 11 | - | - | - | - | 11 | 0.05 |
| AN | *Cirriformia spirabrancha* | - | - | 2 | - | - | - | - | - | 1 | 5 | - | 2 | - | 1 | - | - | - | - | 11 | 0.05 |
| AN | *Dipolydora socialis* | - | - | - | - | - | - | - | - | 11 | - | - | - | - | - | - | - | - | - | 11 | 0.05 |
| AN | *Scolelepis squamata* | - | - | - | - | - | 4 | - | 6 | - | 1 | - | - | - | - | - | - | - | - | 11 | 0.05 |
| AR | *Aoroides* sp | - | - | - | - | - | - | - | - | 4 | - | 1 | 1 | 2 | - | 3 | - | - | - | 11 | 0.05 |
| AR | *Neotrypaea* sp | 1 | 1 | 7 | 1 | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 11 | 0.05 |
| CN | Actiniaria | - | - | - | - | 6 | - | - | - | 5 | - | - | - | - | - | - | - | - | - | 11 | 0.05 |
| MO | *Mysella* sp A SCAMIT 1988 | - | - | - | - | - | - | - | - | - | 11 | - | - | - | - | - | - | - | - | 11 | 0.05 |
| MO | *Rictaxis punctocaelatus* | - | - | 4 | - | - | - | - | - | - | - | 2 | - | 4 | 1 | - | - | - | - | 11 | 0.05 |
| NE | *Tetrastemma* sp | - | - | - | - | - | - | - | - | 3 | 4 | - | 2 | - | - | 2 | - | - | - | 11 | 0.05 |
| AN | *Glycinde armigera* | 3 | 1 | - | - | - | - | - | - | - | - | - | - | - | 3 | - | - | 1 | 2 | 10 | 0.05 |
| AN | *Phyllodoce hartmanae* | - | - | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 10 | 0.05 |
| AR | *Ogyrides* sp A Roney 1978 | 1 | - | 3 | 1 | - | - | - | - | 1 | 1 | - | 2 | 1 | - | - | - | - | - | 10 | 0.05 |
| CN | Anthozoa | - | 2 | 2 | 1 | - | 3 | - | 2 | - | - | - | - | - | - | - | - | - | - | 10 | 0.05 |
| AN | *Aricidea (Aedicira) pacifica* | - | - | - | 1 | - | - | - | - | - | - | 7 | - | - | - | - | - | - | 1 | 9 | 0.04 |
| AN | *Mooreonuphis stigmatis* | - | - | - | - | - | - | - | - | - | - | - | 9 | - | - | - | - | - | - | 9 | 0.04 |
| AN | *Sigalion spinosus* | - | - | 2 | 2 | - | 1 | - | - | 3 | - | - | - | - | 1 | - | - | - | - | 9 | 0.04 |
| CN | Limnactiniidae sp A SCAMIT 1989 | - | - | - | - | 5 | - | - | - | - | 1 | 1 | 1 | - | - | 1 | - | - | - | 9 | 0.04 |
| MO | *Macoma indentata* | - | - | - | - | - | - | - | - | 3 | 2 | - | - | - | 2 | 2 | - | - | - | 9 | 0.04 |
| AN | *Glycinde polygnatha* | - | 8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 8 | 0.04 |
| AN | *Polydora cirrosa* | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 7 | - | - | - | 8 | 0.04 |
| AR | *Aoroides inermis* | - | - | - | - | - | - | - | - | - | - | - | 3 | - | 5 | - | - | - | - | 8 | 0.04 |
| EC | *Leptosynapta* sp | - | 1 | 1 | 2 | - | 1 | - | 3 | - | - | - | - | - | - | - | - | - | - | 8 | 0.04 |
| PL | *Pseudoceros* sp | - | - | - | - | - | - | - | - | 1 | 2 | 1 | - | 1 | - | - | 3 | - | - | 8 | 0.04 |
| MO | *Nassarius perpinguis* | - | 1 | - | - | - | - | - | - | 1 | 2 | - | - | - | 1 | 1 | 1 | - | - | 7 | 0.03 |
| NE | *Cerebratulus californiensis* | - | 2 | - | 1 | 1 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | 7 | 0.03 |
| AN | *Chone* sp | 1 | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | 2 | - | - | 1 | 6 | 0.03 |
| AN | *Lumbrineris californiensis* | - | - | 1 | - | - | - | - | - | 1 | - | - | 2 | 2 | - | - | - | - | - | 6 | 0.03 |
| AN | *Magelona californica* | - | - | - | - | - | - | - | - | - | - | - | - | 6 | - | - | - | - | - | 6 | 0.03 |
| AR | *Eohaustorius sencillus* | - | - | - | - | - | 5 | 1 | - | - | - | - | - | - | - | - | - | - | - | 6 | 0.03 |

## 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 | Percent Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AR | *Metamysidopsis elongata* | 1 | - | 1 | - | 2 | - | - | - | 1 | - | - | - | - | - | - | - | 1 | - | 6 | 0.03 |
| AR | *Pollicipes polymerus* | - | - | 6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 6 | 0.03 |
| CO | Enteropneusta | 1 | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - | - | - | 3 | - | 6 | 0.03 |
| EC | *Amphiodia urtica* | - | - | - | - | 1 | 1 | 3 | 1 | - | - | - | - | - | - | - | - | - | - | 6 | 0.03 |
| NE | *Tetrastemma candidum* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 4 | 6 | 0.03 |
| NE | *Zygonemertes virescens* | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 | - | - | - | 1 | 6 | 0.03 |
| AN | *Heteromastus* sp | - | - | 5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 | 0.02 |
| AN | *Nephtys* sp | - | - | - | 2 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | 5 | 0.02 |
| AN | *Scolotoma tetraura* Cmplx | - | - | - | - | 1 | - | - | - | 2 | 1 | - | - | - | - | - | - | 1 | - | 5 | 0.02 |
| AN | *Spiophanes* sp | - | 1 | - | - | - | - | 1 | 3 | - | - | - | - | - | - | - | - | - | - | 5 | 0.02 |
| AN | *Syllis (Typosyllis)* sp | - | - | - | - | - | - | - | - | - | 5 | - | - | - | - | - | - | - | - | 5 | 0.02 |
| AR | *Blepharipoda occidentalis* | - | - | - | - | - | - | 2 | 2 | 1 | - | - | - | - | - | - | - | - | - | 5 | 0.02 |
| AR | *Cumella californica* | - | 1 | - | - | 1 | - | - | - | - | 3 | - | - | - | - | - | - | - | - | 5 | 0.02 |
| AR | *Cyclaspis* sp C SCAMIT 1986 | - | - | - | - | - | 5 | - | - | - | - | - | - | - | - | - | - | - | - | 5 | 0.02 |
| AR | Gammaridea | 1 | 1 | - | - | - | - | 1 | - | - | - | - | - | 1 | - | - | - | - | 1 | 5 | 0.02 |
| AR | Harpacticoida | - | - | - | - | - | - | - | - | - | - | 3 | - | 1 | - | - | - | - | 1 | 5 | 0.02 |
| AR | *Jassa marmorata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 | - | - | 5 | 0.02 |
| AR | *Rhepoxynius abronius* | - | - | - | - | - | - | - | - | 1 | - | - | - | 3 | - | - | - | - | 1 | 5 | 0.02 |
| CN | *Renilla kollikeri* | - | - | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - | - | 2 | - | - | 5 | 0.02 |
| EC | *Amphiodia* sp | - | - | - | - | - | - | - | - | - | 3 | - | 1 | - | - | - | - | 1 | - | 5 | 0.02 |
| MO | *Modiolus* sp | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 1 | 2 | - | - | - | 5 | 0.02 |
| MO | *Rochefortia tumida* | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - | 1 | - | 2 | - | 5 | 0.02 |
| NE | *Monostylifera* sp C SCAMIT 1995 | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | 2 | - | - | - | 5 | 0.02 |
| NE | *Tetrastemma* sp A SCAMIT 1995 | - | - | - | - | - | - | - | - | - | - | 3 | 1 | - | - | - | - | 1 | - | 5 | 0.02 |
| AN | *Onuphis eremita parva* | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 2 | 1 | - | - | - | 4 | 0.02 |
| AN | Phyllodocidae | - | - | - | - | - | - | - | - | - | 4 | - | - | - | - | - | - | - | - | 4 | 0.02 |
| AN | *Podarkeopsis glabra* | - | - | - | 1 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | 4 | 0.02 |
| AN | *Typosyllis aciculata* | 1 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | 0.02 |
| AR | *Balanus* sp | - | - | - | - | - | - | - | - | 4 | - | - | - | - | - | - | - | - | - | 4 | 0.02 |
| AR | *Cancer gracilis* | - | 2 | 1 | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 4 | 0.02 |
| AR | *Hartmanodes hartmanae* | - | - | 1 | - | 1 | - | 1 | - | - | - | - | - | - | 1 | - | - | - | - | 4 | 0.02 |
| AR | *Lamprops quadriplicatus* | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 3 | - | 4 | 0.02 |
| AR | Mysidacea | 1 | 2 | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 4 | 0.02 |
| AR | *Zeuxo normani* | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | 2 | - | - | - | 4 | 0.02 |
| EC | Ophiuroidea | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | 1 | 1 | 4 | 0.02 |
| MO | *Chione* sp | - | - | 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | 0.02 |
| MO | *Crepidula norrisiarum* | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 3 | - | - | - | 4 | 0.02 |
| MO | *Macoma yoldiformis* | - | - | 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | 0.02 |
| MO | *Modiolus neglectus* | - | 2 | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | 4 | 0.02 |
| MO | *Pandora bilirata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 3 | - | 4 | 0.02 |
| MO | *Rochefortia* sp A SCAMIT 1988 | - | - | - | - | - | - | - | - | - | - | - | - | 4 | - | - | - | - | - | 4 | 0.02 |
| MO | *Yoldia seminuda* | - | - | 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | 0.02 |
| NE | *Tetrastemma nigrifrons* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | - | 4 | 0.02 |
| AN | *Analtides* sp | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 0.01 |
| AN | *Phyllodoce* sp | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 0.01 |
| AN | *Diopatra ornata* | - | - | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - | - | 3 | 0.01 |
| AN | *Eteone fauchaldi* | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 | 1 | - | - | - | 3 | 0.01 |
| AN | *Goniada maculata* | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | 1 | 3 | 0.01 |
| AN | Lumbrineridae | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 2 | - | - | - | - | 3 | 0.01 |
| AN | *Nereis procera* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 2 | - | 3 | 0.01 |
| AN | *Notomastus* sp A SCAMIT 2001 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | - | 3 | 0.01 |
| AN | *Polycirrus* sp A SCAMIT 1995 | - | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - | - | - | 3 | 0.01 |
| AN | *Sabellaria nanella* | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 0.01 |
| AN | *Syllides* sp | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - | - | - | - | - | 3 | 0.01 |
| AR | *Anoplodactylus oculospinus* | - | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 0.01 |
| AR | *Cancer* sp | - | - | - | 1 | - | - | - | - | 1 | - | - | - | - | - | 1 | - | - | - | 3 | 0.01 |
| AR | *Ischyrocerus anguipes* | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 1 | - | - | - | - | 3 | 0.01 |
| AR | *Ischyrocerus pelagops* | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - | - | - | - | - | 3 | 0.01 |
| AR | *Parasterope hulingsi* | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | - | 1 | - | 3 | 0.01 |
| AR | *Photis brevipes* | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | 3 | 0.01 |
| MO | *Neverita reclusiana* | - | - | - | 1 | 1 | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 3 | 0.01 |
| MO | *Nuculana taphria* | - | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 0.01 |
| MO | *Odostomia* sp D MBC 1975 | - | - | 1 | 1 | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 3 | 0.01 |
| MO | *Protothaca staminea* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 | - | 1 | - | 3 | 0.01 |
| NE | *Carinomella lactea* | - | 1 | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 0.01 |

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 | Percent Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NE | *Enopla* sp A SCAMIT 1995 | - | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - | - | - | 3 | 0.01 |
| NE | Nemertea sp B MBC 2004 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | - | 3 | 0.01 |
| PL | Platyhelminthes | 1 | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 0.01 |
| AN | *Aricidea (Acmira) horikoshii* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - | 2 | 0.01 |
| AN | *Eteone cf. alba* | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| AN | *Glycera nana* | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| AN | *Heteropodarke heteromorpha* | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - | 2 | 0.01 |
| AN | *Leitoscoloplos pugettensis* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | - | 2 | 0.01 |
| AN | *Lumbrineris* sp | - | - | 1 | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| AN | *Magelona* sp | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| AN | *Phloides asperus* | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | 2 | 0.01 |
| AN | *Phyllochaetopterus prolifica* | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | 2 | 0.01 |
| AN | *Phyllodoce pettiboneae* | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - | 2 | 0.01 |
| AN | Spionidae | - | 1 | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| AN | *Tenonia priops* | - | 1 | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 2 | 0.01 |
| AR | *Americhelidium* sp | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| AR | *Cerapus tubularis* Cmplx | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 | - | - | - | - | 2 | 0.01 |
| AR | *Monocorophium acherusicum* | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | - | - | 2 | 0.01 |
| AR | Paguridae | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 | - | - | - | - | 2 | 0.01 |
| AR | *Parasterope baresi* | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | 2 | 0.01 |
| AR | *Pinnixa franciscana* | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| AR | *Pinnixa* sp | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| AR | *Rhepoxynius stenodes* | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| AR | *Rhepoxynius variatus* | - | - | - | - | 1 | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 2 | 0.01 |
| EC | Holothuroidea | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| MO | *Crepidula* sp | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| MO | Gastropoda | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - | - | - | 2 | 0.01 |
| MO | *Nassarius fossatus* | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| MO | Pelecypoda | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| MO | *Polygireulima rutila* | - | - | - | - | 1 | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| NE | *Micrura alaskensis* | - | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.01 |
| NE | *Micrura* sp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 2 | 0.01 |
| PR | *Phoronopsis* sp | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | 2 | 0.01 |
| AN | *Aricidea* sp | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 | 0.00 |
| AN | *Axiothella rubrocincta* | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AN | Capitellidae | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AN | *Chaetozone* sp | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AN | *Chone* sp C (Harris 1984) | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 0.00 |
| AN | *Cirriformia moorei* | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 | 0.00 |
| AN | *Cirriformia* sp | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 | 0.00 |
| AN | *Cirriformia tentaculata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 0.00 |
| AN | *Diopatra* sp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 0.00 |
| AN | *Diopatra spendidissima* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | 0.00 |
| AN | *Eteone brigitteae* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AN | Euclymeninae sp A SCAMIT 1987 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | 0.00 |
| AN | *Exogone lourei* | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 | 0.00 |
| AN | *Glycera* sp | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AN | *Harmothoe hirsuta* | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 | 0.00 |
| AN | *Lumbrineris japonica* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 0.00 |
| AN | *Malmgreniella* sp | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AN | Oligochaeta | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | 0.00 |
| AN | *Parandalia ocularis* | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AN | *Paraprionospio pinnata* | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AN | *Pholoe glabra* | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 0.00 |
| AN | *Phylo felix* | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AN | *Pista disjuncta* | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AN | *Polyophthalmus pictus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | 0.00 |
| AN | Sigalionidae | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 | 0.00 |
| AN | *Sphaerephesia similisetis* | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AN | Syllidae | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 0.00 |
| AN | *Timarete luxuriosa* | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Allenacanthomysis macropsis* | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Amphideutopus oculatus* | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 | 0.00 |
| AR | *Cancer antennarius* | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 | 0.00 |
| AR | *Caprella californica* | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |

## 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 | Percent Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AR | *Caprella* sp | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Caprella verrucosa* | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 0.00 |
| AR | Crustacea (zoea) | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | Cumacea | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Cyclaspis* sp B SCAMIT 1989 | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Cyprideis stewarti* | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 | 0.00 |
| AR | *Eochelidium* sp A SCAMIT 1996 | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Foxiphalus obtusidens* | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Gitanopsis vilordes* | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Holmesimysis costata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 0.00 |
| AR | Ischyroceridae | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Listriella melanica* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 0.00 |
| AR | *Monocorophium* sp | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Monoculodes hartmanae* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Munnogonium tillerae* | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Mysidopsis intii* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Neomysis kadiakensis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 0.00 |
| AR | *Opisthopus transversus* | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Pachycheles rudis* | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Paraonella platybranchia* | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Photis* sp A SCAMIT 1995 | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Postasterope barnesi* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | Pycnogonida | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Pyromaia tuberculata* | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Rhepoxynius lucubrans* | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| AR | *Rhepoxynius tridentatus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | 0.00 |
| AR | *Stenothoe estacola* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 0.00 |
| AR | *Tiron biocellata* | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| CN | *Hydractinia* sp | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 0.00 |
| EC | *Amphiodia digitata* | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 | 0.00 |
| EC | *Amphiura acrystata* | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| EC | *Caudina arenicola* | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| EN | Entoprocta | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 | 0.00 |
| EP | *Cryptoarachnidium argillum* | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| EP | *Triticella elongata* | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 0.00 |
| MO | *Acteocina* sp | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 | 0.00 |
| MO | *Amiantis callosa* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 0.00 |
| MO | *Crepidula onyx* | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 0.00 |
| MO | *Ennucula tenuis* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 | 0.00 |
| MO | *Kurtziella plumbea* | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| MO | *Leptopecten latiauratus* | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 | 0.00 |
| MO | *Lyonsia californica* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 0.00 |
| MO | *Macoma carlottensis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | 0.00 |
| MO | *Mysella* sp | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| MO | Mytilidae | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 | 0.00 |
| MO | *Nitidiscala sawinae* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 | 0.00 |
| MO | *Odostomia* sp | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| MO | *Rochefortia compressa* | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 0.00 |
| MO | *Sulcoretusa xystrum* | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| MO | *Yoldia cooperii* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | 0.00 |
| NE | *Amphiporus* sp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 0.00 |
| NE | *Cerebratulus* sp | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| PL | Platyhelminthes sp A of MBC | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| PL | *Stylochus exiguus* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 | 0.00 |
| SI | Sipuncula | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 | 0.00 |
| | Number of individuals | 511 | 1049 | 612 | 1041 | 699 | 1021 | 399 | 599 | 946 | 1737 | 5311 | 896 | 915 | 1161 | 1123 | 952 | 885 | 1726 | 21583 | |
| | Number of species | 54 | 79 | 68 | 72 | 70 | 53 | 35 | 38 | 81 | 92 | 59 | 82 | 79 | 75 | 75 | 38 | 75 | 60 | 315 | |
| | Number of stations / reps | 5/4 | 5/4 | 5/4 | 5/4 | 5/4 | 5/4 | 5/4 | 5/4 | 5/4 | 5/4 | 3/4 | 5/4 | 5/4 | 5/4 | 5/4 | 4/2 | 5/4 | 5/4 | 5/4 | |
| | Diversity (H') | 2.85 | 3.04 | 3.38 | 3.04 | 3.03 | 2.15 | 2.28 | 2.46 | 3.21 | 3.30 | 1.46 | 3.01 | 3.32 | 2.39 | 2.88 | 1.25 | 2.82 | 2.09 | 3.39 | |

NOTE: From 1978 to 1988 infaunal samples were collected in summer and winter. In this appendix, only summer samples are considered.
Note: 0.00 = < 0.005

# APPENDIX H

## Demersal fish and macroinvertebrate trawl data by station

**Appendix H-1. Species list of fish and macroinvertebrate species taken by trawl. Mandalay Generating Station NPDES, 2005.**

| Phylum | Class | Family | Species | Common name |
|---|---|---|---|---|
| Arthropoda | | | | |
| | Malacostraca | | | |
| | | Cancridae | | |
| | | | *Cancer gracilis* | graceful crab |
| | | Crangonidae | | |
| | | | *Crangon nigromaculata* | blackspotted bay shrimp |
| | | Cymothoidae | | |
| | | | *Elthusa vulgaris* | sea louse |
| | | Majidae | | |
| | | | *Loxorhynchus grandis* | sheep crab |
| | | | *Pyromaia tuberculata* | tuberculate pear crab |
| | | Pinnotheridae | | |
| | | | *Opisthopus transversus* | mottled pea crab |
| | | Portunidae | | |
| | | | *Portunus xantusii* | Xantus swimming crab |
| Echinodermata | | | | |
| | Echinoidea | | | |
| | | Dendrasteridae | | |
| | | | *Dendraster excentricus* | Pacific sand dollar |
| Chordata | | | | |
| | Chondrichthyes | | | |
| | | Platyrhinidae | | |
| | | | *Platyrhinoidis triseriata* | thornback |
| | | Rhinobatidae | | |
| | | | *Rhinobatos productus* | shovelnose guitarfish |
| | | Squalidae | | |
| | | | *Squalus acanthias* | spiny dogfish |
| | | Squatinidae | | |
| | | | *Squatina californica* | Pacific angel shark |
| | | Triakidae | | |
| | | | *Triakis semifasciata* | leopard shark |
| Chordata (Cont.) | | | | |
| | Actinopterygii | | | |
| | | Agonidae | | |
| | | | *Odontopyxis trispinosa* | pygmy poacher |
| | | Batrachoididae | | |
| | | | *Porichthys myriaster* | specklefin midshipman |
| | | Clupeidae | | |
| | | | *Sardinops sagax* | Pacific sardine |
| | | Cottidae | | |
| | | | *Leptocottus armatus* | Pacific staghorn sculpin |
| | | Embiotocidae | | |
| | | | *Amphistichus argenteus* | barred surfperch |
| | | | *Cymatogaster aggregata* | shiner perch |
| | | | *Embiotoca jacksoni* | black perch |
| | | | *Hyperprosopon argenteum* | walleye surfperch |
| | | | *Phanerodon furcatus* | white seaperch |
| | | | *Rhacochilus toxotes* | rubberlip seaperch |
| | | Engraulidae | | |
| | | | *Engraulis mordax* | northern anchovy |
| | | Myliobatidae | | |
| | | | *Myliobatis californica* | bat ray |
| | | Ophididae | | |
| | | | *Ophidion scrippsae* | basketweave cusk-eel |
| | | Paralichthyidae | | |
| | | | *Citharichthys stigmaeus* | speckled sanddab |
| | | | *Xystreurys liolepis* | fantail sole |
| | | Pleuronectidae | | |
| | | | *Parophrys vetulus* | English sole |
| | | | *Pleuronichthys guttulatus* | diamond turbot |
| | | | *Pleuronichthys ritteri* | spotted turbot |
| | | | *Pleuronichthys verticalis* | hornyhead turbot |
| | | Sciaenidae | | |
| | | | *Atractoscion nobilis* | white seabass |
| | | | *Genyonemus lineatus* | white croaker |
| | | | *Menticirrhus undulatus* | California corbina |
| | | | *Seriphus politus* | queenfish |
| | | Scorpaenidae | | |
| | | | *Sebastes auriculatus* | brown rockfish |
| | | Serranidae | | |
| | | | *Paralichthys californicus* | California halibut |
| | | Stromateidae | | |
| | | | *Peprilus simillimus* | Pacific pompano |
| | | Syngnathidae | | |
| | | | *Syngnathus californiensis* | kelp pipefish |
| | | Synodontidae | | |
| | | | *Synodus lucioceps* | California lizardfish |

**Appendix H-2. Abundance of fish species in trawl replicates, winter and summer. Mandalay Generating Station NPDES, 2005.**

| | Winter | | | | | | | | | Summer | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | T3 | | T4 | | | T1 | | T2 | | T3 | | T4 | | | Annual |
| Species | I | II | I | II | I | II | I | II | Total | I | II | I | II | I | II | I | II | Total | Total |
| *Amphistichus argenteus* | 1,389 | 433 | 532 | 384 | 571 | 593 | 400 | 298 | 4,600 | 2 | - | - | - | - | - | 27 | 3 | 32 | 4,632 |
| *Atractoscion nobilis* | 10 | 7 | 5 | 4 | 242 | 47 | 502 | 287 | 1,104 | - | - | - | - | 1 | - | - | 1 | 2 | 1,106 |
| *Citharichthys stigmaeus* | 64 | 30 | 29 | 23 | 49 | 34 | 45 | 21 | 295 | 16 | 9 | 9 | 4 | 3 | 5 | 5 | - | 51 | 346 |
| *Cymatogaster aggregata* | 6 | 2 | 93 | 87 | 1 | - | 6 | 35 | 230 | 10 | 9 | 19 | 27 | 6 | 16 | 2 | 6 | 95 | 325 |
| *Embiotoca jacksoni* | 65 | 33 | 1 | 3 | - | 5 | 1 | 53 | 161 | - | - | - | - | 41 | - | - | - | 41 | 202 |
| *Engraulis mordax* | 3 | 3 | 4 | 2 | 2 | 6 | 4 | 14 | 38 | 1 | - | - | - | 37 | 3 | 36 | 20 | 97 | 135 |
| *Genyonemus lineatus* | 2 | 1 | 5 | 11 | 2 | - | 1 | 2 | 24 | 2 | - | 10 | 11 | 1 | 2 | 2 | 15 | 43 | 67 |
| *Hyperprosopon argenteum* | - | - | 1 | - | - | - | - | - | 1 | 7 | - | 2 | 3 | 25 | 5 | 9 | 1 | 52 | 53 |
| *Leptocottus armatus* | - | - | - | - | - | 10 | - | 31 | 41 | - | - | - | - | - | - | - | - | - | 41 |
| *Menticirrhus undulatus* | - | - | 1 | - | 15 | - | 8 | 3 | 27 | - | - | - | - | - | - | - | - | - | 27 |
| *Myliobatis californica* | 2 | 5 | 5 | 5 | 1 | - | 1 | 2 | 21 | 1 | - | 1 | 1 | - | - | - | - | 3 | 24 |
| *Odontopyxis trispinosa* | - | - | - | - | - | - | - | - | - | - | - | 15 | - | 5 | 2 | 1 | - | 23 | 23 |
| *Ophidion scrippsae* | - | - | 1 | - | - | - | 4 | 13 | 18 | - | - | - | - | - | - | - | - | - | 18 |
| *Paralichthys californicus* | - | - | 1 | 1 | 1 | - | - | - | 3 | - | - | 1 | 1 | 6 | - | 2 | - | 10 | 13 |
| *Parophrys vetulus* | - | - | 5 | - | 2 | 1 | 1 | - | 9 | - | - | - | - | - | - | - | - | - | 9 |
| *Peprilus simillimus* | - | - | - | - | - | - | - | - | - | - | - | 2 | 3 | - | 3 | 1 | - | 9 | 9 |
| *Phanerodon furcatus* | 2 | - | - | 3 | - | - | - | - | 5 | - | - | - | 1 | - | - | - | - | 1 | 6 |
| *Platyrhinoidis triseriata* | 2 | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | 2 | 2 | 4 |
| *Pleuronichthys guttulatus* | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 2 | - | 3 | 3 |
| *Pleuronichthys ritteri* | 1 | 1 | - | - | - | - | - | - | 2 | - | - | - | - | 1 | - | - | - | 1 | 3 |
| *Pleuronichthys verticalis* | - | - | - | - | - | - | - | 2 | 2 | - | - | - | - | - | - | - | - | - | 2 |
| *Porichthys myriaster* | - | - | - | - | 1 | 1 | - | - | 2 | - | - | - | - | - | - | - | - | - | 2 |
| *Rhacochilus toxotes* | - | - | - | - | 1 | - | - | 1 | 2 | - | - | - | - | - | - | - | - | - | 2 |
| *Rhinobatos productus* | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 1 |
| *Sardinops sagax* | - | - | - | 1 | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| *Sebastes auriculatus* | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | 1 |
| *Seriphus politus* | - | - | - | - | - | - | 1 | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| *Squalus acanthias* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 1 |
| *Squatina californica* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 1 |
| *Syngnathus californiensis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 |
| *Synodus lucioceps* | - | - | - | 1 | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| *Triakis semifasciata* | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 1 |
| *Xystreurys liolepis* | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | 1 |
| Total abundance | 2,061 | | 1,208 | | 1,585 | | 1,737 | | 6,591 | 59 | | 110 | | 164 | | 138 | | 471 | 7,062 |
| Species | 11 | | 16 | | 14 | | 16 | | 24 | 9 | | 9 | | 13 | | 15 | | 22 | 33 |
| Diversity (H') | 0.52 | | 0.89 | | 0.86 | | 1.29 | | 1.05 | 1.49 | | 1.67 | | 1.94 | | 1.86 | | 1.96 | 1.30 |
| Distance Trawled (m) | 768 | 644 | 673 | 672 | 695 | 648 | 724 | 694 | | 645 | 600 | 640 | 589 | 651 | 678 | 712 | 699 | | |
| Abundance less than 30 mm SL. | | | | | | | | | | | | | | | | | | | |
| *Genyonemus lineatus* | 197 | 126 | 84 | 35 | - | - | - | - | 442 | 5 | 2 | - | - | - | - | - | - | 7 | 449 |
| Total Abundance < 30 mm S | 197 | 126 | 84 | 35 | - | - | - | - | 442 | 5 | 2 | - | - | - | - | - | - | 7 | 449 |

**Appendix H-3. Abundance of fish species (per 100 m) in trawl replicates, winter and summer. Mandalay Generating Station NPDES, 2005.**

| | Winter | | | | | | | | | Summer | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | T3 | | T4 | | | T1 | | T2 | | T3 | | T4 | | | Annual |
| Species | I | II | I | II | I | II | I | II | Mean | I | II | I | II | I | II | I | II | Mean | Mean |
| *Genyonemus lineatus* | 209.1 | 68.6 | 85.8 | 65.6 | 87.1 | 94.6 | 62.9 | 45.7 | 89.9 | 0.3 | - | - | - | - | - | 4.5 | 0.5 | 0.7 | 45.3 |
| *Seriphus politus* | 1.5 | 1.1 | 0.8 | 0.7 | 36.9 | 7.5 | 78.9 | 44.0 | 21.4 | - | - | - | - | 0.2 | - | - | 0.2 | 0.0 | 10.7 |
| *Syngnathus californiensis* | 9.6 | 4.8 | 4.7 | 3.9 | 7.5 | 5.4 | 7.1 | 3.2 | 5.8 | 2.7 | 1.6 | 1.5 | 0.7 | 0.6 | 0.9 | 0.8 | - | 1.1 | 3.4 |
| *Citharichthys stigmaeus* | 0.9 | 0.3 | 15.0 | 14.9 | 0.2 | - | 0.9 | 5.4 | 4.7 | 1.7 | 1.6 | 3.3 | 4.8 | 1.1 | 2.8 | 0.3 | 1.1 | 2.1 | 3.4 |
| *Engraulis mordax* | 9.8 | 5.2 | 0.2 | 0.5 | - | 0.8 | 0.2 | 8.1 | 3.1 | - | - | - | - | 7.9 | - | - | - | 1.0 | 2.0 |
| *Cymatogaster aggregata* | 0.5 | 0.5 | 0.6 | 0.3 | 0.3 | 1.0 | 0.6 | 2.1 | 0.7 | 0.2 | - | - | - | 7.1 | 0.5 | 6.1 | 3.5 | 2.2 | 1.5 |
| *Amphistichus argenteus* | 0.3 | 0.2 | 0.8 | 1.9 | 0.3 | - | 0.2 | 0.3 | 0.5 | 0.3 | - | 1.7 | 1.9 | 0.2 | 0.3 | 0.3 | 2.6 | 0.9 | 0.7 |
| *Hyperprosopon argenteum* | - | - | 0.2 | - | - | - | - | - | 0.0 | 1.2 | - | 0.3 | 0.5 | 4.8 | 0.9 | 1.5 | 0.2 | 1.2 | 0.6 |
| *Squalus acanthias* | - | - | - | - | - | 1.6 | - | 4.7 | 0.8 | - | - | - | - | - | - | - | - | - | 0.4 |
| *Porichthys myriaster* | - | - | 0.2 | - | 2.3 | - | 1.3 | 0.5 | 0.5 | - | - | - | - | - | - | - | - | - | 0.3 |
| *Phanerodon furcatus* | - | - | - | - | - | - | - | - | - | - | - | 2.6 | - | 1.0 | 0.3 | 0.2 | - | 0.5 | 0.3 |
| *Platyrhinoidis triseriata* | 0.3 | 0.8 | 0.8 | 0.9 | 0.2 | - | 0.2 | 0.3 | 0.4 | 0.2 | - | 0.2 | 0.2 | - | - | - | - | 0.1 | 0.2 |
| *Ophidion scrippsae* | - | - | 0.2 | - | - | - | 0.6 | 2.0 | 0.3 | - | - | - | - | - | - | - | - | - | 0.2 |
| *Parophrys vetulus* | - | - | 0.2 | 0.2 | 0.2 | - | - | - | 0.1 | - | - | 0.2 | 0.2 | 1.1 | - | 0.3 | - | 0.2 | 0.1 |
| *Synodus lucioceps* | - | - | - | - | - | - | - | - | - | - | - | 0.3 | 0.5 | - | 0.5 | 0.2 | - | 0.2 | 0.1 |
| *Myliobatis californica* | - | - | 0.8 | - | 0.3 | 0.2 | 0.2 | - | 0.2 | - | - | - | - | - | - | - | - | - | 0.1 |
| *Menticirrhus undulatus* | 0.3 | - | - | 0.5 | - | - | - | - | 0.1 | - | - | - | 0.2 | - | - | - | - | 0.0 | 0.1 |
| *Embiotoca jacksoni* | 0.3 | - | - | - | - | - | - | - | 0.0 | - | - | - | - | - | - | - | 0.4 | 0.0 | 0.0 |
| *Pleuronichthys verticalis* | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.2 | - | 0.3 | - | 0.1 | 0.0 |
| *Sardinops sagax* | 0.2 | 0.2 | - | - | - | - | - | - | 0.0 | - | - | - | - | 0.2 | - | - | - | 0.0 | 0.0 |
| *Peprilus simillimus* | - | - | - | - | 0.2 | 0.2 | - | - | 0.0 | - | - | - | - | - | - | - | - | - | 0.0 |
| *Atractoscion nobilis* | - | - | - | - | - | - | - | 0.3 | 0.0 | - | - | - | - | - | - | - | - | - | 0.0 |
| *Triakis semifasciata* | - | - | - | - | 0.2 | - | - | 0.2 | 0.0 | - | - | - | - | - | - | - | - | - | 0.0 |
| *Xystreurys liolepis* | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.2 | - | - | - | 0.0 | 0.0 |
| *Rhinobatos productus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.2 | 0.0 | 0.0 |
| *Leptocottus armatus* | - | - | - | - | - | - | - | - | - | - | 0.2 | - | - | - | - | - | - | 0.0 | 0.0 |
| *Squatina californica* | - | - | - | - | - | - | - | - | - | - | 0.2 | - | - | - | - | - | - | 0.0 | 0.0 |
| *Odontopyxis trispinosa* | - | - | - | 0.2 | - | - | - | - | 0.0 | - | - | - | - | - | - | - | - | - | 0.0 |
| *Sebastes auriculatus* | - | - | - | 0.2 | - | - | - | - | 0.0 | - | - | - | - | - | - | - | - | - | 0.0 |
| *Pleuronichthys ritteri* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.2 | - | 0.0 | 0.0 |
| *Rhacochilus toxotes* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.2 | - | 0.0 | 0.0 |
| *Pleuronichthys guttulatus* | - | - | - | - | - | - | 0.2 | - | 0.0 | - | - | - | - | - | - | - | - | - | 0.0 |
| *Paralichthys californicus* | - | - | - | - | - | - | - | 0.2 | 0.0 | - | - | - | - | - | - | - | - | - | 0.0 |
| Total Abundance | 232.7 | 81.6 | 110.1 | 89.7 | 135.5 | 111.2 | 153.2 | 116.9 | 128.9 | 6.5 | 3.5 | 10.1 | 9.0 | 24.5 | 6.3 | 15.0 | 8.6 | 10.4 | 69.6 |

Note: 0.0 = < 0.01

## H-4. Biomass (kg) of fish species in trawl replicates. Mandalay Generating Station NPDES, 2005.

| | Winter | | | | | | | | | Summer | | | | | | | | | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | T3 | | T4 | | | T1 | | T2 | | T3 | | T4 | | | |
| Species | I | II | I | II | I | II | I | II | Total | I | II | I | II | I | II | I | II | Total | Total |
| *Squalus acanthias* | - | - | - | - | - | 3.500 | - | 12.650 | 16.150 | - | - | - | - | - | - | - | - | - | 16.150 |
| *Genyonemus lineatus* | 1.606 | 0.429 | 0.633 | 0.490 | 3.000 | 2.065 | 2.700 | 1.498 | 12.421 | 0.002 | - | - | - | - | - | 0.325 | 0.020 | 0.347 | 12.768 |
| *Myliobatis californica* | - | - | 7.000 | - | 3.000 | 1.312 | 1.000 | - | 12.312 | - | - | - | - | - | - | - | - | - | 12.312 |
| *Seriphus politus* | 0.051 | 0.032 | 0.023 | 0.012 | 2.035 | 0.233 | 5.400 | 2.344 | 10.130 | - | - | - | - | 0.010 | - | - | 0.023 | 0.033 | 10.163 |
| *Platyrhinoidis triseriata* | 0.319 | 1.050 | 1.450 | 1.780 | 0.035 | - | 1.000 | 0.523 | 6.157 | 0.150 | - | 0.175 | 0.195 | - | - | - | - | 0.520 | 6.677 |
| *Rhinobatos productus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4.730 | 4.730 | 4.730 |
| *Amphistichus argenteus* | 0.050 | 0.026 | 0.221 | 0.445 | 0.068 | - | 0.032 | 0.060 | 0.902 | 0.067 | - | 0.131 | 0.121 | 0.031 | 0.027 | 0.084 | 0.740 | 1.201 | 2.103 |
| *Cymatogaster aggregata* | 0.037 | 0.026 | 0.026 | 0.010 | 0.012 | 0.035 | 0.037 | 0.073 | 0.256 | 0.016 | - | - | - | 0.610 | 0.017 | 0.660 | 0.364 | 1.667 | 1.923 |
| *Citharichthys stigmaeus* | 0.011 | 0.004 | 0.317 | 0.307 | 0.003 | - | 0.015 | 0.084 | 0.741 | 0.136 | 0.064 | 0.142 | 0.282 | 0.095 | 0.145 | 0.009 | 0.040 | 0.913 | 1.654 |
| *Engraulis mordax* | 0.429 | 0.240 | 0.001 | 0.004 | - | 0.020 | 0.001 | 0.077 | 0.772 | - | - | - | - | 0.195 | - | - | - | 0.195 | 0.967 |
| *Squatina californica* | - | - | - | - | - | - | - | - | - | - | 0.800 | - | - | - | - | - | - | 0.800 | 0.800 |
| *Parophrys vetulus* | - | - | 0.084 | 0.045 | 0.070 | - | - | - | 0.199 | - | - | 0.048 | 0.056 | 0.387 | - | 0.065 | - | 0.556 | 0.755 |
| *Triakis semifasciata* | - | - | - | - | 0.050 | - | - | 0.450 | 0.500 | - | - | - | - | - | - | - | - | - | 0.500 |
| *Syngnathus californiensis* | 0.063 | 0.033 | 0.039 | 0.035 | 0.056 | 0.041 | 0.060 | 0.014 | 0.341 | 0.048 | 0.015 | 0.021 | 0.012 | 0.003 | 0.016 | 0.012 | - | 0.127 | 0.468 |
| *Menticirrhus undulatus* | 0.257 | - | - | 0.145 | - | - | - | - | 0.402 | - | - | - | 0.011 | - | - | - | - | 0.011 | 0.413 |
| *Ophidion scrippsae* | - | - | 0.003 | - | - | - | 0.140 | 0.106 | 0.249 | - | - | - | - | - | - | - | - | - | 0.249 |
| *Pleuronichthys ritteri* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.209 | - | 0.209 | 0.209 |
| *Pleuronichthys guttulatus* | - | - | - | - | - | - | 0.195 | - | 0.195 | - | - | - | - | - | - | - | - | - | 0.195 |
| *Hyperprosopon argenteum* | - | - | 0.002 | - | - | - | - | - | 0.002 | 0.022 | - | 0.004 | 0.007 | 0.079 | 0.019 | 0.038 | 0.003 | 0.172 | 0.174 |
| *Porichthys myriaster* | - | - | 0.003 | - | 0.071 | - | 0.058 | 0.009 | 0.141 | - | - | - | - | - | - | - | - | - | 0.141 |
| *Pleuronichthys verticalis* | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.045 | - | 0.058 | - | 0.103 | 0.103 |
| *Phanerodon furcatus* | - | - | - | - | - | - | - | - | - | - | - | 0.043 | - | 0.022 | 0.010 | 0.004 | - | 0.079 | 0.079 |
| *Synodus lucioceps* | - | - | - | - | - | - | - | - | - | - | - | 0.012 | 0.028 | - | 0.023 | 0.012 | - | 0.075 | 0.075 |
| *Atractoscion nobilis* | - | - | - | - | - | - | - | 0.061 | 0.061 | - | - | - | - | - | - | - | - | - | 0.061 |
| *Sebastes auriculatus* | - | - | - | 0.045 | - | - | - | - | 0.045 | - | - | - | - | - | - | - | - | - | 0.045 |
| *Sardinops sagax* | 0.008 | 0.016 | - | - | - | - | - | - | 0.024 | - | - | - | - | 0.020 | - | - | - | 0.020 | 0.044 |
| *Xystreurys liolepis* | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.042 | - | - | - | 0.042 | 0.042 |
| *Peprilus simillimus* | - | - | - | - | 0.020 | 0.010 | - | - | 0.030 | - | - | - | - | - | - | - | - | - | 0.030 |
| *Leptocottus armatus* | - | - | - | - | - | - | - | - | - | - | 0.026 | - | - | - | - | - | - | 0.026 | 0.026 |
| *Paralichthys californicus* | - | - | - | - | - | - | - | 0.024 | 0.024 | - | - | - | - | - | - | - | - | - | 0.024 |
| *Embiotoca jacksoni* | 0.004 | - | - | - | - | - | - | - | 0.004 | - | - | - | - | - | - | - | 0.012 | 0.012 | 0.016 |
| *Rhacochilus toxotes* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.011 | - | 0.011 | 0.011 |
| *Odontopyxis trispinosa* | - | - | - | 0.002 | - | - | - | - | 0.002 | - | - | - | - | - | - | - | - | - | 0.002 |
| Total Biomass (kg) | 2.835 | 1.856 | 9.802 | 3.320 | 8.420 | 7.216 | 10.638 | 17.973 | 62.060 | 0.441 | 0.905 | 0.576 | 0.712 | 1.539 | 0.257 | 1.487 | 5.932 | 11.849 | 73.909 |
| Distance Trawled (m) | 768 | 644 | 673 | 672 | 695 | 648 | 724 | 694 | | 645 | 600 | 640 | 589 | 651 | 678 | 712 | 699 | | |

**H-5. Biomass (kg) of fish species (per 100 m) in trawl replicates. Mandalay Generating Station NPDES, 2005.**

| | Winter | | | | | | | | | Summer | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | T3 | | T4 | | | T1 | | T2 | | T3 | | T4 | | | Annual |
| Species | I | II | I | II | I | II | I | II | Mean | I | II | I | II | I | II | I | II | Mean | Mean |
| *Squalus acanthias* | - | - | - | - | - | 0.56 | - | 1.94 | 0.31 | - | - | - | - | - | - | - | - | - | 0.16 |
| *Genyonemus lineatus* | 0.24 | 0.07 | 0.10 | 0.08 | 0.46 | 0.33 | 0.42 | 0.23 | 0.24 | 0.00 | - | - | - | - | - | 0.05 | 0.00 | 0.01 | 0.12 |
| *Myliobatis californica* | - | - | 1.13 | - | 0.46 | 0.21 | 0.16 | - | 0.24 | - | - | - | - | - | - | - | - | - | 0.12 |
| *Seriphus politus* | 0.01 | 0.01 | 0.00 | 0.00 | 0.31 | 0.04 | 0.85 | 0.36 | 0.20 | - | - | - | - | 0.00 | - | - | 0.00 | 0.00 | 0.10 |
| *Platyrhinoidis triseriata* | 0.05 | 0.17 | 0.23 | 0.30 | 0.01 | - | 0.16 | 0.08 | 0.12 | 0.03 | - | 0.03 | 0.03 | - | - | - | - | 0.01 | 0.07 |
| *Rhinobatos productus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.83 | 0.10 | 0.05 |
| *Amphistichus argenteus* | 0.01 | 0.00 | 0.04 | 0.08 | 0.01 | - | 0.01 | 0.01 | 0.02 | 0.01 | - | 0.02 | 0.02 | 0.01 | 0.00 | 0.01 | 0.13 | 0.03 | 0.02 |
| *Cymatogaster aggregata* | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | - | - | - | 0.12 | 0.00 | 0.11 | 0.06 | 0.04 | 0.02 |
| *Citharichthys stigmaeus* | 0.00 | 0.00 | 0.05 | 0.05 | 0.00 | - | 0.00 | 0.01 | 0.02 | 0.02 | 0.01 | 0.02 | 0.05 | 0.02 | 0.03 | 0.00 | 0.01 | 0.02 | 0.02 |
| *Engraulis mordax* | 0.06 | 0.04 | 0.00 | 0.00 | - | 0.00 | 0.00 | 0.01 | 0.01 | - | - | - | - | 0.04 | - | - | - | 0.00 | 0.01 |
| *Squatina californica* | - | - | - | - | - | - | - | - | - | - | 0.14 | - | - | - | - | - | - | 0.02 | 0.01 |
| *Parophrys vetulus* | - | - | 0.01 | 0.01 | 0.01 | - | - | - | 0.00 | - | - | 0.01 | 0.01 | 0.07 | - | 0.01 | - | 0.01 | 0.01 |
| *Triakis semifasciata* | - | - | - | - | 0.01 | - | - | 0.07 | 0.01 | - | - | - | - | - | - | - | - | - | 0.00 |
| *Syngnathus californiensis* | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - | 0.00 | 0.00 |
| *Menticirrhus undulatus* | 0.04 | - | - | 0.02 | - | - | - | - | 0.01 | - | - | - | 0.00 | - | - | - | - | 0.00 | 0.00 |
| *Ophidion scrippsae* | - | - | 0.00 | - | - | - | 0.02 | 0.02 | 0.00 | - | - | - | - | - | - | - | - | - | 0.00 |
| *Pleuronichthys ritteri* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.04 | - | 0.00 | 0.00 |
| *Hyperprosopon argenteum* | - | - | 0.00 | - | - | - | - | - | 0.00 | 0.00 | - | 0.00 | 0.00 | 0.02 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| *Pleuronichthys guttulatus* | - | - | - | - | - | - | 0.03 | - | 0.00 | - | - | - | - | - | - | - | - | - | 0.00 |
| *Porichthys myriaster* | - | - | 0.00 | - | 0.01 | - | 0.01 | 0.00 | 0.00 | - | - | - | - | - | - | - | - | - | 0.00 |
| *Pleuronichthys verticalis* | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.01 | - | 0.01 | - | 0.00 | 0.00 |
| *Phanerodon furcatus* | - | - | - | - | - | - | - | - | - | - | - | 0.01 | - | 0.00 | 0.00 | 0.00 | - | 0.00 | 0.00 |
| *Synodus lucioceps* | - | - | - | - | - | - | - | - | - | - | - | 0.00 | 0.00 | - | 0.00 | 0.00 | - | 0.00 | 0.00 |
| *Atractoscion nobilis* | - | - | - | - | - | - | - | 0.01 | 0.00 | - | - | - | - | - | - | - | - | - | 0.00 |
| *Xystreurys liolepis* | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.01 | - | - | - | 0.00 | 0.00 |
| *Sebastes auriculatus* | - | - | - | 0.01 | - | - | - | - | 0.00 | - | - | - | - | - | - | - | - | - | 0.00 |
| *Sardinops sagax* | 0.00 | 0.00 | - | - | - | - | - | - | 0.00 | - | - | - | - | 0.00 | - | - | - | 0.00 | 0.00 |
| *Peprilus simillimus* | - | - | - | - | 0.00 | 0.00 | - | - | 0.00 | - | - | - | - | - | - | - | - | - | 0.00 |
| *Leptocottus armatus* | - | - | - | - | - | - | - | - | - | - | 0.00 | - | - | - | - | - | - | 0.00 | 0.00 |
| *Paralichthys californicus* | - | - | - | - | - | - | - | 0.00 | 0.00 | - | - | - | - | - | - | - | - | - | 0.00 |
| *Embiotoca jacksoni* | 0.00 | - | - | - | - | - | - | - | 0.00 | - | - | - | - | - | - | - | 0.00 | 0.00 | 0.00 |
| *Rhacochilus toxotes* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.00 | - | 0.00 | 0.00 |
| *Odontopyxis trispinosa* | - | - | - | 0.00 | - | - | - | - | 0.00 | - | - | - | - | - | - | - | - | - | 0.00 |
| Total Abundance | 0.43 | 0.29 | 1.58 | 0.57 | 1.28 | 1.15 | 1.67 | 2.75 | 1.22 | 0.07 | 0.16 | 0.10 | 0.13 | 0.29 | 0.04 | 0.25 | 1.04 | 0.26 | 0.74 |

Note: 0.00 = < 0.001

## Appendix H-6. Length of fish species in trawl replicates. Mandalay Generating Station NPDES, Winter 2005.

| Station T1-I | Standard Length (cm) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 27 | 28 | 29 | 31 | 32 |
| *Amphistichus argenteus* | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Citharichthys stigmaeus* | 3 | - | - | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cymatogaster aggregata* | - | - | - | 1 | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Embiotoca jacksoni* | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Engraulis mordax* | - | 1 | 3 | 1 | 4 | 16 | 26 | 10 | 3 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Genyonemus lineatus* | 41 | 126 | 31 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Menticirrhus undulatus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - | - | - | - | - | - | - | - |
| *Platyrhinoidis triseriata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 |
| *Sardinops sagax* | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Seriphus politus* | - | - | - | 3 | 6 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Syngnathus californiensis* | - | - | - | - | - | - | - | 3 | 3 | 1 | 1 | 5 | 6 | 13 | 10 | 9 | 7 | 2 | 4 | - | - | - | - | - | - | - | - | - |

| Station T1-II | Standard Length (cm) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 27 | 28 | 29 | 31 | 32 | 33 | 35 | 36 | 37 | 38 | 39 |
| *Amphistichus argenteus* | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Citharichthys stigmaeus* | - | - | 1 | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cymatogaster aggregata* | - | - | - | - | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Engraulis mordax* | - | - | - | 1 | 4 | 12 | 5 | 7 | 2 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Genyonemus lineatus* | 69 | 113 | 17 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Platyrhinoidis triseriata* | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | 1 |
| *Sardinops sagax* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Seriphus politus* | - | - | - | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Syngnathus californiensis* | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | 2 | 3 | 2 | 5 | 5 | 6 | - | - | 1 | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - |

| Station T2-I | Standard Length (cm) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 28 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 47 | 48 |
| *Amphistichus argenteus* | - | - | - | - | - | - | 2 | - | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Citharichthys stigmaeus* | 3 | 3 | 14 | 42 | 21 | 8 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cymatogaster aggregata* | - | - | - | 2 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Engraulis mordax* | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Genyonemus lineatus* | 49 | 134 | 16 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Hyperprosopon argenteum* | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Myliobatis californica* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 2 | 1 | 1 |
| *Odontopyxis trispinosa* | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Ophidion scrippsae* | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Parophrys vetulus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Platyrhinoidis triseriata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - | 1 | 2 | - | - | - | - | - | - |
| *Porichthys myriaster* | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Seriphus politus* | - | - | 1 | 2 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Syngnathus californiensis* | - | - | - | - | - | - | - | 1 | 2 | - | 2 | - | 1 | 4 | 2 | 9 | 4 | 3 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |

**Appendix H-6. (Cont.).**

Station T2-II

Standard Length (cm)

| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Amphistichus argenteus* | - | - | - | - | - | 1 | 3 | 3 | - | 1 | - | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Citharichthys stigmaeus* | 3 | - | 15 | 39 | 20 | 7 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cymatogaster aggregata* | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Engraulis mordax* | - | - | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Genyonemus lineatus* | 34 | 126 | 34 | 6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Menticirrhus undulatus* | - | - | - | - | - | - | - | - | - | - | - | 2 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Parophrys vetulus* | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Platyrhinoidis triseriata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | - | - | 1 | 1 | 1 |
| *Sebastes auriculatus* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Seriphus politus* | - | - | - | 3 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Syngnathus californiensis* | - | - | - | - | - | - | - | - | 1 | - | - | 1 | 1 | 1 | 1 | 9 | 5 | 2 | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - | - |

Station T3-1

Standard Length (cm)

| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 42 | 43 | 44 | 45 | 47 | 48 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Amphistichus argenteus* | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Citharichthys stigmaeus* | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cymatogaster aggregata* | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Genyonemus lineatus* | - | 7 | 33 | 91 | 55 | 10 | 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Myliobatis californica* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 |
| *Parophrys vetulus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - |
| *Peprilus simillimus* | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Platyrhinoidis triseriata* | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Porichthys myriaster* | - | - | - | 2 | 5 | 5 | 1 | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Seriphus politus* | - | - | 1 | 21 | 49 | 81 | 44 | 1 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Syngnathus californiensis* | - | - | - | - | - | - | 1 | 1 | - | 2 | 2 | 1 | 7 | 10 | 5 | 7 | 5 | 1 | 6 | 1 | - | - | - | - | - | - | - |
| *Triakis semifasciata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - |

Station T3-2

Standard Length (cm)

| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 47 | 52 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Cymatogaster aggregata* | - | - | - | 5 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Engraulis mordax* | - | - | - | 2 | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Genyonemus lineatus* | 1 | 25 | 87 | 79 | 8 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Myliobatis californica* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - |
| *Peprilus simillimus* | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Seriphus politus* | - | - | 6 | 19 | 15 | 5 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Squalus acanthias* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | - | - | 1 | 2 | - | 1 | - | - | - | 3 | 1 |
| *Syngnathus californiensis* | - | - | - | - | - | - | 2 | 1 | 2 | - | 1 | - | 3 | 6 | 3 | 2 | 5 | 7 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |

Staiton T4-I

Standard Length (cm)

| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 43 | 56 | 66 | 102 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Amphistichus argenteus* | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Citharichthys stigmaeus* | 1 | 1 | - | 3 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cymatogaster aggregata* | - | - | - | 2 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Engraulis mordax* | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Genyonemus lineatus* | - | 1 | 8 | 80 | 80 | 18 | 8 | 1 | - | 1 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Myliobatis californica* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - |
| *Ophidion scrippsae* | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | 1 | - | - | - | - | - | - | 1 | - | - | - | - |
| *Platyrhinoidis triseriata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - |
| *Pleuronichthys guttulatus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - |
| *Porichthys myriaster* | - | - | - | 2 | 1 | 2 | 2 | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Seriphus politus* | - | - | 1 | 11 | 22 | 74 | 67 | 16 | 5 | 3 | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Syngnathus californiensis* | - | - | - | - | - | - | - | - | - | 3 | 4 | - | 4 | 2 | 12 | 6 | 8 | 4 | - | 2 | - | - | - | - | - | - |

## Appendix H-6. (Cont.).

| Station T4-II | Standard Length (cm) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 27 | 28 | 37 | 38 | 39 | 40 | 41 |
| *Amphistichus argenteus* | - | - | - | - | - | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Atractoscion nobilis* | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Citharichthys stigmaeus* | - | - | 7 | 21 | 7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cymatogaster aggregata* | - | - | - | 6 | 7 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Engraulis mordax* | - | - | 35 | 16 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Genyonemus lineatus* | - | 1 | 19 | 87 | 81 | 10 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Ophidion scrippsae* | - | - | - | - | - | 1 | 3 | - | 3 | 3 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Paralichthys californicus* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Platyrhinoidis triseriata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | 1 |
| *Porichthys myriaster* | - | - | - | 1 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Seriphus politus* | - | - | 3 | 22 | 40 | 72 | 47 | 9 | 6 | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Triakis semifasciata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - |

| Station T4-II (Cont.) | Standard Length (cm) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 66 |
| *Squalus acanthias* | 1 | 1 | 1 | 1 | 1 | 1 | - | 4 | 3 | 4 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |

**Appendix H-7. Length of fish species in trawl replicates. Mandalay Generating Station NPDES, Summer 2005.**

| StationT1-I | Standard Length (cm) | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 27 |
| *Amphistichus argenteus* | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Citharichthys stigmaeus* | - | 3 | - | - | - | 1 | 1 | 3 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cymatogaster aggregata* | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Genyonemus lineatus* | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Hyperprosopon argenteum* | - | - | 6 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Platyrhinoidis triseriata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Syngnathus californiensis* | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 2 | 2 | 3 | - | 3 | 1 | 2 | 1 | 1 | - | - |

| Station T1-II | Standard Length (cm) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| *Citharichthys stigmaeus* | 1 | 2 | 2 | - | 1 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Leptocottus armatus* | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Squatina californica* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - |
| *Syngnathus californiensis* | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 2 | 1 | 2 | 1 | 1 | - | - | 1 |

| Staiton T2-I | Standard Length (cm) | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 27 | 28 | 29 |
| *Amphistichus argenteus* | - | - | - | 4 | 5 | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Citharichthys stigmaeus* | 1 | 4 | 3 | 1 | - | 2 | 7 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Hyperprosopon argenteum* | - | 1 | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Parophrys vetulus* | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Phanerodon furcatus* | - | 1 | 7 | 7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Platyrhinoidis triseriata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Syngnathus californiensis* | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | 3 | 2 | - | - | 1 | 1 | - | - | - | - |
| *Synodus lucioceps* | - | - | - | - | - | 1 | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Station T2-II | Standard Length (cm) | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 27 | 28 | 29 | 31 |
| *Amphistichus argenteus* | - | - | - | 4 | 6 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Citharichthys stigmaeus* | 1 | 4 | 2 | 3 | 2 | 1 | 8 | 5 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Hyperprosopon argenteum* | - | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Menticirrhus undulatus* | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Parophrys vetulus* | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Platyrhinoidis triseriata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Syngnathus californiensis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 | - | 1 | - | - | - | - | - | - | - |
| *Synodus lucioceps* | - | - | - | - | - | - | - | 1 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Station TI-I | Standard Length (cm) | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| *Amphistichus argenteus* | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - |
| *Citharichthys stigmaeus* | - | - | - | 1 | - | 3 | - | 1 | 1 | - | - | - | - | - | - | - | - | - |
| *Cymatogaster aggregata* | - | - | 1 | - | 2 | 14 | 15 | 3 | 2 | - | - | - | - | - | - | - | - | - |
| *Engraulis mordax* | - | - | 1 | - | 10 | 26 | 4 | - | - | - | - | - | - | - | - | - | - | - |
| *Hyperprosopon argenteum* | - | 1 | 21 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Parophrys vetulus* | - | - | - | - | - | - | - | - | 1 | 1 | - | - | - | 2 | - | 1 | - | 1 |
| *Phanerodon furcatus* | - | - | - | 5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Pleuronichthys verticalis* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - |
| *Sardinops sagax* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - |
| *Seriphus politus* | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - |
| *Syngnathus californiensis* | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | 1 |
| *Xystreurys liolepis* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - |

| Station T3-2 | Standard Length (cm) | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| *Amphistichus argenteus* | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Citharichthys stigmaeus* | - | 2 | 5 | 1 | - | 2 | 5 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cymatogaster aggregata* | - | - | - | - | 1 | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Hyperprosopon argenteum* | - | - | 4 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Phanerodon furcatus* | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Syngnathus californiensis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 | - | 1 | - | - | 1 |
| *Synodus lucioceps* | - | - | - | - | - | - | 1 | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## Appendix H-7. (Cont.).

Station T4-1

| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Standard Length (cm) | | | | | | | | | | | | | | | | | | | | |
| *Amphistichus argenteus* | - | - | - | - | - | - | - | 1 | - | 1 | - | - | - | - | - | - | - | - | - | - | - |
| *Citharichthys stigmaeus* | - | - | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cymatogaster aggregata* | - | - | - | - | 1 | 15 | 15 | 4 | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| *Genyonemus lineatus* | - | - | - | 4 | 8 | 7 | 6 | 1 | - | - | 1 | - | - | - | - | - | - | - | - | - | - |
| *Hyperprosopon argenteum* | - | - | 6 | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Parophrys vetulus* | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - |
| *Phanerodon furcatus* | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Pleuronichthys ritteri* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - |
| *Pleuronichthys verticalis* | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - | - | - | - | - | - | - |
| *Rhacochilus toxotes* | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Syngnathus californiensis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 2 | - | 1 |
| *Synodus lucioceps* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - |

Station T4-II

| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 102 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Standard Length (cm) | | | | | | | | | | | |
| *Amphistichus argenteus* | - | - | - | - | - | - | - | - | 7 | 5 | 3 | - |
| *Citharichthys stigmaeus* | - | 2 | 1 | - | - | 2 | 1 | - | - | - | - | - |
| *Cymatogaster aggregata* | - | - | - | - | 1 | 12 | 4 | 1 | 2 | - | - | - |
| *Embiotoca jacksoni* | - | - | 1 | 1 | - | - | - | - | - | - | - | - |
| *Genyonemus lineatus* | - | 1 | 1 | - | - | - | 1 | - | - | - | - | - |
| *Hyperprosopon argenteum* | - | - | 1 | - | - | - | - | - | - | - | - | - |
| *Rhinobatos productus* | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Seriphus politus* | - | - | - | - | - | - | - | - | 1 | - | - | - |

**Appendix H-8. Abundance of macroinvertebrate species in trawl replicates, winter and summer. Mandalay Generating Station NPDES, 2005**

| | Winter | | | | | | | | | Summer | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | T3 | | T4 | | | T1 | | T2 | | T3 | | T4 | | | Annual |
| Species | I | II | I | II | I | II | I | II | Total | I | II | I | II | I | II | I | II | Total | Total |
| *Cancer gracilis* | - | - | 2 | 3 | 1 | 3 | 7 | 13 | 29 | 4 | 2 | 2 | 4 | 2 | 4 | 18 | 11 | 47 | 76 |
| *Crangon nigromaculata* | 423 | 404 | 1,088 | 1,945 | 962 | 323 | 683 | 741 | 6,569 | 383 | 301 | 65 | 97 | 18 | 34 | 9 | 9 | 916 | 7,485 |
| *Dendraster excentricus* | - | 3 | 45 | 42 | 28 | 25 | 94 | 87 | 324 | - | - | 38 | 29 | 1 | - | 78 | 59 | 205 | 529 |
| *Loxorhynchus grandis* | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | 1 | 1 |
| *Opisthopus transversus* | - | - | 1 | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| *Portunus xantusii* | 1 | - | 1 | - | - | - | 1 | - | 3 | - | - | - | - | - | - | - | - | - | 3 |
| *Pyromaia tuberculata* | - | - | - | - | - | - | - | - | - | 1 | 1 | - | 2 | - | 2 | - | - | 6 | 6 |
| Total Abundance | 831 | | 3,127 | | 1,342 | | 1,626 | | 6,926 | 692 | | 238 | | 61 | | 184 | | 1,175 | 8,101 |
| Species | 3 | | 4 | | 2 | | 3 | | 5 | 3 | | 5 | | 4 | | 3 | | 5 | 7 |
| Diversity (H') | 0.03 | | 0.14 | | 0.19 | | 0.42 | | 0.22 | 0.07 | | 0.77 | | 0.54 | | 0.74 | | 0.66 | 0.31 |
| Evenness (J') | 0.03 | | 0.10 | | 0.27 | | 0.38 | | 0.14 | 0.06 | | 0.48 | | 0.39 | | 0.67 | | 0.41 | 0.16 |
| Fish Parasites Not Included Above | | | | | | | | | | | | | | | | | | | |
| *Elthusa vulgaris* | - | - | - | - | 1 | - | - | - | 1 | - | - | 2 | 5 | 9 | 3 | 3 | 1 | 23 | 24 |

Appendix H-9. Abundance of macroinvertebrate species ( per 100m ) in trawl replicates, winter and summer. Mandalay Generating Station NPDES, 2005.

| | Winter | | | | | | | | | Summer | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | T3 | | T4 | | | T1 | | T2 | | T3 | | T4 | | | Annual |
| Species | I | II | I | II | I | II | I | II | Total | I | II | I | II | I | II | I | II | Total | Total |
| *Crangon nigromaculata* | 55.08 | 62.71 | 161.65 | 289.43 | 138.50 | 49.85 | 94.38 | 106.84 | 119.80 | 59.39 | 50.15 | 10.16 | 16.47 | 2.77 | 5.01 | 1.26 | 1.29 | 18.31 | 69.06 |
| *Dendraster excentricus* | - | 0.47 | 6.69 | 6.25 | 4.03 | 3.86 | 12.99 | 12.54 | 5.85 | - | - | 5.94 | 4.92 | 0.15 | - | 10.96 | 8.44 | 3.80 | 4.83 |
| *Cancer gracilis* | - | - | 0.30 | 0.45 | 0.14 | 0.46 | 0.97 | 1.87 | 0.52 | 0.62 | 0.33 | 0.31 | 0.68 | 0.31 | 0.59 | 2.53 | 1.57 | 0.87 | 0.70 |
| *Pyromaia tuberculata* | - | - | - | - | - | - | - | - | - | 0.16 | 0.17 | - | 0.34 | - | 0.29 | - | - | 0.12 | 0.06 |
| *Portunus xantusii* | 0.13 | - | 0.15 | - | - | - | 0.14 | - | 0.05 | - | - | - | - | - | - | - | - | - | 0.03 |
| *Loxorhynchus grandis* | - | - | - | - | - | - | - | - | - | - | - | 0.16 | - | - | - | - | - | 0.02 | 0.01 |
| *Opisthopus transversus* | - | - | 0.15 | - | - | - | - | - | 0.02 | - | - | - | - | - | - | - | - | - | 0.01 |
| Total Abundance/100m | 55.21 | 63.17 | 168.93 | 296.13 | 142.68 | 54.17 | 108.48 | 121.26 | 126.25 | 60.17 | 50.65 | 16.57 | 22.41 | 3.23 | 5.90 | 14.75 | 11.30 | 23.12 | 74.69 |

**Appendix H-10. Biomass (kg) of macroinvertebrates species in trawl replicates, winter and summer. Mandalay Generating Station NPDES, 2005.**

| | Winter | | | | | | | | | Summer | | | | | | | | | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | T3 | | T4 | | | T1 | | T2 | | T3 | | T4 | | | |
| Species | I | II | I | II | I | II | I | II | Total | I | II | I | II | I | II | I | II | Total | Total |
| *Cancer gracilis* | - | - | 0.062 | 0.092 | 0.030 | 0.039 | 0.053 | 0.193 | 0.469 | 0.056 | 0.007 | 0.001 | 0.062 | 0.059 | 0.150 | 0.095 | 0.198 | 0.628 | 1.097 |
| *Crangon nigromaculata* | 1.340 | 1.280 | 3.450 | 6.167 | 3.050 | 1.023 | 2.165 | 2.350 | 20.825 | 1.236 | 0.897 | 0.160 | 0.222 | 0.073 | 0.099 | 0.032 | 0.036 | 2.755 | 23.580 |
| *Dendraster excentricus* | - | 0.006 | 0.068 | 0.066 | 0.035 | 0.033 | 0.855 | 0.805 | 1.868 | - | - | 0.110 | 0.070 | 0.002 | - | 0.434 | 0.385 | 1.001 | 2.869 |
| *Loxorhynchus grandis* | - | - | - | - | - | - | - | - | - | - | - | 4.100 | - | - | - | - | - | 4.100 | 4.100 |
| *Opisthopus transversus* | - | - | 0.001 | - | - | - | - | - | 0.001 | - | - | - | - | - | - | - | - | - | 0.001 |
| *Portunus xantusii* | 0.005 | - | 0.007 | - | - | - | 0.003 | - | 0.015 | - | - | - | - | - | - | - | - | - | 0.015 |
| *Pyromaia tuberculata* | - | - | - | - | - | - | - | - | - | 0.001 | 0.001 | - | 0.006 | - | 0.002 | - | - | 0.010 | 0.010 |
| Total Biomass (kg) | 1.345 | 1.286 | 3.588 | 6.325 | 3.115 | 1.095 | 3.076 | 3.348 | 23.178 | 1.293 | 0.905 | 4.373 | 0.362 | 0.138 | 0.252 | 0.563 | 0.620 | 8.506 | 31.684 |
| Species | 3 | | 4 | | 2 | | 3 | | 5 | 3 | | 5 | | 4 | | 3 | | 5 | 7 |
| Diversity (H') | 0.03 | | 0.14 | | 0.19 | | 0.42 | | 0.22 | 0.07 | | 0.77 | | 0.54 | | 0.74 | | 0.66 | 0.31 |
| Evenness (J') | 0.03 | | 0.10 | | 0.27 | | 0.38 | | 0.14 | 0.06 | | 0.48 | | 0.39 | | 0.67 | | 0.41 | 0.16 |

Fish parasites not included above

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Elthusa vulgaris | - | - | - | - | 0.001 | - | - | - | 0.001 | - | - | 0.002 | 0.002 | 0.004 | 0.001 | 0.002 | 0.001 | 0.012 | 0.013 |

**Appendix H-11. Biomass (kg) of macroinvertebrates species (per 100 m) in trawl replicates, winter and summer. Mandalay Generating Station NPDES, 2005.**

| | Winter | | | | | | | | | Summer | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | | T2 | | T3 | | T4 | | | T1 | | T2 | | T3 | | T4 | | | Annual |
| Species | I | II | I | II | I | II | I | II | Mean | I | II | I | II | I | II | I | II | Mean | Mean |
| *Cancer gracilis* | - | - | 0.009 | 0.014 | 0.004 | 0.006 | 0.007 | 0.028 | 0.009 | 0.009 | 0.001 | 0.000 | 0.011 | 0.009 | 0.022 | 0.013 | 0.028 | 0.012 | 0.010 |
| *Crangon nigromaculata* | 0.174 | 0.199 | 0.513 | 0.918 | 0.439 | 0.158 | 0.299 | 0.339 | 0.380 | 0.192 | 0.149 | 0.025 | 0.038 | 0.011 | 0.015 | 0.004 | 0.005 | 0.055 | 0.217 |
| *Dendraster excentricus* | - | 0.001 | 0.010 | 0.010 | 0.005 | 0.005 | 0.118 | 0.116 | 0.033 | - | - | 0.017 | 0.012 | 0.000 | - | 0.061 | 0.055 | 0.018 | 0.026 |
| *Loxorhynchus grandis* | - | - | - | - | - | - | - | - | - | - | - | 0.641 | - | - | - | - | - | 0.080 | 0.040 |
| *Opisthopus transversus* | - | - | 0.000 | - | - | - | - | - | 0.000 | - | - | - | - | - | - | - | - | - | 0.000 |
| *Portunus xantusii* | 0.001 | - | 0.001 | - | - | - | 0.000 | - | 0.000 | - | - | - | - | - | - | - | - | - | 0.000 |
| *Pyromaia tuberculata* | - | - | - | - | - | - | - | - | - | 0.000 | 0.000 | - | 0.001 | - | 0.000 | - | - | 0.000 | 0.000 |
| Total Biomass (kg) | 0.175 | 0.200 | 0.533 | 0.941 | 0.448 | 0.169 | 0.425 | 0.483 | 0.422 | 0.201 | 0.151 | 0.683 | 0.061 | 0.021 | 0.037 | 0.079 | 0.089 | 0.165 | 0.294 |
| Species | 3 | | 5 | | 3 | | 4 | | 5 | 3 | | 5 | | 4 | | 3 | | 5 | 7 |
| Diversity (H') | 0.03 | | 0.14 | | 0.19 | | 0.42 | | 0.22 | 0.07 | | 0.77 | | 0.54 | | 0.74 | | 0.66 | 0.31 |
| Evenness (J') | 0.03 | | 0.09 | | 0.17 | | 0.30 | | 0.14 | 0.06 | | 0.48 | | 0.39 | | 0.67 | | 0.41 | 0.16 |

| Fish parasites not included above | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Elthusa vulgaris* | - | - | - | - | 0.001 | - | - | - | 0.001 | - | - | 0.002 | 0.002 | 0.004 | 0.001 | 0.002 | 0.001 | 0.012 | 0.012 |

**Appendix H-12. Abundance of fish species in trawl replicates, 1978 - 2005. Mandalay Generating Station NPDES, 2005.**

| | 1978 | | 1980 | | 1986 | | 1988 | | 1990 | | 1991 | | 1992 | | 1993 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | W | S | W | S | W | S | W | S | W | S | W | S | W | S | W | S |
| *Genyonemus lineatus* | 2129 | 4584 | 4174 | 4272 | 302 | 1162 | - | 1150 | 598 | 994 | 382 | 1909 | 1692 | 1064 | 30 | 3013 |
| *Seriphus politus* | 371 | 595 | 4183 | 706 | 400 | 430 | 18 | 177 | 794 | 163 | 788 | 553 | 1643 | 4406 | 265 | 2744 |
| *Engraulis mordax* | 218 | 1258 | 221 | 273 | 2 | - | - | 52 | 23 | 65 | - | 359 | 1211 | 258 | - | 159 |
| *Citharichthys stigmaeus* | 29 | 7 | 4 | 4 | 18 | 22 | 35 | 29 | 35 | 41 | 180 | 37 | 3 | 1 | 52 | 23 |
| *Cymatogaster aggregata* | 59 | 48 | 1 | 23 | - | - | - | 4 | - | 33 | 1 | 62 | 1 | 3 | 2 | 56 |
| *Amphistichus argenteus* | 95 | 115 | 96 | 76 | 10 | 36 | 173 | 50 | - | 38 | 7 | 88 | 2 | 27 | 99 | 16 |
| *Phanerodon furcatus* | 32 | 213 | 78 | 243 | - | 2 | - | 17 | - | 18 | - | 26 | 1 | 4 | - | 5 |
| *Hyperprosopon argenteum* | 107 | 228 | 198 | 142 | 1 | 7 | 1 | 17 | - | - | - | 50 | 2 | 3 | 1 | 25 |
| *Syngnathus californiensis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Platyrhinoidis triseriata* | 2 | 25 | 15 | 6 | 4 | 8 | 13 | 3 | - | 6 | 44 | 12 | 4 | - | 30 | 137 |
| *Paralichthys californicus* | 3 | 22 | 3 | 51 | 4 | 62 | 5 | 53 | 1 | 20 | 12 | 15 | - | 1 | 3 | 5 |
| *Menticirrhus undulatus* | 15 | - | 2 | 1 | 73 | 6 | - | - | - | - | 3 | - | 1 | 1 | 31 | 2 |
| *Synodus lucioceps* | 5 | 12 | 1 | 4 | - | - | - | - | - | 8 | - | - | - | 1 | 2 | - |
| *Umbrina roncador* | 2 | - | - | - | 11 | - | 1 | - | - | - | 1 | - | - | - | 79 | - |
| *Syngnathus exilis* | 1 | 2 | - | - | - | - | 19 | 58 | 4 | 1 | - | - | - | - | - | - |
| *Xystreurys liolepis* | - | - | - | 10 | - | 17 | - | 10 | - | 1 | - | 3 | - | 1 | - | 1 |
| *Parophrys vetulus* | - | 22 | - | 8 | - | 5 | - | 49 | 2 | 5 | - | - | - | - | - | 1 |
| *Ophidion scrippsae* | 1 | - | 3 | - | 8 | 1 | - | - | 7 | 1 | 45 | - | - | - | 23 | 5 |
| *Rhinobatos productus* | - | 6 | 4 | 7 | - | 6 | - | 22 | - | 13 | 2 | 16 | - | - | 1 | 18 |
| *Peprilus simillimus* | - | 2 | 2 | 21 | - | - | - | 6 | - | - | - | 1 | - | 7 | - | - |
| *Syngnathus* spp | - | - | 6 | - | 11 | 6 | - | - | - | - | 5 | 13 | 8 | 3 | 6 | 19 |
| *Pleuronichthys verticalis* | 8 | - | - | 17 | - | - | - | - | - | - | 29 | 2 | - | - | - | - |
| *Leptocottus armatus* | - | - | 2 | - | 4 | 3 | 2 | 17 | 1 | 2 | 1 | 5 | - | - | - | 8 |
| *Myliobatis californica* | 1 | 3 | 4 | - | - | - | - | - | 3 | 2 | - | 2 | 3 | 1 | 1 | 1 |
| *Pleuronichthys guttulatus* | 1 | 8 | 8 | 7 | 2 | 1 | 5 | 1 | 8 | - | 3 | - | - | - | 2 | 3 |
| *Squalus acanthias* | 4 | 2 | 37 | - | 3 | - | - | - | - | - | 3 | 2 | - | - | - | - |
| *Pleuronichthys ritteri* | - | 5 | - | - | 1 | 2 | - | - | - | 3 | - | 1 | - | - | - | 5 |
| *Embiotoca jacksoni* | - | 2 | - | 3 | - | - | - | - | - | - | - | - | 3 | - | - | - |
| *Sardinops sagax* | - | - | - | - | 2 | - | - | - | - | 1 | 1 | - | 9 | 6 | - | 2 |
| *Hyperprosopon anale* | 10 | 7 | 2 | 15 | - | - | - | - | - | - | - | - | - | - | - | - |
| *Brachyistius frenatus* | 2 | - | 27 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Atherinopsis californiensis* | - | - | - | - | - | - | - | 12 | - | 1 | - | - | - | - | - | 1 |
| *Atractoscion nobilis* | 4 | - | - | - | - | - | - | - | - | - | - | 2 | - | 4 | 3 | 9 |
| *Rhacochilus toxotes* | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - |
| *Mustelus californicus* | - | 1 | 2 | 1 | 2 | 6 | - | - | - | - | - | - | - | - | 1 | 1 |
| *Rhacochilus vacca* | 11 | - | 4 | 1 | - | - | - | 1 | - | - | - | - | - | - | - | - |
| *Atherinops affinis* | - | - | 1 | - | - | - | - | - | - | - | - | - | 13 | 3 | - | - |
| *Stellerina xyosterna* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Squatina californica* | 1 | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - |
| *Sebastes auriculatus* | - | 1 | 6 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Sphyraena argentea* | - | - | - | - | - | - | - | - | - | - | - | - | - | 9 | - | - |
| *Triakis semifasciata* | - | - | - | - | - | 1 | - | 4 | - | - | - | 1 | - | - | 1 | - |
| *Mustelus henlei* | - | 1 | - | - | - | - | - | 2 | - | - | - | 3 | - | - | - | - |
| *Zalembius rosaceus* | - | 5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Porichthys myriaster* | - | 2 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| *Raja inornata* | - | - | - | - | 1 | - | 1 | 1 | 1 | - | 2 | - | - | - | - | - |
| *Symphurus atricauda* | 1 | 4 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Anchoa compressa* | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - | 1 | - |
| *Paralabrax nebulifer* | - | - | - | - | 1 | 1 | - | - | - | - | 1 | - | - | - | - | - |
| *Porichthys notatus* | - | - | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - |
| *Roncador stearnsii* | - | - | 4 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Raja binoculata* | - | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Urolophus halleri* | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - |
| *Heterostichus rostratus* | 1 | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - |
| *Platichthys stellatus* | 1 | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Sebastes carnatus* | - | - | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - |
| *Aulorhynchus flavidus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Chilara taylori* | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Clupea pallasii* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Raja kincaidii* | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - |
| *Sebastes miniatus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Sebastes paucispinis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Sebastes serranoides* | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Torpedo californica* | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Trichiurus nitens* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Odontophyxis trispinosa* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Number of individuals | 3114 | 7185 | 9091 | 5895 | 861 | 1787 | 274 | 1735 | 1480 | 1416 | 1512 | 3162 | 4596 | 5803 | 633 | 6259 |
| Number of species | 27 | 31 | 30 | 24 | 21 | 23 | 12 | 22 | 13 | 20 | 20 | 22 | 15 | 19 | 20 | 24 |
| Total Biomass (kg) | 149.9 | 351.1 | 405.1 | 760.3 | 51.9 | 61.3 | 9.6 | 66.9 | 54.8 | 79.0 | 62.8 | 25.4 | 49.4 | 62.7 | 17.7 | 61.0 |
| Stations /Replicates | 14/14 | | 12/12 | | 3/6 | | 3/6 | | 4/8 | | 4/8 | | 4/8 | | 4/8 | |
| Number of seasons sampled | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | |

Notes: W = winter, S = summer, F.O. = frequency of occurrence, 0.00 = < 0.005

**Appendix H-12. (Cont.).**

| | 1994 | | 1997 | 1999 | | 2000 | | 2001 | | 2002 | | 2003 | 2004 | | 2005 | | | Percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | W | S | S | W | S | W | S | W | S | W | S | S | W | S | W | S | Total | Total |
| *Genyonemus lineatus* | 300 | 6937 | 20 | 76 | 287 | 994 | 4369 | 906 | 127 | 201 | 9141 | - | 16 | - | 24 | 43 | 50829 | 48.79 |
| *Seriphus politus* | 1185 | 4298 | - | 70 | 6 | 42 | 1310 | 782 | 3848 | 26 | 3945 | 8 | 4 | 134 | 1 | - | 33894 | 32.54 |
| *Engraulis mordax* | 88 | 27 | - | 35 | 605 | 253 | 3 | 145 | 238 | 2 | 1214 | 9 | 448 | 2874 | 38 | 97 | 10040 | 9.64 |
| *Citharichthys stigmaeus* | 13 | 3 | 7 | 103 | 40 | 96 | 123 | 30 | 8 | 85 | 139 | 51 | 398 | 78 | 295 | 51 | 1694 | 1.63 |
| *Cymatogaster aggregata* | 1 | 87 | 17 | - | 190 | - | 42 | 1 | 10 | 3 | 526 | 18 | 1 | 117 | 230 | 95 | 1306 | 1.25 |
| *Amphistichus argenteus* | 25 | 16 | 18 | 1 | - | 25 | 8 | 7 | 2 | 10 | 32 | - | 25 | 20 | 4600 | 32 | 1117 | 1.07 |
| *Phanerodon furcatus* | - | 80 | 12 | - | 25 | - | - | - | 1 | - | 225 | - | - | - | 5 | 1 | 982 | 0.94 |
| *Hyperprosopon argenteum* | 7 | 21 | 1 | - | 1 | - | 16 | - | 37 | - | 28 | 1 | - | 9 | 1 | 52 | 903 | 0.87 |
| *Syngnathus californiensis* | - | - | - | 26 | 54 | 24 | 125 | 25 | 79 | 13 | 166 | 3 | 90 | 28 | - | 1 | 633 | 0.61 |
| *Platyrhinoidis triseriata* | - | 2 | 3 | 4 | 9 | 5 | 9 | 3 | 3 | 23 | 29 | - | 1 | 1 | 2 | 2 | 401 | 0.38 |
| *Paralichthys californicus* | 1 | 10 | - | - | 2 | - | 5 | 1 | - | 2 | 2 | - | - | - | 3 | 10 | 283 | 0.27 |
| *Menticirrhus undulatus* | 19 | - | - | 2 | - | 64 | 9 | 23 | 1 | 8 | 1 | - | 8 | - | 27 | - | 270 | 0.26 |
| *Synodus lucioceps* | - | 4 | - | - | 1 | - | 1 | 5 | 21 | 1 | 114 | - | 1 | - | 1 | - | 181 | 0.17 |
| *Umbrina roncador* | 50 | - | - | - | - | - | - | 3 | - | - | - | - | - | - | - | - | 147 | 0.14 |
| *Syngnathus exilis* | 14 | 44 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 143 | 0.14 |
| *Xystreurys liolepis* | - | 5 | 1 | - | 39 | - | 27 | - | 1 | 1 | 15 | - | - | - | - | 1 | 132 | 0.13 |
| *Parophrys vetulus* | 2 | 2 | 1 | - | 7 | - | - | - | - | - | 15 | - | - | 1 | 9 | - | 120 | 0.12 |
| *Ophidion scrippsae* | 4 | - | - | 1 | - | 3 | 2 | - | - | - | - | - | - | - | 18 | - | 104 | 0.10 |
| *Rhinobatos productus* | - | 2 | - | 1 | - | - | 2 | - | - | - | 2 | - | - | - | - | 1 | 102 | 0.10 |
| *Peprilus simillimus* | - | 3 | - | - | - | - | 30 | - | 2 | - | 20 | - | - | 1 | - | 9 | 95 | 0.09 |
| *Syngnathus* spp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 77 | 0.07 |
| *Pleuronichthys verticalis* | 3 | - | - | - | 1 | 1 | 8 | - | 2 | - | - | - | - | - | 2 | - | 71 | 0.07 |
| *Leptocottus armatus* | - | 1 | - | - | 1 | - | - | - | - | 1 | 4 | - | 2 | 1 | 41 | - | 55 | 0.05 |
| *Myliobatis californica* | - | 2 | - | 4 | 1 | - | 3 | 4 | 1 | 1 | 1 | - | 15 | 2 | 21 | 3 | 55 | 0.05 |
| *Pleuronichthys guttulatus* | - | - | - | - | 1 | - | - | - | - | 1 | 1 | 1 | - | - | - | 3 | 53 | 0.05 |
| *Squalus acanthias* | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 1 | 52 | 0.05 |
| *Pleuronichthys ritteri* | 3 | 20 | - | - | - | - | - | - | 3 | 1 | - | - | - | - | 2 | 1 | 44 | 0.04 |
| *Embiotoca jacksoni* | - | 3 | - | - | - | - | - | - | - | - | 30 | - | 2 | - | 161 | 41 | 43 | 0.04 |
| *Sardinops sagax* | - | 1 | - | - | - | - | 9 | - | 1 | - | - | - | - | 7 | 1 | - | 39 | 0.04 |
| *Hyperprosopon anale* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 34 | 0.03 |
| *Brachyistius frenatus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 29 | 0.03 |
| *Atherinopsis californiensis* | - | 1 | 9 | - | - | - | - | - | - | - | 1 | - | - | 1 | - | - | 26 | 0.02 |
| *Atractoscion nobilis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1104 | 2 | 22 | 0.02 |
| *Rhacochilus toxotes* | - | 3 | - | - | - | - | - | - | - | - | 18 | - | - | - | 2 | - | 22 | 0.02 |
| *Mustelus californicus* | - | 2 | - | - | - | - | 1 | - | - | - | 2 | - | - | - | - | - | 19 | 0.02 |
| *Rhacochilus vacca* | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 19 | 0.02 |
| *Atherinops affinis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 17 | 0.02 |
| *Stellerina xyosterna* | - | - | - | - | - | - | - | - | - | - | - | - | 14 | 1 | - | - | 15 | 0.01 |
| *Squatina californica* | - | - | - | - | - | - | 6 | - | 1 | - | 5 | - | - | - | - | 1 | 14 | 0.01 |
| *Sebastes auriculatus* | - | - | - | - | - | - | - | - | - | - | - | - | 2 | - | 1 | - | 9 | 0.01 |
| *Sphyraena argentea* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 9 | 0.01 |
| *Triakis semifasciata* | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 8 | 0.01 |
| *Mustelus henlei* | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 7 | 0.01 |
| *Zalembius rosaceus* | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 | - | - | 7 | 0.01 |
| *Porichthys myriaster* | - | - | - | - | 1 | - | - | - | - | - | 1 | - | - | - | 2 | - | 6 | 0.01 |
| *Raja inornata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 6 | 0.01 |
| *Symphurus atricauda* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5 | 0.00 |
| *Anchoa compressa* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | 0.00 |
| *Paralabrax nebulifer* | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | 0.00 |
| *Porichthys notatus* | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 4 | 0.00 |
| *Roncador stearnsii* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4 | 0.00 |
| *Raja binoculata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 0.00 |
| *Urolophus halleri* | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 0.00 |
| *Heterostichus rostratus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.00 |
| *Platichthys stellatus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.00 |
| *Sebastes carnatus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 | 0.00 |
| *Aulorhynchus flavidus* | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 | 0.00 |
| *Chilara taylori* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| *Clupea pallasii* | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 1 | 0.00 |
| *Raja kincaidii* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| *Sebastes miniatus* | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| *Sebastes paucispinis* | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| *Sebastes serranoides* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| *Torpedo californica* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| *Trichiurus nitens* | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 0.00 |
| *Odontophyxis trispinosa* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 23 | - | 0.00 |
| Number of individuals | 1718 | 11578 | 89 | 326 | 1271 | 1508 | 6108 | 1935 | 4389 | 379 | 15677 | 91 | 1027 | 3277 | 6591 | 471 | 104176 | |
| Number of species | 18 | 26 | 10 | 14 | 18 | 11 | 21 | 13 | 22 | 16 | 26 | 7 | 15 | 17 | 24 | 22 | 65 | |
| Total Biomass (kg) | 25.7 | 152.6 | 2.5 | 15.0 | 27.8 | 13.1 | 146.1 | 22.0 | 65.1 | 9.5 | 279.8 | 1.3 | 60.7 | 46.8 | 60.7 | 46.8 | 3136.9 | |
| Stations /Replicates | 4/8 | | 4/8 | 4/8 | | 4/8 | | 4/8 | | 4/8 | | 4/4 | 4/8 | | 4/8 | | | |
| Number of seasons sampled | 2 | | 1 | 2 | | 2 | | 2 | | 2 | | 1 | 2 | | 2 | | | |

Notes: W = winter, S = summer, F.O. = frequency of occurrence, 0.00 = < 0.005

**Appendix H-13. Abundance of macroinvertebrates in trawl replicates, 1978 - 2005. Mandalay Generating Station NPDES, 2005.**

| | 1978 | | 1980 | | 1986 | | 1988 | | 1990 | | 1991 | | 1992 | | 1993 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | W | S | W | S | W | S | W | S | W | S | W | S | W | S | W | S |
| *Dendraster excentricus* | 10 | - | - | - | 912 | 2941 | - | 165 | 339 | 197 | 520 | 161 | 4 | 1 | 2 | 1 |
| *Crangon nigromaculata* | 47 | 8 | 5 | 3 | 69 | 168 | 36 | 80 | 242 | 4 | 317 | 85 | 15 | 3 | 64 | 6 |
| *Cancer gracilis* | 3 | - | 3 | - | 2 | 1 | 1 | - | 138 | 3 | 7 | - | - | - | 4 | - |
| *Astropecten verrilli* | 90 | 5 | - | - | - | - | - | - | - | 3 | - | - | - | - | - | - |
| *Pyromaia tuberculata* | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Pleurobranchia bachei* | - | - | - | - | - | - | - | - | - | - | 45 | - | - | - | - | - |
| *Penaeus californiensis* | - | - | 33 | 5 | 1 | - | - | - | - | - | - | - | - | - | - | - |
| *Portunus xantusii* | 12 | - | - | - | - | - | - | - | - | - | 5 | - | - | - | 3 | 1 |
| *Panulirus interruptus* | 1 | 2 | 1 | 1 | - | 2 | - | - | - | 2 | 1 | - | - | 2 | - | 2 |
| *Polyorchis pencillata* | - | - | - | - | - | 1 | - | 1 | - | - | - | - | - | - | - | - |
| *Heptacarpus* sp A of MBC | - | - | - | - | - | - | - | - | 4 | - | - | - | - | - | - | - |
| *Cancer anthonyi* | - | - | - | - | - | 9 | 1 | 5 | 2 | - | 1 | - | - | - | - | - |
| *Heptacarpus stimpsoni* | - | - | - | - | - | - | - | - | 4 | - | - | - | - | - | - | - |
| *Loxorhynchus grandis* | 1 | - | 2 | - | - | - | - | - | 2 | - | 4 | - | - | - | 1 | 1 |
| *Randallia ornata* | 10 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Opisthopus transversus* | 5 | - | 4 | - | 1 | - | - | - | - | - | - | - | - | - | - | - |
| *Astropecten armatus* | - | - | - | - | - | - | - | - | - | 5 | - | 1 | - | - | - | 1 |
| *Cancer antennarius* | 3 | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 4 | - |
| *Nassarius fossatus* | - | - | - | - | - | - | - | - | - | 1 | 1 | 3 | - | - | - | - |
| *Renilla kollikeri* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Farfantepenaeus californicus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Nassarius perpinguis* | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - |
| *Pugettia producta* | 5 | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - |
| *Heterocrypta occidentalis* | 6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Caudina arenicola* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Thetys vagina* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Cancer* spp | - | - | - | - | - | 1 | - | - | - | - | 1 | - | - | - | 1 | - |
| *Heptacarpus palpator* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Isocheles pilosus* | - | - | - | - | - | - | 1 | - | - | - | - | 1 | - | - | - | - |
| *Loxorhynchus crispatus* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - |
| *Blepharipoda occidentalis* | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - |
| *Calliostoma* sp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Nassarius* sp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Pisaster brevispinis* | 1 | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - |
| *Pisaster ochraceus* | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Polinices* sp | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Astropecten* sp | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - |
| *Hippolytes californiensis* | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - |
| *Idotea* sp | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - |
| *Muricea californica* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - |
| Paguridae | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - |
| *Pagurus spilocarpus* | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - |
| *Pelagia noctiluca* | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - |
| Penaeid shrimp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Rossia pacifica* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Salpa* sp | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Solen* sp | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - |
| *Synidotea harfordi* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Triopha maculata* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Number of Individuals | 196 | 19 | 48 | 9 | 989 | 3126 | 39 | 253 | 731 | 218 | 904 | 252 | 19 | 6 | 79 | 13 |
| Number of species | 15 | 6 | 6 | 3 | 8 | 10 | 4 | 6 | 7 | 10 | 12 | 6 | 2 | 3 | 7 | 7 |
| Total Biomass (kg) | na | na | na | na | na | na | 0.05 | 2.09 | 8.44 | 1.95 | 11.2 | 1.75 | 0.05 | 0.14 | 1.73 | 1.72 |
| Parasitic species (not included above): | | | | | | | | | | | | | | | | |
| *Elthusa vulgaris* | 3 | 6 | - | - | 1 | - | - | 2 | - | - | 15 | 4 | 23 | 8 | 8 | 3 |
| *Elthusa* sp | - | - | - | - | - | - | - | - | 4 | 2 | - | - | - | - | - | - |
| *Ethusa californica* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Nerocila* sp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Copepoda | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - |
| Bopyridae, unid. | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

Notes: na = not available, W = winter, S = summer

**Appendix H-13. (Cont.).**

| Species | 1994 W | 1994 S | 1997 S | 1999 W | 1999 S | 2000 W | 2000 S | 2001 W | 2001 S | 2002 W | 2002 S | 2003 S | 2004 W | 2004 S | 2005 W | 2005 S | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Dendraster excentricus* | 90 | 1232 | 11 | 181 | 17679 | 452 | 12426 | 3882 | 7879 | 2122 | 710 | 132 | 5 | 42 | 324 | 205 | 52096 |
| *Crangon nigromaculata* | 113 | 240 | 5 | 272 | 1960 | 2154 | 1186 | 482 | 250 | 273 | 738 | 706 | 2977 | 69 | 6569 | 916 | 12577 |
| *Cancer gracilis* | 3 | 2 | - | 3 | 9 | 14 | 5 | 78 | 25 | 56 | 3 | 16 | 56 | 37 | 29 | 47 | 469 |
| *Astropecten verrilli* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 98 |
| *Pyromaia tuberculata* | - | 1 | - | 13 | 33 | - | 2 | 1 | 2 | - | 1 | 1 | - | 1 | - | 6 | 56 |
| *Pleurobranchia bachei* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 45 |
| *Penaeus californiensis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 39 |
| *Portunus xantusii* | 4 | 1 | - | 6 | - | - | 1 | 1 | - | - | - | - | 3 | - | 3 | - | 37 |
| *Panulirus interruptus* | - | 1 | - | 1 | - | 8 | 3 | 3 | - | 2 | 2 | - | - | - | - | - | 34 |
| *Polyorchis pencillata* | - | - | - | 22 | 1 | 4 | 1 | - | - | 2 | 1 | - | - | - | - | - | 33 |
| *Heptacarpus* sp A of MBC | - | 26 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 30 |
| *Cancer anthonyi* | 2 | - | - | - | - | - | 1 | - | 1 | - | - | - | 3 | - | - | - | 25 |
| *Heptacarpus stimpsoni* | 12 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 16 |
| *Loxorhynchus grandis* | - | - | 2 | - | - | - | - | - | - | 1 | 1 | - | - | - | - | 1 | 15 |
| *Randallia ornata* | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | 11 |
| *Opisthopus transversus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 10 |
| *Astropecten armatus* | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 8 |
| *Cancer antennarius* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 8 |
| *Nassarius fossatus* | - | 1 | - | - | - | - | - | - | - | - | 1 | - | 1 | - | - | - | 8 |
| *Renilla kollikeri* | - | - | - | 4 | 2 | - | - | - | 1 | 1 | - | - | - | - | - | - | 8 |
| *Farfantepenaeus californicus* | - | - | - | - | - | 2 | 5 | - | - | - | - | - | - | - | - | - | 7 |
| *Nassarius perpinguis* | - | - | - | - | - | - | - | - | 1 | - | 4 | - | - | 1 | - | - | 7 |
| *Pugettia producta* | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | 7 |
| *Heterocrypta occidentalis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 6 |
| *Caudina arenicola* | - | - | - | - | - | - | 1 | 1 | - | - | - | - | 2 | - | - | - | 4 |
| *Thetys vagina* | - | - | - | - | - | - | - | - | - | 1 | 3 | - | - | - | - | - | 4 |
| *Cancer* spp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 3 |
| *Heptacarpus palpator* | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - | - | - | 3 |
| *Isocheles pilosus* | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 3 |
| *Loxorhynchus crispatus* | - | - | - | - | 1 | - | - | - | - | - | - | - | 1 | - | - | - | 3 |
| *Blepharipoda occidentalis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| *Calliostoma* sp | - | - | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | 2 |
| *Nassarius* sp | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | 2 |
| *Pisaster brevispinis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| *Pisaster ochraceus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| *Polinices* sp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| *Astropecten* sp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| *Hippolytes californiensis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Idotea* sp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Muricea californica* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Paguridae | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Pagurus spilocarpus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Pelagia noctiluca* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Penaeid shrimp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Rossia pacifica* | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Salpa* sp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Solen* sp | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Synidotea harfordi* | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Triopha maculata* | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 |
| Number of Individuals | 225 | 1505 | 18 | 503 | 19688 | 2634 | 13632 | 4448 | 8164 | 2459 | 1464 | 855 | 3049 | 150 | 6926 | 1175 | 65695 |
| Number of species | 7 | 9 | 3 | 9 | 9 | 6 | 11 | 7 | 9 | 9 | 10 | 4 | 9 | 5 | 5 | 5 | 49 |
| Total Biomass (kg) | 1.41 | 1.68 | 0.08 | 3.66 | 25.26 | 6.42 | 34.21 | 18.05 | 45.01 | 19.02 | 9.98 | 2.42 | 6.49 | 0.45 | 6.49 | 0.45 | 203.20 |
| Parasitic species (not included above): | | | | | | | | | | | | | | | | | |
| *Elthusa vulgaris* | 34 | - | - | - | 2 | - | 2 | - | - | - | 31 | 15 | - | 4 | - | 4 | 161 |
| *Elthusa* sp | - | - | - | - | - | 3 | - | - | 5 | - | - | - | 52 | - | 52 | - | 66 |
| *Ethusa californica* | - | - | - | - | - | - | - | 4 | - | - | - | - | - | - | - | - | 4 |
| *Nerocila* sp | - | - | - | - | - | 1 | 1 | 1 | - | - | - | - | - | - | - | - | 3 |
| Copepoda | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 2 |
| Bopyridae, unid. | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 1 |

Notes: W = winter, S = summer

# APPENDIX I

## Fish and macroinvertebrate heat treatment and normal operation data

**Appendix I-1. Master species list of fish and macroinvertebrate species impinged during heat treatments and normal operation surveys. Mandalay Generating Station NPDES, 2005.**

| PHYLUM / Class / Family / Species | Common Name |
|---|---|
| ARTHROPODA | |
| Malacostraca | |
| Grapsidae | |
| *Pachygrapsus crassipes* | striped shore crab |
| Palinuridae | |
| *Panulirus interruptus* | California spiny lobste |
| MOLLUSCA | |
| Gastropoda | |
| Aplysiidae | |
| *Aplysia californica* | California seahare |
| CHORDATA | |
| Chondrichthyes | |
| Myliobatidae | |
| *Myliobatis californica* | bat ray |
| Platyrhinidae | |
| *Platyrhinoidis triseriata* | thornback |
| Actinopterygii | |
| Atherinopsidae | |
| *Leuresthes tenuis* | California grunion |
| Carangidae | |
| *Trachurus symmetricus* | jack mackerel |
| Clinidae | |
| *Gibbonsia elegans* | spotted kelpfish |
| Clupeidae | |
| *Sardinops sagax* | Pacific sardine |
| Cottidae | |
| *Leptocottus armatus* | staghorn sculpin |
| Embiotocidae | |
| *Cymatogaster aggregata* | shiner perch |
| *Embiotoca jacksoni* | black perch |
| *Phanerodon furcatus* | white seaperch |
| Engraulidae | |
| *Anchoa compressa* | deepbody anchovy |
| *Engraulis mordax* | northern anchovy |
| Gobiidae | |
| *Lepidogobius lepidus* | bay goby |
| Paralichthyidae | |
| *Paralichthys californicus* | California halibut |
| *Xystreurys liolepis* | fantail sole |
| Pleuronectidae | |
| *Pleuronichthys guttulatus* | diamond turbot |
| Sciaenidae | |
| *Atractoscion nobilis* | white seabass |
| *Seriphus politus* | queenfish |
| Stromateidae | |
| *Peprilus simillimus* | Pacific pompano |
| Syngnathidae | |
| *Syngnathus leptorhynchus* | bay pipefish |

**Appendix I-2. Abundance and biomass (kg) of fish impinged during heat treatments and normal operations between 1 October 2003 and 30 September 2004. Mandalay Generating Station NPDES, 2005.**

| Species | Heat Treatment | | Monitored Normal Operations | | Estimated Normal Operations* | | Survey Total | | Percent Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Abundancce | Biomass (kg) | Abundancce | Biomass (kg) | Abundancce | Biomass (kg) | Abundancce | Biomass (kg) | Abundance | Biomass |
| *Leuresthes tenuis* | 24 | 1.203 | 1,049 | 25.524 | 39,886 | 977.91 | 39,910 | 979.113 | 74.5 | 79.2 |
| *Cymatogaster aggregata* | 397 | 4.241 | 280 | 2.810 | 8,486 | 81.16 | 8,883 | 85.402 | 16.6 | 6.9 |
| *Engraulis mordax* | 3 | 0.036 | 138 | 2.912 | 3,134 | 66.79 | 3,137 | 66.826 | 5.9 | 5.4 |
| *Pleuronichthys guttulatus* | - | - | 14 | 0.297 | 444 | 20.75 | 444 | 20.755 | 0.8 | 1.7 |
| *Sardinops sagax* | - | - | 7 | 0.147 | 260 | 5.53 | 260 | 5.527 | 0.5 | 0.4 |
| *Myliobatis californica* | - | - | 7 | 1.042 | 179 | 20.72 | 179 | 20.723 | 0.3 | 1.7 |
| *Paralichthys californicus* | 2 | 0.169 | 3 | 0.114 | 172 | 6.32 | 174 | 6.491 | 0.3 | 0.5 |
| *Anchoa compressa* | 5 | 0.064 | 6 | 0.057 | 122 | 1.14 | 127 | 1.200 | 0.2 | 0.1 |
| *Leptocottus armatus* | 10 | 0.384 | 5 | 0.041 | 103 | 0.86 | 113 | 1.247 | 0.2 | 0.1 |
| *Lepidogobius lepidus* | 2 | 0.026 | 1 | 0.023 | 77 | 1.76 | 79 | 1.789 | 0.1 | 0.1 |
| *Embiotoca jacksoni* | - | - | 1 | 0.078 | 77 | 5.98 | 77 | 5.977 | 0.1 | 0.5 |
| *Seriphus politus* | 2 | 0.012 | 2 | 0.009 | 42 | 0.20 | 44 | 0.210 | 0.1 | 0.0 |
| *Gibbonsia elegans* | 1 | 0.008 | 1 | 0.018 | 40 | 0.71 | 41 | 0.721 | 0.1 | 0.1 |
| *Syngnathus leptorhynchus* | 3 | 0.005 | 1 | 0.001 | 23 | 0.02 | 26 | 0.028 | 0.0 | 0.0 |
| *Platyrhinoidis triseriata* | - | - | 1 | 1.402 | 23 | 32.05 | 23 | 32.046 | 0.0 | 2.6 |
| *Atractoscion nobilis* | 3 | 0.616 | 1 | 0.125 | 19 | 2.40 | 22 | 3.018 | 0.0 | 0.2 |
| *Phanerodon furcatus* | 1 | 0.010 | 1 | 0.009 | 19 | 0.17 | 20 | 0.182 | 0.0 | 0.0 |
| *Trachurus symmetricus* | - | - | 1 | 0.110 | 19 | 2.11 | 19 | 2.107 | 0.0 | 0.2 |
| *Xystreurys liolepis* | - | - | 1 | 0.113 | 19 | 2.17 | 19 | 2.172 | 0.0 | 0.2 |
| *Peprilus simillimus* | 1 | 0.034 | - | - | - | - | 1 | 0.034 | 0.0 | 0.0 |
| Number of individuals | 454 | 7 | 1,520 | 35 | 53,144 | 1,229 | 53,598 | 1,235.567 | | |
| Number of species | 13 | | 19 | | 19 | | 20 | | | |

*Estimations derived by multiplying mean daily CPUE by total reported annual flow in millions of gallons (33,998.9546 mg) for monitoring year 2005.
Note: 0.0 = <0.005.

**Appendix I-3. Abundance and biomass (kg) of fish impinged during heat treatments by date. Mandalay Generating Station NPDES, 2005.**

| | Abundance | | | | Biomass | | | |
|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | | | 2004 | 2005 | | |
| | Nov | Jul | | % | Nov | Jul | | % |
| Species | 4 | 29 | Total | Total | 4 | 29 | Total | Total |
| *Cymatogaster aggregata* | 226 | 171 | 397 | 87.4 | 1.157 | 3.084 | 4.241 | 62.3 |
| *Leuresthes tenuis* | 5 | 19 | 24 | 5.3 | 0.778 | 0.425 | 1.203 | 17.7 |
| *Leptocottus armatus* | 10 | - | 10 | 2.2 | 0.384 | - | 0.384 | 5.6 |
| *Anchoa compressa* | - | 5 | 5 | 1.1 | - | 0.064 | 0.064 | 0.9 |
| *Atractoscion nobilis* | - | 3 | 3 | 0.7 | - | 0.616 | 0.616 | 9.0 |
| *Engraulis mordax* | - | 3 | 3 | 0.7 | - | 0.036 | 0.036 | 0.5 |
| *Syngnathus leptorhynchus* | 3 | - | 3 | 0.7 | 0.005 | - | 0.005 | 0.1 |
| *Lepidogobius lepidus* | - | 2 | 2 | 0.4 | - | 0.026 | 0.026 | 0.4 |
| *Paralichthys californicus* | 2 | - | 2 | 0.4 | 0.169 | - | 0.169 | 2.5 |
| *Seriphus politus* | 1 | 1 | 2 | 0.4 | 0.003 | 0.009 | 0.012 | 0.2 |
| *Gibbonsia elegans* | 1 | - | 1 | 0.2 | 0.008 | - | 0.008 | 0.1 |
| *Peprilus simillimus* | - | 1 | 1 | 0.2 | - | 0.034 | 0.034 | 0.5 |
| *Phanerodon furcatus* | - | 1 | 1 | 0.2 | - | 0.010 | 0.010 | 0.1 |
| Survey totals | 248 | 206 | 454 | | 2.504 | 4.304 | 6.808 | |
| Number of species | 7 | 9 | 13 | | | | | |

**Appendix I-4. Abundance of fish impinged during normal operation surveys by month. Mandalay Generating Station NPDES, 2005.**

| | 2004 | 2005 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Jan | Feb | May | Jul | Aug | Sep | | % | Cum. |
| Species | 26 | 5 | 3 | 20 | 7 | 30 | 30 | Total | Total | % |
| *Leuresthes tenuis* | - | 935 | 9 | 65 | 30 | 3 | 7 | 1,049 | 69.01 | 69.0 |
| *Cymatogaster aggregata* | - | 113 | 5 | 14 | 119 | 22 | 7 | 280 | 18.42 | 87.4 |
| *Engraulis mordax* | - | - | 1 | 18 | 116 | 1 | 2 | 138 | 9.08 | 96.5 |
| *Pleuronichthys guttulatus* | 1 | - | 2 | 10 | 1 | - | - | 14 | 0.92 | 97.4 |
| *Myliobatis californica* | - | 2 | - | 4 | - | 1 | - | 7 | 0.46 | 97.9 |
| *Sardinops sagax* | - | - | 2 | 2 | 2 | 1 | - | 7 | 0.46 | 98.4 |
| *Anchoa compressa* | - | - | - | 4 | 2 | - | - | 6 | 0.39 | 98.8 |
| *Leptocottus armatus* | - | - | - | 3 | 2 | - | - | 5 | 0.33 | 99.1 |
| *Paralichthys californicus* | - | - | 2 | 1 | - | - | - | 3 | 0.20 | 99.3 |
| *Seriphus politus* | - | - | - | 1 | - | 1 | - | 2 | 0.13 | 99.4 |
| *Atractoscion nobilis* | - | - | - | - | - | - | 1 | 1 | 0.07 | 99.5 |
| *Embiotoca jacksoni* | - | - | 1 | - | - | - | - | 1 | 0.07 | 99.5 |
| *Gibbonsia elegans* | - | 1 | - | - | - | - | - | 1 | 0.07 | 99.6 |
| *Lepidogobius lepidus* | - | - | 1 | - | - | - | - | 1 | 0.07 | 99.7 |
| *Phanerodon furcatus* | - | - | - | 1 | - | - | - | 1 | 0.07 | 99.7 |
| *Platyrhinoidis triseriata* | - | - | - | - | 1 | - | - | 1 | 0.07 | 99.8 |
| *Syngnathus leptorhynchus* | - | - | - | - | 1 | - | - | 1 | 0.07 | 99.9 |
| *Trachurus symmetricus* | - | - | - | 1 | - | - | - | 1 | 0.07 | 99.9 |
| *Xystreurys liolepis* | - | - | - | - | - | - | 1 | 1 | 0.07 | 100.0 |
| Survey totals | 1 | 1,051 | 23 | 124 | 274 | 29 | 18 | 1,520 | | |
| Number of species | 1 | 4 | 8 | 12 | 9 | 6 | 5 | 19 | | |

**Appendix I-5. Fish abundance per 100 mgd impinged during normal operation surveys by month. Mandalay Generating Station NPDES, 2005.**

| | 2004 | 2005 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Jan | Feb | May | Jul | Aug | Sep | Mean Daily | Mean Daily | Estimated Annual |
| Species | 26 | 5 | 3 | 20 | 7 | 30 | 30 | CPUE | Std Dev | Abundance* |
| *Leuresthes tenuis* | - | 763.07 | 14.20 | 25.64 | 14.12 | 1.41 | 2.77 | 117.31 | 284.90 | 39,886 |
| *Cymatogaster aggregata* | - | 92.22 | 7.89 | 5.52 | 56.00 | 10.32 | 2.77 | 24.96 | 35.32 | 8,486 |
| *Engraulis mordax* | - | - | 1.58 | 7.10 | 54.59 | 0.47 | 0.79 | 9.22 | 20.16 | 3,134 |
| *Pleuronichthys guttulatus* | 1.58 | - | 3.16 | 3.94 | 0.47 | - | - | 1.31 | 1.65 | 444 |
| *Sardinops sagax* | - | - | 3.16 | 0.79 | 0.94 | 0.47 | - | 0.76 | 1.12 | 260 |
| *Myliobatis californica* | - | 1.63 | - | 1.58 | - | 0.47 | - | 0.53 | 0.76 | 179 |
| *Paralichthys californicus* | - | - | 3.16 | 0.39 | - | - | - | 0.51 | 1.18 | 172 |
| *Anchoa compressa* | - | - | - | 1.58 | 0.94 | - | - | 0.36 | 0.64 | 122 |
| *Leptocottus armatus* | - | - | - | 1.18 | 0.94 | - | - | 0.30 | 0.52 | 103 |
| *Embiotoca jacksoni* | - | - | 1.58 | - | - | - | - | 0.23 | 0.60 | 77 |
| *Lepidogobius lepidus* | - | - | 1.58 | - | - | - | - | 0.23 | 0.60 | 77 |
| *Seriphus politus* | - | - | - | 0.39 | - | 0.47 | - | 0.12 | 0.21 | 42 |
| *Gibbonsia elegans* | - | 0.82 | - | - | - | - | - | 0.12 | 0.31 | 40 |
| *Platyrhinoidis triseriata* | - | - | - | - | 0.47 | - | - | 0.07 | 0.18 | 23 |
| *Syngnathus leptorhynchus* | - | - | - | - | 0.47 | - | - | 0.07 | 0.18 | 23 |
| *Atractoscion nobilis* | - | - | - | - | - | - | 0.40 | 0.06 | 0.15 | 19 |
| *Phanerodon furcatus* | - | - | - | 0.39 | - | - | - | 0.06 | 0.15 | 19 |
| *Trachurus symmetricus* | - | - | - | 0.39 | - | - | - | 0.06 | 0.15 | 19 |
| *Xystreurys liolepis* | - | - | - | - | - | - | 0.40 | 0.06 | 0.15 | 19 |
| Total (#/100mg) | 1.58 | 857.74 | 36.29 | 48.91 | 128.95 | 13.60 | 7.12 | 156.31 | 312.32 | 53,144 |
| Note: Numerical anomalies due to rounding. | | | | | | | | | | |

*Estimations derived by multiplying mean daily CPUE by total reported annual flow in millions of gallons (33,998.9546 mg) for monitoring year 2005.

**Appendix I-6. Biomass (kg) of fish impinged during normal operation surveys by month. Mandalay Generating Station NPDES, 2005.**

| | 2004 | 2005 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Jan | Feb | May | Jul | Aug | Sep | | % | Cum. |
| Species | 26 | 5 | 3 | 20 | 7 | 30 | 30 | Total | Total | % |
| *Leuresthes tenuis* | - | 23.194 | 0.199 | 1.340 | 0.643 | 0.020 | 0.128 | 25.524 | 73.3 | 73.3 |
| *Engraulis mordax* | - | - | 0.008 | 0.041 | 2.828 | 0.022 | 0.013 | 2.912 | 8.4 | 81.6 |
| *Cymatogaster aggregata* | - | 0.961 | 0.040 | 0.329 | 1.304 | 0.144 | 0.032 | 2.81 | 8.1 | 89.7 |
| *Platyrhinoidis triseriata* | - | - | - | - | 1.402 | - | - | 1.402 | 4.0 | 93.7 |
| *Myliobatis californica* | - | 0.025 | - | 0.948 | - | 0.069 | - | 1.042 | 3.0 | 96.7 |
| *Pleuronichthys guttulatus* | 0.137 | - | 0.124 | 0.020 | 0.016 | - | - | 0.297 | 0.9 | 97.6 |
| *Sardinops sagax* | - | - | 0.043 | 0.039 | 0.052 | 0.013 | - | 0.147 | 0.4 | 98.0 |
| *Atractoscion nobilis* | - | - | - | - | - | - | 0.125 | 0.125 | 0.4 | 98.4 |
| *Paralichthys californicus* | - | - | 0.072 | 0.042 | - | - | - | 0.114 | 0.3 | 98.7 |
| *Xystreurys liolepis* | - | - | - | - | - | - | 0.113 | 0.113 | 0.3 | 99.0 |
| *Trachurus symmetricus* | - | - | - | 0.110 | - | - | - | 0.11 | 0.3 | 99.3 |
| *Embiotoca jacksoni* | - | - | 0.078 | - | - | - | - | 0.078 | 0.2 | 99.5 |
| *Anchoa compressa* | - | - | - | 0.045 | 0.012 | - | - | 0.057 | 0.2 | 99.7 |
| *Leptocottus armatus* | - | - | - | 0.020 | 0.021 | - | - | 0.041 | 0.1 | 99.8 |
| *Lepidogobius lepidus* | - | - | 0.023 | - | - | - | - | 0.023 | 0.1 | 99.9 |
| *Gibbonsia elegans* | - | 0.018 | - | - | - | - | - | 0.018 | 0.1 | 99.9 |
| *Seriphus politus* | - | - | - | 0.002 | - | 0.007 | - | 0.009 | 0.0 | 100.0 |
| *Phanerodon furcatus* | - | - | - | 0.009 | - | - | - | 0.009 | 0.0 | 100.0 |
| *Syngnathus leptorhynchus* | - | - | - | - | 0.001 | - | - | 0.001 | 0.0 | 100.0 |
| Survey totals | 0.137 | 24.198 | 0.587 | 2.945 | 6.279 | 0.275 | 0.411 | 34.832 | | |
| Number of species | 1 - | 4 | 8 | 12 | 9 | 6 | 5 | 19 | | |

**Appendix I-7. Fish biomass per 100 mgd impinged during normal operation surveys by month. Mandalay Generating Station NPDES, 2005.**

| | 2004 | 2005 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Jan | Feb | May | Jul | Aug | Sep | Mean Daily | Mean Daily | Estimated Annual |
| Species | 26 | 5 | 3 | 20 | 7 | 30 | 30 | CPUE | Std Dev | Biomass* |
| *Leuresthes tenuis* | - | 18.93 | 0.31 | 0.53 | 0.30 | 0.01 | 0.05 | 2.88 | 7.08 | 977.91 |
| *Cymatogaster aggregata* | - | 0.78 | 0.06 | 0.13 | 0.61 | 0.07 | 0.01 | 0.24 | 0.32 | 81.16 |
| *Engraulis mordax* | - | - | 0.01 | 0.02 | 1.33 | 0.01 | 0.01 | 0.20 | 0.50 | 66.79 |
| *Platyrhinoidis triseriata* | - | - | - | - | 0.66 | - | - | 0.09 | 0.25 | 32.05 |
| *Pleuronichthys guttulatus* | 0.22 | - | 0.20 | 0.01 | 0.01 | - | - | 0.06 | 0.10 | 20.75 |
| *Myliobatis californica* | - | 0.02 | - | 0.37 | - | 0.03 | - | 0.06 | 0.14 | 20.72 |
| *Paralichthys californicus* | - | - | 0.11 | 0.02 | - | - | - | 0.02 | 0.04 | 6.32 |
| *Embiotoca jacksoni* | - | - | 0.12 | - | - | - | - | 0.02 | 0.05 | 5.98 |
| *Sardinops sagax* | - | - | 0.07 | 0.02 | 0.02 | 0.01 | - | 0.02 | 0.02 | 5.53 |
| *Atractoscion nobilis* | - | - | - | - | - | - | 0.05 | 0.01 | 0.02 | 2.40 |
| *Xystreurys liolepis* | - | - | - | - | - | - | 0.04 | 0.01 | 0.02 | 2.17 |
| *Trachurus symmetricus* | - | - | - | 0.04 | - | - | - | 0.01 | 0.02 | 2.11 |
| *Lepidogobius lepidus* | - | - | 0.04 | - | - | - | - | 0.01 | 0.01 | 1.76 |
| *Anchoa compressa* | - | - | - | 0.02 | 0.01 | - | - | 0.00 | 0.01 | 1.14 |
| *Leptocottus armatus* | - | - | - | 0.01 | 0.01 | - | - | 0.00 | 0.00 | 0.86 |
| *Gibbonsia elegans* | - | 0.01 | - | - | - | - | - | 0.00 | 0.01 | 0.71 |
| *Seriphus politus* | - | - | - | 0.00 | - | 0.00 | - | 0.00 | 0.00 | 0.20 |
| *Phanerodon furcatus* | - | - | - | 0.00 | - | - | - | 0.00 | 0.00 | 0.17 |
| *Syngnathus leptorhynchus* | - | - | - | - | 0.00 | - | - | 0.00 | 0.00 | 0.02 |
| Total (#/100mg) | 0.22 | 19.75 | 0.93 | 1.16 | 2.95 | 0.13 | 0.16 | 3.61 | 7.18 | 1,228.76 |

Note: Numerical anomalies due to rounding.

*Estimations derived by multiplying mean daily CPUE by total reported annual flow in millions of gallons (33,998.9546 mg) for monitoring year 2005.

**Appendix I-8. Standard length (cm) of impinged fish. Mandalay Generating Station NPDES, 2005.**

| | Standard Length (cm) | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 22 | 24 | 27 | 42 | 59 |
| *Anchoa compressa* | - | - | - | - | 1 | 1 | 3 | 5 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Atractoscion nobilis* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | 1 | 1 | 1 | - | - |
| *Cymatogaster aggregata* | 44 | 17 | 105 | 175 | 60 | 35 | 143 | 60 | 11 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Embiotoca jacksoni* | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| *Engraulis mordax* | 1 | 12 | 12 | 92 | 12 | - | 2 | 5 | 2 | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - |
| *Gibbonsia elegans* | - | - | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Lepidogobius lepidus* | - | - | - | - | - | - | - | 2 | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - |
| *Leptocottus armatus* | - | - | - | - | 3 | 1 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | - | - | - | - |
| *Leuresthes tenuis* | - | - | 5 | 2 | 1 | 1 | 22 | 50 | 36 | 79 | 38 | 36 | 42 | 18 | 5 | 2 | 1 | - | - | - | - | - | - |
| *Myliobatis californica** | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | 3 | 1 | - | - | - | 1 | - | 1 | - |
| *Paralichthys californicus* | - | - | - | - | - | - | - | - | - | - | 2 | 2 | - | - | - | - | - | 1 | - | - | - | - | - |
| *Peprilus simillimus* | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Phanerodon furcatus* | - | - | - | 1 | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Platyrhinoidis triseriata*** | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 |
| *Pleuronichthys guttulatus* | - | 4 | 6 | - | 1 | 2 | - | - | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - |
| *Sardinops sagax* | - | - | - | - | - | - | - | 1 | 1 | 1 | 3 | 1 | - | - | - | - | - | - | - | - | - | - | - |
| *Seriphus politus* | - | 1 | 1 | - | - | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| *Syngnathus leptorhynchu* | - | - | - | - | - | - | - | - | - | - | - | 2 | 1 | - | 1 | - | - | - | - | - | - | - | - |
| *Trachurus symmetricus* | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | - | - |
| *Xystreurys liolepis* | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

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

**Appendix I-9. Abundance of macroinvertebrates impinged during normal operation surveys by month. Mandalay Generating Station NPDES, 2005.**

| | 2004 | 2005 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Oct | Jan | Feb | May | Jul | Aug | Sep | | % |
| Species | 26 | 5 | 3 | 20 | 7 | 30 | 30 | Total | Total |
| *Pachygrapsus crassipes* | - | - | 2 | - | - | - | - | 2 | 66.67 |
| *Aplysia californica* | - | 1 | - | - | - | - | - | 1 | 33.33 |
| Survey totals | - | 1 | 2 | - | - | - | - | 3 | |
| Number of species | - | 1 | 1 | - | - | - | - | 2 | |

**Appendix I-10. Macroinvertebrate abundance per 100 mgd impinged during normal operation surveys by month. Mandalay Generating Station NPDES, 2005.**

| | 2004 | 2005 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Jan | Feb | May | Jul | Aug | Sep | Mean Daily | Mean Daily | Estimated Annual |
| Species | 26 | 5 | 3 | 20 | 7 | 30 | 30 | CPUE | Std Dev | Abundance* |
| *Pachygrapsus crassipes* | - | - | 3.16 | - | - | - | - | 0.45 | 1.19 | 153 |
| *Aplysia californica* | - | 0.82 | - | - | - | - | - | 0.12 | 0.31 | 40 |
| Total (# /100mg) | - | 0.82 | 3.16 | - | - | - | - | 0.57 | 1.18 | 193 |

Note: Numerical anomalies due to rounding.
*Estimations derived by multiplying mean daily CPUE by total reported annual flow in millions of gallons (33,998.9546 mg) for monitoring year 2005.

**Appendix I-11. Biomass (kg) of macroinvertebrates impinged during normal operation surveys by month. Mandalay Generating Station NPDES, 2005.**

| | 2004 | 2005 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Oct | Jan | Feb | May | Jul | Aug | Sep | | % |
| Species | 26 | 5 | 3 | 20 | 7 | 30 | 30 | Total | Total |
| *Aplysia californica* | - | 0.365 | - | - | - | - | - | 0.365 | 66.67 |
| *Pachygrapsus crassipes* | - | - | 0.036 | - | - | - | - | 0.036 | 33.33 |
| Survey totals | - | 0.365 | 0.036 | - | - | - | - | 0.401 | |
| Number of species | - | 1.000 | 1.000 | - | - | - | - | 2.000 | |

**Appendix I-12. Macroinvertebrate biomass (kg) per 100 mgd impinged during normal operation surveys by month. Mandalay Generating Station NPDES, 2005.**

| | 2004 | 2005 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Jan | Feb | May | Jul | Aug | Sep | Mean Daily | Mean Daily | Estimated Annual |
| Species | 26 | 5 | 3 | 20 | 7 | 30 | 30 | CPUE | Std Dev | Abundance* |
| *Aplysia californica* | - | 0.30 | - | - | - | - | - | 0.04 | 0.11 | 14.47 |
| *Pachygrapsus crassipes* | - | - | 0.06 | - | - | - | - | 0.01 | 0.02 | 2.76 |
| Total (# /100mg) | - | 0.30 | 0.06 | - | - | - | - | 0.05 | 0.11 | 17 |

Note: Numerical anomalies due to rounding.

*Estimations derived by multiplying mean daily CPUE by total reported annual flow in millions of gallons (33,998.9546 mg) for monitoring yea 2005.

**Appendix I-13. Abundance and biomass (kg) of macroinvertebrates impinged during heat treatments by date. Mandalay Generating Station NPDES, 2004.**

| | Abundance | | | | Biomass | | | |
|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | | | 2004 | 2005 | | % |
| | Nov | Jul | | % | Nov | Jul | | |
| Species | 4 | 29 | Total | Total | 4* | 29 | Total | Total |
| *Panulirus interruptus* | 1 | 2 | 3 | 50.0 | - | 1.244 | 1.244 | 96.7 |
| *Pachygrapsus crassipes* | - | 3 | 3 | 50.0 | - | 0.043 | 0.043 | 3.3 |
| Survey totals | 1 | 5 | 6 | | - | 1.287 | 1.287 | |
| Number of species | 1 | 2 | 2 | | | | | |

"*" = No biomass recorded for *P. interruptus.*

**Appendix I-14. Abundance and biomass (kg) of macroinvertebrates impinged during heat treatments and normal operations. Mandalay Generating Station NPDES, 2005.**

| | Heat Treatment | | Monitored Normal Operations | | Estimated Normal Operations* | | Total | Total |
|---|---|---|---|---|---|---|---|---|
| Species | Abundance | Biomass | Abundance | Biomass | Abundance | Biomass | Abundance | Biomass |
| *Pachygrapsus crassipes* | 3 | 0.043 | 2 | 0.036 | 153 | 2.759 | 156 | 2.802 |
| *Aplysia californica* | - | - | 1 | 0.365 | 40 | 14.468 | 40 | 14.468 |
| *Panulirus interruptus* | 3 | 1.244 | - | - | - | - | 3 | 1.244 |
| Survey totals | 6 | 1.287 | 3 | 0.401 | 193 | 17.227 | 199 | 18.514 |
| Number of species | 2 | | 2 | | 2 | | | |

*Estimations derived by multiplying mean daily CPUE by total reported annual flow (54692.20 mg) for monitoring year 2004.