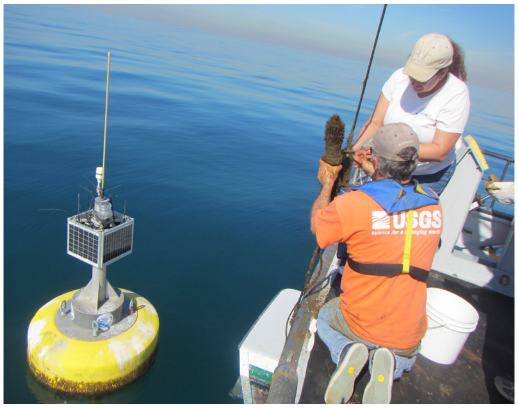

Orange County Sanitation District

Ocean Monitoring Report

Year 2015-2016

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March 8, 2017

Kurt V. Berchtold, Executive Officer
California Regional Water Quality Control Board
Santa Ana Region 8
3737 Main Street, Suite 500
Riverside, CA 92501-3339

SUBJECT: Board Order No. R8-2012-0035, NPDES No. CA0110604 2015-16 Marine Monitoring Annual Report

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Enclosed is the Orange County Sanitation District (Sanitation District) 2015-16 Marine Monitoring Annual Report. This report focuses on the findings and conclusions for the monitoring period July 1, 2015 to June 30, 2016. Overall, the results of the monitoring program document that the disposal of our treated and disinfected effluent into coastal marine waters continues to protect the environment and human health.

The results of the 2015-16 monitoring effort showed minimal changes in the receiving water conditions. Plume-related changes in temperature, salinity, dissolved oxygen, pH, and transmissivity beyond the ZID were well within the range of natural variability, and compliance with numeric receiving water criteria was achieved over 98% of the time. This demonstrated that the coastal receiving water environment outside the zone of initial dilution (ZID) has not been degraded by the Sanitation District's wastewater discharge. The low concentrations of bacteria in water contact zones, together with the limited distributions of ammonium, also suggest that the wastewater discharge posed no human health risk and did not compromise recreational use.

There were no impacts to the benthic animal communities within and adjacent to the ZID. Infauna, epibenthic macroinvertebrate, and fish communities in the monitoring area were healthy, with all sites classifying as reference condition. In addition, permit-regulated sediment contaminants remained at background levels. The low levels of contaminants in fish tissues, and the low incidence of external abnormalities and diseases in fish populations demonstrated that the outfall was not an epicenter of disease.

Should you have questions regarding the information provided in this report, or wish to meet with Sanitation District staff to discuss any aspect of our ocean monitoring program, please feel free to contact me at (714) 593-7450.

However, you may also contact Dr. Jeff Armstrong, the Supervisor of our Ocean Monitoring section, who may be reached at (714) 593-7455 or at jarmstrong@ocsd.com.

James Colston
Director of Environmental Services

JC:JA:dt:bg:pe
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Enclosure

cc: Alexis Strauss, U.S. EPA, Region IX

Our Mission: To protect public health and the environment by providing effective wastewater collection, treatment, and recycling.

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Orange County Sanitation District
10844 Ellis Avenue, Fountain Valley, CA 92708
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March 8, 2017

Certification Statement

The following certification satisfies Sections A.10 and A.15 of the Orange County Sanitation District Monitoring and Reporting Program No. R8-2012-0035, NPDES No. CA0110604, for the submittal of the attached OCSD Annual Report 2017 – Marine Monitoring.

> I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for known violations.

James Colston
Director of Environmental Services

March 8, 2017
Date

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ACKNOWLEDGMENTS

The following individuals are acknowledged for their contributions to the Marine Monitoring Volume of the 2015-16 Annual Report:

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EXECUTIVE SUMMARY

The Orange County Sanitation District (District) conducts extensive ocean monitoring to evaluate potential environmental and public health risks from its discharge of highly treated wastewater into the coastal waters off Huntington Beach and Newport Beach, California. The effluent is released in 60 m of water, 7 km offshore. The data collected are used to determine compliance with receiving water conditions as specified in the District's National Pollution Discharge Elimination System permit (R8-2012-0035, CA0110604), jointly issued in 2012 by the U.S. Environmental Protection Agency (EPA), Region IX and the Regional Water Quality Control Board (RWQCB), Region 8. This report focuses on monitoring results and conclusions from July 2015 through June 2016.

WATER QUALITY

Overall, the public health risks and measured environmental effects to the receiving water continue to be small. Consistent with previous years, minor changes in measured water quality parameters related to the discharge of wastewater to the coastal ocean were detected. Plume-related changes in temperature, salinity, dissolved oxygen, pH, and light transmissivity was measurable beyond the initial mixing zone (<2 km) during some surveys. None of these changes were determined to be environmentally significant; all values were within the ranges of natural variability for the study area, and reflected seasonal and yearly changes of large-scale regional influences. The limited observable plume effects occurred primarily at depth, even during the winter when stratification was weakest. All state and federal offshore bacterial standards were met during all surveys. In summary, staff concluded that the discharge in 2015-16 did not greatly affect the receiving water environment and that beneficial uses were protected and maintained.

SEDIMENT QUALITY

Sediment parameter values were comparable between within-ZID (zone of initial dilution) and non-ZID station groups. Values were below levels of biological concern (ERM values) at all stations. Whole sediment toxicity tests showed no measurable toxicity. These results, coupled with the presence of healthy fish and invertebrate communities both near and away from the outfall (see below), suggest good sediment quality in the monitoring area.

BIOLOGICAL COMMUNITIES

Infaunal Communities

The infaunal communities were similar within the monitoring area, with comparable community measure values and equivalent species assemblages at within-ZID and non-ZID stations. The infaunal community at all shelf-stations in both summer and winter surveys can be classified as reference condition based on their Benthic Response Index and Infaunal Trophic Index values. These multiple lines of evidence demonstrate that the outfall discharge had an overall negligible effect on the benthic community structure within the monitoring area.

Demersal Fishes and Epibenthic Macroinvertebrates

Results for the epibenthic macroinvertebrates (EMIs) and demersal fishes were generally consistent with past findings. Community measure values of the EMIs and fishes were generally comparable between outfall and non-outfall stations. Furthermore, fish communities at all stations were classified as reference condition based on their low Fish Response Index values. These results indicated that the outfall area was not degraded and that it supported normal fish and EMI populations.

Tissue Contaminants in Fish

Muscle and liver tissue concentrations of mercury and other chlorinated pesticides were similar in demersal fishes caught by otter trawl at outfall and non-outfall stations. Concentrations of mercury, arsenic, selenium, DDT, PCB, and other chlorinated pesticides in tissues of sport fishes caught by hook-and-line at outfall and non-outfall locations were below federal and state human consumption guidelines. These results demonstrated that the outfall is not an epicenter of disease due to the bioaccumulation of contaminants in fish tissue and suggest there is little risk from consuming fish from the monitored areas.

Fish Health

Fishes appeared normal in both color and odor. The lack of tumors, fin erosion, and skin lesions showed that fishes in the monitoring area were healthy. External parasites and other external abnormalities occurred in less than 1% of the fishes collected, comparable to Southern California Bight background levels. These results were consistent with previous years and indicate that the outfall is not an epicenter of disease.

Liver Histopathology

For the 2015-16 monitoring period, there were no differences in Hornyhead Turbot liver histopathology among the outfall and non-outfall stations. In contrast, English Sole samples at the outfall exhibited slightly more liver tissue damage than those at the non-outfall station. However, most English Sole samples at the outfall were not classified as irreparable. These results further demonstrate that the outfall is not an epicenter of disease.

CONCLUSION

In summary, California Ocean Plan criteria for water quality were met. State and federal bacterial standards were also met at offshore stations. Sediment quality was not degraded by loading of measured chemical contaminants or by physical changes from the discharge of wastewater solids. This was corroborated by the absence of sediment toxicity in controlled laboratory tests and the presence of normal infaunal communities throughout the monitoring area. Fish and trawl invertebrate communities in the monitoring area were also healthy and diverse. Federal and state fish consumption guidelines were met. Altogether, these results indicate that the receiving waters environment was not degraded. All permit compliance criteria were met, and environmental and human health were protected.

CHAPTER 1
The Ocean Monitoring Program

INTRODUCTION

The Orange County Sanitation District (District) operates 2 wastewater treatment facilities, one located in Fountain Valley (Plant 1) and the other in Huntington Beach (Plant 2), California. The District discharges treated wastewater to the Pacific Ocean through a submarine outfall located offshore of the Santa Ana River Mouth (Figure 1-1). This discharge is regulated by the US Environmental Protection Agency (EPA), Region IX and the Regional Water Quality Control Board (RWQCB), Region 8 under the Federal Clean Water Act, the California Ocean Plan, and the RWQCB Basin Plan. Specific discharge and monitoring requirements are contained in a National Pollutant Discharge Elimination System (NPDES) permit issued jointly by the EPA and the RWQCB (Order No. R8-2012-0035, NPDES Permit No. CA0110604) on June 15, 2012.

Southern California's Mediterranean climate and convenient beach access results in high, year-round public use of beaches. For example, although the highest visitation occurs during the summer months, winter beach usage within the District's study area can exceed 2 million visitors per month (City of Huntington Beach 2016, City of Newport Beach 2016, CDPR 2016). As a result, a large percentage of the local economies rely on beach use and its associated recreational activities, which are highly dependent upon water quality conditions (Turbow and Jiang 2004, Leeworthy and Wiley 2007). In 2012, Orange County's coastal economy accounted for $3.8 billion (2%) of the county's Gross Domestic Product (NOAA 2015). It has been estimated that a single day of beach closure at Bolsa Chica State Beach would result in an economic loss of $7.3 million (WHOI 2003).

For 2015-16, total beach attendance for Bolsa Chica State Beach, Huntington Beach City Beach, Huntington Beach State Beach, Newport Beach City Beach, and Crystal Cove State Beach was over 26 million (Figure 1-2a; City of Huntington Beach 2016, City of Newport Beach 2016, CDPR 2016). Total monthly visitations ranged from 934,544 in December 2015 to 4,654,578 in July 2015 (Figure 1-2b). While the 2015-16 seasonal visitation patterns were similar to those of previous years (highest in the summer, lowest in the winter), several months had greater than average monthly visitation due to unseasonal high air temperatures (WRCC 2016). March 2015, for example, had nearly twice the average attendance, which may be attributed to the record average high temperature for the month (NOAA 2016).

DESCRIPTION OF THE DISTRICT'S OPERATIONS

The District's mission is to safely collect, process, recycle, and dispose of treated wastewater while protecting human health and the environment in accordance with federal, state, and local laws and regulations. These objectives are achieved through extensive industrial pre-treatment (source control), secondary treatment processes, biosolids management, and water reuse programs.

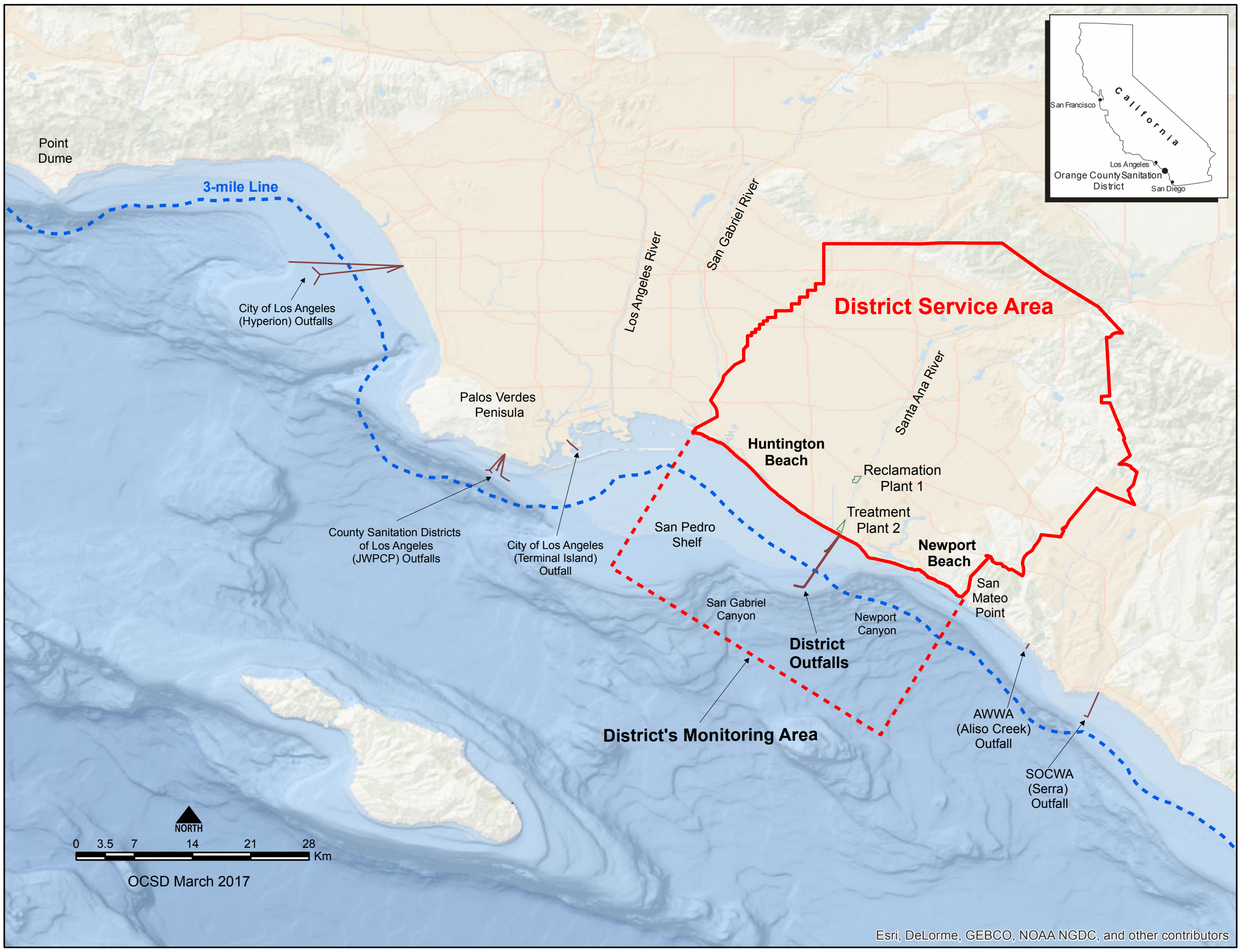

Figure 1–1 Regional setting for the District's Ocean Monitoring Program including monitoring area of the program.

Together, the District's 2 wastewater treatment plants receive domestic sewage from approximately 80% of the county's 3.2 million residents and industrial wastewater from 688 permitted businesses within its service area. Under normal operations, the treated wastewater (effluent) is discharged through a 120-in (305-cm) diameter ocean outfall, which extends 4.4 miles (7.1 km) from the Huntington Beach shoreline (Figure 1-1). The last 1.1 miles (1.8 km) of the outfall consists of a diffuser with 503 ports that discharge the treated effluent at an approximate depth of 197 ft (60 m).

Since 1999, the District has accepted a total of 8.6 billion gallons of dry-weather urban runoff from various locations in North and Central Orange County that would otherwise have entered the ocean without treatment (OCSD 2016). The collection and treatment of dry-weather runoff, began as a regional effort to reduce beach bacterial pollution associated with chronic dry-weather flows, has grown to include accepting diversions of high selenium flows to protect Orange County's waterways. There are currently 19 active diversions including storm water pump stations, the Santa Ana River, several creeks, and 3 flood control channels. The diversions are owned and operated by the City of Huntington Beach (n=11), the Public Works Department of Orange County (3), the Irvine Ranch Water District (2), the City of Newport Beach (2), and PH Finance, LLC (1). For 2015-16, the diverted monthly average daily discharge flows ranged from 0.32–1.21 million gallons per day (MGD) ($1.2–4.6 \times 10^6$ L/day) with an average daily discharge of 1.07 MGD (4.0×10^6 L/day).

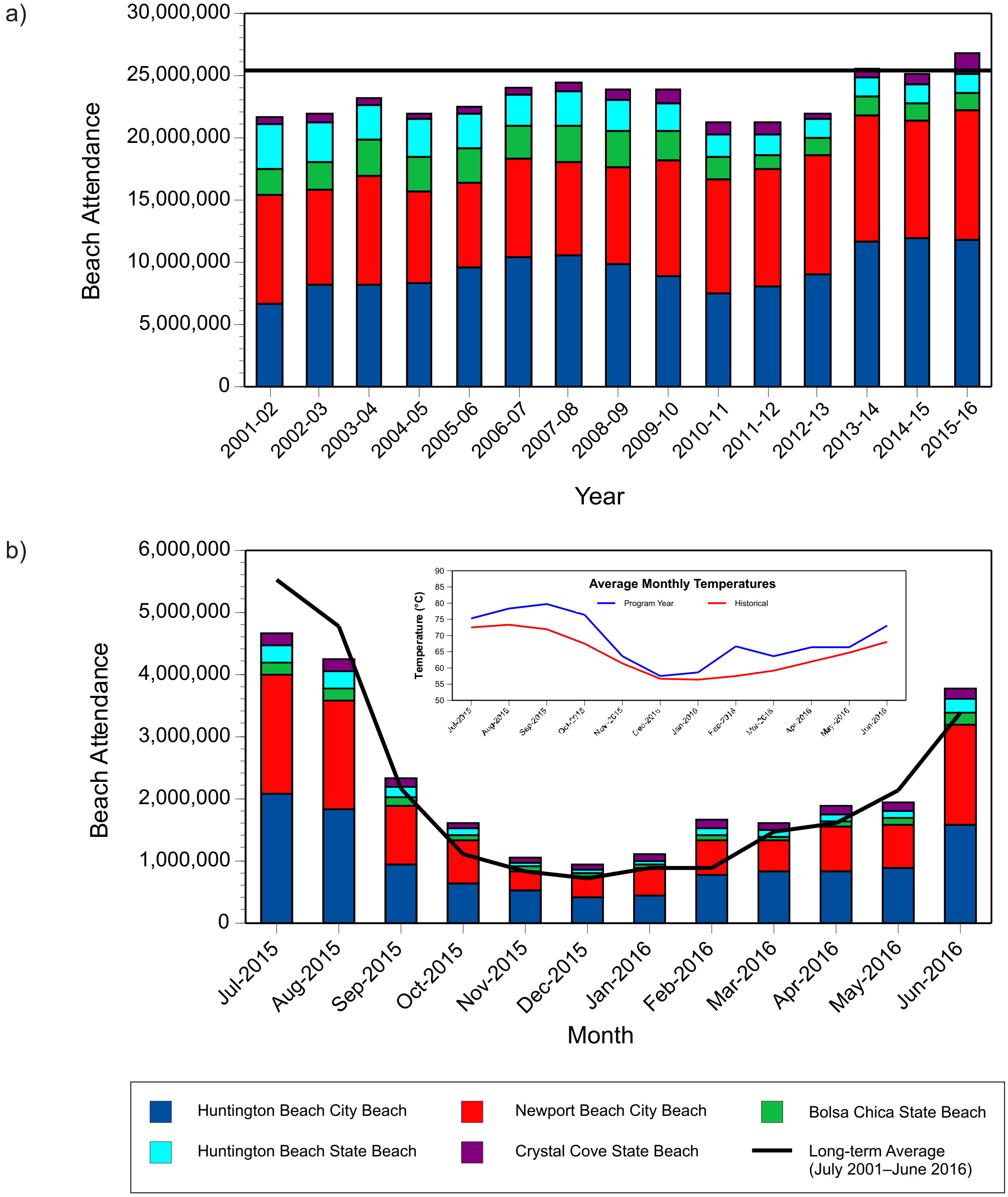

Figure 1–2 Annual (July–June) total (A) and 2015-16 monthly (B) total beach attendance for selected Orange County beaches (City of Huntington Beach 2016, City of Newport Beach 2016, and CDPR 2016).

The District has a long history of providing treated effluent to the Orange County Water District (OCWD) for water reclamation starting with Water Factory 21 in the late 1970s. Since July of 1986, 3–10 MGD (1.1–3.8 × 10^7 L/day) of the final effluent has been provided to the OCWD where it received further (tertiary) treatment to remove residual solids in support of the Green Acres Project (GAP). OCWD provides this water for a variety of uses including public landscape irrigation (e.g., freeways, golf courses) and for use as a saltwater intrusion barrier in the local aquifer OCWD manages. In 2007-08, the District began diverting additional flows to OCWD for the Groundwater Replenishment System (GWRS) totaling 35 MGD (1.3 × 10^8 L/day). Over time, the average GAP and GWRS diversions increased to 68 MGD (2.6 × 10^8 L/day) in 2008-09, 84 MGD (3.2 × 10^8 L/day) in 2013-14, and 124 MGD (4.7 × 10^8 L/day) in 2015-16 (Figure 1-3).

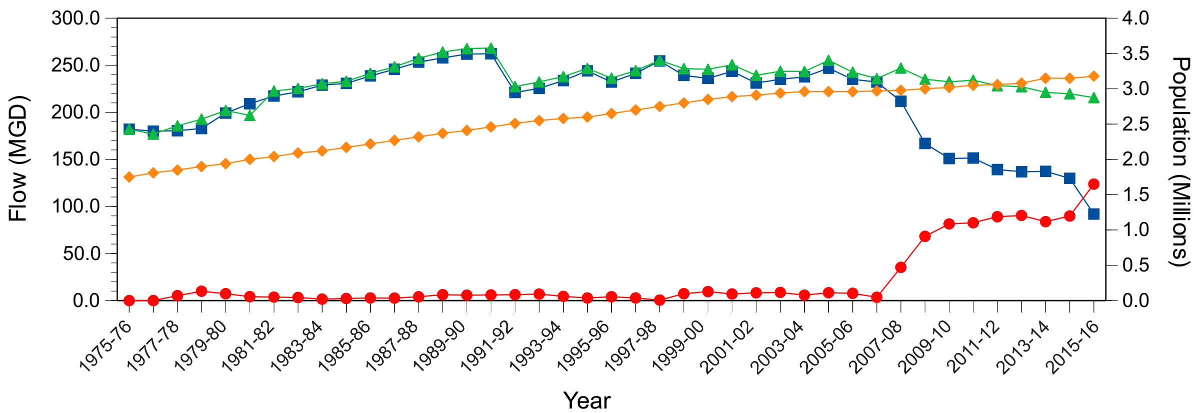

Figure 1–3 Annual daily average final effluent discharge flow (blue line) and recycle flow (red line) for the District, combined discharge and recycle flows (green line), and annual population (orange line) for Orange County, California, 1975–2016 (CDF 2016).

During 2015-16, the 2 wastewater treatment plants received and processed influent volumes averaging 183 MGD (6.9 × 10^8 L/day). Treatment plant processes achieved a 98% reduction in suspended solids concentration. After diversions to the GAP and GWRS and the return of OCWD's reject flows (e.g., brines), the District discharged an average of 92 MGD (3.4 × 10^8 L/day) of treated wastewater to the ocean (Figure 1-3). Peak flow [101.4 MGD (3.8 × 10^8 L/day)] occurred in June 2016, which was well below the historical peak flow of 550 MGD (2.1 × 10^9 L/day) that occurred during an extreme rainfall even in the winter of 1996. Seasonal and interannual differences in flow volumes are due to the variability in the amount of local water conservation efforts, rainfall, infiltration of the treatment system by runoff, and reclamation.

Prior to 1990, the annual wastewater discharge volumes gradually increased with population growth within the District's service area (Figure 1-3). However, wastewater flows decreased in 1991-92 due to drought conditions and water conservation measures. Since then combined effluent and water reclamation flows have remained relatively stable despite continued population growth. Since 2007, average discharge flows have declined dramatically due to the implementation of the GWRS.

REGULATORY SETTING FOR THE OCEAN MONITORING PROGRAM

The District's permit includes requirements to monitor influent, effluent, and the receiving water. Effluent flows, constituent concentrations, and toxicity are monitored to determine compliance with permit limits and to provide data for interpreting changes to receiving water conditions. Wastewater impacts to coastal receiving waters are evaluated by the District's Ocean Monitoring Program (OMP) based on 3 inter-related components: Core monitoring, Strategic Process Studies (SPS), and Regional monitoring. In addition, the District conducts other special studies not required under the existing NPDES permit. Information obtained from each of these program components is used to further the understanding of the coastal ocean environment and improve interpretations of the monitoring data. These program elements are summarized below.

The Core monitoring program was designed to measure compliance with permit conditions and for temporal trend analysis. Four major components comprise the program: (1) coastal oceanography and water quality, (2) sediment quality, (3) benthic infaunal community health, and (4) demersal fish and epibenthic macroinvertebrate community health, which include fish tissue contaminant concentrations.

The District conducts SPS to provide information about relevant coastal and ecotoxicological processes that are not addressed by Core monitoring. These studies have included evaluating the physical and chemical processes that affect the fate and transport of the discharged wastewater, tracking wastewater particles, contributing to the development of ocean circulation models, and studying the effects of endocrine disrupting compounds on fish.

Since 1994, the District has participated in 5 regional monitoring studies of environmental conditions within the Southern California Bight (SCB): 1994 Southern California Bight Pilot Project, Bight'98, Bight'03, Bight'08, and Bight'13. The District has played an integral role in these regional projects, carrying out program design, sampling, quality assurance, sample analysis, data analysis, and report writing. Results from these efforts provide information that is used by individual dischargers, local, state, and federal resource managers, researchers, and the public to improve understanding of regional environmental conditions. This provides a larger-scale perspective for comparisons with data collected from local, individual point sources. Program documents, data, and reports can be found at the Southern California Coastal Water Research Project's (SCCWRP) website (http://sccwrp.org). Another long-term regional program that began in 1997, is the Central Bight Water Quality Program. This is a quarterly, collaborative regional water quality sampling effort along with the City of Oxnard, the City of Los Angeles, the County Sanitation Districts of Los Angeles, and the City of San Diego.

Other collaborative projects organized by SCCWRP include "Characteristics of Effluents from Large Municipal Wastewater Treatment Facilities" and "Comparison of Mass Emissions among Sources in the Southern California Bight." Both of these projects involved analyses of historical data from large publicly owned treatment works (POTWs), including the District. Finally, the District has been working with the Southern California Coastal Ocean Observing System (http://www.sccoos.org) to provide the public with historical and ongoing water quality data. The District also partnered with SCCWRP, other local POTWs, and the Orange County Health Care Agency in conducting studies not mandated by the NPDES permit. Recent examples include continuing research on source tracking of bacterial contamination and evaluating rapid tests for fecal indicator bacteria.

The District's OMP has contributed substantially to the understanding of water quality and environmental conditions along the beaches and in the area adjacent to the submarine outfall. This monitoring program has generated a vast amount of data that provides a broad understanding of both natural and anthropogenic processes that affect coastal oceanography and marine biology.

ENVIRONMENTAL SETTING

The District's ocean monitoring area is adjacent to one of the most highly urbanized areas in the United States, covering most of the San Pedro Shelf and extending off the shelf (Figure 1-1). The shelf is composed primarily of soft sediments (sands with silts and clays) and inhabited by biological communities typical of these environments. The seafloor increases in depth gradually from the shoreline to a depth of approximately 262 ft (80 m), after which the depth increases rapidly as it slopes down to the open basin. The outfall diffuser lies at about 60 m depth on the shelf between the Newport and San Gabriel submarine canyons, located southeast and northwest, respectively. The area southeast of the shelf is characterized by a much narrower shelf and deeper water offshore (Figure 1-1). The 120-inch outfall represents one of the largest artificial reefs in this coastal region and supports communities typical of hard substrates that would not otherwise be found in the monitoring area (CDFG 1989, OCSD 2000). Together with the District's 78-inch outfall, approximately 1.1×10^6 ft^2 (102,193 m^2) of seafloor was converted from a flat, sandy habitat into a raised, hard-bottom substrate.

Conditions within the District's monitoring area are affected by large regional-scale current patterns that influence the water characteristics and the direction of water flow along the Orange County coastline. Locally, the predominant low-frequency current flows in the monitoring area are alongshore (i.e., either upcoast or downcoast) with minor across-shelf (i.e., toward the beach) transport (OCSD 1997, 1998, 2004, 2011; SAIC 2001, 2009, 2011). The specific direction of the flows varies with depth and is subject to reversals over time periods of days to weeks (SAIC 2011).

Other natural oceanographic processes, such as upwelling and eddies, also influence the characteristics of receiving waters on the San Pedro Shelf. Tidal flows, currents, and internal waves mix and transport the District's wastewater discharge with coastal waters and resuspended sediments. Tidal currents in the study region are relatively weak compared to lower frequency currents, which are responsible for transporting material over long distances (OCSD 2001, 2004). Combined, these processes contribute to the variability of seawater movement observed within the monitoring area.

Episodic storms, drought, and climatic cycles influence environmental conditions and biological communities within the monitoring area. For example, storm water runoff has a large influence on sediment movement in the region (Brownlie and Taylor 1981, Warrick and Millikan 2003). Major storms contribute large amounts of contaminants to the ocean and can generate waves capable of extensive shoreline erosion, sediment resuspension, and movement of sediments along the coast as well as offshore. Some of the greatest effects are produced by wet weather cycles, periods of drought, and periodic oceanographic events, such as El Niño and La Niña conditions. An understanding of the effects of the inputs from rivers and watersheds, particularly non-point source runoff, is important for evaluating spatial and temporal trends in the environmental quality of coastal areas. River flows, together with urban storm water runoff, represent significant, episodic sources of freshwater, sediments, suspended particles, nutrients, bacteria and other contaminants to the coastal area (Hood 1993, Grant et al. 2001, Warwick et al. 2007), although recent studies indicate that the spatial impact of these effects may be limited (Ahn et al. 2005, Reifel et al. 2009). While many of the materials supplied to coastal waters by rivers are essential to natural biogeochemical cycles, an excess or a deficit may have important environmental consequences. In 2015-16, total rainfall for Newport Harbor was 7.5 inches (190 mm) (Orange County, CA Department of Public Works 2016), well below the long-term historical mean of 10.9 inches (277 mm) (Figure 1-4). As a result, annual flows in the Santa Ana River were below average (Figure 1-5), which had significant impacts on local beach bacteria levels (Heal the Bay 2016).

Nearshore coastal waters of the SCB receive wastes from a variety of human-related sources, such as wastewater discharges, dredged material disposal, oil and gas activities, boat/vessel discharges, urban and agricultural runoff, and atmospheric fallout. The majority of municipal and industrial sources are located between Point Dume and San Mateo Point (Figure 1-1) while discharges from the Los Angeles, San Gabriel, and Santa Ana Rivers are responsible for substantial surface water contaminant inputs to the SCB (Schafer and Gossett 1988, SCCWRP 1992, Schiff and Tiefenthaler 2001).

A goal of the District's OMP is to provide an understanding of the effects of its wastewater discharge on beneficial uses of the ocean. However, distinguishing the effects of the District's discharge from

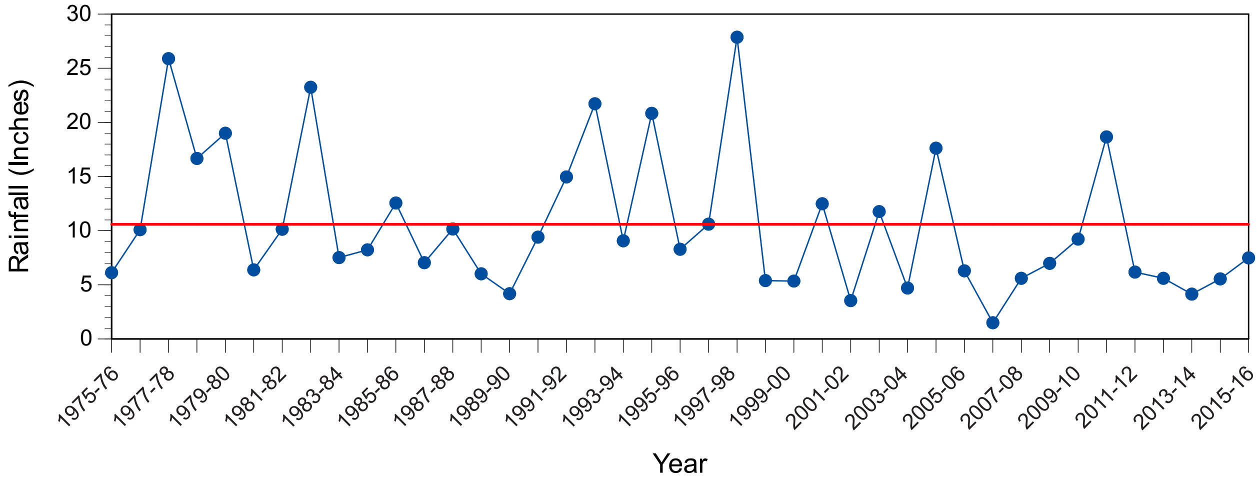

Figure 1–4 Annual rainfall for Newport Harbor, 1975-2016. Red line represents the historical annual mean value from 1975–2016 (OCPW 2016).

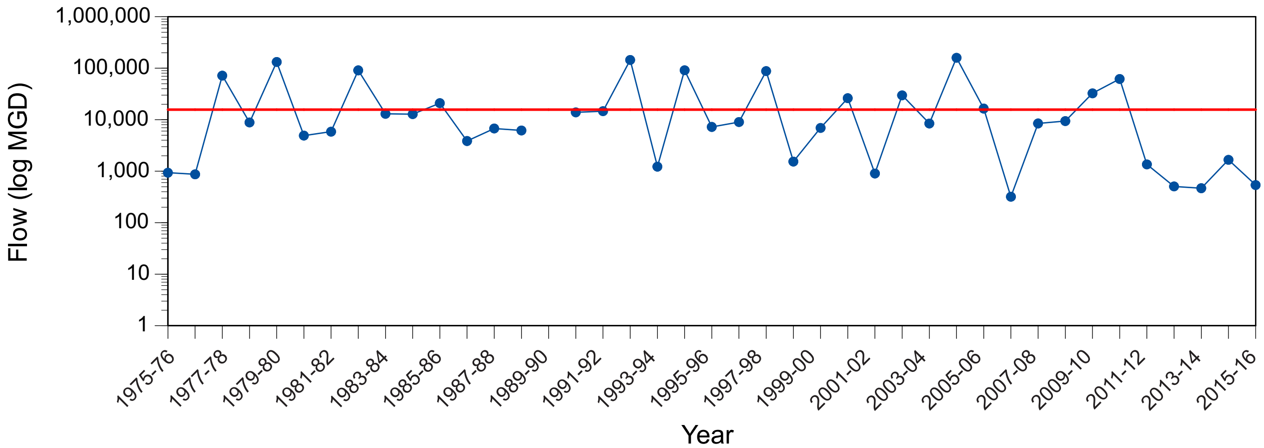

Figure 1–5 Annual flow for the Santa Ana River, 1975-2016. Red line represents the historical annual mean value from 1975–2016 (USGS 2016).

those of natural and other human influences is difficult, especially as the “signal” (impact) from the outfall has been greatly reduced since the 1970s (Figure 1-3). The complexities of the environmental setting and related difficulties in assigning a cause or source to a pollution event are the rationale for the District’s extensive monitoring program.

This report presents OMP compliance determinations for data collected from July 2015 through June 2016. Compliance determinations were made by comparing OMP findings to the criteria specified in the District’s NPDES permit. Any related special studies or regional monitoring efforts are also documented.

In September 2016, the District’s laboratory staff discovered an error in percent lipid calculations for Hornyhead Turbot and English Sole samples collected by trawling between January 2009 and March 2013, which affected the lipid-normalized ΣDDT and ΣPCB tissue data. An errata report containing information about how these errors were handled can be found in Appendix D.

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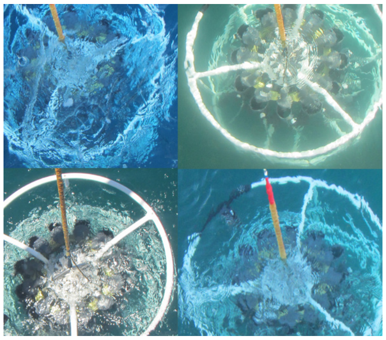

CHAPTER 2
Compliance Determinations

INTRODUCTION

This chapter provides compliance results for the 2015-16 monitoring year for the Orange County Sanitation District's (District) Ocean Monitoring Program (OMP). The program includes sample collection, analysis, and data interpretation to evaluate potential impacts of wastewater discharge on the following receiving water characteristics:

- Bacterial
- Physical
- Chemical
- Biological
- Radioactivity

Each of these characteristics have specific criteria (Table 2-1) for which permit compliance must be determined each monitoring year based on the Federal Clean Water Act, the California Ocean Plan (COP), and the Regional Water Quality Control Board Basin Plan.

The Core OMP sampling locations include 28 offshore water quality stations, 68 benthic stations to assess sediment chemistry and bottom-dwelling communities, 14 trawl stations to evaluate demersal fish and macroinvertebrate communities, and 2 rig-fishing zones for assessing human health risk from the consumption of sport fishes (Figures 2-1 to 2-3). Monitoring frequencies varied by component, and ranged from 2–5 days per week for surfzone water quality to annual assessments of fish health and tissue analyses.

WATER QUALITY

Offshore bacteria

The majority (70–93%; n=699) of fecal indicator bacteria (FIB) counts collected at the 8 REC-1 stations were below the method detection limit (MDL) of 10 MPN/100 mL leading to most depth-averaged values being below detection (Tables B-1 to B-3). The highest density observed for any single sample for total coliforms, fecal coliforms, and enterococci was 670, 92, and 52 MPN/100 mL, respectively. Compliance for all 3 FIB were achieved 100% for both state and federal criteria, indicating no impact of bacteria to offshore receiving waters.

Floating Particulates and Oil and Grease

There were no observations of oils and grease or floating particles of sewage origin at any offshore or nearshore station in 2015-16 (Tables B-4 and B-5). Therefore, compliance was achieved.

Table 2–1 List of compliance criteria from NPDES ocean discharge permit (Order No. R8-2012-0035, Permit # CA0110604) and compliance status for each criterion in 2015-16. N/A = Not Applicable.

Criteria	Criteria Met
Bacterial Characteristics	
V.A.1.a. For the Ocean Plan Water-Contact Standards, total coliform density shall not exceed a 30-day Geometric Mean of 1,000 per 100 mL nor a single sample maximum of 10,000 per 100 mL. The total coliform density shall not exceed 1,000 per 100 mL when the single sample maximum fecal coliform/total coliform ratio exceeds 0.1.	Yes
V.A.1.a. For the Ocean Plan Water-Contact Standards, fecal coliform density shall not exceed a 30-day Geometric Mean of 200 per 100 mL nor a single sample maximum of 400 per 100 mL.	Yes
V.A.1.a. For the Ocean Plan Water-Contact Standards, *Enterococcus* density shall not exceed a 30-day Geometric Mean of 35 per 100 mL nor a single sample maximum of 104 per 100 mL.	Yes
V.A.1.b. For the USEPA Primary Recreation Criteria in Federal Waters, *Enterococcus* density shall not exceed a 30 day Geometric Mean (per 100 mL) of 35 nor a single sample maximum (per 100 mL) of 104 for designated bathing beach, 158 for moderate use, 276 for light use, and 501 for infrequent use.	Yes
V.A.1.c. For the Ocean Plan Shellfish Harvesting Standards, the median total coliform density shall not exceed 70 per 100 mL, and not more than 10 percent of the samples shall exceed 230 per 100 mL.	N/A
Physical Characteristics	
V.A.2.a. Floating particulates and grease and oil shall not be visible.	Yes
V.A.2.b. The discharge of waste shall not cause aesthetically undesirable discoloration of the ocean surface.	Yes
V.A.2.c. Natural light shall not be significantly reduced at any point outside the initial dilution zone as a result of the discharge of waste.	Yes
V.A.2.d. The rate of deposition of inert solids and the characteristics of inert solids in ocean sediments shall not be changed such that benthic communities are degraded.	Yes
Chemical Characteristics	
V.A.3.a. The dissolved oxygen concentration shall not at any time be depressed more than 10 percent from that which occurs naturally, as the result of the discharge of oxygen demanding waste materials.	Yes
V.A.3.b. The pH shall not be changed at any time more than 0.2 units from that which occurs naturally.	Yes
V.A.3.c. The dissolved sulfide concentration of waters in and near sediments shall not be significantly increased above that present under natural conditions.	Yes
V.A.3.d. The concentration of substances, set forth in Chapter II, Table B of the Ocean Plan, in marine sediments shall not be increased to levels which would degrade indigenous biota.	Yes
V.A.3.e. The concentration of organic materials in marine sediments shall not be increased to levels which would degrade marine life.	Yes
V.A.3.f. Nutrient materials shall not cause objectionable aquatic growths or degrade indigenous biota.	Yes
V.A.3.g. The concentrations of substances, set forth in Chapter II, Table B of the Ocean Plan, shall not be exceeded in the area within the waste field where initial dilution is completed.	Yes
Biological Characteristics	
V.A.4.a. Marine communities, including vertebrate, invertebrate, and plant species, shall not be degraded.	Yes
V.A.4.b. The natural taste, odor, and color of fish, shellfish, or other marine resources used for human consumption shall not be altered.	Yes
V.A.4.c. The concentration of organic materials in fish, shellfish, or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.	Yes
V.A.5. Discharge of radioactive waste shall not degrade marine life.	Yes

Ocean Discoloration and Transparency

The water clarity standards were met 100% and 99.8% of the time for Zone A and B station groups, respectively (Table 2-2). Overall compliance was met 99.9% of the time for all stations combined. Compliance was slightly higher than the previous year's value of 97.4% and was well within the annual ranges since 1985 (Figure 2-4). All transmissivity values (Table B-6) were within natural ranges of variability to which marine organisms are exposed (OCSD 1996a). Hence, there were no impacts from the wastewater discharge relative to ocean discoloration at any offshore station.

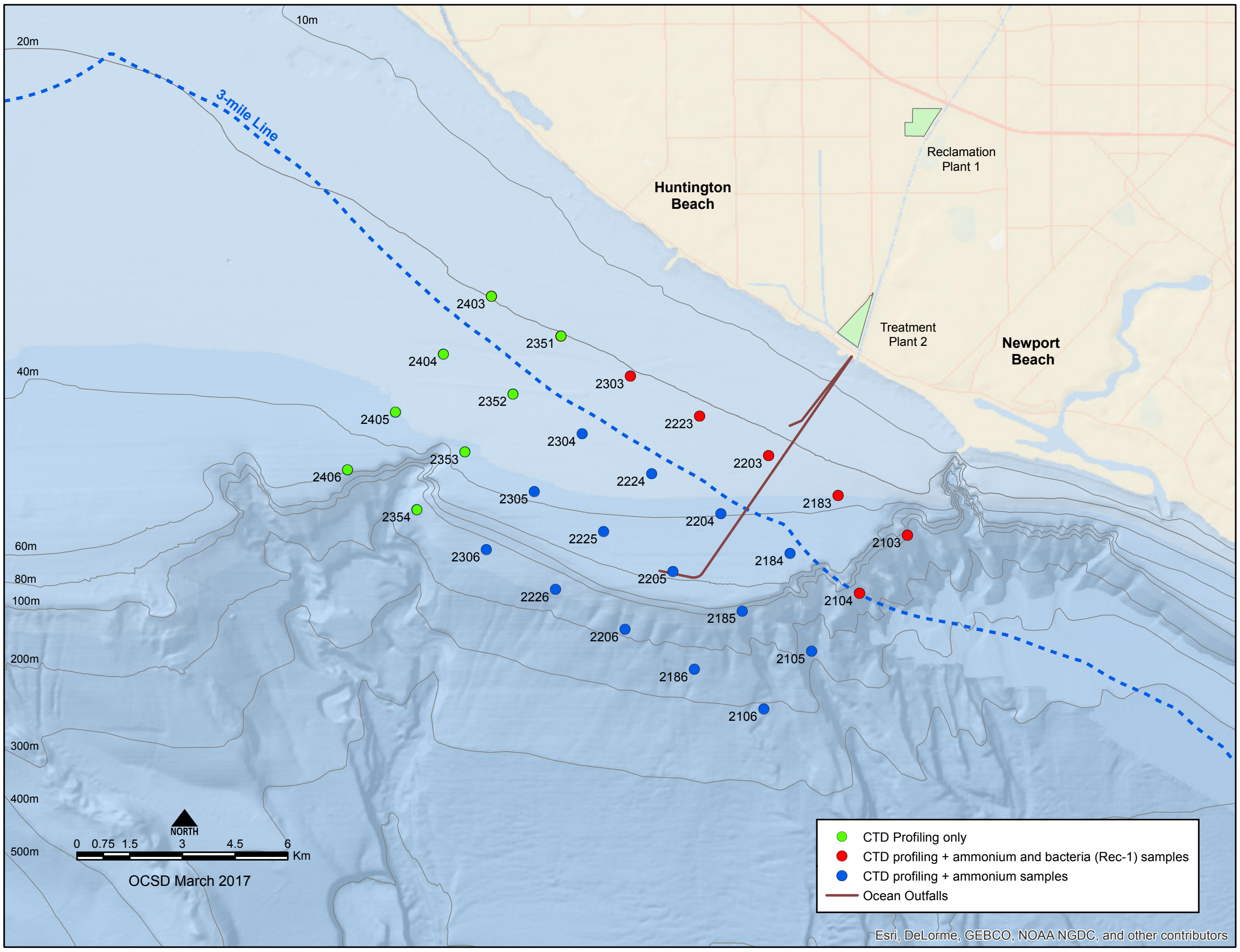

Figure 2–1 Offshore water quality monitoring stations for 2015-16.

Table 2–2 Summary of offshore water quality compliance testing results for dissolved oxygen, pH, and transmissivity for 2015-16.

Parameter	Number of Observations	Number of Out-of-Range Occurrences	Percent Out-of-Range Occurrences	Number Out-of-Compliance	Percent Out-of-Compliance
Zone A Stations					
Dissolved Oxygen	483	42	8.7	2	0.4
pH	483	8	1.7	2	0.4
%Transmissivity	483	197	40.8	0	0.0
Zone B Stations					
Dissolved Oxygen	467	77	16.5	8	1.7
pH	467	5	1.1	1	0.2
%Transmissivity	467	111	23.8	1	0.2
Total (Zone A and Zone B Stations Combined)					
Dissolved Oxygen	950	119	12.5	10	1.1
pH	950	13	1.4	3	0.3
%Transmissivity	950	308	32.4	1	0.1

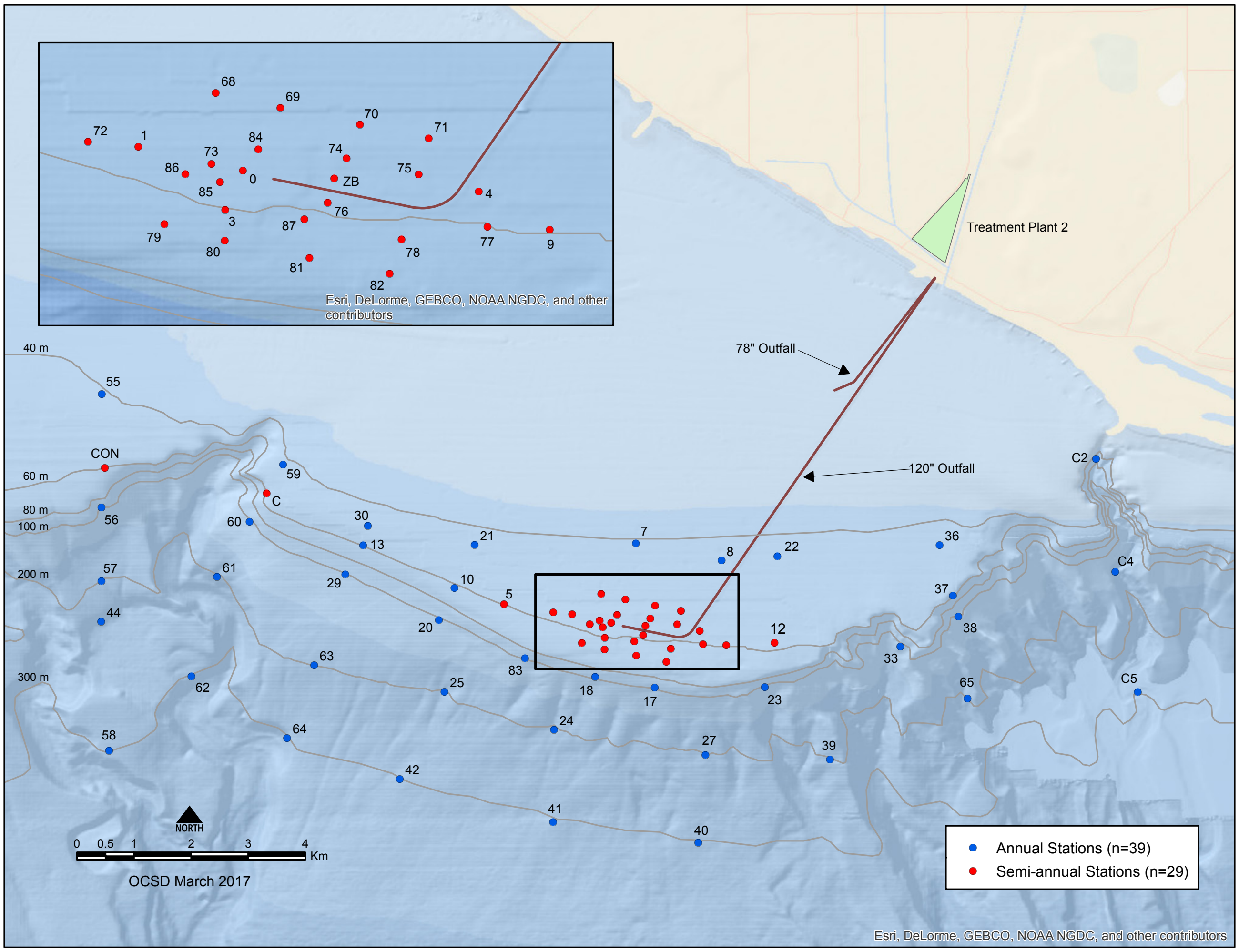

Figure 2–2 Benthic (sediment geochemistry and infauna) monitoring stations for 2015-16.

Dissolved Oxygen (DO)

In 2015-16, compliance was met 99.6% and 98.3% of the time for Zone A and B station groups, respectively (Table 2-2). Overall compliance was met 98.9% of the time for all stations combined. This represents a slight decrease in compliance of 0.6% from the 2014-15 monitoring year (Figure 2-4). The DO values (Table B-6) were well within the range of long-term monitoring results (OCSD 1996b, 2004). Thus, it was determined that there were no environmentally significant effects to DO from the wastewater discharge.

Acidity (pH)

Compliance was met 99.6% and 99.8% of the time for Zone A and B station groups, respectively (Table 2-2). Overall compliance was met 99.7% of the time for all stations combined, a 0.1% decrease from the previous year's value and were within the annual ranges since 1985 (Figure 2-4). There were no environmentally significant effects to pH from the wastewater discharge as the measured values (Table B-6) were within the range to which marine organisms are naturally exposed.

Nutrients (Ammonium)

During 2015-16, 85% (n=1,655) of the samples were below the MDL (<0.02 mg/L). Detectable ammonium concentrations (n=256) ranged from 0.02 to 0.17 mg/L, with over 75% of the detected values found below 15 m (Table B-6). Plume-related changes in ammonium were not considered

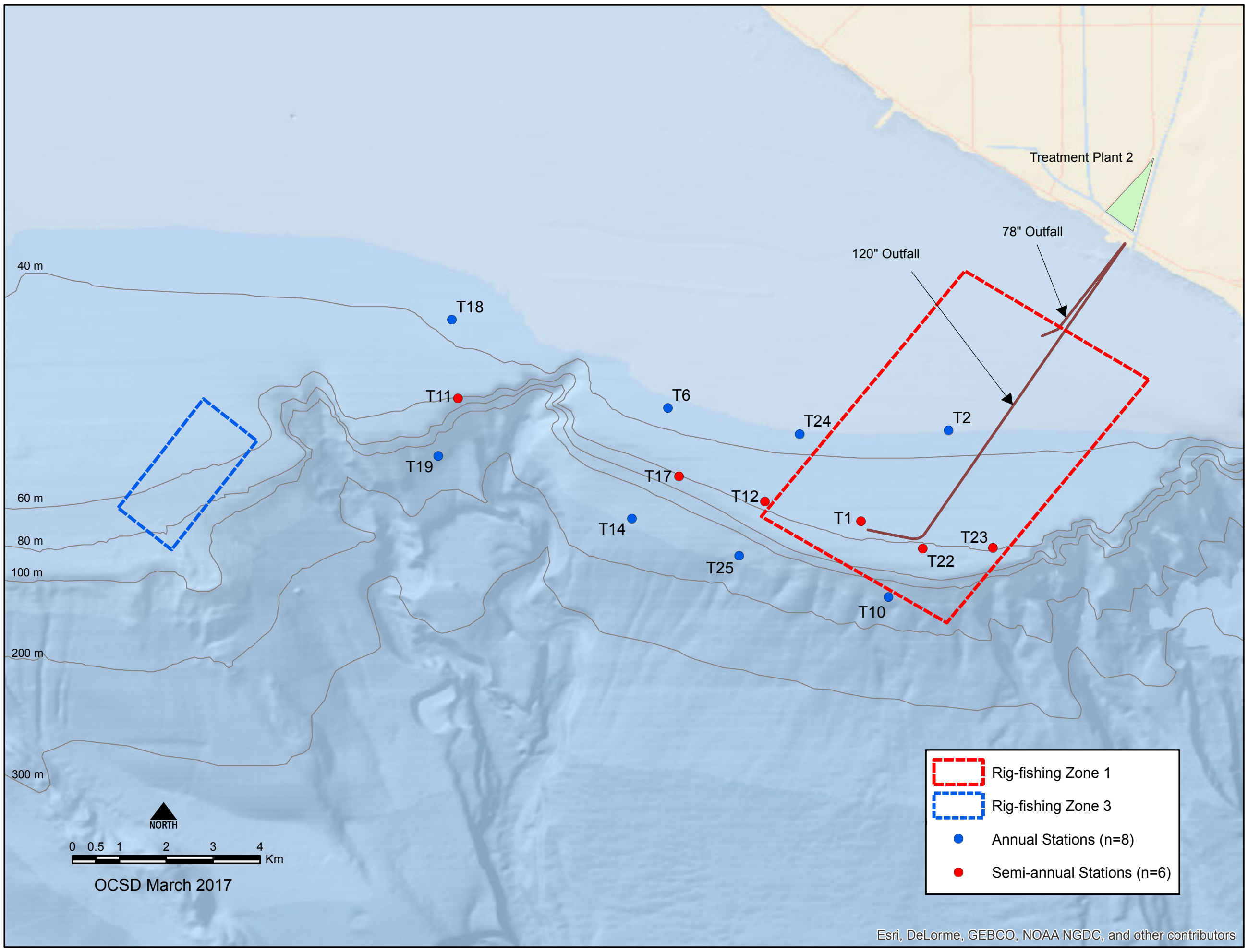

Figure 2–3 Trawl monitoring stations, as well as rig-fishing locations, for 2015-16.

environmentally significant as maximum values were over 20 times less than the chronic (4 mg/L) and more than 35 times less than the acute (6 mg/L) toxicity standards of the COP (SWRCB 2012). In addition, there were no detectable plankton-associated impacts (i.e., excessive plankton blooms caused by the discharge).

Organics in the Water Column

Only 8 constituents from Table B of the COP have effluent limitations established in the District's NPDES permit. During the period from July 2015 through June 2016, none of these constituents exceeded the effluent limitations established in the permit.

Radioactivity

The District measures the effluent for radioactivity but not the receiving waters. The results of the effluent analyses during 2015-16 indicated that both state and federal standards were consistently met, and are published in the District's Discharge Monitoring Reports. As fish and invertebrate communities are diverse and healthy, compliance is considered to be met.

Overall Results

Overall, results from the District's 2015-16 water quality monitoring program detected minor changes in measured water quality parameters related to the discharge of wastewater to the coastal ocean.

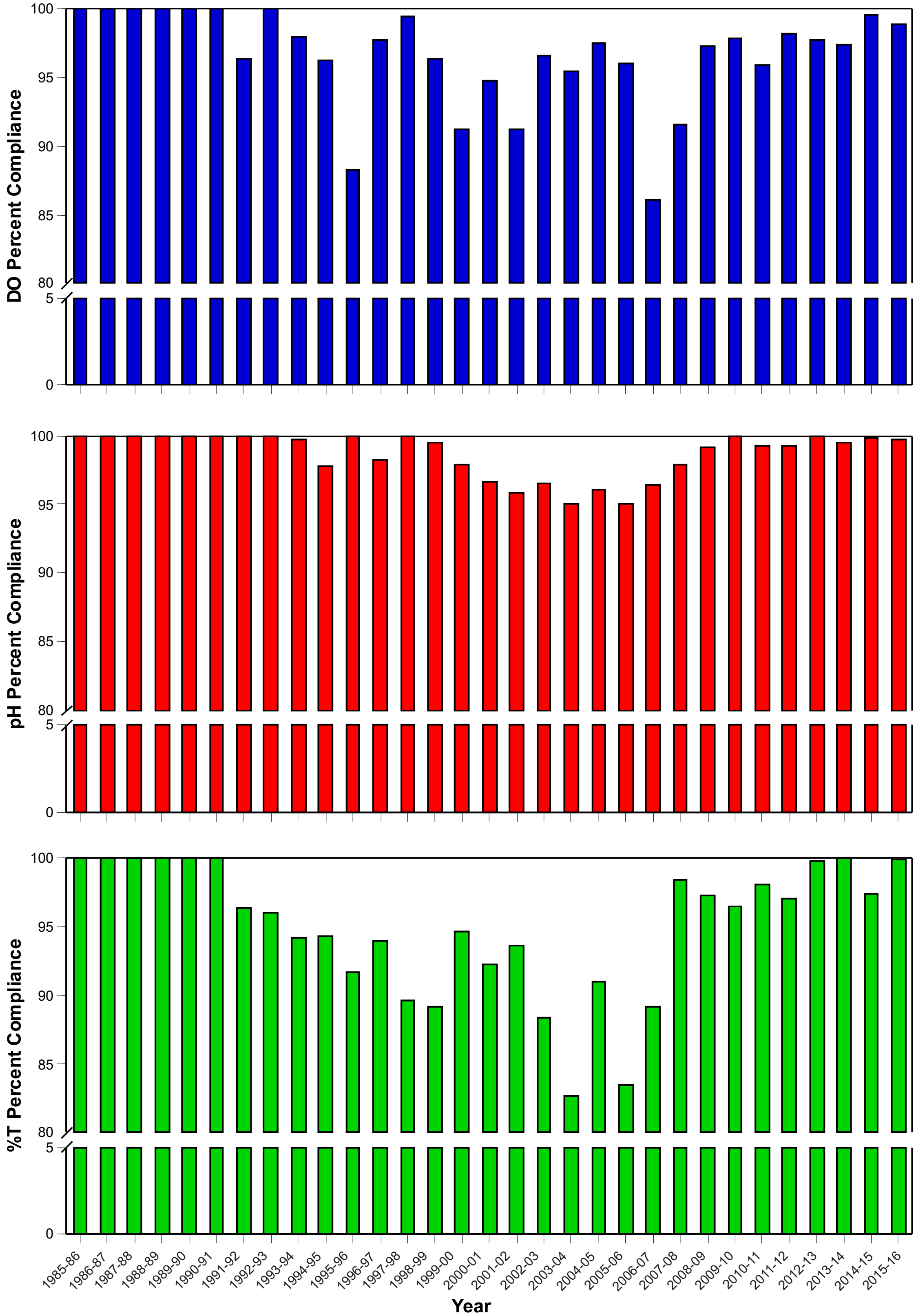

Figure 2–4 Summary of mean percent compliance for dissolved oxygen (DO), pH, and light transmissivity (%T) for all compliance stations compared to reference stations, 1985-2016.

This is consistent with previously reported results (e.g., OCSD 2016). Plume-related changes in temperature, salinity, DO, pH, and transmissivity were measurable beyond the initial mixing zone during some surveys. This usually extended only into the nearfield stations, typically <2 km away from the outfall, similar to what has been seen in the past. None of these changes were determined to be environmentally significant since they fell within natural ranges to which marine organisms are exposed (OCSD 1996a, 2004; Wilber and Clarke 2001, Chavez et al. 2002, Jarvis et al. 2004, Allen et al. 2005, Hsieh et al. 2005). Overall, the public health risks and measured environmental effects to the receiving water continue to be small. All values were within the ranges of natural variability for the study area, and reflected seasonal and yearly changes of large-scale regional influences. The limited observable plume effects occurred primarily at depth, even during the winter when stratification was weakest. In summary, OMP staff concluded that the discharge, in 2015-16, did not greatly affect the receiving water environment, and that beneficial uses were protected and maintained.

SEDIMENT GEOCHEMISTRY

Consistent with previous years (OCSD 2014, 2016), mean concentrations of organic contaminants and metals tended to increase with increasing depth, with the highest in depositional areas (Tables 2-3 to 2-6). Sediment geochemistry values were also below levels of biological concern (Effects Range-Median (ERM) values) (Long et al. 1995). Most means of sediment geochemistry parameter values in 2015-16 were comparable between within-ZID and non-ZID station groups and were either similar to or well below regional values. The elevated mean sulfide value (9.81 mg/kg) for the non-ZID station group in Summer 2015 was driven by the 198 mg/kg value at Newport Canyon Station C2 and was not representative of the Middle Shelf Zone 2 stations. When Station C2 was removed as an outlier, the mean at the non-ZID group (3.09 µg/kg) was similar to that of the within-ZID group (3.64 µg/kg). The elevated mean copper (Cu) value (37.39 mg/kg) for the within-ZID group in Summer 2015 was driven by the 119 mg/kg value at Station 0. This is not cause for concern, as the Cu concentration at Station 0 was below the ERM in Summer 2015 and was measured at 11.50 mg/kg in Winter 2016. These results, coupled with the absence of sediment toxicity in amphipod survival tests (Table 2-7) and the presence of healthy fish and invertebrate communities both near and away from the outfall (see below), suggest good sediment quality in the monitoring area. Therefore, we conclude that compliance was met.

BIOLOGICAL COMMUNITIES

Infaunal Communities

A total of 592 invertebrate taxa comprising 21,613 individuals were collected in the 2015-16 monitoring year. As with previous years (OCSD 2013, 2014), there were noticeable declines in the mean species number (richness) and mean abundance of infauna at stations deeper than 120 m (Table 2-8) and the Annellida (segmented worms) was the dominant taxonomic group at all depth strata (Table B-7). Mean community measure values were comparable between within- and non-ZID stations, and most station values were within regional and District historical ranges in both surveys (Tables 2-8 and 2-9). The infaunal community at all within-ZID and non-ZID stations in both surveys can be classified as reference condition based on their low (<25) Benthic Response Index (BRI) values and/or high (>60) Infaunal Trophic Index (ITI) values. The community composition at all within-ZID stations, except for Station 4 in winter, was similar to that of non-ZID stations based on multivariate analyses of the infaunal species and abundances (Figure 2-5). The absence of the polychaetes *Chaetozone columbiana*, *Aricidea* (*Acmira*) *catherinae*, and *Magelona hartmanae*, among others, contributed to the infaunal community dissimilarity at Station 4 in winter. Nevertheless, the infaunal community at this station can be classified as reference condition based on the low BRI and high ITI values (Table 2-9). In addition, there was no pollution-tolerant polychaete species *Capitella capitata* Cmplx

Table 2–3 Physical properties and organic contaminant concentrations of sediment samples collected at each semi-annual and annual (*) station in Summer 2015 compared to Effects Range-Median (ERM) values and regional measurements. ZID = Zone of Initial Dilution, AWM = Area Weighted Mean, ND = Not Detected, N/A = Not Applicable.

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (mg/kg)	ΣDDT (mg/kg)	ΣPest (mg/kg)	ΣPCB (mg/kg)
Middle Shelf Zone 1 (31-50 m)											
7 *	41	3.81	35.6	0.42	1.90	1100	400	76.3	ND	ND	0.44
8 *	44	3.86	38.3	0.44	4.32	1000	360	50.2	ND	ND	0.79
21 *	44	3.74	31.4	0.40	1.85	1100	330	52.3	ND	ND	0.15
22 *	45	3.85	37.7	0.40	3.55	1100	380	89.0	ND	ND	0.36
30 *	46	3.62	26.7	0.27	4.28	1100	390	62.1	ND	ND	ND
36 *	45	3.84	38.8	0.28	1.73	980	390	65.7	ND	ND	ND
55 *	40	2.84	6.4	0.17	1.52	680	170	21.6	ND	ND	0.19
59 *	40	3.31	18.4	0.22	1.40	1000	300	34.4	2.19	ND	3.85
	Mean	**3.61**	**29.2**	**0.32**	**2.57**	**1008**	**340**	**56.4**	**0.27**	**ND**	**0.72**
Middle Shelf Zone 2, Within-ZID (51-90 m)											
0	56	3.34	9.7	0.39	1.54	1400	440	62.3	2.14	ND	9.66
4	56	3.41	16.0	0.30	1.68	910	350	66.3	ND	ND	0.71
76	58	3.44	17.2	0.32	4.36	920	330	46.4	ND	ND	2.76
ZB	56	3.40	14.5	0.28	6.97	1000	390	38.1	ND	ND	2.69
	Mean	**3.40**	**14.3**	**0.32**	**3.64**	**1058**	**378**	**53.3**	**0.54**	**ND**	**3.96**
Middle Shelf Zone 2, Non-ZID (51-90 m)											
1	56	3.54	17.7	0.28	1.72	1100	360	129.8	1.89	ND	7.06
3	60	3.49	16.2	0.39	1.62	1000	310	32.9	ND	ND	2.70
5	59	3.78	32.7	0.26	1.65	1000	310	30.4	ND	ND	1.73
9	59	3.34	15.4	0.23	3.04	850	260	61.0	ND	ND	ND
10 *	62	3.85	36.9	0.40	1.73	990	370	76.2	ND	ND	1.39
12	58	3.32	15.9	0.27	5.21	830	290	30.3	ND	ND	ND
13 *	59	3.85	39.3	0.39	1.95	900	380	74.9	1.82	ND	4.26
37 *	56	2.79	12.4	0.23	5.67	560	360	48.5	ND	ND	ND
68	52	3.71	28.0	0.27	2.37	940	360	33.4	ND	ND	4.00
69	52	3.59	22.1	0.23	1.33	910	380	78.3	ND	ND	0.44
70	52	3.48	18.7	0.25	2.74	1000	350	39.1	ND	ND	0.79
71	52	3.44	17.1	0.27	4.12	940	340	101.0	ND	ND	0.41
72	55	3.60	20.6	0.26	3.37	1100	360	52.8	1.88	ND	2.14
73	55	3.43	13.7	0.34	3.96	2000	400	83.3	ND	ND	7.87
74	57	3.39	14.1	0.27	4.16	900	330	41.9	ND	ND	0.43
75	60	3.40	13.9	0.21	2.42	970	250	22.8	ND	ND	0.17
77	60	3.26	12.8	0.24	3.78	860	350	17.2	ND	ND	0.41
78	63	3.43	15.6	0.37	4.76	920	300	28.0	ND	ND	1.41
79	65	3.59	20.1	0.26	2.79	900	310	79.2	ND	ND	0.17
80	65	3.83	40.4	0.28	1.94	1000	320	25.9	ND	ND	1.52
81	65	3.46	16.7	0.24	2.04	870	310	20.2	ND	ND	ND
82	65	3.41	15.3	0.25	2.28	920	300	24.3	ND	ND	0.17
84	54	3.43	14.0	0.27	2.90	1100	400	157.1	ND	ND	6.05
85	57	3.38	11.6	0.43	2.52	1400	410	268.5	ND	ND	9.36
86	57	3.48	16.5	0.34	5.19	1000	340	87.7	ND	ND	6.26
87	60	3.46	17.6	0.26	4.77	950	290	21.9	ND	ND	0.53
C	56	3.51	22.6	0.27	4.57	940	340	25.5	2.14	ND	0.44
C2 *	56	4.89	87.0	1.29	198.00	970	1100	306.9	7.09	ND	5.51
CON	59	3.54	21.9	0.28	1.86	1000	310	20.1	1.94	ND	ND
	Mean	**3.54**	**22.3**	**0.32**	**9.81**	**994**	**362**	**69.6**	**0.58**	**ND**	**2.25**
Middle Shelf Zone 3 (91-120 m)											
17 *	91	3.46	20.5	0.43	6.43	830	360	47.7	ND	ND	0.16
18 *	91	3.68	25.6	0.37	2.00	840	360	16.7	ND	ND	0.20
20 *	100	3.99	49.1	0.55	3.38	980	520	85.1	2.14	ND	2.67
23 *	100	3.33	16.7	0.37	9.91	820	330	95.5	0.74	ND	7.14
29 *	100	4.23	60.6	0.62	5.15	1000	570	86.6	1.84	ND	0.19
33 *	100	3.54	29.7	0.36	12.40	820	480	55.9	ND	ND	ND
38 *	100	4.03	51.0	0.47	6.92	1000	580	85.2	2.16	ND	ND
56 *	100	4.04	51.4	0.47	5.22	1000	540	71.0	4.88	ND	2.94
60 *	100	4.01	50.4	0.44	7.29	1000	510	121.7	3.67	ND	2.78
83 *	100	3.74	29.4	0.41	5.46	870	480	79.6	19.17	ND	0.39
	Mean	**3.80**	**38.4**	**0.45**	**6.42**	**916**	**473**	**74.5**	**3.46**	**ND**	**1.65**
Outer Shelf (121-200 m)											
24 *	200	4.55	76.2	1.01	5.46	1000	890	158.8	12.66	ND	0.80
25 *	200	4.72	77.2	1.26	17.80	970	1100	44.6	6.22	ND	2.85
27 *	200	4.09	53.2	0.71	4.50	1000	670	63.9	3.46	ND	0.17
39 *	200	3.66	32.1	0.41	3.01	930	540	56.1	2.22	ND	ND
57 *	200	5.59	88.1	1.59	13.90	1000	1400	220.0	22.11	ND	11.33
61 *	200	4.72	73.8	0.97	10.60	1000	910	125.4	7.86	ND	6.16
63 *	200	4.72	77.9	0.88	16.30	1000	950	106.6	6.70	ND	4.06
65 *	200	4.41	61.6	0.80	8.54	1000	860	137.9	3.20	ND	1.36
C4 *	187	5.60	85.0	1.71	82.00	980	1300	251.1	5.09	ND	3.03
	Mean	**4.67**	**69.5**	**1.04**	**18.01**	**987**	**958**	**129.4**	**7.72**	**ND**	**3.31**

Table 2-3 continues.

Table 2-3 continued.

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (mg/kg)	ΣDDT (mg/kg)	ΣPest (mg/kg)	ΣPCB (mg/kg)
Upper Slope/Canyon (201-500 m)											
40 *	303	4.74	78.4	1.17	13.20	1100	1200	93.3	3.81	ND	0.57
41 *	303	4.70	73.5	1.13	13.90	1000	1100	87.5	6.72	13.3	1.41
42 *	303	4.95	78.1	1.38	15.40	940	1300	172.8	7.82	1.67	2.20
44 *	241	6.09	89.6	2.06	15.50	1100	1900	178.8	13.07	1.00	9.20
58 *	300	5.96	90.8	2.01	18.60	910	1700	325.6	24.24	ND	5.79
62 *	300	5.97	88.3	1.97	21.30	850	1800	219.8	11.34	ND	8.59
64 *	300	5.80	86.2	1.57	13.70	1000	940	131.8	2.93	ND	0.15
C5 *	296	6.01	87.9	2.37	88.20	940	1800	228.8	4.97	ND	2.07
	Mean	**5.53**	**84.1**	**1.71**	**24.98**	**980**	**1468**	**179.8**	**9.36**	**2**	**3.75**
Sediment quality guidelines and regional summer values											
ERM		N/A	N/A	N/A	N/A	N/A	N/A	44,792.0	46.10	N/A	180.00
Bight'13 AWM Middle Shelf		N/A	48.0	0.70	N/A	N/A	N/A	55.0	18.00	N/A	2.70
Bight'13 AWM Outer Shelf		N/A	49.0	0.93	N/A	N/A	N/A	92.0	79.00	N/A	4.50
Bight'13 AWM Upper Slope		N/A	75.0	1.90	N/A	N/A	N/A	160.0	490.00	N/A	15.00

Table 2–4 Metal concentrations (mg/kg) in sediment samples collected at each semi-annual and annual (*) station in Summer 2015 compared to Effects Range-Median (ERM) values and regional measurements. ZID = Zone of Initial Dilution, AWM = Area Weighted Mean, ND = Not Detected, NA = Not Applicable.

Station	Depth (m)	Sb	As	Ba	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
Middle Shelf Zone 1 (31-50 m)														
7 *	41	ND	2.21	37.5	0.21	0.21	19.90	9.86	6.59	0.02	9.8	ND	0.12	37.3
8 *	44	ND	2.44	48.1	0.21	0.23	19.20	9.56	5.76	0.02	9.7	0.22	0.11	37.2
21 *	44	ND	2.43	37.5	0.20	0.19	20.60	9.91	6.23	0.01	10.0	0.19	0.11	37.6
22 *	45	ND	2.56	41.4	0.23	0.25	20.80	10.10	6.31	0.02	10.9	0.17	0.10	40.6
30 *	46	ND	1.94	33.7	0.20	0.18	18.90	8.30	5.80	0.01	8.7	ND	0.10	33.5
36 *	45	ND	2.43	39.4	0.22	0.23	18.60	8.63	6.32	0.01	10.2	ND	0.06	37.8
55 *	40	ND	1.43	24.0	0.14	0.09	12.90	4.52	3.46	0.01	6.2	ND	0.04	22.7
59 *	40	ND	1.86	31.3	0.17	0.16	16.40	6.62	4.54	0.01	7.8	ND	0.07	28.6
	Mean	**ND**	**2.16**	**36.6**	**0.20**	**0.19**	**18.41**	**8.44**	**5.63**	**0.01**	**9.2**	**0.07**	**0.09**	**34.4**
Middle Shelf Zone 2, Within-ZID (51-90 m)														
0	56	ND	3.69	30.7	0.25	0.44	28.60	119.00	6.35	0.04	10.2	0.39	0.21	49.3
4	56	ND	2.52	28.9	0.23	0.22	20.10	9.07	4.72	0.01	9.0	0.33	0.13	40.8
76	58	ND	2.23	33.8	0.28	0.28	21.60	10.70	4.63	0.02	10.0	0.39	0.16	46.4
ZB	56	ND	2.83	37.3	0.28	0.38	22.50	10.80	4.83	0.02	10.0	0.40	0.13	46.2
	Mean	**ND**	**2.82**	**32.7**	**0.26**	**0.33**	**23.20**	**37.39**	**5.13**	**0.02**	**9.8**	**0.38**	**0.16**	**45.7**
Middle Shelf Zone 2, Non-ZID (51-90 m)														
1	56	ND	2.51	36.7	0.26	0.38	23.90	12.70	5.97	0.02	9.3	0.35	0.23	43.6
3	60	ND	2.63	34.1	0.29	0.26	23.60	11.20	5.19	0.06	10.0	0.35	0.16	46.6
5	59	ND	2.85	41.3	0.28	0.24	23.50	11.80	6.02	0.02	10.9	0.36	0.17	45.6
9	59	ND	2.59	31.5	0.26	0.19	21.60	8.82	4.83	0.01	9.5	0.37	0.11	39.2
10 *	62	ND	3.32	38.8	0.27	0.23	30.80	11.60	6.17	0.02	10.8	0.41	0.17	44.0
12	58	ND	2.56	30.9	0.28	0.21	20.70	8.47	4.82	0.01	9.6	0.41	0.10	39.8
13 *	59	ND	2.06	43.4	0.21	0.24	21.30	10.70	5.54	0.01	10.7	0.20	0.15	40.4
37 *	56	ND	1.75	29.2	0.19	0.22	14.80	6.81	4.50	0.01	8.5	ND	0.05	33.3
68	52	ND	2.77	38.0	0.25	0.27	22.60	11.10	5.74	0.02	10.0	0.34	0.18	43.1
69	52	ND	3.17	34.6	0.26	0.26	23.50	10.20	5.55	0.02	10.4	0.34	0.14	43.0
70	52	ND	3.21	39.6	0.26	0.28	21.40	10.10	5.31	0.02	9.8	0.38	0.17	43.3
71	52	ND	2.96	35.7	0.26	0.31	21.20	9.48	5.12	0.02	9.7	0.32	0.13	41.9
72	55	ND	2.83	36.5	0.27	0.27	23.50	11.30	5.61	0.02	9.9	0.35	0.20	43.7
73	55	ND	3.29	34.7	0.27	0.51	23.90	45.50	7.43	0.11	9.8	0.38	0.30	48.0
74	57	ND	2.81	31.1	0.24	0.33	19.90	9.15	4.61	0.04	9.1	0.31	0.11	42.2
75	60	ND	2.69	30.9	0.26	0.31	19.40	8.05	4.23	0.01	8.7	0.31	0.10	41.3
77	60	ND	2.58	29.7	0.25	0.20	20.30	8.23	4.47	0.01	8.6	0.39	0.11	37.7
78	63	ND	2.30	31.3	0.28	0.19	22.10	9.20	4.78	0.06	9.8	0.38	0.12	37.2
79	65	ND	2.82	35.2	0.28	0.18	22.10	10.30	5.06	0.02	10.3	0.39	0.14	45.4
80	65	ND	3.48	42.4	0.35	0.21	22.60	12.30	5.67	0.02	12.7	0.41	0.10	53.2
81	65	ND	2.46	37.5	0.30	0.19	20.50	8.94	4.70	0.02	9.6	0.33	0.11	42.0
82	65	ND	2.23	33.6	0.27	0.19	21.80	8.86	4.50	0.01	9.9	0.40	0.10	42.7
84	54	0.1	3.36	32.0	0.24	0.32	22.40	12.60	5.80	0.02	9.6	0.37	0.47	44.7
85	57	ND	2.83	26.9	0.24	0.48	22.90	12.70	5.37	0.02	9.1	0.34	0.23	43.2
86	57	ND	2.47	34.1	0.24	0.44	24.50	13.00	5.66	0.03	10.0	0.35	0.23	46.9
87	60	ND	2.08	31.6	0.27	0.22	22.10	10.10	4.53	0.01	9.6	0.39	0.13	45.7
C	56	ND	3.05	44.1	0.27	0.23	21.90	9.98	6.34	0.02	10.6	0.39	0.12	46.4
C2 *	56	0.1	4.15	99.7	0.41	0.45	32.60	22.00	12.40	0.03	21.2	0.43	0.13	92.0
CON	59	0.1	2.62	48.0	0.27	0.19	23.70	10.20	6.09	0.02	11.1	0.36	0.11	43.9
	Mean	**0.01**	**2.77**	**37.7**	**0.27**	**0.28**	**22.59**	**11.91**	**5.59**	**0.02**	**10.3**	**0.35**	**0.16**	**44.8**

Table 2-4 continues.

Table 2-4 continued.

Station	Depth (m)	Sb	As	Ba	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
Middle Shelf Zone 3 (91-120 m)														
17 *	91	ND	1.75	34.7	0.26	0.18	20.10	8.97	4.71	0.01	11.0	0.20	0.08	43.0
18 *	91	ND	1.55	37.1	0.25	0.19	20.50	8.89	4.94	0.01	11.0	ND	0.08	42.5
20 *	100	ND	2.49	48.0	0.25	0.26	24.00	13.60	6.55	0.02	12.6	0.20	0.16	47.5
23 *	100	ND	2.05	31.6	0.23	0.18	17.70	7.54	4.38	0.01	9.8	0.17	0.06	37.5
29 *	100	ND	2.18	52.2	0.26	0.28	25.10	15.00	7.31	0.02	13.9	0.25	0.17	51.3
33 *	100	ND	2.10	47.6	0.24	0.31	20.70	9.68	5.02	0.01	12.2	0.29	0.09	46.1
38 *	100	0.1	2.66	57.1	0.27	0.42	22.80	11.40	6.08	0.02	13.1	0.31	0.11	48.6
56 *	100	0.1	2.80	70.5	0.33	0.30	34.60	14.70	7.38	0.03	14.0	0.62	0.20	54.2
60 *	100	0.1	1.99	54.9	0.26	0.29	25.60	14.20	7.08	0.02	13.4	0.24	0.18	49.8
83 *	100	ND	2.30	42.0	0.25	0.19	22.00	10.60	5.88	0.01	12.0	0.19	0.10	46.1
	Mean	**0.03**	**2.19**	**47.6**	**0.26**	**0.26**	**23.31**	**11.46**	**5.93**	**0.02**	**12.3**	**0.25**	**0.12**	**46.7**
Outer Shelf (121-200 m)														
24 *	200	0.1	2.99	81.6	0.41	0.42	36.80	18.20	8.53	0.04	17.3	0.20	0.19	61.7
25 *	200	0.1	3.34	99.1	0.41	0.51	40.90	20.50	9.62	0.03	18.2	0.94	0.25	66.4
27 *	200	ND	1.88	58.8	0.29	0.33	26.90	13.10	6.41	0.02	14.9	0.31	0.10	50.2
39 *	200	ND	2.28	46.4	0.27	0.26	23.10	10.60	5.35	0.01	13.0	0.28	0.08	45.3
57 *	200	0.2	4.91	154.0	0.50	0.74	50.10	37.60	16.00	0.03	24.6	1.19	0.62	87.7
61 *	200	0.1	3.12	105.0	0.34	0.60	35.60	25.20	10.50	0.04	20.0	0.52	0.35	69.5
63 *	200	0.1	3.26	151.0	0.40	0.46	40.30	20.10	9.31	0.02	18.1	0.89	0.25	64.3
65 *	200	0.1	3.38	74.7	0.36	0.59	28.70	16.90	7.40	0.02	17.3	0.52	0.15	62.5
C4 *	187	0.2	6.05	102.0	0.52	0.63	45.80	25.00	12.40	0.03	23.5	1.06	0.22	90.6
	Mean	**0.1**	**3.47**	**97.0**	**0.39**	**0.50**	**36.47**	**20.80**	**9.50**	**0.03**	**18.5**	**0.66**	**0.25**	**66.5**
Upper Slope/Canyon (201-500 m)														
40 *	303	0.1	2.40	92.0	0.37	0.48	37.10	21.30	8.91	0.02	20.5	0.62	0.16	66.3
41 *	303	0.2	3.80	94.4	0.45	0.45	39.40	21.20	9.31	0.02	19.8	0.99	0.19	68.5
42 *	303	0.2	4.70	119.0	0.51	0.56	52.40	25.30	11.30	0.02	22.1	1.30	0.27	76.6
44 *	241	0.2	3.69	154.0	0.48	0.79	55.80	38.50	13.70	0.04	27.6	1.11	0.49	90.1
58 *	300	0.3	5.76	177.0	0.59	0.69	56.60	34.40	16.00	0.02	27.5	1.68	0.43	86.1
62 *	300	0.2	5.33	172.0	0.50	0.92	59.80	43.80	18.10	0.05	28.6	0.95	0.65	95.7
64 *	300	0.1	4.86	104.0	0.49	0.48	39.90	28.40	11.20	0.02	26.2	0.70	0.18	76.7
C5 *	296	0.2	5.88	119.0	0.58	0.80	57.10	32.00	14.60	0.03	26.4	1.64	0.35	93.9
	Mean	**0.2**	**4.55**	**128.9**	**0.50**	**0.65**	**49.76**	**30.61**	**12.89**	**0.03**	**24.8**	**1.12**	**0.34**	**81.7**
Sediment quality guidelines and regional summer values														
ERM		N/A	70.00	N/A	N/A	9.60	370.00	270.00	218.00	0.70	51.6	N/A	3.70	410.0
Bight'13 AWM Middle Shelf		0.9	2.70	130.0	0.21	0.68	30.00	7.90	7.00	0.05	15.0	0.10	0.29	48.0
Bight'13 AWM Outer Shelf		1.1	5.30	130.0	0.36	0.82	37.00	11.00	10.00	0.07	18.0	0.21	0.39	57.0
Bight'13 AWM Upper Slope		1.4	5.40	160.0	0.27	1.50	57.00	21.00	12.00	0.08	30.0	0.89	0.24	88.0

and a total of 27 individuals of the pollution-sensitive amphipod genera *Ampelisca* and *Rhepoxynius* at Station 4 in winter. These multiple lines of evidence suggest that the outfall discharge had an overall negligible effect on the benthic community structure within the monitoring area. We conclude, therefore, that the biota was not degraded by the outfall discharge, and as such, compliance was met.

Epibenthic Macroinvertebrate Communities

A total of 54 epibenthic macroinvertebrate (EMI) species, comprising 8,442 individuals and a total weight of 30.3 kg, was collected from the monitoring area during trawls conducted in the 2015-16 period (Tables B-8 and B-9). *Ophiura luetkenii* (brittlestar) and *Strongylocentrotus fragilis* (sea urchin) were the most dominant species in terms of abundance (n=6,496; 77% of total) and biomass (12.3 kg; 41% of total), respectively. All mean community measure values for EMIs, except for abundance, at the Middle Shelf Zone 2, outfall stratum were comparable to those at the Middle Shelf Zone 2, non-outfall stratum in both surveys (Table 2-10). Large catches (>1,500) of *O. luetkenii* at Station T11 in summer and winter contributed to the higher mean abundance values at the Middle Shelf Zone 2, non-outfall stratum (Table B-8). Historically, interannual abundance of EMIs is highly variable and typically reflect changes in several dominant species such as *O. luetkenii* (OCSD 2014). Multivariate analyses (cluster and non-metric multidimensional scaling (nMDS)) of the EMI species and abundance data revealed that the EMI community composition was similar between Middle Shelf Zone 2, outfall and non-outfall stations in both surveys (Figure 2-6). This suggests that the outfall discharge had an overall negligible effect on the EMI community structure within the monitoring area. Based on these

Table 2–5 Physical properties and organic contaminant concentrations of sediment samples collected at each semi-annual station in Winter 2016 compared to Effects Range-Median (ERM) values and regional measurements. ZID = Zone of Initial Dilution, AWM = Area Weighted Mean, ND = Not Detected, N/A = Not Applicable.

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (mg/kg)	ΣDDT (mg/kg)	ΣPest (mg/kg)	ΣPCB (mg/kg)
Middle Shelf Zone 2, Within-ZID (51-90 m)											
0	56	3.36	11.8	0.36	2.30	1200	550	146.6	2.26	ND	13.63
4	56	3.37	13.6	0.26	2.45	850	350	55.5	ND	ND	0.39
76	58	3.42	16.4	0.26	5.50	960	310	24.8	ND	ND	1.01
ZB	56	3.44	17.6	0.29	7.41	860	290	52.3	ND	ND	0.57
	Mean	**3.40**	**14.9**	**0.29**	**4.42**	**968**	**375**	**69.8**	**0.57**	**ND**	**3.90**
Middle Shelf Zone 2, Non-ZID (51-90 m)											
1	56	3.57	21.1	0.30	ND	1100	430	51.7	2.16	ND	5.35
3	60	3.51	16.0	0.31	1.89	970	390	21.2	1.80	ND	3.08
5	59	3.77	30.9	0.33	3.87	930	380	30.9	2.35	ND	1.70
9	59	3.37	13.4	0.29	3.25	820	290	38.7	ND	ND	0.16
12	58	3.32	14.2	0.30	5.59	820	570	149.1	ND	ND	ND
68	52	3.69	26.0	0.30	4.17	930	340	47.1	3.27	ND	1.15
69	52	3.66	26.4	0.32	5.34	1000	340	48.6	2.15	ND	2.35
70	52	3.55	23.3	0.32	4.47	990	430	72.6	2.07	ND	3.81
71	52	3.40	14.4	0.28	4.32	1000	370	34.6	1.79	ND	0.38
72	55	3.57	19.8	0.29	4.31	950	430	48.8	2.13	ND	2.12
73	55	3.37	12.9	0.37	9.11	1100	340	197.0	2.42	ND	6.51
74	57	3.42	15.8	0.27	8.60	990	380	58.5	2.19	ND	1.36
75	60	3.38	13.8	0.30	6.59	860	370	29.5	ND	ND	0.40
77	60	3.37	14.0	0.24	2.39	890	370	24.0	ND	ND	0.16
78	63	3.42	14.5	0.25	5.08	900	340	31.6	ND	ND	0.35
79	65	3.55	19.6	0.30	5.54	940	390	51.7	1.76	ND	2.76
80	65	3.60	24.7	0.27	4.90	940	ND	22.5	ND	ND	ND
81	65	3.47	17.3	0.29	4.71	870	290	24.5	ND	ND	ND
82	65	3.37	14.7	0.28	4.40	880	370	19.0	ND	ND	ND
84	54	3.44	14.4	0.34	7.68	990	400	58.1	2.10	ND	6.56
85	57	3.35	9.2	0.39	21.10	1300	540	295.3	2.69	ND	13.73
86	57	3.50	22.1	0.35	9.61	1000	490	90.4	1.92	ND	13.34
87	60	3.40	14.4	0.26	8.42	960	330	24.0	ND	ND	1.19
C	56	3.44	19.0	0.31	5.10	950	380	25.0	2.16	ND	1.71
CON	59	3.58	21.7	0.36	9.01	950	410	36.5	2.76	ND	0.54
	Mean	**3.48**	**18.1**	**0.30**	**5.98**	**961**	**390**	**61.2**	**1.43**	**ND**	**2.75**
Sediment quality guidelines and regional summer values											
ERM		N/A	N/A	N/A	N/A	N/A	N/A	44,792.0	46.10	N/A	180.00
Bight'13 AWM Middle Shelf		N/A	48.0	0.70	N/A	N/A	N/A	55.0	18.00	N/A	2.70

overall results, we conclude that the EMI communities within the monitoring area were not degraded by the outfall discharge, and consequently, compliance was met.

Fish Communities

A total of 33 fish taxa, comprising 5,636 individuals and a total weight of 211.7 kg, were collected from the monitoring area during the 2015-16 trawling effort (Tables B-10 and B-11). The mean species richness, abundance, biomass, H′, and SDI values of demersal fishes were comparable between outfall and non-outfall stations in both surveys, with values falling within historical ranges (Table 2-11). More importantly, the fish communities at outfall and non-outfall stations were classified as reference condition based on their low (<45) mean fish response index (FRI) values in both surveys. Multivariate analyses (cluster and nMDS) of the demersal fish species and abundance data further demonstrated that the fish communities were similar between the outfall and non-outfall stations (Figure 2-7). These results indicate that the outfall discharge had no adverse effect on the demersal fish community structure within the monitoring area. We conclude that the demersal fish communities within the monitoring area were not degraded by the outfall discharge, and thus, compliance was met.

Table 2–6 Metal concentrations (mg/kg) in sediment samples collected at each semi-annual station in Winter 2016 compared to Effects Range-Median (ERM) values and regional measurements. ZID = Zone of Initial Dilution, AWM = Area Weighted Mean, ND = Not Detected, NA = Not Applicable.

Station	Depth (m)	Sb	As	Ba	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
Middle Shelf Zone 2, Within-ZID (51-90 m)														
0	56	0.1	3.08	29.3	0.21	0.43	21.50	11.50	5.11	0.03	8.7	0.33	0.17	43.5
4	56	ND	2.41	27.0	0.21	0.19	18.40	7.84	4.44	0.02	8.0	0.27	0.08	37.0
76	58	ND	2.07	33.0	0.26	0.26	19.00	10.10	4.03	0.02	9.3	0.31	0.12	42.5
ZB	56	ND	2.80	33.5	0.22	0.26	20.90	9.57	4.66	0.02	9.8	0.29	0.10	43.0
	Mean	**0.02**	**2.59**	**30.7**	**0.22**	**0.28**	**19.95**	**9.75**	**4.56**	**0.02**	**9.0**	**0.30**	**0.12**	**41.5**
Middle Shelf Zone 2, Non-ZID (51-90 m)														
1	56	ND	2.60	33.2	0.22	0.30	21.30	11.30	5.16	0.03	11.0	0.34	0.19	42.1
3	60	ND	2.15	34.6	0.23	0.27	21.90	10.60	4.79	0.02	9.7	0.32	0.16	46.4
5	59	ND	2.74	39.7	0.23	0.24	21.90	10.40	5.26	0.02	10.2	0.34	0.14	42.6
9	59	ND	2.11	31.8	0.22	0.23	18.90	8.18	4.95	0.02	8.4	0.31	0.10	38.2
12	58	ND	2.34	28.5	0.21	0.18	26.10	7.34	4.41	0.01	8.2	0.30	0.09	35.6
68	52	0.1	2.98	38.1	0.23	0.26	21.30	10.70	5.52	0.02	9.9	0.34	0.17	43.8
69	52	0.1	3.09	36.8	0.23	0.30	21.20	10.50	5.25	0.02	9.8	0.34	0.15	43.0
70	52	ND	2.29	31.3	0.22	0.30	19.20	9.44	4.80	0.03	8.7	0.30	0.14	38.6
71	52	ND	2.39	29.8	0.21	0.26	18.00	7.92	4.36	0.02	8.1	0.31	0.10	36.5
72	55	ND	1.98	34.5	0.22	0.27	20.50	10.40	4.88	0.02	9.0	0.29	0.18	41.0
73	55	0.1	3.21	29.2	0.21	0.36	20.30	11.90	5.19	0.03	8.6	0.30	0.15	40.5
74	57	ND	2.42	31.2	0.23	0.31	19.50	8.70	4.59	0.02	8.6	0.30	0.12	39.7
75	60	ND	2.41	32.6	0.23	0.36	20.20	8.70	4.01	0.03	9.0	0.30	0.12	39.9
77	60	ND	2.32	31.5	0.23	0.21	20.80	8.59	4.44	0.01	8.6	0.31	0.10	40.0
78	63	0.1	2.21	29.3	0.23	0.21	19.80	8.00	3.92	0.01	8.3	0.33	0.09	38.7
79	65	ND	2.07	36.3	0.26	0.23	20.60	9.84	4.74	0.02	9.9	0.32	0.12	44.5
80	65	ND	2.57	32.4	0.28	0.16	19.90	10.10	4.88	0.01	10.0	0.28	0.08	45.5
81	65	ND	2.01	34.7	0.25	0.18	19.20	8.40	4.14	0.02	9.1	0.31	0.11	38.4
82	65	ND	2.11	29.0	0.22	0.16	18.60	7.44	3.99	0.01	8.4	0.28	0.08	35.9
84	54	ND	3.07	35.3	0.21	0.32	22.40	11.90	5.73	0.03	8.9	0.35	0.31	42.1
85	57	0.1	3.17	30.8	0.22	0.55	22.60	12.50	7.18	0.05	8.7	0.38	0.30	44.8
86	57	0.1	2.19	30.8	0.23	0.38	20.50	14.30	5.03	0.02	9.0	0.36	0.18	44.0
87	60	ND	2.18	29.1	0.23	0.20	20.00	9.00	4.20	0.02	8.8	0.29	0.94	40.4
C	56	0.1	2.59	44.0	0.22	0.18	20.90	8.86	5.26	0.02	10.0	0.31	0.09	41.2
CON	59	0.1	2.23	45.9	0.22	0.18	21.70	9.01	5.11	0.02	10.2	0.32	0.09	39.9
	Mean	**0.04**	**2.46**	**33.6**	**0.23**	**0.26**	**20.69**	**9.76**	**4.87**	**0.02**	**9.2**	**0.32**	**0.17**	**40.9**
Sediment quality guidelines and regional summer values														
ERM		N/A	70.00	N/A	N/A	9.60	370.00	270.00	218.00	0.70	51.6	N/A	3.70	410.0
Bight'13 AWM Middle Shelf		0.9	2.70	130.0	0.21	0.68	30.00	7.90	7.00	0.05	15.0	0.10	0.29	48.0

Table 2–7 Whole-sediment *Eohaustorius estuarius* (amphipod) toxicity test results for 2015-16. The home sediment represents the control; N/A = Not Applicable.

Station	% Survival	% of home	p-value	Assessment
home	100	N/A	N/A	N/A
0	94	94	0.01	Nontoxic
1	99	99	0.17	Nontoxic
4	98	98	0.07	Nontoxic
72	99	99	0.17	Nontoxic
73	100	100	0.50	Nontoxic
76	97	97	0.08	Nontoxic
77	98	98	0.07	Nontoxic
CON	99	99	0.17	Nontoxic
ZB	100	100	0.50	Nontoxic
ZB Dup	98	98	0.07	Nontoxic

FISH BIOACCUMULATION AND HEALTH

Demersal Fish Tissue Chemistry

Muscle tissue contaminant concentrations in Hornyhead Turbot were generally similar between outfall and non-outfall stations (Table 2-12). In English Sole, the ΣDDT mean for muscle was higher for the outfall sample compared to the non-outfall sample. However, this mean value falls within historical ranges within the monitoring area (OCSD 2014).

Table 2–8 Summary of infaunal community measure values for each semi-annual and annual (*) station sampled during the Summer 2015 benthic survey, including regional and Districal historical values. ZID = Zone of Initial Dilution; N/A = Not Applicable; NC = Not Calculated.

Station	Depth (m)	Total No. of Species	Total Abundance	H'	SDI	ITI	BRI
Middle Shelf Zone 1 (31-50 m)							
7 *	41	102	476	3.42	22	94	13
8 *	44	109	337	4.01	43	91	15
21 *	44	98	286	4.06	40	91	8
22 *	45	87	269	3.93	34	98	13
30 *	46	98	340	4.15	40	88	14
36 *	45	63	168	3.61	25	97	11
55 *	40	83	283	3.95	31	84	14
59 *	40	77	219	3.85	32	91	14
	Mean	**90**	**297**	**3.87**	**33**	**92**	**13**
Middle Shelf Zone 2, Within-ZID (51-90 m)							
0	56	96	476	3.64	22	73	21
4	56	81	258	3.87	32	80	22
76	58	77	277	3.51	25	77	22
ZB	56	68	236	3.44	20	81	20
	Mean	**81**	**312**	**3.62**	**25**	**78**	**21**
Middle Shelf Zone 2, Non-ZID (51-90 m)							
1	56	71	357	3.46	18	82	14
3	60	75	343	3.56	22	75	16
5	59	74	245	3.78	25	79	15
9	59	87	269	3.75	30	78	19
10 *	62	74	224	3.72	27	83	14
12	58	66	228	3.6	23	81	18
13 *	59	74	213	3.88	32	90	12
37 *	56	80	298	3.82	28	91	14
68	52	85	277	3.92	32	92	15
69	52	87	309	3.83	30	88	14
70	52	97	386	3.9	31	84	15
71	52	98	323	3.96	33	85	16
72	55	74	332	3.55	20	79	15
73	55	86	433	3.45	20	78	19
74	57	79	379	3.41	19	78	18
75	60	82	327	3.65	25	76	17
77	60	67	248	3.48	21	77	20
78	63	80	325	3.54	21	71	15
79	65	93	353	3.72	28	80	13
80	65	79	399	3.41	17	89	15
81	65	75	280	3.62	26	82	14
82	65	71	284	3.6	23	76	13
84	54	92	357	3.74	25	81	19
85	57	86	429	3.46	19	73	23
86	57	82	456	3.41	16	79	22
87	60	86	292	3.85	32	81	16
C	56	69	149	3.97	33	90	10
C2 *	56	41	90	3.47	20	64	38
CON	59	82	204	3.99	36	84	13
	Mean	**79**	**304**	**3.67**	**25**	**81**	**17**
Middle Shelf Zone 3 (91-120 m)							
17 *	91	74	337	3.73	23	83	12
18 *	91	89	405	3.66	21	82	14
20 *	100	76	289	3.7	27	89	18
23 *	100	68	238	3.66	24	80	13
29 *	100	85	356	3.84	28	85	20
33 *	100	82	301	3.86	29	72	23
38 *	100	66	389	3.37	21	88	26
56 *	100	71	199	3.95	31	86	16
60 *	100	82	327	3.89	29	82	20
83 *	100	76	281	3.64	23	89	10
	Mean	**77**	**312**	**3.73**	**26**	**84**	**17**
Outer Shelf (121-200 m)							
24 *	200	43	87	3.49	22	75	24
25 *	200	37	74	3.36	19	64	27
27 *	200	51	143	3.51	21	73	24
39 *	200	56	234	3.23	15	55	23
57 *	200	24	40	3.05	15	56	30

Table 2-8 continues.

Table 2-8 continued.

Station	Depth (m)	Total No. of Species	Total Abundance	H'	SDI	ITI	BRI
61 *	200	34	71	3.27	17	81	22
63 *	200	32	59	3.28	18	54	29
65 *	200	33	78	3.08	16	63	20
C4 *	187	27	62	2.92	13	64	36
	Mean	**37**	**94**	**3.24**	**17**	**65**	**26**
Upper Slope/Canyon (201-500 m)							
40 *	303	29	56	3.21	16	N/A	N/A
41 *	303	26	53	2.93	14	N/A	N/A
42 *	303	20	45	2.73	9	N/A	N/A
44 *	241	20	46	2.65	9	N/A	N/A
58 *	300	15	26	2.52	9	N/A	N/A
62 *	300	21	48	2.36	10	N/A	N/A
64 *	300	13	22	2.39	8	N/A	N/A
C5 *	296	23	41	2.96	13	N/A	N/A
	Mean	**21**	**42**	**2.72**	**11**	**N/A**	**N/A**
Regional reference values [mean (range)]							
Bight'08 Middle Shelf		99 (30-153)	393 (79-1159)	3.83 (2.82-4.32)	31 (13-48)	NC	15 (2-26)
Bight'08 Outer Shelf		62 (27-127)	190 (43-532)	3.52 (2.93-4.19)	24 (12-41)	NC	15 (-2-33)
Bight'08 Upper Slope		26 (9-69)	70 (13-258)	2.72 (1.71-3.83)	11 (4-28)	N/A	N/A
District historical summer values (2005-2015 Fiscal Years) [mean (range)]							
Middle Shelf Zone 1		112 (6-156)	452 (11-820)	3.99 (1.42-4.46)	35 (4-51)	83 (67-95)	17 (8-23)
Middle Shelf Zone 2, Within-ZID		91 (33-138)	540 (211-1491)	3.36 (0.36-4)	22 (1-35)	48 (1-83)	29 (13-52)
Middle Shelf Zone 2, Non-ZID		100 (29-143)	442 (142-829)	3.74 (2.29-4.42)	29 (5-52)	75 (1-96)	19 (10-57)
Middle Shelf Zone 3		101 (67-146)	513 (177-882)	3.79 (3.04-4.23)	28 (14-42)	82 (65-93)	18 (13-26)
Outer Shelf		48 (23-80)	143 (41-367)	3.31 (2.50-3.95)	19 (8-32)	73 (42-100)	23 (14-39)
Upper Slope/Canyon		28 (14-49)	66 (22-165)	2.90 (2.31-3.40)	13 (7-21)	65 (33-100)	25 (13-42)

In Hornyhead Turbot, all liver tissue contaminant concentrations, except for ΣPCB, were generally similar between outfall and non-outfall stations (Table 2-12). The different ΣPCB values may have been attributed to the uneven sample sizes at the two sampling locations (n=1 vs n=6).

One of the 10 English Sole individuals collected at the outfall station had notably elevated concentrations of ΣDDT (20,967 µg/kg) and ΣPCB (1,627 µg/kg) in its liver tissue which skewed the means. This is not cause for concern as elevated mean values have been historically attributed to high concentrations in one or two individuals in a sample (OCSD 2010).

Comparison between sample sites is further confounded by the transitory nature of fishes because it is assumed that the location of capture is also the location of exposure. Generally, concentrations of contaminants in fish tissues are highest in fish residing near the source of the contaminant (Mearns et al. 1991). However, demersal fish with large ranges may transport contaminants away from the source or be captured away from the primary location of exposure (Allen 2006). This appears to be the case for the single English Sole individual as ΣPCB and ΣDDT in sediment samples at the outfall were <14 µg/kg in the Summer 2015 and Winter 2016 surveys (see Sediment Geochemistry section above).

Sport Fish Muscle Chemistry

Arsenic levels were similar in sport fishes collected at the outfall and non-outfall zones. More importantly, all other fish muscle tissue contaminant levels at both zones were well below federal and/or state human consumption guidelines (Table 2-13). These results indicate there is little risk from consuming fish from the monitored areas and compliance was achieved.

Fish Health

Fishes appeared normal in both color and odor in 2015-16, thus compliance was met. Furthermore, less than 1% of all fishes collected showed evidence of irregularities. The most common irregularity was the presence of the eye parasite *Phrixocephalus cincinnatus* on the Pacific Sanddab (*Citharichthys sordidus*), which occurred in ~1% of the examined fish. These results are comparable to background

Table 2–9 Summary of infaunal community measures for each semi-annual station sampled during the Winter 2016 benthic survey, including regional and District historical values. ZID = Zone of Initial Dilution; NC = Not Calculated.

Station	Depth (m)	Total No. of Species	Total Abundance	H'	SDI	ITI	BRI
Middle shelf Zone 2, Within-ZID (51-90 m)							
0	56	67	165	3.81	28	84	16
4	56	50	88	3.66	28	86	9
76	58	56	118	3.69	27	89	11
ZB	56	56	117	3.75	28	81	17
	Mean	**57**	**122**	**3.73**	**28**	**85**	**13**
Middle shelf Zone 2, Non-ZID (51-90 m)							
1	56	67	166	3.85	29	89	14
3	60	74	183	3.98	33	84	18
5	59	77	290	3.86	27	95	10
9	59	57	115	3.72	29	91	10
12	58	59	113	3.73	32	90	13
68	52	79	224	3.99	34	91	15
69	52	70	234	3.78	26	94	12
70	52	88	227	3.99	36	87	14
71	52	55	119	3.5	26	86	14
72	55	60	213	3.65	24	83	10
73	55	66	150	3.71	29	85	12
74	57	81	248	3.95	32	93	10
75	60	57	131	3.7	26	83	14
77	60	54	96	3.71	31	78	16
78	63	59	112	3.83	32	78	17
79	65	59	168	3.75	27	87	10
80	65	72	202	3.83	31	93	10
81	65	69	176	3.84	30	83	16
82	65	70	146	3.89	34	80	12
84	54	78	200	3.86	33	89	12
85	57	70	168	3.85	30	88	19
86	57	63	177	3.77	28	80	17
87	60	63	146	3.8	28	89	12
C	56	78	200	3.99	33	91	14
CON	59	73	180	3.97	32	89	12
	Mean	**68**	**175**	**3.82**	**30**	**87**	**13**
Regional reference values [mean (range)]							
Bight'08 Middle Shelf		99 (30-153)	393 (79-1159)	3.83 (2.82-4.32)	31 (13-48)	NC	15 (2-26)
District historical winter values (2005-2015 Fiscal Years) [mean (range)]							
Middle Shelf Zone 2, Within-ZID		85 (35-128)	421 (142-1230)	3.38 (0.89-4.04)	22 (1-37)	49 (3-84)	28 (16-45)
Middle Shelf Zone 2, Non-ZID		90 (45-142)	352 (152-634)	3.74 (2.87-4.32)	28 (9-48)	77 (47-95)	19 (10-46)

levels found within the Southern California Bight (Perkins and Gartman 1997) and do not indicate a degraded biota.

Liver Histopathology

For the 2015-16 monitoring period, there were no differences in Hornyhead Turbot liver histopathology among the outfall and non-outfall stations (Stuart and Forsgren 2016). In contrast, English Sole samples at the outfall exhibited slightly more liver tissue damage than those at the non-outfall station. However, the majority of samples at the outfall were not classified as irreparable. These results further demonstrate that the outfall is not an epicenter of disease.

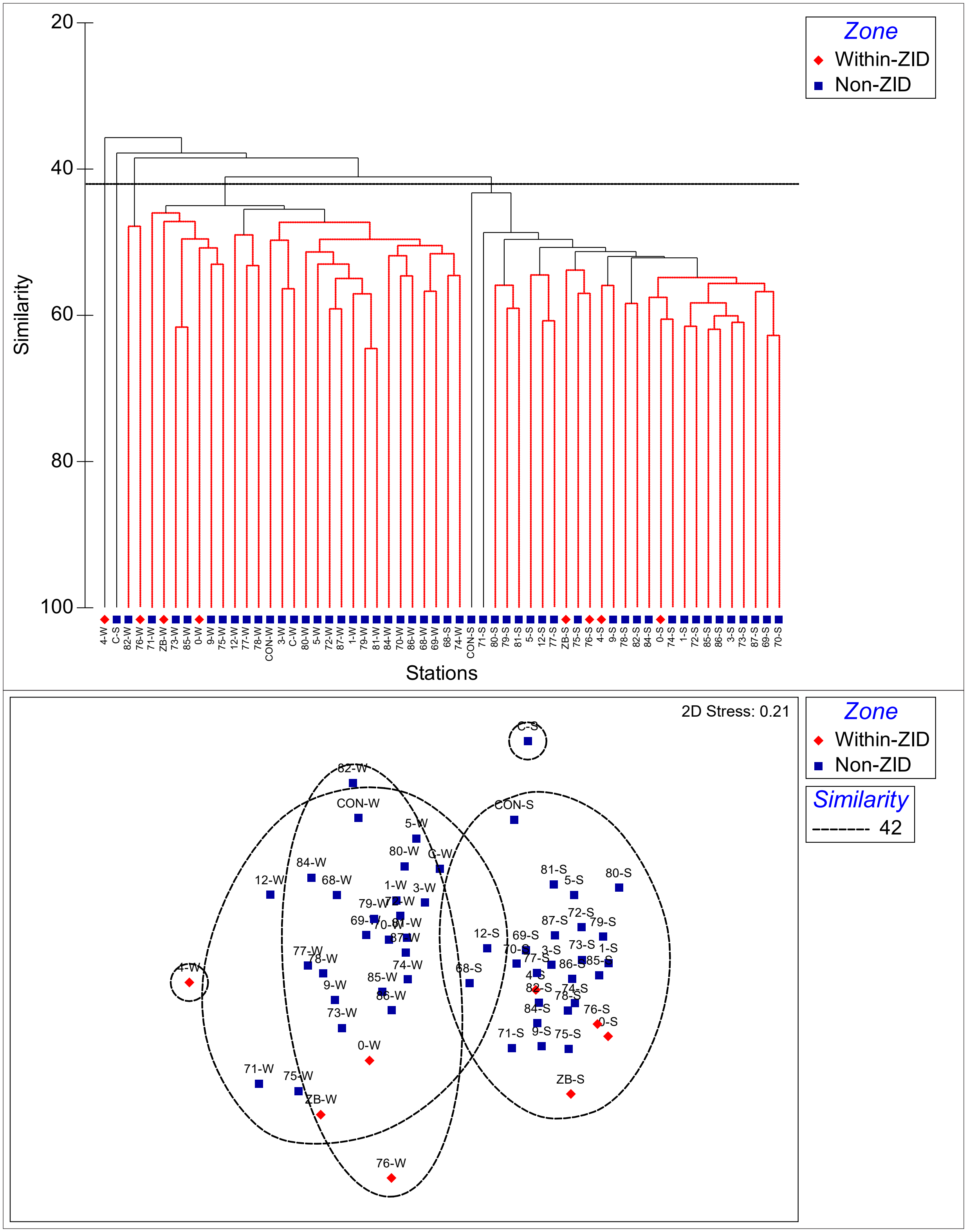

Figure 2–5 Dendrogram (top panel) and non-metric multidimensional scaling (nMDS) plot (bottom panel) of the infauna collected at within- and non-ZID stations along the Middle Shelf Zone 2 stratum for the Summer 2015 (S) and Winter 2016 (W) benthic surveys. Stations connected by red lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The 5 main clusters formed at a 42% similarity on the dendrogram are superimposed on the nMDS plot.

Table 2–10 Summary of epibenthic macroinvertebrate community measures for each semi-annual and annual (*) station sampled during the Summer 2015 and Winter 2016 trawl surveys, as well as District historical values.

Season	Station	Nominal Depth (m)	Total No. of Species	Total Abundance	Biomass (kg)	H'	SDI
Summer	*Middle Shelf Zone 1 (31-50 m)*						
	T2 *	35	13	54	0.04	2.05	5
	T24 *	36	17	101	0.09	2.22	5
	T6 *	36	13	47	0.05	1.99	4
	T18 *	36	3	1923	1.64	0.01	1
		Mean	**12**	**531**	**0.45**	**1.57**	**4**
	Middle Shelf Zone 2, Outfall (51-90 m)						
	T22	60	11	69	0.94	1.57	3
	T1	55	12	57	1.10	1.58	2
		Mean	**12**	**63**	**1.02**	**1.58**	**3**
	Middle Shelf Zone 2, Non-outfall (51-90 m)						
	T23	58	11	183	0.85	1.35	3
	T12	57	10	294	1.43	0.31	1
	T17	60	11	39	0.08	1.81	5
	T11	60	9	2373	2.82	0.11	1
		Mean	**10**	**722**	**1.29**	**0.90**	**3**
	Outer Shelf (121-200 m)						
	T10 *	137	8	181	10.29	0.40	1
	T25 *	137	10	82	3.75	0.95	1
	T14 *	137	8	36	0.11	1.24	2
	T19 *	137	9	211	0.69	1.00	2
		Mean	**9**	**128**	**3.71**	**0.90**	**2**
Winter	*Middle Shelf Zone 2, Outfall (51-90 m)*						
	T22	60	12	156	0.33	1.49	3
	T1	55	10	614	1.12	0.58	1
		Mean	**11**	**385**	**0.72**	**1.04**	**2**
	Middle Shelf Zone 2, Non-outfall (51-90 m)						
	T23	58	9	131	1.19	1.59	3
	T12	57	9	66	0.13	1.71	4
	T17	60	7	127	1.21	1.08	2
	T11	60	9	1698	2.48	0.39	1
		Mean	**9**	**506**	**1.25**	**1.19**	**3**
District historical values (all trawl surveys from 2005-2015 FY) [mean (range)]							
Middle Shelf Zone 1			12 (4-23)	322 (18-2592)	0.79 (0.01-3.44)	1.42 (0.07-2.09)	3 (1-4)
Middle Shelf Zone 2, Outfall			12 (7-18)	376 (49-2204)	1.60 (0.08-3.60)	1.31 (0.18-2.12)	3 (1-5)
Middle Shelf Zone 2, Non-outfall			11 (5-18)	302 (12-2498)	1.67 (0.01-11.16)	1.34 (0.06-2.43)	3 (1-9)
Outer Shelf			10 (3-15)	154 (19-548)	3.47 (0.03-19.31)	1.08 (0.15-2.12)	2 (1-8)

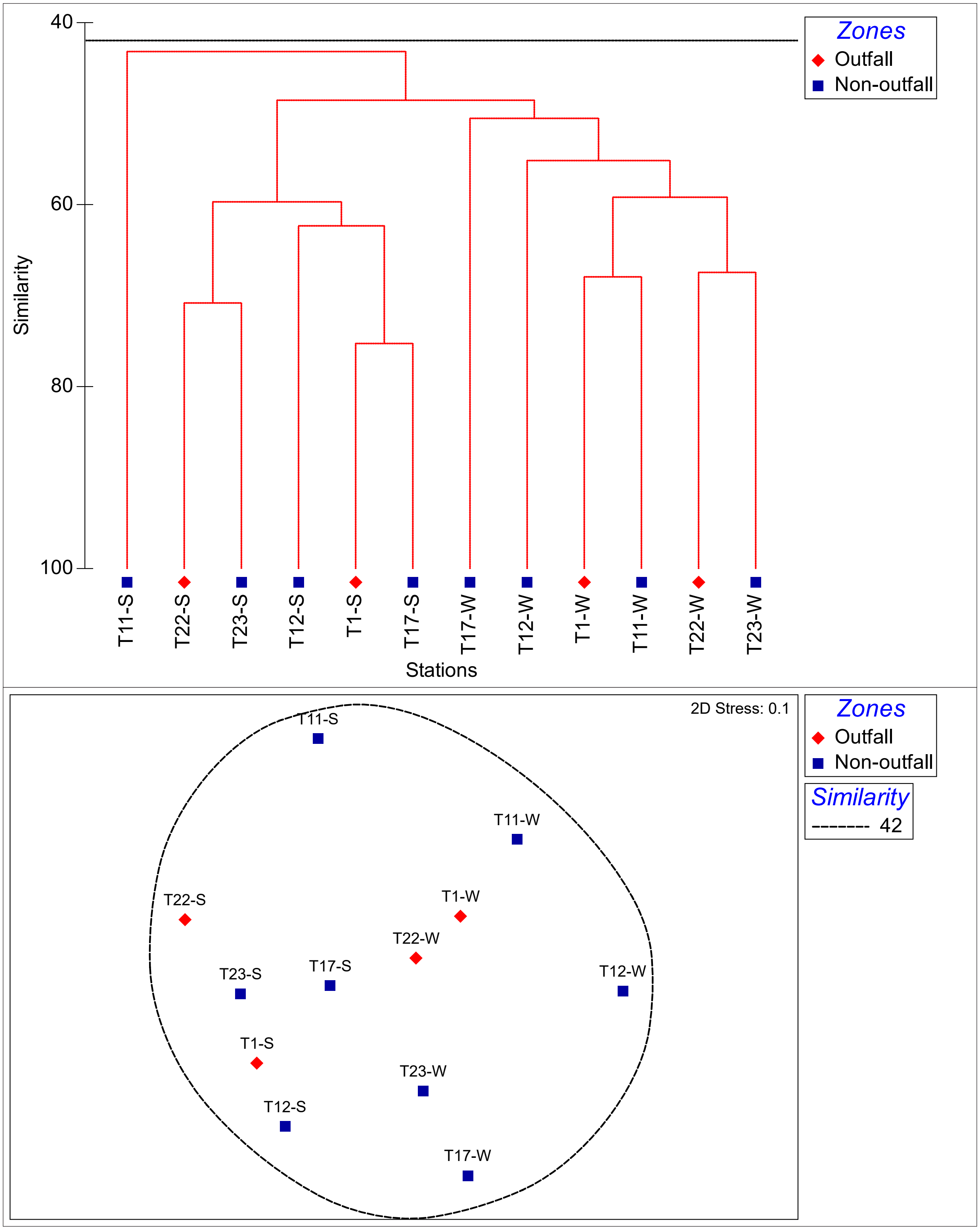

Figure 2–6 Dendrogram (top panel) and non-metric multidimensional scaling (nMDS) plot (bottom panel) of the epibenthic macroinvertebrates collected at outfall and non-outfall stations along the Middle Shelf Zone 2 stratum for the Summer 2015 (S) and Winter 2016 (W) trawl surveys. Stations connected by red lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The single main cluster formed at a 42% similarity on the dendrogram is superimposed on the nMDS plot.

Table 2–11 Summary of demersal fish community measures for each semi-annual and annual (*) station sampled during the Summer 2015 and Winter 2016 trawl surveys, as well as District historical values.

Season	Station	Nominal Depth (m)	Total No. of Species	Total Abundance	Biomass (kg)	H'	SDI	FRI
Summer	*Middle Shelf Zone 1 (31-50 m)*							
	T2 *	35	8	125	4.13	1.38	2	19
	T24 *	36	8	83	1.75	1.53	3	20
	T6 *	36	9	147	2.18	1.14	2	23
	T18 *	36	7	83	1.16	1.20	2	24
		Mean	**8**	**110**	**2.30**	**1.31**	**2**	**21**
	Middle Shelf Zone 2, Outfall (51-90 m)							
	T22	60	15	344	24.33	0.95	1	26
	T1	55	13	187	10.61	1.84	4	22
		Mean	**14**	**266**	**17.47**	**1.40**	**3**	**24**
	Middle Shelf Zone 2, Non-outfall (51-90 m)							
	T23	58	12	307	19.74	0.97	1	28
	T12	57	8	51	1.99	1.37	3	22
	T17	60	10	163	7.40	1.53	3	17
	T11	60	10	82	1.83	1.94	5	26
		Mean	**10**	**151**	**7.74**	**1.45**	**3**	**23**
	Outer Shelf (121-200 m)							
	T10 *	137	14	616	12.68	1.60	3	13
	T25 *	137	19	543	19.20	1.67	3	6
	T14 *	137	14	404	9.91	1.56	3	12
	T19 *	137	21	1220	39.19	1.71	3	19
		Mean	**17**	**696**	**20.25**	**1.64**	**3**	**13**
Winter	*Middle Shelf Zone 2, Outfall (51-90 m)*							
	T22	60	13	203	10.50	1.64	3	23
	T1	55	13	190	7.37	2.14	6	18
		Mean	**13**	**197**	**8.93**	**1.89**	**5**	**21**
	Middle Shelf Zone 2, Non-outfall (51-90 m)							
	T23	58	13	235	10.04	1.62	3	22
	T12	57	14	260	10.12	1.82	3	26
	T17	60	12	198	7.77	1.57	3	32
	T11	60	11	195	7.31	2.07	6	21
		Mean	**13**	**222**	**8.81**	**1.77**	**4**	**25**
District historical values (all trawl surveys from 2005-2015 FY) [mean (range)]								
Middle Shelf Zone 1			12 (2-16)	273 (110-651)	5.84 (1.88-12.72)	1.71 (0.69-2.22)	4 (2-6)	22 (18-26)
Middle Shelf Zone 2, Outfall			14 (5-21)	608 (218-3227)	27.17 (6.74-102.05)	1.70 (0.91-2.11)	3 (1-5)	24 (18-37)
Middle Shelf Zone 2, Non-Outfall			15 (3-25)	681 (140-12274)	15.12 (2.28-135.64)	1.73 (0.14-2.29)	3 (1-6)	23 (13-31)
Outer Shelf			16 (11-23)	686 (260-2644)	17.70 (2.60-86.41)	1.43 (0.74-1.91)	3 (1-5)	14 (2-33)

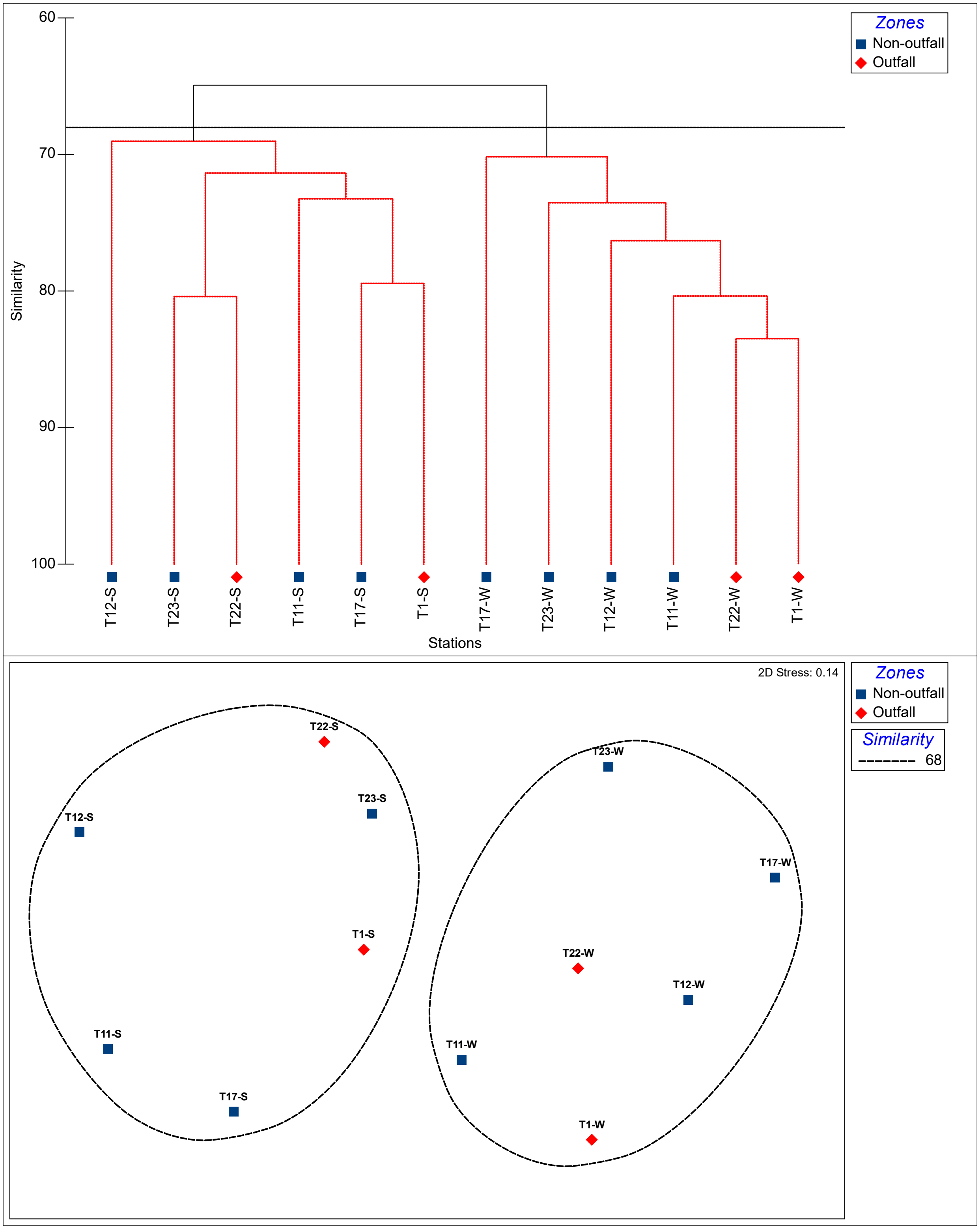

Figure 2–7 Dendrogram (top panel) and non-metric multidimensional scaling (nMDS) plot (bottom panel) of the demersal fishes collected at outfall and non-outfall stations along the Middle Shelf Zone 2 stratum for the Summer 2015 (S) and Winter 2016 (W) trawl surveys. Stations connected by red lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The two main clusters formed at a 68% similarity on the dendrogram is superimposed on the nMDS plot.

Table 2–12 Summary statistics of tissue contaminant concentrations in selected flatfishes collected by trawling in July 2015 at Stations T1 (outfall) and T11 (non-outfall). ND = Not Detected.

Species (Common Name)	Tissue	Station	n	Standard Length (mm)	Percent Lipid	Mercury (mg/kg)	ΣDDT (µg/kg)	ΣPCB (µg/kg)	ΣChlordane (µg/kg)	Dieldrin (µg/kg)
Pleuronichthys verticalis (Hornyhead Turbot)	Muscle	Non-outfall	1	181	ND	0.07	ND	ND	ND	ND
		Outfall	6	171 (150-188)	ND (ND-0.22)	0.12 (0.03-0.19)	2.68 (0-5.39)	0.65 (0-1.71)	ND (All ND)	ND (All ND)
	Liver	Non-outfall	1	181	5.35	0.17	336.2	ND	ND	ND
		Outfall	6	171 (150-188)	5.00 (3.64-5.40)	0.29 (0.06-0.49)	263.63 (103-420.30)	167.72 (114.71-273.09)	4.5 (0-27)	ND (All ND)
Parophrys vetulus (English Sole)	Muscle	Non-outfall	10	184 (158-200)	0.52 (0.24-0.97)	0.04 (0.02-0.06)	ND (All ND)	ND (All ND)	ND (All ND)	ND (All ND)
		Outfall	10	180 (167-193)	0.64 (0.21-1.14)	0.07 (0.04-0.09)	227.45 (9.46-633.46)	4.65 (0-12.23)	ND (All ND)	ND (All ND)
	Liver	Non-outfall	10	184 (158-200)	8.85 (3.45-14.90)	0.06 (0.04-0.10)	996.84 (110-5253.60)	99.32 (0-292.40)	ND (All ND)	ND (All ND)
		Outfall	10	180 (167-193)	13.46 (5.39-20.20)	0.08 (0.05-0.12)	4799.76 (292.30-20967)	476.00 (33.61-1627.29)	ND (All ND)	ND (All ND)

Table 2–13 Summary statistics of muscle tissue contaminant concentrations in selected scorpaenid fishes collected by rig-fishing in September 2015 at Zones 1 (outfall) and 3 (non-outfall). ND = Not Detected; N/A = Not Applicable.

Zone	Species (Common Name)	n	Standard Length (mm)	Percent Lipid	Mercury (mg/kg)	Arsenic (mg/kg)	Selenium (mg/kg)	ΣDDT (µg/kg)	ΣPCB (µg/kg)	ΣChlordane (µg/kg)	Dieldrin (µg/kg)
Outfall	*Sebastes auriculatus* (Brown Rockfish)	2	325 (315-335)	0.16 (0.16-0.18)	0.22 (0.10-0.35)	0.85 (0.34-1.36)	0.31 (0.28-0.35)	ND (All ND)	ND (All ND)	ND (All ND)	ND (All ND)
	Sebastes miniatus (Vermilion Rockfish)	8	280 (252-317)	0.86 (0.47-1.66)	0.05 (0.04-0.08)	2.22 (0.68-3.66)	0.28 (0.23-0.32)	8.24 (0-16.80)	1.98 (0-10.77)	0.09 (0-1.45)	ND (All ND)
Non-outfall	*Sebastes hopkinsi* (Squarespot Rockfish)	9	185 (161-212)	1.18 (0.65-2.29)	0.14 (0.08-0.24)	1.24 (0.60-2.00)	0.24 (0.20-0.29)	18.21 (8.74-44.96)	4.73 (0-18.20)	ND (All ND)	ND (All ND)
	Sebastes paucispinis (Bocaccio)	1	340	0.24	0.19	0.13	0.26	16.38	2.33	ND	ND
			CA Advisory Tissue Level	N/A	0.44	N/A	15	2100	120	560	46
			Federal Action Level	N/A	1	N/A	N/A	5000	2000	300	300

CONCLUSIONS

In summary, COP criteria for water quality were met and state and federal bacterial standards were also met at offshore stations. Sediment quality was not degraded by loading of measured chemical contaminants or by physical changes from the discharge of wastewater solids. This was corroborated by the absence of sediment toxicity in controlled laboratory tests and the presence of normal infaunal communities throughout the monitoring area. Fish and trawl invertebrate communities in the monitoring area were also healthy and diverse, and federal and state fish consumption guidelines were met. Altogether, these results indicate that the receiving environment was not degraded by the discharge of the treated wastewater, all permit compliance criteria were met, and environmental and human health were protected.

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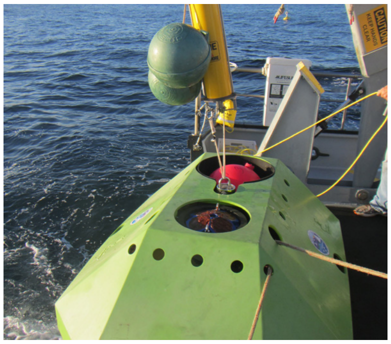

CHAPTER 3
Strategic Process Studies and Regional Monitoring

INTRODUCTION

The Orange County Sanitation District (District) operates under the auspices of a National Pollutant Discharge Elimination System (NPDES) permit issued jointly by the United States Environmental Protection Agency and the State of California Regional Water Quality Control Board (Order No. R8-2012-0035, NPDES Permit No. CA0110604) in June 2012. The permit requires the District to conduct an Ocean Monitoring Program (OMP) that documents the effectiveness of the District's source control and wastewater treatment operations in protecting coastal ocean resources and beneficial uses. A requirement of the OMP is to conduct Strategic Process Studies (SPS) and to participate in regional monitoring programs. In addition, the District performs special studies, which are generally less involved than SPS and have no regulatory requirement for prior approval or level of effort.

SPS are designed to address unanswered questions raised by the Core monitoring program results or they may focus on issues of interest to the District, such as the effect of contaminants of emerging concern on local fish populations. Some SPS are enumerated in the NPDES permit. Other SPS are proposed and must be approved by state and/or federal regulators to ensure proper focus and level of effort. For the 2015-16 program year, no SPS were conducted.

Regional monitoring studies are those not focused solely on the District's monitoring area, but which sample larger areas of the Southern California Bight. These may include the "Bight" studies coordinated by the Southern California Coastal Water Research Project (SCCWRP) or studies conducted in coordination with other public agencies and/or non-governmental organizations in the region. Examples include the Central Region Kelp Survey Consortium and the Central Bight Water Quality Study.

This chapter provides study overviews of recently completed and ongoing special studies and regional monitoring efforts. Unlike the other chapters in this report, these summaries are the most recent information available to date. This chapter provides study summaries only and the projects described are not intended as comprehensive reports. When appropriate, this information is also incorporated in other report chapters to supplement Core monitoring results. Links to final study reports, if available, are listed under each section below.

REGIONAL MONITORING

Regional Nearshore (Surfzone) Bacterial Sampling

The District partners with the Orange County Health Care Agency (OCHCA), the South Orange County Wastewater Authority, and the Orange County Public Works in the Ocean Water Protection Program, a regional bacterial sampling program that samples 126 stations along 42 miles (67.5 km) of coastline (Seal Beach to San Clemente State Beach) and 70 miles (112.6 km) of harbor and bay frontage. In 2015, over 8,600 samples were collected and analyzed for 3 fecal indicator bacteria (FIB; total coliform, fecal coliform, and enterococci).

OCHCA reviews bacteriological data to determine whether a station meets Ocean Water-Contact Sports Standards (i.e., Assembly Bill 411; AB411), basing beach closures, postings, or health advisories on these results. The 2015 Annual Ocean, Harbor, and Bay Water Quality Report (OCHCA 2016) provides a countywide summary of beach bacteriological water quality. Included in the report are year-to-year variability and trends since 1987.

A few of the countywide report findings for 2015 include:

- The number of reported sewage spills (133) for 2015 represented a continued annual decline since 2002.
- The number of beach closures due to sewage spills (10) was 53% below the 29-year average (19).
- The total number of Beach Mile Days closures (18.9) due to sewage spills was below the 1999–2015 average (28.2).
- Total Beach Mile Days posted due to bacteriological standards violations during the AB411 period (April 1 to October 31) was 36.2, which was just over 90% less than the record high of 366 in 2002.

The District samples 38 of the 126 regional surfzone stations, of which 18 are legacy stations sampled since the 1970s (Figure 3-1). These legacy stations were analyzed separately for 2015-16 for comparison with the District's historical surfzone results (Table B-12). Table B-13 presents summary statistics for the remaining stations. Results for the 18 District stations were similar to those of previous years (OCSD 2014, 2015, 2016). FIB counts at these stations varied by season, location, and by bacteria type. A general spatial pattern was associated with the mouth of the Santa Ana River. Seasonal geomeans and the percent of samples exceeding geomean and single sample standards all peaked near the river mouth and tapered off upcoast and downcoast. Collectively, exceedance of the state single sample standard (AB411) was low, with less than 4% for total coliforms, less than 6% for fecal coliforms, and slightly over 7% for enterococci.

Central Bight Regional Water Quality Program

The District is a member of a regional cooperative sampling effort known as the Central Bight Regional Water Quality Monitoring Program (Central Bight) with the City of Oxnard, City of Los Angeles, the County Sanitation Districts of Los Angeles, and the City of San Diego. Each quarter, the participating agencies sample 301 stations that covers the coastal waters from Ventura County to Crystal Cove State Beach and from Point Loma to the United States–Mexico Border (Figure 3-2). The participants use similarly equipped CTDs and comparable field sampling methods. The District samples 66 stations, which include our 28 Core water quality program data as part of this effort. The Central Bight monitoring provides regional data that enhances the evaluation of water quality changes due to natural or anthropogenic discharges (e.g., stormwater) and provides a regional context for comparisons with the District's monitoring results. The Central Bight data also provides a link to other larger-scale regional programs, such as the California Cooperative Oceanic Fisheries Investigations (CalCOFI) and serve as the basis for the Bight'13 Nutrients sampling. Currently, the Central Bight group is working to develop closer ties to the CalCOFI program and District staff are working with the regional Southern California Coastal Ocean Observing System (SCCOOS) to develop quality assurance guidelines for submitting Central Bight data to SCCOOS that complies with the national Integrated Ocean Observing System guidelines.

Bight'13 Regional Monitoring

Since 1994, the District has participated in 5 regional monitoring studies of environmental conditions within the Southern California Bight (SCB): 1994 Southern California Bight Pilot Project, Bight'98,

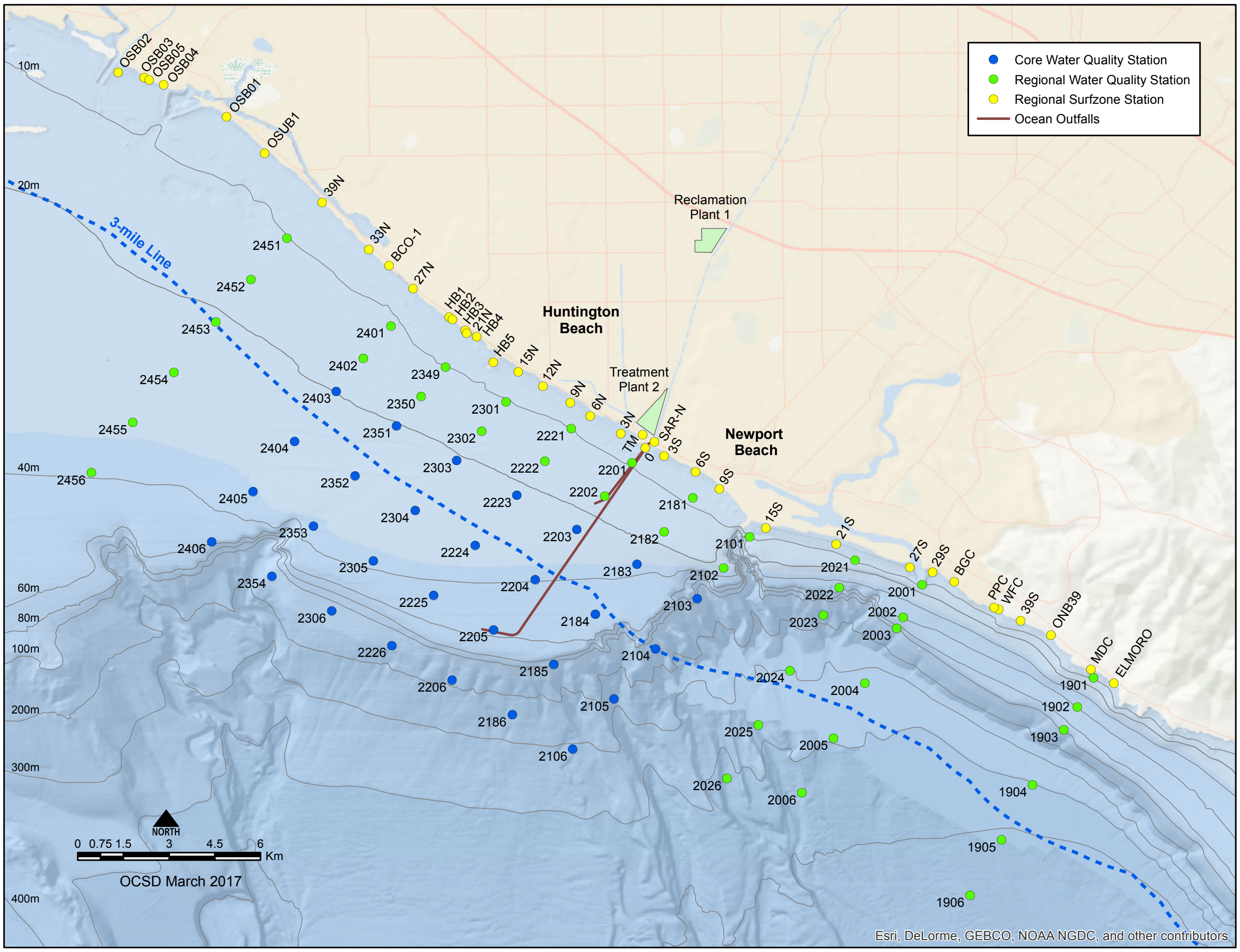

Figure 3–1 Offshore and Nearshore (surfzone) water quality monitoring stations for 2015-16.

Bight'03, Bight'08, and Bight'13. The District has played a considerable role in all aspects of these regional projects, including program design, sampling, quality assurance, data analysis, and report writing. Results from these efforts provide information that is used by individual dischargers, resource managers, and the public to improve region-wide understanding of environmental conditions and to provide a regional perspective for comparisons with data collected from individual point sources. During the summer of 2013, District staff conducted field operations, ranging from Orange County south to Camp Pendleton in northern San Diego County and west to the southern end of Santa Catalina Island, as part of the Bight'13 sampling effort. Currently District staff is involved in final report production for the Bight'13 project. At this time, some Bight'13 final reports are available, with a few remaining reports expected to be available by December 2017. Project documents, data, and reports on the previous studies are available on SCCWRP's website (http://www.sccwrp.org).

Regional Kelp Survey Consortium – Central Region

The District is a member of the Central Region Kelp Survey Consortium (CRKSC), which was formed in 2003 to map Giant Kelp (*Macrocystis pyrifera*) beds off Ventura, Los Angeles, and Orange Counties via aerial photography. The program is modeled after the San Diego Regional Water Quality Control Board, Region Nine Kelp Survey Consortium, which began in 1983. Both consortiums sample quarterly to count the number of observable kelp beds and calculate maximum kelp canopy coverage. Combined, the CRKSC and San Diego aerial surveys provide synoptic coverage of kelp beds along approximately 81% of the 270 miles (435 km) of the southern California mainland coast from northern

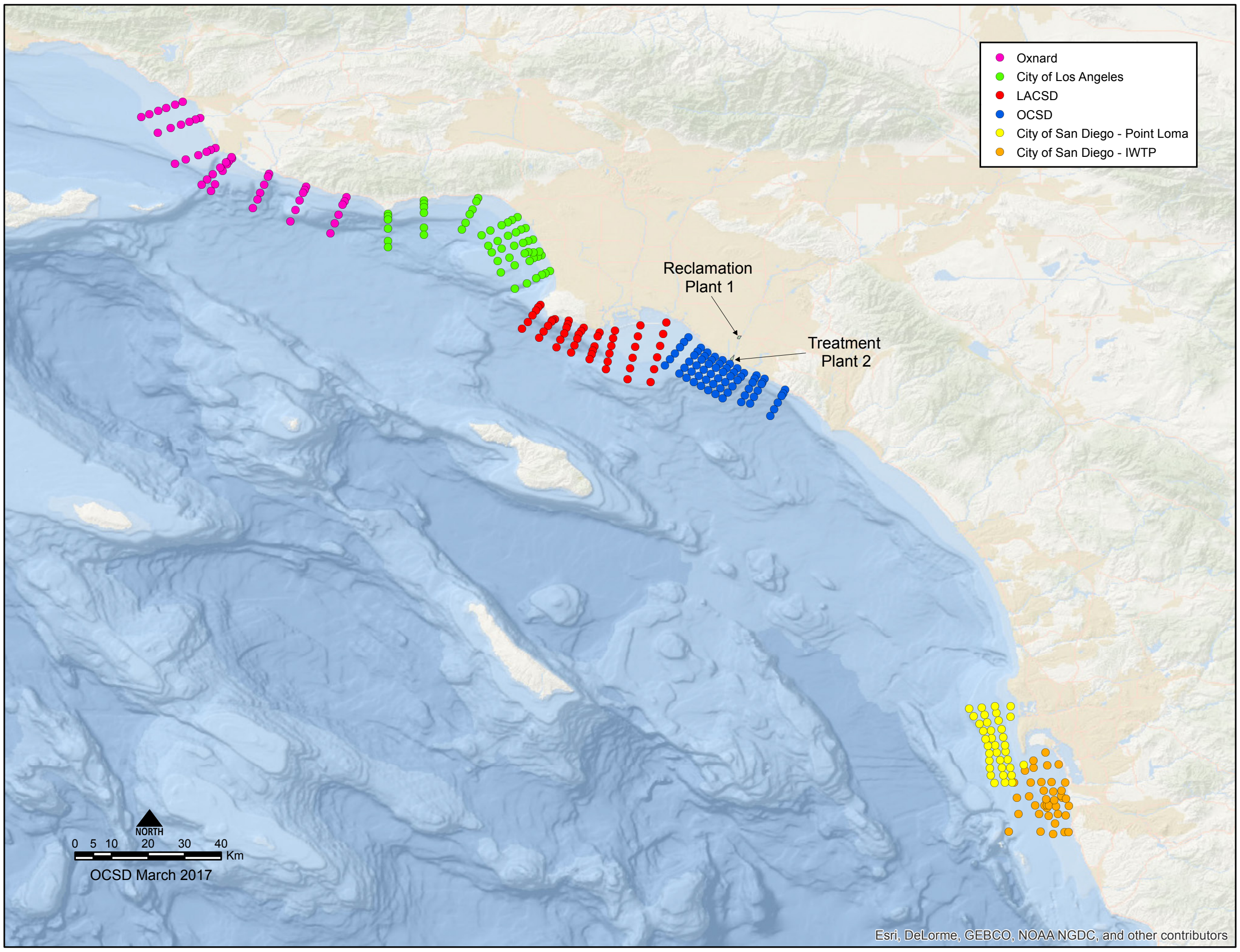

Figure 3–2 Central Bight Water Quality Group monitoring stations for 2015-16.

Ventura County to the United States–Mexico Border. Survey results are published and presented annually by MBC Applied Environmental Sciences to both consortium groups, regulators, and the public. Reports are available on the SCCWRP's website (http://kelp.sccwrp.org/reports.html).

<u>2015 Central Region Results</u>

The number of kelp beds displaying canopy slightly decreased in the Central Region (21 of 26), however, the overall canopy cover increased by nearly 22.7% from 1.65 mi^2 (4.28 km^2) in 2014 to 2.03 mi^2 (5.26 km^2) in 2015. Nine kelp beds had increased surface coverage (1–434%), 11 beds had decreased surface coverage (10–88%), 1 bed had no change, and 5 beds were not visible. However, total coverage in 2015 was still above the long-term (1965-2015) regional average of 1.68 mi^2 (4.34 km^2) (MBC 2016). Consistent with previous results, most of the Central Region kelp beds reached their maximum extent in early summer.

There was no evidence of any adverse effects on Giant Kelp resources from any of the region's dischargers. Rather, the Giant Kelp surveys of 2015 continued to demonstrate that most kelp bed dynamics in the Central region are influenced by the large-scale oceanographic environment, while micro-variations in local topography and currents can cause anomalies in kelp bed performances.

Ocean Acidification Mooring

Increased acidification of coastal waters is an issue that has become increasingly important along the west coast, as reflected by its incorporation into the State of California Ocean Protection Council's (OPC) most recent 5-year strategic plan (OPC 2012). The acidity/alkalinity (pH) of receiving waters is an important biologic parameter as it affects the solubility of calcium carbonate, a necessary building material for organisms with calcareous shells. Aragonite concentration is a conventional metric used to evaluate potential impacts to marine organisms with saturation values ≥1 considered necessary for calcium formation. Preindustrial surface pH has been estimated to be 8.16 and a pH value of 7.75 has been associated with an aragonite saturation of 1 (Orr et al. 2005, Feely et al. 2008, Bernie 2009, Bijma et al. 2009, Pelejero et al. 2010). Since 1985, an average of 11% of pH samples collected by the District fell below 7.75, with a range of <1% (1989 and 1991) to 33% (1998).

Eutrophication and high nutrients levels have been linked to increased coastal acidification (NOAA 2012). While southern California experiences large nutrient inputs from natural spring upwelling, findings from the Bight'08 project showed that nutrients discharged from ocean outfalls off heavily urbanized regions were equivalent to these natural sources (Howard et al. 2012). Additionally, Howard et al. (2012) showed that algal bloom intensity has increased significantly over the last decade and algal bloom 'hotspots' were shown to be co-located with major anthropogenic sources, including ocean outfalls, and extended water residence times. These findings led to the inclusion of enhanced nutrient and pH monitoring in the SCB as part of the Bight'13 Nutrients program (SCCWRP 2013).

Primary productivity and nutrient cycling (including oxygen demanding processes like nitrification) can have direct and indirect effects on the ecological condition of coastal waters. The California Ocean Plan (COP) establishes criteria for the amount of influence that anthropogenic wastewater dischargers are permitted to have on the ecological condition of coastal waters. These include criteria for nutrients ("shall not cause objectionable growth or degrade indigenous biota"), dissolved oxygen ("shall not be depressed by more than 10% of that which would occur naturally"), and pH ("shall not be changed more than 0.2 pH units"). However, how anthropogenic nutrients influence each of these is not well understood and existing pH sensors are not sensitive or stable enough to measure small changes in pH.

The District's Ocean Acidification (OA) Mooring experienced problems with the pH sensors that required the mooring to be out of the water for most of 2015. Results have not been analyzed and the mooring was redeployed in October 2016.

SPECIAL STUDIES

California Ocean Plan Compliance Determination Method Comparison

Background

Southern California ocean dischargers maintain extensive monitoring programs to assess their effects on ambient receiving water quality and to determine compliance with COP standards. However, each agency uses a different approach for analyzing these data and determining COP compliance. In 2009, at the behest of the State Water Resources Control Board (SWRCB), SCCWRP, in collaboration with dischargers, began developing a new method to establish an Out-of-Range occurrence (ORO_{SCCWRP}) for dissolved oxygen (DO). Here we present a comparison, for the 2015-16 program year, between the District's standard approach used over the past 30 years and the newly developed SCCWRP method for DO.

Compliance Determinations

District Approach

Compliance evaluations for DO are based on statistical comparisons between 2 (inner and outer) reference stations located up-current of the outfall. For each survey, the presence and depth range of the pycnocline is calculated for each station with data binned into above, within, or below the pycnocline strata; when a pycnocline is absent, data are binned into the top, middle, or bottom third of the water column. Mean values for each parameter are calculated by stratum and station. Out-of-range occurrences (ORO_{OCSD}) are calculated by station for each depth strata and sampling date. District OROs are based on comparing each station with the corresponding reference station data to determine whether the station exceeded the COP compliance criteria (i.e., a 10% decrease in oxygen concentration values).

To determine whether an ORO_{OCSD} was Out-of-Compliance (OOC), distributional maps are created that identify the reference stations for each monthly survey and location of each ORO_{OCSD}. These maps are evaluated to determine if a logical OOC event is represented based on: (A) presence of the plume using a combination of temperature, density, salinity, Colored Dissolved Organic Matter (CDOM), ammonium (NH4+), and current direction; (B) water column features relative to naturally occurring events (e.g., high chlorophyll-*a* due to phytoplankton); and (C) unique station characteristics that may make them inappropriate for comparison with reference stations (e.g., excessive differences in depth strata).

A detailed summary of the District's water quality compliance methodology is presented in Appendix A.

SCCWRP Approach

The methodology involves 3 steps: (A) identification of the area affected by effluent wastewater, (B) selection of reference sampling sites representing "natural" conditions, and (C) comparison between water quality profiles in the reference and plume-affected zones. Plume-affected areas are identified using CDOM as a wastewater indicator. Reference sites are selected from the areas around the outfalls, excluding the sites affected by the effluent. Reference density profiles are calculated and the DO profiles in the plume zone are compared to the reference profiles and a maximum difference value is used to establish the number of ORO_{SCCWRP}.

Comparison Method

The 2 methods differ in their approach to establishing OROs and the SCCWRP methodology does not calculate OOCs, therefore the following steps were taken to make the output of both approaches more comparable.

Under the District approach, a station may have multiple ORO_{OCSD} and/or OOC values on a given survey, while the SCCWRP approach identifies a single maximum difference value per station. For the comparison, monthly station ORO_{OCSD} were recalculated as presence/absence when multiple ORO_{OCSD} occurred. Unlike the District method, the SCCWRP method does not provide a path to evaluate whether an ORO did or did not constitute an OOC. For this comparison, it was assumed that an ORO_{SCCWRP} was equivalent to the District's OOC.

Results and Discussion

In general, the SCCWRP approach identifies fewer plume-impacted stations and OROs, while using a much greater, though variable, number of reference stations (Table 3-1). The primary source of these differences is probably the different approaches used in identifying plume-impacted stations. The District uses multiple parameters and contextual information (e.g., Is the station up-current of the outfall?; Was there a large phytoplankton bloom?), either singly or in combination. ORO_{SCCWRP}

Table 3–1 Comparison of District and SCCWRP California Ocean Plan compliance determinations for dissolved oxygen for program year 2015-2016.

Month	Year	# Plume Impacted Stations		# Reference Stations		# Out-of-Ranges	
		OCSD	SCCWRP	OCSD	SCCWRP	OCSD	SCCWRP
July	2015	0	4	2	17	0	0
August	2015	11	8	2	13	5	0
September	2015	10	6	2	13	0	0
October	2015	0	4	2	15	0	0
November	2015	12	4	2	17	0	0
December	2015	3	3	2	10	0	0
January	2016	6	2	2	10	1	0
February	2016	5	3	2	16	0	0
March	2016	6	5	2	13	2	0
May	2016	7	8	2	10	1	0
May	2016	15	6	2	11	0	1
June	2016	8	7	2	16	0	0

events are established using only CDOM values that exceed the 85th percentile of all CDOM samples per survey. The SCCWRP approach also does not take into account values that are due to natural variability. For example, the single ORO_{SCCWRP} value identified was at an offshore station (2306) on May 5, 2016. Currents were downcoast so Station 2306 was up-current of the outfall and the station was being impacted by naturally occurring colder, more saline water that was intruding upon the shelf. Using the District's multi-parameter filter, this station would not have been categorized as OOC.

The benefit of using the SCCWRP approach is its ability to be standardized so that all agencies are using the same methodology. One disadvantage to this approach is disregard of actual plume transport (i.e., currents) and changes due to natural variability. The District's approach identifies a greater number of ORO/OOCs, but it involves a greater amount of effort that is harder to replicate across agencies.

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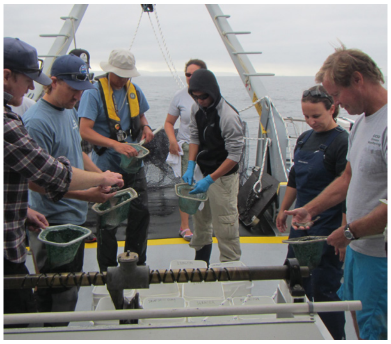

APPENDIX A
Methods

INTRODUCTION

This appendix contains a summary of the field sampling, laboratory testing, and data analysis methods used in the District's Ocean Monitoring Program (OMP). The methods also include calculations of water quality compliance with California Ocean Plan (COP) criteria.

WATER QUALITY MONITORING

Field Methods

Offshore Zone

Permit-specified water quality monitoring was conducted 3 times per quarter at 28 stations (Figure 2-1). Eight stations located inshore of the 3-mile line of the coast are designated as areas used for water contact sports by the Regional Water Quality Control Board (i.e., waters designated as REC-1), and were sampled an additional 3 days per quarter for fecal indicator bacteria (FIB). The additional surveys were conducted in order to calculate a 30-day geometric mean.

Each survey included measurements of pressure (from which depth is calculated), temperature, conductivity (from which salinity is calculated), dissolved oxygen (DO), pH, water clarity (light transmissivity, beam attenuation coefficient [beam-c], and photosynthetically active radiation [PAR]), chlorophyll-*a* fluorescence, and colored dissolved organic matter (CDOM). Measurements were conducted using a Sea-Bird Electronics SBE 911plus conductivity-temperature-depth (CTD) profiling system deployed from the M/V *Nerissa*. Profiling was conducted at each station from 1 m below the surface to 2 m above the bottom or to a maximum depth of 75 m, when water depths exceeded 75 m. SEASOFT (2016a) software was used for data acquisition, data display, and sensor calibration. PAR was measured in conjunction with chlorophyll-*a* because of the positive linkage between light intensity and photosynthesis per unit chlorophyll (Hardy 1993). Wind condition, sea state, and visual observations of floatable materials or grease that might be of sewage origin were also conducted. Discrete water samples were collected using a Sea-Bird Electronics Carousel Water Sampler (SBE 32) equipped with Niskin bottles for ammonium (NH3-N) and FIB at specified stations and depths. All discrete samples were kept on wet ice in coolers and transported to the District's laboratory within 6 hours. A summary of the sampling and analysis methods is presented in Table A-1.

Central Bight Regional Water Quality

An expanded grid of water quality stations was sampled quarterly as part of the District's Central Bight Regional Water Quality monitoring. These 38 stations were sampled in conjunction with the 28 Core water quality stations (see Figure 3-1) along with the County Sanitation Districts of Los Angeles, the City of Los Angeles, and the City of Oxnard. The total sampling area extends from the Ventura River in the north to Crystal Cove State Beach in the south. Data were collected using CTDs in a fixed-grid

Table A–1 Water quality sample collection and analysis methods by parameter during 2015-16.

Parameter	Sampling Method	Method Reference	Preservation	Container	Holding Time	Sampling Interval	Field Replicates
Nearshore (Surfzone)							
Total Coliforms		Standard Methods 9222 B **					
Fecal Coliforms	grab	Standard Methods 9222 D **	Ice (<6°C)	125 mL HDPE (Sterile container)	8 hrs. (field + lab)	Ankle-deep water	at least 10% of samples
Enterococci		EPA Method 1600 ***					
Offshore							
Temperature [1]	in-situ probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Salinity [2] (conductivity)	in-situ probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
pH [3]	in-situ probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Dissolved Oxygen [4]	in-situ probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Transmissivity [5]	in-situ probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Photosynthetically Active Radiation (PAR) [6]	in-situ probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Chlorophyll-*a* fluorescence [6]	in-situ probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Color Dissolved Organic Matter (CDOM) [6]	in-situ probe	SOP 1500.1 - CTD Operations	not applicable	not applicable	not applicable	every 1 m *	at least 10% of stations
Ammonium (NH3-N)	Niskin	SOP 4500-NH3.G, Rev. J **	Ice (<6°C)	125 mL HDPE	28 days	Surface, 10m, 20m, 30m, 40m, 50m, 60m, Bottom	at least 10% of samples
Total Coliforms and *Escherichia coli* [7]	Niskin	Standard Methods 9223 C **	Ice (<6°C)	125 mL HDPE (Sterile container)	8 hrs. (field + lab)	Surface, 10m, 20m, 30m, 40m, 50m, 60m, Bottom	at least 10% of samples
Enterococci	Niskin	Standard Methods 9230 D	Ice (<6°C)	125 mL HDPE (Sterile container)	8 hrs. (field + lab)	Surface, 10m, 20m, 30m, 40m, 50m, 60m, Bottom	at least 10% of samples
Surface Observations	visual observations	Permit specs.	not applicable	not applicable	not applicable	surface	not applicable

1 Calibrated to reference cells (0.0005°C accuracy) annually.
2 Calibrated to IAPSO Standard and Guildline 8400B Autosal annually.
3 Referenced and calibrated to NIST buffers of pH 7, 8, and 9 prior to every survey.
4 Referenced and calibrated each survey by comparison with the lab DO probe, which is calibrated daily.
5 Referenced and calibrated to known transmittance in air.
6 Factory calibrated annually.
7 Fecal coliform count calculation: (Escherichia coli MPN/100mL x 1.1)
* Sampled continuously at 24 scans/second but data processed to 1 m intervals.
** APHA (2012).
*** Available online at: www.epa.gov.

pattern comprising 216 stations during a targeted 3 to 4 day period. Parameters measured included pressure, water temperature, conductivity, DO, pH, chlorophyll-*a*, CDOM, and water clarity. Profiling was conducted from the surface to 2 m from the bottom or to a maximum depth of 100 m. Sampling and analytical methods were the same as those presented in Table A-1.

Nearshore Zone

Regional nearshore (surfzone) FIB samples were collected 1–2 days per week at a total of 38 stations (Figure 3-1). When water from creek/storm drain stations flowed to the ocean, a bacteriological sample was collected at the source, 25 yards downcoast, and 25 yards upcoast. When flow was absent, a single sample was collected 25 yards downcoast.

Samples were collected in ankle-deep water, with the mouth of the sterile bottle facing an incoming wave but away from both the sampler and ocean bottom. After the sample was taken, the bottle was tightly capped and promptly stored on ice in the dark. The occurrence and size of any grease particles at the high tide line were also recorded. Laboratory analysis of FIB samples began within 6 hours of collection.

Laboratory Methods

Laboratory analyses of NH3-N and bacteriology samples followed methods listed in Table A-1. Quality assurance/quality control (QA/QC) procedures included analysis of laboratory blanks and duplicates. All data underwent at least 3 separate reviews prior to being included in the final database used for statistical analysis, comparison to standards, and data summaries.

Data Analyses

Raw CTD data were processed using both SEASOFT (2016b) and third party (IGODS 2012) software. The steps included retaining downcast data and removing potential outliers, i.e. data that exceeded specific criteria limits. Flagged data were removed if they were considered to be due to instrument failures, electrical noise (e.g., large data spikes), or physical interruptions of sensors (e.g., by bubbles) rather than by actual oceanographic events. After outlier removal, averaged 1 m depth values were prepared from the downcast data; if there were any missing 1 m depth values, then the upcast data were used as a replacement. CTD and discrete data were then combined to create a single data file that contained all sampled stations for each survey day.

Compliance Determinations

COP compliance was assessed based on: (1) specific numeric criteria for DO, pH, and 3 FIB (total and fecal coliform and enterococci); and (2) narrative (non-numeric) criteria for transmissivity, floating particulates, oil and grease, water discoloration, beach grease, and excess nutrients.

Dissolved Oxygen, pH, and Transmissivity

Station locations were defined as either Zone A (stations inshore of the 3-mile limit for state waters) or Zone B (offshore of the 3-mile limit) as shown in Figure A-1. Compliance evaluations for DO, pH, and transmissivity were based on statistical comparisons to the corresponding Zone A or Zone B reference station located upcurrent of the outfall (OCSD 1999). For each survey, the depth of the pycnocline layer, if present, was calculated for each station using temperature and salinity data. The pycnocline is defined as the depth layer where stability is greater than 0.05 kg/m^3 (Officer 1976). Data for each station and numeric compliance parameter (transmissivity, dissolved oxygen, and pH) were binned by water column stratum: above, within, or below the pycnocline. When a pycnocline was absent, data were binned into the top, middle, or bottom third of the water column for each station. Mean values for each parameter were calculated by stratum and station. The number of observations usually differed from station to station and survey to survey due to different water and pycnocline depths. The selection of appropriate reference stations (i.e., upcoast or downcoast) for each survey

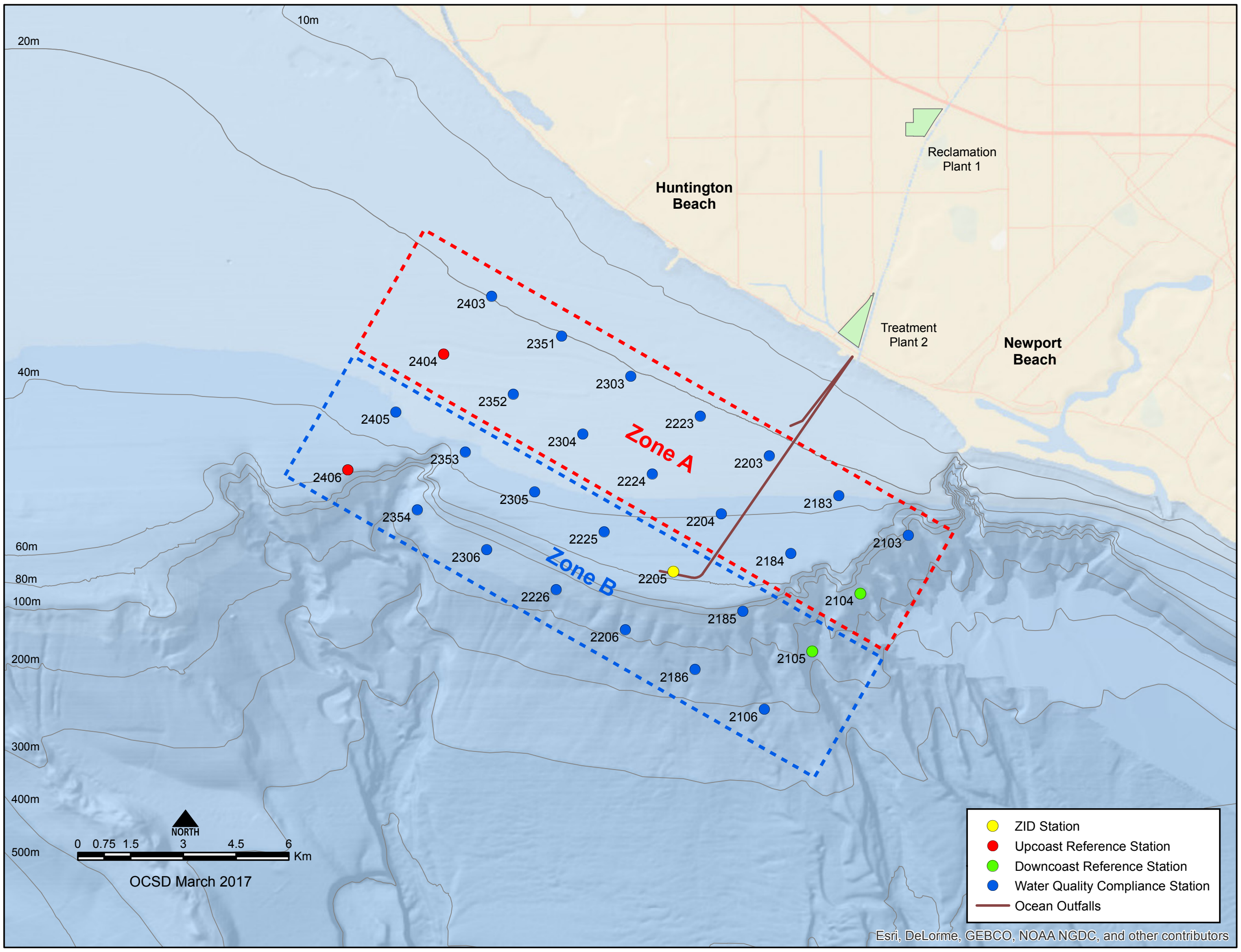

Figure A–1 Water quality monitoring stations and zones used for compliance determinations.

day were determined based on available current measurements and the presence or absence of typical plume "signals" (e.g., elevated ammonium, FIB, and CDOM). If the choice of a reference station was indeterminate, then the data were analyzed twice using both upcoast and downcoast reference stations. Once reference stations were determined, the data were analyzed using in-house MATLAB (2007) routines to calculate out-of-range occurrences (OROs) for each sampling date and parameter. These OROs were based on comparing the mean data by stratum and station with the corresponding reference station data to determine whether the following criteria were exceeded:

- Dissolved oxygen: cannot be depressed >10% below the mean;
- pH: cannot be greater than ± 0.2 pH units of the mean; and
- Natural light (defined as transmissivity): shall not be significantly reduced, where statistically different from the mean is defined as the lower 95% confidence limit.

In accordance with permit specifications, the outfall station (2205) was not included in the comparisons because it is within the zone of initial dilution (ZID).

To determine whether an ORO was out-of-compliance (OOC), distributional maps were created that identified the reference stations for each sampling date and location of each ORO, including which stratum was out of range. Each ORO was then evaluated to determine if it represented a logical OOC event. These evaluations were based on: (A) evaluation of the wastewater plume location relative to depth using a combination of temperature, density, salinity, CDOM, and when available, FIB and NH3-N; (B) evaluation of features in the water column relative to naturally occurring events (i.e., high chlorophyll-*a* due to phytoplankton); and (C) unique characteristics of some stations that may not be comparable with permit-specified reference stations (2104/2105 or 2404/2406) due to differences in water depth and/or variable oceanographic conditions. For example, Zone A Stations 2103, 2203, 2303, and 2403 are located at shallower depths than reference Station 2104. Waves and currents can cause greater mixing and resuspension of bottom sediments at shallower stations under certain conditions (e.g., winter storm surges). This can result in naturally decreased water clarity (transmissivity) that is unrelated to the wastewater discharge. An ORO can be in-compliance if, for example, a downcurrent station is different from the reference, but no intermediate (e.g., nearfield) stations exhibited OROs.

Once the total number of OOC events was summed by parameter, the percentage of OROs and OOCs were calculated according to the total number of observations. In a typical year, Zone A has a total of 504 possible comparisons if 14 stations (not including the reference station) and 3 strata over 12 survey dates per year are used. For Zone B, 432 comparisons are possible from 12 stations (not including the reference station), 3 strata, and 12 sampling dates. The total combined number of ORO and OOC events was then determined by summing the Zone A and Zone B results. When all of the strata are not present (e.g. below thermocline at shallow stations) or additional surveys are conducted, the total number of comparisons in the analysis may be more or less than the target number of comparisons possible (936).

<u>Fecal Indicator Bacteria (FIB)</u>

FIB compliance used corresponding bacterial standards at each REC-1 station and for stations outside the 3-mile state limit. FIB counts at individual REC-1 stations were averaged per survey and compliance for each FIB was determined using the following COP criteria (SWRCB 2010):

30-day Geometric Mean

- Total coliform density shall not exceed 1,000 per 100 mL.
- Fecal coliform density shall not exceed 200 per 100 mL.
- Enterococci density shall not exceed 35 per 100 mL.

Single Sample Maximum

- Total coliform density shall not exceed 10,000 per 100 mL.
- Fecal coliform density shall not exceed 400 per 100 mL.
- Enterococci density shall not exceed 104 per 100 mL.
- Total coliform density shall not exceed 1,000 per 100 mL when the fecal coliform/total coliform ratio exceeds 0.1.

Additionally, the District's permit includes the following USEPA Primary Recreation Criteria for *Enterococcus* (EPA 1994a).

- 30-day geometric mean: Density less than 35 per 100 mL.
- Single sample: Density less than 104 per 100 mL for designated bathing beaches.
- Single sample: Density less than 158 per 100 mL for moderate use.
- Single sample: Density less than 276 per 100 mL for light use.
- Single sample: Density less than 501 per 100 mL for infrequent use.

For purposes of this report, compliance with the EPA criteria was based on infrequent use.

Determinations of fecal coliform compliance were accomplished by multiplying *E. coli* data by 1.1 to obtain a calculated fecal coliform value.

There are no compliance criteria for FIB at the nearshore stations. Nevertheless, FIB data were given to the Orange County Health Agency (which follows State Department of Health Service

AB411 standards) for the Ocean Water Protection Program (http://ocbeachinfo.com/); and are briefly discussed in Chapter 2.

Nutrients and Aesthetics

These compliance determinations were done based on presence/absence and level of potential effect at each station. Station groupings are shown in Table B-4 and are based on relative distance and direction from the outfall. Compliance for the floating particulates, oil and grease, and water discoloration were determined based on presence/absence at the ocean surface for each station. Compliance with the excess nutrient criterion was based on evaluation of NH3-N compared to COP objectives for chronic (4 mg/L) and acute (6 mg/L) toxicity to marine organisms. Compliance was also evaluated by looking at potential spatial relationships between NH3-N distribution and phytoplankton (using chlorophyll-*a* fluorescence).

SEDIMENT GEOCHEMISTRY MONITORING

Field Methods

Sediment samples were collected for geochemistry analyses from 29 semi-annual stations in July 2015 (summer) and in January 2016 (winter) as well as from 39 annual stations in July 2015 (Figure 2-2). In addition, 2–3 L of sediment was collected from Stations 0, 1, 4, 72, 73, 76, 77, CON, and ZB in January 2016 for sediment toxicity testing. Each station was assigned to 1 of 6 station groups: (1) Middle Shelf Zone 1 (31–50 m); (2) Middle Shelf Zone 2, within-ZID (51–90 m); (3) Middle Shelf Zone 2, non-ZID (51–90 m); (4) Middle Shelf Zone 3 (91–120 m); (5) Outer Shelf (121–200 m); and (6) Upper Slope/Canyon (201–500 m). In Chapter 2, the Middle Shelf Zone 2, within- and non-ZID station groups are simply referred to as within-ZID and non-ZID stations, respectively.

A single sample was collected at each station using a paired 0.1 m^2 Van Veen grab sampler deployed from the M/V *Nerissa*. All sediment samples were qualitatively and quantitatively assessed for acceptability prior to processing. Samples were deemed acceptable if they had a minimum depth of 5 cm. However, if 3 consecutive sediment grabs each yielded a depth of <5 cm at a station, then the depth threshold was lowered to ≤4 cm. The top 2 cm of the sample was transferred into separate containers and a resealable plastic bag using a stainless steel scoop (Table A-2). The sampler and scoop were rinsed thoroughly with filtered seawater prior to sample collection. All sediment samples were transported on wet ice to the laboratory. Sample storage and holding times followed specifications in the District's Environmental Laboratory and Ocean Monitoring Standard Operating Procedures (ELOM SOP) (OCSD 2015; Table A-2).

Table A–2 Sediment collection and analysis summary during 2015-16. * = Available online at: www.epa.gov.

Parameter	Container	Preservation	Holding Time	Method
Dissolved Sulfides	HDPE container	Freeze	6 months	ELOM SOP 4500-S G Rev. B
Grain Size	Plastic bag	4o C	6 months	Plumb (1981)
Mercury	Amber glass jar	Freeze	6 months	ELOM SOP 245.1B Rev. F
Metals	Amber glass jar	Freeze	6 months	ELOM SOP 200.8B_SED Rev E
Sediment Toxicity	HDPE container	4o C	2 months	ELOM SOP 8810
Total Chlorinated Pesticides (ΣPest)	Glass jar	Freeze	6 months	ELOM SOP 8000-SPP
Total DDT (ΣDDT)	Glass jar	Freeze	6 months	ELOM SOP 8000-SPP
Total Nitrogen (TN)	Glass jar	Freeze	6 months	EPA 351.2M and 353.2M*
Total Organic Carbon (TOC)	Glass jar	Freeze	6 months	EPA 9060*
Total Phosphorus (TP)	Glass jar	Freeze	6 months	EPA 6010B*
Total Polychlorinated Biphenyls (ΣPCB)	Glass jar	Freeze	6 months	ELOM SOP 8000-SPP
Total Polycyclic Aromatic Hydrocarbons (ΣPAH)	Glass jar	Freeze	6 months	ELOM SOP 8000-SPP

Laboratory Methods

Sediment grain size, total organic carbon (TOC), total nitrogen, and total phosphorus samples were subsequently transferred to local and interstate laboratories for analysis (see Appendix C). Sample transfers were conducted and documented using required chain of custody protocols through the Laboratory Information Management Systems software. All other analyses were conducted by District lab staff.

Sediment chemistry and grain size samples were processed and analyzed using the methods listed in Table A-2. The measured sediment chemistry parameters are listed in Table A-3. Method blanks, analytical quality control samples (duplicates, matrix spikes, and blank spikes), and standard reference materials were prepared and analyzed with each sample batch. Total polychlorinated biphenyls (ΣPCB) and total polycyclic aromatic hydrocarbons (ΣPAH) were calculated by summing the measured value of each respective constituent listed in Table A-3. Total dichlorodipheynltrichloroethane (ΣDDT) represents the summed values of 4,4'-DDMU and the 2,4- and 4,4'-isomers of DDD, DDE, and DDT, and total chlorinated pesticides (ΣPest) represents the summed values of 13 chlordane derivative compounds plus dieldrin.

Table A–3 Parameters measured in sediment samples during 2015-16.

	Metals		
Antimony	Cadmium	Lead	Selenium
Arsenic	Chromium	Mercury	Silver
Barium	Copper	Nickel	Zinc
Beryllium			
	Chlorinated Pesticides		
Chlordane Derivatives and Dieldrin			
Aldrin	Endosulfan-alpha	*gamma*-BHC	Hexachlorobenzene
cis-Chlordane	Endosulfan-beta	Heptachlor	Mirex
trans-Chlordane	Endosulfan-sulfate	Heptachlor epoxide	*trans*-Nonachlor
Dieldrin	Endrin		
DDT Derivatives			
2,4'-DDD (o,p'-DDD)	2,4'-DDE (o,p'-DDE)	2,4'-DDT (o,p'-DDT)	4,4'-DDMU
4,4'-DDD (p,p'-DDD)	4,4'-DDE (p,p'-DDE)	4,4'-DDT (p,p'-DDT)	
	Polychlorinated Biphenyl (PCB) Congeners		
PCB 18	PCB 81	PCB 126	PCB 170
PCB 28	PCB 87	PCB 128	PCB 177
PCB 37	PCB 99	PCB 138	PCB 180
PCB 44	PCB 101	PCB 149	PCB 183
PCB 49	PCB 105	PCB 151	PCB 187
PCB 52	PCB 110	PCB 153/168	PCB 189
PCB 66	PCB 114	PCB 156	PCB 194
PCB 70	PCB 118	PCB 157	PCB 201
PCB 74	PCB 119	PCB 167	PCB 206
PCB 77	PCB 123	PCB 169	
	Polycyclic Aromatic Hydrocarbon (PAH) Compounds		
Acenaphthene	Benzo[g,h,i]perylene	Fluoranthene	1-Methylnaphthalene
Acenaphthylene	Benzo[k]fluoranthene	Fluorene	2-Methylnaphthalene
Anthracene	Biphenyl	Indeno[1,2,3-c,d]pyrene	2,6-Dimethylnaphthalene
Benz[a]anthracene	Chrysene	Naphthalene	1,6,7-Trimethylnaphthalene
Benzo[a]pyrene	Dibenz[a,h]anthracene	Perylene	2,3,6-Trimethylnaphthalene
Benzo[b]fluoranthene	Dibenzothiophene	Phenanthrene	1-Methylphenanthrene
Benzo[e]pyrene		Pyrene	
	Other Parameters		
Dissolved Sulfides	Total Nitrogen	Total Organic Carbon	Total Phosphorus
Grain Size			

Sediment toxicity was conducted using the 10-day *Eohaustorius estuarius* amphipod survival test (EPA 1994). Amphipods were exposed to test and home (control) sediments, and the percent survival in each was determined.

Data Analyses

All analytes that were undetected (i.e., value below the method detection limit) are reported as ND (not detected) in Tables 2-3 to 2-6. Further, an ND value was treated as zero for calculating a mean analyte concentration; however, if a station group contained all NDs for a particular analyte, then the mean analyte concentration is reported as ND. Sediment contaminant concentrations were evaluated against sediment quality guidelines known as Effects Range-Median (ERM) (Long et al. 1998). The ERM guidelines were developed for the National Oceanic and Atmospheric Administration (NOAA) National Status and Trends Program (NOAA 1993) as non-regulatory benchmarks to aid in the interpretation of sediment chemistry data and to complement toxicity, bioaccumulation, and benthic community assessments (Long and MacDonald 1998). The ERM is the 50th percentile sediment concentration above which a toxic effect frequently occurs (Long et al. 1995), and as such, an ERM exceedance is considered a significant potential for adverse biological effects. Bight'13 sediment geochemistry data (Dodder et al. 2016) were also used as benchmarks. Data analysis consisted of summary statistics and qualitative comparisons only.

Toxicity threshold criteria applied in this report were consistent with those of the Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1 Sediment Quality (Bay et al. 2009, SWRCB 2009). Stations with statistically different ($p<0.05$) survival rates when compared to the control, determined by a two sample t-test, were categorized as nontoxic when survival was 90–100% of the control, lowly toxic when survival was 82–89% of the control, and moderately toxic when survival was 59-81% of the control. Stations with no statistically different ($p>0.05$) survival rates when compared to the control were categorized as nontoxic when survival was 82–100% of the control and lowly toxic when survival was 59–81% of the control. Any station exhibiting survival less than 59% of the control was categorized as highly toxic.

BENTHIC INFAUNA MONITORING

Field Methods

A paired, 0.1 m^2 Van Veen grab sampler deployed from the M/V *Nerissa* was used to collect a sediment sample from 29 semi-annual stations in July 2015 (summer) and in January 2016 (winter) as well as from 39 annual stations in July 2015 (Figure 2-2). The purpose of the semi-annual surveys was to determine long-term trends and potential effects along the 60 m depth contour, while the annual survey was conducted primarily to assess the spatial extent of the influence of the effluent discharge. Each station was assigned to 1 of 6 depth categories as described above in the sediment geochemistry field methods section.

All sediment samples were qualitatively and quantitatively assessed for acceptability prior to processing as described above in the sediment geochemistry field methods section. At each station, acceptable sediment in the sampler was emptied into a 63.5 cm × 45.7 cm × 20.3 cm (25 in × 18 in × 8 in) plastic tray and then decanted onto a sieving table whereupon a hose with a fan spray nozzle was used to gently wash the sediment with filtered seawater through a 40.6 cm × 40.6 cm (16 in × 16 in), 1.0 mm sieve. Organisms retained on the sieve were rinsed with 7% magnesium sulfate anesthetic into one or more 1 L plastic containers and then placed in a cooler containing ice packs. After approximately 30 minutes in the anesthetic, animals were fixed by adding full strength buffered formaldehyde to the container to achieve a 10%, by volume, solution. Samples were transported to the District's laboratory for further processing.

Laboratory Methods

After 3–10 days in formalin, samples were rinsed with tap water and then transferred to 70% ethanol for long-term preservation. Samples were sent to Marine Taxonomic Services, Inc. (San Marcos, CA) to be sorted to 5 major taxonomic groups, Polychaeta, (worms), Mollusca (snails, clams, etc.), Arthropoda (shrimps, crabs, etc.), Echinodermata (sea stars, sea urchins, etc.), and miscellaneous phyla (Cnidaria, Nemertea, etc.). Removal of organisms was monitored to ensure that at least 95% of all organisms were successfully separated from the sediment matrix (see Appendix C). Upon completion of sample sorting, the major taxonomic groups were distributed for identification and enumeration (Table A-4). Taxonomic differences were resolved and the database was edited accordingly (see Appendix C). Species names used in this report follow those given in Cadien and Lovell (2016).

Table A–4 Benthic infauna sample distribution for 2015-16.

Quarter	Survey	Taxonomic Groups									
		Annelida		Arthropoda		Mollusca		Echinodermata		Misc. Phyla	
		OCSD	Con-tractor	OCSD	Con-tractor	OCSD	Con-tractor	OCSD	Con-tractor	OCSD	Con-tractor
Summer 2015	Semi-annual	28	1	0	29	14	15	0	29	0	29
Summer 2015	Annual	36	3	39	0	20	19	39	0	39	0
Winter 2016	Semi-annual	18	11	0	29	15	14	0	29	0	29

Data Analyses

Infaunal community data were analyzed to determine if populations outside the ZID were affected by the outfall discharge. Six community measures were used to assess infaunal community health and function: (1) total number of species (richness), (2) total number of individuals (abundance), (3) Shannon-Wiener Diversity (H′), (4) Swartz's 75% Dominance Index (SDI), (5) Infaunal Trophic Index (ITI), and (6) Benthic Response Index (BRI). H′ was calculated using $\log_e$ (Zar 1999). SDI was calculated as the minimum number of species with combined abundance equal to 75% of the individuals in the sample (Swartz 1978). SDI is inversely proportional to numerical dominance, thus a low index value indicates high dominance (i.e., a community dominated by a few species). The ITI was developed by Word (1978, 1990) to provide a measure of infaunal community "health" based on a species' mode of feeding (e.g., primarily suspension vs. deposit feeder). ITI values greater than 60 are considered indicative of a "normal" community, while 30–60 represent a "changed" community, and values less than 30 indicate a "degraded" community. The BRI measures the pollution tolerance of species on an abundance-weighted average basis (Smith et al. 2001). This measure is scaled inversely to ITI with low values (<25) representing reference conditions and high values (>72) representing defaunation or the exclusion of most species. The intermediate value range of 25–34 indicates a marginal deviation from reference conditions, 35–44 indicates a loss of biodiversity, and 45–72 indicates a loss of community function. The ITI and BRI were not calculated for stations >200 m in depth following recommendations provided by Word (1978) and Ranasinghe et al. (2012), respectively. The BRI was used to determine compliance with NPDES permit conditions, as it is a commonly used southern California benchmark for infaunal community structure and was developed with the input of regulators (Ranasinghe et al. 2007, 2012). The District's historical infauna data from the past 10 monitoring periods, as well as Bight'08 infauna data (Ranasinghe et al. 2012), were also used as benchmarks.

The presence or absence of certain indicator species (pollution sensitive and pollution tolerant) was also determined for each station. The presence of pollution sensitive species, i.e., *Amphiodia urtica* (brittlestar) and amphipod crustaceans in the genera *Ampelisca* and *Rhepoxynius*, typically indicates the existence of a healthy environment, while the occurrence of large numbers of pollution tolerant species, i.e., *Capitella capitata* Cmplx (polychaete), may indicate stressed or organically enriched environments. Patterns of these species were used to assess the spatial and temporal influence of the wastewater discharge in the receiving environment.

PRIMER v6 (2001) multivariate statistical software was also used to examine the spatial patterns of infaunal invertebrate communities at the Middle Shelf Zone 2 stations. The other stations were excluded from the analyses, as Clarke and Warwick (2001) advocated that clustering is less useful and may be misleading where there is a strong environmental forcing, such as depth. Analyses included (1) hierarchical clustering with group-average linking based on Bray-Curtis similarity indices and similarity profile (SIMPROF) permutation tests of the clusters, (2) ordination of the same data using non-metric multidimensional scaling (nMDS) to confirm hierarchical clustering, and (3) similarity percentages (SIMPER) routine to determine the species contributing to the dissimilarity between groupings. Prior to the calculation of the Bray-Curtis indices, the data were square root transformed in order to down-weight the highly abundant species and to incorporate the less common species (Clarke and Warwick 2001).

TRAWL COMMUNITIES MONITORING

Field Methods

Demersal fishes and epibenthic macroinvertebrates (EMIs) were collected by trawling in July and August, 2015 (summer) and in January and March, 2016 (winter). Sampling was conducted at 15 stations: Inner Shelf (18 m) Station T0; Middle Shelf Zone 1 (36 m) Stations T2, T24, T6, and T18; Middle Shelf Zone 2 (60 m) Stations T23, T22, T1, T12, T17, and T11; and Outer Shelf (137 m) Stations T10, T25, T14, and T19 (Figure 2-3). Only Middle Shelf, Zone 2 stations were sampled in both summer and winter; the remaining stations were sampled in summer only. Station T0 was sampled to maintain the long-term abundance records of fishes and EMIs at this site. Data for this historical station are not discussed in this report, however.

A minimum of 1 trawl was conducted from the M/V *Nerissa* at each station using a 7.6 m (25 ft) wide, Marinovich, semi-balloon otter trawl (2.54 cm mesh) with a 0.64 cm mesh cod-end liner, an 8.9 m chain-rigged foot rope, and 23 m long trawl bridles following regionally adopted methodology (Mearns and Allen 1978). The trawl wire scope varied from a ratio of approximately 5:1 at the shallowest stations to approximately 3:1 at the deepest station. To minimize catch variability due to weather and current conditions, which may affect the bottom-time duration of the trawl, trawls generally were taken along a constant depth at each station, and usually in the same direction.

Established trawl QA/QC methods for southern California were used (see Appendix C). Station locations and trawling speeds and paths were determined using Global Positioning System navigation. Trawl depths were determined using a Sea-Bird Electronics SBE 39 pressure sensor attached to one of the trawl boards.

Upon retrieval of the trawl net, the contents (fishes and EMIs) were emptied into a large flow-through water tank and then sorted by species into separate containers. Fish bioaccumulation and histopathology specimens were counted, recorded, and removed for processing (see Fish Tissue Contaminants Monitoring and Fish Health Monitoring sections below). The remaining fish specimens were processed as follows: (1) a minimum of 15 arbitrarily selected specimens of each species were weighed to the nearest gram and measured individually to the nearest millimeter (standard length); and (2) if a haul sample contained substantially more than 15 individuals of a species, then the excess specimens were enumerated in 1 cm size classes and a bulk weight was recorded. All fish specimens were examined for abnormalities such as external tumors, lesions, parasites, and skeletal deformities. EMIs were sorted to species, counted, and batch weighed. For each invertebrate species with large abundances (n>100), 100 individuals were counted and batch weighed; the remaining individuals were batch weighed and enumerated later by back calculating using the weight of the first 100 individuals. EMI specimens that could not be identified in the field were preserved in 10% buffered formalin for subsequent laboratory analysis.

Laboratory Methods

After 3–10 days in formalin, the EMI specimens retained for further taxonomic scrutiny were rinsed with tap water and then transferred to 70% ethanol for long-term preservation. These EMIs were identified using relevant taxonomic keys and, in some cases, were compared to voucher specimens housed in the District's Taxonomy Lab. Species and common names used in this report follow those given in Page et al. (2013) and Cadien and Lovell (2016).

Data Analyses

Total number of species, total abundance, biomass, H′, and SDI were calculated for both fishes and EMIs at each station. Fish biointegrity in the District's monitoring area was assessed using the fish response index (FRI). The FRI is a multivariate weighted-average index produced from an ordination analysis of calibrated species abundance data (Allen et al. 2001, 2006). FRI scores less than 45 are classified as reference (normal) and those greater than 45 are non-reference (abnormal or disturbed). The District's historical trawl EMI and fish data from the past 10 monitoring periods were also used as benchmarks.

PRIMER (2001) multivariate statistical software was used to examine the spatial patterns of the fish and EMI assemblages at the Middle Shelf Zone 2 stations. The other stations were excluded from the analyses, as Clarke and Warwick (2001) advised that clustering is less useful and may be misleading where there is a strong environmental forcing, such as depth. Analyses included (1) hierarchical clustering with group-average linking based on Bray-Curtis similarity indices and similarity profile (SIMPROF) permutation tests of the clusters and (2) ordination of the same data using non-metric multidimensional scaling (nMDS) to confirm hierarchical clustering. Prior to the calculation of the Bray-Curtis indices, the data were fourth-root transformed in order to down-weight the highly abundant species and incorporate the importance of the less common species (Clarke and Warwick 2001).

Middle Shelf Zone 2 stations were grouped into the following categories to assess spatial, outfall-related patterns: "outfall" (Stations T22 and T1) and "non-outfall" (Stations T23, T12, T17, and T11).

FISH TISSUE CONTAMINANTS MONITORING

Two demersal fish species, English Sole (*Parophrys vetulus*) and Hornyhead Turbot (*Pleuronichthys verticalis*), were targeted for analysis of muscle and liver tissue chemistry. Muscle tissue was analyzed because contaminants may bioaccumulate in this tissue and can be transferred to higher trophic levels. Liver tissue was analyzed because it typically has higher lipid content than muscle tissue and thus bioaccumulates relatively higher concentrations of lipid-soluble contaminants that have been linked to pathological conditions as well as immunological or reproductive impairment (Arkoosh et al. 1998).

Demersal fishes in the Scorpaenidae (e.g., California Scorpionfish and Vermilion Rockfish) and Serranidae (e.g., Kelp Bass and Sand Bass) were targeted, as they are frequently caught and consumed by recreational anglers. As such, contaminants in the muscle tissue of these fishes were analyzed to gauge human health risk.

Field Methods

The sampling objective for bioaccumulation analysis was to collect 10 individuals each of English Sole and Hornyhead Turbot at outfall (T1) and non-outfall (T11) stations during the July 2015 trawl survey. Likewise, 10 individuals in total of scorpaenid and serranid fishes were targeted at the outfall (Zone 1) and non-outfall (Zone 3) areas using hook-and-line fishing gear ("rig-fishing") in September 2015 (Figure 2-3).

Each fish collected for bioaccumulation analysis was weighed to the nearest gram and its standard length measured to the nearest millimeter; placed in pre-labelled, plastic, re-sealable bags; and stored on wet ice in an insulated cooler. Bioaccumulation samples were subsequently transported under chain of custody protocols to the District's laboratory. Sample storage and holding times for bioaccumulation analyses followed specifications in the District's ELOM SOP (Table A-5; OCSD 2015).

Laboratory Methods

Individual fish were dissected in the laboratory under clean conditions. Muscle and liver tissues were analyzed for various parameters listed in Table A-6 using methods shown in Table A-5. Method blanks, analytical quality control samples (duplicates, matrix spikes, and blank spikes), and standard reference materials were prepared and analyzed with each sample batch. All reported concentrations are on a wet weight basis.

Total dichlorodipheynltrichloroethane (ΣDDT) represents the summed values of 2,4- and 4,4'-isomers of DDD, DDE, and DDT and 4,4'-DDMU, total polychlorinated biphenyls (ΣPCB) represents the summed values of 44 congeners, and total chlordane (ΣChlordane) represents the sum of 7 derivative

Table A–5 Fish tissue handling and analysis summary during 2015-16. * = Available online at www.epa.gov; N/A = Not Applicable.

Parameter	Container	Preservation	Holding Time	Method
Arsenic and Selenium	Ziplock® bag	Freeze	6 months	NS&T (NOAA 1993); EPA 200.8 *
Chlorinated Pesticides	Ziplock® bag	Freeze	6 months	NS&T (NOAA 1993); EPA 8270 *
DDTs	Ziplock® bag	Freeze	6 months	NS&T (NOAA 1993); EPA 8270 *
Lipids	Ziplock® bag	Freeze	N/A	EPA 9071 *
Mercury	Ziplock® bag	Freeze	6 months	EPA 245.6 *
Polychlorinated Biphenyls	Ziplock® bag	Freeze	6 months	NS&T (NOAA 1993); EPA 8270 *

Table A–6 Parameters measured in fish tissue samples during 2015-16. * = Analyzed only in rig-fish specimens.

Metals		
Arsenic *	Mercury	Selenium *
Chlorinated Pesticides		
Chlordane Derivatives and Dieldrin		
cis-Chlordane	Dieldrin	*cis*-Nonachlor
trans-Chlordane	Heptachlor	*trans*-Nonachlor
Oxychlordane	Heptachlor epoxide	
DDT Derivatives		
2,4'-DDD (o,p'-DDD)	2,4'-DDE (o,p'-DDE)	2,4'-DDT (o,p'-DDT)
4,4'-DDD (p,p'-DDD)	4,4'-DDE (p,p'-DDE)	4,4'-DDT (p,p'-DDT)
		4,4'-DDMU
Polychlorinated Biphenyl (PCB) Congeners		
PCB 18	PCB 101	PCB 156
PCB 28	PCB 105	PCB 157
PCB 37	PCB 110	PCB 167
PCB 44	PCB 114	PCB 169
PCB 49	PCB 118	PCB 170
PCB 52	PCB 119	PCB 177
PCB 66	PCB 123	PCB 180
PCB 70	PCB 126	PCB 183
PCB 74	PCB 128	PCB 187
PCB 77	PCB 138	PCB 189
PCB 81	PCB 149	PCB 194
PCB 87	PCB 151	PCB 201
PCB 99	PCB 153/168	PCB 206
Other Parameter		
Lipids		

compounds (*cis*- and *trans*-chlordane, *cis*- and *trans*-nonachlor, heptachlor, heptachlor epoxide, and oxychlordane). Organic contaminant data were not lipid normalized.

Data Analyses

All analytes that were undetected (i.e., value below the method detection limit) are reported as not detected (ND) in Tables 2-12 and 2-13. Further, an ND value was treated as zero for calculating a mean analyte concentration; however, if fish tissue samples had all NDs for a particular analyte, then the mean analyte concentration is reported as ND. Data analysis consisted of summary statistics (i.e., means and ranges) and qualitative comparisons only.

The U.S. Food and Drug Administration action levels and the State of California Office of Environmental Health Hazard Assessment advisory tissue levels for ΣDDT, ΣPCB, methylmercury, dieldrin and ΣChlordane were used to assess human health risk in rig-caught fish (Klasing and Brodberg 2008; FDA 2011).

Analysis of bioaccumulation data consisted of summary statistics and qualitative comparisons only.

FISH HEALTH MONITORING

Assessments of the overall health (diseases and liver histopathology) of fish populations are also required by the NPDES permit. Liver histopathology analysis aims to detect tissue abnormalities (e.g., neoplasms) which can result from exposure to water column and sediment contaminants. Thus assessing the health of hepatic tissue is an effective way to assess overall fish health.

Field Methods

All trawl fish samples collected during the 2015-16 monitoring period were visually inspected for large, non-mobile external parasites, lesions, tumors, and other signs (e.g., skeletal deformities) of disease. Any atypical odor and coloration of fish samples were also noted. Moreover, 40 individuals each of English Sole and Hornyhead Turbot at outfall (T1) and non-outfall (T11) stations were targeted during the July 2015 trawl survey for liver histopathology analysis. Each fish collected for histopathology analysis was weighed to the nearest gram and its standard length measured to the nearest millimeter; placed in pre-labelled, plastic, re-sealable bags; and stored on wet ice in an insulated cooler. These samples were subsequently transported under chain of custody protocols to the District's laboratory and then given to Dr. Kristy Forsgren at California State University, Fullerton for analysis.

Data Analyses

Analysis of fish disease data consisted of qualitative comparisons only. For histopathology protocols, see Stuart and Forsgren (2016).

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APPENDIX B
Supporting Data

Table B–1 Depth-averaged total coliform bacteria (MPN/100 mL) collected in offshore waters and used for comparison with California Ocean Plan (COP) Water-Contact (REC-1) compliance criteria, July 2015 through June 2016.

Station	Date					Meets COP 30-day Geometric Mean of ≤1000/100mL	Meets COP Single Sample Standard of ≤10,000/100mL	Meets COP Single Sample Standard of ≤1000/100mL *
	7/23/2015	**8/6/2015**	**8/10/2015**	**8/12/2015**	**8/13/2015**			
2103	<10	11	<10	<10	10	YES	YES	YES
2104	<10	25	<10	<10	<10	YES	YES	YES
2183	<10	30	<10	10	<10	YES	YES	YES
2203	<10	<10	11	12	<10	YES	YES	YES
2223	<10	<10	<10	10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	10/14/2015	**10/15/2015**	**10/29/2015**	**11/4/2015**	**11/5/2015**			
2103	<10	<10	114	10	12	YES	YES	YES
2104	<10	<10	59	16	<10	YES	YES	YES
2183	<10	<10	142	33	11	YES	YES	YES
2203	<10	<10	68	12	22	YES	YES	YES
2223	<10	<10	157	63	16	YES	YES	YES
2303	<10	10	93	65	141	YES	YES	YES
2351	<10	28	11	72	78	YES	YES	YES
2403	<10	98	<10	62	21	YES	YES	YES
	1/20/2016	**1/21/2016**	**2/2/2016**	**2/9/2016**	**2/10/2016**			
2103	<10	17	16	27	<10	YES	YES	YES
2104	17	28	21	11	10	YES	YES	YES
2183	<10	11	10	28	14	YES	YES	YES
2203	<10	10	<10	<10	10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	10	<10	<10	<10	YES	YES	YES
2351	<10	<10	10	<10	<10	YES	YES	YES
2403	<10	<10	<10	14	<10	YES	YES	YES
	4/26/2016	**4/27/2016**	**5/3/2016**	**5/5/2016**	**5/9/2016**			
2103	<10	<10	17	42	11	YES	YES	YES
2104	<10	10	46	22	<10	YES	YES	YES
2183	<10	<10	20	<10	14	YES	YES	YES
2203	<10	<10	11	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	12	10	<10	<10	<10	YES	YES	YES

* Standard is based on when the single sample maximum fecal coliform/total coliform ratio >0.1.

Table B–2 Depth-averaged fecal coliform bacteria counts (MPN/100 mL) collected in offshore waters and used for comparison with California Ocean Plan (COP) Water-Contact (REC-1) compliance criteria, July 2015 through June 2016.

Station	Date					Meets COP 30-day Geometric Mean ≤200/100mL	Meets COP single sample standard of ≤400/100mL
	7/23/2015	**8/6/2015**	**8/10/2015**	**8/12/2015**	**8/13/2015**		
2103	<10	<10	<10	<10	<10	YES	YES
2104	<10	11	<10	<10	<10	YES	YES
2183	<10	17	<10	<10	<10	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES
	10/14/2015	**10/15/2015**	**10/29/2015**	**11/4/2015**	**11/5/2015**		
2103	<10	<10	10	<10	<10	YES	YES
2104	<10	<10	11	<10	<10	YES	YES
2183	<10	<10	<10	<10	<10	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES
2403	<10	11	<10	<10	<10	YES	YES
	1/20/2016	**1/21/2016**	**2/2/2016**	**2/9/2016**	**2/10/2016**		
2103	<10	<10	10	<10	<10	YES	YES
2104	<10	12	10	<10	<10	YES	YES
2183	<10	<10	<10	10	<10	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES
2403	<10	<10	<10	11	<10	YES	YES
	4/26/2016	**4/27/2016**	**5/3/2016**	**5/5/2016**	**5/9/2016**		
2103	<10	<10	10	13	<10	YES	YES
2104	<10	<10	19	12	<10	YES	YES
2183	<10	<10	10	<10	<10	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES
2403	12	<10	<10	<10	<10	YES	YES

Table B–3 Depth-averaged enterococci bacteria (MPN/100mL) collected in offshore waters and used for comparison with California Ocean Plan (COP) Water-Contact (REC-1) compliance criteria and EPA Primary Recreation Criteria in Federal Waters, July 2015 through June 2016.

Station	Date					Meets COP 30-day Geometric Mean of ≤35/100 mL	Meets COP single sample standard of ≤104/100 mL	Meets EPA single sample standard of ≤501/100 mL *
	7/23/2015	**8/6/2015**	**8/10/2015**	**8/12/2015**	**8/13/2015**			
2103	<10	<10	10	<10	<10	YES	YES	YES
2104	<10	<10	<10	<10	<10	YES	YES	YES
2183	<10	<10	<10	<10	<10	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	10/14/2015	**10/15/2015**	**10/29/2015**	**11/4/2015**	**11/5/2015**			
2103	<10	<10	<10	<10	<10	YES	YES	YES
2104	<10	<10	<10	<10	<10	YES	YES	YES
2183	<10	<10	<10	<10	<10	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	1/20/2016	**1/21/2016**	**2/2/2016**	**2/9/2016**	**2/10/2016**			
2103	<10	<10	<10	<10	<10	YES	YES	YES
2104	<10	10	<10	<10	<10	YES	YES	YES
2183	<10	<10	<10	<10	<10	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	4/26/2016	**4/27/2016**	**5/3/2016**	**5/5/2016**	**5/9/2016**			
2103	<10	<10	<10	<10	<10	YES	YES	YES
2104	<10	<10	<10	<10	<10	YES	YES	YES
2183	14	<10	<10	<10	<10	YES	YES	YES
2203	10	<10	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES

* Standard is based on area of infrequent use.

Table B–4 Summary of floatable material by station group observed during the 28-station grid water quality surveys, July 2015 through June 2016. Total number of station visits = 336.

Surface Observation	Station Group							Totals
	Upcoast Offshore	Upcoast Nearshore	Nearfield Offshore	Within ZID	Nearfield Nearshore	Downcoast Offshore	Downcoast Nearshore	
	2225, 2226 2305, 2306 2353, 2354 2405, 2406	2223, 2224 2303, 2304 2351, 2352 2403, 2404	2206	2205	2203, 2204	2105, 2106 2185, 2186	2103, 2104 2183, 2184	
Oil and Grease	0	0	0	0	0	0	0	0
Trash/Debris	3	0	0	0	1	0	1	5
Biological Material (kelp)	0	3	0	1	0	0	1	5
Material of Sewage Origin	0	0	0	0	0	0	0	0
Totals	3	3	0	1	1	0	2	10

Table B–5 Summary of floatable material by station group observed during the REC-1 water quality surveys, July 2015 through June 2016. Total number of station visits = 134.

Surface Observation	Station Group				Totals
	Upcoast Nearshore	Within ZID	Nearfield Nearshore	Downcoast Nearshore	
	2223, 2303 2351, 2403	2205	2203	2103, 2104	
Oil and Grease	0	0	0	0	0
Trash/Debris	0	0	0	2	2
Biological Material (kelp)	0	0	0	1	1
Material of Sewage Origin	0	0	0	0	0
Totals	0	0	0	3	3

Table B–6 Summary of monthly Core water quality parameters by season and depth strata, July 2015 to June 2016.

Depth Strata (m)	Summer				Fall				Winter				Spring				Annual			
	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Temperature (°C)																				
1-15	15.35	21.41	25.19	2.02	15.51	19.04	23.82	2.58	14.19	15.51	17.01	0.53	14.32	17.14	18.94	1.09	14.19	18.29	25.19	2.82
16-30	12.90	17.19	22.81	2.24	15.14	17.67	22.32	1.36	13.68	15.22	16.18	0.53	11.68	14.53	18.50	1.29	11.68	16.17	22.81	1.98
31-45	11.69	14.51	18.20	1.68	14.75	16.70	18.21	0.73	12.35	14.96	15.78	0.54	10.86	11.96	13.78	0.52	10.86	14.54	18.21	1.96
45-60	11.10	13.33	17.23	1.73	14.23	15.55	17.32	0.70	11.28	14.05	15.63	1.10	10.44	11.02	11.88	0.27	10.44	13.49	17.32	1.96
61-75	10.90	12.46	15.43	1.34	13.50	14.67	16.03	0.53	10.86	12.72	14.94	1.11	9.99	10.49	11.02	0.20	9.99	12.58	16.03	1.74
All	10.90	16.91	25.19	3.85	13.50	17.27	23.82	2.21	10.86	14.82	17.01	1.13	9.99	13.91	18.94	2.70	9.99	15.74	25.19	3.02
Density (kg/m³)																				
1-15	20.94	23.15	24.58	0.55	22.56	23.84	24.64	0.70	24.35	24.72	25.03	0.13	23.97	24.36	24.96	0.24	20.94	24.02	25.03	0.75
16-30	22.82	24.18	25.10	0.51	22.96	24.16	24.74	0.38	24.57	24.79	25.11	0.11	24.07	24.91	25.47	0.27	22.82	24.50	25.47	0.49
31-45	23.91	24.74	25.31	0.37	23.92	24.38	24.80	0.18	24.66	24.84	25.39	0.11	25.07	25.46	25.78	0.12	23.91	24.85	25.78	0.45
45-60	24.15	24.99	25.49	0.38	24.29	24.62	24.93	0.17	24.74	25.03	25.66	0.22	25.48	25.70	25.88	0.08	24.15	25.08	25.88	0.46
61-75	24.52	25.20	25.66	0.33	24.42	24.83	25.10	0.15	24.86	25.33	25.83	0.25	25.70	25.86	26.08	0.07	24.42	25.31	26.08	0.43
All	20.94	24.20	25.66	0.90	22.56	24.24	25.10	0.56	24.35	24.87	25.83	0.25	23.97	25.06	26.08	0.59	20.94	24.59	26.08	0.73
Salinity (psu)																				
1-15	31.89	33.39	33.48	0.14	33.32	33.51	33.69	0.10	33.36	33.52	33.59	0.05	33.48	33.54	33.61	0.03	31.89	33.49	33.69	0.11
16-30	33.20	33.33	33.46	0.04	33.23	33.45	33.68	0.13	33.41	33.53	33.59	0.04	33.44	33.50	33.59	0.02	33.20	33.45	33.68	0.10
31-45	33.14	33.28	33.34	0.04	33.16	33.43	33.64	0.13	33.41	33.52	33.59	0.05	33.41	33.54	33.69	0.04	33.14	33.44	33.69	0.13
45-60	33.12	33.29	33.41	0.04	33.18	33.40	33.64	0.11	33.37	33.52	33.63	0.05	33.47	33.62	33.76	0.07	33.12	33.46	33.76	0.14
61-75	33.14	33.33	33.54	0.09	33.18	33.43	33.57	0.10	33.42	33.57	33.75	0.06	33.57	33.70	33.91	0.07	33.14	33.51	33.91	0.16
All	31.89	33.33	33.54	0.10	33.16	33.46	33.69	0.12	33.36	33.53	33.75	0.05	33.41	33.56	33.91	0.08	31.89	33.47	33.91	0.13
Dissolved Oxygen (mg/L)																				
1-15	6.48	7.42	8.86	0.52	6.16	7.03	7.87	0.22	5.79	7.51	8.57	0.40	6.05	7.90	8.50	0.28	5.79	7.46	8.86	0.49
16-30	6.36	8.05	8.83	0.35	6.01	7.18	8.01	0.49	5.61	7.25	8.16	0.47	4.13	6.49	8.41	1.03	4.13	7.25	8.83	0.85
31-45	5.83	7.47	8.54	0.64	5.83	7.03	8.05	0.54	4.64	6.93	7.76	0.49	3.57	4.57	6.53	0.58	3.57	6.51	8.54	1.26
45-60	5.46	6.93	8.12	0.79	5.51	6.53	8.00	0.64	4.27	5.94	7.27	0.76	3.32	3.92	5.01	0.37	3.32	5.84	8.12	1.33
61-75	4.88	6.33	8.12	0.89	5.10	6.00	7.79	0.66	3.70	4.80	6.36	0.54	2.94	3.76	4.55	0.40	2.94	5.23	8.12	1.21
All	4.88	7.41	8.86	0.80	5.10	6.88	8.05	0.61	3.70	6.81	8.57	1.01	2.94	5.90	8.50	1.76	2.94	6.76	8.86	1.25
pH																				
1-15	8.06	8.13	8.17	0.02	7.87	7.96	8.02	0.03	8.06	8.15	8.21	0.03	8.02	8.13	8.19	0.03	7.87	8.09	8.21	0.08
16-30	8.02	8.12	8.18	0.03	7.85	7.95	8.01	0.03	8.01	8.13	8.19	0.04	7.75	8.02	8.17	0.09	7.75	8.05	8.19	0.09
31-45	7.84	8.05	8.17	0.07	7.81	7.91	7.98	0.04	7.90	8.10	8.18	0.04	7.68	7.82	8.02	0.06	7.68	7.97	8.18	0.12
45-60	7.81	7.97	8.15	0.09	7.70	7.85	7.95	0.05	7.80	8.03	8.14	0.09	7.66	7.75	7.82	0.04	7.66	7.90	8.15	0.13
61-75	7.74	7.90	8.10	0.10	7.66	7.79	7.89	0.04	7.76	7.92	8.10	0.09	7.65	7.72	7.80	0.04	7.65	7.83	8.10	0.11
All	7.74	8.06	8.18	0.10	7.66	7.91	8.02	0.07	7.76	8.09	8.21	0.09	7.65	7.95	8.19	0.17	7.65	8.00	8.21	0.14
Chlorophyll-a (μg/L)																				
1-15	0.02	0.48	3.37	0.47	0.01	0.82	4.63	0.72	0.10	1.42	5.94	1.05	0.07	2.07	11.75	1.87	0.01	1.20	11.75	1.30
16-30	0.13	1.56	6.92	1.32	0.16	1.12	2.84	0.48	0.49	1.82	5.19	0.86	0.67	2.70	10.47	1.43	0.13	1.79	10.47	1.23
31-45	0.51	1.74	4.29	0.78	0.27	0.88	2.09	0.30	0.14	1.23	4.43	0.63	0.07	0.97	4.23	0.60	0.07	1.21	4.43	0.69
45-60	0.32	0.97	2.43	0.33	0.16	0.60	1.91	0.31	0.04	0.49	1.34	0.29	0.02	0.26	1.61	0.26	0.02	0.58	2.43	0.39
61-75	0.16	0.61	1.17	0.22	0.10	0.37	1.47	0.25	0.01	0.14	0.62	0.10	0.01	0.08	0.57	0.08	0.01	0.30	1.47	0.28
All	0.02	1.08	6.92	0.97	0.01	0.83	4.63	0.56	0.01	1.22	5.94	0.96	0.01	1.56	11.75	1.63	0.01	1.17	11.75	1.13

Table B-6 continues.

Table B-6 Continued

Depth Strata (m)	Summer				Fall				Winter				Spring				Annual			
	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Light Transmissivity (%)																				
1-15	65.34	84.56	88.42	3.46	61.99	84.27	88.37	3.99	68.73	82.35	86.81	4.02	64.14	80.71	86.49	4.97	61.99	82.98	88.42	4.42
16-30	75.88	84.49	87.98	2.81	54.78	82.92	88.27	4.69	33.79	82.41	87.24	4.91	65.21	81.34	86.17	4.33	33.79	82.81	88.27	4.40
31-45	76.29	84.39	87.40	1.81	59.54	83.76	88.32	3.91	64.67	83.91	88.21	3.35	59.36	85.47	88.58	2.57	59.36	84.38	88.58	3.08
45-60	81.69	86.04	88.69	1.26	53.24	84.85	88.59	4.92	72.89	85.38	88.33	1.80	78.72	86.87	88.67	1.31	53.24	85.78	88.69	2.87
61-75	82.62	86.70	88.87	1.36	74.98	86.85	88.69	2.31	82.85	86.80	88.72	1.22	81.25	87.33	89.11	1.38	74.98	86.92	89.11	1.64
All	65.34	84.96	88.87	2.72	53.24	84.19	88.69	4.32	33.79	83.57	88.72	4.04	59.36	83.35	89.11	4.64	33.79	84.02	89.11	4.04
Photosynthetically Active Radiation (%)																				
1-15	2.20	27.12	100.00	17.77	0.33	20.43	100.00	15.98	0.00	20.51	100.00	17.56	1.73	23.74	100.00	22.90	0.00	22.98	100.00	18.92
16-30	0.62	8.70	26.40	5.25	0.01	4.71	23.26	4.56	0.09	3.29	14.66	2.40	0.19	3.11	13.83	2.49	0.01	5.00	26.40	4.52
31-45	0.07	1.86	10.32	1.60	0.00	0.90	8.15	1.05	0.01	0.63	2.72	0.46	0.08	0.59	2.61	0.49	0.00	1.00	10.32	1.14
45-60	0.01	0.36	1.58	0.30	0.00	0.18	2.14	0.25	0.00	0.13	0.57	0.10	0.06	0.29	1.11	0.25	0.00	0.24	2.14	0.25
61-75	0.00	0.08	0.44	0.08	0.00	0.04	0.55	0.06	0.00	0.03	0.12	0.03	0.04	0.24	0.85	0.22	0.00	0.10	0.85	0.15
All	0.00	10.88	100.00	15.05	0.00	7.58	100.00	12.50	0.00	7.22	100.00	13.16	0.04	8.17	100.00	16.32	0.00	8.48	100.00	14.41
Ammonium (mg/L)[1]																				
1-15	0.015	0.015	0.020	0.001	0.015	0.015	0.020	0.001	0.015	0.015	0.030	0.001	0.015	0.017	0.070	0.005	0.015	0.016	0.070	0.003
16-30	0.015	0.015	0.040	0.003	0.015	0.016	0.090	0.007	0.015	0.018	0.117	0.014	0.015	0.017	0.042	0.003	0.015	0.017	0.117	0.008
31-45	0.015	0.024	0.170	0.026	0.015	0.018	0.120	0.015	0.015	0.022	0.112	0.020	0.015	0.019	0.078	0.011	0.015	0.021	0.170	0.019
45-60	0.015	0.018	0.110	0.012	0.015	0.017	0.070	0.007	0.015	0.023	0.105	0.190	0.015	0.025	0.144	0.025	0.015	0.021	0.144	0.018
61-75	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
All	0.015	0.017	0.170	0.011	0.015	0.016	0.120	0.007	0.015	0.018	0.117	0.014	0.015	0.019	0.144	0.013	0.015	0.017	0.170	0.011

[1] Ammonium values below MDL (0.02 mg/L) were adjusted to 75% of MDL (0.015 mg/L)

Table B–7 Species richness and abundance values of the major taxonomic groups collected at each depth stratum and season during the 2015-16 infauna survey. Values represent the mean and range (in parentheses).

Season	Parameter	Stratum	Annelida	Arthropoda	Echinodermata	Misc. Phyla	Mollusca
Summer	Number of Species	Middle Shelf Zone 1 (31-50m)	48 (33-58)	18 (13-22)	5 (3-6)	8 (4-11)	12 (7-16)
		Middle Shelf Zone 2, Within-ZID (51-90m)	41 (35-51)	21 (16-23)	2 (1-3)	5 (3-7)	11 (9-14)
		Middle Shelf Zone 2, Non-ZID (51-90m)	45 (25-59)	18 (2-25)	3 (1-7)	5 (0-9)	9 (4-15)
		Middle Shelf Zone 3 (91-120m)	44 (34-51)	13 (3-22)	3 (2-5)	5 (3-9)	12 (9-16)
		Outer Shelf (121-200m)	21 (16-30)	4 (1-16)	2 (0-4)	1 (0-2)	9 (5-14)
		Upper Slope/Canyon (201-500m)	12 (9-18)	2 (1-3)	1 (0-2)	0 (0-1)	6 (2-10)
	Abundance	Middle Shelf Zone 1 (31-50m)	178 (92-245)	44 (34-58)	18 (5-43)	37 (7-141)	21 (9-30)
		Middle Shelf Zone 2, Within-ZID (51-90m)	188 (132-312)	85 (63-114)	3 (1-6)	9 (6-13)	27 (20-34)
		Middle Shelf Zone 2, Non-ZID (51-90m)	209 (55-372)	58 (4-123)	12 (1-62)	7 (0-19)	18 (7-27)
		Middle Shelf Zone 3 (91-120m)	170 (107-219)	38 (14-86)	53 (12-167)	8 (4-13)	43 (31-65)
		Outer Shelf (121-200m)	53 (27-107)	6 (1-24)	3 (0-5)	2 (0-3)	31 (10-96)
		Upper Slope/Canyon (201-500m)	24 (13-37)	2 (1-4)	1 (0-2)	0 (0-1)	15 (7-25)
Winter	Number of Species	Middle Shelf Zone 2, Within-ZID (51-90m)	30 (26-35)	16 (13-20)	3 (2-4)	3 (1-4)	6 (5-9)
		Middle Shelf Zone 2, Non-ZID (51-90m)	39 (24-52)	15 (11-20)	4 (1-7)	4 (1-8)	7 (1-12)
	Abundance	Middle Shelf Zone 2, Within-ZID (51-90m)	67 (54-94)	31 (19-37)	8 (5-12)	3 (1-4)	14 (5-28)
		Middle Shelf Zone 2, Non-ZID (51-90m)	121 (63-211)	29 (16-48)	8 (2-28)	5 (1-12)	11 (2-23)

Table B–8 Abundance of epibenthic macroinvertebrates by station and species for the Summer 2015 and Winter 2016 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	Total	%
Ophiura luetkenii	2	4	14	1921	6	14	9	87		530	3	12	4	1	2331	1557		1			6496	77
Lytechinus pictus		10		1	108	17	25	7	14	2	279		3	59	1		6	4	6	84	626	7.4
Thesea sp B	17	24	12		29	10	25	17	29	21	3	2	19	7	29	34					278	3.3
Strongylocentrotus fragilis																	167	64			231	2.7
Pleuroncodes planipes						32		24				7		1		81					145	1.7
Sicyonia ingentis					4	1				1		3						1	23	111	144	1.7
Sicyonia penicillata						53		9	3	6	3	4	2	55		6					141	1.7
Hamatoscalpellum californicum	7	13			2			4	2	45		28	2		1	15		1			120	1.4
Ophiothrix spiculata	4	20	4		1	2	1	1	1		1		1		1					10	47	0.6
Astropecten californicus					1			2	1	6	1	8	3	3		2		1	1		29	0.3
Acanthoptilum sp					24		1		1				1				1				28	0.3
Orthopagurus minimus		10			4		2	1							3						20	0.2
Astropecten sp			7						1		1				4						13	0.2
Heterogorgia tortuosa					3	1	2	1	1	1	1		2			1					13	0.2
Dendronotus venustus	12																				12	0.1
Philine auriformis		9	1																	1	11	0.1
Apostichopus californicus					1	1	1		2	1	1						2				9	0.1
Octopus rubescens							1								1	1	2		1	1	7	0.1
Pyromaia tuberculata	2	2	2										1								7	0.1
Anthozoa																		6			6	0.1
Loxorhynchus crispatus	2	1	1						1												5	0.1
Coryrhynchus lobifrons								2	1				1								4	<0.1
Platymera gaudichaudii							1	1							2						4	<0.1
Astropecten ornatissimus																		2	1		3	<0.1
Neocrangon zacae																			2	1	3	<0.1
Polycera tricolor	3																				3	<0.1
Dendronotus iris		1	1																		2	<0.1
Dirona picta	1		1																		2	<0.1
Ericerodes hemphillii	1	1																			2	<0.1
Flabellina iodinea	1	1																			2	<0.1
Latulambrus occidentalis		1		1																	2	<0.1
Luidia asthenosoma			1															1			2	<0.1
Luidia foliolata	1													1							2	<0.1
Neocrangon resima																			1	1	2	<0.1
Solenocera mutator																	1			1	2	<0.1
Acanthodoris rhodoceras		1																			1	<0.1
Aglaja ocelligera			1																		1	<0.1
Amphiura arcystata												1									1	<0.1
Calinaticina oldroydii																		1			1	<0.1
Chiridota sp											1										1	<0.1
Diaulula sandiegensis		1																			1	<0.1
Doryteuthis opalescens												1									1	<0.1
Dromalia alexandri																				1	1	<0.1
Erileptus spinosus			1																		1	<0.1
Henricia sp		1																			1	<0.1
Megasurcula carpenteriana																1					1	<0.1
Metacarcinus anthonyi																	1				1	<0.1
Neverita draconis			1																		1	<0.1
Octopus californicus																	1				1	<0.1

Table B-8 continues.

Table B-8 continued.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	Total	%
Paguristes turgidus							1														1	<0.1
Romaleon jordani	1																				1	<0.1
Simnia sp										1											1	<0.1
Stylasterias forreri		1																			1	<0.1
Virgularia sp																			1		1	<0.1
Total Abundance	**54**	**101**	**47**	**1923**	**183**	**131**	**69**	**156**	**57**	**614**	**294**	**66**	**39**	**127**	**2373**	**1698**	**181**	**82**	**36**	**211**	**8442**	**100**
Total No. of Species	**13**	**17**	**13**	**3**	**11**	**9**	**11**	**12**	**12**	**10**	**10**	**9**	**11**	**7**	**9**	**9**	**8**	**10**	**8**	**9**	**54**	

Table B–9 Biomass (kg) of epibenthic macroinvertebrates by station and species for the Summer 2015 and Winter 2016 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19	Total	%
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S		
Strongylocentrotus fragilis																	8.665	3.595			12.260	40.4
Ophiura luetkenii	0.002	0.001	0.014	1.633	0.003	0.018	0.003	0.053		0.838	0.001	0.005	0.001	0.001	2.495	1.760		0.001			6.829	22.5
Apostichopus californicus					0.506	0.363	0.556		0.966	0.166	0.516						1.103				4.176	13.8
Sicyonia penicillata						0.553		0.093	0.059	0.090	0.062	0.043	0.053	0.998		0.083					2.034	6.7
Lytechinus pictus		0.040		0.001	0.228	0.053	0.063	0.005	0.027	0.001	0.848		0.005	0.188	0.001		0.002	0.007	0.009	0.218	1.696	5.6
Pleuroncodes planipes						0.193		0.153				0.063		0.009		0.503					0.921	3.0
Sicyonia ingentis					0.079	0.001				0.001		0.002						0.024	0.078	0.388	0.573	1.9
Platymera gaudichaudii							0.268	0.002							0.296						0.566	1.9
Metacarcinus anthonyi																	0.328				0.328	1.1
Octopus rubescens							0.018								0.009	0.053	0.127		0.022	0.030	0.259	0.9
Thesea sp B	0.017	0.030	0.008		0.015	0.005	0.022	0.015	0.031	0.006	0.001	0.001	0.008	0.004	0.016	0.041					0.220	0.7
Calinaticina oldroydii																		0.100			0.100	0.3
Octopus californicus																	0.067				0.067	0.2
Astropecten californicus					0.002			0.003	0.011	0.004	0.001	0.007	0.005	0.007		0.005		0.003	0.001		0.049	0.2
Dromalia alexandri																				0.045	0.045	0.1
Megasurcula carpenteriana																0.035					0.035	0.1
Ophiothrix spiculata	0.002	0.008	0.001		0.001	0.001	0.001	0.001	0.001		0.001		0.001		0.001					0.007	0.026	0.1
Hamatoscalpellum californicum	0.001	0.001			0.001			0.001	0.001	0.009		0.003	0.001		0.001	0.002		0.001			0.022	0.1
Philine auriformis		0.001	0.013																	0.001	0.015	<0.1
Anthozoa																		0.013			0.013	<0.1
Acanthoptilum sp					0.008		0.001		0.001				0.001				0.001				0.012	<0.1
Luidia foliolata	0.008													0.002							0.010	<0.1
Heterogorgia tortuosa					0.001	0.001	0.001	0.001	0.001	0.001	0.001		0.001			0.001					0.009	<0.1
Astropecten sp			0.002						0.001		0.001				0.003						0.007	<0.1
Orthopagurus minimus		0.001			0.001		0.001	0.001							0.001						0.005	<0.1
Astropecten ornatissimus																		0.003	0.001		0.004	<0.1
Loxorhynchus crispatus	0.001	0.001	0.001						0.001												0.004	<0.1
Pyromaia tuberculata	0.001	0.001	0.001										0.001								0.004	<0.1
Coryrhynchus lobifrons								0.001	0.001				0.001								0.003	<0.1

Table B-9 continues.

Table B-9 continued.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19	Total	%
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S		
Dendronotus iris		0.001	0.001																		0.002	<0.1
Dirona picta	0.001		0.001																		0.002	<0.1
Ericerodes hemphillii	0.001	0.001																			0.002	<0.1
Flabellina iodinea	0.001	0.001																			0.002	<0.1
Latulambrus occidentalis		0.001		0.001																	0.002	<0.1
Luidia asthenosoma			0.001															0.001			0.002	<0.1
Neocrangon resima																			0.001	0.001	0.002	<0.1
Neocrangon zacae																			0.001	0.001	0.002	<0.1
Solenocera mutator																	0.001			0.001	0.002	<0.1
Acanthodoris rhodoceras		0.001																			0.001	<0.1
Aglaja ocelligera			0.001																		0.001	<0.1
Amphiura arcystata												0.001									0.001	<0.1
Chiridota sp											0.001										0.001	<0.1
Dendronotus venustus	0.001																				0.001	<0.1
Diaulula sandiegensis		0.001																			0.001	<0.1
Doryteuthis opalescens												0.001									0.001	<0.1
Erileptus spinosus			0.001																		0.001	<0.1
Henricia sp		0.001																			0.001	<0.1
Neverita draconis			0.001																		0.001	<0.1
Paguristes turgidus							0.001														0.001	<0.1
Polycera tricolor	0.001																				0.001	<0.1
Romaleon jordani	0.001																				0.001	<0.1
Simnia sp										0.001											0.001	<0.1
Stylasterias forreri		0.001																			0.001	<0.1
Virgularia sp																			0.001		0.001	<0.1
Total Biomass	**0.038**	**0.092**	**0.046**	**1.635**	**0.845**	**1.188**	**0.935**	**0.329**	**1.101**	**1.117**	**1.433**	**0.126**	**0.078**	**1.209**	**2.823**	**2.483**	**10.294**	**3.748**	**0.114**	**0.692**	**30.326**	**100**

Table B–10 Abundance of demersal fishes by station and species for the Summer 2015 and Winter 2016 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19	Total	%
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S		
Citharichthys sordidus	4	5	7	14	234	103	274	106	79	57	31	79	90	72	26	54	340	273	215	460	2523	44.8
Zaniolepis latipinnis					24	61	10	16	30	21	5	75	8	69	3	18	67	123	74	135	739	13.1
Sebastes saxicola																	66	30	31	367	494	8.8
Synodus lucioceps	63	39	103	44	23	9	13	5	18	16	5	19	24	2	17	7		1	1	3	412	7.3
Symphurus atricaudus	2	2	5	1	4	31	17	31	13	32	3	44	3	17	1	35				6	247	4.4
Microstomus pacificus					2		1					1		5			41	9	22	120	201	3.6
Parophrys vetulus			1		9	4	3	9	17	6	2	12	5	23	8	20	1	3	4	16	143	2.5
Citharichthys xanthostigma	35	19	8					1	1	8		12	5								89	1.6
Pleuronichthys verticalis	4	4	1	1	4	5	6	8	9	9	3	1		2		19	1	2		4	83	1.5
Lyopsetta exilis																	14	25	26	8	73	1.3
Porichthys notatus					1		2							1			19	12		38	73	1.3
Lycodes pacificus																	20	14	13	22	69	1.2
Icelinus quadriseriatus	9	3	8			4	1	4	1	6			9		10	13					68	1.2
Xystreurys liolepis	1			1				17		13		8		2		16					58	1
Zalembius rosaceus						2	1	2		16		2		1	6		6	18	3		57	1
Citharichthys stigmaeus	7	10	13	21																	51	0.9
Hippoglossina stomata					1	10		2	2	4		3	1	3		11	1	4	5	4	51	0.9
Zaniolepis frenata																	23	14	4	10	51	0.9
Chitonotus pugetensis		1			3		6		12	1	1	1	15		6	1				2	49	0.9
Sebastes semicinctus						1											16	7		15	39	0.7
Pleuronichthys decurrens					1	3	7	1	2			2			3			1			20	0.4
Odontopyxis trispinosa			1		1		1		1		1		3		2	1					11	0.2
Raja inornata						1	1	1	2									1	3		9	0.2
Scorpaena guttata														1				4		2	7	0.1
Chilara taylori						1													1	3	5	0.1
Sebastes elongatus																		1	2	2	5	0.1
Genyonemus lineatus												1					1				2	<0.1
Paralabrax nebulifer				1						1											2	<0.1
Agonopsis sterletus							1														1	<0.1
Merluccius productus																				1	1	<0.1
Plectobranchus evides																				1	1	<0.1
Sebastes eos																		1			1	<0.1
Sebastes levis																				1	1	<0.1
Total Abundance	**125**	**83**	**147**	**83**	**307**	**235**	**344**	**203**	**187**	**190**	**51**	**260**	**163**	**198**	**82**	**195**	**616**	**543**	**404**	**1220**	**5636**	**100**
Total No. of Species	**8**	**8**	**9**	**7**	**12**	**13**	**15**	**13**	**13**	**13**	**8**	**14**	**10**	**12**	**10**	**11**	**14**	**19**	**14**	**21**	**33**	

Table B–11 Biomass (kg) of demersal fishes by station and species for the Summer 2015 and Winter 2016 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19	Total	%
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S		
Citharichthys sordidus	0.015	0.010	0.021	0.039	16.360	6.849	22.013	7.202	5.805	3.744	1.483	5.947	5.145	4.915	0.849	3.871	7.128	11.489	4.248	27.341	134.474	63.5
Parophrys vetulus			0.295		0.854	0.399	0.366	0.549	1.768	0.595	0.190	0.817	0.508	1.597	0.381	0.687	0.092	0.284	0.468	1.673	11.523	5.4
Zaniolepis latipinnis					0.365	0.966	0.183	0.277	0.480	0.351	0.063	0.576	0.081	0.594	0.036	0.294	1.309	2.226	1.290	2.366	11.457	5.4
Synodus lucioceps	1.660	0.546	1.158	0.479	1.514	0.184	0.500	0.127	0.631	0.470	0.095	0.520	0.720	0.028	0.284	0.222		0.160	0.019	0.064	9.381	4.4
Sebastes saxicola																	1.128	0.481	0.685	5.229	7.523	3.6
Citharichthys xanthostigma	1.938	0.815	0.341					0.079	0.210	0.390		1.009	0.669								5.451	2.6
Pleuronichthys verticalis	0.347	0.283	0.200	0.067	0.268	0.179	0.338	0.312	0.596	0.332	0.081	0.017		0.050		0.638	0.076	0.170		0.440	4.394	2.1
Symphurus atricaudus	0.040	0.033	0.060	0.013	0.072	0.360	0.286	0.497	0.291	0.381	0.067	0.535	0.050	0.157	0.020	0.447				0.182	3.491	1.6
Microstomus pacificus					0.129		0.045					0.026		0.145			0.495	0.223	0.601	1.652	3.316	1.6
Raja inornata						0.460	0.061	0.700	0.505									0.305	0.840		2.871	1.4
Hippoglossina stomata					0.055	0.421		0.056	0.056	0.222		0.151	0.041	0.159		0.400	0.090	0.252	0.375	0.476	2.754	1.3
Lyopsetta exilis																	0.543	0.783	0.955	0.246	2.527	1.2
Xystreurys liolepis	0.040			0.220				0.626		0.483		0.325		0.030		0.690					2.414	1.1
Porichthys notatus					0.043		0.055							0.017			0.557	0.403		0.941	2.016	1
Scorpaena guttata														0.075				1.275		0.336	1.686	0.8
Lycodes pacificus																	0.327	0.287	0.270	0.350	1.234	0.6
Pleuronichthys decurrens					0.043	0.141	0.379	0.045	0.155			0.093			0.136			0.170			1.162	0.5
Zalembius rosaceus						0.036	0.023	0.014		0.209		0.002		0.001	0.028		0.173	0.378	0.077		0.941	0.4
Sebastes semicinctus						0.001											0.315	0.142		0.241	0.699	0.3
Zaniolepis frenata																	0.347	0.117	0.071	0.047	0.582	0.3
Chitonotus pugetensis		0.009			0.038		0.066		0.103	0.005	0.006	0.009	0.134		0.046	0.017				0.027	0.460	0.2
Paralabrax nebulifer				0.210						0.165											0.375	0.2
Citharichthys stigmaeus	0.055	0.053	0.078	0.132																	0.318	0.2
Icelinus quadriseriatus	0.033	0.005	0.021			0.018	0.003	0.014	0.005	0.019			0.045		0.046	0.038					0.247	0.1
Genyonemus lineatus												0.090					0.100				0.190	0.1
Chilara taylori						0.021													0.004	0.043	0.068	<0.1
Merluccius productus																				0.058	0.058	<0.1
Sebastes elongatus																		0.024	0.005	0.004	0.033	<0.1
Sebastes eos																		0.033			0.033	<0.1
Sebastes levis																				0.018	0.018	<0.1
Odontopyxis trispinosa			0.001		0.002		0.001		0.003		0.002		0.003		0.002	0.002					0.016	<0.1
Agonopsis sterletus							0.007														0.007	<0.1
Plectobranchus evides																				0.006	0.006	<0.1
Total Biomass	**4.128**	**1.754**	**2.175**	**1.160**	**19.743**	**10.035**	**24.326**	**10.498**	**10.608**	**7.366**	**1.987**	**10.117**	**7.396**	**7.768**	**1.828**	**7.306**	**12.680**	**19.202**	**9.908**	**41.740**	**211.73**	**100**

Table B–12 Summary statistics of legacy District Core nearshore stations for total coliforms, fecal coliforms, and enterococci bacteria (CFU/100mL) by station and season during 2015-2016.

Station	Summer 2015				Fall 2015				Winter 2016				Spring 2016				Annual			
	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Total Coliforms																				
39N	<17	37	>20000	5.11	<17	37	>9400	5.19	<17	25	1400	3.9	<17	20	1200	3.51	<17	31	>20000	4.57
33N	<17	34	>20000	5.44	<17	37	>9400	5.9	<17	33	1200	4.37	<17	15	50	1.46	<17	30	>20000	4.65
27N	<17	28	>20000	5.55	<17	52	>12000	9.19	<17	37	1900	4.8	<17	14	50	1.46	<17	31	>20000	5.67
21N	<17	38	>20000	6.6	<17	39	5800	5.74	<17	29	2500	4.88	<17	14	17	1.16	<17	31	>20000	5.11
15N	<17	30	>20000	6.25	<17	49	5600	5.13	<17	29	2600	5.4	<17	24	1200	3.62	<17	33	>20000	5.23
12N	<17	33	>20000	6.27	<17	41	5700	5.04	<17	31	2800	6.06	<17	23	9300	6.21	<17	32	>20000	5.71
9N	<17	49	>20000	7.69	<17	54	4300	4.22	<17	27	1500	4.3	<17	20	>6100	3.56	<17	35	>20000	5.04
6N	<17	74	>20000	7.68	<17	51	3500	4.38	<17	32	1100	4.33	<17	26	>5100	3.7	<17	42	>20000	5.1
3N	<17	76	>20000	10.74	<17	57	2600	4.32	<17	65	2100	5.35	<17	26	>5700	3.79	<17	52	>20000	5.99
0	<17	41	>20000	12.41	<17	41	1700	4.5	<17	47	1500	3.9	<17	21	>7000	3.92	<17	36	>20000	5.8
3S	<17	18	>7100	3.63	<17	23	880	3.12	<17	116	>20000	10.99	<17	15	83	1.68	<17	27	>20000	4.87
6S	<17	18	3000	2.93	<17	24	1900	3.31	<17	34	1800	4.41	<17	13	<17	1	<17	20	3000	3.08
9S	<17	17	3300	2.93	<17	22	540	2.87	<17	33	1600	4.06	<17	13	17	1.08	<17	19	3300	2.89
15S	<17	20	1600	2.73	<17	22	3200	3.57	<17	31	520	3.36	<17	13	17	1.11	<17	21	3200	2.87
21S	<17	17	1200	2.52	<17	19	83	1.9	<17	27	640	3.23	<17	15	50	1.46	<17	19	1200	2.32
27S	<17	20	1100	3.37	<17	16	50	1.5	<17	19	1000	3.29	<17	15	130	1.9	<17	18	1100	2.57
29S	<17	25	1100	3.26	<17	19	83	1.73	<17	21	150	2.29	<17	15	33	1.31	<17	21	1100	2.36
39S	<17	20	>20000	4.77	<17	14	17	1.15	<17	18	83	1.9	<17	16	67	1.57	<17	17	>20000	2.71
All	<17	33	>20000	2.77	<17	34	>12000	1.95	<17	36	>20000	1.93	<17	18	9300	1.47	<17	29	>20000	1.35
Fecal Coliforms																				
39N	<17	26	>20000	4.63	<17	20	200	2.09	<17	15	33	1.31	<17	18	820	3.03	<17	20	>20000	3.05
33N	<17	25	6100	3.94	<17	20	420	2.55	<17	14	17	1.13	<17	14	17	1.13	<17	19	6100	2.69
27N	<17	20	8100	3.76	<17	29	1500	4.39	<17	17	120	1.84	<17	14	17	1.13	<17	20	8100	3.23
21N	<17	22	3800	3.76	<17	24	250	2.46	<17	14	50	1.46	<17	13	<17	1	<17	19	3800	2.63
15N	<17	26	>20000	4.93	<17	27	130	2.13	<17	15	33	1.31	<17	15	33	1.43	<17	21	>20000	2.95
12N	<17	25	>20000	4.97	<17	24	130	2.45	<17	18	120	1.94	<17	19	560	2.74	<17	22	>20000	3.25
9N	<17	36	>20000	5.87	<17	27	130	2.35	<17	16	220	1.81	<17	17	120	1.85	<17	23	>20000	3.06
6N	<17	52	>20000	6.41	<17	26	400	2.46	<17	19	320	2.16	<17	19	150	2.27	<17	27	>20000	3.46
3N	<17	53	>20000	8.5	<17	37	320	2.77	<17	33	2100	3.98	<17	19	130	2	<17	34	>20000	4.3
0	<17	32	>20000	9.23	<17	26	>4000	3.63	<17	23	150	2.17	<17	17	400	2.08	<17	24	>20000	4.01
3S	<17	17	2600	2.94	<17	18	100	1.86	<17	44	1500	4.55	<17	15	50	1.46	<17	20	2600	2.8
6S	<17	16	1300	2.46	<17	17	83	1.79	<17	18	180	2.2	<17	15	83	1.68	<17	17	1300	2.07
9S	<17	15	1600	2.53	<17	16	100	1.66	<17	17	270	2.32	<17	13	17	1.08	<17	15	1600	2.03
15S	<17	17	800	2.28	<17	20	1800	3.06	<17	19	120	2.05	<17	13	17	1.11	<17	18	1800	2.29
21S	<17	16	760	2.22	<17	15	83	1.51	<17	18	130	2.02	<17	14	33	1.3	<17	16	760	1.84
27S	<17	15	780	2.2	<17	15	83	1.51	<17	16	220	2.2	<17	15	100	1.77	<17	15	780	1.92
29S	<17	17	460	2.23	<17	15	50	1.43	<17	13	17	1.11	<17	14	33	1.31	<17	15	460	1.71
39S	<17	16	3400	2.93	<17	14	33	1.25	<17	13	17	1.08	<17	14	33	1.31	<17	14	3400	1.95
All	<17	25	>20000	2.14	<17	22	>4000	0.81	<17	19	2100	0.92	<17	15	820	0.59	<17	20	>20000	0.75

Table B-12 continues.

Table B-12 continued.

Station	Summer 2015				Fall 2015				Winter 2016				Spring 2016				Annual			
	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Enterococci																				
39N	<2	11	>400	4.78	<2	5	114	3.86	<2	5	34	3.31	<2	3	20	2.35	<2	6	>400	4.11
33N	2	15	>400	4.34	<2	7	88	3.56	<2	7	48	3.3	<2	4	12	2.15	<2	8	>400	3.85
27N	<2	6	216	3.66	<2	10	194	4.68	<2	14	102	5.05	<2	4	>400	4.65	<2	7	>400	4.51
21N	<2	7	338	3.61	<2	7	74	3.41	<2	7	50	3.53	<2	3	18	2.22	<2	6	338	3.37
15N	<2	6	356	3.96	<2	9	146	4.41	<2	11	>136	4.14	<2	4	38	2.55	<2	7	356	3.93
12N	<2	9	>400	3.83	<2	7	182	4.79	<2	8	218	4.9	<2	2	16	2.35	<2	7	>400	4.23
9N	<2	10	>400	4.27	<2	7	64	4.12	<2	8	268	4.08	<2	3	12	2.05	<2	6	>400	3.93
6N	<2	15	>400	4.33	<2	7	68	3.92	2	11	310	3.68	<2	4	82	2.83	<2	8	>400	3.99
3N	<2	18	>400	4.39	<2	12	>400	5.47	<2	16	310	3.97	<2	5	>400	4.38	<2	11	>400	4.88
0	<2	5	>400	5.11	<2	4	120	3.88	<2	10	288	3.46	<2	2	30	2.31	<2	5	>400	3.96
3S	<2	3	100	2.64	<2	3	118	3.35	6	38	>400	4.05	<2	2	34	2.71	<2	5	>400	4.5
6S	<2	3	54	2.69	<2	3	88	2.92	<2	9	242	4.77	<2	2	16	1.99	<2	3	242	3.26
9S	<2	2	38	2.15	<2	3	70	3.31	<2	6	288	4.44	<2	2	4	1.44	<2	3	288	2.95
15S	<2	3	>400	3.76	<2	3	188	3.99	<2	9	156	3.4	<2	2	2	1.13	<2	3	>400	3.63
21S	<2	2	34	2.13	<2	3	46	3.32	<2	4	128	3.72	<2	2	12	2.07	<2	3	128	2.74
27S	<2	3	26	2.35	<2	3	62	3.39	<2	4	288	4.49	<2	2	6	1.57	<2	3	288	2.89
29S	<2	4	138	3.15	<2	3	74	2.8	<2	5	24	2.68	<2	3	92	3.45	<2	4	138	2.98
39S	<2	3	>400	3.35	<2	3	18	2.25	<2	2	8	1.87	<2	2	6	1.56	<2	2	>400	2.47
All	<2	7	>400	0.90	<2	6	>400	0.78	<2	10	>400	0.79	<2	3	>400	0.93	<2	5	>400	0.68

Table B–13 Summary statistics of OCHCA nearshore stations for total coliforms, fecal coliforms, and enterococci bacteria (CFU/100mL) by station and season during 2015-2016.

Station	Summer 2015				Fall 2015				Winter 2016				Spring 2016				Annual			
	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Total Coliforms																				
OSB02	<17	118	>20000	7.71	<17	124	>20000	9.61	<17	133	>9700	6.38	<17	58	760	3.27	<17	103	>20000	6.58
OSB03	17	220	>20000	8.16	17	126	>20000	6.99	<17	125	>6500	5.01	<17	68	380	2.48	<17	124	>20000	5.5
OSB05	<17	107	3600	4.44	17	128	>20000	7.11	<17	87	>5700	5.62	<17	62	900	3.95	<17	93	>20000	5.09
OSB04	<17	44	4900	4.89	<17	51	>15000	8.54	<17	52	>6500	7.54	<17	16	67	1.58	<17	37	>15000	5.54
OSB01	<17	22	220	2.3	<17	29	5000	6.33	<17	38	860	3.97	<17	13	<17	1	<17	24	5000	3.51
OSUB1	<17	26	780	3.17	<17	28	4500	6.18	<17	33	880	4.04	<17	13	17	1.11	<17	24	4500	3.65
BCO-1	<17	25	700	3.18	<17	36	>10000	7.42	<17	47	1000	3.89	<17	15	33	1.31	<17	28	>10000	3.98
HB1U	3100		3100														3100		3100	
HB1	3200		3200														3200		3200	
HB1D	<17	33	1900	5.23	<17	80	>7500	8.17	<17	30	1800	5.72	<17	13	17	1.11	<17	32	>7500	5.34
HB2U	1200		1200														1200		1200	
HB2	>6800		>6800														>6800		>6800	
HB2D	<17	27	2800	5.54	<17	93	>11000	9.66	<17	29	1200	4.43	<17	16	50	1.55	<17	33	>11000	5.47
HB3U	3900		3900														3900		3900	
HB3	>40000		>40000														>40000		>40000	
HB3D	<17	39	2500	5.68	<17	57	8100	7.85	<17	26	1200	5.29	<17	13	17	1.11	<17	30	8100	5.11
HB4U	6700		6700														6700		6700	
HB4	1700		1700														1700		1700	
HB4D	<17	35	2200	5.89	<17	50	5800	8.04	<17	32	1200	4.38	<17	15	33	1.31	<17	30	5800	4.85
HB5U	2100		2100														2100		2100	
HB5	1900		1900														1900		1900	
HB5D	<17	31	1500	6.22	<17	81	>9100	7.9	<17	29	1600	5.56	<17	18	150	2.01	<17	34	>9100	5.49
SAR-N	<17	64	>20000	15.85	<17	53	1200	4.66	<17	76	>20000	8.75	<17	50	>8700	10.02	<17	60	>20000	8.82
TM	<17	39	>20000	8.88	<17	37	520	3.28	<17	43	3500	4.59	<17	20	380	2.59	<17	33	>20000	4.64
BGCU	<17	95	2000	4.6	17	120	12000	6.23	<17	41	370	3.1	17	142	900	3.42	<17	90	12000	4.44
BGC	>530	5978	>40000	3.08	200	1495	>40000	4.52	530	1572	>4200	1.76	>1200	7835	>40000	2.82	200	3229	>40000	3.77
BGCD	<17	76	3300	5.93	<17	77	>2900	6.02	<17	47	600	3.78	<17	92	1000	4.7	<17	71	3300	4.95
PPCU	33	84	600	3.77	<17	19	50	1.91	<17	50	200	7					<17	42	600	3.6
PPC	>3800	12066	>40000	3.32	>3400	17336	>40000	3.51	>2100	3031	>2800	1.23					>2100	10581	>40000	3.37
PPCD	<17	19	300	2.41	<17	25	280	3.08	<17	19	200	2.41	<17	19	120	2.29	<17	20	300	2.5
WFCU	<17	24	540	2.85	<17	16	83	1.67	<17	23	200	2.58	<17	19	120	1.95	<17	20	540	2.26
WFC	>77	1082	>14000	4.02	67	843	>16000	4.09	>330	1207	>3800	2.25	<15	1078	>40000	11.92	<15	1042	>40000	4.96
WFCD	<17	20	330	2.41	<17	23	800	3.24	<17	17	83	2.02	<17	16	67	1.77	<17	19	800	2.34
ONB39	<17	17	50	1.58	<17	23	1800	3.8	<17	19	130	2.24	<17	23	800	3.9	<17	20	1800	2.8
MDCU	<17	55	700	6.73	<17	20	50	1.91	<17	20	67	1.77	<17	16	33	1.52	<17	21	700	2.39
MDC	>1600	12247	>40000	5.25	400	2140	>40000	5.9	730	1885	>40000	3.26	<15	2504	>40000	12.47	<15	2682	>40000	6.38
MDCD	<17	24	1100	3.46	<17	28	1200	3.66	<17	35	>3000	5.02	<17	20	120	1.89	<17	26	>3000	3.42
ELMOROU					<17		<17										<17		<17	
ELMORO					5800		5800										5800		5800	
ELMOROD	<17	17	120	1.8	<17	16	83	1.71	<17	17	180	2.14	<17	14	33	1.31	<17	16	180	1.74
All	<17	3025	>40000	3.02	<17	965	>40000	2.63	<17	313	>40000	1.91	<15	468	>40000	3.21	<15	2667	>40000	2.04

Table B-13 continues.

Table B-13 continued.

Station	Summer 2015				Fall 2015				Winter 2016				Spring 2016				Annual			
	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev	Min	Mean	Max	Std Dev
Fecal Coliforms																				
OSB02	<17	52	>20000	7.55	<17	59	8200	5.15	<17	41	700	2.76	<17	25	130	2.15	<17	42	>20000	4.36
OSB03	<17	132	>20000	8.14	17	57	250	2.5	<17	46	230	2.33	<17	44	120	2.13	<17	63	>20000	3.73
OSB05	<17	83	400	2.82	<17	44	1100	4.62	<17	43	250	2.61	<17	52	1000	3.96	<17	53	1100	3.46
OSB04	<17	28	300	2.93	<17	25	100	1.95	<17	19	120	2.05	<17	14	17	1.13	<17	20	300	2.14
OSB01	<17	17	120	1.92	<17	13	17	1.08	<17	22	170	2.47	<17	13	<17	1	<17	16	170	1.8
OSUB1	<17	18	230	2.31	<17	17	83	1.84	<17	16	50	1.55	<17	13	<17	1	<17	16	230	1.75
BCO-1	<17	20	150	2.15	<17	19	120	2.2	<17	21	170	2.43	<17	14	17	1.15	<17	18	170	2.03
HB1U	600		600														600		600	
HB1	620		620														620		620	
HB1D	<17	23	420	3.2	<17	29	370	2.83	<17	18	130	1.93	<17	14	17	1.13	<17	20	420	2.39
HB2U	560		560														560		560	
HB2	13000		13000														13000		13000	
HB2D	<17	20	660	3.05	<17	27	330	2.83	<17	15	50	1.46	<17	13	17	1.11	<17	18	660	2.25
HB3U	1300		1300														1300		1300	
HB3	>40000		>40000														>40000		>40000	
HB3D	<17	18	580	2.86	<17	24	350	3.03	<17	15	33	1.42	<17	14	17	1.13	<17	17	580	2.21
HB4U	2700		2700														2700		2700	
HB4	500		500														500		500	
HB4D	<17	20	370	2.92	<17	27	400	2.96	<17	14	33	1.31	<17	13	17	1.08	<17	18	400	2.24
HB5U	460		460														460		460	
HB5	290		290														290		290	
HB5D	<17	24	170	2.55	<17	38	300	3.09	<17	17	83	1.73	<17	13	17	1.08	<17	21	300	2.36
SAR-N	<17	45	>20000	10.39	<17	31	520	3.08	<17	30	420	3.3	<17	40	2700	5.43	<17	36	>20000	5.05
TM	<17	30	>20000	7.55	<17	22	270	2.58	<17	37	760	3.29	<17	15	33	1.31	<17	25	>20000	3.66
BGCU	<17	37	660	4.51	<17	60	12000	6.56	<17	24	130	2.21	<17	23	120	2.18	<17	33	12000	3.85
BGC	31	302	12000	5.82	15	529	45000	7.79	46	165	2100	2.95	46	419	2000	3.59	15	327	45000	5.05
BGCD	<17	37	1400	5.15	<17	51	3300	5.05	<17	26	230	3.03	<17	18	280	2.32	<17	31	3300	3.94
PPCU	<17	28	300	4.85	<17	16	33	1.61	<17	13	<17	1					<17	19	300	2.75
PPC	270	1965	>40000	10.38	77	467	2000	3.9	33	309	2900	23.69					33	764	>40000	7.84
PPCD	<17	15	130	1.86	<17	22	620	3.07	<17	13	<17	1	<17	14	50	1.46	<17	16	620	1.97
WFCU	<17	16	220	2.14	<17	14	33	1.31	<17	15	33	1.45	<17	13	<17	1	<17	15	220	1.57
WFC	15	192	6600	5.66	<15	98	2100	5.78	<15	58	1100	6.84	<15	110	560	3.47	<15	107	6600	5.39
WFCD	<17	16	170	2.05	<17	15	130	1.9	<17	14	33	1.31	<17	13	<17	1	<17	15	170	1.65
ONB39	<17	14	33	1.3	<17	20	440	2.86	<17	14	33	1.31	<17	14	33	1.31	<17	15	440	1.78
MDCU	<17	25	50	2.2	<17	13	17	1.11	<17	14	33	1.33	<17	13	17	1.1	<17	15	50	1.46
MDC	200	2106	12000	5.63	<15	419	2000	6.07	<15	51	3200	5.67	31	340	3900	5.23	<15	231	12000	7.93
MDCD	<17	18	83	1.85	<17	22	350	3.03	<17	17	320	2.44	<17	14	33	1.31	<17	17	350	2.18
ELMOROU					<17		<17										<17		<17	
ELMORO					15		15										15		15	
ELMOROD	<17	13	17	1.08	<17	15	50	1.49	<17	14	33	1.31	<17	14	50	1.46	<17	14	50	1.35
All	<15	1983	>40000	2.65	<15	74	45000	1.78	<15	39	3200	4.25	<15	50	3900	1.31	<15	1801	>45000	1.78

Table B-13 continues.

Table B-13 continued.

Station	Summer 2015 Min	Summer 2015 Mean	Summer 2015 Max	Summer 2015 Std Dev	Fall 2015 Min	Fall 2015 Mean	Fall 2015 Max	Fall 2015 Std Dev	Winter 2016 Min	Winter 2016 Mean	Winter 2016 Max	Winter 2016 Std Dev	Spring 2016 Min	Spring 2016 Mean	Spring 2016 Max	Spring 2016 Std Dev	Annual Min	Annual Mean	Annual Max	Annual Std Dev
Enterococci																				
OSB02	<2	32	>400	5.67	<2	12	356	4.83	8	35	>400	2.56	<2	23	>400	4.61	<2	24	>400	4.54
OSB03	2	30	>400	4.98	<2	17	136	3.85	<2	18	116	3.18	<2	10	50	2.97	<2	18	>400	3.8
OSB05	<2	14	72	2.79	2	12	120	3.78	4	20	76	2.54	<2	10	352	4.76	<2	13	352	3.42
OSB04	<2	8	88	3.18	<2	7	106	3.34	<2	14	70	2.87	<2	3	18	2.29	<2	7	106	3.21
OSB01	<2	5	120	3.36	<2	3	36	3.16	<2	5	46	3.56	<2	2	2	1.15	<2	3	120	3.03
OSUB1	<2	6	262	4.22	<2	4	92	3.91	<2	5	38	3.22	<2	2	2	1.15	<2	4	262	3.4
BCO-1	<2	5	206	3.86	<2	4	82	3.02	<2	8	130	4.65	2	3	8	1.62	<2	5	206	3.35
HB1U	>400		>400														>400		>400	
HB1	310		310														310		310	
HB1D	<2	8	222	4.19	<2	10	76	4.36	<2	9	292	4.76	<2	3	16	2.26	<2	7	292	4.1
HB2U	290		290														290		290	
HB2	>400		>400														>400		>400	
HB2D	<2	5	348	5.16	<2	8	100	3.48	2	17	134	3.21	<2	2	54	2.61	<2	6	348	4.23
HB3U	>400		>400														>400		>400	
HB3	>400		>400														>400		>400	
HB3D	<2	8	274	4.21	<2	7	60	3.17	<2	11	136	4.27	<2	3	16	2.09	<2	6	274	3.7
HB4U	>400		>400														>400		>400	
HB4	156		156														156		156	
HB4D	2	7	170	3.3	<2	12	80	3.55	<2	8	54	3.43	<2	2	10	1.83	<2	6	170	3.44
HB5U	380		380														380		380	
HB5	156		156														156		156	
HB5D	<2	5	166	3.82	<2	13	236	6.6	<2	8	100	4.21	<2	3	10	2.07	<2	6	236	4.46
SAR-N	<2	7	>400	9.34	<2	3	30	2.55	<2	39	>400	4.44	<2	7	60	3.75	<2	9	>400	5.85
TM	<2	5	>400	4.75	<2	6	56	3.65	2	15	404	4.56	<2	3	24	2.54	<2	6	>404	4.14
BGCU	<2	11	242	5.73	<2	31	>400	7.18	<2	11	66	3.37	<2	9	56	2.53	<2	13	>400	4.78
BGC	126	252	>400	1.58	32	176	>400	2.75	42	174	>400	2.29	110	274	>400	1.76	32	214	>400	2.13
BGCD	<2	11	>400	6.52	<2	15	>400	8.38	<2	6	204	5.24	<2	7	76	3.72	<2	9	>400	5.8
PPCU	<2	8	166	9.43	<2	5	22	3.5	6	8	12	1.63					<2	7	166	4.58
PPC	104	338	>400	2.19	170	348	>400	1.66	216	329	>400	1.81					104	340	>400	1.78
PPCD	<2	3	78	2.92	<2	3	30	2.53	<2	2	18	2.08	<2	2	28	2.36	<2	3	78	2.43
WFCU	<2	3	56	2.89	<2	3	24	2.43	<2	2	14	2.26	<2	3	20	2.5	<2	3	56	2.49
WFC	174	308	>400	1.53	20	70	>400	2.57	28	105	>400	2.4	<2	190	>400	4.75	<2	147	>400	3.17
WFCD	<2	3	26	2.53	<2	4	352	4.7	<2	2	10	1.68	<2	2	6	1.65	<2	3	352	2.71
ONB39	<2	2	22	2.31	<2	4	>400	4.87	<2	3	26	2.58	<2	3	54	3.81	<2	3	>400	3.29
MDCU	<2	7	38	3.96	<2	3	22	3.01	<2	3	18	2.34	<2	2	36	2.88	<2	3	38	2.83
MDC	174	384	>400	1.7	38	148	>400	3.05	76	199	>400	1.99	86	174	>400	2.23	38	195	>400	2.29
MDCD	<2	4	106	4.19	<2	5	>400	5.93	<2	3	>400	5.01	<2	2	6	1.75	<2	4	>400	4.11
ELMOROU					6		6										6		6	
ELMORO					122		122										122		122	
ELMOROD	<2	2	6	1.45	<2	2	24	2.45	<2	3	14	2.33	<2	2	4	1.44	<2	2	24	1.93
All	<2	139	>400	2.18	<2	36	>400	1.67	<2	38	>404	1.09	<2	29	>400	1.06	<2	125	>404	1.47

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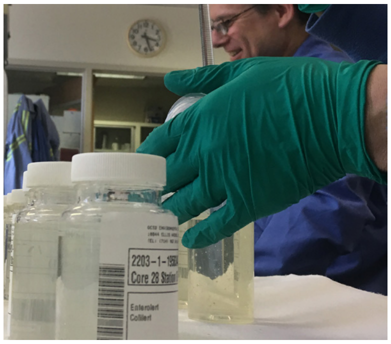

APPENDIX C
Quality Assurance/Quality Control

This appendix details quality assurance/quality control information for the collection and analyses of water quality, sediment geochemistry, fish tissue chemistry, benthic infauna, and trawl fish and invertebrate samples for the Orange County Sanitation District's (District) 2015-16 ocean monitoring program.

INTRODUCTION

The Core monitoring program is designed to measure compliance with permit conditions and for temporal and spatial trend analysis. The program includes measurements of:

- Water quality;
- Sediment quality;
- Benthic infaunal community health;
- Fish and macroinvertebrate community health;
- Fish tissue contaminant concentrations (chemical body burden); and
- Fish health (including external parasites and diseases).

The Core monitoring program complies with the District's Quality Assurance Project Plan (QAPP) (OCSD 2015a) requirements and applicable federal, state, local, and contract requirements. The objectives of the quality assurance program are as follows:

- Scientific data generated will be of sufficient quality to stand up to scientific and legal scrutiny.
- Data will be gathered or developed in accordance with procedures appropriate for the intended use of the data.
- Data will be of known and acceptable precision, accuracy, representativeness, completeness, and comparability as required by the program.

The various aspects of the program are conducted on a schedule that varies weekly, monthly, quarterly, semi-annually, and annually. Sampling and data analyses are designated by quarters 1 through 4, which are representative of the summer (July–September), fall (October–December), winter (January–March), and spring (April–June) seasons, respectively.

WATER QUALITY NARRATIVE

Ammonium

Introduction

The District's Environmental Laboratory and Ocean Monitoring (ELOM) staff collected 737, 751, 654, and 654 discrete ammonium samples during the quarterly collections beginning July 1, 2015 and ending June 30, 2016. All samples were iced upon collection, preserved with 1:1 sulfuric acid upon receipt by the ELOM laboratory staff, and stored at 4±2 °C until analysis according to laboratory Standard Operating Procedures (SOPs, OCSD 2015b).

Analytical Method - Ammonium

The samples were analyzed for ammonium on a segmented flow analyzer using Standard Methods 4500-NH3 G. In the analysis, sodium phenolate and sodium hypochlorite reacted with ammonium to form indophenol blue in a concentration proportional to the ammonium concentration in the sample. The blue color was intensified with sodium nitroprusside and was measured at 660 nm.

QA/QC - Ammonium

A typical sample batch included a blank at a maximum of every 20 samples, an external reference standard, and a spike in seawater collected from a control site at a maximum of every 20 of samples. One spike and spike replicate was added to the batch every 10 samples. The method detection limits (MDLs) for ammonium samples using the segmented flow instrument is presented in Table C-1. QA/QC summary data are presented in Table C-2. All samples were analyzed within the required holding time. All analyses met the QA/QC criteria for blanks, blank spikes, external reference standards, matrix spikes and matrix spike replicates as shown in Table C-2. One precision measurement for matrix spike and matrix spike replicate was out of control for fourth quarter samples due to instrumentation malfunction.

Table C–1 Method detection limit (MDL) for ammonium and bacteria in receiving water, July 2015–June 2016.

Parameter	MDL
Ammonium	0.0162 mg/L *
Total coliform	10 MPN/100mL
E. coli	10 MPN/100mL
Enterococci	10 MPN/100mL

* The reporting limit for ammonium is 0.020 mg/L. Values between the MDL and the RL were estimated.

Bacteria

Introduction

All bacteria samples were iced upon collection and stored at <10 °C until analysis following ELOM SOPs.

Analytical Method

Samples collected offshore were analyzed for bacteria using Enterolert™ for enterococci and Colilert-18™ for total coliforms and *Escherichia coli*. Fecal coliforms were estimated by multiplying the *Escherichia coli* result by a factor of 1.1. These methods utilize enzyme substrates that produce, upon hydrolyzation, a fluorescent signal when viewed under long-wavelength (365 nm) ultraviolet light. For samples collected along the surfzone, samples were analyzed by culture-based methods for direct count of bacteria. EPA Method 1600 was applied to enumerate enterococci bacteria. For enumeration of total and fecal coliforms, respectively, Standards Methods 9222B and 9222D were used. MDLs for bacteria are presented in Table C-1.

QA/QC

All samples were analyzed within the required holding time. Recreational (REC-1) samples were processed and incubated within 8 hours of sample collection. Duplicate analyses were performed on a minimum of 10% of samples with at least one sample per sample batch. All equipment, reagents, and dilution waters used for sample analyses were sterilized before use. Sterility of sample bottles

Table C–2 Water quality ammonium QA/QC summary, July 2015–June 2016.

Quarter	Total No. of Samples (Total No. of Batches)	QA/QC Sample Type	Number Tested	Number of Compounds Tested	% Compounds Passed *
Summer	737 (10)	Blank	40	1	100
		Blank Spike	40	1	100
		Matrix Spike	76	1	100
		Matrix Spike Duplicate	76	1	100
		Matrix Spike Precision	76	1	100
Fall	751 (11)	Blank	42	1	100
		Blank Spike	42	1	100
		Matrix Spike	78	1	100
		Matrix Spike Duplicate	78	1	100
		Matrix Spike Precision	78	1	100
Winter	654 (8)	Blank	37	1	100
		Blank Spike	38	1	100
		Matrix Spike	70	1	100
		Matrix Spike Duplicate	70	1	100
		Matrix Spike Precision	70	1	100
Spring	654 (8)	Blank	37	1	100
		Blank Spike	37	1	100
		Matrix Spike	69	1	100
		Matrix Spike Duplicate	69	1	100
		Matrix Spike Precision	69	1	99

* An analysis passed if the following criteria were met:
For blank – Target accuracy % recovery <2X MDL.
For blank spike – Target accuracy % recovery 90-110.
For matrix spike – Target accuracy % recovery 80-120.
For matrix spike duplicate – Target accuracy % recovery 80-120.
For matrix spike precision – Target precision % RPD <11%.

was tested for each new lot/batch before use. Each lot of medium, whether prepared or purchased, was tested for sterility and performance with known positive and negative controls prior to use. For surfzone samples, a positive and a negative control were run simultaneously with each batch of sample for each type of media used to ensure performance. New lots of Quanti-Tray and petri dish were checked for sterility before use. Each Quanti-Tray sealer was checked monthly by addition of Gram stain dye to 100 mL of water, and the tray was sealed and subsequently checked for leaking. Each lot of dilution blanks commercially purchased was checked for appropriate volume and sterility. New lots of ≤10 mL volume pipettes were checked for accuracy by weighing volume delivery on a calibrated top loading scale.

SEDIMENT CHEMISTRY NARRATIVE

Semi-Annual Collections (July 2015 and January 2016)

Introduction

The District's ELOM laboratory received 68 sediment samples from ELOM's ocean monitoring staff during July 2015, and 29 samples during January 2016. All samples were stored according to ELOM SOPs. All samples were analyzed for organochlorine pesticides, polychlorinated biphenyl congeners (PCBs), polycyclic aromatic hydrocarbons (PAHs), trace metals, mercury, dissolved sulfides (DS), total organic carbon (TOC), total nitrogen (TN), total phosphorus (TP), and grain size. All samples were analyzed within the required holding times.

Analytical Methods – PAHs, PCBs, and Organochlorine Pesticides

The analytical methods used to detect PAHs, organochlorine pesticides, and PCBs in the samples are described in the ELOM SOPs. All sediment samples were extracted using an accelerated solvent extractor (ASE). Approximately 10 g (dry weight) of sample were used for each analysis. A separatory funnel extraction was performed using 100 mL of sample when field and rinse blanks were included in the batch. All sediment extracts were analyzed by GC/MS.

A typical sample batch included 20 field samples with required quality control (QC) samples. Sample batches that were analyzed for PAHs, organochlorine pesticides, and PCBs included the following

QC samples: 1 sand blank, 1 blank spike, 1 standard reference material (SRM), 1 matrix spike set, and 1 sample extraction duplicate.

Method detection limits (MDLs) for PAHs are presented in Table C-3. Acceptance criteria for the PAH SRM are presented in Table C-4. Sediment PAH QA/QC summary data are presented in Table C-5.

MDLs for PCBs/pesticides are presented in Table C-3. Acceptance criteria for the PCBs/pesticide SRM are presented in Table C-6. Sediment PCBs/pesticide QA/QC summary data are presented in Table C-7.

All analyses were performed within holding times and with appropriate quality control measures, as stated in the District's QAPP. When constituent concentrations exceeded the calibration range of the instrument, dilutions were performed and the samples reanalyzed. Any deviation from standard protocol that occurred during sample preparation or analyses are noted in the raw data packages.

Table C–3 Method detection limit (MDL) for PAH, chlorinated pesticide, and PCB constituents in sediments, July 2015–June 2016.

Parameter	MDL (ng/g wet weight)	Parameter	MDL (ng/g wet weight)
PAH Compounds			
Acenaphthene	0.4	Fluoranthene	0.4
Acenaphthylene	0.4	Fluorene	0.4
Anthracene	0.3	Indeno[1,2,3-c,d]pyrene	0.3
Benz[a]anthracene	0.2	Naphthalene	1.1
Benzo[a]pyrene	0.2	Perylene	0.6
Benzo[b]fluoranthene	0.4	Phenanthrene	0.8
Benzo[e]pyrene	0.4	Pyrene	0.2
Benzo[g,h,i]perylene	0.4	1-Methylnaphthalene	0.5
Benzo[k]fluoranthene	0.5	2-Methylnaphthalene	0.9
Biphenyl	0.8	2,6-Dimethylnaphthalene	0.4
Chrysene	0.3	1,6,7-Trimethylnaphthalene	0.4
Dibenz[a,h]anthracene	0.2	2,3,6-Trimethylnaphthalene	0.5
Dibenzothiophene	0.3	1-Methylphenanthrene	0.5
Chlorinated Pesticides			
Aldrin	0.42	Hexachlorobenzene	0.98
cis-Chlordane	1.29	Mirex	0.70
trans-Chlordane	1.58	*trans*-Nonachlor	1.48
Dieldrin	2.00	2,4'-DDD	2.18
Endosulfan-alpha	1.54	4,4'-DDD	1.47
Endosulfan-beta	2.00	2,4'-DDE	1.51
Endosulfan-sulfate	0.94	4,4'-DDE	1.75
Endrin	3.52	2,4'-DDT	1.56
gamma-BHC	2.64	4,4'-DDT	0.56
Heptachlor	2.01	4,4'-DDMU	2.16
Heptachlor epoxide	1.10		
PCB Congeners			
PCB 18	0.20	PCB 126	0.21
PCB 28	0.14	PCB 128	0.31
PCB 37	0.40	PCB 138	0.19
PCB 44	0.17	PCB 149	0.17
PCB 49	0.39	PCB 151	0.16
PCB 52	0.20	PCB 153/168	0.79
PCB 66	0.31	PCB 156	0.20
PCB 70	0.30	PCB 157	0.15
PCB 74	0.24	PCB 167	0.19
PCB 77	0.15	PCB 169	0.11
PCB 81	0.17	PCB 170	0.11
PCB 87	0.26	PCB 177	0.15
PCB 99	0.18	PCB 180	0.17
PCB 101	0.19	PCB 183	0.18
PCB 105	0.17	PCB 187	0.14
PCB 110	0.18	PCB 189	0.13
PCB 114	0.17	PCB 194	0.13
PCB 118	0.16	PCB 201	0.19
PCB 119	0.20	PCB 206	0.17
PCB 123	0.14		

Table C–4 Acceptance criteria for standard reference material SRM 1944 (New York/New Jersey Waterway Sediment, National Institute of Standards and Technology) for PAH constituents in sediments, July 2015–June 2016. * = Non-certified value used for this parameter.

Parameter	True Value (ng/g)	Acceptance Range (ng/g)	
		Minimum	Maximum
Acenaphthene *	390	234	546
Anthracene *	1130	678	1582
Benz[a]anthracene	4720	2832	6608
Benzo[a]pyrene	4300	2580	6020
Benzo[b]fluoranthene	3870	2322	5418
Benzo[e]pyrene	3280	1968	4592
Benzo[g,h,i]perylene	2840	1704	3976
Benzo[k]fluoranthene	2300	1380	3220
Biphenyl *	250	150	350
Chrysene	4860	2916	6804
Dibenz[a,h]anthracene	424	254.4	593.6
Dibenzothiophene *	500	300	700
Fluoranthene	8920	5352	12488
Fluorene *	480	288	672
Indeno[1,2,3-c,d]pyrene	2780	1668	3892
Naphthalene *	1280	768	1792
Perylene	1170	702	1638
Phenanthrene	5270	3162	7378
Pyrene	9700	5820	13580
1-Methylnaphthalene *	470	282	658
2-Methylnaphthalene *	740	444	1036
1-Methylphenanthrene *	1700	1020	2380
Percent Dry Weight	1.3	–	–

Table C–5 Sediment ΣPAHs QA/QC summary, July 2015–June 2016.

Quarter	Total No. of Samples (Total No. of Batches)	QA/QC Sample Type	Number Tested	Number of Compounds Tested	% Compounds Passed *
Summer	68 (4)	Blank	4	26	94
		Blank Spike	4	26	94
		Matrix Spike	4	26	100
		Matrix Spike Duplicate	4	26	100
		Matrix Spike Precision	4	26	100
		Duplicate	5	26	78
		SRM Analysis	6	24	87
Winter	29 (3)	Blank	3	26	99
		Blank Spike	4	26	87
		Matrix Spike	2	26	100
		Matrix Spike Duplicate	2	26	100
		Matrix Spike Precision	2	26	94
		Duplicate	2	26	83
		SRM Analysis	2	21	93

* An analysis passed if the following criteria were met:
For blank – Target accuracy % recovery <3X MDL.
For blank spike – Target accuracy % recovery 60-120.
For matrix spike – Target accuracy % recovery 40-120.
For matrix spike duplicate – Target accuracy % recovery 40-120.
For matrix spike precision – Target precision % RPD <30%.
For duplicate – Target precision % RPD <30% at 3X MDL of sample mean.
For SRM analysis – Target accuracy % recovery 60-140% or certified value, whichever is greater.

Analytical Methods - Trace Metals

Dried sediment samples were analyzed for trace metals in accordance with methods in the ELOM SOPs. A typical sample batch for silver, cadmium, chromium, copper, nickel, lead, zinc, selenium, arsenic, and beryllium analyses included 3 blanks, a blank spike, and 1 SRM. Additionally, sample duplicates, sample spikes, and sample spike duplicates were analyzed a minimum of once every 10 sediment samples. QC for a typical sample batch for aluminum and iron analyses included 3 blanks, an SRM, field sample duplicates, sample spikes, and sample spike duplicates analyzed a minimum of once every 10 sediment samples. The analysis of the blank spike and SRM provided a measure of the accuracy of the analysis. The analysis of the sample, its duplicate, and the 2 sample spikes were evaluated for precision. The samples that were spiked with aluminum and iron were not evaluated

Table C–6 Acceptance criteria for standard reference material SRM 1944 (New York/New Jersey Waterway Sediment, National Institute of Standards and Technology) for chlorinated pesticide and PCB constituents in sediments, July 2015–June 2016. * = Non-certified value used for this parameter.

Parameter	True Value (ng/g)	Acceptance Range (ng/g)	
		Minimum	Maximum
Chlorinated Pesticides			
cis-Chlordane	16.5	9.9	23.1
trans-Chlordane *	19.0	11.4	26.6
gamma-BHC *	2.0	–	–
Hexachlorobenzene	6.0	3.6	8.4
cis-Nonachlor *	3.7	2.2	5.2
trans-Nonachlor	8.2	4.9	11.5
2,4’-DDD *	38.0	22.8	53.2
4,4’-DDD *	108.0	64.8	151.2
2,4’-DDE *	19.0	11.4	26.6
4,4’-DDE *	86.0	51.6	120.4
4,4’-DDT *	170.0	102.0	238.0
PCB Congeners			
PCB 18	51.0	30.6	71.4
PCB 28	80.8	48.5	113.1
PCB 44	60.2	36.1	84.3
PCB 49	53.0	31.8	74.2
PCB 52	79.4	47.6	111.2
PCB 66	71.9	43.1	100.7
PCB 87	29.9	17.9	41.9
PCB 99	37.5	22.5	52.5
PCB 101	73.4	44.0	102.8
PCB 105	24.5	14.7	34.3
PCB 110	63.5	38.1	88.9
PCB 118	58.0	34.8	81.2
PCB 128	8.5	5.1	11.9
PCB 138	62.1	37.3	86.9
PCB 149	49.7	29.8	69.6
PCB 151	16.9	10.2	23.7
PCB 153/168	74.0	44.4	103.6
PCB 156	6.5	3.9	9.1
PCB 170	22.6	13.6	31.6
PCB 180	44.3	26.6	62.0
PCB 183	12.2	7.3	17.1
PCB 187	25.1	15.1	35.1
PCB 194	11.2	6.7	15.7
PCB 206	9.2	5.5	12.9
Other			
Percent Dry Weight	1.3	–	–

Table C–7 Sediment ΣPCB and ΣPesticides QA/QC summary, July 2015–June 2016.

Quarter	Total No. of Samples (Total No. of Batches)	QA/QC Sample Type	Number Tested	Number of Compounds Tested	% Compounds Passed *
Summer	68 (4)	Blank	4	60	100
		Blank Spike	4	60	91
		Matrix Spike	4	60	92
		Matrix Spike Duplicate	4	60	91
		Matrix Spike Precision	4	60	76
		Duplicate	4	60	100
		SRM Analysis	4	33	62
Winter	29 (3)	Blank	3	60	100
		Blank Spike	3	60	86
		Matrix Spike	2	60	88
		Matrix Spike Duplicate	2	60	84
		Matrix Spike Precision	2	60	96
		Duplicate	2	60	100
		SRM Analysis	2	33	88

* An analysis passed if the following criteria were met:
For blank – Target accuracy % recovery <3X MDL.
For blank spike – Target accuracy % recovery 60-120.
For matrix spike – Target accuracy % recovery 40-120.
For matrix spike duplicate – Target accuracy % recovery 40-120.
For matrix spike precision – Target precision % RPD <30%.
For duplicate – Target precision % RPD <30% at 3X MDL of sample mean.
For SRM analysis – Target accuracy % recovery 60-140% or certified value, whichever is greater.

for spike recoveries because the spike levels were extremely low compared to the concentrations of aluminum and iron in the native samples. The samples were spiked at 20 mg/kg dry weight whereas the native concentrations ranged between 5,000 and 35,000 mg/kg dry weight.

All samples were analyzed within a 6-month holding time. If any analyte exceeded both the appropriate calibration curve and Linear Dynamic Range, the sample was diluted and reanalyzed. MDLs for metals are presented in Table C-8. Acceptance criteria for trace metal SRMs are presented in Table C-9.

The digested samples were analyzed for silver, cadmium, chromium, copper, nickel, lead, zinc, selenium, arsenic, and beryllium by inductively coupled mass spectroscopy (ICPMS). Aluminum and iron were analyzed using inductively coupled emission spectroscopy (ICPES).

Sediment trace metal QA/QC summary data are presented in Table C-10.

Analytical Methods - Mercury

Dried sediment samples were analyzed for mercury in accordance with methods described in the ELOM SOPs. QC for a typical batch included a blank, blank spike, and SRM. Sediment sample duplicates, sample spike, and spike duplicates were run approximately once every 10 sediment samples. When sample mercury concentration exceeded the appropriate calibration curve, the sample was diluted with the reagent blank and reanalyzed. The samples were analyzed for mercury on a Perkin Elmer FIMS 400 system.

The MDL for sediment mercury is presented in Table C-8. Acceptance criteria for mercury SRM is presented in Table C-9. All QA/QC summary data are presented in Table C-10.

All samples, with some noted exceptions, met the QA/QC criteria guidelines for accuracy and precision.

Analytical Methods - Dissolved Sulfides

Dissolved sulfides (DS) samples were analyzed in accordance with methods described in the ELOM SOPs. The MDL for DS is presented in Table C-11. Sediment DS QA/QC summary data are presented in Table C-12. All analyses met the QA/QC criteria for blanks, blank spikes, matrix spike, matrix spike duplicates, and matrix spike precisions. Most sample duplicates did not pass the precision criterion (<30%) due to low DS content in the sediment samples.

Table C–8 Method detection limit (MDL) for trace metals in sediments, July 2015–June 2016.

Parameter	MDL (mg/kg dry weight)
Aluminum	50
Antimony	0.1
Arsenic	0.15
Barium	0.1
Beryllium	0.01
Cadmium	0.01
Chromium	0.15
Copper	0.1
Iron	50
Lead	0.1
Mercury	0.000
Nickel	0.1
Selenium	0.15
Silver	0.02
Zinc	0.15

Table C–9 Acceptance criteria for standard reference material Priority PollutnT™ /CLP Inorganic Soils – Microwave Digestion (Environmental Resource Associates) for trace metals in sediments, July 2015–June 2016.

Parameter	True Value (mg/kg)	Certified Acceptance Criteria (mg/kg)	
		Min.	Max.
Aluminum	9510	4160	14800
Antimony	72.9	18.7	206
Arsenic	161	114	209
Barium	385	286	484
Beryllium	146	110	182
Cadmium	149	110	191
Chromium	180	127	233
Copper	162	122	207
Iron	13000	4220	21800
Lead	103	73	132
Mercury	3.73	1.9	5.55
Nickel	133	97.4	172
Selenium	153	103	202
Silver	71.1	47.8	94.5
Zinc	352	254	450

Table C–10 Sediment metals QA/QC summary, July 2015–June 2016.

Quarter	Total No. of Samples (Total No. of Batches)	Parameter	QA/QC Sample Type	Number Tested	Number of Compounds Tested	% Compounds Passed *
Summer	68 (4)	Aluminum, Iron	Blank	8	2	100
			CRM	2	2	100
	68 (2)	Mercury	Blank	4	1	100
			Blank Spike	4	1	100
			Matrix Spike	7	1	100
			Matrix Spike Dup	7	1	100
			Matrix Spike Precision	7	1	100
			Duplicate Analysis	7	1	100
			CRM Analysis	2	1	100
	68 (4)	Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc, Silver, Barium	Blank	8	12	100
			Blank Spike	4	12	100
			Matrix Spike	7	12	86
			Matrix Spike Dup	7	12	75
			Matrix Spike Precision	7	12	100
			Duplicate Analysis	7	12	100
			CRM Analysis	2	12	100
Winter	38 (2)	Aluminum, Iron	Blank	8	2	100
			CRM	2	2	100
	38 (2)	Mercury	Blank	2	1	100
			Blank Spike	2	1	100
			Matrix Spike	4	1	100
			Matrix Spike Dup	4	1	100
			Matrix Spike Precision	4	1	100
			Duplicate Analysis	4	1	100
			CRM Analysis	1	1	100
	38 (2)	Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc, Silver, Barium	Blank	4	12	100
			Blank Spike	2	12	100
			Matrix Spike	4	12	92
			Matrix Spike Dup	4	12	92
			Matrix Spike Precision	4	12	100
			Duplicate Analysis	4	12	100
			CRM Analysis	1	12	100

* An analysis passed if the following criteria were met:
For blank- Target accuracy % recovery <3X MDL.
For blank spike –Target accuracy % recovery 90-110.
For matrix spike –Target accuracy % recovery 70-130
For matrix Spike duplicate – Target precision % RPD <20.
For duplicate – Target precision % RPD 30.
For SRM analysis –Target accuracy % recovery 80-120% or certified value whichever is greater.

Analytical Methods - Total Organic Carbon

Total Organic Carbon (TOC) samples were analyzed by ALS Environmental Services, Kelso, WA. The MDL for TOC is presented in Table C-11. Sediment TOC QA/QC summary data are presented in

Table C–11 Method detection limit (MDL) for dissolved sulfides, total organic carbon, grain size, total nitrogen, and total phosphorus in sediments, July 2015–June 2016.

Parameter	MDL
Dissolved Sulfides (OCSD)	1.03 mg/kg dry weight
Total Organic Carbon (ALS Environmental)	0.10%
Grain Size (EMSL Analytical)	0.001%
Total Nitrogen (Weck Labs)	60 mg/kg dry
Total Phosphorus (Weck Labs)	3.7 mg/kg dry

Table C–12 Sediment dissolved sulfides QA/QC summary, July 2015–June 2016. N/A = Not Applicable.

Quarter	Total No. of Samples (Total No. of Batches)	QA/QC Sample Type	Number Tested	Number of Compounds Tested	% Compounds Passed *
Summer	68 (7)	Blank	7	1	100
		Blank Spike	7	1	100
		Matrix Spike	7	1	100
		Matrix Spike Duplicate	7	1	100
		Matrix Spike Precision	7	1	100
		Duplicate	7	1	43
		SRM Analysis	N/A	N/A	N/A
Winter	29 (3)	Blank	3	1	100
		Blank Spike	3	1	100
		Matrix Spike	3	1	100
		Matrix Spike Duplicate	3	1	100
		Matrix Spike Precision	3	1	100
		Duplicate	3	1	0
		SRM Analysis	N/A	N/A	N/A

* An analysis passed if the following criteria were met:
For blank – Target accuracy % recovery <2X MDL.
For blank spike – Target accuracy % recovery 80-120.
For matrix spike – Target accuracy % recovery 70-130.
For matrix spike duplicate – Target accuracy % recovery 70-130.
For matrix spike precision – Target precision % RPD <30%.
For duplicate – Target precision % RPD <30%.

Table C–13 Sediment total organic carbon QA/QC summary, July 2015–June 2016.

Quarter	Total No. of Samples (Total No. of Batches)	QA/QC Sample Type	Number Tested	Number of Compounds Tested	% Compounds Passed *
Summer	68 (5)	Blank	6	1	100
		Blank Spike	10	1	100
		Matrix Spike	5	1	100
		Matrix Spike Duplicate	5	1	100
		Matrix Spike Precision	5	1	100
		Duplicate	6	1	100
		SRM Analysis	10	1	100
Winter	29 (2)	Blank	2	1	100
		Blank Spike	2	1	100
		Matrix Spike	2	1	100
		Matrix Spike Duplicate	2	1	100
		Matrix Spike Precision	2	1	100
		Duplicate	4	1	100
		SRM Analysis	2	1	100

* An analysis passed if the following criteria were met:
For blank – Target accuracy % recovery <2X MDL.
For blank spike – Target accuracy % recovery 80-120.
For matrix spike – Target accuracy % recovery 80-120.
For matrix spike duplicate – Target accuracy % recovery 80-120.
For matrix spike precision – Target precision % RPD <10%.
For duplicate – Target precision % RPD <10%.
For SRM analysis – Target accuracy % recovery 80-120% or certified value whichever is greater.

Table C-13. All analyzed TOC samples passed the QA/QC criteria.

Analytical Methods - Grain Size

Grain size samples were analyzed by EMSL Analytical, Cinnaminson, NJ. The MDL for sediment grain size is presented in Table C-11. Sediment grain size QA/QC summary data are presented in Table C-14. Seven samples and their duplicate analyses had a RPD ≤10%. Thirty replicates of station 12 samples were analyzed as grain size standard reference material (SRM) and all analysis results were within 3 standard deviations of SRM for the statistical parameters (median phi, dispersion, and skewness), percent gravel, percent sand, percent clay, and percent silt.

Table C–14 Sediment grain size QA/QC summary, July 2015–June 2016. N/A = Not Applicable.

Quarter	Total No. of Samples (Total No. of Batches)	QA/QC Sample Type	Number Tested	Number of Compounds Tested	% Compounds Passed *
Summer	68 (7)	Blank	N/A	N/A	N/A
		Blank Spike	N/A	N/A	N/A
		Matrix Spike	N/A	N/A	N/A
		Matrix Spike Duplicate	N/A	N/A	N/A
		Matrix Spike Precision	N/A	N/A	N/A
		Duplicate	7	1	100
		SRM Analysis	30	1	100
Winter	29 (4)	Blank	N/A	N/A	N/A
		Blank Spike	N/A	N/A	N/A
		Matrix Spike	N/A	N/A	N/A
		Matrix Spike Duplicate	N/A	N/A	N/A
		Matrix Spike Precision	N/A	N/A	N/A
		Duplicate	3	1	100
		SRM Analysis	N/A	N/A	N/A

* An analysis passed if the following criteria were met:
For duplicate – Target precision % RPD <10%.
For SRM analysis – Mean ± 3 σ of the reference standard for median phi, skewness, dispersion, % gravel, % sand, % clay, and % silt.

Analytical Methods - Total Nitrogen

Total nitrogen (TN) samples were analyzed by Weck Laboratories, Inc., City of Industry, CA. The MDL for TN is presented in Table C-11. Sediment TN QA/QC summary data are presented in Table C-15. The matrix spikes and their duplicate analyses had a RPD of less than 30%. The associated

Table C–15 Sediment total nitrogen QA/QC summary, July 2015–June 2016.

Quarter	Total No. of Samples (Total No. of Batches)	QA/QC Sample Type	Number Tested	Number of Compounds Tested	% Compounds Passed *
Summer	68 (3)	Blank	5	1	100
		Blank Spike	5	1	100
		Matrix Spike	7	1	43
		Matrix Spike Duplicate	7	1	72
		Matrix Spike Precision	7	1	100
		Duplicate	7	1	100
		SRM Analysis	5	1	100
Winter	29 (1)	Blank	2	1	100
		Blank Spike	2	1	100
		Matrix Spike	3	1	100
		Matrix Spike Duplicate	3	1	100
		Matrix Spike Precision	3	1	100
		Duplicate	2	1	100
		SRM Analysis	2	1	100

* An analysis passed if the following criteria were met:
For blank – Target accuracy % recovery <2X MDL.
For blank spike – Target accuracy % recovery 80-120.
For matrix spike – Target accuracy % recovery 70-130.
For matrix spike duplicate – Target accuracy % recovery 70-130.
For matrix spike precision – Target precision % RPD <30%.
For duplicate – Target precision % RPD <30%.
For SRM analysis – Target accuracy % recovery 80-120% or certified value whichever is greater.

laboratory control sample (LCS) met acceptance criteria; however, only 29% and 43% of matrix spikes and matrix spike duplicates, respectively, met the recovery criteria of 70-130% range due to matrix interferences in the analysis.

Analytical Methods - Total Phosphorus

Total phosphorus (TP) samples were analyzed by Weck Laboratories. The MDL for TP is presented in Table C-11. Sediment TP QA/QC summary data are presented in Table C-16. Seven samples and their duplicate analyses had a RPD of less than 30%. The associated LCS met acceptance criteria; however, 2 sample spikes and 3 spike duplicates did not meet target recoveries of 70-130% range

Table C–16 Sediment total phosphorus QA/QC summary, July 2015–June 2016.

Quarter	Total No. of Samples (Total No. of Batches)	QA/QC Sample Type	Number Tested	Number of Compounds Tested	% Compounds Passed *
Summer	68 (2)	Blank	4	1	100
		Blank Spike	4	1	100
		Matrix Spike	7	1	29
		Matrix Spike Duplicate	7	1	43
		Matrix Spike Precision	7	1	100
		Duplicate	7	1	100
		SRM Analysis	4	1	100
Winter	29 (1)	Blank	2	1	100
		Blank Spike	2	1	100
		Matrix Spike	3	1	33
		Matrix Spike Duplicate	3	1	33
		Matrix Spike Precision	3	1	100
		Duplicate	3	1	100
		SRM Analysis	2	1	100

* An analysis passed if the following criteria were met:
For blank – Target accuracy % recovery <2X MDL.
For blank spike – Target accuracy % recovery 80-120.
For matrix spike – Target accuracy % recovery 70-130.
For matrix spike duplicate – Target accuracy % recovery 70-130.
For matrix spike precision – Target precision % RPD <30%.
For duplicate – Target precision % RPD <30%.
For SRM analysis – Target accuracy % recovery 80-120% or certified value whichever is greater.

due to matrix interferences.

FISH TISSUE CHEMISTRY NARRATIVE

First Quarter (July 2015)

Introduction

The District's ELOM laboratory received 20 individual rig-fish samples and 27 individual trawl fish samples from ELOM's ocean monitoring staff during the month of July 2015. The individual samples were stored, dissected, and homogenized according to methods described in the ELOM's SOPs. A 1:1 muscle to water ratio was used for muscle samples. No water was used for liver samples. After the individual samples were homogenized, equal aliquots of muscle from each rig-fish sample, and equal aliquots of muscle and liver from each trawl fish sample were frozen and distributed to the metals and organic chemistry sections of the analytical chemistry laboratory for analyses.

In addition to the percent lipid content determination, the organic chemistry section extracted 20 rig-fish muscle samples, 27 trawl fish muscle tissue samples, and 27 trawl fish liver tissue samples, and analyzed them for PCB congeners and organochlorine pesticides.

A typical organic tissue sample batch included 15 field samples with required QC samples. The QC samples included 1 hydromatrix blank, 2 sample duplicates, 1 matrix spike, 1 matrix spike duplicate, 1 SRM, and 1 reporting level spike (matrix of choice was tilapia).

For mercury analysis, 1 sample batch consisted of 15–20 fish tissue samples and the required QC samples, which included a blank, blank spike, SRM, sample duplicates, matrix spikes, and matrix spike duplicates.

For arsenic and selenium, 1 batch consisted of 15-20 fish tissue samples and the required QC samples, which included 3 blanks, a blank spike, SRM, sample duplicates, matrix spikes, and matrix spike duplicates.

Analytical Methods - Organochlorine Pesticides and PCB Congeners

The analytical methods used for organochlorine pesticides and PCB congeners were according to methods described in the ELOM SOPs. All fish tissue was extracted using an ASE 350 and analyzed by GC/MS.

The MDLs for pesticides and PCBs in fish tissue are presented in Table C-17. Acceptance criteria for PCBs and pesticides SRM in fish tissue are presented in Table C-18. Fish tissue pesticide and PCB QA/QC summary data are presented in Table C-19. All analyses were performed within the required holding times and with appropriate quality control measures. In cases where constituent concentrations exceeded the calibration range of the instrument, the samples were diluted and reanalyzed. Any deviation from standard protocol that occurred during sample preparation or analyses are noted in the raw data packages.

Table C–17 Method detection limit (MDL) for chlorinated pesticide and PCB constituents in fish tissue, DSQ II, July 2015-June 2016. * = Reporting limit used for this parameter.

Parameter	MDL (ng/g net weight)	Parameter	MDL (ng/g net weight)
Chlorinated Pesticides			
cis-Chlordane	0.33	2,4'-DDD	0.33
trans-Chlordane	0.25	4,4'-DDD	0.16
Oxychlordane *	1.000	2,4'-DDE	0.23
Dieldrin	0.31	4,4'-DDE	0.31
Heptachlor	0.23	2,4'-DDT	0.33
Heptachlor epoxide	0.37	4,4'-DDT	0.24
cis-Nonachlor	0.19	4,4'-DDMU	0.43
trans-Nonachlor	0.21		
PCB Congeners			
PCB 18	0.24	PCB 126	0.11
PCB 28	0.21	PCB 128	0.08
PCB 37	0.27	PCB 138	0.16
PCB 44	0.36	PCB 149	0.33
PCB 49	0.17	PCB 151	0.22
PCB 52	0.17	PCB 153/168	0.23
PCB 66	0.26	PCB 156	0.10
PCB 70	0.23	PCB 157	0.10
PCB 74	0.24	PCB 167	0.09
PCB 77	0.21	PCB 169	0.15
PCB 81	0.19	PCB 170	0.18
PCB 87	0.17	PCB 177	0.09
PCB 99	0.44	PCB 180	0.18
PCB 101	0.14	PCB 183	0.13
PCB 105	0.13	PCB 187	0.06
PCB 110	0.19	PCB 189	0.12
PCB 114	0.10	PCB 194	0.17
PCB 118	0.22	PCB 201	0.20
PCB 119	0.14	PCB 206	0.11
PCB 123	0.21		

Table C–18 Acceptance criteria for standard reference material SRM 1946 (Lake Superior Fish Tissue; National Institute of Standards and Technology) for lipid and chlorinated pesticides and PCB constituents in fish tissue, July 2015–June 2016. * Non-certified value used for this parameter.

Parameter	True Value (ng/g)	Acceptance Range (ng/g)	
		Minimum	Maximum
Chlorinated Pesticides			
cis-Chlordane	32.5	30.7	34.3
trans-Chlordane	8.36	7.45	9.27
Oxychlordane	18.9	17.4	20.4
Dieldrin	32.5	29.0	36.0
Heptachlor epoxide	5.50	5.27	5.73
cis-Nonachlor	59.1	55.5	62.7
trans-Nonachlor	99.6	92.0	107
2,4'-DDD	2.20	1.95	2.45
4,4'-DDD	17.7	14.9	20.5
2,4'-DDE *	1.04	0.75	1.33
4,4'-DDE	373	325	421
2,4'-DDT *	22.3	19.1	25.5
4,4'-DDT	37.2	33.7	40.7
PCB Congeners			
PCB 18 *	0.84	0.73	0.95
PCB 28 *	2.00	1.76	2.24
PCB 44	4.66	3.80	5.52
PCB 49	3.80	3.41	4.19
PCB 52	8.1	7.1	9.1
PCB 66	10.8	8.9	12.7
PCB 70	14.9	14.3	15.5
PCB 74	4.83	4.32	5.34
PCB 77	0.327	0.30	0.35
PCB 87	9.4	8.0	10.8
PCB 99	25.6	23.3	27.9
PCB 101	34.6	32.0	37.2
PCB 105	19.9	19.0	20.8
PCB 110	22.8	20.8	24.8
PCB 118	52.1	51.1	53.1
PCB 126	0.380	0.36	0.40
PCB 128	22.8	20.9	24.7
PCB 138	115	102	128
PCB 149	26.3	25.0	27.6
PCB 153/168	170	161	179
PCB 156	9.52	9.01	10.0
PCB 170	25.2	23.0	27.4
PCB 180	74.4	70.4	78.4
PCB 183	21.9	19.4	24.4
PCB 187	55.2	53.1	57.3
PCB 194	13.0	11.7	14.3
PCB 201 *	2.83	2.70	2.96
PCB 206	5.40	4.97	5.83
Other			
Lipid *	10.17	–	–

Table C–19 Fish ΣPCBs and ΣPesticides QA/QC summary, July 2015–June 2016.

Quarter	Total No. of Samples (Total No. of Batches)	QA/QC Sample Type	Number Tested	Number of Compounds Tested	% Compounds Passed *
Summer	74 (5)	Blank	10	54	100
		Blank Spike	5	54	89
		Matrix Spike	5	54	90
		Matrix Spike Dup	5	54	90
		Matrix Spike Precision	5	54	96
		Duplicate	10	54	96
		CRM Analysis	5	41	78

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <3X MDL.
For blank spike - Target accuracy % recovery 60-120.
For matrix spike - Target accuracy % recovery 40-120.
For matrix spike duplicate - Target accuracy % recovery 40-120.
For matrix spike precision - Target precision % RPD <20%.
For duplicate - Target precision % RPD <20% at 3X MDL of sample mean.
For SRM analysis - Target accuracy % recovery 60-140 or certified value, whichever is greater.

Analytical Methods - Lipid Content

Lipids were extracted by dichloromethane from approximately 1 to 2 g of sample and concentrated to 2 mL. A 100 µL aliquot of the extract was placed in a tarred aluminum weighing boat and allowed to evaporate to dryness. The remaining residue was weighed, and the percent lipid content calculated. Lipid content QA/QC summary data are presented in Table C-20. All analyses were performed within the required holding times and with appropriate quality control measures. Any deviation from standard protocol that occurred during sample preparation or analyses are noted in the raw data packages.

Table C–20 Fish tissue percent lipid QA/QC summary, July 2015–June 2016.

Sample Set	Tissue Type	Parameter	Description	Number of Compounds Tested	Number of Compounds Passed	Target Precision % RPD
FISH-EXLIPJUL 15_MV	Muscle	Percent Lipid	Duplicate Samples	2	2	<25%
FISH-EXLIPJUL15_LS	Liver	Percent Lipid	Duplicate Samples	2	2	<25%
FISH-EXLIPJUL15_LT	Liver	Percent Lipid	Duplicate Samples	2	1	<25%
FISH-EXLIPJUL15_MU	Muscle	Percent Lipid	Duplicate Samples	2	2	<25%
FISH-EXLIPJUL15_MW	Muscle	Percent Lipid	Duplicate Samples	2	2	<25%

Analytical Methods - Mercury

Fish tissue samples were analyzed for mercury in accordance with ELOM SOP 245.1A. Typical QC analyses for a tissue sample batch included a blank, a blank spike, and SRMs (liver and muscle). In the same batch, additional QC samples included duplicate analyses of the sample, spiked samples, and duplicate spiked samples, which were run approximately once every 10 samples.

The MDL for fish mercury is presented in Table C-21 Acceptance criteria for the mercury SRMs are presented in Table C-22. Fish tissue mercury QA/QC summary data are presented in Table C-23. All samples were analyzed within a 6-month holding time and met the QA criteria guidelines.

Pretreated (resected and 1:1 Muscle: water homogenized) fish samples were analyzed for mercury in accordance with methods described in the ELOM SOPs. QC for a typical batch included a blank, a blank spike, and an SRM (whole fish). Fish samples with duplicates, spiked samples, and duplicate spiked samples were run approximately once every 10 fish samples. When sample mercury

Table C–21 Method detection limit (MDL) and reporting limit (RL) for metals in fish tissue, July 2015–June 2016.

Parameter	MDL (mg/kg)	RL (mg/kg)
Arsenic	0.002	0.015
Mercury	0.001	0.004
Selenium	0.001	0.01

Table C–22 Acceptance criteria for standard reference material Fish Protein Certified Reference Material (National Research Council Canada DORM-3) for metals in fish muscle tissue, July 2015–June 2016.

Parameter	True Value (mg/kg)	Certified Acceptance Criteria (mg/kg)	
		Min.	Max.
Arsenic	6.88	5.68	7.18
Selenium *	3.3	–	–
Mercury	0.382	0.322	0.442

* Certified min. and max. values were not calculated due to scattering of results by the manufacturer.

Table C–23 Fish tissue mercury, arsenic, and selenium QA/QC summary, July 2015–June 2016.

Quarter	Total No. of Samples (Total No. of Batches)	Parameter	QA/QC Sample Type	Number Tested	Number of Compounds Tested	% Compounds Passed *
Summer	74 (4)	Mercury	Blank	4	1	100
			Blank Spike	4	1	100
			Matrix Spike	8	1	100
			Matrix Spike Dup	8	1	100
			Matrix Spike Precision	8	1	100
			Duplicate	8	1	100
			SRM Analysis	2	1	100
Summer	1 (20)	Arsenic and Selenium	Blank	3	2	100
			Blank Spike	1	2	100
			Matrix Spike	2	2	100
			Matrix Spike Dup	2	2	100
			Matrix Spike Precision	2	2	100
			Duplicate	2	2	100
			SRM Analysis	1	2	100

* An analysis passed if the following criteria were met:
For blank- Target accuracy % recovery <2X MDL.
For blank spike –Target accuracy % recovery 90-110.
For matrix spike –Target accuracy % recovery 70-130.
For matrix Spike duplicate – Target precision % RPD <20.
For duplicate – Target precision % RPD 30.
For SRM analysis –Target accuracy % recovery 80-120% or certified value whichever is greater.

concentration exceeded the appropriate calibration curve, the sample was diluted with the reagent blank and reanalyzed. The samples were analyzed for mercury on a Perkin Elmer FIMS 400 system.

All samples met the QA criteria guidelines for accuracy and precision.

<u>Analytical Methods - Arsenic and Selenium</u>

Fish tissue samples were analyzed for arsenic and selenium in accordance with ELOM SOP 200.8B. A typical QC analyses for a tissue sample batch included 3 blanks, a blank spike, and SRMs (liver and muscle). In the same batch, additional QC samples included duplicate analyses of the sample, spiked samples and duplicate spiked samples which were run approximately once every 10 samples.

The MDLs for fish arsenic and selenium are presented in Table C-21. Acceptance criteria for the arsenic and selenium SRMs are presented in Table C-22. Fish tissue arsenic and selenium QA/QC summary data are presented in Table C-23. All samples were analyzed within a 6-month holding time and met the QA criteria guidelines.

Pretreated (resected and 1:1 Muscle: water homogenized) fish samples were analyzed for arsenic and selenium in accordance with methods described in the ELOM SOPs. The samples were analyzed for Arsenic and Selenium on a Perkin Elmer ELAN 6100 system.

All samples met the QA criteria guidelines for accuracy and precision.

BENTHIC INFAUNA NARRATIVE

Sorting and Taxonomy QA/QC

The sorting and taxonomy QA/QC follows the District's QAPP. These QA/QC procedures were conducted on sediment samples collected for infaunal community analysis in July 2015 (summer) from 29 semi-annual stations (52–65 m) and 39 annual stations (40–300 m), and in January 2016 (winter) from the same 29 semi-annual stations, for a total of 97 samples for the year (see Appendix A). A single sample was collected at each station for infauna.

<u>Sorting QA/QC Procedures</u>

The sorting procedure involved removal, by Marine Taxonomic Services, Inc. (MTS), of organisms including their fragments from sediment samples into separate vials by major taxa. The abundance of countable organisms (heads only) per station was recorded. After MTS' in-house sorting efficiency criteria were met, the organisms and remaining particulates (grunge) were returned to the District. Ten percent of these samples (10 of 97) were randomly selected for re-sorting by District staff. A tally was made of any countable organisms missed by MTS. A sample passed QC if the total number of countable animals found in the re-sort was ≤ 5% of the total number of individuals originally reported.

2015-16 Sorting QA/QC Results

Sorting results for all QA samples were well below the 5% QC limit.

Taxonomic Identification QA/QC Procedures

Benthic infauna samples underwent comparative taxonomic analysis by 2 independent taxonomists. Samples were randomly chosen for re-identification from each taxonomist's allotment of assigned samples. These were swapped between taxonomists with the same expertise in the major taxa. The resulting data sets were compared and a discrepancy report generated. The participating taxonomists reconciled the discrepancies. Necessary corrections to taxon names or abundances were made to the database. The results were scored and errors tallied by station. Percent errors were calculated using the equations below:

Equation 1. $\%Error_{\#\ Taxa} = [(\#\ Taxa_{Resolved} - \#\ Taxa_{Original}) \div \#\ Taxa_{Resolved}] \times 100$

Equation 2. $\%Error_{\#\ Individuals} = [(\#\ Individuals_{Resolved} - \#\ Individuals_{Original}) \div \#\ Individuals_{Resolved]} \times 100$

Equation 3. $\%Error_{\#\ ID\ Taxa} = (\#\ Taxa_{Misidentification} \div \#\ Taxa_{Resolved}) \times 100$

Equation 4. $\%Error_{\#\ ID\ Individuals} = (\#\ Individuals_{Misidentification} \div \#\ Individuals_{Resolved}) \times 100$

Please refer to the District's QAPP for detailed explanation of the variables.

The first 3 equations are considered gauges of errors in accounting (e.g., recording on wrong line, miscounting, etc.), which, by their random nature, are difficult to predict. Equation 4 (Eq. 4) is the preferred measure of identification accuracy. It is weighted by abundance and has a more rigorous set of corrective actions (e.g., additional taxonomic training) when errors exceed 10%.

In addition to the re-identifications, a synoptic data review was conducted upon completion of all data entry and QA. This consisted of a review of the infauna data for the survey year, aggregated by taxonomist (including both in-house and contractor). From this, any possible anomalous species reports, such as species reported outside its known depth range and possible data entry errors, were flagged.

Table C–24 Percent error rates calculated for July 2015 QA samples.

Error Type	Station			Mean
	C	59	70	
1. $\%Error_{\#\ Taxa}$	6.9	5.8	6.8	**6.5**
2. $\%Error_{\#\ Individuals}$	1.4	0.2	0.7	**0.8**
3. $\%Error_{\#\ ID\ Taxa}$	4.0	10.0	7.8	**7.2**
4. $\%Error_{\#\ ID\ Individuals}$	1.2	5.8	2.4	**3.1**

2015-16 Taxonomic QA/QC Results

QC objectives for identification accuracy (Eq. 4) were met in 2015-16 (Table C-24). No significant changes to the 2015-16 infauna dataset were made following the synoptic data review.

OTTER TRAWL NARRATIVE

The District's trawl sampling protocols are based upon regionally developed sampling methods (Mearns and Stubs 1974, Mearns and Allen 1978) and US Environmental Protection Agency 301(h) guidance documents (Tetra Tech 1986). These methods require that a portion of the trawl track must pass within a 100-m circle centered on the nominal sample station position and be within 10% of the station's nominal depth. In addition, the speed of the trawl should range from 0.77 to 1.0 m/s (1.5 to 2.0 kts). Since 1985, the District has trawled a set distance of 450 m (the distance that the net is on the bottom collecting fish and invertebrates). This contrasts with previous regional trawl surveys which factored in time on the bottom, not distance. Station locations and trawling speeds and paths were determined using Global Positioning System navigation. Trawl depths were determined using a Sea-Bird Electronics SBE 39 pressure sensor attached to one of the trawl boards.

For Summer 2015, trawl distances averaged 449 m and average trawl speed was 1.9 kts (Table C-25). All of the trawls passed through the designated 100-meter circle (Figure C-1) except at Station T23, and all trawls were within ±10% of the nominal station depth (Figure C-2). For Winter 2016, trawl distances averaged 459 m and average trawl speed was 2.0 kts (Table C-25). All the trawls passed through the designated 100-meter circle (Figure C-3), and all trawls were within ±10% of the nominal station depth (Figure C-4).

Table C–25 Trawl track distances and vessel speed for sampling conducted in Summer 2015 and Winter 2016. Vessel speeds outside of the QA range of 1.5-2.0 knots are denoted with a † symbol.

Season	Station	Distance Trawled (m)	Vessel speed (kts)
Summer	T1	457.1	1.9
	T2	463.2	2.0
	T6	455.0	2.3 †
	T10	391.1	1.7
	T11	463.2	2.4 †
	T12	453.3	1.3 †
	T14	454.9	2.0
	T17	457.1	1.5
	T18	457.9	2.2 †
	T19	457.1	1.9
	T22	455.1	1.5
	T23	453.4	1.7
	T24	408.4	1.8
	T25	460.4	1.8
	Mean	**449.1**	**1.9**
Winter	T1	456.7	2.0
	T11	450.8	1.8
	T12	456.1	2.1 †
	T17	449.9	2.0
	T22	459.5	1.9
	T23	483.0	2.1 †
	Mean	**459.3**	**2.0**

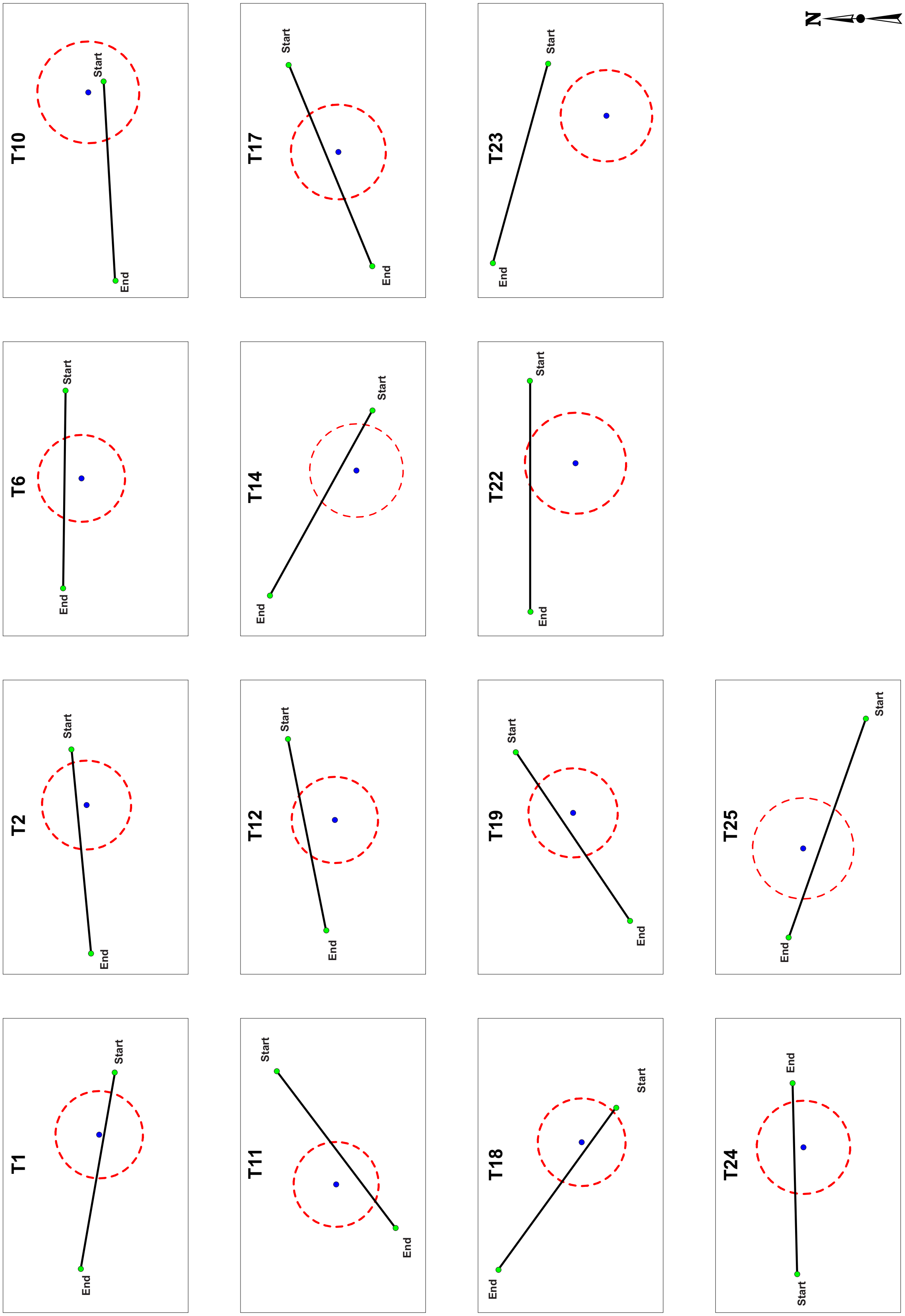

Figure C–1 Quality assurance plots of otter trawl paths in relation to a 100-m circle (red dashes) surrounding each nominal station position, July and August 2015.

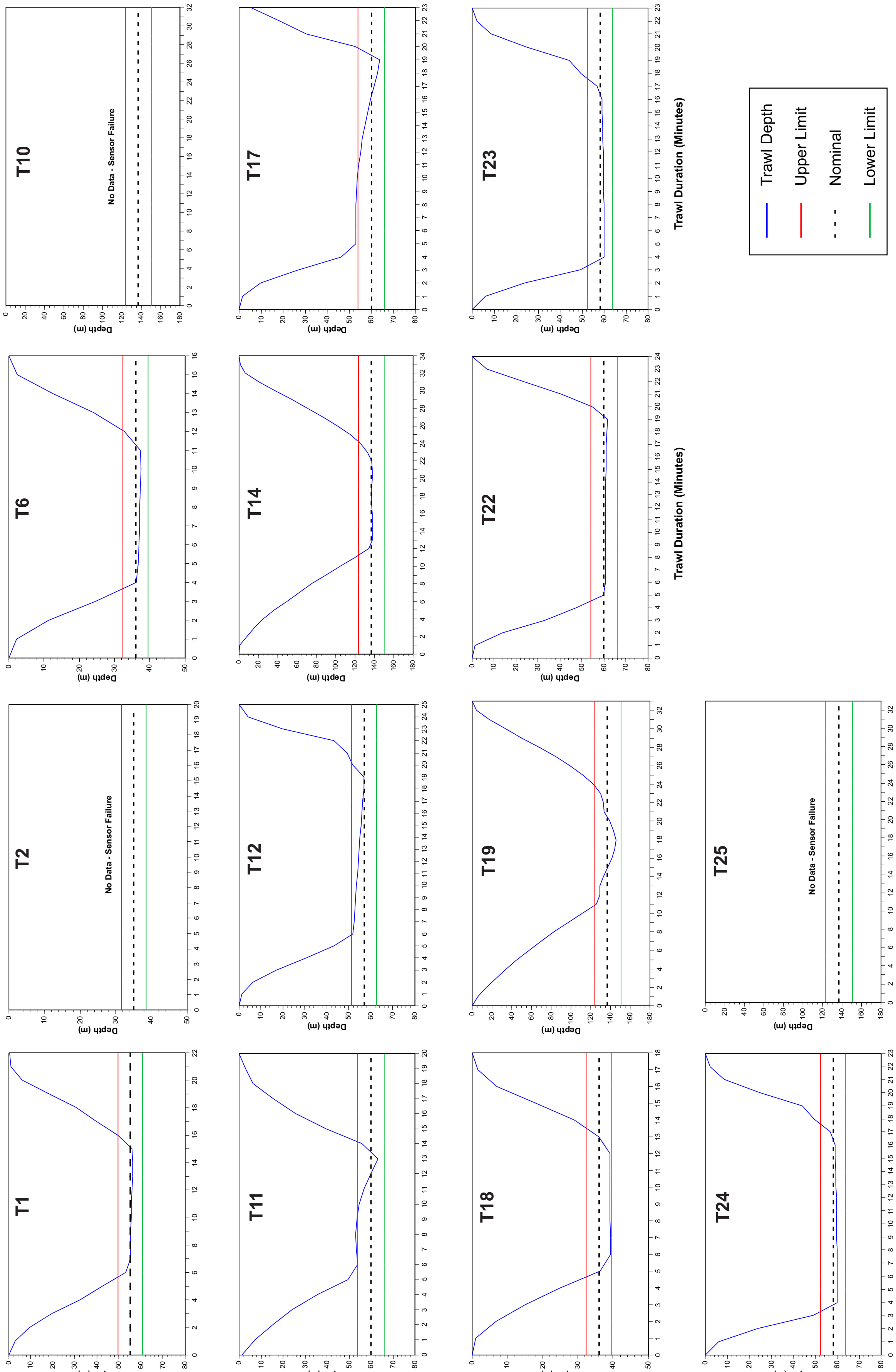

Figure C–2 Quality assurance plots of trawl depth per haul for otter trawl stations, July and August 2015. Upper and lower limit lines are ±10% of nominal trawl depth.

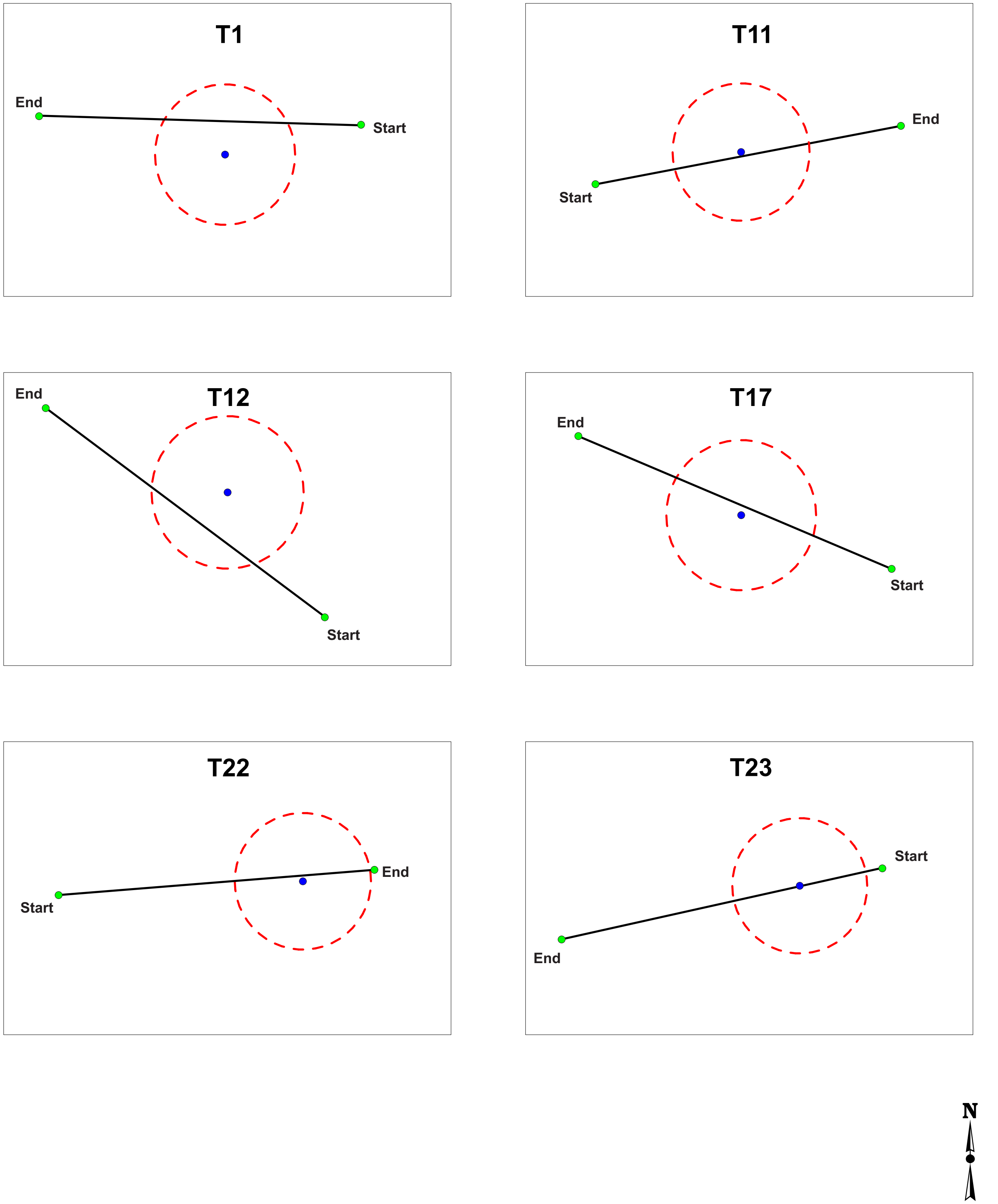

Figure C–3 Quality assurance plots of otter trawl paths in relation to a 100-m circle (red dashes) surrounding each nominal station position, January and March 2016.

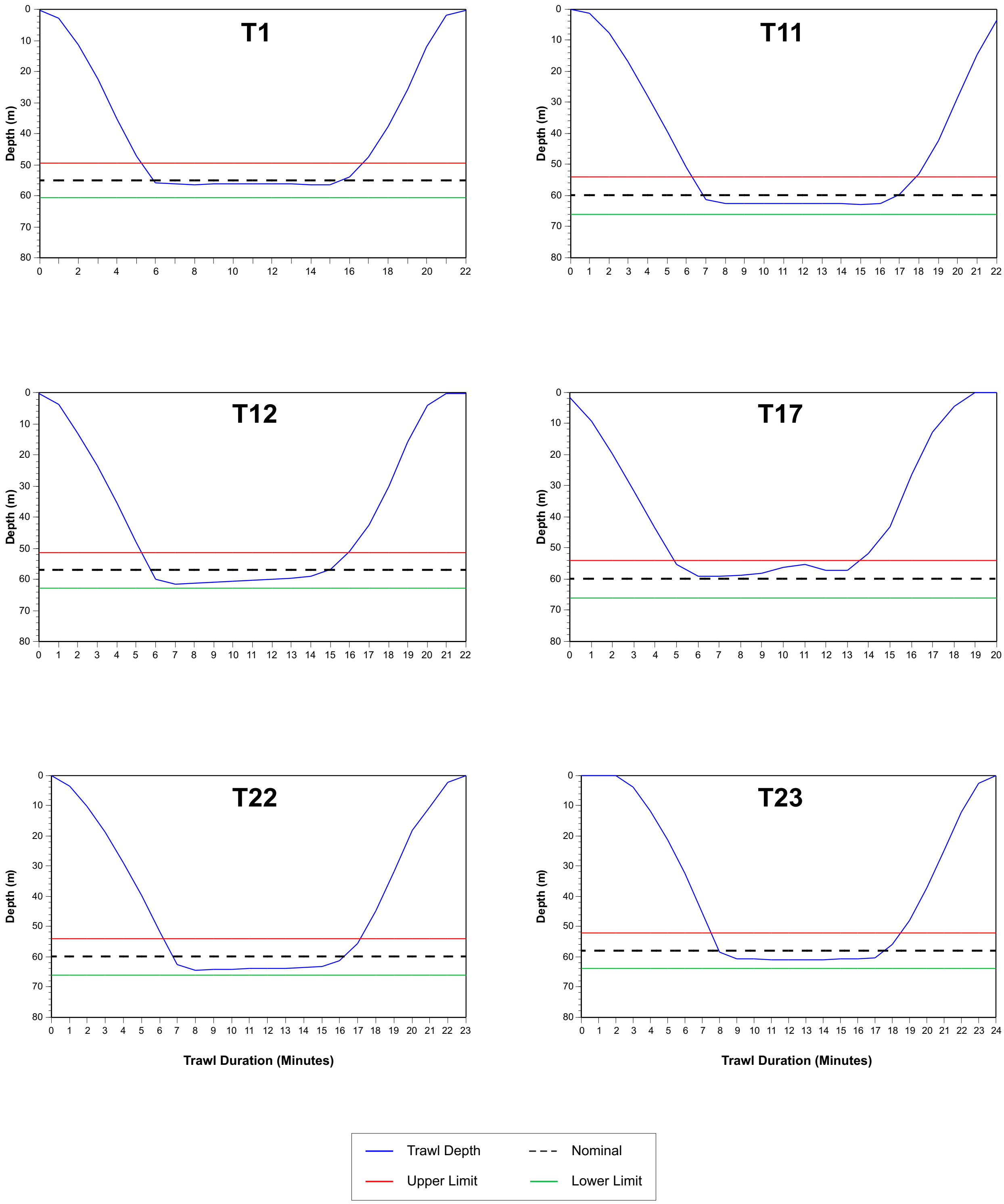

Figure C–4 Quality assurance plots of trawl depth per haul for otter trawl stations, January and March 2016. Upper and lower limit lines are ±10% of nominal trawl depth

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APPENDIX D
Fish Tissue Addendum

In September 2016, the Orange County Sanitation District's (District) laboratory staff discovered an error in percent lipid calculations for Hornyhead Turbot and English Sole samples collected by trawling between January 2009 and March 2013, which affected the lipid-normalized ΣDDT and ΣPCB tissue data. As such, fish tissue ΣDDT and ΣPCB values were subsequently recalculated using the corrected lipid values to verify the accuracy of the District's bioaccumulation conclusions during this time period. Nearly all recalculated means were similar to or considerably lower than the corresponding initial means (Tables D-1 to D-5). Thus, the final conclusions with regard to fish tissue bioaccumulation for those reporting years (2008-09, 2009-10, 2010-11, 2011-12, and 2012-13) remain accurate.

Table D–1 Initial and corrected ΣDDT and ΣPCB values in muscle and liver tissues of selected flatfishes collected by trawling in January 2009 at Stations T1 (outfall) and T11 (non-outfall).

Species (Common Name)	Tissue	Station	n	Initial ΣDDT (µg/kg)	Corrected ΣDDT (µg/kg)	Initial ΣPCB (µg/kg)	Corrected ΣPCB (µg/kg)
Pleuronichthys verticalis (Hornyhead Turbot)	Muscle	Non-outfall	10	276 (66.2-1160)	87.3 (0-220.9)	113 (0-266)	45.8 (0-250.6)
		Outfall	10	134 (76.7-269)	29.6 (0-134.4)	28 (18.4-43.3)	5.8 (0-17.2)
	Liver	Non-outfall	10	312 (65.2-1030)	199.5 (65.2-1029.7)	252 (8.4-2314)	23.4 (8.4-49.4)
		Outfall	10	203 (87.9-452)	202.6 (87.9-451.9)	43.6 (7.9-96.8)	43.6 (7.9-96.8)
Parophrys vetulus (English Sole)	Muscle	Non-outfall	10	115 (49.6-188)	57.5 (24.8-93.8)	7.3 (0-11.6)	3.7 (0-5.8)
		Outfall	10	586 (40.2-4570)	213.5 (0-1582.8)	74.4 (0-556)	28.0 (0-192.2)
	Liver	Non-outfall	10	296 (95.7-629)	296.1 (95.8-628.6)	66.9 (9.8-199)	66.9 (9.8-199.1)
		Outfall	10	205 (39-974)	204.9 (39.0-973.5)	30.6 (8.4-104)	30.6 (8.4-103.6)

Table D–2 Initial and corrected ΣDDT and ΣPCB values in muscle and liver tissues of selected flatfishes collected by trawling in July 2009 at Stations T1 (outfall) and T11 (non-outfall).

Species (Common Name)	Tissue	Station	n	Initial ΣDDT (µg/kg)	Corrected ΣDDT (µg/kg)	Initial ΣPCB (µg/kg)	Corrected ΣPCB (µg/kg)
Pleuronichthys verticalis (Hornyhead Turbot)	Muscle	Non-outfall	2	65.6 (11.4-211)	17.9 (0-35.7)	11.1 (0-36.4)	4.6 (0-9.1)
		Outfall	10	74 (25.4-163)	32 (0-82.1)	21 (1.4-36.9)	9.2 (0-28.4)
	Liver	Non-outfall	2	78.4 (17.8-207)	158.1 (109.3-207)	7.8 (0-25.9)	32.1 (12.4-51.8)
		Outfall	10	58.3 (16.8-156)	58.3 (16.8-155.9)	23.5 (8.2-57.9)	23.5 (8.2-45.5)
Parophrys vetulus (English Sole)	Muscle	Non-outfall	6	273 (50-1506)	81.8 (28.7-181.3)	33.3 (7.7-117)	12.6 (3.8-23.9)
		Outfall	10	148 (27-390)	85.1 (13.8-219.1)	96.8 (2.9-800)	28.8 (1.4-204.1)
	Liver	Non-outfall	6	1237 (87-8622)	150.4 (27-378.5)	78.9 (0-387)	17.6 (0-44.5)
		Outfall	10	658 (157-1448)	54 (0-219)	414 (35-2438)	29.2 (0-172.9)

Table D–3 Initial and corrected ΣDDT and ΣPCB values in muscle and liver tissues of selected flatfishes collected by trawling in January 2011 at Stations T1 (outfall) and T11 (non-outfall).

Species (Common Name)	Tissue	Station	n	Initial ΣDDT (µg/kg)	Corrected ΣDDT (µg/kg)	Initial ΣPCB (µg/kg)	Corrected ΣPCB (µg/kg)
Pleuronichthys verticalis (Hornyhead Turbot)	Muscle	Non-outfall	5	20 (4.2-85)	54.6 (16.4-91.8)	0.4 (0-3.6)	0.36 (0-1.8)
		Outfall	5	6.1 (3.2-9.4)	10.7 (0-36.6)	ND	ND
	Liver	Non-outfall	5	83.5 (20.5-216)	126.9 (68.8-215.9)	3 (0-15.5)	5 (0-15.5)
		Outfall	5	49.3 (18.3-77.8)	62.3 (52.4-64.2)	7.2 (0-27)	12.9 (6-12.3)
Parophrys vetulus (English Sole)	Muscle	Non-outfall	5	104 (23.2-365)	83.8 (0-183.8)	6.5 (0-52)	5.2 (0-26)
		Outfall	5	232 (28.4-691)	78.6 (14.2-141.5)	18.7 (0-42.1)	4.6 (0-22.8)
	Liver	Non-outfall	5	68.9 (18.9-130)	72 (21.4-111.5)	8.6 (0.8-63.1)	14.5 (2.5-63.1)
		Outfall	5	137 (51.7-436)	74.2 (51.7-103.3)	11.6 (0-38.8)	3.2 (0-15.7)

Table D–4 Initial and corrected ΣDDT and ΣPCB values in muscle and liver tissues of selected flatfishes collected by trawling in August 2011 at Stations T1 (outfall) and T11 (non-outfall). Note: the initial data did not include ranges.

Species (Common Name)	Tissue	Station	n	Initial ΣDDT (µg/kg)	Corrected ΣDDT (µg/kg)	Initial ΣPCB (µg/kg)	Corrected ΣPCB (µg/kg)
Pleuronichthys verticalis (Hornyhead Turbot)	Muscle	Non-outfall	1	74.9	91.4	15	22.5
		Outfall	10	27.6	61.9 (0-288.4)	2.9	2.1 (0-58.9)
	Liver	Non-outfall	1	70.3	21	3.6	2.4
		Outfall	10	76.5	76.6 (47.9-134.2)	23.1	23.1 (4.9-104.8)
Parophrys vetulus (English Sole)	Muscle	Non-outfall	10	99.9	49.9 (26-76.2)	7.3	3.6 (0-9.4)
		Outfall	10	90.8	46.6 (12-83.1)	11.4	5.7 (0-20.9)
	Liver	Non-outfall	10	44.6	79.1 (17.1-417.8)	10.2	10.2 (2.8-46.9)
		Outfall	10	51.7	51.7 (15.8-96.8)	14.6	14.6 (3.8-26.4)

Table D–5 Initial and corrected ΣDDT and ΣPCB values in muscle and liver tissues of selected flatfishes collected by trawling in March 2013 at Stations T1 (outfall) and T11 (non-outfall).

Species (Common Name)	Tissue	Station	n	Initial ΣDDT (µg/kg)	Corrected ΣDDT (µg/kg)	Initial ΣPCB (µg/kg)	Corrected ΣPCB (µg/kg)
Pleuronichthys verticalis (Hornyhead Turbot)	Muscle	Non-outfall	10	14.7 (0-43.8)	31.8 (0-117.7)	0.5 (0-3.8)	0.24 (0-1.88)
		Outfall	10	8.27 (0-27.5)	13 (0-36.3)	1.9 (0-13.3)	2.14 (0-6.7)
	Liver	Non-outfall	10	119 (17.1-355)	118.6 (17.1-355.5)	8.3 (0-26.1)	8.3 (0-26.1)
		Outfall	10	67.5 (43.2-122)	67.5 (43.2-121.8)	8.3 (1.5-18.7)	8.3 (1.5-18.7)
Parophrys vetulus (English Sole)	Muscle	Non-outfall	10	543 (14.6-1635)	299 (0-817.6)	22.5 (0-103)	11.3 (0-51.3)
		Outfall	10	102.2 (1.15-389)	90.8 (0.6-277)	22.1 (0-141)	18.4 (0-70.3)
	Liver	Non-outfall	10	290 (12.8-1104)	289.9 (12.8-1103.8)	33.7 (2.42-79.2)	33.7 (2.4-79.2)
		Outfall	10	191 (27-423)	191.1 (27-341.3)	32.9 (0-105)	32.9 (0-109.2)

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