SD Public Utilities

Interim Receiving Waters Monitoring Report for the Point Loma and South Bay Ocean Outfalls

2018

Environmental Monitoring and Technical Services
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The City *of*
SAN DIEGO
Public Utilities Department
Environmental Monitoring & Technical Services Division

June 30, 2019

David W. Gibson, Executive Officer
California Regional Water Quality Control Board
San Diego Region
2375 Northside Drive, Suite 100
San Diego, CA 92108

Attention: POTW Compliance Unit

Dear Mr. Gibson:

Enclosed is the 2018 Interim Receiving Waters Monitoring Report for the Point Loma and South Bay Ocean Outfalls as per requirements set forth in Order No. R9-2017-0007 for the City of San Diego's Point Loma Wastewater Treatment Plant (NPDES No. CA0107409), Order No. R9-2013-0006 as amended by Order Nos. R9-2014-0071 and R9-2017-0023 for the City's South Bay Water Reclamation Plant (NPDES No. CA0109045), and Order No. R9-2014-0009 as amended by Order Nos. R9-2014-0094 and R9-2017-0024 for the United States Section of the International Boundary and Water Commission's South Bay International Wastewater Treatment Plant (NPDES No. CA0108928). This combined report for the Point Loma and South Bay outfall regions contains data summaries, analyses, and preliminary assessments of all main portions of the ocean monitoring program conducted during calendar year 2018, including water quality monitoring, benthic condition monitoring, and fish and invertebrate monitoring.

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

Sincerely,

Peter S. Vroom, Ph.D.
Deputy Director, Public Utilities Department

TS/akl

cc: U.S. Environmental Protection Agency, Region 9
International Boundary and Water Commission, U.S. Section

SD Public Utilities

Interim Receiving Waters Monitoring Report for the Point Loma and South Bay Ocean Outfalls 2018

Point Loma Wastewater Treatment Plant
(Order No. R9-2017-0007; NPDES No. CA0107409)

South Bay Water Reclamation Plant
(Order No. R9-2013-0006 as amended; NPDES No. CA0109045)

South Bay International Wastewater Treatment Plant
(Order No. R9-2014-0009 as amended; NPDES No. CA0108928)

Prepared by:

City of San Diego Ocean Monitoring Program

Environmental Monitoring & Technical Services Division

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June 2019

Table of Contents

Table of Contents

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M/V Marlin

Executive Summary

The City of San Diego (City) conducts an extensive ocean monitoring program to evaluate potential environmental effects associated with the discharge of treated wastewater to the Pacific Ocean via the Point Loma and South Bay ocean outfalls (PLOO and SBOO, respectively). The data collected are used to determine compliance with ocean receiving water conditions as specified in the NPDES permits and associated orders issued by the U.S. Environmental Protection Agency (USEPA) and San Diego Regional Water Quality Control Board (San Diego Water Board) for the City's Point Loma Wastewater Treatment Plant and South Bay Water Reclamation Plant, as well as the South Bay International Wastewater Treatment Plant operated by the U.S. Section of the International Boundary and Water Commission (USIBWC).

The three primary objectives of the combined PLOO and SBOO ocean monitoring programs are:

- Measure and document compliance with NPDES permit requirements and California Ocean Plan (Ocean Plan) water quality objectives.

- Monitor changes in ocean conditions and the health and status of the San Diego marine ecosystem over space and time.

- Assess any impact of wastewater discharge or other factors on the local marine environment, including effects on coastal water quality, seafloor sediments, and marine life.

Although governed by three separate NPDES permits, this interim report summarizes the purpose, scope, methods and findings of all receiving waters monitoring conducted for the PLOO and SBOO regions from January through December 2018. In contrast, a full biennial monitoring and assessment report covering calendar years 2018 and 2019 will be produced and submitted to the San Diego Water Board and USEPA no later than July 1, 2020. Specific details of the main ocean monitoring activities conducted during 2018 are presented in the following four chapters herein, while raw data are presented in Appendices A–D or are available online and by request. Chapter 1 provides a general introduction and overview of the combined PLOO and SBOO program. Chapter 2 presents data characterizing the results of water quality monitoring at 103 different shore or offshore stations located throughout the two regions. This includes measuring densities of fecal indicator bacteria in seawater samples and collecting various types of oceanographic data to evaluate dispersal of the PLOO and SBOO wastewater plumes and to assess compliance with Ocean Plan water contact standards. Assessments of benthic sediment quality (e.g., sediment chemistry, particle size distributions) and the ecological status of macrobenthic invertebrate communities at 49 core monitoring stations are presented in Chapter 3. Chapter 4 presents the results of trawling activities conducted at 13 different monitoring stations to assess the health and status of bottom dwelling (demersal) fish and megabenthic invertebrate communities.

Overall, the state of San Diego's coastal ocean waters remained in good condition in 2018 based on the preliminary findings and conclusions summarized in this report. Results for both the PLOO and SBOO regions were consistent with conditions documented in previous years, and there were few changes to local receiving waters, benthic sediments, and marine invertebrate and fish communities that could be attributed to wastewater discharge or other human activities. Coastal water quality conditions and compliance with

Ocean Plan standards were excellent, and there was no evidence that wastewater plumes from the two outfalls were transported into nearshore recreational waters. There were also no clear outfall related patterns in sediment contaminant distributions or differences between invertebrate and fish assemblages at the different monitoring sites. Additionally, benthic habitats surrounding both outfalls remained in generally good condition that is characteristic of reference conditions for much of the Southern California Bight. Finally, the general lack of physical anomalies or other symptoms of disease or stress in local fish populations was also indicative of a healthy marine environment off San Diego.

Chapter 1. General Introduction

Program Requirements & Objectives

Ocean monitoring within the Point Loma and South Bay outfall regions is conducted by the City of San Diego (City) in accordance with requirements set forth in National Pollution Discharge Elimination System (NPDES) permits and associated orders for the City's Point Loma Wastewater Treatment Plant (PLWTP) and South Bay Water Reclamation Plant (SBWRP), as well as the South Bay International Wastewater Treatment Plant (SBIWTP) that is owned and operated by the U.S. Section of the International Boundary and Water Commission (see Table 1.1). These documents specify the terms and conditions that allow treated effluent to be discharged to the Pacific Ocean via the Point Loma Ocean Outfall (PLOO) and South Bay Ocean Outfall (SBOO). In addition, the Monitoring and Reporting Program (MRP) included within each of these orders defines the requirements for monitoring ocean (receiving) waters surrounding the two outfalls, including sampling design, frequency of sampling, field operations and equipment, regulatory compliance criteria, types of laboratory tests and analyses, data management and analysis, statistical methods and procedures, environmental assessment, and reporting guidelines.

Overall, the combined ocean monitoring program for these regions is designed to assess the impact of wastewater discharged through the PLOO and SBOO on the coastal marine environment off San Diego. The main objectives of the program are to: (1) provide data that satisfy NPDES requirements; (2) demonstrate compliance with water-contact standards specified in the California Ocean Plan (Ocean Plan); (3) track movement and dispersion of the wastewater plumes discharged via the outfalls; and (4) identify any biological, chemical or physical changes that may be associated with the outfalls and wastewater discharge. These data are then used to evaluate and document any effects of wastewater discharge, other man-made influences (e.g., storm water discharge, urban runoff), or natural factors (e.g., seasonality, climate change) on coastal water quality, seafloor sediment conditions, and local marine organisms.

Background

Point Loma Ocean Outfall

The City began operation of the PLWTP and original PLOO off Point Loma in 1963, at which time treated effluent was discharged at a depth of about 60 m located approximately 3.9 km west of the Point Loma peninsula. The PLWTP operated as a primary treatment facility from 1963 to 1985, after which it was upgraded to advanced primary treatment between mid-1985 and July 1986. This improvement involved the addition of chemical coagulation to the treatment process, which resulted in an increase in removal of total suspended solids (TSS) to about 75%. Since then, the treatment process has continued to be improved with the addition of more sedimentation basins, expanded aerated grit removal, and refinements in chemical treatment, which together further reduced mass emissions from the plant. For example, TSS removals are now consistently greater than the 80% required by the NPDES permit.

The structure of the PLOO was significantly modified in the early 1990s when it was extended about 3.3 km farther offshore to prevent intrusion of the waste field into nearshore waters and to increase compliance with Ocean Plan standards for water-contact sports areas. Discharge from the original 60-m terminus was discontinued in November 1993 following completion of the outfall extension. The present deeper water PLOO extends approximately 7.2 km west of the PLWTP to a depth of about 94 m, where the main outfall pipe splits into a Y-shaped (wye) multiport diffuser system. The two diffuser legs extend an additional 762 m to the north and south, each terminating at a depth of about 98 m.

South Bay Ocean Outfall
The SBOO is located just north of the international border between the United States and Mexico where it terminates approximately 5.6 km offshore and west of Imperial Beach at a depth of about 27 m. Unlike other southern California ocean outfalls that lie on the surface of the seafloor, the SBOO pipeline begins as a tunnel on land that extends from the SBWRP and SBIWTP facilities to the coastline, after which it continues beneath the seabed to about 4.3 km offshore. From there the outfall pipe connects to a vertical riser assembly that conveys effluent to a pipeline buried just beneath the surface of the seafloor. This subsurface pipeline then splits into a Y-shaped (wye) multiport diffuser system with the two diffuser legs each extending an additional 0.6 km to the north or south. The SBOO was originally designed to discharge wastewater through 165 diffuser ports and risers, which included one riser at the center of the wye and 82 risers spaced along each diffuser leg. Since discharge began, however, low flow rates have required closure of all ports along the northern diffuser leg and many along the southern diffuser leg for the outfall to operate effectively. Consequently, wastewater discharge is restricted primarily to the distal end of the southern diffuser leg and to a few intermediate points at or near the center of the wye.

Receiving Waters Monitoring

The combined monitoring area for the PLOO and SBOO programs covers about 881 km^2 (~340 mi^2) of coastal marine waters from Northern San Diego County to Northern Baja California. Core monitoring for the Point Loma region is conducted at 82 different stations located from the shore seaward to a depth of about 116 m, while core monitoring for the South Bay region is conducted at 53 stations ranging from along the shore to offshore depths of about 61 m (Figure 1.1). Each of the core monitoring stations is sampled for specific parameters as specified in their respective MRPs. A summary of the results for all quality assurance procedures performed during calendar year (CY) 2018 in support of these requirements can be found in City of San Diego (2019a). Data files, detailed methodologies, completed reports, and other pertinent information submitted to the California Regional Water Quality Control Board, San Diego Region (San Diego Water Board) and the U.S. Environmental Protection Agency (USEPA), Region IX during the year are available online at the City's website at: www.sandiego.gov/public-utilities/sustainability/ocean-monitoring.

Prior to 1994, the City conducted an extensive ocean monitoring program off Point Loma surrounding the original 60-m discharge site. This program was subsequently expanded with the construction and operation of the deeper outfall as discussed previously. Data from the last year of regular monitoring near the original PLOO discharge site are presented in City of San Diego (1995b), while the results of a 3-year "recovery study" are summarized in City of San Diego (1998). Additionally, a more detailed assessment of spatial and temporal patterns surrounding the original discharge site is available in Zmarzly et al. (1994). From 1991 through 1993, the City also conducted "pre-discharge" monitoring for the new PLOO discharge site to collect baseline data prior to wastewater discharge into these deeper waters (City of San Diego 1995a, b). All permit-mandated monitoring for the South Bay region has also been performed by the City since wastewater discharge through the SBOO began in 1999, which included pre-discharge monitoring for 3½ years (July 1995–December 1998) to provide background information against which post-discharge conditions could be compared (City of San Diego 2000). Results of NPDES-mandated monitoring for the extended PLOO from 1994 to 2017 and the SBOO from 1999 to 2017 are available in previous annual or biennial receiving waters monitoring reports (e.g., City of San Diego 2016a, b, 2017, 2018a). Finally, additional detailed assessments of the PLOO region have been completed as part of past modified NPDES permit renewal applications for the PLWTP submitted by the City and subsequent technical decisions issued by the USEPA (e.g., City of San Diego 2015a, USEPA 2017).

In addition to the above, the City has conducted annual region-wide surveys off the coast of San Diego since 1994 either as part of regular ocean monitoring requirements (e.g., City of San Diego 1999, 2016b) or as part of larger, multi-agency surveys of the entire Southern California Bight (SCB). The latter include the 1994 Southern California Bight Pilot Project (Allen et al. 1998, Bergen et al. 1998, 2001, Schiff and Gossett 1998) and subsequent Bight'98, Bight'03, Bight'08 and Bight'13 programs in 1998, 2003, 2008 and 2013 respectively (Allen et al. 2002, 2007, 2011, Noblet et al. 2002, Ranasinghe et al. 2003, 2007, 2012, Schiff et al. 2006, 2011, Dodder et al. 2016, Gillett et al. 2017, Walther et al. 2017). During 2018, the City participated in the sixth SCB-wide survey (Bight'18 SQPC 2018). These large-scale surveys are useful for characterizing the ecological health of diverse coastal areas and in distinguishing reference sites from those impacted by wastewater or storm water discharges, urban runoff, or other sources of contamination. In addition to the above activities, the City participates as a member of the Region IX Kelp Survey Consortium to fund aerial surveys of all the major kelp beds in San Diego and Orange Counties (e.g., MBC Applied Environmental Sciences 2018).

Special Studies & Enhanced Monitoring

The City has been actively working on or supporting several important special projects or enhanced ocean monitoring studies over the past 10 years or more. Many of these projects were identified as the result a scientific review of the City's Ocean Monitoring Program and environmental monitoring needs for the region that was conducted by a team of scientists from the Scripps Institution of Oceanography and other institutions (SIO 2004), as well as in consultation with staff from the San Diego Water Board, USEPA, SCCWRP and others. Examples of special projects or enhanced monitoring efforts that are presently underway, or that are just being initiated include:

- Real-Time Observing Systems for the Point Loma and South Bay Ocean Outfalls: This project addresses the primary recommendation of previous studies of the fate and behavior of wastewater discharged to the ocean via the SBOO (Terrill et al. 2009) and PLOO (Rogowski et al. 2012a, 2012b, 2013). The study involves installation and operation of a new real-time ocean observing system that spans both outfall regions. The project began in late 2015 with initial deployment of the SBOO mooring in December 2016 and the PLOO mooring in March 2018. This project is being conducted in partnership between the City and the Ocean Time Series Group of SIO that presently operates a similar mooring system off Del Mar. The project is expected to enhance the City's environmental monitoring capabilities to address current and emerging issues relevant to the health of San Diego's coastal waters, including plume dispersion, subsurface current patterns, ocean acidification, hypoxia, nutrient sources, and coastal upwelling. Additional details are available in City of San Diego (2018b, 2019c).

- Sediment Toxicity Monitoring of the San Diego Ocean Outfall Regions: This project represents a 3-year pilot study that was implemented as a new joint regulatory requirement for the Point Loma and South Bay outfall regions in 2015 (see City of San Diego 2015b). The results and recommendations from the pilot study are available in the final project report (City of San Diego 2019b).

● San Diego Regional Benthic Condition Assessment Project: This multi-phase study represents an ongoing, long-term project designed to assess the condition of continental shelf and slope habitats throughout the entire San Diego region. A preliminary summary of the deeper slope (>200 m) results for data collected between 2003–2013 was included in Appendix C.5 of City of San Diego (2015a), while several publications covering the remainder of the project are planned for completion in late 2019.

● Remote Sensing of the San Diego / Tijuana Coastal Region: This project represents a long-term effort funded by the City and the International Boundary and Water Commission since 2002 to utilize satellite and aerial imagery to better understand regional water quality conditions off San Diego. The project is conducted by Ocean Imaging (Littleton, CO), and is focused on detecting and tracking the dispersion of wastewater plumes from local ocean outfalls and nearshore sediment plumes caused by stormwater runoff or outflows from local bays and rivers. Results from this project for calendar year 2018 are available in Hess (2019).

● San Diego Kelp Forest Ecosystem Monitoring Project: This project represents continuation of a long-term commitment by the City to support this important research conducted by SIO. Overall, this work is essential to assessing the health of San Diego's kelp forests and to monitoring the effects of wastewater discharge on the local coastal ecosystem relative to other factors. The final project report for the 4-year agreement conducted from July 1, 2010 through June 30, 2014 is available in Parnell et al. (2014), while results for calendar years 2016–2017 were summarized in Appendix A of last year's biennial report (City of San Diego 2018a). The results for calendar year 2018 will be presented in the City's next biennial report for 2018-2019 scheduled to be published by July 1, 2020.

Report Components & Organization

This report presents summaries of the results of all receiving waters monitoring activities conducted during CY2018 (January – December 2018) for both the Point Loma and South Bay outfall regions. A more comprehensive assessment, including detailed comparisons of long-term spatial and temporal changes and trends, will be prepared as part of the second Biennial Receiving Waters Monitoring and Assessment Report for calendar years 2018-2019 to be submitted to the San Diego Water Board and USEPA by July 1, 2020. Included herein are results from all regular core stations that comprise the fixed-site monitoring grids surrounding the two outfalls (Figure 1.1). During 2018, the following modifications were made due to a resource exchange agreement approved by the San Diego Water Board and USEPA to accommodate participation in the Bight'18 regional monitoring program:

1. Benthic sampling was limited to 25 out of 49 core benthic stations during the summer 2018 survey. These included the 12 PLOO primary core stations located along the 98-m discharge depth contour, PLOO station E15 located in slightly deeper waters (116 m) just west of the center of the outfall diffuser legs (i.e., west of the wye), and the 12 SBOO primary core stations located along the 28-m discharge depth contour.

2. No separate San Diego regional survey of randomly selected benthic sites was conducted during the summer of 2018. Instead, the City sampled and processed 43 of the randomized Bight'18 benthic stations located in San Diego waters. Additionally, the City processed the benthic samples from another 25 Bight'18 stations collected by other agencies.

3. No trawling was performed at the six PLOO and seven SBOO trawl stations during the summer of 2018. Instead, the City conducted trawling activities at a total of 20 randomly selected Bight'18 stations located in the San Diego region.

4. No fish tissue sampling was conducted at the PLOO and SBOO trawl and rig fishing stations as would normally occur in October 2018 in order to reallocate resources towards processing Bight'18 tissue sampling activities.

The major components of the combined PLOO and SBOO monitoring program are covered in the following chapters and associated appendices of this report: Executive Summary; General Introduction (Chapter 1); Water Quality (Chapter 2, Appendix A); Benthic Conditions (Chapter 3, Appendix B); Demersal Fishes and Megabenthic Invertebrates (Chapter 4, Appendix C).

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Chapter 1

Figures & Tables

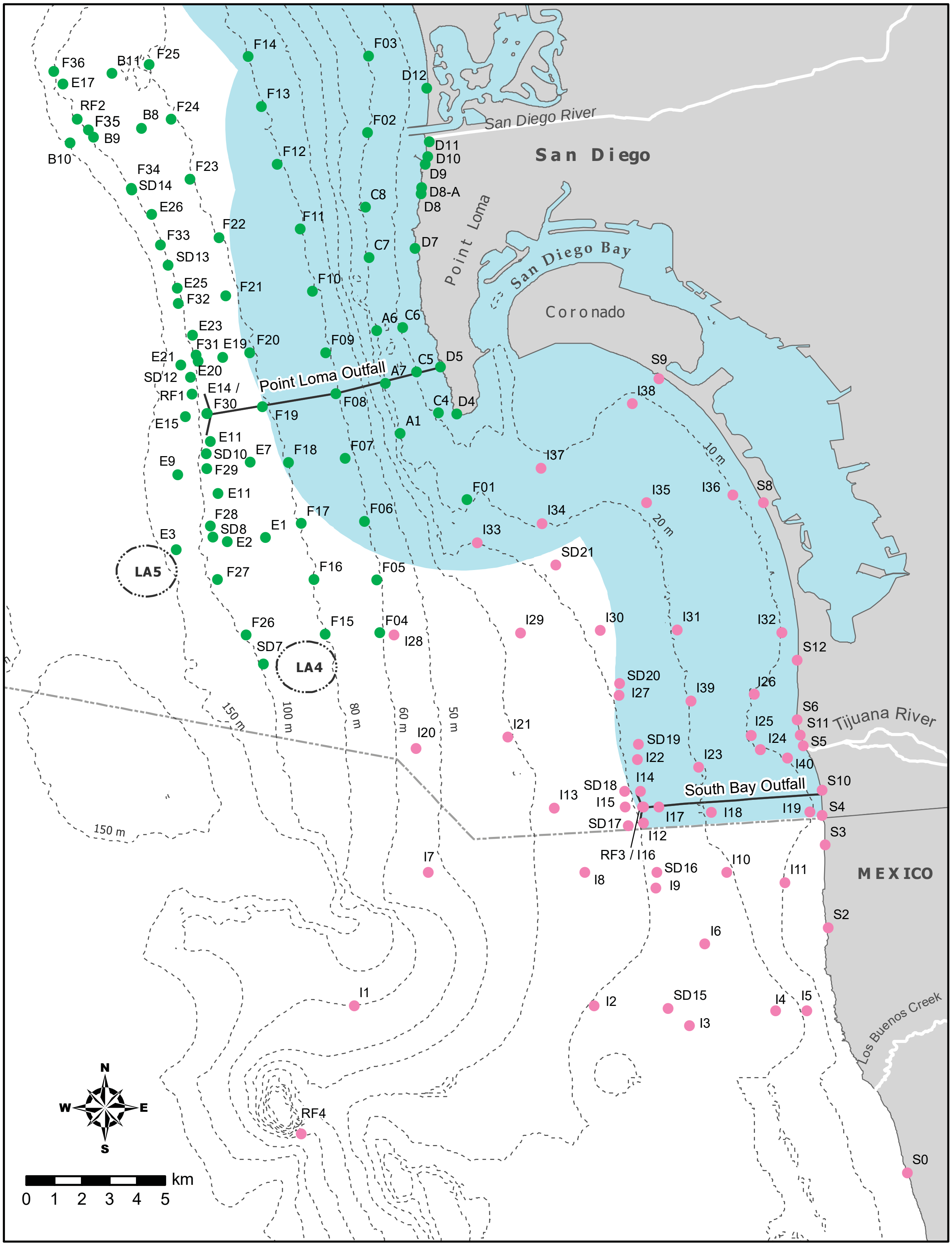

Figure 1.1

Core receiving waters monitoring stations for the Point Loma Ocean Outfall (green) and South Bay Ocean Outfall (pink) as part of the City of San Diego's Ocean Monitoring Program. Light blue shading represents State of California jurisdictional waters.

Table 1.1

NPDES permits and associated orders issued by the San Diego Water Board for the Point Loma Wastewater Treatment Plant (PLWTP), South Bay Water Reclamation Plant (SBWRP), and South Bay International Wastewater Treatment Plant (SBIWTP) discharges to the Pacific Ocean via the Point Loma Ocean Outfall (PLOO) and South Bay Ocean Outfall (SBOO).

Facility	Outfall	NPDES Permit No.	Order No.	Effective Dates
PLWTP	PLOO	CA0107409	R9-2017-0007	October 1, 2017–September 30, 2022
SBWRP	SBOO	CA0109045	R9-2013-0006 [a]	April 4, 2013–April 3, 2018
SBIWTP	SBOO	CA0108928	R9-2014-0009 [b]	August 1, 2014–July 31, 2019

[a] Order R9-2013-0006 amended by Order R9-2014-0071 and R9-2017-0023 (permit administratively extended)

[b] Order R9-2014-0009 amended by Order R9-2014-0094 and R9-2017-0024

Chapter 2. Water Quality

Introduction

The City of San Diego conducts extensive monitoring along the shoreline and in offshore coastal waters surrounding the Point Loma and South Bay ocean outfalls (PLOO and SBOO, respectively) to characterize regional water quality conditions and to identify possible impacts of wastewater discharge or other contaminant sources on the marine environment. In addition, the City's water quality monitoring efforts are designed to assess compliance with the water contact standards specified in the California Ocean Plan (Ocean Plan) to protect the beneficial uses of California's ocean waters (SWRCB 2015). This chapter presents summaries and preliminary analyses of the oceanographic and microbiological data collected during calendar year 2018 at a total of 103 water quality monitoring stations surrounding the PLOO and SBOO. Raw data summaries supporting these results are presented in Appendix A. A more comprehensive assessment of these results will be presented in the 2018-2019 Biennial Assessment Report to be submitted by July 1, 2020.

Materials and Methods

Field Sampling

Shore stations

Seawater samples were collected weekly at 19 shore stations to monitor densities of fecal indicator bacteria (FIB) in waters adjacent to public beaches (Figure 2.1). Sixteen of these stations are in State of California jurisdictional waters and are therefore subject to Ocean Plan water-contact standards (Table 2.1, SWRCB 2015). These include eight PLOO stations (D4, D5, D7, D8/D8-A/D8-B, D9, D10, D11, D12) located from Mission Beach southward to the tip of Point Loma and eight SBOO stations (S4, S5, S6, S8, S9, S10, S11, S12) located between the USA/Mexico border and Coronado. The other three SBOO shore stations (S0, S2, S3) are located south of the border and are not subject to Ocean Plan requirements.

Seawater samples were collected from the surf zone at each of the above stations in sterile 250-mL bottles, after which they were transported on blue ice to the City's Marine Microbiology Laboratory and analyzed to determine densities of three types of FIB (i.e., total coliform, fecal coliform, *Enterococcus* bacteria). In addition, weather conditions and visual observations of water color, surf height, and human or animal activity were recorded at the time of collection.

Kelp and other offshore stations

Fifteen stations located in relatively shallow waters within or near the Point Loma or Imperial Beach kelp forests (i.e., referred to as "kelp" stations herein) were monitored weekly to assess water quality conditions and Ocean Plan compliance in nearshore areas used for recreational activities such as SCUBA diving, surfing, fishing, and kayaking (Figure 2.1). These included PLOO stations C4, C5 and C6 located along the 9-m depth contour near the inner edge of the Point Loma kelp forest, PLOO stations A1, A6, A7, C7 and C8 located along the 18-m depth contour near the outer edge of the kelp forest, SBOO stations I25, I26 and I39 located at depths of 9–18 m contiguous to the Imperial Beach kelp bed, and SBOO stations I19, I24, I32 and I40 located in other nearshore waters along the 9-m depth contour in the South Bay region.

An additional 69 offshore stations were sampled quarterly to monitor water quality conditions and to estimate dispersion of the PLOO and SBOO wastewater plumes. These stations were monitored during February, May, August and November in 2018 with the 36 PLOO and 33 SBOO stations sampled over four to five days during each survey (Table 2.2). Stations F1–F36 are arranged in a grid surrounding the PLOO along or adjacent to the 18, 60, 80 and 100-m depth contours, while stations I1–I40 are arranged in a grid surrounding the SBOO along the 9, 19, 28, 38 and 55-m depth contours (Figure 2.1). Of these, 15 of the PLOO stations (i.e., F01–F03, F06–F14, F18–F20) and 15 of the SBOO stations (i.e., I12, I14, I16–I18, I22–I23, I27, I31, I33–I38) are located within State of California jurisdictional waters (i.e., within 3 nautical miles of shore) and therefore subject to the Ocean Plan compliance standards.

Seawater samples for FIB analyses were collected from 3–5 discrete depths at the kelp and offshore stations as indicated in Table 2.3. These samples were typically collected using a rosette sampler fitted with Niskin bottles surrounding a central conductivity, temperature, and depth instrument (CTD), although replacement samples due to misfires or other causes may have been collected from a separate follow-up cast using stand-alone Van Dorn bottles if necessary. All weekly kelp/nearshore samples and quarterly offshore SBOO samples were analyzed for all three types of FIB, while the quarterly offshore PLOO samples were only analyzed for *Enterococcus* per permit requirements. All FIB samples were refrigerated at sea and then transported on blue ice to the City's Marine Microbiology Lab for processing and analysis. Oceanographic data were collected using a SeaBird SBE 25 CTD. The CTD was lowered through the water column at each station to collect continuous measurements of water temperature, conductivity (used to calculate salinity), pressure (used to calculate depth), dissolved oxygen (DO), pH, transmissivity (a proxy for water clarity), chlorophyll *a* fluorescence (a proxy for phytoplankton), and colored dissolved organic matter (CDOM). Vertical profiles of each parameter were constructed for each station per survey by averaging the data values recorded within each 1-m depth bin. This level of data reduction ensures that physical measurements used in subsequent analyses will correspond to discrete sampling depths required for bacterial monitoring. Visual observations of weather, sea conditions, and human and/or animal activity were also recorded at the time of sampling.

Laboratory Analyses

The City Marine Microbiology Laboratory follows guidelines issued by the U.S. Environmental Protection Agency (USEPA) Water Quality Office, the California Department of Public Health (CDPH), and the California Environmental Laboratory Accreditation Program (CA ELAP) with respect to sampling and analytical procedures (Bordner et al. 1978, APHA 2005, 2012, CDPH 2000, USEPA 2009). All bacterial analyses were initiated within eight hours of sample collection and conformed to standard membrane filtration techniques, for which the laboratory is certified (APHA 2005, 2012).

FIB densities were determined and validated in accordance with USEPA and APHA guidelines (Bordner et al. 1978, APHA 2005, 2012, USEPA 2009). Plates with FIB counts above or below the ideal counting range were given greater than (>), greater than or equal to (≥), less than (<), or estimated (e) qualifiers. However, these qualifiers were dropped and the counts treated as discrete values when calculating means and in determining compliance with Ocean Plan standards.

Quality assurance tests were performed routinely on bacterial samples to ensure that analyses and sampling variability did not exceed acceptable limits. Laboratory and field duplicate bacteriological samples were processed according to method requirements to measure analyst precision and variability between samples, respectively. Results of these procedures were reported under separate cover (City of San Diego 2019).

Data Analyses

Oceanographic data analyses

Water column parameters measured in 2018 were summarized as quarterly means for each monitoring region by the following depth layers: PLOO stations = 1–20 m, 21–60 m, 61–80 m, and 81–100 m; SBOO stations = 1–9 m, 10–19 m, 20–28 m, 29–38 m, and 39–55 m. Unless otherwise noted, analyses were performed using R (R Core Team, 2018) and various functions within the following packages: zoo, reshape2, Rmisc, fields, RODBC, mixOmics, Hmisc, oce, dplyr, data.table (Zeileis and Grothendieck 2005, Wickham 2007, Hope 2013, Nychka et al. 2017, Ripley and Lapsley 2017, Rohart et al. 2017, Harrell et al. 2018, Kelley and Richards 2018, Wickham and Francois 2018, Dowle and SrinivaSan 2019).

Bacteriological data analyses

Compliance with Ocean Plan water-contact standards was summarized as the number of times per survey that stations within state waters exceeded geometric mean or single sample maximum (SSM) standards for total coliforms, fecal coliforms, and *Enterococcus* (Table 2.1, SWRCB 2015). Exceedances observed during resampling were included in these calculations. These analyses were performed using R (R Core Team, 2018) and various functions within the following packages: reshape2, RODBC, Hmisc, quantreg, psych, openxlsx, gtools, tidyr (Wickham 2007, Ripley and Lapsley 2017, Harrell et al. 2018, Koenker 2018, Revelle 2018, Walker 2018, Warnes et al. 2018, Wickham and Henry 2018).

Wastewater Plume Detection and Out-of-Range Calculations

Presence or absence of the wastewater plume at the PLOO and SBOO offshore stations was estimated by evaluation of a combination of oceanographic parameters (i.e., detection criteria). All stations along the 9-m depth contour were excluded from analyses due to the potential for coastal runoff or sediment resuspension in shallow nearshore waters to confound any CDOM signal that could be associated with plume dispersion from the outfalls (Appendices A.1, A.2). Previous monitoring results have consistently found that the PLOO plume remains trapped below the pycnocline with no evidence of surfacing throughout the year (City of San Diego 2010a–2014a, 2015b, 2016a, 2018, Rogowski et al. 2012a, b, 2013). In contrast, the SBOO plume stays trapped below the pycnocline during seasonal periods of water column stratification, but may rise to the surface when waters become more mixed and stratification breaks down (City of San Diego 2010b–2014b, 2015c, 2016b, 2018, Terrill et al. 2009). Water column stratification and pycnocline depth were quantified using buoyancy frequency (BF, cycles/min) calculations for each quarterly survey. This measure of the water column's static stability was used to quantify the magnitude of stratification for each survey and was calculated as follows:

$$BF = \sqrt{((g)/\rho) \times (d\rho/dz)}$$

where g is the acceleration due to gravity, ρ is the seawater density, and dρ/dz is the density gradient (Mann and Lazier 1991). The depth of maximum BF was used as a proxy for the depth at which stratification was the greatest. If the water column was determined to be stratified (i.e., maximum BF > 5.5 cycles/min), subsequent analyses were limited to depths below the pycnocline.

Identification of potential plume signal at each monitoring station was based on a combination of CDOM, chlorophyll *a* and salinity levels, as well as a visual review of the overall water column profile. Detection thresholds for the PLOO and SBOO stations were adaptively set for each quarterly sampling period according to the criteria described in City of San Diego (2016a, b). It should be noted that these thresholds are based on observations of ocean properties specific to the distinct PLOO and SBOO monitoring regions, and are thus constrained to use within those regions. Finally, water column profiles were visually interpreted to remove stations with spurious signals (e.g., CDOM signals near the sea floor that were likely caused by resuspension of sediments). All analyses were performed using R (R Core Team, 2018) and the various functions within the following packages: reshape2, Rmisc, gridExtra, fields, RODBC, mixOmics, tidyverse, pracma, oce, gtools, ggplot2 (Wickham 2007, Hope 2013, Auguie 2017, Nychka et al 2017, Ripley and Lapsley 2017, Rohart et al 2017, Wickham 2017, Borchers 2018, Kelley and Richards 2018, Warnes et al 2018, Wickham et al 2018).

The effect of any potential "plume detection" on local water quality was evaluated by comparing mean values of DO, pH, and transmissivity within the possible plume boundaries to thresholds calculated for the same depths from reference stations. Stations with CDOM values below the 85th percentile were considered "reference" (Appendix A.3). Individual non-reference stations were then determined to be out-of-range (OOR) compared to the reference stations if values for the above parameters exceeded narrative water quality standards defined in the Ocean Plan (see Table 2.1). For example, the Ocean Plan defines OOR thresholds for DO as a 10% reduction from that which occurs naturally, for pH as a 0.2 pH unit change, and for transmissivity as below the lower 95% confidence interval from the mean. For purposes of this report, "naturally" is defined for DO as the mean concentration minus one standard deviation (see Nezlin et al. 2016).

Results

All water quality data and associated visual observations for calendar year 2018 have been previously reported in monthly receiving waters monitoring reports submitted to the San Diego Water Board and the USEPA (see City of San Diego 2018-2019a, b).

Oceanographic Conditions in 2018

Ocean temperatures, salinity, DO, pH, transmissivity, and chlorophyll *a* data recorded in 2018 for the PLOO and SBOO monitoring regions are summarized by depth layer for the entire year in Tables 2.4 and 2.5, and by depth layer for each survey in Appendices A.4 and A.5. These same parameters are plotted by depth and survey in Appendices A.6–A.17.

Water Quality Conditions in 2018

Bacteriological Compliance

Compliance rates for the different geometric mean and single sample maximum (SSM) Ocean Plan water-contact standards are summarized in Tables 2.6 and 2.7. All seawater samples collected from the PLOO and SBOO water quality stations that contained elevated FIB densities are listed in Appendices A.18 and A.19.

Plume Dispersion and Effects

The dispersion of wastewater plumes in 2018 and their effects on natural light, DO and pH levels in local ocean waters off San Diego were assessed by evaluating the results of 164 CTD profile casts performed at the PLOO stations and another 116 CTD casts performed at the SBOO stations. These results are summarized in Appendices A.20 and A.21.

Summary

Oceanographic conditions off San Diego in 2018 in terms of ocean temperatures, salinity, dissolved oxygen concentrations, pH, transmissivity, and concentrations of chlorophyll *a* were generally within historical ranges reported for the PLOO and SBOO monitoring regions. Conditions typically indicative of coastal upwelling were most evident during the spring months, while maximum stratification or layering of the water column occurred during mid-summer, after which the waters became more mixed in the winter. Decreases in water clarity or transmissivity tended to be associated with terrestrial runoff or outflows from rivers and bays, the re-suspension of nearshore bottom sediments due to waves or storm activity, or the presence of phytoplankton blooms.

The detection of the PLOO and SBOO wastewater plumes and their effects on various water quality indicators such as natural light levels, dissolved oxygen concentrations, and pH were low in 2018. Additionally, water quality conditions were excellent in both regions during this year. For example, overall compliance with the Ocean Plan water contact standards was 96% in 2018, which was similar to results for 2016-2017 (e.g., City of San Diego 2018). Compliance with both the SSM and geometric mean standards was typically higher at the PLOO and SBOO kelp and offshore stations compared to stations along the shore, and also tended to be higher at the PLOO stations than at the SBOO stations. Reduced compliance in both outfall regions tended to occur during the wet season. Finally, there was no evidence that wastewater discharged into the ocean via either outfall reached nearshore recreational waters.

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Chapter 2

Figures & Tables

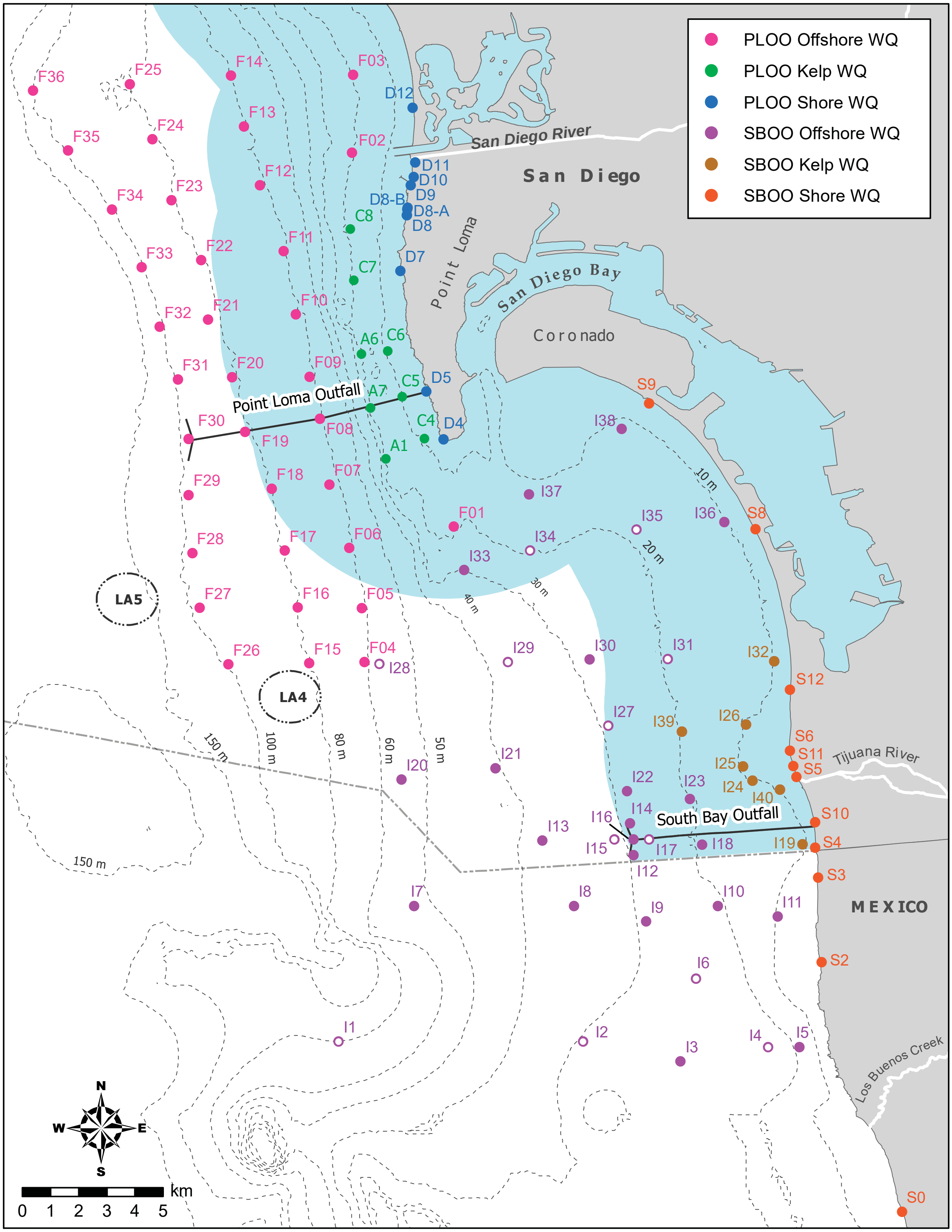

Figure 2.1
Water quality (WQ) monitoring station locations sampled around the Point Loma and South Bay ocean outfalls as part of the City of San Diego's Ocean Monitoring Program. Light blue shading represents State of California jurisdictional waters. Open circles are sampled by CTD only.

Table 2.1
Water quality objectives for water-contact areas, California Ocean Plan (SWRCB 2015).

A. Bacterial Characteristics – Water Contact Standards; CFU = colony forming units

(a) 30-day Geometric Mean - The following standards are based on the geometric mean of the five most recent samples from each site:

1) Total coliform density shall not exceed 1000 CFU/100 mL
2) Fecal coliform density shall not exceed 200 CFU/100 mL
3) *Enterococcus* density shall not exceed 35 CFU/100 mL

(b) Single Sample Maxium:

1) Total coliform density shall not exceed 10,000 CFU/100 mL
2) Fecal coliform density shall not exceed 400 CFU/100 mL
3) *Enterococcus* density shall not exceed 104 CFU/100 mL
4) Total coliform density shall not exceed 1000 CFU/100 mL when the fecal coliform:total coliform ratio exceeds 0.1

B. Physical Characteristics

(a) Floating particulates and oil and grease shall not be visible
(b) The discharge of waste shall not cause aesthetically undesirable discoloration of the ocean surface
(c) Natural light shall not be significantly reduced at any point outside of the initial dilution zone as the result of the discharge of waste

C. Chemical Characteristics

(a) The dissolved oxygen concentration shall not at any time be depressed more than 10 percent from what occurs naturally, as a result of the discharge of oxygen demanding waste materials

Table 2.2

Sample dates for quarterly oceanographic surveys conducted during 2018. All stations in each station group were sampled on a single day (see Figure 2.1 for stations and locations).

PLOO Sampling Dates					SBOO Sampling Dates				
Station Group	**Feb**	**May**	**Aug**	**Nov**	**Station Group**	**Feb**	**May**	**Aug**	**Nov**
Kelp WQ	16	Apr 30	27	14	Kelp WQ	5	14	20	5
18 & 60-m WQ	13	1	28	16	North WQ	8	18	23	8
80-m WQ	14	3	29	15	Mid WQ	7	17	22	7
100-m WQ	15	2	30	17	South WQ	6	15	21	6

Table 2.3

Depths from which seawater samples are collected for bacteriological analysis from kelp and offshore stations.

Station Contour	PLOO Sample Depth (m)								
	1	3	9	12	18	25	60	80	98
Kelp Bed									
9-m	x	x	x						
18-m	x			x	x				
Offshore									
18-m	x			x	x				
60-m	x					x	x		
80-m	x					x	x	x	
100-m	x					x	x	x	x

Station Contour	SBOO Sample Depth (m)							
	2	6	9/11	12	18	27	37	55
Kelp Bed								
9-m	x	x	x[a]					
19-m	x			x	x			
Offshore								
9-m	x	x	x[a]					
19-m	x			x	x			
28-m	x				x	x		
38-m	x				x		x	
55-m	x				x			x

[a] Stations I25, I26, I32, and I40 sampled at 9 m; stations I11, I19, I24, I36, I37, and I38 sampled at 11 m

Table 2.4

Summary of temperature, salinity, dissolved oxygen (DO), pH, transmissivity, and chlorophyll *a* for various depth layers as well as the entire water column for all PLOO stations during 2018. See Appendix A.19 for sample sizes.

		Depth (m)				
Parameter		**1–20**	**21–60**	**61–80**	**81–100**	**1–100**
Temperature (°C)	min	10.7	9.8	9.6	9.5	9.5
	max	23.9	18.6	14.8	13.6	23.9
	mean	16.5	13.5	12.0	11.3	13.9
Salinity (ppt)	min	33.36	33.45	33.44	33.43	33.36
	max	33.87	33.88	33.94	34.01	34.01
	mean	33.62	33.57	33.61	33.66	33.60
DO (mg/L)	min	4.1	3.3	3.2	3.0	3.0
	max	9.3	8.8	7.8	7.0	9.3
	mean	7.7	6.6	5.4	4.9	6.6
pH	min	7.8	7.7	7.7	7.7	7.7
	max	8.3	8.2	8.1	8.1	8.3
	mean	8.1	8.0	7.9	7.9	8.0
Transmissivity (%)	min	25	77	71	49	25
	max	90	90	90	90	90
	mean	85	87	87	87	87
Chlorophyll *a* (µg/L)	min	0.0	0.0	0.0	0.0	0.0
	max	3.3	6.3	2.0	0.5	6.3
	mean	0.7	0.9	0.3	0.1	0.7

Table 2.5

Summary of temperature, salinity, dissolved oxygen (DO), pH, transmissivity, and chlorophyll *a* for various depth layers as well as the entire water column for all SBOO stations during 2018. See Appendix A.20 for sample sizes.

		Depth (m)					
Parameter		**1–9**	**10–19**	**20–28**	**29–38**	**39–55**	**1–55**
Temperature (°C)	min	12.3	11.0	10.9	10.7	10.5	10.5
	max	24.2	23.1	18.2	16.8	15.4	24.2
	mean	17.7	15.6	14.4	13.7	13.0	15.8
Salinity (ppt)	min	33.30	33.33	33.44	33.44	33.45	33.30
	max	33.99	34.02	33.67	33.69	33.72	34.02
	mean	33.62	33.56	33.54	33.54	33.55	33.57
DO (mg/L)	min	6.6	4.9	4.3	4.0	3.8	3.8
	max	10.3	10.2	8.9	8.6	8.6	10.3
	mean	8.6	8.1	7.2	6.8	6.3	7.9
pH	min	8.0	7.8	7.8	7.7	7.7	7.7
	max	8.3	8.4	8.3	8.2	8.2	8.4
	mean	8.2	8.1	8.0	8.0	7.9	8.1
Transmissivity (%)	min	49	30	51	61	78	30
	max	89	90	90	89	89	90
	mean	80	80	82	85	87	81
Chlorophyll *a* (µg/L)	min	0.0	0.0	0.0	0.1	0.3	0.0
	max	25.9	48.0	32.5	26.4	2.1	48.0
	mean	1.4	4.8	4.6	2.1	0.9	3.0

Table 2.6

Compliance rates for the three geometric mean water-contact standards and for the four single sample maximum water contact standards from the PLOO monitoring stations during 2018. PLOO offshore stations are sampled quarterly and total and fecal coliform bacteria are not analyzed at these stations; ns = not sampled.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Geometric Mean												
Shore Stations												
Total	100	100	100	100	100	100	100	100	100	100	100	100
Fecal	100	100	100	100	100	100	100	100	100	100	100	100
Entero	92	96	100	100	100	100	100	100	100	100	100	100
Kelp Stations												
Total	100	100	100	100	100	100	100	100	100	100	100	100
Fecal	100	100	100	100	100	100	100	100	100	100	100	100
Entero	100	100	100	100	100	100	100	100	100	100	100	100
Single Sample Maximum												
Shore Stations												
Total	93	100	100	100	100	100	100	100	100	100	100	100
Fecal	90	100	100	100	100	100	100	100	100	100	100	100
Entero	88	96	96	100	97	100	93	100	100	100	100	100
F:T	95	100	100	100	100	100	100	100	100	100	100	100
Kelp Stations												
Total	100	100	100	100	100	100	100	100	100	100	100	100
Fecal	100	100	100	100	100	100	100	100	99	100	100	100
Entero	100	100	100	100	100	100	100	100	99	100	100	100
F:T	100	100	100	100	100	100	100	100	99	100	100	100
Offshore Stations												
Entero	ns	100	ns	ns	94	ns	ns	98	ns	ns	100	ns

Table 2.7

Compliance rates for the three geometric mean water-contact standards and the four single sample maximum water contact standards from the SBOO monitoring stations during 2018. SBOO offshore stations are sampled quarterly; ns = not sampled.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Geometric Mean												
Shore Stations												
Total	98	98	96	96	100	100	100	100	100	100	100	73
Fecal	98	98	100	100	100	100	100	100	100	100	100	69
Entero	67	83	94	99	100	99	89	100	100	100	100	56
Kelp Stations												
Total	100	100	100	100	100	100	100	100	100	100	100	92
Fecal	100	100	100	100	100	100	100	100	100	100	100	92
Entero	100	100	100	100	100	100	100	100	100	100	100	89
Single Sample Maximum												
Shore Stations												
Total	82	100	97	100	100	100	100	100	100	100	100	63
Fecal	82	100	97	100	100	100	100	100	100	98	100	47
Entero	69	100	97	100	100	72	95	100	97	98	100	45
F:T	88	100	97	100	100	100	100	100	100	95	100	58
Kelp Stations												
Total	97	100	99	100	100	100	100	100	100	100	100	86
Fecal	95	100	99	98	100	100	100	100	100	100	100	71
Entero	90	100	100	97	100	89	91	100	100	100	100	80
F:T	97	100	100	99	100	100	100	100	100	100	100	77
Offshore Stations												
Total	ns	100	ns	ns	100	ns	ns	100	ns	ns	100	ns
Fecal	ns	100	ns	ns	100	ns	ns	100	ns	ns	100	ns
Entero	ns	100	ns	ns	100	ns	ns	100	ns	ns	100	ns
F:T	ns	100	ns	ns	100	ns	ns	100	ns	ns	100	ns

Chapter 3. Benthic Conditions

Introduction

The City of San Diego conducts extensive monitoring of the benthic sediments and communities of small benthic invertebrates (macrofauna) that live within or on the surface of soft-bottom seafloor habitats surrounding the Point Loma and South Bay Ocean Outfalls (PLOO and SBOO, respectively) to characterize regional benthic conditions and identify potential effects of wastewater discharge or other anthropogenic inputs on the marine benthic environment. This chapter presents summaries and preliminary analyses of the sediment quality and macrofaunal community data collected during calendar year 2018 at benthic monitoring stations surrounding the PLOO and SBOO. Raw data summaries supporting these results are presented in Appendix B. A more comprehensive assessment of these results will be presented in the 2018-2019 Biennial Assessment Report to be submitted by July 1, 2020.

Materials and Methods

Collection and Processing of Samples

Samples were collected at 49 permanent benthic stations to monitor ocean sediments and macrofaunal communities during winter (January) and summer (July) of 2018 (Figure 3.1). These included 12 primary core PLOO stations located along the 98-m depth contour (i.e., PLOO discharge depth), 10 secondary core stations arranged in a grid surrounding the PLOO along or adjacent to the 88-m or 116-m depth contours, 12 primary core SBOO stations located along the 28-m depth contour (i.e., SBOO discharge depth), and 15 secondary core stations arranged in a grid surrounding the SBOO along or adjacent to the 19, 38, or 55-m depth contours. The four stations located within 1000 m of the zone of initial dilution (ZID) for each outfall are considered to represent near-ZID conditions. These include PLOO stations E11, E14, E15 and E17, and SBOO stations I12, I14, I15 and I16. All 49 stations were sampled during January 2018 for the winter survey, while only the primary core PLOO and SBOO stations, plus PLOO station E15, were sampled during the summer of 2018 due to an approved resource exchange agreement to allow City and U.S. Section of the International Boundary and Water Commission (USIBWC) participation in the Bight'18 regional monitoring program.

Samples for sediment and benthic community analyses were collected using a double 0.1-m^2 Van Veen grab. Sub-samples for various sediment grain size and chemical analyses were taken from the top 2 cm of the sediment surface of one of the two grabs and handled according to standard guidelines available in USEPA (1987). The other grab sample from the cast was used for macrofaunal community analysis. Visual observations of weather, sea conditions, and human or animal activity were also recorded at the time of sampling (see Addendum 1A).

Criteria established by the U.S. Environmental Protection Agency (USEPA) to ensure consistency of samples for benthic community analysis were followed with regard to sample disturbance and depth of penetration (USEPA 1987). All samples were brought aboard ship, washed with seawater, and sieved through a 1.0-mm mesh screen. The organisms retained on the screen were then collected, transferred to sample jars, and relaxed for 30 minutes in a magnesium sulfate solution before being fixed with buffered formalin. After a minimum of 72 hours in the buffered formalin, each sample was rinsed with fresh water and transferred to 70% ethanol for final preservation. All macrofaunal organisms were separated from the raw material and sorted into six major taxonomic groups (i.e., Annelida, Arthropoda, Mollusca, Echinodermata, Ophiuroidea, miscellaneous phyla) by a subcontract lab, after which they were identified to species (or the lowest taxon possible) and enumerated by City marine biologists. All identifications followed nomenclatural standards established by the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT 2018).

Laboratory Analyses

All sediment chemistry and particle size analyses were performed at the City of San Diego's Environmental Chemistry Services Laboratory. A detailed description of the analytical protocols can be found in City of San Diego (2019). Briefly, sediment sub-samples were analyzed on a dry weight basis to determine concentrations of various indictors of organic loading (i.e., biochemical oxygen demand, total organic carbon, total nitrogen, total sulfides, total volatile solids), 18 trace metals, 9 chlorinated pesticides, 40 polychlorinated biphenyl compound congeners (PCBs), and 24 polycyclic aromatic hydrocarbons (PAHs). These data were generally limited to values above the method detection limit (MDL) for each parameter (see Appendix B.1). However, concentrations below MDLs were included as estimated values if presence of the specific constituent was verified by mass spectrometry.

Particle size analysis was performed using either a Horiba LA-950V2 Laser Particle Size Analyzer or a set of nested sieves. The Horiba measures particles ranging in size from 0.5 to 2000 µm. Coarser sediments were removed and quantified prior to laser analysis by screening samples through a 2000 µm mesh sieve. These data were later combined with the Horiba results to obtain a complete distribution of particle sizes totaling 100%, and then classified into 11 sub-fractions and four main size fractions based on the Wentworth scale (Folk 1980) (see Appendix B.2). When a sample contained substantial amounts of coarse sand, gravel, shell hash or other large materials that could damage the Horiba analyzer or where the general distribution of sediments would be poorly represented by laser analysis, a set of nested sieves with mesh sizes of 2000 µm, 1000 µm, 500 µm, 250 µm, 125 µm, and 63 µm was used to divide the samples into seven sub-fractions.

Data Analyses

Sediments

Data summaries for the various sediment parameters included detection rate, mean, minimum and maximum values for all samples by outfall region (i.e., PLOO, SBOO). All means were calculated using detected values only with no substitutions made for non-detects (i.e., concentrations < MDL). Total DDT (tDDT), total hexachlorocyclohexane (tHCH), total chlordane, total PCB (tPCB), and total PAH (tPAH) were calculated for each sample as the sum of all constituents with reported values for individual constituents. Contaminant concentrations were compared to the Effects Range Low (ERL) and Effects Range Median (ERM) sediment quality guidelines of Long et al. (1995) when available. ERLs represent chemical concentrations below which adverse biological effects are rarely observed, while values above ERLs but below ERMs represent levels at which effects occasionally occur. Concentrations above the ERM indicate likely biological effects, although these may not always be validated by toxicity testing (Schiff and Gossett 1998). Analyses were performed using R (R Core Team 2018) and various functions within the dplyr, plyr, reshape2, tidyr, and zoo packages (Zeileis and Grothendieck 2005, Wickham 2007, 2011, Wickham and Henry 2017, Wickham et al. 2017).

Macrobenthic Assemblages

The following benthic community metrics were determined for each station and expressed per 0.1-m^2 grab: species richness (number of species or distinct taxa), abundance (number of individuals), Shannon diversity index (H'), Pielou's evenness index (J'), Swartz dominance index (see Swartz et al. 1986, Ferraro et al. 1994), and benthic response index (BRI; see Smith et al. 2001). Unless otherwise noted, the above analyses were performed using R (R Core Team 2018) and various functions within the reshape2, Rmisc, RODBC, tidyverse, and vegan packages (Wickham 2007, 2017, Hope 2013, Oksanen et al. 2017, Ripley and Lapsley 2017).

To examine spatial and temporal patterns among benthic communities in the PLOO and SBOO regions, multivariate analyses were performed on macrofaunal abundance data using methods available in PRIMER v7, which included hierarchical agglomerative clustering (cluster analysis) with group-average linking and similarity profile analysis (SIMPROF) to confirm the non-random structure of resultant cluster dendrograms (see Clarke et al. 2008, 2014). The Bray-Curtis measure of similarity was used as the basis for clustering, and data were square-root transformed to lessen the influence of overly abundant species and increase the importance (or impact) of rare species. Major ecologically-relevant clusters receiving SIMPROF support were retained.

Results

Sediment Quality in 2018

Sediment grain size (i.e., main particle size fractions) and chemistry data are summarized for the PLOO and SBOO monitoring regions in Table 3.1. The particle size composition of sediments is summarized for each station by survey in Appendices B.3 and B.4. Concentrations of organic loading indicators are summarized for each station by survey in Appendices B.5 and B.6. Trace metal concentrations are summarized for each station by survey in Appendices B.7 and B.8. Concentrations of detected pesticides, total PCB, and total PAH are summarized for each station by survey in Appendices B.9 and B.10. Individual constituents of total chlordane, total DDT, total HCH, total PCB, and total PAH are listed by station for each survey in Appendices B.11 and B.12.

Macrobenthic Communities in 2018

Key community structure parameters, including species richness, abundance, diversity, evenness, dominance, and BRI as indicated above are summarized for the PLOO and SBOO monitoring regions in Table 3.2. These same parameters are listed by station and survey in Appendices B.13 and B.14. The 25 most abundant macroinvertebrate taxa identified during 2018 are summarized by percent abundance, frequency of occurrence, and abundance per grab in Tables 3.3 and 3.4. Total numbers of each individual taxon encountered are listed in Appendices B.15 and B.16. A cluster analysis was performed to illustrate and quantify the ecological patterns at the macroinvertebrate community level within each region. Figures 3.2 and 3.3 show the resulting dendrograms and SIMPROF supported cluster groups.

Summary

Preliminary analysis of sediment and macroinvertebrate data collected in 2018 indicate that wastewater discharged through the Point Loma and South Bay ocean outfalls has not negatively impacted benthic communities in the coastal waters off San Diego. During the current reporting period, there was no evidence of fine-particle loading related to wastewater discharge via the PLOO or SBOO. Contaminant concentrations at near-ZID stations were generally within the range of variability observed throughout both outfall regions and did not appear to be reflect any significant organic enrichment. The quality of PLOO and SBOO sediments in 2018 was similar to previous years (e.g., City of San Diego 2018), with overall contaminant concentrations remaining relatively low compared to available thresholds or other southern California coastal areas (Schiff and Gossett 1998, Noblet et al. 2002, Schiff et al. 2006, 2011, Maruya and Schiff 2009, Dodder et al. 2016). Further, values for most benthic infauna community parameters were similar at stations located both near and far away from the outfall discharge sites. These metrics were within historical ranges reported for the San Diego region (e.g., City of San Diego 2018), and were representative of those characteristic of similar habitats throughout the Southern California Bight (Barnard and Ziesenhenne 1961, Jones 1969, Fauchald and Jones 1979, Thompson et al. 1987, 1993a, b, Zmarzly et al. 1994, Diener and Fuller 1995, Bergen et al. 1998, 2000, 2001, Ranasinghe et al. 2003, 2007, 2010, 2012, Mikel et al. 2007, Gillett et al. 2017).

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Chapter 3

Figures & Tables

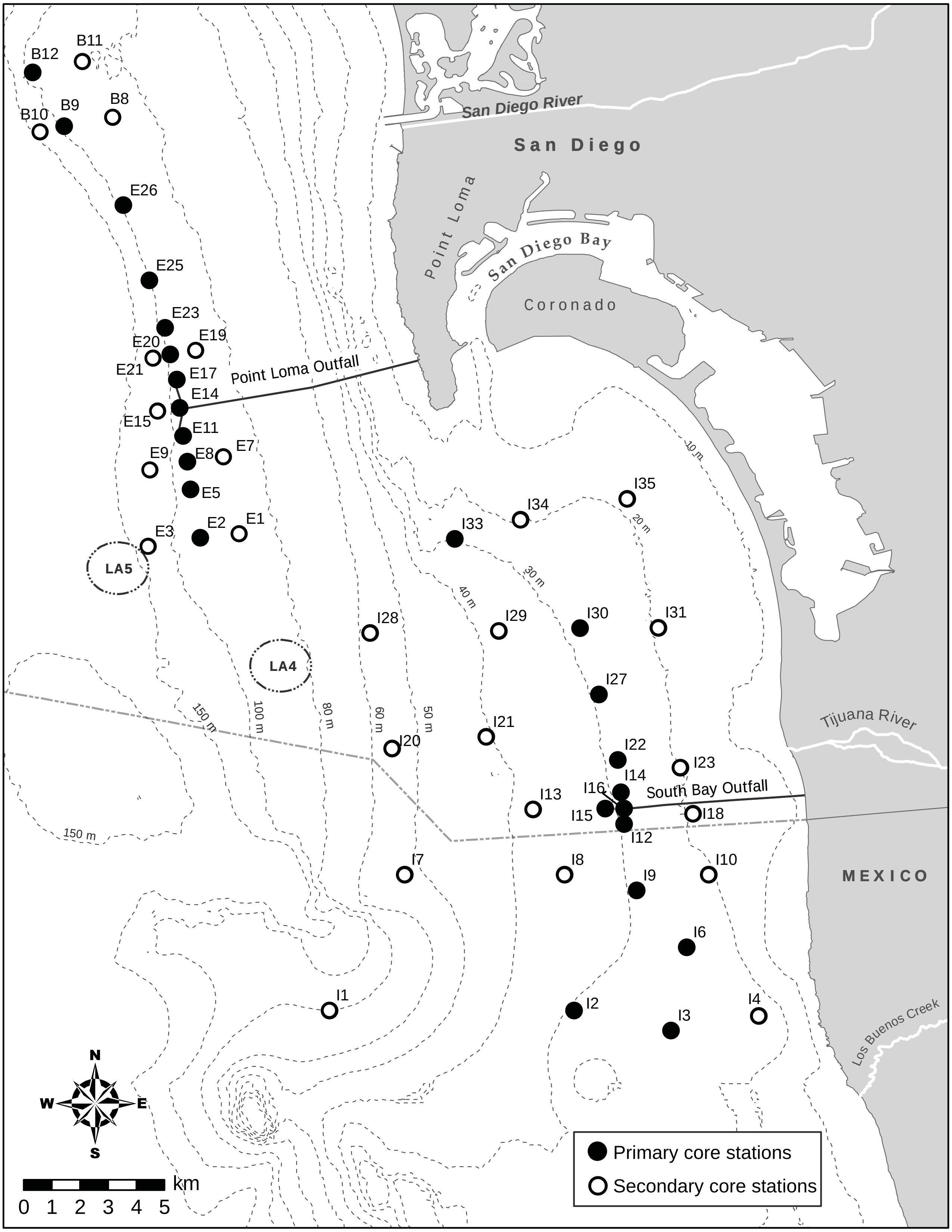


Figure 3.1
Benthic station locations sampled around the Point Loma and South Bay Ocean Outfalls as part of the City of San Diego's Ocean Monitoring Program.

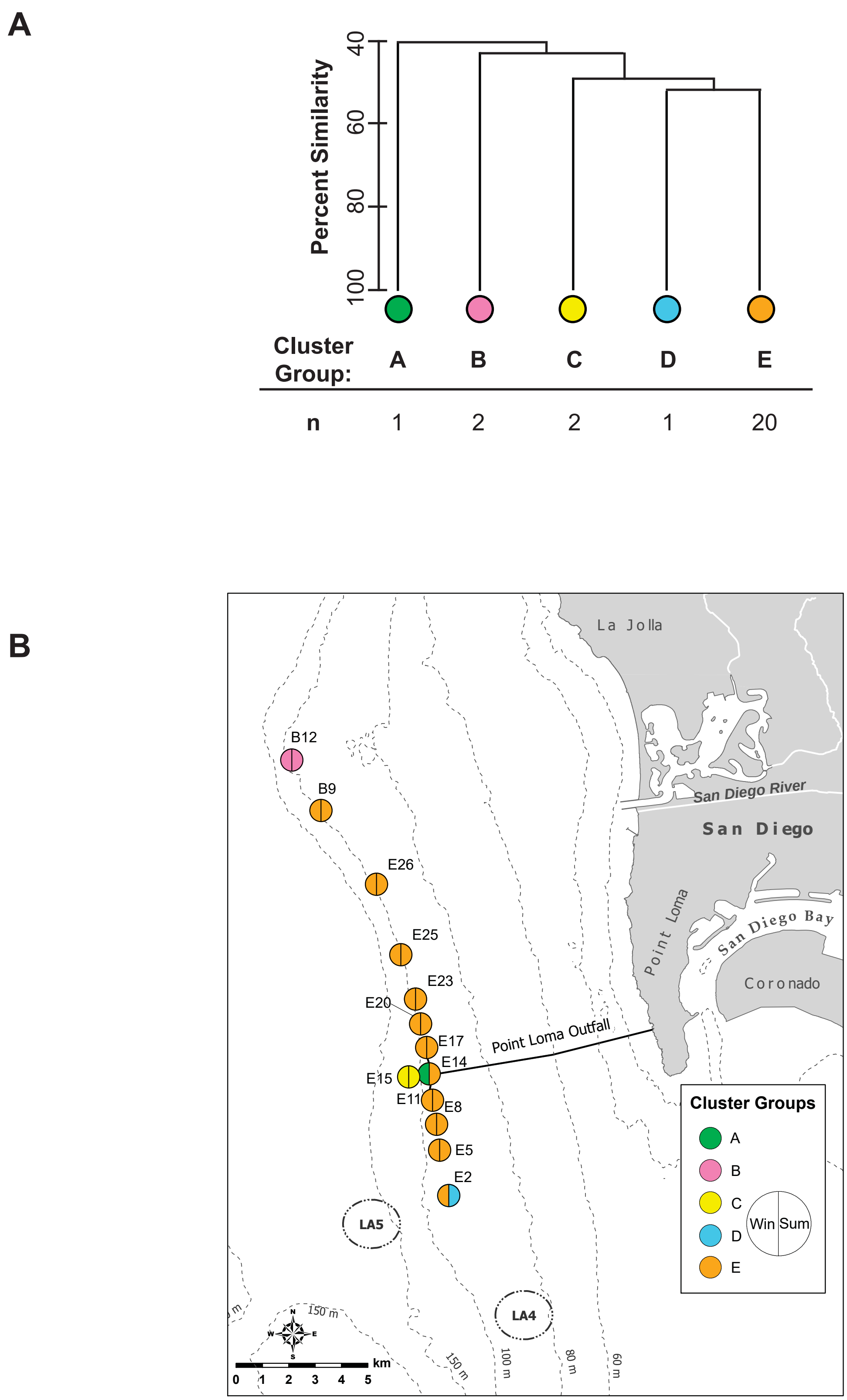
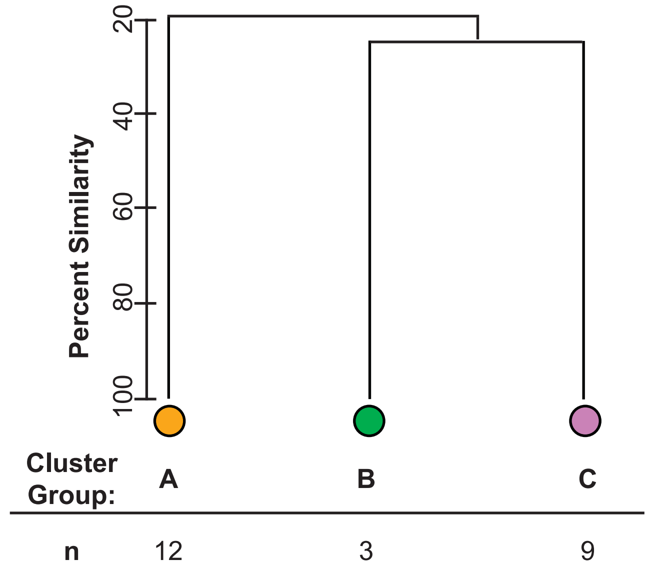


Figure 3.2
Results of cluster analysis of macrofaunal assemblages at PLOO primary core benthic stations sampled during 2018. Data are presented as: (A) dendrogram of main cluster groups and (B) distribution of cluster groups in the PLOO region during winter (Win) and summer (Sum) surveys.

A



B

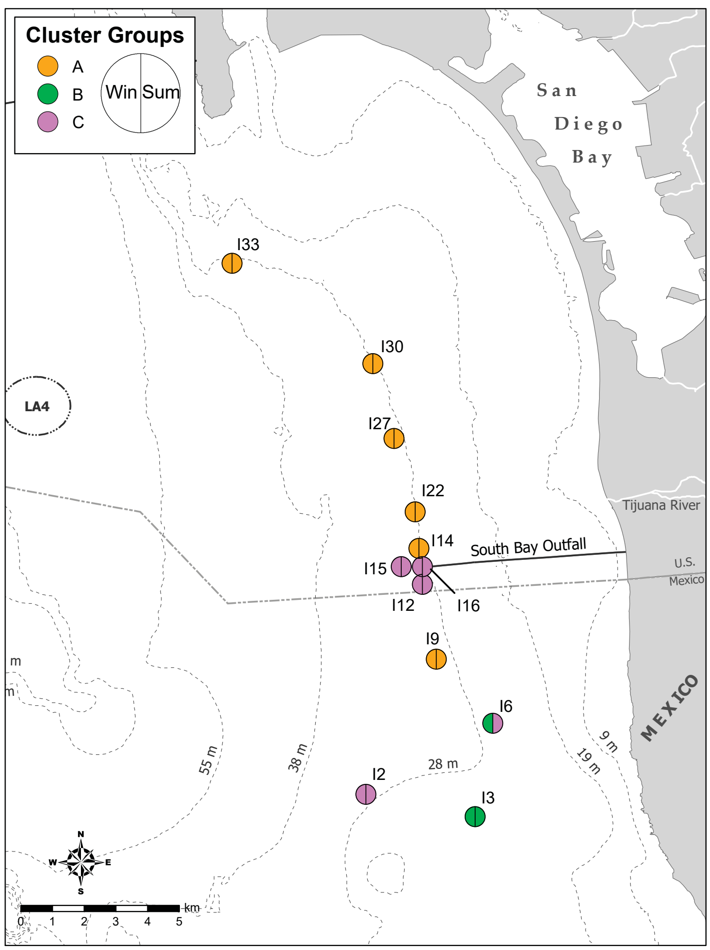


Figure 3.3
Results of cluster analysis of macrofaunal assemblages at SBOO primary core benthic stations sampled during 2018. Data are presented as: (A) dendrogram of main cluster groups and (B) distribution of cluster groups in the SBOO region during winter (Win) and summer (Sum) surveys.

Table 3.1

Summary of particle sizes and chemistry concentrations in sediments from PLOO and SBOO benthic stations sampled during 2018. Data include the detection rate (DR), mean, minimum, and maximum values for the each survey area; nd = not detected.

	PLOO[a]				SBOO[b]			
Parameter	**DR (%)**	**Mean**	**Min**	**Max**	**DR (%)**	**Mean**	**Min**	**Max**
Particle Size								
Coarse Particles(%)	29	1.9	0.0	23.4	54	3.8	0.0	44.8
Med-Coarse Sands (%)	100	4.7	0.1	27.8	100	38.0	0.4	91.3
Fine sands (%)	100	58.1	36.9	84.1	100	49.6	0.9	90.9
Fines (%)	100	35.4	12.5	63.1	90	8.6	0.0	34.4
Organic Indicators								
BOD (ppm)	100	305.72	159.00	584.00	ns	ns	ns	ns
Sulfides (ppm)	100	8.38	1.44	108.00	74	4.28	nd	37.40
TN (% weight)	100	0.05	0.03	0.08	59	0.03	nd	0.05
TOC (% weight)	100	0.53	0.29	2.01	72	0.18	nd	0.70
TVS (% weight)	100	1.94	1.20	3.50	100	0.69	0.30	1.20
Trace Metals (ppm)								
Aluminum	100	6713	4670	10400	100	3284	572	7180
Antimony	94	1.09	nd	1.83	28	0.63	nd	0.94
Arsenic	100	2.52	1.76	4.63	77	2.66	nd	9.78
Barium	100	29.39	16.10	62.70	100	14.97	1.37	35.80
Beryllium	40	0.15	nd	0.29	21	0.09	nd	0.12
Cadmium	37	0.073	nd	0.111	10	0.045	nd	0.049
Chromium	100	14.59	10.30	22.40	100	8.31	2.97	12.10
Copper	94	3.41	nd	6.42	38	1.37	nd	2.14
Iron	100	10489	6700	19400	100	5035	1210	8810
Lead	100	3.05	1.98	5.19	100	1.53	0.82	3.06
Manganese	100	76.25	53.50	122.00	100	40.96	5.61	88.20
Mercury	37	0.021	nd	0.051	8	0.007	nd	0.012
Nickel	100	5.06	3.58	7.85	95	1.73	nd	3.63
Selenium	77	0.49	nd	0.64	13	0.28	nd	0.41
Silver	0	—	—	—	0	—	—	—
Thallium	0	—	—	—	0	—	—	—
Tin	83	0.55	nd	0.89	18	0.38	nd	0.79
Zinc	100	24.17	16.70	39.10	100	10.25	1.73	22.50
Pesticides (ppt)								
Total DDT	100	293.01	111.80	1082.60	59	70.45	nd	230.00
Total HCH	53	70.11	nd	305.40	33	162.59	nd	771.40
Total Chlordane	15	29.48	nd	51.60	0	—	—	—
HCB	71	129.23	nd	537.00	54	192.93	nd	1540.00
Total PCB (ppt)	100	418.44	12.30	2497.90	59	81.18	nd	945.70
Total PAH (ppb)	100	56.09	7.54	211.70	79	11.63	nd	53.45

[a] Minimum and maximum values were based on all samples (n = 35), whereas means were calculated on detected values only (n ≤ 35)

[b] Minimum and maximum values were based on all samples (n = 39), whereas means were calculated on detected values only (n ≤ 39)

Table 3.2

Summary of macrofaunal community parameters for PLOO and SBOO benthic stations sampled during 2018. Data for each region include mean, 95% confidence interval (CI), minimum, and maximum values; SR = species richness; Abun = abundance; H' = Shannon diversity index; J' = Pielou's evenness; Dom = Swartz dominance; BRI = benthic response index.

		SR	Abun	H'	J'	Dom	BRI
All PLOO Grabs	Mean	84	456	3.6	0.81	23	14
(n = 35)	95% CI	6	45	0.1	0.01	3	2
	Min	44	243	3.1	0.73	12	6
	Max	125	702	4.2	0.92	44	34
All SBOO Grabs	Mean	57	199	3.3	0.83	21	17
(n = 39)	95% CI	9	40	0.2	0.03	4	3
	Min	21	41	2.2	0.61	6	-2
	Max	164	568	4.4	0.95	52	30

Table 3.3

Macroinvertebrate taxa with the top 25 abundances collected from PLOO benthic stations during 2018. Data are expressed as percent abundance (number of individuals per species/total abundance of all species), frequency of occurrence (percentage of grabs in which a species occurred) and abundance per grab (mean number of individuals per grab, n = 35).

Species	Taxonomic Classification	Percent Abundance	Frequency of Occurrence	Abundance per Grab
Spiophanes duplex	Polychaeta: Spionidae	10	100	45
Phisidia sanctaemariae	Polychaeta: Terebellidae	6	91	29
Eclysippe trilobata	Polychaeta: Ampharetidae	6	100	29
Axinopsida serricata	Mollusca: Bivalvia	6	94	28
Mediomastus sp	Polychaeta: Capitellidae	6	100	26
Amphiodia urtica	Echinodermata: Ophiuroidea	4	86	20
Lanassa venusta venusta	Polychaeta: Terebellidae	3	89	13
Aphelochaeta glandaria Cmplx	Polychaeta: Cirratulidae	3	89	12
Nuculana sp A	Mollusca: Bivalvia	2	97	10
Praxillella pacifica	Polychaeta: Maldanidae	2	94	9
Spiophanes kimballi	Polychaeta: Spionidae	2	94	9
Prionospio jubata	Polychaeta: Spionidae	2	97	9
Tellina carpenteri	Mollusca: Bivalvia	2	94	7
Polycirrus sp	Polychaeta: Terebellidae	2	83	7
Tellina sp B	Mollusca: Bivalvia	1	89	6
Paradiopatra parva	Polychaeta: Onuphidae	1	91	6
Polycirrus sp A	Polychaeta: Terebellidae	1	83	6
Polycirrus sp OC1	Polychaeta: Terebellidae	1	40	6
Sternaspis affinis	Polychaeta: Sternaspidae	1	100	6
Scoloplos armiger Cmplx	Polychaeta: Orbiniidae	1	91	6
Chaetozone hartmanae	Polychaeta: Cirratulidae	1	91	5
Capitella teleta	Polychaeta: Capitellidae	1	29	5
Travisia brevis	Polychaeta: Travisiidae	1	57	5
Pectinaria californiensis	Polychaeta: Pectinariidae	1	91	5
Rhepoxynius bicuspidatus	Arthropoda: Amphipoda	1	80	4

Table 3.4

Macroinvertebrate taxa with the top 25 abundances collected from SBOO benthic stations during 2018. Data are expressed as percent abundance (number of individuals per species/total abundance of all species), frequency of occurrence (percentage of grabs in which a species occurred) and abundance per grab (mean number of individuals per grab, n = 39).

Species	Taxonomic Classification	Percent Abundance	Frequency of Occurrence	Abundance per Grab
Spiophanes norrisi	Polychaeta: Spionidae	9	95	18
Spiophanes duplex	Polychaeta: Spionidae	4	74	7
Mediomastus sp	Polychaeta: Capitellidae	4	54	7
Ampelisca cristata microdentata	Arthropoda: Amphipoda	3	46	6
Euphilomedes carcharodonta	Arthropoda: Ostracoda	2	46	5
Ampharete labrops	Polychaeta: Ampharetidae	2	59	3
NEMATODA	Nematoda	2	64	3
Photis sp	Arthropoda: Amphipoda	2	26	3
Saccocirrus sp	Polychaeta: Saccocirridae	1	3	3
Prionospio pygmaeus	Polychaeta: Spionidae	1	56	3
Tubulanus polymorphus	Nemertea: Palaeonemertea	1	56	3
Rhepoxynius menziesi	Arthropoda: Amphipoda	1	62	3
Simomactra falcata	Mollusca: Bivalvia	1	23	3
Paramphinome sp	Polychaeta: Amphinomidae	1	5	3
Ampelisca brevisimulata	Arthropoda: Amphipoda	1	38	2
Foxiphalus obtusidens	Arthropoda: Amphipoda	1	67	2
Lanassa venusta venusta	Polychaeta: Terebellidae	1	21	2
Glycera oxycephala	Polychaeta: Glyceridae	1	41	2
Prionospio jubata	Polychaeta: Spionidae	1	46	2
Mooreonuphis sp SD1	Polychaeta: Onuphidae	1	5	2
Lumbrinerides platypygos	Polychaeta: Lumbrineridae	1	41	2
Chaetozone corona	Polychaeta: Cirratulidae	1	36	2
Pista wui	Polychaeta: Terebellidae	1	41	2
Lumbrineris latreilli	Polychaeta: Lumbrineridae	1	13	2
Sigalion spinosus	Polychaeta: Sigalionidae	1	67	2
Dialychone veleronis	Polychaeta: Sabellidae	1	41	2
Protodorvillea gracilis	Polychaeta: Dorvilleidae	1	13	2

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Chapter 4. Demersal Fishes and Megabenthic Invertebrates

Introduction

The City of San Diego collects bottom dwelling (demersal) fishes and large (megabenthic) mobile invertebrates by otter trawl to examine the potential effects of wastewater discharge or other disturbances on the marine environment surrounding the Point Loma and South Bay Ocean Outfalls (PLOO and SBOO, respectively). This chapter presents summaries and preliminary analyses of the demersal fish and megabenthic invertebrate data collected during calendar year 2018 at a total of 13 trawl stations surrounding the PLOO and SBOO. Raw data summaries supporting these results are presented in Appendix C. A more comprehensive assessment of these results will be presented in the 2018-2019 Biennial Assessment Report to be submitted by July 1, 2020.

Materials and Methods

Field Sampling

Trawls were conducted at 13 stations to monitor demersal fish and megabenthic invertebrate populations during winter 2018 (Figure 4.1). These included six PLOO stations located along the 100-m depth PLOO discharge depth contour ranging from 9 km south to 8 km north of the outfall, and seven SBOO stations located along the 28-m SBOO discharge depth contour ranging from 7 km south to 8.5 km north of the outfall. The two PLOO stations (i.e., SD10, SD12) and two SBOO stations (i.e., SD17, SD18) located within 1000 m of the outfall structures are considered to represent nearfield conditions. All 13 stations were sampled during January for the winter survey, while no PLOO or SBOO trawl sampling was conducted during the summer of 2018 due to an approved resource exchange agreement to allow City and U.S. Section of the International Boundary and Water Commission (USIBWC) participation in the Bight'18 regional monitoring program. A single trawl was performed at each station during the winter survey using a 7.6-m Marinovich otter trawl fitted with a 1.3-cm cod-end mesh net. Standard sampling procedures require towing the net for a total of 10 minutes bottom time per trawl at a speed of about 2 knots along a predetermined heading. The catch from each successful trawl was sorted and inspected aboard ship. All individual fish and invertebrates captured were identified to species or to the lowest taxon possible based on accepted taxonomic protocols for the region (i.e., Eschmeyer and Herald 1998, Lawrence et al. 2013, SCAMIT 2018). If an animal could not be accurately identified to species in the field, it was returned to the laboratory for further identification if possible. The total number of individuals (abundance) and total biomass (kg, wet weight) were recorded for each species of fish. Additionally, each fish was inspected for the presence of physical anomalies (e.g., tumors, lesions, fin erosion, discoloration) or external parasites (e.g., copepods, cymothoid isopods, leeches). The length of each individual fish was measured to the nearest centimeter to determine size class; total length (TL) was measured for cartilaginous fishes while standard length (SL) was measured for bony fishes (SCCWRP 2018). For trawl-caught invertebrates, only the total number of individuals was recorded for each species. Visual observations of weather, sea conditions, and human and animal activity were also recorded at the time of sampling (see Addendum 1B).

Data Analyses

The following community structure parameters were calculated per trawl for both fishes and invertebrates captured during the PLOO and SBOO trawl surveys: species richness (number of species), total abundance (number of individuals), and Shannon diversity index (H'). Total biomass was also calculated for each species of fish. These analyses were performed using R (R Core Team 2018) and various functions within the dplyr, plyr, reshape2, RODBC, sqldf, and vegan packages (Wickham 2007, 2011, Grothendieck 2014, Wickham and Francois 2016, Okansanen et al. 2018, Ripley and Lapsley 2018).

Multivariate analyses were performed using PRIMER v7 software to determine spatial patterns in the demersal fish and megabenthic invertebrate data collected during the winter survey of 2018 (see Clarke 1993, Warwick 1993, Clarke et al. 2014). These analyses included hierarchical agglomerative clustering (cluster analysis) with group-average linking and similarity profile analysis (SIMPROF) to confirm the non-random structure of the resultant cluster dendrogram (Clarke et al. 2008). The Bray-Curtis measure of similarity was used as the basis for the cluster analysis, and the fish and invertebrate abundance data were square-root transformed to lessen the influence of the most abundant species and increase the importance of rare species. The major ecologically-relevant clusters receiving SIMPROF support were retained as cluster groups for both the fish and invertebrate assessments.

Results

Demersal Fishes

All fish species captured during the 2018 winter trawl survey are summarized by percent abundance, frequency of occurrence, mean abundance per haul, and abundance per occurrence in Tables 4.1 and 4.2. Species richness (number of species), abundance (number of individuals), diversity (H'), and biomass (kg, wet weight) values for each station are summarized in Table 4.3. The total number of individuals, total biomass, and the minimum, maximum and mean length (cm) per species are included in Appendices C.1 and C.2. Total abundance and biomass by species for each station are summarized in Appendices C.3 – C.6. All abnormalities and parasites found on trawled fish during 2018 are listed in Appendix C.7. A cluster analysis was performed to illustrate and quantify the ecological patterns at the demersal fish community level within each monitoring region. Figures 4.2 and 4.3 show the resulting dendrograms and SIMPROF supported cluster groups.

Megabenthic Invertebrates

All trawled invertebrate species captured during the 2018 winter trawl survey are summarized by percent abundance, frequency of occurrence, mean abundance per haul, and abundance per occurrence in Tables 4.4 and 4.5. Species richness (number of species), abundance (number of individuals), and diversity (H') values for each station are summarized in Table 4.6. The total number of individuals per species are included in Appendices C.8 and C.9. Total abundance by species for each station are summarized in Appendices C.10 and C.11. A cluster analysis was performed to illustrate and quantify the ecological patterns at the megabenthic invertebrate community level within each monitoring region. Figures 4.4 and 4.5 show the resulting dendrograms and SIMPROF supported cluster groups.

Summary

Preliminary analysis of the demersal fish and megabenthic invertebrate data collected in 2018 indicate that wastewater discharged through the Point Loma and South Bay ocean outfalls has not negatively impacted these communities in the coastal waters off San Diego, with the values for most community parameters being similar at stations located both near and far away from the outfall discharge sites. Major community metrics such as species richness, abundance, and diversity were within historical ranges reported for the San Diego region (City of San Diego 1995, 1998, 2000, 2018), and were representative of those characteristic of similar habitats throughout the Southern California Bight (e.g., Allen et al. 1998, 2002, 2007, 2011, Walther et al. 2017).

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Chapter 4

Figures & Tables

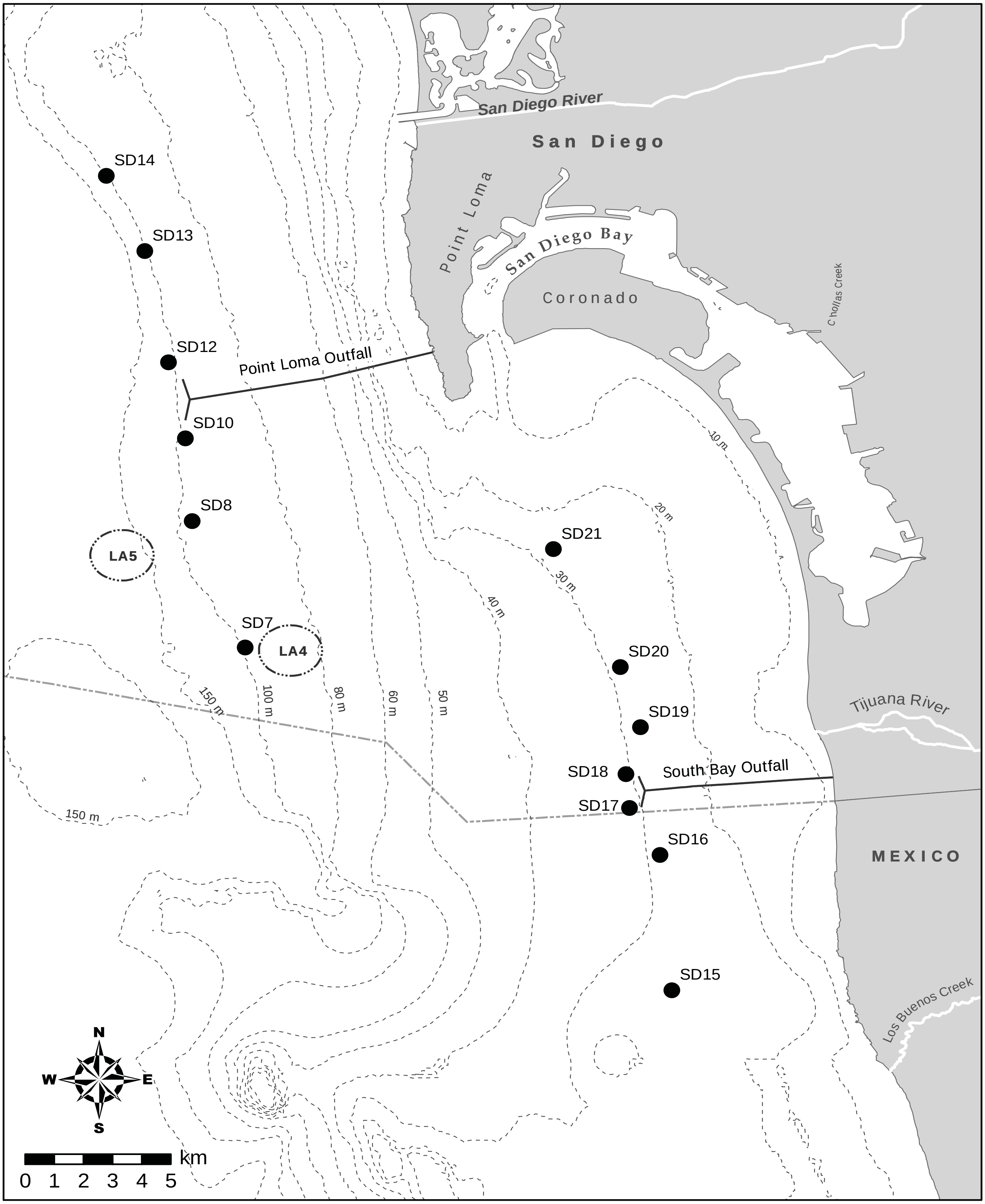

Figure 4.1

Trawl station locations sampled around the Point Loma and South Bay Ocean Outfalls as part of the City of San Diego's Ocean Monitoring Program.

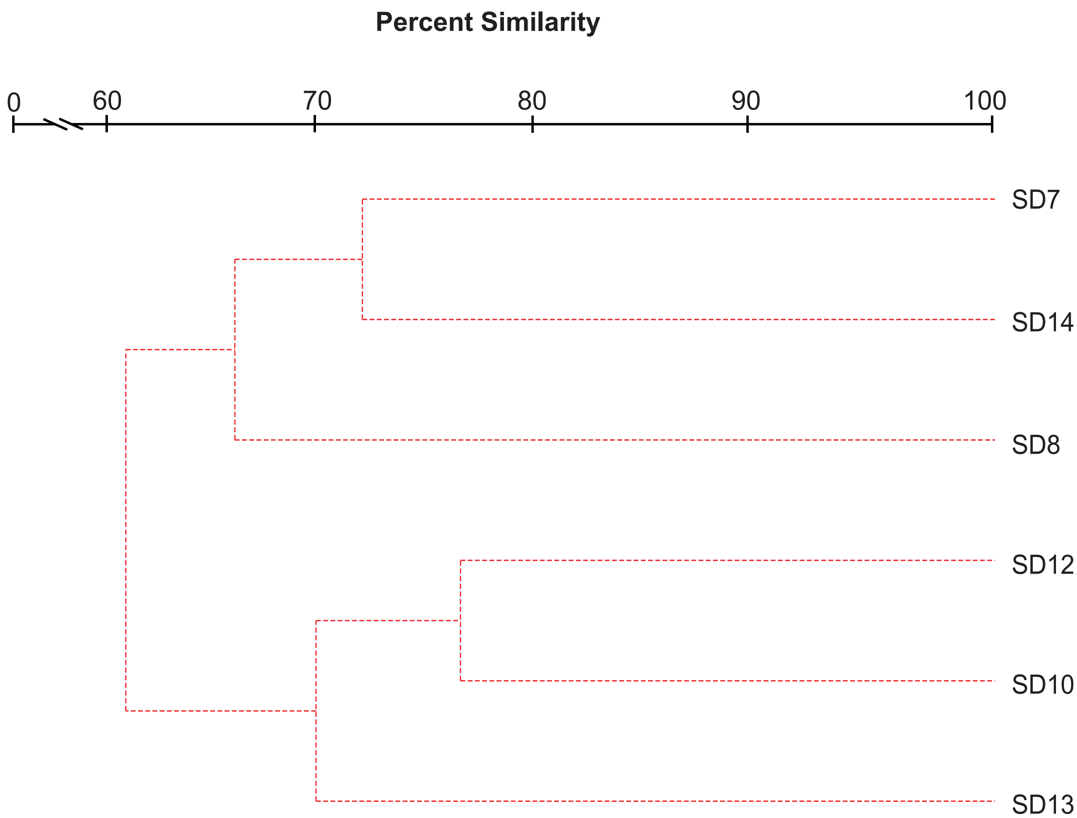

Figure 4.2
Results of cluster analysis of demersal fish assemblages from PLOO trawl stations sampled during winter 2018. No cluster groups were supported by SIMPROF (see text).

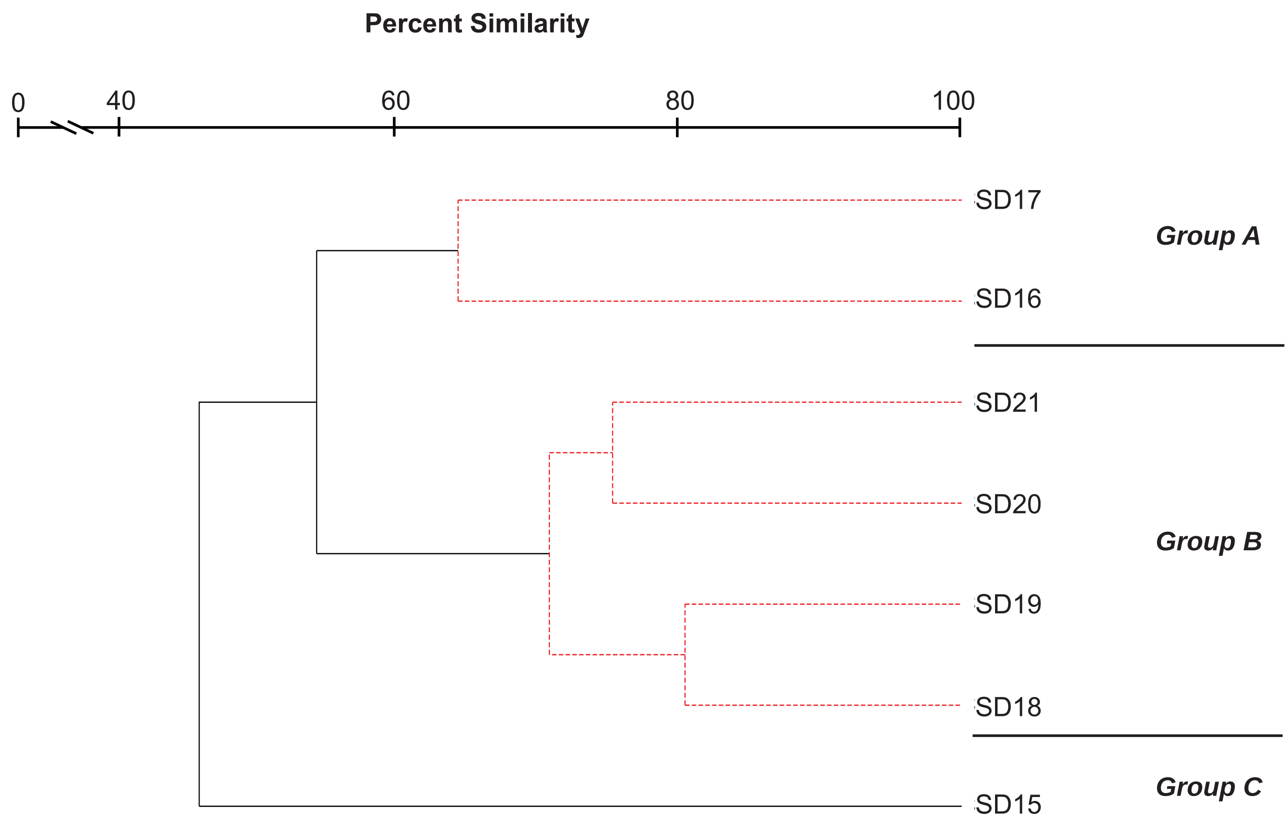

Figure 4.3
Results of cluster analysis of demersal fish assemblages from SBOO trawl stations sampled during winter 2018. Solid black lines indicate non-random structures of the dendrogram that have been confirmed by SIMPROF.

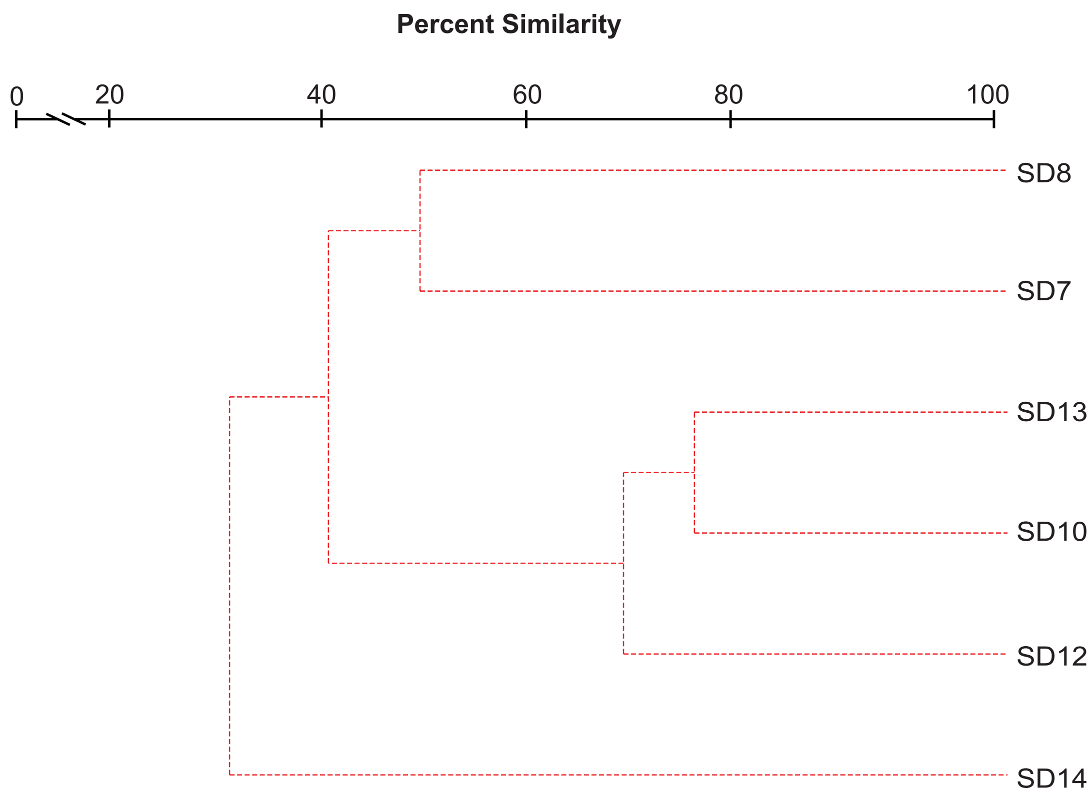

Figure 4.4
Results of cluster analysis of megabenthic invertebrate assemblages from PLOO trawl stations sampled during winter 2018. No cluster groups were supported by SIMPROF (see text).

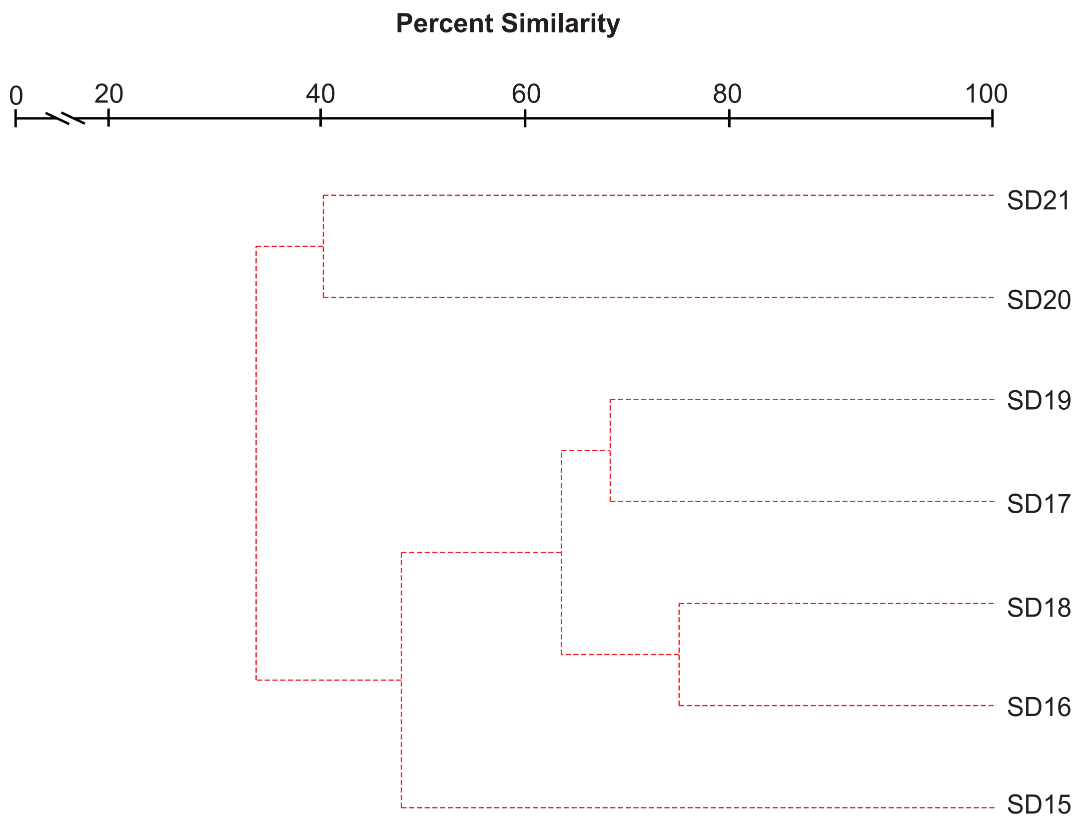

Figure 4.5
Results of cluster analysis of megabenthic invertebrate assemblages from SBOO trawl stations sampled during winter

Table 4.1

Demersal fish species collected from 6 trawls conducted in the PLOO region during winter 2018. PA = percent abundance; FO = frequency of occurrence; MAH = mean abundance per haul; MAO = abundance per occurrence.

Species	PA	FO	MAH	MAO
Pacific Sanddab	54	100	173	173
Halfbanded Rockfish	22	50	71	142
Dover Sole	5	100	15	15
Stripetail Rockfish	5	100	15	15
California Lizardfish	3	100	9	9
Longspine Combfish	2	100	7	7
Plainfin Midshipman	2	100	5	5
Squarespot Rockfish	1	33	4	14
Shortspine Combfish	1	67	4	6
Vermilion Rockfish	1	17	3	20
Pink Seaperch	1	83	3	4
English Sole	1	100	3	3
California Tonguefish	1	83	2	3
Hornyhead Turbot	<1	67	1	2
California Scorpionfish	<1	67	1	2
Spotted Cusk-eel	<1	67	1	2
Longfin Sanddab	<1	50	1	1
Greenstriped Rockfish	<1	17	<1	3
Rosethorn Rockfish	<1	33	<1	2
Flag Rockfish	<1	17	<1	2
Bigmouth Sole	<1	17	<1	1
Blacktip Poacher	<1	17	<1	1
Bluebanded Ronquil	<1	17	<1	1
California Skate	<1	17	<1	1
Fantail Sole	<1	17	<1	1
Greenspotted Rockfish	<1	17	<1	1
Pacific Argentine	<1	17	<1	1
Spotfin Sculpin	<1	17	<1	1
Yellowchin Sculpin	<1	17	<1	1

Table 4.2

Demersal fish species collected from 7 trawls conducted in the SBOO region during winter 2018. PA = percent abundance; FO = frequency of occurrence; MAH = mean abundance per haul; MAO = abundance per occurrence.

Species	PA	FO	MAH	MAO
California Lizardfish	56	100	130	130
Speckled Sanddab	30	100	70	70
Longfin Sanddab	7	71	15	22
California Tonguefish	3	86	7	8
California Halibut	1	43	2	4
Hornyhead Turbot	1	71	2	2
Plainfin Midshipman	<1	57	1	2
Fantail Sole	<1	43	1	2
Roughback Sculpin	<1	29	1	2
Unidentified Pipefish	<1	57	1	1
Round Stingray	<1	29	1	2
Longspine Combfish	<1	14	<1	3
Giant Kelpfish	<1	14	<1	2
Specklefin Midshipman	<1	29	<1	1
Pacific Sanddab	<1	14	<1	1
Queenfish	<1	14	<1	1
Shiner Perch	<1	14	<1	1
Spotted Cusk-eel	<1	14	<1	1
Spotted Turbot	<1	14	<1	1

Table 4.3

Summary of demersal fish community parameters for PLOO and SBOO trawl stations sampled during winter 2018. Data are included for species richness (SR), abundance, diversity (H'), and biomass (kg, wet weight).

Region	Station	SR	Abundance	Diversity	Biomass
PLOO	SD7	16	240	1.5	3.5
	SD8	19	642	1.5	5.9
	SD10	10	292	1.1	5.3
	SD12	14	229	0.9	5.5
	SD13	15	187	1.0	6.0
	SD14	16	344	1.6	11.7
SBOO	SD15	6	39	1.1	2.2
	SD16	4	283	0.4	4.8
	SD17	11	492	0.9	7.8
	SD18	9	208	1.3	9.3
	SD19	8	281	1.1	3.8
	SD20	7	182	0.9	3.6
	SD21	12	137	1.4	4.0

Table 4.4

Megabenthic invertebrate species collected from 6 trawls conducted in the PLOO region during winter 2018. PA = percent abundance; FO = frequency of occurrence; MAH = mean abundance per haul; MAO = abundance per occurrence.

Species	PA	FO	MAH	MAO
Lytechinus pictus	93	100	288	288
Elthusa vulgaris	2	83	7	9
Crangon alaskensis	2	100	6	6
Sicyonia penicillata	1	33	2	6
Sicyonia ingentis	<1	50	2	3
Platymera gaudichaudii	<1	50	1	2
Apostichopus californicus	<1	50	1	2
Astropecten californicus	<1	33	1	2
Adelogorgia phyllosclera	<1	17	<1	2
Luidia asthenosoma	<1	17	<1	2
Octopus rubescens	<1	33	<1	1
Doryteuthis opalescens	<1	17	<1	1
Neverita draconis	<1	17	<1	1
Luidia foliolata	<1	17	<1	1
Metridium farcimen	<1	17	<1	1
Ophiopteris papillosa	<1	17	<1	1
Ophiothrix spiculata	<1	17	<1	1
Parapagurodes laurentae	<1	17	<1	1
Pilumnoides rotundus	<1	17	<1	1
Pleurobranchaea californica	<1	17	<1	1
Suberites latus	<1	17	<1	1

Table 4.5

Megabenthic invertebrate species collected from 7 trawls conducted in the SBOO region during winter 2018. PA = percent abundance; FO = frequency of occurrence; MAH = mean abundance per haul; MAO = abundance per occurrence.

Species	PA	FO	MAH	MAO
Philine auriformis	35	71	17	23
Lytechinus pictus	9	57	4	8
Ophiothrix spiculata	9	43	4	10
Sicyonia penicillata	8	71	4	6
Elthusa vulgaris	8	86	4	4
Astropecten californicus	6	57	3	5
Crangon nigromaculata	5	100	2	2
Dendraster terminalis	4	14	2	14
Portunus xantusii	2	43	1	3
Pleurobranchaea californica	2	57	1	2
Crangon alba	2	14	1	5
Kelletia kelletii	2	43	1	2
Lovenia cordiformis	2	14	1	5
Metacarcinus anthonyi	1	43	<1	1
Octopus rubescens	1	14	<1	3
Pugettia dalli	1	29	<1	2
Pugettia producta	1	14	<1	3
Heptacarpus palpator	1	14	<1	2
Aphrodita armifera	<1	14	<1	1
Caesia perpinguis	<1	14	<1	1
Ericerodes hemphillii	<1	14	<1	1
Neverita recluziana	<1	14	<1	1
Lamellaria diegoensis	<1	14	<1	1
Latulambrus occidentalis	<1	14	<1	1
Triopha maculata	<1	14	<1	1

Table 4.6

Summary of megabenthic invertebrate community parameters for PLOO and SBOO trawl stations sampled during winter 2018. Data are included for species richness (SR), abundance, and diversity (H').

Region	Station	SR	Abundance	Diversity
PLOO	SD7	5	302	0.3
	SD8	11	1232	0.1
	SD10	6	43	1.2
	SD12	5	183	0.7
	SD13	8	82	1.1
	SD14	9	22	1.9
SBOO	SD15	12	114	1.7
	SD16	11	59	1.8
	SD17	9	41	1.7
	SD18	8	40	1.8
	SD19	8	32	1.7
	SD20	4	14	1.0
	SD21	10	30	1.7

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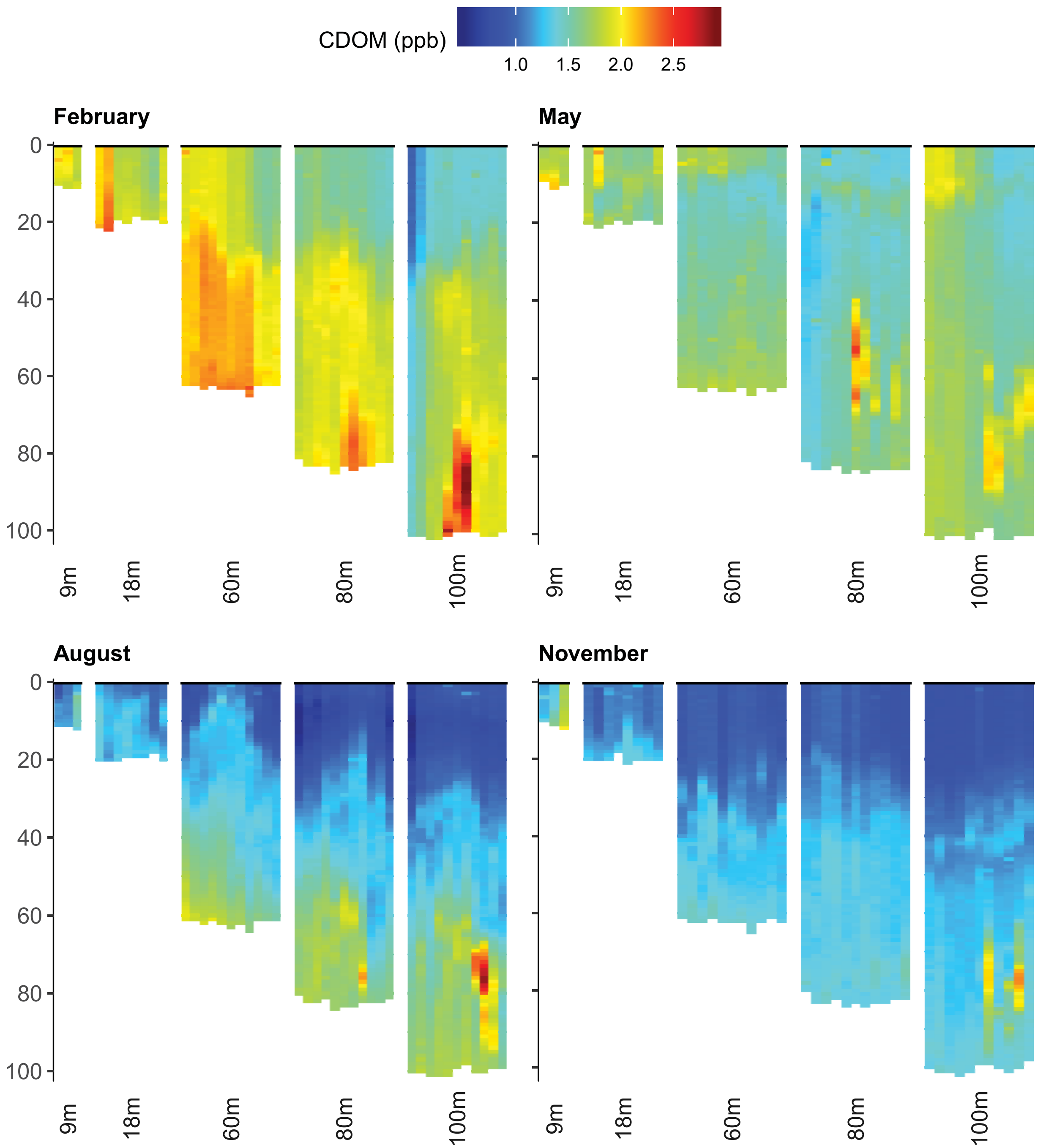
Appendices

Appendix A

Water Quality

2018 Raw Data Summaries

PLOO and SBOO Stations



Appendix A.1
Concentrations of CDOM recorded in the PLOO region during 2018. Within each contour, stations are ordered north to south. Data were collected over four days during each survey.

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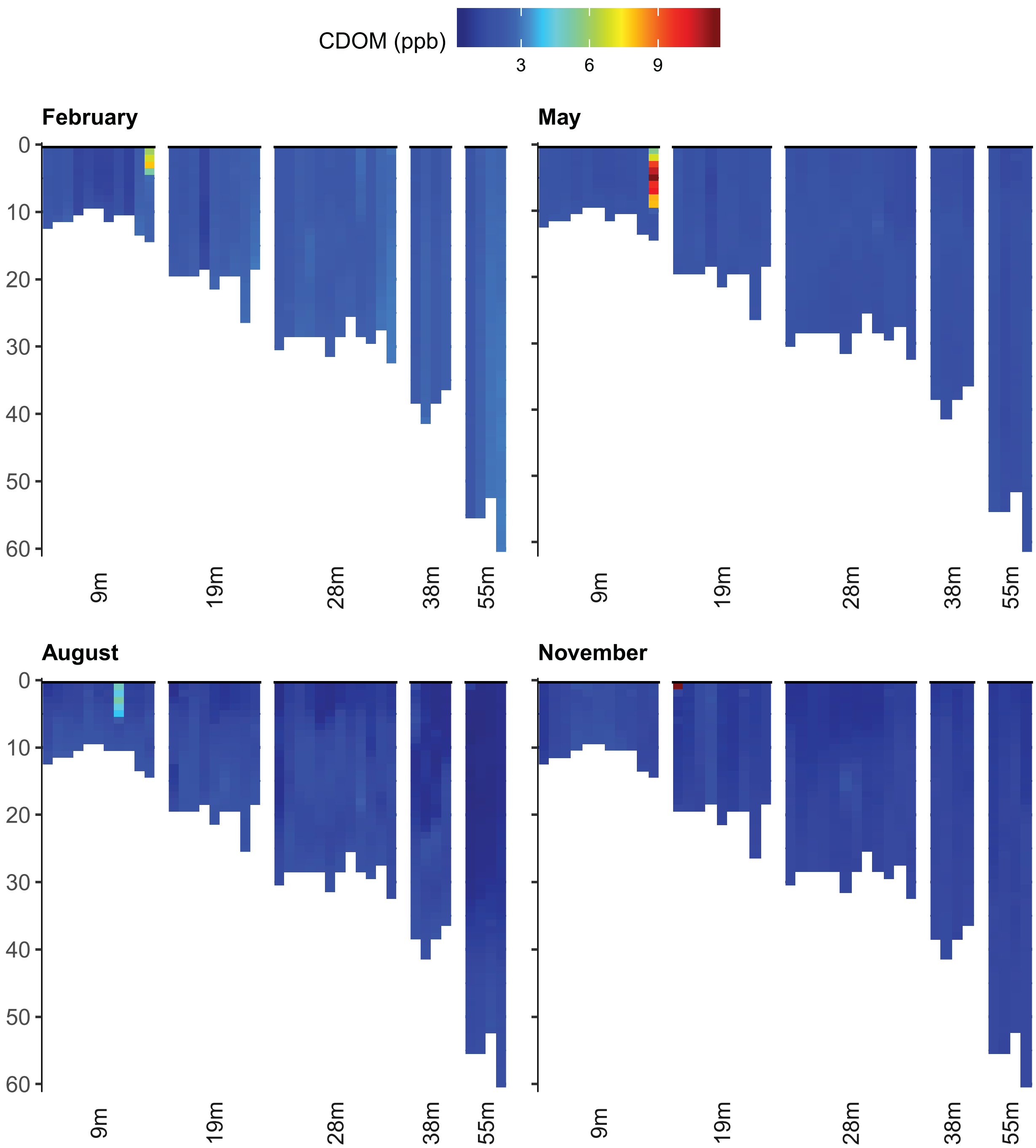

Appendix A.2

Concentrations of CDOM recorded in the SBOO region during 2018. Within each contour, stations are ordered north to south. Data were collected over four to five days during each survey.

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Appendix A.3

Summary of PLOO and SBOO reference stations used during 2018 to calculate out-of-range thresholds (see text for details).

Month	Stations
February	
PLOO	A1, A6, A7, C7, C8, F01, F04, F06, F15, F16, F22, F23, F24, F25, F26, F29, F33, F34, F35, F36
SBOO	I8, I9, I10, I13, I14, I15, I16, I17, I18, I20, I21, I23, I27, I28, I29, I30, I31, I33, I34, I35, I39
May	
PLOO	A1, C7, C8, F04, F05, F15, F17, F21, F22, F23, F24, F25, F31
SBOO	I1, I2, I3, I7, I8, I9, I10, I13, I17, I20, I21, I27, I28, I39
August	
PLOO	A1, A6, A7, C7, C8, F01, F02, F03, F04, F05, F06, F07, F15, F16, F17, F26, F36
SBOO	I1, I2, I3, I8, I9, I14, I16, I17, I20, I28, I33, I34, I39
November	
PLOO	A1, A6, A7, C7, C8, F01, F02, F03, F04, F05, F06, F09, F34
SBOO	I6, I12, I13, I14, I17, I18, I20, I22, I23, I27, I30, I34, I35

Appendix A.4

Summary of temperature, salinity, dissolved oxygen (DO), pH, transmissivity, and chlorophyll *a* for various depth layers as well as the entire water column for all PLOO stations during 2018. For each quarter: n ≥ 2878 (1–20 m), n ≥ 5284 (21–60 m), n ≥ 1858 (61–80 m), n ≥ 1005 (81–100 m). Sample sizes differed due to variations in bottom depth at individual stations.

		Depth (m)				
		1–20	**21–60**	**61–80**	**81–100**	**1–100**
Temperature (°C)						
February	min	13.8	12.4	11.6	10.9	10.9
	max	16.6	16.1	13.6	12.3	16.6
	mean	15.8	14.3	12.5	11.6	14.2
May	min	10.7	9.8	9.6	9.5	9.5
	max	15.8	11.3	10.1	10.0	15.8
	mean	13.1	10.3	9.9	9.7	11.0
August	min	13.9	12.1	11.1	10.5	10.5
	max	23.9	17.1	13.0	12.1	23.9
	mean	18.7	13.6	12.0	11.2	14.7
November	min	15.9	13.3	12.3	11.7	11.7
	max	19.0	18.6	14.8	13.6	19.0
	mean	18.3	15.6	13.5	12.7	15.8
Salinity (ppt)						
February	min	33.36	33.45	33.46	33.43	33.36
	max	33.54	33.53	33.55	33.64	33.64
	mean	33.50	33.47	33.48	33.53	33.48
May	min	33.53	33.56	33.77	33.81	33.53
	max	33.86	33.88	33.94	34.01	34.01
	mean	33.63	33.74	33.85	33.92	33.74
August	min	33.49	33.50	33.44	33.52	33.44
	max	33.87	33.57	33.64	33.73	33.87
	mean	33.63	33.53	33.56	33.63	33.58
November	min	33.52	33.50	33.45	33.48	33.45
	max	33.80	33.76	33.58	33.64	33.80
	mean	33.70	33.56	33.54	33.57	33.60

Appendix A.4 *continued*

		Depth (m)				
		1–20	**21–60**	**61–80**	**81–100**	**1–100**
DO (mg/L)						
February	min	5.9	5.7	4.8	4.5	4.5
	max	8.4	8.2	6.6	5.7	8.4
	mean	8.1	7.3	5.8	5.1	7.1
May	min	4.1	3.3	3.2	3.0	3.0
	max	9.3	5.5	4.3	4.2	9.3
	mean	6.8	4.2	3.7	3.4	4.8
August	min	7.2	5.4	4.8	4.4	4.4
	max	9.0	8.8	6.8	5.7	9.0
	mean	8.3	7.2	5.5	5.0	7.1
November	min	7.1	6.3	5.8	5.4	5.4
	max	8.4	8.3	7.8	7.0	8.4
	mean	7.8	7.6	6.8	6.2	7.4
pH						
February	min	8.1	8.0	7.9	7.8	7.8
	max	8.2	8.2	8.0	8.0	8.2
	mean	8.2	8.1	8.0	7.9	8.1
May	min	7.8	7.7	7.7	7.7	7.7
	max	8.2	7.9	7.8	7.8	8.2
	mean	8.0	7.8	7.8	7.8	7.9
August	min	8.0	7.9	7.8	7.8	7.8
	max	8.3	8.2	8.0	7.9	8.3
	mean	8.2	8.1	7.9	7.8	8.1
November	min	7.9	7.9	7.9	7.9	7.9
	max	8.2	8.2	8.1	8.1	8.2
	mean	8.1	8.1	8.0	8.0	8.1

Appendix A.4 *continued*

		Depth (m)				
		1–20	**21–60**	**61–80**	**81–100**	**1–100**
Transmissivity (%)						
February	min	80	79	71	71	71
	max	86	87	87	87	87
	mean	84	85	84	83	84
May	min	38	77	75	81	38
	max	90	90	90	90	90
	mean	84	89	88	89	87
August	min	58	82	83	81	58
	max	89	90	90	90	90
	mean	85	88	88	89	87
November	min	25	82	81	49	25
	max	89	89	89	89	89
	mean	87	88	88	87	88
Chlorophyll *a* (µg/L)						
February	min	0.1	0.4	0.2	0.1	0.1
	max	1.9	6.3	2.0	0.5	6.3
	mean	0.6	1.3	0.5	0.2	0.9
May	min	0.4	0.0	0.0	0.0	0.0
	max	3.3	1.7	0.4	0.2	3.3
	mean	1.4	0.4	0.1	0.1	0.6
August	min	0.0	0.0	0.0	0.0	0.0
	max	2.8	3.7	0.6	0.2	3.7
	mean	0.7	0.9	0.1	0.0	0.6
November	min	0.0	0.2	0.2	0.1	0.0
	max	1.8	2.8	1.0	0.5	2.8
	mean	0.3	0.9	0.4	0.2	0.6

Appendix A.5

Summary of temperature, salinity, DO, pH, transmissivity, and chlorophyll *a* for various depth layers as well as the entire water column from all SBOO stations during 2018. For each quarter: n ≥ 1188 (1–9 m), n ≥ 1180 (10–19 m), n ≥ 739 (20–28 m), n ≥ 352 (29–38 m), n ≥ 293 (39–55 m). Sample sizes differed due to slight variations in depth at individual stations.

		Depth (m)					
		1–9	**10–19**	**20–28**	**29–38**	**39–55**	**1–55**
Temperature (°C)							
February	min	14.7	14.0	13.8	13.1	12.6	12.6
	max	16.1	15.7	15.5	14.4	13.6	16.1
	mean	15.5	15.1	14.5	13.8	13.0	14.9
May	min	12.3	11.0	10.9	10.7	10.5	10.5
	max	16.9	15.7	12.3	11.7	11.0	16.9
	mean	15.3	12.8	11.4	11.0	10.8	13.1
August	min	16.7	15.0	14.5	14.0	13.0	13.0
	max	24.2	23.1	17.2	16.4	14.7	24.2
	mean	21.5	17.3	15.4	14.7	13.7	17.9
November	min	16.3	15.3	15.1	14.4	13.9	13.9
	max	19.6	19.5	18.2	16.8	15.4	19.6
	mean	18.4	17.5	16.4	15.5	14.6	17.2
Salinity (ppt)							
February	min	33.30	33.42	33.44	33.44	33.45	33.30
	max	33.58	33.72	33.49	33.48	33.48	33.72
	mean	33.48	33.47	33.46	33.45	33.46	33.47
May	min	33.56	33.47	33.57	33.59	33.63	33.47
	max	33.85	33.70	33.67	33.69	33.72	33.85
	mean	33.65	33.60	33.61	33.65	33.68	33.63
August	min	33.52	33.33	33.52	33.50	33.51	33.33
	max	33.99	34.02	33.58	33.55	33.55	34.02
	mean	33.71	33.57	33.54	33.53	33.54	33.61
November	min	33.52	33.45	33.49	33.48	33.50	33.45
	max	33.73	33.72	33.63	33.56	33.55	33.73
	mean	33.64	33.59	33.55	33.53	33.53	33.59

Appendix A.5 *continued*

		Depth (m)					
		1–9	**10–19**	**20–28**	**29–38**	**39–55**	**1–55**
DO (mg/L)							
February	min	7.0	7.3	7.2	6.2	6.0	6.0
	max	9.4	9.2	8.8	7.9	6.9	9.4
	mean	8.4	8.3	7.8	7.0	6.3	8.0
May	min	6.9	4.9	4.3	4.0	3.8	3.8
	max	10.3	10.2	8.0	5.7	4.7	10.3
	mean	9.4	7.7	5.3	4.6	4.3	7.4
August	min	6.6	6.8	6.7	6.7	6.2	6.2
	max	10.3	10.1	8.9	8.6	8.6	10.3
	mean	8.4	8.6	8.0	7.9	7.2	8.2
November	min	6.8	6.8	7.6	7.3	6.9	6.8
	max	9.6	8.3	8.3	8.4	8.2	9.6
	mean	8.1	8.0	7.9	7.7	7.4	7.9
pH							
February	min	8.0	7.9	7.9	7.8	7.8	7.8
	max	8.2	8.2	8.2	8.1	8.0	8.2
	mean	8.1	8.1	8.1	8.0	7.9	8.1
May	min	8.0	7.8	7.8	7.7	7.7	7.7
	max	8.3	8.2	8.1	7.9	7.8	8.3
	mean	8.2	8.0	7.8	7.8	7.7	8.0
August	min	8.1	8.1	8.1	8.0	8.0	8.0
	max	8.3	8.4	8.3	8.2	8.2	8.4
	mean	8.3	8.2	8.2	8.2	8.1	8.2
November	min	8.1	8.1	8.1	8.1	8.0	8.0
	max	8.3	8.2	8.2	8.1	8.1	8.3
	mean	8.2	8.1	8.1	8.1	8.0	8.1

Appendix A.5 *continued*

		Depth (m)					
		1–9	**10–19**	**20–28**	**29–38**	**39–55**	**1–55**
Transmissivity (%)							
February	min	60	39	70	70	78	39
	max	86	85	85	86	87	87
	mean	82	81	81	82	85	82
May	min	49	30	51	61	86	30
	max	84	89	89	89	89	89
	mean	75	69	74	84	88	75
August	min	61	65	81	83	87	61
	max	89	90	90	89	89	90
	mean	81	83	86	87	88	83
November	min	61	54	83	83	86	54
	max	89	89	88	88	88	89
	mean	84	86	87	87	87	85
Chlorophyll *a* (µg/L)							
February	min	0.2	0.6	1.2	1.2	0.7	0.2
	max	3.4	4.8	5.9	6.0	2.1	6.0
	mean	0.9	1.7	3.0	2.5	1.1	1.7
May	min	0.2	0.4	0.4	0.3	0.3	0.2
	max	25.9	48.0	32.5	26.4	1.6	48.0
	mean	2.4	14.5	12.8	3.6	0.7	8.0
August	min	0.0	0.0	0.0	0.1	0.5	0.0
	max	6.7	6.3	3.2	2.9	1.6	6.7
	mean	1.3	2.0	1.5	1.3	0.9	1.5
November	min	0.0	0.2	0.6	0.7	0.6	0.0
	max	9.0	4.1	2.0	1.7	1.6	9.0
	mean	1.0	1.0	1.0	1.1	0.9	1.0

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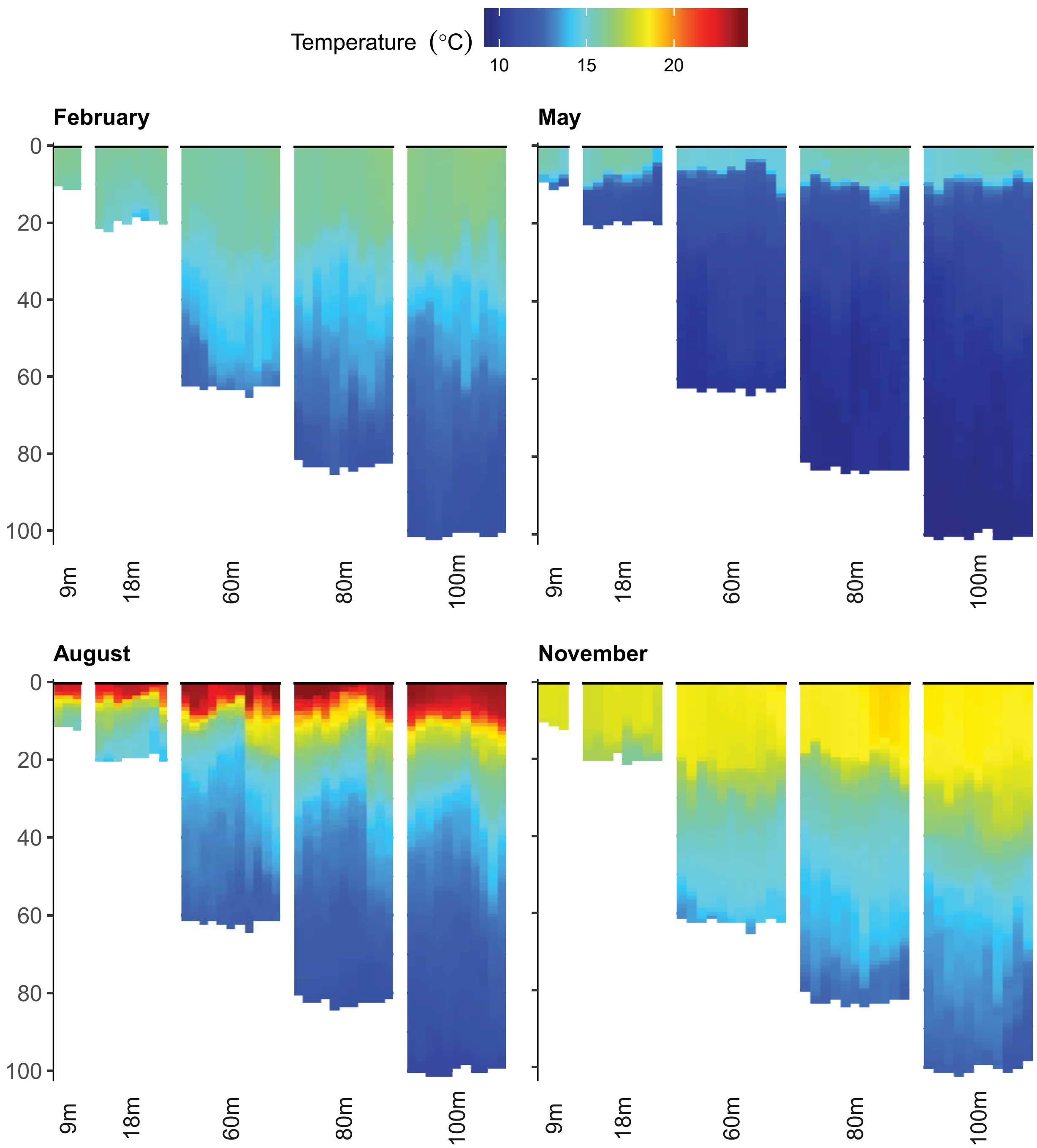
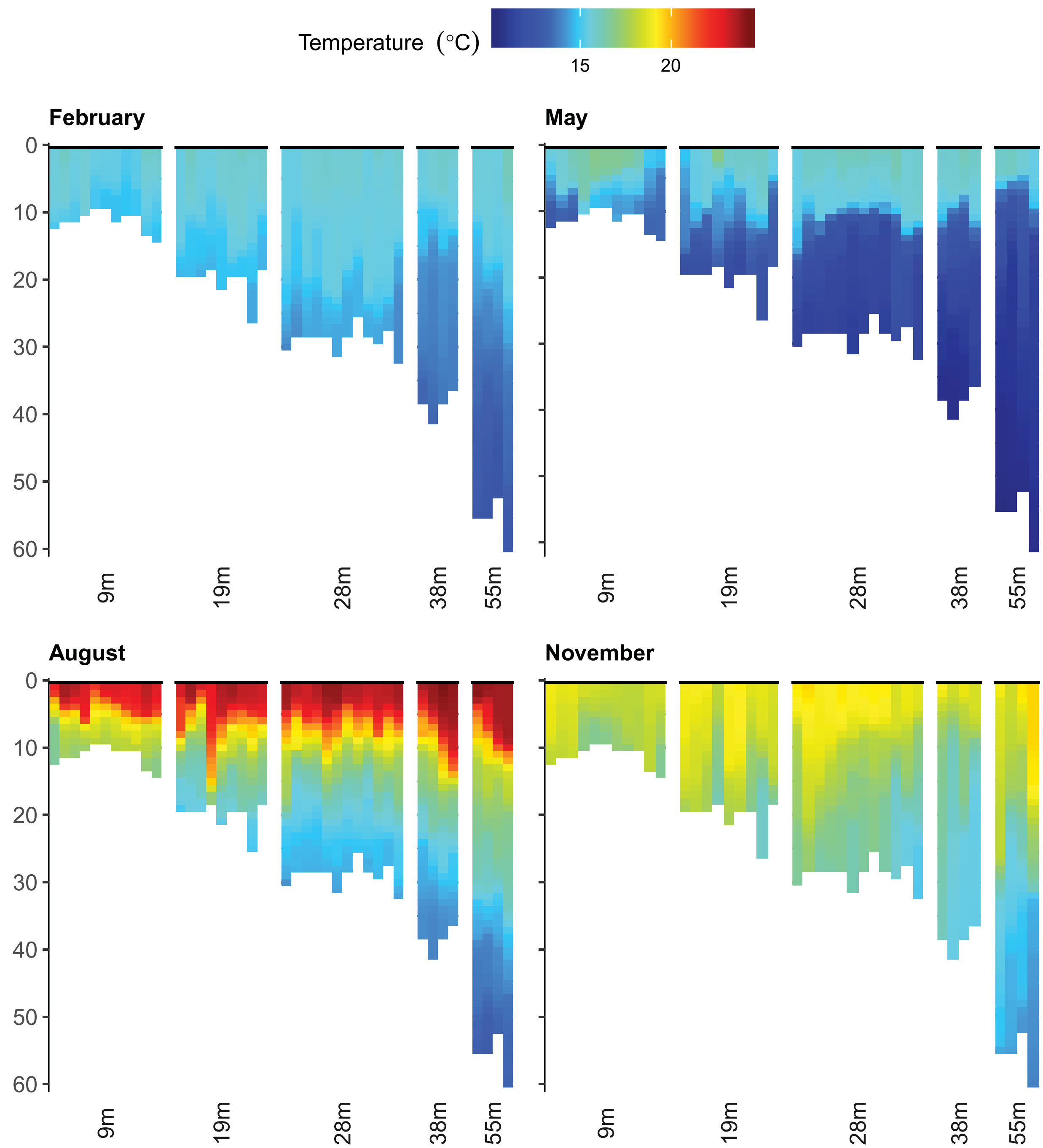


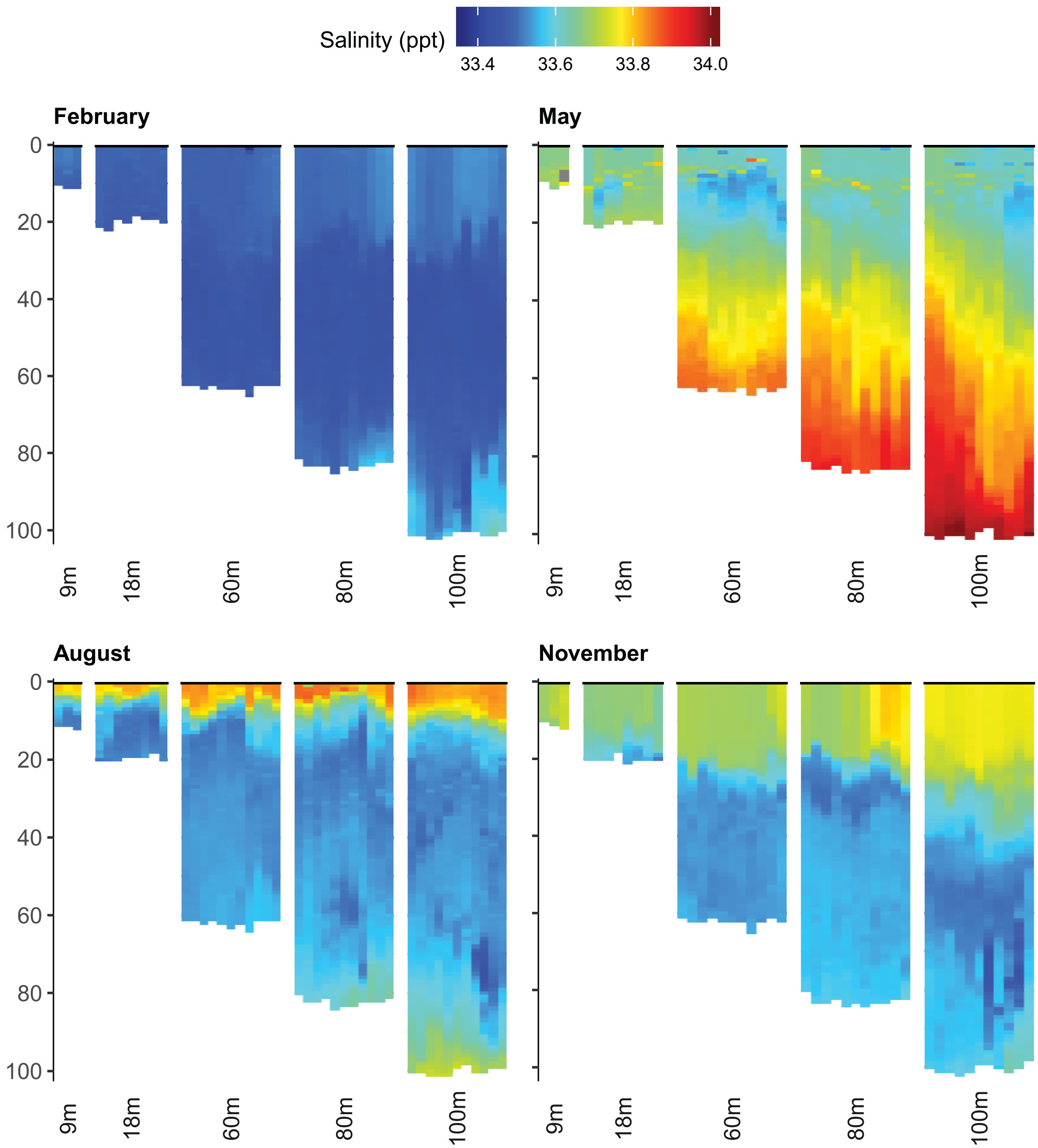
Appendix A.6

Temperature recorded in the PLOO region during 2018. Within each contour, stations are ordered north to south. Data were collected over four days during each survey.



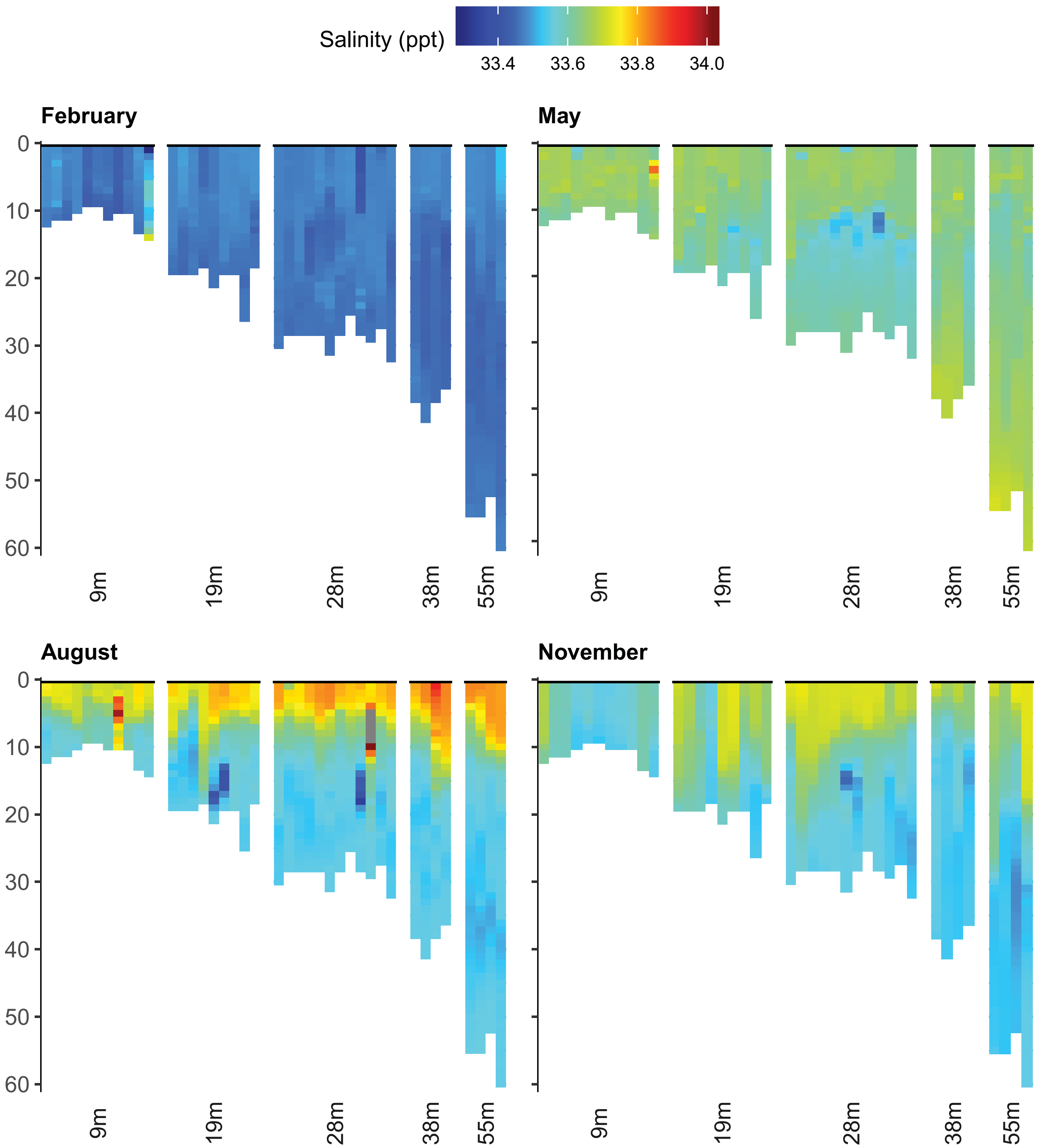
Appendix A.7

Temperature recorded in the SBOO region during 2018. Within each contour, stations are ordered north to south. Data were collected over four to five days during each survey.



Appendix A.8

Salinity recorded in the PLOO region during 2018. Within each contour, stations are ordered north to south. Data were collected over four days during each survey.



Appendix A.9

Salinity recorded in the SBOO region during 2018. Within each contour, stations are ordered north to south. Data were collected over four to five days during each survey.

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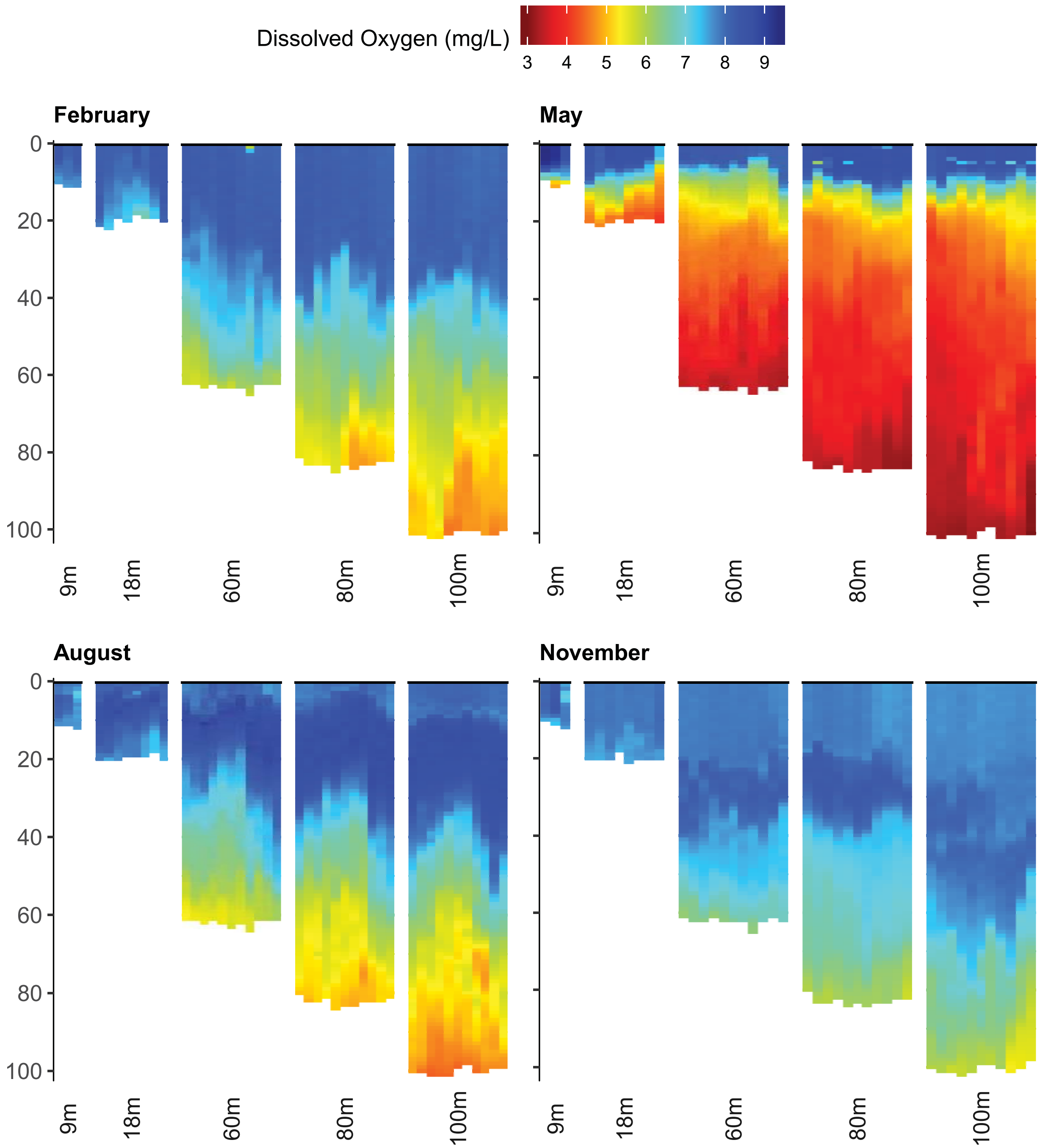

Appendix A.10
Dissolved oxygen recorded in the PLOO region during 2018. Within each contour, stations are ordered north to south. Data were collected over four days during each survey.

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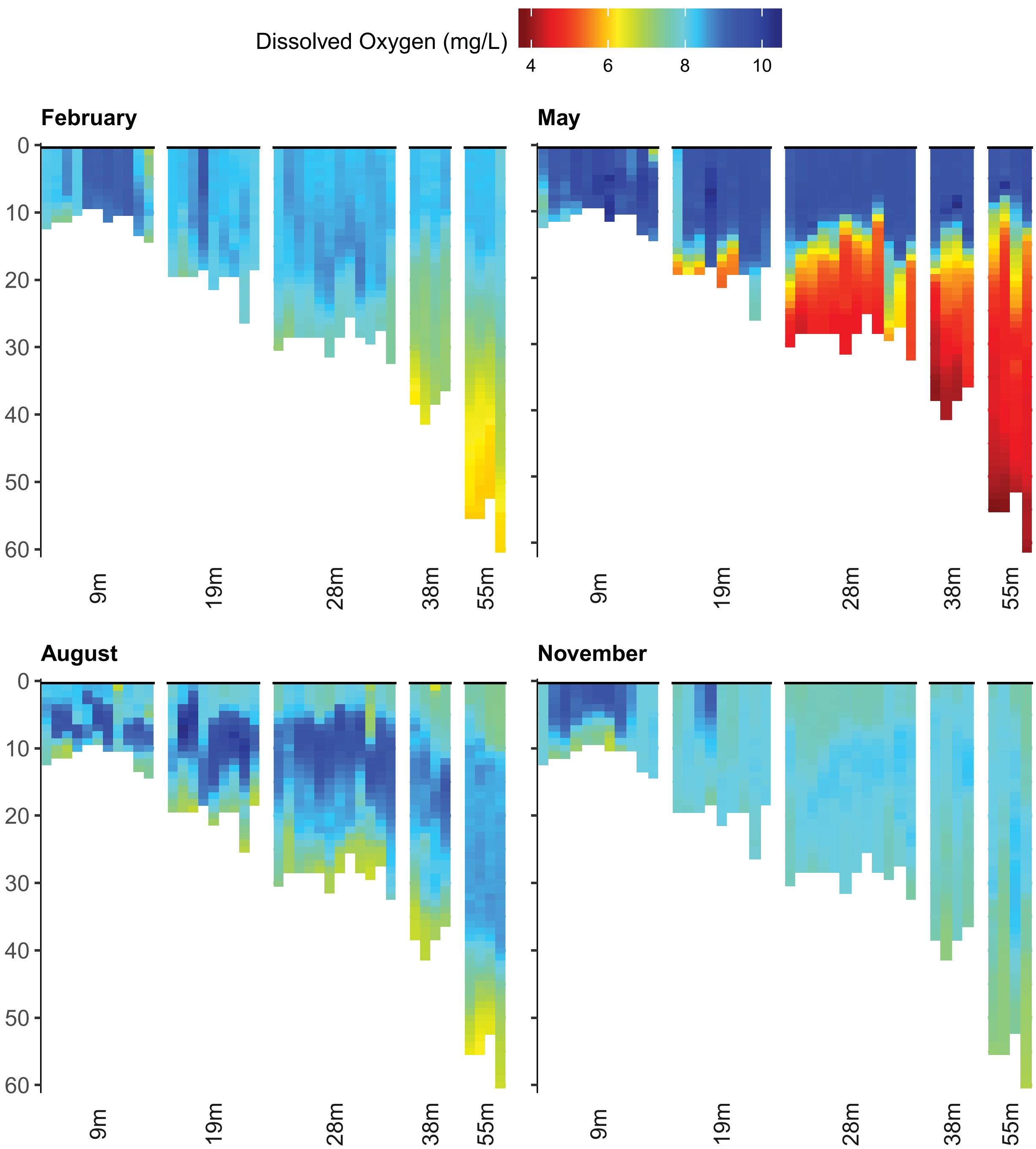
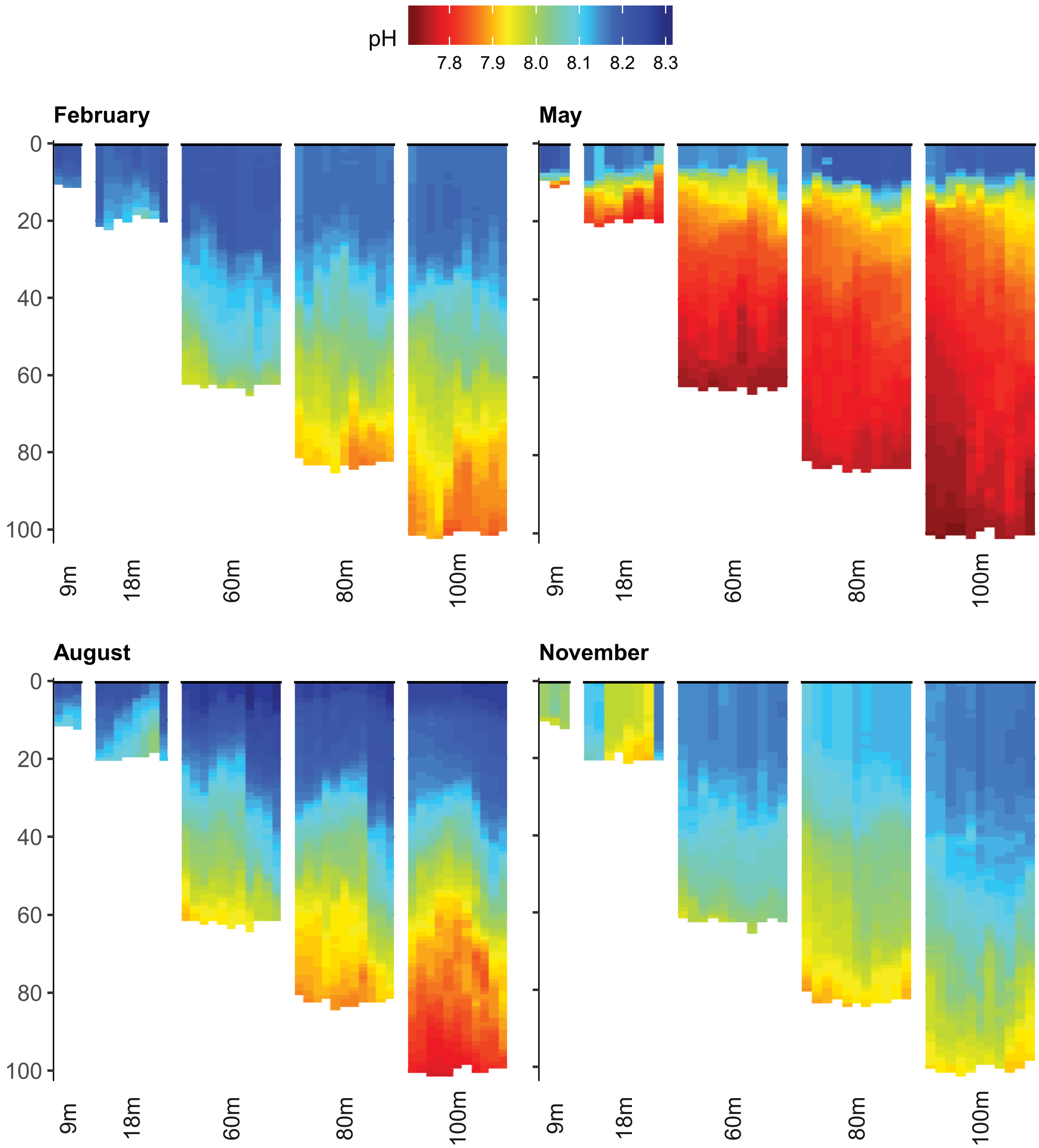


Appendix A.11

Dissolved oxygen recorded in the SBOO region during 2018. Within each contour, stations are ordered north to south. Data were collected over four to five days during each survey.



Appendix A.12

Values of pH recorded in the PLOO region during 2018. Within each contour, stations are ordered north to south. Data were collected over four days during each survey.

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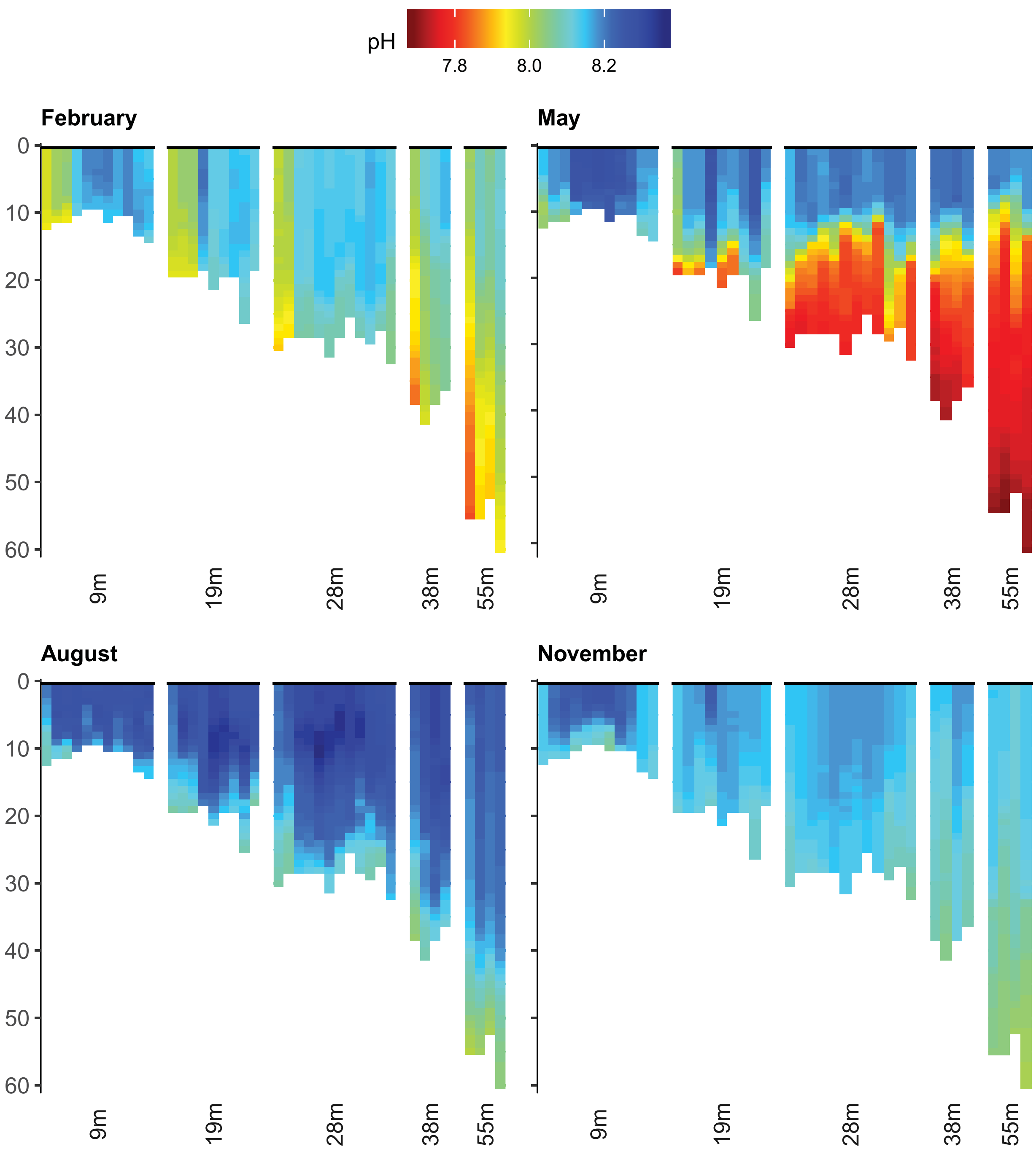
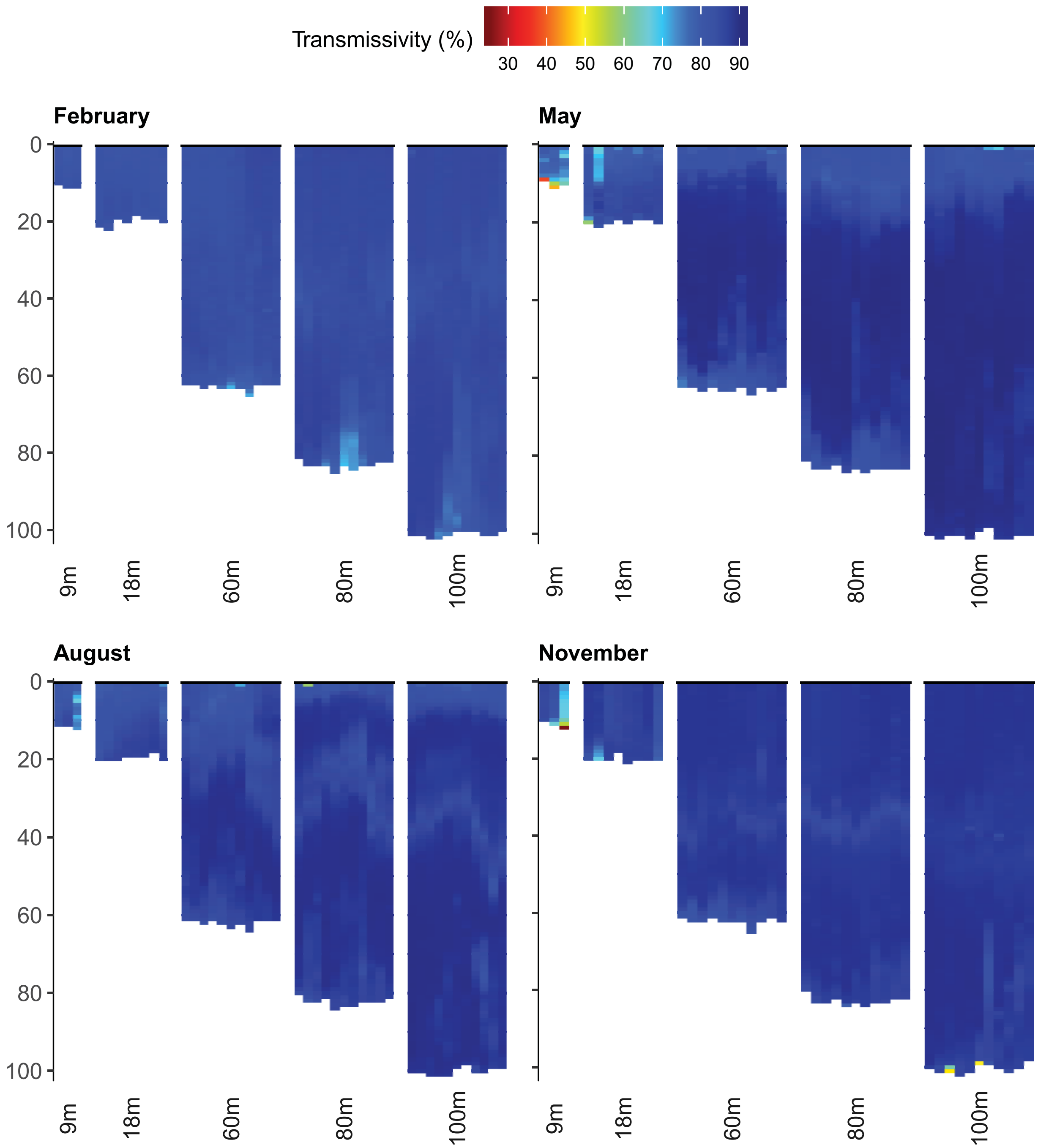


Appendix A.13

Values of pH recorded in the SBOO region during 2018. Within each contour, stations are ordered north to south. Data were collected over four to five days during each survey.



Appendix A.14

Transmissivity recorded in the PLOO region during 2018. Within each contour, stations are ordered north to south. Data were collected over four days during each survey.

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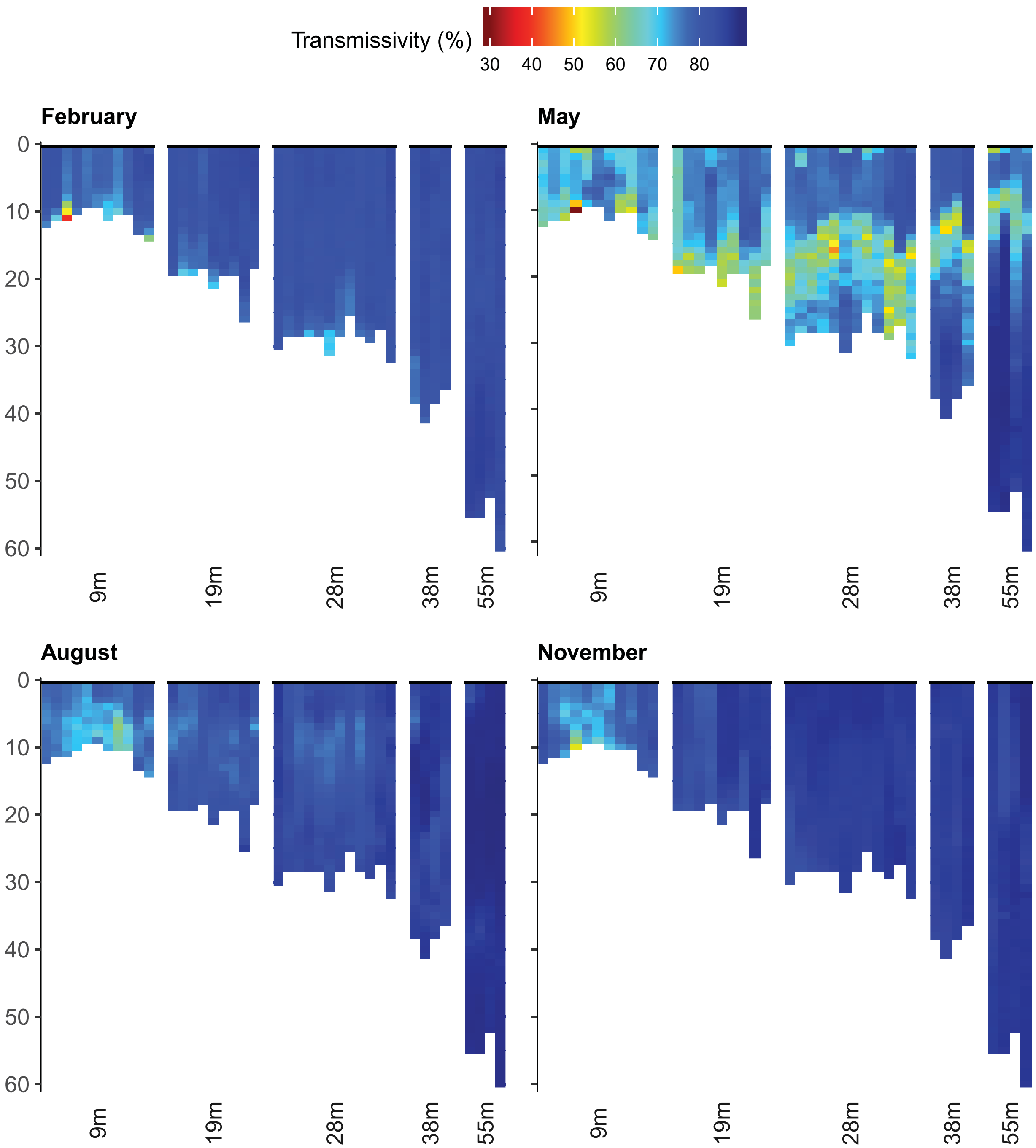
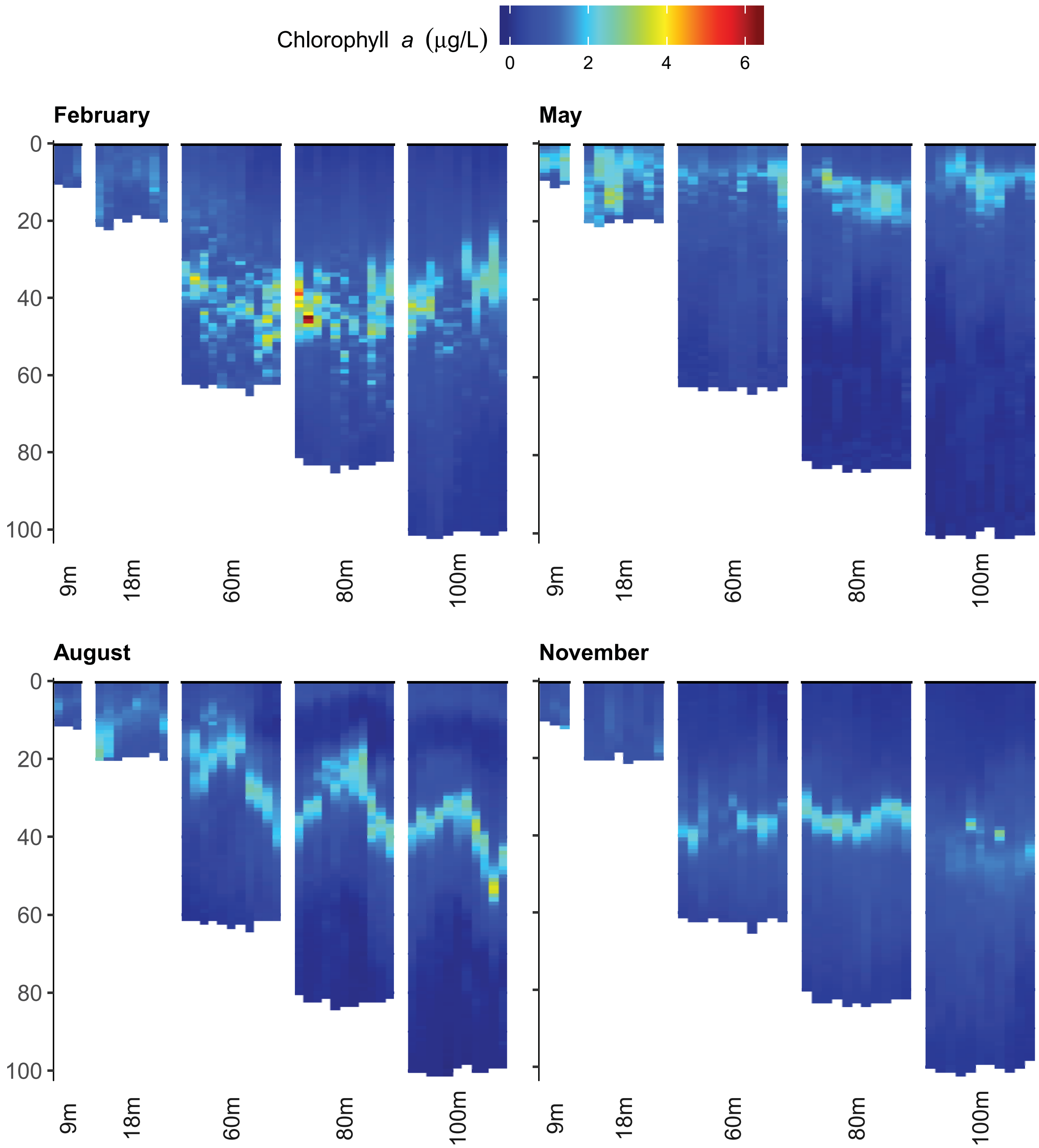
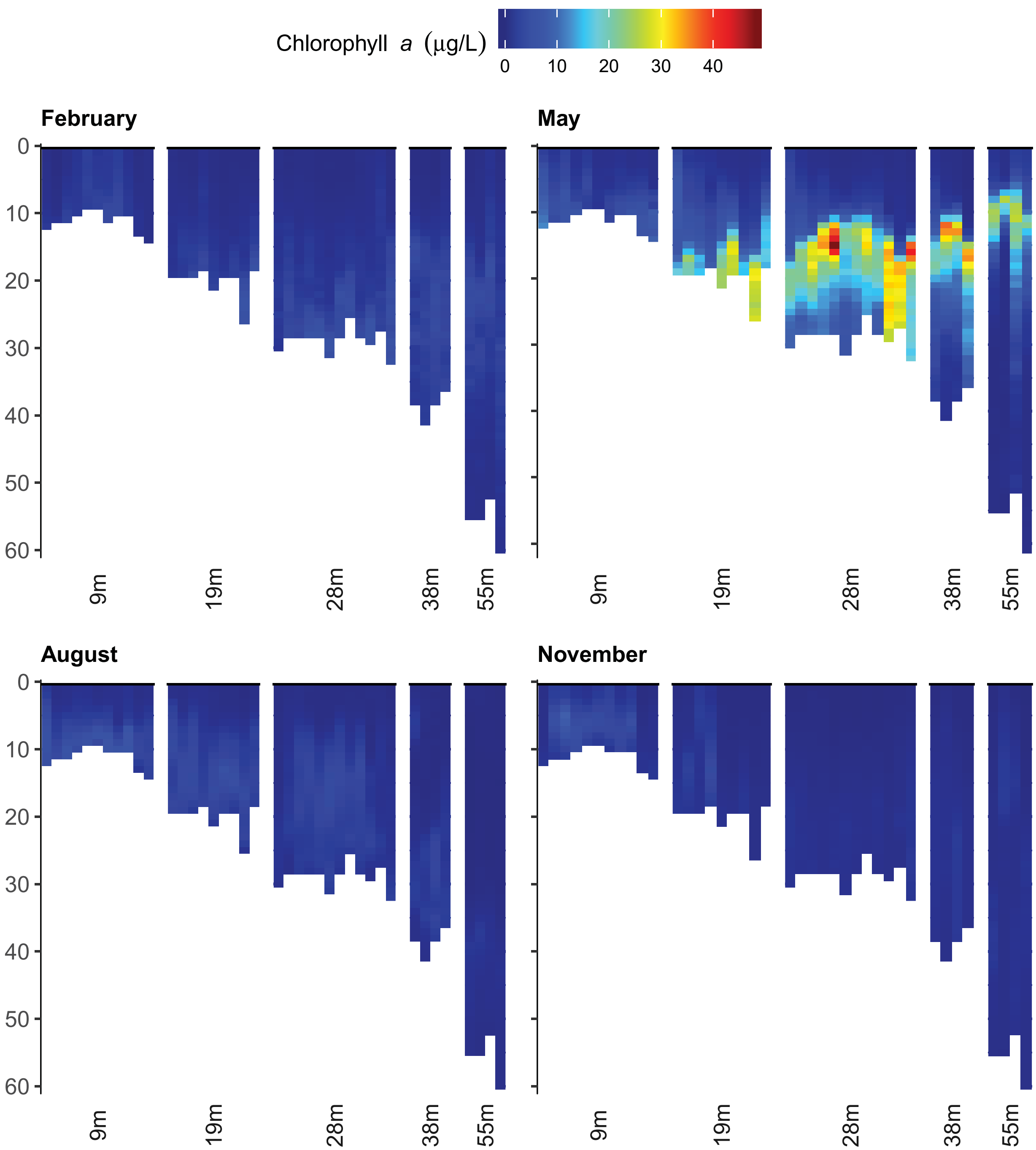


Appendix A.15

Transmissivity recorded in the SBOO region during 2018. Within each contour, stations are ordered north to south. Data were collected over four to five days during each survey.



Appendix A.16
Chlorophyll *a* recorded in the PLOO region during 2018. Within each contour, stations are ordered north to south. Data were collected over four days during each survey.



Appendix A.17

Chlorophyll *a* recorded in the SBOO region during 2018. Within each contour, stations are ordered north to south. Data were collected over four to five days during each survey.

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Appendix A.18

Summary of elevated bacteria densities in samples collected from PLOO shore, kelp, and offshore stations during 2018. Bold values exceed benchmarks for total coliform (> 10,000 CFU/100 mL), fecal coliform (> 400 CFU/100 mL), *Enterococcus* (> 104 CFU/100 mL), or the FTR criterion (total coliforms > 1000 CFU/100 mL and F:T > 0.10).

Station Group	Date	Depth (m)	Total	Fecal	Entero	F:T
Shore Stations						
D9	03-Jan-18	—	680	68	**300**	0.10
D9	10-Jan-18	—	**16,000**	**800**	**860**	0.05
D10	10-Jan-18	—	**16,000**	**580**	**800**	0.04
D11	10-Jan-18	—	**16,000**	**12,000**	**12,000**	**0.75**
D8-A	31-Jan-18	—	2600	**1800**	32	**0.69**
D11	31-Jan-18	—	60	36	**260**	0.60
D11	28-Feb-18	—	40	2	**110**	0.05
D11	14-Mar-18	—	160	14	**140**	0.09
D8-B	02-May-18	—	400	2	**120**	0.01
D11	05-Jul-18	—	200	54	**3200**	0.27
D12	05-Jul-18	—	20	2	**170**	0.10
Kelp Stations						
A6	17-Sep-18	1	3000	**2400**	**180**	**0.80**
Offshore Stations						
F30	15-Feb-18	80	—	—	**280**	—
F30	15-Feb-18	98	—	—	**160**	—
F31	15-Feb-18	80	—	—	**160**	—
F31	15-Feb-18	98	—	—	**160**	—
F32	15-Feb-18	98	—	—	**240**	—
F26	02-May-18	60	—	—	**400**	—
F27	02-May-18	60	—	—	**280**	—
F27	02-May-18	80	—	—	**220**	—
F28	02-May-18	80	—	—	**420**	—
F29	02-May-18	80	—	—	**440**	—
F30	02-May-18	80	—	—	**340**	—
F16	03-May-18	60	—	—	**220**	—
F18	03-May-18	60	—	—	**800**	—
F19	03-May-18	60	—	—	**400**	—
F20	03-May-18	60	—	—	**380**	—
F18	29-Aug-18	80	—	—	**120**	—

Appendix A.18 *continued*

Station Group	Date	Depth (m)	Total	Fecal	Entero	F:T
F28	30-Aug-18	80	—	—	**280**	—
F27	17-Nov-18	80	—	—	**110**	—
F30	17-Nov-18	80	—	—	**220**	—

Appendix A.19

Summary of elevated bacteria densities in samples collected from SBOO shore, kelp, and offshore stations during 2018. Bold values exceed benchmarks for total coliform (> 10,000 CFU/100 mL), fecal coliform (> 400 CFU/100 mL), *Enterococcus* (> 104 CFU/100 mL), or the FTR criterion (total coliforms > 1000 CFU/100 mL and F:T > 0.10).

Station Group	Date	Depth (m)	Total	Fecal	Entero	F:T
Shore Stations South of USA/Mexico Border						
S0	09-Jan-18	—	**16,000**	**980**	**3600**	0.06
S2	09-Jan-18	—	**16,000**	**940**	**2400**	0.06
S3	09-Jan-18	—	**16,000**	**1200**	**6200**	0.08
S0	16-Jan-18	—	600	140	**500**	0.23
S0	23-Jan-18	—	1600	110	**260**	0.07
S0	30-Jan-18	—	1500	**460**	**560**	**0.31**
S0	13-Feb-18	—	1200	74	**320**	0.06
S0	20-Feb-18	—	1800	60	**160**	0.03
S0	27-Feb-18	—	**16,000**	**12,000**	**12,000**	**0.75**
S2	27-Feb-18	—	200	36	**260**	0.18
S0	20-Mar-18	—	**16,000**	**3400**	**1400**	**0.21**
S0	27-Mar-18	—	4400	46	**440**	0.01
S0	02-May-18	—	8200	**920**	**1400**	**0.11**
S0	29-May-18	—	**16,000**	**1600**	**2400**	0.10
S0	19-Jun-18	—	1300	10	**200**	0.01
S0	03-Jul-18	—	6400	88	**140**	0.01
S0	07-Aug-18	—	4000	76	**320**	0.02
S0	21-Aug-18	—	1400	80	**160**	0.06
S0	28-Aug-18	—	5600	280	**2800**	0.05
S0	04-Sep-18	—	400	2	**130**	0.01
S2	11-Sep-18	—	300	2	**120**	0.01
S2	23-Oct-18	—	1000	24	**140**	0.02
S2	30-Oct-18	—	6600	100	**600**	0.02
S3	30-Oct-18	—	9800	120	**960**	0.01

Appendix A.19 *continued*

Station Group	Date	Depth (m)	Total	Fecal	Entero	F:T
S0	13-Nov-18	—	540	14	**140**	0.03
S0	27-Nov-18	—	—	200	**120**	—
S0	19-Dec-18	—	4400	100	**320**	0.02
S2	19-Dec-18	—	2600	180	**340**	0.07
Shore Stations North of USA/Mexico Border						
S4	09-Jan-18	—	**16,000**	**5000**	**12,000**	**0.31**
S5	09-Jan-18	—	2800	80	**460**	0.03
S6	09-Jan-18	—	**16,000**	**2200**	**7000**	**0.14**
S8	09-Jan-18	—	1000	100	**220**	0.10
S10	09-Jan-18	—	**16,000**	**5000**	**12,000**	**0.31**
S11	09-Jan-18	—	**16,000**	**5000**	**9600**	**0.31**
S12	09-Jan-18	—	**11,000**	**1000**	**3400**	0.09
S4[a]	11-Jan-18	—	**16,000**	**2000**	**7800**	**0.13**
S5[a]	11-Jan-18	—	—	—	**12,000**	—
S6[a]	11-Jan-18	—	4600	180	**360**	0.04
S10[a]	11-Jan-18	—	**16,000**	**12,000**	**12,000**	**0.75**
S11[a]	11-Jan-18	—	8400	120	**480**	0.01
S4[a]	12-Jan-18	—	**16,000**	**980**	**280**	0.06
S5[a]	12-Jan-18	—	—	—	**12,000**	—
S10[a]	12-Jan-18	—	**16,000**	**1400**	**520**	0.09
S4	16-Jan-18	—	1400	66	**120**	0.05
S5	16-Jan-18	—	2400	240	**130**	0.10
S10	16-Jan-18	—	400	58	**220**	0.15
S5	13-Mar-18	—	**16,000**	**12,000**	**12,000**	**0.75**
S4	12-Jun-18	—	2800	110	**400**	0.04
S5	12-Jun-18	—	440	18	**180**	0.04
S6	12-Jun-18	—	400	14	**320**	0.04
S10	12-Jun-18	—	1400	50	**240**	0.04
S11	12-Jun-18	—	300	28	**200**	0.09
S12	12-Jun-18	—	100	8	**110**	0.08
S9	26-Jun-18	—	800	200	**1200**	0.25
S9[a]	28-Jun-18	—	—	—	**140**	—
S9[a]	29-Jun-18	—	—	—	**320**	—
S9	03-Jul-18	—	180	52	**160**	0.29

[a] Resample

Appendix A.19 *continued*

Station Group	Date	Depth (m)	Total	Fecal	Entero	F:T
S12	31-Jul-18	—	60	6	**320**	0.10
S4	11-Sep-18	—	80	10	**140**	0.13
S5	16-Oct-18	—	2000	400	14	**0.20**
S4	30-Oct-18	—	6800	**840**	**940**	**0.12**
S5	04-Dec-18	—	**16,000**	**12,000**	**4800**	**0.75**
S10	04-Dec-18	—	**16,000**	**980**	**540**	0.06
S11	04-Dec-18	—	7200	**840**	100	**0.12**
S5[a]	06-Dec-18	—	**16,000**	**12,000**	**12,000**	**0.75**
S10[a]	06-Dec-18	—	**16,000**	**1400**	**2800**	0.09
S11[a]	06-Dec-18	—	**16,000**	**12,000**	—	**0.75**
S5[a]	07-Dec-18	—	**16,000**	**12,000**	**12,000**	**0.75**
S10[a]	07-Dec-18	—	**16,000**	**1800**	**3200**	**0.11**
S11[a]	07-Dec-18	—	**16,000**	**6000**	—	**0.38**
S5	09-Dec-18	—	8800	**660**	**600**	0.08
S10	09-Dec-18	—	3600	**680**	100	**0.19**
S11	09-Dec-18	—	6400	**940**	—	**0.15**
S4	11-Dec-18	—	**16,000**	**3800**	**1200**	**0.24**
S5	11-Dec-18	—	4800	**680**	**880**	**0.14**
S6	11-Dec-18	—	1400	160	**600**	**0.11**
S10	11-Dec-18	—	**16,000**	**3000**	**700**	**0.19**
S11	11-Dec-18	—	**16,000**	**800**	**460**	0.05
S12	11-Dec-18	—	200	14	**180**	0.07
S4[a]	13-Dec-18	—	**16,000**	**12,000**	**3200**	**0.75**
S5[a]	13-Dec-18	—	**12,000**	**1300**	**400**	**0.11**
S6[a]	13-Dec-18	—	1600	80	**130**	0.05
S10[a]	13-Dec-18	—	**16,000**	**12,000**	**4200**	**0.75**
S11[a]	13-Dec-18	—	3200	320	**150**	0.10
S4[a]	14-Dec-18	—	7800	**1000**	**480**	**0.13**
S5[a]	14-Dec-18	—	**16,000**	**4800**	**2600**	**0.30**
S10[a]	14-Dec-18	—	**16,000**	**12,000**	**4400**	**0.75**
S11[a]	14-Dec-18	—	3200	220	**110**	0.07
S4[a]	16-Dec-18	—	8800	**3000**	**340**	**0.34**
S5[a]	16-Dec-18	—	800	100	**140**	0.13
S10[a]	16-Dec-18	—	**16,000**	**4800**	**120**	**0.30**

[a]Resample

Appendix A.19 *continued*

Station Group	Date	Depth (m)	Total	Fecal	Entero	F:T
S5	18-Dec-18	—	140	24	**12,000**	0.17
S10	18-Dec-18	—	7200	**620**	**200**	0.09
S5[a]	20-Dec-18	—	—	—	**14,000**	—
S4	26-Dec-18	—	5800	**640**	**660**	**0.11**
S10	26-Dec-18	—	**16,000**	**1000**	**1600**	0.06
S4[a]	27-Dec-18	—	**16,000**	**3200**	**550**	**0.20**
S10[a]	27-Dec-18	—	**16,000**	**1200**	**460**	0.08
S4[a]	29-Dec-18	—	**15,000**	**2600**	**420**	**0.17**
S10[a]	29-Dec-18	—	**16,000**	**13,000**	**4600**	**0.81**
Kelp Stations						
I19	11-Jan-18	2	**16,000**	**6000**	**3000**	**0.38**
I19	11-Jan-18	6	**15,000**	**1600**	**1400**	**0.11**
I19	11-Jan-18	11	5800	320	**380**	0.06
I24	11-Jan-18	2	10,000	280	**560**	0.03
I24	11-Jan-18	6	—	400	**680**	—
I25	11-Jan-18	2	3000	60	**320**	0.02
I26	11-Jan-18	2	220	22	**110**	0.10
I39	11-Jan-18	2	130	28	**140**	0.22
I40	11-Jan-18	2	**16,000**	**5400**	**3800**	**0.34**
I40	11-Jan-18	6	9200	**820**	**1100**	0.09
I40	11-Jan-18	9	7200	**540**	**900**	0.08
I40	12-Mar-18	2	**16,000**	**460**	98	0.03
I19	02-Apr-18	2	8000	**860**	**280**	**0.11**
I19	02-Apr-18	6	6000	**440**	**360**	0.07
I19	02-Apr-18	11	3200	240	**260**	0.08
I19	11-Jun-18	6	180	2	**220**	0.01
I24	11-Jun-18	2	60	2	**140**	0.03
I24	11-Jun-18	6	740	32	**440**	0.04
I24	11-Jun-18	11	440	36	**160**	0.08
I25	11-Jun-18	6	280	24	**280**	0.09
I25	11-Jun-18	9	320	24	**120**	0.08
I40	11-Jun-18	2	60	4	**160**	0.07
I40	11-Jun-18	6	960	40	**600**	0.04
I40	11-Jun-18	9	1300	68	**480**	0.05
I19	09-Jul-18	6	1300	18	**160**	0.01
I19	09-Jul-18	11	2600	82	**260**	0.03
I24	09-Jul-18	11	1000	8	**110**	0.01

[a]Resample

Appendix A.19 *continued*

Station Group	Date	Depth (m)	Total	Fecal	Entero	F:T
I25	09-Jul-18	6	1800	18	**130**	0.01
I25	09-Jul-18	9	2400	10	**150**	0.00
I26	09-Jul-18	2	3600	2	**110**	0.00
I26	09-Jul-18	6	2800	6	**110**	0.00
I26	09-Jul-18	9	3400	6	**140**	0.00
I40	09-Jul-18	6	2000	4	**340**	0.00
I19	03-Dec-18	2	5400	**560**	14	0.10
I19	03-Dec-18	6	**11,000**	**620**	100	0.06
I24	03-Dec-18	6	3000	**500**	52	**0.17**
I25	03-Dec-18	2	**13,000**	**720**	56	0.06
I25	03-Dec-18	6	5000	**540**	52	**0.11**
I25	03-Dec-18	9	3000	320	16	**0.11**
I40	03-Dec-18	2	6400	**580**	26	0.09
I40	03-Dec-18	6	3400	**440**	28	**0.13**
I19	10-Dec-18	2	5400	**760**	**120**	**0.14**
I19	10-Dec-18	6	6200	**1200**	**180**	**0.19**
I19	10-Dec-18	11	**11,000**	**1200**	**160**	**0.11**
I24	10-Dec-18	2	**16,000**	**1600**	**220**	0.10
I24	10-Dec-18	6	**16,000**	**1200**	**400**	0.08
I24	10-Dec-18	11	4400	280	**200**	0.06
I26	10-Dec-18	9	260	60	**120**	0.23
I32	10-Dec-18	9	440	110	**160**	0.25
I40	10-Dec-18	2	**16,000**	**1200**	80	0.08
I40	10-Dec-18	6	5600	**480**	**120**	0.09
I40	10-Dec-18	9	4800	**640**	**260**	**0.13**
I19	20-Dec-18	2	4600	**420**	84	0.09
I19	20-Dec-18	6	1600	360	66	**0.23**
I19	20-Dec-18	11	2400	300	**110**	**0.13**
I19	27-Dec-18	2	**14,000**	**1200**	**300**	0.09
I19	27-Dec-18	6	**17,000**	**1400**	**300**	0.08
I19	27-Dec-18	11	**16,000**	**2000**	**460**	**0.13**
I24	27-Dec-18	2	1400	320	100	**0.23**
I24	27-Dec-18	6	1600	**480**	66	**0.30**
I24	27-Dec-18	11	1200	**520**	80	**0.43**
I25	27-Dec-18	2	1100	180	88	**0.16**
I25	27-Dec-18	9	1500	260	90	**0.17**
I40	27-Dec-18	2	**16,000**	**2600**	**180**	**0.16**
I40	27-Dec-18	6	**14,000**	**1200**	**340**	0.09
I40	27-Dec-18	9	**14,000**	**2000**	**280**	**0.14**

Appendix A.20

Summary of oceanographic data within potential detected plume at PLOO offshore stations and corresponding reference values during 2018. Plume depth is the minimum depth at which CDOM exceeds the 95th percentile while plume width is the number of meters across which that exceedance occurs. Out-of-range values are indicated with an asterisk. DO = dissolved oxygen; XMS = transmissivity; SD = standard deviation; CI = confidence interval.

		Potential Plume					Reference		
Station	Date	Depth (m)	Width (m)	Mean DO	Mean pH	Mean XMS	DO (Mean - SD)	pH (Mean)	XMS (Mean - 95% CI)
F07[a]	13-Feb-18	53	7	6.4	8.0	80*	6.1	8.0	85
F12[a]	13-Feb-18	24	28	7.1	8.1	84	7.2	8.1	84
F19[a]	14-Feb-18	71	11	5.0	7.9	75*	5.4	7.9	85
F30	15-Feb-18	78	20	4.8	7.9	80*	5.1	7.9	84
F31	15-Feb-18	75	23	4.9	7.9	79*	5.1	7.9	84
F32	15-Feb-18	95	4	4.8	7.9	76*	4.9	7.9	83
F26	2-May-18	60	11	3.6	7.8	88	3.6	7.8	88
F27	2-May-18	65	10	3.6	7.8	88	3.5	7.8	87
F29	2-May-18	77	13	3.6	7.8	88	3.4	7.8	86
F30	2-May-18	57	20	3.8	7.8	88	3.4	7.8	87
F16	3-May-18	62	5	3.7	7.8	88*	3.6	7.8	89
F18[a]	3-May-18	66	3	3.8	7.8	89	3.6	7.8	88
F19[a]	3-May-18	48	10	3.9	7.8	89	3.7	7.8	88
F20[a]	3-May-18	40	30	3.8	7.8	88*	3.7	7.8	89
F14[a]	28-Aug-18	51	8	5.7	7.9	87*	6.2	8.0	89
F18[a]	29-Aug-18	71	9	4.9	7.9	86*	5.2	7.9	87
F19[a]	29-Aug-18	58	6	5.5	7.9	88	6.0	8.0	88
F20[a]	29-Aug-18	55	9	5.5	7.9	88	6.0	8.0	88
F23	29-Aug-18	69	7	5.3	7.9	87*	5.3	7.9	88

[a]Station located within State jurisdictional waters

Appendix A.20 *continued*

		Potential Plume					Reference		
Station	Date	Depth (m)	Width (m)	Mean DO	Mean pH	Mean XMS	DO (Mean - SD)	pH (Mean)	XMS (Mean - 95% CI)
F27	30-Aug-18	74	22	5.2	7.9	88	5.2	7.9	85
F28	30-Aug-18	67	29	5.0	7.9	86	5.3	7.9	86
F29	30-Aug-18	68	12	5.1	7.9	87*	5.4	7.9	88
F30	30-Aug-18	62	6	5.4	7.9	89	5.9	8.0	89
F31	30-Aug-18	64	8	5.3	7.9	89	5.8	8.0	89
F33	30-Aug-18	61	1	5.5	7.9	89	5.9	8.0	88
F15	15-Nov-18	72	7	6.0*	7.9	87*	6.8	8.0	89
F18[a]	15-Nov-18	73	3	6.3	8.0	87*	6.8	8.0	89
F27	17-Nov-18	63	26	6.5	8.0	87*	6.8	8.0	89
F28	17-Nov-18	77	18	6.3	8.0	88*	6.6	8.0	89
F29	17-Nov-18	85	3	6.5	8.0	87*	6.6	8.0	89
F30	17-Nov-18	65	32	6.4	8.0	85*	6.7	8.0	89

[a] Station located within State jurisdictional waters

Appendix A.21

Summary of oceanographic data within potential detected plume at SBOO offshore stations and corresponding reference values during 2018. Plume depth is the minimum depth at which CDOM exceeds the 95th percentile while plume width is the number of meters across which that exceedance occurs. Out-of-range values are indicated with an asterisk. DO = dissolved oxygen; XMS = transmissivity; SD = standard deviation; CI = confidence interval.

		Potential Plume					Reference		
Station	Date	Depth (m)	Width (m)	Mean DO	Mean pH	Mean XMS	DO (Mean - SD)	pH (Mean)	XMS (Mean - 95% CI)
I1	6-Feb-18	6	24	7.7	8.1	84	7.2	8.0	81
I2	6-Feb-18	16	14	7.7	8.1	82	7.6	8.1	81
I7	6-Feb-18	7	21	7.4	8.0	83	7.3	8.0	81
I12[a]	17-May-18	2	13	5.3*	7.8	70	6.6	8.1	66
I18[a]	17-May-18	2	13	8.4	8.1	64*	6.6	8.1	66
I23[a]	17-May-18	1	14	8.8	8.1	71	6.3	8.0	67
I31[a]	18-May-18	4	13	8.3	8.1	71	6.2	8.0	66
I12[a]	22-Aug-18	6	14	8.1	8.2	81*	8.4	8.2	83
I18[a]	22-Aug-18	4	13	8.4	8.2	79*	8.4	8.2	82
I23[a]	22-Aug-18	2	17	8.2	8.2	82*	8.4	8.2	84
I1	6-Nov-18	3	24	8.1	8.1	86	7.8	8.1	83
I15	7-Nov-18	4	14	8.1	8.2	87	8.0	8.2	85
I16[a]	7-Nov-18	6	15	8.1	8.2	87	8.0	8.2	86

[a]Station located within State jurisdictional waters

Appendix B

Benthic Conditions

2018 Raw Data Summaries

PLOO and SBOO Stations

Appendix B.1

Constituents and method detection limits (MDL) used for the analysis of sediments during 2018.

Parameter	MDL	Parameter	MDL
Organic Indicators			
Biological Oxygen Demand (BOD, ppm)	2	Total Sulfides (ppm)	0.38
Total Nitrogen (TN, % wt.)	0.008-0.012	Total Volatile Solids (TVS, % wt.)	0.11
Total Organic Carbon (TOC, % wt.)	0.06-0.07		
Metals (ppm)			
Aluminum (Al)	2.4-36.1	Lead (Pb)	0.124-0.52
Antimony (Sb)	0.206-0.851	Manganese (Mn)	0.161-0.719
Arsenic (As)	0.308-2.95	Mercury (Hg)	0.003-0.058
Barium (Ba)	0.08-1.02	Nickel (Ni)	0.052-0.3
Beryllium (Be)	0.02-0.161	Selenium (Se)	0.14-2.09
Cadmium (Cd)	0.039-0.146	Silver (Ag)	0.132-0.59
Chromium (Cr)	0.056-0.223	Thallium (Tl)	0.095-0.43
Copper (Cu)	0.695-3.8	Tin (Sn)	0.18-0.722
Iron (Fe)	2.64-11.9	Zinc (Zn)	0.408-1.71
Chlorinated Pesticides (ppt)			
Hexachlorocyclohexane (HCH)			
HCH, Alpha isomer	50.9-70.6	HCH, Delta isomer	55.7-79.9
HCH, Beta isomer	31.4-75.2	HCH, Gamma isomer	56.0-75.3
Total Chlordane			
Alpha (cis) Chlordane	42.2-108	Heptachlor epoxide	42.2-108
Cis Nonachlor	33.8-293	Methoxychlor	33.8-293
Gamma (trans) Chlordane	43.5-121	Oxychlordane	43.5-121
Heptachlor	94.6-114	Trans Nonachlor	94.6-114
Total Dichlorodiphenyltrichloroethane (DDT)			
o,p-DDD	31.3-44.4	p,p-DDE	42.1-121
o,p-DDE	34.4-43.0	p,p-DDMU	29.4-189
o,p-DDT	39.0-94.0	p,p-DDT	47.6-74.7
p,p-DDD	30.3-121		
Miscellaneous Pesticides			
Aldrin	38.4-395	Endrin	42.9-496
Alpha Endosulfan	40.3-263	Endrin aldehyde	34.7-345
Beta Endosulfan	41.7-501	Hexachlorobenzene (HCB)	693-1280
Dieldrin	33.6-443	Mirex	30.6-79.5
Endosulfan Sulfate	29.7-557		

Appendix B.1 *continued*

Parameter	MDL	Parameter	MDL
Polychlorinated Biphenyl Congeners (PCBs) (ppt)			
PCB 8	40.9-57.7	PCB 126	28.5-53.3
PCB 18	26.8-46.9	PCB 128	21.2-38.1
PCB 28	22.8-38.9	PCB 138	46.8-65.4
PCB 37	24.8-40.1	PCB 149	26.4-31.3
PCB 44	38.9-81.1	PCB 151	37.0-55.8
PCB 49	29.5-41.6	PCB 153/168	48.8-109
PCB 52	34.7-51.9	PCB 156	19.0-34.2
PCB 66	27.0-38.1	PCB 157	20.4-30.8
PCB 70	30.2-44.8	PCB 158	23.2-33.8
PCB 74	26.3-38	PCB 167	29.8-49.7
PCB 77	32.3-57.4	PCB 169	24.7-67.4
PCB 81	28.1-56.5	PCB 170	24.1-97.2
PCB 87	38.0-72.5	PCB 177	31.2-45.1
PCB 99	51.3-101	PCB 180	38.2-55.2
PCB 101	49.9-58.1	PCB 183	30.1-43.5
PCB 105	37.2-52.4	PCB 187	31.7-69.5
PCB 110	21.1-85.1	PCB 189	21.5-31.4
PCB 114	39.6-127	PCB 194	33.0-57.7
PCB 118	37.3-118	PCB 195	29.2-42.2
PCB 119	45.2-117	PCB 201	28.1-72.1
PCB 123	46.5-67.2	PCB 206	45.0-65.1
Polycyclic Aromatic Hydrocarbons (PAHs) (ppb)			
1-methylnaphthalene	6.48-14.1	Benzo[G,H,I]perylene	4.18-16.4
1-methylphenanthrene	7.24-22.5	Benzo[K]fluoranthene	4.32-13.9
2,3,5-trimethylnaphthalene	10.5-17.7	Biphenyl	8.39-21.3
2,6-dimethylnaphthalene	7.24-20.2	Chrysene	4.66-14.8
2-methylnaphthalene	3.27-9.93	Dibenzo(A,H)anthracene	1.73-12.0
3,4-benzo(B)fluoranthene	10.7-17.6	Fluoranthene	3.18-13.6
Acenaphthene	8.46-15.7	Fluorene	10.9-17.9
Acenaphthylene	7.98-16.2	Indeno(1,2,3-CD)pyrene	4.57-11.7
Anthracene	4.78-13.5	Naphthalene	5.55-32.9
Benzo[A]anthracene	3.5-12.5	Perylene	3.23-14.6
Benzo[A]pyrene	4.38-11.4	Phenanthrene	4.47-14.3
Benzo[e]pyrene	20.0, 11.4	Pyrene	5.85-15.4

Appendix B.2

Particle size classification schemes (based on Folk 1980) used in the analysis of sediments during 2018. Included is a subset of the Wentworth scale presented as "phi" categories with corresponding Horiba channels, sieve sizes, and size fractions.

Wentworth Scale

	Horiba[a]				
Phi size	Min µm	Max µm	Sieve Size	Sub-Fraction	Fraction
-1	—	—	SIEVE_2000	Granules	Coarse Particles
0	1100	2000	SIEVE_1000	Very coarse sand	Coarse Particles
1	590	1000	SIEVE_500	Coarse sand	Med-Coarse Sands
2	300	500	SIEVE_250	Medium sand	Med-Coarse Sands
3	149	250	SIEVE_125	Fine sand	Fine Sands
4	64	125	SIEVE_63	Very fine sand	Fine Sands
5	32	62.5	SIEVE_0[b]	Coarse silt	Fine Particles[c]
6	16	31	—	Medium silt	Fine Particles[c]
7	8	15.6	—	Fine silt	Fine Particles[c]
8	4	7.8	—	Very fine silt	Fine Particles[c]
9	≤	3.9	—	Clay	Fine Particles[c]

[a] Values correspond to Horiba channels; particles >2000 µm measured by sieve
[b] SIEVE_0 = sum of all silt and clay, which cannot be distinguished for samples processed by nested sieves
[c] Fine particles also referred to as percent fines

Appendix B.3

Summary of particle size parameters (%) for each PLOO station sampled during winter 2018. Visual observations are from sieved “grunge” (i.e., particles retained on 1-mm mesh screen and preserved with infauna for benthic community analysis). Gran = Granules; VCS = Very Coarse Sand; CS = Coarse Sand; MS = Medium Sand; FS = Fine Sand; VFS = Very Fine Sand; CSi = Coarse Silt; MSi = Medium Silt; FSi = Fine Silt; VFSi = Very Fine Silt.

		Coarse Particles			Med-Coarse Sands			Fine Sands			Fine Particles						
		Gran	VCS	Total	CS	MS	Total	FS	VFS	Total	CSi	MSi	FSi	VFSi	Clay	Total	Visual Observations
88-m Stations	B11[s]	6.7	3.7	10.4	5.5	10.6	16.1	14.8	24.9	39.7	—	—	—	—	—	33.9	pea gravel, shell hash
	B8	0.0	0.0	0.0	0.0	0.1	0.1	5.9	31.0	36.9	30.0	13.7	14.8	4.5	0.1	63.1	shell hash, organic debris[b]
	E19	0.0	0.0	0.0	0.0	0.1	0.1	7.9	39.8	47.7	28.9	9.8	10.3	3.2	0.0	52.1	
	E7	0.0	0.0	0.0	0.0	0.2	0.2	11.1	42.8	53.9	24.4	8.1	9.9	3.4	0.1	45.9	
	E1	0.0	0.0	0.0	0.0	4.9	4.9	21.4	33.7	55.1	17.8	8.2	10.5	3.4	0.0	39.9	shell hash, coarse sand
98-m Stations	B12[s]	1.4	2.4	3.8	5.0	22.8	27.8	20.7	27.5	48.2	—	—	—	—	—	20.2	shell hash, pea gravel[b]
	B9	0.0	0.0	0.0	0.0	1.8	1.8	15.0	38.3	53.3	20.4	8.5	11.6	4.3	0.2	44.9	some mud, pea gravel
	E26	0.0	0.0	0.0	0.0	0.2	0.2	10.6	42.5	53.1	23.6	8.3	11.0	3.8	0.1	46.9	shell hash
	E25	0.0	0.0	0.0	0.0	0.7	0.7	14.4	46.1	60.5	21.5	6.2	8.0	3.0	0.1	38.8	
	E23	0.0	0.0	0.0	0.0	0.2	0.2	11.4	45.1	56.5	23.4	7.4	9.2	3.3	0.1	43.4	
	E20	0.0	0.0	0.0	0.0	0.2	0.2	12.5	47.1	59.6	21.6	6.7	8.8	3.0	0.0	40.2	shell hash, organic debris[b]
	E17[a]	0.0	0.0	0.0	0.0	0.6	0.6	15.8	49.4	65.2	18.0	5.2	7.7	3.1	0.1	34.1	shell hash, organic debris[b]
	E14[a]	0.0	0.0	0.0	0.0	1.2	1.2	17.4	53.8	71.2	14.0	2.9	6.0	4.5	0.3	27.7	black sand, shell hash, org debris[b]
	E11[a]	0.0	0.0	0.0	0.0	1.3	1.3	18.7	50.5	69.2	15.8	3.9	6.3	3.5	0.2	29.6	shell hash, black sand, org debris[b]
	E8	0.0	0.0	0.0	0.0	1.6	1.6	18.1	44.6	62.7	18.2	6.0	8.2	3.2	0.1	35.8	shell hash
	E5	0.0	0.0	0.0	0.0	1.9	1.9	20.2	45.5	65.7	17.2	5.1	6.9	3.1	0.1	32.4	
	E2[s]	1.4	1.8	3.3	4.0	8.5	12.4	18.6	34.4	53.0	—	—	—	—	—	31.4	red relic sand, shell hash
116-m Stations	B10[s]	0.4	0.3	0.7	0.4	2.3	2.7	15.7	68.4	84.1	—	—	—	—	—	12.5	shell hash, pea gravel
	E21	0.0	0.0	0.0	0.0	0.5	0.5	14.8	50.2	65.0	18.1	5.3	7.8	3.2	0.1	34.5	shell hash
	E15[a]	0.0	0.0	0.0	0.0	1.3	1.3	17.1	49.8	66.9	16.8	4.5	7.0	3.4	0.1	31.8	black sand, shell hash, org debris[b]
	E9[s]	0.5	11.9	12.4	16.0	4.9	20.9	7.5	33.8	41.3	—	—	—	—	—	25.3	black sand, shell hash
	E3[s]	12.8	10.6	23.4	11.6	11.8	23.4	26.3	12.1	38.4	—	—	—	—	—	14.8	red relic sand, shell hash

[a] Near-ZID station
[s] measured by sieve (not Horiba; silt and clay fractions are indistinguishable)
[b] contained worm tubes

Appendix B.3 *continued*

Summary of particle size parameters (%) for each PLOO station sampled during summer 2018. Visual observations are from sieved "grunge" (i.e., particles retained on 1-mm mesh screen and preserved with infauna for benthic community analysis). Gran = Granules; VCS = Very Coarse Sand; CS = Coarse Sand; MS = Medium Sand; FS = Fine Sand; VFS = Very Fine Sand; CSi = Coarse Silt; MSi = Medium Silt; FSi = Fine Silt; VFSi = Very Fine Silt; ns = not sampled.

		Coarse Particles			Med-Coarse Sands			Fine Sands			Fine Particles						
		Gran	VCS	Total	CS	MS	Total	FS	VFS	Total	CSi	MSi	FSi	VFSi	Clay	Total	Visual Observations
88-m Stations	B11	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	B8	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	E19	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	E7	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	E1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
98-m Stations	B12[s]	2.4	1.8	4.2	4.2	21.3	25.5	21.6	28.0	49.6	—	—	—	—	—	20.8	shell hash, gravel
	B9	0.0	0.0	0.0	0.0	1.4	1.4	13.5	38.4	51.9	20.7	8.8	12.4	4.5	0.2	46.6	pea gravel
	E26	0.0	0.0	0.0	0.0	0.2	0.2	10.9	41.8	52.7	21.9	8.6	12.4	4.2	0.1	47.2	shell hash, gravel
	E25[s]	0.2	0.2	0.4	0.3	0.7	1.0	15.6	46.7	62.3	—	—	—	—	—	36.3	shell hash, gravel
	E23[s]	0.4	0.2	0.6	0.2	0.2	0.4	9.9	49.7	59.6	—	—	—	—	—	39.4	shell hash
	E20	0.0	0.0	0.0	0.0	0.6	0.6	14.3	48.6	62.9	19.3	5.8	8.3	3.1	0.1	36.6	
	E17[a]	0.0	0.0	0.0	0.0	0.7	0.7	15.6	47.9	63.5	18.9	6.2	8.1	2.6	0.0	35.9	organic debris[b]
	E14[a]	0.0	0.0	0.0	0.0	0.2	0.2	16.0	59.9	75.9	12.1	2.1	5.2	4.2	0.3	23.9	gravel
	E11[a]	0.0	0.0	0.0	0.0	0.8	0.8	17.9	50.7	68.6	15.4	4.4	7.5	3.3	0.1	30.7	shell hash, gravel
	E8	0.0	0.0	0.0	0.0	1.2	1.2	16.6	44.9	61.5	17.5	6.5	9.9	3.3	0.0	37.3	
	E5	0.0	0.0	0.0	0.0	1.4	1.4	17.5	44.8	62.3	19.1	6.1	7.8	3.2	0.1	36.3	
	E2[s]	3.1	3.1	6.2	3.9	5.8	9.7	12.7	31.7	44.4	—	—	—	—	—	39.8	
116-m Stations	B10	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	E21	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	E15[a]	0.0	0.0	0.0	0.0	0.7	0.7	17.3	52.8	70.1	15.5	4.0	6.5	3.1	0.1	29.2	
	E9	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	E3	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	

[a] Near-ZID station
[s] measured by sieve (not Horiba; silt and clay fractions are indistinguishable)
[b] contained worm tubes

Appendix B.4

Summary of particle size parameters (%) for each SBOO station sampled during winter 2018. Visual observations are from sieved "grunge" (i.e., particles retained on 1-mm mesh screen and preserved with infauna for benthic community analysis). Gran = Granules; VCS = Very Coarse Sand; CS = Coarse Sand; MS = Medium Sand; FS = Fine Sand; VFS = Very Fine Sand; CSi = Coarse Silt; MSi = Medium Silt; FSi = Fine Silt; VFSi = Very Fine Silt.

		Coarse Particles			Med-Coarse Sands			Fine Sands			Fine Particles						
		Gran	VCS	Total	CS	MS	Total	FS	VFS	Total	CSi	MSi	FSi	VFSi	Clay	Total	Visual Observations
19-m Stations	I35	0.0	0.0	0.0	0.0	2.1	2.1	18.6	44.9	63.5	20.0	6.4	6.2	1.9	0.0	34.4	
	I34[s]	11.9	32.9	44.8	25.6	20.0	45.6	6.4	0.4	6.8	—	—	—	—	—	2.8	red relic sand, shell hash
	I31	0.0	0.0	0.0	0.0	0.6	0.6	18.5	71.8	90.3	5.1	0.0	1.5	2.3	0.2	9.1	
	I23[s]	0.4	0.2	0.6	1.6	3.4	5.0	19.3	66.9	86.2	—	—	—	—	—	8.3	shell hash
	I18	0.0	0.0	0.0	0.0	0.7	0.7	18.8	70.8	89.6	7.0	0.0	1.0	1.6	0.1	9.7	
	I10	0.0	0.0	0.0	0.0	3.0	3.0	26.1	61.5	87.6	5.4	0.1	1.7	2.0	0.1	9.4	shell hash, organic debris[b]
	I4[s]	0.3	0.7	1.0	31.3	58.2	89.5	6.2	1.2	7.3	—	—	—	—	—	2.2	shell hash
28-m Stations	I33	0.0	0.0	0.0	0.0	2.9	2.9	35.0	50.7	85.7	3.9	1.0	3.5	3.0	0.1	11.5	
	I30	0.0	0.0	0.0	0.0	0.5	0.5	13.1	66.6	79.7	13.8	1.3	2.5	2.1	0.1	19.7	
	I27	0.0	0.0	0.0	0.0	0.7	0.7	14.4	67.7	82.1	11.7	0.7	2.0	2.6	0.3	17.2	
	I22	0.0	0.0	0.0	0.0	4.4	4.4	27.5	53.7	81.2	9.1	0.9	2.2	2.1	0.1	14.4	
	I14[a]	0.0	0.0	0.0	0.0	2.0	2.0	19.0	61.0	80.0	12.4	0.9	2.2	2.4	0.1	18.0	
	I16[a]	0.0	0.5	0.5	13.9	48.8	62.7	29.8	5.0	34.8	0.6	0.4	0.8	0.1	0.0	1.9	shell hash, black sand
	I15	0.0	0.0	0.0	6.4	41.0	47.4	37.8	11.0	48.8	2.0	0.6	0.9	0.3	0.0	3.8	
	I12[a]	0.0	0.0	0.0	5.3	36.6	41.9	35.9	17.5	53.4	2.5	0.7	1.1	0.3	0.0	4.6	shell hash, organic debris[b]
	I9	0.0	0.0	0.0	0.0	0.5	0.5	13.6	65.8	79.4	14.1	1.3	2.6	2.0	0.1	20.1	organic debris[b]
	I6[s]	0.0	1.8	1.8	30.8	57.7	88.5	9.1	0.6	9.7	0.0	0.0	0.0	0.0	0.0	0.0	shell hash
	I2	0.0	0.1	0.1	8.8	53.7	62.5	32.9	3.0	35.9	0.2	0.4	0.8	0.1	0.0	1.5	
	I3	0.0	0.5	0.5	14.7	57.6	72.3	25.6	1.6	27.2	0.0	0.0	0.0	0.0	0.0	0.0	shell hash
38-m Stations	I29[s]	1.0	30.0	31.0	60.1	5.8	65.9	0.5	0.4	0.9	—	—	—	—	—	2.3	red relic sand
	I21	0.0	4.6	4.6	49.1	42.2	91.3	4.0	0.1	4.1	0.0	0.0	0.0	0.0	0.0	0.0	
	I13	0.0	6.2	6.2	54.9	36.0	90.9	2.9	0.1	2.9	0.0	0.0	0.0	0.0	0.0	0.0	
	I8	0.0	0.1	0.1	11.4	57.3	68.7	26.4	3.1	29.5	0.3	0.3	0.9	0.2	0.0	1.7	
55-m Stations	I28[s]	7.0	10.5	17.5	20.3	13.5	33.8	4.2	25.8	30.0	—	—	—	—	—	18.8	black sand, pea gavel, shell hash
	I20	0.0	14.5	14.5	68.8	11.8	80.6	2.9	0.7	3.6	0.0	0.3	0.8	0.1	0.0	1.3	red relic sand
	I7[s]	0.6	12.0	12.6	57.3	26.1	83.4	2.3	0.2	2.5	—	—	—	—	—	1.5	red relic sand
	I1	0.0	0.0	0.0	0.0	5.6	5.6	49.6	35.8	85.4	3.2	1.1	2.8	1.9	0.0	9.1	

[a] Near-ZID station
[s] measured by sieve (not Horiba; silt and clay fractions are indistinguishable)
[b] contained worm tubes

Appendix B.4 *continued*

Summary of particle size parameters (%) for each SBOO station sampled during summer 2018. Visual observations are from sieved "grunge" (i.e., particles retained on 1-mm mesh screen and preserved with infauna for benthic community analysis). Gran = Granules; VCS = Very Coarse Sand; CS = Coarse Sand; MS = Medium Sand; FS = Fine Sand; VFS = Very Fine Sand; CSi = Coarse Silt; MSi = Medium Silt; FSi = Fine Silt; VFSi = Very Fine Silt; not sampled.

		Coarse Particles			Med-Coarse Sands			Fine Sands			Fine Particles						
		Gran	VCS	Total	CS	MS	Total	FS	VFS	Total	CSi	MSi	FSi	VFSi	Clay	Total	Visual Observations
19-m Stations	I35	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	I34	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	I31	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	I23	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	I18	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	I10	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	I4	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
28-m Stations	I33 [s]	0.0	0.1	0.1	0.4	1.6	2.0	27.3	63.6	90.9	—	—	—	—	—	7.0	
	I30	0.0	0.0	0.0	0.0	0.5	0.5	13.5	64.3	77.8	14.4	1.9	3.3	2.0	0.0	21.6	
	I27 [s]	0.0	0.1	0.1	0.1	0.2	0.4	1.4	81.0	82.4	—	—	—	—	—	17.2	
	I22	0.0	0.0	0.0	0.0	3.7	3.7	26.1	53.9	80.0	9.7	1.2	2.9	2.4	0.1	16.3	
	I14 [a]	0.0	0.0	0.0	0.0	0.8	0.8	16.2	63.4	79.6	13.0	1.1	2.7	2.6	0.2	19.6	
	I16 [a]	0.0	0.0	0.0	2.5	27.5	30.0	49.4	16.0	65.4	1.8	0.9	1.5	0.5	0.0	4.6	
	I15	0.0	0.4	0.4	14.8	61.3	76.1	17.5	3.0	20.5	1.1	0.7	1.0	0.3	0.0	3.0	
	I12 [a]	0.0	0.4	0.4	12.9	56.3	69.2	24.3	4.7	29.0	0.7	0.1	0.7	0.0	0.0	1.4	shell hash
	I9	0.0	0.0	0.0	0.0	0.8	0.8	14.6	64.7	79.3	14.7	1.2	2.2	1.8	0.1	20.0	
	I6 [s]	0.3	0.4	0.7	22.6	64.2	86.8	10.8	0.5	11.3	—	—	—	—	—	1.2	red relic sand, shell hash
	I2	0.0	0.1	0.1	11.8	60.8	72.6	25.5	1.5	27.0	0.0	0.0	0.4	0.0	0.0	0.4	
	I3	0.3	11.2	11.5	53.3	31.4	84.7	3.7	0.1	3.7	0.0	0.0	0.2	0.0	0.0	0.2	red relic sand, shell hash
38-m Stations	I29	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	I21	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	I13	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	I8	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
55-m Stations	I28	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	I20	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	I7	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	
	I1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	

[a] Near-ZID station

[s] measured by sieve (not Horiba; silt and clay fractions are indistinguishable)

Appendix B.5

Concentrations of organic loading indicators detected in sediments from PLOO stations sampled during winter and summer 2018. See Table B.1 for MDLs; ns = not sampled.

	Winter					Summer				
	BOD (ppm)	Sulfides (ppm)	TN (% wt)	TOC (% wt)	TVS (% wt)	BOD (ppm)	Sulfides (ppm)	TN (% wt)	TOC (% wt)	TVS (% wt)
88-m Depth Contour										
B11	ns	6.50	0.081	0.88	3.5	ns	ns	ns	ns	ns
B8	ns	7.38	0.079	0.69	2.7	ns	ns	ns	ns	ns
E19	ns	2.61	0.057	0.48	2.2	ns	ns	ns	ns	ns
E7	ns	2.91	0.051	0.44	1.9	ns	ns	ns	ns	ns
E1	ns	1.61	0.044	0.40	1.6	ns	ns	ns	ns	ns
98-m Depth Contour										
B12	256	3.28	0.055	1.87	3.0	543	4.62	0.059	2.01	2.9
B9	213	17.00	0.062	0.54	2.3	375	4.53	0.061	0.65	2.7
E26	210	3.79	0.054	0.35	1.9	378	1.44	0.063	0.70	1.9
E25	227	2.95	0.041	0.32	1.7	367	3.33	0.050	0.55	1.9
E23	246	3.80	0.049	0.40	1.8	351	12.20	0.053	0.58	2.0
E20	215	2.74	0.045	0.34	1.5	358	4.79	0.043	0.47	1.6
E17 [a]	299	3.33	0.039	0.32	1.6	288	14.70	0.043	0.45	1.6
E14 [a]	204	14.30	0.041	0.36	1.4	577	6.46	0.034	0.35	1.4
E11 [a]	213	1.49	0.037	0.31	1.7	242	5.82	0.041	0.42	1.7
E8	202	3.76	0.037	0.32	1.7	351	4.41	0.045	0.50	1.8
E5	165	3.21	0.044	0.37	1.8	295	108.00	0.042	0.45	1.8
E2	159	4.45	0.039	0.33	2.0	325	10.30	0.055	0.62	2.4
116-m Depth Contour										
B10	ns	3.81	0.044	0.35	1.9	ns	ns	ns	ns	ns
E21	ns	3.99	0.042	0.34	1.6	ns	ns	ns	ns	ns
E15 [a]	ns	3.26	0.040	0.31	1.7	584	9.06	0.040	0.41	1.6
E9	ns	5.61	0.049	0.45	1.9	ns	ns	ns	ns	ns
E3	ns	1.85	0.037	0.29	1.2	ns	ns	ns	ns	ns
Detection Rate (%)	100	100	100	100	100	100	100	100	100	100

[a] Near-ZID station

Appendix B.6

Concentrations of organic indicators detected in sediments from SBOO stations sampled during winter and summer 2018. See Table B.1 for MDLs; nd = not detected; ns = not sampled.

	Winter				Summer			
	Sulfides (ppm)	TN (% wt)	TOC (% wt)	TVS (% wt)	Sulfides (ppm)	TN (% wt)	TOC (% wt)	TVS (% wt)
19-m Stations								
I35	6.02	0.032	0.22	1.2	ns	ns	ns	ns
I34	0.65	nd	0.70	0.6	ns	ns	ns	ns
I31	0.84	0.020	0.10	0.6	ns	ns	ns	ns
I23	1.60	0.023	0.11	0.7	ns	ns	ns	ns
I18	0.97	nd	0.07	0.6	ns	ns	ns	ns
I10	1.25	0.022	0.08	0.9	ns	ns	ns	ns
I4	nd	nd	nd	0.5	ns	ns	ns	ns
28-m Stations								
I33	1.94	0.027	0.17	1.2	16.80	0.030	0.24	1.2
I30	1.70	0.024	0.14	1.0	6.70	0.026	0.23	0.9
I27	1.04	0.026	0.15	1.0	5.65	0.024	0.19	0.7
I22	0.94	0.026	0.14	0.8	16.30	0.028	0.23	0.8
I14 [a]	1.13	0.030	0.18	1.1	37.40	0.037	0.35	1.0
I16 [a]	0.53	nd	nd	0.5	6.27	nd	0.12	0.4
I15	0.62	0.021	0.07	0.5	0.86	0.016	0.15	0.4
I12 [a]	1.01	0.021	0.06	0.7	1.69	nd	0.13	0.4
I9	2.49	0.025	0.14	1.1	5.43	0.030	0.27	0.8
I6	nd	nd	nd	0.5	0.41	nd	0.11	0.4
I2	0.52	nd	nd	0.5	0.54	nd	0.11	0.4
I3	nd	nd	nd	0.5	nd	nd	nd	0.3
38-m Stations								
I29	nd	nd	nd	0.4	ns	ns	ns	ns
I21	nd	nd	nd	0.6	ns	ns	ns	ns
I13	nd	nd	nd	0.4	ns	ns	ns	ns
I8	nd	0.021	0.07	0.5	ns	ns	ns	ns
55-m Stations								
I28	2.32	0.045	0.35	1.2	ns	ns	ns	ns
I20	nd	0.018	nd	0.5	ns	ns	ns	ns
I7	nd	nd	nd	0.5	ns	ns	ns	ns
I1	0.54	0.025	0.13	0.5	ns	ns	ns	ns
Detection Rate (%)	67	59	63	100	92	58	92	100

[a] Near-ZID station

Appendix B.7

Concentrations of trace metals (ppm) detected in sediments from PLOO stations sampled during winter 2018. See Table B.1 for MDLs and translation of periodic table symbols; nd = not detected.

	Al	Sb	As	Ba	Be	Cr	Cu	Fe	Pb	Mn	Ni	Se	Sn	Zn
88-m Depth Contour														
B11	9880	1.8	3.98	40.0	nd	22.2	4.3	19,200	3.9	122.0	7.3	0.60	0.8	39.1
B8	10,400	1.4	2.54	47.3	nd	19.8	5.2	14,200	4.5	111.0	7.9	nd	0.9	33.9
E19	8460	1.0	2.68	38.0	nd	16.2	3.9	11,200	3.4	95.4	6.5	0.56	0.5	27.1
E7	7110	1.1	2.64	35.1	nd	15.1	4.4	10,000	3.7	83.7	6.0	0.43	0.7	24.8
E1	6080	1.1	2.30	30.7	nd	12.7	4.0	8850	4.2	72.2	4.8	0.48	0.6	22.1
98-m Depth Contour														
B12	5990	1.8	4.63	19.0	0.07	21.8	nd	19,200	3.0	54.3	4.1	0.64	nd	30.8
B9	8150	1.4	2.63	43.9	nd	20.5	2.8	14,800	3.6	95.8	6.5	0.63	0.5	32.3
E26	7120	1.0	2.59	31.0	nd	14.8	3.5	9970	3.2	82.4	5.9	0.51	0.6	23.8
E25	5990	0.9	2.34	26.0	nd	13.2	2.8	8900	2.9	71.5	5.0	0.44	0.5	21.3
E23	7470	1.1	2.25	31.8	nd	14.7	3.3	10,000	3.1	85.5	5.8	0.56	0.5	24.2
E20	6470	0.9	2.11	26.9	nd	13.0	2.7	8860	2.6	75.3	5.0	0.45	0.4	20.9
E17[a]	6220	0.8	2.28	24.0	nd	12.8	2.9	8640	2.5	71.6	4.9	0.62	nd	20.6
E14[a]	4670	nd	2.00	18.8	nd	10.9	2.9	6920	2.1	60.3	4.3	0.41	nd	17.8
E11[a]	5150	nd	1.99	20.0	nd	11.0	2.2	7550	2.1	61.2	4.0	0.49	nd	18.1
E8	5420	0.9	2.23	24.0	nd	12.0	2.6	8080	2.5	65.1	4.3	0.32	0.5	19.3
E5	5800	1.1	2.74	25.5	nd	12.6	3.1	8690	2.8	66.3	4.6	0.36	0.5	20.4
E2	7120	1.1	2.40	39.8	nd	14.0	4.3	10,800	3.4	82.8	4.8	0.49	0.6	25.1
116-m Depth Contour														
B10	6220	1.3	2.50	21.3	nd	16.8	1.8	12,900	2.6	64.9	4.2	0.46	0.5	26.6
E21	5780	0.8	2.00	23.0	nd	12.3	2.5	8110	2.6	67.2	4.7	0.29	nd	19.5
E15[a]	5020	0.4	1.78	19.6	nd	11.7	2.3	7560	2.4	57.3	4.0	0.44	nd	18.2
E9	5310	1.2	2.84	23.3	nd	15.4	6.4	9970	5.2	58.1	4.3	0.32	0.6	30.6
E3	6730	1.2	2.02	42.0	nd	11.8	6.1	10,800	3.8	79.0	3.6	0.50	0.6	27.5
Detection Rate (%)	100	91	100	100	5	100	95	100	100	100	100	95	73	100
ERL[b]	—	—	8.2	—	—	81	34	—	46.7	—	20.9	1.0	—	150
ERM[b]	—	—	70.0	—	—	370	270	—	218	—	51.6	3.7	—	410

[a] Near-ZID station
[b] From Long et al. 1995

Appendix B.7 *continued*

Concentrations of trace metals (ppm) detected in sediments from PLOO stations sampled during summer 2018. See Table B.1 for MDLs and translation of periodic table symbols; nd = not detected; ns = not sampled.

	Al	Sb	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Se	Sn	Zn
88-m Depth Contour																
B11	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
B8	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
E19	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
E7	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
E1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
98-m Depth Contour																
B12	6120	1.6	4.56	18.2	0.29	0.06	22.4	nd	19,400	2.9	53.5	0.012	4.1	0.50	0.4	32.2
B9	8120	1.3	2.94	62.7	0.22	0.05	18.8	2.9	13,600	3.5	92.7	0.023	6.2	0.55	0.6	31.2
E26	7840	1.1	2.74	32.0	0.17	0.07	15.4	3.6	10,600	3.5	86.6	0.023	6.2	0.57	0.6	26.4
E25	6690	0.9	2.31	26.8	0.14	0.07	13.3	2.7	9030	2.8	75.6	0.018	5.1	nd	0.4	22.1
E23	7490	1.1	2.62	39.9	0.16	0.08	14.8	3.5	10,100	3.1	84.2	0.019	6.0	nd	0.5	24.5
E20	6240	0.9	2.36	24.2	0.13	0.07	12.6	2.7	8450	2.6	70.7	0.015	4.8	0.50	0.4	20.4
E17[a]	6380	0.9	1.99	23.6	0.13	0.11	12.3	3.1	8100	2.4	75.6	0.014	4.8	nd	0.6	19.8
E14[a]	5050	0.9	2.30	16.1	0.11	0.11	10.3	3.0	6700	2.0	60.3	0.010	3.8	nd	0.5	16.7
E11[a]	6300	0.9	2.20	21.5	0.13	0.10	11.9	2.9	8050	2.2	74.0	0.019	4.5	nd	0.5	19.0
E8	7320	1.1	2.43	25.7	0.15	0.08	13.2	3.1	9160	2.6	82.0	0.015	4.9	0.49	0.6	21.3
E5	6520	1.0	2.27	25.5	0.15	0.05	12.9	3.0	9000	2.8	71.7	0.020	4.8	nd	0.5	21.4
E2	8800	1.2	2.25	42.3	0.18	0.02	15.9	5.6	12,300	3.9	93.0	0.034	5.7	0.53	0.6	29.5
116-m Depth Contour																
B10	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
E21	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
E15[a]	5530	0.9	1.76	19.2	0.12	0.08	11.6	2.5	7410	2.3	66.0	0.051	4.0	nd	0.4	17.6
E9	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
E3	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Detection Rate (%)	100	100	100	100	100	100	100	92	100	100	100	100	100	46	100	100
ERL[b]	—	—	8.2	—	—	1.2	81	34	—	46.7	—	0.15	20.9	1.0	—	150
ERM[b]	—	—	70.0	—	—	9.6	370	270	—	218	—	0.71	51.6	3.7	—	410

[a] Near-ZID station
[b] From Long et al. 1995

Appendix B.8

Concentrations of trace metals (ppm) detected in sediments from SBOO stations sampled during winter 2018. See Table B.1 for MDLs and translation of periodic table symbols; nd=not detected.

	Al	Sb	As	Ba	Cr	Cu	Fe	Pb	Mn	Ni	Se	Sn	Zn
19-m Stations													
I35	6730	0.9	2.50	35.7	12.1	1.8	8810	2.7	88.2	3.5	0.41	0.6	22.5
I34	1340	nd	3.14	6.1	3.0	nd	3130	1.5	32.4	0.5	nd	nd	5.9
I31	3180	nd	1.36	12.6	7.2	nd	3800	1.2	48.3	1.4	nd	nd	8.5
I23	4510	nd	1.54	22.6	9.1	1.0	5380	1.6	57.1	2.3	nd	nd	12.3
I18	4170	nd	nd	25.7	11.4	nd	6270	1.4	68.5	1.9	nd	nd	11.1
I10	5420	nd	nd	29.2	10.5	nd	6660	1.3	72.0	2.7	nd	nd	15.5
I4	572	nd	1.22	1.5	3.7	nd	1320	1.0	7.4	0.4	nd	nd	2.0
28-m Stations													
I33	4330	nd	2.04	18.4	8.3	1.4	6070	2.4	65.9	2.1	nd	0.8	15.2
I30	5660	nd	1.78	26.0	10.8	1.3	6200	1.6	59.8	2.8	0.24	nd	15.6
I27	5260	nd	1.39	27.5	10.0	1.2	6010	1.5	60.1	2.7	0.16	nd	14.5
I22	4170	nd	1.31	23.0	8.9	0.8	4900	1.5	52.4	2.3	nd	nd	11.2
I14[a]	6100	nd	nd	31.2	10.8	nd	6770	1.3	70.8	3.1	nd	nd	16.4
I16[a]	2690	nd	nd	12.8	5.9	nd	4340	1.0	38.6	1.0	nd	nd	10.0
I15	2440	nd	nd	8.4	8.9	nd	4450	1.5	34.5	1.1	nd	nd	8.3
I12[a]	3490	nd	nd	18.0	7.6	nd	4890	1.0	47.6	1.5	nd	nd	11.4
I9	6260	nd	1.65	35.8	11.4	1.4	7370	1.3	73.6	3.5	0.35	nd	17.8
I6	766	nd	4.62	1.4	7.5	nd	3510	1.5	8.3	nd	nd	nd	2.7
I2	1050	nd	nd	2.2	5.8	nd	1260	0.9	8.7	0.6	nd	nd	2.4
I3	769	nd	nd	1.4	5.8	nd	1210	0.9	8.4	0.5	nd	nd	1.7
38-m Stations													
I29	1250	nd	4.11	2.4	7.4	nd	6870	2.1	17.1	0.5	nd	nd	6.1
I21	973	nd	9.78	2.0	11.4	nd	8370	3.1	12.6	nd	nd	nd	5.9
I13	935	nd	6.51	2.1	8.5	nd	5330	2.1	14.1	0.3	nd	nd	4.7
I8	1730	nd	2.28	4.8	9.4	nd	4260	1.3	20.4	0.8	nd	nd	7.9
55-m Stations													
I28	4090	nd	2.10	18.1	8.1	1.9	5890	2.1	45.6	3.5	0.23	nd	13.4
I20	1130	nd	3.08	2.5	5.4	nd	5070	1.6	15.0	0.4	nd	nd	5.6
I7	963	nd	6.71	2.5	7.8	nd	6770	2.1	12.7	0.3	nd	nd	4.9
I1	2740	nd	nd	9.3	7.3	nd	3840	1.5	41.3	2.4	nd	nd	7.8
Detection Rate (%)	100	4	67	100	100	30	100	100	100	93	19	7	100
ERL[b]	—	—	8.2	—	81	34	—	46.7	—	20.9	1.0	—	150
ERM[b]	—	—	70.0	—	370	270	—	218	—	51.6	3.7	—	410

[a] Near-ZID station
[b] From Long et al. 1995

Appendix B.8 *continued*

Concentrations of trace metals (ppm) detected in sediments from SBOO stations sampled during summer 2018. See Table B.1 for MDLs and translation of periodic table symbols; nd=not detected; ns=not sampled.

	Al	Sb	As	Ba	Be	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Ni	Sn	Zn
19-m Stations															
I35	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
I34	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
I31	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
I23	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
I18	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
I10	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
I4	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
28-m Stations															
I33	4510	0.6	2.07	20.6	0.09	0.05	8.2	2.0	6120	2.6	66.8	0.012	2.1	0.4	16.4
I30	6050	0.7	1.88	25.6	0.10	0.04	10.4	1.3	6270	1.6	60.0	0.004	2.8	0.2	17.0
I27	5760	0.7	1.85	25.5	0.10	0.04	9.8	1.0	6190	1.4	60.4	nd	2.6	nd	16.1
I22	4870	0.6	1.51	24.2	0.09	nd	9.5	1.0	5410	1.5	58.0	nd	2.5	0.3	13.5
I14 [a]	6950	0.8	1.71	31.9	0.12	nd	11.3	1.5	7530	1.5	73.4	0.004	3.4	0.2	20.0
I16 [a]	3100	0.5	1.26	17.4	0.07	nd	7.1	1.0	4430	1.3	50.3	nd	1.3	nd	10.6
I15	2050	0.4	2.23	5.9	0.06	nd	8.3	nd	4190	1.5	23.0	nd	0.9	nd	8.3
I12 [a]	2020	0.4	1.53	8.5	nd	nd	5.9	nd	3260	1.0	27.8	nd	0.7	nd	7.0
I9	7180	0.8	1.70	34.8	0.12	nd	11.6	2.1	7700	1.3	73.8	nd	3.6	0.2	21.1
I6	1110	0.5	4.67	2.7	nd	0.05	8.3	nd	3870	1.5	8.9	nd	0.4	nd	4.0
I2	1110	nd	0.93	2.0	nd	nd	5.3	nd	1270	0.9	8.1	nd	0.7	nd	2.7
I3	647	nd	1.30	1.6	nd	nd	4.6	nd	1360	0.8	5.6	nd	0.5	nd	2.0
38-m Stations															
I29	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
I21	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
I13	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
I8	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
55-m Stations															
I28	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
I20	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
I7	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
I1	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Detection Rate (%)	100	83	100	100	67	33	100	58	100	100	100	25	100	42	100
ERL [b]	—	—	8.2	—	—	1.2	81	34	—	46.7	—	0.15	20.9	—	150
ERM [b]	—	—	70.0	—	—	9.6	370	270	—	218	—	0.71	51.6	—	410

[a] Near-ZID station
[b] From Long et al. 1995

Appendix B.9

Concentrations of pesticides, PCB and PAH detected in sediments from PLOO stations sampled during winter and summer 2018. See Table B.1 for MDLs; tChlor = total chlordane; nd = not detected; nr = not reportable; ns = not sampled; na = not analyzed.

	Winter						Summer			
	tChlor (ppt)	**tDDT (ppt)**	**tHCH (ppt)**	**HCB (ppt)**	**tPCB (ppt)**	**tPAH (ppb)**	**tDDT (ppt)**	**HCB (ppt)**	**tPCB (ppt)**	**tPAH (ppb)**
88-m Stations										
B11	nd	496	96	207	381	nr	ns	ns	ns	ns
B8	nd	327	nd	537	785	55	ns	ns	ns	ns
E19	nd	437	179	94	506	72	ns	ns	ns	ns
E7	nd	397	13	101	336	94	ns	ns	ns	ns
E1	nd	595	15	nd	696	57	ns	ns	ns	ns
98-m Stations										
B12	nd	202	16	256	62	82	256	61	167	13
B9	nd	1083	15	98	12	44	380	48	399	30
E26	nd	257	nd	nd	358	34	268	nd	292	13
E25	nd	114	6	nd	117	21	297	nd	302	23
E23	nd	211	13	nd	217	28	279	41	177	20
E20	nd	223	17	155	239	150	175	nd	284	15
E17[a]	32	291	229	39	96	29	252	73	114	9
E14[a]	36	131	111	nd	95	8	112	15	46	8
E11[a]	na	na	na	na	na	8	128	nd	123	28
E8	nd	179	11	211	246	19	221	37	170	37
E5	20	381	27	196	448	77	388	79	467	29
E2	7	475	163	82	2498	148	348	27	583	100
116-m Stations										
B10	nd	119	nd	nd	97	21	ns	ns	ns	ns
E21	nd	194	12	38	1790	137	ns	ns	ns	ns
E15[a]	52	275	305	151	185	212	133	58	90	37
E9	nd	181	27	430	nr	109	ns	ns	ns	ns
E3	nd	161	8	67	1431	142	ns	ns	ns	ns
Detection Rate (%)	24	100	86	71	100	100	100	69	100	100
ERL[b]	—	1580	—	—	—	4022	1580	—	—	4022
ERM[b]	—	46,100	—	—	—	44,792	46,100	—	—	44,792

[a] Near-ZID station
[b] From Long et al. 1995

Appendix B.10

Concentrations of pesticides, PCB and PAH detected in sediments from SBOO stations sampled during winter and summer 2018. See Table B.1 for MDLs; tChlor = total chlordane; nd = not detected; nr = not reportable; ns = not sampled.

	Winter					Summer				
	tDDT (ppt)	tHCH (ppt)	HCB (ppt)	tPCB (ppt)	tPAH (ppb)	tDDT (ppt)	tHCH (ppt)	HCB (ppt)	tPCB (ppt)	tPAH (ppb)
19-m Stations										
I35	117	nd	193	946	33	ns	ns	ns	ns	ns
I34	nd	nd	nd	67	nr	ns	ns	ns	ns	ns
I31	nd	49	nd	151	3	ns	ns	ns	ns	ns
I23	nd	nd	nd	46	10	ns	ns	ns	ns	ns
I18	41	54	235	173	nr	ns	ns	ns	ns	ns
I10	nd	nd	nd	88	2	ns	ns	ns	ns	ns
I4	nd	nd	nd	3	1	ns	ns	ns	ns	ns
28-m Stations										
I33	nd	nd	nd	17	7	98	9	47	30	34
I30	5	9	nd	11	nr	98	nd	54	nd	14
I27	49	242	183	nd	5	87	nd	179	nd	5
I22	61	7	75	37	12	132	nd	87	nd	9
I14 [a]	nd	20	155	nd	7	156	11	175	nd	32
I16 [a]	nd	nd	nd	25	1	82	nd	18	nd	nd
I15	34	nd	nd	25	1	96	nd	28	nd	nd
I12 [a]	25	nd	nd	15	1	17	nd	nd	nd	nd
I9	80	nd	nd	nd	4	62	nd	125	nd	7
I6	30	380	7	12	1	14	nd	29	nd	nd
I2	nd	nd	388	28	nd	nd	nd	nd	nd	5
I3	nd	21	57	26	1	43	nd	27	nd	nd
38-m Stations										
I29	nd	nd	nd	30	nr	ns	ns	ns	ns	ns
I21	9	48	178	51	26	ns	ns	ns	ns	ns
I13	nd	nd	1540	11	53	ns	ns	ns	ns	ns
I8	nd	nd	nd	nd	9	ns	ns	ns	ns	ns
55-m Stations										
I28	230	491	nd	35	nr	ns	ns	ns	ns	ns
I20	nd	nd	nd	15	1	ns	ns	ns	ns	ns
I7	56	771	nd	nd	nd	ns	ns	ns	ns	ns
I1	nd	nd	270	27	29	ns	ns	ns	ns	ns
Detection Rate (%)	44	41	41	81	91	92	17	83	8	58
ERL [b]	1580	—	—	—	4022	1580	—	—	—	4022
ERM [b]	46,100	—	—	—	44,792	46,100	—	—	—	44,792

[a] Near-ZID station
[b] From Long et al. 1995

Appendix B.11

Summary of the constituents that make up total chlordane, total DDT, total HCH, total PCB, and total PAH in sediments from the PLOO region during 2018; nd = not detected; ns = not sampled.

Station	Class	Constituent	Winter	Summer	Units
B8	DDT	o,p-DDE	9.72	ns	ppt
B8	DDT	p,p-DDE	224	ns	ppt
B8	DDT	p,p-DDT	93	ns	ppt
B8	PAH	1-methylphenanthrene	0.83	ns	ppb
B8	PAH	2,6-dimethylnaphthalene	10	ns	ppb
B8	PAH	2-methylnaphthalene	1.67	ns	ppb
B8	PAH	3,4-benzo(B)fluoranthene	8.34	ns	ppb
B8	PAH	Anthracene	1.67	ns	ppb
B8	PAH	Benzo[A]pyrene	6.67	ns	ppb
B8	PAH	Benzo[e]pyrene	5.01	ns	ppb
B8	PAH	Fluoranthene	5.84	ns	ppb
B8	PAH	Fluorene	1.67	ns	ppb
B8	PAH	Naphthalene	1.67	ns	ppb
B8	PAH	Phenanthrene	3.34	ns	ppb
B8	PAH	Pyrene	8.34	ns	ppb
B8	PCB	PCB 87	58.1	ns	ppt
B8	PCB	PCB 101	140	ns	ppt
B8	PCB	PCB 128	43.4	ns	ppt
B8	PCB	PCB 138	150	ns	ppt
B8	PCB	PCB 149	170	ns	ppt
B8	PCB	PCB 153/168	176	ns	ppt
B8	PCB	PCB 180	47.2	ns	ppt
B9	DDT	p,p-DDD	nd	13.70	ppt
B9	DDT	o,p-DDE	12.10	17.00	ppt
B9	DDT	p,p-DDD	82.50	37.50	ppt
B9	DDT	p,p-DDE	259.00	262.00	ppt
B9	DDT	p,-p-DDMU	nd	21.30	ppt
B9	DDT	p,p-DDT	729.00	28.10	ppt
B9	HCH	HCH, Beta isomer	15.2	nd	ppt
B9	PAH	2,6-dimethylnaphthalene	10.1	11.6	ppb
B9	PAH	2-methylnaphthalene	1.56	nd	ppb
B9	PAH	3,4-benzo(B)fluoranthene	5.45	5.27	ppb
B9	PAH	Benzo[A]pyrene	4.67	3.94	ppb
B9	PAH	Benzo[e]pyrene	3.98	nd	ppb
B9	PAH	Biphenyl	1.56	nd	ppb
B9	PAH	Fluoranthene	5.45	4.24	ppb
B9	PAH	Fluorene	2.33	nd	ppb
B9	PAH	Phenanthrene	3.11	nd	ppb
B9	PAH	Pyrene	5.45	4.64	ppb
B9	PCB	PCB 8	nd	16.9	ppt
B9	PCB	PCB 18	nd	27.1	ppt
B9	PCB	PCB 28	nd	26.6	ppt
B9	PCB	PCB 44	nd	15.4	ppt
B9	PCB	PCB 49	nd	15.9	ppt
B9	PCB	PCB 52	nd	25	ppt
B9	PCB	PCB 66	nd	15.7	ppt
B9	PCB	PCB 70	nd	16.5	ppt
B9	PCB	PCB 87	nd	10.1	ppt
B9	PCB	PCB 99	nd	18	ppt
B9	PCB	PCB 101	12.3	30.4	ppt
B9	PCB	PCB 105	nd	14	ppt
B9	PCB	PCB 110	nd	28.7	ppt

Appendix B.11 *continued*

Station	Class	Constituent	Winter	Summer	Units
B9	PCB	PCB 118	nd	31.8	ppt
B9	PCB	PCB 138	nd	31.8	ppt
B9	PCB	PCB 149	nd	22.7	ppt
B9	PCB	PCB 153/168	nd	37.5	ppt
B9	PCB	PCB 187	nd	15.2	ppt
B10	DDT	p,p-DDE	110	ns	ppt
B10	DDT	p,p-DDT	8.63	ns	ppt
B10	PAH	2,6-dimethylnaphthalene	5.36	ns	ppb
B10	PAH	2-methylnaphthalene	0.77	ns	ppb
B10	PAH	3,4-benzo(B)fluoranthene	3.06	ns	ppb
B10	PAH	Benzo[A]pyrene	2.3	ns	ppb
B10	PAH	Benzo[e]pyrene	3.06	ns	ppb
B10	PAH	Biphenyl	0.77	ns	ppb
B10	PAH	Fluoranthene	2.3	ns	ppb
B10	PAH	Pyrene	3.06	ns	ppb
B10	PCB	PCB 138	29	ns	ppt
B10	PCB	PCB 153/168	23.9	ns	ppt
B10	PCB	PCB 170	43.9	ns	ppt
B11	DDT	o,p-DDE	13.9	ns	ppt
B11	DDT	p,p-DDE	331	ns	ppt
B11	DDT	p,p-DDT	151	ns	ppt
B11	HCH	HCH, Alpha isomer	26.6	ns	ppt
B11	HCH	HCH, Beta isomer	37.7	ns	ppt
B11	HCH	HCH, Delta isomer	31.5	ns	ppt
B11	PCB	PCB 37	23.2	ns	ppt
B11	PCB	PCB 52	19.2	ns	ppt
B11	PCB	PCB 128	27.5	ns	ppt
B11	PCB	PCB 138	31.3	ns	ppt
B11	PCB	PCB 149	43	ns	ppt
B11	PCB	PCB 153/168	62.4	ns	ppt
B11	PCB	PCB 167	3.96	ns	ppt
B11	PCB	PCB 180	35.1	ns	ppt
B11	PCB	PCB 189	90.6	ns	ppt
B11	PCB	PCB 206	45.2	ns	ppt
B12	DDT	o,p-DDE	11.00	16.40	ppt
B12	DDT	p,p-DDD	nd	17.00	ppt
B12	DDT	p,p-DDE	191.00	186.00	ppt
B12	DDT	p,-p-DDMU	nd	13.50	ppt
B12	DDT	p,p-DDT	nd	23.10	ppt
B12	HCH	HCH, Beta isomer	15.90	nd	ppt
B12	PAH	2,6-dimethylnaphthalene	8.58	13.1	ppb
B12	PAH	2-methylnaphthalene	10.4	nd	ppb
B12	PAH	3,4-benzo(B)fluoranthene	6.24	nd	ppb
B12	PAH	Acenaphthene	8.58	nd	ppb
B12	PAH	Anthracene	3.12	nd	ppb
B12	PAH	Benzo[A]pyrene	5.46	nd	ppb
B12	PAH	Benzo[e]pyrene	5.46	nd	ppb
B12	PAH	Benzo[K]fluoranthene	4.68	nd	ppb
B12	PAH	Chrysene	7.8	nd	ppb
B12	PAH	Fluoranthene	7.8	nd	ppb
B12	PAH	Naphthalene	3.9	nd	ppb
B12	PAH	Pyrene	10.4	nd	ppb

Appendix B.11 *continued*

Station	Class	Constituent	Winter	Summer	Units
B12	PCB	PCB 8	nd	9.47	ppt
B12	PCB	PCB 28	nd	10.1	ppt
B12	PCB	PCB 37	16.8	nd	ppt
B12	PCB	PCB 49	nd	9.58	ppt
B12	PCB	PCB 52	nd	9.89	ppt
B12	PCB	PCB 99	nd	12.9	ppt
B12	PCB	PCB 101	nd	14	ppt
B12	PCB	PCB 110	nd	12.8	ppt
B12	PCB	PCB 118	nd	15.9	ppt
B12	PCB	PCB 138	21.1	18.8	ppt
B12	PCB	PCB 149	nd	15	ppt
B12	PCB	PCB 153/168	23.8	26.9	ppt
B12	PCB	PCB 187	nd	12.1	ppt
E1	DDT	o,p-DDD	26.8	ns	ppt
E1	DDT	o,p-DDE	7.09	ns	ppt
E1	DDT	o,p-DDT	36.3	ns	ppt
E1	DDT	p,p-DDD	86.5	ns	ppt
E1	DDT	p,p-DDE	324	ns	ppt
E1	DDT	p,p-DDT	114	ns	ppt
E1	HCH	HCH, Beta isomer	14.5	ns	ppt
E1	PAH	2,6-dimethylnaphthalene	7.25	ns	ppb
E1	PAH	2-methylnaphthalene	1.46	ns	ppb
E1	PAH	3,4-benzo(B)fluoranthene	9.42	ns	ppb
E1	PAH	Benzo[A]pyrene	6.89	ns	ppb
E1	PAH	Benzo[e]pyrene	5.44	ns	ppb
E1	PAH	Benzo[K]fluoranthene	3.28	ns	ppb
E1	PAH	Chrysene	5.81	ns	ppb
E1	PAH	Fluoranthene	6.17	ns	ppb
E1	PAH	Indeno(1,2,3-CD)pyrene	2.55	ns	ppb
E1	PAH	Naphthalene	1.09	ns	ppb
E1	PAH	Pyrene	7.99	ns	ppb
E1	PCB	PCB 49	43.4	ns	ppt
E1	PCB	PCB 52	30.4	ns	ppt
E1	PCB	PCB 66	41.7	ns	ppt
E1	PCB	PCB 70	33.9	ns	ppt
E1	PCB	PCB 99	39.1	ns	ppt
E1	PCB	PCB 101	89	ns	ppt
E1	PCB	PCB 110	78.7	ns	ppt
E1	PCB	PCB 149	68.3	ns	ppt
E1	PCB	PCB 153/168	159	ns	ppt
E1	PCB	PCB 170	26.6	ns	ppt
E1	PCB	PCB 187	73.1	ns	ppt
E1	PCB	PCB 194	13.1	ns	ppt
E2	Chlordane	Heptachlor epoxide	7.48	nd	ppt
E2	DDT	o,p-DDD	28.3	9.57	ppt
E2	DDT	o,p-DDE	21.4	11.6	ppt
E2	DDT	o,p-DDT	nd	12.5	ppt
E2	DDT	p,p-DDD	51.3	28.7	ppt
E2	DDT	p,p-DDE	292	202	ppt
E2	DDT	p,-p-DDMU	nd	15.6	ppt
E2	DDT	p,p-DDT	82.4	68.2	ppt
E2	HCH	HCH, Alpha isomer	57.3	nd	ppt
E2	HCH	HCH, Beta isomer	39.9	nd	ppt

Appendix B.11 *continued*

Station	Class	Constituent	Winter	Summer	Units
E2	HCH	HCH, Delta isomer	26.2	nd	ppt
E2	HCH	HCH, Gamma isomer	39.2	nd	ppt
E2	PAH	2,6-dimethylnaphthalene	5.94	7.94	ppb
E2	PAH	2-methylnaphthalene	1.49	nd	ppb
E2	PAH	3,4-benzo(B)fluoranthene	24.1	16.2	ppb
E2	PAH	Acenaphthylene	2.23	nd	ppb
E2	PAH	Anthracene	3.71	nd	ppb
E2	PAH	Benzo[A]anthracene	nd	6.19	ppb
E2	PAH	Benzo[A]pyrene	20.6	11.6	ppb
E2	PAH	Benzo[e]pyrene	14.6	9.01	ppb
E2	PAH	Benzo[G,H,I]perylene	1.49	7.55	ppb
E2	PAH	Benzo[K]fluoranthene	14.8	5.01	ppb
E2	PAH	Chrysene	17.2	6.99	ppb
E2	PAH	Fluoranthene	13.8	8.01	ppb
E2	PAH	Indeno(1,2,3-CD)pyrene	nd	7.11	ppb
E2	PAH	Phenanthrene	nd	3.04	ppb
E2	PAH	Naphthalene	2.97	nd	ppb
E2	PAH	Perylene	8.17	nd	ppb
E2	PAH	Pyrene	16.9	10.9	ppb
E2	PCB	PCB 28	57.1	nd	ppt
E2	PCB	PCB 37	19.4	nd	ppt
E2	PCB	PCB 44	140	nd	ppt
E2	PCB	PCB 49	120	13	ppt
E2	PCB	PCB 52	200	15.1	ppt
E2	PCB	PCB 66	130	15	ppt
E2	PCB	PCB 70	140	11.5	ppt
E2	PCB	PCB 74	73.5	nd	ppt
E2	PCB	PCB 87	92	11.4	ppt
E2	PCB	PCB 99	120	28.7	ppt
E2	PCB	PCB 101	170	43.2	ppt
E2	PCB	PCB 105	85.3	13.5	ppt
E2	PCB	PCB 110	200	44	ppt
E2	PCB	PCB 118	130	40.6	ppt
E2	PCB	PCB 128	39.7	15.6	ppt
E2	PCB	PCB 138	170	53.9	ppt
E2	PCB	PCB 149	160	45.4	ppt
E2	PCB	PCB 151	nd	10.7	ppt
E2	PCB	PCB 153/168	290	74.4	ppt
E2	PCB	PCB 170	28.8	17.3	ppt
E2	PCB	PCB 177	nd	13.2	ppt
E2	PCB	PCB 180	55.2	39.9	ppt
E2	PCB	PCB 183	nd	14.2	ppt
E2	PCB	PCB 187	44.7	34.7	ppt
E2	PCB	PCB 206	32.2	27.9	ppt
E3	DDT	o,p-DDE	13.8	ns	ppt
E3	DDT	p,p-DDE	147	ns	ppt
E3	HCH	HCH, Beta isomer	8.41	ns	ppt
E3	PAH	2,6-dimethylnaphthalene	4.92	ns	ppb
E3	PAH	2-methylnaphthalene	2.11	ns	ppb
E3	PAH	3,4-benzo(B)fluoranthene	22.8	ns	ppb
E3	PAH	Acenaphthylene	2.81	ns	ppb
E3	PAH	Anthracene	4.21	ns	ppb
E3	PAH	Benzo[A]pyrene	16.9	ns	ppb
E3	PAH	Benzo[e]pyrene	12.1	ns	ppb

Appendix B.11 *continued*

Station	Class	Constituent	Winter	Summer	Units
E3	PAH	Benzo[G,H,I]perylene	13.3	ns	ppb
E3	PAH	Benzo[K]fluoranthene	9.13	ns	ppb
E3	PAH	Chrysene	7.73	ns	ppb
E3	PAH	Fluoranthene	10.5	ns	ppb
E3	PAH	Indeno(1,2,3-CD)pyrene	10.5	ns	ppb
E3	PAH	Naphthalene	4.21	ns	ppb
E3	PAH	Perylene	4.21	ns	ppb
E3	PAH	Phenanthrene	2.81	ns	ppb
E3	PAH	Pyrene	13.3	ns	ppb
E3	PCB	PCB 37	16.8	ns	ppt
E3	PCB	PCB 44	39.5	ns	ppt
E3	PCB	PCB 49	59.6	ns	ppt
E3	PCB	PCB 52	79.2	ns	ppt
E3	PCB	PCB 66	51.1	ns	ppt
E3	PCB	PCB 70	44.7	ns	ppt
E3	PCB	PCB 74	25.1	ns	ppt
E3	PCB	PCB 87	27.3	ns	ppt
E3	PCB	PCB 101	140	ns	ppt
E3	PCB	PCB 110	130	ns	ppt
E3	PCB	PCB 128	58.5	ns	ppt
E3	PCB	PCB 138	150	ns	ppt
E3	PCB	PCB 149	140	ns	ppt
E3	PCB	PCB 153/168	190	ns	ppt
E3	PCB	PCB 180	130	ns	ppt
E3	PCB	PCB 187	63.4	ns	ppt
E3	PCB	PCB 194	41.9	ns	ppt
E3	PCB	PCB 206	43.6	ns	ppt
E5	Chlordane	Heptachlor epoxide	20.2	nd	ppt
E5	DDT	o,p-DDD	30.40	11.80	ppt
E5	DDT	o,p-DDE	13.60	21.20	ppt
E5	DDT	p,p-DDD	ns	43.20	ppt
E5	DDT	p,p-DDE	275.00	254.00	ppt
E5	DDT	p,p-DDT	62.10	31.70	ppt
E5	DDT	p,-p-DDMU	nd	26.20	ppt
E5	HCH	HCH, Beta isomer	26.9	nd	ppt
E5	PAH	1-methylphenanthrene	1.5	nd	ppb
E5	PAH	2,6-dimethylnaphthalene	8.26	8.59	ppb
E5	PAH	2-methylnaphthalene	1.5	nd	ppb
E5	PAH	3,4-benzo(B)fluoranthene	9.01	5.46	ppb
E5	PAH	Acenaphthylene	1.5	nd	ppb
E5	PAH	Benzo[A]pyrene	6.76	3.83	ppb
E5	PAH	Benzo[e]pyrene	7.51	nd	ppb
E5	PAH	Benzo[G,H,I]perylene	7.96	nd	ppb
E5	PAH	Chrysene	6.01	3.35	ppb
E5	PAH	Dibenzo(A,H)anthracene	3.75	nd	ppb
E5	PAH	Fluoranthene	7.51	3.47	ppb
E5	PAH	Fluorene	1.5	nd	ppb
E5	PAH	Naphthalene	3.0	nd	ppb
E5	PAH	Perylene	3.75	nd	ppb
E5	PAH	Pyrene	7.51	4.32	ppb
E5	PCB	PCB 37	22.7	nd	ppt
E5	PCB	PCB 49	34.0	10.1	ppt
E5	PCB	PCB 52	34.6	16.5	ppt
E5	PCB	PCB 66	31.9	11.5	ppt

Appendix B.11 *continued*

Station	Class	Constituent	Winter	Summer	Units
E5	PCB	PCB 70	38.1	13.4	ppt
E5	PCB	PCB 87	nd	15	ppt
E5	PCB	PCB 99	nd	23.2	ppt
E5	PCB	PCB 101	nd	37.3	ppt
E5	PCB	PCB 105	19.3	15.6	ppt
E5	PCB	PCB 110	42.3	36.5	ppt
E5	PCB	PCB 118	nd	37.8	ppt
E5	PCB	PCB 128	nd	14.3	ppt
E5	PCB	PCB 138	nd	46.9	ppt
E5	PCB	PCB 149	41	36.2	ppt
E5	PCB	PCB 153/168	77.4	54.9	ppt
E5	PCB	PCB 170	nd	13.5	ppt
E5	PCB	PCB 177	nd	9.07	ppt
E5	PCB	PCB 180	nd	28.2	ppt
E5	PCB	PCB 187	33.3	21.7	ppt
E5	PCB	PCB 194	30.3	nd	ppt
E5	PCB	PCB 206	43.5	25.3	ppt
E7	DDT	o,p-DDD	31.2	ns	ppt
E7	DDT	o,p-DDE	15	ns	ppt
E7	DDT	p,p-DDD	39.4	ns	ppt
E7	DDT	p,p-DDE	259	ns	ppt
E7	DDT	p,p-DDT	52.4	ns	ppt
E7	HCH	HCH, Beta isomer	12.6	ns	ppt
E7	PAH	2,6-dimethylnaphthalene	8.62	ns	ppb
E7	PAH	2-methylnaphthalene	12.5	ns	ppb
E7	PAH	3,4-benzo(B)fluoranthene	8.62	ns	ppb
E7	PAH	Acenaphthene	12.5	ns	ppb
E7	PAH	Acenaphthylene	2.35	ns	ppb
E7	PAH	Benzo[A]pyrene	6.27	ns	ppb
E7	PAH	Benzo[e]pyrene	5.49	ns	ppb
E7	PAH	Benzo[G,H,I]perylene	7.84	ns	ppb
E7	PAH	Chrysene	4.7	ns	ppb
E7	PAH	Fluoranthene	5.49	ns	ppb
E7	PAH	Indeno(1,2,3-CD)pyrene	6.27	ns	ppb
E7	PAH	Naphthalene	5.49	ns	ppb
E7	PAH	Pyrene	7.84	ns	ppb
E7	PCB	PCB 49	25	ns	ppt
E7	PCB	PCB 52	19.5	ns	ppt
E7	PCB	PCB 66	23.3	ns	ppt
E7	PCB	PCB 70	17.3	ns	ppt
E7	PCB	PCB 74	14.8	ns	ppt
E7	PCB	PCB 101	45.4	ns	ppt
E7	PCB	PCB 110	27	ns	ppt
E7	PCB	PCB 128	13.9	ns	ppt
E7	PCB	PCB 138	48.3	ns	ppt
E7	PCB	PCB 153/168	70.8	ns	ppt
E7	PCB	PCB 206	30.2	ns	ppt
E8	DDT	o,p-DDE	nd	9.43	ppt
E8	DDT	p,p-DDD	22.4	32.2	ppt
E8	DDT	p,p-DDE	157	142	ppt
E8	DDT	p,-p-DDMU	nd	12.9	ppt

Appendix B.11 *continued*

Station	Class	Constituent	Winter	Summer	Units
E8	DDT	p,p-DDT	nd	24.6	ppt
E8	HCH	HCH, Beta isomer	10.9	nd	ppt
E8	PAH	2,6-dimethylnaphthalene	5.98	11.1	ppb
E8	PAH	3,4-benzo(B)fluoranthene	nd	7.21	ppb
E8	PAH	Benzo[A]pyrene	nd	4.88	ppb
E8	PAH	Benzo[e]pyrene	2.99	4.19	ppb
E8	PAH	Biphenyl	nd	4.95	ppb
E8	PAH	Chrysene	2.99	nd	ppb
E8	PAH	Fluoranthene	2.99	4.84	ppb
E8	PAH	Pyrene	3.74	nd	ppb
E8	PCB	PCB 52	11.4	nd	ppt
E8	PCB	PCB 99	37.7	12.7	ppt
E8	PCB	PCB 101	23.8	18.8	ppt
E8	PCB	PCB 110	29.5	17.9	ppt
E8	PCB	PCB 118	nd	18.4	ppt
E8	PCB	PCB 138	26.1	22.2	ppt
E8	PCB	PCB 149	23.4	17.7	ppt
E8	PCB	PCB 153/168	43.5	32.5	ppt
E8	PCB	PCB 180	nd	17.5	ppt
E8	PCB	PCB 187	nd	12.5	ppt
E8	PCB	PCB 189	50.6	nd	ppt
E9	DDT	p,p-DDE	181	ns	ppt
E9	HCH	HCH, Beta isomer	26.6	ns	ppt
E9	PAH	2,6-dimethylnaphthalene	7.35	ns	ppb
E9	PAH	2-methylnaphthalene	1.47	ns	ppb
E9	PAH	3,4-benzo(B)fluoranthene	20.8	ns	ppb
E9	PAH	Acenaphthylene	1.47	ns	ppb
E9	PAH	Benzo[A]pyrene	15.6	ns	ppb
E9	PAH	Benzo[e]pyrene	11.5	ns	ppb
E9	PAH	Benzo[K]fluoranthene	8.08	ns	ppb
E9	PAH	Chrysene	8.82	ns	ppb
E9	PAH	Fluoranthene	7.35	ns	ppb
E9	PAH	Indeno(1,2,3-CD)pyrene	6.61	ns	ppb
E9	PAH	Pyrene	19.5	ns	ppb
E11	DDT	p,p-DDD	nd	13.1	ppt
E11	DDT	p,p-DDE	nd	115	ppt
E11	PAH	2,6-dimethylnaphthalene	3.72	5.84	ppb
E11	PAH	3,4-benzo(B)fluoranthene	nd	5.76	ppb
E11	PAH	Benzo[A]anthracene	nd	5.45	ppb
E11	PAH	Benzo[A]pyrene	nd	1.96	ppb
E11	PAH	Benzo[G,H,I]perylene	nd	2.23	ppb
E11	PAH	Chrysene	nd	2.2	ppb
E11	PAH	Fluoranthene	2.23	4.39	ppb
E11	PAH	Pyrene	2.23	nd	ppb
E11	PCB	PCB 101	nd	12	ppt
E11	PCB	PCB 110	nd	10.7	ppt
E11	PCB	PCB 118	nd	12.3	ppt
E11	PCB	PCB 138	nd	19.4	ppt
E11	PCB	PCB 149	nd	13.7	ppt
E11	PCB	PCB 153/168	nd	25.9	ppt
E11	PCB	PCB 180	nd	9.65	ppt

Appendix B.11 *continued*

Station	Class	Constituent	Winter	Summer	Units
E11	PCB	PCB 187	nd	9.26	ppt
E11	PCB	PCB 99	nd	9.87	ppt
E14	Chlordane	Gamma(trans)Chlordane	36.2	nd	ppt
E14	DDT	p,p-DDD	nd	10.4	ppt
E14	DDT	p,p-DDE	131	88	ppt
E14	DDT	p,p-DDT	nd	13.4	ppt
E14	HCH	HCH, Alpha isomer	38	nd	ppt
E14	HCH	HCH, Beta isomer	36.4	nd	ppt
E14	HCH	HCH, Gamma isomer	36.9	nd	ppt
E14	PAH	2,6-dimethylnaphthalene	7.54	8.27	ppb
E14	PCB	PCB 101	nd	5	ppt
E14	PCB	PCB 110	nd	4.7	ppt
E14	PCB	PCB 118	nd	10	ppt
E14	PCB	PCB 138	20.8	12	ppt
E14	PCB	PCB 149	nd	4.5	ppt
E14	PCB	PCB 153/168	nd	9.9	ppt
E14	PCB	PCB 189	50	nd	ppt
E14	PCB	PCB 206	23.8	nd	ppt
E15	Chlordane	Heptachlor epoxide	51.6	nd	ppt
E15	DDT	p,p-DDD	nd	14.10	ppt
E15	DDT	p,p-DDE	213.00	105.00	ppt
E15	DDT	p,p-DDT	62.30	13.90	ppt
E15	HCH	HCH, Alpha isomer	72.1	nd	ppt
E15	HCH	HCH, Beta isomer	57.1	nd	ppt
E15	HCH	HCH, Delta isomer	76.5	nd	ppt
E15	HCH	HCH, Gamma isomer	99.7	nd	ppt
E15	PAH	1-methylphenanthrene	21.6	nd	ppb
E15	PAH	2,3,5-trimethylnaphthalene	17.1	nd	ppb
E15	PAH	2,6-dimethylnaphthalene	28.4	7.24	ppb
E15	PAH	2-methylnaphthalene	23.1	nd	ppb
E15	PAH	3,4-benzo(B)fluoranthene	6.7	5.93	ppb
E15	PAH	Acenaphthene	22	nd	ppb
E15	PAH	Acenaphthylene	19.6	nd	ppb
E15	PAH	Benzo[A]pyrene	nd	4.4	ppb
E15	PAH	Benzo[e]pyrene	4.47	4.72	ppb
E15	PAH	Biphenyl	21.8	2.74	ppb
E15	PAH	Chrysene	2.23	2.72	ppb
E15	PAH	Fluoranthene	nd	3.21	ppb
E15	PAH	Fluorene	14.2	nd	ppb
E15	PAH	Indeno(1,2,3-CD)pyrene	nd	5.66	ppb
E15	PAH	Naphthalene	20.1	nd	ppb
E15	PAH	Phenanthrene	10.4	nd	ppb
E15	PCB	PCB 66	18.7	nd	ppt
E15	PCB	PCB 70	11.6	nd	ppt
E15	PCB	PCB 99	nd	9.02	ppt
E15	PCB	PCB 101	nd	12	ppt
E15	PCB	PCB 110	nd	11.4	ppt
E15	PCB	PCB 138	17.7	17.5	ppt
E15	PCB	PCB 149	nd	13.5	ppt
E15	PCB	PCB 153/168	39.4	26.2	ppt
E15	PCB	PCB 187	15.2	nd	ppt
E15	PCB	PCB 189	53	nd	ppt
E15	PCB	PCB 206	28.9	nd	ppt

Appendix B.11 *continued*

Station	Class	Constituent	Winter	Summer	Units
E17	Chlordane	Alpha(cis)Chlordane	31.9	nd	ppt
E17	DDT	o,p-DDE	13	nd	ppt
E17	DDT	o,p-DDT	nd	11.8	ppt
E17	DDT	p,p-DDD	38.3	22.1	ppt
E17	DDT	p,p-DDE	178	161	ppt
E17	DDT	p,-p-DDMU	nd	12.4	ppt
E17	DDT	p,p-DDT	61.2	45.1	ppt
E17	HCH	HCH, Alpha isomer	59.6	nd	ppt
E17	HCH	HCH, Beta isomer	43.6	nd	ppt
E17	HCH	HCH, Delta isomer	53	nd	ppt
E17	HCH	HCH, Gamma isomer	72.6	nd	ppt
E17	PAH	2,6-dimethylnaphthalene	11.5	8.89	ppb
E17	PAH	2-methylnaphthalene	2.3	nd	ppb
E17	PAH	Benzo[e]pyrene	2.3	nd	ppb
E17	PAH	Biphenyl	2.3	nd	ppb
E17	PAH	Fluoranthene	3.07	nd	ppb
E17	PAH	Naphthalene	3.84	nd	ppb
E17	PAH	Pyrene	3.84	nd	ppb
E17	PCB	PCB 99	nd	9.95	ppt
E17	PCB	PCB 101	nd	12.1	ppt
E17	PCB	PCB 110	29.9	12.5	ppt
E17	PCB	PCB 118	nd	15.2	ppt
E17	PCB	PCB 138	nd	17.1	ppt
E17	PCB	PCB 149	22.4	12.5	ppt
E17	PCB	PCB 153/168	nd	25.3	ppt
E17	PCB	PCB 187	nd	9.29	ppt
E17	PCB	PCB 189	8.62	nd	ppt
E17	PCB	PCB 206	34.8	nd	ppt
E19	DDT	o,p-DDE	15	ns	ppt
E19	DDT	p,p-DDD	49.3	ns	ppt
E19	DDT	p,p-DDE	333	ns	ppt
E19	DDT	p,p-DDT	39.3	ns	ppt
E19	HCH	HCH, Alpha isomer	73.5	ns	ppt
E19	HCH	HCH, Beta isomer	43.7	ns	ppt
E19	HCH	HCH, Gamma isomer	62	ns	ppt
E19	PAH	2,6-dimethylnaphthalene	11.1	ns	ppb
E19	PAH	2-methylnaphthalene	15.1	ns	ppb
E19	PAH	3,4-benzo(B)fluoranthene	7.15	ns	ppb
E19	PAH	Acenaphthene	11.1	ns	ppb
E19	PAH	Anthracene	3.97	ns	ppb
E19	PAH	Chrysene	3.97	ns	ppb
E19	PAH	Fluoranthene	5.56	ns	ppb
E19	PAH	Naphthalene	6.36	ns	ppb
E19	PAH	Pyrene	7.95	ns	ppb
E19	PCB	PCB 37	17	ns	ppt
E19	PCB	PCB 52	7.9	ns	ppt
E19	PCB	PCB 66	32	ns	ppt
E19	PCB	PCB 70	12	ns	ppt
E19	PCB	PCB 101	48	ns	ppt
E19	PCB	PCB 105	16	ns	ppt
E19	PCB	PCB 118	19	ns	ppt
E19	PCB	PCB 138	47	ns	ppt
E19	PCB	PCB 149	46	ns	ppt
E19	PCB	PCB 153/168	72	ns	ppt

Appendix B.11 *continued*

Station	Class	Constituent	Winter	Summer	Units
E19	PCB	PCB 156	9.4	ns	ppt
E19	PCB	PCB 187	36	ns	ppt
E19	PCB	PCB 189	75	ns	ppt
E19	PCB	PCB 194	23	ns	ppt
E19	PCB	PCB 206	46	ns	ppt
E20	DDT	o,p-DDD	24.50	nd	ppt
E20	DDT	p,p-DDD	nd	15.50	ppt
E20	DDT	p,p-DDE	198.00	126.00	ppt
E20	DDT	p,-p-DDMU	nd	11.20	ppt
E20	HCH	HCH, Beta isomer	16.8	nd	ppt
E20	PAH	1-methylphenanthrene	15.4	nd	ppb
E20	PAH	2,3,5-trimethylnaphthalene	10	nd	ppb
E20	PAH	2,6-dimethylnaphthalene	22.6	11.8	ppb
E20	PAH	2-methylnaphthalene	14.6	nd	ppb
E20	PAH	3,4-benzo(B)fluoranthene	5.39	nd	ppb
E20	PAH	Acenaphthene	15.4	nd	ppb
E20	PAH	Acenaphthylene	13.1	nd	ppb
E20	PAH	Benzo[A]pyrene	nd	3.33	ppb
E20	PAH	Benzo[e]pyrene	3.08	nd	ppb
E20	PAH	Biphenyl	16.2	nd	ppb
E20	PAH	Fluoranthene	3.08	nd	ppb
E20	PAH	Fluorene	11.6	nd	ppb
E20	PAH	Naphthalene	12.3	nd	ppb
E20	PAH	Phenanthrene	3.85	nd	ppb
E20	PAH	Pyrene	3.85	nd	ppb
E20	PCB	PCB 28	nd	10.1	ppt
E20	PCB	PCB 37	18.4	nd	ppt
E20	PCB	PCB 52	nd	9.48	ppt
E20	PCB	PCB 66	17.3	9.73	ppt
E20	PCB	PCB 70	9.03	nd	ppt
E20	PCB	PCB 74	17.7	nd	ppt
E20	PCB	PCB 99	nd	12.3	ppt
E20	PCB	PCB 101	nd	16.4	ppt
E20	PCB	PCB 110	nd	14.9	ppt
E20	PCB	PCB 118	29.3	15.5	ppt
E20	PCB	PCB 138	26.2	21.7	ppt
E20	PCB	PCB 149	nd	24.2	ppt
E20	PCB	PCB 153/168	nd	31.2	ppt
E20	PCB	PCB 177	nd	12.9	ppt
E20	PCB	PCB 180	nd	38.4	ppt
E20	PCB	PCB 183	nd	12	ppt
E20	PCB	PCB 187	33.7	31.8	ppt
E20	PCB	PCB 189	63.2	nd	ppt
E20	PCB	PCB 194	24.3	nd	ppt
E20	PCB	PCB 206	nd	23.4	ppt
E21	DDT	o,p-DDE	18.9	ns	ppt
E21	DDT	p,p-DDE	175	ns	ppt
E21	HCH	HCH, Beta isomer	11.6	ns	ppt
E21	PAH	1-methylphenanthrene	16.5	ns	ppb
E21	PAH	2,3,5-trimethylnaphthalene	15.7	ns	ppb
E21	PAH	2,6-dimethylnaphthalene	22.9	ns	ppb
E21	PAH	2-methylnaphthalene	15.7	ns	ppb
E21	PAH	3,4-benzo(B)fluoranthene	3.74	ns	ppb

Appendix B.11 *continued*

Station	Class	Constituent	Winter	Summer	Units
E21	PAH	Acenaphthene	15.7	ns	ppb
E21	PAH	Acenaphthylene	15.7	ns	ppb
E21	PAH	Fluoranthene	2.99	ns	ppb
E21	PAH	Fluorene	11.2	ns	ppb
E21	PAH	Naphthalene	9.73	ns	ppb
E21	PAH	Phenanthrene	2.99	ns	ppb
E21	PAH	Pyrene	3.74	ns	ppb
E21	PCB	PCB 18	29	ns	ppt
E21	PCB	PCB 37	20.7	ns	ppt
E21	PCB	PCB 49	18.3	ns	ppt
E21	PCB	PCB 52	55.5	ns	ppt
E21	PCB	PCB 66	30.8	ns	ppt
E21	PCB	PCB 70	39.2	ns	ppt
E21	PCB	PCB 87	61.8	ns	ppt
E21	PCB	PCB 101	140	ns	ppt
E21	PCB	PCB 105	81	ns	ppt
E21	PCB	PCB 110	170	ns	ppt
E21	PCB	PCB 118	92.2	ns	ppt
E21	PCB	PCB 128	55.5	ns	ppt
E21	PCB	PCB 138	190	ns	ppt
E21	PCB	PCB 149	130	ns	ppt
E21	PCB	PCB 151	25.8	ns	ppt
E21	PCB	PCB 153/168	320	ns	ppt
E21	PCB	PCB 170	79.8	ns	ppt
E21	PCB	PCB 180	79.6	ns	ppt
E21	PCB	PCB 189	94	ns	ppt
E21	PCB	PCB 194	40.6	ns	ppt
E21	PCB	PCB 206	35.8	ns	ppt
E23	DDT	o,p-DDD	nd	9.37	ppt
E23	DDT	o,p-DDE	10.70	nd	ppt
E23	DDT	o,p-DDT	nd	11.00	ppt
E23	DDT	p,p-DDD	nd	22.00	ppt
E23	DDT	p,p-DDE	200.00	183.00	ppt
E23	DDT	p,-p-DDMU	nd	12.00	ppt
E23	DDT	p,p-DDT	nd	41.50	ppt
E23	HCH	HCH, Beta isomer	13.2	nd	ppt
E23	PAH	2,6-dimethylnaphthalene	7.69	12	ppb
E23	PAH	3,4-benzo(B)fluoranthene	nd	4.73	ppb
E23	PAH	Benzo[A]pyrene	5.39	nd	ppb
E23	PAH	Benzo[e]pyrene	4.62	nd	ppb
E23	PAH	Fluoranthene	3.08	3.29	ppb
E23	PAH	Indeno(1,2,3-CD)pyrene	2.31	nd	ppb
E23	PAH	Pyrene	4.62	nd	ppb
E23	PCB	PCB 37	16.5	nd	ppt
E23	PCB	PCB 49	24.3	nd	ppt
E23	PCB	PCB 52	35.1	nd	ppt
E23	PCB	PCB 87	33.8	nd	ppt
E23	PCB	PCB 99	nd	15.6	ppt
E23	PCB	PCB 101	nd	19.6	ppt
E23	PCB	PCB 110	nd	19.8	ppt
E23	PCB	PCB 118	nd	22.3	ppt
E23	PCB	PCB 138	32.7	29.3	ppt
E23	PCB	PCB 149	nd	19.4	ppt
E23	PCB	PCB 153/168	45.6	33.9	ppt

Apendix B.11 *continued*

Station	Class	Constituent	Winter	Summer	Units
E23	PCB	PCB 187	nd	17.3	ppt
E23	PCB	PCB 206	29	nd	ppt
E25	DDT	o,p-DDE	10.8	9.14	ppt
E25	DDT	o,p-DDT	nd	10.6	ppt
E25	DDT	p,p-DDD	nd	26.4	ppt
E25	DDT	p,p-DDE	103	196	ppt
E25	DDT	p,-p-DDMU	nd	12.8	ppt
E25	DDT	p,p-DDT	nd	41.9	ppt
E25	HCH	HCH, Beta isomer	6.32	nd	ppt
E25	PAH	2,6-dimethylnaphthalene	6.8	11.2	ppb
E25	PAH	2-methylnaphthalene	1.51	nd	ppb
E25	PAH	3,4-benzo(B)fluoranthene	nd	4.77	ppb
E25	PAH	Benzo[A]pyrene	3.02	nd	ppb
E25	PAH	Benzo[e]pyrene	3.02	nd	ppb
E25	PAH	Chrysene	1.51	nd	ppb
E25	PAH	Fluoranthene	2.27	3.3	ppb
E25	PAH	Pyrene	3.02	3.54	ppb
E25	PCB	PCB 52	nd	10.4	ppt
E25	PCB	PCB 66	14.1	9.45	ppt
E25	PCB	PCB 70	9.21	nd	ppt
E25	PCB	PCB 87	nd	10.1	ppt
E25	PCB	PCB 99	nd	17.1	ppt
E25	PCB	PCB 101	nd	26.4	ppt
E25	PCB	PCB 105	nd	10.4	ppt
E25	PCB	PCB 110	nd	28.3	ppt
E25	PCB	PCB 118	nd	27.6	ppt
E25	PCB	PCB 128	nd	9.09	ppt
E25	PCB	PCB 138	nd	33.7	ppt
E25	PCB	PCB 149	51.3	24.7	ppt
E25	PCB	PCB 153/168	42.4	38	ppt
E25	PCB	PCB 180	nd	22.4	ppt
E25	PCB	PCB 187	nd	15	ppt
E25	PCB	PCB 206	nd	19.5	ppt
E26	DDT	p,p-DDE	185	10.5	ppt
E26	DDT	p,p-DDD	nd	24.2	ppt
E26	DDT	p,p-DDE	nd	189	ppt
E26	DDT	p,-p-DDMU	nd	14.8	ppt
E26	DDT	p,p-DDT	71.7	29	ppt
E26	PAH	2,6-dimethylnaphthalene	6.93	10.2	ppb
E26	PAH	3,4-benzo(B)fluoranthene	4.62	nd	ppb
E26	PAH	Benzo[A]pyrene	3.85	nd	ppb
E26	PAH	Benzo[e]pyrene	3.85	nd	ppb
E26	PAH	Benzo[G,H,I]perylene	5.39	nd	ppb
E26	PAH	Chrysene	2.31	nd	ppb
E26	PAH	Fluoranthene	3.08	3.14	ppb
E26	PAH	Pyrene	3.85	nd	ppb
E26	PCB	PCB 37	9.51	nd	ppt
E26	PCB	PCB 52	38.2	nd	ppt
E26	PCB	PCB 66	28.5	nd	ppt
E26	PCB	PCB 70	10.6	nd	ppt
E26	PCB	PCB 87	23.6	nd	ppt
E26	PCB	PCB 99	nd	14.9	ppt
E26	PCB	PCB 101	39	16.5	ppt

Appendix B.11 *continued*

Station	Class	Constituent	Winter	Summer	Units
E26	PCB	PCB 110	46.1	17	ppt
E26	PCB	PCB 118	nd	26.3	ppt
E26	PCB	PCB 128	6.77	12.9	ppt
E26	PCB	PCB 138	44.5	48.9	ppt
E26	PCB	PCB 149	41.2	24.4	ppt
E26	PCB	PCB 153/168	49.2	51.4	ppt
E26	PCB	PCB 170	20.9	13.2	ppt
E26	PCB	PCB 180	nd	28.2	ppt
E26	PCB	PCB 187	nd	18.1	ppt
E26	PCB	PCB 206	nd	20.2	ppt

Appendix B.12

Summary of the constituents that make up total chlordane, total DDT, total HCH, total PCB, and total PAH in sediments from the SBOO region during 2018; nd = not detected.

Station	Class	Constituent	Winter	Summer	Units
I1	PAH	1-methylphenanthrene	1.06	ns	ppb
I1	PAH	2,6-dimethylnaphthalene	4.24	ns	ppb
I1	PAH	2-methylnaphthalene	2.82	ns	ppb
I1	PAH	3,4-benzo(B)fluoranthene	1.77	ns	ppb
I1	PAH	Acenaphthene	1.41	ns	ppb
I1	PAH	Acenaphthylene	1.42	ns	ppb
I1	PAH	Benzo[A]pyrene	1.42	ns	ppb
I1	PAH	Benzo[e]pyrene	2.48	ns	ppb
I1	PAH	Chrysene	4.59	ns	ppb
I1	PAH	Fluoranthene	2.13	ns	ppb
I1	PAH	Fluorene	1.77	ns	ppb
I1	PAH	Pyrene	4.24	ns	ppb
I1	PCB	PCB 37	9	ns	ppt
I1	PCB	PCB 70	8.5	ns	ppt
I1	PCB	PCB 206	9.2	ns	ppt
I2	PAH	1-methylphenanthrene	nd	0.76	ppb
I2	PAH	2,6-dimethylnaphthalene	nd	1.3	ppb
I2	PAH	2-methylnaphthalene	nd	0.857	ppb
I2	PAH	Acenaphthylene	nd	0.57	ppb
I2	PAH	Naphthalene	nd	1.2	ppb
I2	PCB	PCB 156	6.36	nd	ppt
I2	PCB	PCB 206	21.3	nd	ppt
I3	DDT	p,p-DDD	nd	29	ppt
I3	DDT	p,p-DDE	nd	14	ppt
I3	HCH	HCH, Alpha isomer	14.1	nd	ppt
I3	HCH	HCH, Beta isomer	7.11	nd	ppt
I3	PAH	2,6-dimethylnaphthalene	1.38	nd	ppb
I3	PCB	PCB 206	17.7	nd	ppt
I3	PCB	PCB 157	8.43	nd	ppt
I4	PAH	2,6-dimethylnaphthalene	0.68	ns	ppb
I4	PCB	PCB 66	2.61	ns	ppt
I6	DDT	p,p-DDE	29.5	13.9	ppt
I6	HCH	HCH, Alpha isomer	126	nd	ppt
I6	HCH	HCH, Beta isomer	44.9	nd	ppt
I6	HCH	HCH, Delta isomer	46.5	nd	ppt
I6	HCH	HCH, Gamma isomer	163	nd	ppt
I6	PAH	2,6-dimethylnaphthalene	0.69	nd	ppb
I6	PCB	PCB 18	12	nd	ppt
I7	DDT	p,p-DDE	55.7	ns	ppt
I7	HCH	HCH, Alpha isomer	281	ns	ppt
I7	HCH	HCH, Beta isomer	80.4	ns	ppt
I7	HCH	HCH, Delta isomer	154	ns	ppt
I7	HCH	HCH, Gamma isomer	256	ns	ppt
I8	PAH	3,4-benzo(B)fluoranthene	2.09	ns	ppb
I8	PAH	Benzo[e]pyrene	2.09	ns	ppb
I8	PAH	Benzo[K]fluoranthene	2.09	ns	ppb
I8	PAH	Fluoranthene	1.39	ns	ppb

Appendix B.12 *continued*

Station	Class	Constituent	Winter	Summer	Units
I8	PAH	Pyrene	1.39	ns	ppb
I9	DDT	p,p-DDD	52.9	nd	ppt
I9	DDT	p,p-DDE	26.7	62.2	ppt
I9	PAH	2,6-dimethylnaphthalene	3.66	7.03	ppb
I10	PAH	2,6-dimethylnaphthalene	2.17	ns	ppb
I10	PCB	PCB 28	14.1	ns	ppt
I10	PCB	PCB 66	7.47	ns	ppt
I10	PCB	PCB 70	4.86	ns	ppt
I10	PCB	PCB 189	38	ns	ppt
I10	PCB	PCB 206	23.8	ns	ppt
I12	DDT	p,p-DDE	24.8	16.6	ppt
I12	PAH	2,6-dimethylnaphthalene	0.69	nd	ppt
I12	PCB	PCB 18	15.3	nd	ppt
I13	PAH	2-methylnaphthalene	1.31	ns	ppb
I13	PAH	3,4-benzo(B)fluoranthene	4.2	ns	ppb
I13	PAH	Acenaphthylene	0.66	ns	ppb
I13	PAH	Anthracene	1.31	ns	ppb
I13	PAH	Benzo[A]anthracene	12.5	ns	ppb
I13	PAH	Benzo[A]pyrene	5.25	ns	ppb
I13	PAH	Benzo[e]pyrene	5.25	ns	ppb
I13	PAH	Benzo[G,H,I]perylene	3.28	ns	ppb
I13	PAH	Benzo[K]fluoranthene	5.25	ns	ppb
I13	PAH	Chrysene	7.22	ns	ppb
I13	PAH	Fluoranthene	2.63	ns	ppb
I13	PAH	Phenanthrene	1.31	ns	ppb
I13	PAH	Pyrene	3.28	ns	ppb
I13	PCB	PCB 167	10.7	ns	ppt
I14	DDT	o,p-DDE	nd	10.1	ppt
I14	DDT	p,p-DDD	nd	20.2	ppt
I14	DDT	p,p-DDE	nd	112	ppt
I14	DDT	p,-p-DDMU	nd	14	ppt
I14	HCH	HCH, Alpha isomer	nd	11.2	ppt
I14	HCH	HCH, Beta isomer	20.2	nd	ppt
I14	PAH	1-methylphenanthrene	nd	3.64	ppb
I14	PAH	2,6-dimethylnaphthalene	6.65	9.5	ppb
I14	PAH	2-methylnaphthalene	nd	4.49	ppb
I14	PAH	Acenaphthylene	nd	3.66	ppb
I14	PAH	Biphenyl	nd	3.96	ppb
I14	PAH	Naphthalene	nd	6.89	ppb
I15	PCB	PCB 28	5.38	nd	ppt
I15	PCB	PCB 77	1.63	nd	ppt
I15	PCB	PCB 206	18.1	nd	ppt
I15	DDT	p,p-DDD	nd	63.9	ppt
I15	DDT	p,p-DDE	33.8	27.2	ppt
I15	DDT	p,p-DDT	nd	4.79	ppt
I15	PAH	2,6-dimethylnaphthalene	1.37	nd	ppb
I16	DDT	p,p-DDD	nd	39.8	ppt
I16	DDT	p,p-DDE	nd	42.3	ppt

Appendix B.12 *continued*

Station	Class	Constituent	Winter	Summer	Units
I16	PAH	2,6-dimethylnaphthalene	0.69	nd	ppb
I16	PCB	PCB 206	24.9	nd	ppt
I18	DDT	o,p-DDE	12.4	ns	ppt
I18	DDT	p,-p-DDMU	28.6	ns	ppt
I18	HCH	HCH, Beta isomer	32.7	ns	ppt
I18	HCH	HCH, Delta isomer	21.3	ns	ppt
I18	PCB	PCB 18	30.3	ns	ppt
I18	PCB	PCB 28	60.6	ns	ppt
I18	PCB	PCB 37	25	ns	ppt
I18	PCB	PCB 49	16.7	ns	ppt
I18	PCB	PCB 52	21.3	ns	ppt
I18	PCB	PCB 70	13.5	ns	ppt
I18	PCB	PCB 157	5.28	ns	ppt
I20	PAH	2,6-dimethylnaphthalene	0.68	ns	ppb
I20	PCB	PCB 206	15.1	ns	ppb
I21	DDT	o,p-DDE	9.2	ns	ppt
I21	HCH	HCH, Beta isomer	22.4	ns	ppt
I21	HCH	HCH, Delta isomer	22	ns	ppt
I21	HCH	HCH, Gamma isomer	3.99	ns	ppt
I21	PAH	1-methylphenanthrene	1.75	ns	ppb
I21	PAH	2,3,5-trimethylnaphthalene	1.99	ns	ppb
I21	PAH	2,6-dimethylnaphthalene	2.45	ns	ppb
I21	PAH	2-methylnaphthalene	2.78	ns	ppb
I21	PAH	3,4-benzo(B)fluoranthene	1.03	ns	ppb
I21	PAH	Acenaphthene	2.8	ns	ppb
I21	PAH	Acenaphthylene	2.45	ns	ppb
I21	PAH	Anthracene	1.4	ns	ppb
I21	PAH	Biphenyl	1.77	ns	ppb
I21	PAH	Chrysene	2.06	ns	ppb
I21	PAH	Fluorene	2.8	ns	ppb
I21	PAH	Naphthalene	1.4	ns	ppb
I21	PAH	Phenanthrene	1.75	ns	ppb
I21	PCB	PCB 28	9.2	ns	ppt
I21	PCB	PCB 37	25	ns	ppt
I21	PCB	PCB 70	3.99	ns	ppt
I21	PCB	PCB 101	13	ns	ppt
I22	DDT	p,p-DDD	nd	12	ppt
I22	DDT	p,p-DDE	60.9	98.8	ppt
I22	DDT	p,-p-DDMU	nd	10.3	ppt
I22	DDT	p,p-DDT	nd	11.1	ppt
I22	HCH	HCH, Beta isomer	7.24	nd	ppt
I22	PAH	2,6-dimethylnaphthalene	5.1	9.11	ppb
I22	PAH	Fluoranthene	2.19	nd	ppb
I22	PAH	Phenanthrene	2.19	nd	ppb
I22	PAH	Pyrene	2.92	nd	ppb
I22	PCB	PCB 66	4.4	nd	ppt
I22	PCB	PCB 105	7.4	nd	ppt
I22	PCB	PCB 187	3.9	nd	ppt
I22	PCB	PCB 206	21	nd	ppt
I23	PAH	2,6-dimethylnaphthalene	5.14	ns	ppb
I23	PAH	2-methylnaphthalene	1.47	ns	ppb

Appendix B.12 *continued*

Station	Class	Constituent	Winter	Summer	Units
I23	PAH	Acenaphthylene	1.47	ns	ppb
I23	PAH	Fluoranthene	0.73	ns	ppb
I23	PAH	Pyrene	1.47	ns	ppb
I23	PCB	PCB 81	5.1	ns	ppt
I23	PCB	PCB 189	17.1	ns	ppt
I23	PCB	PCB 206	23.7	ns	ppt
I27	DDT	p,p-DDD	nd	11.6	ppt
I27	DDT	p,p-DDE	48.7	75.2	ppt
I27	HCH	HCH, Alpha isomer	79.9	nd	ppt
I27	HCH	HCH, Beta isomer	67.9	nd	ppt
I27	HCH	HCH, Gamma isomer	94.1	nd	ppt
I27	PAH	2,6-dimethylnaphthalene	3.73	4.94	ppb
I27	PAH	Biphenyl	1.49	nd	ppb
I28	DDT	p,p-DDE	230	ns	ppt
I28	HCH	HCH, Alpha isomer	149	ns	ppt
I28	HCH	HCH, Beta isomer	54.6	ns	ppt
I28	HCH	HCH, Delta isomer	98.3	ns	ppt
I28	HCH	HCH, Gamma isomer	189	ns	ppt
I28	PCB	PCB 66	12.1	ns	ppt
I28	PCB	PCB 70	11	ns	ppt
I28	PCB	PCB 206	12	ns	ppt
I29	PCB	PCB 37	4.61	ns	ppt
I29	PCB	PCB 206	24.9	ns	ppt
I30	DDT	p,p-DDE	5.15	81.1	ppt
I30	DDT	p,p-DDT	nd	16.8	ppt
I30	HCH	HCH, Beta isomer	9.05	nd	ppt
I30	PAH	2,6-dimethylnaphthalene	nd	8.73	ppb
I30	PAH	Biphenyl	nd	4.9	ppb
I30	PCB	PCB 66	10.7	nd	ppt
I31	HCH	HCH, Alpha isomer	48.9	ns	ppt
I31	PAH	2,6-dimethylnaphthalene	2.87	ns	ppb
I31	PCB	PCB 37	20.3	ns	ppt
I31	PCB	PCB 66	16.7	ns	ppt
I31	PCB	PCB 118	5.34	ns	ppt
I31	PCB	PCB 169	42.5	ns	ppt
I31	PCB	PCB 189	39.4	ns	ppt
I31	PCB	PCB 206	26.7	ns	ppt
I33	DDT	o,p-DDE	nd	8.86	ppt
I33	DDT	p,p-DDD	nd	13.7	ppt
I33	DDT	p,p-DDE	nd	65.5	ppt
I33	DDT	p,-p-DDMU	nd	9.96	ppt
I33	HCH	HCH, Beta isomer	nd	8.84	ppt
I33	PAH	2,6-dimethylnaphthalene	3.69	7.38	ppb
I33	PAH	3,4-benzo(B)fluoranthene	nd	4.9	ppb
I33	PAH	Benzo[A]anthracene	nd	4.91	ppb
I33	PAH	Benzo[A]pyrene	nd	3.08	ppb
I33	PAH	Benzo[e]pyrene	nd	2.79	ppb
I33	PAH	Benzo[K]fluoranthene	nd	1.57	ppb
I33	PAH	Chrysene	nd	4.28	ppb

Appendix B.12 *continued*

Station	Class	Constituent	Winter	Summer	Units
I33	PAH	Fluoranthene	1.48	1.78	ppb
I33	PAH	Indeno(1,2,3-CD)pyrene	nd	1.85	ppb
I33	PAH	Pyrene	2.22	1.66	ppb
I33	PCB	PCB 18	5.3	nd	ppt
I33	PCB	PCB 66	11.8	nd	ppt
I33	PCB	PCB 101	nd	8.99	ppt
I33	PCB	PCB 118	nd	10.4	ppt
I33	PCB	PCB 138	nd	10.9	ppt
I34	PCB	PCB 66	17.6	ns	ppt
I34	PCB	PCB 189	49.4	ns	ppt
I35	DDT	p,p-DDE	117	ns	ppt
I35	PAH	1-methylphenanthrene	0.74	ns	ppb
I35	PAH	2,6-dimethylnaphthalene	5.89	ns	ppb
I35	PAH	2-methylnaphthalene	1.47	ns	ppb
I35	PAH	3,4-benzo(B)fluoranthene	4.42	ns	ppb
I35	PAH	Acenaphthylene	1.47	ns	ppb
I35	PAH	Benzo[A]pyrene	3.68	ns	ppb
I35	PAH	Benzo[e]pyrene	2.94	ns	ppb
I35	PAH	Biphenyl	1.47	ns	ppb
I35	PAH	Fluoranthene	4.42	ns	ppb
I35	PAH	Fluorene	2.21	ns	ppb
I35	PAH	Pyrene	4.42	ns	ppb
I35	PCB	PCB 18	91	ns	ppt
I35	PCB	PCB 28	32.2	ns	ppt
I35	PCB	PCB 37	35.4	ns	ppt
I35	PCB	PCB 49	26.2	ns	ppt
I35	PCB	PCB 52	55.2	ns	ppt
I35	PCB	PCB 66	42.9	ns	ppt
I35	PCB	PCB 70	40.8	ns	ppt
I35	PCB	PCB 87	69.3	ns	ppt
I35	PCB	PCB 99	38.3	ns	ppt
I35	PCB	PCB 101	120	ns	ppt
I35	PCB	PCB 110	160	ns	ppt
I35	PCB	PCB 118	73.7	ns	ppt
I35	PCB	PCB 138	99	ns	ppt
I35	PCB	PCB 149	61.7	ns	ppt

Appendix B.13

Macrofaunal community parameters by grab for PLOO benthic stations sampled during 2018. SR = species richness; Abun = abundance; H' = Shannon diversity index; J' = Pielou's evenness; Dom = Swartz dominance; BRI = benthic response index. Stations are listed north to south from top to bottom for each depth contour; ns = no sample.

Depth Contour	Station	Survey	SR	Abun	H'	J'	Dom	BRI
88-m	B11	winter	108	347	4.2	0.90	43	14
		summer	ns	ns	ns	ns	ns	ns
	B8	winter	70	304	3.4	0.79	20	6
		summer	ns	ns	ns	ns	ns	ns
	E19	winter	81	534	3.3	0.76	15	12
		summer	ns	ns	ns	ns	ns	ns
	E7	winter	91	554	3.5	0.77	19	13
		summer	ns	ns	ns	ns	ns	ns
	E1	winter	98	433	3.9	0.86	32	9
		summer	ns	ns	ns	ns	ns	ns
98-m	B12	winter	125	441	4.1	0.84	39	10
		summer	96	461	3.6	0.79	25	14
	B9	winter	92	335	4.0	0.89	33	11
		summer	117	692	3.8	0.80	26	12
	E26	winter	81	367	3.6	0.82	22	12
		summer	90	626	3.6	0.81	21	9
	E25	winter	58	392	3.3	0.82	17	13
		summer	74	537	3.4	0.79	16	12
	E23	winter	72	483	3.3	0.76	14	9
		summer	88	637	3.5	0.79	18	14
	E20	winter	82	406	3.6	0.82	20	14
		summer	84	687	3.4	0.77	17	14
	E17 [a]	winter	68	382	3.5	0.82	18	17
		summer	102	702	3.4	0.75	17	18
	E14 [a]	winter	59	317	3.3	0.81	15	34
		summer	77	600	3.2	0.75	15	27
	E11 [a]	winter	85	515	3.6	0.80	19	21
		summer	82	547	3.2	0.73	18	20
	E8	winter	81	348	3.7	0.84	24	10
		summer	68	331	3.5	0.83	20	8
	E5	winter	86	455	3.6	0.81	21	11
		summer	92	597	3.7	0.82	25	10
	E2	winter	89	373	3.9	0.87	29	11
		summer	105	590	3.6	0.78	24	11

[a] Near-ZID station

Appendix B.13 *continued*

Depth Contour	Station	Survey	SR	Abun	H'	J'	Dom	BRI
116-m	B10	winter	93	390	3.9	0.85	30	13
		summer	ns	ns	ns	ns	ns	ns
	E21	winter	56	249	3.4	0.85	17	16
		summer	ns	ns	ns	ns	ns	ns
	E15[a]	winter	60	437	3.3	0.82	16	14
		summer	44	249	3.1	0.81	12	14
	E9	winter	86	386	3.8	0.85	27	14
		summer	ns	ns	ns	ns	ns	ns
	E3	winter	99	243	4.2	0.92	44	11
		summer	ns	ns	ns	ns	ns	ns

Appendix B.14

Macrofaunal community parameters by grab for SBOO benthic stations sampled during 2018. SR = species richness; Abun = abundance; H' = Shannon diversity index; J' = Pielou's evenness; Dom = Swartz dominance; BRI = benthic response index. Stations are listed north to south from top to bottom for each depth contour; ns = no sample.

Depth Contour	Station	Survey	SR	Abun	H'	J'	Dom	BRI
19-m	I35	winter	47	116	3.5	0.90	20	22
		summer	ns	ns	ns	ns	ns	ns
	I34	winter	49	535	2.7	0.68	7	24
		summer	ns	ns	ns	ns	ns	ns
	I31	winter	54	136	3.7	0.92	24	22
		summer	ns	ns	ns	ns	ns	ns
	I23	winter	72	183	3.8	0.88	28	22
		summer	ns	ns	ns	ns	ns	ns
	I18	winter	51	95	3.7	0.93	28	16
		summer	ns	ns	ns	ns	ns	ns
	I10	winter	95	271	4.1	0.90	38	23
		summer	ns	ns	ns	ns	ns	ns
	I4	winter	21	41	2.7	0.89	11	-2
		summer	ns	ns	ns	ns	ns	ns
28-m	I33	winter	76	175	4.1	0.94	36	23
		summer	114	464	4.1	0.86	39	26
	I30	winter	66	181	3.8	0.90	28	25
		summer	75	177	3.8	0.88	31	20
	I27	winter	56	128	3.7	0.92	26	23
		summer	68	195	3.7	0.87	27	24
	I22	winter	78	274	3.8	0.87	27	27
		summer	82	396	3.6	0.82	24	22
	I14 [a]	winter	74	259	3.7	0.87	27	27
		summer	63	244	3.2	0.78	18	27
	I16 [a]	winter	34	167	3.1	0.87	12	11
		summer	53	242	2.8	0.71	13	19
	I15	winter	28	74	3.0	0.90	12	18
		summer	35	165	2.3	0.65	7	18
	I12 [a]	winter	42	86	3.3	0.89	21	23
		summer	55	229	2.5	0.63	13	18
	I9	winter	87	247	4.0	0.90	36	25
		summer	96	313	3.9	0.86	31	25
	I6	winter	41	106	3.2	0.86	18	12
		summer	49	190	2.7	0.70	11	11
	I2	winter	26	97	2.3	0.69	7	21
		summer	23	61	2.5	0.79	9	17
	I3	winter	32	178	2.2	0.63	6	10
		summer	34	101	3.1	0.87	13	11

[a] Near-ZID station

Appendix B.14 *continued*

Depth Contour	Station	Survey	SR	Abun	H'	J'	Dom	BRI
38-m	I29	winter	46	226	2.7	0.71	9	1
		summer	ns	ns	ns	ns	ns	ns
	I21	winter	30	67	3.1	0.91	14	10
		summer	ns	ns	ns	ns	ns	ns
	I13	winter	39	104	3.2	0.87	16	5
		summer	ns	ns	ns	ns	ns	ns
	I8	winter	37	201	2.2	0.61	6	30
		summer	ns	ns	ns	ns	ns	ns
55-m	I28	winter	164	568	4.4	0.87	52	18
		summer	ns	ns	ns	ns	ns	ns
	I20	winter	42	241	2.8	0.74	10	-1
		summer	ns	ns	ns	ns	ns	ns
	I7	winter	38	65	3.5	0.95	22	0
		summer	ns	ns	ns	ns	ns	ns
	I1	winter	62	159	3.6	0.88	25	14
		summer	ns	ns	ns	ns	ns	ns

Appendix B.15

Summary taxonomic listing of benthic infauna taxa identified from PLOO stations during 2018. Data are total number of individuals (n). Taxonomic arrangement from SCAMIT (2018).

Taxon/Species				n
CNIDARIA				
	Hydrozoa			
		Campanulariidae	*Laomedea calceolifera*	2
	Anthozoa			
		Plexauridae	*Thesea* sp B	2
		Virgulariidae	*Stylatula* sp	4
		Edwardsiidae		15
			Edwardsia olguini	14
			Scolanthus triangulus	20
		Halcampidae	*Halcampa decemtentaculata*	1
			Halianthella sp A	2
PLATYAYHELMINTHES				
	Rhabditophora			
		Plehniidae	*Diplehnia caeca*	4
		Leptoplanidae		2
NEMERTEA				1
	Anopla			3
		Cephalotrichidae	*Cephalothrix* sp	1
		Carinomidae	*Carinoma mutabilis*	4
			Carinomella lactea	1
		Tubulanidae		7
			Tubulanus cingulatus	3
			Tubulanus polymorphus	32
			Tubulanus sp A	1
		Palaeonemertea		4
		Lineidae		21
			Cerebratulus californiensis	3
			Lineidae sp SD1	2
			Lineus bilineatus	17
			Maculaura alaskensis Cmplx	2
			Heteronemertea sp SD2	110
	Enopla			
		Emplectonematidae	*Paranemertes californica*	4
		Hoplonemertea		1
			Hoplonemertea sp D	1
MOLLUSCA				
	Gastropoda			
		Solariellidae	*Solariella peramabilis*	1
		Cerithiidae	*Lirobittium larum*	15
		Naticidae	*Neverita draconis*	2
			Neverita recluziana	1
		Rissoidae	*Alvania rosana*	5
		Caecidae	*Caecum crebricinctum*	6
		Eulimidae	*Eulima raymondi*	2
			Melanella rosa	1
		Columbellidae	*Amphissa undata*	1
		Nassariidae		1
		Mangeliidae	*Kurtzina beta*	12

Taxon/Species				n
		Drillidae	*Elaeocyma empyrosia*	1
		Pseudomelatomidae	*Megasurcula carpenteriana*	1
		Cancellariidae	*Cancellaria cooperii*	1
			Cancellaria crawfordiana	1
		Acteonidae	*Rictaxis punctocaelatus*	6
		Pyramidellidae	*Odostomia* sp	23
			Turbonilla chocolata	1
			Turbonilla santarosana	10
			Turbonilla sp SD5	2
			Turbonilla sp SD6	1
			Turbonilla sp SD9	1
			Turbonilla sp	3
		Cumanotidae	*Cumanotus fernaldi*	1
		Rhizoridae	*Volvulella californica*	2
			Volvulella cylindrica	9
		Acteocinidae	*Acteocina cerealis*	25
		Philinidae	*Philine auriformis*	1
		Aglajidae	*Aglaja ocelligera*	2
			Melanochlamys diomedea	1
		Gastropteridae	*Gastropteron pacificum*	3
		Cylichnidae	*Cylichna diegensis*	11
		Diaphanidae	*Diaphana californica*	1
	Bivalvia			8
		Nuculidae	*Acila castrensis*	6
			Ennucula tenuis	100
		Solemyidae	*Solemya pervernicosa*	7
		Nucinellidae	*Huxleyia munita*	3
		Nuculanidae	*Nuculana hamata*	4
			Nuculana sp A	353
		Mytilidae		1
			Crenella decussata	1
			Solamen columbianum	1
			Amygdalum pallidulum	5
		Carditidae	*Cyclocardia ventricosa*	1
		Lucinidae	*Parvilucina tenuisculpta*	81
			Lucinoma annulatum	12
		Thyasiridae		1
			Adontorhina cyclia	83
			Axinopsida serricata	981
			Neverita recluziana	1
		Lasaeidae	*Kurtiella tumida*	4
			Kurtiella sp D	6
			Kurtiella sp	1
		Cardiidae	*Keenaea centifilosum*	23
		Tellinidae	*Tellina carpenteri*	257
			Tellina sp B	226
			Tellina sp	11
			Macoma carlottensis	7
		Hiatellidae	*Saxicavella nybakkeni*	1

Appendix B.15 *continued*

Taxon/Species				n
		Petricolidae	*Cooperella subdiaphana*	6
		Lyonsiidae		1
	Scaphopoda			
		Dentaliidae	*Dentalium vallicolens*	1
		Gadilidae	*Polyschides quadrifissatus*	65
SIPUNCULA				1
	Sipunculidea			
		Golfingiidae	*Thysanocardia nigra*	1
		Phascolionidae	*Phascolion* sp A	20
		Sipunculidae	*Siphonosoma ingens*	1
	Phascolosomatidea			
		Phascolosomatidae	*Apionsoma misakianum*	1
ANNELIDA				
	Polychaeta			
		Thalassematidae	*Listriolobus pelodes*	2
		Amphinomidae	*Chloeia pinnata*	22
		Eunicidae	*Leodice americana*	1
		Lumbrineridae	*Eranno bicirrata*	5
			Eranno lagunae	4
			Lumbrineris cruzensis	16
			Lumbrineris latreilli	7
			Lumbrineris ligulata	4
			Lumbrineris sp Group I	12
			Ninoe sp	1
			Scoletoma tetraura Cmplx	13
			Scoletoma sp	1
		Oenonidae	*Drilonereis falcata*	5
			Drilonereis sp	11
			Notocirrus californiensis	5
		Onuphidae		20
			Hyalinoecia juvenalis	1
			Mooreonuphis sp SD2	1
			Mooreonuphis sp	3
			Onuphis iridescens	5
			Onuphis multiannulata	1
			Onuphis sp A	10
			Onuphis sp	1
			Paradiopatra parva	221
		Aphroditidae	*Aphrodita* sp	2
		Polynoidae	Polynoinae	1
			Malmgreniella baschi	5
			Malmgreniella macginitiei	1
			Malmgreniella scriptoria	3
			Malmgreniella sp A	28
			Subadyte mexicana	1
			Tenonia priops	5
		Pholoidae	*Pholoe glabra*	67

Appendix B.15 *continued*

Taxon/Species			n
	Sigalionidae	*Pholoides asperus*	1
		Sigalion spinosus	6
		Sthenelais tertiaglabra	16
		Sthenelais sp	1
		Sthenelanella uniformis	16
	Glyceridae	*Glycera americana*	9
		Glycera macrobranchia	1
		Glycera nana	34
		Glycera tesselata	1
	Goniadidae	*Glycinde armigera*	10
		Goniada brunnea	4
		Goniada maculata	26
	Hesionidae	*Podarkeopsis glabrus*	5
	Nereididae	*Nereis* sp A	19
	Pilargidae	*Sigambra tentaculata*	1
	Syllidae	*Proceraea* sp	1
		Paraehlersia articulata	4
		Exogone lourei	4
		Syllis heterochaeta	2
	Nephtyidae	*Aglaophamus verrilli*	3
		Bipalponephtys cornuta	1
		Nephtys caecoides	23
		Nephtys ferruginea	92
		Nephtys sp	1
	Phyllodocidae	*Eteone* sp	1
		Eulalia levicornuta Cmplx	1
		Eulalia quadrioculata	1
		Eumida longicornuta	1
		Sige sp A	9
		Paranaitis sp SD1	2
		Phyllodoce cuspidata	1
		Phyllodoce groenlandica	1
		Phyllodoce hartmanae	20
		Phyllodoce longipes	10
		Phyllodoce pettiboneae	34
		Phyllodoce sp	3
	Oweniidae	*Myriochele gracilis*	3
		Myriochele olgae	5
		Myriochele sp	1
		Owenia collaris	1
	Sabellidae	Sabellinae	1
		Acromegalomma splendidum	2
		Dialychone albocincta	8
		Dialychone trilineata	84
		Dialychone veleronis	2
		Euchone arenae	1
		Euchone hancocki	4

Appendix B.15 *continued*

Taxon/Species			n
		Euchone incolor	36
		Euchone sp A	9
		Jasmineira sp B	4
		Paradialychone ecaudata	2
		Paradialychone harrisae	2
		Paradialychone paramollis	9
		Potamethus sp A	2
	Apistobranchidae	*Apistobranchus ornatus*	1
	Longosomatidae	*Heterospio catalinensis*	5
	Magelonidae	*Magelona berkeleyi*	8
		Magelona hartmanae	2
		Magelona hobsonae	1
		Magelona sp	1
	Poecilochaetidae	*Poecilochaetus* sp	1
	Spionidae	*Dipolydora socialis*	13
		Laonice cirrata	2
		Laonice nuchala	20
		Microspio pigmentata	74
		Paraprionospio alata	64
		Polydora sp	1
		Prionospio dubia	133
		Prionospio jubata	301
		Prionospio lighti	28
		Prionospio sp	1
		Scolelepis (Scolelepis) squamata	1
		Spio filicornis	1
		Spio maciolekae	1
		Spiophanes berkeleyorum	40
		Spiophanes duplex	1567
		Spiophanes kimballi	315
		Spiophanes norrisi	2
		Spiophanes wigleyi	1
		Spiophanes sp	7
	Cirratulidae		4
		Aphelochaeta glandaria Cmplx	422
		Aphelochaeta monilaris	67
		Aphelochaeta phillipsi	14
		Aphelochaeta tigrina	26
		Aphelochaeta williamsae	18
		Aphelochaeta sp LA1	19
		Aphelochaeta sp SD5	31
		Aphelochaeta sp	13
		Chaetozone columbiana	3
		Chaetozone hartmanae	183
		Chaetozone lunula	4
		Chaetozone sp SD2	5
		Chaetozone sp SD3	1
		Chaetozone sp SD5	8
		Chaetozone sp SD7	47

Appendix B.15 *continued*

Taxon/Species			n
		Chaetozone sp	4
		Kirkegaardia cryptica	23
		Kirkegaardia serratiseta	1
		Kirkegaardia siblina	48
		Kirkegaardia tesselata	6
		Kirkegaardia sp SD9	5
		Kirkegaardia sp	2
	Fauveliopsidae	*Fauveliopsis* sp SD1	88
	Flabelligeridae	*Brada pluribranchiata*	1
		Lamispina schmidtii	1
		Pherusa neopapillata	1
		Trophoniella harrisae	3
	Sternaspidae	*Sternaspis affinis*	202
	Ampharetidae		12
		Amage scutata	41
		Ampharete finmarchica	18
		Ampharete sp	7
		Ampharetidae sp SD1	2
		Amphicteis glabra	3
		Amphicteis scaphobranchiata	39
		Amphicteis sp	1
		Amphisamytha bioculata	1
		Anobothrus gracilis	57
		Asabellides lineata	1
		Eclysippe trilobata	1012
		Lysippe sp A	80
		Lysippe sp B	80
		Lysippe sp	1
		Sabellides manriquei	1
		Samytha californiensis	2
		Sosane occidentalis	12
		Melinna oculata	3
	Pectinariidae	*Pectinaria californiensis*	172
	Terebellidae	*Amaeana occidentalis*	32
		Polycirrus californicus	68
		Polycirrus sp A	210
		Polycirrus sp OC1	203
		Polycirrus sp	246
		Terebellinae	14
		Lanassa venusta venusta	467
		Phisidia sanctaemariae	1015
		Pista brevibranchiata	4
		Pista estevanica	35
		Pista moorei	1
		Pista wui	9
		Pista sp	2
		Proclea sp A	15
		Streblosoma sp	2
	Trichobranchidae	*Terebellides californica*	22

Appendix B.15 *continued*

Taxon/Species			n
		Terebellides reishi	1
		Terebellides sp Type C	1
		Trichobranchus hancocki	4
	Chaetopteridae	*Phyllochaetopterus* sp	2
		Spiochaetopterus costarum Cmplx	61
	Capitellidae		2
		Capitella teleta	179
		Decamastus gracilis	31
		Mediomastus sp	896
		Notomastus hemipodus	67
		Notomastus latericeus	16
		Notomastus tenuis	2
		Notomastus sp	7
	Cossuridae		1
		Cossura candida	14
		Cossura sp A	3
		Cossura sp	6
	Maldanidae		86
		Euclymeninae	35
		Euclymeninae sp A	123
		Axiothella sp	3
		Clymenella complanata	1
		Clymenura gracilis	78
		Petaloclymene pacifica	27
		Praxillella gracilis	16
		Praxillella pacifica	325
		Maldaninae	3
		Maldane sarsi	46
		Maldane sp	1
		Metasychis disparidentatus	1
		Praxillura maculata	1
		Rhodine bitorquata	97
	Orbiniidae		1
		Leitoscoloplos pugettensis	1
		Scoloplos armiger Cmplx	196
		Scoloplos sp	3
	Paraonidae	*Aricidea (Acmira) catherinae*	108
		Aricidea (Acmira) lopezi	60
		Aricidea (Acmira) rubra	1
		Aricidea (Acmira) simplex	5
		Aricidea (Acmira) sp	5
		Aricidea (Aricidea) pseudoarticulata	1
		Aricidea (Aricidea) wassi	2
		Aricidea (Strelzovia) antennata	19
		Aricidea (Strelzovia) hartleyi	5
		Aricidea (Strelzovia) sp A	13
		Levinsenia gracilis	18
		Levinsenia kirbyae	12
	Scalibregmatidae	*Scalibregma californicum*	23

Appendix B.15 *continued*

Taxon/Species				n
		Travisiidae	*Travisia brevis*	178
ARTHROPODA				
	Ostracoda			
		Philomedidae	*Euphilomedes carcharodonta*	8
			Euphilomedes producta	11
		Podocopida		1
	Malacostraca			
		Mysidae		1
			Mysidella americana	2
		Caprellidae	*Mayerella banksia*	1
		Photidae	*Gammaropsis thompsoni*	2
			Photis californica	1
			Photis lacia	6
			Photis sp	6
			Podoceropsis ociosa	9
		Aoridae	*Aoroides* sp A	6
		Corophiidae	*Protomedeia articulata* Cmplx	18
		Oedicerotidae	*Americhelidium shoemakeri*	11
			Americhelidium sp SD4	2
			Bathymedon pumilus	2
			Deflexilodes norvegicus	21
			Hartmanodes hartmanae	1
			Monoculodes emarginatus	2
			Westwoodilla tone	13
		Liljeborgiidae	*Listriella eriopisa*	2
			Listriella goleta	12
			Listriella melanica	1
		Ampeliscidae	*Ampelisca agassizi*	6
			Ampelisca brevisimulata	17
			Ampelisca cf *brevisimulata*	6
			Ampelisca careyi	57
			Ampelisca hancocki	5
			Ampelisca pacifica	47
			Ampelisca pugetica	31
			Ampelisca sp	12
			Byblis millsi	6
		Argissidae	*Argissa hamatipes*	1
		Urothoidae	*Urothoe elegans* Cmplx	7
		Phoxocephalidae		3
			Foxiphalus obtusidens	3
			Foxiphalus similis	1
			Rhepoxynius bicuspidatus	150
			Rhepoxynius menziesi	5
			Eyakia robusta	4
			Heterophoxus ellisi	3
			Heterophoxus oculatus	28
			Heterophoxus sp	3
		Pakynidae	*Pachynus barnardi*	3
		Aegidae	*Rocinela belliceps*	1

Appendix B.15 *continued*

Taxon/Species				n
		Gnathiidae		1
			Caecognathia crenulatifrons	19
		Anthuridae	*Haliophasma geminata*	3
		Tanaidacea		1
		Akanthophoreidae	*Akanthophoreus phillipsi*	1
		Leptocheliidae	*Chondrochelia dubia* Cmplx	14
		Tanaellidae	*Araphura breviaria*	6
			Araphura sp SD1	1
			Tanaella propinquus	2
		Tanaopsidae	*Tanaopsis cadieni*	5
		Leuconidae	*Eudorella pacifica*	1
		Nannastacidae	*Procampylaspis caenosa*	6
		Diastylidae	*Diastylis crenellata*	8
		Pinnotheridae	*Pinnixa occidentalis* Cmplx	1
	Hexanauplia			
		Scalpellidae	*Hamatoscalpellum californicum*	1
NEMATODA				4
ECHINODERMATA				
	Ophiuroidea			4
		Ophiuridae	*Ophiura luetkenii*	2
		Amphiuridae		133
			Amphichondrius granulatus	23
			Amphiodia digitata	38
			Amphiodia urtica	692
			Amphiodia sp	65
			Amphioplus strongyloplax	1
			Amphiura arcystata	13
			Dougaloplus amphacanthus	13
			Dougaloplus sp A	2
	Echinoidea			
		Toxopneustidae	*Lytechinus pictus*	2
		Spatangoida		1
		Brissidae	*Brissopsis pacifica*	2
	Holothuroidea			
		Phyllophoridae	*Pentamera populifera*	2
		Synaptidae	*Leptosynapta* sp	35
		Chiridotidae	*Chiridota* sp	12
PHORONIDA				3
		Phoronidae	*Phoronis* sp SD1	1
CHORDATA			*Phoronis* sp	9
	Enteropneusta			
		Ptychoderidae	*Balanoglossus* sp	2
		Spengeliidae	*Schizocardium* sp	1
		Harrimaniidae	*Stereobalanus* sp	14
	Ascidiacea			
		Molgulidae	*Molgula* sp	2

Appendix B.16

Summary taxonomic listing of benthic infauna taxa identified from SBOO stations during 2018. Data are total number of individuals (n). Taxonomic arrangement from SCAMIT (2018).

Taxon/Species				n
CNIDARIA				
	Hydrozoa			
		Corymorphidae	*Corymorpha bigelowi*	6
			Euphysa sp A	6
		Campanulariidae	*Laomedea calceolifera*	3
		Virgulariidae	*Stylatula elongata*	1
	Anthozoa			
		Ceriantharia		6
		Arachnactidae	*Arachnanthus* sp A	1
		Actiniaria		3
		Edwardsiidae		50
			Edwardsia juliae	3
			Edwardsia olguini	20
			Scolanthus triangulus	6
		Halcampidae	*Halcampa decemtentaculata*	5
			Halianthella sp A	3
			Pentactinia californica	2
		Isanthidae	*Zaolutus actius*	1
		Limnactiniidae	Limnactiniidae sp A	1
		Haloclavidae	*Anemonactis* sp A	1
			Harenactis attenuata	2
Platyhelminthes				
	Rhabditophora			
		Stylochidae	*Stylochus exiguus*	1
		Cryptocelidae	*Cryptocelis occidentalis*	6
		Leptoplanoidea		2
			Rhabdocoela sp A	1
Nemertea				1
	Anopla			9
		Cephalotrichidae	*Cephalothrix* sp	4
		Palaeonemertea		3
		Carinomidae	*Carinoma mutabilis*	65
		Tubulanidae		7
			Tubulanus polymorphus	115
			Tubulanus sp A	5
		Heteronemertea		3
		Lineidae		39
			Cerebratulus californiensis	3
			Lineidae sp SD1	6
			Lineus bilineatus	10
			Maculaura alaskensis Cmplx	6
			Zygeupolia rubens	2
			Heteronemertea sp SD2	41
	Enopla			3
		Emplectonematidae		2
			Paranemertes californica	7
		Prosorhochmidae	*Prosorhochmus albidus*	2
		Oerstediidae	*Oerstedia dorsalis* Cmplx	4

Appendix B.16 *continued*

Taxon/Species				n
		Amphiporidae	*Amphiporus flavescens*	1
		Tetrastemmatidae	*Tetrastemma candidum*	8
		Hoplonemertea		8
			Hoplonemertea sp B	1
MOLLUSCA				
	Caudofoveata			
		Chaetodermatidae		1
			Chaetoderma marinelli	1
			Chaetoderma pacificum	3
	Gastropoda			
		Lottiidae	*Lottia rosacea*	1
		Trochidae	*Halistylus pupoideus*	2
			Lirularia sp	1
		Calyptraeidae		2
			Calyptraea fastigiata	4
			Crepidula sp	1
			Garnotia naticarum	3
		Naticidae	*Neverita recluziana*	7
		Barleeiidae	*Lirobarleeia kelseyi*	3
		Caecidae	*Caecum crebricinctum*	15
		Epitoniidae	*Epitonium sawinae*	2
			Opalia spongiosa	1
		Eulimidae	*Eulima raymondi*	4
			Polygireulima rutila	20
		Buccinidae	*Kelletia kelletii*	1
		Nassariidae	*Nassarius mendicus*	1
		Olivellidae	*Callianax baetica*	24
		Borsoniidae	*Ophiodermella inermis*	2
		Mangeliidae	*Kurtzia arteaga*	1
			Kurtziella plumbea	6
			Kurtzina beta	3
		Terebridae	*Terebra pedroana*	2
		Acteonidae	*Rictaxis punctocaelatus*	2
		Pyramidellidae	*Odostomia* sp	3
			Turbonilla chocolata	1
			Turbonilla santarosana	6
			Turbonilla sp A	2
			Turbonilla sp SD7	1
			Turbonilla sp	1
		Dendronotidae	*Dendronotus* sp	1
		Dotoidae	*Doto* sp	1
		Rhizoridae	*Volvulella californica*	2
			Volvulella cylindrica	2
		Acteocinidae	*Acteocina cerealis*	3
			Acteocina culcitella	3
			Acteocina harpa	1
		Philinidae	*Philine auriformis*	9
		Aglajidae	*Aglaja ocelligera*	3
		Philinoglossidae	*Philinoglossa* sp A	1

Appendix B.16 *continued*

Taxon/Species				n
		Cylichnidae	*Cylichna diegensis*	5
		Diaphanidae	*Diaphana californica*	1
			Bullomorpha sp A	1
	Bivalvia			2
		Nuculidae	*Ennucula tenuis*	4
		Solemyidae	*Solemya pervernicosa*	7
		Nuculanidae	*Nuculana hamata*	1
			Nuculana taphria	15
			Nuculana sp A	1
			Nuculana sp	2
			Saccella penderi	1
		Glycymerididae	*Glycymeris septentrionalis*	3
		Mytilidae	*Crenella decussata*	6
			Solamen columbianum	1
			Modiolinae	1
			Amygdalum pallidulum	1
		Limidae	*Limatula saturna*	1
		Pectinidae		2
			Leptopecten latiauratus	9
		Carditidae	*Cyclocardia ventricosa*	4
			Cyclocardia sp	1
		Lucinidae	*Parvilucina tenuisculpta*	10
		Thyasiridae	*Axinopsida serricata*	3
			Thyasira flexuosa	2
		Lasaeidae	*Kurtiella tumida*	29
		Cardiidae	*Keenaea centifilosum*	9
			Trachycardium quadragenarium	1
		Tellinidae	*Tellina carpenteri*	8
			Tellina modesta	46
			Tellina sp B	3
			Macoma nasuta	1
			Macoma yoldiformis	17
			Macoma sp	1
		Pharidae	*Ensis myrae*	7
		Veneridae	*Compsomyax subdiaphana*	3
		Petricolidae	*Cooperella subdiaphana*	12
		Mactridae		1
			Simomactra falcata	104
		Pandoridae	*Pandora bilirata*	1
		Lyonsiidae		1
		Thraciidae		2
		Periplomatidae	*Periploma discus*	1
		Cuspidariidae	*Cardiomya planetica*	1
	Scaphopoda			2
		Dentaliidae	*Dentalium vallicolens*	3
		Gadilidae	*Polyschides quadrifissatus*	26
			Gadila aberrans	51
SIPUNCULA				27
	Sipunculidea			

Appendix B.16 *continued*

Taxon/Species				n
		Golfingiidae	*Nephasoma diaphanes*	1
			Thysanocardia nigra	20
		Phascolionidae	*Phascolion* sp A	5
		Sipunculidae	*Siphonosoma ingens*	1
	Phascolosomatidea			
		Phascolosomatidae	*Apionsoma misakianum*	44
ANNELIDA				
	Polychaeta			1
		Amphinomidae	*Paramphinome* sp	104
		Dorvilleidae	*Protodorvillea gracilis*	67
		Eunicidae		1
			Leodice americana	1
			Marphysa disjuncta	1
		Lumbrineridae		2
			Lumbrinerides platypygos	78
			Lumbrineris cruzensis	7
			Lumbrineris index	1
			Lumbrineris latreilli	73
			Lumbrineris ligulata	15
			Lumbrineris sp Group I	1
			Lumbrineris sp	9
			Scoletoma tetraura Cmplx	2
		Oenonidae	*Arabella* sp	1
			Drilonereis falcata	1
			Drilonereis sp	1
		Onuphidae		6
			Diopatra ornata	3
			Diopatra splendidissima	9
			Diopatra tridentata	5
			Diopatra sp	1
			Mooreonuphis nebulosa	14
			Mooreonuphis sp SD1	83
			Mooreonuphis sp	1
			Onuphis elegans	3
			Onuphis eremita parva	2
			Onuphis iridescens	2
			Onuphis sp A	36
			Onuphis sp	10
			Paradiopatra parva	20
			Paradiopatra sp	1
			Rhamphobrachium longisetosum	1
		Aphroditidae	*Aphrodita* sp	3
		Eulepethidae	*Grubeulepis* sp	1
		Polynoidae	*Arcteobia* cf *anticostiensis*	1
			Malmgreniella bansei	2
			Malmgreniella macginitiei	2
			Malmgreniella sp A	2
			Malmgreniella sp	1
			Tenonia priops	14

Appendix B.16 *continued*

Taxon/Species			n
	Pholoidae	*Pholoe glabra*	1
	Sigalionidae	*Pisione* sp	61
		Sigalion spinosus	67
		Sthenelais tertiaglabra	4
		Sthenelais verruculosa	2
		Sthenelanella uniformis	44
	Glyceridae	*Glycera americana*	4
		Glycera macrobranchia	6
		Glycera oxycephala	88
		Glycera robusta	1
		Glycera tesselata	1
		Hemipodia borealis	1
	Goniadidae	*Glycinde armigera*	46
		Goniada brunnea	1
		Goniada littorea	9
		Goniada maculata	13
		Goniada sp	2
	Chrysopetalidae	*Chrysopetalum occidentale*	2
	Hesionidae	*Heteropodarke heteromorpha*	2
		Micropodarke dubia	4
		Oxydromus pugettensis	4
		Podarkeopsis glabrus	3
	Nereididae	*Nereis latescens*	1
		Nereis sp A	54
		Platynereis bicanaliculata	11
	Pilargidae	*Hermundura fauveli*	2
	Syllidae		1
		Epigamia-Myrianida Cmplx	2
		Proceraea sp	2
		Eusyllis transecta	7
		Eusyllis sp SD2	2
		Odontosyllis phosphorea	8
		Paraehlersia articulata	1
		Exogone lourei	9
		Parexogone breviseta	3
		Sphaerosyllis californiensis	4
		Sphaerosyllis ranunculus	1
		Syllis farallonensis	9
		Syllis heterochaeta	24
		Syllis sp SD1	4
		Syllis sp SD2	5
		Syllis sp	2
	Nephtyidae	*Bipalponephtys cornuta*	3
		Nephtys caecoides	20
		Nephtys ferruginea	5
		Nephtys simoni	6
		Nephtys sp SD2	4
	Phyllodocidae	*Eteone* sp	1
		Eulalia quadrioculata	4

Appendix B.16 *continued*

Taxon/Species			n
		Eulalia sp SD1	3
		Eumida longicornuta	19
		Hesionura coineaui difficilis	38
		Mystides sp	1
		Sige sp A	3
		Nereiphylla sp 2	2
		Nereiphylla sp SD1	2
		Paranaitis polynoides	2
		Paranaitis sp	1
		Phyllodoce hartmanae	20
		Phyllodoce longipes	22
		Phyllodoce pettiboneae	19
		Phyllodoce sp	2
	Oweniidae	*Myriochele gracilis*	1
		Myriochele olgae	3
		Myriochele striolata	10
		Owenia collaris	2
	Sabellariidae	*Sabellaria gracilis*	8
	Sabellidae		1
		Sabellinae	10
		Acromegalomma pigmentum	7
		Acromegalomma sp	5
		Claviramus sp A	4
		Dialychone albocincta	9
		Dialychone trilineata	3
		Dialychone veleronis	67
		Euchone arenae	3
		Euchone hancocki	3
		Euchone incolor	3
		Euchone sp	1
		Jasmineira sp B	30
		Myxicola sp	1
		Paradialychone ecaudata	1
		Paradialychone harrisae	2
		Paradialychone paramollis	27
		Potamethus sp A	11
	Longosomatidae	*Heterospio catalinensis*	1
	Magelonidae	*Magelona sacculata*	10
	Poecilochaetidae	*Poecilochaetus johnsoni*	6
		Poecilochaetus sp	4
	Spionidae		2
		Aonides sp SD1	1
		Dipolydora socialis	6
		Dispio uncinata	10
		Laonice cirrata	12
		Laonice nuchala	2
		Microspio microcera	2
		Microspio pigmentata	3
		Paraprionospio alata	53

Appendix B.16 *continued*

Taxon/Species			n
		Polydora sp	1
		Prionospio dubia	26
		Prionospio jubata	84
		Prionospio lighti	6
		Prionospio multibranchiata	1
		Prionospio pygmaeus	115
		Spio maculata	20
		Spiophanes berkeleyorum	27
		Spiophanes duplex	285
		Spiophanes kimballi	1
		Spiophanes norrisi	687
	Cirratulidae		1
		Aphelochaeta glandaria Cmplx	1
		Aphelochaeta monilaris	5
		Aphelochaeta tigrina	1
		Aphelochaeta williamsae	12
		Aphelochaeta sp LA1	3
		Aphelochaeta sp	3
		Caulleriella pacifica	1
		Caulleriella sp	1
		Chaetozone columbiana	24
		Chaetozone corona	76
		Chaetozone hartmanae	21
		Chaetozone hedgpethi	1
		Chaetozone sp SD5	12
		Chaetozone sp	8
		Cirriformia sp B	1
		Cirriformia sp SD1	1
		Cirriformia sp SD2	17
		Kirkegaardia cryptica	2
		Kirkegaardia siblina	65
		Kirkegaardia tesselata	9
		Kirkegaardia sp	6
	Flabelligeridae	*Flabelligera* sp SD1	1
		Pherusa neopapillata	2
		Trophoniella harrisae	1
	Sternaspidae	*Sternaspis affinis*	3
	Ampharetidae		7
		Amage anops	6
		Amage scutata	12
		Ampharete labrops	136
		Ampharete sp	3
		Ampharetidae sp SD1	3
		Amphicteis scaphobranchiata	23
		Amphicteis sp	4
		Amphisamytha bioculata	8
		Anobothrus gracilis	9
		Asabellides lineata	2
		Eclysippe trilobata	16

Appendix B.16 *continued*

Taxon/Species			n
		Lysippe sp A	21
		Lysippe sp B	2
		Sabellides manriquei	2
		Melinna oculata	29
	Pectinariidae	*Pectinaria californiensis*	13
	Terebellidae	*Amaeana occidentalis*	9
		Polycirrus californicus	1
		Polycirrus sp I	4
		Polycirrus sp A	62
		Polycirrus sp SD3	4
		Polycirrus sp	60
		Terebellinae	1
		Eupolymnia heterobranchia	4
		Lanassa venusta venusta	89
		Phisidia sanctaemariae	16
		Pista brevibranchiata	11
		Pista estevanica	29
		Pista moorei	1
		Pista wui	74
		Proclea sp A	1
		Thelepodinae	1
		Streblosoma crassibranchia	4
		Streblosoma sp B	12
		Streblosoma sp SF1	3
		Streblosoma sp	3
	Trichobranchidae	*Terebellides californica*	1
		Terebellides sp	1
	Chaetopteridae		1
		Phyllochaetopterus limicolus	1
		Phyllochaetopterus prolifica	11
		Phyllochaetopterus sp	9
		Spiochaetopterus costarum Cmplx	60
	Capitellidae		1
		Anotomastus gordiodes	2
		Capitella teleta	1
		Decamastus sp	1
		Heteromastus filiformis Cmplx	3
		Mediomastus acutus	1
		Mediomastus sp	273
		Notomastus hemipodus	3
		Notomastus latericeus	33
		Notomastus sp	4
	Maldanidae		19
		Euclymeninae	21
		Euclymeninae sp A	33
		Axiothella sp	2
		Clymenella complanata	1
		Clymenella sp A	1
		Clymenura gracilis	4

Appendix B.16 *continued*

Taxon/Species				n
			Petaloclymene pacifica	8
			Praxillella pacifica	21
			Maldane sarsi	3
			Maldane sp	1
			Metasychis disparidentatus	16
			Rhodine bitorquata	1
		Opheliidae	*Armandia brevis*	1
			Ophelia pulchella	8
		Orbiniidae	*Leitoscoloplos pugettensis*	2
			Naineris uncinata	2
			Scoloplos armiger Cmplx	29
			Scoloplos sp	2
		Paraonidae		1
			Aricidea (Acmira) cerrutii	4
			Aricidea (Acmira) horikoshii	1
			Aricidea (Acmira) lopezi	1
			Aricidea (Acmira) simplex	9
			Aricidea (Aricidea) wassi	1
			Aricidea (Strelzovia) antennata	3
			Aricidea (Strelzovia) hartleyi	1
			Cirrophorus furcatus	3
			Levinsenia gracilis	2
			Levinsenia kirbyae	1
			Paradoneis sp SD1	10
		Scalibregmatidae	*Scalibregma californicum*	5
		Travisiidae	*Travisia gigas*	1
			Travisia sp	1
		Saccocirridae	*Saccocirrus* sp	116
	Clitellata			
		Oligochaeta		8
ARTHROPODA				
	Ostracoda			1
		Cylindroleberididae	*Leuroleberis sharpei*	4
			Xenoleberis californica	1
		Philomedidae	*Euphilomedes carcharodonta*	180
		Sarsiellidae	*Eusarsiella thominx*	1
	Malacostraca			
		Nebaliidae	*Nebalia daytoni*	4
			Nebalia pugettensis Cmplx	2
		Mysidae	*Neomysis kadiakensis*	2
		Caprellidae	*Caprella mendax*	1
			Mayerella banksia	1
		Ischyroceridae	*Ericthonius brasiliensis*	25
			Microjassa sp	1
			Notopoma sp A	13
		Kamakidae	*Amphideutopus oculatus*	41
		Photidae	*Ampelisciphotis podophthalma*	20
			Gammaropsis thompsoni	5
			Photis bifurcata	3

Appendix B.16 *continued*

Taxon/Species			n
		Photis brevipes	63
		Photis californica	6
		Photis lacia	2
		Photis sp C	5
		Photis sp OC1	34
		Photis sp	120
	Aoridae	*Aoroides exilis*	5
		Aoroides inermis	6
		Aoroides sp	2
		Bemlos sp	1
	Corophiidae		1
	Megaluropidae	*Gibberosus myersi*	1
		Megaluropidae sp A	1
	Oedicerotidae	*Americhelidium shoemakeri*	18
		Americhelidium sp SD1	15
		Hartmanodes hartmanae	5
		Monoculodes sp	1
		Westwoodilla tone	15
	Eusiridae	*Rhachotropis* sp A	1
	Liljeborgiidae	*Listriella goleta*	10
		Listriella melanica	2
	Pleustidae	*Pleusymtes subglaber*	1
	Stenothoidae		1
		Metopa dawsoni	2
	Melphidippidae	*Melphisana bola* Cmplx	1
	Ampeliscidae	*Ampelisca agassizi*	8
		Ampelisca brachycladus	25
		Ampelisca brevisimulata	97
		Ampelisca cf *brevisimulata*	4
		Ampelisca careyi	7
		Ampelisca cristata cristata	45
		Ampelisca cristata microdentata	225
		Ampelisca hancocki	2
		Ampelisca indentata	5
		Ampelisca pugetica	27
		Ampelisca romigi	1
		Ampelisca sp	16
		Byblis millsi	2
	Synopiidae	*Tiron biocellata*	1
	Argissidae	*Argissa hamatipes*	4
	Platyischnopidae	*Tiburonella viscana*	4
	Phoxocephalidae		2
		Foxiphalus golfensis	2
		Foxiphalus obtusidens	94
		Foxiphalus similis	1
		Foxiphalus sp	2
		Rhepoxynius fatigans	4
		Rhepoxynius heterocuspidatus	66
		Rhepoxynius lucubrans	11

Appendix B.16 *continued*

Taxon/Species				n
			Rhepoxynius menziesi	109
			Rhepoxynius stenodes	18
			Rhepoxynius variatus	1
			Rhepoxynius sp	5
			Cephalophoxoides homilis	3
			Heterophoxus ellisi	1
			Heterophoxus sp	1
		Lysianassoidea		1
		Lysianassidae	*Aruga oculata*	7
		Tryphosidae	*Hippomedon zetesimus*	7
			Hippomedon sp	1
			Lepidepecreum serraculum	1
		Acidostomatidae	*Acidostoma hancocki*	1
		Cirolanidae	*Eurydice caudata*	29
		Gnathiidae	*Caecognathia crenulatifrons*	32
		Anthuridae	*Haliophasma geminata*	2
		Idoteidae	*Edotia sublittoralis*	10
			Synidotea magnifica	3
		Leptocheliidae	*Chondrochelia dubia* Cmplx	58
		Tanaopsidae	*Tanaopsis cadieni*	1
		Bodotriidae	*Cyclaspis nubila*	2
		Nannastacidae	*Campylaspis rubromaculata*	1
			Procampylaspis caenosa	1
		Lampropidae		1
			Hemilamprops californicus	24
		Diastylidae	*Anchicolurus occidentalis*	1
			Diastylis californica	1
			Oxyurostylis pacifica	8
		Caridea		1
		Crangonidae	*Crangon* sp	1
		Callianassidae	*Neotrypaea* sp	1
		Albuneidae	*Lepidopa californica*	1
		Blepharipodidae	*Blepharipoda occidentalis*	1
		Cyclodorippidae	*Deilocerus* sp	1
		Majoidea		2
		Pinnotheridae	*Pinnixa franciscana*	5
			Pinnixa longipes	6
			Pinnixa occidentalis Cmplx	2
			Pinnixa sp	4
NEMATODA				122
ECHINODERMATA				
	Asteroidea			2
		Astropectinidae	*Astropecten californicus*	5
			Astropecten sp	4
	Ophiuroidea			3
		Ophiuridae	*Ophiura luetkenii*	18
		Ophioscolecidae	*Ophiuroconis bispinosa*	6
		Amphiuridae		16
			Amphiodia digitata	1

Appendix B.16 *continued*

Taxon/Species				n
			Amphiodia psara	1
			Amphiodia sp	4
			Amphioplus sp A	4
			Amphioplus sp	1
			Amphipholis squamata	11
		Ophiotrichidae	*Ophiothrix spiculata*	2
	Echinoidea			6
		Toxopneustidae	*Lytechinus pictus*	1
		Dendrasteridae	*Dendraster terminalis*	38
		Spatangoida		1
		Loveniidae	*Lovenia cordiformis*	34
	Holothuroidea			
		Dendrochirotida		1
		Phyllophoridae	Phyllophoridae sp A	1
		Synaptidae	*Leptosynapta* sp	24
		Chiridotidae	*Chiridota* sp	2
PHORONIDA				3
		Phoronidae	*Phoronis* sp SD1	2
			Phoronis sp	8
BRACHIOPODA				
	Lingulata			
		Lingulidae	*Glottidia albida*	38
CHORDATA				
	Enteropneusta			
		Ptychoderidae	*Balanoglossus* sp	9
		Spengeliidae	*Schizocardium* sp	6
		Harrimaniidae	*Saccoglossus* sp	2
	Ascidiacea			
		Styelidae	*Cnemidocarpa rhizopus*	4
		Molgulidae	*Eugyra* sp	1
			Molgula regularis	2
			Molgula sp	1
	Leptocardii			
		Branchiostomatidae	*Branchiostoma californiense*	16

Appendix C

Demersal Fishes and Megabenthic Invertebrates

2018 Raw Data Summaries

PLOO and SBOO Stations

Appendix C.1

Summary taxonomic listing of demersal fish species captured at PLOO trawl stations during winter 2018. Data are total number of fish (n), biomass (BM, wet weight, kg), minimum (Min), maximum (Max), and mean length (standard length, cm). Taxonomic arrangement and scientific names are of Eschmeyer and Herald (1998) and Lawrence et al. (2013).

Taxon/Species			Common Name	n	BM	Length (cm) Min	Max	Mean
RAJIFORMES								
	Rajidae							
		Raja inornata	California Skate[a]	1	0.9	50	50	50
ARGENTINIFORMES								
	Argentinidae							
		Argentina sialis	Pacific Argentine	1	0.1	7	7	7
AULOPIFORMES								
	Synodontidae							
		Synodus lucioceps	California Lizardfish	55	1.5	12	26	18
OPHIDIIFORMES								
	Ophidiidae							
		Chilara taylori	Spotted Cusk-eel	6	0.4	14	17	16
BATRACHOIDIFORMES								
	Batrachoididae							
		Porichthys notatus	Plainfin Midshipman	31	0.6	4	20	12
SCORPAENIFORMES								
	Scorpaenidae							
		Scorpaena guttata	California Scorpionfish	6	0.4	14	18	16
	Sebastidae							
		Sebastes chlorostictus	Greenspotted Rockfish	1	0.1	5	5	5
		Sebastes elongatus	Greenstriped Rockfish	3	0.1	6	7	7
		Sebastes helvomaculatus	Rosethorn Rockfish	3	0.5	7	21	15
		Sebastes hopkinsi	Squarespot Rockfish	27	1.0	7	22	11
		Sebastes miniatus	Vermilion Rockfish	20	1.9	14	21	16
		Sebastes rubrivinctus	Flag Rockfish	2	0.1	4	8	6
		Sebastes saxicola	Stripetail Rockfish	91	0.7	5	10	7
		Sebastes semicinctus	Halfbanded Rockfish	427	6.7	5	17	9
	Hexagrammidae							
		Zaniolepis frenata	Shortspine Combfish	22	0.4	9	15	12
		Zaniolepis latipinnis	Longspine Combfish	42	0.6	7	15	11
	Cottidae							
		Icelinus quadriseriatus	Yellowchin Sculpin	1	0.1	4	4	4
		Icelinus tenuis	Spotfin Sculpin	1	0.1	9	9	9
	Agonidae							
		Xeneretmus latifrons	Blacktip Poacher	1	0.1	14	14	14
PERCIFORMES								
	Embiotocidae							
		Zalembius rosaceus	Pink Seaperch	19	0.5	5	12	8
	Bathymasteridae							
		Rathbunella hypoplecta	Bluebanded Ronquil	1	0.1	17	17	17

[a] Length measured as total length, not standard length (see text)

Appendix C.1 *continued*

Taxon/Species			Common Name	n	BM	Length (cm) Min	Max	Mean
PLEURONECTIFORMES								
	Paralichthyidae							
		Citharichthys sordidus	Pacific Sanddab	1038	16.7	3	26	9
		Citharichthys xanthostigma	Longfin Sanddab	4	0.3	12	15	14
		Hippoglossina stomata	Bigmouth Sole	1	0.1	18	18	18
		Xystreurys liolepis	Fantail Sole	1	0.5	27	27	27
	Pleuronectidae							
		Microstomus pacificus	Dover Sole	91	1.4	8	15	11
		Parophrys vetulus	English Sole	16	1.1	12	25	17
		Pleuronichthys verticalis	Hornyhead Turbot	7	0.4	12	17	14
	Cynoglossidae							
		Symphurus atricaudus	California Tonguefish	15	0.5	10	15	13

Appendix C.2

Summary taxonomic listing of demersal fish species captured at SBOO trawl stations during winter 2018. Data are total number of fish (n), biomass (BM, wet weight, kg), minimum (Min), maximum (Max), and mean length (standard length, cm). Taxonomic arrangement and scientific names are of Eschmeyer and Herald (1998) and Lawrence et al. (2013).

						Length (cm)		
Taxon/Species			Common Name	n	BM	Min	Max	Mean
MYLIOBATIFORMES								
	Urolophidae							
		Urobatis halleri	Round Stingray [a]	4	1.7	18	39	25
AULOPIFORMES								
	Synodontidae							
		Synodus lucioceps	California Lizardfish	911	12.8	9	27	12
OPHIDIIFORMES								
	Ophidiidae							
		Chilara taylori	Spotted Cusk-eel	1	0.1	17	17	17
BATRACHOIDIFORMES								
	Batrachoididae							
		Porichthys myriaster	Specklefin Midshipman	2	0.2	10	11	10
		Porichthys notatus	Plainfin Midshipman	8	0.4	4	7	5
GASTEROSTEIFORMES								
	Syngnathidae							
		Syngnathus spp	Unidentified Pipefish	4	0.4	14	21	17
SCORPAENIFORMES								
	Hexagrammidae							
		Zaniolepis latipinnis	Longspine Combfish	3	0.1	13	15	14
	Cottidae							
		Chitonotus pugetensis	Roughback Sculpin	5	0.2	6	8	7
PEFCIFORMES								
	Sciaenidae							
		Seriphus politus	Queenfish	1	0.1	17	17	17
	Embiotocidae							
		Cymatogaster aggregata	Shiner Perch	1	0.1	8	8	8
	Clinidae							
		Heterostichus rostratus	Giant Kelpfish	2	0.1	12	13	12
PLEURONECTIFORMES								
	Paralichthyidae							
		Citharichthys sordidus	Pacific Sanddab	1	0.1	5	5	5
		Citharichthys stigmaeus	Speckled Sanddab	491	6.4	5	12	8
		Citharichthys xanthostigma	Longfin Sanddab	108	3.4	6	17	10
		Paralichthys californicus	California Halibut	12	4.9	23	40	27
		Xystreurys liolepis	Fantail Sole	5	1.3	17	21	20
	Pleuronectidae							
		Pleuronichthys ritteri	Spotted Turbot	1	0.7	17	17	17
		Pleuronichthys verticalis	Hornyhead Turbot	11	1.2	6	20	10
	Cynoglossidae							
		Symphurus atricaudus	California Tonguefish	51	1.3	7	14	11

[a] Length measured as total length, not standard length (see text)

Appendix C.3

Total abundance by species and station for demersal fish collected at PLOO trawl stations during winter 2018.

	Winter 2018						
Species	**SD7**	**SD8**	**SD10**	**SD12**	**SD13**	**SD14**	**Species Abundance by Survey**
Pacific Sanddab	150	199	205	184	145	155	1038
Halfbanded Rockfish	28	298				101	427
Stripetail Rockfish	11	58	14	2	2	4	91
Dover Sole	10	25	34	15	1	6	91
California Lizardfish	7	8	6	7	18	9	55
Longspine Combfish	4	3	21	3	3	8	42
Plainfin Midshipman	12	4	3	7	2	3	31
Squarespot Rockfish		7				20	27
Shortspine Combfish	5	9			3	5	22
Vermilion Rockfish						20	20
Pink Seaperch	4	9	1		1	4	19
English Sole	1	4	2	2	5	2	16
California Tonguefish	3	7	3	1		1	15
Hornyhead Turbot	1			3	1	2	7
Spotted Cusk-eel		1	3	1	1		6
California Scorpionfish		2		1	1	2	6
Longfin Sanddab	1			1	2		4
Rosethorn Rockfish				1		2	3
Greenstriped Rockfish		3					3
Flag Rockfish		2					2
Yellowchin Sculpin	1						1
Spotfin Sculpin	1						1
Pacific Argentine	1						1
Greenspotted Rockfish		1					1
Fantail Sole					1		1
California Skate				1			1
Bluebanded Ronquil		1					1
Blacktip Poacher		1					1
Bigmouth Sole					1		1
Annual Total	240	642	292	229	187	344	1934

Appendix C.4

Total abundance by species and station for demersal fish collected at SBOO trawl stations during winter 2018.

Species	Winter 2018							Species Abundance by Survey
	SD15	SD16	SD17	SD18	SD19	SD20	SD21	
California Lizardfish	13	254	381	92	114	35	22	911
Speckled Sanddab	21	26	40	62	130	130	82	491
Longfin Sanddab			42	38	13	7	8	108
California Tonguefish		2	13	7	19	5	5	51
California Halibut				2		3	7	12
Hornyhead Turbot	2			2	2	1	4	11
Plainfin Midshipman	1		5	1	1			8
Roughback Sculpin			4			1		5
Fantail Sole				3	1		1	5
Round Stingray	1						3	4
Unidentified Pipefish	1	1			1		1	4
Longspine Combfish			3					3
Specklefin Midshipman			1				1	2
Giant Kelpfish							2	2
Spotted Turbot				1				1
Spotted Cusk-eel			1					1
Shiner Perch							1	1
Queenfish			1					1
Pacific Sanddab			1					1
Annual Total	39	283	492	208	281	182	137	1622

Appendix C.5

Biomass (kg) by species and station for demersal fish collected at PLOO trawl stations during winter 2018.

	Winter 2018						
Species	SD7	SD8	SD10	SD12	SD13	SD14	Species Biomass by Survey
Pacific Sanddab	1.9	1.7	3.7	3.4	3.3	2.7	16.7
Halfbanded Rockfish	0.1	2.2				4.4	6.7
Vermilion Rockfish						1.9	1.9
California Lizardfish	0.2	0.2	0.1	0.1	0.8	0.1	1.5
Dover Sole	0.1	0.2	0.8	0.1	0.1	0.1	1.4
English Sole	0.1	0.1	0.1	0.1	0.3	0.4	1.1
Squarespot Rockfish		0.1				0.9	1.0
California Skate				0.9			0.9
Stripetail Rockfish	0.1	0.2	0.1	0.1	0.1	0.1	0.7
Plainfin Midshipman	0.1	0.1	0.1	0.1	0.1	0.1	0.6
Longspine Combfish	0.1	0.1	0.1	0.1	0.1	0.1	0.6
Rosethorn Rockfish				0.1		0.4	0.5
Pink Seaperch	0.1	0.1	0.1		0.1	0.1	0.5
Fantail Sole					0.5		0.5
California Tonguefish	0.1	0.1	0.1	0.1		0.1	0.5
Spotted Cusk-eel		0.1	0.1	0.1	0.1		0.4
Shortspine Combfish	0.1	0.1			0.1	0.1	0.4
Hornyhead Turbot	0.1			0.1	0.1	0.1	0.4
California Scorpionfish		0.1		0.1	0.1	0.1	0.4
Longfin Sanddab	0.1			0.1	0.1		0.3
Yellowchin Sculpin	0.1						0.1
Spotfin Sculpin	0.1						0.1
Pacific Argentine	0.1						0.1
Greenstriped Rockfish		0.1					0.1
Greenspotted Rockfish		0.1					0.1
Flag Rockfish		0.1					0.1
Bluebanded Ronquil		0.1					0.1
Blacktip Poacher		0.1					0.1
Bigmouth Sole					0.1		0.1
Annual Total	3.5	5.9	5.3	5.5	6.0	11.7	37.9

Appendix C.6

Biomass (kg) by species and station for demersal fish collected at SBOO trawl stations during winter 2018.

Name	Winter 2018							Species Biomass by Survey
	SD15	SD16	SD17	SD18	SD19	SD20	SD21	
California Lizardfish	0.2	3.6	4.9	2.1	1.4	0.3	0.3	12.8
Speckled Sanddab	0.3	1.0	1.0	1.1	1.1	1.3	0.6	6.4
California Halibut				1.3		1.6	2.0	4.9
Longfin Sanddab			1.1	1.4	0.7	0.1	0.1	3.4
Round Stingray	1.4						0.3	1.7
Fantail Sole				1.0	0.2		0.1	1.3
California Tonguefish		0.1	0.1	0.8	0.1	0.1	0.1	1.3
Hornyhead Turbot	0.1			0.8	0.1	0.1	0.1	1.2
Spotted Turbot				0.7				0.7
Plainfin Midshipman	0.1		0.1	0.1	0.1			0.4
Unidentified Pipefish	0.1	0.1			0.1		0.1	0.4
Specklefin Midshipman			0.1				0.1	0.2
Roughback Sculpin			0.1			0.1		0.2
Spotted Cusk-eel			0.1					0.1
Shiner Perch							0.1	0.1
Queenfish			0.1					0.1
Pacific Sanddab			0.1					0.1
Longspine Combfish			0.1					0.1
Giant Kelpfish							0.1	0.1
Annual Total	2.2	4.8	7.8	9.3	3.8	3.6	4.0	35.5

Appendix C.7

Summary of demersal fish abnormalities and parasites at trawl stations sampled during winter 2018. PE = eye parasite; T = tumor; L = lesion.

Region	Survey	Station	Species	Size Class	Count	Type	Abnormalities/Parasite
PLOO	Winter	SD7	Pacific Sanddab	8	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD8	Pacific Sanddab	6	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD10	Pacific Sanddab	15	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD10	Pacific Sanddab	10	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD10	Pacific Sanddab	8	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD10	Pacific Sanddab	12	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD10	Pacific Sanddab	11	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD10	Dover Sole	13	1	T	Tumor, ventral side
PLOO	Winter	SD12	Pacific Sanddab	6	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD12	Pacific Sanddab	9	5	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD12	Pacific Sanddab	7	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD12	Pacific Sanddab	12	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD12	Pacific Sanddab	8	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD13	Pacific Sanddab	13	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD13	Pacific Sanddab	10	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD13	Pacific Sanddab	8	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD13	Pacific Sanddab	9	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD13	Pacific Sanddab	12	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD14	Pacific Sanddab	6	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD14	Pacific Sanddab	7	1	PE	*Phrixocephalus cininnatus*
PLOO	Winter	SD14	Dover Sole	10	1	T/L	Tumor and Lesion, ventral side

An additional 70 external parasites - *Elthusa vulgaris* were identified as part of invertebrate trawl catches during this annual survey; see Appendices D.8 and D.9.

Appendix C.8

Summary taxonomic listing of megabenthic invertebrate taxa captured at PLOO trawl stations during winter 2018. Data are number of individuals (n). Taxonomic arrangement from SCAMIT (2014).

Taxon/Species				n
SILICEA				
	Demospongiae			
		Suberitidae	*Suberites latus*	1
CNIDARIA				
	Anthozoa			
		Gorgoniidae	*Adelogorgia phyllosclera*	2
		Metridiidae	*Metridium farcimen*	1
MOLLUSCA				
	Gastropoda			
		Naticidae	*Neverita draconis*	1
		Pleurobranchidae	*Pleurobranchaea californica*	1
	Cephalopoda			
		Loliginidae	*Doryteuthis opalescens*	1
		Octopodidae	*Octopus rubescens*	2
ARTHROPODA				
	Malacostraca			
		Cymothoidae	*Elthusa vulgaris*	44
		Sicyoniidae	*Sicyonia ingentis*	9
			Sicyonia penicillata	13
		Crangonidae	*Crangon alaskensis*	35
		Paguridae	*Parapagurodes laurentae*	1
		Calappidae	*Platymera gaudichaudii*	7
		Pilumnoididae	*Pilumnoides rotundus*	1
ECHINODERMATA				
	Asteroidea			
		Luidiidae	*Luidia asthenosoma*	2
			Luidia foliolata	1
		Astropectinidae	*Astropecten californicus*	4
	Ophiuroidea			
		Ophiotricidae	*Ophiothrix spiculata*	1
		Ophiocomidae	*Ophiopteris papillosa*	1
	Echinoidea			
		Toxopneustidae	*Lytechinus pictus*	1730
	Holothuroidea			
		Stichopodidae	*Apostichopus californicus*	6

Appendix C.9

Summary taxonomic listing of megabenthic invertebrate taxa captured at SBOO trawl stations during winter 2018. Data are number of individuals (n). Taxonomic arrangement from SCAMIT (2014).

Taxon/Species				n
MOLLUSCA				
	Gastropoda			
		Naticidae	*Neverita recluziana*	1
		Velutinidae	*Lamellaria diegoensis*	1
		Buccinidae	*Kelletia kelletii*	5
		Nassariidae	*Caesia perpinguis*	1
		Philinidae	*Philine auriformis*	116
		Pleurobranchidae	*Pleurobranchaea californica*	6
		Polyceridae	*Triopha maculata*	1
	Cephalopoda			
		Octopodidae	*Octopus rubescens*	3
ANNELIDA				
	Polychaeta			
		Aphroditidae	*Aphrodita armifera*	1
ARTHROPODA				
	Malacostraca			
		Cymothoidae	*Elthusa vulgaris*	26
		Sicyoniidae	*Sicyonia penicillata*	28
		Hippolytidae	*Heptacarpus palpator*	2
		Crangonidae	*Crangon alba*	5
			Crangon nigromaculata	15
		Epialtidae	*Pugettia dalli*	3
			Pugettia producta	3
		Inachidae	*Ericerodes hemphillii*	1
		Parthenopidae	*Latulambrus occidentalis*	1
		Cancridae	*Metacarcinus anthonyi*	3
		Portunidae	*Portunus xantusii*	8
ECHINODERMATA				
	Asteroidea			
		Astropectinidae	*Astropecten californicus*	20
	Ophiuroidea			
		Ophiotricidae	*Ophiothrix spiculata*	30
	Echinoidea			
		Toxopneustidae	*Lytechinus pictus*	31
		Dendrasteridae	*Dendraster terminalis*	14
		Loveniidae	*Lovenia cordiformis*	5

Appendix C.10

Total abundance by species and station for megabenthic invertebrates captured at PLOO trawl stations during winter 2018.

Species	Winter 2018						Species Abundance by Survey
	SD7	SD8	SD10	SD12	SD13	SD14	
Lytechinus pictus	285	1211	25	150	55	4	1730
Elthusa vulgaris		2	7	13	14	8	44
Crangon alaskensis	2	4	6	16	6	1	35
Sicyonia penicillata	10					3	13
Sicyonia ingentis	4				3	2	9
Platymera gaudichaudii			3	3	1		7
Apostichopus californicus		4	1		1		6
Astropecten californicus		3				1	4
Octopus rubescens	1		1				2
Luidia asthenosoma		2					2
Adelogorgia phyllosclera		2					2
Suberites latus		1					1
Pleurobranchaea californica					1		1
Pilumnoides rotundus		1					1
Parapagurodes laurentae		1					1
Ophiothrix spiculata					1		1
Ophiopteris papillosa		1					1
Metridium farcimen						1	1
Luidia foliolata						1	1
Neverita draconis				1			1
Doryteuthis opalescens						1	1
AnnualTotal	302	1232	43	183	82	22	1864

Appendix C.11

Total abundance by species and station for megabenthic invertebrates captured at SBOO trawl stations during winter 2018.

	Winter 2018							
Species	**SD15**	**SD16**	**SD17**	**SD18**	**SD19**	**SD20**	**SD21**	**Species Abundance by Survey**
Philine auriformis	60	13	19	13	11			116
Lytechinus pictus	10	5	5	11				31
Ophiothrix spiculata	1	26		3				30
Sicyonia penicillata		2	7	2	1		16	28
Elthusa vulgaris		2	3	4	5	9	3	26
Astropecten californicus	8	3			8		1	20
Crangon nigromaculata	4	3	1	3	2	1	1	15
Dendraster terminalis	14							14
Portunus xantusii	4		3				1	8
Pleurobranchaea californica	1			1	1	3		6
Lovenia cordiformis	5							5
Kelletia kelletii			1		3		1	5
Crangon alba	5							5
Pugettia producta							3	3
Pugettia dalli						1	2	3
Octopus rubescens				3				3
Metacarcinus anthonyi			1		1		1	3
Heptacarpus palpator		2						2
Triopha maculata							1	1
Latulambrus occidentalis		1						1
Lamellaria diegoensis			1					1
Neverita recluziana	1							1
Ericerodes hemphillii		1						1
Caesia perpinguis	1							1
Aphrodita armifera		1						1
Annual Total	114	59	41	40	32	14	30	330