Marine Monitoring Annual Report

Program Year 2020-2021

ORANGE COUNTY SANITATION DISTRICT

ORANGE COUNTY SANITATION DISTRICT
ENVIRONMENTAL LABORATORY AND OCEAN MONITORING DIVISION
10844 Ellis Avenue
Fountain Valley, California 92708-7018
714.962.2411

www.ocsan.gov

ORANGE COUNTY SANITATION DISTRICT
10844 Ellis Avenue
Fountain Valley, CA 92708
714.962.2411
www.ocsan.gov

March 14, 2022

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

SUBJECT: 2012 NPDES Permit Requirement (Order No. R8-2012-0035, NPDES Permit No. CA0110604) Marine Monitoring Annual Report

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In accordance with the requirements of the 2012 NPDES Permit (Order No. R8-2012-0035, NPDES permit No. CA0110604), Attachment E. Monitoring and Reporting Program, Section XI. Other Monitoring Requirements, Subsection D(3) Receiving Water Monitoring Report (pg. E-72), enclosed is the Orange County Sanitation District (OC San) 2020-21 Marine Monitoring Annual Report.

This report focuses on the findings and conclusions for the monitoring period of July 1, 2020 to June 30, 2021. The results from this reporting period document that OC San's ocean discharge, which consisted of water reclamation reject flows and secondary-treated wastewater, did not adversely affect the receiving environment or pose a risk to human health.

Compliance with bacteria standards in zones used for water contact sports was achieved in 100% of the water samples. Numeric receiving water criteria for water clarity, dissolved oxygen, and pH were met in more than 90% of the samples. Concentrations of ammonia-nitrogen in water samples were nearly 20 and 30 times lower than the chronic and acute toxicity standards of the California Ocean Plan, respectively.

There were no discernible impacts to the sediment-dwelling animal communities within and adjacent to the zone of initial dilution (ZID). Infauna and demersal fish communities in the monitoring area were considered healthy (i.e., comparable to reference condition) based on the low Benthic Response Index (<25) and Fish Response Index (<45) scores, respectively. In addition, the contaminant concentrations in all sediment samples were comparable to background levels (i.e., below threshold levels), and no measurable toxicity was recorded in whole sediment toxicity tests. The low levels of contaminants in fish tissue samples and the negligible disease symptoms in fish samples demonstrated that OC San's ocean discharge was not associated with any incidence or prevalence of fish disease.

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Irvine Ranch Water District

Yorba Linda Water District

If you have any questions or comments, please contact me at (714) 593-7450 or Dr. Violet Renick, Ocean Monitoring Supervisor at (714) 593-7465.

Wiborg, Lan

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Lan C. Wiborg
Director of Environmental Services

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Enclosure

cc: T. Torres, EPA (via email)

ORANGE COUNTY SANITATION DISTRICT
10844 Ellis Avenue
Fountain Valley, CA 92708
714.962.2411
www.ocsan.gov

March 14, 2022

Tomas Torres
U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street
San Francisco, CA 94105

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Lan C. Wiborg
Director of Environmental Services

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Enclosure

cc: J. Joy, RWQCB (via email)

ORANGE COUNTY SANITATION DISTRICT
10844 Ellis Avenue
Fountain Valley, CA 92708
714.962.2411
www.ocsan.gov

March 10, 2022

Certification Statement

The following certification satisfies Attachment E of the Orange County Sanitation District (OC San) Monitoring and Reporting Program, Order No. R8-2012-0035, NPDES No. CA0110604, for the submittal of the attached OC San 2020-21 Marine Monitoring Annual Report.

I certify under penalty of law that this document was prepared under my 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 data, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fines and imprisonment for known violations.

WiboRg, Lan

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Lan C. Wiborg
Director of Environmental Services

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County of Orange
Costa Mesa Sanitary District
Midway City Sanitary District
Irvine Ranch Water District
Yorba Linda Water District

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Acknowledgments

The following individuals are acknowledged for their contributions to the 2020-21 Marine Monitoring Annual Report:

Orange County Sanitation District Management:

Lan C. Wiborg	Director, Environmental Services Department
Dr. Sam Choi	Manager, Environmental Laboratory and Ocean Monitoring Division
Dr. Jeffrey L. Armstrong	Environmental Supervisor (retired), Ocean Monitoring Section
Dr. Violet C. Renick	Environmental Supervisor, Ocean Monitoring Section
Canh Nguyen	Environmental Supervisor, Analytical Chemistry Section
Dr. Yiping Cao	Environmental Supervisor, Microbiology & General Chemistry Section

Ocean Monitoring Team:

George Robertson	Senior Scientist
Dr. Danny Tang	Scientist
Kelvin Barwick	Principal Environmental Specialist
Ken Sakamoto	Senior Environmental Specialist
Hai Nguyen	Senior Environmental Specialist
Robert Gamber	Senior Environmental Specialist
Laura Terriquez	Senior Environmental Specialist
Ernest Ruckman	Senior Environmental Specialist
Benjamin Ferraro	Senior Environmental Specialist
Matthew Hirsch	Environmental Specialist
Mark Kibby	Boat Captain
Bryce Perog	Intern

Laboratory and QA/QC Team:

IV Arambula, Jim Campbell, Absalon Diaz, Arturo Diaz, Marta Dudek, Joel Finch, Elaine Galvez, Yen Kiang, David Lo, Tony Luong, Thang Mai, Joe Manzella, Ryan McMullin, Dawn Myers, Thomas Nguyen, Paulo Pavia, Vanh Phonsiri, Anthony Pimentel, Larry Polk, Paul Raya, Joseph Robledo, Jesus Rodriguez, Luis Ruiz, Rachel Van Exel, and Brandon Yokoyama.

IT and LIMS Data Support:

Emmeline McCaw and Matthew Garchow.

Contributing Authors:

Kelvin Barwick, Dr. Yiping Cao, Arturo Diaz, Benjamin Ferraro, Joel Finch, Robert Gamber, Thang Mai, Joe Manzella, Dawn Myers, Hai Nguyen, Vanh Phonsiri, Anthony Pimentel, Dr. Violet Renick, George Robertson, Ernest Ruckman, Luis Ruiz, Ken Sakamoto, Dr. Danny Tang, and Laura Terriquez.

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 monitoring of water quality, sediment quality, invertebrate and fish communities, fish bioaccumulation, and fish health off the coastal cities of Newport Beach and Huntington Beach, California. The final effluent, consisting of secondary-treated wastewater mixed with water reclamation reject 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 2020 through June 2021.

WATER QUALITY

Compliance for all 3 fecal indicator bacteria was achieved in 100% of the water samples, indicating no impact of bacteria to offshore receiving waters during the program year. Minimal plume-related changes in water clarity, dissolved oxygen, and pH were occasionally detected less than 1.2 miles (2.0 km) beyond the zone of initial dilution[1] (ZID). 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 2020-21 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 ZID. Furthermore, measured values were comparable to OC San historical values and Southern California Bight Regional Monitoring results, 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. In addition, the infaunal communities within the monitoring area can be classified as reference condition based on their

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

low Benthic Response Index scores (<25) and high Infaunal Trophic Index scores (>60). These results indicate that the outfall discharge had an indistinguishable impact on the benthic community structure within the monitoring area.

Demersal Fish and Epibenthic Macroinvertebrate Communities

The community measure values and community structure of the epibenthic macroinvertebrates (EMIs) and demersal fishes 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 healthy fish and EMI populations.

Contaminants in Fish Tissue

Concentrations of chlorinated pesticides and trace metals in muscle and/or liver tissues of flatfish and sport fish samples were similar between outfall and non-outfall locations. Furthermore, 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. Moreover, the absence of morphological abnormalities, tumors, fin erosion, and skin lesions, together with the low incidence (<1%) of external parasites in demersal fish samples, indicated that fishes in the monitoring area were healthy. These results suggest that OC San's ocean discharge does not impair the health condition of fishes.

CONCLUSION

Consistent with previous program years, the California Ocean Plan water quality criteria were met within the monitoring area in 2020-21. Sediment quality was not degraded by chemical contaminants in OC San's ocean discharge. 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 of the state's "Do not consume" guidelines for sport fish samples. In summary, OC San's ocean discharge did not adversely affect the receiving environment or pose a risk to human health during the 2020-21 program year.

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-inch (305-cm) diameter, 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 for program year 2020-21 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 ocean monitoring area is adjacent to California's most highly urbanized area (OCSD 2021). 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 inputs 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). Untreated 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) with scattered hard substrate reefs and manmade structures and is inhabited by biological communities typical of these environments (OCSD 2004). Seafloor depths on the shelf 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-inch outfall, and its associated ballast rock, cover soft-bottom habitat and is one of the largest artificial reefs in the SCB. As a reef, it 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, nearly 25 acres (approximately 102,193 m^2 or 1.1×10^6 ft^2) of seafloor was converted from a flat, sandy habitat into a raised, hard-bottom substrate.

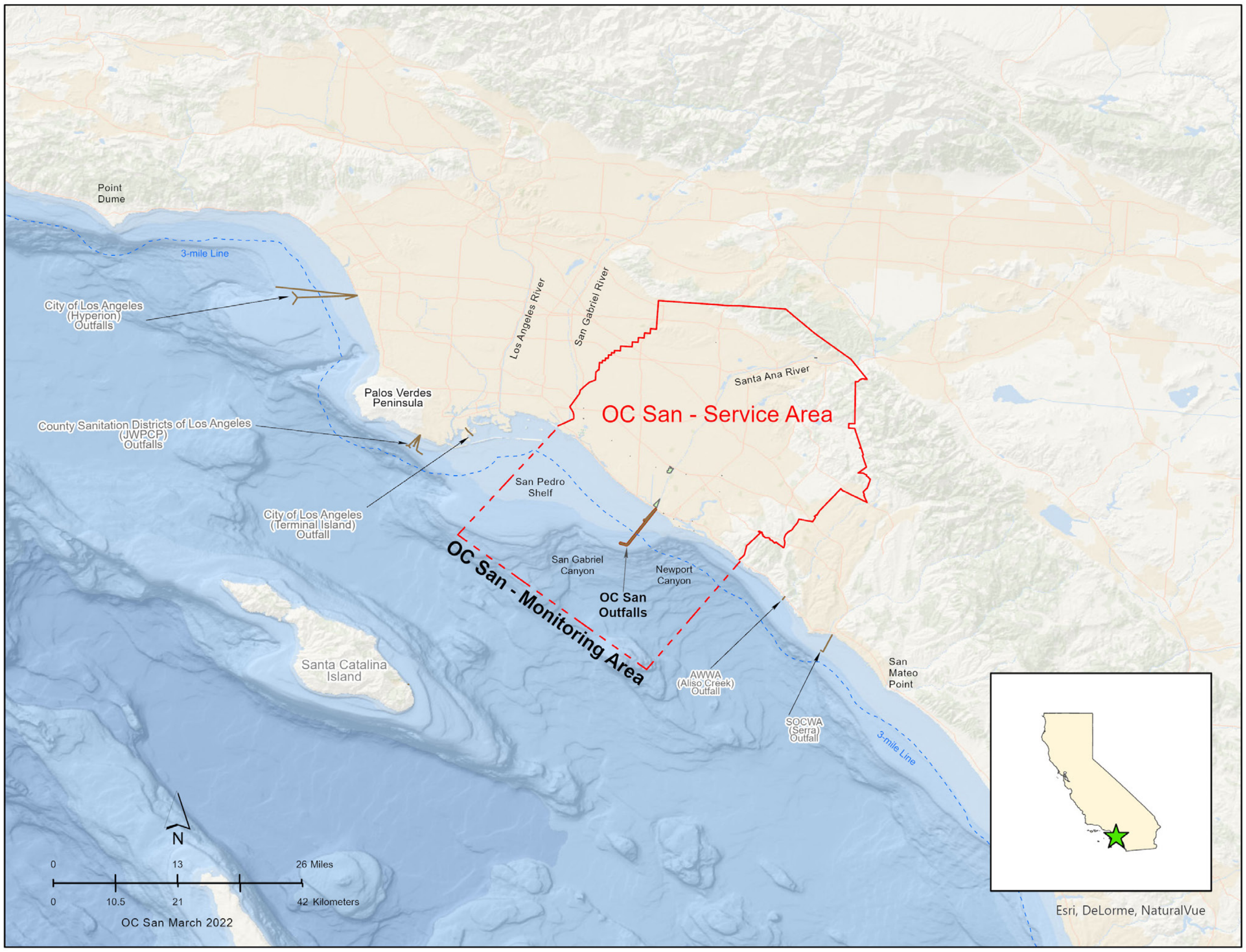

Figure 1–1 Regional setting and sampling area for OC San's Ocean Monitoring Program.

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 Climate Index (MOCI; Farallon Institute 2021) is a unitless measure that synthesizes multiple local and regional ocean and atmospheric conditions to represent the environmental state of California's coastal ocean (Figure 1-2). It displays both temporal and spatial ocean state variability and intensity along the coast and has been shown to have good predictive skill relative to biology across multiple trophic levels (Garcia-Reyes and Sydeman 2017). Consistent with MOCI, measured temperature anomalies along the CalCOFI Line 90 (SIO 2021) illustrate that the basin-wide, cross-shelf temperature signal reaches out to 500 km from shore and spans the water column from near the surface to the OC San outfall depth (Figure 1-3).

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

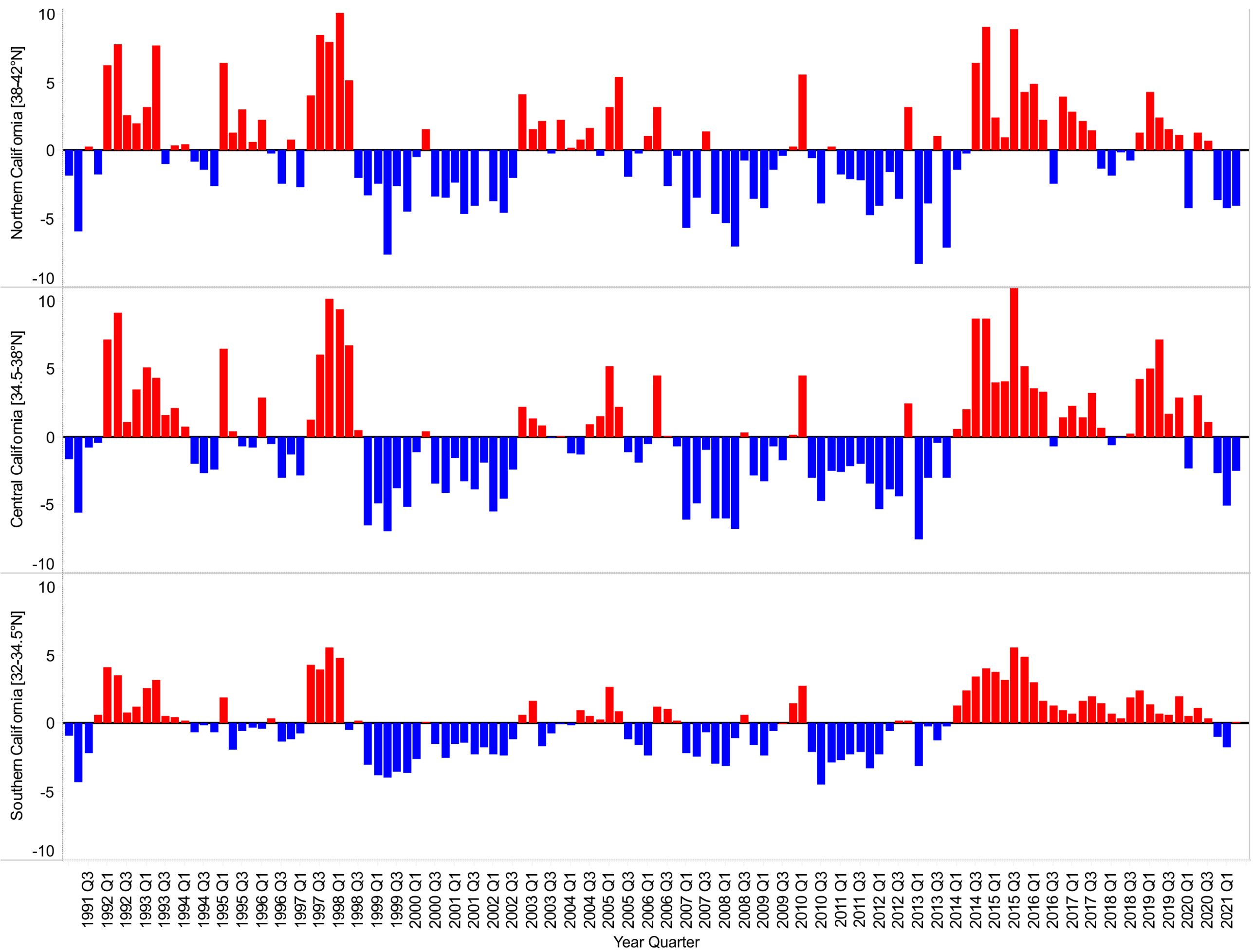

Figure 1–2 California Multivariate Ocean Climate Index for Northern (A), Central (B) and Southern (C) California (MOCI — Farallon Institute).

flow 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, Smith et al. 2018, UCSC 2018, CeNCOOS 2022).

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, Warrick 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.

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

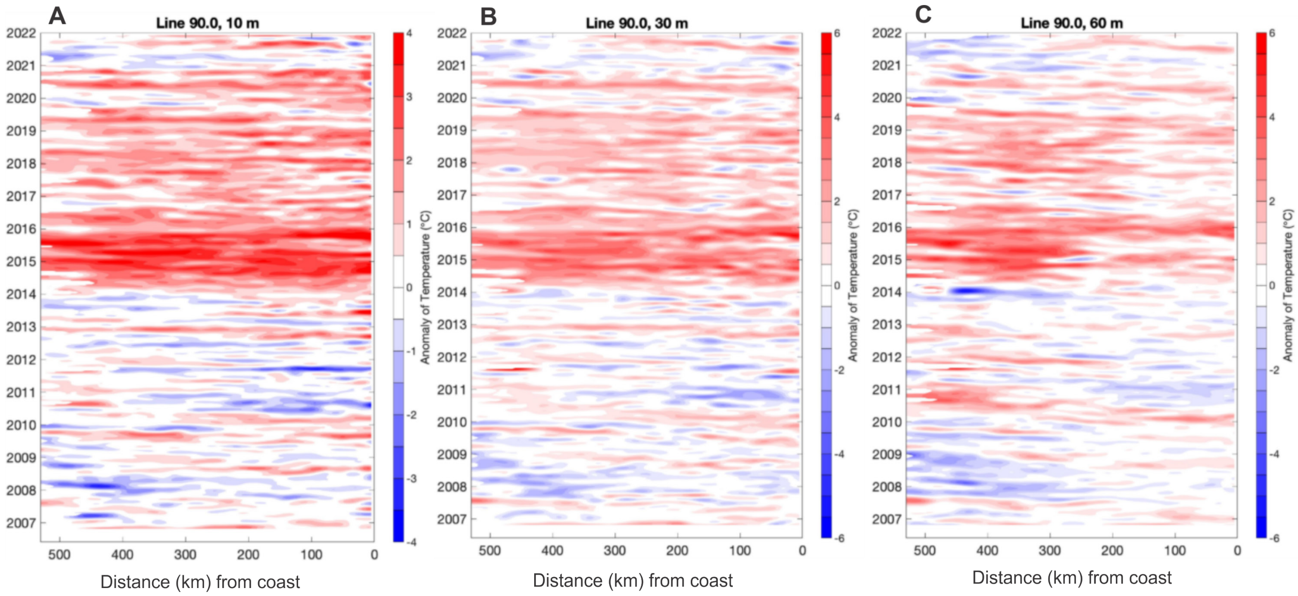

Figure 1–3 Temperature anomalies along CalCOFI Line 90 at (A) surface (10 m), (B) typical plume trapping depth (30 m), and (C) OC San nominal outfall depth (60 m). Source: California Underwater Glider Network, Scripps Institution of Oceanography (https://spraydata.ucsd.edu/projects/CUGN/, 12/27/2021).

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, especially as it relates to beach bacterial contamination. For example, in 2020–2021, during non-rainfall periods, 96% of monitored Orange County Beaches received grades of either “A” or “B”, while after storm events, this dropped down to 52% (Heal the Bay 2021).

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. 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).

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 (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, industrial wastewater from 688 permitted businesses within its service area and, for the past 22 years, dry weather urban runoff discharges. Once treated, a portion of this flow is provided to the Orange County Water District (OCWD). OCWD further treats this water for industrial and landscaping uses and to recharge local groundwater supplies (as a saltwater intrusion barrier and for indirect potable use). The remaining treated effluent is, under normal operations, discharged through the 120-in ocean outfall, which extends 7.1 km (4.4 mi) from the Huntington Beach shoreline (Figure 1-1). The last 1.8 km (1.1 mi) of the outfall consists of a diffuser with 503 ports that discharge the treated effluent at a nominal depth of 60 m.

During 2020-21, OC San received and processed influent volumes averaging 182 million gallons per day (MGD) (6.9×10^8 L/day). After diversions to OCWD and the return of their reject flows (e.g., brines), OC San discharged an average of 91 MGD (3.4×10^8 L/day) of treated wastewater to the ocean (Figure 1-4).

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.

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 demersal 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).

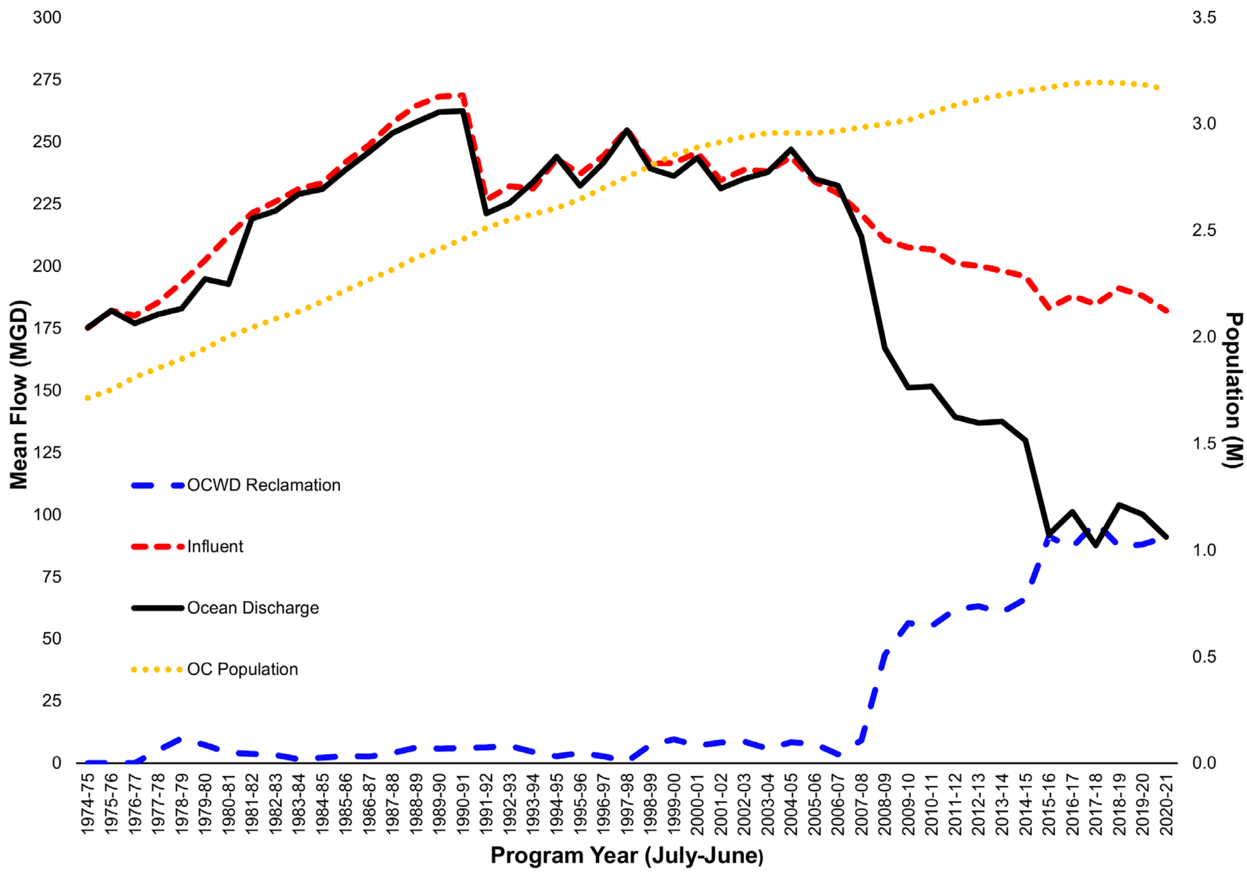

Figure 1–4 Total annual population for Orange County (OC), California, and annual mean OC San influent and ocean discharge flows and Orange County Water District (OCWD) reclamation flows, 1974–2021.

- 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 its related beneficial uses.

This report presents OMP compliance determinations for data collected from July 2020 through June 2021. Compliance determinations were made by comparing OMP findings to the criteria specified in OC San's NPDES permit (Chapter 2). Progress and outcomes for 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 2020-21 program 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 geochemistry and infaunal communities, 14 trawl stations to evaluate demersal fish and epibenthic 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 tissue analyses (see Appendix A).

WATER QUALITY

Offshore Bacteria

The majority (69–93%) of samples for 3 fecal indicator Bacteria (FIB) were below the method detection limit (10 MPN/100mL), with over 99% of the individual sample counts being below their respective 30-day geometric mean limits (Table B-1). The highest density observed for any single sample at any single depth for total coliforms, fecal coliforms, and enterococci was 3,448, 848, and 145 MPN/100 mL, respectively. Compliance for all 3 FIB was achieved 100%, indicating no impact of bacteria to offshore receiving waters (Tables B-2, B-3, and B-4).

Floating Particulates and Oil and Grease

There were no observations of oils and grease or floating particles of sewage origin at any water quality station in 2020-21 (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 2020-21. 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 U.S. EPA 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 3 of the CA 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 3 of the CA 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

Overall, water clarity (transmissivity) standards were met 90% 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).

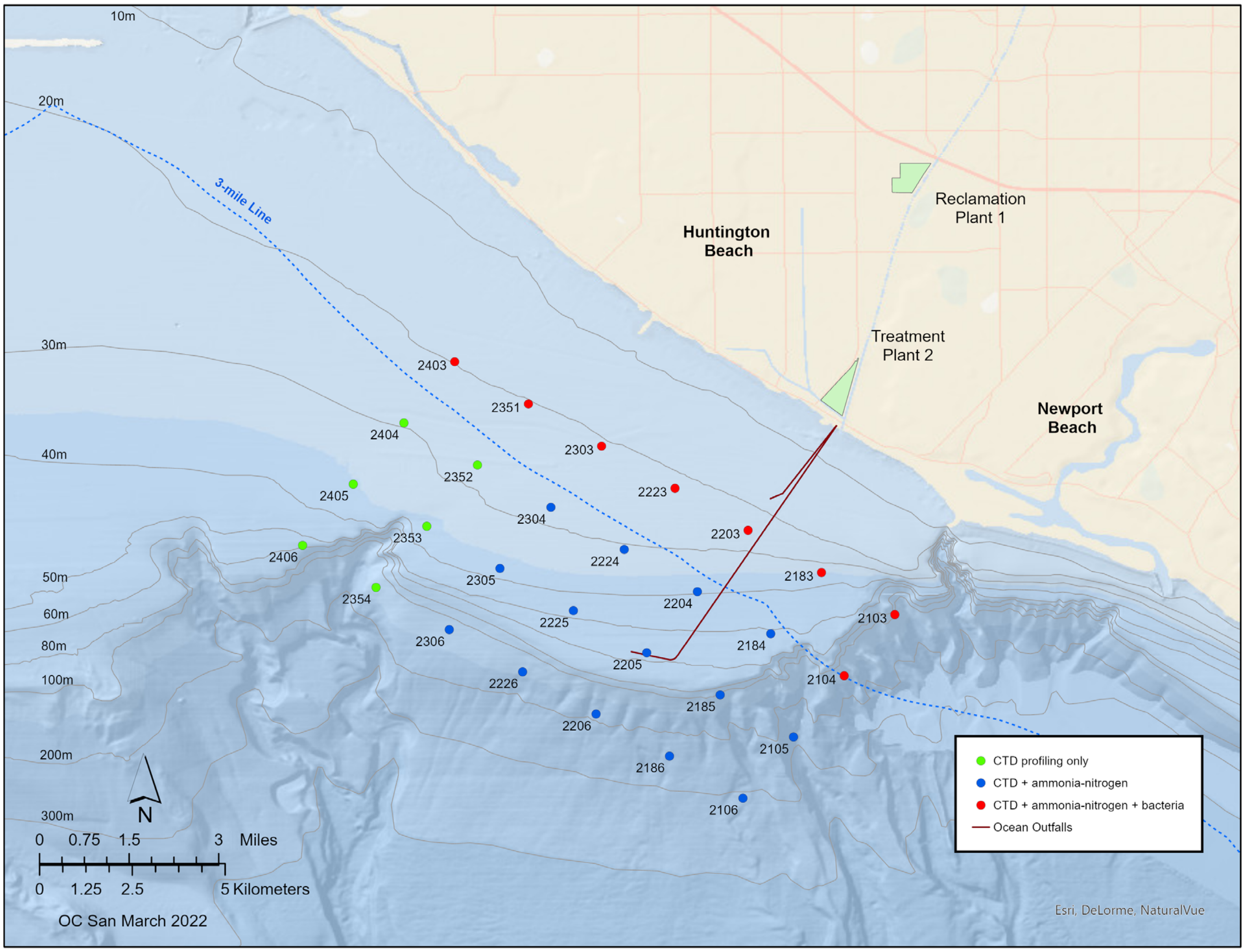

Figure 2–1 Offshore water quality monitoring stations for 2020-21.

Acidity (pH)

Compliance with COP pH standard 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).

Table 2–2 Summary of OC San's monthly offshore water quality compliance testing results for dissolved oxygen, pH, and transmissivity for 2020-21. ORO = Out-of-Range-Occurrence; OOC = Out-of-Compliance.

Survey Date	Number of Stations *	Dissolved Oxygen		pH		Transmissivity	
		ORO	OOC	ORO	OOC	ORO	OOC
7/29/2020	27	0%	0%	0%	0%	26%	19%
8/5/2020	27	0%	0%	0%	0%	19%	7%
9/1/2020	27	0%	0%	0%	0%	26%	26%
10/21/2020	27	0%	0%	0%	0%	19%	19%
11/4/2020	27	0%	0%	0%	0%	4%	0%
12/9/2020	27	0%	0%	0%	0%	0%	0%
2/2/2021	27	0%	0%	0%	0%	4%	4%
2/9/2021	27	0%	0%	0%	0%	15%	11%
3/17/2021	27	0%	0%	0%	0%	15%	15%
4/22/2021	27	0%	0%	0%	0%	7%	7%
5/4/2021	27	0%	0%	0%	0%	0%	0%
6/8/2021	27	0%	0%	0%	0%	15%	15%
Annual	324	0%	0%	0%	0%	12%	10%

* Does not include within-ZID Station 2205.

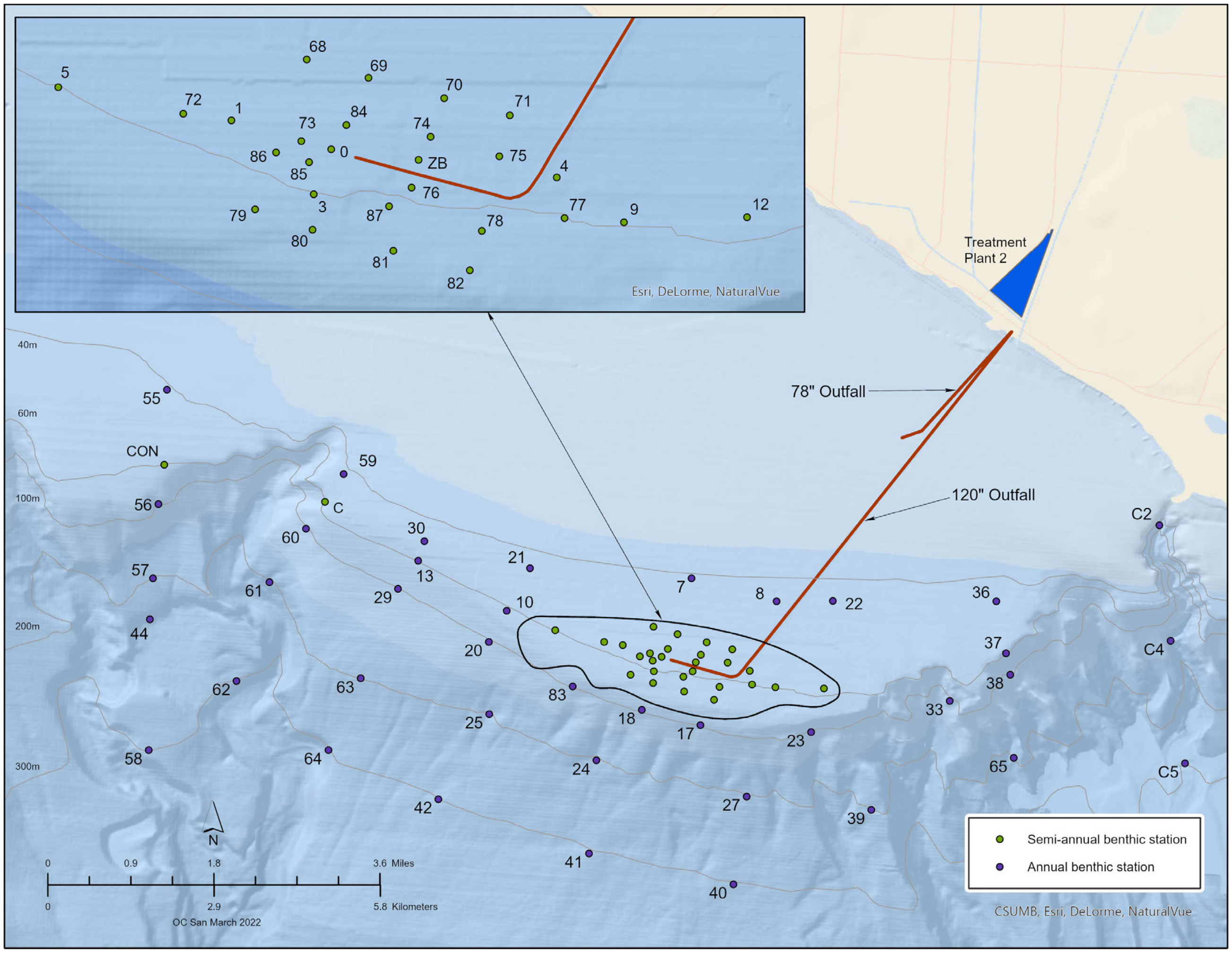

Figure 2–2 Benthic (sediment geochemistry and infauna) monitoring stations for 2020-21.

Nutrients (Ammonia-Nitrogen)

For the 2020-21 program year, over 95% of the monthly Core water samples for ammonia-nitrogen (NH_3-N)—which included 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 0.21 mg/L (Figure 2-4A). Plume-related changes in NH_3-N were not considered environmentally significant as maximum values were nearly 20 times less than the chronic (4 mg/L) and nearly 30 times less than the acute (6 mg/L) toxicity standards of the COP (Figure 2-4B; SWRCB 2012). In addition, and in contrast to colored dissolved organic matter, there were no positive relationships between NH_3-N values and phytoplankton as measured by proxy of chlorophyll-*a* fluorescence (Figure B-1) indicating no direct impact to aquatic life (e.g., phytoplankton blooms caused by the discharge).

COP Water Quality Objectives

OC San's NPDES permit contains 8 parameters from Table 3 of the COP that have effluent limitations (see Table 9 of the permit). Receiving water compliance for these constituents was met during the period from July 2020 through June 2021 because none exceeded their respective effluent limitations.

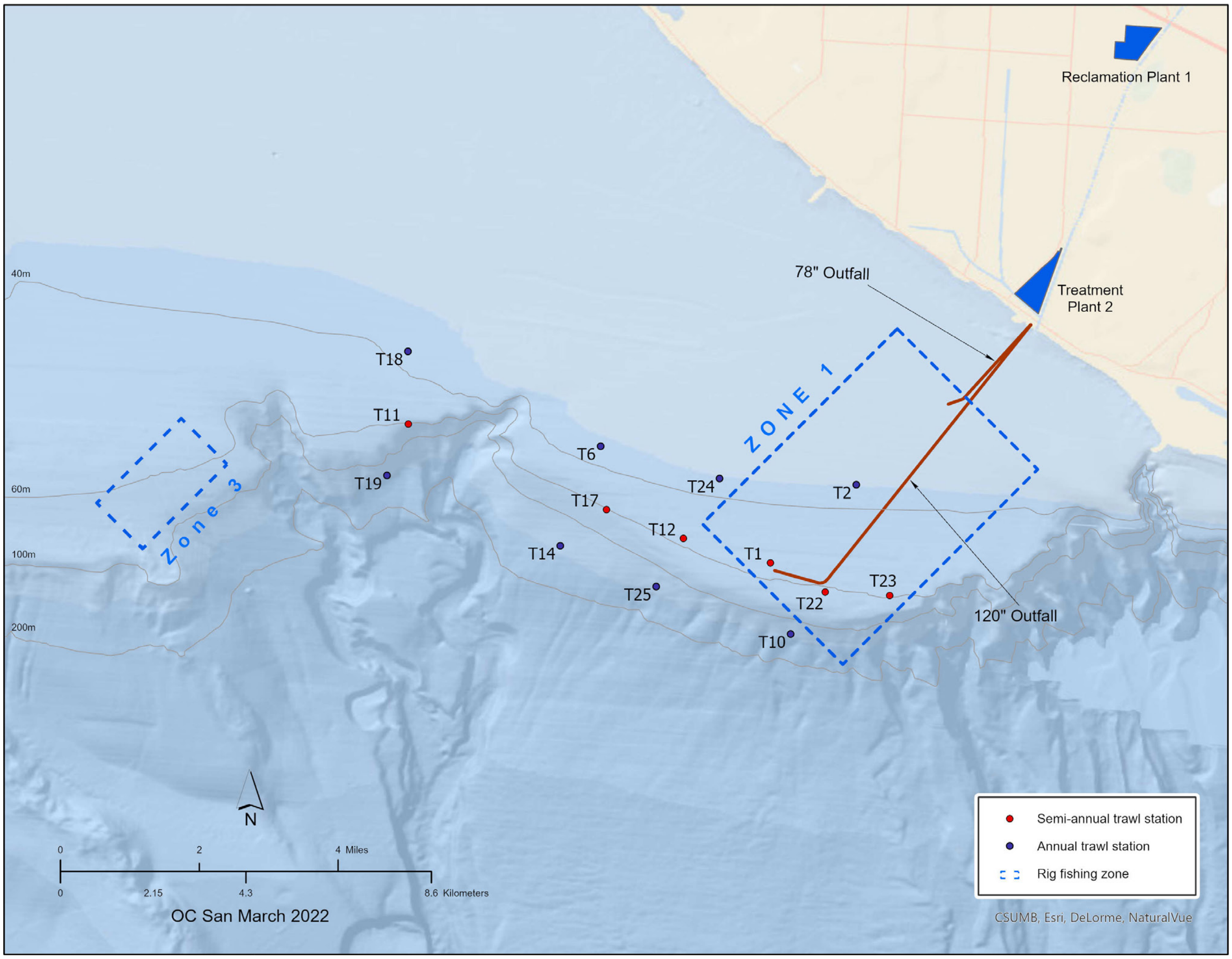

Figure 2–3 Trawl monitoring stations, as well as rig fishing locations, for 2020-21.

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 2020-21 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.

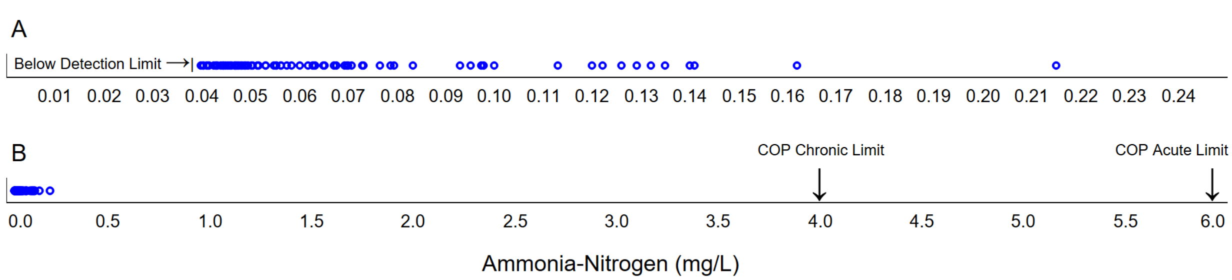

Figure 2–4 Summary plots of ammonia-nitrogen (NH_3-N) showing (A) measured range of values and (B) measured range of values compared to California Ocean Plan (COP) chronic and acute toxicity levels for the 2020-21 monthly 28-station water quality surveys.

SEDIMENT GEOCHEMISTRY

As with the previous monitoring years, the mean granulometric values and concentrations of most contaminants and metals were (a) higher at the deeper strata, (b) similar at the 2 outfall-depth strata (51–90 m) in both surveys, and (c) generally comparable to the regional 2013 Southern California Bight (SCB) survey and historical OC San averages (Tables 2-3, 2-4, 2-5, and 2-6). Nevertheless, the total polycyclic aromatic hydocarbons (ΣPAH) was comparatively higher at some outfall-depth stations, such as at Station 73 in both surveys (514.7 µg/kg in summer, 1,017.0 µg/kg in winter), at Stations 0 (414.1 µg/kg) and 87 (742.8 µg/kg) in the summer survey, and at Station 84 (1,713.9 µg/kg) in the winter survey. The sulfide value at outfall-depth Station C2 in the summer survey was also higher (45.3 µg/kg) than at the other stations in the same stratum. However, the elevated ΣPAH values at the 4 aforementioned stations were well below the 44,792 µg/kg Effects Range-Median threshold of biological concern (Long et al. 1995), and the summer sulfide value at Station C2 was within OC San's 10-year summer historical range. Furthermore, there was no measurable sediment toxicity at any of the 9 stations monitored, including Station 73, in the winter survey (Table 2-7). These results suggest that compliance was met.

BIOLOGICAL COMMUNITIES

Infaunal Communities

A total of 608 invertebrate taxa comprising 23,063 individuals were collected in the 2020-21 program 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 most station values were within regional and OC San historical ranges in both surveys (Tables 2-8 and 2-9). The infaunal community at all within-ZID and non-ZID stations in both surveys can be classified as reference condition based on their low (<25) Benthic Response Index (BRI) values and/or high (>60) Infaunal Trophic Index (ITI) values. The community composition at most within-ZID stations was similar to that of non-ZID stations based on multivariate analyses (cluster and non-metric multidimensional scaling (nMDS)) of the infaunal species and abundances (Figure 2-5). These multiple lines of evidence suggest that the outfall discharge had an overall indistinguishable impact on the benthic community structure within the monitoring area. We conclude, therefore, that the biota was not degraded by the outfall discharge, and as such, compliance was met.

Epibenthic Macroinvertebrate Communities

A total of 54 epibenthic macroinvertebrate (EMI) species, comprising 12,118 individuals and a total weight of 53.6 kg, were collected from 20 trawls conducted in 2020-21 (Tables B-10 and B-11). During this program year, *Lytechinus pictus* (urchin) was the most numerous species in terms of abundance (n=6,257; 12.0 kg; 52% of total abundance) and had the highest percent frequency of occurrence (collected from 85% of the hauls). While *Strongylocentrotus fragilis* (urchin) was the leading species in respect to biomass (n=398; 19.0 kg; 36% of total biomass), it was collected in only 2 of the 20 hauls. Within the Middle Shelf Zone 2 stratum, the overall EMI community composition at the outfall stations were similar to those at other non-outfall stations in both Summer and Winter surveys based on the results of the multivariate analyses (cluster and nMDS) (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 indistinguishable impact 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.

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 2020 compared to Effects Range-Median (ERM), regional, and historical values. 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	3.49	11.5	0.40	1.21	870	370	43.0	2.05	ND	ND
8 *	44	3.58	14.7	0.36	2.63	830	570	36.8	2.10	ND	ND
21 *	44	3.33	7.4	0.39	ND	920	370	42.1	1.71	ND	ND
22 *	45	3.52	8.8	0.42	14.10	910	450	72.9	14.21	ND	ND
30 *	46	3.16	6.8	0.34	1.27	870	420	16.1	1.24	ND	ND
36 *	45	3.54	8.7	0.37	1.68	880	460	51.7	1.78	ND	ND
55 *	40	2.45	2.0	0.19	ND	550	190	3.8	0.94	ND	ND
59 *	40	3.06	8.3	0.28	1.16	830	310	23.6	1.37	ND	ND
	Mean	**3.27**	**8.5**	**0.34**	**2.76**	**832**	**392**	**36.2**	**3.18**	**0**	**0**
					Middle Shelf Zone 2, Non-ZID (51–90 m)						
1	56	3.20	5.8	0.45	1.62	850	450	72.1	2.30	ND	0.38
3	60	3.14	5.2	0.40	3.00	800	410	36.0	1.80	ND	1.03
5	59	3.34	8.8	0.40	1.15	910	430	37.1	2.00	ND	0.27
9	59	3.06	7.9	0.38	2.31	730	450	26.1	1.33	ND	ND
10 *	62	3.52	9.6	0.39	1.79	880	440	42.3	2.10	ND	ND
12	58	3.00	5.8	0.36	1.03	740	420	30.8	1.54	ND	ND
13 *	59	3.38	7.4	0.37	ND	850	420	28.3	1.85	ND	ND
37 *	56	2.47	6.4	0.32	2.83	480	360	20.5	1.36	ND	ND
68	52	3.34	8.9	0.49	1.39	850	660	53.6	1.96	ND	ND
69	52	3.23	8.9	0.41	1.41	830	430	35.1	1.95	ND	ND
70	52	3.14	5.6	0.41	2.74	860	500	41.4	1.65	ND	ND
71	52	3.05	6.5	0.41	1.34	900	420	12.5	1.37	ND	ND
72	55	3.26	7.0	0.40	ND	880	340	41.6	1.57	ND	ND
73	55	3.11	7.6	0.50	1.44	1,000	520	514.7	2.35	ND	20.45
74	57	3.15	6.5	0.57	2.42	820	470	92.9	1.36	ND	ND
75	60	2.98	6.3	0.40	ND	1300	360	33.0	1.28	ND	ND
77	60	3.05	6.0	0.38	1.62	860	440	41.3	1.60	ND	ND
78	63	3.01	5.7	0.35	ND	850	410	32.8	1.52	ND	ND
79	65	3.26	6.7	0.38	1.70	820	410	61.6	1.82	ND	ND
80	65	3.18	8.0	0.39	1.62	830	390	52.3	1.82	ND	ND
81	65	3.10	4.6	0.35	1.63	770	330	13.1	1.36	ND	ND
82	65	3.04	5.2	0.36	ND	800	430	18.3	1.51	ND	ND
84	54	3.16	6.4	0.49	ND	1,100	550	119.8	2.05	ND	0.58
85	57	3.08	6.9	0.58	1.08	1,400	490	179.9	2.33	ND	23.11
86	57	3.19	9.5	0.44	1.49	1,000	480	57.3	1.85	ND	0.52
87	60	3.10	5.3	0.35	1.92	890	490	742.8	1.31	ND	ND
C	56	3.10	6.9	0.41	1.21	790	430	28.1	3.74	ND	ND
C2 *	56	4.72	45.2	1.98	45.30	840	2000	206.1	2.07	ND	ND
CON	59	3.21	7.4	0.39	ND	810	420	34.6	2.58	ND	ND
	Mean	**3.19**	**8.2**	**0.47**	**2.83**	**877**	**495**	**93.3**	**1.84**	**0**	**1.6**
					Middle Shelf Zone 2, Within-ZID (51–90 m)						
0	56	3.06	6.5	0.54	ND	1,100	440	414.1	1.97	ND	2.84
4	56	3.07	6.5	0.36	ND	790	410	33.3	1.40	ND	ND
76	58	3.20	9.6	0.39	ND	830	420	22.7	1.50	ND	ND
ZB	56	3.10	5.3	0.48	1.28	870	460	37.9	1.62	ND	ND
	Mean	**3.11**	**7.0**	**0.44**	**0.32**	**898**	**432**	**127.0**	**1.62**	**0**	**0.71**

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 3 (91–120 m)						
17 *	91	3.11	5.7	0.40	1.14	770	380	30.1	1.91	ND	ND
18 *	91	3.19	6.9	0.39	1.24	770	410	23.5	1.66	ND	ND
20 *	100	3.64	9.7	0.52	1.45	950	510	35.7	2.36	ND	ND
23 *	100	2.84	4.3	0.36	1.55	660	430	23.7	1.21	ND	ND
29 *	100	3.80	17.9	0.57	1.60	880	710	64.3	2.79	ND	ND
33 *	100	2.68	8.0	0.36	2.48	560	350	20.5	1.12	ND	ND
38 *	100	3.60	14.0	0.53	1.31	840	560	51.3	1.96	ND	ND
56 *	100	3.51	11.6	0.51	1.47	930	520	67.8	2.79	ND	ND
60 *	100	3.75	13.5	0.61	1.29	900	590	55.6	4.75	ND	ND
83 *	100	3.41	9.6	0.40	1.42	800	470	23.0	1.72	ND	ND
	Mean	**3.35**	**10.1**	**0.46**	**1.50**	**806**	**493**	**39.6**	**2.23**	**0**	**0**
					Outer Shelf (121–200 m)						
24 *	200	4.10	27.2	0.92	4.76	840	1,100	64.1	3.43	ND	ND
25 *	200	4.81	47.4	1.16	4.27	870	1,400	91.5	7.35	ND	ND
27 *	200	3.95	24.7	0.73	2.70	860	830	53.5	3.03	ND	ND
39 *	200	3.30	12.1	0.56	2.20	780	590	36.8	2.20	ND	ND
57 *	200	4.94	50.5	1.55	5.82	870	1,600	157.8	10.05	ND	0.64
61 *	200	4.87	49.0	1.16	3.14	890	1,200	139.6	7.82	ND	0.49
63 *	200	4.09	22.2	0.88	1.77	870	940	46.2	7.18	ND	ND
65 *	200	5.03	52.6	1.23	20.20	860	990	83.8	3.84	ND	ND
C4 *	187	4.94	50.4	1.33	20.00	890	1,400	213.7	3.91	ND	ND
	Mean	**4.45**	**37.3**	**1.06**	**7.21**	**859**	**1,117**	**98.6**	**5.42**	**0**	**0.13**
					Upper Slope/Canyon (201–500 m)						
40 *	303	4.23	34.0	1.20	3.05	750	1,300	75.8	5.20	ND	ND
41 *	303	4.19	34.0	1.17	5.32	730	1,200	81.0	3.19	ND	ND
42 *	303	4.78	46.9	1.50	3.87	720	1,600	63.4	10.72	ND	1.23
44 *	241	4.94	50.6	1.79	11.40	880	1,800	208.0	12.66	ND	0.78
58 *	300	5.32	59.2	2.04	6.51	810	2,100	232.7	14.71	ND	ND
62 *	300	5.36	61.2	2.05	14.10	960	2,400	120.8	5.72	ND	ND
64 *	300	4.55	40.8	1.49	ND	760	1,600	123.5	8.85	ND	ND
C5 *	296	5.77	73.0	2.03	22.40	760	2,300	117.2	3.93	ND	ND
	Mean	**4.89**	**50.0**	**1.66**	**8.33**	**796**	**1,788**	**127.8**	**8.12**	**0**	**0.25**
					Sediment quality guidelines						
ERM		—	—	—	—	—	—	44,792.0	46.10	—	180.00
					Regional Bight'13 summer values [area weighted mean (range)]						
Middle Shelf		—	48.5 (14.1–88.4)	0.70	—	—	690	55.0	14.00 (0.10–150.70)	—	2.00 (ND–31.70)
Outer Shelf		—	49.2 (6.1–77.0)	0.93	—	—	1,000	92.0	71.60 (0.10–1,141.50)	—	4.30 (ND–58.20)
Upper Slope/Canyon		—	75.0	1.90	—	—	2,500	160.0	490.00	—	15.00
					OC San historical summer values (July 2010–September 2019) [mean (range)]						
Middle Shelf Zone 1		3.55 (2.50–4.03)	25.0 (3.2–51.3)	0.42 (0.16–1.18)	3.11 (1.10–7.87)	968 (600–1,300)	359 (170–640)	46.3 (1.5–388.5)	3.32 (ND–43.65)	0.08 (ND–3.99)	0.48 (ND–3.85)
Middle Shelf Zone 2, Non-ZID		3.45 (2.55–5.68)	20.8 (6.3–91.6)	0.41 (0.21–2.70)	6.24 (1.07–198.00)	918 (360–2,000)	384 (69–2,100)	70.4 (4.0–527.2)	2.05 (ND–52.90)	0.11 (ND–9.20)	2.81 (ND–70.39)
Middle Shelf Zone 2, Within-ZID		3.31 (2.99–3.57)	13.8 (5.8–33.1)	0.39 (0.27–0.72)	4.27 (1.08–13.30)	981 (490–1,700)	381 (90–610)	125.6 (14.9–758.3)	1.06 (ND–4.05)	0.49 (ND–9.37)	3.47 (ND–24.75)
Middle Shelf Zone 3		3.68 (2.57–4.36)	32.0 (5.8–69.1)	0.58 (0.27–3.93)	5.53 (1.08–18.60)	904 (640–1,200)	464 (230–800)	55.8 (7.7–147.3)	3.76 (ND–69.12)	0 (All ND)	0.98 (ND–7.14)
Outer Shelf		4.66 (3.61–5.91)	64.2 (18.3–95.1)	1.16 (0.41–2.66)	12.13 (1.28–82.00)	956 (790–1,200)	936 (490–1,600)	119.4 (19.4–367.3)	6.92 (ND–23.82)	0 (All ND)	2.55 (ND–11.59)
Upper Slope/Canyon		5.34 (2.19–6.50)	78.5 (40.9–98.1)	1.77 (0.82–3.35)	16.37 (1.46–88.20)	914 (700–1,100)	1452 (460–2,300)	148.4 (20.6–336.3)	8.89 (1.22–34.33)	0.40 (0–13.30)	3.12 (ND–10.33)

Table 2–4 Metal concentrations (mg/kg) in sediment samples collected at each semi-annual and annual (*) station in Summer 2020 compared to Effects Range-Median (ERM), regional, and historical values. 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	0.1	3.79	42.5	0.24	0.12	17.00	7.37	7.08	0.01	8.0	1.33	0.10	36.2
8 *	44	0.1	3.40	54.5	0.24	0.15	16.30	6.94	6.23	0.01	8.0	1.21	0.09	35.3
21 *	44	0.1	3.43	41.4	0.24	0.11	16.80	6.75	6.37	0.01	7.8	1.03	0.12	35.2
22 *	45	0.1	4.35	47.6	0.28	0.15	18.00	7.86	7.53	0.02	9.2	1.16	0.11	40.9
30 *	46	0.1	3.02	38.4	0.22	0.09	16.20	6.02	6.03	0.01	7.0	1.09	0.08	33.2
36 *	45	0.1	3.86	47.9	0.25	0.13	16.00	6.64	6.90	0.01	8.4	1.12	0.05	37.5
55 *	40	0.1	2.03	25.0	0.16	0.04	11.70	3.40	3.67	0.01	6.0	0.78	0.02	21.5
59 *	40	0.1	2.73	33.7	0.20	0.07	14.10	4.90	4.81	0.01	6.7	1.20	0.06	26.8
	Mean	**0.1**	**3.33**	**41.4**	**0.23**	**0.11**	**15.76**	**6.24**	**6.08**	**0.01**	**7.6**	**1.12**	**0.08**	**33.32**
Middle Shelf Zone 2, Non-ZID (51–90 m)														
1	56	0.1	3.26	37.7	0.27	0.16	19.30	10.00	7.88	0.02	8.4	1.19	0.16	38.3
3	60	0.1	2.47	34.9	0.26	0.17	17.90	8.24	5.24	0.02	8.0	0.99	0.13	40.6
5	59	0.1	3.13	45.6	0.28	0.15	18.80	8.30	5.92	0.02	9.0	1.24	0.13	39.8
9	59	0.1	2.77	33.2	0.26	0.10	16.90	6.19	5.13	0.01	7.8	1.02	0.07	35.5
10 *	62	0.1	3.13	50.2	0.27	0.16	19.00	8.48	6.81	0.01	9.2	1.34	0.19	42.3
12	58	0.1	2.96	32.8	0.26	0.11	15.90	5.66	5.09	0.01	7.6	1.05	0.07	32.7
13 *	59	0.1	3.35	50.2	0.27	0.14	20.30	7.83	6.24	0.01	8.9	1.15	0.11	39.8
37 *	56	0.1	2.66	32.7	0.23	0.10	12.80	5.06	4.72	0.01	6.9	0.99	0.04	33.2
68	52	0.1	4.17	42.1	0.27	0.14	19.10	8.66	6.51	0.01	9.0	1.14	0.11	38.6
69	52	0.1	3.72	39.7	0.28	0.16	18.70	8.14	6.26	0.02	9.1	1.19	0.10	39.7
70	52	0.1	4.00	38.1	0.25	0.17	17.90	7.98	5.89	0.01	8.6	1.22	0.10	38.3
71	52	0.1	4.12	34.5	0.26	0.14	16.80	6.34	5.38	0.02	7.8	0.95	0.07	36.7
72	55	0.1	3.05	38.6	0.26	0.16	17.60	10.10	5.72	0.02	8.0	1.16	0.13	40.3
73	55	0.1	3.72	38.1	0.27	0.29	20.90	13.30	7.68	0.03	8.4	1.13	0.18	42.8
74	57	0.1	4.13	39.9	0.27	0.19	18.30	7.72	6.07	0.01	8.5	1.25	0.10	39.8
75	60	0.1	3.59	36.1	0.28	0.37	17.20	7.14	4.96	0.03	8.4	1.17	0.09	39.9
77	60	0.1	3.93	34.5	0.28	0.09	18.10	6.91	5.69	0.01	8.3	1.26	0.07	37.2
78	63	0.1	3.65	32.1	0.28	0.08	16.90	6.35	5.11	0.01	7.7	1.07	0.06	36.0
79	65	0.1	3.12	39.5	0.30	0.12	18.10	8.33	6.24	0.02	8.8	1.14	0.10	41.4
80	65	0.1	3.02	37.2	0.32	0.09	18.50	8.18	5.73	0.03	9.2	1.27	0.08	41.5
81	65	0.1	3.03	37.3	0.28	0.09	17.40	6.72	5.16	0.01	8.3	1.48	0.08	37.6
82	65	0.1	2.78	32.7	0.28	0.08	18.10	6.45	5.04	0.01	8.6	1.06	0.06	37.6
84	54	0.1	3.42	35.6	0.26	0.25	19.30	9.40	6.43	0.03	8.6	1.08	0.17	40.3
85	57	0.1	4.62	34.2	0.28	0.26	20.30	10.80	7.17	0.07	8.2	1.04	0.15	39.1
86	57	0.1	3.39	37.6	0.26	0.19	18.60	8.66	6.12	0.01	8.1	1.00	0.15	38.9
87	60	0.1	3.35	37.9	0.29	0.09	17.80	7.33	5.39	0.06	8.3	1.07	0.08	40.6
C	56	0.1	2.94	46.1	0.26	0.13	18.50	7.09	6.11	0.01	8.9	0.84	0.08	39.7
C2 *	56	0.2	9.60	123.0	0.69	0.54	28.20	23.00	21.8	0.05	17.6	2.84	0.18	109.0
CON	59	0.1	3.09	52.0	0.27	0.10	18.80	7.39	6.32	0.01	9.1	1.14	0.08	38.7
	Mean	**0.1**	**3.59**	**41.5**	**0.29**	**0.17**	**18.48**	**8.47**	**6.48**	**0.02**	**8.7**	**1.19**	**0.11**	**41.24**
Middle Shelf Zone 2, Within-ZID (51–90 m)														
0	56	0.1	4.84	34.6	0.26	0.33	20.40	11.20	7.19	0.05	8.4	1.10	0.23	44.2
4	56	0.1	3.66	32.1	0.25	0.11	17.40	6.45	5.47	0.01	7.8	0.82	0.07	36.6
76	58	0.1	3.00	34.1	0.28	0.10	17.00	6.87	4.80	0.01	8.1	1.23	0.07	37.5
ZB	56	0.1	3.43	37.7	0.27	0.17	17.70	7.75	5.52	0.01	8.3	1.16	0.09	38.8
	Mean	**0.1**	**3.73**	**34.6**	**0.26**	**0.18**	**18.12**	**8.07**	**5.74**	**0.02**	**8.1**	**1.08**	**0.12**	**39.28**

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	0.1	3.23	44.3	0.32	0.14	17.60	7.26	5.75	0.01	9.5	1.02	0.08	43.2
18 *	91	0.1	2.77	43.3	0.31	0.10	17.70	6.81	5.96	0.01	8.8	1.27	0.07	41.9
20 *	100	0.1	3.15	60.2	0.30	0.17	20.70	9.49	6.99	0.02	10.4	1.23	0.13	45.4
23 *	100	0.1	3.05	36.3	0.28	0.13	15.60	5.74	5.34	0.01	8.1	1.06	0.05	36.6
29 *	100	0.1	3.05	66.7	0.31	0.20	21.30	10.30	7.67	0.02	10.4	1.18	0.17	46.2
33 *	100	0.1	3.44	39.5	0.26	0.17	14.90	5.59	4.80	0.01	8.2	1.05	0.06	36.3
38 *	100	0.1	3.73	63.9	0.30	0.30	18.60	7.73	6.80	0.01	10.0	1.28	0.08	45.0
56 *	100	0.1	3.41	70.6	0.31	0.18	21.30	9.62	7.65	0.02	10.5	1.45	0.15	45.3
60 *	100	0.1	3.44	77.0	0.34	0.31	23.20	11.90	8.44	0.02	11.4	1.50	0.25	50.7
83 *	100	0.1	3.14	50.2	0.30	0.11	18.20	7.20	6.28	0.01	8.9	1.35	0.09	40.7
	Mean	**0.1**	**3.24**	**55.2**	**0.30**	**0.18**	**18.91**	**8.16**	**6.57**	**0.01**	**9.6**	**1.24**	**0.11**	**43.13**
Outer Shelf (121–200 m)														
24 *	200	0.1	4.05	96.9	0.40	0.39	25.40	13.10	9.59	0.02	13.1	1.75	0.23	56.1
25 *	200	0.1	4.52	118.0	0.42	0.39	28.00	15.30	10.60	0.02	14.5	1.56	0.23	61.2
27 *	200	0.1	3.40	73.0	0.35	0.26	22.70	9.87	7.39	0.02	11.8	1.45	0.11	47.4
39 *	200	0.1	3.41	53.1	0.33	0.20	20.10	8.43	6.40	0.03	10.0	1.40	0.07	44.0
57 *	200	0.1	5.32	148.0	0.50	0.56	35.90	23.20	14.80	0.03	17.0	1.99	0.51	74.2
61 *	200	0.1	4.74	134.0	0.42	0.49	29.60	17.60	11.40	0.18	14.7	2.10	0.36	62.0
63 *	200	0.1	4.09	154.0	0.40	0.35	25.90	13.20	9.31	0.02	13.4	1.89	0.23	56.1
65 *	200	0.1	6.15	108.0	0.49	0.72	29.40	17.40	13.10	0.03	15.5	1.98	0.32	68.9
C4 *	187	0.1	6.92	93.4	0.52	0.45	26.60	16.40	13.00	0.03	15.4	1.87	0.15	75.4
	Mean	**0.1**	**4.73**	**108.7**	**0.43**	**0.42**	**27.07**	**14.94**	**10.62**	**0.04**	**13.9**	**1.78**	**0.25**	**60.59**
Upper Slope/Canyon (201–500 m)														
40 *	303	0.1	3.92	92.5	0.39	0.32	26.40	13.60	9.07	0.02	13.6	1.73	0.16	54.5
41 *	303	0.1	4.38	98.6	0.44	0.31	28.30	14.40	9.91	0.01	14.5	2.21	0.17	59.5
42 *	303	0.3	5.04	130.0	0.48	0.40	31.80	17.10	12.10	0.02	16.2	2.01	0.24	66.6
44 *	241	0.1	6.44	177.0	0.52	0.66	36.80	23.80	15.30	0.03	17.8	2.40	0.51	76.9
58 *	300	0.1	6.96	194.0	0.59	0.52	42.00	24.70	16.50	0.02	20.3	2.68	0.41	83.6
62 *	300	0.1	7.72	179.0	0.60	0.76	43.40	28.00	17.90	0.03	20.5	2.43	0.60	89.6
64 *	300	0.1	7.13	155.0	0.53	0.59	32.70	18.60	13.90	0.02	16.6	2.53	0.34	79.5
C5 *	296	0.1	7.62	137.0	0.65	0.80	39.50	24.10	16.60	0.03	20.6	2.80	0.38	94.1
	Mean	**0.1**	**6.15**	**145.4**	**0.52**	**0.54**	**35.11**	**20.54**	**13.91**	**0.02**	**17.5**	**2.35**	**0.35**	**75.54**
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 (range)]														
Middle Shelf		0.92	2.70	130.0	0.21	0.68	30.00	7.45 (ND–15.66)	6.95 (1.30–13.20)	0.05 (0.01–0.20)	15.0	0.10	0.21 (ND–3.05)	45.9 (15.2–94.5)
Outer Shelf		1.10	5.30	130.0	0.36	0.82	37.00	10.56 (ND–79.13)	9.61 (3.80–24.21)	0.07 (ND–0.78)	18.0	0.21	0.35 (ND–5.79)	56.5 (21.8–104.3)
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 2010–September 2019) [mean (range)]														
Middle Shelf Zone 1		0.10 (0.07–0.29)	3.12 (1.43–4.60)	40.2 (24.0–51.8)	0.22 (0.13–0.31)	0.18 (0.04–0.30)	18.01 (11.00–26.10)	7.92 (3.38–11.00)	5.63 (2.47–7.40)	0.02 (0.01–0.08)	8.6 (5.4–11.1)	0.52 (0.17–1.55)	0.11 (0.02–0.51)	35.0 (21.9–45.8)
Middle Shelf Zone 2, Non-ZID		0.15 (0.04–5.12)	3.00 (1.56–9.27)	40.3 (22.9–202.0)	0.65 (0.12–95.20)	0.29 (0.08–8.78)	20.77 (5.65–95.00)	10.53 (4.13–45.50)	5.80 (2.79–21.10)	0.03 (0.01–1.23)	9.7 (3.5–26.8)	0.75 (0.16–8.88)	0.17 (0.03–4.10)	43.5 (20.0–132.0)
Middle Shelf Zone 2, Within-ZID		0.14 (0.05–0.69)	3.08 (2.10–4.48)	38.2 (25.7–117.0)	0.26 (0.20–0.45)	0.34 (0.12–0.88)	21.00 (16.60–41.30)	13.90 (6.84–119.00)	6.67 (2.68–71.20)	0.07 (0.01–1.13)	9.4 (7.6–19.9)	0.71 (0.23–1.70)	0.16 (0.06–0.31)	44.0 (36.3–65.6)
Middle Shelf Zone 3		0.11 (0.06–0.18)	3.07 (1.55–7.48)	52.5 (27.3–132.0)	0.28 (0.20–0.56)	0.26 (0.10–0.69)	22.51 (16.00–34.60)	10.90 (5.85–21.10)	6.17 (3.20–15.30)	0.02 (0.01–0.04)	11.8 (8.3–33.1)	0.55 (0.15–1.72)	0.14 (0.05–0.35)	46.8 (32.2–85.1)
Outer Shelf		0.16 (0.09–0.48)	4.30 (1.88–8.75)	104.7 (33.1–195.0)	0.40 (0.23–0.58)	0.51 (0.17–0.94)	34.49 (19.90–83.10)	19.79 (8.60–40.00)	9.93 (4.90–17.10)	0.03 (0.01–0.06)	17.2 (8.7–25.0)	0.91 (0.20–2.35)	0.29 (0.07–0.82)	65.7 (43.3–95.4)
Upper Slope/Canyon		0.17 (0.04–0.30)	5.40 (1.20–8.43)	129.8 (32.0–212.0)	0.49 (0.09–0.81)	0.63 (0.11–1.25)	44.64 (6.64–86.80)	27.08 (4.37–55.50)	12.80 (2.83–25.80)	0.03 (0.01–0.06)	21.8 (3.3–31.7)	1.35 (0.38–3.23)	0.37 (0.08–1.15)	78.1 (13.5–108.0)

Table 2–5 Physical properties, as well as biogeochemical and contaminant concentrations, of sediment samples collected at each semi-annual station in Winter 2021 compared to Effects Range-Median (ERM), regional, and historical values. 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	3.33	13.2	0.40	2.43	890	470	87.5	1.49	ND	ND
3	60	3.21	7.6	0.38	3.53	940	470	93.1	1.28	ND	0.20
5	59	3.66	18.0	0.42	2.03	1,000	460	41.8	1.75	ND	ND
9	59	3.16	12.3	0.36	1.39	860	420	36.5	1.05	ND	ND
12	58	2.97	10.1	0.36	ND	870	450	20.4	7.55	ND	ND
68	52	3.50	16.4	0.45	1.79	970	460	33.1	1.44	ND	ND
69	52	3.21	7.2	0.39	1.70	930	450	39.3	1.58	ND	ND
70	52	3.14	7.8	0.37	1.20	850	320	53.4	1.43	ND	ND
71	52	3.08	7.6	0.39	1.67	890	340	27.6	1.13	ND	ND
72	55	3.32	11.8	0.40	2.60	970	370	69.3	1.57	ND	0.39
73	55	3.15	9.3	0.47	5.21	1400	590	1017.0	1.64	ND	3.50
74	57	3.09	5.8	0.38	ND	910	330	35.0	1.22	ND	0.42
75	60	3.10	7.3	0.35	ND	960	410	47.4	1.05	ND	0.25
77	60	3.13	10.9	0.37	1.56	830	520	23.0	1.09	ND	ND
78	63	3.04	5.5	0.35	1.99	1,000	440	200.2	0.95	ND	ND
79	65	3.36	13.4	0.39	ND	840	560	29.0	1.24	ND	ND
80	65	3.42	16.0	0.38	1.03	910	400	23.4	0.96	ND	ND
81	65	3.12	6.6	0.35	2.26	840	350	19.9	0.99	ND	ND
82	65	3.07	5.2	0.32	1.32	850	560	27.3	0.89	ND	ND
84	54	3.14	10.6	0.45	3.69	1,200	460	1713.9	1.43	ND	0.79
85	57	3.05	5.3	0.46	1.04	980	400	169.9	1.52	ND	1.74
86	57	3.23	11.2	0.42	1.67	900	370	66.3	1.29	ND	0.43
87	60	3.22	12.2	0.40	ND	870	380	25.1	0.89	ND	ND
C	56	3.40	18.3	0.38	3.53	820	410	21.5	1.14	ND	ND
CON	59	3.26	10.7	0.39	ND	810	340	29.4	1.62	ND	ND
	Mean	**3.21**	**10.4**	**0.39**	**1.67**	**932**	**429**	**158.0**	**1.53**	**0**	**0.31**
Middle Shelf Zone 2, Within-ZID (51–90 m)											
0	56	3.05	6.5	0.47	1.21	1,100	490	233.7	1.95	ND	5.12
4	56	3.20	12.8	0.37	1.28	890	430	105.9	1.02	ND	ND
76	58	3.05	4.9	0.38	1.25	950	430	27.6	1.02	ND	0.27
ZB	56	3.23	12.8	0.42	1.10	880	330	40.4	1.18	ND	ND
	Mean	**3.13**	**9.2**	**0.41**	**1.21**	**955**	**420**	**101.9**	**1.29**	**0**	**1.35**
Sediment quality guidelines											
ERM		—	—	—	—	—	—	44,792.0	46.10	—	180.00
Regional Bight'13 summer values [area weighted mean (range)]											
Middle Shelf		—	48.5 (14.1–88.4)	0.70	—	—	690	55.0	14.00 (0.10–150.70)	—	2.00 (ND–31.70)
OC San historical winter values (January 2011–March 2020) [mean (range)]											
Middle Shelf Zone 2, Non-ZID		3.41 (2.76–5.65)	20.7 (4.0–92.9)	0.36 (0.14–1.63)	4.92 (1.15–49.10)	899 (540–1,500)	380 (190–1,100)	67.8 (2.7–645.0)	2.55 (ND–31.30)	0.25 (ND–36.26)	4.32 (ND–244.30)
Middle Shelf Zone 2, Within-ZID		3.31 (2.92–3.55)	15.4 (4.3–32.4)	0.37 (0.23–0.65)	5.13 (1.29–19.00)	983 (510–2,200)	386 (230–580)	104.2 (6.5–751.3)	2.91 (ND–58.25)	0.61 (ND–21.40)	6.06 (ND–36.87)

Table 2–6 Metal concentrations (mg/kg) in sediment samples collected at each semi-annual station in Winter 2021 compared to Effects Range-Median (ERM), regional, and historical values. ND = Not Detected.

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	0.07	3.08	36.9	0.26	0.17	18.10	8.34	7.18	0.03	8.3	1.57	0.13	38.6
3	60	0.06	3.46	37.2	0.28	0.11	17.70	7.64	6.18	0.02	8.2	1.36	0.13	40.4
5	59	0.08	3.20	45.3	0.28	0.16	19.10	8.80	7.24	0.02	9.2	1.43	0.14	42.4
9	59	0.06	2.88	34.2	0.26	0.10	16.60	6.30	5.71	0.01	7.7	1.35	0.08	35.8
12	58	0.06	3.07	31.3	0.24	0.10	15.50	5.75	5.60	0.01	7.3	1.42	0.07	34.1
68	52	0.07	3.66	44.2	0.26	0.15	17.70	7.83	6.97	0.02	8.4	1.52	0.13	38.7
69	52	0.09	3.87	41.7	0.27	0.14	18.50	7.90	7.19	0.02	8.8	1.60	0.10	39.9
70	52	0.08	3.18	38.2	0.27	0.21	17.50	7.71	6.57	0.02	8.2	1.42	0.11	40.5
71	52	0.07	4.27	35.5	0.25	0.15	16.70	6.59	6.01	0.01	8.0	1.39	0.08	36.9
72	55	0.08	3.24	42.0	0.27	0.16	18.20	8.57	6.84	0.02	8.6	1.54	0.13	39.6
73	55	0.07	3.48	36.8	0.26	0.36	20.70	12.70	8.37	0.05	8.3	1.54	0.19	44.0
74	57	0.07	3.24	38.7	0.26	0.17	17.20	7.33	6.07	0.01	8.1	1.49	0.10	40.1
75	60	0.06	3.58	37.9	0.26	0.17	16.30	6.78	5.50	0.02	8.1	1.15	0.09	39.3
77	60	0.06	3.39	33.7	0.27	0.09	17.30	6.57	5.96	0.02	8.1	1.44	0.09	37.7
78	63	0.06	3.25	34.2	0.27	0.08	16.80	6.59	5.65	0.01	8.0	1.28	0.07	38.1
79	65	0.07	3.03	44.6	0.30	0.10	18.00	7.81	6.40	0.02	8.9	1.31	0.10	43.0
80	65	0.06	3.23	40.3	0.33	0.08	18.20	8.24	6.65	0.01	9.5	1.84	0.08	44.2
81	65	0.06	2.83	33.7	0.25	0.10	16.50	6.48	6.00	0.01	7.8	1.31	0.08	36.4
82	65	0.06	2.85	34.8	0.29	0.08	16.90	6.48	5.36	0.01	8.5	1.57	0.07	38.6
84	54	0.08	3.71	37.5	0.26	0.25	19.20	9.59	10.1	0.03	8.3	1.38	0.16	41.1
85	57	0.09	3.24	34.7	0.26	0.34	20.40	10.20	7.78	0.05	8.3	1.51	0.19	43.0
86	57	0.09	2.91	38.0	0.26	0.24	17.60	9.13	6.73	0.02	7.8	1.47	0.16	38.8
87	60	0.06	3.45	32.7	0.28	0.09	16.80	6.95	5.95	0.01	8.0	1.39	0.07	39.3
C	56	0.07	3.63	51.9	0.28	0.14	18.40	7.55	6.77	0.02	9.4	1.34	0.09	42.3
CON	59	0.08	2.87	49.8	0.25	0.09	17.70	7.22	6.41	0.01	8.6	1.49	0.07	38.0
	Mean	**0.07**	**3.30**	**38.6**	**0.27**	**0.15**	**17.74**	**7.80**	**6.61**	**0.02**	**8.3**	**1.44**	**0.11**	**39.6**
Middle Shelf Zone 2, Within-ZID (51–90 m)														
0	56	0.09	4.40	35.1	0.27	0.25	20.80	11.90	8.26	0.02	8.3	1.45	0.19	43.1
4	56	0.07	4.01	34.4	0.27	0.10	17.60	6.45	6.15	0.01	7.8	1.44	0.07	37.7
76	58	0.07	2.95	37.8	0.29	0.11	17.50	7.26	5.74	0.01	8.2	1.57	0.10	40.2
ZB	56	0.07	3.50	35.2	0.27	0.19	17.10	7.23	5.88	0.16	8.0	1.38	0.10	39.3
	Mean	**0.08**	**3.72**	**35.6**	**0.28**	**0.16**	**18.25**	**8.21**	**6.51**	**0.05**	**8.1**	**1.46**	**0.12**	**40.08**
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	7.45 (ND–15.66)	6.95 (1.30–13.20)	0.05 (0.01–0.20)	15.0	0.10	0.21 (ND–3.05)	45.9 (15.2–94.5)
OC San historical winter values (January 2011-March 2020) [mean (range)]														
Middle Shelf Zone 2, Non-ZID		0.09 (0.05–0.26)	3.00 (1.87–7.70)	35.5 (26.7–52.6)	0.27 (0.21–0.62)	0.25 (0.06–0.87)	20.85 (14.00–50.40)	9.68 (5.61–29.70)	5.42 (3.40–15.10)	0.02 (0.01–0.43)	9.8 (7.4–24.9)	0.84 (0.28–3.23)	0.25 (0.05–5.46)	41.9 (31.3–123.0)
Middle Shelf Zone 2, Within-ZID		0.10 (0.05–0.15)	3.15 (2.07–4.90)	33.3 (26.7–40.0)	0.26 (0.21–0.32)	0.39 (0.10–2.76)	22.49 (16.40–98.40)	10.92 (6.92–40.80)	5.43 (3.51–12.10)	0.05 (0.01–0.39)	9.9 (7.4–35.0)	0.76 (0.27–2.45)	0.34 (0.08–7.00)	43.4 (35.3–55.7)

Table 2–7 Whole-sediment *Eohaustorius estuarius* (amphipod) toxicity test results at selected outfall-depth stations for 2020-21. The home sediment represents the control; within-ZID stations are indicated by an asterisk.

Station	% Survival	% of home	p-value	Assessment
home	99	–	–	–
0 *	95	96	0.42	Nontoxic
1	99	100	0.91	Nontoxic
4 *	96	97	0.47	Nontoxic
72	99	100	0.91	Nontoxic
73	99	100	0.91	Nontoxic
76 *	98	99	0.75	Nontoxic
77	98	99	0.89	Nontoxic
CON	100	101	0.98	Nontoxic
ZB *	100	101	0.98	Nontoxic
ZB Dup *	98	99	0.89	Nontoxic

Table 2–8 Community measure values for each semi-annual and annual (*) station sampled during the Summer 2020 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	83	503	3.39	15	75	18
8 *	44	76	307	3.61	25	82	19
21 *	44	83	337	3.58	23	81	19
22 *	45	84	344	3.65	28	81	18
30 *	46	85	316	3.81	29	82	15
36 *	45	73	268	3.70	30	82	16
55 *	40	68	263	3.55	21	75	14
59 *	40	100	688	3.31	15	80	14
	Mean	**82**	**378**	**3.58**	**23**	**80**	**17**
Middle Shelf Zone 2, Non-ZID (51–90 m)							
1	56	85	359	3.74	25	80	17
3	60	96	393	3.74	25	85	13
5	59	79	251	3.89	32	75	15
9	59	81	266	3.81	30	77	15
10 *	62	71	218	3.57	26	80	19
12	58	111	424	4.07	37	59	20
13 *	59	64	245	3.61	23	82	18
37 *	56	92	280	4.06	35	75	14
68	52	78	394	3.39	19	76	15
69	52	84	451	3.29	17	82	11
70	52	80	349	3.75	27	83	12
71	52	76	338	3.35	16	86	12
72	55	88	331	3.69	26	76	15
73	55	88	302	3.86	31	82	15
74	57	92	467	3.54	24	78	12
75	60	90	416	3.66	23	78	17
77	60	68	268	3.57	24	78	14
78	63	60	201	3.53	24	77	16
79	65	67	235	3.63	23	79	18
80	65	79	239	3.81	34	80	11
81	65	72	243	3.65	27	82	17
82	65	71	174	3.78	30	77	17
84	54	89	424	3.68	24	75	14
85	57	92	413	3.73	24	76	14
86	57	90	349	3.86	31	81	15
87	60	91	297	4.01	34	77	17
C	56	106	316	4.24	42	79	16
C2 *	56	35	155	2.96	11	66	36
CON	59	72	219	3.84	28	83	16
	Mean	**81**	**311**	**3.70**	**27**	**78**	**16**
Middle Shelf Zone 2, Within-ZID (51–90 m)							
0	56	71	302	3.65	21	77	17
4	56	87	349	3.83	27	74	18
76	58	79	289	3.70	26	78	12
ZB	56	92	335	3.99	34	73	22
	Mean	**82**	**319**	**3.79**	**27**	**76**	**17**

Table 2–8 continues.

Table 2–8 continued.

Station	Depth (m)	Species Richness	Abundance	H'	SDI	ITI	BRI
			Middle Shelf Zone 3 (91–120 m)				
17 *	91	57	194	3.66	24	74	22
18 *	91	56	120	3.77	30	67	19
20 *	100	56	172	3.52	21	72	19
23 *	100	49	150	3.47	19	64	24
29 *	100	55	220	3.56	21	71	24
33 *	100	67	201	3.67	24	86	16
38 *	100	63	303	3.52	22	78	18
56 *	100	71	264	3.62	26	75	23
60 *	100	51	199	3.48	19	68	28
83 *	100	55	137	3.58	24	81	16
	Mean	**58**	**196**	**3.59**	**23**	**74**	**21**
			Outer Shelf (121–200 m)				
24 *	200	26	71	2.58	10	67	23
25 *	200	36	97	3.13	15	70	26
27 *	200	35	97	3.06	15	49	27
39 *	200	39	245	2.44	7	59	24
57 *	200	19	63	1.95	5	58	30
61 *	200	20	68	2.41	6	67	32
63 *	200	25	60	2.76	11	71	17
65 *	200	18	55	1.99	6	44	25
C4 *	187	29	229	1.80	3	65	40
	Mean	**27**	**109**	**2.46**	**9**	**61**	**27**
			Upper Slope/Canyon (201–500 m)				
40 *	303	34	88	2.76	13	N/A	N/A
41 *	303	25	76	2.52	9	N/A	N/A
42 *	303	22	55	2.62	9	N/A	N/A
44 *	241	24	127	1.71	3	N/A	N/A
58 *	300	18	39	2.50	9	N/A	N/A
62 *	300	15	36	2.37	7	N/A	N/A
64 *	300	19	69	1.91	6	N/A	N/A
C5 *	296	15	77	1.57	4	N/A	N/A
	Mean	**22**	**71**	**2.25**	**8**	**N/A**	**N/A**
			Regional Bight'13 summer values [mean (range)]				
Middle Shelf		90 (45–171)	491 (142–2,718)	3.60 (2.10–4.10)	—	—	18 (7–30)
Outer Shelf		66 (24–129)	289 (51–1,492)	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 2010–September 2019) [mean (range)]				
Middle Shelf Zone 1		99 (7–146)	391 (12–820)	3.85 (1.59–4.35)	32 (4–47)	84 (64–98)	15 (8–21)
Middle Shelf Zone 2, Non-ZID		91 (20–142)	400 (90–1,080)	3.67 (2.24–4.38)	27 (6–52)	77 (40–94)	17 (8–49)
Middle Shelf Zone 2, Within-ZID		88 (33–138)	459 (212–1,491)	3.44 (0.36–4.10)	24 (1–38)	64 (1–91)	23 (13–52)
Middle Shelf Zone 3		84 (45–146)	379 (123–807)	3.70 (3.09–4.23)	26 (14–43)	81 (65–94)	18 (9–26)
Outer Shelf		40 (19–78)	119 (38–367)	3.17 (1.91–3.68)	17 (3–28)	66 (42–91)	25 (14–39)
Upper Slope/Canyon		24 (13–38)	55 (22–106)	2.81 (2.04–3.41)	12 (5–21)	—	—

Fish Communities

A total of 43 fish taxa, comprising 9,084 individuals and a total weight of 131.1 kg, was collected from the monitoring area during the 2020-21 trawling effort (Tables B-12 and B-13). 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 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 (Middle Shelf Zone 2 stratum) regardless of season (Figure 2-7). These results indicate that the outfall discharge had no adverse effect on the

Table 2–9 Community measure values for each semi-annual station sampled during the Winter 2021 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	79	350	3.59	24	79	13
3	60	88	340	3.88	30	77	12
5	59	58	196	3.29	18	80	13
9	59	87	257	3.89	33	71	14
12	58	68	187	3.72	28	85	11
68	52	70	332	3.50	21	76	13
69	52	61	381	3.23	14	78	13
70	52	85	397	3.54	19	77	13
71	52	92	471	3.54	19	78	15
72	55	74	248	3.69	25	76	16
73	55	94	298	4.01	35	78	16
74	57	88	365	3.83	26	79	11
75	60	67	254	3.64	22	83	11
77	60	61	239	3.55	19	76	14
78	63	46	121	3.40	19	85	10
79	65	79	295	3.71	25	81	10
80	65	78	269	3.73	25	80	17
81	65	63	184	3.67	25	81	13
82	65	72	197	3.91	32	81	13
84	54	84	425	3.70	25	80	14
85	57	100	367	3.99	33	79	17
86	57	86	334	3.87	30	72	16
87	60	70	181	3.80	29	82	15
C	56	70	228	3.63	23	75	20
CON	59	61	201	3.55	20	82	12
	Mean	**75**	**285**	**3.67**	**25**	**79**	**14**
Middle Shelf Zone 2, Within-ZID (51–90 m)							
0	56	87	319	3.81	28	76	17
4	56	80	207	3.95	32	83	13
76	58	68	202	3.84	29	85	13
ZB	56	60	220	3.59	22	82	14
	Mean	**74**	**237**	**3.80**	**28**	**82**	**14**
Regional Bight'13 summer values [mean (range)]							
Middle Shelf		90 (45–171)	491 (142–2,718)	3.60 (2.10–4.10)	—	—	18 (7–30)
OC San historical winter values (January 2011–March 2020) [mean (range)]							
Middle Shelf Zone 2, Non-ZID		85 (45–142)	340 (96–750)	3.72 (2.87–4.32)	27 (9–48)	78 (47–95)	17 (9–46)
Middle Shelf Zone 2, Within-ZID		80 (35–135)	356 (88–1,230)	3.54 (0.89–4.68)	25 (1–76)	67 (3–89)	22 (9–45)

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.

FISH BIOACCUMULATION AND HEALTH

Demersal and Sport Fish Tissue Chemistry

Only 15 samples (out of 20) of *Pleuronichthys verticalis* (Hornyhead Turbot) and 1 sample (out of 20) of *Parophrys vetulus* (English Sole) were collected for bioaccumulation analysis from a total of 5 hauls conducted at Stations T1 (outfall) and T11 (non-outfall) during the 2020-21 program year (Table 2-12). Concentrations of trace metals and chlorinated pesticides measured in muscle and liver tissues of Hornyhead Turbot were similar between outfall and non-outfall locations (Table 2-12). Among the 20 sport fish samples, 1 Barred Sand Bass collected at Zone 1 (outfall area) had a total PCB concentration that placed it in the advisory tissue level (ATL) category of one 8-ounce serving per week (Table 2-13). All other contaminant concentrations (except mercury) in the other sport fish samples were below the least restrictive seven 8-ounce servings per week ATL. For mercury, all fish had average concentrations below the "do not consume" ATL. As such, mercury concentrations at both the outfall and non-outfall locations were elevated enough to warrant limiting the number of 8-ounce servings consumed within a week (see Table A-7). Of the contaminants measured in the regional 2018 SCB survey, mercury concentrations in one or more

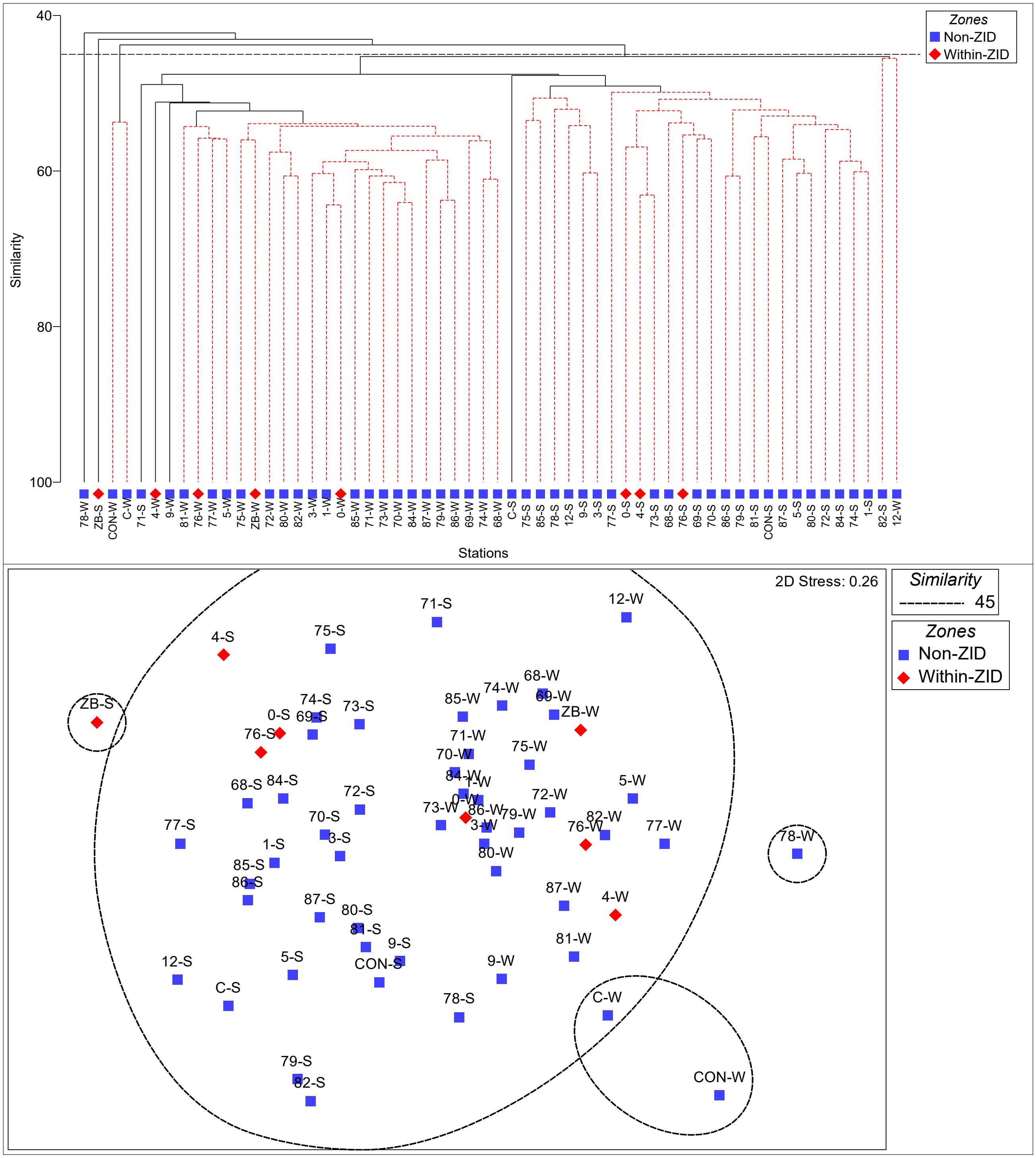

Figure 2–5 Dendrogram (top panel) and non-metric multidimensional scaling (nMDS) plot (bottom panel) of the infauna collected at within- and non-ZID stations along the Middle Shelf Zone 2 stratum for the Summer 2020 (S) and Winter 2021 (W) benthic surveys. Stations connected by red dashed lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The 4 main clusters formed at a 45% similarity on the dendrogram are superimposed on the nMDS plot.

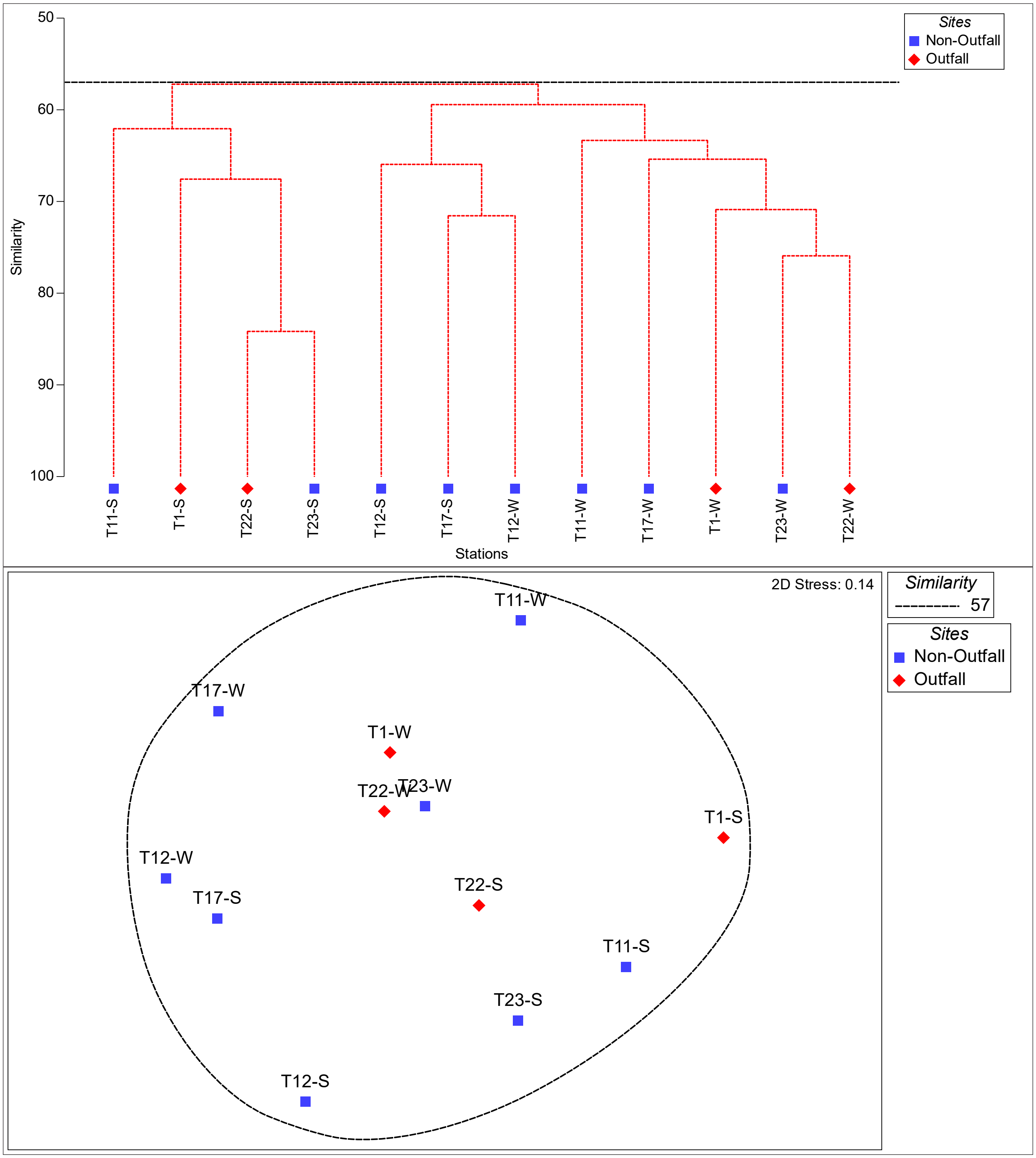

Figure 2–6 Dendrogram (top panel) and non-metric multidimensional scaling (nMDS) plot (bottom panel) of the epibenthic macroinvertebrates collected at outfall and non-outfall stations along the Middle Shelf Zone 2 stratum for the Summer 2020 (S) and Winter 2021 (W) trawl surveys. Stations connected by red dashed lines in the dendrogram are not significantly differentiated based on the SIMPROF test. The single cluster formed at a 57% similarity on the dendrogram is 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 2020 and Winter 2021 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	1,465	2.39	0.34	1
	T24 *	36	26	587	0.35	1.76	3
	T6 *	36	18	256	0.10	1.39	3
	T18 *	36	9	276	0.79	0.68	1
		Mean	**17**	**646**	**0.91**	**1.04**	**2**
				Middle Shelf Zone 2, Non-outfall (51–90 m)			
	T23	58	11	1,791	3.51	0.23	1
	T12	57	10	158	0.36	1.90	5
	T17	60	12	156	1.24	1.68	3
	T11	60	16	539	1.56	1.31	3
		Mean	**12**	**661**	**1.67**	**1.28**	**3**
				Middle Shelf Zone 2, Outfall (51–90 m)			
	T22	60	13	1,026	4.92	0.46	1
	T1	55	19	594	0.88	0.89	1
		Mean	**16**	**810**	**2.90**	**0.68**	**1**
				Outer Shelf (121–200 m)			
	T10 *	137	7	33	0.64	1.63	4
	T25 *	137	11	597	21.83	0.84	2
	T14 *	137	5	267	5.15	0.33	1
	T19 *	137	3	94	0.37	0.12	1
		Mean	**7**	**248**	**7.00**	**0.73**	**2**
				Middle Shelf Zone 2, Non-Outfall (51–90 m)			
Winter	T23	58	15	1,845	3.63	0.50	1
	T12	57	12	277	0.50	1.45	3
	T17	60	11	105	1.46	1.89	5
	T11	60	21	409	0.90	1.88	4
		Mean	**15**	**659**	**1.62**	**1.43**	**3**
				Middle Shelf Zone 2, Outfall (51–90 m)			
	T22	60	16	1,063	2.01	0.98	1
	T1	55	14	580	1.04	1.51	3
		Mean	**15**	**822**	**1.53**	**1.25**	**2**
				Regional Bight'13 summer values [area-weighted mean (range)]			
	Middle Shelf		12 (3–23)	1093 (19–17,973)	5 (0.31–36)	1.11 (0.09–2.49)	—
	Outer Shelf		15 (3–29)	728 (4–5,160)	27 (0.39–83)	1.26 (0.10–2.39)	—
				OC San historical values (July 2010–June 2020) [mean (range)]			
	Middle Shelf Zone 1		11 (2–18)	626 (2–3,926)	0.93 (0.00–3.44)	1.14 (0.01–2.22)	2 (1–5)
	Middle Shelf Zone 2, Non-outfall		11 (5–19)	469 (12–2,498)	1.66 (0.04–11.16)	1.26 (0.06–2.43)	3 (1–9)
	Middle Shelf Zone 2, Outfall		12 (7–18)	326 (49–1,420)	1.28 (0.08–3.60)	1.42 (0.22–2.15)	3 (1–5)
	Outer Shelf		10 (3–15)	199 (26–844)	4.85 (0.09–33.27)	1.06 (0.17–2.12)	2 (1–8)

target species exceeded the "consume not more than 2 servings per week" threshold in most fishing zones (McLaughlin et al. 2020). 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 area.

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 associated with any incidence or prevalence of fish disease.

Liver Histopathology

Hornyhead Turbot and English Sole were targeted for bioaccumulation (see above) and histopathology analyses. However, the liver from individual fish cannot be used for both analyses.

Table 2–11 Summary of demersal fish community measures for each semi-annual and annual (*) station sampled during the Summer 2020 and Winter 2021 trawl surveys, including regional and historical values.

Season	Station	Depth (m)	Species Richness	Abundance	Biomass (kg)	H'	SDI	FRI
				Middle Shelf Zone 1 (31–50 m)				
Summer	T2 *	35	8	54	14.63	1.53	3	17
	T24 *	36	10	407	1.94	1.46	3	19
	T6 *	36	10	228	3.20	1.53	3	16
	T18*	36	9	119	1.00	1.46	3	22
		Mean	**9**	**202**	**5.19**	**1.50**	**3**	**18**
				Middle Shelf Zone 2, Non-outfall (51–90 m)				
	T23	58	7	199	2.20	1.04	2	15
	T12	57	19	437	6.89	1.87	3	22
	T17	60	18	1,146	15.12	1.86	4	20
	T11	60	13	420	4.04	1.57	3	15
		Mean	**14**	**551**	**7.06**	**1.59**	**3**	**18**
				Middle Shelf Zone 2, Outfall (51–90 m)				
	T22	60	13	279	5.09	1.47	3	23
	T1	55	10	341	3.46	1.63	3	12
		Mean	**12**	**310**	**4.27**	**1.55**	**3**	**18**
				Outer Shelf (121–200 m)				
	T10 *	137	20	686	15.81	2.07	4	19
	T25 *	137	20	596	11.06	2.04	4	22
	T14 *	137	19	686	11.53	1.64	3	33
	T19 *	137	4	27	0.96	1.20	2	44
		Mean	**16**	**499**	**9.84**	**1.74**	**3**	**29**
				Middle Shelf Zone 2, Non-outfall (51–90 m)				
Winter	T23	58	11	282	2.80	1.26	2	18
	T12	57	16	883	6.74	1.58	3	22
	T17	60	15	1004	6.31	1.70	3	17
	T11	60	11	574	3.81	1.20	2	12
		Mean	**13**	**686**	**4.92**	**1.44**	**3**	**17**
				Middle Shelf Zone 2, Outfall (51–90 m)				
	T22	60	16	388	5.99	1.79	3	24
	T1	55	15	328	8.07	2.08	4	19
		Mean	**16**	**358**	**7.03**	**1.94**	**4**	**21**
				Regional Bight'13 summer values [area-weighted mean (range)]				
	Middle Shelf		15 (5–24)	506 (12–2,446)	12 (0.70–64.20)	1.65 (0.67–2.35)	—	28 (17–61)
	Outer Shelf		14 (2–21)	790 (2–3,088)	16 (0.20–54.50)	1.35 (0.59–2.01)	—	20 (-1–51)
				OC San historical values (July 2010–September 2019) [mean (range)]				
	Middle Shelf Zone 1		10 (2–15)	221 (83–470)	4.54 (0.76–11.86)	1.53 (0.69–2.10)	3 (2–5)	21 (17–26)
	Middle Shelf Zone 2, Non–outfall		14 (8–25)	594 (45–12,274)	13.02 (1.25–135.64)	1.72 (0.14–2.20)	3 (1–6)	22 (12–34)
	Middle Shelf Zone 2, Outfall		13 (2–18)	417 (110–3,227)	15.17 (2.47–78.72)	1.70 (0.67–2.18)	3 (1–6)	22 (13–32)
	Outer Shelf		16 (2–24)	689 (260–1,610)	14.51 (2.60–39.19)	1.42 (0.65–1.91)	3 (1–4)	17 (4–41)

For 2020-21, liver histopathology analysis was not conducted due to an insufficient number of individuals caught at Stations T1 and T11.

CONCLUSIONS

Overall, results from OC San's 2020-21 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) 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.

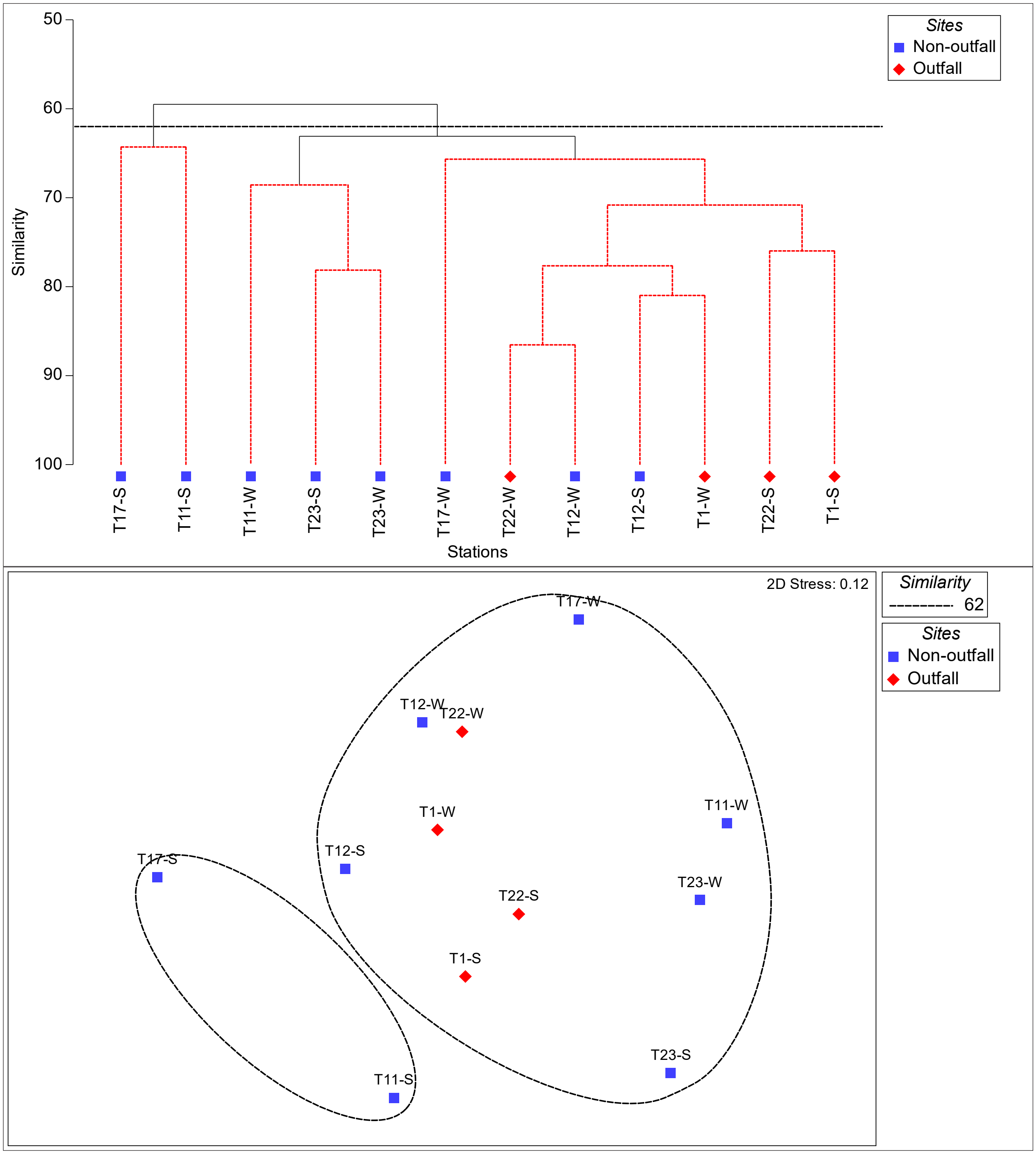

Figure 2–7 Dendrogram (top panel) and non-metric multidimensional scaling plot (bottom panel) of the demersal fishes collected at outfall and non-outfall stations along the Middle Shelf Zone 2 stratum for the Summer 2020 (S) and Winter 2021 (W) trawl surveys. Stations connected by red dashed lines in 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 2–12 Means and ranges of percent lipid and contaminant concentrations (ng/g) in tissues of flatfishes collected by trawling in September 2020 at Stations T1 (Outfall) and T11 (Non-outfall), including historical values. ND = Not Detected.

Species	Tissue	Station	n	Mean Standard Length (mm)	Percent Lipid	Mercury	ΣDDT	ΣPCB	ΣChlordane	ΣDieldrin
Pleuronichthys verticalis (Hornyhead Turbot)	Muscle	Non-outfall	10	149	0.21 (ND–0.97)	60 (20–160)	8.30 (1.32–45.66)	0.16 (ND–1.56)	ND (All ND)	ND (All ND)
		Outfall	5	138	ND (All ND)	30 (20–50)	2.39 (0–3.49)	ND (All ND)	ND (All ND)	ND (All ND)
	Liver	Non-outfall	10	149	5.97 (1.25–13.00)	120 (60–250)	181.37 (25.90–834.50)	27.92 (ND–195.60)	ND (All ND)	ND (All ND)
		Outfall	5	138	3.51 (0.99–8.67)	100 (60–160)	93.70 (64.10–136.00)	8.08 (ND–15.76)	ND (All ND)	ND (All ND)
Parophrys vetulus (English Sole)	Muscle	Non-outfall	0	—	—	—	—	—	—	—
		Outfall	1	230	1.39	20	30.29	12.75	ND	ND
	Liver	Non-outfall	0	—	—	—	—	—	—	—
		Outfall	1	230	4.88	50	107.00	29.52	ND	ND
OC San historical values (July 2010–June 2020)										
Pleuronichthys verticalis (Hornyhead Turbot)	Muscle	Non-outfall	66	146 (98–193)	0.16 (ND–1.07)	50 (10–180)	9.71 (ND–38.75)	1.98 (ND–18.36)	0.05 (ND–1.45)	ND (All ND)
		Outfall	79	156 (110–195)	0.12 (ND–0.77)	80 (10–420)	6.37 (ND–54.50)	1.42 (ND–12.57)	0.01 (ND–0.71)	0.23 (ND–12.70)
	Liver	Non-outfall	66	148 (98–193)	4.83 (ND–30.40)	180 (50–480)	480.93 (ND–2,100.00)	39.02 (ND–432.59)	ND (All ND)	ND (All ND)
		Outfall	79	154 (110–195)	7.62 (ND–23.40)	190 (10–590)	440.92 (ND–1,822.70)	88.14 (ND–457.80)	3.06 (0–81.70)	ND (All ND)
Parophrys vetulus (English Sole)	Muscle	Non-outfall	85	185 (125–268)	0.92 (ND–6.22)	50 (20–120)	72.97 (6.18–524.30)	8.17 (ND–61.20)	ND (All ND)	0.05 (ND–4.45)
		Outfall	78	188 (136–290)	1.24 (ND–8.23)	50 (10–110)	75.72 (3.75–480.00)	11.35 (ND–130.90)	0.08 (ND–5.88)	ND (All ND)
	Liver	Non-outfall	85	185 (125–268)	10.49 (1.93–26.80)	60 (20–190)	1,151.11 (42.60–14,300.00)	154.73 (ND–1,694.70)	0.07 (ND–5.27)	ND (All ND)
		Outfall	78	187 (136–290)	11.13 (0.58–27.10)	70 (20–160)	1,151.18 (58.80–20,967.00)	154.66 (ND–1,627.29)	0.90 (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 September 2020 at Zones 1 (Outfall) and 3 (Non-outfall), including historical values. ND = Not Detected.

Zone	Species	n	Mean Standard Length (mm)	Percent Lipid	Mercury	Arsenic	Selenium	ΣDDT	ΣPCB	ΣChlordane	Dieldrin
Non-outfall	*Sebastes constellatus* (Starry Rockfish)	2	265	1.48 (1.25–1.70)	310 (300–320)	1040 (790–1280)	580 (530–620)	44.20 (39.10–49.30)	4.44 (3.66–5.22)	ND (All ND)	ND (All ND)
	Sebastes hopkinsi (Squarespot Rockfish)	1	225	1.16	150	1740	450	10.20	ND	ND	ND
	Sebastes miniatus (Vermilion Rockfish)	2	268	0.90 (0.85–0.95)	110 (90–120)	2040 (1850–2220)	430 (410–450)	16.15 (11.80–20.50)	0.40 (ND–0.80)	ND (All ND)	ND (All ND)
	Sebastes paucispinis (Bocaccio)	4	330	0.95 (0.35–1.32)	130 (60–180)	560 (440–650)	490 (410–590)	20.52 (15.10–31.20)	1.19 (ND–3.62)	ND (All ND)	ND (All ND)
	Sebastes serriceps (Treefish)	1	212	2.35	180	1090	550	44.40	8.39	ND	ND
Outfall	*Paralabrax clathratus* (Kelp Bass)	1	260	0.55	90	740	290	5.69	ND	ND	ND
	Paralabrax nebulifer (Barred Sand Bass)	1	386	2.42	230	2290	470	106.01	43.50	1.24	ND
	Sebastes constellatus (Starry Rockfish)	1	214	0.84	100	880	590	16.00	3.13	ND	ND
	Sebastes dallii (Calico Rockfish)	1	157	0.64	270	3600	630	2.87	ND	ND	ND
	Sebastes miniatus (Vermilion Rockfish)	5	239	0.74 (0.39-0.96)	60 (30–90)	2610 (1370–3590)	600 (430–1070)	11.40 (1.25–23.40)	0.59 (ND–2.95)	ND (All ND)	ND (All ND)
	Sebastes rosaceus (Rosy Rockfish)	1	195	0.50	130	1570	720	7.36	0.83	ND	ND
*OC San historical values (July 2013–June 2020) **											
Non-outfall	*Sebastes hopkinsi* (Squarespot Rockfish)	18	188	1.51 (0.65–2.41)	160 (80–310)	1650 (600–2600)	430 (200–760)	20.08 (8.74–44.96)	2.89 (ND–18.20)	ND (All ND)	ND (All ND)
	Sebastes miniatus (Vermilion Rockfish)	25	243	0.80 (ND–2.45)	70 (40–200)	2810 (1070–10300)	630 (70–1540)	17.07 (2.57–99.20)	0.74 (ND–8.02)	ND (All ND)	ND (All ND)
	Sebastes paucispinis (Bocaccio)	1	340	0.24	190	130	260	16.38	2.33	ND	ND
Outfall	*Paralabrax nebulifer* (Barred Sand Bass)	11	317	1.39 (ND–4.60)	160 (50–670)	1220 (460–2720)	440 (280–620)	102.51 (18.30–260.60)	61.92 (3.66–152.27)	1.51 (ND–8.00)	ND (All ND)
	Sebastes dallii (Calico Rockfish)	9	138	1.11 (ND–2.67)	80 (20–130)	630 (490–850)	980 (450–1310)	14.67 (6.49–22.50)	1.71 (ND–5.30)	0.88 (ND–7.89)	ND (All ND)
	Sebastes miniatus (Vermilion Rockfish)	52	262	1.12 (ND–3.82)	50 (20–80)	2680 (680–5890)	530 (170–880)	13.14 (ND–58.30)	1.75 (ND–17.24)	0.20 (ND–8.80)	ND (All ND)

* Starry Rockfish, Treefish, Kelp Bass, and Rosy Rockfish are not included as these fishes were not collected during this time period.

Sediment quality was not affected based on the relatively 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 negligible disease symptoms were observed in fish samples. These results, along with the limited changes to water quality parameters described above, suggest that the receiving environment was not degraded by OC San's discharge of treated wastewater. In conclusion, all permit compliance criteria were met in 2020-21 and environmental and human health were protected.

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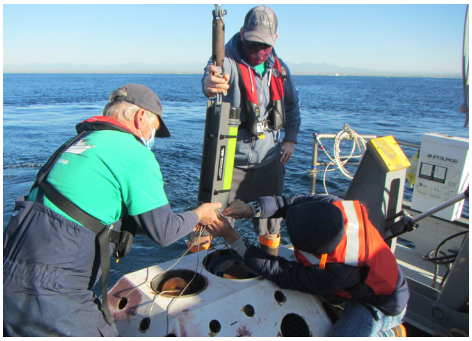

CHAPTER 3
Strategic Process Studies and Regional Monitoring

INTRODUCTION

The Orange County Sanitation District (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 Strategic Process Studies (SPS) and regional monitoring programs. In addition, OC San performs special studies that have neither regulatory requirements nor prior approvals or defined levels 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. For the 2020-21 program year, 5 SPS were in progress.

Regional monitoring studies focus on the larger Southern California Bight (the coastline extending from 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 of the latter 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 2020–June 2021). Links to study reports and documentation, if available, are included under each section. Most projects continued to be 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 2020-21 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

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 (e.g., GWRS) (Figure 1-4). To evaluate the spatial extent and temporal variability of the discharged plume, OC San will work with SCCWRP and their collaborators to (1) model and assess its discharged effluent before and after (compare and contrast) the implementation of the GWRS Final Expansion and (2) explore model sensitivity on plume dispersion over a variety of different ocean states or conditions.

Over the past year, OC San staff worked with SCCWRP modelers to further refine model scenarios to better account for temporal variability in ocean state and to verify projected future OC San discharge flows (Tables 3-1 and 3-2). Modeling of the 1- and 3-day plume visitation frequencies will recommence in the Winter of 2022 with a final report due in 3 years.

Characterization of Microplastics in Wastewater

Wastewater treatment plants are a known conduit of microplastics (<5 mm) from upstream residential and industrial sources to aquatic, marine, and terrestrial environments (Ziajahromi et al. 2016, Okoffo et al. 2019). In the last several years, significant gains have been made in demonstrating how different wastewater treatment technologies can lead to effective removal of microplastics from the influent (Freeman et al. 2020). Despite this, very few studies have characterized microplastics in Southern California wastewater treatment plants, including at OC San. This SPS specifically aims to address these data gaps by characterizing the quantity and types of microplastics found at various points 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.

In-house method development was initiated in 2019 for the collection, processing, and analysis of microplastics in various wastewater matrices. Composite samples were subsequently collected throughout the treatment trains at both Plant 1 and Plant 2, and immediately processed in the lab to remove interfering organic material. All suspected microplastic particles between 45–1,000 µm were visually identified, counted, and characterized by optical microscopy. A subset of particles across color and morphology categories were manually removed from samples, photographed and measured, and isolated for further chemical confirmation and characterization. In 2021, a Fourier Transform Infrared microscope was purchased which will allow further confirmation and polymeric characterization of a subset of suspected microplastic particles. Remaining project tasks include the development of reference spectral libraries and spectroscopic analysis of selected particles. 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

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 may be useful to more efficiently evaluate and prioritize sites for continued monitoring. This study was developed to address current gaps of knowledge regarding CECs in OC San's coastal receiving environment using a modern monitoring tool, in-vitro cell bioassays. The study goals were to characterize the bioactivity of known and unknown CECs in wastewater and the receiving environment, improve our understanding of the applicability of cell bioassays in coastal habitats, and to determine whether standard CECs measured across sites with elevated bioactivity could explain the observed responses.

Sampling of influent, final effluent, seawater, and sediment occurred at selected stations with varying discharge plume influence in May and June of 2019. Aqueous and sediment samples were all processed and analyzed using 3 in-vitro cell bioassays that screen for estrogen

Table 3–1 Pre- and post-GWRS modeling scenarios. The common ocean base year used in all model runs is 2000.

Phase	Model Year
Pre-GWRS	2000
GRWS Phase 1	2008
GRWS Initial Expansion	2016
GRWS Final Expansion	2023 *

* Effluent flows estimated.

Table 3–2 List of model variability simulations. Abbreviations are as follows: El Niño Southern Oscillation (ENSO), Pacific Decadal Oscillation (PDO), mixed layer depth (MLD), and North Pacific Gyre Oscillation (NPGO).

Base Year	Modeled Period (M/D/ YYYY)	Ocean State	Season
1997-98	11/12/1997 1/2/1998 5/6/1998 7/8/1998	Negative to neutral NPGO; Positive PDO Positive ENSO (El Niño, very strong) Deep MLD	Max (ENSO) Fall '97 Winter [most mixed] Spring (Upwelling) Summer [most stratified]
1999	1/2/1999 5/6/1999 7/8/1999	Positive NPGO; Negative PDO Negative ENSO (La Niña, very strong) Deep MLD	Winter Spring (Upwelling) Summer
2000	1/2/2000 5/6/2000 7/8/2000	Neutral climate signals Average temperature and MLD	Winter Spring (Upwelling) Summer
2004	1/2/2004 5/6/2004 7/8/2004	Neutral climate signals; Warm Weak ocean transport	Winter Spring (Upwelling) Summer
2008	1/2/2008 5/6/2008 7/8/2008	Positive NPGO; Negative PDO; Neutral ENSO Cold and shallow MLD	Winter Spring (Upwelling) Summer
2009	1/2/2009 5/6/2009 7/8/2009	Positive NPGO; Neutral PDO	Winter Spring (Upwelling) Summer

receptor-alpha (ERα), aryl hydrocarbon receptor (AhR), and glucocorticoid receptor (GR) activity. These cell bioassay receptors were selected to cover a range of bioactivity pathways and were based on recommendations from the State Water Resources Control Board 2012 Science Advisory Panel on the Monitoring of CECs in Ambient Waters (Maruya et al. 2014). Mean ERα and GR bioassay responses were reduced significantly in the effluent relative to the influent, while AhR bioactivity was comparable in both samples. There was no cell bioassay activity detected in any of the seawater samples collected at varying depths and distances from the ocean outfall discharge, possibly indicating effective dilution of CECs in seawater following ocean discharge. All sediment stations had measurable ERα and AhR bioactivity levels, particularly at Stations C2 and C4 (sites in the Newport Canyon) and Station 44 (a historical depositional site in the San Gabriel Canyon). No GR activity was detected in any receiving environment station. A mass balance approach comparing targeted CECs measured in samples with bioactivity revealed that very little bioactivity could be explained by targeted contaminants in the 3 sediment stations that were studied (44, C2, and C4).

This study resulted in one of the first datasets of in-vitro cell bioassay responses used to assess the impacts of wastewater discharges in marine habitats. Complementary measurements of targeted CECs could not fully explain bioactivity patterns, indicating that suites of commonly measured CECs are likely not those causing bioactivity, particularly in the receiving environment. This finding demonstrates the ability of cell bioassays to detect the presence of unknown CECs that are not routinely measured and highlights the potential for additional non-targeted approaches to fully understand causality and inform source reduction measures. Lessons learned and data gaps were identified where further methodological development, refinement, and investment into this screening tool are needed before application for widespread monitoring. Moving forward, this study points to the potential for cell bioassays to be used either for a preliminary investigation of contamination in new sites or samples, or as a complementary validation tool to understand the bioactivity potential of sites with known contamination issues. For OC San, bioanalytical screening could be further refined as a monitoring tool to track and quantify broad changes in the receiving environment with changes in effluent quantity and quality after implementation of the GRWS Final Expansion and beyond.

Effluent Monitoring for Targeted Contaminants of Emerging Concern

Since 2014, OC San has annually monitored for 15 pharmaceuticals and personal care products (PPCPs), 7 hormones, 7 industrial endocrine disrupting compounds (IEDCs), and 9 polybrominated diphenyl ethers (PBDE) flame retardants in the final effluent (Table 3-3). For the 2020-21 program year, all PPCPs were detected with concentrations ranging from 0.0033 µg/L (triclosan) to 20 µg/L (salicylic acid). Of the 7 hormones, 5 were detected with concentrations ranging from 0.0036 µg/L to 0.137 µg/L, while 6 of the 7 IEDCs were detected with a maximum concentration of 3 µg/L, which is about 6 times less concentrated than in previous years (EPA 2021). A notable finding for the 2020-21 year was the detection of 4 of the 9 PBDE flame retardants with concentrations ranging from 0.053 µg/L to 1.33 µg/L, while none were detected in the previous years (EPA 2021). The detection of PBDE flame retardants in the final effluent is attributed to the change of the analytical method used, from a gas chromatograph coupled with a mass spectrometer (GC-MS) to a high resolution GC combined with high resolution MS (EPA Method 1614A). The latter is a more sensitive methodology, which resulted in the detections of PBDE flame retardants at much lower concentrations than in previous years.

Sediment Linear Alkylbenzenes

Linear Alkylbenzenes (LABs) are raw materials found in the production of commonly used detergents. These organic contaminants have been found to be concentrated in wastewater effluent, and as a result 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, quantity, and dispersion due to the GWRS Final Expansion.

In the Summer of 2020, OC San laboratory staff initiated improvements to the GC-MS LAB analytical method by enhancing quantitation reliability through the addition of several commercially available surrogate and internal standards. In the Fall of 2020, OC San laboratory staff subsequently analyzed LAB signatures from a total of 68 sediment samples collected from semi-annual and annual monitoring stations. LAB measurements were added to a database of historical LAB data measured throughout OC San's monitoring region. Data analysis and comparisons are ongoing to determine spatial and temporal changes in the amount of total LABs detected among the benthic sediment stations. Remaining steps include a summarization 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 potential future applications.

Meiofauna Baseline

The increase of reverse osmosis concentrate (brine) return flows from the GWRS Final Expansion may negatively affect marine biota in the receiving water. While meiofauna (animals ranging from 63 to 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

Table 3–3 Contaminants of emerging concern monitored in OC San's final effluent.

	Hormones	
17a-Estradiol 17b-Estradiol 17a-Ethinyl estradiol	Estriol Estrone	Progesterone Testosterone
	Industrial Endocrine Disrupting Compounds	
Bisphenol A 4-tert-Octylphenol	Nonylphenol Nonylphenol diethoxylate Nonylphenol monoethoxylate	Octylphenol diethoxylate Octylphenol monoethoxylate
	Pharmaceuticals and Personal Care Products	
Acetaminophen Azithromycin Caffeine Carbamazepine DEET	Erythromycin Fluoxetine Gemfibrozil Ibuprofen Oxybenzone	Primidone Salicylic acid Sulfamethoxazole Triclosan Trimethoprim
	Flame Retardants	
BDE-28 BDE-47 BDE-85	BDE-99 BDE-100 BDE-153	BDE-154 BDE-183 BDE-209

Expansion. This project did not commence in the 2020-21 program year because soliciting the services of a contractor was halted due to OC San's COVID-19 restrictions that were implemented after March 2020. A Request for Proposals was issued in the Fall of 2021 with the expectation that a contractor would be selected to commence the project in the Spring of 2022.

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 termed "legacy" (historical OC San water quality compliance) stations because they have been 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 confluence of the Santa Ana River mouth and Talbert Marsh. Quarterly geometric means 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

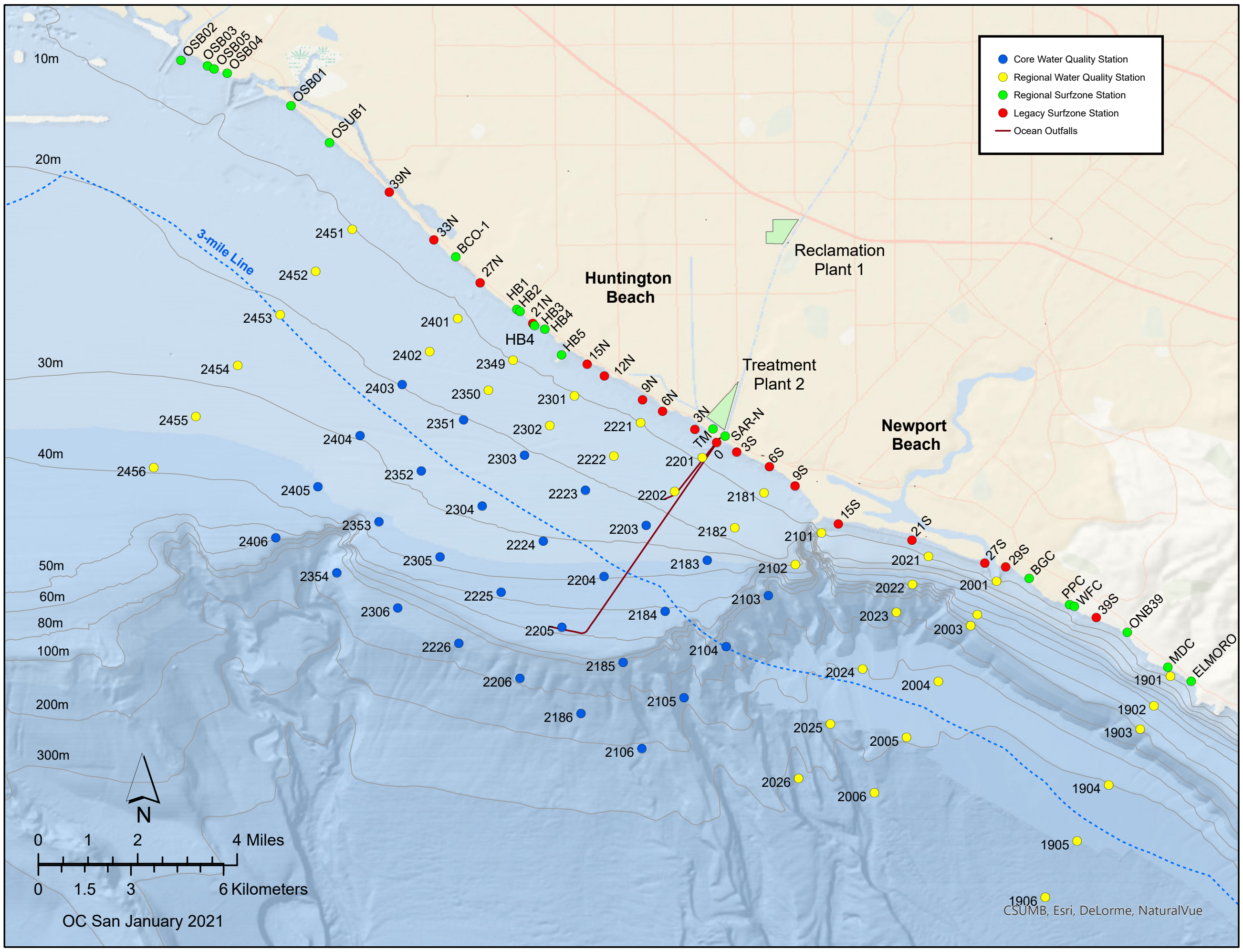

Figure 3–1 OC San's offshore and nearshore (aka surfzone) water quality monitoring stations for 2020-21.

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).

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 (SCBPP), Bight'98, Bight'03, Bight'08, Bight'13, and Bight'18 (Southern California Bight Regional Monitoring Program – Southern California Coastal Water Research Project). OC San has played a considerable role in all aspects of this program, including study design, sampling, 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 SCB environmental conditions 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

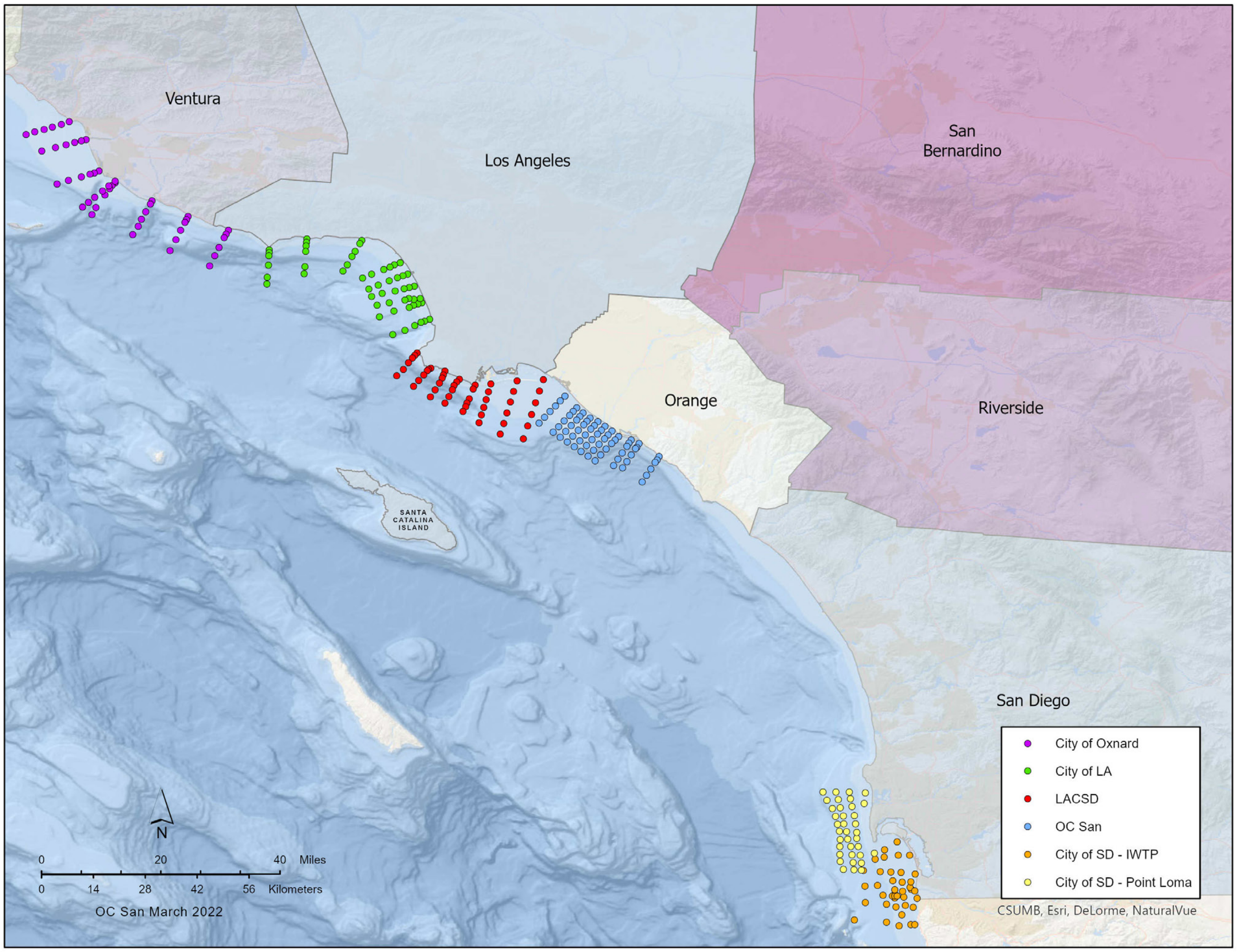

Figure 3–2 Southern California Bight Regional Water Quality Program monitoring stations for 2020-21.

July to September 2018 and quarterly water column (ocean acidification) sampling from January to December 2019. Bight assessment reports are available at Bight Program Documents – Southern California Coastal Water Research Project (sccwrp.org).

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 presented annually by MBC Aquatic Sciences to consortium groups, regulators, and the public and is published as a report biennially for the CRKSC region (MBC 2020).

2019 & 2020 CRKSC Results

Total combined kelp surface canopy in the Central Region decreased by 64% in 2019, compared to 2018 (7.9 km² versus 2.8 km²). In 2020, surface canopy increased from 2019, but still had a

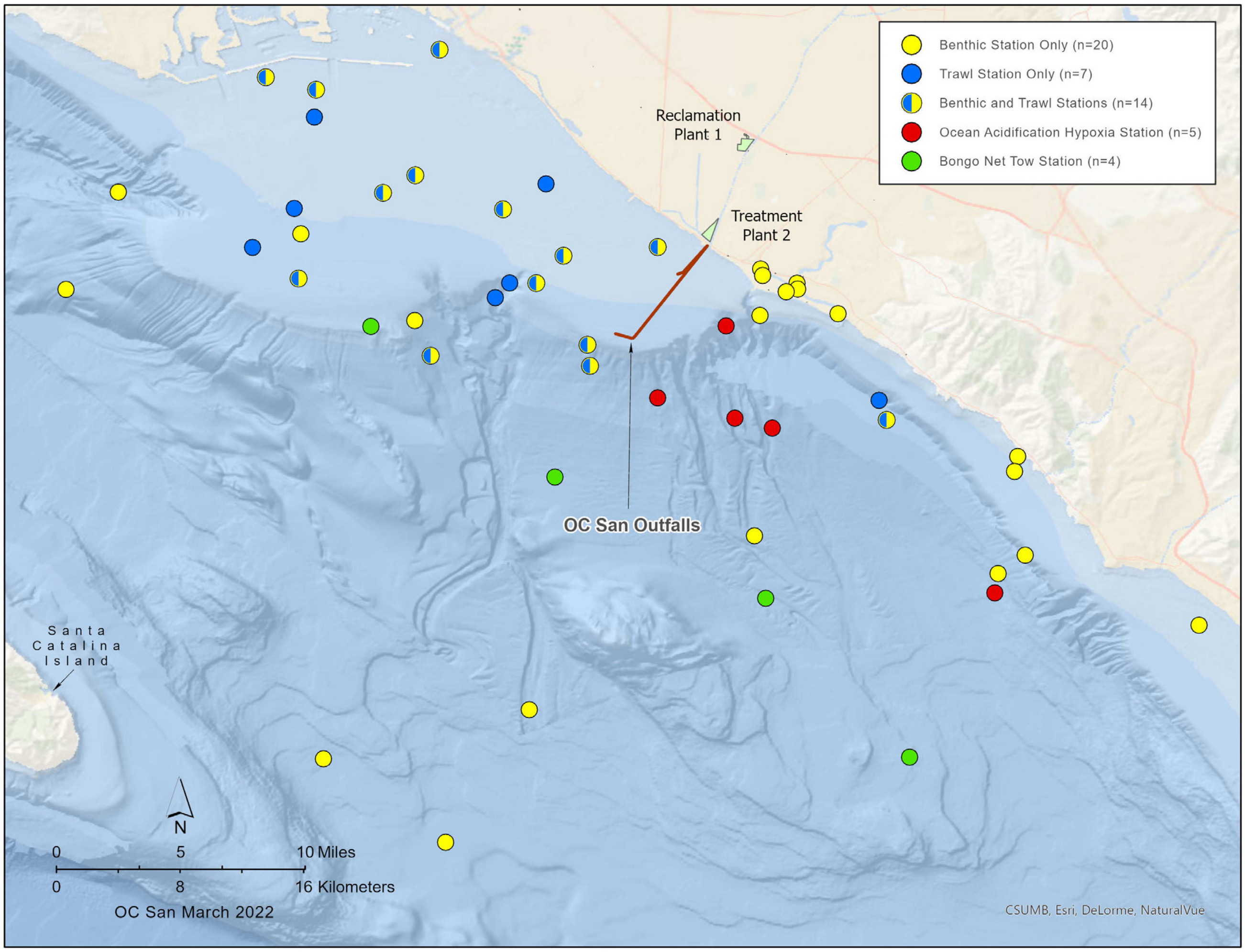

Figure 3–3 OC San's Bight'18 sampling stations.

53% decrease when compared to 2018 (7.9 km² versus 3.7 km²). All 24 kelp beds that were visible in 2018 have decreased in size with 7 disappearing. 2019 had the lowest canopy coverage recorded since 2007.

For the 4 survey areas nearest to OC San's outfall, 3 (Horseshoe Kelp, Huntington Flats and Huntington Flats to Newport Harbor) continued to show no surface canopy. The adjacent Corona Del Mar kelp beds also disappeared in 2020.

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

Ocean Acidification and Hypoxia Mooring

OC San continued the deployment of an Ocean Acidification and Hypoxia Mooring, however mooring hardware updates and COVID-19 restrictions after March 2020 prevented routine mooring turnarounds during the program year. Table 3-4 lists deployment and recovery dates during the 2020-21 program year.

Table 3–4 OC San Ocean Acidification and Hypoxia Mooring (Station M21) deployment and recovery dates.

Deployment Date	Recovery Date
12/19/2019	6/23/2020
12/2/2020	3/31/2021
5/27/2021	1/5/2022

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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) during the 2020-21 program year. 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, beam attenuation coefficient [beam-c], and photosynthetically active radiation [PAR]), chlorophyll-*a* fluorescence, and colored dissolved organic matter (CDOM). Measurements were conducted using a Sea-Bird Electronics 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 2020-21. N/A = Not Applicable.

Parameter	# Sampling Events	Sampling Method	Method Reference	Field Preservation	Container	Holding Time	Sampling Depth	Field Replicates
Nearshore (Surfzone)								
Total Coliforms Fecal Coliforms Enterococci	1–2/week 1–2/week 1–2/week	Grab	Standard Methods 9222 B ** Standard Methods 9222 D ** EPA Method 1600 ***	Ice (<6 °C)	125 mL HDPE (Sterile container)	8 hrs. (field + lab)	Ankle-deep water	At least 10% of samples
Offshore								
Temperature [1]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m *	At least 10% of stations
Salinity (conductivity) [2]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m *	At least 10% of stations
pH [3]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m *	At least 10% of stations
Dissolved Oxygen [4]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m *	At least 10% of stations
Transmissivity [5]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m *	At least 10% of stations
Photosynthetically Active Radiation (PAR) [6]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m *	At least 10% of stations
Chlorophyll-*a* fluorescence [6]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m *	At least 10% of stations
Color Dissolved Organic Matter (CDOM) [6]	6/quarter	*in-situ* probe	ELOM SOP 1500.1 - CTD Operations	N/A	N/A	N/A	Every 1 m *	At least 10% of stations
Ammonia-nitrogen (NH_3-N)	6/quarter	Niskin	ELOM SOP 4500-NH3.G, Rev. L **	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.	N/A	N/A	N/A	Surface	N/A

[1] Calibrated to reference cells (0.0005 °C accuracy) annually.
[2] Calibrated to IAPSO Standard and Guildline 8400B Autosal annually.
[3] Referenced and calibrated to NIST buffers of pH 7, 8, and 9 prior to every survey.
[4] Referenced and calibrated each survey by comparison with the lab DO probe, which is calibrated daily.
[5] Referenced and calibrated to known transmittance in air.
[6] Factory calibrated annually.
[7] Fecal coliform count calculation: (*Escherichia coli* MPN/100mL x 1.1).
[8] REC-1 surveys completed within 30 days for geometric mean 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 additional 38 stations were 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 water at the 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 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. Bacterial counts were averaged by depth at each 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

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

Table A–2 Sediment collection and analysis summary during 2020-21.

Parameter	Container	Preservation	Holding Time	Method
Dissolved Sulfides	HDPE container	Freeze	6 months	ELOM SOP 4500-S G Rev. B
Grain Size	Plastic bag	4 °C	6 months	Plumb (1981)
Linear Alkylbenzenes	Glass jar	Freeze	12 months	ELOM SOP 8000-PAH
Mercury	Amber glass jar	Freeze	6 months	ELOM SOP 245.1B Rev. G
Metals	Amber glass jar	Freeze	6 months	ELOM SOP 200.8B_SED Rev. F
Sediment Toxicity	HDPE container	4 °C	2 months	ELOM SOP 8810
Total Chlorinated Pesticides (ΣPest)	Glass jar	Freeze	12 months	ELOM SOP 8000-SPP
Total DDT (ΣDDT)	Glass jar	Freeze	12 months	ELOM SOP 8000-SPP
Total Nitrogen (TN)	Glass jar	Freeze	6 months	EPA 351.2M and 353.2M *
Total Organic Carbon (TOC)	Glass jar	Freeze	6 months	ASTM D4129-05 *
Total Phosphorus (TP)	Glass jar	Freeze	6 months	EPA 6010B *
Total Polychlorinated Biphenyls (ΣPCB)	Glass jar	Freeze	12 months	ELOM SOP 8000-SPP
Total Polycyclic Aromatic Hydrocarbons (ΣPAH)	Glass jar	Freeze	12 months	ELOM SOP 8000-PAH

* Available online at: www.epa.gov.

particulates, oil and grease, and water discoloration were determined based on presence/absence at the ocean surface for each station. Compliance with the excess nutrient criterion was based on evaluation of 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 2020 (summer) and in January 2021 (winter), as well as from 39 annual stations in July 2020 (Figure 2-2). In addition, 2–3 L of sediment was collected from Stations 0, 1, 4, 72, 73, 76, 77, CON, and ZB in January 2021 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.

OC San's benthic sampling protocols are based upon regionally developed sampling methods (Kelly et al. 2013). 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. A manual bilge pump was used to siphon off the overlying water from the sediment grabs. 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 Environmental Laboratory and Ocean Monitoring Standard Operating Procedures (ELOM SOP) (OCSD 2016; Table A-2).

Laboratory Methods

Sediment grain size, total organic carbon, total nitrogen, and total phosphorus samples were subsequently transferred to contract 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), and

Table A–3 Parameters measured in sediment samples during 2020-21.

	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	Linear Alkylbenzenes	Total Organic Carbon	Total Phosphorus
Grain Size	Total Nitrogen		

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

Sediment samples were collected using the same field methods and at the same stations and frequencies as described above in the sediment geochemistry field methods section (Figure 2-2).

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). A subset of the samples from each of the 5 major taxonomic groups was identified by 2 taxonomists as part of the QC analysis (see Appendix C). Taxonomic differences arising from the QC analysis were resolved, and the database was edited accordingly. 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), (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

Table A–4 Benthic infauna taxonomic aliquot distribution for 2020-21.

Quarter	Survey (No. of samples)	Taxonomic Aliquots	Contractor	OC San
Summer 2020	Annual (39)	Annelida	0	39
		Arthropoda	0	39
		Echinodermata	0	39
		Mollusca	1	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 2021	Semi-annual (29)	Annelida	29	0
		Arthropoda	29	0
		Echinodermata	29	0
		Mollusca	0	29
		Miscellaneous Phyla	29	0
		Total	**204**	**282**

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 September 2020 (summer) and in March 2021 (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 net 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 fathometer, which were confirmed with 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 "outfall" (Stations T22 and T1) and "non-outfall" (Stations T23, T12, T17, and T11) categories to assess spatial, outfall-related patterns.

FISH TISSUE CONTAMINANTS MONITORING

For bioaccumulation monitoring in demersal fishes, 2 fish species, English Sole (*Parophrys vetulus*) and Hornyhead Turbot (*Pleuronichthys verticalis*), in the size range of 15 to 20 cm standard length 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).

For bioaccumulation monitoring in sport fishes, 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 of demersal fish tissue samples was to collect 10 individuals each of English Sole and Hornyhead Turbot by trawling at outfall (T1) and non-outfall (T11) stations during the 2020-21 program year. Five hauls were conducted at each station in September 2020. For analysis of sport fish tissue samples, 10 individuals in total of scorpaenid and serranid fishes were targeted at the outfall (Zone 1) and non-outfall (Zone 3) areas using hook-and-line fishing gear ("rig fishing") in September 2020 (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 ELOM 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

Table A–5 Fish tissue handling and analysis summary during 2020-21. N/A = Not Applicable.

Parameter	Container	Preservation	Holding Time	Method
Arsenic and Selenium	Ziplock bag	Freeze	6 months	ELOM 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	N/A	EPA 9071 *
Mercury	Ziplock bag	Freeze	6 months	ELOM SOP 245.1B Rev. G
Polychlorinated Biphenyls	Ziplock bag	Freeze	6 months	NS&T (NOAA 1993); EPA 8270 *

* Available online at https://www.epa.gov; N/A = Not Applicable.

Table A–6 Parameters measured in fish tissue samples during 2020-21.

	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.

standard reference materials were prepared and analyzed with each sample batch. All reported concentrations are on a wet weight basis.

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).

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

Contaminant	ATLs for the number of 8-ounce 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).

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).

Field Methods

All trawl fish samples collected during the 2020-21 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. Forty individuals each of English Sole and Hornyhead Turbot were targeted for liver histopathology analysis at the outfall (T1) and non-outfall (T11) stations during the September 2020 trawl survey. Unfortunately, no fish samples for liver histopathology analysis were collected in any of the 5 hauls conducted at the 2 sampling stations.

Data Analyses

Analysis of fish disease data consisted of qualitative comparisons only.

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APPENDIX B
Supporting Data

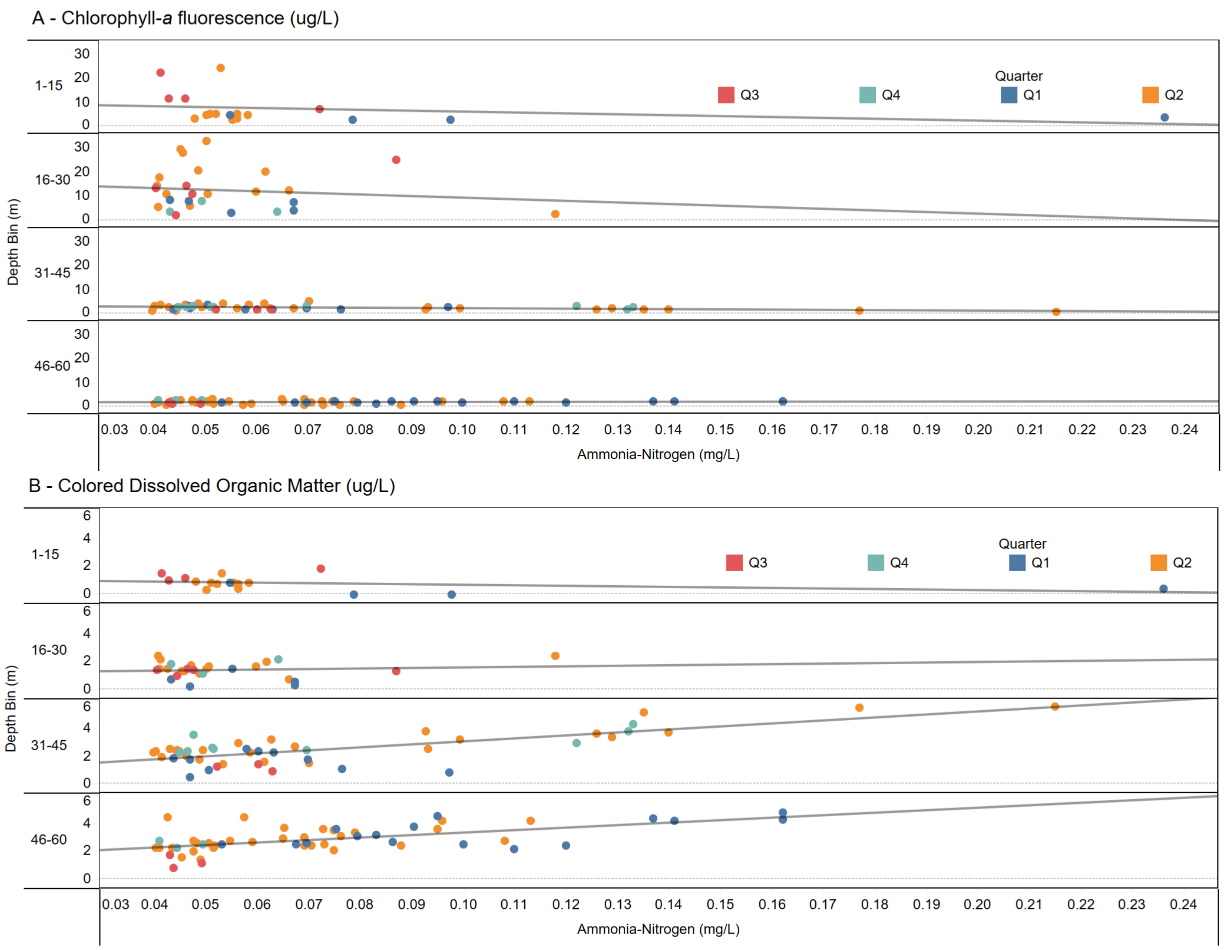

Figure B–1 Linear regression plots of ammonia-nitrogen (NH_3-N) versus chlorophyll-*a* (A) and colored dissolved organic matter (CDOM) by 15-m depth bins for the 2020-21 Core monthly water quality cruises (n=12). Quarter designations are: Q3 = summer, Q4 = fall, Q1 = winter, and Q2 = spring.

Table B–1 Percentages of fecal indicator bacteria densities (MPN/100 mL) by quarter and depth strata for OC San's 2020-21 REC-1 water quality surveys (5 surveys/quarter; 8 stations/survey).

Sampling Period	Depth Strata (m)	n	Total Coliform				Fecal Coliform				Enterococci			
			<10 *	10–1,000	1,001–10,000 **	>10,000 ***	<10 *	10–200	201–400 **	>400 ***	<10 *	10–35	36–104 **	>104 ***
Summer	1–15	80	88.8%	11.3%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	95.0%	5.0%	0.0%	0.0%
	16–30	60	73.3%	26.7%	0.0%	0.0%	98.3%	1.7%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
	31–45	15	40.0%	60.0%	0.0%	0.0%	86.7%	13.3%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
	46–60	20	65.0%	35.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	95.0%	5.0%	0.0%	0.0%
	Water Column	**175**	**76.6%**	**23.4%**	**0.0%**	**0.0%**	**98.3%**	**1.7%**	**0.0%**	**0.0%**	**97.1%**	**2.9%**	**0.0%**	**0.0%**
Fall	1–15	80	60.0%	40.0%	0.0%	0.0%	98.8%	1.3%	0.0%	0.0%	97.5%	2.5%	0.0%	0.0%
	16–30	60	25.0%	75.0%	0.0%	0.0%	83.3%	16.7%	0.0%	0.0%	90.0%	10.0%	0.0%	0.0%
	31–45	15	13.3%	86.7%	0.0%	0.0%	73.3%	26.7%	0.0%	0.0%	93.3%	6.7%	0.0%	0.0%
	46–60	20	20.0%	80.0%	0.0%	0.0%	80.0%	20.0%	0.0%	0.0%	90.0%	5.0%	5.0%	0.0%
	Water Column	**175**	**39.4%**	**60.6%**	**0.0%**	**0.0%**	**89.1%**	**10.9%**	**0.0%**	**0.0%**	**93.7%**	**5.7%**	**0.6%**	**0.0%**
Winter	1–15	80	83.8%	16.3%	0.0%	0.0%	96.3%	3.8%	0.0%	0.0%	95.0%	5.0%	0.0%	0.0%
	16–30	60	71.7%	28.3%	0.0%	0.0%	93.3%	6.7%	0.0%	0.0%	95.0%	5.0%	0.0%	0.0%
	31–45	15	26.7%	66.7%	6.7%	0.0%	46.7%	46.7%	0.0%	6.7%	60.0%	26.7%	6.7%	6.7%
	46–60	20	30.0%	70.0%	0.0%	0.0%	40.0%	55.0%	5.0%	0.0%	70.0%	25.0%	5.0%	0.0%
	Water Column	**175**	**68.6%**	**30.9%**	**0.6%**	**0.0%**	**84.6%**	**14.3%**	**0.6%**	**0.6%**	**89.1%**	**9.1%**	**1.1%**	**0.6%**
Spring	1–15	80	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	95.0%	5.0%	0.0%	0.0%
	16–30	60	93.3%	6.7%	0.0%	0.0%	95.0%	5.0%	0.0%	0.0%	91.7%	8.3%	0.0%	0.0%
	31–45	15	60.0%	33.3%	6.7%	0.0%	73.3%	20.0%	0.0%	6.7%	93.3%	0.0%	0.0%	6.7%
	46–60	20	65.0%	35.0%	0.0%	0.0%	80.0%	20.0%	0.0%	0.0%	85.0%	15.0%	0.0%	0.0%
	Water Column	**175**	**90.3%**	**9.1%**	**0.6%**	**0.0%**	**93.7%**	**5.7%**	**0.0%**	**0.6%**	**92.6%**	**6.9%**	**0.0%**	**0.6%**
Annual	1–15	320	83.1%	16.9%	0.0%	0.0%	98.8%	1.3%	0.0%	0.0%	95.6%	4.4%	0.0%	0.0%
	16–30	240	65.8%	34.2%	0.0%	0.0%	92.5%	7.5%	0.0%	0.0%	94.2%	5.8%	0.0%	0.0%
	31–45	60	35.0%	61.7%	3.3%	0.0%	70.0%	26.7%	0.0%	3.3%	86.7%	8.3%	1.7%	3.3%
	46–60	80	45.0%	55.0%	0.0%	0.0%	75.0%	23.8%	1.3%	0.0%	85.0%	12.5%	2.5%	0.0%
	Water Column	**700**	**68.7%**	**31.0%**	**0.3%**	**0.0%**	**91.4%**	**8.1%**	**0.1%**	**0.3%**	**93.1%**	**6.1%**	**0.4%**	**0.3%**

* MDL; ** Geometric mean; *** 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 (COP) Water-Contact (REC-1) compliance criteria, July 2020 through June 2021.

Station	Date					Met COP 30-day Geometric Mean of ≤1,000/100 mL	Met COP Single Sample Standard of ≤10,000/100 mL	Met COP Single Sample Standard of ≤1,000/100 mL *
	7/28/2020	**7/29/2020**	**7/30/2020**	**8/4/2020**	**8/5/2020**			
2103	12	<10	15	<10	<10	YES	YES	YES
2104	<10	14	14	<10	<10	YES	YES	YES
2183	12	18	12	<10	<10	YES	YES	YES
2203	<10	<10	13	<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	12	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	10/20/2020	**10/21/2020**	**10/22/2020**	**11/3/2020**	**11/4/2020**			
2103	16	40	35	96	19	YES	YES	YES
2104	30	42	22	21	15	YES	YES	YES
2183	12	26	23	11	22	YES	YES	YES
2203	13	82	11	10	13	YES	YES	YES
2223	<10	14	13	34	<10	YES	YES	YES
2303	11	11	11	38	15	YES	YES	YES
2351	13	<10	10	10	<10	YES	YES	YES
2403	<10	<10	<10	13	10	YES	YES	YES
	1/21/2021	**2/1/2021**	**2/2/2021**	**2/4/2021**	**2/9/2021**			
2103	<10	22	31	48	10	YES	YES	YES
2104	<10	39	20	66	29	YES	YES	YES **
2183	<10	<10	15	16	<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	11	<10	<10	YES	YES	YES
2403	<10	10	<10	<10	<10	YES	YES	YES
	4/22/2021	**5/3/2021**	**5/4/2021**	**5/6/2021**	**5/11/2021**			
2103	10	11	<10	<10	<10	YES	YES	YES
2104	26	12	<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

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

** Depth combined, meet single sample standard (date 2/2/2021 and 4/22/2021).

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 (COP) Water-Contact (REC-1) compliance criteria, July 2020 through June 2021.

Station	Date					Met COP 30-day Geometric Mean of ≤1,000/100 mL	Met COP single sample standard of ≤400/100 mL
	7/28/2020	**7/29/2020**	**7/30/2020**	**8/4/2020**	**8/5/2020**		
2103	<10	<10	<10	<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	<10	<10	<10	<10	<10	YES	YES
	10/20/2020	**10/21/2020**	**10/22/2020**	**11/3/2020**	**11/4/2020**		
2103	<10	<10	10	29	<10	YES	YES
2104	<10	<10	<10	<10	<10	YES	YES
2183	<10	<10	11	<10	<10	YES	YES
2203	<10	23	<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
	1/21/2021	**2/1/2021**	**2/2/2021**	**2/4/2021**	**2/9/2021**		
2103	<10	13	17	13	<10	YES	YES
2104	<10	23	16	22	17	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
	4/22/2021	**5/3/2021**	**5/4/2021**	**5/6/2021**	**5/11/2021**		
2103	<10	<10	<10	<10	<10	YES	YES
2104	20	<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	<10	<10	<10	<10	<10	YES	YES

* Depth combined, meet single sample standard (date 2/2/2021 and 4/22/2021).

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 (COP) Water-Contact (REC-1) and EPA compliance criteria, July 2020 through June 2021.

Station	Date					Met COP 30-day Geometric Mean of ≤35/100 mL	Met COP single sample standard of ≤104/100 mL	Met EPA single sample standard of ≤501/100 mL*
	7/28/2020	**7/29/2020**	**7/30/2020**	**8/4/2020**	**8/5/2020**			
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
	10/20/2020	**10/21/2020**	**10/22/2020**	**11/3/2020**	**11/4/2020**			
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
	1/21/2021	**2/1/2021**	**2/2/2021**	**2/4/2021**	**2/9/2021**			
2103	<10	<10	<10	<10	<10	YES	YES	YES
2104	<10	10	11	11	<10	YES	YES **	YES
2183	<10	<10	<10	<10	<10	YES	YES	YES
2203	<10	<10	<10	<10	<10	YES	YES	YES
2223	<10	10	<10	<10	<10	YES	YES	YES
2303	<10	<10	<10	<10	<10	YES	YES	YES
2351	<10	<10	<10	<10	<10	YES	YES	YES
2403	<10	<10	<10	<10	<10	YES	YES	YES
	4/22/2021	**5/3/2021**	**5/4/2021**	**5/6/2021**	**5/11/2021**			
2103	<10	<10	<10	<10	<10	YES	YES	YES
2104	12	<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

* Standard is based on area of infrequent use.

** Depth combined, met single sample standard (date 2/2/2021 and 4/22/2021).

Table B–5 Summary of floatable material by station group observed during the 28-station grid water quality surveys, July 2020 through June 2021. 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	1	0	1
Biological Material (kelp)	0	0	0	1	0	0	2	3
Material of Sewage Origin	0	0	0	0	0	0	0	0
Totals	**0**	**0**	**0**	**1**	**0**	**1**	**2**	**4**

Table B–6 Summary of floatable material by station group observed during the REC-1 water quality surveys, July 2020 through June 2021. 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	1	1
Biological Material (kelp)	1	1	0	2	4
Material of Sewage Origin	0	0	0	0	0
Totals	**1**	**1**	**0**	**3**	**5**

Table B–7 Summary of OC San's Core monthly water quality compliance parameters by sampling period and selected depth strata for 2020-21 (3 surveys/quarter; 28 stations/survey).

Sampling Period	Depth Strata (m)	Oxygen (mg/L)				pH				Transmissivity (%)			
		Minimum	Mean	Maximum	Std. Dev.	Minimum	Mean	Maximum	Std. Dev.	Minimum	Mean	Maximum	Std. Dev.
Summer	1–15	5.96	7.95	9.42	0.47	8.08	8.19	8.25	0.03	68.90	80.01	87.03	3.77
	16–30	5.00	6.61	9.24	0.92	8.01	8.14	8.24	0.07	72.02	81.86	88.27	3.18
	31–45	4.43	5.56	7.29	0.55	8.02	8.11	8.21	0.05	80.93	87.04	88.91	1.26
	46–60	4.27	5.04	6.21	0.44	8.02	8.10	8.17	0.04	84.79	87.66	89.04	0.94
	61–75	3.93	4.65	5.58	0.35	8.04	8.11	8.17	0.04	85.92	88.01	89.11	0.73
	Water Column	**3.93**	**6.42**	**9.42**	**1.36**	**8.01**	**8.14**	**8.25**	**0.06**	**68.90**	**83.65**	**89.11**	**4.34**
Fall	1–15	6.14	7.64	8.25	0.23	8.06	8.18	8.25	0.04	72.04	83.50	87.43	2.94
	16–30	5.85	6.85	7.98	0.50	7.96	8.10	8.23	0.06	77.82	84.15	87.00	1.37
	31–45	5.37	5.97	7.10	0.25	7.91	8.00	8.10	0.04	71.04	86.25	88.62	1.41
	46–60	4.93	5.53	6.10	0.21	7.88	7.94	8.02	0.03	83.60	87.36	89.39	0.97
	61–75	4.33	5.18	5.71	0.30	7.81	7.91	7.97	0.03	83.70	87.62	89.39	0.92
	Water Column	**4.33**	**6.57**	**8.25**	**0.95**	**7.81**	**8.06**	**8.25**	**0.11**	**71.04**	**85.14**	**89.39**	**2.53**
Winter	1–15	5.01	7.46	8.87	0.81	7.81	8.03	8.19	0.09	67.75	83.61	87.45	3.31
	16–30	4.04	6.69	8.19	1.32	7.72	7.97	8.16	0.12	78.02	85.55	88.70	1.73
	31–45	3.69	5.69	7.79	1.19	7.69	7.89	8.10	0.12	81.01	87.73	89.06	1.23
	46–60	3.43	4.72	6.05	0.70	7.66	7.79	7.98	0.07	84.65	88.39	89.22	0.84
	61–75	3.29	4.11	5.24	0.38	7.65	7.74	7.83	0.05	85.89	88.43	89.26	0.70
	Water Column	**3.29**	**6.21**	**8.87**	**1.54**	**7.65**	**7.92**	**8.19**	**0.14**	**67.75**	**86.02**	**89.26**	**2.90**
Spring	1–15	6.54	8.29	10.56	0.55	8.02	8.14	8.31	0.05	63.10	80.99	86.85	4.78
	16–30	4.19	7.34	9.10	1.07	7.73	8.04	8.21	0.08	67.79	81.41	87.37	4.12
	31–45	3.87	5.19	7.63	0.96	7.70	7.83	8.01	0.08	73.01	85.57	88.35	2.07
	46–60	3.71	4.56	6.02	0.55	7.68	7.76	7.89	0.05	82.70	87.31	89.05	1.15
	61–75	3.50	4.21	5.04	0.34	7.65	7.73	7.80	0.03	82.54	87.19	89.15	1.59
	Water Column	**3.50**	**6.54**	**10.56**	**1.79**	**7.65**	**7.96**	**8.31**	**0.17**	**63.10**	**83.44**	**89.15**	**4.50**
Annual	1–15	5.01	7.83	10.56	0.64	7.81	8.13	8.31	0.08	63.10	82.03	87.45	4.07
	16–30	4.04	6.87	9.24	1.03	7.72	8.06	8.24	0.11	67.79	83.25	88.70	3.28
	31–45	3.69	5.60	7.79	0.86	7.69	7.96	8.21	0.13	71.04	86.65	89.06	1.73
	46–60	3.43	4.97	6.21	0.63	7.66	7.90	8.17	0.14	82.70	87.68	89.39	1.07
	61–75	3.29	4.54	5.71	0.54	7.65	7.87	8.17	0.16	82.54	87.81	89.39	1.14
	Water Column	**3.29**	**6.44**	**10.56**	**1.45**	**7.65**	**8.02**	**8.31**	**0.15**	**63.10**	**84.56**	**89.39**	**3.82**

Table B–8 Summary of OC San's Core monthly water quality ammonia-nitrogen (mg/L) by sampling period and selected depth strata for 2020-21 (3 surveys/quarter; 22 stations/survey).

Sampling Period	Depth Strata (m)	n	<MDL *	MDL–3.9	4–5.9 **	≥6 ***
Summer	1–15	128	98.4%	1.6%	0%	0%
	16–30	112	100.0%	0.0%	0%	0%
	31–45	45	97.8%	2.2%	0%	0%
	46–60	64	100.0%	0.0%	0%	0%
	Water Column	**349**	**99.1%**	**0.9%**	**0%**	**0%**
Fall	1–15	134	100.0%	0.0%	0%	0%
	16–30	122	99.2%	0.8%	0%	0%
	31–45	46	91.3%	8.7%	0%	0%
	46–60	68	100.0%	0.0%	0%	0%
	Water Column	**370**	**98.7%**	**1.4%**	**0%**	**0%**
Winter	1–15	132	99.2%	0.8%	0%	0%
	16–30	120	99.2%	0.8%	0%	0%
	31–45	45	86.7%	13.3%	0%	0%
	46–60	66	89.4%	10.6%	0%	0%
	Water Column	**363**	**95.9%**	**4.1%**	**0%**	**0%**
Spring	1–15	132	95.5%	4.6%	0%	0%
	16–30	119	92.4%	7.6%	0%	0%
	31–45	45	71.1%	28.9%	0%	0%
	46–60	65	81.5%	18.5%	0%	0%
	Water Column	**361**	**88.9%**	**11.1%**	**0%**	**0%**
Annual	1–15	526	98.3%	1.7%	0%	0%
	16–30	473	97.7%	2.3%	0%	0%
	31–45	181	86.7%	13.3%	0%	0%
	46–60	263	92.8%	7.2%	0%	0%
	Water Column	**1,443**	**95.6%**	**4.4%**	**0%**	**0%**

* MDL = 0.04 mg/L; ** COP chronic criteria; *** 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 2020-21 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)	44 (33–55)	17 (11–28)	3 (2–6)	8 (5–13)	10 (2–14)
		Middle Shelf Zone 2, Within-ZID (51–90 m)	45 (42–52)	17 (12–22)	3 (1–4)	9 (7–12)	8 (6–12)
		Middle Shelf Zone 2, Non-ZID (51–90 m)	48 (23–71)	15 (2–23)	4 (0–7)	6 (3–9)	8 (3–15)
		Middle Shelf Zone 3 (91–120 m)	33 (29–37)	8 (2–12)	3 (0–5)	5 (0–7)	11 (6–15)
		Outer Shelf (121–200 m)	18 (10–24)	3 (1–7)	2 (0–3)	1 (0–2)	5 (2–8)
		Upper Slope/Canyon (201–500 m)	12 (5–17)	3 (0–7)	1 (0–2)	1 (0–2)	4 (2–7)
	Abundance	Middle Shelf Zone 1 (31–50 m)	280 (136–597)	51 (22–104)	18 (7–35)	13 (8–21)	17 (3–34)
		Middle Shelf Zone 2, Within-ZID (51–90 m)	239 (216–274)	37 (19–64)	7 (3–11)	20 (12–26)	16 (9–21)
		Middle Shelf Zone 2, Non-ZID (51–90 m)	240 (118–387)	33 (2–62)	9 (0–21)	11 (3–20)	18 (5–41)
		Middle Shelf Zone 3 (91–120 m)	121 (70–180)	13 (2–27)	19 (0–73)	10 (0–17)	33 (14–77)
		Outer Shelf (121–200 m)	94 (49–218)	4 (1–12)	2 (0–5)	1 (0–2)	10 (3–27)
		Upper Slope/Canyon (201–500 m)	55 (24–107)	5 (0–12)	2 (0–5)	1 (0–3)	7 (2–13)
Winter	Species Richness	Middle Shelf Zone 2, Within-ZID (51–90 m)	45 (37–51)	16 (14–18)	2 (1–4)	5 (3–6)	6 (3–11)
		Middle Shelf Zone 2, Non-ZID (51–90 m)	44 (27–58)	16 (11–25)	2 (0–4)	6 (2–11)	7 (3–13)
	Abundance	Middle Shelf Zone 2, Within-ZID (51–90 m)	183 (146–251)	32 (23–42)	5 (1–9)	9 (6–12)	8 (4–16)
		Middle Shelf Zone 2, Non-ZID (51–90 m)	224 (83–378)	36 (20–62)	4 (0–9)	10 (3–19)	11 (3–24)

Table B–10 Abundance and species richness of epibenthic macroinvertebrates collected in the Summer 2020 and Winter 2021 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	**T2**	**T24**	**T6**	**T18**	**T23**		**T22**		**T1**		**T12**		**T17**		**T11**		**T10**	**T25**	**T14**	**T19**		
Nominal Depth (m)	**35**	**36**	**36**	**36**	**58**		**60**		**55**		**57**		**60**		**60**		**137**	**137**	**137**	**137**		
Season	**S**	**S**	**S**	**S**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**S**	**S**	**S**	**Total**	**%**
Lytechinus pictus		14	15	232	1,722	1,656	936	798	475	205	45	43	5	8	49	48	2	4			6,257	51.6
Ophiura luetkenii	1,375		10	1	2	3	1	2						3	351	117					1,865	15.4
Sicyonia ingentis		12			11	85	14	132	9	198	37	160	73	43	6	34	14	179	248	92	1,347	11.1
Thesea sp B	20	180	11	3	35	50	32	23	57	60	18	18	21	15	40	98					681	5.6
Philine auriformis	6	233	175	20					7												441	3.6
Hamatoscalpellum californicum	38	34	13		8	20	12	27	16	80	14	12	24		41	80					419	3.5
Strongylocentrotus fragilis																	4	394			398	3.3
Astropecten californicus	5	2	3	7	1	11	17	47	1	23	11	22	13	11	6	6	4	2	1		193	1.6
Luidia asthenosoma		5	6	1	4	7	2	6	3	1	15	9	10	5	30	5					109	0.9
Ophiothrix spiculata		61			2	3	2	4	3	3				8	5	2					93	0.8
Luidia foliolata	3	1	1	1		3	1	7		1	2	3	5	3		1		8	9	1	50	0.4
Astropecten sp	7	5	4		3		5		7		14				2						47	0.4
Doryteuthis opalescens	1	2	3	10	2		2		2				1		2		6	1			32	0.3
Sicyonia penicillata	1	1				1		7		4		4		7		2					27	0.2
Orthopagurus minimus		9	5			2			2	1						3					22	0.2
Neocrangon zacae								4	1			3	1				2	2	8		21	0.2
Acanthoptilum sp	3	2	1			1			1							3					11	0.1
Dendronotus venustus		5	4																		9	0.1
Heterogorgia tortuosa		2	1				1	2	1							2					9	0.1
Neomysis kadiakensis	3	5																			8	0.1
Octopus rubescens								1		1	1		1		1			2			7	0.1
Apostichopus californicus						1		1					1	1	1	1					6	<0.1
Luidia sp									5												5	<0.1
Acanthodoris rhodoceras	1	2														1					4	<0.1
Aglaja ocelligera		3	1																		4	<0.1
Armina californica		2		1								1									4	<0.1
Acanthodoris brunnea									1	1					1						3	<0.1
Ericerodes hemphillii	1							1								1					3	<0.1
Heptacarpus decorus									1						2						3	<0.1
Platymera gaudichaudii														1	1		1				3	<0.1
Pleurobranchaea californica		1								1								1			3	<0.1
Pyromaia tuberculata		1							1							1					3	<0.1
Rossia pacifica																		3			3	<0.1
Astropecten armatus		2																			2	<0.1
Baptodoris mimetica			1													1					2	<0.1
Calliostoma turbinum					1						1										2	<0.1
Loxorhynchus crispatus							1									1					2	<0.1
Metacarcinus gracilis		1											1								2	<0.1
Neocrangon resima								1										1			2	<0.1
Spirontocaris snyderi										1					1						2	<0.1
Amphichondrius granulatus																1					1	<0.1
Astropecten ornatissimus																				1	1	<0.1
Diaulula sandiegensis			1																		1	<0.1
Erileptus spinosus						1															1	<0.1
Flabellinopsis iodinea	1																				1	<0.1
Hermissenda opalescens		1																			1	<0.1
Latulambrus occidentalis		1																			1	<0.1
Lovenia cordiformis						1															1	<0.1

Table B–10 continues.

Table B–10 continued.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	**T2**	**T24**	**T6**	**T18**	**T23**		**T22**		**T1**		**T12**		**T17**		**T11**		**T10**	**T25**	**T14**	**T19**		
Nominal Depth (m)	**35**	**36**	**36**	**36**	**58**		**60**		**55**		**57**		**60**		**60**		**137**	**137**	**137**	**137**		
Season	**S**	**S**	**S**	**S**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**S**	**S**	**S**	**Total**	**%**
Megasurcula carpenteriana												1									1	<0.1
Octopus californicus																			1		1	<0.1
Paguristes sp									1												1	<0.1
Paguristes turgidus			1																		1	<0.1
Simnia sp												1									1	<0.1
Tritonia festiva																1					1	<0.1
Total Abundance	**1,465**	**587**	**256**	**276**	**1,791**	**1,845**	**1,026**	**1,063**	**594**	**580**	**158**	**277**	**156**	**105**	**539**	**409**	**33**	**597**	**267**	**94**	**12,118**	**100**
Total No. of Species	**14**	**26**	**18**	**9**	**11**	**15**	**13**	**16**	**19**	**14**	**10**	**12**	**12**	**11**	**16**	**21**	**7**	**11**	**5**	**3**	**54**	

Table B–11 Biomass (kg) of epibenthic macroinvertebrates collected in the Summer 2020 and Winter 2021 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	**T2**	**T24**	**T6**	**T18**	**T23**		**T22**		**T1**		**T12**		**T17**		**T11**		**T10**	**T25**	**T14**	**T19**		
Nominal Depth (m)	**35**	**36**	**36**	**36**	**58**		**60**		**55**		**57**		**60**		**60**		**137**	**137**	**137**	**137**		
Season	**S**	**S**	**S**	**S**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**S**	**S**	**S**	**Total**	**%**
Strongylocentrotus fragilis																	0.145	18.930			19.075	35.6
Lytechinus pictus		0.064	0.033	0.748	3.410	2.700	2.060	1.500	0.698	0.293	0.095	0.050	0.014	0.004	0.050	0.043	0.009	0.010			11.781	22
Sicyonia ingentis		0.003			0.058	0.103	0.065	0.175	0.033	0.327	0.155	0.236	0.118	0.063	0.025	0.023	0.153	2.090	3.348	0.348	7.323	13.7
Apostichopus californicus						0.548		0.001					1.003	1.103	0.900	0.545					4.100	7.6
Luidia foliolata	0.011	0.005	0.010	0.003		0.183	0.008	0.123		0.001	0.015	0.007	0.020	0.048		0.077		0.608	1.748	0.004	2.871	5.4
Loxorhynchus crispatus							2.710									0.002					2.712	5.1
Ophiura luetkenii	2.310		0.004	0.001	0.001	0.001	0.001	0.001						0.001	0.298	0.085					2.703	5
Thesea sp B	0.015	0.053	0.007	0.005	0.025	0.032	0.030	0.030	0.123	0.095	0.020	0.015	0.018	0.011	0.065	0.075					0.619	1.2
Astropecten californicus	0.011	0.004	0.008	0.022	0.006	0.007	0.035	0.063	0.001	0.053	0.065	0.038	0.050	0.040	0.004	0.011	0.085	0.045	0.032		0.580	1.1
Platymera gaudichaudii														0.148	0.155		0.243				0.546	1
Sicyonia penicillata	0.027	0.016				0.012		0.093		0.053		0.103		0.033		0.022					0.359	0.7
Octopus rubescens								0.020		0.195	0.007		0.005		0.017			0.047			0.291	0.5
Ophiothrix spiculata		0.123			0.001	0.001	0.001	0.001	0.001	0.001				0.004	0.001	0.001					0.135	0.3
Pleurobranchaea californica		0.001								0.001								0.095			0.097	0.2
Philine auriformis	0.001	0.041	0.025	0.007					0.010												0.084	0.2
Hamatoscalpellum californicum	0.006	0.007	0.002		0.001	0.002	0.004	0.002	0.001	0.013	(0.002)	0.001	0.002		0.030	0.004					0.073	0.1
Luidia asthenosoma		0.001	0.001	0.001	0.001	0.004	0.001	0.001	0.001	0.001	0.003	0.022	0.002	0.008	0.013	0.002					0.062	0.1
Lovenia cordiformis						0.031															0.031	0.1
Megasurcula carpenteriana												0.025									0.025	<0.1
Doryteuthis opalescens	0.001	0.001	0.001	0.004	0.001		0.001		0.001				0.001		0.001		0.006	0.001			0.019	<0.1
Astropecten ornatissimus																				0.017	0.017	<0.1
Astropecten sp	0.001	0.002	0.001		0.001		0.005		0.001		0.005				0.001						0.017	<0.1
Octopus californicus																			0.015		0.015	<0.1
Neocrangon zacae								0.001	0.001			0.001	0.001				0.001	0.001	0.004		0.010	<0.1
Orthopagurus minimus		0.003	0.001			0.001			0.001	0.001						0.001					0.008	<0.1
Astropecten armatus		0.007																			0.007	<0.1
Latulambrus occidentalis		0.007																			0.007	<0.1
Acanthoptilum sp	0.001	0.001	0.001			0.001			0.001							0.001					0.006	<0.1
Heterogorgia tortuosa		0.001	0.001				0.001	0.001	0.001							0.001					0.006	<0.1

Tabel B–11 continues.

Table B–11 continued.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	T2	T24	T6	T18	T23		T22		T1		T12		T17		T11		T10	T25	T14	T19		
Nominal Depth (m)	35	36	36	36	58		60		55		57		60		60		137	137	137	137		
Season	S	S	S	S	S	W	S	W	S	W	S	W	S	W	S	W	S	S	S	S	Total	%
Rossia pacifica																		0.005			0.005	<0.1
Acanthodoris brunnea									0.001	0.001					0.001						0.003	<0.1
Acanthodoris rhodoceras	0.001	0.001														0.001					0.003	<0.1
Armina californica		0.001		0.001								0.001									0.003	<0.1
Ericerodes hemphillii	0.001							0.001								0.001					0.003	<0.1
Pyromaia tuberculata		0.001							0.001							0.001					0.003	<0.1
Aglaja ocelligera		0.001	0.001																		0.002	<0.1
Baptodoris mimetica			0.001													0.001					0.002	<0.1
Calliostoma turbinum					0.001						0.001										0.002	<0.1
Dendronotus venustus		0.001	0.001																		0.002	<0.1
Heptacarpus decorus									0.001						0.001						0.002	<0.1
Metacarcinus gracilis		0.001											0.001								0.002	<0.1
Neocrangon resima								0.001										0.001			0.002	<0.1
Neomysis kadiakensis	0.001	0.001																			0.002	<0.1
Spirontocaris snyderi										0.001					0.001						0.002	<0.1
Amphichondrius granulatus																0.001					0.001	<0.1
Diaulula sandiegensis			0.001																		0.001	<0.1
Erileptus spinosus						0.001															0.001	<0.1
Flabellinopsis iodinea	0.001																				0.001	<0.1
Hermissenda opalescens		0.001																			0.001	<0.1
Luidia sp									0.001												0.001	<0.1
Paguristes sp									0.001												0.001	<0.1
Paguristes turgidus			0.001																		0.001	<0.1
Simnia sp												0.001									0.001	<0.1
Tritonia festiva																0.001					0.001	<0.1
Total	**2.388**	**0.348**	**0.100**	**0.792**	**3.506**	**3.627**	**4.922**	**2.014**	**0.879**	**1.036**	**0.364**	**0.500**	**1.235**	**1.463**	**1.563**	**0.899**	**0.642**	**21.833**	**5.147**	**0.369**	**53.627**	**100**

Table B–12 Abundance and species richness of demersal fishes collected in the Summer 2020 and Winter 2021 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	**T2**	**T24**	**T6**	**T18**	**T23**		**T22**		**T1**		**T12**		**T17**		**T11**		**T10**	**T25**	**T14**	**T19**		
Nominal Depth (m)	**35**	**36**	**36**	**36**	**58**		**60**		**55**		**57**		**60**		**60**		**137**	**137**	**137**	**137**		
Season	**S**	**S**	**S**	**S**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**S**	**S**	**S**	**Total**	**%**
Citharichthys sordidus				4	138	178	159	171	96	70	136	177	178	195	97	111	234	172	266	4	2,386	26.3
Icelinus quadriseriatus	7	193	99	28	30	38	25	31	71	84	107	102	190	255	209	364	4				1,837	20.2
Citharichthys xanthostigma	4	22	13	4	6	2	48	6	103	61	86	24	211	14	9	4	6	4	2		629	6.9
Sebastes sp					1	2		12		10	8	442	32					1			508	5.6
Symphurus atricaudus	7	13	7	3	13	14	14	36	43	40	39	38	66	57	20	33	31	11	4	2	491	5.4
Sebastes semicinctus						32								351		17	50	7	1		458	5
Zaniolepis latipinnis							1	12	1	3	2	9	385	11			6	10			440	4.8
Sebastes saxicola																	131	154	103	12	400	4.4
Microstomus pacificus								2			1	1	1	1			70	43	190	9	318	3.5
Zalembius rosaceus							1	85		9	8	53	11	83			4	1			255	2.8
Citharichthys stigmaeus	28	99	64	56																	247	2.7
Chitonotus pugetensis		58	30	20			2		6	2	24		33		25	2					202	2.2
Zaniolepis frenata																	82	69	16		167	1.8
Lyopsetta exilis																	22	71	68		161	1.8
Hippoglossina stomata	2	14	6		9	9	7	7	14	16	3	15		6	9	28	3	4	1		153	1.7
Pleuronichthys verticalis	1	4	4	2		2	2	4	3	8	3	5	8	3	5	9	6				69	0.8
Scorpaena guttata		1		1	2	1	8	3	1	2	8	3	10	1	10		6	6			63	0.7
Parophrys vetulus						3	3	8		6	1	8		13		1	9	7	2		61	0.7
Argentina sialis											1		8		31						40	0.4
Porichthys notatus								4			1				1		3	16	10		35	0.4
Sebastes elongatus														12			6	7	8		33	0.4
Xystreurys liolepis	4	2	3	1		1		5		6		2				4					28	0.3
Lycodes pacificus																	8	5	9		22	0.2
Odontopyxis trispinosa		1						1	3	3	1	2	8		2						21	0.2
Engraulis mordax							8				5										13	0.1
Synodus lucioceps										8	2	1									11	0.1
Merluccius productus																	4	4			8	0.1
Raja inornata			1				1	1				1		1							5	0.1
Sebastes rosenblatti																	1	3	1		5	0.1
Paralabrax nebulifer			1											1		1					3	<0.1
Porichthys myriaster											1		1		1						3	<0.1
Agonopsis sterletus															1						1	<0.1
Chilara taylori																		1			1	<0.1
Diaphus theta													1								1	<0.1
Genyonemus lineatus													1								1	<0.1
Glyptocephalus zachirus																			1		1	<0.1
Kathetostoma averruncus																			1		1	<0.1
Paralichthys californicus	1																				1	<0.1
Plectobranchus evides																			1		1	<0.1
Pleuronichthys decurrens													1								1	<0.1
Sebastes levis																			1		1	<0.1
Sebastes paucispinis																			1		1	<0.1
Strongylura exilis													1								1	<0.1
Total Abundance	**54**	**407**	**228**	**119**	**199**	**282**	**279**	**388**	**341**	**328**	**437**	**883**	**1,146**	**1,004**	**420**	**574**	**686**	**596**	**686**	**27**	**9,084**	**100**
Total No. of Species	**8**	**10**	**10**	**9**	**7**	**11**	**13**	**16**	**10**	**15**	**19**	**16**	**18**	**15**	**13**	**11**	**20**	**20**	**19**	**4**	**43**	

Table B–13 Biomass (kg) of demersal fishes collected in the Summer 2020 and Winter 2021 trawl surveys.

Stratum	Middle Shelf Zone 1				Middle Shelf Zone 2												Outer Shelf					
Station	**T2**	**T24**	**T6**	**T18**	**T23**		**T22**		**T1**		**T12**		**T17**		**T11**		**T10**	**T25**	**T14**	**T19**		
Nominal Depth (m)	**35**	**36**	**36**	**36**	**58**		**60**		**55**		**57**		**60**		**60**		**137**	**137**	**137**	**137**		
Season	**S**	**S**	**S**	**S**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**W**	**S**	**S**	**S**	**S**	**Total**	**%**
Citharichthys sordidus				0.005	1.120	1.410	1.050	1.080	0.314	0.416	0.473	0.848	0.813	0.955	0.197	0.417	4.170	2.350	3.440	0.195	19.253	14.7
Citharichthys xanthostigma	0.053	0.163	0.093	0.033	0.143	0.080	1.380	0.253	1.354	1.503	2.300	1.323	5.310	1.115	0.090	0.115	0.370	0.323	0.103		16.104	12.3
Paralichthys californicus	13.000																				13.000	9.9
Scorpaena guttata		0.230		0.223	0.450	0.115	1.290	0.490	0.138	0.625	1.490	0.560	2.190	0.430	2.140		1.190	1.150			12.711	9.7
Hippoglossina stomata	0.835	0.443	0.690		0.166	0.395	0.113	0.300	0.582	1.603	0.068	0.710		0.175	0.148	1.070	0.323	0.183	0.283		8.087	6.2
Sebastes saxicola																	2.590	2.850	2.100	0.258	7.798	5.9
Symphurus atricaudus	0.113	0.213	0.118	0.038	0.203	0.175	0.263	0.595	0.660	0.604	0.603	0.515	1.000	0.790	0.383	0.490	0.590	0.197	0.087	0.049	7.686	5.9
Parophrys vetulus						0.225	0.480	1.148		0.925	0.313	0.950		0.840		0.030	0.990	0.503	0.223		6.627	5.1
Microstomus pacificus								0.038			0.004	0.025	0.002	0.023			1.790	0.623	2.600	0.458	5.563	4.2
Zaniolepis latipinnis							0.003	0.230	0.014	0.062	0.023	0.150	4.110	0.095			0.123	0.223			5.033	3.8
Pleuronichthys verticalis	0.210	0.077	0.033	0.388		0.215	0.083	0.258	0.155	0.800	0.123	0.430	0.383	0.260	0.398	0.480	0.293				4.586	3.5
Icelinus quadriseriatus	0.014	0.223	0.123	0.039	0.113	0.097	0.079	0.078	0.199	0.218	0.303	0.078	0.413	0.360	0.362	0.589	0.025				3.313	2.5
Zalembius rosaceus							0.017	1.198		0.242	0.466	0.400	0.263	0.180			0.143	0.032			2.941	2.2
Lyopsetta exilis																	0.258	1.080	1.290		2.628	2
Raja inornata			1.000				0.290	0.090				0.310		0.600							2.290	1.7
Xystreurys liolepis	0.303	0.107	0.550	0.073		0.070		0.198		0.275		0.200				0.216					1.992	1.5
Zaniolepis frenata																	0.830	0.663	0.128		1.621	1.2
Sebastes semicinctus						0.020								0.220		0.017	1.010	0.148	0.015		1.430	1.1
Merluccius productus																	0.883	0.283			1.166	0.9
Synodus lucioceps										0.764	0.248	0.120									1.132	0.9
Chitonotus pugetensis		0.183	0.103	0.053			0.018		0.036	0.011	0.173		0.243		0.097	0.012					0.929	0.7
Paralabrax nebulifer			0.300											0.200		0.375					0.875	0.7
Citharichthys stigmaeus	0.103	0.298	0.188	0.147																	0.736	0.6
Porichthys myriaster											0.493		0.120		0.120						0.733	0.6
Sebastes paucispinis																			0.700		0.700	0.5
Porichthys notatus								0.033			0.013				0.031		0.047	0.248	0.260		0.632	0.5
Sebastes sp					0.001	0.001		0.003		0.010	0.013	0.320	0.039					0.001			0.388	0.3
Sebastes elongatus														0.070			0.073	0.055	0.053		0.251	0.2
Lycodes pacificus																	0.083	0.077	0.075		0.235	0.2
Pleuronichthys decurrens													0.102								0.102	0.1
Glyptocephalus zachirus																			0.096		0.096	0.1
Sebastes rosenblatti																	0.028	0.058	0.006		0.092	0.1
Genyonemus lineatus													0.090								0.090	0.1
Argentina sialis											0.001		0.013		0.069						0.083	0.1
Kathetostoma averruncus																			0.063		0.063	<0.1
Odontopyxis trispinosa		0.002						0.001	0.006	0.010	0.001	0.003	0.021		0.004						0.048	<0.1
Engraulis mordax							0.020				0.018										0.038	<0.1
Chilara taylori																		0.009			0.009	<0.1
Plectobranchus evides																			0.004		0.004	<0.1
Sebastes levis																			0.002		0.002	<0.1
Strongylura exilis													0.002								0.002	<0.1
Agonopsis sterletus															0.002						0.002	<0.1
Diaphus theta													0.001								0.001	<0.1
Total	**14.631**	**1.939**	**3.198**	**0.999**	**2.196**	**2.803**	**5.086**	**5.993**	**3.458**	**8.068**	**7.126**	**6.942**	**15.115**	**6.313**	**4.041**	**3.811**	**15.809**	**11.056**	**11.528**	**0.960**	**131.072**	**100**

Table B–14 Summary statistics of OC San's legacy nearshore (surfzone) stations for total coliform, fecal coliform, and enterococci by station and season during 2020-21. Station 0 = mouth of the Santa Ana River.

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 (MPN/100 mL)																				
39N	<17	18	100	1.98	<17	33	17,000	8.23	<17	29	6,100	5.54	<17	20	100	1.89	<17	24	17,000	4.12
33N	<17	23	150	2.48	<17	36	13,000	6.86	<17	22	6,600	5.6	<17	18	100	1.85	<17	24	13,000	4
27N	<17	14	17	1.15	<17	32	>15,000	7.78	<17	26	5,600	5.24	<17	14	17	1.16	<17	20	>15,000	3.8
21N	<17	16	33	1.4	<17	34	>18,000	7.91	<17	31	4,900	5.26	<17	18	50	1.7	<17	24	>18,000	3.91
15N	<17	20	120	2.18	<17	55	15,000	6.61	<17	42	3,900	7.44	<17	25	7,500	5.8	<17	33	15,000	5.36
12N	<17	30	250	3.29	<17	41	16,000	7.01	<17	32	6,600	5.44	<17	43	>20,000	8.49	<17	36	>20,000	5.7
9N	<17	31	440	3.1	<17	57	8,900	4.39	<17	33	5,200	3.85	<17	39	>20,000	5.43	<17	39	>20,000	4.15
6N	<17	110	6,500	6.04	<17	74	10,000	5.26	<17	67	9,500	6.57	<17	48	>20,000	6.1	<17	72	>20,000	5.97
3N	<17	25	120	2.23	<17	33	3,100	3.99	<17	48	2,900	4.43	<17	34	>20,000	5.83	<17	34	>20,000	4.03
0	<17	17	100	1.75	<17	35	2,800	3.9	<17	60	4,300	4.56	<17	31	>20,000	6.42	<17	32	>20,000	4.29
3S	<17	13	17	1.11	<17	22	440	3.14	<17	46	1,200	4.04	<17	19	83	2.03	<17	22	1,200	2.84
6S	<17	19	67	1.68	<17	17	400	2.58	<17	28	280	3.05	<17	16	83	1.71	<17	20	400	2.28
9S	<17	13	17	1.08	<17	30	5,800	5.47	<17	27	180	2.81	<17	13	17	1.12	<17	19	5,800	2.84
15S	<17	14	>17	1.18	<17	29	2,400	4.58	<17	24	380	3.3	<17	13	17	1.12	<17	19	2,400	2.72
21S	<17	17	33	1.38	<17	17	280	2.33	<17	29	350	3.2	<17	27	220	2.51	<17	22	350	2.39
27S	<17	15	33	1.3	<17	17	170	2.1	<17	19	480	2.76	<17	14	17	1.14	<17	16	480	1.89
29S	<17	17	50	1.62	<17	23	83	1.84	<17	25	>280	3.15	<17	18	67	1.65	<17	21	>280	2.08
39S	<17	17	67	1.72	<17	30	170	2.72	<17	16	83	1.85	<17	14	33	1.33	<17	19	170	2.03
All	<17	24	6,500	1.19	<17	34	>18,000	2.16	<17	34	9,500	1.48	<17	24	>20,000	2.40	<17	28	>20,000	1.27
Fecal Coliforms (MPN/100 mL)																				
39N	<17	13	17	1.11	<17	18	760	3.1	<17	17	130	1.95	<17	19	50	1.63	<17	17	760	2
33N	<17	18	150	2.01	<17	18	620	2.91	<17	18	50	1.65	<17	18	100	1.85	<17	18	620	2.07
27N	<17	15	17	1.16	<17	21	640	3.14	<17	19	67	1.74	<17	17	33	1.39	<17	18	640	1.93
21N	<17	16	67	1.66	<17	22	660	3.02	<17	16	33	1.42	<17	15	50	1.46	<17	17	660	1.94
15N	<17	26	170	2.6	<17	28	420	3.07	<17	26	2,400	3.94	<17	21	67	1.84	<17	25	2,400	2.81
12N	<17	28	230	3.23	<17	29	280	2.66	<17	20	83	1.77	<17	26	350	2.6	<17	26	350	2.53
9N	<17	34	400	2.65	11	31	280	3.04	<17	20	83	1.92	<17	28	580	3.36	11	28	580	2.77
6N	<2	93	6,600	7.18	<17	44	3,000	3.87	<17	38	8,700	5.2	<17	34	2,700	4.49	<2	49	8,700	5.35
3N	<17	19	250	2.32	<17	21	120	2.1	<17	34	300	2.75	<17	25	16,000	4.87	<17	24	16,000	3
0	<17	17	130	1.83	<17	19	180	2.13	<17	27	130	2.21	<17	27	>20,000	4.59	<17	22	>20,000	2.69
3S	<17	13	17	1.08	<17	16	67	1.77	<17	16	33	1.41	<17	14	20	1.16	<17	15	67	1.42
6S	<17	15	50	1.53	<17	14	17	1.13	<17	18	170	2.06	<17	13	17	1.09	<17	15	170	1.55
9S	<17	14	17	1.13	<17	15	83	1.68	<17	17	67	1.63	<17	14	17	1.14	<17	15	83	1.45
15S	<17	14	17	1.15	<17	19	83	2.14	<17	15	67	1.58	<17	14	33	1.32	<17	15	83	1.6
21S	<17	15	50	1.45	<17	13	17	1.08	<17	18	150	2.33	<17	24	83	2.03	<17	17	150	1.83
27S	<17	13	17	1.11	<17	13	17	1.11	<17	13	17	1.08	<17	14	17	1.14	<17	13	17	1.11
29S	<17	14	17	1.15	<17	16	50	1.45	<17	16	67	1.66	<17	16	67	1.6	<17	16	67	1.47
39S	<17	15	50	1.44	<17	13	17	1.11	<17	14	33	1.3	<17	14	33	1.32	<17	14	50	1.31
All	<2	22	6,600	1.45	11	21	3,000	0.88	<17	20	8,700	1.01	<17	20	>20,000	1.28	<2	20	>20,000	0.98

Table B–14 continues.

Table B–14 continued.

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
									Enterococci (CFU/100mL)											
39N	<2	4	24	2.2	<2	9	216	4.05	<2	5	42	3.19	<2	4	24	2.32	<2	5	216	2.98
33N	<2	6	50	3.56	<2	8	206	4.01	<2	6	94	2.89	<2	3	14	2.12	<2	5	206	3.25
27N	2	8	92	2.86	<2	9	>400	5.68	2	16	124	3.26	<2	6	48	3.38	<2	9	>400	3.82
21N	<2	6	30	3	<2	8	226	3.38	<2	7	118	4.9	<2	10	48	3.02	<2	8	226	3.51
15N	<2	7	50	3.37	<2	12	136	4.76	<2	12	136	5.08	<2	3	18	2.68	<2	8	136	4.22
12N	<2	10	72	3.6	<2	16	88	3.81	<2	9	240	4.72	2	8	20	1.8	<2	10	240	3.43
9N	<2	14	162	3.58	<2	21	136	3.04	<2	9	110	3.4	<2	10	118	3.64	<2	13	162	3.48
6N	2	34	>400	5.06	2	24	>400	3.35	<2	14	>400	6.41	<2	13	>400	4.86	<2	20	>400	5.01
3N	<2	8	122	3.83	<2	8	98	4.54	<2	18	158	4.22	<2	8	>400	4.23	<2	10	>400	4.28
0	<2	5	42	2.84	<2	5	182	4.35	<2	15	92	3.39	<2	5	>400	4.12	<2	7	>400	3.93
3S	<2	4	30	2.77	<2	4	58	3.74	2	12	46	3.16	<2	4	26	2.56	<2	5	58	3.23
6S	<2	4	22	2.7	<2	4	50	3.57	<2	8	38	3.12	<2	3	10	2.06	<2	4	50	2.94
9S	<2	3	22	2.64	<2	10	204	3.95	<2	8	24	2.94	<2	3	12	2.31	<2	5	204	3.29
15S	<2	4	24	2.19	<2	4	92	3.52	<2	6	60	4.35	<2	3	16	2.72	<2	4	92	3.12
21S	<2	3	6	1.7	<2	4	46	2.95	<2	4	54	3.55	<2	4	24	2.94	<2	4	54	2.74
27S	<2	3	12	1.97	<2	3	54	3.64	<2	3	26	2.47	<2	2	4	1.33	<2	3	54	2.4
29S	<2	4	40	2.77	<2	5	38	2.82	<2	6	74	4.46	<2	5	26	2.52	<2	5	74	3.05
39S	<2	2	14	2.05	<2	2	18	2.19	<2	2	10	1.87	<2	3	12	2.08	<2	2	18	2.02
All	<2	7	>400	0.82	<2	9	>400	0.80	<2	9	>400	1.09	<2	5	>400	0.92	<2	7	>400	0.71

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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, and local 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 grouped into Winter Quarter (January–March), Spring Quarter (April–June), Summer Quarter (July–September), and Fall Quarter (October–December) categories.

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 2020-21 Core OMP.

WATER QUALITY NARRATIVE

OC San's Environmental Laboratory and Ocean Monitoring (ELOM) staff collected 2,613 ammonia-nitrogen (NH_3-N) samples (or 654 in the Winter Quarter, 653 in each of the other quarters) between July 1, 2020, and June 30, 2021. 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 ELOM laboratory staff, and then stored at <6.0 °C until analysis using the ELOM's Standard Operating Procedures (SOPs) (OCSD 2016b).

ELOM staff also collected 175 bacteria samples in each quarter of the 2020-21 program year. All samples were iced upon collection and stored at <10 °C until analysis in accordance with ELOM 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. 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 for blanks and blank spikes met the QA/QC criteria as shown in Table C-2. One matrix spike duplicate/matrix spike precision were out of control in the Fall Quarter and 1 matrix spike/matrix spike duplicate were out of control in the Spring Quarter (Table C-2). All affected samples were reanalyzed where necessary to ensure validity of results.

Bacteria

Samples collected offshore (i.e., Recreational (aka REC-1)) were analyzed for fecal indicator bacteria using culture-based methods, i.e., Enterolert™ for enterococci and Colilert-18™ for total coliforms and *Escherichia coli*. Concentrations of 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 (membrane filtration) for direct count of bacteria. EPA Method 1600 was used to enumerate enterococci. 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 dishes 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 (MPN) methods due to a lack of established precision criteria specific to the MPN methods. Acceptable duplicates (based on the precision criterion) ranged from 83% to 97% in the 4 quarters for the 3 fecal indicator bacteria (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 2020–June 2021. N/A = Not Applicable.

Parameter	MDL (MPN/100 mL)	RL (MPN/100 mL)	Parameter	MDL (mg/L)	RL (mg/L)
Receiving water					
Fecal Indicator Bacteria and Nutrients					
Total coliform	10	10	Ammonia-nitrogen	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	3.00
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	0.20	PCB 126	0.53	0.60
PCB 28	0.43	0.50	PCB 128	0.61	0.70
PCB 37	0.47	0.50	PCB 138	0.71	0.80
PCB 44	0.47	0.50	PCB 149	0.60	0.56
PCB 49	0.61	0.70	PCB 151	0.35	0.40
PCB 52	0.51	0.60	PCB 153/168	0.75	0.80
PCB 66	0.62	0.70	PCB 156	0.67	0.70
PCB 70	0.74	0.80	PCB 157	0.70	0.70
PCB 74	0.61	0.70	PCB 167	0.55	0.60
PCB 77	0.52	0.60	PCB 169	0.28	0.30
PCB 81	0.39	0.40	PCB 170	0.36	0.40
PCB 87	0.43	0.50	PCB 177	0.61	0.70
PCB 99	0.41	0.50	PCB 180	0.38	0.40
PCB 101	0.47	0.50	PCB 183	0.57	0.60
PCB 105	0.58	0.60	PCB 187	0.55	0.60
PCB 110	0.58	0.60	PCB 189	0.34	0.40
PCB 114	0.49	0.50	PCB 194	0.29	0.30
PCB 118	0.76	0.80	PCB 201	0.58	0.60
PCB 119	0.32	0.40	PCB 206	0.36	0.40
PCB 123	0.43	0.50			
PAH Compounds					
1,6,7-Trimethylnaphthalene	0.24	1.00	Benzo[g,h,i]perylene	0.69	1.00
1-Methylnaphthalene	0.29	1.00	Benzo[k]fluoranthene	0.43	1.00
1-Methylphenanthrene	1.11	2.00	Biphenyl	2.83	5.00
2,3,6-Trimethylnaphthalene	0.31	1.00	Chrysene	0.38	1.00
2,6-Dimethylnaphthalene	0.36	1.00	Dibenz[a,h]anthracene	0.71	1.00
2-Methylnaphthalene	0.36	1.00	Fluoranthene	0.50	1.00
Acenaphthene	0.45	1.00	Fluorene	0.46	1.00
Acenaphthylene	0.4	1.00	Indeno[1,2,3-c,d]pyrene	0.80	1.00
Anthracene	0.50	1.00	Naphthalene	0.42	1.00
Benz[a]anthracene	0.48	1.00	Perylene	0.71	1.00
Benzo[a]pyrene	0.31	1.00	Phenanthrene	0.29	1.00
Benzo[b]fluoranthene	1.69	2.00	Pyrene	0.49	1.00
Benzo[e]pyrene	1.32	2.00			
Linear Alkylbenzene Compounds					
2-Phenyldecane	0.00	1.00	6-Phenyltetradecane	—	2.00
3-Phenyldecane	—	1.00	7-Phenyltetradecane	—	2.00
4-Phenyldecane	—	1.00	2-Phenyltridecane	—	4.00
5-Phenyldecane	—	1.00	3-Phenyltridecane	—	4.00
2-Phenyldodecane	—	3.00	4-Phenyltridecane	—	5.00
3-Phenyldodecane	—	2.00	5-Phenyltridecane	—	5.00
4-Phenyldodecane	—	3.00	7+6-Phenyltridecane	—	8.00
5-Phenyldodecane	—	4.00	2-Phenylundecane	—	1.00
6-Phenyldodecane	—	3.00	3-Phenylundecane	—	1.00
2-Phenyltetradecane	—	1.00	4-Phenylundecane	—	1.00
3-Phenyltetradecane	—	1.00	5-Phenylundecane	—	2.00
4-Phenyltetradecane	—	1.00	6-Phenylundecane	—	1.00
5-Phenyltetradecane	—	2.00			

Tabel C–1 continues.

Table C–1 continued.

Parameter	MDL	RL	Parameter	MDL	RL
Sediment					
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	1.50
Copper	0.138	0.200			
Parameter	**MDL (mg/kg dry)**	**RL (mg/kg dry)**	**Parameter**	**MDL (%)**	**RL (%)**
Miscellaneous Parameters					
Dissolved Sulfides	1.12	1.12	Total Phosphorus (Summer Quarter)	0.27	5.80
Nitrite-Nitrate as N (Summer Quarter)	0.78	2.40	Total Phosphorus (Winter Quarter)	0.19	4.10
Nitrite-Nitrate as N (Winter Quarter)	0.52	1.60	Total Organic Carbon	0.02	0.10
Total TKN (Summer Quarter)	N/A	95			
Total TKN (Winter Quarter)	N/A	63			
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 2020–June 2021.

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	653 (9)	Blank	39	1	39	100
			Blank Spike	39	1	39	100
			Matrix Spike	71	1	71	100
			Matrix Spike Duplicate	71	1	70	99
			Matrix Spike Precision	71	1	70	99
Winter	Ammonia-nitrogen	653 (9)	Blank	37	1	37	100
			Blank Spike	37	1	37	100
			Matrix Spike	69	1	69	100
			Matrix Spike Duplicate	69	1	69	100
			Matrix Spike Precision	69	1	69	100
Spring	Ammonia-nitrogen	653 (9)	Blank	38	1	38	100
			Blank Spike	38	1	38	100
			Matrix Spike	70	1	69	99
			Matrix Spike Duplicate	70	1	69	99
			Matrix Spike Precision	70	1	70	100

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <2 × 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%.

Summer	Total Coliforms	175 (5)	Duplicate	35	1	32	91
	Fecal Coliforms**	175 (5)	Duplicate	35	1	29	83
	Enterococci	175 (5)	Duplicate	35	1	31	89
Fall	Total Coliforms	175 (5)	Duplicate	35	1	34	97
	Fecal Coliforms**	175 (5)	Duplicate	35	1	32	91
	Enterococci	175 (5)	Duplicate	35	1	33	94
Winter	Total Coliforms	175 (5)	Duplicate	35	1	31	89
	Fecal Coliforms**	175 (5)	Duplicate	35	1	34	97
	Enterococci	175 (5)	Duplicate	35	1	33	94
Spring	Total Coliforms	175 (5)	Duplicate	35	1	33	94
	Fecal Coliforms**	175 (5)	Duplicate	35	1	32	91
	Enterococci	175 (5)	Duplicate	35	1	30	86
Annual	Total Coliforms	700 (20)	Duplicate	140	1	130	93
	Fecal Coliforms**	700 (20)	Duplicate	140	1	127	91
	Enterococci	700 (20)	Duplicate	140	1	127	91

* Analysis passed if the average range of logarithms is less than the precision criterion.
** Fecal coliforms were estimated by multiplying *E. coli* by a factor of 1.1

SEDIMENT CHEMISTRY NARRATIVE

OC San's ELOM laboratory received 68 sediment samples from ELOM's OMP staff during July 2020, and 29 samples during January 2021. All samples were stored according to ELOM 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. In addition, samples collected in the Summer Quarter (July 2020) were analyzed for linear alkylbenzenes (LABs). In addition, linear alkylbenzenes were analyzed in samples collected in the Summer Quarter for the Strategic Process Study as described in Chapter 3.

PAHs, LABs, PCBs, and Organochlorine Pesticides

The analytical methods used to detect PAHs, LABs, organochlorine pesticides, and PCBs in the samples are described in the ELOM SOPs. All sediment samples were extracted using an accelerated solvent extractor (ASE). Approximately 10 g (dry weight) of sample 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, LABs, 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 ELOM 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 (ICPMS). If any analyte in a sample exceeded both the appropriate calibration curve and linear dynamic range of the method, 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. Barium displayed high recovery in the matrix spike and matrix spike duplicate in the Winter Quarter, possibly due to matrix interference (Table C-4). Antimony displayed low recovery in the matrix spike and matrix spike duplicates in both quarters due to sediment matrix interferences. Low antimony recovery due to matrix interference is a persistent and well-documented issue in this matrix. 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 ELOM 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. One matrix spike and 1 matrix spike duplicate failed for accuracy in the Winter Quarter, possibly due to matrix interference (Table C-4). All other 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 ELOM SOPs. The MDL for DS is presented in Table C-1. All QC samples in both quarters (i.e., summer and winter) met the QC acceptance criteria (Table C-4).

Table C–3 Acceptance criteria for standard reference materials, July 2020–June 2021.

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 18	51.0	30.6	71.4
PCB 28	80.8	48.5	113
PCB 44	60.2	36.1	84.3
PCB 49	53.0	31.8	74.2
PCB 52	79.4	47.6	111
PCB 66	71.9	43.1	101
PCB 87	29.9	17.9	41.9
PCB 99	37.5	22.5	52.5
PCB 101	73.4	44.0	102.8
PCB 105	24.5	14.7	34.3
PCB 110	63.5	38.1	88.9
PCB 118	58.0	34.8	81.2
PCB 128	8.47	5.08	11.9
PCB 138	62.1	37.3	86.9
PCB 149	49.7	29.8	69.6
PCB 151	16.93	10.2	23.7
PCB 153/168	74.0	44.4	104
PCB 156	6.52	3.91	9.13
PCB 170	22.6	13.6	31.6
PCB 180	44.3	26.6	62.0
PCB 183	12.19	7.31	17.1
PCB 187	25.1	15.1	35.1
PCB 194	11.2	6.72	15.7
PCB 206	9.21	5.53	12.9
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
4,4'-DDE *	86.0	51.6	120
4,4'-DDT *	170	102	238
cis-Chlordane	16.51	9.91	23.1
trans-Chlordane *	19.0	11.4	26.6
gamma-BHC *	2.0	1.20	2.80
Hexachlorobenzene	6.03	3.62	8.44
trans-Nonachlor	8.20	4.92	11.5
Percent Dry Weight	1.3	—	—
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 *	1,700	1,020	2,380
2-Methylnaphthalene *	740	444	1,036
Acenaphthene *	390	234	546
Anthracene *	1,130	678	1,582
Benz[a]anthracene	4,720	2,832	6,608
Benzo[a]pyrene	4,300	2,580	6,020
Benzo[b+j]fluoranthene	5,960	3,576	8,344
Benzo[e]pyrene	3,280	1,968	4,592
Benzo[g,h,i]perylene	2,840	1,704	3,976
Benzo[k]fluoranthene	2,300	1,380	3,220
Biphenyl *	250	150	350
Chrysene	4,860	2,916	6,804
Dibenz[a,h]anthracene	424	254	594
Fluoranthene	8,920	5,352	12,488
Fluorene *	480	288	672
Indeno[1,2,3-c,d]pyrene	2,780	1,668	3,892
Naphthalene *	1,280	768	1,792
Perylene	1,170	702	1,638
Phenanthrene	5,270	3,162	7,378
Pyrene	9,700	5,820	13,580
Percent Dry Weight	98.7	—	—
Metals (CRM-540 ERA Metals in Soil; Lot No. D107-540)			
Antimony	120	22.8	302
Arsenic	95.5	66.9	124
Barium	300	225	375
Beryllium	103	77.2	129
Cadmium	135	101	169
Chromium	147	103	191
Copper	150	113	188
Lead	92.3	64.6	120
Mercury	18.4	11	29.3
Nickel	59.8	41.9	77.8
Selenium	42	23.4	60.7
Silver	40.3	27.9	52.7
Zinc	369	258	480

Table C–3 continues.

Table C–3 continued.

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	1.18
PCB 28 *	2.00	1.20	2.80
PCB 44	4.66	2.80	6.52
PCB 49	3.80	2.28	5.32
PCB 52	8.10	4.86	11.3
PCB 66	10.8	6.48	15.1
PCB 70	14.9	8.94	20.9
PCB 74	4.83	2.90	6.76
PCB 77	0.327	0.196	0.458
PCB 87	9.40	5.64	13.2
PCB 99	25.6	15.4	35.8
PCB 101	34.6	20.8	48.4
PCB 105	19.9	11.9	27.9
PCB 110	22.8	13.7	31.9
PCB 118	52.1	31.3	72.9
PCB 126	0.380	0.228	0.532
PCB 128	22.8	13.7	31.9
PCB 138	115	69.0	161
PCB 149	26.3	15.8	36.8
PCB 153/168	170	102	238
PCB 156	9.52	5.71	13.3
PCB 170	25.2	15.1	35.3
PCB 180	74.4	44.6	104
PCB 183	21.9	13.1	30.7
PCB 187	55.2	33.1	77.3
PCB 194	13.0	7.80	18.2
PCB 201 *	2.83	1.70	3.96
PCB 206	5.40	3.24	7.56
2,4'-DDD	2.20	1.32	3.08
2,4'-DDE *	1.04	0.624	1.46
2,4'-DDT *	22.3	13.4	31.2
4,4'-DDD	17.7	10.6	24.8
4,4'-DDE	373	224	522
4,4'-DDT	37.2	22.3	52.1
cis-Chlordane	32.5	19.5	45.5
trans-Chlordane	8.36	5.02	11.7
Oxychlordane	18.9	11.3	26.5
Dieldrin	32.5	19.5	45.5
Heptachlor epoxide	5.50	3.30	7.70
cis-Nonachlor	59.1	35.5	82.7
trans-Nonachlor	99.6	59.8	139
Parameter	**True Value (%)**	**Acceptance Range (%)**	
		Minimum	**Maximum**
Lipid (SRM1946, Lake Superior Fish Tissue; National Institute of Standards and Technology)			
Lipid *	10.2	6.10	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 2020–June 2021. N/A = Not Applicable.

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 (5)	Blank	5	25	125	100
			Blank Spike	5	25	119	95
			Matrix Spike	5	25	125	100
			Matrix Spike Duplicate	5	25	125	100
			Matrix Spike Precision	5	25	125	100
			SRM Analysis	5	21	94	90
Summer	LABs	68 (5)	Blank	5	25	125	100
			Blank Spike	5	25	124	99
			Matrix Spike	5	25	124	99
			Matrix Spike Duplicate	5	25	124	99
			Matrix Spike Precision	5	25	125	100
			SRM Analysis	0	0	N/A	N/A
Winter	PAHs	29 (2)	Blank	2	25	50	100
			Blank Spike	2	25	50	100
			Matrix Spike	2	25	46	92
			Matrix Spike Duplicate	2	25	50	100
			Matrix Spike Precision	2	25	47	94
			SRM Analysis	2	21	38	90

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <3 × 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 <30%.
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	220	92
			Matrix Spike	4	60	220	92
			Matrix Spike Duplicate	4	60	221	92
			Matrix Spike Precision	4	60	236	98
			SRM Analysis	4	33	115	87
Winter	PCBs and Pesticides	29 (2)	Blank	2	60	120	100
			Blank Spike	2	60	111	93
			Matrix Spike	2	60	116	97
			Matrix Spike Duplicate	2	60	118	98
			Matrix Spike Precision	2	60	120	100
			SRM Analysis	2	33	56	85

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <3 × 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 <30%.
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	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 Duplicate	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	7	88
			Matrix Spike Duplicate	8	1	7	88
			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 Duplicate	3	12	31	86
			Matrix Spike Precision	3	12	36	100
			Duplicate	3	12	36	100
			SRM Analysis	1	12	12	100
Winter	Mercury	29 (1)	Blank	3	1	3	100
			Blank Spike	3	1	3	100
			Matrix Spike	3	1	3	100
			Matrix Spike Duplicate	3	1	3	100
			Matrix Spike Precision	3	1	3	100
			Duplicate	3	1	3	100
			SRM Analysis	2	1	2	100

* An analysis passed if the following criteria were met.
For blank - Target amount <3 × 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 3 × MDL of sample mean.
For SRM analysis - Target accuracy % recovery 80–120% 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	Dissolved Sulfides	68 (4)	Blank	5	1	5	100
			Blank Spike	4	1	4	100
			Matrix Spike	7	1	7	100
			Matrix Spike Duplicate	7	1	7	100
			Matrix Spike Precision	7	1	7	100
			Duplicate	7	1	7	100
Winter	Dissolved Sulfides	29 (2)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	3	1	3	100
			Matrix Spike Duplicate	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 <2 × 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 3 × MDL of sample mean.

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	68 (4)	Blank	4	1	4	100
			Blank Spike	4	1	4	100
			Matrix Spike	4	1	4	100
			Matrix Spike Duplicate	4	1	4	100
			Matrix Spike Precision	4	1	4	100
			Duplicate	8	1	8	100
Winter	TOC	29 (2)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	3	1	3	100
			Matrix Spike Duplicate	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 <3 × 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 <20% at 10 × MDL of sample mean.

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	Grain Size	68 (2)	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.

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	Nitrite-Nitrate as N	68 (4)	Blank	4	1	4	100
			Blank Spike	4	1	4	100
			Matrix Spike	7	1	7	100
			Matrix Spike Duplicate	7	1	7	100
			Matrix Spike Precision	7	1	7	100
			Duplicate **	—	—	—	—
Winter	Nitrite-Nitrate as N	29 (2)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	2	1	2	100
			Matrix Spike Duplicate	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate **	—	—	—	—

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <3 × 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 <20% at 10 × MDL of sample mean.
** Contract lab did not perform all of the QC required by the OMP QAPP.

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 Kjeldahl Nitrogen	68 (8)	Blank	8	1	8	100
			Blank Spike	8	1	8	100
			Matrix Spike **	—	—	—	—
			Matrix Spike Duplicate **	—	—	—	—
			Matrix Spike Precision **	—	—	—	—
			Duplicate	8	1	7	88
Winter	Total Kjeldahl Nitrogen	29 (2)	Blank	3	1	3	100
			Blank Spike	3	1	3	100
			Matrix Spike **	—	—	—	—
			Matrix Spike Duplicate **	—	—	—	—
			Matrix Spike Precision **	—	—	—	—
			Duplicate	5	1	4	80

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <3 × 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 <20% at 10 × MDL of sample mean.
** Contract lab did not perform all of the QC required by the OMP QAPP.

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	Total P	68(4)	Blank	4	1	4	100
			Blank Spike	4	1	4	100
			Matrix Spike	4	1	4	100
			Matrix Spike Duplicate	4	1	4	100
			Matrix Spike Precision	4	1	4	100
			Duplicate	4	1	4	100
Winter	Total P	29(2)	Blank	2	1	2	100
			Blank Spike	2	1	2	100
			Matrix Spike	2	1	2	100
			Matrix Spike Duplicate	2	1	2	100
			Matrix Spike Precision	2	1	2	100
			Duplicate	2	1	2	100

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <3 × 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 <20% at 10 × MDL of sample mean.

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 relative percentage difference (RPD) ≤10% (Table C-4).

Total Nitrogen (TN)

TN was calculated by analyzing each sample for combined nitrate + nitrite (as N) and for Total Kjeldahl Nitrogen (TKN) and summing the results. Samples were analyzed by Weck Laboratories, Inc., City of Industry, CA. The MDL values for nitrate + nitrite (as N) and TKN are presented in Table C-1. For nitrate + nitrate (as N), the laboratory did not analyze field sample duplicates as required by the OMP QAPP. However, matrix spike duplicates were analyzed in all batches, and displayed good precision. All other samples analyzed for nitrate + nitrite (as N) met the designated QC acceptance criteria (Table C-4). For TKN, the laboratory did not analyze matrix spikes and matrix spike duplicates as required by the OMP QAPP. However, blank spikes were analyzed in all batches, and displayed acceptable accuracy. Duplicate field samples were also analyzed, and most of them displayed acceptable precision. All other samples analyzed for TKN met the designated QC acceptance criteria. The issue with missing QC samples has been addressed with the contract laboratory.

Total Phosphorus (TP)

TP samples were analyzed by Weck Laboratories. The MDL for TP is presented in Table C-1. All QC sample results for all batches analyzed met the QC acceptance criteria (Table C-4).

FISH TISSUE CHEMISTRY NARRATIVE

For the 2020-21 program year, the ELOM laboratory received 16 trawl fish samples and 20 rig fish samples in September 2020. The individual samples were stored, dissected, and homogenized according to methods described in the ELOM 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 ELOM 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). One notable exception occurred in summer set MZ where the RPD failed for the matrix spike set. A corrective action was initiated in the Laboratory Information Management System for this incident with investigation ID CAPA-2020-0046. A duplicate field sample within the same batch did meet the acceptance criterion for precision, thereby demonstrating that the analytical system was still in control. As is usual for an analysis in which such a large number of analytes are measured, there were a few instances of QC failures in the blank spike, duplicate, and SRM. While a certain number of QC failures are to be expected, the percentage of failures this year was notably higher than in previous years. This increased failure rate can primarily be attributed to the age of the analytical system. The instrument used for this analysis experienced several issues during this program year, and the instrument is no longer supported by the manufacturer for service visits or parts. The instrument has been replaced and will no longer be used for any analyses. 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 ELOM SOPs. Lipids were extracted with 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 ELOM 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).

Table C–5 Fish tissue QA/QC summary, July 2020–June 2021.

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 **	16 (1)	Blank	1	53	53	100
			Blank Spike	1	53	44	83
			Matrix Spike	1	53	45	85
			Matrix Spike Dup	1	53	42	79
			Matrix Spike Precision	1	53	45	85
			Duplicate	1	53	52	98
			SRM	1	36	34	94
Summer (Trawl samples)	PCBs and Pesticides	16 (1)	Blank	1	54	54	100
			Blank Spike	1	54	47	87
			Matrix Spike	1	54	45	83
			Matrix Spike Dup	1	54	54	100
			Matrix Spike Precision	1	54	0	0
			Duplicate	1	54	54	100
			SRM	1	37	34	92
Summer (Rig fish samples)	PCBs and Pesticides	20 (1)	Blank	1	54	54	100
			Blank Spike	1	54	53	98
			Matrix Spike	1	54	54	100
			Matrix Spike Dup	1	54	54	100
			Matrix Spike Precision	1	54	54	100
			Duplicate	1	54	54	100
			SRM	1	37	35	95

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <3 × 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 3 × MDL of sample mean.
For SRM analysis - Target accuracy % recovery 60–140 or certified value, whichever is greater.
** Dieldrin was not analyzed for this batch, therefore reducing the number of compounds tested.

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	16 (1)	Duplicate	1	1	1	100
			SRM	1	1	1	100
	Percent Lipid - Muscle	16 (1)	Duplicate	1	1	1	100
			SRM	1	1	1	100
Summer (Rig fish samples)	Percent Lipid - Muscle	20 (1)	Duplicate	1	1	1	100
			SRM	1	1	1	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	52 (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	2	50
			SRM Analysis	1	2	2	100

* An analysis passed if the following criteria were met:
For blank - Target accuracy % recovery <3 × MDL.
For blank spike - Target accuracy % recovery 85-115.
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 10 × MDL of sample mean.
For SRM analysis - Target accuracy % recovery 70–130 or certified value, whichever is greater.

Arsenic and Selenium

Rig fish tissue samples were analyzed for arsenic and selenium in accordance with ELOM 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. One duplicate sample exceeded the acceptance limit of 30% for RPD for both arsenic and selenium. All other quality control samples met the QC criteria (Table C-5).

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 2020 (summer) from 29 semi-annual stations (52–65 m) and 39 annual stations (40–300 m) and in January 2021 (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 (10 of 97) 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 scientific 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: $\%Error_{\#\ Individuals} = (|\#\ Individuals_{Resolved} - \#\ Individuals_{Original}| \div \#\ Individuals_{Resolved}) \times 100$

Equation 2: $\%Error\ \#_{ID\ Taxa} = (\#\ Taxa_{Misidentification} \div \#\ Taxa_{Resolved}) \times 100$

Equation 3: $\%Error\ \#_{IDIndividuals} = (\#\ Individuals_{Misidentification} \div \#\ Individuals_{Resolved}) \times 100$

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 program 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 2020-21 (Table C-6). No significant changes were made to the 2020-21 infauna dataset based on the SDR.

Table C–6 Percent error rates calculated for the July 2020 infauna QA samples.

Error Type	Station			Mean
	64	71	82	
1. %Error # Individuals	7.2	1.2	2.3	**3.6**
2. %Error # ID Taxa	5.0	8.9	1.3	**5.1**
3. %Error # ID Individuals	1.4	3.0	0.6	**1.7**

REFERENCES

APHA (American Public Health Association, American Water Works Association, and Water Environment Federation). 2017. Standard methods for the examination of water and waste water, 23rd edition. American Public Health Association, Washington, DC.

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ORANGE COUNTY SANITATION DISTRICT
Environmenta Laboratory and Ocean Monitoring Division
10844 Ellis Avenue
Fountain Valley, California 92708-7018
714.962.2411

www.ocsan.gov