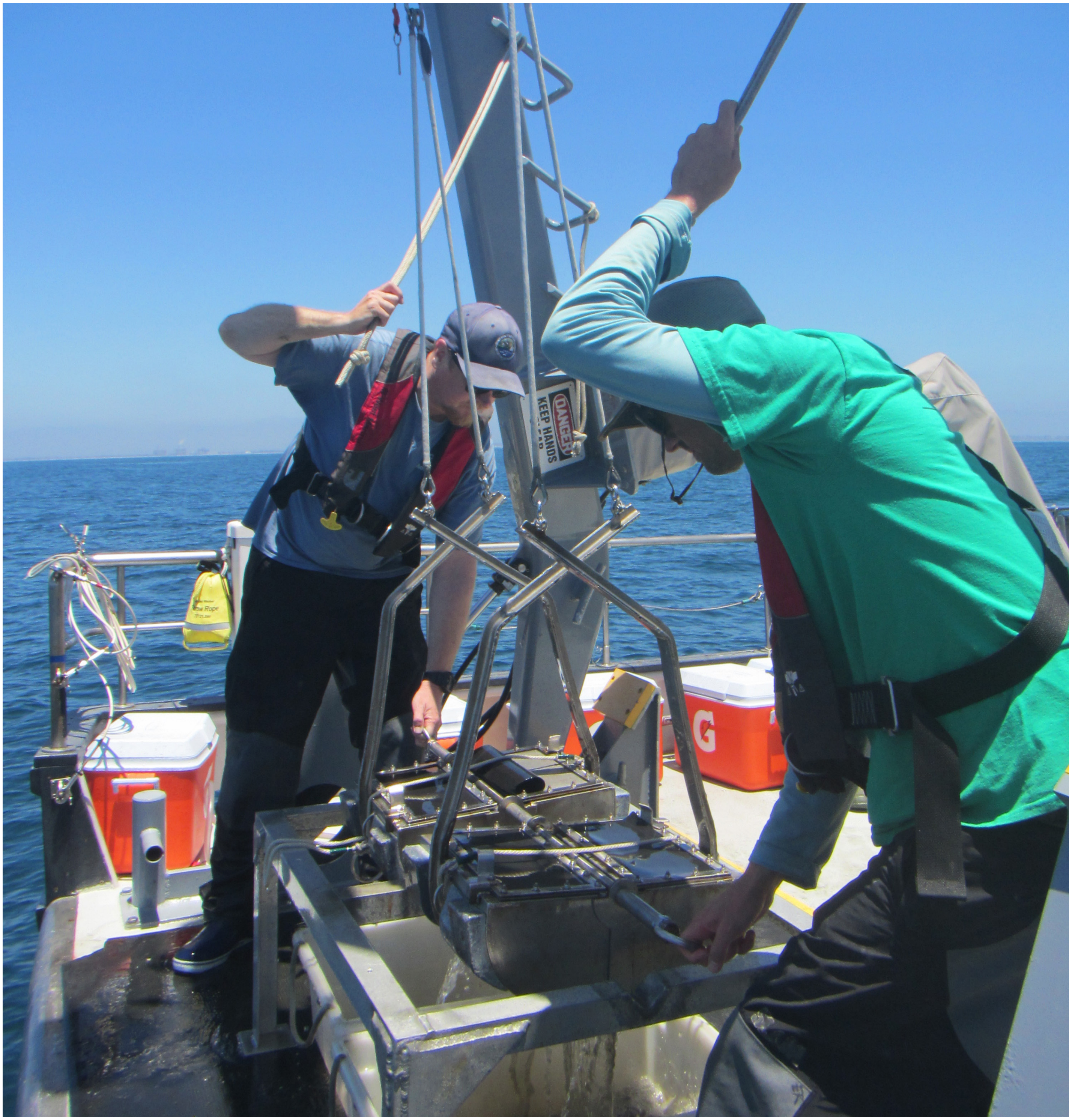

Marine Monitoring Annual Report

Year 2019-2020

OC SAN
ORANGE COUNTY SANITATION DISTRICT

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March 10, 2021

Hope Smythe, Executive Officer
California Regional Water Quality Control Board
Santa Ana Region 8
3737 Main Street, Suite 500
Riverside, CA 92501-3348

SUBJECT: Board Order No. R8-2012-0035, NPDES No. CA0110604,
2019-20 Marine Monitoring Annual Report

Enclosed is the Orange County Sanitation District's (OC San) 2019-20 Marine Monitoring Annual Report. This report focuses on the findings and conclusions for the monitoring period July 1, 2019 to June 30, 2020. The results of the monitoring program document that the discharge of OC San's combined water reclamation reject flows and secondary-treated wastewater (collectively, the final effluent) into the coastal waters off Huntington Beach and Newport Beach, California affected neither the receiving environment nor posed a risk to human health.

Compliance with bacteria water quality objectives in zones of water contact recreation as well as with numeric receiving water criteria was achieved, respectively, 100% and more than 95% of the time. Concentrations of ammonia-nitrogen in water samples were more than 10 times lower than the chronic (4 mg/L) and nearly 18 times less than the acute (6 mg/L) toxicity standards of the California Ocean Plan. Occasional plume-related changes in water clarity, dissolved oxygen, and pH beyond the zone of initial dilution (ZID) were detected, but they were well within the range of natural variability.

There were no impacts to the benthic animal communities within and adjacent to the ZID. Infauna and fish communities in the monitoring area were considered healthy (reference condition) based on, respectively, the low Benthic Response Index (<25) and Fish Response Index (<45) scores. Moreover, contaminants in all sediment samples were comparable to background levels and no measurable toxicity was recorded in whole sediment toxicity tests. The low levels of contaminants in fish tissue samples and the absence of disease symptoms in fish samples 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 OC San's staff to discuss any aspect of our ocean monitoring

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Tustin
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Midway City Sanitary District
Irvine Ranch Water District
Yorba Linda Water District

ORANGE COUNTY SANITATION DISTRICT

program, please feel free to contact me at (714) 593-7450 or lwiborg@ocsd.com or you may also contact Dr. Jeff Armstrong, Ocean Monitoring supervisor who can be reached at (714) 593-7455 or jarmstrong@ocsd.com.

Wiborg, Lan

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Lan C. Wiborg
Director of Environmental Services

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Enclosure

cc: T. Torres (via email)

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March 10, 2021

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Certification Statement

The following certification satisfies Attachment E of the Orange County Sanitation District's Monitoring and Reporting Program, Order No. R8-2012-0035, NPDES No. CA0110604, for the submittal of the attached OCSD Annual Report 2021 – 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.

Wiborg, Lan

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Date: 2021.03.10 07:58:08 -08'00'

Lan C. Wiborg
Director of Environmental Services

LCW:DT:pe
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Acknowledgments

The following individuals are acknowledged for their contributions to the 2019-20 Marine Monitoring Annual Report:

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EXECUTIVE SUMMARY

To evaluate potential environmental and human health impacts from its discharge of final effluent into the Pacific Ocean, the Orange County Sanitation District (OC San) conducts extensive water quality, sediment quality, fish and invertebrate community, and fish health monitoring off the coastal cities of Newport Beach and Huntington Beach, California. The final effluent, consisting of secondary-treated wastewater mixed with water reclamation flows, is released through a 120-in (305-cm) outfall extending 4.4 miles (7.1 km) offshore in 197 ft (60 m) of water. The data collected are used to determine compliance with receiving water conditions as specified in OC San's National Pollution Discharge Elimination System permit (Order No. R8-2012-0035, Permit No. CA0110604), jointly issued in 2012 by the U.S. Environmental Protection Agency, Region IX and the Regional Water Quality Control Board, Region 8. This report focuses on monitoring results and conclusions from July 2019 through June 2020.

WATER QUALITY

Compliance for all 3 fecal indicator bacteria was achieved 100%, indicating no impact of bacteria to offshore receiving waters during the monitoring period. Minimal plume-related changes in water clarity, dissolved oxygen, and pH were occasionally detected less than 1.2 miles (2.0 km) beyond the initial mixing zone. However, none of these changes were determined to be environmentally significant since they fell within natural ranges to which marine organisms are exposed. In summary, the 2019-20 discharge of final effluent did not negatively affect the receiving water environment; therefore, beneficial uses were protected and maintained.

SEDIMENT QUALITY

Measured sediment parameters were comparable among benthic stations located within and beyond the zone of initial dilution[1] (ZID) Furthermore, all measured values were comparable to regional and historical values and were below applicable Effects-Range-Median guidelines of biological concern. In addition, whole sediment toxicity tests showed no measurable toxicity, indicating overall good sediment quality in the monitoring area.

BIOLOGICAL COMMUNITIES

Infaunal Communities

Infaunal communities were generally similar among within-ZID and non-ZID benthic stations based on comparable community measure values and community structure. Moreover, the infaunal communities within the monitoring area can be classified as reference condition based on their low Benthic Response Index scores (<25) and high Infaunal Trophic Index scores (>60). These

[1] The zone of initial dilution represents a 60 m area around the OC San outfall diffuser.

results indicate that the outfall discharge had an overall negligible effect on the benthic community structure within the monitoring area.

Demersal Fishes and Epibenthic Macroinvertebrates

The community measure values and community structure of the epibenthic macroinvertebrates (EMIs) and demersal fishes collected at outfall and non-outfall trawl stations were comparable. In addition, the community measure values were within regional and OC San historical ranges. Fish communities at all stations were classified as reference condition based on their low Fish Response Index scores (<45). These results indicate that the monitoring area supports normal fish and EMI populations.

Tissue Contaminants in Fish

Concentrations of chlorinated pesticides and trace metals in muscle and/or liver tissues of flatfish and rockfish samples were similar between outfall and non-outfall locations. Moreover, the average concentrations of all contaminants measured in sport fish samples did not exceed California's "Do not consume" Advisory Tissue Level. These results suggest that demersal fishes residing near the outfall are not more prone to bioaccumulation of contaminants and demonstrate there is negligible human health risk from consuming demersal fishes captured in the monitoring area.

Fish Health

The odor and color of demersal fish samples appeared normal during the monitoring period. Furthermore, the absence of morphological abnormalities, tumors, fin erosion, and skin lesions, together with the low incidence (<1%) of external parasites, in demersal fish samples showed that fishes in the monitoring area were healthy. These results indicate that the outfall is not an epicenter of disease.

CONCLUSION

As with previous program years, California Ocean Plan water quality criteria, including state bacterial standards, were met within the monitoring area in 2019-20. Sediment quality was not degraded by chemical contaminants from the discharge of the final effluent. This was supported by the absence of sediment toxicity in controlled laboratory tests, the presence of normal invertebrate and fish communities throughout the monitoring area, the absence of symptoms of fish disease, and no exceedances in the state's "Do not consume" guideline in sport fish samples. In summary, OC San's discharge of final effluent neither affected the receiving environment nor posed a risk to human health during the 2019-20 monitoring period.

CHAPTER 1
The Ocean Monitoring Program

INTRODUCTION

The Orange County Sanitation District (OC San) operates 2 wastewater treatment facilities located in Fountain Valley (Plant 1) and Huntington Beach (Plant 2), California. OC San discharges treated wastewater to the Pacific Ocean through a 120-in (305-cm) submarine outfall located offshore of the Santa Ana River (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.

ENVIRONMENTAL SETTING

OC San's Core ocean monitoring area is adjacent to California's most highly urbanized area (Figure 1-2). The Core monitoring area covers most of the San Pedro Shelf and extends southeast off the shelf. (Figure 1-1). These nearshore coastal waters receive wastes from a variety of anthropogenic sources, such as wastewater discharges, dredged material disposals, 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—representing nearly 30% of the surface flow to the Southern California Bight (SCB) (SCCWRP, personal communication, November 30, 2020)—are responsible for a substantial amount of contaminant inputs (Schafer and Gossett 1988, SCCWRP 1992, Schiff et al. 2000, Schiff and Tiefenthaler 2001, Tiefenthaler et al. 2005).

The San Pedro Shelf is primarily composed of soft sediments (sands with silts and clays) and is inhabited by biological communities typical of these environments (OCSD 2004). Seafloor depths increase gradually from the shoreline to approximately 80 m (262 ft), after which it increases rapidly down to the open basin. The outfall diffuser lies at a nominal depth of 60 m (197 ft) on the southern portion of the shelf between the Newport and San Gabriel submarine canyons. The monitoring area southeast of the outfall is characterized by a much narrower shelf and deeper water offshore (Figure 1-1).

The 120-in outfall represents one of the largest artificial reefs in this region and supports communities typical of hard substrates that would not otherwise be found in the monitoring area (Lewis and McKee 1989, OCSD 2000). Together with OC San's 78-in (198 cm) outfall, approximately 102,193 m² (1.1×10^6 ft^2) of seafloor was converted from a flat, sandy habitat into a raised, hard-bottom substrate.

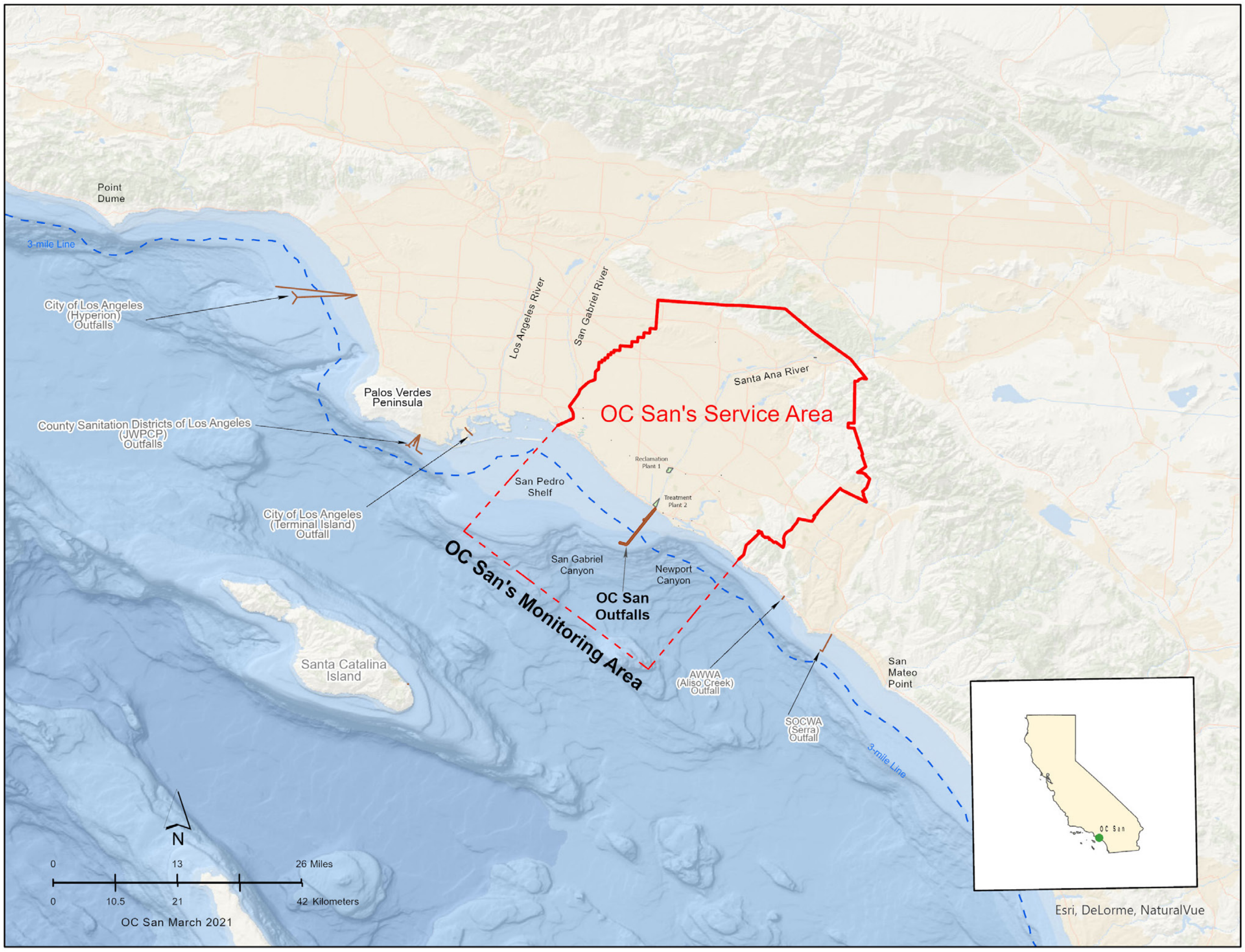

Figure 1–1 Regional setting and sampling area for OC San's Ocean Monitoring Program.

As part of the California Current Ecosystem, conditions within OC San's Core monitoring area are affected by global, regional, and local oceanographic influences. Global climatic (e.g., El Niño) and large-scale regional current conditions (e.g., California Current) influence the water characteristics and the direction of water flow along the Orange County coastline (Hood 1993). The California Multivariate Ocean Index (Farallon Institute 2020) incorporates multiple local and regional conditions summarizing the environmental state of California's coastal ocean and demonstrates alternating periods of warmer (red) and cooler (blue) conditions (Figure 1-3A–C). These trends are reflected locally in surface waters along the San Pedro Shelf at the shore (Newport Pier; SIO 2020), mid-shelf (OC San outfall) and off-shelf (San Pedro Buoy; CDIP 2020) (Figure 1-3D–F), with the last 7 years being warmer than average. Temperature anomalies along the CalCOFI Line 90 (SIO 2021) illustrate the cross-shelf temperature signal reaches out to 500 km (311 miles) from shore and spans the water column from near the surface to the OC San outfall depth (Figure 1-4A–C).

Other oceanographic processes (e.g., upwelling, coastal eddies) and algal blooms also influence the characteristics of receiving waters on the San Pedro Shelf. Tidal flows, currents, and internal waves mix and transport OC San's wastewater discharge with coastal waters and resuspended sediments. Locally, the predominant low-frequency current flows in the monitoring area are alongshore (upcoast or downcoast) with minor across-shelf (toward the beach) transport (CSDOC 1997, 1998; SAIC 2001, 2009, 2011; OCSD, 2004, 2011). The specific direction of the

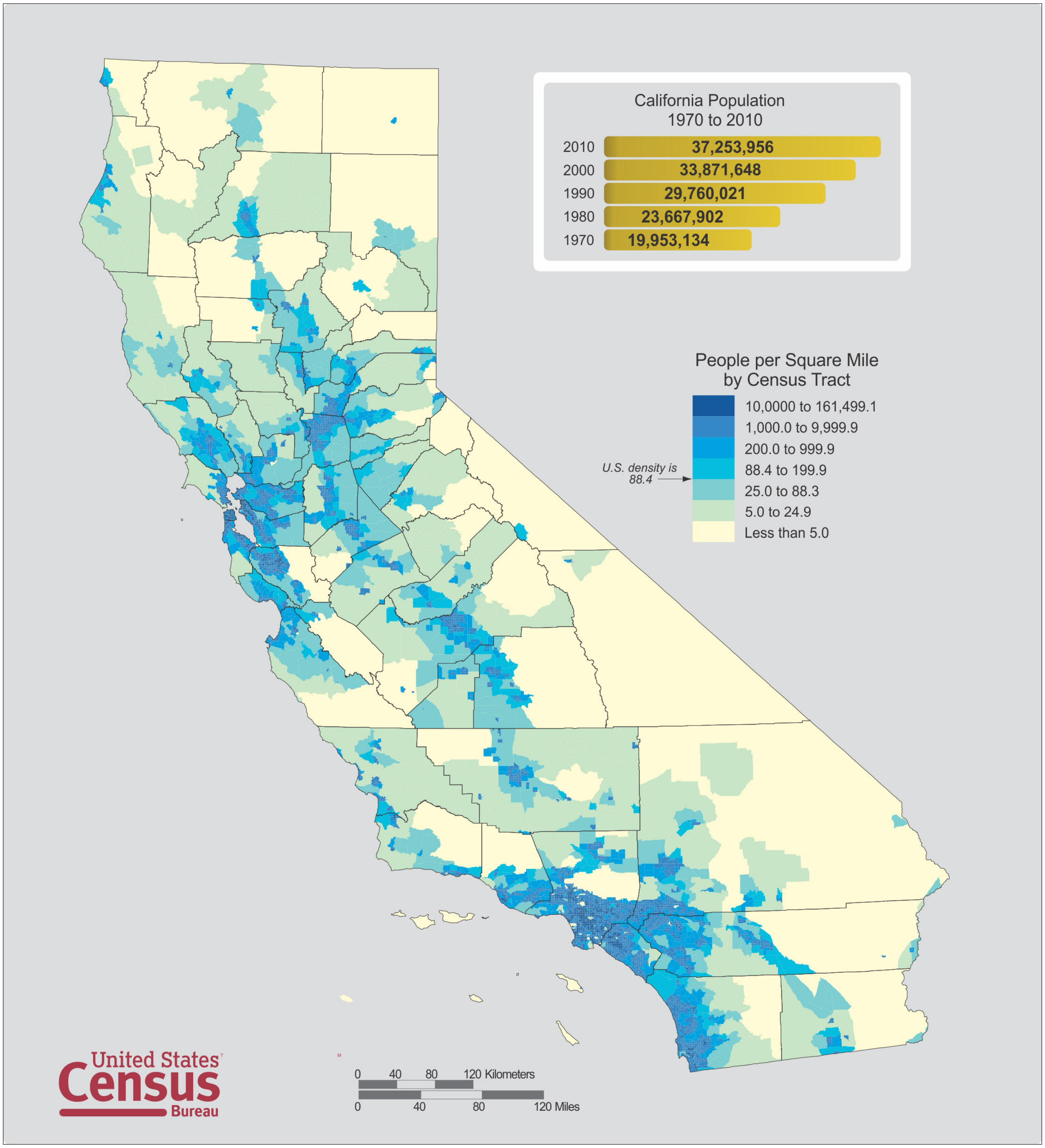

Figure 1–2 California 2010 urbanized areas (adapted from https://www2.census.gov/geo/maps/dc10_thematic/2010_Profile/2010_Profile_Map_California.pdf).

flows varies with depth and season and is subject to reversals over time periods of days to weeks (SAIC 2011). Tidal currents in the monitoring area 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. Algal blooms, while variable, have both regional and local distributions that can impact human and marine organism health (Nezlin et al. 2018, UCSC 2018, CeNCOOS 2019).

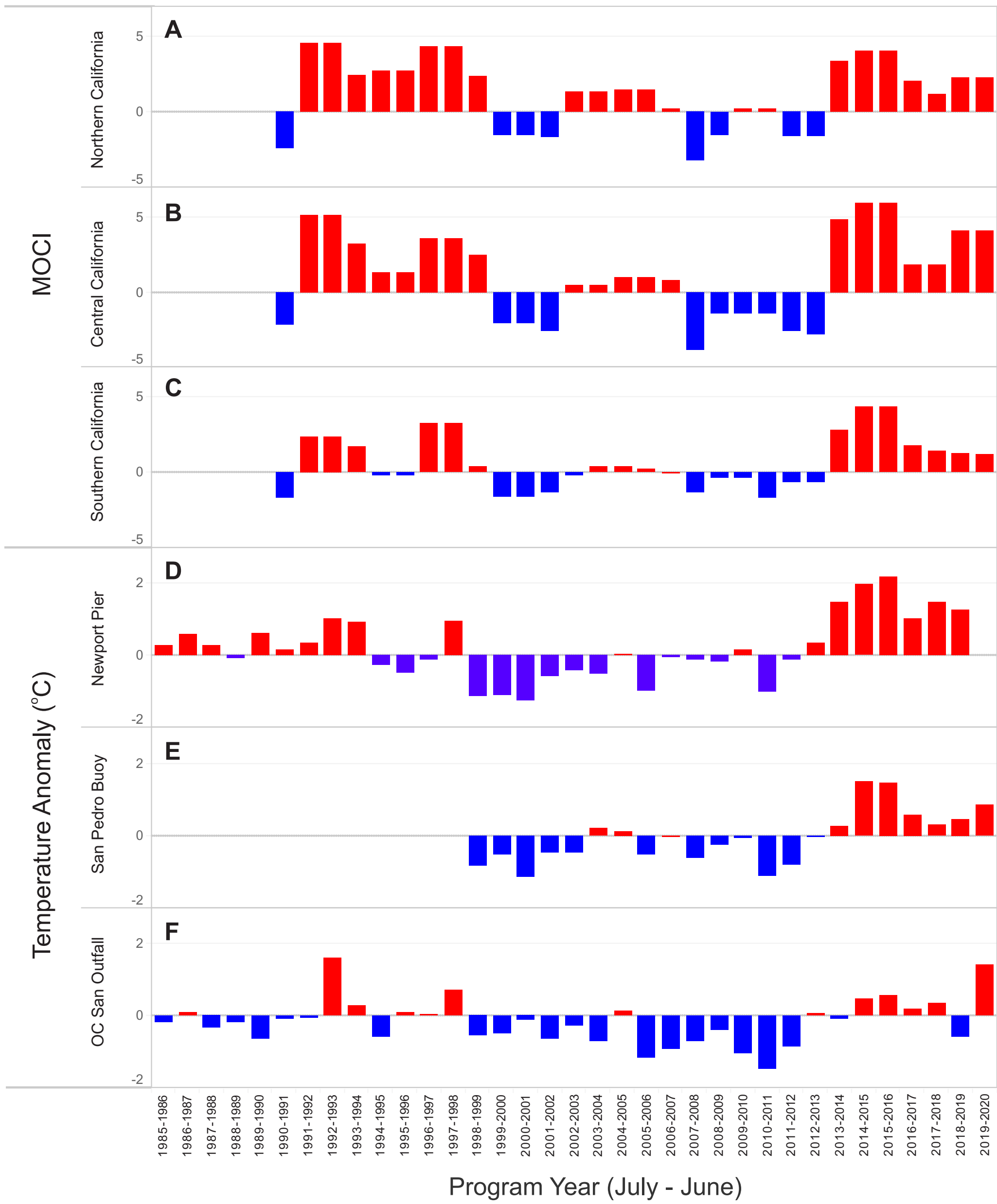

Figure 1–3 California Multivariate Ocean Climate Index (A–C) and ocean surface (0–3 m) temperature anomalies recorded at (D) Scripps Institution of Oceanography Newport Pier shore station, (E) OC San outfall (Stations 0 and 2205), and (F) Coastal Data Information Program (Station 092; NDBC 46222) by Program Year (July–June).

Atmospheric weather events (e.g., episodic storms, drought, and climatic cycles) influence surface flows and hence, environmental conditions and biological communities. River flows, together with urban stormwater runoff, represent significant, if episodic, sources of fresh water, sediments, suspended particles, nutrients, bacteria, and other contaminants to the coastal area (Hood 1993, Grant et al. 2001, Warwick et al. 2007), although some studies indicate that the spatial impact of these effects may be limited (Ahn et al. 2005, Reifel et al. 2009). While materials supplied to coastal waters by rivers and stormwater flows are essential to natural biogeochemical cycles, an excess or a deficit may have important environmental and human health consequences.

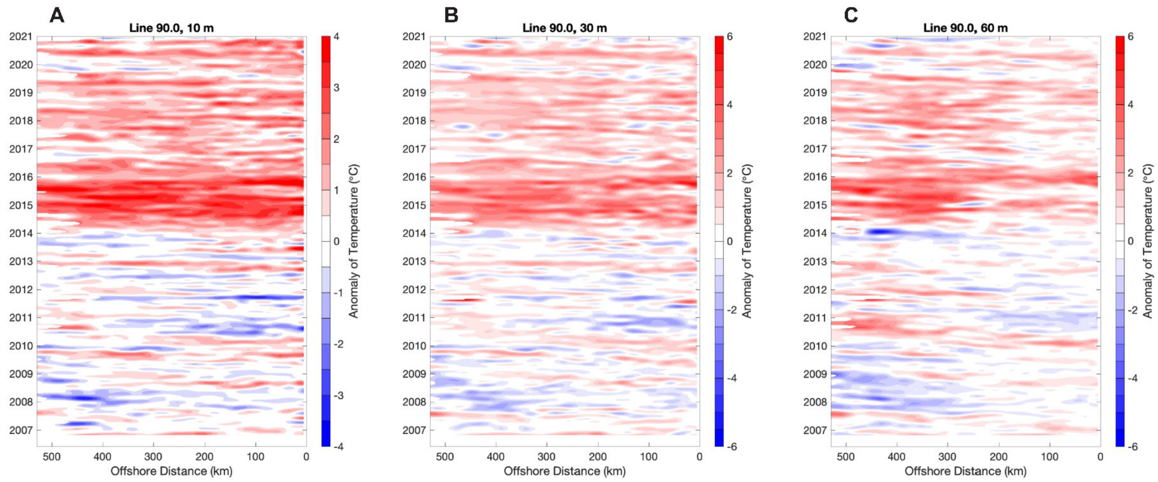

Figure 1–4 Temperature anomalies along CalCOFI Line 90 at (A) surface (10 m), (B) typical plume trapping depth (30 m), and (C) OC San outfall depth (60 m). Source: California Underwater Glider Network, Scripps Institution of Oceanography (https://spraydata.ucsd.edu/projects/CUGN/, 1/6/2021).

Stormwater runoff has a large influence on sediment movement in the region (Brownlie and Taylor 1981, Warrick and Millikan 2003). Major storm events can generate waves capable of extensive coastal erosion and inundation and can resuspend and move sediments along the coast. Understanding the interplay of weather cycles and watershed inputs is an important factor in evaluating spatial and temporal trends in local coastal environmental quality. For 2019-20, annual rainfall at Newport Harbor (NCEI 2020) was at its historical average of 10.26 inches, while Santa Ana River flows (USGS 2020) were 10,076 cubic feet per second (CFS), well below the average 23,107 CFS (Figure 1-5A, C). While both rainfall and river flow are highly variable (Figure 1-5B, D), mean Santa Ana River flows are dominated by relatively few large flow events beginning in 1968-69.

Beaches are a primary reason for people to visit coastal California (Kildow and Colgan 2005, NOAA 2015). Although highest visitations occur during the warmer, summer months, southern California's Mediterranean climate and convenient beach access results in significant year-round use by the public (Figure 1-6). Daily beach attendance for the City of Newport Beach in 2019-20 was below average for most of the year even with higher (up to 5 ºF) monthly air temperatures. The much lower visitation in March and April 2020 may be attributed to statewide COVID-19 restrictions. For the year, total beach attendance slightly exceeded 7.7 million and fell below the long-term mean (approx. 9 million). A large percentage of the local economies rely on beach use and its associated recreational activities, which are highly dependent upon local water quality conditions (Turbow and Jiang 2004, Leeworthy and Wiley 2007, Leggett et al. 2014). In 2012, Orange County's coastal economy accounted for $3.8 billion (or 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 southern California beaches, Heal the Bay (2020) found 93% of the monitored beaches received "grades" of A or B during the summer (5-year mean = 97%) and 94% in the winter (5-year mean = 89%).

OC San OPERATIONS

OC San'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 requirements. These objectives are achieved through extensive industrial pre-treatment

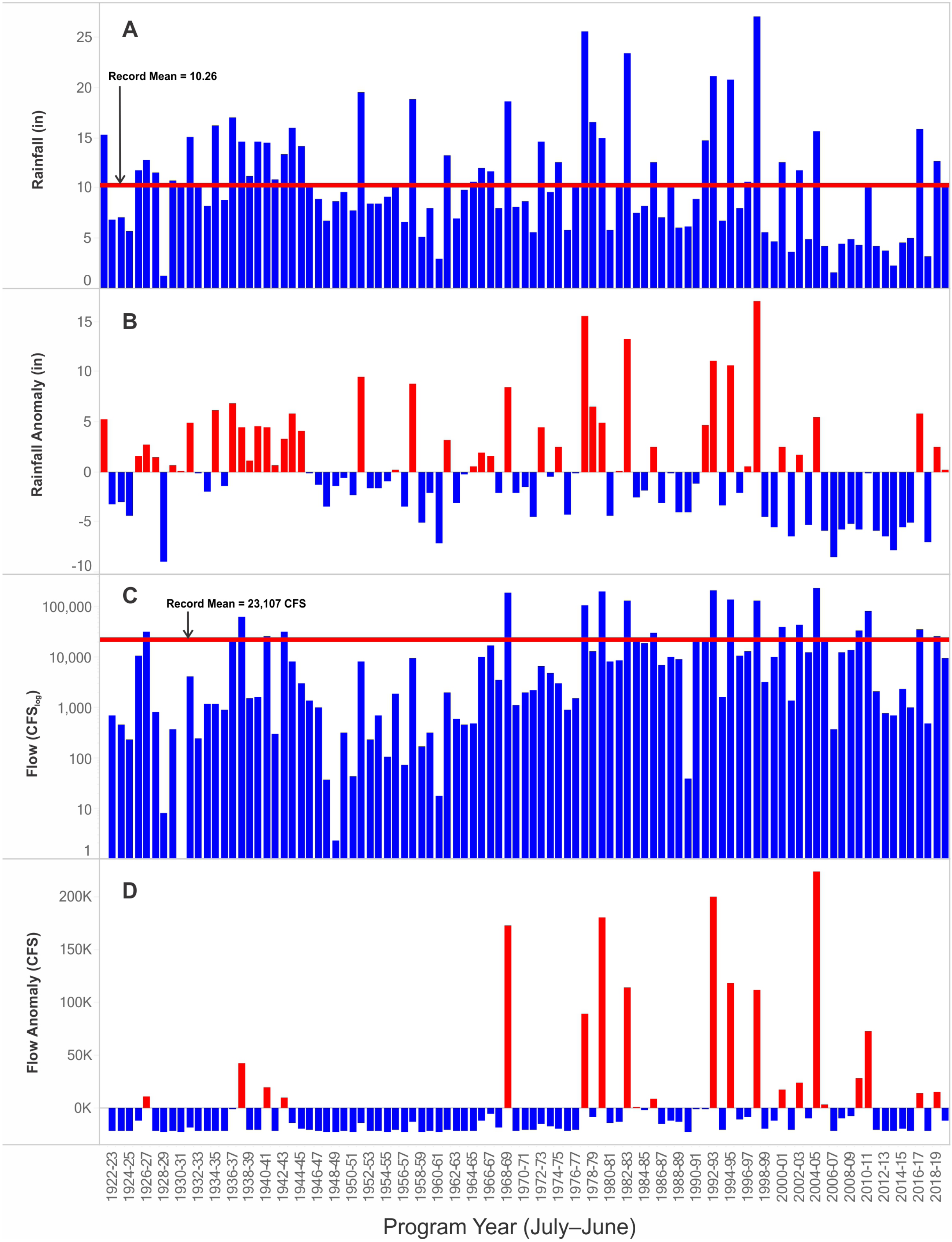

Figure 1–5 Annual Newport Harbor rainfall (A), rainfall anomalies (B), Santa Ana River flows (C), and flow anomalies (D).

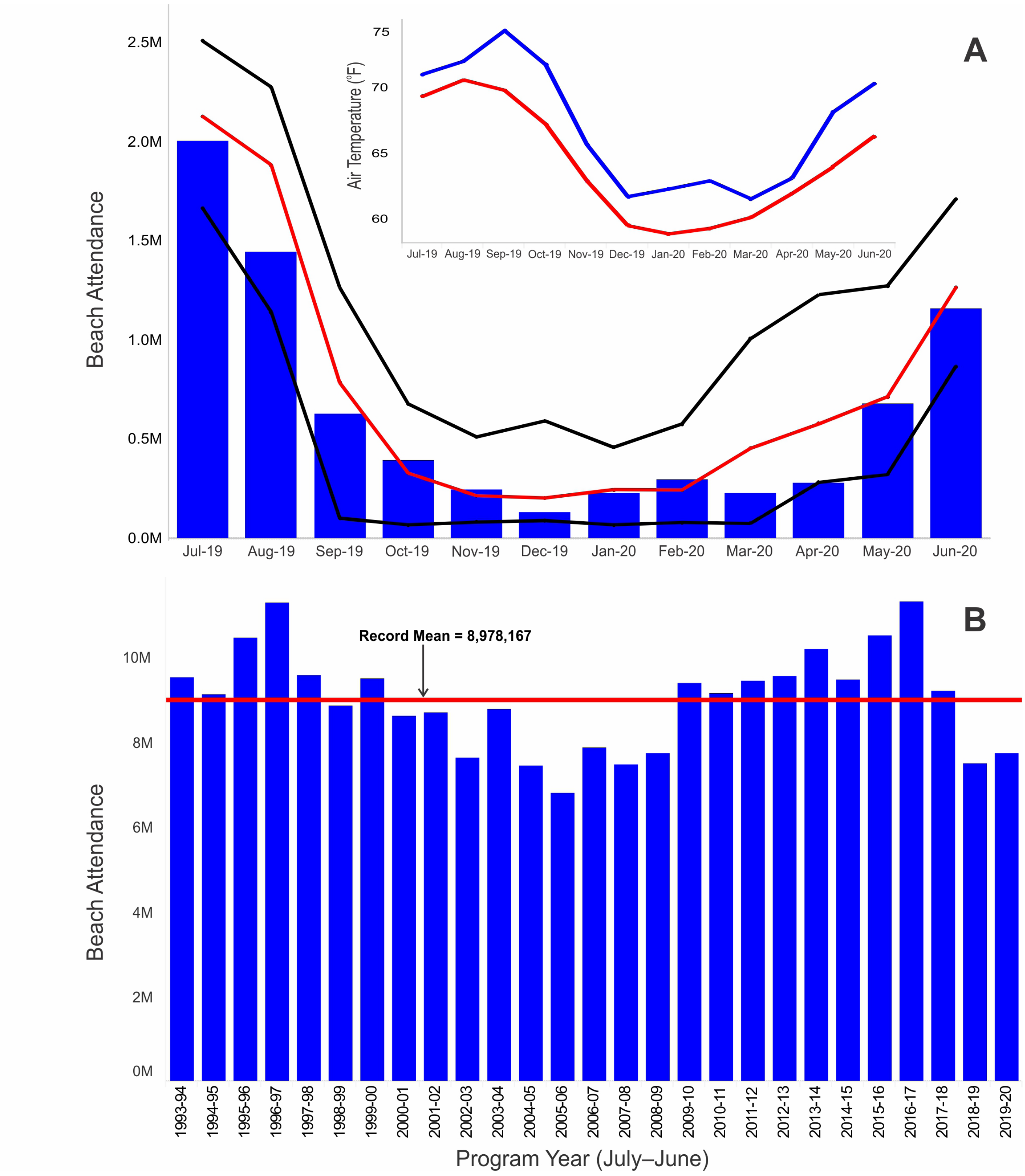

Figure 1–6 Monthly 2019-20 beach attendance and air temperature (A) and annual beach attendance (B) at the City of Newport Beach, California.

(source control), secondary treatment processes, biosolids management, and water reuse programs.

OC San's 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 diameter ocean outfall, which extends 7.1 km (4.4 miles) from the Huntington Beach shoreline (Figure 1-1). The last 1.8 km (1.1 miles) of the outfall consists of a diffuser with 503 ports that discharge the treated effluent at a nominal depth of 60 m.

During the past 21 years, OC San has treated over 10.2 billion gallons of dry weather urban runoff that would have otherwise gone into the ocean without treatment. Currently accepting 10 million gallons per day (MGD) (3.8×10^7 L/day) the collection and treatment of urban runoff, which began as a regional effort to reduce beach bacterial pollution associated with chronic dry-weather flows, has grown to include accepting diversions to help remediate other environmental problems, such as high selenium flows, to protect Orange County's waterways. There are 21 active diversions including stormwater pump stations, the Santa Ana River, several creeks, and 3 flood control channels. For 2019-20, OC San treated 480 MG (1.8×10^9 L) of flow, exceeding the 2013–2019 average yearly flow of 371 MG (1.4×10^9 L). Monthly average daily diversion flows ranged from 0.4–2.1 MGD ($1.5–7.9 \times 10^6$ L/day) with a normalized monthly flow of 1.5 MGD (5.7×10^6 L/day) (OCSD 2020).

OC San 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 1986, 3–10 MGD ($1.1–3.8 \times 10^7$ L/day) of the final effluent has been provided to 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, OC San 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 net GAP and GWRS diversions (diversions minus return flows to OC San) increased to 44 MGD (1.7×10^8 L/day) in 2008-09, 61 MGD (2.3×10^8 L/day) in 2013-14, and 88 MGD (3.3×10^8 L/day) in 2019-20 (Figure 1-7).

During 2019-20, OC San received and processed influent volumes averaging 188 MGD (7.1×10^8 L/day). After diversions to the GAP and GWRS and the return of OCWD's reject flows (e.g., brines), OC San discharged an average of 100 MGD (3.8×10^8 L/day) of treated wastewater to the ocean (Figure 1-7).

Prior to 1990, the annual wastewater discharge volumes increased faster than Orange County population growth (CDF 2020) (Figure 1-7). Wastewater flows decreased in 1991-92 due to drought conditions and water conservation measures and then rose at the same rate as the population until the end of the late 1990s. Since then, influent flows have decreased. Reductions in influent flows have been attributed to improved water efficiency and decreases in water use. The combined effect of reduced influent and increased water reclamation flows have dramatically reduced ocean discharge flows.

REGULATORY SETTING FOR THE OCEAN MONITORING PROGRAM

OC San's NPDES 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 OC San's Ocean Monitoring Program (OMP) based on 3 inter-related components: (1) Core monitoring; (2) Strategic Process Studies (SPS); and (3) Regional monitoring. 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.

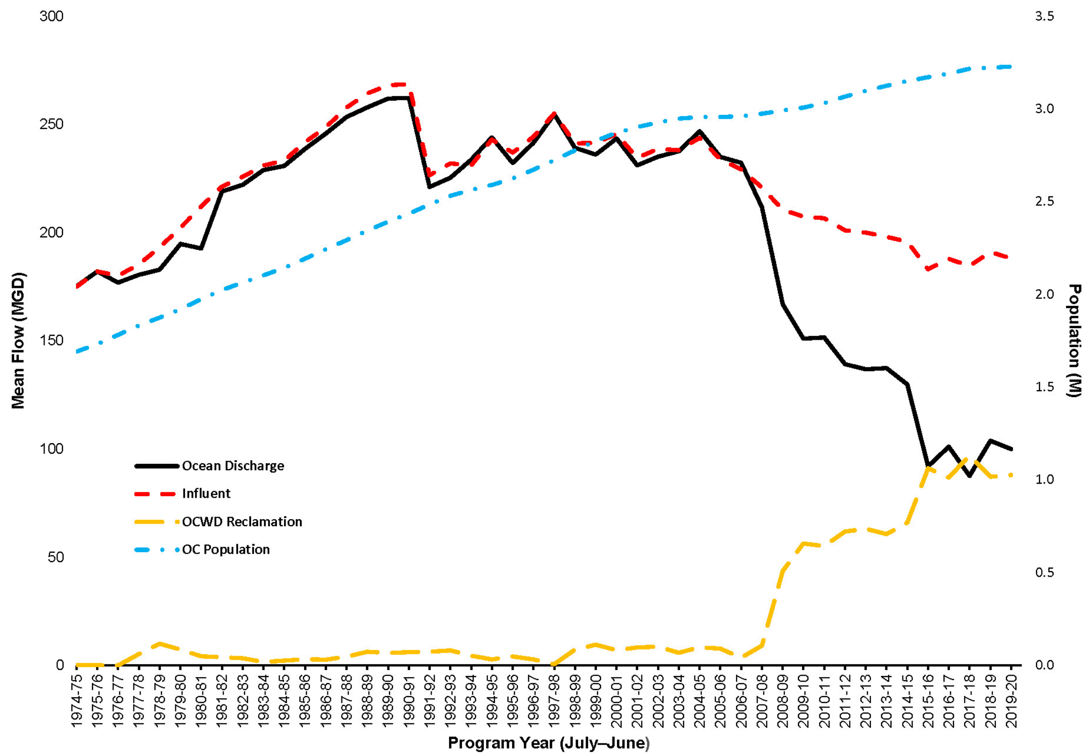

Figure 1–7 Total annual population for Orange County (OC), California, and annual mean OC San influent and ocean discharge flows and Orange County Water District (OCWD) reclamation flows, 1974–2020.

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 includes fish tissue contaminant and histopathology analyses.

OC San conducts SPS, as well as other smaller special studies, to provide information about relevant coastal and ecotoxicological processes that are not addressed by Core monitoring. Recent studies have included contributions to the development of ocean circulation and biogeochemical models and fish tracking.

Since 1994, OC San has participated in 6 regional monitoring studies of environmental conditions within the SCB: 1994 Southern California Bight Pilot Project, Bight'98, Bight'03, Bight'08, Bight'13, and Bight'18. OC San plays an integral role in these regional projects by leading many of the program design decisions and by doing field sampling, sample and data analyses, and reporting. 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 and reports can be found at the Southern California Coastal Water Research Project's website (https://www.sccwrp.org/about/research-areas/regional-monitoring/southern-california-bight-regional-monitoring-program/).

Other collaborative regional monitoring efforts include:

- Participation in the Southern California Bight Regional Water Quality Program (previously known as the Central Bight Water Quality Program), a water quality sampling effort with the City of Oxnard, the City of Los Angeles, the County Sanitation Districts of Los Angeles, and the City of San Diego.
- Supporting and working with the Southern California Coastal Ocean Observing System to upgrade sensors on the Newport Pier Automated Shore Station (http://www.sccoos.org/data/autoss).
- Partnering with the Orange County Health Care Agency and other local publicly owned treatment works to conduct regional nearshore (aka surfzone) bacterial monitoring used to determine the need for beach postings and/or closure.
- Collaborating on a regional aerial kelp monitoring program.

The complexities of the environmental setting and related difficulties in assigning a cause or source to a pollution event are the rationale for OC San's extensive OMP. The program has contributed substantially to the understanding of water quality and environmental conditions along Orange County beaches and coastal ocean reach. The large amount of information collected provides a broad understanding of both natural and anthropogenic processes that affect coastal oceanography and marine biology, the near-coastal ocean ecosystem, and beneficial uses of the ocean.

This report presents OMP compliance determinations for data collected from July 2019 through June 2020. Compliance determinations were made by comparing OMP findings to the criteria specified in OC San's NPDES permit (Chapter 2). Any related special studies or regional monitoring efforts are also documented (Chapter 3). Supporting information is provided in appendices.

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CHAPTER 2
Compliance Determinations

INTRODUCTION

This chapter provides compliance results for the 2019-20 monitoring year for the Orange County Sanitation District's (OC San) Ocean Monitoring Program (OMP). The program includes sample collection, analysis, and data interpretation to evaluate potential impacts of treated 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, 2-2, and 2-3). Monitoring frequencies varied by component and ranged from 1–2 days per week for nearshore (also called surfzone) water quality sampling to annual assessments of fish health and tissue analyses (see Appendix A).

WATER QUALITY

Offshore bacteria

For all 3 fecal indicator bacteria (FIB), 89–100% of the samples were below their 30-day geomean values and none exceeded their respective single sample standard (Table B-1). The highest density observed for any single sample at any single depth for total coliforms, fecal coliforms, and enterococci was 1,670, 451, and 85 MPN/100 mL, respectively. With the large number of samples being below the detection limit of 10 MPN/100 mL, most of the depth-averaged values used for water contact compliance were below detection (Tables B-2, B-3, and B-4). Compliance for all 3 FIB was achieved 100%, 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 station in 2019-20 (Tables B-5 and B-6). Therefore, compliance was achieved.

Table 2–1 Listing of compliance criteria from OC San's NPDES permit (Order No. R8-2012-0035, Permit # CA0110604) and compliance status for each criterion in 2019-20. Abbreviation: N/A = Not Applicable.

Criteria	Criteria Met
Bacterial Characteristics	
V.A.1.a. For the CA 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 CA 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 CA Ocean Plan Water-Contact Standards, enterococci 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, enterococci 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 CA 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 1 (formerly 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 1 (formerly 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 96% of the time (Table 2-2). All transmissivity values were within natural ranges of variability to which marine organisms are exposed (Table B-7; CSDOC 1996a, b; OCSD 2004). Hence, there were no impacts from the treated wastewater discharge relative to ocean discoloration at any offshore station.

Dissolved Oxygen

Oxygen compliance was 100% (Table 2-2), with values well within the range of long-term monitoring results (Table B-7; CSDOC 1996a, b; OCSD 2004).

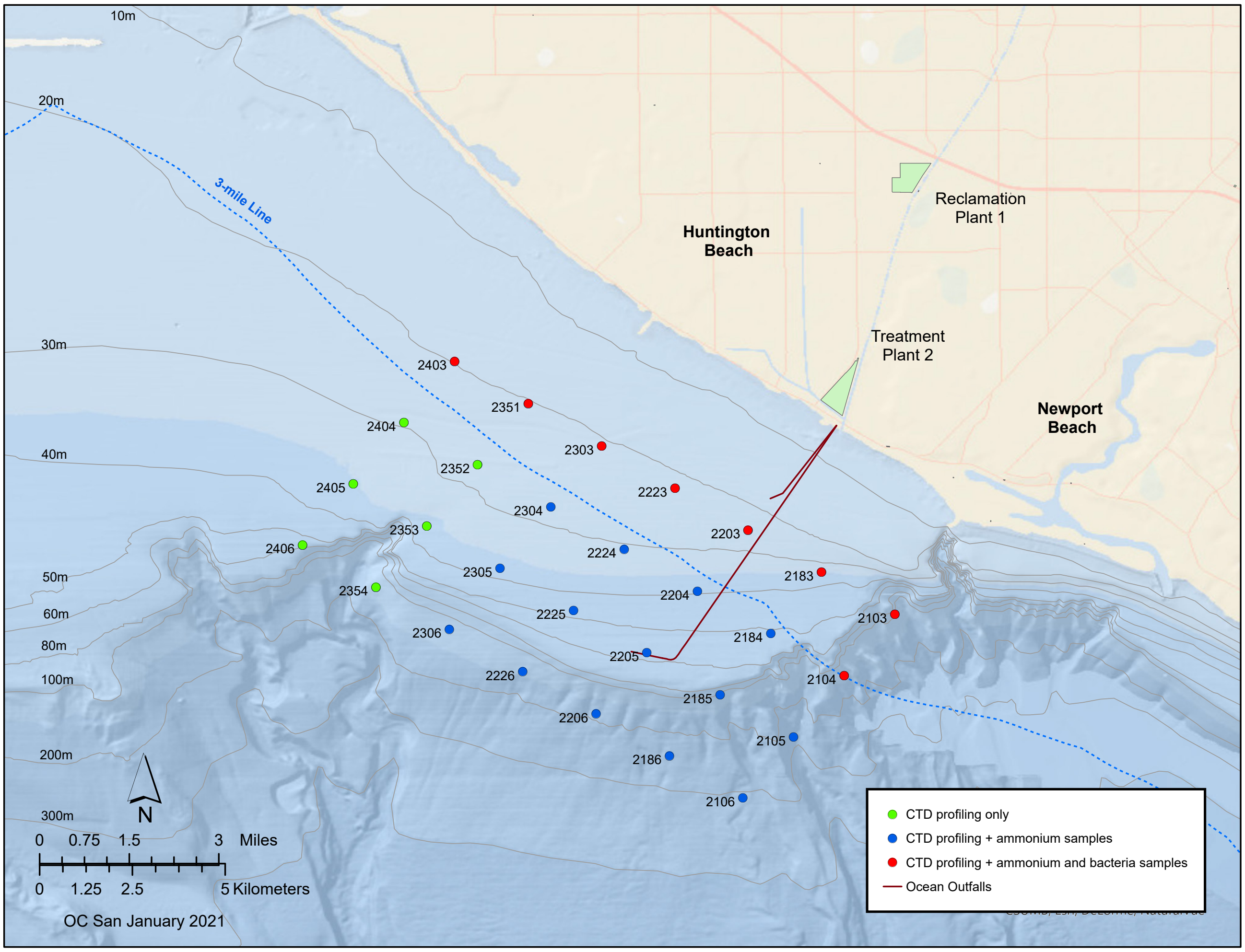

Figure 2–1 Offshore water quality monitoring stations for 2019-20.

Acidity (pH)

Compliance with COP pH standards was 100% (Table 2-2), with measured values within the range to which marine organisms are naturally exposed (Table B-7; CSDOC 1996a, b; OCSD 2004).

Nutrients (Ammonia-Nitrogen)

For the 2019-20 program year, 75% of the monthly Core water samples for ammonia-nitrogen (NH_3-N), including those from the within-ZID Station 2205, were below the method detection limit of 0.04 mg/L (Table B-8). Detectable NH_3-N concentrations, including estimated values, ranged from 0.04 to 0.34 mg/L (Figure 2-4A). Plume-related changes in NH_3-N were not considered environmentally significant as maximum values were more than 10 times less than the chronic (4 mg/L) and nearly 18 times less than the acute (6 mg/L) toxicity standards of the COP (Figure 2-4B; SWRCB 2012). In addition, there were no detectable plankton-associated impacts (i.e., excessive plankton blooms caused by the discharge).

COP Water Quality Objectives

OC San's NPDES permit contains 8 constituents from Table 1 (formerly Table B-8) of the COP that have effluent limitations (see Table 9 of OC San's NPDES Permit). Receiving water compliance was met during the period from July 2019 through June 2020 because none of these constituents exceeded their respective effluent limitations.

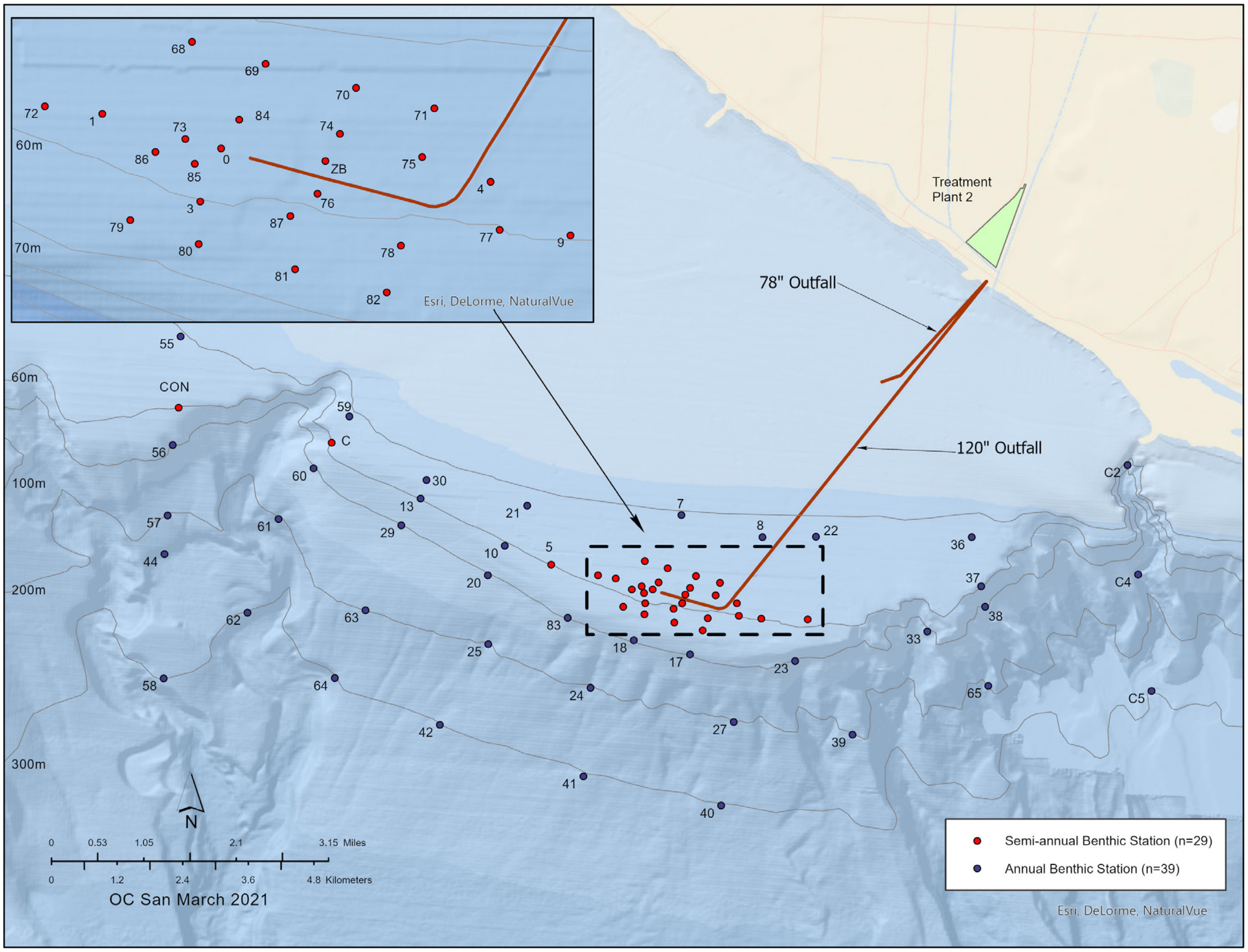

Figure 2–2 Benthic (sediment geochemistry and infauna) monitoring stations for 2019-20.

Radioactivity

Pursuant to OC San's NPDES Permit, OC San measures the influent and the effluent for radioactivity but not the receiving waters. The results of the influent and the effluent analyses during 2019-20 indicated that both state and federal standards were consistently met and are published in OC San's Discharge Monitoring Reports. As fish and invertebrate communities are diverse and healthy, compliance was met.

SEDIMENT GEOCHEMISTRY

Consistent with previous years (OCSD 2014, 2016), the percent fines and mean concentrations of contaminants and metals tended to increase with increasing depth (Tables 2-3, 2-4, 2-5, and 2-6). The mean values for the physical properties and chemical concentrations of samples collected at the outfall-depth stations were similar in both surveys. Chemical contaminant concentrations were also well below applicable Effects Range-Median (ERM) guidelines of biological concern (Long et al. 1995) and were comparable to regional and historical values. Furthermore, there was no measurable sediment toxicity at any of the 9 stations monitored in the winter survey (Table 2-7). These results suggest that compliance was met.

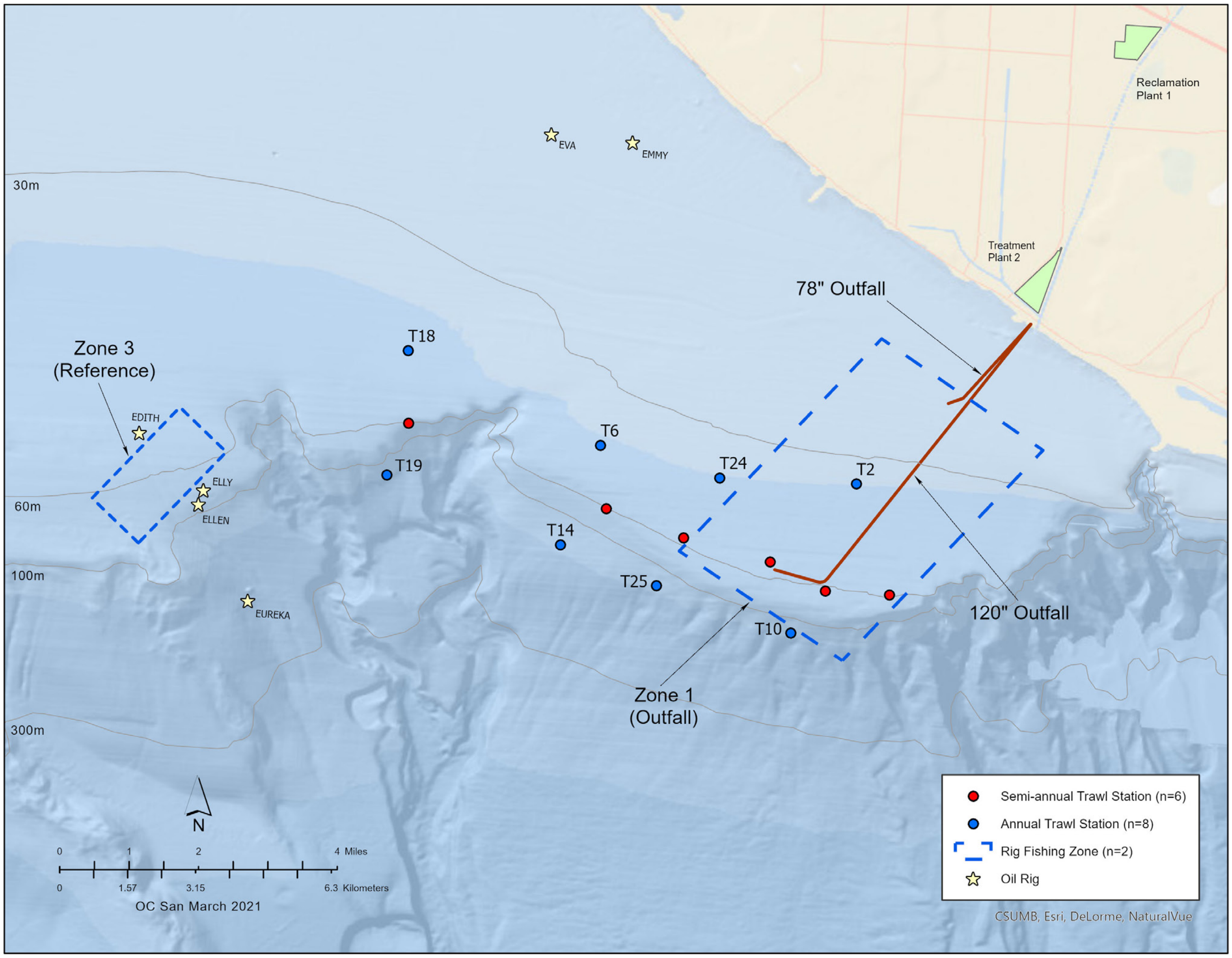

Figure 2–3 Trawl monitoring stations, as well as rig fishing locations, for 2019-20.

Table 2–2 Summary of OC San's offshore water quality compliance testing results for dissolved oxygen, pH, and transmissivity for 2019-20. Abbreviations: ORO = Out-of-Range; OOC = Out-of-Compliance.

Survey Date	Number of Stations *	Dissolved Oxygen		pH		Transmissivity	
		ORO	OOC	ORO	OOC	ORO	OOC
7/24/2019	27	0%	0%	0%	0%	7%	4%
8/13/2019	27	0%	0%	0%	0%	0%	0%
9/5/2019	27	0%	0%	0%	0%	4%	0%
10/24/2019	27	0%	0%	0%	0%	4%	4%
11/5/2019	27	0%	0%	0%	0%	7%	4%
12/10/2019	27	0%	0%	0%	0%	7%	4%
1/21/2019	27	0%	0%	0%	0%	11%	11%
2/5/2020	27	0%	0%	0%	0%	0%	0%
3/11/2020	27	0%	0%	0%	0%	0%	0%
4/29/2020	27	0%	0%	0%	0%	7%	0%
5/6/2020	27	0%	0%	0%	0%	11%	11%
6/9/2020	27	11%	0%	0%	0%	15%	15%
Annual	324	1%	0%	0%	0%	6%	4%

* Does not include within-ZID Station 2205.

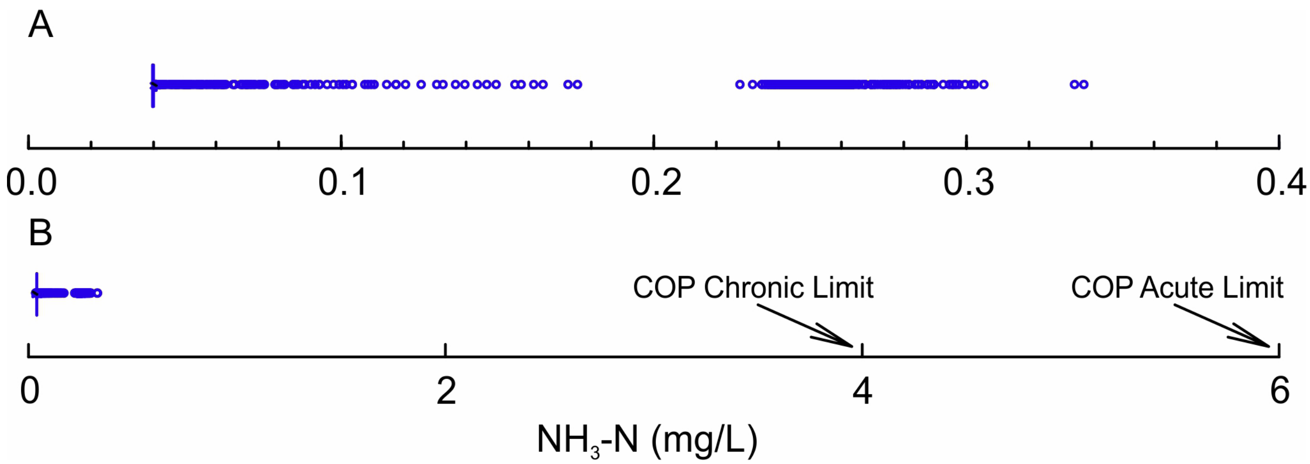

Figure 2–4 Summary box plots of ammonia-nitrogen (NH_3-N) showing (A) range of values and (B) range of values compared to California Ocean Plan (COP) toxicity levels for 2019-20.

Table 2–3 Physical properties, as well as biogeochemical and contaminant concentrations, of sediment samples collected at each semi-annual and annual (*) station in Summer 2019 compared to Effects Range-Median (ERM), regional, and historical values. Abbreviation: ND = Not Detected.

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (µg/kg)	ΣDDT (µg/kg)	ΣPest (µg/kg)	ΣPCB (µg/kg)
Middle Shelf Zone 1 (31–50 m)											
7 *	41	3.35	6.3	0.31	2.76	1100	380	51.2	1.63	ND	ND
8 *	44	3.46	11.5	0.38	ND	990	430	34.6	1.90	ND	ND
21 *	44	3.48	14.5	0.37	1.67	940	470	67.6	43.65	ND	ND
22 *	45	3.59	18.2	0.40	ND	950	440	37.7	2.00	ND	ND
30 *	46	3.30	13.8	0.33	2.08	960	380	14.1	1.27	ND	ND
36 *	45	3.74	27.0	0.33	ND	900	410	25.5	1.99	ND	ND
55 *	40	2.50	3.5	0.18	1.12	600	200	1.5	1.05	ND	ND
59 *	40	3.06	11.3	0.32	ND	950	210	6.2	1.19	ND	ND
	Mean	**3.31**	**13.3**	**0.33**	**1.91**	**924**	**365**	**29.8**	**6.84**	**ND**	**ND**
Middle Shelf Zone 2, Non-ZID (51–90 m)											
1	56	3.26	11.1	0.37	1.40	1000	420	73.1	1.65	ND	0.20
3	60	3.12	8.7	0.44	ND	910	430	57.1	1.80	ND	0.23
5	59	3.36	7.7	0.38	ND	920	390	81.3	1.79	ND	ND
9	59	2.99	6.3	0.38	ND	800	570	23.6	1.13	ND	ND
10 *	62	3.51	10.8	0.39	ND	920	380	25.4	2.06	ND	ND
12	58	2.85	6.3	0.34	1.07	820	360	25.8	1.38	ND	ND
13 *	59	3.57	19.2	0.38	ND	910	420	24.2	1.91	ND	ND
37 *	56	3.70	34.3	0.40	4.30	570	480	28.9	1.57	ND	ND
68	52	3.41	14.2	0.39	ND	880	450	65.9	1.74	ND	ND
69	52	3.32	11.1	0.45	1.14	940	440	93.2	1.76	ND	ND
70	52	3.30	13.3	0.42	ND	970	730	203.8	1.80	ND	ND
71	52	3.28	20.8	0.36	1.12	930	450	80.1	1.50	ND	ND
72	55	3.24	9.7	0.37	ND	970	470	81.6	1.51	ND	ND
73	55	3.33	18.0	0.47	1.08	1400	690	227.9	2.19	ND	6.62
74	57	3.08	6.4	0.42	ND	890	440	68.0	1.44	1.78	ND
75	60	3.13	13.7	0.35	ND	1000	440	37.5	1.05	ND	ND
77	60	3.11	10.1	0.33	ND	920	340	16.0	9.97	ND	ND
78	63	3.16	7.8	0.34	2.01	900	340	26.4	1.18	ND	ND
79	65	3.20	10.8	0.37	1.94	900	430	18.1	1.39	ND	0.20
80	65	3.86	28.0	0.39	1.20	880	350	4.0	ND	ND	ND
81	65	3.27	13.9	0.28	ND	900	320	11.9	1.18	ND	ND
82	65	3.04	7.2	0.32	ND	950	380	21.9	1.11	ND	ND
84	54	3.13	6.3	0.35	ND	910	410	39.8	1.49	ND	0.27
85	57	3.09	9.3	0.50	ND	1100	440	42.6	1.74	ND	1.61
86	57	3.12	7.9	0.41	ND	970	480	43.8	1.72	ND	0.42
87	60	3.11	7.3	0.34	1.48	910	350	33.4	1.08	ND	ND
C	56	3.34	20.3	0.32	ND	880	370	14.1	1.51	ND	ND
C2 *	56	4.82	47.7	2.32	37.90	1100	2100	255.2	7.46	ND	ND
CON	59	3.30	12.8	0.34	2.69	960	450	17.5	2.25	ND	ND
	Mean	**3.31**	**13.8**	**0.45**	**4.78**	**935**	**494**	**60.1**	**2.01**	**0.06**	**0.33**

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 (µg/kg)	ΣDDT (µg/kg)	ΣPest (µg/kg)	ΣPCB (µg/kg)
Middle Shelf Zone 2, Within-ZID (51–90 m)											
0	56	3.10	8.6	0.41	ND	1200	410	71.5	1.81	ND	4.29
4	56	3.13	11.1	0.39	ND	900	440	46.5	1.22	ND	ND
76	58	3.04	8.8	0.31	2.49	930	390	14.9	1.02	ND	4.61
ZB	56	3.09	9.0	0.38	ND	920	390	45.8	1.30	ND	ND
	Mean	**3.09**	**9.4**	**0.37**	**2.49**	**988**	**408**	**44.7**	**1.34**	**ND**	**2.22**
Middle Shelf Zone 3 (91–120 m)											
17 *	91	3.35	21.4	0.36	1.58	780	400	7.7	1.66	ND	ND
18 *	91	3.24	11.3	0.40	ND	890	460	9.7	1.81	ND	ND
20 *	100	3.69	17.8	0.50	2.17	900	510	23.3	2.51	ND	ND
23 *	100	2.98	6.5	0.33	3.29	840	410	7.7	1.38	ND	ND
29 *	100	3.82	17.4	0.50	4.67	960	580	50.9	2.96	ND	ND
33 *	100	3.03	11.2	0.42	2.10	730	800	23.1	1.72	ND	ND
38 *	100	3.55	20.8	0.48	1.95	870	510	44.3	2.14	ND	ND
56 *	100	3.56	14.9	0.51	1.66	1000	570	41.3	3.35	ND	ND
60 *	100	3.81	21.6	0.60	8.75	900	650	37.3	3.24	ND	ND
83 *	100	3.41	13.1	0.41	ND	840	460	21.9	1.72	ND	ND
	Mean	**3.44**	**15.6**	**0.45**	**3.27**	**871**	**535**	**26.7**	**2.25**	**ND**	**ND**
Outer Shelf (121–200 m)											
24 *	200	3.86	18.3	0.81	2.80	950	850	47.7	23.82	ND	ND
25 *	200	4.43	37.0	1.04	3.45	920	1100	40.4	5.40	ND	ND
27 *	200	3.78	20.8	0.66	1.28	970	660	44.9	3.52	ND	ND
39 *	200	4.22	40.1	0.54	ND	840	550	22.2	1.86	ND	ND
57 *	200	5.02	52.5	1.56	6.59	940	1600	133.5	6.48	ND	0.84
61 *	200	4.27	35.5	1.03	3.26	910	1000	89.8	2.64	ND	2.88
63 *	200	4.54	40.4	0.88	3.01	970	980	91.1	3.05	ND	0.65
65 *	200	5.78	69.3	1.15	6.81	930	910	48.2	2.12	ND	ND
C4 *	187	4.99	51.5	1.20	11.80	900	1300	122.0	2.66	ND	ND
	Mean	**4.54**	**40.6**	**0.99**	**4.88**	**926**	**994**	**71.1**	**5.73**	**ND**	**0.49**
Upper Slope/Canyon (201–500 m)											
40 *	303	5.39	59.2	1.20	2.29	890	1200	20.6	2.91	ND	ND
41 *	303	4.47	40.9	1.13	1.84	870	1100	40.6	3.73	ND	ND
42 *	303	5.65	67.0	1.44	3.10	890	1400	93.6	3.84	ND	ND
44 *	241	5.78	68.5	ND	4.18	930	1700	62.3	4.62	ND	0.44
58 *	300	5.89	73.3	1.91	4.69	920	2300	149.7	6.38	ND	ND
62 *	300	5.87	72.3	1.97	10.40	930	2100	88.0	4.14	ND	3.12
64 *	300	5.39	60.6	0.93	5.04	970	1100	79.6	1.22	ND	ND
C5 *	296	6.12	78.9	1.93	38.20	870	2000	101.0	3.46	ND	ND
	Mean	**5.57**	**65.1**	**1.50**	**8.72**	**909**	**1612**	**79.4**	**3.79**	**ND**	**0.44**
Sediment quality guidelines											
ERM	—	—	—	—	—	—	44,792.0	46.10	—	180.00	
Regional Bight'13 summer values (area weighted mean)											
Middle Shelf	—	48.0	0.70	—	—	690	55.0	18.00	—	2.70	
Outer Shelf	—	49.0	0.93	—	—	1000	92.0	796.00	—	4.50	
Upper Slope/ Canyon	—	75.0	1.90	—	—	2500	160.0	490.00	—	15.00	
OC San historical summer values (July 2009–September 2018) [mean (range)]											
Middle Shelf Zone 1	3.60 (2.57–4.05)	27.7 (3.2–51.8)	0.42 (0.16–1.18)	3.28 (1.10–7.87)	978 (600–1300)	357 (170–640)	50.7 (7.9–388.5)	3.00 (ND–22.35)	0.08 (ND–3.99)	0.84 (ND–4.82)	
Middle Shelf Zone 2, Non-ZID	3.48 (2.55–5.68)	22.2 (6.3–91.8)	0.41 (0.21–2.70)	6.36 (1.18–198)	915 (360–2000)	364 (69–1200)	70.9 (7.7–527.2)	2.21 (ND–52.90)	0.12 (ND–9.20)	3.15 (ND–70.39)	
Middle Shelf Zone 2, Within-ZID	3.35 (2.99–3.57)	14.4 (5.8–33.1)	0.39 (0.27–0.72)	4.71 (1.08–14.16)	980 (490–1700)	376 (90–610)	147.1 (19.4–758.3)	1.19 (ND–4.14)	0.53 (ND–9.37)	4.04 (ND–24.75)	
Middle Shelf Zone 3	3.74 (2.57–4.37)	35.5 (5.8–71.1)	0.58 (0.27–3.93)	5.74 (1.08–18.60)	912 (640–1200)	447 (230–680)	58.5 (13.6–147.3)	4.39 (ND–69.12)	ND (All ND)	1.31 (ND–7.14)	
Outer Shelf	4.70 (3.61–5.91)	68.8 (24.5–95.1)	1.17 (0.41–2.66)	12.47 (1.74–82.00)	964 (790–1200)	922 (490–1600)	122.8 (19.4–367.3)	8.26 (ND–22.11)	0.16 (ND–8.50)	3.23 (ND–11.59)	
Upper Slope/ Canyon	5.35 (2.19–6.51)	81.9 (44.7–98.1)	1.78 (0.82–3.35)	17.06 (1.46–88.20)	915 (700–1100)	1412 (460–2300)	157.5 (44.0–336.3)	11.30 (1.90–34.33)	0.48 (ND–13.30)	4.19 (ND–13.79)	

Table 2–4 Metal concentrations (mg/kg) in sediment samples collected at each semi-annual and annual (*) station in Summer 2019 compared to Effects Range-Median (ERM), regional, and historical values. Abbreviation: ND = Not Detected.

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	0.07	3.49	45.2	0.22	0.14	15.60	7.00	6.42	0.02	7.5	0.46	0.11	34.3
8 *	44	0.09	3.57	50.9	0.24	0.13	16.50	7.13	6.53	0.02	8.0	1.14	0.08	35.2
21 *	44	0.07	3.97	48.4	0.23	0.12	17.90	8.15	7.40	0.01	8.5	0.39	0.12	38.2
22 *	45	0.08	4.21	48.3	0.26	0.16	17.80	7.83	7.31	0.02	8.9	0.46	0.10	41.8
30 *	46	0.07	3.08	35.4	0.21	0.10	15.80	6.18	5.98	0.02	6.9	0.37	0.10	32.9
36 *	45	0.09	4.14	51.8	0.25	0.13	15.80	6.77	6.99	0.02	8.3	1.03	0.05	36.5
55 *	40	0.07	2.22	24.2	0.15	0.05	11.00	3.38	3.63	0.01	5.4	0.19	ND	22.7
59 *	40	0.08	3.01	39.9	0.19	0.08	14.40	5.37	5.59	0.02	6.7	0.49	0.08	29.9
	Mean	**0.08**	**3.46**	**43.0**	**0.22**	**0.11**	**15.60**	**6.48**	**6.23**	**0.02**	**7.5**	**0.57**	**0.09**	**33.9**
							Middle Shelf Zone 2, Non-ZID (51–90 m)							
1	56	0.07	3.00	41.1	0.26	0.17	18.00	9.22	6.15	0.02	8.1	1.30	0.14	39.7
3	60	0.09	3.37	38.3	0.26	0.17	18.60	9.03	5.95	0.02	8.4	1.27	0.15	41.5
5	59	0.08	3.57	48.1	0.26	0.17	18.10	8.74	6.11	0.02	9.0	1.31	0.13	42.1
9	59	0.06	3.09	36.7	0.26	0.10	16.90	6.61	5.30	0.01	7.8	1.15	0.07	36.7
10 *	62	0.06	3.50	47.2	0.26	0.19	18.70	8.71	6.40	0.02	8.9	0.53	0.15	42.1
12	58	0.06	2.84	34.2	0.23	0.10	15.00	5.73	5.04	0.01	6.9	1.42	0.06	33.9
13 *	59	0.07	3.17	53.7	0.25	0.16	18.10	7.91	6.54	0.02	8.6	0.44	0.12	40.6
37 *	56	0.07	3.02	35.6	0.24	0.14	13.70	6.03	5.98	0.01	7.1	0.24	0.06	34.6
68	52	0.08	3.58	42.1	0.25	0.14	17.70	7.97	6.37	0.02	8.6	1.26	0.12	39.3
69	52	0.09	3.53	43.0	0.26	0.16	18.60	8.63	6.42	0.02	9.4	1.35	0.12	40.7
70	52	0.09	3.08	41.5	0.26	0.18	18.00	8.05	6.14	0.02	8.6	1.17	0.11	41.5
71	52	0.07	3.25	37.9	0.25	0.22	17.20	7.41	5.44	0.01	8.1	1.35	0.11	39.8
72	55	0.08	2.86	40.7	0.26	0.15	18.00	8.72	6.17	0.02	8.6	1.24	0.14	40.0
73	55	0.08	3.32	38.4	0.26	0.33	20.40	14.50	7.68	0.22	8.4	1.27	0.19	43.4
74	57	0.08	3.16	39.7	0.26	0.21	17.80	7.94	5.88	0.02	8.2	1.14	0.11	41.1
75	60	0.08	3.87	40.1	0.26	0.18	16.70	7.47	5.48	0.01	8.0	1.15	0.08	39.9
77	60	0.06	2.57	35.2	0.25	0.12	17.10	6.96	5.12	0.01	7.6	1.10	0.16	37.7
78	63	0.07	2.75	38.2	0.27	0.10	16.80	6.65	4.99	0.01	7.9	1.17	0.08	39.2
79	65	0.09	3.55	38.5	0.27	0.13	17.40	8.14	6.00	0.02	8.3	1.26	0.11	39.3
80	65	0.07	3.77	47.5	0.39	0.10	17.80	10.20	6.62	0.01	10.3	1.40	0.07	47.8
81	65	0.06	2.77	38.0	0.30	0.09	18.30	6.95	5.14	0.01	8.7	0.95	0.07	39.0
82	65	0.07	2.94	38.3	0.28	0.08	17.60	6.85	5.40	0.01	8.4	1.17	0.07	39.7
84	54	0.08	3.21	39.9	0.25	0.23	18.30	9.16	6.01	0.20	8.3	1.64	0.14	41.1
85	57	0.10	3.63	34.9	0.25	0.29	18.90	10.70	6.95	0.03	8.1	1.19	0.17	42.2
86	57	0.08	3.68	36.4	0.24	0.68	18.20	9.02	6.35	0.03	7.8	0.99	0.13	39.7
87	60	0.06	3.09	38.4	0.29	0.12	17.20	8.70	5.35	0.01	8.2	1.16	0.10	40.1
C	56	0.09	3.00	49.1	0.25	0.13	17.90	7.18	6.17	0.01	8.5	1.50	0.08	39.8
C2 *	56	0.05	1.87	30.1	0.12	0.09	5.65	4.13	3.92	0.04	3.5	0.38	0.03	21.3
CON	59	0.10	3.12	52.3	0.28	0.10	17.80	7.22	5.88	0.01	8.9	1.09	0.07	39.0
	Mean	**0.08**	**3.18**	**40.5**	**0.26**	**0.17**	**17.26**	**8.09**	**5.89**	**0.03**	**8.2**	**1.12**	**0.11**	**39.4**
							Middle Shelf Zone 2, Within-ZID (51–90 m)							
0	56	0.08	3.23	35.2	0.24	0.41	19.00	10.60	5.95	0.04	7.8	1.12	0.18	46.1
4	56	0.08	3.86	35.9	0.26	0.12	17.40	7.11	5.76	0.01	7.8	1.45	0.08	38.9
76	58	0.06	3.06	38.4	0.27	0.13	16.70	7.97	4.95	0.01	8.2	1.14	0.10	40.7
ZB	56	0.12	3.40	38.2	0.26	0.17	17.30	8.33	5.37	0.03	8.1	1.37	0.09	38.1
	Mean	**0.08**	**3.39**	**36.9**	**0.26**	**0.21**	**17.60**	**8.50**	**5.51**	**0.02**	**8.0**	**1.27**	**0.11**	**41.0**

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	0.06	2.84	40.7	0.28	0.11	16.80	6.83	5.53	0.01	8.9	0.42	0.07	42.1
18 *	91	0.18	7.48	132.0	0.56	0.69	33.90	21.10	15.30	0.01	18.3	1.12	0.35	85.1
20 *	100	0.09	3.53	64.6	0.29	0.18	20.00	9.73	8.05	0.02	10.1	0.41	0.15	45.7
23 *	100	0.06	3.21	36.8	0.26	0.14	16.00	5.87	5.68	0.01	8.3	0.37	0.06	37.5
29 *	100	0.10	3.32	61.0	0.29	0.18	20.80	10.90	7.54	0.02	10.2	0.49	0.19	48.6
33 *	100	0.08	4.46	61.0	0.29	0.27	23.00	10.00	6.85	0.01	12.8	0.63	0.09	55.7
38 *	100	0.08	4.03	56.6	0.31	0.26	18.00	8.14	7.14	0.02	10.0	0.44	0.08	46.9
56 *	100	0.11	3.31	66.8	0.30	0.18	21.40	10.10	7.60	0.02	10.5	0.51	0.14	47.2
60 *	100	0.09	4.34	65.9	0.31	0.24	21.90	11.10	8.09	0.02	10.7	0.47	0.20	48.7
83 *	100	0.08	3.24	48.2	0.29	0.13	17.50	7.37	6.17	0.01	8.9	0.43	0.08	42.2
	Mean	**0.09**	**3.98**	**63.4**	**0.32**	**0.24**	**20.93**	**10.11**	**7.80**	**0.02**	**10.9**	**0.53**	**0.14**	**50.0**
Outer Shelf (121–200 m)														
24 *	200	0.10	3.58	84.9	0.36	0.31	23.70	12.00	8.54	0.03	12.7	0.71	0.15	54.2
25 *	200	0.12	3.65	81.3	0.37	0.30	24.30	12.00	8.41	0.04	12.8	0.70	0.15	56.3
27 *	200	0.09	3.38	67.9	0.33	0.25	21.50	9.88	7.10	0.02	11.5	0.50	0.11	50.5
39 *	200	0.09	3.53	48.4	0.31	0.17	19.90	8.60	6.68	0.01	10.4	0.53	0.07	47.5
57 *	200	0.16	5.56	146.0	0.46	0.55	36.10	23.60	15.30	0.05	16.8	0.92	0.52	75.6
61 *	200	0.13	4.95	122.0	0.41	0.53	28.20	17.80	11.40	0.03	13.9	0.94	0.35	64.5
63 *	200	0.48	3.80	158.0	0.37	0.37	25.60	13.90	9.83	0.03	13.1	0.55	0.24	57.4
65 *	200	0.14	6.16	99.6	0.44	0.63	27.50	16.80	12.60	0.03	14.7	0.75	0.31	68.1
C4 *	187	0.18	8.75	104.0	0.50	0.50	26.20	17.90	14.30	0.03	16.0	0.75	0.17	80.1
	Mean	**0.17**	**4.82**	**101.3**	**0.39**	**0.40**	**25.89**	**14.72**	**10.46**	**0.03**	**13.5**	**0.71**	**0.23**	**61.6**
Upper Slope/Canyon (201–500 m)														
40 *	303	0.14	3.92	101.0	0.42	0.35	27.40	14.20	9.74	0.02	14.3	2.16	0.16	57.8
41 *	303	0.14	4.09	105.0	0.49	0.31	27.00	14.10	9.99	0.02	14.2	0.88	0.16	60.9
42 *	303	0.16	5.13	120.0	0.46	0.42	30.70	16.90	11.90	0.02	15.7	1.13	0.23	67.8
44 *	241	0.18	6.87	135.0	0.51	0.86	37.90	25.80	17.50	0.04	17.8	0.88	0.58	79.4
58 *	300	0.18	6.90	174.0	0.55	0.54	38.60	23.60	16.30	0.04	18.5	1.30	0.38	80.7
62 *	300	0.04	1.20	33.1	0.09	0.11	6.64	4.37	2.83	0.04	3.3	0.38	0.08	13.5
64 *	300	0.14	7.80	106.0	0.64	0.31	30.40	21.30	12.80	0.02	19.8	0.85	0.17	74.0
C5 *	296	0.19	7.44	132.0	0.56	0.71	34.70	21.30	15.40	0.03	18.3	1.19	0.37	85.4
	Mean	**0.15**	**5.42**	**113.3**	**0.46**	**0.45**	**29.17**	**17.70**	**12.06**	**0.03**	**15.2**	**1.10**	**0.27**	**64.9**
Sediment quality guidelines														
ERM		—	70.00	—	—	9.60	370.00	270.00	218.00	0.70	51.6	—	3.70	410.0
Regional Bight'13 summer values (area weighted mean)														
Middle Shelf		0.92	2.70	130.0	0.21	0.68	30.00	7.90	7.00	0.05	15.0	0.10	0.29	48.0
Outer Shelf		1.10	5.30	130.0	0.36	0.82	37.00	11.00	10.00	0.07	18.0	0.21	0.39	57.0
Upper Slope/ Canyon		1.40	5.40	160.0	0.27	1.50	57.00	21.00	12.00	0.08	30.0	0.89	0.24	88.0
OC San historical summer values (July 2009–September 2018) [mean (range)]														
Middle Shelf Zone 1		0.12 (0.10–0.29)	3.09 (1.43–4.60)	39.6 (24.0–51.8)	0.22 (0.13–0.31)	0.19 (0.04–0.30)	18.25 (12.50–26.10)	8.19 (3.87–11.00)	5.61 (2.47–7.27)	0.02 (0.01–0.08)	8.8 (5.8–11.1)	0.50 (0.17–1.55)	0.12 (0.02–0.51)	35.4 (21.9–45.8)
Middle Shelf Zone 2, Non-ZID		0.20 (0.04–5.12)	2.98 (1.56–9.27)	40.3 (22.9–202.0)	0.68 (0.18–95.20)	0.31 (0.08–8.78)	21.19 (10.40–95.00)	10.87 (5.37–45.50)	5.80 (2.79–21.10)	0.03 (0.01–1.23)	10.0 (7.0–26.8)	0.68 (0.16–8.88)	0.18 (0.04–4.10)	44.3 (20.0–132.0)
Middle Shelf Zone 2, Within-ZID		0.17 (0.05–0.69)	3.04 (2.10–4.48)	38.4 (25.7–117.0)	0.26 (0.20–0.45)	0.38 (0.13–0.96)	21.46 (16.60–41.30)	14.40 (6.84–119.00)	6.81 (2.68–71.20)	0.07 (0.01–1.13)	9.6 (7.6–19.9)	0.62 (0.23–1.70)	0.19 (0.06–1.33)	45.2 (36.3–77.7)
Middle Shelf Zone 3		0.12 (0.10–0.16)	2.97 (1.55–4.12)	50.4 (27.3–74.8)	0.28 (0.20–0.35)	0.26 (0.10–0.46)	22.66 (16.20–34.60)	11.07 (5.85–16.20)	5.93 (3.20–9.02)	0.02 (0.01–0.04)	12.0 (8.6–33.1)	0.55 (0.15–1.72)	0.14 (0.05–0.33)	46.5 (32.2–55.2)
Outer Shelf		0.15 (0.11–0.22)	4.27 (1.88–7.52)	105.4 (33.1–195.0)	0.40 (0.23–0.61)	0.54 (0.17–0.94)	35.98 (21.40–83.10)	20.89 (9.21–40.30)	9.85 (4.90–17.10)	0.03 (0.01–0.06)	18.0 (8.7–25.30)	0.94 (0.20–2.35)	0.30 (0.07–0.82)	67.1 (43.3–95.4)
Upper Slope/ Canyon		0.17 (0.10–0.30)	5.40 (1.89–8.43)	133.2 (32.0–212.0)	0.50 (0.25–0.81)	0.67 (0.23–1.25)	46.70 (20.60–86.80)	28.57 (9.65–55.50)	12.85 (3.59–25.80)	0.03 (0.01–0.06)	22.8 (9.1–31.7)	1.38 (0.47–3.23)	0.39 (0.14–1.15)	80.7 (41.2–108.0)

Table 2–5 Physical properties, as well as biogeochemical and contaminant concentrations, of sediment samples collected at each semi-annual station in Winter 2020 compared to Effects Range-Median (ERM), regional, and historical values. Abbreviation: ND = Not Detected.

Station	Depth (m)	Median Phi	Fines (%)	TOC (%)	Sulfides (mg/kg)	Total P (mg/kg)	Total N (mg/kg)	ΣPAH (µg/kg)	ΣDDT (µg/kg)	ΣPest (µg/kg)	ΣPCB (µg/kg)
Middle Shelf Zone 2, Non-ZID (51–90 m)											
1	56	3.39	15.6	0.35	3.03	810	440	57.8	31.30	ND	ND
3	60	3.15	6.7	0.35	2.39	800	440	21.4	1.44	ND	0.32
5	59	3.39	9.3	0.39	1.96	840	460	51.3	1.71	ND	ND
9	59	2.90	5.3	0.34	2.87	780	390	8.5	1.07	ND	ND
12	58	3.13	20.5	0.35	1.88	760	410	21.7	1.37	ND	ND
68	52	3.32	9.3	0.42	4.81	810	420	35.2	1.42	ND	ND
69	52	3.24	9.5	0.43	3.26	870	410	39.8	1.40	ND	ND
70	52	3.08	7.8	0.42	4.43	770	520	42.1	1.48	ND	ND
71	52	3.06	7.2	0.36	2.51	900	530	59.9	1.10	ND	ND
72	55	3.19	7.5	0.40	3.64	790	410	55.7	1.63	ND	ND
73	55	3.06	5.4	0.42	5.14	1500	490	218.6	2.05	ND	3.93
74	57	3.06	4.0	0.45	2.62	800	430	43.1	1.38	ND	ND
75	60	2.98	5.8	0.32	3.15	850	350	15.6	6.76	ND	ND
77	60	2.93	5.5	0.32	1.31	1200	370	9.7	2.41	ND	ND
78	63	3.05	8.7	0.32	2.12	940	360	12.7	1.12	ND	ND
79	65	3.14	5.4	0.34	2.01	860	450	24.2	1.54	ND	ND
80	65	3.24	8.8	0.36	2.00	930	460	26.0	1.34	ND	0.51
81	65	3.14	8.1	0.31	1.21	800	440	13.3	1.22	ND	ND
82	65	3.00	4.1	0.28	ND	920	360	9.7	0.91	ND	ND
84	54	3.09	7.5	0.42	4.03	1100	510	62.9	1.59	ND	ND
85	57	3.03	5.1	0.43	10.60	1200	490	257.9	2.13	ND	1.48
86	57	3.13	5.8	0.40	1.56	990	570	51.8	3.33	ND	ND
87	60	3.13	8.1	0.34	1.78	980	480	37.8	1.00	ND	ND
C	56	3.05	5.6	0.34	1.42	960	490	18.6	1.33	ND	ND
CON	59	3.20	9.2	0.36	2.29	990	530	37.1	2.19	ND	ND
	Mean	**3.12**	**7.8**	**0.37**	**3.00**	**926**	**448**	**49.3**	**2.97**	**ND**	**0.25**
Middle Shelf Zone 2, Within-ZID (51–90 m)											
0	56	2.92	5.1	0.54	4.54	1100	550	613.2	1.59	ND	5.19
4	56	3.03	6.7	0.42	4.54	820	570	35.8	1.24	ND	0.78
76	58	3.03	5.1	0.38	5.85	940	460	23.4	1.17	ND	ND
ZB	56	3.03	4.3	0.30	5.26	890	300	22.0	0.78	ND	ND
	Mean	**3.00**	**5.3**	**0.41**	**5.05**	**938**	**470**	**173.6**	**1.20**	**ND**	**1.49**
Sediment quality guidelines											
ERM		—	—	—	—	—	—	44,792.0	46.10	—	180.00
Regional Bight'13 summer values (area weighted mean)											
Middle Shelf		—	48.0	0.70	—	—	690	55.0	18.00	—	2.70
OC San historical winter values (January 2010–March 2019) [mean (range)]											
Middle Shelf Zone 2, Non-ZID		3.45 (2.76–5.65)	22.3 (5.6–92.9)	0.35 (0.14–1.63)	5.09 (1.15–49.10)	895 (540–1400)	369 (190–1100)	69.3 (2.7–645.0)	2.49 (ND–28.88)	0.27 (ND–36.26)	4.70 (ND–244.30)
Middle Shelf Zone 2, Within-ZID		3.36 (3.05–3.55)	16.4 (6.2–32.4)	0.37 (0.23–0.69)	5.36 (1.29–19.00)	989 (510–2200)	374 (230–580)	106.9 (6.5–751.3)	2.96 (ND–58.25)	0.61 (ND–21.40)	7.69 (ND–36.87)

Table 2–6 Metal concentrations (mg/kg) in sediment samples collected at each semi-annual station in Winter 2020 compared to Effects Range-Median (ERM), regional, and historical values.

Station	Depth (m)	Sb	As	Ba	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Zn
Middle Shelf Zone 2, Non-ZID (51–90 m)														
1	56	0.06	3.63	39.3	0.27	0.14	18.90	11.30	6.48	0.02	8.6	1.32	0.16	41.8
3	60	0.05	3.16	38.6	0.28	0.11	17.70	7.94	5.73	0.01	8.3	1.22	0.29	43.2
5	59	0.06	3.54	43.8	0.28	0.16	19.60	9.19	6.34	0.02	9.6	1.55	0.13	44.2
9	59	0.05	3.33	32.7	0.26	0.11	17.00	6.44	5.17	0.01	7.9	1.40	0.06	36.2
12	58	0.10	3.04	32.1	0.26	0.10	16.30	6.04	5.42	0.01	7.6	1.27	0.07	33.6
68	52	0.06	3.70	44.2	0.28	0.16	19.00	8.64	6.44	0.02	9.0	1.26	0.12	42.5
69	52	0.06	3.78	40.7	0.27	0.15	18.60	8.46	6.55	0.02	8.8	1.41	0.10	41.8
70	52	0.06	3.78	38.5	0.26	0.14	18.00	7.58	6.14	0.01	8.6	1.18	0.09	40.3
71	52	0.10	3.81	34.9	0.30	0.18	17.90	7.41	5.91	0.01	8.5	1.45	0.11	39.2
72	55	0.07	3.15	42.3	0.27	0.14	18.30	8.32	6.12	0.02	8.4	1.26	0.19	40.6
73	55	0.07	3.76	34.7	0.26	0.32	20.40	15.30	7.88	0.02	12.4	1.26	0.26	44.9
74	57	0.06	3.10	35.6	0.27	0.23	18.70	7.90	5.46	0.05	8.4	1.31	0.10	40.9
75	60	0.06	3.20	34.1	0.26	0.23	17.00	6.68	5.02	0.02	8.1	1.41	0.13	40.8
77	60	0.06	3.15	31.1	0.27	0.09	17.10	6.42	6.76	0.01	7.6	1.36	0.07	37.8
78	63	0.05	3.30	33.7	0.28	0.09	17.20	6.34	5.08	0.01	7.7	1.34	0.07	37.0
79	65	0.06	2.66	38.7	0.28	0.15	18.90	8.02	5.65	0.02	9.1	1.13	0.12	42.4
80	65	0.09	3.85	41.6	0.35	0.08	18.70	8.36	6.08	0.01	9.3	1.54	0.08	43.3
81	65	0.09	2.79	34.0	0.32	0.09	17.10	6.65	5.55	0.01	8.4	1.66	0.07	37.7
82	65	0.05	2.99	29.2	0.26	0.06	16.00	5.61	4.54	0.01	7.4	1.27	0.05	36.1
84	54	0.08	3.67	39.8	0.26	0.23	18.70	9.57	6.9	0.03	8.5	1.51	0.49	44.4
85	57	0.07	3.21	34.9	0.26	0.34	21.50	12.90	7.54	0.02	7.9	1.17	0.17	42.5
86	57	0.10	4.00	34.8	0.28	0.16	18.90	8.99	6.40	0.03	8.4	1.59	0.12	39.2
87	60	0.06	2.72	33.5	0.28	0.11	17.60	7.31	5.12	0.02	8.2	1.06	0.09	39.4
C	56	0.08	2.96	43.1	0.26	0.11	17.80	6.62	6.05	0.01	8.4	1.30	0.07	39.0
CON	59	0.08	3.20	47.3	0.27	0.10	18.50	7.16	6.13	0.02	9.0	3.23	0.08	39.1
	Mean	**0.07**	**3.34**	**37.3**	**0.28**	**0.15**	**18.22**	**8.21**	**6.02**	**0.02**	**8.6**	**1.42**	**0.13**	**40.3**
Middle Shelf Zone 2, Within-ZID (51–90 m)														
0	56	0.10	4.07	40.0	0.27	0.48	22.50	13.80	12.10	0.24	8.6	1.36	0.58	46.7
4	56	0.07	3.40	36.7	0.28	0.14	22.90	7.12	6.76	0.01	8.0	1.33	0.08	49.1
76	58	0.05	2.84	36.1	0.28	0.10	17.50	7.44	5.15	0.01	8.2	1.14	0.08	40.5
ZB	56	0.05	4.23	35.3	0.28	0.18	17.60	7.37	4.92	0.01	8.5	0.97	0.10	42.6
	Mean	**0.07**	**3.64**	**37.0**	**0.28**	**0.22**	**20.12**	**8.93**	**7.23**	**0.07**	**8.3**	**1.20**	**0.21**	**44.7**
Sediment quality guidelines														
ERM		—	70.00	—	—	9.60	370.00	270.00	218.00	0.70	51.6	—	3.70	410.0
Regional Bight'13 summer values (area weighted mean)														
Middle Shelf		0.92	2.70	130.0	0.21	0.68	30.00	7.90	7.00	0.05	15.0	0.10	0.29	48.0
OC San historical winter values (January 2010-March 2019) [mean (range)]														
Middle Shelf Zone 2, Non-ZID		0.10 (0.06–0.26)	2.95 (1.87–7.70)	35.3 (26.7–52.6)	0.26 (0.21–0.62)	0.27 (0.08–0.87)	21.08 (14.00–50.40)	9.84 (6.06–29.70)	5.32 (3.40–15.10)	0.02 (0.01–0.43)	9.9 (7.4–24.9)	0.76 (0.28–2.99)	0.26 (0.06–5.46)	42.0 (31.3–123.0)
Middle Shelf Zone 2, Within-ZID		0.10 (0.07–0.15)	3.06 (2.07–4.90)	32.8 (26.7–37.1)	0.26 (0.21–0.32)	0.42 (0.10–2.76)	22.37 (14.40–98.40)	11.12 (6.92–40.80)	5.16 (3.18–10.90)	0.05 (0.01–0.39)	10.0 (7.4–35.0)	0.67 (0.27–2.45)	0.33 (0.08–7.00)	43.2 (35.3–55.7)

Table 2–7 Whole-sediment *Eohaustorius estuarius* (amphipod) toxicity test results for 2019-20.

Station	% Survival	% of home	p-value	Assessment
home (control)	100	—	—	—
0	97	97	0.52	Nontoxic
1	99	99	0.75	Nontoxic
4	99	99	0.75	Nontoxic
72	99	99	0.75	Nontoxic
73	100	100	0.91	Nontoxic
76	99	99	0.75	Nontoxic
77	97	97	0.28	Nontoxic
CON	100	100	0.91	Nontoxic
ZB	99	99	0.75	Nontoxic
ZB Dup	98	98	0.75	Nontoxic

BIOLOGICAL COMMUNITIES

Infaunal Communities

A total of 664 invertebrate taxa comprising 30,051 individuals were collected in the 2019-20 monitoring year. Annelida (segmented worms) was the dominant taxonomic group at all depth strata (Table B-9). Mean community measure values were comparable between within- and non-ZID stations, and all station values were within regional and OC San historical ranges in both surveys (Tables 2-8 and 2-9). The infauna community at all outfall-depth stations, except for one (Station C2), can be classified as reference condition in both surveys based on their low (<25) Benthic Response Index (BRI) scores and/or high (>60) Infaunal Trophic Index (ITI) scores. A BRI score of 39, indicating a loss of biodiversity, was recorded at Station C2. This station is located at the head of the Newport Canyon and typically differs from other 60-m, non-ZID stations in sediment characteristics (e.g., percent fines) and contaminant concentrations (see Table 2-3), all of which affect species composition and distribution (OCSD 2014). The community composition at most within-ZID stations was similar to that of non-ZID stations based on multivariate analyses of the infaunal species and abundances (Figure 2-5). 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 48 epibenthic macroinvertebrate (EMI) species, comprising 16,783 individuals and a total weight of 67.8 kg, was collected from 20 trawls conducted in the 2019-20 monitoring period (Tables B-10 and B-11). As with the previous monitoring period, *Ophiura luetkenii* (brittlestar) was the most dominant species in terms of abundance (n=8,818; 52.5% of total). By contrast, *Strongylocentrotus fragilis* (urchin) was the dominant species in respect to biomass (39.803 kg; 58.7% of total). Within the Middle Shelf Zone 2 stratum, the overall EMI community composition at the outfall stations was similar to those at other non-outfall stations in both Summer and Winter surveys based on the results of the multivariate analyses (cluster and non-metric multidimensional scaling (nMDS) analyses) (Figure 2-6). Furthermore, the community measure values at the outfall stations are within regional and OC San historical ranges (Table 2-10). These results suggest that the outfall discharge had an overall negligible effect on the EMI community structure within the monitoring area, and as such, 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 40 fish taxa, comprising 9,763 individuals and a total weight of 184.7 kg, was collected from the monitoring area during the 2019-20 trawling effort (Tables B-12 and B-13). Although the trawl sample at Station T18 was deemed acceptable based on the sampling criteria given in Appendix A, and yielded EMIs, no fish was captured. As a result, community measures were

Table 2–8 Community measure values for each semi-annual and annual (*) station sampled during the Summer 2019 infauna survey, including regional and historical values. N/A = Not Applicable.

Station	Depth (m)	Species Richness	Abundance	H'	SDI	ITI	BRI
			Middle Shelf Zone 1 (31–50 m)				
7 *	41	76	238	3.76	28	77	19
8 *	44	69	291	3.39	20	79	15
21 *	44	116	654	3.73	29	80	11
22 *	45	79	351	3.62	24	89	15
30 *	46	108	630	3.75	28	72	15
36 *	45	85	281	3.63	27	88	13
55 *	40	72	495	2.99	13	77	15
59 *	40	90	667	3.34	17	74	14
	Mean	**87**	**451**	**3.53**	**23**	**80**	**15**
			Middle Shelf Zone 2, Non-ZID (51–90 m)				
1	56	84	448	3.44	21	73	14
3	60	64	300	3.29	17	72	20
5	59	67	230	3.40	21	77	17
9	59	84	286	3.76	26	78	14
10 *	62	60	302	3.26	17	77	21
12	58	86	344	3.54	22	77	13
13 *	59	74	294	3.27	19	77	20
37 *	56	94	304	4.05	36	78	14
68	52	86	413	3.40	19	72	17
69	52	95	590	3.32	18	72	17
70	52	119	1042	3.45	18	71	16
71	52	124	762	3.86	28	75	14
72	55	78	318	3.44	20	77	16
73	55	66	323	3.41	18	82	17
74	57	89	619	3.47	18	72	16
75	60	84	350	3.49	19	76	16
77	60	107	464	3.64	25	74	14
78	63	68	289	3.49	20	76	17
79	65	66	300	3.53	20	81	16
80	65	104	434	3.85	30	76	17
81	65	81	351	3.61	23	72	17
82	65	78	292	3.69	25	81	16
84	54	113	1080	3.32	18	68	18
85	57	90	460	3.65	23	74	16
86	57	57	124	3.70	27	81	12
87	60	101	463	3.76	25	75	14
C	56	50	155	3.43	19	73	27
C2 *	56	45	405	2.24	8	64	39
CON	59	64	181	3.41	22	75	18
	Mean	**82**	**411**	**3.49**	**21**	**75**	**17**
			Middle Shelf Zone 2, Within-ZID (51–90 m)				
0	56	87	498	3.51	21	73	21
4	56	83	409	3.34	18	76	14
76	58	84	262	3.90	29	76	20
ZB	56	87	441	3.67	22	72	17
	Mean	**85**	**403**	**3.61**	**23**	**74**	**18**
			Middle Shelf Zone 3 (91–120 m)				
17 *	91	62	270	3.33	20	71	20
18 *	91	60	312	3.21	14	66	20
20 *	100	46	180	3.10	14	71	24
23 *	100	54	160	3.5	23	69	19
29 *	100	70	295	3.59	23	78	18
33 *	100	54	229	3.27	15	65	26
38 *	100	69	284	3.70	24	77	18
56 *	100	46	123	3.46	21	77	20
60 *	100	53	248	3.41	18	74	20
83 *	100	47	180	3.25	15	72	19
	Mean	**56**	**228**	**3.38**	**19**	**72**	**20**
			Outer Shelf (121–200 m)				
24 *	200	35	92	3.11	15	58	29
25 *	200	42	114	3.03	15	65	24
27 *	200	37	171	2.80	10	74	22
39 *	200	49	284	2.76	8	53	17
57 *	200	22	63	2.33	8	45	22
61 *	200	29	87	2.61	9	67	27
63 *	200	36	89	3.11	15	67	24
65 *	200	22	54	2.43	9	52	23
C4 *	187	23	150	1.91	3	65	37
	Mean	**33**	**123**	**2.68**	**10**	**61**	**25**

Table 2–8 continues.

Table 2–8 continued.

Station	Depth (m)	Species Richness	Abundance	H’	SDI	ITI	BRI
Upper Slope/Canyon (201–500 m)							
40 *	303	24	56	2.78	11	N/A	N/A
41 *	303	27	66	2.98	12	N/A	N/A
42 *	303	18	36	2.45	9	N/A	N/A
44 *	241	19	59	2.25	6	N/A	N/A
58 *	300	19	48	2.57	9	N/A	N/A
62 *	300	15	36	2.04	7	N/A	N/A
64 *	300	18	39	2.62	9	N/A	N/A
C5 *	296	15	42	2.19	5	N/A	N/A
	Mean	**19**	**48**	**2.49**	**9**	**N/A**	**N/A**
Regional Bight’13 summer values [mean (range)]							
Middle Shelf		90 (45–171)	491 (142–2718)	3.60 (2.10–4.10)	—	—	18 (7–30)
Outer Shelf		66 (24–129)	289 (51–1492)	3.40 (2.30–4.10)	—	—	18 (8–28)
Upper Slope/Canyon		30 (6–107)	96 (12–470)	2.70 (0.60–3.90)	—	—	—
OC San historical summer values (July 2009-September 2018) [mean (range)]							
Middle Shelf Zone 1		100 (7–146)	383 (12–820)	3.89 (1.59–4.35)	33 (4–47)	85 (64–98)	15 (8–21)
Middle Shelf Zone 2, Non-ZID		88 (33–138)	465 (212–1491)	3.42 (0.36–4.10)	24 (1–38)	63 (1–91)	23 (13–52)
Middle Shelf Zone 2, Within-ZID		93 (20–142)	399 (90–785)	3.70 (2.27–4.38)	27 (6–52)	77 (40–94)	17 (8–49)
Middle Shelf Zone 3		88 (45–146)	399 (177–807)	3.74 (3.09–4.23)	27 (16–43)	82 (65–94)	17 (9–26)
Outer Shelf		41 (19–78)	119 (38–367)	3.23 (2.33–3.68)	18 (8–28)	66 (42–91)	25 (14–39)
Upper Slope/Canyon		25 (13–38)	55 (22–106)	2.86 (2.29–3.41)	12 (6–21)	—	—

Table 2–9 Community measure values for each semi-annual station sampled during the Winter 2020 infauna survey, including regional and historical values.

Station	Depth (m)	Species Richness	Abundance	H’	SDI	ITI	BRI
Middle Shelf Zone 2, Non-ZID (51–90 m)							
1	56	63	254	3.59	21	80	18
3	60	60	236	3.46	19	75	21
5	59	65	292	3.51	20	75	17
9	59	62	172	3.65	23	79	18
12	58	67	217	3.71	24	82	13
68	52	65	263	3.45	19	75	15
69	52	65	265	3.46	18	76	15
70	52	104	646	3.79	25	76	15
71	52	94	518	3.66	22	74	14
72	55	62	277	3.16	17	70	21
73	55	98	440	3.8	26	75	15
74	57	84	520	3.59	19	71	16
75	60	90	327	3.86	28	78	16
77	60	85	327	3.83	26	74	18
78	63	64	222	3.63	23	77	19
79	65	78	241	3.87	29	75	18
80	65	82	245	3.94	33	77	17
81	65	81	270	3.81	27	76	16
82	65	58	128	3.70	27	76	19
84	54	87	481	3.64	21	74	22
85	57	70	287	3.53	20	75	20
86	57	80	319	3.75	26	77	17
87	60	80	287	3.79	27	76	18
C	56	96	335	3.83	31	71	13
CON	59	57	194	3.42	20	80	17
	Mean	**76**	**311**	**3.66**	**24**	**76**	**17**
Middle Shelf Zone 2, Within-ZID (51–90 m)							
0	56	80	294	3.77	25	73	21
4	56	66	232	3.62	23	75	20
76	58	71	304	3.71	23	78	15
ZB	56	100	492	3.91	26	76	16
	Mean	**79**	**331**	**3.75**	**24**	**76**	**18**
Regional Bight’13 summer values [mean (range)]							
Middle Shelf		90 (45–171)	491 (142–2718)	3.60 (2.10–4.10)	—	—	18 (7–30)
OC San historical winter values (January 2010-March 2019) [mean (range)]							
Middle Shelf Zone 2, Non-ZID		81 (35–135)	359 (88–1230)	3.52 (0.89–4.68)	25 (1–76)	66 (3–89)	22 (9–45)
Middle Shelf Zone 2, Within-ZID		86 (45–142)	344 (96–750)	3.72 (2.87–4.32)	27 (9–48)	78 (47–95)	17 (9-46)

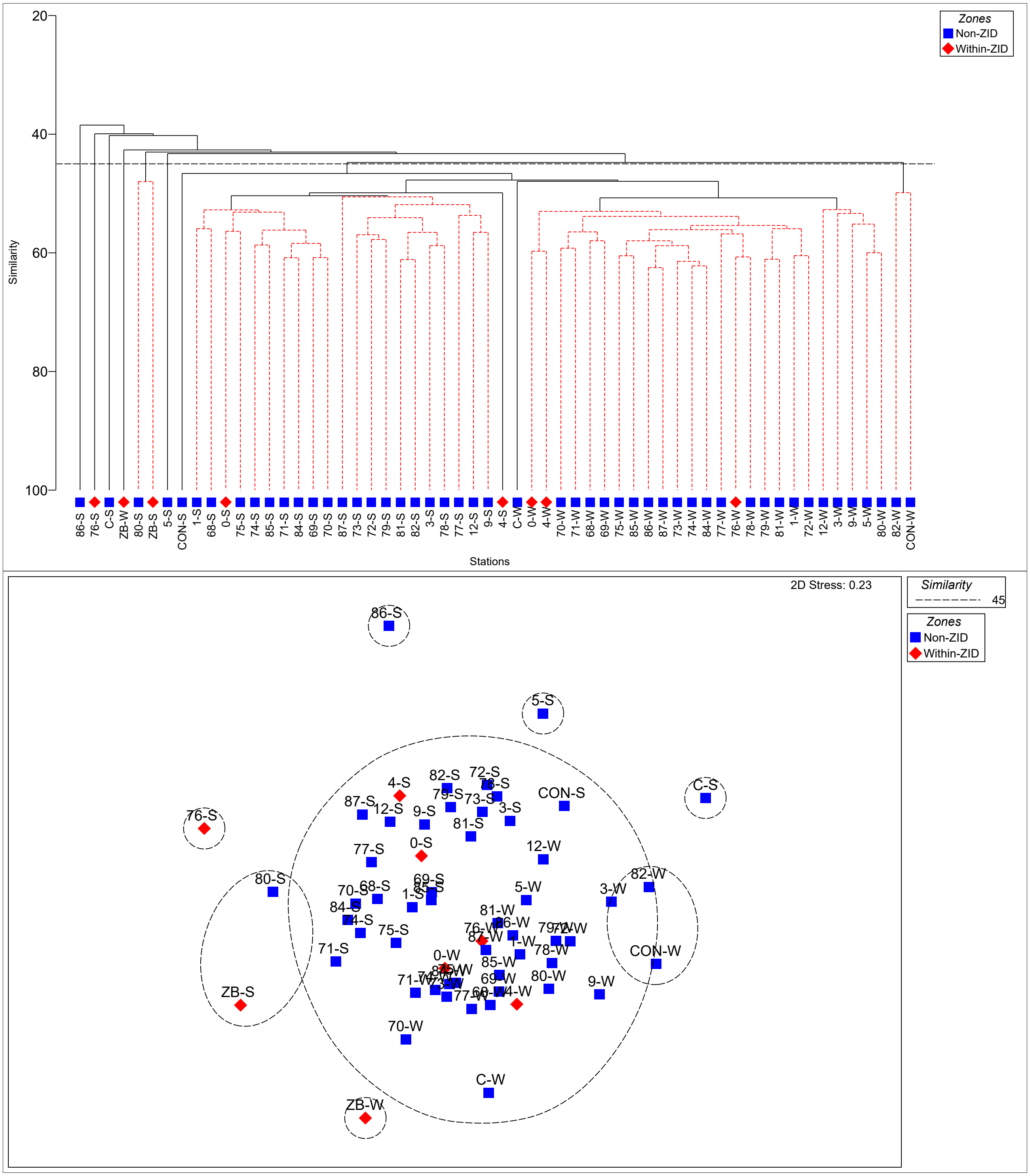

Figure 2–5 Dendrogram (top panel) and non-metric multidimensional scaling (nMDS) plot (bottom panel) of the infauna collected at within- and non-ZID stations along the Middle Shelf Zone 2 stratum for the Summer 2019 (S) and Winter 2020 (W) benthic surveys. Stations connected by red dashed lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The 8 main clusters formed at a 45% similarity on the dendrogram are superimposed on the nMDS plot.

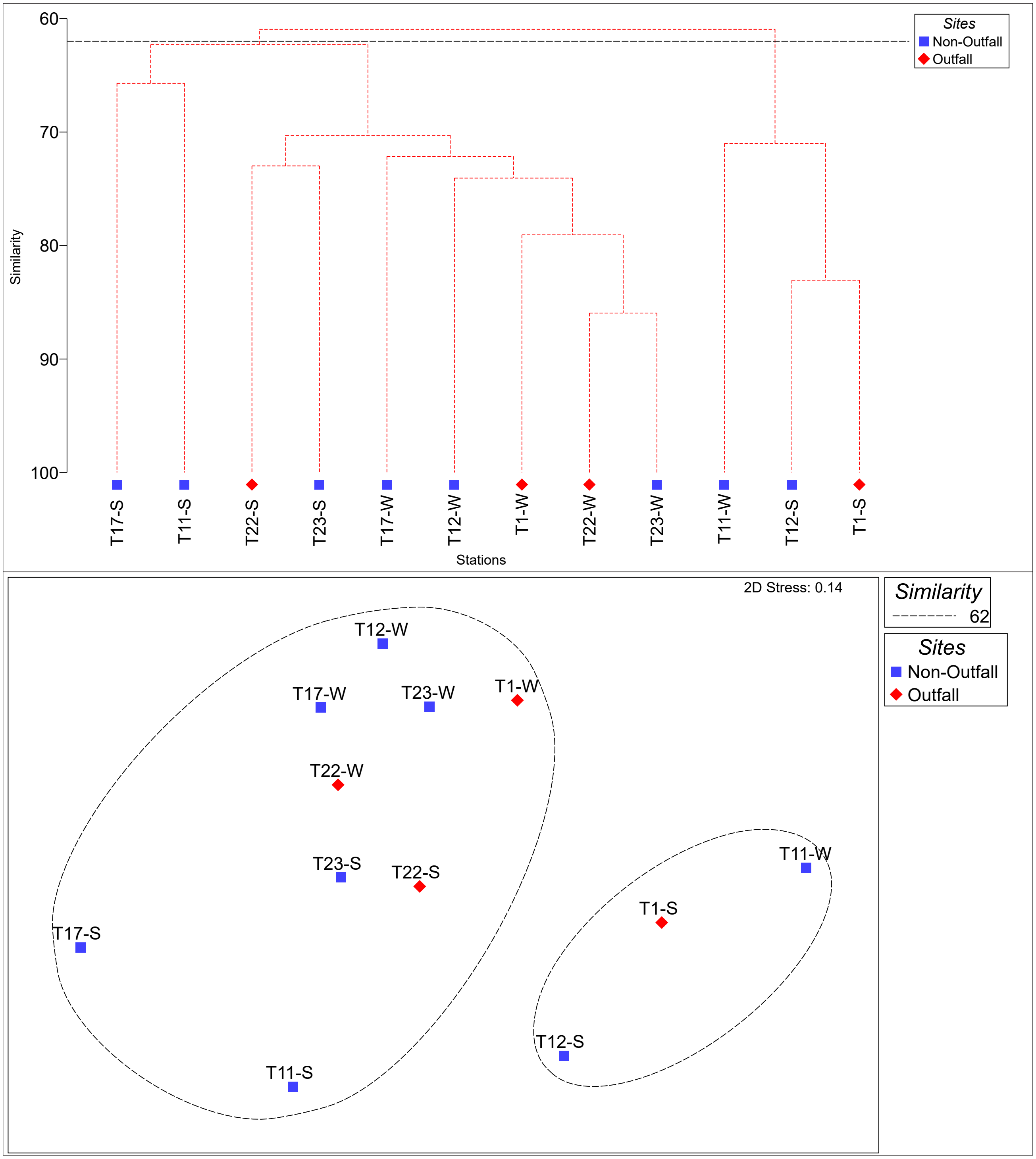

Figure 2–6 Dendrogram (top panel) and non-metric multidimensional scaling (nMDS) plot (bottom panel) of the epibenthic macroinvertebrates collected at outfall and non-outfall stations along the Middle Shelf Zone 2 stratum for the Summer 2019 (S) and Winter 2020 (W) trawl surveys. Stations connected by red dashed lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The 2 main clusters formed at a 62% 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 2019 and Winter 2020 trawl surveys, including regional and historical values.

Season	Station	Depth (m)	Species Richness	Abundance	Biomass (kg)	H'	SDI
				Middle Shelf Zone 1 (31–50 m)			
Summer	T2 *	35	14	3926	2.93	0.17	1
	T24 *	36	13	1297	1.82	1.11	2
	T6 *	36	10	1062	0.90	0.49	1
	T18 *	36	3	130	0.43	0.09	1
		Mean	**10**	**1604**	**1.52**	**0.47**	**1**
				Middle Shelf Zone 2, Non-outfall (51–90 m)			
	T23	58	12	1199	2.99	0.48	1
	T12	57	10	1776	2.74	0.39	1
	T17	60	6	85	0.16	1.44	3
	T11	60	9	97	0.32	1.62	3
		Mean	**9**	**789**	**1.55**	**0.98**	**2**
				Middle Shelf Zone 2, Outfall (51–90 m)			
	T22	60	11	232	0.40	1.25	2
	T1	55	12	1420	1.52	0.96	2
		Mean	**12**	**826**	**0.96**	**1.11**	**2**
				Outer Shelf (121–200 m)			
	T10 *	137	6	844	33.27	0.24	1
	T25 *	137	13	173	2.73	1.07	1
	T14 *	137	7	139	5.26	1.35	2
	T19 *	137	11	404	6.58	1.15	2
		Mean	**9**	**390**	**11.96**	**0.95**	**2**
				Middle Shelf Zone 2, Non-outfall (51–90 m)			
Winter	T23	58	12	809	1.26	0.79	1
	T12	57	12	203	0.38	1.90	4
	T17	60	11	186	0.48	1.90	4
	T11	60	18	1060	0.97	1.10	2
		Mean	**13**	**565**	**0.77**	**1.42**	**3**
				Middle Shelf Zone 2, Outfall (51-90 m)			
	T22	60	10	1131	1.73	0.41	1
	T1	55	14	610	0.92	1.39	2
		Mean	**12**	**871**	**1.33**	**0.90**	**2**
				Regional Bight'13 summer values [area-weighted mean (range)]			
Middle Shelf			12 (3–23)	1093 (19–17973)	5 (0.31–36)	1.11 (0.09–2.49)	—
Outer Shelf			15 (3–29)	728 (4–5160)	27 (0.39–83)	1.26 (0.10–2.39)	—
				OC San historical values (July 2009–June 2019) [mean (range)]			
Middle Shelf Zone 1			11 (2–18)	511 (2–2592)	0.86 (0–3.44)	1.22 (0.01–2.22)	2 (1–5)
Middle Shelf Zone 2, Non-outfall			12 (7–18)	267 (49–1369)	1.29 (0.08–3.60)	1.46 (0.22–2.15)	3 (1–5)
Middle Shelf Zone 2, Outfall			11 (5–19)	450 (12–2498)	1.70 (0.04–11.16)	1.26 (0.06–2.43)	3 (1–9)
Outer Shelf			10 (3–15)	177 (26–526)	4.01 (0.09–19.31)	1.07 (0.17–2.12)	2 (1–8)

not calculated for Station T18 (Table 2-11). The reason for no fish being captured at Station T18 was undetermined. However, due to Station T18 being far upcoast and inshore of the outfall (Figure 2-3), it is likely the outfall discharge was not a contributing factor. The mean species richness, abundance, biomass, Shannon-Wiener Diversity (H′), and Swartz's 75% Dominance Index (SDI) values of demersal fishes collected at all stations except T18 were comparable between outfall and non-outfall stations in both surveys, with values falling within regional and/or OC San 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) scores 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 regardless of season (Figure 2-7). These results indicate that the outfall discharge had no adverse effect on the demersal fish community structure within the monitoring area. OC San concludes that the demersal fish communities within the monitoring area were not degraded by the outfall discharge, and thus, compliance was met.

Table 2–11 Summary of demersal fish community measures for each semi-annual and annual (*) station sampled during the Summer 2019 and Winter 2020 trawl surveys, including regional and historical values. Abbreviation: NC = Not Calculated.

Season	Station	Depth (m)	Species Richness	Abundance	Biomass (kg)	H'	SDI	FRI
				Middle Shelf Zone 1 (31–50 m)				
Summer	T2 *	35	11	92	2.62	1.93	4	20
	T24 *	36	11	93	2.01	1.45	2	21
	T6 *	36	9	158	1.20	1.38	2	20
	T18 *	36	0	0	0.00	NC	NC	NC
		Mean	**8**	**86**	**1.46**	**1.59**	**3**	**20**
				Middle Shelf Zone 2, Non-outfall (51–90 m)				
	T23	58	13	613	8.30	1.38	2	20
	T12	57	13	342	4.82	1.75	3	21
	T17	60	16	700	13.05	1.81	3	23
	T11	60	14	659	13.73	1.80	4	21
		Mean	**14**	**579**	**9.98**	**1.69**	**3**	**21**
				Middle Shelf Zone 2, Outfall (51–90 m)				
	T22	60	13	353	7.48	1.69	3	20
	T1	55	13	708	9.48	1.60	3	13
		Mean	**13**	**531**	**8.48**	**1.65**	**3**	**17**
				Outer Shelf (121–200 m)				
	T10 *	137	24	1115	27.71	1.70	4	17
	T25 *	137	20	910	12.06	1.91	4	24
	T14 *	137	20	914	19.83	1.66	3	18
	T19 *	137	18	959	11.28	1.78	3	20
		Mean	**21**	**975**	**17.72**	**1.76**	**4**	**20**
				Middle Shelf Zone 2, Non-outfall (51–90 m)				
Winter	T23	58	11	255	5.61	1.54	3	17
	T12	57	12	438	8.43	1.82	4	16
	T17	60	15	492	13.77	2.01	4	18
	T11	60	15	505	12.85	1.85	4	18
		Mean	**13**	**423**	**10.16**	**1.81**	**4**	**17**
				Middle Shelf Zone 2, Outfall (51–90 m)				
	T22	60	10	178	2.58	1.55	3	16
	T1	55	12	279	7.94	1.72	4	17
		Mean	**11**	**229**	**5.26**	**1.64**	**4**	**17**
				Regional Bight'13 summer values [area-weighted mean (range)]				
Middle Shelf			15 (5–24)	506 (12–2446)	12 (0.70–64.20)	1.65 (0.67–2.35)	—	28 (17–61)
Outer Shelf			14 (2–21)	790 (2–3088)	16 (0.20–54.50)	1.35 (0.59–2.01)	—	20 (-1–51)
				OC San historical values (July 2009–September 2018) [mean (range)]				
Middle Shelf Zone 1			10 (2–15)	230 (83–470)	4.77 (0.76–11.86)	1.52 (0.69–2.10)	3 (2–5)	22 (17–26)
Middle Shelf Zone 2, Non–outfall			14 (2–18)	421 (110–3227)	16.09 (2.47–78.72)	1.71 (0.67–2.18)	4 (1–6)	22 (13–32)
Middle Shelf Zone 2, Outfall			14 (8–25)	602 (45–12274)	13.30 (1.25–135.64)	1.72 (0.14–2.20)	3 (1–6)	23 (12–34)
Outer Shelf			15 (2–22)	655 (260–1610)	14.13 (2.60–39.19)	1.38 (0.65–1.81)	2 (1–4)	17 (4–41)

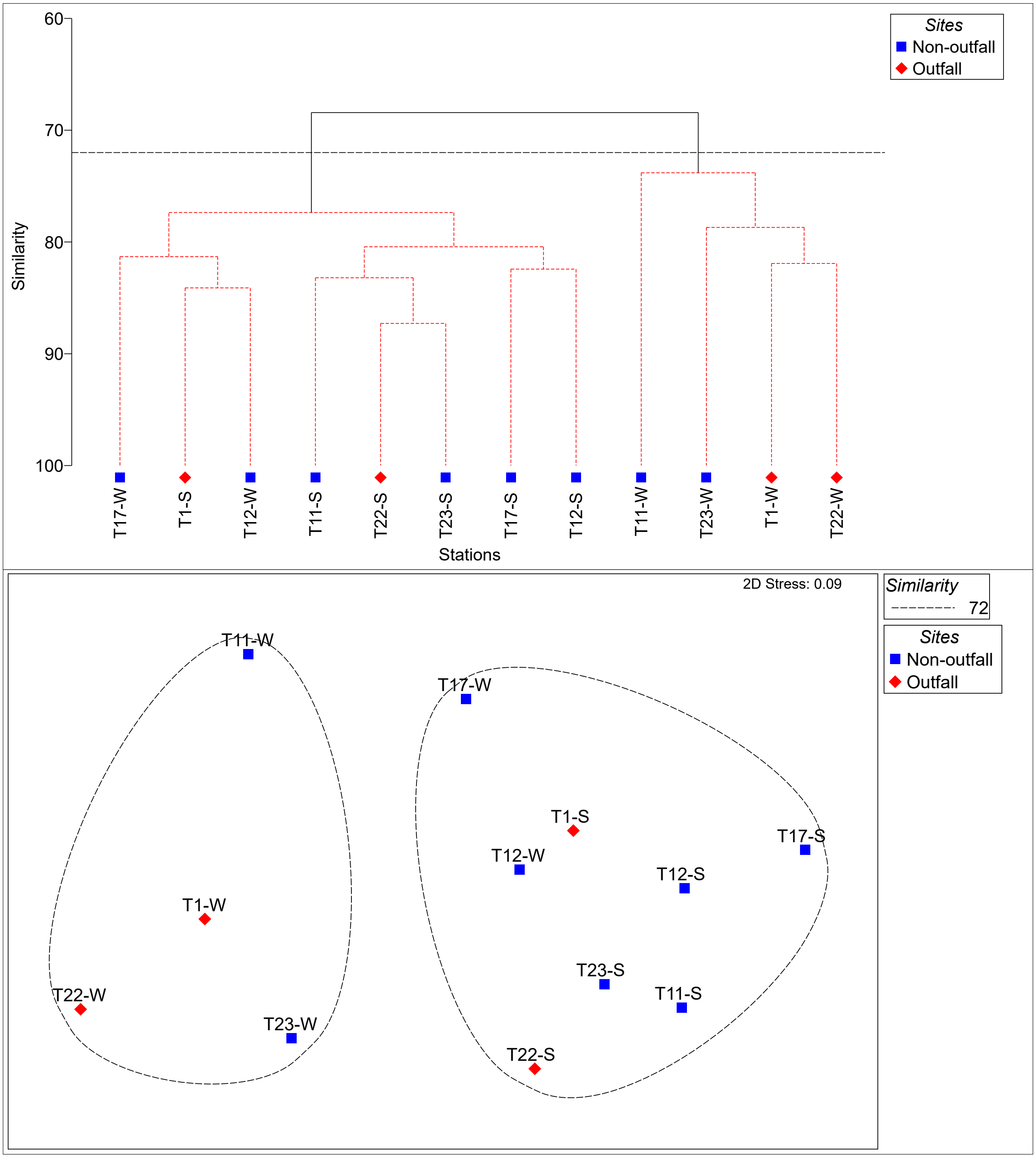

Figure 2–7 Dendrogram (top panel) and non-metric multidimensional scaling plot (bottom panel) of the demersal fishes collected at outfall and non-outfall stations along the Middle Shelf Zone 2 stratum for the Summer 2019 (S) and Winter 2020 (W) trawl surveys. Stations connected by red dashed lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The 2 main clusters formed at a 72% similarity on the dendrogram are superimposed on the nMDS plot.

FISH BIOACCUMULATION AND HEALTH

Demersal and Sport Fish Tissue Chemistry

Concentrations of trace metals and chlorinated pesticides measured in muscle and/or liver tissues of flatfishes and sport fishes were similar between outfall and non-outfall locations (Tables 2-12 and 2-13). The average concentrations of all contaminants measured in sport fish samples did not exceed California's "Do not consume" Advisory Tissue Level (see Table A-7). Thus, it is safe to consume at least 1 eight-ounce serving of sport fish captured in the monitored area. Due to the very low concentrations of some contaminants (i.e., chlordane, dieldrin), as much as 7 eight-ounce servings of sport fish could be safely consumed per week. These results suggest that demersal fishes residing near the outfall are not more prone to bioaccumulation of contaminants and demonstrate there is negligible human health risk from consuming demersal fishes captured in the monitored areas.

Fish Health

The color and odor of demersal fishes captured in the monitoring area appeared normal. Disease symptoms, such as tumors, fin erosion, and skin lesions, were absent in trawl-caught fishes. In addition, external parasites were recorded in less than 1% of the fishes collected, which is comparable to Southern California Bight background levels (Walther et al. 2017). These results indicate that the outfall is not an epicenter of disease.

Liver Histopathology

No histopathology analysis was conducted for the 2019-20 monitoring period (see Appendix A).

CONCLUSIONS

Overall, results from OC San's 2019-20 water quality monitoring program detected minor changes in measured water quality parameters related to the discharge of wastewater to the coastal ocean. This is consistent with previously reported results (e.g., OCSD 2017). While plume-related changes in DO, pH, and transmissivity were measurable beyond the initial mixing zone during some surveys, these usually extended only into the nearfield stations, typically <2 km away from the outfall. None of these changes were determined to be environmentally significant since they fell within natural ranges to which marine organisms are exposed (CSDOC 1996a, Wilber and Clarke 2001, Chavez et al. 2002, Jarvis et al. 2004, OCSD 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. Sediment quality was not affected based on the low concentration of chemical contaminants at both within- and non-ZID areas, as well as the absence of sediment toxicity in controlled laboratory tests. The animal communities and contaminant concentrations in fish tissue samples were comparable between outfall and non-outfall areas, and there was negligible disease in fish samples. These results suggest that the receiving environment was not degraded by OC San's discharge of treated wastewater, and as such, all permit compliance criteria were met in 2019-20 and environmental and human health were protected.

Table 2–12 Means and ranges of percent lipid and contaminant concentrations (ng/g) in tissues of flatfishes collected by trawling in August 2019 at Stations T1 (Outfall) and T11 (Non-outfall), as well as historical values. Abbreviation: ND = Not Detected.

Species	Tissue	Station	n	Mean Standard Length (mm)	Percent Lipid	Mercury	ΣDDT	ΣPCB	ΣChlordane	Dieldrin
Pleuronichthys verticalis (Hornyhead Turbot)	Muscle	Non-outfall	5	140	ND (All ND)	50 (20–70)	2.58 (ND–4.27)	0.41 (ND–2.07)	ND (All ND)	ND (All ND)
		Outfall	3	133	ND (All ND)	40 (20–50)	1.49 (ND–2.75)	ND (All ND)	ND (All ND)	ND (All ND)
	Liver	Non-outfall	5	140	4.66 (3.08–6.90)	140 (60–240)	155.34 (44.20–254.40)	14.75 (ND–20.72)	ND (All ND)	ND (All ND)
		Outfall	3	133	8.90 (3.03–19.50)	110 (60–210)	128.10 (41.60–283.00)	16.53 (ND–25.80)	ND (All ND)	ND (All ND)
Parophrys vetulus (English Sole)	Muscle	Non-outfall	1	215	0.48	30	8.75	2.00	ND	ND
		Outfall	10	184	0.85 (0.43–2.03)	40 (20–80)	14.90 (5.70–38.38)	2.37 (ND–8.44)	0.59 (0–5.88)	ND (All ND)
	Liver	Non-outfall	1	215	5.06	60	125.58	44.40	ND	ND
		Outfall	10	184	6.87 (3.83–11.50)	60 (40–90)	157.93 (58.80–331.80)	36.76 (7.81–103.70)	ND (All ND)	ND (All ND)
OC San historical values (July 2009–June 2019)										
Pleuronichthys verticalis (Hornyhead Turbot)	Muscle	Non-outfall	64	147 (98–217)	0.17 (ND–1.07)	50 (10–30)	10.30 (ND–38.75)	2.09 (ND–18.36)	0.05 (ND–1.45)	ND (All ND)
		Outfall	86	156 (110–195)	0.14 (ND–0.77)	80 (10–420)	6.57 (ND–54.50)	1.48 (ND–12.57)	0.01 (ND–0.71)	0.21 (ND–12.70)
	Liver	Non-outfall	64	150 (98–217)	4.93 (ND–30.40)	180 (50–480)	512.24 (ND–2100.00)	41.35 (ND–432.59)	ND (All ND)	ND (All ND)
		Outfall	86	155 (110–195)	8.13 (ND–24.60)	180 (10–590)	455.14 (ND–1822.70)	91.40 (ND–457.80)	3.20 (ND–81.70)	ND (All ND)
Parophrys vetulus (English Sole)	Muscle	Non-outfall	91	184 (125–268)	0.90 (ND–6.22)	50 (20–120)	66.84 (ND–524.30)	7.37 (ND–61.20)	ND (All ND)	0.05 (ND–4.45)
		Outfall	78	187 (136–290)	1.22 (ND–8.23)	60 (10–110)	92.86 (3.75–633.46)	12.72 (ND–130.90)	ND (All ND)	ND (All ND)
	Liver	Non-outfall	91	184 (125–268)	10.22 (1.93–26.80)	60 (20–190)	1164.43 (42.60–14300.00)	156.18 (ND–1694.70)	0.07 (ND–5.27)	ND (All ND)
		Outfall	78	187 (136–290)	11.69 (ND–27.10)	60 (20–160)	1311.39 (70.70–20967.00)	173.67 (ND–1627.29)	1.05 (ND–30.80)	ND (All ND)

Table 2–13 Means and ranges of percent lipid and contaminant concentrations (ng/g) in muscle tissue of sport fishes collected by rig fishing in July 2019 at Zones 1 (Outfall) and 3 (Non-outfall), including historical values. Abbreviation: ND = Not Detected.

Zone	Species	n	Mean Standard Length (mm)	Percent Lipid	Mercury	Arsenic	Selenium	ΣDDT	ΣPCB	ΣChlordane	Dieldrin
Non-outfall	*Sebastes hopkinsi* (Squarespot Rockfish)	9	191	1.85 (1.20–2.41)	180 (90–310)	2060 (1630–2600)	610 (420–760)	21.94 (10.40–29.80)	1.06 (ND–3.12)	ND (All ND)	ND (All ND)
	Sebastes miniatus (Vermilion Rockfish)	1	213	0.79	80	1590	500	10.50	ND	ND	ND
Outfall	*Paralabrax nebulifer* (Barred Sand Bass)	3	351	0.32 (ND–0.96)	410 (140–670)	680 (460–840)	360 (300–480)	105.17 (20–260.60)	40.42 (3.66–106.78)	0.20 (ND–1.22)	ND (All ND)
	Sebastes miniatus (Vermilion Rockfish)	7	241	0.69 (ND–1.28)	60 (40–70)	2750 (1450–3610)	470 (290–530)	8.58 (5.05–13.60)	0.22 (ND–1.51)	ND (All ND)	ND (All ND)
OC San historical values (July 2012–June 2019)											
Non-outfall	*Sebastes hopkinsi* (Squarespot Rockfish)	9	185	1.18 (0.65–2.29)	140 (80–240)	1240 (600–2000)	240 (200–290)	18.21 (8.74–44.96)	4.73 (ND–18.20)	ND (All ND)	ND (All ND)
	Sebastes miniatus (Vermilion Rockfish)	24	244	0.80 (ND–2.45)	70 (40–200)	2860 (1070–10300)	640 (70–1540)	17.34 (2.57–99.20)	0.77 (ND–8.02)	ND (All ND)	ND (All ND)
Outfall	*Paralabrax nebulifer* (Barred Sand Bass)	8	304	1.80 (0.43–4.60)	70 (50–90)	1420 (580–2720)	470 (280–620)	101.51 (18.30–243.68)	69.99 (16.59–152.27)	1.93 (ND–8)	ND (All ND)
	Sebastes miniatus (Vermilion Rockfish)	45	265	1.19 (ND–3.82)	50 (20–80)	2670 (680–5890)	540 (170–880)	13.00 (0–58.30)	1.95 (ND–17.24)	0.23 (ND–8.80)	ND (All ND)

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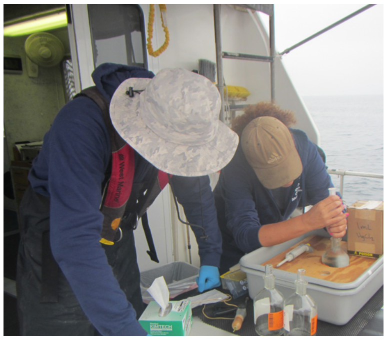

CHAPTER 3
Strategic Process Studies and Regional Monitoring

INTRODUCTION

The Orange County Sanitation District (OC San) operates under the requirements of a National Pollutant Discharge Elimination System (NPDES) permit issued jointly by the United States Environmental Protection Agency (US EPA) and the State of California Regional Water Quality Control Board, Region 8 (RWQCB8) (Order No. R8-2012-0035, NPDES Permit No. CA0110604) in June 2012. To document the effectiveness of its source control and wastewater treatment operations in protecting the coastal ocean, OC San conducts an Ocean Monitoring Program (OMP) that includes a Core monitoring program, Strategic Process Studies (SPS), and regional monitoring programs. In addition, OC San 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 and/or focus on issues of interest to OC San and/or its regulators, such as the effect of contaminants of emerging concern on local fish populations. SPS are proposed and must be approved by RWQCB8 to ensure appropriate focus and level of effort.

Regional monitoring studies focus on the larger Southern California Bight (Point Conception to the US-Mexican Border). These 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 Southern California Bight Regional Water Quality Program.

This chapter provides short overviews of recently completed and ongoing projects. Unlike other chapters in this report, these summaries are not restricted to the most recent program year (i.e., July 2019–June 2020). When appropriate, this information is also incorporated into other report chapters to supplement Core monitoring results (e.g., sediment chemistry). Links to study reports and documentation, if available, are listed under each section below. Most projects were impacted by COVID-19 workplace safety precautions (e.g., restrictions in field sampling). Program impacts and changes to overall project goals and objectives will be detailed in their respective final reports.

STRATEGIC PROCESS STUDIES

For the 2019-20 program year, OC San had 5 in-progress SPS designed to address potential changes in the quantity and quality of its discharged effluent when the Groundwater Replenishment System (GWRS) Final Expansion project is completed in 2023.

ROMS-BEC Ocean Outfall Modeling (2019–2022)

OC San last modeled and characterized its discharge plume in the early 2000s. Since then, significant changes have occurred in both the quantity and quality of the effluent discharged due to water conservation and reclamation efforts. To evaluate the spatial extent and temporal variability of the discharged plume, OC San will work with SCCWRP and their collaborators to model and assess the spatial and temporal extent of its discharged effluent before and after (compare and contrast) the implementation of the GWRS Final Expansion in 2023. To date, modeling has confirmed that initial dilutions calculated using ROMS are consistent with calculations conducted using engineering models (i.e., NRFIELD; EPA 2003). Model runs using 3 different discharge scenarios, pre-GWRS, GWRS-partial, and GWRS-complete, will be performed over the next year.

Characterization of Microplastics in Wastewater (2019–2020)

Wastewater treatment plants are a known conduit of microplastics (<5 mm) to the environment (Ziajahromi et al. 2016, Okoffo et al. 2019). However, there are limited data regarding the effectiveness of different wastewater treatments and overall removal of microplastics before the ocean discharge of treated effluent, including from OC San. This SPS aims to characterize the quantity and types of microplastics throughout OC San's treatment system. A secondary goal of this study is to develop methods and analyses to extract, measure, and quantify microplastics from different types of wastewater matrices. Samples were collected throughout the treatment train in the summer of 2019 and were immediately processed in the laboratory. Quantification and characterization of suspected microplastics using visual microscopy will be completed this year, along with the confirmation of sub-samples using advanced spectroscopy. Ultimately this project will preliminarily inform the transport and fate of microplastics through OC San's wastewater treatment process to the receiving environment.

In-vitro Cell Bioassay Monitoring for Contaminants of Emerging Concern (2019–2020)

Contaminants of Emerging Concern (CECs) include hundreds of thousands of chemicals that may be present in the environment alone or in complex mixtures. Many are known or suspected to be detrimental to living organisms, including humans, with continued exposure over time. Due to the diverse analytical challenges associated with monitoring for individual CECs, non-targeted screening methods are used to more efficiently evaluate and prioritize sites for continued monitoring. This study will provide a preliminary assessment of non-targeted CECs in OC San's wastewater and receiving environment using in-vitro cell bioassay techniques. Cell bioassays were performed on extracts of seawater and sediment samples collected in the summer of 2019 from a subset of Core annual benthic stations. Follow-up targeted analyses were conducted in 2020 to identify classes of CECs that may be present in samples that exhibited significant bioactivity. Analyses of cell bioassay responses and targeted chemistry are ongoing and are expected to be completed this year. Used as a screening tool, cell bioassays should help researchers identify sites with significant CEC activity and evaluate their potential impacts prior to and following the GWRS Final Expansion in 2023.

Sediment Linear Alkylbenzenes (2020–2021)

Linear alkylbenzenes (LABs) are organic contaminants that are concentrated in wastewater and that have been used to track the presence and settling of wastewater particles in the offshore environment. From 1998–2014, OC San used LABs to measure its discharge footprint and investigate whether other contaminants present in the sediment were associated with the effluent discharge. This study will provide updated data and a recalibrated baseline for evaluating future changes in effluent quality and quantity due to the GWRS Final Expansion. This project has been initiated by performing improvements to the analytical method for measuring LABs by gas chromatography mass spectrometry (GC-MS), which are ongoing. The optimized LAB analysis method will be performed on selected sediment samples collected in the summer of 2021. Additional outputs of this project will include a review of historical LAB discharge patterns, and a brief literature review of potential alternative sewage tracers that may be used to complement or enhance the current LAB tracers for future applications.

Meiofauna Baseline (2020–2021)

The increase of reverse osmosis concentrate return flows from the GWRS Final Expansion may negatively affect marine biota in the receiving water. While meiofauna (animals ranging from 63–500 µm in size) are known to be more sensitive to anthropogenic impacts than macrofauna, information on meiofauna diversity and abundance in OC San's monitoring area is non-existent. This study will characterize the meiofauna communities in the receiving environment and evaluate the suitability of using meiofauna for a Before-After Control-Impact (BACI) study of the GWRS Final Expansion. This project did not commence in the 2019-20 program year due largely to OC San's COVID-19 restrictions that were implemented after March 2020.

REGIONAL MONITORING

Regional Nearshore (Surfzone) Bacterial Sampling

OC San 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 (68 km) of coastline (from Seal Beach to San Clemente State Beach) and 70 miles (113 km) of harbor and bay frontage. OC San samples 38 stations 1–2 days/week along 19 miles (31 km) of beach from Seal Beach to Crystal Cove State Beach (Figure 3-1).

OCHCA reviews bacteriological data to determine whether a station meets Ocean Water-Contact Sports Standards (i.e., Assembly Bill 411; AB411), and uses these results as the basis for health advisories, postings, or beach closures. Results are available on the OCHCA's website (https://ocbeachinfo.com/download/).

Of the 38 regional surfzone stations sampled by OC San, 18 are legacy (historical OC San water quality compliance) stations sampled since the 1970s (Figure 3-1). Results for these stations were similar to those of previous years with fecal indicator bacteria counts varying by quarter, location, and bacteria type (Table B-14). A general spatial pattern was associated with the mouth of the Santa Ana River. Quarterly geomeans peaked near the river mouth and tapered off upcoast and downcoast.

Southern California Bight Regional Water Quality Program

OC San is a member of a cooperative regional sampling effort known as the Southern California Bight Regional Water Quality Program (SCBRWQP; previously known as the Central Bight Regional Water Quality Monitoring Program) 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 cover 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 comparable conductivity-temperature-depth (aka CTD) profiling systems and field sampling methods. OC San samples 66 stations, which includes the 28 Core water quality program stations, as part of this program (Figure 3-1). The SCBRWQP monitoring provides regional data that enhances the evaluation of water quality changes due to natural (e.g., upwelling) or anthropogenic discharges (e.g., outfalls and stormwater flows) and provides a regional context for comparisons with OC San's monitoring results. The SCBRWQP serves as the basis for SCCWRP's Bight water quality sampling (see section below). To make this data more widely accessible, the

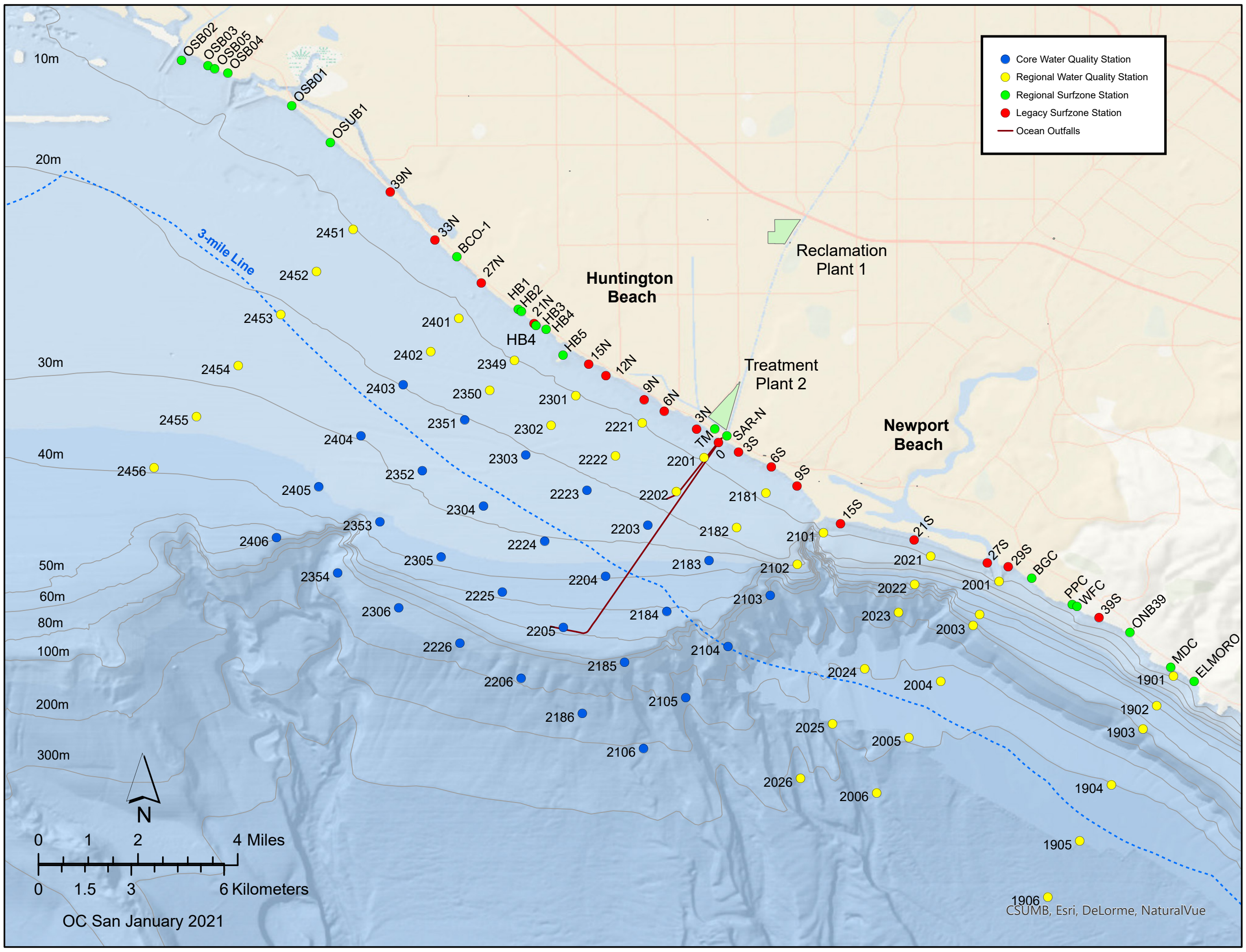

Figure 3–1 OC San's offshore and nearshore (aka surfzone) water quality monitoring stations for 2019-20.

group is evaluating adopting "FAIR" (findable, accessible, interoperable, and reusable) data standards and posting data to the Southern California Coastal Ocean Observing System.

Bight Regional Monitoring

Since 1994, OC San has participated in all 6 studies that comprise the Southern California Bight Regional Monitoring Program: 1994 Southern California Bight Pilot Project, Bight'98, Bight'03, Bight'08, Bight'13, and Bight'18. OC San has played a considerable role in all aspects of this program, including program design, sampling, laboratory analysis, quality assurance, data analysis, and reporting. Results from these efforts provide information that is used by individual dischargers, resource managers, and the public to improve understanding of environmental conditions in the Southern California Bight and to provide a regional perspective for comparisons with data collected from individual point sources. For Bight'18, OC San staff conducted field operations, ranging from Dana Point in southern Orange County to the Long Beach breakwater in southern Los Angeles County and southwest to the southern end of Santa Catalina Island (Figure 3-3). Sampling included sediment grabs (geochemistry and benthic infauna) and trawling (epibenthic fish and macroinvertebrates) from July to September 2018 and quarterly water column (ocean acidification) sampling from January to December 2019. Detailed information is available on SCCWRP's website (Southern California Bight Regional Monitoring Program - Southern California Coastal Water Research Project (sccwrp.org)).

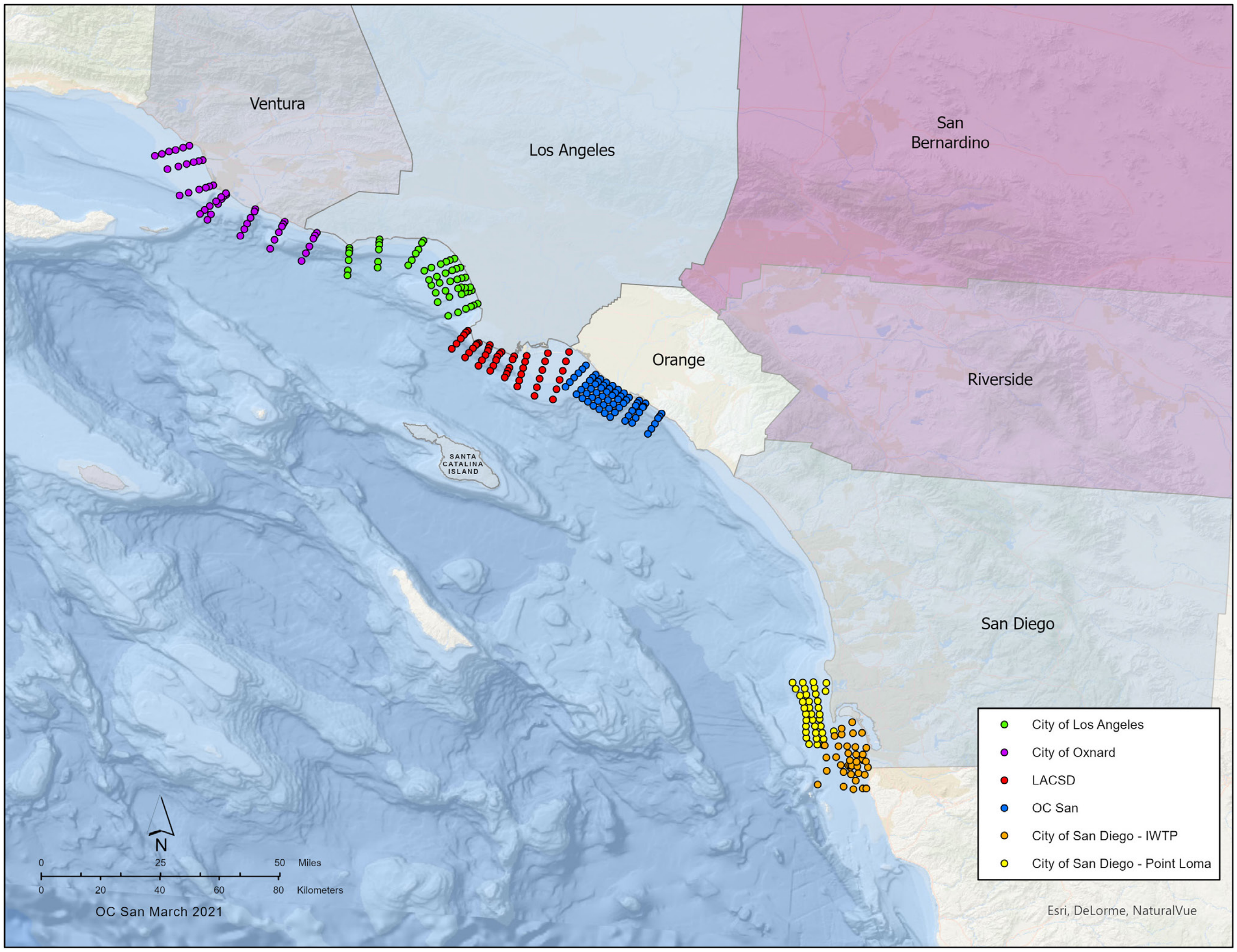

Figure 3–2 Southern California Bight Regional Water Quality Program monitoring stations for 2019-20.

Regional Kelp Survey Consortium – Central Region

OC San 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 was modeled after the San Diego Regional Water Quality Control Board, Region 9 Kelp Survey Consortium, which began in 1983. Both consortiums sample 3–4 times/year 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 Ventura County to the United States–Mexico Border. Survey results are typically published and presented annually by MBC Applied Environmental Sciences to both consortium groups, regulators, and the public. No report was completed for 2019, but the overall finding was that the total kelp canopy (2,804 km^2; unpublished data) was the lowest since 2005.

Ocean Acidification Mooring

OC San continued the deployment of an Ocean Acidification Mooring, however, mooring hardware updates and COVID-19 restrictions after March 2020 prevented routine mooring turnarounds during the program year and only 6 months of data were collected.

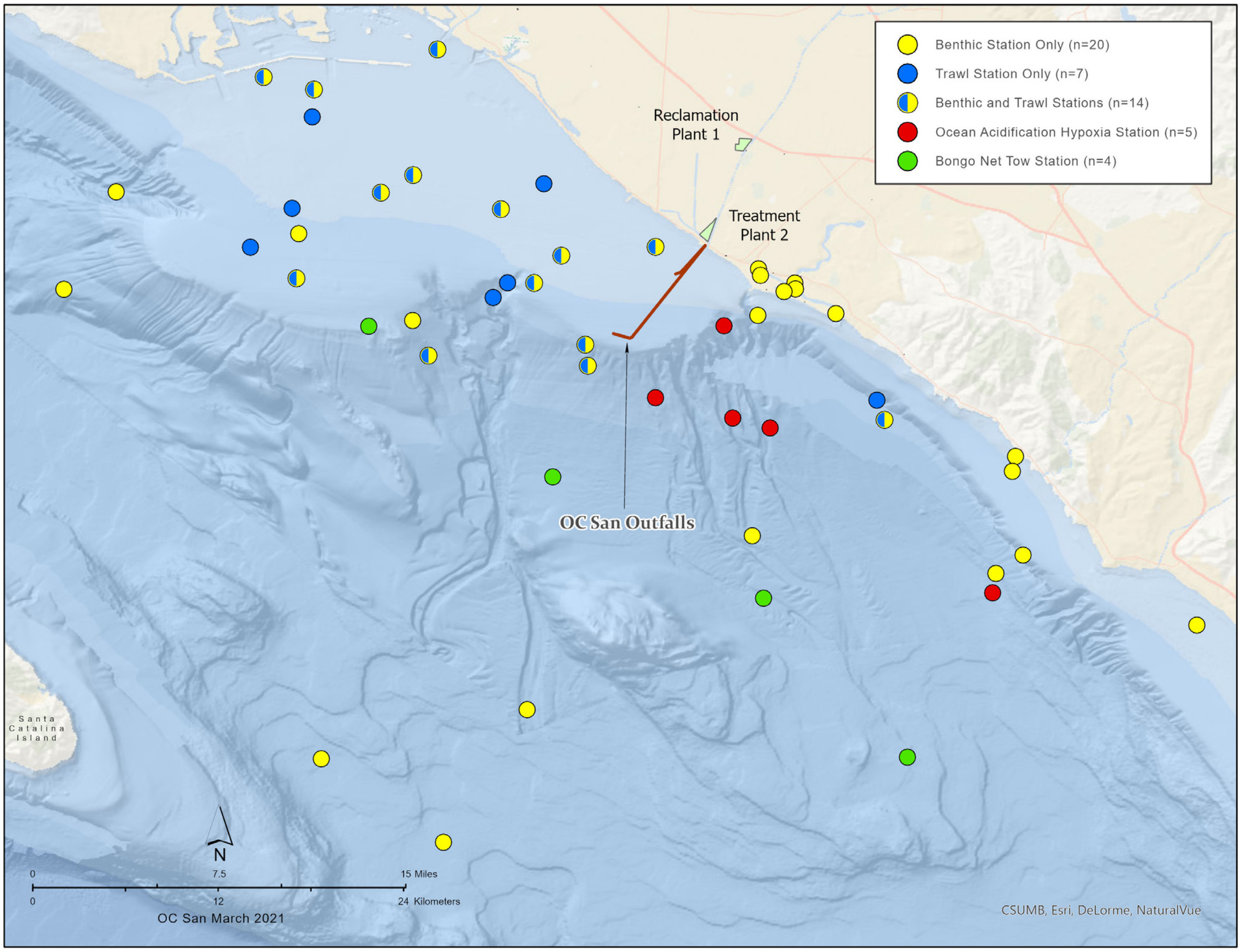

Figure 3–3 OC San's 2018 Southern California Bight Regional Monitoring Program (Bight'18) sampling stations.

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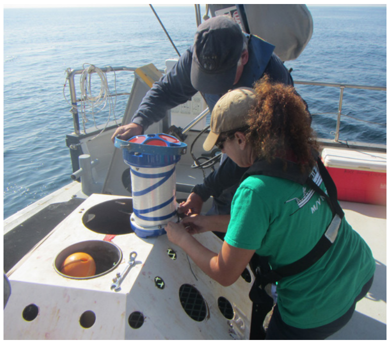

APPENDIX A
Methods

INTRODUCTION

This appendix contains a summary of the field sampling, laboratory testing, and data analysis methods used for the Ocean Monitoring Program (OMP) at the Orange County Sanitation District (OC San). 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 6 times per quarter for COP compliance determinations. Three surveys sampled the full 28-station grid for dissolved oxygen, pH, transmissivity, and nutrient compliance determinations. During 2 of these cruises, bacteriological samples were also collected at a subset of 8 stations (REC-1 stations) located within 3 miles of the coast. These samples, when combined with those from the 3 additional REC-1 station surveys, were used for water-contact compliance determinations (Table A-1; Figure 2-1).

Each survey included measurements of pressure (from which depth is calculated), temperature, conductivity (from which salinity is calculated), dissolved oxygen (DO), acidity/basicity (pH), water clarity (light transmissivity and photosynthetically active radiation [PAR]), chlorophyll-*a* fluorescence, and colored dissolved organic matter (CDOM). Measurements were conducted using a Sea-Bird Electronics SBE911 plus 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 V2 (2018a) 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). Weather conditions, sea state, and visual observations of floatable materials or grease that might be of sewage origin were also noted. Discrete water samples were collected using a Sea-Bird Electronics Carousel Water Sampler (SBE32) equipped with Niskin bottles for ammonia-nitrogen (NH_3-N) and fecal indicator bacteria (FIB) at specified stations and depths. Six liters of surface seawater (control sample) were collected at Station 2106 during each survey for NH_3-N quality assurance/quality control (QA/QC) analysis. All bottled samples were kept on wet ice in coolers and transported to OC San's laboratory within 6 hours. A summary of the sampling and analysis methods is presented in Table A-1.

Table A–1 Water quality sample collection and analysis methods by parameter during 2019-20.

Parameter	# Sampling Events	Sampling Method	Method Reference	Field Preservation	Container	Holding Time	Sampling Depth	Field Replicates
Nearshore (Surfzone)								
Total Coliforms	1–2/week	Grab	Standard Methods 9222 B **	Ice (<6 °C)	125 mL HDPE (Sterile container)	8 hrs. (field + lab)	Ankle-deep water	At least 10% of samples
Fecal Coliforms	1–2/week		Standard Methods 9222 D **					
Enterococci	1–2/week		EPA Method 1600 ***					
Offshore								
Temperature [1]	6/quarter	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	Not applicable	Not applicable	Not applicable	Every 1 m *	At least 10% of stations
Salinity (conductivity) [2]	6/quarter	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	Not applicable	Not applicable	Not applicable	Every 1 m *	At least 10% of stations
pH [3]	6/quarter	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	Not applicable	Not applicable	Not applicable	Every 1 m *	At least 10% of stations
Dissolved Oxygen [4]	6/quarter	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	Not applicable	Not applicable	Not applicable	Every 1 m *	At least 10% of stations
Transmissivity [5]	6/quarter	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	Not applicable	Not applicable	Not applicable	Every 1 m *	At least 10% of stations
Photosynthetically Active Radiation (PAR) [6]	6/quarter	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	Not applicable	Not applicable	Not applicable	Every 1 m *	At least 10% of stations
Chlorophyll-*a* fluorescence [6]	6/quarter	*in-situ* probe	LMC 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]	6/quarter	*in-situ* probe	LMC SOP 1500.1 - CTD Operations	Not applicable	Not applicable	Not applicable	Every 1 m *	At least 10% of stations
Ammonia-nitrogen (NH_3-N)	6/quarter	Niskin	LMC SOP 4500-NH3.G, Rev. J **	Ice (<6 °C)	125 mL HDPE	28 days	Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, Bottom	At least 10% of stations
Total Coliforms and *Escherichia coli* [7]	5/quarter [8]	Niskin	Standard Methods 9223 C **	Ice (<6 °C)	125 mL HDPE (Sterile container)	8 hrs. (field + lab)	Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, Bottom	At least 10% of stations
Enterococci	5/quarter [8]	Niskin	Standard Methods 9230 D	Ice (<6 °C)	125 mL HDPE (Sterile container)	8 hrs. (field + lab)	Surface, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, Bottom	At least 10% of stations
Surface Observations	6/quarter	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/100 mL x 1.1).
[8] REC-1 surveys completed within 30 days for geomean calculations.
* Sampled continuously at 24 scans/second but data processed to 1 m intervals.
** APHA (2012).
*** Available online at: www.epa.gov.

Southern California Bight Regional Water Quality

An expanded grid of 38 water quality stations was sampled quarterly as part of the Southern California Bight Regional Water Quality monitoring program. These stations were sampled by OC San in conjunction with the 28 Core water quality stations (Figure 3-1) and those of the County Sanitation Districts of Los Angeles, the City of Los Angeles, the City of Oxnard, and the City of San Diego. The total sampling area extends from the Ventura River in the north to the U.S./Mexico Border in the south, with a significant spatial gap between Crystal Cove State Beach and Mission Bay (Figure 3-2). Data were collected using CTDs within a fixed-grid pattern comprising 304 stations during a targeted period of 3–4 days. 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. OC San's sampling and analytical methods were the same as those presented in Table A-1.

Nearshore Zone

Regional nearshore (also referred to as "surfzone") FIB samples were collected 1–2 days per week at a total of 38 stations (Figure 3-1). When creek/storm drain stations flowed to the ocean, 3 bacteriological samples were collected at the source and 25 yards (nearly 23 m) up- and downcoast. 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 NH_3-N and bacteriology samples followed methods listed in Table A-1. 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 V2 (2018b) and third party (IGODS 2012) software. The steps included retaining down-cast data and removing potential outliers (i.e., data that exceeded specific sensor response 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 air bubbles) rather than by actual oceanographic events. After outlier removal, averaged 1 m depth values were prepared from the down-cast data; if there were any missing 1 m depth values, then the up-cast 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 FIB (REC-1 zone only); and (2) narrative (non-numeric) criteria for transmissivity, floating particulates, oil and grease, water discoloration, beach grease, and excess nutrients (i.e., NH_3-N).

DO, pH, and Transmissivity

- DO: cannot be depressed >10% below the reference profile mean;
- pH: cannot exceed ±0.2 pH units of the reference profile mean; and

- Natural light (defined as transmissivity): shall not be significantly reduced, where statistically different from the reference profile mean is defined as the lower 95% confidence limit.

Compliance was calculated using a method developed by Southern California Coastal Water Research Project (SCCWRP) in conjunction with its member agencies and the State Water Resources Control Board. The methodology involves 4 steps: (A) identification of the stations affected by the effluent plume using CDOM, (B) selection of reference sampling sites representing non-plume impacted conditions using CDOM, (C) a per meter comparison between water quality profiles in the reference and plume-affected zones, and (D) calculation of maximum delta and comparison to COP standards to determine Out of Range Occurrences (OROs). Reference density profiles are calculated and the profiles below the mixed layer at plume (CDOM) stations are compared and a maximum difference value is used to establish the number of OROs. Detailed methodology, as applied to DO, can be found in Nezlin et al. (2016). 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 an Out-of-Compliance (OOC) event, each ORO was evaluated to determine if it represented a logical OOC event. These evaluations were based on: (A) current direction; (B) confirmation of wastewater with FIB and NH_3-N, when available; and (C) water column features relative to naturally occurring events (i.e., low transmissivity due to elevated phytoplankton as measured by chlorophyll-*a*). ORO and OOC percentages were calculated according to the total number of observations (n=324).

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

FIB compliance used corresponding bacterial standards at each REC-1 station. Counts were depth-averaged by station and compliance 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[1] 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.

OC San has no permit compliance criteria for FIB at the nearshore (surfzone) stations. These data were given to the Orange County Health Care Agency (which follows State Department of Health Service AB411 standards) for the Ocean Water Protection Program (http://ocbeachinfo.com/) as part of a cooperative regional monitoring program.

<u>Nutrients and Aesthetics</u>

These compliance determinations were done based on presence/absence and level of potential effect at each station. Station groupings for aesthetic evaluations are shown in Tables B-5 and B-6 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

[1] Fecal coliform compliance was determined by multiplying detected *E. coli* counts by 1.1 to obtain calculated fecal coliform counts

at the ocean surface for each station. Compliance with the excess nutrient criterion was based on evaluation of NH_3-N compared to COP objectives for chronic (4 mg/L) and acute (6 mg/L) toxicity to marine organisms.

SEDIMENT GEOCHEMISTRY MONITORING

Field Methods

Sediment samples were collected for geochemistry analyses from 29 semi-annual stations in July 2019 (summer) and in January 2020 (winter), as well as from 39 annual stations in July 2019 (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 February 2020 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 m² 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 containers 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 OC San's Laboratory, Monitoring, and Compliance Standard Operating Procedures (LMC SOP) (OCSD 2016; Table A-2).

Table A–2 Sediment collection and analysis summary during 2019-20.

Parameter	Container	Preservation	Holding Time	Method
Dissolved Sulfides	HDPE container	Freeze	6 months	LMC SOP 4500-S G Rev. B
Grain Size	Plastic bag	4 °C	6 months	Plumb (1981)
Mercury	Amber glass jar	Freeze	6 months	LMC SOP 245.1B Rev. G
Metals	Amber glass jar	Freeze	6 months	LMC SOP 200.8B_SED Rev. F
Sediment Toxicity	HDPE container	4 °C	2 months	LMC SOP 8810
Total Chlorinated Pesticides (ΣPest)	Glass jar	Freeze	6 months	LMC SOP 8000-SPP
Total DDT (ΣDDT)	Glass jar	Freeze	6 months	LMC 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	ASTM D4129-05 *
Total Phosphorus (TP)	Glass jar	Freeze	6 months	EPA 6010B *
Total Polychlorinated Biphenyls (ΣPCB)	Glass jar	Freeze	6 months	LMC SOP 8000-SPP
Total Polycyclic Aromatic Hydrocarbons (ΣPAH)	Glass jar	Freeze	6 months	LMC SOP 8000-PAH

* Available online at: www.epa.gov.

Laboratory Methods

Sediment grain size, total organic carbon, 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 OC San 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),

Table A–3 Parameters measured in sediment samples during 2019-20.

Metals			
Antimony	Cadmium	Lead	Selenium
Arsenic	Chromium	Mercury	Silver
Barium	Copper	Nickel	Zinc
Beryllium			
Organochlorine 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	2,4’-DDE	2,4’-DDT	4,4’-DDMU
4,4’-DDD	4,4’-DDE	4,4’-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+j]fluoranthene		Phenanthrene	1-Methylphenanthrene
Benzo[e]pyrene		Pyrene	
Other Parameters			
Dissolved Sulfides	Total Nitrogen	Total Organic Carbon	Total Phosphorus
Grain Size			

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 dichlorodiphenyltrichloroethane (ΣDDT) represents the summed values of 4,4’-DDMU and the 2,4- and 4,4’-isomers of DDD, DDE, and DDT. Total chlorinated pesticides (ΣPest) represent the summed values of 13 chlordane derivative compounds plus dieldrin.

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

Data Analyses

All analytes that were undetected (i.e., value below the method detection limit) are reported as ND (not detected). Further, an ND value was treated as zero for calculating a mean analyte concentration; however, if a station group contained all ND 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 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. OC San’s historical sediment geochemistry data from the past 10 monitoring periods, as well as 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 ($p<0.05$) amphipod 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 ($p>0.05$) amphipod 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 amphipod 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 the same stations and frequencies as described above in the sediment geochemistry field methods section (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.

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 plastic tray and then decanted onto a sieving table whereupon a hose with an attached fan spray nozzle was used to gently wash the sediment with filtered seawater into a 40.6 cm × 40.6 cm, 1.0 mm sieve. Organisms retained on the sieve were rinsed with 7% magnesium sulfate anesthetic into 1 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 OC San'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 Aquatic Bioassay and Consulting, Inc. (Ventura, CA), where they were sorted to 5 major taxonomic groups (aliquots): Annelida (bristle 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 (2018).

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),

Table A–4 Benthic infauna taxonomic aliquot distribution for 2019-20.

Quarter	Survey (No. of samples)	Taxonomic Aliquots	Contractor	OC San
Summer 2019	Annual (39)	Annelida	0	39
		Arthropoda	0	39
		Echinodermata	0	39
		Mollusca	0	39
		Miscellaneous Phyla	0	39
	Semi-annual (29)	Annelida	0	29
		Arthropoda	29	0
		Echinodermata	29	0
		Mollusca	0	29
		Miscellaneous Phyla	29	0
Winter 2020	Semi-annual (29)	Annelida	29	0
		Arthropoda	29	0
		Echinodermata	29	0
		Mollusca	0	29
		Miscellaneous Phyla	29	0
		Totals	**203**	**282**

(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 SDI 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 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). OC San's historical infauna data from the past 10 monitoring periods, as well as Bight'13 infauna data (Gillett et al. 2017), 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* (brittle star) 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 v7 (2015) multivariate statistical software was also used to examine the spatial patterns of infaunal invertebrate communities at the 29 semi-annual stations. 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 to incorporate the less common species (Clarke and Warwick 2014). The 39 annual stations were excluded from the analyses, as Clarke and Warwick (2014) advised that clustering is less useful and may be misleading where there is a strong environmental forcing, such as depth.

TRAWL COMMUNITIES MONITORING

Field Methods

Demersal fishes and epibenthic macroinvertebrates (EMIs) were collected by trawling in August 2019 (summer) and in February 2020 (winter). Sampling was conducted at 14 stations: 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.

OC San's trawl sampling protocols are based upon regionally developed sampling methods (Kelly et al. 2013). These methods require that a portion of the trawl track must pass within a 100 m radius of the nominal station position and be within 10% of the station's nominal depth. In addition, the speed and bottom-time duration of the trawl should range from 0.77–1.0 m/s and 8–15 minutes, respectively. A minimum of 1 trawl was conducted from the M/V *Nerissa* at each station using a 7.6 m 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 and usually in the same direction at each station. 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. Fishes were sorted by species into separate containers; EMIs were placed together in one or more containers. The identity of individual fish in each container was checked for sorting accuracy. Fish samples collected at Stations T1 and T11 were processed as follows: (1) up to 15 arbitrarily selected specimens of each species were weighed to the nearest gram and measured individually to the nearest millimeter (standard length for most species; total length for some species); and (2) if a trawl catch contained more than 15 individuals of a species, then the excess specimens were enumerated in 1 cm size classes and a bulk weight was recorded. Fish samples collected at the other stations were enumerated in 1 cm size classes and a bulk weight was recorded for each species. EMIs were sorted to species, counted, and batch weighed. For each invertebrate species with large abundances (n>100), 100 individuals were counted and then 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 taxonomic analysis in the laboratory.

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 OC San's Taxonomy Lab. Species and common names used in this report follow those given in Page et al. (2013) and Cadien and Lovell (2018).

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 OC San'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). OC San's historical trawl EMI and fish data from the past 10 monitoring periods, as well as Bight'13 trawl data (Walther et al. 2017), were also used as benchmarks.

PRIMER v.7 (2015) multivariate statistical software was used to examine the spatial patterns of the fish and EMI assemblages at the Middle Shelf Zone 2 stations. Analyses included (1) hierarchical clustering with group-average linking based on Bray-Curtis similarity indices and SIMPROF permutation tests of the clusters and (2) ordination of the same data using 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 2014). Stations at the other strata were excluded from the analyses, as Clarke and Warwick (2014) advised that clustering is less useful and may be misleading where there is a strong environmental forcing, such as depth.

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 families Scorpaenidae (e.g., California Scorpionfish and Vermilion Rockfish) and Serranidae (e.g., Kelp Bass and Sand Bass) were also 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 2019-20 monitoring period. Five hauls were conducted at each station in August 2019. Ten 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 July 2019 (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 a pre-labelled, plastic, re-sealable bag; and stored on wet ice in an insulated cooler. Bioaccumulation samples were subsequently transported under chain of custody protocols to OC San's laboratory. Sample storage and holding times for bioaccumulation analyses followed specifications in OC San's LMC SOP (OCSD 2016; Table A-5).

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.

Table A–5 Fish tissue handling and analysis summary during 2019-20.

Parameter	Container	Preservation	Holding Time	Method
Arsenic and Selenium	Ziplock bag	Freeze	6 months	LMC SOP 200.8B SED Rev. F
Organochlorine 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	Not applicable	EPA 9071 *
Mercury	Ziplock bag	Freeze	6 months	LMC SOP 245.1B Rev. G
Polychlorinated Biphenyls	Ziplock bag	Freeze	6 months	NS&T (NOAA 1993); EPA 8270 *

* Available online at www.epa.gov.

Table A–6 Parameters measured in fish tissue samples during 2019-20.

	Metals	
Arsenic *	Mercury	Selenium *
	Organochlorine Pesticides	
	Chlordane Derivatives and Dieldrin	
cis-Chlordane	Dieldrin	*cis*-Nonachlor
trans-Chlordane	Heptachlor	*trans*-Nonachlor
Oxychlordane	Heptachlor epoxide	
	DDT Derivatives	
2,4'-DDD	2,4'-DDE	2,4'-DDT
4,4'-DDD	4,4'-DDE	4,4'-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	

* Analyzed only in rig fish specimens.

ΣDDT and ΣPCB were calculated as described in the sediment geochemistry section. Total chlordane (ΣChlordane) represents the sum of 7 derivative 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 ND. Further, an ND value was treated as zero for calculating a mean analyte concentration; however, if fish tissue samples had all ND 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 State of California Office of Environmental Health Hazard Assessment advisory tissue levels for ΣDDT, ΣPCB, methylmercury, selenium, dieldrin and ΣChlordane were used to assess human health risk in rig fishing samples (Table A-7; Klasing and Brodberg 2008).

FISH HEALTH MONITORING

Assessment of the overall health of fish populations is also required by the NPDES permit. This entails documenting physical symptoms of disease in fish samples collected during each trawl survey, as well as conducting liver histopathology analysis once every 5 years (starting from June 15, 2012, the issue date of the current NPDES permit).

Table A–7 Advisory tissue levels (ATLs) for selected contaminants in 8-ounce servings of uncooked fish.

Contaminant	ATLs for the number of servings per week * (in ng/g)							
	7	6	5	4	3	2	1	Do not consume
Mercury (Women 18–45; children 1–17)	≤31	>31–36	>36–44	>44–55	>55–70	>70–150	>150–440	>440
Mercury (Women >45; men)	≤94	>94–109	>109–130	>130–160	>160–220	>220–440	>440–1,310	>1,310
Selenium	≤1,000	>1,000–1,200	>1,200–1,400	>1,400–1,800	>1,800–2,500	>2,500–4,900	>4,900–15,000	>15,000
ΣDDT	≤220	>220–260	>260–310	>310–390	>390–520	>520–1,000	>1,000–2,100	>2,100
ΣPCB	≤9	>9–10	>10–13	>13–16	>16–21	>21–42	>42–120	>120
ΣChlordane	≤80	>80–90	>90–110	>110–140	>140–190	>190–280	>280–560	>560
Dieldrin	≤7	>7–8	>8–9	>9–11	>11–15	>15–23	>23–46	>46

* Serving sizes are based on an average 160 pound person. Individuals weighing less than 160 pounds should eat proportionately smaller amounts (for example, individuals weighing 80 pounds should eat one 4-ounce serving a week when the table recommends eating one 8-ounce serving a week).

Field Methods

All trawl fish samples collected during the 2019-20 monitoring period were visually inspected for lesions, tumors, large, non-mobile external parasites, and other signs (e.g., skeletal deformities) of disease. Any atypical odor and coloration of fish samples were also noted. No fish samples were collected for liver histopathology analysis, as this analysis was conducted during the 2015-16 monitoring period (OCSD 2017).

Data Analyses

Analysis of fish disease data consisted of qualitative comparisons only.

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APPENDIX B
Supporting Data

Table B–1 Percentages of fecal indicator bacteria densities (MPN/100 mL) by sampling period and selected depth strata for OC San's 2019-20 REC-1 water quality surveys (5 surveys/quarter; 8 stations/survey).

Total Coliform						
Sampling Period	**Depth Strata (m)**	**n**	**<10**	**10–1,000**	**1,001–10,000 ***	**>10,000 ****
Summer	1–15	96	93%	7%	0%	0%
	16–30	77	70%	30%	0%	0%
	31–45	24	54%	46%	0%	0%
	46–60	38	79%	21%	0%	0%
	Water Column	235	79%	21%	0%	0%
Fall	1–15	102	89%	11%	0%	0%
	16–30	71	83%	17%	0%	0%
	31–45	20	65%	35%	0%	0%
	46–60	36	67%	33%	0%	0%
	Water Column	229	82%	18%	0%	0%
Winter	1–15	104	92%	8%	0%	0%
	16–30	71	63%	37%	0%	0%
	31–45	20	50%	45%	5%	0%
	46–60	34	41%	59%	0%	0%
	Water Column	229	72%	28%	0%	0%
Spring	1–15	99	93%	7%	0%	0%
	16–30	71	72%	27%	1%	0%
	31–45	22	27%	68%	5%	0%
	46–60	38	18%	79%	3%	0%
	Water Column	230	68%	31%	1%	0%
Annual	1–15	401	92%	8%	0%	0%
	16–30	290	72%	28%	0%	0%
	31–45	86	49%	49%	2%	0%
	46–60	146	51%	48%	1%	0%
	Water Column	923	75%	24%	0%	0%
Fecal Coliform						
Sampling Period	**Depth Strata (m)**	**n**	**<10**	**10–200**	**201–400 ***	**>400 ****
Summer	1–15	96	98%	2%	0%	0%
	16–30	77	83%	17%	0%	0%
	31–45	24	75%	25%	0%	0%
	46–60	38	84%	16%	0%	0%
	Water Column	235	89%	11%	0%	0%
Fall	1–15	102	98%	2%	0%	0%
	16–30	71	97%	3%	0%	0%
	31–45	20	80%	20%	0%	0%
	46–60	36	83%	6%	11%	0%
	Water Column	229	94%	4%	2%	0%
Winter	1–15	104	98%	2%	0%	0%
	16–30	71	86%	14%	0%	0%
	31–45	20	70%	25%	5%	0%
	46–60	34	76%	24%	0%	0%
	Water Column	229	89%	11%	0%	0%
Spring	1–15	99	99%	1%	0%	0%
	16–30	71	87%	11%	0%	0%
	31–45	22	41%	55%	0%	0%
	46–60	38	42%	53%	5%	0%
	Water Column	230	80%	18%	1%	0%
Annual	1–15	401	98%	2%	0%	0%
	16–30	290	88%	11%	0%	0%
	31–45	86	66%	31%	1%	0%
	46–60	146	71%	25%	4%	0%
	Water Column	923	88%	11%	1%	0%

Table B–1 continues.

Table B–1 continued.

Sampling Period	Depth Strata (m)	n	Enterococci <10	10–35	36–104 *	>104 **
Summer	1–15	96	92%	8%	0%	0%
	16–30	77	87%	13%	0%	0%
	31–45	24	92%	8%	0%	0%
	46–60	38	97%	3%	0%	0%
	Water Column	235	91%	9%	0%	0%
Fall	1–15	102	95%	5%	0%	0%
	16–30	71	97%	3%	0%	0%
	31–45	20	90%	10%	0%	0%
	46–60	36	81%	19%	0%	0%
	Water Column	229	93%	7%	0%	0%
Winter	1–15	104	88%	12%	0%	0%
	16–30	71	90%	8%	1%	0%
	31–45	20	90%	5%	5%	0%
	46–60	34	91%	6%	3%	0%
	Water Column	229	90%	9%	1%	0%
Spring	1–15	99	97%	3%	0%	0%
	16–30	71	92%	7%	1%	0%
	31–45	22	68%	23%	9%	0%
	46–60	38	63%	29%	8%	0%
	Water Column	230	87%	10%	3%	0%
Annual	1–15	401	93%	7%	0%	0%
	16–30	290	91%	8%	1%	0%
	31–45	86	85%	12%	3%	0%
	46–60	146	83%	14%	3%	0%
	Water Column	923	90%	9%	1%	0%

* Geomean; ** Single sample

Table B–2 Depth-averaged total coliform densities (MPN/100 mL) in discrete samples collected in offshore waters and used for comparison with California Ocean Plan Water-Contact (REC-1) compliance criteria, July 2019 through June 2020.

Station	Date					Meets 30-day Geometric Mean of ≤1000/100 mL	Meets Single Sample Standard of ≤10,000/100 mL	Meets Single Sample Standard of ≤1000/100 mL *
	7/23/2019	**7/24/2019**	**7/25/2019**	**8/12/2019**	**8/13/2019**			
2103	<10	<10	<10	11	13	YES	YES	YES
2104	<10	<10	<10	13	16	YES	YES	YES
2183	12	<10	10	<10	14	YES	YES	YES
2203	<10	<10	<10	<10	14	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
	10/22/2019	10/23/2019	10/24/2019	11/4/2019	11/5/2019			
2103	<10	38	32	<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	13	<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	11	<10	YES	YES	YES
2403	31	<10	<10	<10	<10	YES	YES	YES
	1/16/2020	**1/20/2020**	**1/21/2020**	**2/5/2020**	**2/6/2020**			
2103	18	14	<10	11	17	YES	YES	YES
2104	43	10	10	<10	11	YES	YES	YES **
2183	42	<10	<10	<10	<10	YES	YES	YES
2203	<10	10	<10	16	<10	YES	YES	YES
2223	<10	<10	<10	<10	12	YES	YES	YES
2303	12	<10	<10	<10	<10	YES	YES	YES
2351	10	<10	<10	13	<10	YES	YES	YES
2403	<10	<10	12	<10	<10	YES	YES	YES
	4/28/2020	**4/29/2020**	**4/30/2020**	**5/5/2020**	**5/6/2020**			
2103	21	48	53	<10	20	YES	YES	YES **
2104	19	44	44	<10	109	YES	YES	YES **
2183	<10	15	18	<10	<10	YES	YES	YES
2203	14	<10	<10	<10	<10	YES	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES	YES
2303	<10	13	<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 when the single sample maximum fecal coliform/total coliform ratio >0.1.

** Depths combined, meet single sample standard (1/16/20, 4/30/20, 5/16/2020).

Table B–3 Depth-averaged fecal coliform densities (MPN/100 mL) in discrete samples collected in offshore waters and used for comparison with California Ocean Plan Water-Contact (REC-1) compliance criteria, July 2019 through June 2020.

Station	Date					Meets 30-day Geometric Mean of ≤200/100 mL	Meets single sample standard of ≤400/100 mL
	7/23/2019	**7/24/2019**	**7/25/2019**	**8/12/2019**	**8/13/2019**		
2103	<10	<10	<10	<10	<10	YES	YES
2104	<10	<10	<10	10	13	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	<10	<10	YES	YES
	10/22/2019	**10/23/2019**	**10/24/2019**	**11/4/2019**	**11/5/2019**		
2103	<10	26	16	<10	<10	YES	YES
2104	<10	<10	<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	19	<10	<10	<10	<10	YES	YES
	1/16/2020	**1/20/2020**	**1/21/2020**	**2/5/2020**	**2/6/2020**		
2103	11	<10	<10	<10	<10	YES	YES
2104	18	<10	<10	<10	<10	YES	YES
2183	18	<10	<10	<10	<10	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES
2223	<10	<10	<10	<10	<10	YES	YES
2303	11	<10	<10	<10	<10	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES
2403	<10	<10	11	<10	<10	YES	YES
	4/28/2020	**4/29/2020**	**4/30/2020**	**5/5/2020**	**5/6/2020**		
2103	15	19	31	<10	12	YES	YES *
2104	<10	11	24	<10	43	YES	YES *
2183	<10	<10	12	<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

* Depths combined, meet single sample standard (4/30/20, 5/6/20).

Table B–4 Depth-averaged enterococci densities (MPN/100 mL) in discrete samples collected in offshore waters and used for comparison with California Ocean Plan Water-Contact (REC-1) compliance criteria and EPA Primary Recreation Criteria in Federal Waters, July 2019 through June 2020.

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*
	7/23/2019	**7/24/2019**	**7/25/2019**	**8/12/2019**	**8/13/2019**			
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
	10/22/2019	**10/23/2019**	**10/24/2019**	**11/4/2019**	**11/5/2019**			
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
	1/16/2020	**1/20/2020**	**1/21/2020**	**2/5/2020**	**2/6/2020**			
2103	<10	<10	<10	10	<10	YES	YES	YES
2104	10	<10	11	<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	12	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	4/28/2020	**4/29/2020**	**4/30/2020**	**5/5/2020**	**5/6/2020**			
2103	<10	10	15	<10	<10	YES	YES	YES
2104	<10	<10	10	<10	21	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

* Standard is based on area of infrequent use.

Table B–5 Summary of floatable material by station group observed during the 28-station grid water quality surveys, July 2019 through June 2020. Total number of station visits = 336.

Surface Observation	Station Group							Totals
	Upcoast Offshore	Upcoast Inshore	Infield Offshore	Within-ZID	Infield Inshore	Downcoast Offshore	Downcoast Inshore	
	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	0	0	0	0	0	0	0	0
Biological Material (kelp)	0	0	0	0	0	0	0	0
Material of Sewage Origin	0	0	0	0	0	0	0	0
Totals	0	0	0	0	0	0	0	0

Table B–6 Summary of floatable material by station group observed during the REC-1 water quality surveys, July 2019 through June 2020. Total number of station visits = 108.

Surface Observation	Station Groups				Totals
	Upcoast Inshore	Within-ZID	Infield Inshore	Downcoast Inshore	
	2223, 2303 2351, 2403	2205	2203	2103, 2104, 2183	
Oil and Grease	0	0	0	0	0
Trash/Debris	0	0	0	0	0
Biological Material (kelp)	0	0	0	0	0
Material of Sewage Origin	0	0	0	0	0
Totals	0	0	0	0	0

Table B–7 Summary of OC San's Core water quality compliance parameters by sampling period and selected depth strata for 2019-20 (3 surveys/quarter; 28 stations/survey).

		Oxygen (mg/L)				pH				Transmissivity (%)			
Sampling Period	Depth Strata (m)	Minimum	Mean	Maximum	Std. Dev.	Minimum	Mean	Maximum	Std. Dev.	Minimum	Mean	Maximum	Std. Dev.
Summer	1–15	6.43	7.83	8.80	0.43	7.81	7.97	8.11	0.05	68.82	79.49	84.88	2.79
	16–30	4.71	6.81	8.48	0.75	7.60	7.81	7.98	0.08	71.87	81.36	87.54	3.10
	31–45	4.42	5.61	7.53	0.68	7.54	7.67	7.87	0.06	79.48	85.68	88.19	1.42
	46–60	4.22	4.96	6.87	0.50	7.51	7.59	7.73	0.04	83.88	86.95	88.90	1.14
	61–75	3.91	4.48	5.88	0.29	7.46	7.53	7.64	0.03	83.97	87.44	89.02	1.02
	Water Column	3.91	6.37	8.80	1.35	7.46	7.77	8.11	0.17	68.82	83.07	89.02	3.96
Fall	1–15	6.25	7.74	8.64	0.28	7.87	7.97	8.07	0.04	67.96	81.97	86.64	4.05
	16–30	5.95	7.38	8.17	0.44	7.77	7.90	8.03	0.04	65.36	83.85	86.99	2.18
	31–45	5.46	6.74	8.06	0.54	7.68	7.82	7.94	0.06	81.57	85.78	88.23	1.01
	46–60	5.22	6.20	7.08	0.43	7.65	7.76	7.87	0.05	83.44	86.95	88.56	0.99
	61–75	4.76	5.58	6.55	0.37	7.61	7.70	7.80	0.05	83.70	87.47	88.63	0.86
	Water Column	4.76	7.00	8.64	0.84	7.61	7.86	8.07	0.10	65.36	84.50	88.63	3.27
Winter	1–15	7.14	7.82	8.38	0.22	7.83	7.93	8.01	0.04	70.76	83.18	87.65	3.36
	16–30	5.84	7.52	8.31	0.41	7.76	7.90	8.00	0.04	69.11	83.90	87.50	2.73
	31–45	5.36	6.74	7.84	0.66	7.67	7.82	7.95	0.06	73.56	85.61	88.31	2.05
	46–60	4.89	5.97	7.48	0.54	7.66	7.74	7.90	0.05	75.58	86.77	88.81	1.48
	61–75	4.21	5.26	6.44	0.50	7.56	7.68	7.79	0.04	82.86	87.20	89.26	1.33
	Water Column	4.21	6.99	8.38	1.00	7.56	7.85	8.01	0.10	69.11	84.78	89.26	2.99
Spring	1–15	4.43	8.63	11.49	1.38	7.69	8.16	8.38	0.09	58.63	79.15	86.25	3.32
	16–30	3.81	5.62	9.09	1.06	7.51	7.89	8.19	0.16	69.61	82.63	88.01	3.08
	31–45	3.45	4.33	5.93	0.45	7.48	7.76	8.15	0.19	77.48	86.41	89.12	2.03
	46–60	3.36	3.97	4.89	0.26	7.49	7.73	8.09	0.20	81.09	87.25	89.17	1.45
	61–75	3.14	3.74	4.30	0.26	7.52	7.72	8.07	0.21	82.54	87.46	89.26	1.28
	Water Column	3.14	5.87	11.49	2.17	7.48	7.91	8.38	0.24	58.63	83.42	89.26	4.28
Annual	1–15	4.43	8.00	11.49	0.82	7.69	8.00	8.38	0.11	58.63	80.96	87.65	3.80
	16–30	3.81	6.85	9.09	1.03	7.51	7.87	8.19	0.10	65.36	82.94	88.01	2.98
	31–45	3.45	5.88	8.06	1.15	7.48	7.77	8.15	0.12	73.56	85.86	89.12	1.71
	46–60	3.36	5.30	7.48	0.99	7.49	7.71	8.09	0.12	75.58	86.98	89.17	1.29
	61–75	3.14	4.78	6.55	0.80	7.46	7.66	8.07	0.13	82.54	87.39	89.26	1.14
	Water Column	3.14	6.57	11.49	1.50	7.46	7.85	8.38	0.17	58.63	83.95	89.26	3.72

Table B–8 Summary of OC San's Core water quality ammonia-nitrogen (mg/L) by sampling period and selected depth strata for 2019-20 (3 surveys/quarter; 22 stations/survey).

Sampling Period	Depth Strata (m)	n	<MDL *	MDL–3.9	4–5.9 **	≥6 ***
Summer	1–15	190	77%	23%	0%	0%
	16–30	159	81%	19%	0%	0%
	31–45	65	63%	37%	0%	0%
	46–60	98	63%	37%	0%	0%
	Water Column	512	74%	26%	0%	0%
Fall	1–15	176	85%	15%	0%	0%
	16–30	177	75%	25%	0%	0%
	31–45	62	74%	26%	0%	0%
	46–60	89	71%	29%	0%	0%
	Water Column	504	78%	22%	0%	0%
Winter	1–15	188	80%	20%	0%	0%
	16–30	166	73%	27%	0%	0%
	31–45	58	59%	41%	0%	0%
	46–60	90	67%	33%	0%	0%
	Water Column	502	73%	27%	0%	0%
Spring	1–15	184	81%	19%	0%	0%
	16–30	163	75%	25%	0%	0%
	31–45	56	64%	36%	0%	0%
	46–60	97	66%	34%	0%	0%
	Water Column	500	74%	26%	0%	0%
Annual	1–15	738	81%	19%	0%	0%
	16–30	665	76%	24%	0%	0%
	31–45	241	65%	35%	0%	0%
	46–60	374	67%	33%	0%	0%
	Water Column	2,018	75%	25%	0%	0%

* MDL = 0.04 mg/L; ** COP chronic crteria; *** COP acute criteria.

Table B–9 Species richness and abundance values of the major taxonomic groups collected at each depth stratum and season during the 2019-20 infauna survey. Values represent the mean and range (in parentheses).

Season	Parameter	Stratum	Annelida	Arthropoda	Echinodermata	Misc. Phyla	Mollusca
Summer	Species Richness	Middle Shelf Zone 1 (31–50 m)	48 (33–67)	19 (11–28)	4 (2–6)	7 (4–13)	9 (3–14)
		Middle Shelf Zone 2, Within-ZID (51–90 m)	51 (49–52)	17 (7–26)	3 (2–5)	8 (7–11)	7 (4–12)
		Middle Shelf Zone 2, Non-ZID (51–90 m)	47 (26–69)	15 (4–27)	3 (0–7)	8 (3–17)	8 (3–15)
		Middle Shelf Zone 3 (91–120 m)	37 (26–49)	5 (3–9)	2 (2–4)	4 (3–6)	8 (4–12)
		Outer Shelf (121–200 m)	22 (16–27)	3 (1–8)	1 (0–2)	1 (0–2)	7 (3–12)
		Upper Slope/Canyon (201–500 m)	10 (8–14)	1 (0–3)	1 (0–2)	0 (0–2)	5 (2–8)
	Abundance	Middle Shelf Zone 1 (31–50 m)	336 (122–570)	70 (38–104)	13 (2–23)	15 (4–28)	17 (6–33)
		Middle Shelf Zone 2, Within-ZID (51–90 m)	328 (181–400)	39 (9–63)	6 (5–8)	20 (13–28)	10 (3–19)
		Middle Shelf Zone 2, Non-ZID (51–90 m)	333 (82–963)	37 (7–76)	8 (0–29)	19 (3–40)	14 (4–26)
		Middle Shelf Zone 3 (91–120 m)	173 (75–266)	8 (3–12)	19 (7–48)	10 (3–15)	19 (9–39)
		Outer Shelf (121–200 m)	99 (42–202)	5 (1–14)	2 (0–4)	2 (0–4)	17 (4–64)
		Upper Slope/Canyon (201–500 m)	33 (24–53)	2 (0–6)	2 (0–5)	1 (0–3)	9 (3–15)
Winter	Species Richness	Middle Shelf Zone 2, Within-ZID (51–90 m)	44 (39–50)	19 (13–26)	4 (2–7)	6 (5–8)	7 (5–9)
		Middle Shelf Zone 2, Non-ZID (51–90 m)	46 (33–64)	15 (8–23)	3 (1–6)	6 (3–10)	6 (3–11)
	Abundance	Middle Shelf Zone 2, Within-ZID (51–90 m)	243 (187–323)	63 (26–131)	6 (2–14)	9 (6–12)	10 (6–14)
		Middle Shelf Zone 2, Non-ZID (51–90 m)	247 (94–485)	37 (19–113)	5 (1–12)	12 (4–23)	10 (3–19)

Table B–10 Abundance and species richness of epibenthic macroinvertebrates collected in the Summer 2019 and Winter 2020 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	**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	3818	622	944		23	4	13	1	972	4	1646	7		36	2	726					8818	52.5
Lytechinus pictus	2	16	11	128	1085	654	148	1039	21	233	13	38	2	2	20	18	33	9	19	3	3494	20.8
Thesea sp B	57	83	21		40	86	42	44	327	259	46	46	15	50	40	185					1341	8.0
Strongylocentrotus fragilis																	801	2	56	44	903	5.4
Sicyonia ingentis					12	21	5	18	28	29	10	23	27	34	4	56	4	131	49	257	708	4.2
Ophiothrix spiculata	1	536				5		1	5	5	1	1			1	9		2			567	3.4
Hamatoscalpellum californicum	25	19	73		17	13	6	11	43	45	35	53	29	11	19	39					438	2.6
Astropecten californicus	3	1	2		14	4	8	11	11	12	16	17	11	28	6	6		4	2	3	159	0.9
Neocrangon zacae																		11		74	85	0.5
Luidia foliolata		2	2		3	3	3	2	7	15	5		1	4	4	1	1	5	10	4	72	0.4
Sicyonia penicillata					1	9		2		3		13		16		2					46	0.3
Heterogorgia tortuosa	1	3	3			5	1	2	1	1		2		2							21	0.1
Neocrangon resima																		3		13	16	0.1
Luidia asthenosoma				1	1		1		3		3					4					13	0.1
Acanthoptilum sp	3					3	4					1									11	0.1
Orthopagurus minimus		5	4							1											10	0.1
Luidia armata	8			1																	9	0.1
Octopus rubescens																1	4	1	2	1	9	0.1
Pleurobranchaea californica		5																2			7	<0.1
Simnia sp						2				1				2		2					7	<0.1
Philine auriformis		3	1																		4	<0.1
Pyromaia tuberculata												1				3					4	<0.1
Apostichopus californicus					1							1						1			3	<0.1
Cancellaria crawfordiana																				3	3	<0.1
Calliostoma turbinum					1									1							2	<0.1
Dendronotus venustus																2					2	<0.1
Flabellinopsis iodinea	2																				2	<0.1
Heptacarpus tenuissimus																2					2	<0.1
Lamellaria diegoensis																2					2	<0.1
Paguristes bakeri	1	1																			2	<0.1
Platymera gaudichaudii					1										1						2	<0.1
Polycera tricolor	2																				2	<0.1
Rossia pacifica																		1		1	2	<0.1
Stylatula elongata	2																				2	<0.1
Tritia insculpta																		1		1	2	<0.1
Amphichondrius granulatus																1					1	<0.1
Antiplanes catalinae																	1				1	<0.1
Astropecten armatus									1												1	<0.1
Baptodoris mimetica									1												1	<0.1
Ericerodes hemphillii										1											1	<0.1
Heterogorgia sp											1										1	<0.1
Latulambrus occidentalis	1																				1	<0.1
Leopecten diegensis			1																		1	<0.1
Metacarcinus anthonyi																			1		1	<0.1
Octopus californicus							1														1	<0.1
Paguristes turgidus																1					1	<0.1
Pagurus spilocarpus		1																			1	<0.1
Pteropurpura macroptera										1											1	<0.1
Total Abundance	**3926**	**1297**	**1062**	**130**	**1199**	**809**	**232**	**1131**	**1420**	**610**	**1776**	**203**	**85**	**186**	**97**	**1060**	**844**	**173**	**139**	**404**	**16783**	**100**
Total No. of Species	**14**	**13**	**10**	**3**	**12**	**12**	**11**	**10**	**12**	**14**	**10**	**12**	**6**	**11**	**9**	**18**	**6**	**13**	**7**	**11**	**48**	

Table B–11 Biomass (kg) of epibenthic macroinvertebrates collected in the Summer 2019 and Winter 2020 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	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	%
Strongylocentrotus fragilis																	32.840	0.173	3.190	3.600	39.803	58.7
Ophiura luetkenii	2.670	0.560	0.850		0.030	0.001	0.004	0.001	1.148	0.001	2.600	0.002		0.043	0.001	0.603					8.514	12.6
Lytechinus pictus	0.015	0.046	0.009	0.400	2.148	1.000	0.222	1.590	0.035	0.333	0.014	0.028	0.001	0.004	0.013	0.008	0.203	0.020	0.046	0.003	6.138	9.1
Sicyonia ingentis					0.046	0.033	0.040	0.029	0.100	0.053	0.035	0.053	0.105	0.043	0.010	0.068	0.068	1.400	0.500	2.700	5.283	7.8
Luidia foliolata		0.035	0.009		0.001	0.001	0.004	0.013	0.001	0.193	0.001		0.012	0.005	0.045	0.001	0.123	0.143	0.790	0.235	1.612	2.4
Ophiothrix spiculata	0.001	1.098				0.001		0.001	0.001	0.001	0.001	0.001			0.001	0.003		0.001			1.110	1.6
Apostichopus californicus					0.498							0.001						0.495			0.994	1.5
Thesea sp B	0.065	0.032	0.015		0.022	0.065	0.016	0.050	0.180	0.228	0.026	0.055	0.007	0.045	0.017	0.163					0.986	1.5
Sicyonia penicillata					0.039	0.153		0.029		0.043		0.173		0.213		0.026					0.676	1.0
Metacarcinus anthonyi																			0.660		0.660	1.0
Astropecten californicus	0.003	0.001	0.004		0.001	0.001	0.019	0.013	0.034	0.053	0.045	0.055	0.034	0.123	0.016	0.001		0.083	0.037	0.002	0.525	0.8
Platymera gaudichaudii					0.198										0.218						0.416	0.6
Pleurobranchaea californica		0.001																0.395			0.396	0.6
Luidia armata	0.145			0.030																	0.175	0.3
Octopus rubescens																0.030	0.035	0.014	0.038	0.004	0.121	0.2
Octopus californicus							0.088														0.088	0.1
Paguristes turgidus																0.050					0.050	0.1
Hamatoscalpellum californicum	0.004	0.001	0.003		0.001	0.002	0.001	0.007	0.001	0.005	0.001	0.004	0.001	0.002	0.001	0.010					0.044	0.1
Pagurus spilocarpus		0.043																			0.043	0.1
Luidia asthenosoma				0.004	0.001		0.003		0.016		0.011					0.002					0.037	0.1
Neocrangon zacae																		0.002		0.024	0.026	<0.1
Stylatula elongata	0.014																				0.014	<0.1
Heterogorgia tortuosa	0.001	0.001	0.002			0.003	0.001	0.001	0.001	0.001		0.001		0.001							0.013	<0.1
Latulambrus occidentalis	0.012																				0.012	<0.1
Neocrangon resima																		0.001		0.007	0.008	<0.1
Astropecten armatus									0.005												0.005	<0.1
Acanthoptilum sp	0.001					0.001	0.001					0.001									0.004	<0.1
Cancellaria crawfordiana																				0.004	0.004	<0.1
Simnia sp						0.001				0.001				0.001		0.001					0.004	<0.1
Orthopagurus minimus		0.001	0.001							0.001											0.003	<0.1
Pteropurpura macroptera										0.003											0.003	<0.1
Pyromaia tuberculata												0.001				0.002					0.003	<0.1
Calliostoma turbinum					0.001									0.001							0.002	<0.1
Heptacarpus tenuissimus																0.002					0.002	<0.1
Paguristes bakeri	0.001	0.001																			0.002	<0.1
Philine auriformis		0.001	0.001																		0.002	<0.1
Rossia pacifica																		0.001		0.001	0.002	<0.1
Tritia insculpta																		0.001		0.001	0.002	<0.1
Amphichondrius granulatus																0.001					0.001	<0.1
Antiplanes catalinae																	0.001				0.001	<0.1
Baptodoris mimetica									0.001												0.001	<0.1
Dendronotus venustus																0.001					0.001	<0.1
Ericerodes hemphillii										0.001											0.001	<0.1
Flabellinopsis iodinea	0.001																				0.001	<0.1
Heterogorgia sp											0.001										0.001	<0.1
Lamellaria diegoensis																0.001					0.001	<0.1
Leopecten diegensis			0.001																		0.001	<0.1
Polycera tricolor	0.001																				0.001	<0.1
Total	**2.934**	**1.821**	**0.895**	**0.434**	**2.986**	**1.262**	**0.399**	**1.734**	**1.523**	**0.917**	**2.735**	**0.375**	**0.160**	**0.481**	**0.322**	**0.973**	**33.270**	**2.729**	**5.261**	**6.581**	**67.792**	**100**

Table B–12 Abundance and species richness of demersal fishes collected in the Summer 2019 and Winter 2020 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	**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**	**%**
Citharichthys sordidus		17	8		209	133	127	78	167	33	67	119	166	124	279	71	603	380	488	385	3454	35.4
Icelinus quadriseriatus	2	2	31		284	31	108	44	292	30	154	113	136	100	124	142	3			5	1601	16.4
Symphurus atricaudus	13	1	2		12	30	11	26	34	58	7	73	10	100	12	158	17	38	8	41	651	6.7
Citharichthys xanthostigma	22	1	5		16	30	34	7	137	116	37	71	18	62	28	12	1	4			601	6.2
Zaniolepis latipinnis					58		40		11	7	22	5	252	36	74		35	9	16		565	5.8
Microstomus pacificus					1						1	1	5	5			101	132	89	209	544	5.6
Sebastes saxicola																	120	104	123		347	3.6
Sebastes semicinctus													14			2	71	7	2	143	239	2.4
Lyopsetta exilis																	18	83	60	70	231	2.4
Zaniolepis frenata																	89	78	42	7	216	2.2
Hippoglossina stomata	8	7	11		10	12	6	13	11	18	3	14	1	4	16	55	7	2	3	3	204	2.1
Citharichthys stigmaeus	24	53	91																		168	1.7
Chitonotus pugetensis	1	2	4		1		1		29		9	3	24	8	34	9	1				126	1.3
Synodus lucioceps	1	2			4	7	9	1	15	3	17	23	13	19	9	2					125	1.3
Parophrys vetulus	1				2	2	1		2	5	9	4	38	11	2	8	14	8	13	4	124	1.3
Porichthys notatus	2					1			1					1		1	9	22	44	43	124	1.3
Zalembius rosaceus					10		10		5		13	3	13		62			3	3		122	1.2
Pleuronichthys verticalis	5	1	3		5	7	3	4	1	6		9	2	12	3	16	3		1	4	85	0.9
Lycodes pacificus																	5	25	5	24	59	0.6
Xystreurys liolepis	13	6	3					3		1				6		20					52	0.5
Scorpaena guttata					1	1	2	1		1	1		4		13	4	3	2	3		36	0.4
Odontopyxis trispinosa						1			3		2		3	3	2	4					18	0.2
Glyptocephalus zachirus																	1	1	3	8	13	0.1
Raja inornata								1		1				1		1	1	2	4		11	0.1
Sebastes elongatus																	4		4		8	0.1
Sebastes hopkinsi																		8			8	0.1
Argentina sialis																				6	6	0.1
Merluccius productus																	3			2	5	0.1
Chilara taylori																			1	3	4	<0.1
Sebastes rosenblatti																	4				4	<0.1
Sebastes chlorostictus																			2		2	<0.1
Sebastes sp															1					1	2	<0.1
Genyonemus lineatus							1														1	<0.1
Hydrolagus colliei																				1	1	<0.1
Paralichthys californicus		1																			1	<0.1
Plectobranchus evides																	1				1	<0.1
Pleuronichthys decurrens																		1			1	<0.1
Raja rhina													1								1	<0.1
Sebastes macdonaldi																	1				1	<0.1
Xeneretmus triacanthus																		1			1	<0.1
Total Abundance	**92**	**93**	**158**	**0**	**613**	**255**	**353**	**178**	**708**	**279**	**342**	**438**	**700**	**492**	**659**	**505**	**1115**	**910**	**914**	**959**	**9763**	**100**
Total No. of Species	**11**	**11**	**9**	**0**	**13**	**11**	**13**	**10**	**13**	**12**	**13**	**12**	**16**	**15**	**14**	**15**	**24**	**20**	**20**	**18**	**40**	

Table B–13 Biomass (kg) of demersal fishes collected in the Summer 2019 and Winter 2020 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	**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**	**%**
Citharichthys sordidus		0.118	0.023		3.850	2.848	2.837	0.483	0.661	0.352	0.493	1.140	2.487	2.537	5.972	1.542	15.758	2.698	9.258	2.800	55.857	30.2
Citharichthys xanthostigma	0.317	0.014	0.028		0.837	1.253	1.937	0.248	5.350	3.984	1.168	3.190	1.348	4.190	0.787	1.070	0.066	0.223			26.010	14.1
Parophrys vetulus	0.210				0.208	0.223	0.105		0.169	0.950	0.763	0.542	2.637	0.848	0.145	0.790	1.700	0.937	1.533	0.462	12.222	6.6
Symphurus atricaudus	0.148	0.021	0.026		0.198	0.400	0.198	0.360	0.498	0.905	0.128	1.000	0.163	1.448	0.201	2.487	0.398	0.785	0.185	0.700	10.249	5.5
Hippoglossina stomata	0.387	0.198	0.387		0.428	0.213	0.153	0.397	0.629	0.615	0.053	0.600	0.024	0.058	0.808	2.082	0.154	0.050	0.123	0.443	7.802	4.2
Microstomus pacificus					0.053						0.044	0.027	0.053	0.148			2.337	1.517	1.848	1.588	7.615	4.1
Zaniolepis latipinnis					0.718		0.753		0.108	0.148	0.263	0.075	2.448	0.300	0.940		0.688	0.243	0.347		7.031	3.8
Sebastes saxicola																	2.600	1.687	2.648		6.935	3.8
Pleuronichthys verticalis	0.837	0.083	0.243		0.098	0.250	0.103	0.348	0.007	0.371		0.840	0.163	0.650	0.139	1.640	0.167		0.050	0.187	6.176	3.3
Synodus lucioceps	0.014	0.090			0.313	0.213	0.467	0.090	0.748	0.270	0.883	0.598	0.773	0.990	0.560	0.140					6.149	3.3
Scorpaena guttata					0.293	0.084	0.222	0.095		0.060	0.130		0.987		2.155	0.227	0.557	0.497	0.437		5.744	3.1
Icelinus quadriseriatus	0.003	0.004	0.054		0.948	0.101	0.385	0.153	0.937	0.104	0.480	0.350	0.448	0.258	0.359	0.333	0.008			0.018	4.943	2.7
Xystreurys liolepis	0.543	0.538	0.028					0.148		0.075				1.498		1.630					4.460	2.4
Sebastes semicinctus													0.053			0.002	1.200	0.123	0.024	2.748	4.150	2.2
Lyopsetta exilis																	0.304	1.498	1.253	0.658	3.713	2.0
Zalembius rosaceus					0.353		0.218		0.137		0.353	0.020	0.343		1.478			0.103	0.078		3.083	1.7
Porichthys notatus	0.004					0.020			0.018					0.065		0.015	0.243	0.437	1.003	0.787	2.592	1.4
Raja inornata								0.260		0.110				0.650		0.800	0.077	0.078	0.127		2.102	1.1
Zaniolepis frenata																	0.937	0.663	0.327	0.037	1.964	1.1
Chitonotus pugetensis	0.007	0.007	0.013		0.006		0.035		0.214		0.055	0.048	0.183	0.120	0.186	0.089	0.005				0.968	0.5
Raja rhina													0.937								0.937	0.5
Citharichthys stigmaeus	0.153	0.278	0.393																		0.824	0.4
Glyptocephalus zachirus																	0.060	0.045	0.423	0.199	0.727	0.4
Lycodes pacificus																	0.033	0.283	0.067	0.287	0.670	0.4
Paralichthys californicus		0.658																			0.658	0.4
Merluccius productus																	0.290			0.153	0.443	0.2
Hydrolagus colliei																				0.165	0.165	0.1
Sebastes elongatus																	0.058		0.067		0.125	0.1
Sebastes hopkinsi																		0.103			0.103	0.1
Pleuronichthys decurrens																		0.080			0.080	<0.1
Genyonemus lineatus							0.062														0.062	<0.1
Sebastes rosenblatti																	0.048				0.048	<0.1
Chilara taylori																			0.006	0.027	0.033	<0.1
Odontopyxis trispinosa						0.002			0.007		0.002		0.006	0.006	0.002	0.006					0.031	<0.1
Argentina sialis																				0.023	0.023	<0.1
Sebastes chlorostictus																			0.022		0.022	<0.1
Sebastes macdonaldi																	0.015				0.015	<0.1
Xeneretmus triacanthus																		0.012			0.012	<0.1
Plectobranchus evides																	0.004				0.004	<0.1
Sebastes sp															0.001					0.001	0.002	<0.1
Total	**2.623**	**2.009**	**1.195**	**0.000**	**8.303**	**5.607**	**7.475**	**2.582**	**9.483**	**7.944**	**4.815**	**8.430**	**13.053**	**13.766**	**13.733**	**12.853**	**27.707**	**12.062**	**19.826**	**11.283**	**184.749**	**100**

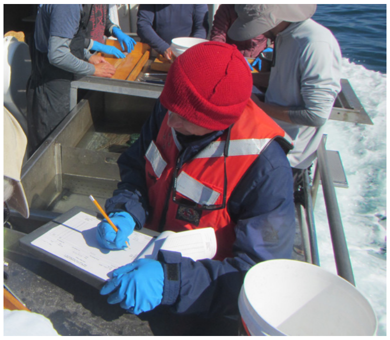
Table B–14 Summary statistics of OC San's legacy nearshore (surfzone) stations for total coliforms, fecal coliforms, and enterococci bacteria (CFU/100 mL) by station and season during 2019-20.

Station	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.
Total Coliforms																				
39N	<17	13	17	1.11	<17	16	33	1.41	<17	25	130	2.59	<17	27	220	2.97	<17	19	220	2.16
33N	<17	13	17	1.08	<17	18	33	1.52	<17	30	400	2.81	<17	20	200	2.26	<17	19	400	2.07
27N	<17	15	<100	1.63	<17	19	130	1.91	<17	21	170	2.22	<17	23	270	2.59	<17	19	270	2.07
21N	<17	14	>17	1.19	<17	20	>1200	3.54	<17	24	100	2.2	<17	36	2200	5.89	<17	22	2200	3.19
15N	<17	17	33	1.39	<17	19	67	1.8	<17	35	420	3.97	<17	36	1600	4.86	<17	25	1600	3.01
12N	<17	15	>33	1.39	<17	21	33	1.54	<17	39	560	3.39	<17	42	1000	3.69	<17	26	1000	2.69
9N	<17	26	170	2.23	<17	38	>20000	4.38	<17	32	>7500	5.53	<17	38	3200	4.29	<17	32	>20000	3.84
6N	<17	50	900	4.02	<17	54	>11000	5.64	<17	54	>10000	7.67	<17	41	5100	4.08	<17	50	>11000	5.18
3N	<17	35	1400	3.41	<17	39	>9500	5.49	<17	60	>20000	9.52	<17	56	>6700	5.39	<17	46	>20000	5.7
0	<17	17	100	1.57	<17	29	>20000	6.39	<17	80	>20000	8.63	<17	88	>7100	8.23	<17	38	>20000	6.09
3S	<17	16	33	1.33	<17	20	130	2.11	<17	20	67	1.8	<17	25	270	2.95	<17	20	270	2.08
6S	<17	14	17	1.13	<17	20	270	2.76	<17	17	50	1.62	<17	20	120	2.16	<17	17	270	1.98
9S	<17	14	>17	1.18	<17	27	420	2.94	<17	21	50	1.74	<17	16	83	1.66	<17	19	420	1.99
15S	<17	13	17	1.11	<17	23	330	2.99	<17	15	33	1.31	<17	29	230	2.8	<17	19	330	2.24
21S	<17	23	2100	4.25	<17	26	320	3.25	<17	15	33	1.31	<17	23	200	2.83	<17	22	2100	2.9
27S	<17	14	17	1.13	<17	16	100	1.83	<17	16	50	1.55	<17	15	100	1.77	<17	15	100	1.59
29S	<17	16	33	1.4	<17	22	1300	3.58	<17	32	200	2.96	<17	16	150	1.97	<17	21	1300	2.55
39S	<17	16	180	2.07	<17	29	1400	5.73	<17	14	17	1.13	<17	16	67	1.67	<17	18	1400	2.71
All	<17	19	2100	1.02	<17	25	>20000	1.63	<17	31	>20000	2.63	<17	31	>7100	1.75	<17	25	>20000	1.34
Fecal Coliforms																				
39N	<17	13	17	1.11	<17	14	33	1.3	<17	15	33	1.31	<17	16	280	2.44	<17	15	280	1.59
33N	<17	14	17	1.13	<17	14	17	1.13	<17	21	270	2.71	<17	18	67	1.87	<17	16	270	1.82
27N	<17	13	<17	1	<17	18	120	1.91	<17	15	33	1.31	<17	18	67	1.73	<17	16	120	1.58
21N	<17	14	17	1.13	<17	19	480	2.63	<17	18	67	1.78	<17	26	2000	4.3	<17	19	2000	2.53
15N	<17	14	33	1.31	<17	18	67	1.86	<17	27	250	2.92	<17	19	67	1.82	<17	19	250	2.05
12N	<17	15	50	1.46	<17	19	83	1.75	<17	20	120	2.23	<17	24	150	2.44	<17	19	150	1.98
9N	<17	24	250	2.35	<17	30	7000	3.74	<17	20	420	2.58	<17	20	370	2.4	<17	24	7000	2.76
6N	<17	38	1100	4.1	<17	43	3400	4.46	<17	32	560	3.66	<17	32	3400	3.82	<17	36	3400	3.96
3N	<17	38	15000	4.81	<17	31	3800	4.38	<17	36	2300	4.4	<17	24	1100	3.3	<17	32	15000	4.19
0	<17	15	33	1.34	<17	23	>20000	5.35	<17	39	2700	4.41	<17	30	3700	4.16	<17	23	>20000	3.75
3S	<17	14	33	1.31	<17	17	83	1.84	<17	18	33	1.55	<17	14	33	1.31	<17	16	83	1.52
6S	<17	13	17	1.11	<17	16	180	2.07	<17	15	50	1.46	<17	14	17	1.15	<17	15	180	1.51
9S	<17	15	50	1.46	<17	19	540	2.76	<17	16	33	1.42	<17	14	33	1.31	<17	16	540	1.81
15S	<17	13	<17	1	<17	16	67	1.58	<17	13	17	1.11	<17	17	120	1.92	<17	15	120	1.5
21S	<17	20	1400	3.5	<17	26	200	2.68	<17	17	50	1.61	<17	27	170	2.55	<17	22	1400	2.59
27S	<17	14	67	1.58	<17	13	<17	1	<17	13	<17	1	<17	13	<17	1	<17	13	67	1.26
29S	<17	13	17	1.08	<17	20	1100	3.38	<17	30	220	2.67	<17	15	50	1.46	<17	18	1100	2.33
39S	<17	18	280	2.37	<17	16	67	1.76	<17	14	33	1.31	<17	14	33	1.31	<17	16	280	1.73
All	<17	18	15000	1.15	<17	21	>20000	1.26	<17	21	2700	1.09	<17	20	3700	1.04	<17	19	>20000	0.90

Table B–14 continues.

Table B–14 continued.

	Summer				Fall				Winter				Spring				Annual			
Station	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	3	14	2.27	<2	4	24	2.29	<2	4	34	3.17	<2	3	100	3.57	<2	4	100	2.73
33N	<2	3	12	2.07	<2	4	36	2.98	2	11	56	3.15	<2	4	40	3.01	<2	5	56	3.08
27N	<2	3	28	2.38	<2	5	86	3.02	4	12	72	2.84	<2	5	64	3.57	<2	5	86	3.18
21N	<2	6	26	2.41	<2	8	>400	4.52	2	10	108	2.91	2	8	>400	5.08	<2	8	>400	3.63
15N	<2	5	22	2.7	<2	7	50	3.82	<2	9	42	3.09	<2	6	132	3.2	<2	7	132	3.14
12N	<2	3	14	2.46	<2	7	46	3.18	<2	9	66	3.12	<2	8	208	3.98	<2	7	208	3.26
9N	<2	14	114	3.83	<2	12	>400	4.63	2	8	288	3.35	<2	7	>400	4.05	<2	10	>400	4.01
6N	<2	16	>400	5.78	<2	18	>400	6.17	2	13	244	4.12	<2	10	>400	3.78	<2	14	>400	4.95
3N	<2	10	>400	5.44	<2	9	>400	5.43	2	23	>400	3.72	<2	10	>400	4.4	<2	12	>400	4.87
0	<2	3	22	2.28	<2	5	>400	4.46	<2	14	>400	4.5	<2	15	>400	6.05	<2	7	>400	4.6
3S	<2	3	22	2.11	<2	5	42	3.72	2	8	40	2.51	<2	3	16	2.49	<2	4	42	2.9
6S	<2	2	12	2.02	<2	4	32	3.02	<2	4	18	2.51	<2	3	32	2.76	<2	3	32	2.61
9S	<2	3	18	2.48	<2	5	32	3.57	<2	4	18	2.47	<2	4	18	2.21	<2	4	32	2.65
15S	<2	2	8	1.79	<2	6	140	4.46	<2	4	70	3.05	<2	4	16	2.64	<2	4	140	3.02
21S	<2	3	>400	4.75	<2	5	>400	5.6	<2	3	8	1.9	<2	4	46	3.17	<2	4	>400	3.78
27S	<2	2	4	1.43	<2	3	44	3.57	<2	4	74	3.67	<2	2	28	2.21	<2	3	74	2.8
29S	<2	7	32	2.81	<2	6	256	5.1	<2	10	308	6.57	<2	3	16	2.32	<2	6	308	4.22
39S	<2	3	12	2.24	<2	4	326	6.14	<2	2	6	1.64	<2	3	42	2.68	<2	3	326	3.1
All	<2	5	>400	1.25	<2	6	>400	1.15	<2	8	>400	1.09	<2	6	>400	1.04	<2	6	>400	0.76



APPENDIX C
Quality Assurance/Quality Control

INTRODUCTION

The Orange County Sanitation District's (OC San) Core Ocean Monitoring Program (OMP) 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 epibenthic macroinvertebrate community health;
- Fish tissue contaminant concentrations (chemical body burden); and
- Fish health (including external parasites and diseases).

The Core OMP complies with OC San's Quality Assurance Project Plan (QAPP) (OCSD 2016a) 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 weekly, monthly, quarterly, semi-annual, or annual schedule. Sampling and data analyses are designated by Quarters 1 through 4, which are referred to as the Winter (January–March; Quarter 1), Spring (April–June; Quarter 2), Summer (July–September; Quarter 3), and Fall (October–December; Quarter 4).

This appendix details quality assurance/quality control (QA/QC) information for the collection and analysis of water quality, sediment geochemistry, fish tissue chemistry, and benthic infauna samples for OC San's 2019-20 Core OMP.

WATER QUALITY NARRATIVE

OC San's Laboratory, Monitoring, and Compliance (LMC) staff collected 2,616 ammonia-nitorgen (NH_3-N) samples (or 654 quarterly) between July 1, 2019 and June 30, 2020. Twelve surface seawater samples were also collected at a control site (Station 2106) in each quarter. All samples were iced upon collection. NH_3-N samples were preserved with 1:1 sulfuric acid upon receipt by the LMC laboratory staff, and then stored at <6.0 °C until analysis according to the LMC's Standard Operating Procedures (SOPs) (OCSD 2016b).

LMC staff also collected 175 bacteria samples in each of the Summer, Fall, and Winter quarters of the 2019-20 monitoring period. In the 2020 Spring quarter, 174 samples were collected. All samples were iced upon collection and stored at <10 °C until analysis in accordance with LMC SOPs.

Ammonia-Nitrogen (NH_3-N)

The samples were analyzed for NH_3-N on a segmented flow analyzer using Standard Methods 4500-NH_3-G-Ocean Water. Sodium salicylate and dichloroisocyanuric acid were added to the samples to react with NH_3-N to form indophenol blue in a concentration proportional to the NH_3-N concentration in the sample. The blue color was intensified with sodium nitroprusside and was measured at 660 nm.

For each batch, a blank and a spike in a seawater control were analyzed every 20 or fewer samples. In addition, a matrix spike and matrix spike duplicate were analyzed every 10 or fewer samples. An external reference sample was analyzed once each month. The method detection limit (MDL) for low-level NH_3-N samples using the segmented flow instrument is shown in Table C-1. All samples were analyzed within the required holding time. All analyses conducted met the QA/QC criteria for accuracy and precision (Table C-2).

Table C–1 Method detection limit (MDL) and reporting limit (RL) for constituents analyzed in receiving water, sediment, and fish tissue samples, July 2019–June 2020.

Receiving water					
Parameter	**MDL (MPN/100 mL)**	**RL (MPN/100 mL)**	**Parameter**	**MDL (mg/L)**	**RL (mg/L)**
Fecal Indicator Bacteria and Nutrients					
Total coliform	10	10	Ammonia-nitrogen (effective 12/18/2018)	0.040 *	0.040
E. coli	10	10			
Enterococci	10	10			
Sediment					
Parameter	**MDL (ng/g dry)**	**RL (ng/g dry)**	**Parameter**	**MDL (ng/g dry)**	**RL (ng/g dry)**
Organochlorine Pesticides					
2,4’-DDD	0.61	1.00	Endosulfan-alpha	0.78	1.00
2,4’-DDE	0.62	1.00	Endosulfan-beta	0.75	1.00
2,4’-DDT	0.71	1.00	Endosulfan-sulfate	1.01	2.00
4,4’-DDD	1.14	2.00	Endrin	0.61	1.00
4,4’-DDE	0.68	1.00	*gamma*-BHC	0.67	1.00
4,4’-DDT	0.56	1.00	Heptachlor	2.64	5.00
4,4’-DDMU	0.84	1.00	Heptachlor epoxide	0.80	1.00
Aldrin	1.97	2.00	Hexachlorobenzene	0.80	1.00
cis-Chlordane	0.70	1.00	Mirex	0.43	1.00
trans-Chlordane	0.76	1.00	*trans*-Nonachlor	0.82	1.00
Dieldrin	0.48	1.00			
PCB Congeners					
PCB 18	0.19	0.50	PCB 126	0.53	1.00
PCB 28	0.43	0.50	PCB 128	0.61	1.00
PCB 37	0.47	0.50	PCB 138	0.71	1.00
PCB 44	0.47	0.50	PCB 149	0.60	1.00
PCB 49	0.61	1.00	PCB 151	0.35	0.50
PCB 52	0.51	1.00	PCB 153/168	0.75	1.00
PCB 66	0.62	1.00	PCB 156	0.67	1.00
PCB 70	0.74	1.00	PCB 157	0.70	1.00
PCB 74	0.61	1.00	PCB 167	0.55	1.00
PCB 77	0.52	1.00	PCB 169	0.28	0.50
PCB 81	0.39	0.50	PCB 170	0.36	0.50
PCB 87	0.43	0.50	PCB 177	0.61	1.00
PCB 99	0.41	0.50	PCB 180	0.38	0.50
PCB 101	0.47	0.50	PCB 183	0.57	1.00
PCB 105	0.58	1.00	PCB 187	0.55	1.00
PCB 110	0.58	1.00	PCB 189	0.34	0.50
PCB 114	0.49	0.50	PCB 194	0.29	0.50
PCB 118	0.76	1.00	PCB 201	0.58	1.00
PCB 119	0.32	0.50	PCB 206	0.36	0.50
PCB 123	0.43	0.50			

Table C–1 continues.

Table C–1 continued.

Parameter	MDL	RL	Parameter	MDL	RL
Sediment					
Parameter	**MDL (ng/g dry)**	**RL (ng/g dry)**	**Parameter**	**MDL (ng/g dry)**	**RL (ng/g dry)**
PAH Compounds					
1,6,7-Trimethylnaphthalene	0.87	1.00	Benzo[g,h,i]perylene	2.34	5.00
1-Methylnaphthalene	1.15	2.00	Benzo[k]fluoranthene	1.07	2.00
1-Methylphenanthrene	1.09	2.00	Biphenyl	1.22	2.00
2,3,6-Trimethylnaphthalene	1.03	2.00	Chrysene	1.09	2.00
2,6-Dimethylnaphthalene	1.01	2.00	Dibenz[a,h]anthracene	2.96	5.00
2-Methylnaphthalene	1.64	2.00	Dibenzothiophene	0.69	1.00
Acenaphthene	0.70	1.00	Fluoranthene	0.98	1.00
Acenaphthylene	0.79	1.00	Fluorene	1.26	2.00
Anthracene	0.83	1.00	Indeno[1,2,3-c,d]pyrene	2.19	5.00
Benz[a]anthracene	1.07	2.00	Naphthalene	2.80	5.00
Benzo[a]pyrene	0.98	1.00	Perylene	1.33	2.00
Benzo[b]fluoranthene	0.95	1.00	Phenanthrene	0.87	1.00
Benzo[e]pyrene	1.20	2.00	Pyrene	1.27	2.00
Parameter	**MDL (µg/kg dry)**	**RL (µg/kg dry)**	**Parameter**	**MDL (µg/kg dry)**	**RL (µg/kg dry)**
Metals					
Antimony	0.116	0.200	Lead	0.040	0.100
Arsenic	0.054	0.100	Mercury	0.038	0.040
Barium	0.151	0.200	Nickel	0.114	0.200
Beryllium	0.030	0.100	Selenium	0.481	0.500
Cadmium	0.089	0.100	Silver	0.139	0.200
Chromium	0.058	0.100	Zinc	0.862	1.500
Copper	0.138	0.200			
Parameter	**MDL (mg/kg dry)**	**RL (mg/kg dry)**	**Parameter**	**MDL (%)**	**RL (%)**
Miscellaneous Parameters					
Dissolved Sulfides	1.03	1.03	Total Organic Carbon	0.02	0.10
Total Nitrogen (Summer)	0.51	64.00			
Total Nitrogen (Winter)	0.51	63.00			
Total Phosphorus (Summer)	0.36	7.90			
Total Phosphorus (Winter)	0.12	2.50			
Fish Tissue					
Parameter	**MDL (ng/g wet)**	**RL (ng/g wet)**	**Parameter**	**MDL (ng/g wet)**	**RL (ng/g wet)**
Organochlorine Pesticides					
2,4’-DDD	1.22	2.00	*cis*-Chlordane	1.40	2.00
2,4’-DDE	1.41	2.00	*trans*-Chlordane	0.94	1.00
2,4’-DDT	1.58	2.00	Oxychlordane	2.64	5.00
4,4’-DDD	2.16	5.00	Heptachlor	2.25	5.00
4,4’-DDE	1.12	2.00	Heptachlor epoxide	1.26	2.00
4,4’-DDT	1.20	2.00	*cis*-Nonachlor	1.21	2.00
4,4’-DDMU	1.28	2.00	*trans*-Nonachlor	1.13	2.00
Dieldrin	2.41	5.00			
PCB Congeners					
PCB 18	1.89	1.89	PCB 126	0.91	1.00
PCB 28	1.33	1.33	PCB 128	1.07	1.07
PCB 37	1.64	1.64	PCB 138	0.79	1.00
PCB 44	1.19	1.19	PCB 149	0.89	1.00
PCB 49	0.62	1.00	PCB 151	0.93	1.00
PCB 52	0.69	1.00	PCB 153/168	1.46	1.46
PCB 66	0.85	1.00	PCB 156	0.72	1.00
PCB 70	1.35	1.35	PCB 157	0.75	1.00
PCB 74	2.06	2.06	PCB 167	0.70	1.00
PCB 77	1.06	1.06	PCB 169	0.69	1.00
PCB 81	0.70	1.00	PCB 170	0.70	1.00
PCB 87	0.78	1.00	PCB 177	1.12	1.12
PCB 99	0.61	1.00	PCB 180	1.13	1.13
PCB 101	1.45	1.45	PCB 183	0.66	1.00
PCB 105	1.17	1.17	PCB 187	0.59	1.00
PCB 110	0.92	1.00	PCB 189	0.94	1.00
PCB 114	0.72	1.00	PCB 194	0.71	1.00
PCB 118	0.76	1.00	PCB 201	0.86	1.00
PCB 119	0.70	1.00	PCB 206	0.57	1.00
PCB 123	1.12	1.12			
Parameter	**MDL (µg/kg wet)**	**RL (µg/kg wet)**	**Parameter**	**MDL (µg/kg wet)**	**RL (µg/kg wet)**
Metals					
Arsenic	0.054	0.100	Mercury	0.038	0.040
Selenium	0.481	0.500			

* Values reported between the MDL and the RL were estimated.

Table C–2 Water quality QA/QC summary, July 2019–June 2020.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	Ammonia-nitrogen	654 (10)	Blank	40	1	40	100
			Blank Spike	40	1	40	100
			Matrix Spike	70	1	70	100
			Matrix Spike Duplicate	70	1	70	100
			Matrix Spike Precision	70	1	70	100
Fall	Ammonia-nitrogen	654 (9)	Blank	38	1	38	100
			Blank Spike	38	1	38	100
			Matrix Spike	69	1	69	100
			Matrix Spike Duplicate	69	1	69	100
			Matrix Spike Precision	69	1	69	100
Winter	Ammonia-nitrogen	654 (9)	Blank	39	1	39	100
			Blank Spike	39	1	39	100
			Matrix Spike	69	1	69	100
			Matrix Spike Duplicate	69	1	69	100
			Matrix Spike Precision	69	1	69	100
Spring	Ammonia-nitrogen	654 (8)	Blank	37	1	37	100
			Blank Spike	37	1	37	100
			Matrix Spike	68	1	68	100
			Matrix Spike Duplicate	68	1	68	100
			Matrix Spike Precision	68	1	68	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 and matrix spike duplicate - Target accuracy % recovery 80–120.
For matrix spike precision - Target precision % RPD <11%.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	Total Coliforms	35 (5)	Duplicate	35	1	32	91
	Fecal Coliforms	35 (5)	Duplicate	35	1	30	86
	Enterococci	35 (5)	Duplicate	35	1	31	89
Fall	Total Coliforms	35 (5)	Duplicate	35	1	34	97
	Fecal Coliforms	35 (5)	Duplicate	35	1	34	97
	Enterococci	35 (5)	Duplicate	35	1	31	89
Winter	Total Coliforms	35 (5)	Duplicate	35	1	33	94
	Fecal Coliforms	35 (5)	Duplicate	35	1	31	89
	Enterococci	35 (5)	Duplicate	35	1	33	94
Spring	Total Coliforms	35 (5)	Duplicate	35	1	35	100
	Fecal Coliforms	35 (5)	Duplicate	35	1	33	94
	Enterococci	35 (5)	Duplicate	35	1	31	89
Annual	Total Coliforms	140 (20)	Duplicate	140	1	134	96
	Fecal Coliforms	140 (20)	Duplicate	140	1	128	91
	Enterococci	140 (20)	Duplicate	140	1	126	90

* Analysis passed if the average range of logarithms is less than the precision criterion.

Bacteria

Samples collected offshore (i.e., Recreational (aka REC-1)) were analyzed for bacteria using Enterolert™ for enterococci and Colilert-18™ for total coliforms and *Escherichia coli*. Fecal coliforms were estimated by multiplying detected *E. coli* results 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, Standard Methods 9222B and 9222D were used, respectively. MDLs for bacteria are presented in Table C-1.

All samples were analyzed within the required holding time. REC-1 samples were processed and incubated within 8 hours of sample collection. At least 1 duplicate sample was analyzed in each sample batch; additional duplicates were analyzed based on the number of samples in the batch. At a minimum, duplicate analyses were performed on 10% of samples per sample batch. All equipment, reagents, and dilution waters were sterilized before use. Sterility of sample bottles 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 leakage. Each lot of commercially purchased dilution blanks 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. Although the precision criterion is used to measure the precision of duplicate analyses for plate-based methods (APHA 2017), this criterion was used for most probable number methods due to a lack of criterion. Acceptable duplicates ranged from 86% to 100% in all 4 quarters and from 90% to 96% for the year for the 3 fecal indicator bacteria (Table C-2).

SEDIMENT CHEMISTRY NARRATIVE

OC San's LMC laboratory received 68 sediment samples from LMC's OMP staff during July 2019, and 29 samples during January 2020. All samples were stored according to LMC SOPs. All samples were analyzed for organochlorine pesticides (dieldrin and derivatives of dichlorodiphenyltrichloroethane and chlordane), polychlorinated biphenyl congeners (PCBs), polycyclic aromatic hydrocarbons (PAHs), trace metals, mercury, dissolved sulfides, total organic carbon (TOC), total nitrogen, total phosphorus, and grain size. All samples were analyzed within the required holding times.

PAHs, PCBs, and Organochlorine Pesticides

The analytical methods used to detect PAHs, organochlorine pesticides, and PCBs in the samples are described in the LMC SOPs. All sediment samples were extracted using an accelerated solvent extractor (ASE). Approximately 10 g (dry weight) of sample was 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 gas chromatography/mass spectrometry (GC/MS).

A typical sample batch included 20 field samples with required 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), and 1 matrix spike set. MDLs and SRM acceptance criteria for each PAH, PCB, and pesticide constituent are presented in Tables C-1 and C-3, respectively.

All analyses were performed with appropriate QC measures, as stated in OC San's QAPP, with most of the compounds tested during the 2 quarters meeting QA/QC criteria (Table C-4). When constituent concentrations in a sample exceeded the calibration range of the instrument, the sample was diluted and reanalyzed. Any deviations from standard protocol that occurred during sample preparation or analysis are noted in the raw data packages.

Trace Metals

Dried sediment samples were analyzed for trace metals in accordance with methods in the LMC SOPs. A typical sample batch for antimony, arsenic, barium, beryllium, cadmium, chromium, copper, nickel, lead, silver, selenium, and zinc analyses included 3 blanks, a blank spike, and 1 SRM. Additionally, sample duplicates, matrix spikes, and matrix spike duplicates were analyzed at least once for 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.

All samples were analyzed using inductively coupled plasma mass spectroscopy. If any analyte in a sample exceeded both the appropriate calibration curve and linear dynamic range, the sample was diluted and reanalyzed. MDLs for metals are presented in Table C-1. Acceptance criteria for trace metal SRMs are presented in Table C-3. Duplicate sample precision failed in 2 of 36 compounds

Table C–3 Acceptance criteria for standard reference materials, July 2019–June 2020.

Sediment			
Parameter	**True Value (ng/g)**	**Acceptance Range (ng/g)**	
		Minimum	**Maximum**
Organochlorine Pesticides, PCB Congeners, and Percent Dry Weight (SRM 1944; New York/New Jersey Waterway Sediment, National Institute of Standards and Technology)			
PCB 8	22.3	13.38	31.22
PCB 18	51.0	30.6	71.4
PCB 28	80.8	48.48	113.12
PCB 44	60.2	36.12	84.28
PCB 49	53.0	31.8	74.2
PCB 52	79.4	47.64	111.16
PCB 66	71.9	43.14	100.66
PCB 87	29.9	17.94	41.86
PCB 99	37.5	22.5	52.5
PCB 101	73.4	44.04	102.76
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	8.47	5.082	11.858
PCB 138	62.1	37.26	86.94
PCB 149	49.7	29.82	69.58
PCB 151	16.93	10.158	23.702
PCB 153/168	74.0	44.4	103.6
PCB 156	6.52	3.912	9.128
PCB 170	22.6	13.56	31.64
PCB 180	44.3	26.58	62.02
PCB 183	12.19	7.314	17.066
PCB 187	25.1	15.06	35.14
PCB 194	11.2	6.72	15.68
PCB 195	3.75	2.25	5.25
PCB 206	9.21	5.526	12.894
PCB 209	6.81	4.086	9.534
2,4’-DDD *	38.0	22.8	53.2
2,4’-DDE *	19.0	11.4	26.6
4,4’-DDD *	108.0	64.8	151.2
4,4’-DDE *	86.0	51.6	120.4
4,4’-DDT *	170	102	238
cis-Chlordane	16.51	9.906	23.114
trans-Chlordane *	19.0	11.4	26.6
gamma-BHC *	2.0	1.2	2.8
Hexachlorobenzene	6.03	3.618	8.442
cis-Nonachlor *	3.70	2.22	5.18
trans-Nonachlor	8.20	4.92	11.48
Percent Dry Weight	98.7	—	—
PAH Compounds and Percent Dry Weight (SRM 1944; New York/New Jersey Waterway Sediment, National Institute of Standards and Technology)			
1-Methylnaphthalene *	470	282	658
1-Methylphenanthrene *	1700	1020	2380
2-Methylnaphthalene *	740	444	1036
Acenaphthene *	390	234	546
Anthracene *	1130	678	1582
Benz[a]anthracene	4720	2832	6608
Benzo[a]pyrene	4300	2580	6020
Benzo[b+j]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
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
Percent Dry Weight	98.7	—	—

Table C–3 continues.

Table C–3 continued.

Sediment			
Parameter	**True Value (mg/kg)**	**Acceptance Range (mg/kg)**	
		Minimum	**Maximum**
Metals (CRM-540 ERA Metals in Soil; Lot No. D099-540)			
Antimony	75.5	14.5	199
Arsenic	161	113	209
Barium	260	195	325
Beryllium	97.6	73.2	112
Cadmium	211	158	264
Chromium	136	95.2	177
Copper	166	124	207
Lead	111	78.8	143
Mercury	11.5	6.87	16
Nickel	91.9	64.3	119
Selenium	191	131	252
Silver	43.3	30.1	56.5
Zinc	199	139	259

Fish Tissue			
Parameter	**True Value (ng/g)**	**Acceptance Range (ng/g)**	
		Minimum	**Maximum**
Organochlorine Pesticides and PCB Congeners (SRM1946, Lake Superior Fish Tissue; National Institute of Standards and Technology)			
PCB 18 *	0.840	0.504	1.176
PCB 28 *	2.0	1.2	2.8
PCB 44	4.66	2.796	6.524
PCB 49	3.80	2.28	5.32
PCB 52	8.10	4.86	11.34
PCB 66	10.8	6.48	15.12
PCB 70	14.9	8.94	20.86
PCB 74	4.83	2.898	6.762
PCB 77	0.327	0.196	0.458
PCB 87	9.40	5.64	13.16
PCB 99	25.6	15.36	35.84
PCB 101	34.6	20.76	48.44
PCB 105	19.9	11.94	27.86
PCB 110	22.8	13.68	31.92
PCB 118	52.1	31.26	72.94
PCB 126	0.380	0.228	0.532
PCB 128	22.8	13.68	31.92
PCB 138	115	69	161
PCB 149	26.3	15.78	36.82
PCB 153/168	170	102	238
PCB 156	9.52	5.712	13.328
PCB 170	25.2	15.12	35.28
PCB 180	74.4	44.64	104.16
PCB 183	21.9	13.14	30.66
PCB 187	55.2	33.12	77.28
PCB 194	13.0	7.8	18.2
PCB 201 *	2.83	1.698	3.962
PCB 206	5.40	3.24	7.56
2,4’-DDD	2.20	1.32	3.08
2,4’-DDE *	1.04	0.624	1.456
2,4’-DDT *	22.3	13.38	31.22
4,4’-DDD	17.7	10.62	24.78
4,4’-DDE	373	223.8	522.2
4,4’-DDT	37.2	22.32	52.08
cis-Chlordane	32.5	19.5	45.5
trans-Chlordane	8.36	5.016	11.704
Oxychlordane	18.90	11.34	26.46
Dieldrin	32.5	19.5	45.5
Heptachlor epoxide	5.5	3.3	7.7
cis-Nonachlor	59.1	35.46	82.74
trans-Nonachlor	99.6	59.76	139.44

Table C–3 continues.

Table C–3 continued.

Parameter	True Value (%)	Acceptance Range (%)	
		Minimum	Maximum
Lipid (*SRM1946, Lake Superior Fish Tissue; National Institute of Standards and Technology)*			
Lipid *	10.17	6.1	14.2
Parameter	**True Value (mg/kg)**	**Acceptance Range (mg/kg)**	
		Minimum	**Maximum**
Metals (*SRM DORM-4; National Research Council Canada)*			
Arsenic	6.87	4.81	8.93
Selenium *	3.45	2.42	4.49
Mercury	0.412	0.288	0.536

* Parameter with non-certified value(s).

Table C–4 Sediment QA/QC summary, July 2019–June 2020.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	PAHs	68 (4)	Blank	4	25	100	100
			Blank Spike	4	25	98	98
			Matrix Spike	4	25	100	100
			Matrix Spike Duplicate	4	25	99	99
			Matrix Spike Precision	4	25	100	100
			SRM Analysis	4	21	79	94
Winter	PAHs	29 (2)	Blank	2	25	50	100
			Blank Spike	2	25	48	96
			Matrix Spike	2	25	49	98
			Matrix Spike Duplicate	2	25	49	98
			Matrix Spike Precision	2	25	50	100
			SRM Analysis	2	21	37	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 and matrix spike duplicate - Target accuracy % recovery 40–120.
For matrix spike precision - Target precision % RPD <25%.
For SRM analysis - Target accuracy % recovery 60–140 or certified value, whichever is greater.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	PCBs and Pesticides	68 (4)	Blank	4	60	240	100
			Blank Spike	4	60	206	86
			Matrix Spike	4	60	220	92
			Matrix Spike Duplicate	4	60	220	92
			Matrix Spike Precision	4	60	240	100
			SRM Analysis	4	33	116	88
Winter	PCBs and Pesticides	29 (2)	Blank	2	60	120	100
			Blank Spike	2	60	107	89
			Matrix Spike	2	60	109	91
			Matrix Spike Duplicate	2	60	109	91
			Matrix Spike Precision	2	60	120	100
			SRM Analysis	2	33	54	82

* 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 and matrix spike duplicate - Target accuracy % recovery 40–120.
For matrix spike precision - Target precision % RPD <25%.
For SRM analysis - Target accuracy % recovery 60–140 or certified value, whichever is greater.

Table C–4 continues.

Table C–4 continued.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc	68 (2)	Blank	8	12	96	100
			Blank Spike	4	12	48	100
			Matrix Spike	8	12	88	92
			Matrix Spike Dup	8	12	88	92
			Matrix Spike Precision	8	12	96	100
			Duplicate	8	12	96	100
			SRM Analysis	2	12	24	100
Summer	Mercury	68 (2)	Blank	4	1	4	100
			Blank Spike	4	1	4	100
			Matrix Spike	8	1	8	100
			Matrix Spike Dup	8	1	8	100
			Matrix Spike Precision	8	1	8	100
			Duplicate	8	1	8	100
			SRM Analysis	2	1	2	100
Winter	Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Copper, Lead, Nickel, Selenium, Silver, Zinc	29 (1)	Blank	4	12	48	100
			Blank Spike	2	12	24	100
			Matrix Spike	3	12	32	89
			Matrix Spike Dup	3	12	32	89
			Matrix Spike Precision	3	12	35	97
			Duplicate	3	12	34	94
			SRM Analysis	1	12	12	100
Winter	Mercury	29 (1)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	3	1	3	100
			Matrix Spike Dup	3	1	3	100
			Matrix Spike Precision	3	1	3	100
			Duplicate	3	1	3	100
			SRM Analysis	1	1	1	100

* An analysis passed if the following criteria were met.
For blank - Target amount < 3X MDL or < 10% of sample result, whichever is greater.
For blank spike - Target accuracy % recovery 90–110 for mercury and 85–115 for other metals.
For matrix spike and matrix spike duplicate – Target accuracy % recovery 70–130.
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 80–120% or certified value, whichever is greater.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	Dissolved Sulfides	68 (6)	Blank	6	1	6	100
			Blank Spike	6	1	5	83
			Matrix Spike	6	1	5	83
			Matrix Spike Dup	6	1	6	100
			Matrix Spike Precision	6	1	6	100
			Duplicate	6	1	5	83
Winter	Dissolved Sulfides	29 (3)	Blank	3	1	3	100
			Blank Spike	3	1	3	100
			Matrix Spike	3	1	3	100
			Matrix Spike Dup	3	1	3	100
			Matrix Spike Precision	3	1	3	100
			Duplicate	3	1	3	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 and matrix spike duplicate - Target accuracy % recovery 70–130.
For matrix spike precision - Target precision % RPD <30%.
For duplicate - Target precision % RPD <30% at 3X MDL of sample mean. N/A represents result <3X MDL.

Table C–4 continues.

Table C–4 continued.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer	TOC	67 (4) **	Blank	4	1	4	100
			Blank Spike	4	1	4	100
			Matrix Spike	4	1	4	100
			Matrix Spike Dup	4	1	4	100
			Matrix Spike Precision	4	1	4	100
			Duplicate	7	1	7	100
Winter	TOC	29 (1)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	2	1	2	100
			Matrix Spike Dup	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	3	1	3	100
* An analysis passed if the following criteria were met: For blank - Target accuracy % recovery <10X MDL. For blank spike, matrix spike, and matrix spike duplicate - Target accuracy % recovery 80–120. For matrix spike precision - Target precision % RPD <10%. For duplicate - Target precision % RPD <10% at 3X MDL of sample mean. ** One sample jar was broken in transit to the contract laboratory and could not be salvaged.							
Summer	Grain Size	68 (1)	Duplicate	7	1	7	100
Winter	Grain Size	29 (1)	Duplicate	3	1	3	100
* An analysis passed if the following criterion was met: For duplicate - Target precision mean % RPD <10% of mean phi.							
Summer	Total N	68 (1)	Blank	12	1	12	100
			Blank Spike	12	1	12	100
			Matrix Spike	4	1	4	100
			Matrix Spike Dup	4	1	4	100
			Matrix Spike Precision	4	1	4	100
			Duplicate	8	1	8	100
Winter	Total N	29 (1)	Blank	6	1	6	100
			Blank Spike	7	1	7	100
			Matrix Spike	2	1	2	100
			Matrix Spike Dup	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	4	1	4	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 and matrix spike duplicate - Target accuracy % recovery 80–120. For matrix spike precision - Target precision % RPD <20%. For duplicate - Target precision % RPD <20% at 3X MDL of sample mean.							
Summer	Total P	68 (1)	Blank	4	1	4	100
			Blank Spike	4	1	4	100
			Matrix Spike	4	1	4	100
			Matrix Spike Dup	4	1	4	100
			Matrix Spike Precision	4	1	4	100
Winter	Total P	29 (1)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	2	1	1	50
			Matrix Spike Dup	2	1	1	50
			Matrix Spike Precision	2	1	1	50

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <3X MDL.
For blank spike - Target accuracy % recovery 80–120.
For matrix spike and matrix spike duplicate - Target accuracy % recovery 75–125.
For matrix spike precision - Target precision % RPD <20%.
For duplicate - Target precision % RPD <20% at 10X MDL of sample mean.

analyzed in the Winter quarter, possibly due to matrix interference (Table C-4). Matrix spike accuracy percent recovery failed for 2 compounds in the Winter quarter, resulting in 1 failure in matrix spike precision RPD. Antimony displayed low recovery in the matrix spike and matrix spike duplicates in both quarters due to sediment matrix interferences. All other samples met the QA/QC criteria for all compounds tested (Table C-4).

Mercury

Dried sediment samples were analyzed for mercury in accordance with methods described in the LMC SOPs. QC for a typical batch included a blank, blank spike, and SRM. A set of sediment sample duplicates, matrix spike, and matrix spike duplicates were run once for 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-1. Acceptance criteria for the mercury SRM are presented in Table C-3. All samples met the QA/QC criteria guidelines for accuracy and precision (Table C-4).

Dissolved Sulfides (DS)

DS samples were analyzed in accordance with methods described in the LMC SOPs. The MDL for DS is presented in Table C-1. All QC samples in both quarters met the QC acceptance criteria, except for 1 instance of a failed blank spike, matrix spike, and duplicate in the Summer quarter. (Table C-4). The blank spike failed in 1 summer batch, with a recovery of 72%, just below the acceptance limit of 80%. A matrix spike failed in the same summer batch with a recovery of 67% just below the acceptance limit of 70-130%. Also, 1 summer sample duplicate failed to meet the acceptance criteria of 30% RPD in a separate batch. It failed at 57% RPD with an acceptance limit of 30%.

In the batch where the blank spike failed, the matrix spike duplicate passed the blank spike acceptance criterion of 80–120% recovery, and the sample duplicate was within the acceptable range for RPD. In the batch in which the sample duplicate failed to meet the QC acceptance limit, all other QC passed including the matrix spike and spike replicate which had an RPD of 15%.

TOC

TOC samples were analyzed by ALS Environmental Services, Kelso, WA. The MDL for TOC is presented in Table C-1. All analyzed TOC QC samples passed the QC acceptance criteria (Table C-4).

Grain Size

Grain size samples were analyzed by Integral Consulting Inc., Santa Cruz, CA using a laser diffraction method. The smallest detectable grain size with this method is 0.375 µm. The method can distinguish differences between Phi size ranges to a level of 0.01%. All analyzed grain size QC samples passed the QA/QC criteria of RPD ≤10% (Table C-4).

Total Nitrogen (TN)

TN samples were analyzed by Weck Laboratories, Inc., City of Industry, CA. The MDL for TN is presented in Table C-1. All samples analyzed met the designated QC acceptance criteria (Table C-4).

Total Phosphorus (TP)

TP samples were analyzed by Weck Laboratories. The MDL for TP is presented in Table C-1. In the winter, 1 sample batch experienced failures for matrix spike and matrix spike duplicate recoveries, as well as matrix spike/matrix spike duplicate precision (Table C-4). These failures resulted from the parent sample chosen for the spikes having a high concentration of phosphorus, which negatively impacted both accuracy and precision. The laboratory did not analyze duplicate samples as required by the OMP QAPP. A corrective action has been initiated to address this nonconformance. All other QC sample results for all batches analyzed met the QC acceptance criteria (Table C-4).

FISH TISSUE CHEMISTRY NARRATIVE

For the 2019-20 monitoring year, the LMC laboratory received 19 trawl fish samples in August 2019, and 20 rig fish samples in July 2019. The individual samples were stored, dissected, and homogenized according to methods described in the LMC 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.

Organochlorine Pesticides and PCBs

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

All analyses were performed within the required holding time and with appropriate QC measures. A typical organic tissue or liver sample batch included up to 20 field samples with required QC samples. The QC samples included a laboratory blank, sample duplicates, matrix spike, matrix spike duplicate, SRM, and reporting level spike (matrix of choice was tilapia). The MDLs for pesticides and PCBs in fish tissue are presented in Table C-1. Acceptance criteria for PCBs and pesticides SRM in fish tissue are presented in Table C-3.

Most compounds tested in each parameter group met the QA/QC criteria (Table C-5). In cases where constituent concentrations in a sample exceeded the calibration range of the instrument, the sample was diluted and reanalyzed. Any variances that occurred during sample preparation or analyses are noted in the Comments/Notes section of each batch summary.

Lipid Content

Percent lipid content was determined for each sample of fish using methods described in the LMC SOPs. 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 tared aluminum weighing boat and allowed to evaporate to dryness. The remaining residue was weighed, and the percent lipid content calculated. Acceptance criteria for lipid SRMs are presented in Table C-3. All analyses were performed within the required holding time and with appropriate QC measures. All analyzed samples passed the QC acceptance criteria (Table C-5).

Mercury

Fish tissue samples were analyzed for mercury in accordance with LMC SOPs. 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 sample duplicates, matrix spikes, and matrix spike duplicates, which were run approximately once every 10 samples.

The MDL for fish mercury is presented in Table C-1. Acceptance criteria for the mercury SRMs are presented in Table C-3. All samples were analyzed within their 6-month holding time and met the QC criteria (Table C-5).

Arsenic and Selenium

Rig fish tissue samples were analyzed for arsenic and selenium in accordance with LMC SOPs. Typical QC analyses for a tissue sample batch included 3 blanks, a blank spike, and an SRM (muscle). Additional QC samples included a sample duplicate, a matrix spike, and a matrix spike duplicate, which were run at least once every 10 samples.

The MDLs for arsenic and selenium in fish tissue are presented in Table C-1. Acceptance criteria for the arsenic and selenium SRMs are presented in Table C-3. All samples were analyzed within a 6-month holding time and all analyzed samples met the QC criteria (Table C-5).

Table C–5 Fish tissue QA/QC summary, July 2019–June 2020.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer (Trawl samples)	PCBs and Pesticides	38 (4)	Blank	8	54	429	99
			Blank Spike	8	54	405	94
			Matrix Spike	4	54	214	99
			Matrix Spike Dup	4	54	214	99
			Matrix Spike Precision	4	54	212	98
			Duplicate	4	54	216	100
			SRM	4	38	138	91
Summer (Rig fish samples)	PCBs and Pesticides	20 (2)	Blank	4	54	216	100
			Blank Spike	4	54	208	96
			Matrix Spike	2	54	105	97
			Matrix Spike Dup	2	54	107	99
			Matrix Spike Precision	2	54	100	93
			Duplicate	2	54	108	100
			SRM	2	38	64	84

* 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 and 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.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer (Trawl samples)	Percent Lipid - Liver	19 (2)	Duplicate	2	1	2	100
			SRM	2	1	2	100
	Percent Lipid - Muscle	19 (2)	Duplicate	2	1	2	100
			SRM	2	1	2	100
Summer (Rig fish samples)	Percent Lipid - Muscle	20 (2)	Duplicate	2	1	2	100
			SRM	2	1	2	100

* An analysis passed if the following criteria were met:
For duplicate - Target precision % RPD <25%.
For SRM - Target % recovery 60–140.

Quarter	Parameter	Total samples (Total batches)	QA/QC Sample Type	Number of QA/QC Samples Tested	Number of Compounds Tested	Number of Compounds Passed	% Compounds Passed *
Summer (Trawl & Rig fish samples)	Mercury	58 (3)	Blank	3	1	3	100
			Blank Spike	3	1	3	100
			Matrix Spike	6	1	6	100
			Matrix Spike Dup	6	1	6	100
			Matrix Spike Precision	6	1	6	100
			Duplicate	6	1	6	100
			SRM Analysis	3	1	3	100
Summer (Rig fish samples)	Arsenic & Selenium	20 (1)	Blank	3	2	6	100
			Blank Spike	1	2	2	100
			Matrix Spike	2	2	4	100
			Matrix Spike Dup	2	2	4	100
			Matrix Spike Precision	2	2	4	100
			Duplicate	2	2	4	100
			SRM Analysis	1	2	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 and matrix spike duplicate - Target accuracy % recovery 70–130.
For matrix spike precision - Target precision % RPD <25%.
For duplicate - Target precision % RPD <30% at 10X MDL of sample mean.
For SRM analysis - Target accuracy % recovery 70–130 or certified value, whichever is greater.

BENTHIC INFAUNA NARRATIVE

The sorting and taxonomy QA/QC follow OC San's QAPP. These QA/QC procedures were conducted on infauna samples collected in July 2019 (summer) from 29 semi-annual stations (52–65 m) and 39 annual stations (40–300 m) and in January 2020 (winter) from the same 29 semi-annual stations (Table A-4).

Sorting

The sorting procedure involved removal by Aquatic Bioassay and Consulting Laboratories, Inc. (ABC) of all organisms, including their fragments, from sediment samples into separate vials by major taxa (aliquots). The abundance of countable organisms (i.e., specimens with a head) per station was recorded. After ABC's in-house sorting efficiency criteria were met, the organisms and remaining particulates (grunge) were returned to OC San. Ten percent of these samples (6 of 58) were randomly selected for re-sorting by OC San staff. A tally was made of any countable organisms missed by ABC. 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. Sorting results for all QA samples were well below the 5% QC limit.

Taxonomy

Selected 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 datasets 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. $\%Error_{\#\text{INDIVIDUALS}} = (|\#Individuals_{\text{RESOLVED}} - \#Individuals_{\text{ORIGINAL}}| \div \#Individuals_{\text{RESOLVED}}) \times 100$

Equation 2. $\%Error_{\#\text{ ID TAXA}} = (\#Taxa_{\text{MISIDENTIFICATION}} \div \#Taxa_{\text{RESOLVED}}) \times 100$

Equation 3. $\%Error_{\#\text{ ID INDIVIDUALS}} = (\#Individuals_{\text{MISIDENTIFICATION}} \div \#Individuals_{\text{RESOLVED}}) \times 100$

Please refer to OC San's QAPP for detailed explanation of the variables. The first 2 equations are considered gauges of errors in accounting (e.g., recording on a wrong line, miscounting, etc.), which, by their random nature, are difficult to predict. Equation 3 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 (SDR) 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 for further investigation.

QC objectives for identification accuracy (Equation 3) were met in 2019-20 (Table C-6). No significant changes to the 2019-20 infauna dataset were made based on the SDR.

Table C–6 Percent error rates calculated for the July 2019 infauna QA samples.

Error Type	Station			Mean
	1	9	36	
1. %Error # Individuals	-1.1	-0.7	7.1	1.8
2. %Error # ID Taxa	0.0	0.0	7.4	2.5
3. %Error # ID Individuals	0.0	0.0	2.5	0.8

REFERENCES

OCSD (Orange County Sanitation District). 2016a. Orange County Sanitation District – Ocean Monitoring Program. Quality Assurance Project Plan (QAPP), 2016-17. Fountain Valley, CA.

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