THE CITY OF SAN DIEGO

Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall 2002

Ocean Monitoring Program

Metropolitan Wastewater Department

Environmental Monitoring and Technical Services Division

THE CITY OF SAN DIEGO

July 1, 2003

Mr. John Robertus
Executive Officer
Regional Water Quality Control Board
San Diego Region
9771 Clairemont Mesa Blvd. Suite B
San Diego, CA 92124

Attention: POTW Compliance Unit

Dear Sir:

Enclosed is the 2002 Annual Receiving Waters Monitoring Report for NPDES Permit No. CA0107409, Order No. R9-2002-0025 for the City of San Diego Point Loma Wastewater Treatment Plant, Point Loma Ocean Outfall. This report contains data summaries and statistical analyses for the various portions of the ocean monitoring program, including oceanographic conditions, microbiology, sediment characteristics, benthic infauna, demersal fishes and megabenthic invertebrates, and bioaccumulation of contaminants in fish tissues.

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 information, I certify that 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,

ALAN C. LANGWORTHY
Deputy Metropolitan Wastewater Director

dp
Enclosure

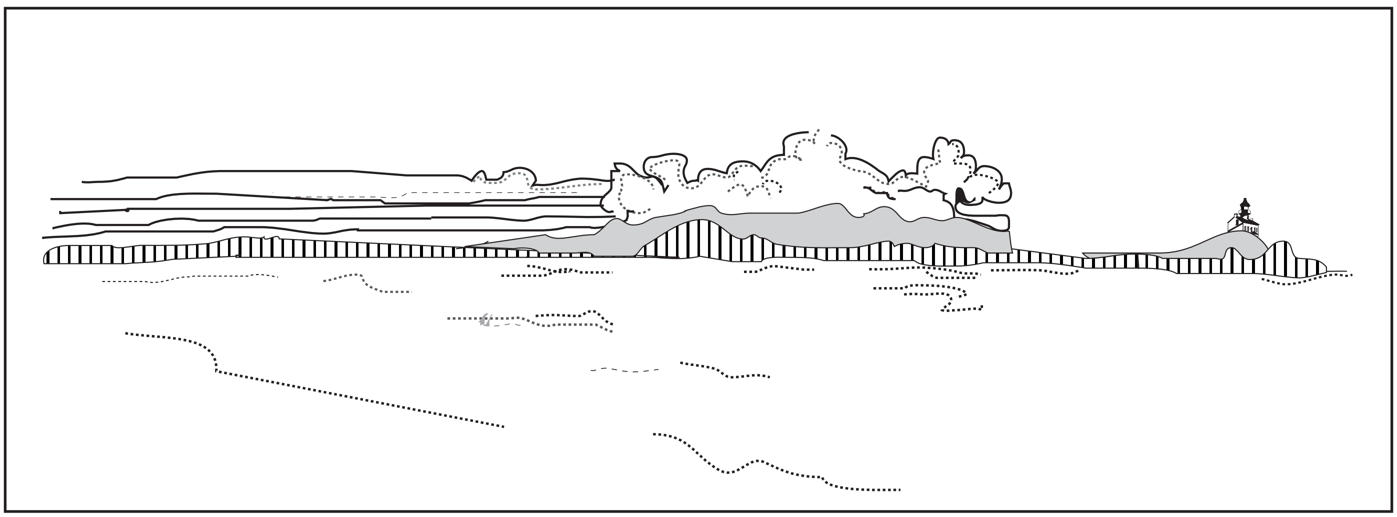
cc: U.S. Environmental Protection Agency, Region 9
State Water Resources Control Board
Department of Health Services, San Diego County

DIVERSITY BRINGS US ALL TOGETHER

Environmental Monitoring and Technical Services Division • Metropolitan Wastewater
4918 North Harbor Drive, Suite 201 • San Diego, CA 92106-2359
Tel (619) 758-2300 Fax (619) 758-2309

The City of San Diego

Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall 2002



Prepared by:

The City of San Diego

Ocean Monitoring Program

Metropolitan Wastewater Department

Environmental Monitoring and Technical Services Division

June 2003

Table of Contents

Table of Contents continued

APPENDICES

Credits and Acknowledgments

CITY OF SAN DIEGO
ANNUAL RECEIVING WATERS MONITORING REPORT
FOR THE POINT LOMA OCEAN OUTFALL
2002

Technical Editor
Dean Pasko

Production Editors
Judes Brooks Dean Pasko

Graphics
Dawn Olson Diane O'Donohue

Executive Summary
Dean Pasko

Chapter 1. General Introduction
Dean Pasko

Chapter 2. Oceanographic Conditions
Dawn Olson

Chapter 3. Microbiology
Dawn Olson Diane O'Donohue

Chapter 4. Sediment Characteristics
Daniel Ituarte

Chapter 5. Benthic Infauna
Eric Nestler

Chapter 6. Demersal Fishes & Megabenthic Invertebrates
Ami Groce Robin Gartman

Chapter 7. Bioaccumulation of Contaminants in Fish Tissues
Ami Groce

Acknowledgments: We are grateful to the personnel of the City's Marine Biology Laboratory for their assistance in the collection and processing of all samples and for discussions of the results. The completion of this report would not have been possible without their continued efforts and contributions. We would also like to acknowledge the City's Microbiology and Chemistry laboratories for providing the bacteriological and chemistry data analyzed herein. Reviews of the various chapters were provided by J. Byrne, R. Duggan, A. Feit, R. Gartman, A. Groce, D. Ituarte, D. James, M. Lilly, E. Nester, L. Othman, R. Rowe, T. Stebbins, W. Storms, and R. Velarde.

Cover: Fishing boats at Driscoll's Wharf, by Daniel Ituarte.

CITY OF SAN DIEGO OCEAN MONITORING PROGRAM

Alan C. Langworthy
Deputy Metropolitan Wastewater Director
Environmental Monitoring and Technical Services Division

Marine Biology & Ocean Operations

Timothy Stebbins
Senior Marine Biologist

Kelvin Barwick
John Byrne
Robin Gartman
Daniel Ituarte
Kathy Langan-Cranford
Ricardo Martinez-Lara
Diane O'Donohue
Rick Rowe
Ron Velarde
Calvin Baugh
Ross Duggan
Ami Groce
David James
Megan Lilly
Rhonda Nesby
Dawn Olson
Jack Russell
Lan Wiborg
Judes Brooks
Adriano Feit
David Gutoff
Michael Kelly
Richard Mange
Eric Nestler
Dean Pasko
Wendy Storms

Marine Microbiology / Vector Management

Ric Amador
Senior Biologist

George Alfonso
Jason Edwards
Nester Malibago
Sonji Romero
Zakee Shabazz
Toby Brown
Christopher Greeff
Laila Othman
David Straup
Roxanne Davis
Andre Macedo
Zaira Rodriguez
Joseph Toctocan

Executive Summary

Executive Summary

The City of San Diego ocean monitoring program for the Point Loma Wastewater Treatment Plant (PLWTP) is mandated by NPDES Permit No. CA0107409, Order No. R9-2002-0025 issued by the San Diego Regional Water Quality Control Board (RWQCB) and the United States Environmental Protection Agency (USEPA). These documents specify the terms and conditions that allow treated effluent to be discharged into the Pacific Ocean via the Point Loma Ocean Outfall (PLOO). In addition, Monitoring and Reporting Program No. R9-2002-0025 contained within the above Order defines the requirements for monitoring the receiving waters surrounding the PLOO, including the sampling plan, compliance criteria, laboratory analyses, statistical analyses and reporting guidelines.

The City's ocean monitoring program for the PLWTP is designed to assess the impact of wastewater discharged through the PLOO on the marine environment off San Diego. The main objectives of the program are to provide data that satisfy the requirements of the NPDES permit, demonstrate compliance with the 2001 California Ocean Plan, track movement and dispersion of the wastewater field, and identify any biological or chemical changes that may be associated with the discharge of wastewater. These data are used to document the effects of the discharge on water quality, sediments, and the marine biota. The study area off Point Loma is centered around the discharge site, which is located approximately 7.2 km offshore of the treatment plant at depths of around 94-98 m. Shoreline monitoring extends from Ocean Beach to Imperial Beach. Offshore monitoring is conducted in an area overlying the coastal shelf from La Jolla to Imperial Beach, and ranging from the 9-m depth contour seaward to depths of about 116 m.

The City's receiving monitoring efforts may be divided into several major components, which comprise separate chapters in this report. These include analyses of oceanographic conditions, microbiology, sediment quality, benthic infauna, demersal fish and invertebrate communities, and the bioaccumulation of contaminants by fishes. Data regarding various physical and chemical oceanographic parameters are evaluated to characterize water mass transport potential in the region. The microbiology portion of the program includes sampling at sites along the shoreline and in the adjacent offshore waters to detect and monitor various indicators of the wastewater plume. Benthic monitoring includes sampling and analyses of soft-bottom infaunal communities and their associated sediments, while demersal fish and megabenthic invertebrate communities are the focus of trawling activities. The monitoring of fish populations is supplemented by bioaccumulation analyses to determine whether or not contaminants are present in the tissues of "local" fish species. In addition to the above activities, the City also supports other projects that are relevant to assessing ocean quality in the region. Summary reports for two of these projects are included in Appendices E and F. Appendix E describes the coastal remote sensing study of the San Diego/ Tijuana region that is jointly funded by the City, the RWQCB and the International Boundary and Water Commission. Appendix F presents a summary report of the long-term and ongoing City funded study of the Point Loma kelp forest that is being conducted by scientists at the Scripps Institution of Oceanography. A general overview and a brief summary for each of the receiving waters monitoring components are included below.

After nine years of wastewater discharge, the evidence indicates that the PLOO has had only a limited effect on the local marine environment. For example, water samples collected in the Point Loma kelp bed have been 100% compliant with California Ocean Plan bacterial water-contact standards ever since the outfall was extended in 1993. In addition, there has been no evidence that the waste field has affected any of the shoreline areas that are monitored during this time. Elevated bacterial concentrations that may be attributable to the discharge of wastewater in 2002 were generally restricted to sites adjacent to the outfall and to subsurface depths of 40 m or below. There has also been no detected change in any physical or chemical water quality parameter (e.g., dissolved oxygen, pH) that could be attributed to wastewater discharge.

Analysis of benthic conditions indicates that some types of changes that may be expected near an ocean outfall have occurred off Point Loma, although these have been restricted to a relatively small, localized region near the discharge site. Such changes include increases over time in sediment concentrations of sulfides and BOD, and the accumulation of coarse sediment particles in the vicinity of the outfall pipe. Differences between reference and near-ZID stations with respect to certain descriptors of benthic community structure (i.e., species diversity, infaunal abundance, populations of the brittle star *Amphiodia urtica* and ITI values) were also indicative of changed conditions near the outfall. However, values for most of these parameters were still characteristic of natural environmental conditions. Other potential indicators of impact such as abundances of pollution-sensitive amphipods (small shrimp-like crustaceans) and concentrations of various sediment contaminants such as trace metals and pesticides, have shown no effects that may be related to the discharge of wastewater. Consequently, there is presently no evidence of significant long-term impacts on sediment quality or benthic infaunal communities in the region. Furthermore, analyses of demersal fish and invertebrate communities also reveal no spatial or temporal patterns that can be attributed to the PLOO. The lack of evidence from an analysis of fish pathology (e.g., fin rot, tumors, and lesions) or bioaccumulation studies also indicate that the San Diego fish community remains healthy and is not adversely affected by anthropogenic sources.

General Introduction

Chapter 1: General Introduction

INTRODUCTION

Treated effluent from the City of San Diego Point Loma Wastewater Treatment Plant (PLWTP) is discharged to the Pacific Ocean through the Point Loma Ocean Outfall (PLOO) under the terms and conditions set forth in Order No. R9-2002-0025, National Pollutant Discharge Elimination System (NPDES) Permit No. CA0107409. This Order was adopted on April 10, 2002 by the California Regional Water Quality Control Board (RWQCB), San Diego Region, in conjunction with the United States Environmental Protection Agency (USEPA). Monitoring and Reporting Program No. R9-2002-0025 contained within the above Order defines the requirements for monitoring the receiving water environment around the PLOO, including the sampling plan, compliance criteria, laboratory analyses, statistical analyses and reporting guidelines.

The City's Ocean Monitoring Program is based on the NPDES permit requirements and is designed to monitor and assess the impact of wastewater discharged through the PLOO on the marine environment. The major objectives of the program are to provide data that satisfy the requirements of the permit, demonstrate compliance with the California Ocean Plan, detect movement and dispersion of the wastewater field, and identify any biological or chemical changes associated with wastewater discharge.

BACKGROUND

The City of San Diego began operation of the wastewater treatment plant and original ocean outfall off Point Loma in 1963, at which time treated effluent was discharged approximately 3.9 km offshore at a depth of about 60 m (200 ft). From 1963 to 1985, the PLWTP operated as a primary treatment facility, removing approximately 60% of the total suspended solids (TSS) by gravity separation. Since then, considerable improvements have been made to the treatment process. For example, the City began upgrading the process to advanced primary treatment (APT) in mid-1985, with full APT status being achieved by July of 1986. This improvement involved the addition of chemical coagulation to the treatment process, and resulted in an increased TSS removal of about 75%. Since 1986, treatment has been further enhanced with the addition of several more sedimentation basins, expanded aerated grit removal, and refinements in chemical treatment. These enhancements have resulted in consistently lower mass emissions from the plant, with TSS removals of greater than 80%. In addition, the PLOO was extended 3.3 km further offshore in the early 1990s in order to prevent intrusion of the wastewater plume into nearshore waters and comply with California Ocean Plan water contact sports standards. Construction of the outfall extension was completed in November 1993 at which time discharge was terminated at the original site. The outfall presently extends approximately 7.2 km offshore to a depth of 94 m (310 ft), where the pipeline splits into a Y-shaped 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 (320 ft) near the edge of the continental shelf.

The average daily flow of effluent through the PLOO in 2002 was 169 million gallons per day (MGD), ranging from a minimum of 155 MGD to a maximum of 189 MGD. This represents a decrease of 3.4% from the average flow of 175 MGD during 2001. TSS removal averaged about 85% during 2002 (see City of San Diego 2003b).

RECEIVING WATERS MONITORING

Prior to 1994, the City conducted an extensive ocean monitoring program around the original PLOO discharge site. This program was subsequently modified and expanded with the construction and operation of the deeper outfall. Data from the last year of regular monitoring near the original inshore site are presented in City of San Diego (1995b), while the results of a three-year recovery study for that area are summarized in City of San Diego (1998). From 1991 through 1993, the City also conducted a voluntary predischarge study in the vicinity of the new site in order to collect baseline data prior to the discharge of effluent in these deeper waters (City of San Diego 1995a, 1995b). Results of monitoring for the extended PLOO from 1994 through 2001 are available in previous monitoring reports (e.g., City of San Diego 2002b). Additionally, the City has participated in a number of regional and other monitoring efforts throughout the Southern California Bight that have provided useful background information for the entire region (e.g., SCBPP 1998, City of San Diego 1999, 2000, 2001, 2002a, Bight'98 Steering Committee 2003).

The PLOO sampling area presently extends from La Jolla southward to Imperial Beach, and from the shoreline seaward to a depth of about 116 m (380 ft). Fixed sites are arranged in a grid surrounding the outfall, and are monitored in accordance with a prescribed sampling schedule. The monitoring program may be divided into the following major components, each comprising a separate chapter in this report: (1) Oceanographic Conditions; (2) Microbiology; (3) Sediment Characteristics; (4) Benthic Infauna; (5) Demersal Fishes and Megabenthic Invertebrates; (6) Bioaccumulation of Contaminants in Fish Tissues. Sampling includes monthly seawater measurements of conditions in the area. Benthic sediment samples are collected quarterly to monitor changes in infaunal macroinvertebrate communities and sediment conditions (e.g., sediment grain size and chemistry). Trawl surveys are conducted quarterly at eight offshore stations and semiannually at several inshore stations in order to describe communities of demersal fish and large, bottom-dwelling invertebrates in the region. Additionally, liver and muscle tissue samples are collected from selected species of fish and analyzed to document the bioaccumulation of chemical constituents that may have ecological or human health implications.

In addition to the above monitoring activities, the City actively supports other projects relevant to assessing ocean quality in the region. Appendix E describes the continuing coastal remote sensing study of the San Diego/Tijuana Region that is funded by the City in collaboration with the RWQCB and the International Boundary and Water Commission. The City has also provided long-term support to the Scripps Institution of Oceanography (SIO) to monitor the health of the kelp forest off Point Loma. A summary report of this project entitled "Stability of the Point Loma Kelp Forest" and prepared by Paul Dayton, Kristin Riser and Ignacio Vilchis of SIO is presented in Appendix F.

This report presents the results of all PLOO monitoring conducted from January through December 2002. In addition, comparisons are made to previous years in order to examine long-term patterns of change in the region. The raw data, detailed methodologies, and other pertinent information are compiled in reports that are submitted to the USEPA and the RWQCB throughout the year. These include monthly receiving waters and outfall monitoring reports. Detailed information concerning station locations, sampling equipment, analytical techniques and quality assurance procedures are included in annual Quality Assurance Manuals for the City's Ocean Monitoring Program (e.g., City of San Diego 2003a).

LITERATURE CITED

Bight'98 Steering Committee. (2003). Southern California Bight 1998 Regional Monitoring Program: Executive Summary. Southern California Coastal Water Research Project, Westminster, CA.

City of San Diego. (1995a). Outfall Extension Pre-Construction Monitoring Report, July 1991 – October 1992. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (1995b). Receiving Waters Monitoring Report for 1994. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental

Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (1998). Recovery Stations Monitoring Report for the Original Point Loma Ocean Outfall (1991-1996). City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (1999). San Diego Regional Monitoring Report for 1994 – 1997. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2000). International Wastewater Treatment Plant Final Baseline Ocean Monitoring Report for South Bay Ocean Outfall (1995-1998). City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2001). Annual Receiving Waters Monitoring Report for the South Bay Ocean Outfall (2000). City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2002a). Annual Receiving Waters Monitoring Report for the South Bay Ocean Outfall (2001). City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

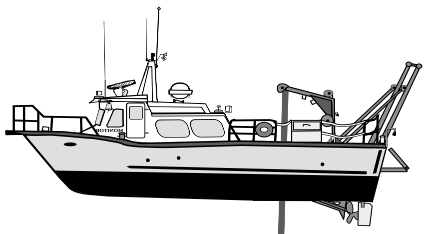
City of San Diego. (2002b). Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, (2001). City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2003a). 2002 Quality Assurance Manual. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

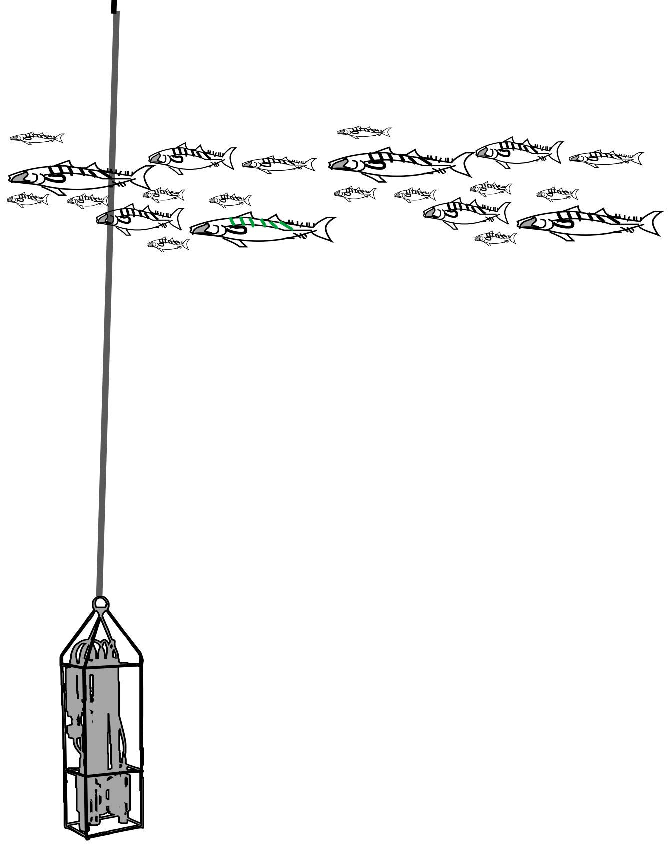
City of San Diego. (2003b). Point Loma Ocean Outfall Annual Monitoring Report for 2002. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

SCBPP (Southern California Bight Pilot Project). (1998). Southern California Bight Pilot Project Reports: Volume I. Executive Summary; Volume II. Water Quality; Volume III. Sediment Chemistry; Volume IV. Benthic Infauna; Volume V. Demersal Fishes and Megabenthic Invertebrates; Volume VI. Sediment Toxicity. Southern California Coastal Water Research Project, Westminster, CA.

This page intentionally left blank



Oceanographic Conditions



Chapter 2. Oceanographic Conditions

INTRODUCTION

Measurements of physical and chemical parameters such as temperature, salinity, density, dissolved oxygen, etc. are important components of a discharge monitoring program because many of these properties determine water column mixing potential. Analysis of temporal and spatial variability of these parameters can also elucidate water mass movement. Moreover, these measurements help determine: (1) deviations from expected patterns that may indicate influence of the wastewater plume from the outfall, and (2) the extent to which water mass movement or mixing reflects the dispersion/dilution potential for discharged material. With a deep offshore discharge, the fate of sewage-influenced waters is strongly determined by horizontal mixing through diffusion, currents and internal waves as well as vertical mixing through diffusion, upwelling, or storm events. Oceanographic properties of the water column influence the degree of stratification and therefore measurements of physical parameters can characterize the vertical transport potential surrounding the Point Loma Ocean Outfall (PLOO) throughout the year. On the other hand, in the absence of deepwater current information, bacterial concentrations may provide the best indication of horizontal transport of discharge waters (see Chapter 3).

Water quality in the marine environment surrounding the Point Loma Ocean Outfall (PLOO) is naturally variable but is also subjected to anthropogenic and natural sources of contamination such as discharge from the Point Loma Wastewater Treatment Plant (PLWTP), San Diego and Mission Bays, and the San Diego River. To assess possible impacts from the outfall discharge, the City of San Diego regularly monitors oceanographic conditions of the water column. This chapter contributes to the investigation of PLOO impacts on the marine environment by analyzing the oceanographic conditions that were present during 2002. Knowledge of water column conditions are important to understanding patterns of bacteriological occurrence (see Chapter 3).

MATERIALS & METHODS

Field Sampling

Oceanographic measurements were collected by lowering a SeaBird conductivity, temperature and depth (CTD) instrument through the water column at each of 49 fixed stations (see **Figure 2.1**). These offshore stations were located in a grid pattern surrounding the outfall, along the 9, 18, 47, 60, 88, 98, and 116-m depth contours. Forty-one stations are in open-water from 1.5 km to12.9 km offshore. The remaining eight stations lie within the Point Loma kelp beds and range between 0.5 and 1.8 km offshore. Three of the kelp stations (C-4, C-5, and C-6) are along the 9-m contour at the inner edge of the kelp bed while the other five stations (A-1, A-6, A-7, C-7, and C-8) are located along the 18-m contour on the outer edge of the bed.

All 49 stations were sampled at least once each month by CTD, usually over a three-day period. Profiles of temperature, salinity, density, pH, transmissivity (water clarity), chlorophyll *a*, and dissolved oxygen values were constructed for each station by averaging the values recorded over 1 m depth intervals during data processing. Further details regarding the CTD data processing are provided in the City's Quality Assurance Manual (City of San Diego 2003). CTD casts for temperature and transmissivity only were conducted at kelp stations four additional times (i.e., for a total of five times) each month in order to meet the California Ocean Plan sampling frequency requirements for kelp bed areas. Three other offshore sites (A-11, A-13, and A-17) were also sampled in conjunction with kelp stations as an on-going study in response to a previous spill event. Visual observations of water color and clarity, surf height, human or animal activity, and weather conditions were also recorded at the time of sample collection.

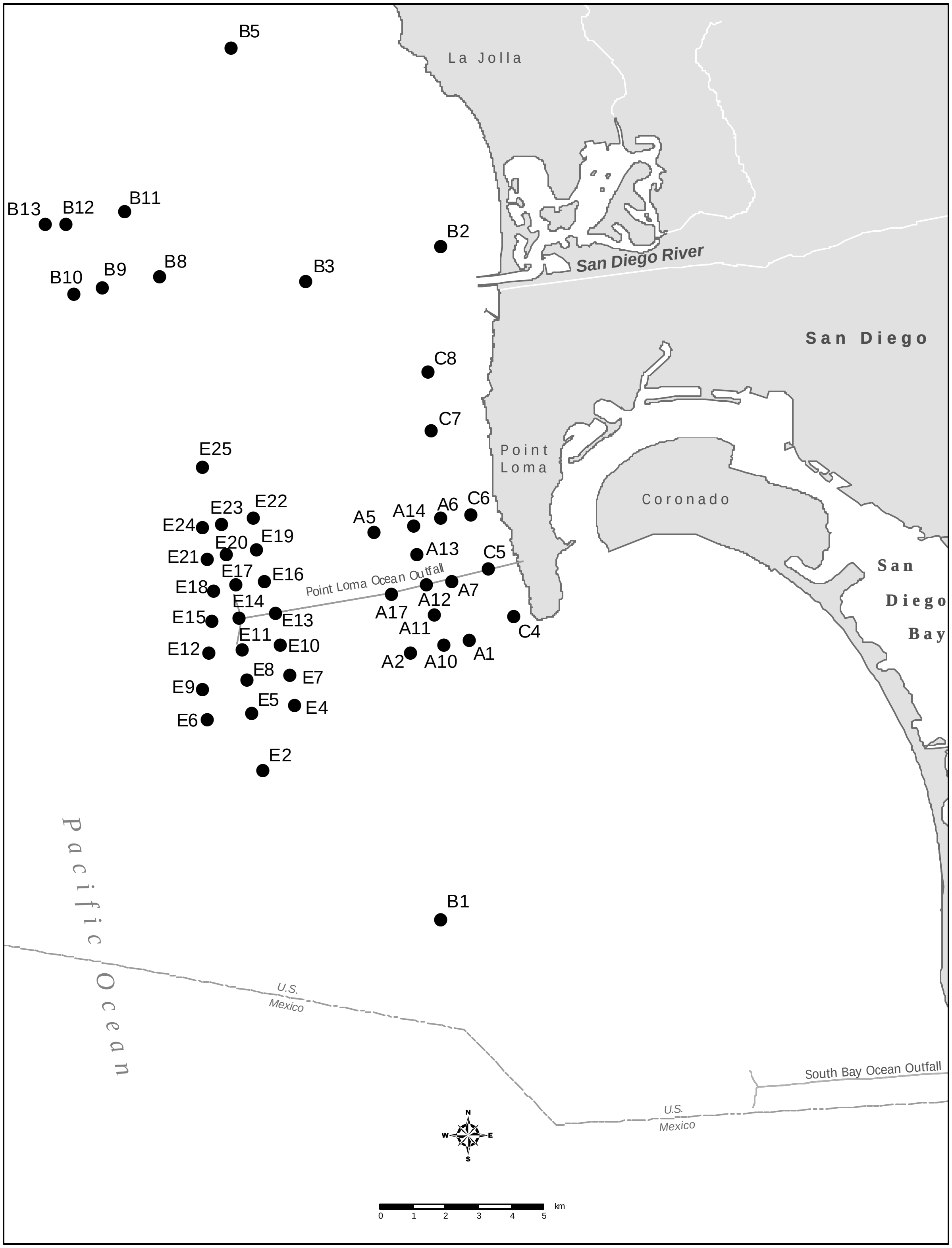


Figure 2.1
Locations of water quality monitoring stations where CTD casts are taken surrounding the Point Loma Ocean Outfall.

RESULTS & DISCUSSION

Expected Seasonal Patterns of Physical and Chemical Parameters

Southern California weather can be classified into two basic "seasons", wet (winter) and dry (spring through fall), and certain patterns in oceanographic conditions off the coast of Point Loma track these "seasons." Although the bottom waters are much colder than the waters above at all times of the year, there is a strong seasonal pattern to the temperature differences between mid-depth waters and surface waters. In the wet winter months, water temperatures throughout the water column are generally cold. The upper water column is well-mixed resulting in similar properties in surface and mid-waters. In contrast, dry summer weather warms the surface waters and introduces thermally-sustained stratification. Despite a sampling schedule that limits oceanographers to snapshots in time spread out over several days during each month, analyses of oceanographic data collected from the Point Loma region over the past 25 years support this pattern.

Each year, typical winter conditions are present in January and February. A high degree of homogeneity within the water column is the normal winter signature for all physical parameters, although stormwater runoff may intermittently influence the density profile by causing a freshwater lens within nearshore surface waters. With little stratification of the water column, the chance that the wastewater plume may surface is highest during these winter months. Winter conditions can extend into March or April, when a decrease in the frequency of winter storms brings about the transition of seasons. The increasing elevation of the sun and lengthening southern California days begin to warm the surface waters and cause the return of a seasonal thermocline and pycnocline to coastal and offshore waters. Once stratification is established by late spring, minimal mixing conditions tend to remain throughout the summer and fall until cooler weather, reduced solar input, and increased stormy weather returns around September or October.

Observed Seasonal Patterns of Physical and Chemical Parameters

Temperature is the main contributor to stratification in southern California waters (Dailey et al. 1993) and provides the best indication of discharge plume surfacing potential. During 2002, thermal stratification followed the expected seasonal pattern (**Figure 2.2**).

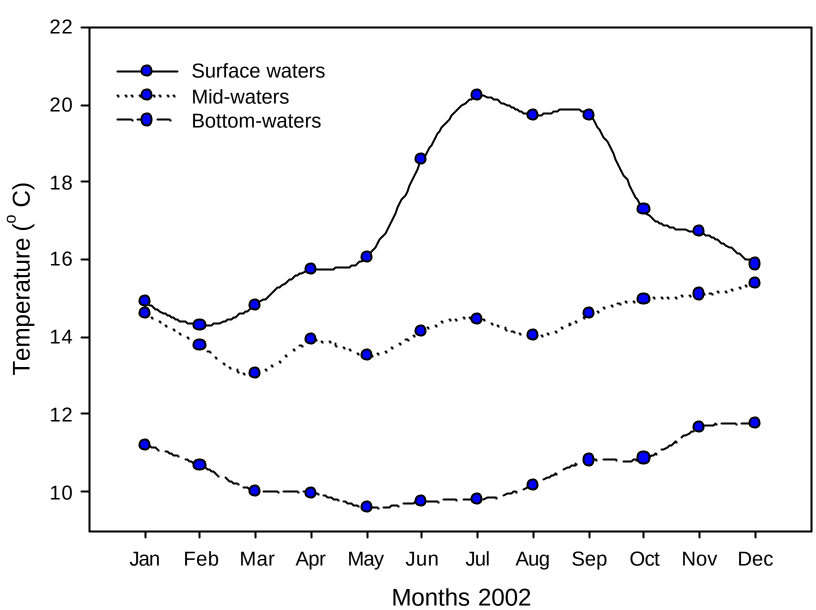


Figure 2.2

Mean monthly temperatures (°C) for surface waters (< 2 m), mid-waters (10 – 20 m), and bottom waters (> 88 m) during 2002. Means are calculated from temperature profile data of PLOO offshore stations.

Throughout the year, bottom waters (> 88 m) were consistently 3° C colder than the mid-waters (10 – 20 m) and surface waters (< 2 m). Seasonally-driven stratification was only evident in comparisons of surface waters versus mid-depth water temperatures. Stratification was minimal or absent from January through March with differences between average surface and mid-water temperatures consistently < 2° C. Surface water temperatures in winter ranged between 13.6 and 15.7° C, while mid-water temperatures were between 11.3 and 15.3° C. The seasonal pattern of temperature change in bottom waters (below 88 m) closely tracked the declining average temperatures of the mid-waters during January through March, although the temperature values were much lower in the deeper waters and ranged between 9.5 and 11.7° C. Beginning in April, however, the temperature difference between surface and mid-waters began to diverge as the surface waters warmed.

From May through October, there was a difference between average surface and mid-water temperatures of at least 2° C and sometimes as great as 6° C. Individual measurements during this time period ranged between 13.4 and 21.3° C in surface waters, 10.5 and 19.4° C in mid-waters, and 9.4 and 11.2° C in bottom waters. The average surface temperature for all stations increased rapidly between May and July and reached the year's highest average temperature (20.2° C) in July. After remaining fairly consistent throughout August and September, average surface temperatures decreased rapidly between September and October. By November and December, the difference between surface and mid-water layers had returned to < 2° C, a difference similar to what was observed from January through March.

Bottom water temperatures remained fairly constant throughout the year, with average monthly temperatures ranging between 9.6 and 11.8° C. There was a slight cooling trend from January through May, followed by a warming trend that lasted from July through November. The lowest average temperature (9.6° C) occurred in May, with bottom waters slowly warming until reaching their highest temperatures (> 11.5° C) in November and December.

These temperature conditions are apparent in single-station profiles and all-station volumetric interpolations of data collected during January, May and September (**Figures 2.3 – 2.5**). The density and dissolved oxygen plots corroborate the seasonal patterns of water column stratification and mixing that were apparent from temperature data. The thoroughly mixed and homogeneous upper water column present January through March is represented by the January plots (Figure 2.3). The transition to stratified conditions began in April and continued throughout May, as evidenced by the patchiness of the surface waters in the temperature, density and dissolved oxygen plots for May (Figure 2.4). Stratification was well established by June and remained strong throughout summer and fall. Low rainfall, a lack of storm activity and overall calm conditions led to a very shallow thermocline during the spring, summer and fall months. During June, July and August, thermocline depths were within the top 10 m of the water column, even at stations farthest from shore, although this had increased slightly to 13 m by September (Figure 2.5). In November, increased mixing induced greater water column homogeneity. Finally, in December, despite significant freshwater input from rains (see **Figure 2.6**), stratification disappeared and the water column returned to a thoroughly mixed state similar to that found in January.

Despite minimal rainfall in 2002, effects of terrestrial runoff continued to intermittently impact nearshore transmissivity. For example, waters offshore of Mission Bay and Point Loma in June had transmissivity values as low as 63% (**Figure 2.7**), even though it had been 14 days since the last rainfall event (according to June records from Lindbergh Field, San Diego). In contrast, the minor rain events of spring reduced the average surface water clarity only slightly, to 83 – 85% transmissivity (see March, April, and May values in **Table 2.1**).

As in past years, no clear pattern linked total suspended solids (TSS) data to water clarity or to outfall discharged waters. Average TSS values generally remained between 3.0 and 8.0 mg/L (Table 2.1). The one exception (22.2 mg/L) occurred in bottom waters in August. This high average was driven by very high values (between 15.5 and 84.9 mg/L) recorded at

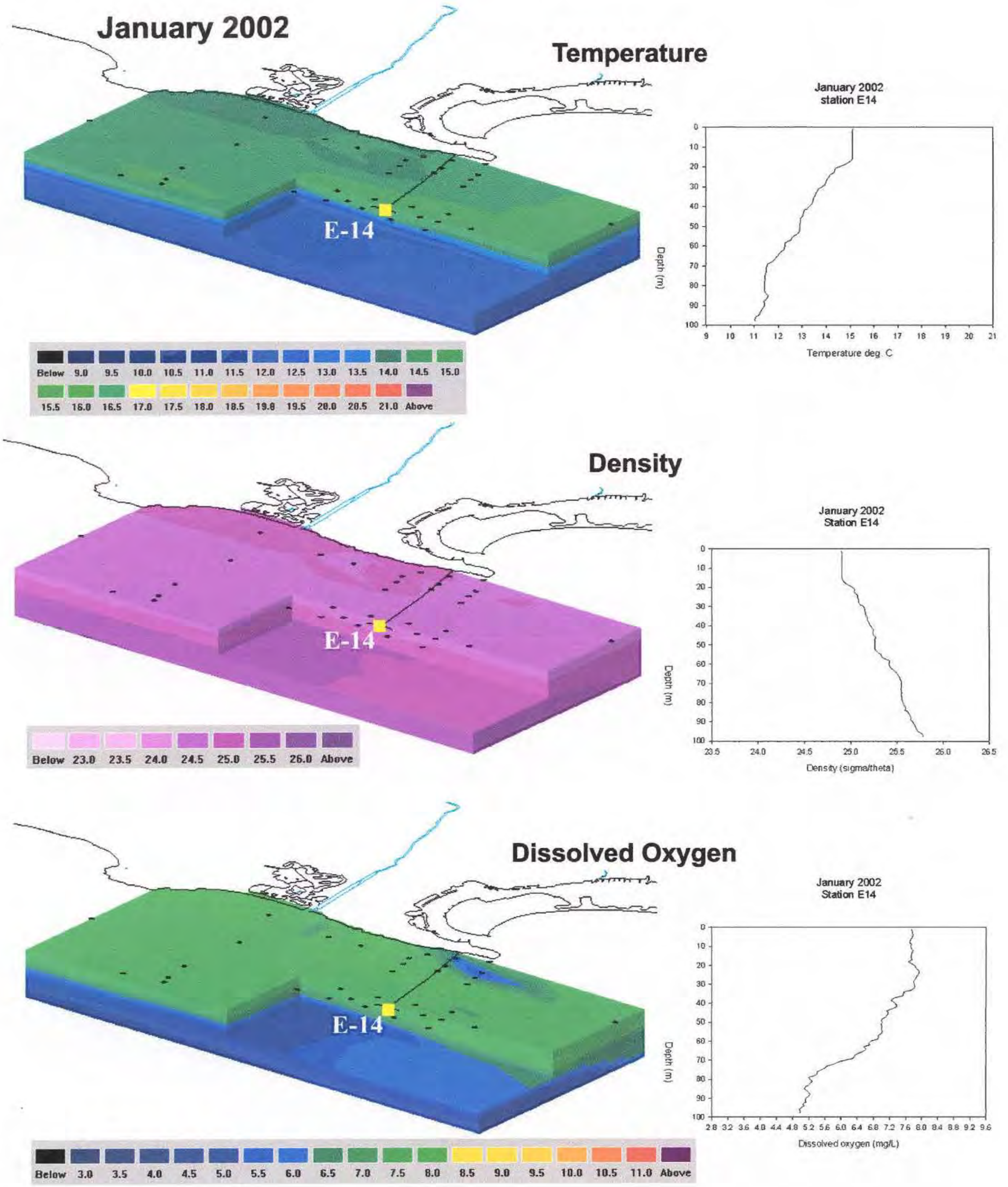


Figure 2.3

Interpolated volumetric (3D) plots of temperature, density (δ/θ), and dissolved oxygen for the PLOO physical oceanography (CTD) stations on January 14th, 16th and 17th, 2002. Accompanying profiles illustrate these same parameters for a specific offshore station, E-14, on January 16th, 2002.

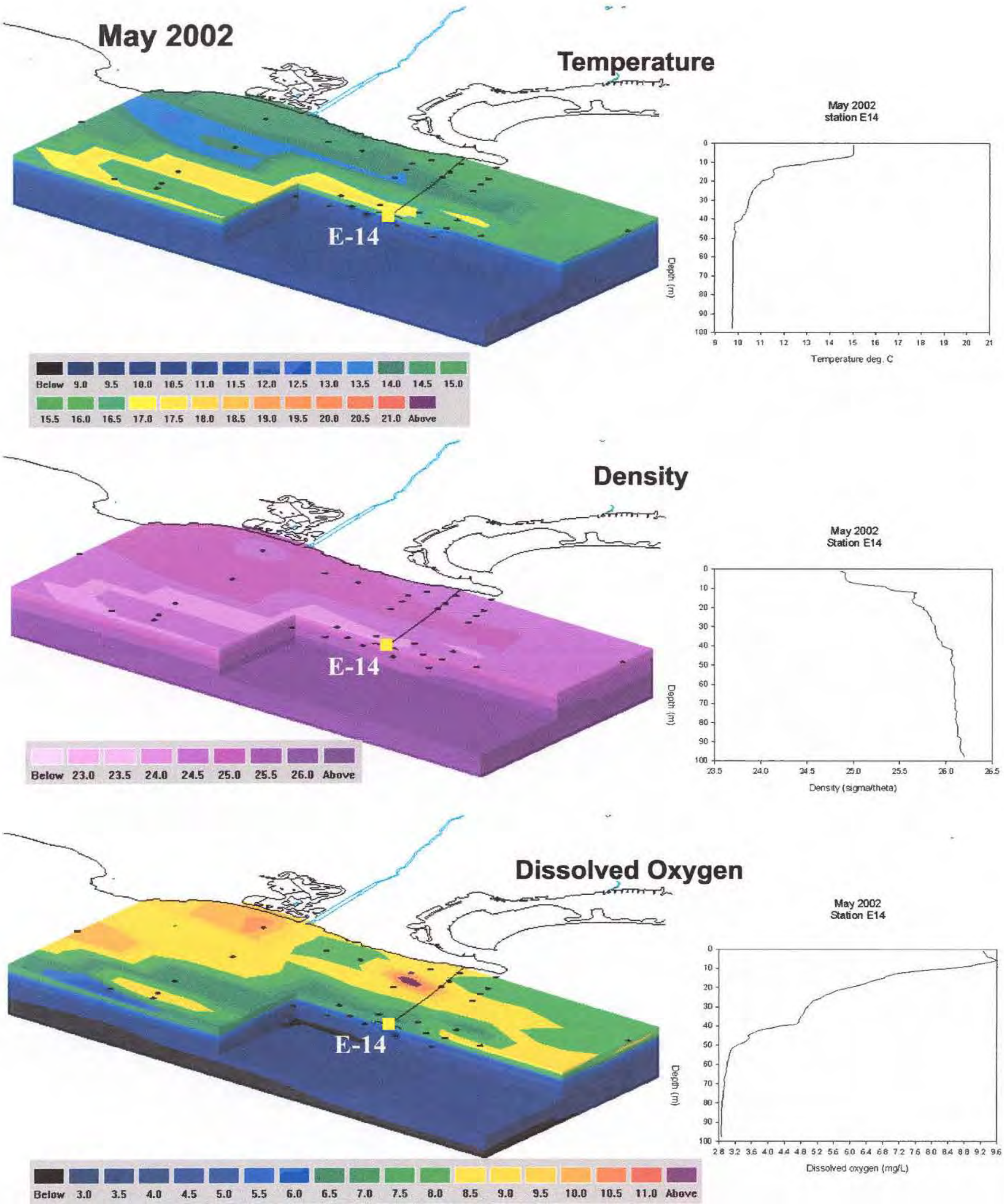


Figure 2.4

Interpolated volumetric (3D) plots of temperature, density (δ/θ), and dissolved oxygen for the PLOO physical oceanography (CTD) stations on May 6 - 8, 2002. Accompanying profiles illustrate these same parameters for a specific offshore station, E-14, on May 7th, 2002.

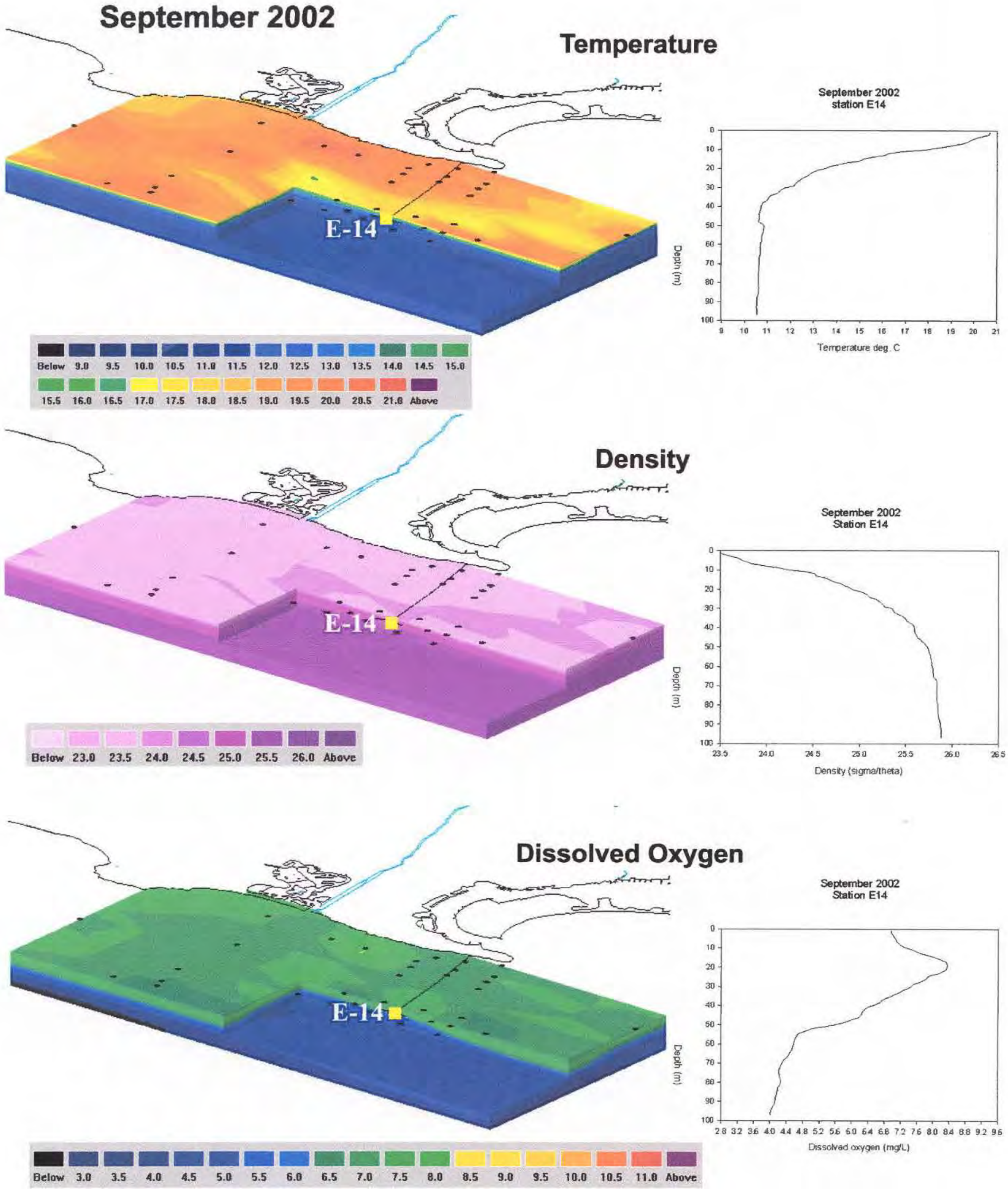


Figure 2.5

Interpolated volumetric (3D) plots of temperature, density (δ/θ), and dissolved oxygen for the PLOO physical oceanography (CTD) stations on September 10 - 12, 2002. Accompanying profiles illustrate these same parameters for a specific offshore station, E-14, on September 11th, 2002.

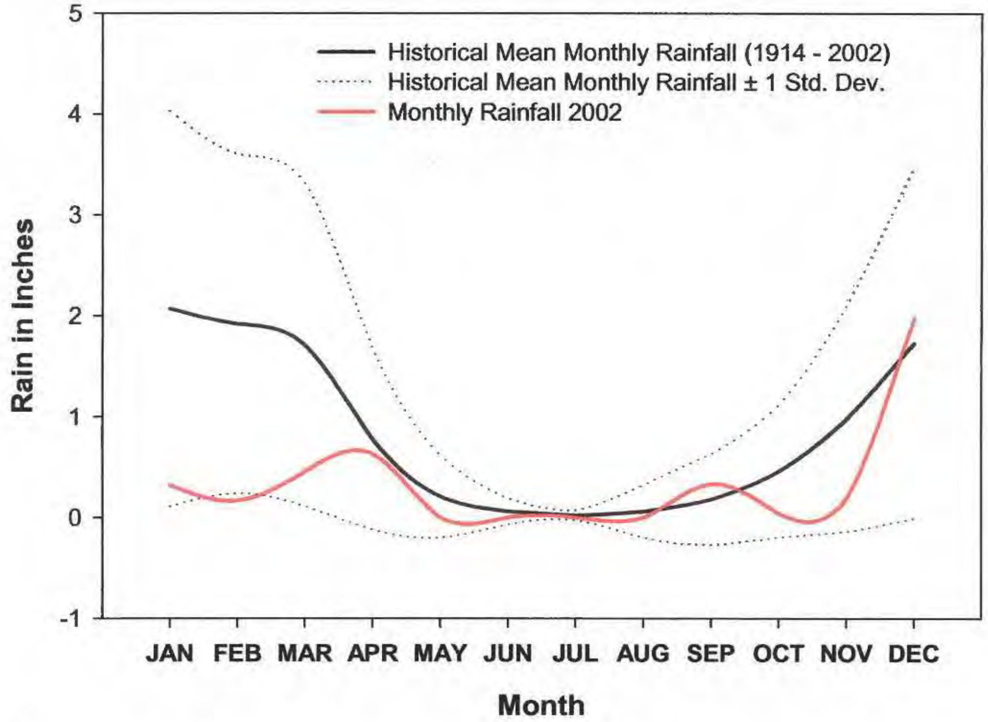


Figure 2.6

Monthly average rainfall for 2002 compared to normal monthly average rainfall for the historical period 1914 through 2002. Rainfall (in inches) was measured at Lindbergh Field, San Diego, CA.

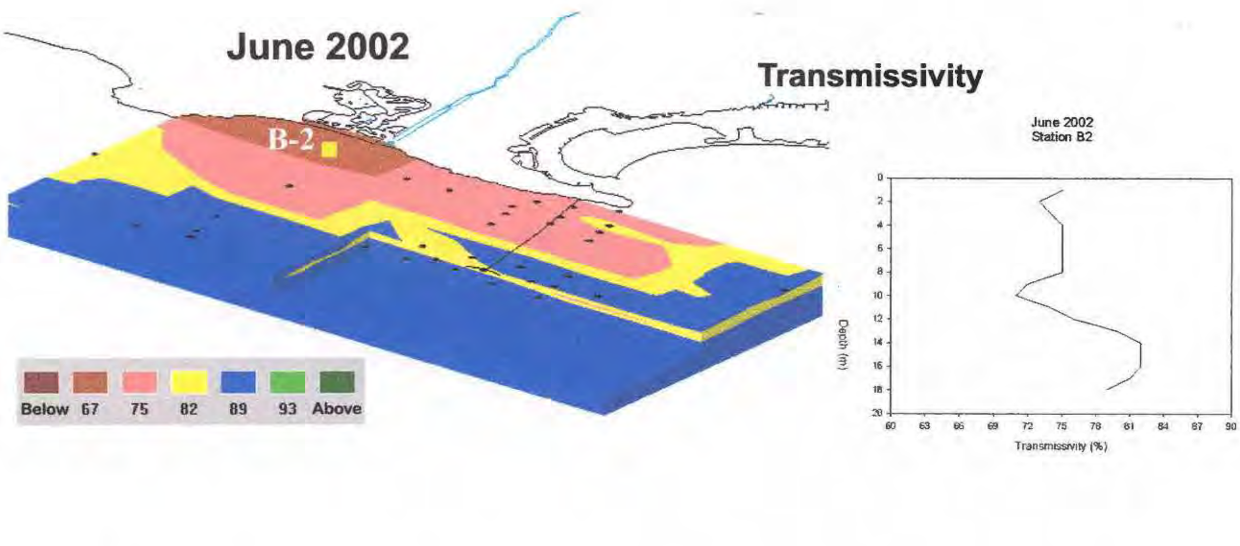


Figure 2.7

Interpolated volumetric (3D) plot of transmissivity for all PLOO CTD stations on June 3 - 5, 2002. Accompanying profile illustrates transmissivity for station B-2 on June 4th, 2002.

Table 2.1

Monthly mean values of temperature (ºC), salinity (ppt), density (δ/θ), dissolved oxygen (mg/L), pH, transmissivity (%), total suspended solids (TSS) and chlorophyll a (µg/L) for top (< 2 m), mid-depth (10 – 20 m) and bottom (> 88 m) waters at all PLOO stations during 2002. TSS and chlorophyll a data are reported for top and bottom depths only.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp	*Top*	14.9	14.3	14.8	15.7	16.1	18.6	20.2	19.7	19.7	17.3	16.7	15.9
	Mid	14.6	13.8	13.0	13.9	13.5	14.2	14.5	14.0	14.6	15.0	15.1	15.4
	Bot	11.2	10.7	10.0	10.0	9.6	9.8	9.8	10.2	10.8	10.9	11.7	11.8
Sal	*Top*	33.62	33.61	33.60	33.63	33.68	33.64	33.70	33.63	33.55	33.46	33.40	33.38
	Mid	33.61	33.61	33.61	33.64	33.72	33.71	33.64	33.59	33.47	33.38	33.36	33.36
	Bot	33.71	33.81	33.92	33.96	33.98	33.88	33.89	33.84	33.73	33.68	33.58	33.59
Dens	*Top*	24.93	25.05	24.93	24.75	24.71	24.08	23.71	23.79	23.72	24.27	24.35	24.53
	Mid	24.98	25.16	25.30	25.15	25.28	25.15	25.03	25.08	24.86	24.71	24.68	24.63
	Bot	25.73	25.91	26.10	26.14	26.22	26.12	26.12	26.02	25.82	25.77	25.55	25.54
DO	*Top*	7.7	8.0	9.1	8.5	8.1	7.9	7.9	7.9	7.4	7.5	7.0	6.8
	Mid	7.6	7.9	8.7	8.6	7.0	8.2	8.6	8.4	7.9	7.7	7.0	6.8
	Bot	4.9	4.4	4.2	3.7	3.0	3.7	3.8	3.4	4.0	3.9	4.4	4.2
pH	*Top*	8.1	8.1	8.2	8.2	8.2	8.1	8.1	8.1	8.1	8.1	8.1	8.1
	Mid	8.1	8.1	8.1	8.1	8.1	8.0	8.1	8.1	8.0	8.1	8.1	8.1
	Bot	7.9	7.8	7.8	7.8	7.7	7.6	7.7	7.7	7.7	7.7	7.8	7.8
XMS	*Top*	89.1	88.3	83.0	84.9	83.6	86.0	87.8	84.9	86.7	86.7	86.6	84.9
	Mid	89.3	89.0	82.3	84.8	85.0	86.7	87.8	83.7	87.5	87.9	86.0	86.0
	Bot	89.9	90.1	91.5	90.8	90.2	90.6	90.7	89.1	90.8	89.7	89.3	87.2
Chlor	*Top*	3.6	1.6	2.6	1.6	4.5	2.0	1.9	1.7	1.6	2.1	1.2	2.1
	Bot	3.1	1.0	0.8	0.7	0.9	0.5	1.2	0.3	0.6	0.5	0.6	0.7
TSS	*Top*	4.3	5.2	8.0	5.0	6.4	6.0	4.8	5.5	6.7	2.8	2.6	2.7
	Bot	4.7	4.6	4.0	7.5	5.5	7.8	6.6	22.2	7.7	3.3	3.4	5.7

three 98-m depth stations. With no corresponding elevated chlorophyll *a* values or bacterial counts (see Chapter 3), these anomalous values were likely the result of resuspension of bottom sediments.

In general, the impact of phytoplankton density (represented by chlorophyll *a* concentrations) on water clarity was restricted to surface waters. Low surface water transmissivity values in May correlated well with high chlorophyll *a* values off Mission Bay and Point Loma (see **Figure 2.8**, Table 2.1) and were coincident with field observations noting the presence of a phytoplankton bloom (City of San Diego 2002). While there was no trend apparent between transmissivity and chlorophyll for all depths, there was evidence of a negative correlation between chlorophyll *a* concentrations and transmissivity values in surface waters during summer months (**Figure 2.9**).

SUMMARY & CONCLUSIONS

Oceanographic conditions during 2002 followed normal seasonal patterns within the expected range of

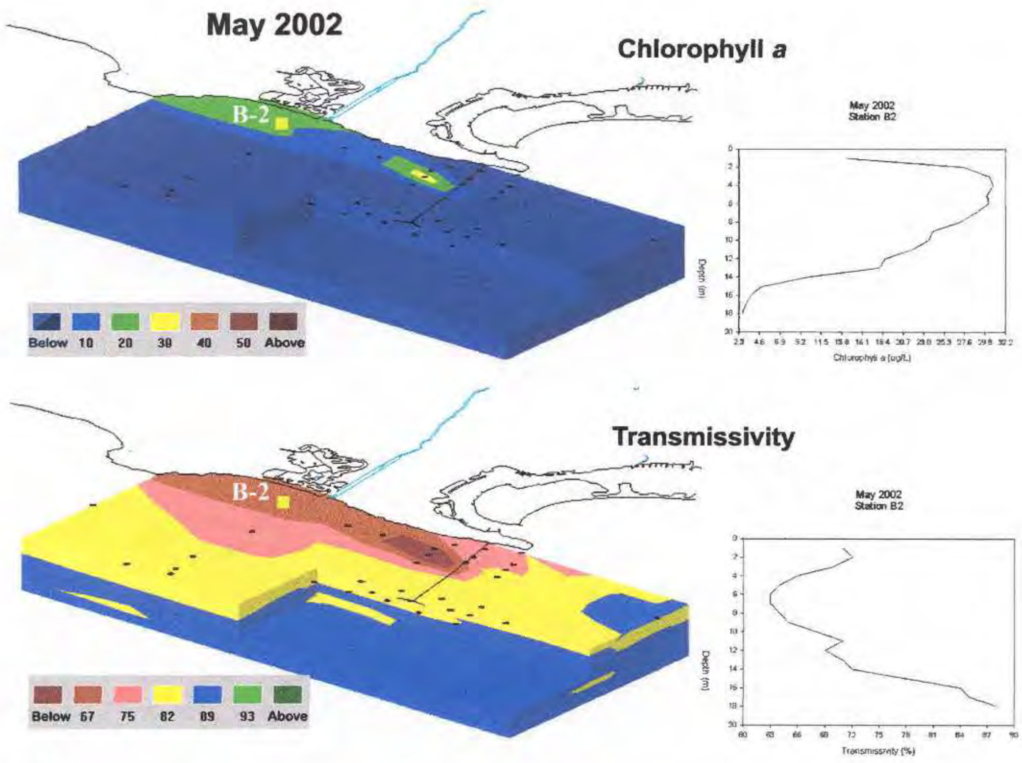


Figure 2.8

Interpolated volumetric (3D) plots of chlorophyll and transmissivity for all PLOO CTD stations during May 6 - 8, 2002. Accompanying profiles illustrate these same parameters for station B-2 on May 7th, 2002.

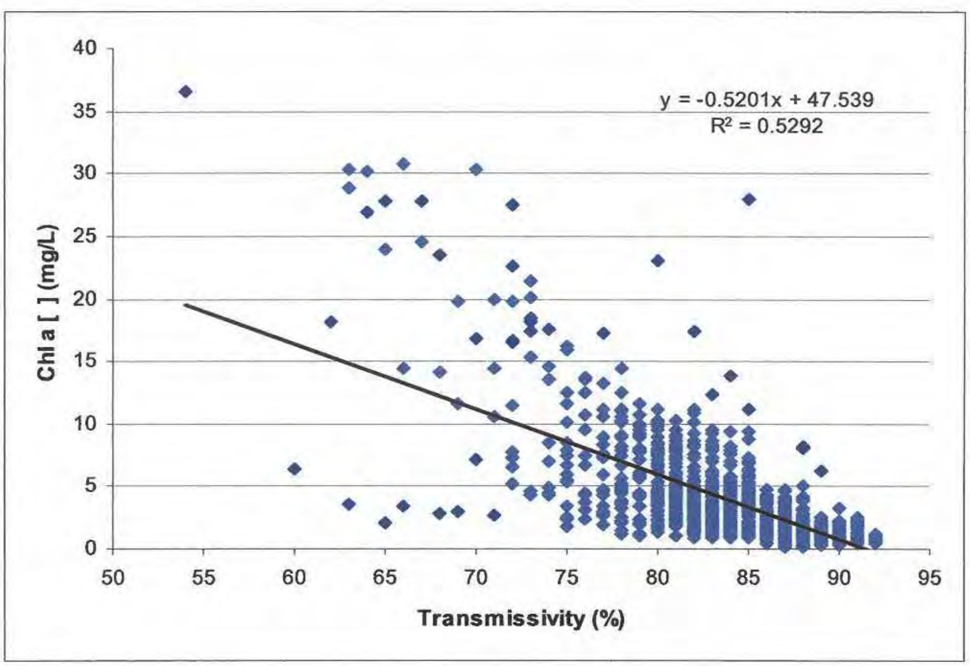


Figure 2.9

Correlation between transmissivity and chlorophyll *a* concentrations at all stations in shallow waters ($\leq$10 m) during the summer months (May – September) of 2002.

annual variability. Lower than average rainfall and the absence of major storm events prior to mid-December resulted in a sea state that was generally calm. There was no evidence of upwelling, and only one nearshore surface plankton bloom.

Impacts of the discharge from the Point Loma Ocean Outfall (PLOO) were not apparent in measurements of water clarity during 2002. The contributions of Mission Bay and either terrestrial runoff or resuspended bottom sediments along the coast of Point Loma appeared to heavily influence transmissivity values in the surface waters of those localized areas. Reduced water clarity was also observed during one plankton bloom and the three instances of subsurface chlorophyll layers, but was otherwise not associated with high chlorophyll concentrations.

Mild weather conditions throughout the year allowed a strong, shallow thermocline to persist from June through September. Data collected from physical and chemical parameters of the water column during 2002 gave no indication that any discharged waters from the outfall had reached surface waters, even during the minimally stratified winter months. These physical conditions will be important in the analysis of spatial patterns of high bacterial concentrations to be discussed in the following chapter.

LITERATURE CITED

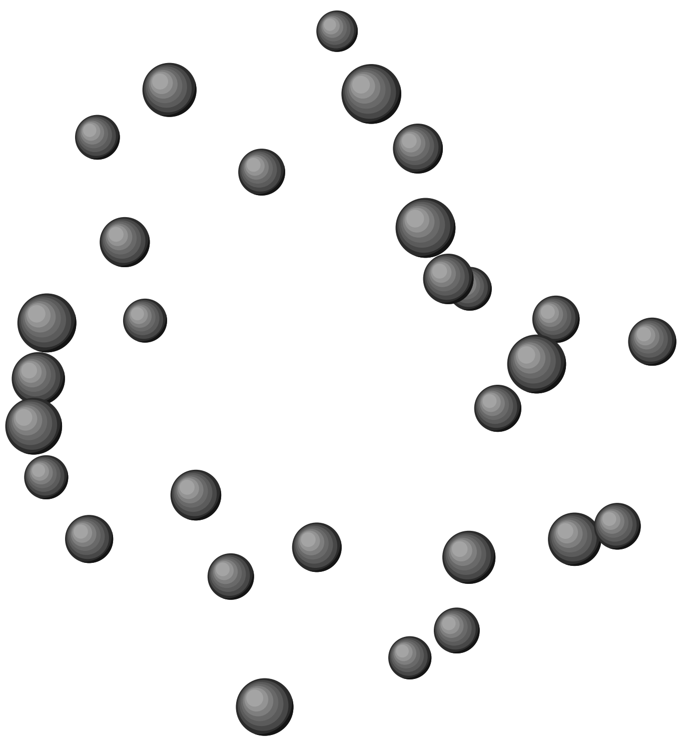
City of San Diego. (2002). Monthly Receiving Waters Monitoring Report for the City of San Diego Point Loma Metropolitan Wastewater Treatment Plant Discharge to the Pacific Ocean through The Point Loma Ocean Outfall (May 2002). City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA

City of San Diego. (2003). 2002 Quality Assurance Manual. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA

Dailey, M.D., Reish, D.J. and Anderson, J.W. (eds.) (1993). Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press, Berkeley, CA. 926 pp.

This page intentionally left blank

Microbiology



Chapter 3. Microbiology

INTRODUCTION

The City of San Diego performs shoreline and water column bacterial monitoring in the region surrounding the Point Loma Ocean Outfall (PLOO). The presence, absence and abundance of bacteria, together with oceanographic data (see Chapter 2), can provide information about the movement and dispersion of wastewater discharged through the outfall. Analyses of these data may also implicate point or non-point sources other than the outfall as contributing to bacterial contamination events in the region. The PLOO monitoring program is designed to assess general water quality and demonstrate level of compliance with the California Ocean Plan (COP) as required by the NPDES discharge permit. This chapter summarizes and interprets bacterial concentration data collected during 2002.

MATERIALS & METHODS

Field Sampling

Water samples for bacterial analysis were collected at fixed shore and offshore bacterial sampling sites regularly throughout the year (**Figure 3.1**). Weekly sampling was performed at nine shore stations (D-1 through D-9) to monitor bacteria levels along public beaches. The stations were located along the coast starting just south of the San Diego River (D9) and ending just north of the Tijuana River (D1). Twenty-seven offshore stations were sampled monthly, usually over a three-day period. These offshore stations were located in a grid pattern surrounding the outfall, along the 9, 18, 47, 60, 88, 98, and 116- m depth contours. The number of samples taken at each station was depth-dependent and ranged from a minimum of three fixed depths sampled at the 9 m and 18 m stations to a maximum of six fixed depths sampled at the 116 m stations. Most of the stations along the 9-m contour and all of the stations along the 18-m contour are within the Point Loma kelp bed and are subject to the water contact standards of the COP. These kelp stations (i.e., A-1, A-6, A-7, and C-4 through C-8) were sampled for bacterial analysis four additional times each month, for a total of five sampling events per month.

Seawater samples from the shore stations were collected from the surf zone in sterile 250 mL bottles. Visual observations of water color and clarity, surf height, human or animal activity, and weather conditions were recorded at the time of collection. The seawater samples were then transported on ice to the City's Marine Microbiology Laboratory and analyzed to determine concentrations of total coliforms, fecal coliforms and enterococcus bacteria.

Offshore samples were analyzed for the same three bacterial parameters as well as oil and grease. The water samples were collected using either a series of Van Dorn bottles or a rosette sampler fitted with Niskin bottles. Aliquots for each analysis were drawn into appropriate sample containers. The samples were refrigerated on board ship and then transported to either the City's Marine Microbiology Laboratory for bacterial analysis or to the City's Wastewater Chemistry Laboratory for analysis of oil and grease. However, the collection of oil and grease samples was discontinued as of July 2002 after the testing requirement was removed from the operating permit. Visual observations of weather and water conditions were also recorded at the time of sampling.

Laboratory Analyses

All bacterial analyses were performed within six hours of sample collection in conformance with the membrane filtration techniques outlined in the City's Quality Assurance Manual (City of San Diego 2003). The Marine Microbiology Laboratory follows guidelines issued by the EPA Water Quality Office, Water Hygiene Division and the California State Department of Health Services, Water Laboratory Approval Group with

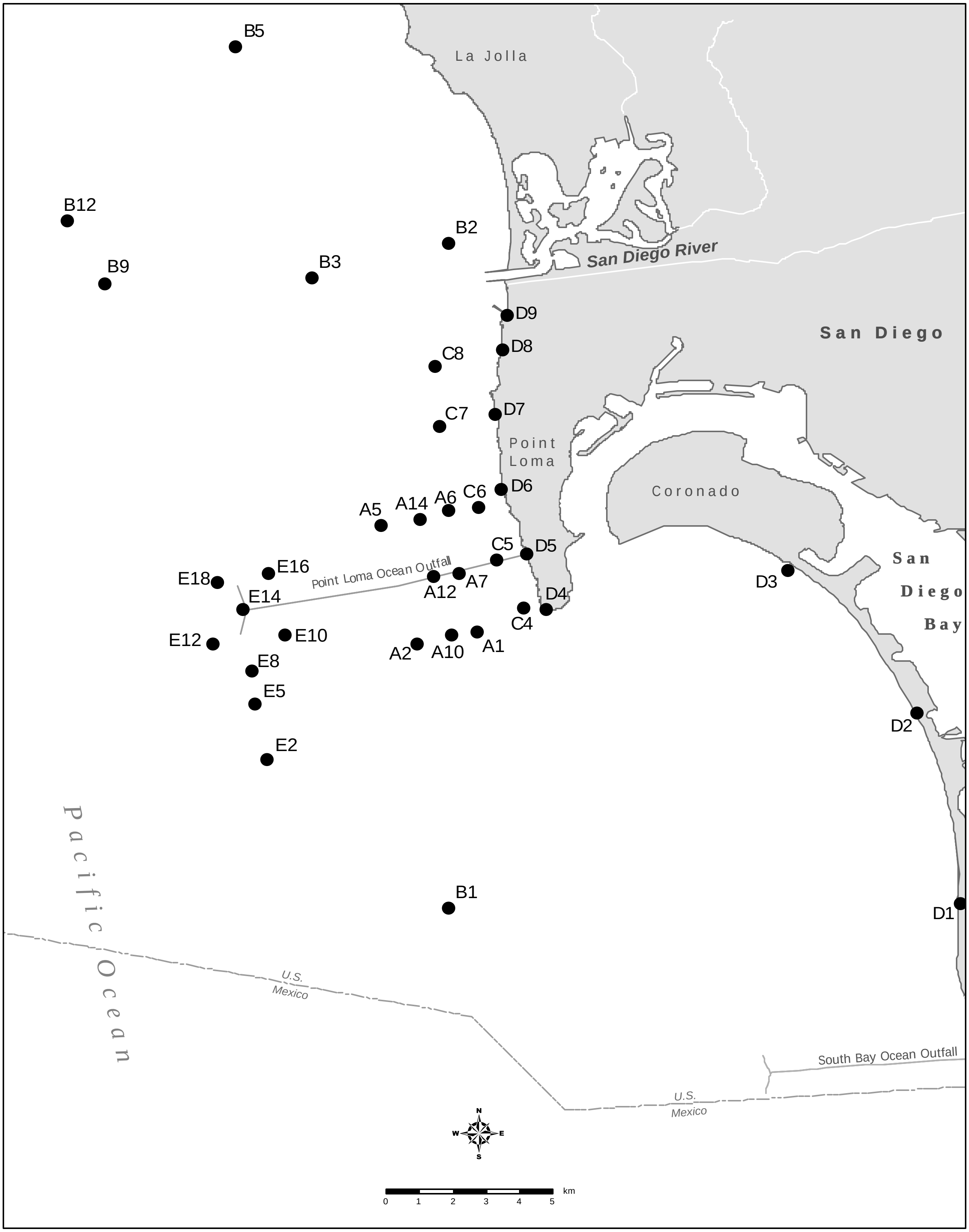


Figure 3.1
Locations of water quality monitoring stations where bacterial samples are taken surrounding the Point Loma Ocean Outfall.

respect to sampling and analytical procedures (Bordner et al. 1978; Greenberg et al. 1992).

Colony counting, calculation of results, data verification and reporting all follow guidelines established by the EPA (see Bordner et al. 1978). Data are recorded in colony forming units (CFU). According to these guidelines, plates with bacterial counts above or below permissible counting limits were given ">", "<", or "e" (estimated) qualifiers. These qualifiers were ignored and the counts were treated as discrete values during the calculation of compliance with COP standards and subsequent statistical analyses.

Quality assurance tests were performed routinely on water samples to insure that sampling variability did not exceed acceptable limits. Duplicate and split field samples were generally collected each month and processed by laboratory personnel to measure intra-sample and inter-analyst variability, respectively. Results of these procedures were reported in the Quality Assurance Manual (City of San Diego 2003).

RESULTS & DISCUSSION

Compliance with California Ocean Plan Standards – Shore and Kelp Bed Stations

California Ocean Plan (COP) bacterial standards for shore and kelp stations are displayed in **Box 3.1**. All but three shore stations (i.e., D-1, D-8, D-9) and every kelp station were 100% compliant with all four standards during 2002 (**Tables 3.1 and 3.2**). Stations D-1, D-8, and D-9 were out of compliance with the 30-day total coliform standard 8% of the time. The rare high bacterial concentrations that caused these exceedences occurred during April and May for station D-1, September and October for D-8, and November for D-9.

In each case, the COP compliance was compromised by a single sample with elevated bacterial concentrations, not repeated days of elevated bacterial densities. For example, a very high total coliform value (>10,000 CFU/100 mL) from April 8 caused station D-1 to be out of compliance for most of April and the first week of May. On another occasion, 30 days of non-compliance from September to October at station D-8 was caused by a total coliform concentration of 1,500 CFU/100 mL on September 14. A similar occasion occurred at station D-9 in November when the total coliform count was 1,300 CFU/100 mL. On each occasion, while total coliform densities were elevated, fecal coliform and enterococcus concentrations were both very low (i.e., all < 73 CFU/100 mL). The absence of confirming fecal coliform or enterococcus bacteria suggests that these elevated total coliform densities may have resulted from sources other than the influence of discharged wastewater (e.g., runoff or decaying plant matter).

Box 3.1

Bacteriological compliance standards for water contact areas, 2001 California Ocean Plan. CFU = colony forming units.

(1) *30 day total coliform* — no more than 20% of the samples at a given station in any 30-day period may exceed a concentration of 1,000 CFU per 100 mL.

(2) *10,000 total coliform standard* — no single sample, when verified by a repeat sample collected within 48 hrs, may exceed a concentration of 10,000 CFU per 100 mL.

(3) *60 day fecal coliform* — no more than 10% of the samples at a given station in any 60-day period may exceed a concentration of 400 CFU per 100 mL.

(4) *geometric mean* — the geometric mean of the fecal coliform concentration at any given station in any 30-day period may not exceed 200 CFU per 100 mL, based on no fewer than 5 samples.

Table 3.1

Summary of compliance with California Ocean Plan water contact standards for PLOO shore stations during 2002. The values reflect the number of days that each station exceeded the 30-day total coliform and 60-day fecal coliform standards. Shore stations are listed left to right from south to north.

30-Day Total Coliform Standard

	# of possible	Shore Stations								
Month	**sampling days**	**D-1**	**D-2**	**D-3**	**D-4**	**D-5**	**D-6**	**D-7**	**D-8**	**D-9**
January	31	0	0	0	0	0	0	0	0	0
February	28	0	0	0	0	0	0	0	0	0
March	31	0	0	0	0	0	0	0	0	0
April	30	23	0	0	0	0	0	0	0	0
May	31	7	0	0	0	0	0	0	0	0
June	30	0	0	0	0	0	0	0	0	0
July	31	0	0	0	0	0	0	0	0	0
August	31	0	0	0	0	0	0	0	0	0
September	30	0	0	0	0	0	0	0	17	0
October	31	0	0	0	0	0	0	0	13	0
November	30	0	0	0	0	0	0	0	0	30
December	31	0	0	0	0	0	0	0	0	0
Percent non-compliance		**8%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**8%**	**8%**
Percent compliance 2002		**92%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**92%**	**92%**

60-Day Fecal Coliform Standard

	# of possible	Shore Stations								
Month	**sampling days**	**D-1**	**D-2**	**D-3**	**D-4**	**D-5**	**D-6**	**D-7**	**D-8**	**D-9**
January	31	0	0	0	0	0	0	0	0	0
February	28	0	0	0	0	0	0	0	0	0
March	31	0	0	0	0	0	0	0	0	0
April	30	0	0	0	0	0	0	0	0	0
May	31	0	0	0	0	0	0	0	0	0
June	30	0	0	0	0	0	0	0	0	0
July	31	0	0	0	0	0	0	0	0	0
August	31	0	0	0	0	0	0	0	0	0
September	30	0	0	0	0	0	0	0	0	0
October	31	0	0	0	0	0	0	0	0	0
November	30	0	0	0	0	0	0	0	0	0
December	31	0	0	0	0	0	0	0	0	0
Percent non-compliance		**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
Percent compliance 2002		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Table 3.2

Summary of compliance with California Ocean Plan water contact standards for PLOO kelp stations during 2002. The values reflect the number of days that each station exceeded the 30-day total coliform and 60-day fecal coliform standards. Stations are listed in geographic order from south to north with stations A-1, A-7, A-6, C-7 and C-8 along the 18-m contour and stations C-4, C-5 and C-6 along the 9-m contour.

30-Day Total Coliform Standard

	# of possible	Kelp Stations							
Month	**sampling days**	**A-1**	**A-7**	**A-6**	**C-7**	**C-8**	**C-4**	**C-5**	**C-6**
January	31	0	0	0	0	0	0	0	0
February	28	0	0	0	0	0	0	0	0
March	31	0	0	0	0	0	0	0	0
April	30	0	0	0	0	0	0	0	0
May	31	0	0	0	0	0	0	0	0
June	30	0	0	0	0	0	0	0	0
July	31	0	0	0	0	0	0	0	0
August	31	0	0	0	0	0	0	0	0
September	30	0	0	0	0	0	0	0	0
October	31	0	0	0	0	0	0	0	0
November	30	0	0	0	0	0	0	0	0
December	31	0	0	0	0	0	0	0	0
Percent non-compliance		0%	0%	0%	0%	0%	0%	0%	0%
Percent compliance 2002		100%	100%	100%	100%	100%	100%	100%	100%

60-Day Fecal Coliform Standard

	# of possible	Kelp Stations							
Month	**sampling days**	**A-1**	**A-7**	**A-6**	**C-7**	**C-8**	**C-4**	**C-5**	**C-6**
January	31	0	0	0	0	0	0	0	0
February	28	0	0	0	0	0	0	0	0
March	31	0	0	0	0	0	0	0	0
April	30	0	0	0	0	0	0	0	0
May	31	0	0	0	0	0	0	0	0
June	30	0	0	0	0	0	0	0	0
July	31	0	0	0	0	0	0	0	0
August	31	0	0	0	0	0	0	0	0
September	30	0	0	0	0	0	0	0	0
October	31	0	0	0	0	0	0	0	0
November	30	0	0	0	0	0	0	0	0
December	31	0	0	0	0	0	0	0	0
Percent non-compliance		0%	0%	0%	0%	0%	0%	0%	0%
Percent compliance 2002		100%	100%	100%	100%	100%	100%	100%	100%

Table 3.3

Mean total coliform, fecal coliform and enterococcus densities (CFU per 100 mL) at PLOO shore stations by station, month and year (2002). Stations are listed left to right in order from south to north. Rainfall (in inches) was measured at Lindbergh Field, San Diego, CA.

Total Coliforms		Shore Stations									
Month	Rain	D1	D2	D3	D4	D5	D6	D7	D8	D9	All Stations
Jan	0.3	14	7	10	8	4	7	2	12	53	13
Feb	0.2	2	3	6	3	2	7	4	86	2	13
Mar	0.5	12	3	9	7	53	7	9	200	6	34
Apr	0.6	3335	2	2	8	3	5	101	75	2	547
May	trace	71	50	2	21	8	3	26	38	3	21
Jun	trace	35	50	38	15	27	14	26	88	27	31
Jul	0	101	176	150	18	25	14	30	29	164	78
Aug	trace	24	28	88	16	16	14	176	28	12	44
Sep	0.3	51	30	40	15	27	126	51	490	16	94
Oct	0	205	35	23	22	2	8	125	67	4	54
Nov	0.3	9	8	3	100	8	6	162	45	675	113
Dec	2	102	20	35	18	317	7	36	283	100	102
n		37	36	36	36	36	35	35	36	36	
Annual min		2	2	2	2	2	2	2	2	2	
Annual max		10,000	600	200	100	650	400	450	1500	1300	
Annual mean		328	35	42	20	42	22	61	127	74	
Fecal Coliforms		D1	D2	D3	D4	D5	D6	D7	D8	D9	All Stations
Jan	0.3	8	6	3	9	2	2	4	5	8	5
Feb	0.2	2	3	8	2	2	2	2	9	2	4
Mar	0.5	2	2	2	2	9	2	6	34	4	7
Apr	0.6	45	2	2	2	2	2	18	5	2	11
May	trace	12	2	2	6	6	2	3	6	2	4
Jun	trace	2	4	2	2	2	2	3	7	4	3
Jul	0	6	9	3	2	4	2	4	5	2	4
Aug	trace	9	3	10	2	2	2	92	3	2	14
Sep	0.3	7	4	4	2	3	7	23	45	2	10
Oct	0	26	9	9	5	2	2	85	33	3	20
Nov	0.3	3	2	2	4	2	2	31	25	42	12
Dec	2	14	2	10	2	2	3	3	37	5	9
n		37	36	36	36	36	35	36	36	36	
Annual min		2	2	2	2	2	2	2	2	2	
Annual max		130	24	26	16	18	20	350	140	72	
Annual mean		11	4	5	3	3	3	24	17	5	
Enterococcus		D1	D2	D3	D4	D5	D6	D7	D8	D9	All Stations
Jan	0.3	4	26	2	2	2	2	2	2	5	5
Feb	0.2	2	2	2	2	2	2	2	7	2	3
Mar	0.5	5	2	4	2	2	2	26	19	2	7
Apr	0.6	6	2	2	4	2	2	2	2	2	3
May	trace	3	2	3	7	6	3	6	2	2	4
Jun	trace	4	2	4	2	5	2	8	3	2	4
Jul	0	6	5	5	2	2	2	3	6	2	4
Aug	trace	11	4	27	2	3	2	3	2	2	6
Sep	0.3	5	12	9	3	3	9	33	19	2	10
Oct	0	27	23	6	2	2	2	7	20	18	12
Nov	0.3	2	18	2	10	2	2	8	7	29	8
Dec	2	88	3	41	3	6	21	2	19	11	22
n		37	36	36	36	36	35	36	36	36	
Annual min		2	2	2	2	2	2	2	2	2	
Annual max		250	64	120	18	18	60	110	64	52	
Annual mean		14	7	10	3	3	5	9	9	6	

Spatial & Temporal Trends – Shore Stations

There was no clear pattern in shoreline bacterial concentrations in 2002. While the average total coliform concentrations at shore stations showed seasonal differences, this was not the case for individual samples that exhibited moderate-to-high total coliforms densities (> 1,000 CFU/100 mL) (**Table 3.3**). For example, average total coliform concentrations at several shore stations (e.g., D1, D2, and D3) increased by at least an order of magnitude during the summer months. On the other hand, the number of sampling events with elevated total coliforms were comparable during the "wet" and "dry" seasons (i.e., 14 such events during January – April and November – December compared to 17 such events during May – October). Moreover, even though April, November and December had higher average total coliform densities for all stations combined, linear regression analyses indicate that there was no clear relationship between coliform densities and rainfall events. For example, the single 10,000 CFU/100 mL value recorded at D-1, which raised the April average an order of magnitude above the average of any other shore station, was unrelated to any seasonal rainfall.

Finally, none of the elevated total coliform densities mentioned above were associated with high densities of fecal or enterococcus bacteria. All shore station samples had fecal coliform concentrations ≤ 350 CFU/100 mL throughout the year, and only four of the 325 bacteriological samples collected over the entire year exceeded 100 CFU/100 mL. The maximum enterococcus density was only 250 CFU/100mL and densities ≥ 64 CFU/100 mL were recorded on only three occasions. The low fecal coliform and enterococcus concentrations present throughout the year, along with the lack of a clear seasonal pattern in total coliform concentrations, supports the earlier assertion that shore station water quality is likely being influenced by sources other than the PLOO discharge. These alternative influences may include terrestrial runoff, plant and animal bacterial input, or patterns of coastal recreation usage.

Spatial & Temporal Trends - Kelp and Offshore Stations

There was little evidence that discharged wastewater impacted offshore surface waters in 2002 (see **Figures 3.2 and 3.3**). Total coliform concentrations

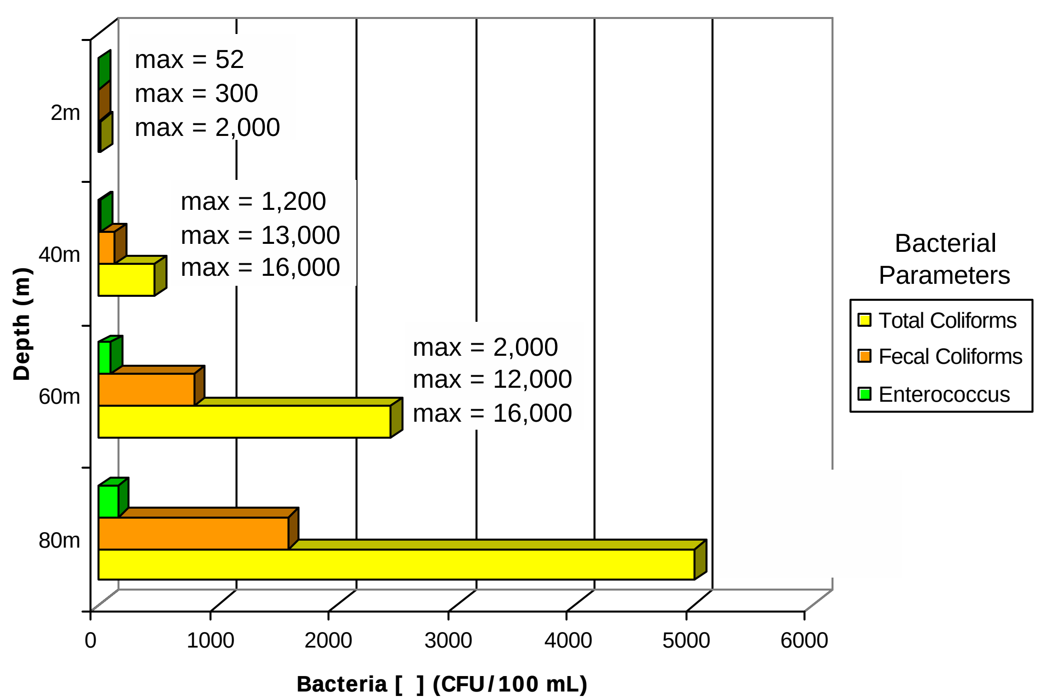


Figure 3.2

Mean total coliform, fecal coliform and enterococcus concentrations (in CFU/100 mL) at four depth intervals for water quality stations along the 98 m contour during 2002. Maximum annual value for each bacterial parameter for each depth range is also listed.

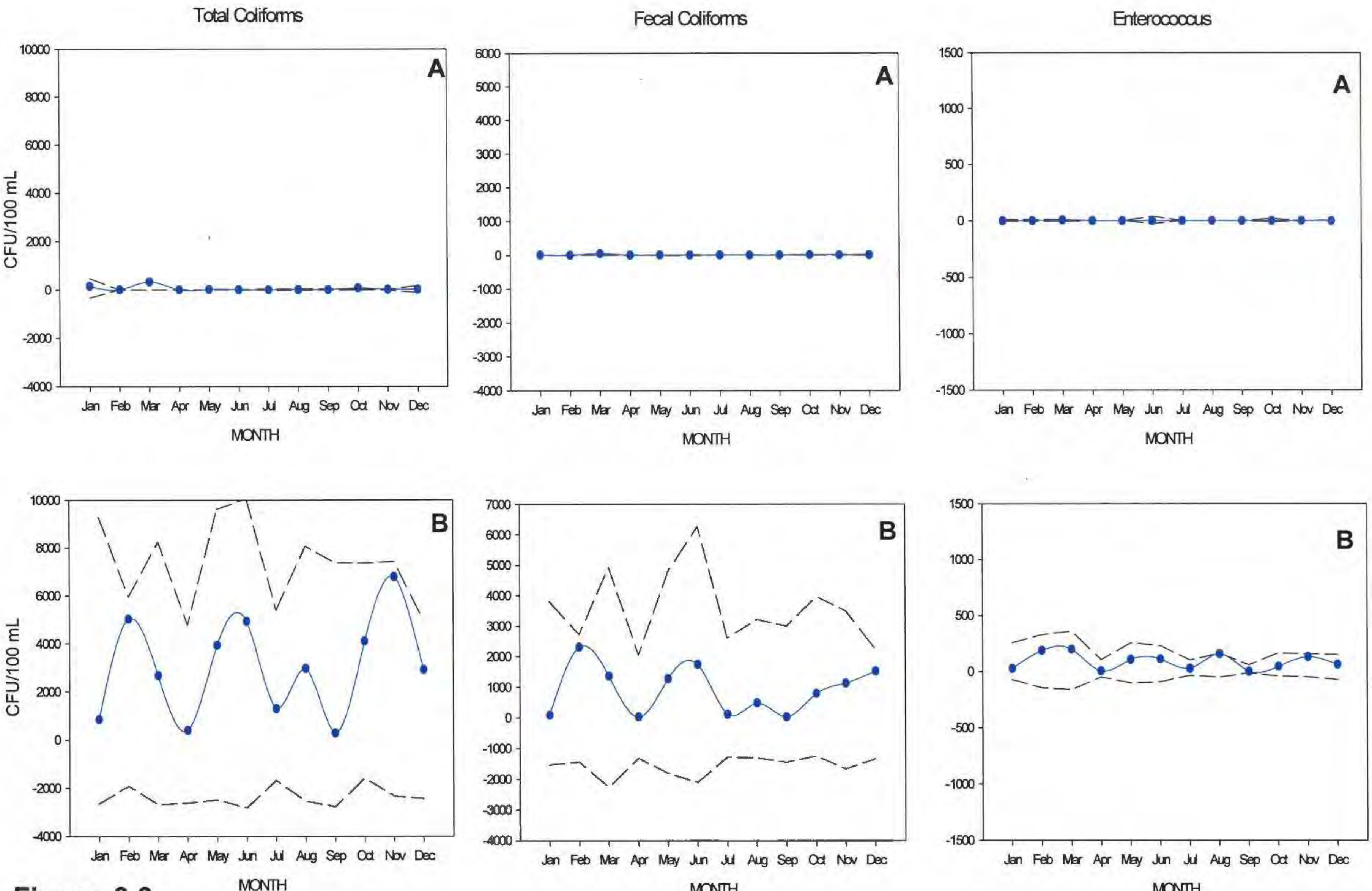


Figure 3.3

Mean total coliform, fecal coliform, and enterococcus concentrations for 2002 shown as data points and solid lines (in CFU / 100 mL) for PLOO stations along the 98-m contour for surface (**A**) waters and bottom (**B**) waters. Dashed lines represent ± 1 std dev and indicate variability for historical data from the period 1995 – 2001.

Table 3.4

Average bacteria densities (in CFU per 100 mL) per month at PLOO kelp stations and offshore stations.

	Total Coliforms		Fecal Coliforms		Enterococcus	
Month	Kelp Stations	Offshore Stations	Kelp Stations	Offshore Stations	Kelp Stations	Offshore Stations
Jan	19	1,036	4	347	3	46
Feb	25	1,562	4	489	3	56
Mar	29	1,222	5	300	2	42
Apr	19	642	3	224	3	26
May	8	2,814	2	1,077	2	143
Jun	16	3,518	2	1,262	2	154
Jul	27	1,671	2	441	3	56
Aug	12	2,943	2	943	3	110
Sep	12	603	2	159	2	9
Oct	37	1,323	3	635	2	38
Nov	34	2,211	2	813	2	82
Dec	32	1,351	4	287	3	28

in surface waters ($\leq$ 2 m) ranged from non-detectable concentrations to 2,000 CFU/100 mL. With the exception of one 2,000 CFU/100 mL value at station E-14 (March 12), total coliforms densities in surface waters were < 1,000 CFU/100 mL throughout the year. Moreover, the moderate total coliform value at E-14 was not accompanied by elevated fecal (300 CFU/100 mL) or enterococcus (42 CFU/100 mL) values. Furthermore, with this one exception, all fecal coliform densities were $\leq$ 90 CFU/100. Collectively, these results suggest that the elevated coliform in surface waters values were not likely due to discharged material.

In contrast, there was a distinct trend toward increasing bacterial densities with depth (Figure 3.2). At depths of 60 and 80 m, average total coliform concentrations exceeded 2,000 and 5,000 CFU/100 mL, respectively. In many cases, these elevated total coliform values were also accompanied by elevated fecal and enterococcus concentrations (see Figure 3.3). This pattern fits with historical data in which bottom waters consistently demonstrate higher average bacterial concentrations and increased variability, especially compared to the low values and minimal variability exhibited within surface waters.

Bacterial concentrations at the kelp and offshore sampling stations showed different seasonal patterns. The kelp stations were less affected by seasonal conditions than waters further from shore (**Table 3.4**). Although there may have been slight increases in bacterial densities during winter and spring months, kelp station concentrations for all three bacteria types were fairly consistent and low throughout the year. In contrast, concentrations of all three bacterial parameters at offshore stations were higher during summer months. Samples taken from May through August show elevated concentrations for total coliform, fecal coliform, and enterococcus compared to samples from other months.

Seasonal affects on the horizontal extent of total coliform values were not apparent (**Figure 3.4**). Elevated total coliform concentrations (i.e., $\geq$1,000 CFU/100 mL) were more widely distributed in waters deeper than 60 m throughout the year; such elevated values were recorded at the northernmost stations (B-5, B-9, and B-12) every month except May. The highest total coliform densities (10,000 CFU/100 mL or greater) occurred every month, but only at the stations immediately surrounding the outfall terminus (i.e., E-5, E-8, E-10, E-12, E-14, E-16, and E-18), and solely at mid- and deep-water depths. Assuming

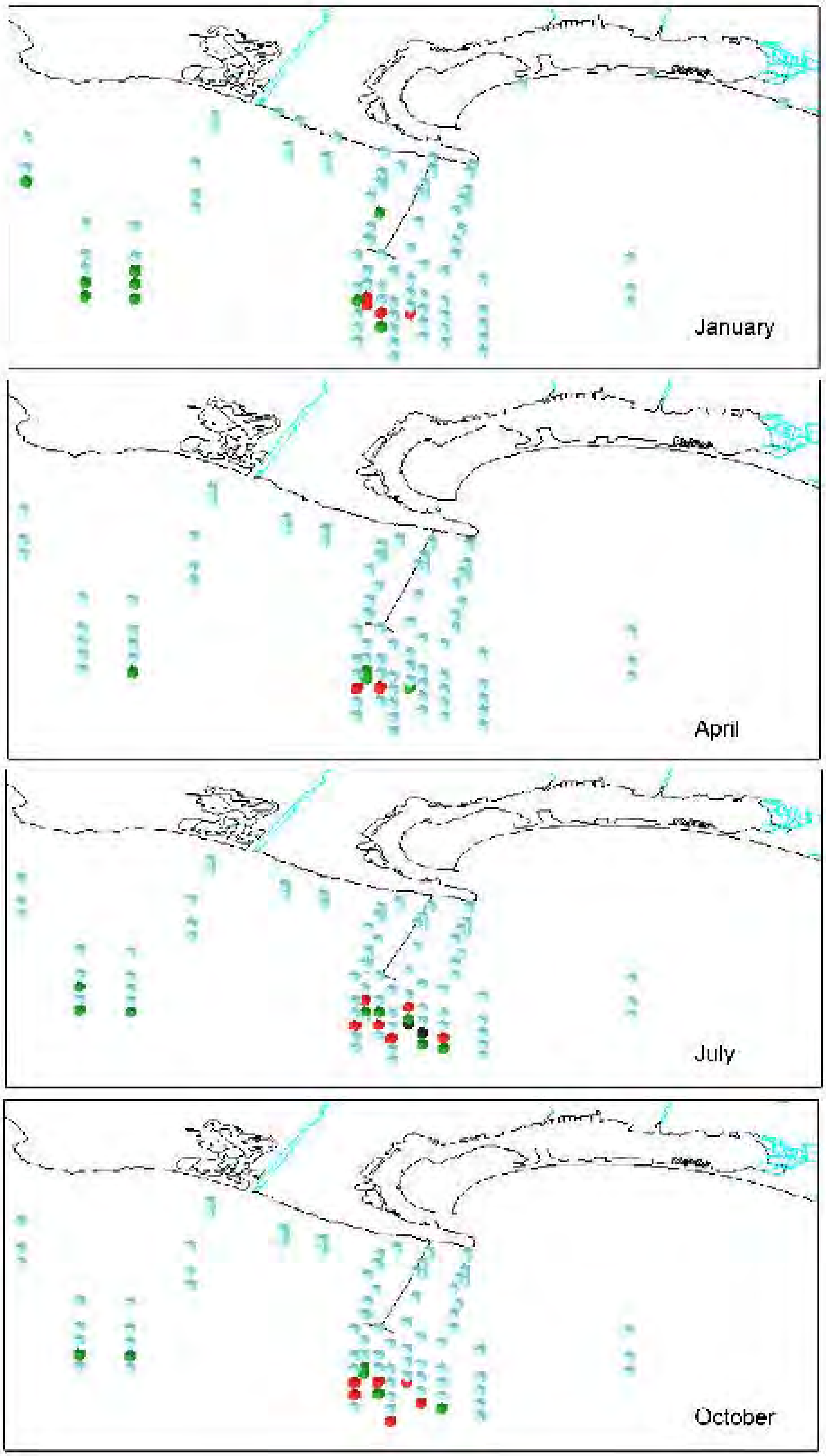


Figure 3.4

Volumetric plots (with deeper sample depths represented by the lowest blocks within each vertical stack of blocks) illustrating total coliform concentrations for seasonally-representative monthly samples at PLOO offshore stations. Abundance of total coliforms (in CFU / 100 mL) is color-coded with blue < 1,000; green > 1,000 but < 10,000; red = 10,000, and purple > 10,000.

these high and moderate total coliform values represent detection of the wastewater plume, the distances that it was transported horizontally did not vary seasonally.

Finally, interpolated data from all offshore and kelp stations also suggest that discharged wastewater from the outfall was rarely if ever transported to shore during 2002 (**Figure 3.5**). Stations along the 9 and 18-m contours exceeded benchmark values for total coliforms, fecal coliforms and enterococcus (1000, 400, and 104 CFU/100 mL, respectively) less than 10% of the time during 2002. Mild weather, calm sea state and strong water column stratification (see Chapter 2) throughout most of the year may have contributed to these results.

Bacterial Patterns and Other Indicators

Oil and grease measurements were not useful indicators of sewage contamination according to the 2002 data. All monthly averages, with one exception, were below the 0.2 mg/L standard detection limit. The exception occurred on January 14, when a concentration of 0.3 mg/L was recorded at station A-5, 4 km northwest of the outfall's northern end diffuser. Bacterial concentrations at A-5 on that day were very low, with total and fecal coliform concentrations $\leq$ 2 CFU/100 mL.

SUMMARY & CONCLUSIONS

In general, evidence of contamination at shore stations during 2002 was minimal. All the kelp stations and all but three shore stations were 100% compliant with every California Ocean Plan standard. The three exceptions, shore stations D-1, D-8, and D-9, were 100% compliant with all but the 30-day total coliform standard, with which they maintained 92% compliance.

Throughout 2002, moderate and high levels of bacteria (> 1,000 CFU/100 mL) introduced to offshore waters by the Point Loma Ocean Outfall discharge were restricted to deep waters far from shore. There were no indications that the plume was transported into recreational kelp bed waters or shoreline waters. Although there were occasional high bacterial counts at some shore stations, and some seasonal differences in average monthly bacterial concentrations were apparent, these differences were unrelated to rainfall events or wastewater discharge. These results suggest that sources other than discharged wastewater are more likely influencing shoreline bacterial contamination. These alternativce sources may include terrestrial run-off, plant and animal input, or recreational use.

Bacteriological data from offshore samples indicate that discharged materials were prevalent in deep waters immediately surrounding the outfall diffusers. The data also suggest that there may have been lateral transport but that such transport would have been parallel to shore and constrained to deeper waters, for the most part. High bacterial densities (i.e., total coliforms $\geq$ 10,000 CFU/ 100 mL) were found only at stations in the immediate vicinity of the PLOO, while moderate bacterial concentrations were evident to the north and, less frequently, to the south of the outfall terminus. If these moderate values represent transport of plume to locations north and south of the outfall terminus, this would suggest that significant dilution/dispersion of wastewater bacteria had occurred within the distance between stations where moderate and high values were recorded (i.e., a distance that ranged from ~ 3 to 16 km).

In addition to minimal transport shoreward, bacterial data from 2002 also indicate that plume material did not reach surface waters, even at stations directly above the outfall diffusers. Although physical characteristics of the water column (see Chapter 2) suggest strong seasonal stratification of the water column, the lack of an increase in bacterial concentrations in surface waters during winter months indicates that seasonal stratification was not the primary factor limiting plume influences on surface waters. The depth of discharge (94 m) may in fact be the strongest factor in restricting the wastewater plume to mid- and deep-water depths. Research shows that vertical displacement of isothermal surfaces within the water column off Point Loma can be as dramatic as 40 m within a 6 hour time period (Hendricks 1994), but data from the region do not

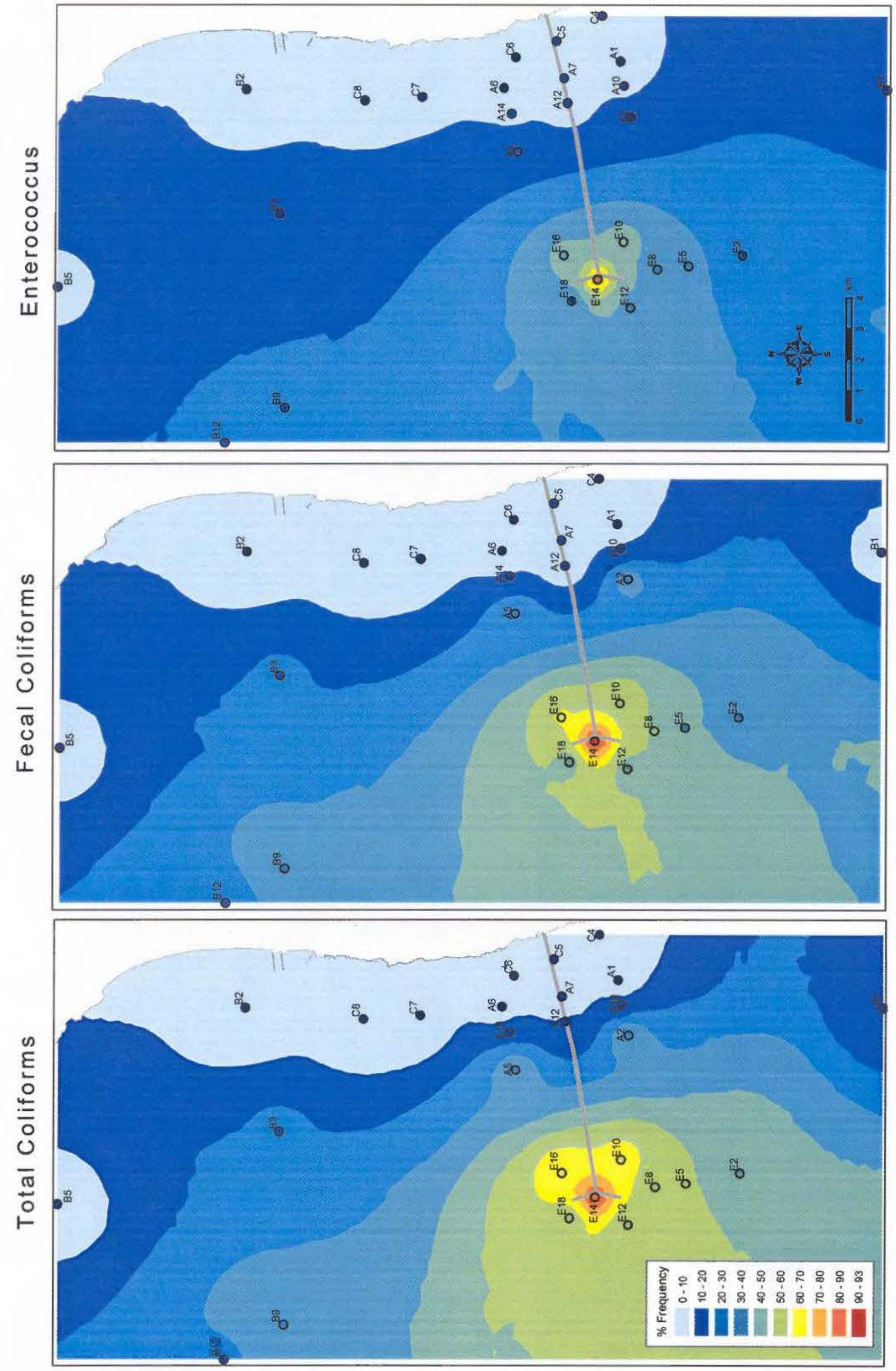


Figure 3.5

Estimated occurrence frequency that a given area of surface water surrounding the Point Loma Ocean Outfall has historically exceed benchmark concentrations for total coliforms (> 1,000 CFU/100 mL), fecal coliforms (> 400 CFU/100 mL) or enterococcus (> 104 CFU/100 mL). Probability surface is derived from krieged monthly data from 1993 – 2001.

indicate that such transport ever reached the surface. Overall, bacteriological data from the 2002 water quality surveys suggest that discharge from the PLOO rarely, if ever, impacted surface waters or nearshore recreational waters.

LITERATURE CITED

Bordner, R., J. Winter, and P. Scarpino (eds.). (1978). Microbiological Methods for Monitoring the Environment: Water and Wastes, EPA Research and Development, EPA-600/8-78-017. 337 pp.

City of San Diego. (2002). Annual Receiving Waters Monitoring Report for the South Bay Ocean Outfall (2001). City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2003). 2002 Quality Assurance Manual. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

Dailey, M.D., D.J. Reisch and J.W. Anderson eds. (1993). Ecology of the Southern California Bight: A Synthesis and Interpretation. 926 pp.

Greenberg A.E., L.S. Clesceri, and A.D. Eaton eds. (1992). Standard Methods for the Examination of Water and Wastewater, 18th edition. American Public Health Association, American Water Works Association, and Water Pollution Control Federation. 1391 pp.

Hendricks, T.J. (1994). Near bottom currents off Southern California. In: Cross, J.N., C. Francisco, and D. Hallock, eds. Southern California Coastal Water Research Project Annual Report 1992-93. Southern California Coastal Water Research Project, Westminster, CA. p. 65 - 80

US Environmental Protection Agency (1986). Ambient Water Quality Criteria for Bacteria - 1986. Office of Water Regulations and Standards, Criteria and Standards Division, EPA 440/5-84-002. 18 pp.

This page intentionally left blank

Sediment Characteristics

Chapter 4. Sediment Characteristics

INTRODUCTION

Sediment conditions can influence the distribution of benthic invertebrates by affecting the ability of various species to burrow, build tubes or feed (Gray 1981, Snelgrove and Butman 1994). In addition, many demersal fishes are associated with specific sediment types that reflect the habitats of their preferred prey (Cross and Allen 1993). Both natural and anthropogenic factors affect the distribution, stability and composition of sediments. Ocean outfalls are one of many anthropogenic factors that can directly influence the composition and distribution of ocean sediments. Wastewater outfalls discharge and subsequently deposit a wide variety of organic and inorganic compounds. Among the commonly detected compounds discharged via outfalls are trace metals, pesticides and various organic compounds (e.g., organic carbon, nitrogen, and sulfide compounds) (Anderson et al. 1993). Additionally, the physical structure of the outfall pipe (4 m diameter, 7 km length) can alter the hydrodynamic regime and substrate in the immediate area.

Natural factors affecting the distribution and stability of sediment grain size on the continental shelf include bottom currents, exposure to large waves, proximity to river mouths, sandy beaches, submarine basins, canyons and hills, and the presence and abundance of calcareous organisms (Emery 1960). The analysis of various parameters (e.g., sediment particle size, sorting coefficient, percentages of sand, silt, and clay) can provide useful information on the amount of wave action, current velocity and sediment stability in a given area.

The chemical composition of sediments can be similarly affected by natural factors, such as the geological history of an area. Sediment erosion from bays, cliffs, shores, rivers and streams contribute to the composition of metals within the area. For example, deposits of red relict sands containing ferric oxide may affect iron concentrations (Emery 1960). Furthermore, the organic content of sediments is greatly affected by nearshore primary productivity such as marine plankton production as well as terrestrial plant debris from bays, estuaries and river runoff (Mann 1982, Parsons et al. 1990). Concentrations of organic materials and trace metals within ocean sediments generally increase with increasing amounts of fine sediment particles chiefly as a result of adsorption (Emery 1960).

This chapter presents summaries and analyses of sediment grain size and chemistry data collected during 2002 in the vicinity of the City of San Diego's Point Loma Ocean Outfall (PLOO). The major goals of this study are to assess any impact of wastewater discharged through the outfall on the benthic environment in the region. Included are analyses of the spatial and temporal patterns of the various sediment grain size and chemistry parameters in an effort to determine the presence of sedimentary and chemical footprints near the discharge site.

MATERIALS & METHODS

Field Sampling

Sediment samples were collected during January, April, July and October 2002 at 23 stations surrounding the PLOO (**Figure 4.1**). These stations span the terminus of the outfall and are located along the 88, 98, and 116-m depth contours. The 17 "E" stations are located within 8 km of the outfall, while the six "B" stations are located greater than 11 km from the discharge site. Benthic sediment samples were collected using a modified 0.1-m^2 chain-rigged van Veen grab (see City of San Diego 2003). Sub-samples were taken from the top two cm of the sediment surface and handled according to EPA guidelines (USEPA 1987).

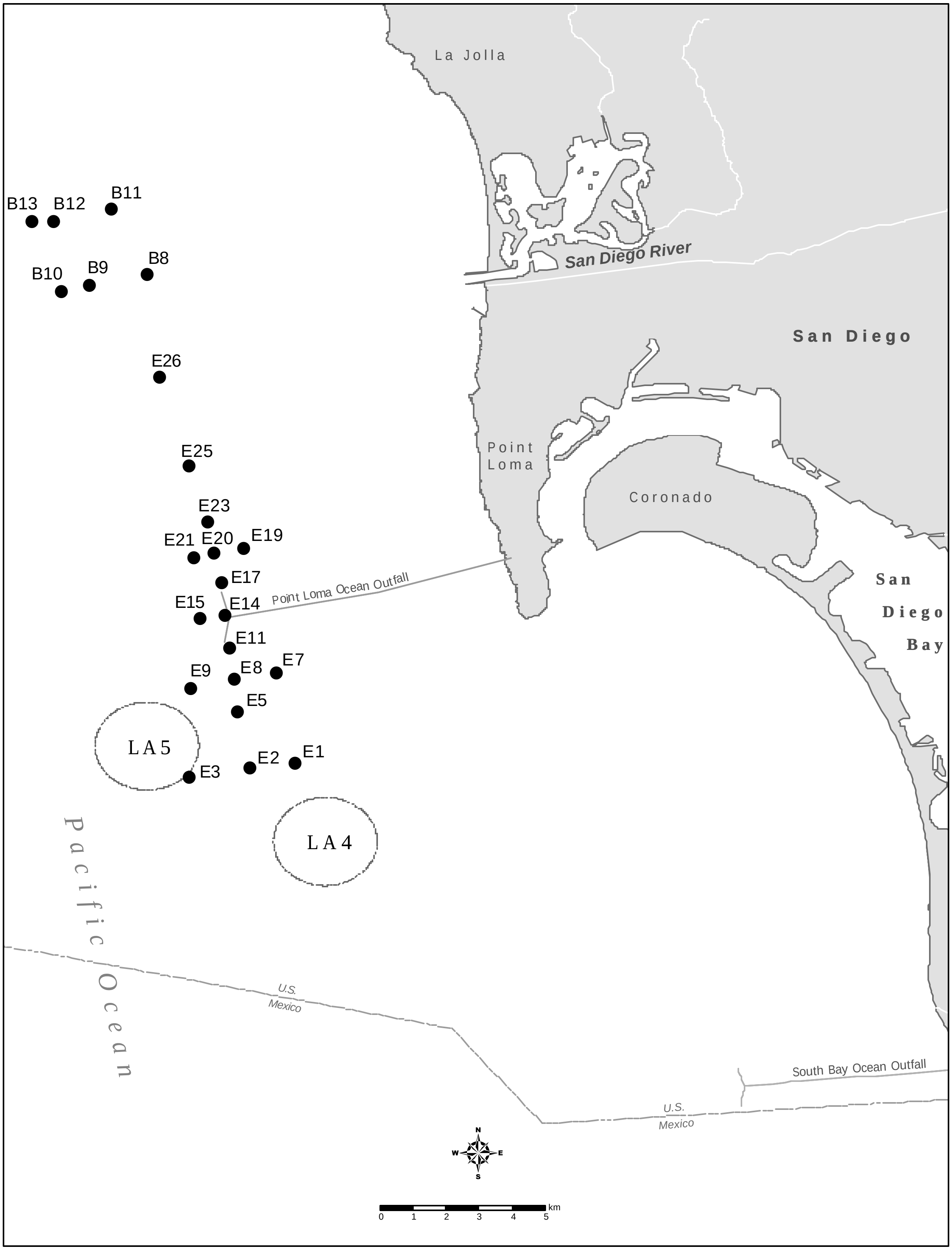


Figure 4.1
Sediment chemistry stations surrounding the City of San Diego Point Loma Ocean Outfall.

Laboratory Analyses

All sediment analyses were performed at the City of San Diego Wastewater Chemistry Laboratory. Particle size analyses were performed using a Horiba LA-900 laser analyzer, which measures particles ranging in size from 0 to 10 phi (i.e., sand, silt, clay fractions). Sand was defined as particles ranging in size from >0 to 4.0 phi, silt as particles from >4.0 to 8.0 phi, and clay as particles >8.0 phi. The fraction of "coarse" sediments (e.g., very coarse sand, gravel, shell hash) in each sample was determined by measuring the weight of particles retained on a 1.0 mm mesh sieve (i.e., $\leq$0 phi), and expressed as a percent weight of the total sample sieved.

Data Analyses

The following particle size parameters were calculated using a normal probability scale (see Folk 1968): median and mean phi size; sorting coefficient (standard deviation of phi size); skewness; kurtosis; percent sediment type (i.e., coarse particles > 1.0 mm in diameter, sand, silt, clay). Sediment samples were analyzed for the following chemical parameters: biochemical oxygen demand (BOD), total organic carbon (TOC), total nitrogen, total volatile solids (TVS), total sulfides, trace metals, chlorinated pesticides (e.g., aldrin, dieldrin, hexachlorocyclohexanes, DDT and derivatives, chlordane and related compounds), polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyl compounds (PCBs). A detailed list of analytes is provided in **Appendix A.1**.

Prior to analysis, these data were generally limited to values above method detection limits (MDLs). Some parameters, however, were determined to be present in a sample with high confidence (i.e., peaks are confirmed by mass-spectrometry), but at levels below the MDL. These were included in the data as estimated values. Null ("not detected") values were treated as zero values when performing statistics or estimating area means.

Concentrations of the various organic indicators and trace metals that were measured in sediments off Point Loma during 2002 were compared to the results from previous pre-discharge (1991–1993) and post–discharge (1994–2001) periods. In addition, values for metals, TOC, TN and pesticides (i.e., DDE) were compared to median values for the Southern California Bight. These bight-wide values were based on the respective cumulative distribution function (CDF) for each parameter (see Schiff and Gossett 1998) and are presented as the 50% CDF in the tables included herein.

RESULTS AND DISCUSSION

Particle Size Distribution

During 2002, Point Loma ocean sediments were composed predominantly of very fine sand and coarse silt, with a mean particle size of 4.1 phi (**Table 4.1**, **Figure 4.2**). Fine sediments (i.e., silt and clay fractions combined) averaged about 39% of the sediments overall, while sands accounted for 58%. Coarser materials such as shell hash and gravel comprised the remaining 3%.

There was an overall increase in proportion of fine particles on the Point Loma ocean shelf in 2002, especially compared to the previous four years (**Figure 4.3**, **Appendix A.2**). This change in fine particle composition was most notable at the north reference stations (e.g., B11-B13). An increase in fine particles within the sampling grid last occurred during 1992–1993 when strong winter storms associated with the 1992 El Niño resulted in increased runoff and erosion (Chavez et al. 2002, Reynolds et al. 1997). From 1993-2000, the area-wide proportion of fine sediments decreased from 44 to 33 percent. This was followed by an increase in fine materials during 2001–2002 coincident with sand nourishment of 76 miles of beaches from the U.S.-Mexican Border to Oceanside Harbor (SANDAG 2002). Overall, however, the distribution of fine sediment was similar to previous years, generally higher northward and inshore of the PLOO. The finest grained sediments during 2002 were measured at stations B8 and B11 (mean phi = 4.7 and 4.6 phi, respectively).

Coarse sediments occurred most frequently at the stations surrounding the outfall, stations near the LA-5 dredge disposal area, and several of the north reference stations (i.e., B11 and B13) (Table 4.1 and **Figure 4.4**).

Table 4.1

Summary of particle size parameters and organic loading indicators at PLOO stations during 2002. Particle size data are expressed as annual means for: mean phi size; standard deviation (SD); median phi size; percent sediment particles > 1.0 mm (Coarse); percent sand; percent silt and clay (Fines). Organic indicators include biochemical oxygen demand (BOD) (mg/L), sulfides (ppm), total nitrogen (TN; %wt); total organic carbon (TOC; %wt); total volatile solids (TVS; %wt). CDF = cumulative distribution functions (see text); *=not determined. MDL = method detection limit. Area Mean = annual mean for 2002. Pre = pre-discharge mean values. Post = post discharge mean values. Values that exceed the median CDF are indicated in bold type.

		Phi			Percent Composition			Organic Indicators				
Station	**Depth**	**Mean**	**SD**	**Median**	**Coarse**	**Sand**	**Fines**	**BOD**	**Sulfides**	**TN**	**TOC**	**TVS**
North Reference Stations												
B11	88	4.7	2.0	4.2	4.0	41.9	54.0	355	5.3	**0.076**	**1.329**	4.24
B8	88	4.7	1.5	4.2	0.0	39.9	60.0	262	2.1	**0.071**	**0.727**	3.21
B12	98	4.2	2.1	3.6	2.7	56.3	40.9	364	1.3	**0.058**	0.477	3.87
B9	98	4.4	1.4	3.9	0.0	56.9	43.1	250	1.6	**0.058**	0.552	3.05
B13	116	3.8	2.3	3.4	7.1	57.2	35.6	390	2.4	**0.057**	**1.679**	3.90
B10	116	4.1	1.5	3.4	0.4	68.5	31.1	321	1.3	**0.052**	0.465	2.95
Stations North of the Outfall												
E19	88	4.4	1.4	4.0	0.0	50.6	49.3	308	2.9	**0.060**	0.556	2.85
E20	98	4.0	1.5	3.6	3.8	59.6	36.6	286	1.8	**0.050**	0.470	2.45
E23	98	4.2	1.5	3.8	0.2	58.0	41.8	358	7.6	**0.055**	0.551	2.46
E25	98	4.1	1.4	3.8	0.7	60.2	39.0	290	3.1	**0.058**	0.524	2.47
E26	98	4.3	1.5	3.8	0.1	55.7	44.2	252	2.8	**0.059**	**0.612**	2.53
E21	116	4.1	1.5	3.6	0.0	63.8	36.1	406	3.3	**0.058**	0.520	2.40
Outfall Stations												
E11	98	4.0	1.3	3.6	0.6	68.7	30.7	298	11.1	0.044	**0.599**	2.38
E14	98	3.6	1.6	3.4	12.2	60.8	26.9	535	12.5	0.037	0.432	2.08
E17	98	3.9	1.3	3.6	0.2	69.5	30.3	299	5.3	0.046	0.456	2.13
E15	116	3.9	1.4	3.5	1.6	68.7	29.6	260	3.0	0.048	0.499	2.52
Stations South of the Outfall												
E1	88	4.1	2.0	3.7	5.0	53.5	41.5	288	6.4	**0.057**	0.560	2.45
E7	88	4.3	1.4	3.9	0.2	54.9	44.9	282	1.7	**0.056**	0.537	2.58
E2	98	4.2	2.2	3.9	6.4	47.4	46.2	315	2.9	**0.056**	**0.617**	2.74
E5	98	3.7	1.4	3.4	2.6	70.0	27.3	270	2.0	0.049	0.541	2.53
E8	98	3.9	1.4	3.5	0.2	67.1	32.6	204	2.6	0.045	0.415	2.30
E3	116	3.7	2.3	3.5	7.3	53.5	39.0	213	4.8	0.035	0.332	2.09
E9	116	4.0	2.3	3.8	11.6	48.3	40.1	354	1.7	**0.051**	0.491	2.97
Area Mean		4.1	1.7	3.7	2.9	57.9	39.2	311	3.9	0.054	0.606	2.75
Pre		4.1	1.6	3.7	1.0	57.1	41.8	236	4.0	0.039	0.532	2.38
Post		3.9	1.7	3.5	2.3	60.0	37.7	301	4.6	0.053	0.639	2.63
MDL								2	0.05	0.005	0.005	*
50% CDF								*	*	0.050	0.597	*

Note: Coarse was determined separately from sand, silt and clay (see Materials and Methods).

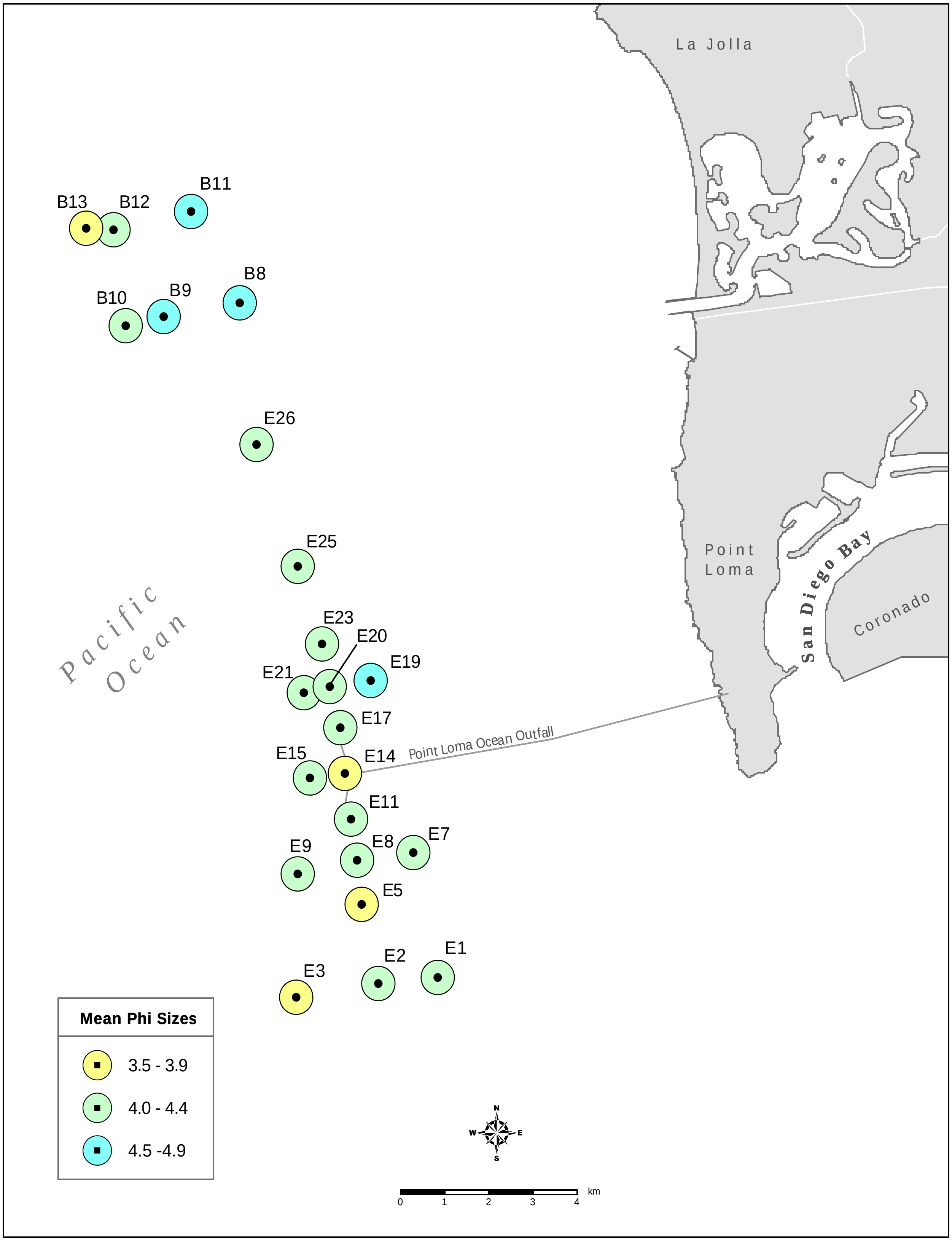


Figure 4.2

Mean phi size per station averaged over four quarters for sediment particle size data collected during 2002.

The coarse sediments at station E14 (i.e., 73% sand and shell hash, mean phi=3.6) are probably due to its location near the center of the outfall "wye." Visual examination of the sediments at this site have occasionally revealed the presence of coarse, black sand that was used as stabilizing material around the outfall pipe (see Appendix A.2). This black sand was also present at stations E8, E9, E11, and E15 indicating the potential spread of this ballast material south and east of the outfall. Sediments at several sites near the LA-5 disposal site were also composed of varying amounts of shell hash and coarse black sand. The source of coarse sediments at these sites is probably the nearby LA-5 disposal site (see **Figures 4.1 and 4.5**). Barges laden with dredged material from San Diego Bay have been observed making deposits at station E5 in the past, and evidence that the main disposal mound has dispersed into areas outside the boundaries of LA-5 has been detected by the United States Geological Survey (Gardner et al. 1998). Sediments at the northern sites B10, B11, B12, and B13 contained variable amounts of shell hash and coarse sands despite the increase in fine particles. These coarse sediments may be related to the location of these northern stations along the outer shelf where strong currents and internal waves export fine sediments down the slope leaving shell hash and larger particles behind (see Shepard and Marshall 1978, Boczar-Karakiewicz et al. 1991).

Organic Indicators

Region-wide mean values of organic indicators during 2002 were generally low, and have changed little over the past several years (**Table 4.1, Appendix A.3**). For example, even though organic content tended to be higher north of the PLOO, most TOC samples were similar to the average pre-discharge level of 0.532% and below the median CDF level of 0.597%.

During 2002, total nitrogen, TOC and total volatile solids (TVS) were highest at some of the north reference stations (i.e., B8, B11, B13). Stations near the PLOO (i.e., E11, E14, E21) also had elevated values for some organic indicators (e.g., sulfides or BOD), but not others. For example, station E21 had the second highest value for BOD (406 mg/L), but

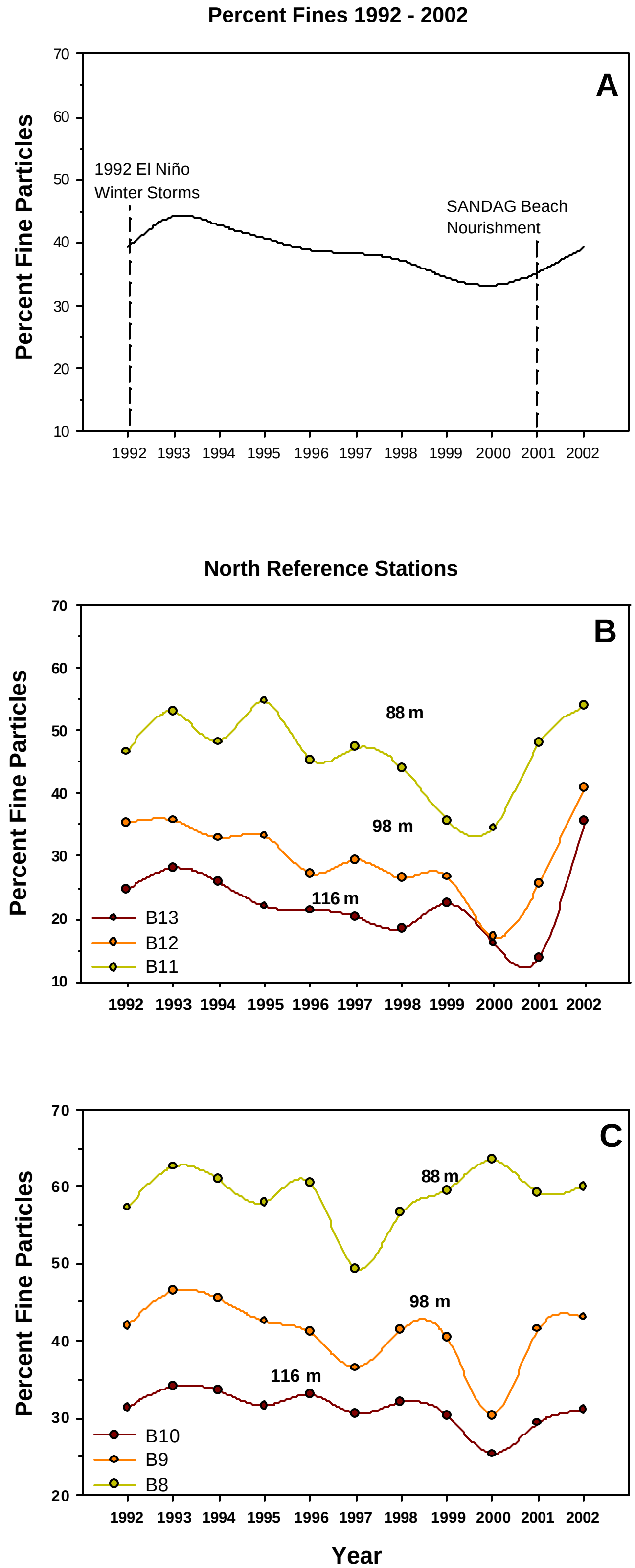


Figure 4.3

Annual mean values for percent fines during 1992–2002 for all stations (**A**), and for northern reference stations B11–B13 (**B**) and B8–B10 (**C**).

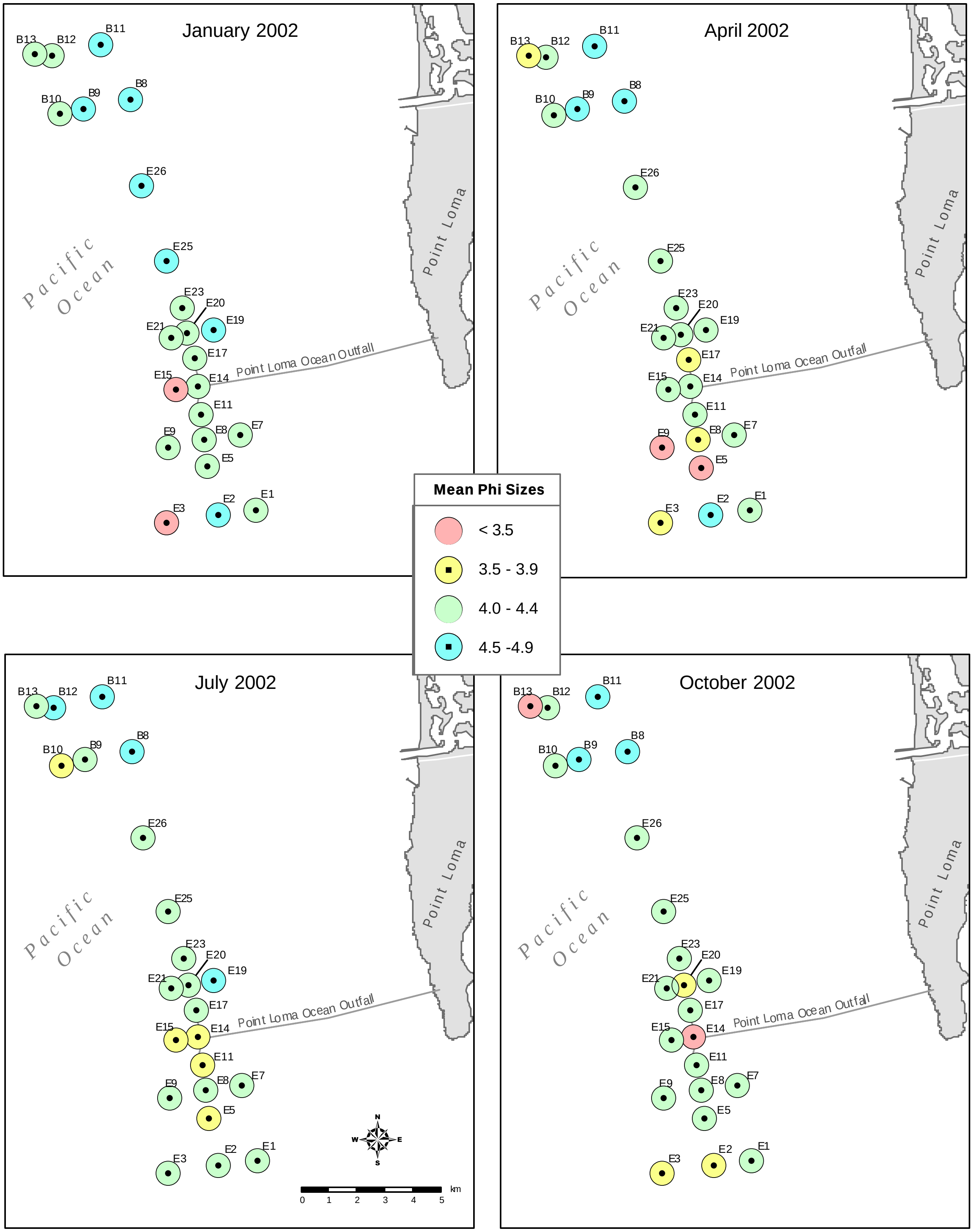


Figure 4.4
Mean phi size data for sediment particle size collected during January, April, July, and October 2002.

Table 4.2

Concentrations of trace metals (ppm) detected at each station during 2002. CDF = cumulative distribution function (see text). MDL = method detection limit. "nd" = not detected. NA = not available. Area Mean = annual mean for 2002. Pre = pre-discharge mean values. Post = post discharge mean values. Values that exceed the median CDF are indicated in bold type.

	Trace Metals																
Station	**Al**	**Sb**	**As**	**Be**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mn**	**Hg**	**Ni**	**Se**	**Ag**	**Tl**	**Sn**	**Zn**
North Reference Stations																	
B11	**11250**	nd	3.6	nd	0.2	20	11	**19075**	1.3	121.3	0.014	6.2	0.15	nd	nd	nd	39
B8	**14625**	**3.5**	4.0	nd	nd	19	**13**	16075	nd	125.3	0.020	9.8	0.13	nd	nd	nd	35
B12	8048	**2.0**	**5.6**	nd	nd	22	9	**21925**	nd	68.5	0.009	3.4	0.15	nd	nd	nd	35
B9	**11725**	**2.5**	3.6	nd	nd	19	**12**	**16850**	nd	111.5	0.014	6.6	0.13	nd	nd	nd	33
B10	8093	nd	2.8	nd	nd	17	8	13950	nd	75.7	0.010	3.3	0.12	nd	nd	nd	28
B13	6955	**3.4**	**16.0**	nd	0.2	30	6	**25200**	3.8	70.8	0.008	3.8	0.14	nd	nd	nd	35
Stations North of the Outfall																	
E19	**12010**	**1.4**	3.5	nd	nd	12	11	13800	nd	112.5	0.030	5.9	0.15	nd	nd	nd	25
E20	**9608**	nd	2.7	nd	nd	14	8	10850	2.2	88.3	0.018	4.6	0.11	nd	2.75	nd	25
E23	**10960**	**1.8**	3.1	nd	nd	15	11	12000	nd	97.1	0.015	5.5	0.14	nd	nd	nd	27
E25	**10370**	**1.3**	2.9	nd	nd	13	9	12250	1.5	83.8	0.017	6.1	0.13	nd	nd	nd	24
E26	**10735**	**1.6**	3.0	nd	nd	16	9	12975	1.4	99.1	0.016	6.1	0.17	**1.0**	nd	nd	29
E21	9080	**1.3**	2.9	nd	nd	14	9	11125	nd	82.0	0.015	4.9	0.12	nd	nd	nd	25
Outfall Stations																	
E11	8535	**1.4**	2.8	nd	nd	13	7	10520	nd	80.7	0.011	4.7	0.13	nd	nd	nd	24
E14	8683	nd	3.0	nd	nd	14	10	11660	nd	110.4	0.008	8.3	0.13	nd	nd	nd	28
E17	8418	**1.3**	2.9	nd	nd	13	8	10103	nd	81.9	0.010	4.0	0.11	nd	2.75	nd	24
E15	8350	**1.3**	2.5	nd	nd	13	8	10085	nd	78.0	0.013	4.0	0.11	nd	nd	nd	23
Stations South of the Outfall																	
E1	**11630**	nd	3.0	**0.5**	nd	15	**13**	13225	5.1	101.2	0.035	6.2	0.11	**1.0**	nd	nd	32
E7	**11150**	**1.3**	3.1	nd	0.1	15	**12**	12325	1.5	102.7	0.020	7.2	0.11	nd	nd	nd	33
E2	**13475**	**1.4**	3.4	nd	nd	19	**15**	15575	2.3	115.8	**0.040**	8.0	0.13	nd	nd	nd	35
E5	**9775**	**1.4**	2.9	nd	nd	14	11	11500	nd	89.4	0.023	4.9	0.12	nd	nd	nd	25
E8	9170	**1.9**	2.7	nd	nd	13	10	10510	nd	87.8	0.010	5.7	0.11	nd	nd	nd	24
E3	**12788**	**5.6**	3.1	nd	nd	15	**16**	14625	nd	119.1	0.027	6.1	0.11	nd	4.75	nd	33
E9	9315	**2.9**	3.3	**0.3**	nd	17	**12**	13550	3.3	82.4	0.017	6.3	0.17	nd	nd	nd	39
Area mean	10206	1.6	3.8	0.0	0.0	16	10	13902	1.0	95.0	0.017	5.7	0.13	0.1	0.45	nd	30
Pre	NA	0.3	2.5	0.3	1.0	17	8	13023	2.2	NA	0.014	6.4	0.18	0.1	7.3	NA	28
Post	10422	1.9	3.7	0.3	0.3	18	10	14191	2.1	100.1	0.015	7.7	0.24	0.1	0.3	0.81	32
MDL	5	5	0.08	0.20	0.5	3	2	3	5.00	0.5	0.03	3.0	0.11	3.0	10	12.0	4.0
50% CDF	9400	0.2	4.8	0.26	0.29	34	12	16800	10.2	NA	0.04	16.3	0.29	0.17	NA	NA	56

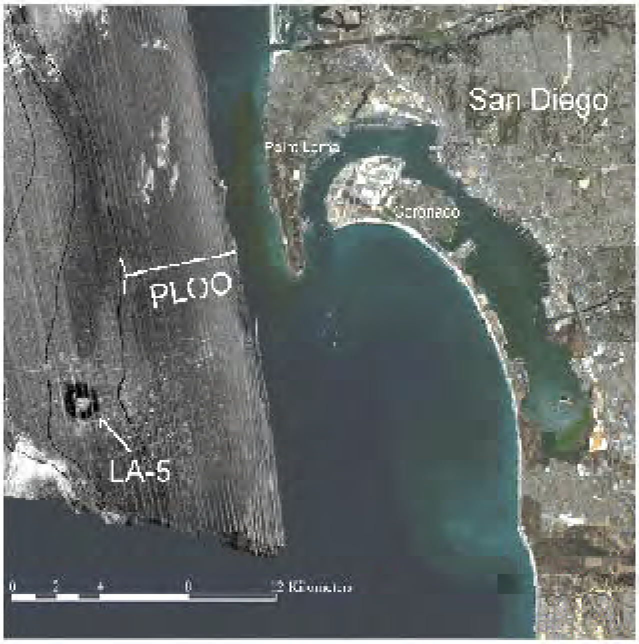


Figure 4.5
The LA-5 dredge disposal site shown as an acoustic backscatter image superimposed on a Landsat-7 satellite land image of San Diego (USGS 1998). Lighter areas represent harder (more dense) substrates.

relatively low values for sulfides, TOC and TVS. Similarly, concentrations of BOD and sulfides were relatively high at station E14, but the levels of the other organic compounds were lower than at many other stations.

Trace Metals

Sediments concentrations of trace metals were generally low off Point Loma in 2002 (**Table 4.2**). Most of the metals detected during the year occurred at levels less than the median values for the Southern California Bight (i.e., 50% CDF). Only aluminum, antimony, arsenic, beryllium, copper, iron, mercury, and silver were all detected above their respective median. Tin was not detected at any station.

The highest concentrations of trace metals occurred at stations to the north and south of the PLOO. For example, several northern reference stations (i.e., B8, B9, B12, B13), stations near LA-5 (i.e., E1, E2, E3, E7, E9), as well as station E26, had values above the median CDF for three or more metals. In contrast, metal concentrations were generally lower near the outfall. Antimony was the only metal detected above the median at stations E11 through E17. With one exception (i.e., aluminum), trace metal concentrations did not increase with decreasing particle sizes or depth. This pattern is similar to that seen in previous years (**Appendix A.4**).

Pesticides, PAHs and PCBs

DDT was the only pesticide detected in sediments sampled off Point Loma in 2002. It was detected in low concentrations, primarily in January and April (**Table 4.3**). The highest values of DDE (the final metabolic degradation product of DDT) were just above 900 ppt (i.e., E7, E19, B8), below the median concentration of 1,200 ppt for DDE. Finally, annual mean values of total DDT were well below the median of 10,000 ppt.

Concentrations of polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyl compounds (PCBs) were generally near or below method detection limits (MDL) during 2002 (see **Table 4.4**). Except for the occurrence of pyrene (a PAH) at station E14, these contaminants were primarily found at the southern stations E1, E2, E3, E5, and E9. Concentrations of both contaminants have been previously reported as relatively high in the area surrounding the LA-5 dredge disposal site (see Anderson et al. 1993, City of San Diego 2000, 2001, 2002). There were no patterns that indicated a chemical footprint around the PLOO.

SUMMARY AND CONCLUSIONS

An increase in fine particles was observed on the Point Loma ocean shelf in 2002 and was most evident at the north reference stations. The accretion of fine particles was coincidental with a SANDAG program for sand nourishment of 76 miles of beaches from the U.S.-Mexican Border to Oceanside Harbor (SANDAG 2002). Shortly after inauguration of the program, much of the deposited sand was lost to wave activity. Offshore transport may have shifted the finer particles offshore to stations within the sampling grid (see Johnson et al. 1982). A similar increase in fine

Table 4.3

Concentrations of p,p DDE (ppt) at PLOO stations during 2002. Total DDT (T-DDT) is the mean of all DDD, DDE, and DDT derivatives for all surveys. CDF = cumulative distribution function (see text). MDL = method detection limit. "nd" = not detected.

	Quarter				Mean of
Station	**Jan**	**Apr**	**Jul**	**Oct**	**T-DDT**
North Reference Stations					
B11	nd	440	nd	nd	110
B8	550	930	nd	nd	370
B12	nd	nd	nd	nd	nd
B9	340	610	nd	nd	238
B13	nd	440	nd	nd	110
B10	nd	470	nd	nd	118
Stations North of the Outfall					
E19	920	520	nd	nd	360
E20	nd	nd	nd	nd	nd
E23	nd	150	nd	nd	38
E25	840	610	nd	nd	363
E26	nd	755	nd	nd	189
E21	nd	440	265	nd	176
Outfall Stations					
E11	560	nd	nd	nd	140
E14	500	nd	nd	nd	125
E17	nd	nd	nd	nd	nd
E15	nd	nd	nd	nd	nd
Stations South of the Outfall					
E1	670	450	360	390	468
E7	920	330	nd	nd	313
E2	780	390	nd	nd	293
E5	830	nd	620	nd	363
E8	720	nd	nd	nd	180
E3	nd	nd	nd	nd	nd
E9	750	270	nd	nd	255
MDL	3800	3800	3800	3800	
50%CDF	1200	1200	1200	1200	10000

particles along the shelf was observed during 1992–1993 following strong winter storms coincident with the 1992 El Niño (see Chavez et al. 2002). Even with this increase in fine particles, the overall composition was similar to previous annual surveys. Very fine sand and coarse silt were the predominant sediment types with the amount of coarser particles rising with increased depth. The two northern reference stations, the southernmost stations near the LA-5 dredged material disposal site and other stations located near the outfall had the greatest amount of coarse materials (e.g., gravel, shell hash). Stations located near the outfall, and between the outfall and LA-5 contained variable amounts of ballast sand, coarse particles and shell hash. Generally, these results reflect the multiple anthropogenic (e.g., outfall construction, dredge disposal) and natural (e.g., Pleistocene and recent detrital deposits) influences on the region's sediment composition.

Overall, the concentration and distribution of organic indicators in 2002 was very similar to pre-discharge periods. The highest concentrations of total nitrogen, total carbon and total volatile solids occurred at the northern reference sites, while the highest values for BOD and sulfide occurred near the PLOO (i.e., station E14). Stations located near the LA-5 disposal site generally had lower values for organic indicators during 2002 compared to previous annual surveys where values at these stations were often high.

Trace metals occurred in the highest concentrations at sites characterized by coarse sediments. This included the northern reference stations and stations near the LA-5 disposal site. The highest copper concentrations were found at stations near LA-5, and may be associated with the disposal of dredged sediments from San Diego Bay. Such sediments often contain residues of copper-tainted antifouling paint, 70% of which may originate at Navy berths in the bay (Schiff and Cross 1992). There was no clear indication of increasing trace metal concentrations with decreasing particle size. Generally, the accumulation of fine particles greatly influences the content of organic materials and metals in sediments (Eganhouse and Venkatesan 1993), however the overall low concentrations may obscure these patterns. Most metals occurred in concentrations well below the median values for sediments in the Southern California Bight.

DDE is the final metabolic degradation product of DDT, and is the most abundant derivative in the environment (Eganhouse and Venkatesan 1993). The wide distribution of low levels of p,p-DDE is a result of its discharge through outfalls and rivers from the early 1950s through 1971, and is an indication of its ubiquitous use and the inherent stability of DDT

Table 4.4

Concentrations for PAH (parts per billion) and PCB (parts per trillion) compounds in PLOO sediments during 2002. MDL = method detection limit. "nd" = not detected.

	PAH					PCB		
Quarter	3,4-Benzo[B] fluoranthene	Benzo[A] anthracene	Benzo[A] pyrene	chrysene	pyrene	PCB_101	PCB_110	PCB_180
January								
E1	nd	13.7	nd	10.7	13.6	380	450	nd
E2	nd	nd	nd	nd	nd	nd	nd	640
E9	nd	nd	nd	nd	nd	nd	nd	750
April								
E3	nd	26.4	18.9	42	31.6	nd	nd	870
July								
E1	nd	11.6	nd	nd	nd	nd	nd	nd
E2	27.9	nd	nd	nd	nd	nd	nd	nd
E9	nd	23.5	nd	nd	nd	nd	nd	nd
October								
E1	nd	nd	18.3	nd	nd	1200	nd	nd
E3	nd	12	19.4	nd	nd	900	nd	nd
E14	nd	nd	nd	nd	41.2	nd	nd	nd
MDL	27	23	18	21	27	2600	2900	2600

derivatives. A change in chemical analysis reporting methods in 2001 (see City of San Diego 2002) resulted in an increase in the overall detection rate of p,p-DDE. Stations with reportable values were therefore more widespread within the sampling region during 2002 than in years prior to 2001 (e.g., City of San Diego 2001). However, even with this increased capability to detect DDE, the distribution of this pesticide appears to be unrelated to distance from the PLOO.

Values for PAHs and PCBs were generally near or below detection limits at all sampling sites. When detected, however, both PAHs and PCBs were typically found at stations located near the LA-5 dredge materials disposal site (i.e., stations E1, E2, E3, E5, E9). Historically, concentrations of PAHs and PCBs have been higher at these southern stations than elsewhere off San Diego, and are most likely the result of misplaced deposits of dredged material that were originally destined for LA-5. Previous studies of PCBs in this area have been attributed to the deposits at LA-5 (Anderson et al. 1993). There were no patterns that coincided with proximity to the PLOO.

LITERATURE CITED

Anderson, J.W., D.J. Reish, R.B. Spies, M.E. Brady, and E.W. Segelhorst. (1993). Human impacts. In: Dailey, M.D., D.J. Reish and J.W. Anderson, (eds.). Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press, Berkeley, CA. p. 682-766

Boczar-Karakiewicz, B., J.L. Bona, and B. Pelchat. (1991). Sand ridges and internal waves on continental shelves. In:Kraus, N., K. Gingerich, and D. Kriebel, (eds.). Coastal Sediments '91. Vol.1. American Society of Civil Engineers, New York. p. 527-541

Chavez, F. P., J. T. Pennington, C.G. Castro, J. P. Ryan, R. P. Michisaki, B. Schlining, P. Walz, K. R. Buck, A. McFadyen, and C. A. Collins. (2002). Biochemical and chemical consequences of the 1997–1998 El Niño in central California waters. In: Progress in Oceanography vol. 54, Pergamon Press. pp. 205–232.

City of San Diego. (2000). Receiving Waters Monitoring Report for 1999, Ocean Monitoring

Program. Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2001). Receiving Waters Monitoring Report for 2000, Ocean Monitoring Program. Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2002). Receiving Waters Monitoring Report for 2001, Ocean Monitoring Program. Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

Cross, J. N., and L. G. Allen. (1993). Fishes. In: Dailey, M.D., D.J. Reish and J.W. Anderson, (eds.). Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press, Berkeley, CA. p. 459-540

Eganhouse, R. P., and M.I. Venkatesan. (1993). Chemical oceanography and geochemistry. In: Dailey, M.D., D.J. Reish and J.W. Anderson, (eds.). Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press, Berkeley, CA.

Emery, K.O. (1960). The Sea Off Southern California. John Wiley, New York. 366 pp.

Folk, R.L. (1968). Petrology of Sedimentary Rocks. Austin, TX. 182 pp. http://www.lib.utexas.edu/geo/FolkReady/TitlePage.html

Gardner, J.V., P. Dartnell, and M.E.Torresan. (1998). LA-5 Marine Disposal Site and Surrounding Area, San Diego, California: Bathymetry, Backscatter, and Volumes of Disposal Materials. Department of the Interior, US Geological Survey, Menlo Park, CA 94025.

Gray, J.S. (1981). The Ecology of Marine Sediments: An Introduction to the Structure and Function of Benthic Communities. Cambridge University Press, Cambridge, England. 185 pp.

Johnson, M. A., N. H. Kenyon, R. H. Belderson and A. H. Stride. (1982). Sand Transport. In: Stride, A. H. (ed.) Offshore Tidal Sands. Chapman and Hall, London.

Mann, K. H. (1982). The Ecology of Coastal Marine Waters: A Systems Approach. University of California Press, Berkely.

Parsons, T.R., M. Takahashi, B. Hargrave (1990). Biological Oceanographic Processes 3rd Edition. Pergamon Press, Oxford.

Reynolds, R., M. Dettinger, D. Cayan, D. Stephens, L. Highland, and R. Wilson. (1997. Effects of El Niño on Stream Flow, Lake Level, and Landslide Potential. U. S. Geological Survey. http://geochange.er.usgs.gov/sw/changes/natural/elnino

SANDAG (San Diego Association of Governments). (2002). SANDAG Regional Beach Monitoring Program: Spring 2002 State of the Coast Report. Prepared for SANDAG by Coastal Frontiers Corporation, Chatsworth, CA 91311-5759. http://www.sandag.org/uploads/publicationid/publicationid_741_1415.pdf

Schiff, K., and J. Cross. (1992). Estimates of ocean disposal inputs to the Southern California Bight. In: Southern California Coastal Water Research Project Annual Report 1990-1991 and 1991-1992. Long Beach, CA. p. 50-60

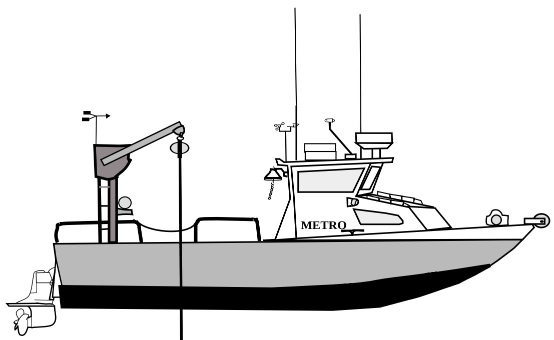
Schiff, K.C., and R.W. Gossett. (1998). Southern California Bight 1994 Pilot Project: Volume III. Sediment Chemistry. Southern California Coastal Water Research Project, Westminister, CA.

Shepard, F.P., and N.F. Marshall. (1978). Currents in submarine canyons and other sea valleys. In: Stanley, D.J., and G. Kelling (eds.). Sedimentation in Submarine Canyons, Fans, and Trenches. Dowden, Hutchinson and Ross, Inc., PA. p. 3-14

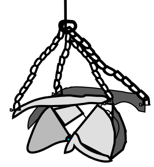
Snelgrove, P.V.R., and C.A. Butman. (1994). Animal-sediment relationships revisited: cause versus effect. Oceanogr. Mar. Biol. Ann. Rev., 32:111-177

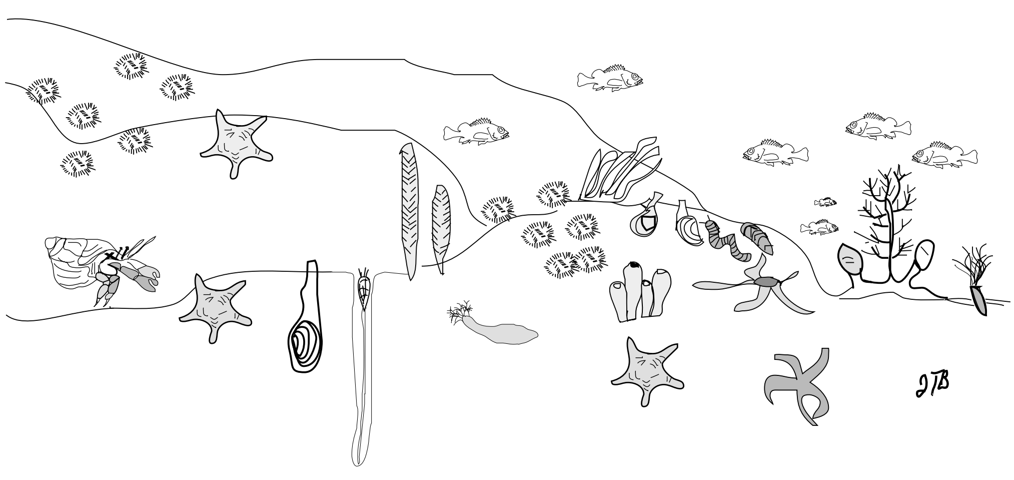
USGS (United States Geological Survey). (1998). EM300 Multibeam Acoustic Backscatter Offshore San Diego, CA. http://walrus.wr.usgs.gov/pacmaps/sd- mos.html

USEPA (United States Environmental Protection Agency). (1987). Quality Assurance and Quality Control (QA/QC) for 301(h) Monitoring Programs: Guidance on Field and Laboratory Methods. EPA Document 430/9-86-004. Office of Marine and Zeng Estuarine Protection. 267 p.



Benthic Infauna





Chapter 5. Benthic Infauna

INTRODUCTION

Marine sediments on the southern California coastal shelf typically contain a diverse community of infaunal invertebrates (Fauchald and Jones 1979, Thompson et al. 1993, Bergen et al. 2001). These animals are essential members of the marine ecosystem, serving vital functions in wide ranging capacities. For example, many species of benthic invertebrates provide the prey base for fish and other organisms, while others decompose organic material as a crucial step in nutrient cycling.

Living among the sediments, however, can expose benthic organisms to the toxic contaminants and low oxygen conditions that are often associated with human impacts. Since benthic infauna generally have limited mobility, they are often not able to avoid such adverse conditions. In addition, because various species respond differently to environmental stress, infaunal assemblages have long been considered valuable indicators of anthropogenic impact (Pearson and Rosenberg 1978). Consequently, the assessment of benthic community structure is a major component of many marine monitoring programs, which document both existing conditions and trends over time.

The structure of infaunal communities is influenced by many factors including sediment conditions (e.g., particle size and sediment chemistry), water conditions (e.g., temperature, salinity, dissolved oxygen and current velocity) and biological factors (e.g., food availability, competition and predation). Although human activities can affect these factors, natural processes largely control the structure of invertebrate communities in marine sediments. Therefore, in order to determine whether changes in community structure are related to human impacts or natural processes, it is necessary to have documentation of background or reference conditions for an area. Such information is available for the region surrounding the Point Loma Ocean Outfall (PLOO) and the San Diego region in general (e.g., City of San Diego 1995, 1999).

This chapter presents analyses and interpretation of the infaunal data collected during 2002 at fixed stations surrounding the PLOO discharge site off San Diego, California. Included are descriptions and comparisons of the different assemblages that inhabit soft bottom sediments in the area and analysis of benthic community structure.

MATERIALS & METHODS

Collection and Processing of Samples

Quarterly benthic samples were collected during January, April, July and October 2002 at 21 stations surrounding the Point Loma Ocean Outfall (**Figure 5.1**). These stations are located along the 88, 98, and 116-m depth contours and span the terminus of the outfall. The 15 “E” stations are located within 8 km north or south of the outfall, while the six “B” stations are located more than 11 km north of the discharge site.

Samples for benthic community analysis were collected from two replicate 0.1 m^2 van Veen grabs per station during each survey. The criteria established by the United States Environmental Protection Agency to ensure the consistency of grab samples were followed with regard to sample disturbance and depth of penetration (USEPA 1987). All samples were sieved aboard ship through a 1.0 mm mesh screen. Organisms retained on the screen were relaxed for 30 minutes in a magnesium sulfate solution and then fixed in buffered formalin (see City of San Diego 2003). After a minimum of 72 hours, each sample was rinsed with fresh water and transferred to 70% ethanol. All organisms were sorted from the debris into major taxonomic groups by a subcontractor (MEC Analytical Systems, Inc., Carlsbad, California). The biomass for each sample was measured as the wet weight in grams for each of the following major groups: Polychaeta

Figure 5.1
Benthic infauna stations surrounding the Point Loma Ocean Outfall.

(Annelida), Crustacea (Arthropoda), Mollusca, Ophiuroidea (Echinodermata), non-ophiuroid Echinodermata, and all other phyla combined (e.g., Cnidaria, Platyhelminthes, Phoronida, Sipuncula, etc.). Values for ophiuroids (i.e., brittle stars) and all other echinoderms were combined to give a total echinoderm biomass. After biomassing, all animals were identified to species or the lowest taxon possible and enumerated by City of San Diego marine biologists.

One sample (station E20, replicate 1) collected during October, 2002, was excluded from analysis due to preservation problems that made it difficult or impossible to accurately identify the animals. Additional information about this sample is available from the City's Marine Biology Laboratory.

Statistical Analyses

The following benthic community structure parameters were calculated for each station: species richness (number of species per grab); total number of species per station (i.e., cumulative of two replicate samples); abundance (number of individuals per grab); biomass (grams per grab, wet weight); Shannon diversity index (H' per grab); Pielou's evenness index (J' per grab); Swartz dominance index (minimum number of species accounting for 75% of the abundance in each grab; see Swartz 1978); Infaunal Trophic Index (ITI per grab; see Word 1980) and Benthic Response Index (BRI per grab; see Smith et al. 2001).

Ordination (principal coordinates) and classification (hierarchical agglomerative clustering) analyses were performed to examine spatio-temporal patterns in the overall similarity of benthic assemblages in the region during 2002. These analyses were performed using Ecological Analysis Package (EAP) software (see Smith 1982, Smith et al. 1988). The macrofaunal abundance data were square-root transformed and standardized by the species mean values greater than zero. Prior to analysis the data set was reduced by excluding any taxon that was represented by less than 10 individuals over all samples. The effect of such reductions on the outcome of subsequent analyses is considered negligible (see Smith et al. 1988).

A BACIP (Before-After-Control-Impact-Paired) statistical model was used to test the null hypothesis (H_0) that there were no changes in various community parameters due to operation of the Point Loma outfall (see Bernstein and Zalinski 1983, Stewart-Oaten et al. 1986, 1992, Osenberg et al. 1994). Briefly, the BACIP model tests differences between control (reference) and impact sites at times before (i.e., July 1991-October 1993) and after (i.e., January 1994-October 2002) an "impact" event (i.e., the onset of discharge). The analyses presented in this report are based on 2.5 years (10 quarterly surveys) of "Before Impact" data and nine years (36 quarterly surveys) of "After Impact" data. The "E" stations, located within 8 km of the outfall, are the most likely to be affected by the discharge. Station E14 was selected as the "impact" site for all analyses; this station is located nearest the Zone of Initial Dilution (ZID) and is probably the site most susceptible to impact. In contrast, the "B" stations are located farther from the outfall (>11 km) and are the obvious candidates for reference or "control" sites. However, benthic communities differed between the "B" and "E" stations prior to discharge (Smith and Riege 1994, City of San Diego 1995). Thus, two stations (E26 and B9) were selected to represent separate control sites in the BACIP tests. Station E26 is located ~8 km from the outfall and is considered the "E" station least likely to be impacted. Previous analyses suggested that station B9 was one of the most appropriate "B" stations for comparison with the "E" stations (Smith and Riege 1994, City of San Diego 1995). Six dependent variables were analyzed, including three community parameters (number of species, infaunal abundance, ITI) and abundances of three taxa that are considered sensitive to organic enrichment. These indicator taxa included ophiuroids in the genus *Amphiodia* (mostly *A. urtica*) and amphipods in the genera *Ampelisca* and *Rhepoxynius.* All BACIP analyses were interpreted using a conventional Type I error rate of $\alpha = 0.05$.

RESULTS & DISCUSSION

Community Parameters

Number of Species

A total of 642 infaunal taxa was identified during the 2002 PLOO surveys. Since the mean number of species per sample (Species Richness) and the cumulative number of species per site undergo similar patterns of change, only species richness is discussed herein. There was little change in species richness between 2001 and 2002 at most stations (**Figure 5.2**). Annual values in 2002 averaged from 69 to 120 species per 0.1 m^2 sample (**Table 5.1**). As in previous years, the number of species was highest at stations generally characterized by coarser sediments. These sites included the northern most "B" stations (i.e., B11, B12, B13), station E9 located near the LA 5 dredged material disposal site to the south, and station E14 located nearest the discharge site. In contrast, the fewest species occurred at northern station B8, which was characterized by the finest sediments in the region (see **Appendix B**).

Polychaetes were the most diverse taxa, typically accounting for about half the species (45-59%) at

Table 5.1

Benthic infaunal community parameters at PLOO stations sampled during 2002. Data are expressed as annual means for: species richness, no. species/0.1 m^2 (SR); total no. species per site (Tot Spp); abundance/0.1 m^2 (Abun); biomass, g/0.1 m^2; diversity (H'); evenness (J'); Swartz dominance, no. species comprising 75% of a community by abundance (Dom); benthic response index (BRI); and infaunal trophic index (ITI).

	SR	Tot Spp	Abun	Biomass	H'	J'	Dom	BRI	ITI
88-m stations									
B11	112	164	310	9.4	4.1	0.9	45	5	79
B8	69	99	362	7.3	3.0	0.7	13	-1	87
E19	77	108	279	6.2	3.6	0.8	26	3	88
E7	77	108	280	4.5	3.5	0.8	24	4	88
98-m stations									
B12	103	142	433	3.7	3.7	0.8	30	5	75
B9	73	104	301	7.4	3.4	0.8	21	2	81
E26	86	120	427	5.9	3.2	0.7	18	3	79
E25	84	113	369	5.9	3.5	0.8	22	3	81
E23	84	114	298	7.9	3.7	0.8	29	3	88
E20	85	114	304	6.6	3.7	0.8	28	4	87
E17	95	130	326	5.3	3.9	0.9	33	7	83
E14	105	145	523	4.7	3.5	0.8	26	12	74
E11	85	118	301	5.6	3.8	0.9	30	8	80
E8	79	109	320	4.4	3.6	0.8	24	3	86
E5	88	121	356	5.7	3.7	0.8	27	1	87
E2	97	140	328	5.3	3.9	0.8	33	1	85
116-m stations									
B13	120	169	421	4.7	4.1	0.9	40	5	79
B10	97	136	310	5.5	4.1	0.9	37	8	77
E21	88	118	259	6.8	4.0	0.9	36	4	86
E15	95	132	309	3.7	4.0	0.9	35	3	85
E9	115	159	358	3.8	4.2	0.9	43	3	84
Mean	91	127	342	5.7	3.7	0.8	29	4	83
Min	69	99	259	3.7	3.0	0.7	13	-1	74
Max	120	169	523	9.4	4.2	0.9	45	12	88

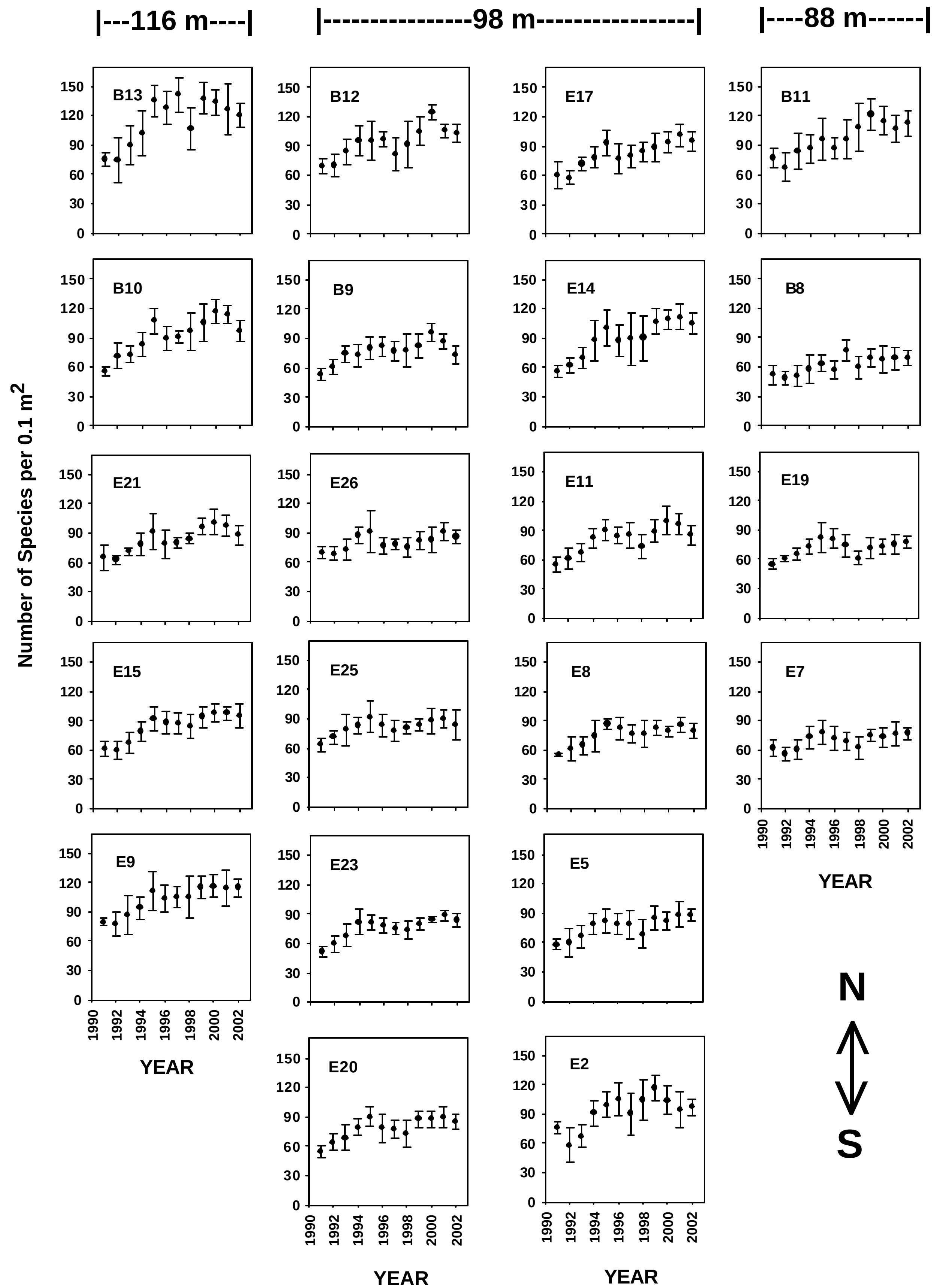


Figure 5.2

Number of species at the PLOO benthic stations from 1991 to 2002. Data are expressed as annual means ± 1 SD

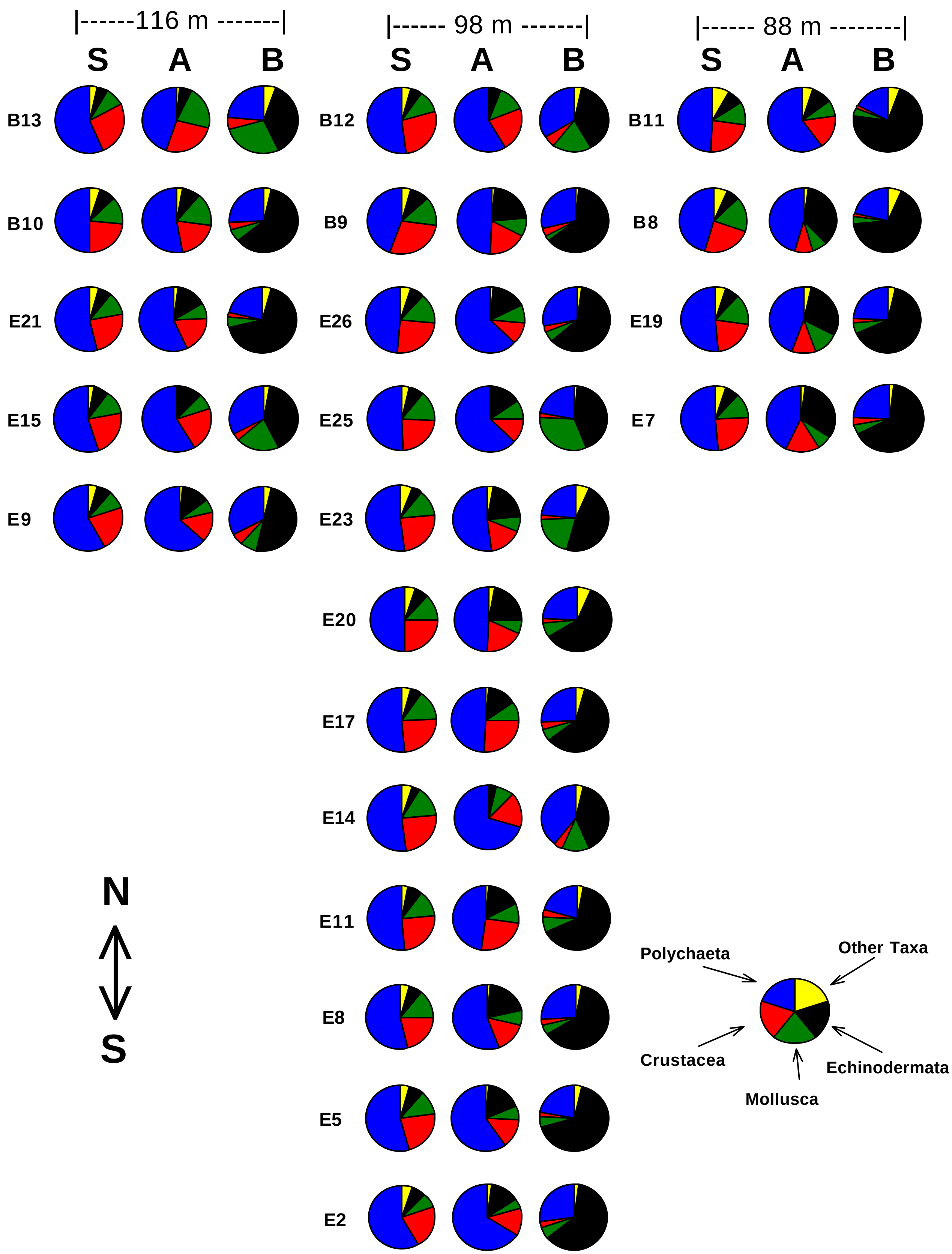


Figure 5.3
Mean percent composition of major taxa at the PLOO benthic stations during 2002. S = number of species; A = abundance; B = biomass.

the various sites during 2002 (**Figure 5.3**). Crustaceans accounted for 21-28% of the species, molluscs 7-17%, echinoderms 4-9%, and all remaining taxa combined accounted for 3-9% of the species.

Infaunal Abundance

Mean abundance per station during 2002 ranged from 259 to 523 animals per sample (Table 5.1). The largest number of animals occurred at station E14, which averaged over 500 animals per 0.1 m^2. Abundance was also relatively high at stations B12, E26 and B13 where annual averages were greater than 400 animals per grab. The remaining stations all averaged from 259 to 369 animals per sample. Mean abundances during 2002 were within the range of historical variation at all stations (**Figure 5.4**).

Polychaetes were the most numerous organisms during 2002, accounting for 43-70% of the mean abundance per sample (Figure 5.3). Crustaceans accounted for 9-26% of mean abundance, echinoderms 2-35%, molluscs 5-21%, and all other phyla combined 1-5%. Station E14 nearest the outfall had the highest relative abundance of polychaetes (70%) and the lowest relative abundance of echinoderms (2%). These values were generally similar to those reported for 2001 (see City of San Diego 2002).

Biomass

Mean biomass ranged from 3.7 to 9.4 grams per 0.1 m^2 during 2002 (Table 5.1). Relatively high biomass values are typically due to the collection of large motile organisms such as sea urchins, sea stars, crabs and snails. For example, this year the largest individual was a sea urchin, *Brissopsis pacifica* (22.9 g), which was collected at station B11. Biomass values were similar to those observed during previous years, and the relative composition by various taxonomic groups has changed very little over time (e.g., City of San Diego 2002). For example, echinoderms (mostly ophiuroids) continue to account for nearly half or more of the benthic biomass at most stations (Figure 5.3). Overall, echinoderms composed 37-72% of the biomass at a station, polychaetes 17-39%, molluscs 3-32%, crustaceans 2-6%, and the remaining taxa 2-7%.

Species Diversity and Dominance

Species diversity (H’) varied little among stations during 2002 and was similar to that observed prior to wastewater discharge. Average diversity values ranged from 3.0 to 4.2 during the year (Table 5.1). The highest diversity (H’ $\geq$ 4.0) occurred at three of the northernmost stations (B10, B11, and B13), station E9 located just north of the LA 5 disposal site, and stations E15 and E21 located near the PLOO discharge. Most of these stations are located along the 116-m depth contour. Diversity was lowest (H’ < 3.5) at stations B8, B9, and E26.

Species dominance was expressed as the Swartz 75% dominance index, the minimum number of species comprising 75% of a community by abundance. Consequently, lower index values (i.e., fewer species) indicate higher dominance. Benthic assemblages around the PLOO during 2002 were characterized by relatively high numbers of evenly distributed species, with no patterns associated with distance from the outfall. Dominance averaged 29 species per station during the past year compared with 19-32 species in previous years (see Table 5.1 and City of San Diego 2002). Evenness (J’) values have also remained stable over time, with means ranging from 0.7 to 0.9 in 2002 (Table 5.1).

Environmental Disturbance Indices

Benthic response index (BRI) values averaged from -1 to 12 at the various stations in 2002 (Table 5.1). These values suggest that benthic communities in the PLOO region are relatively undisturbed, as BRI values below 25 (on a scale of 100) are indicative of “reference conditions” (see Smith et al. 2001). Although all BRI values indicated a healthy benthic community, stations nearest the discharge (E14, E11, E17) had higher values than most other sites in the area.

Annual ITI values averaged from 74 to 88 per station in 2002 (Table 5.1). These values were similar to those reported in previous years (see City of San Diego 2002), with the lowest value again occurring at the station nearest the discharge (E14). Nevertheless, the relatively “high” values (> 60) at this and all other sites are also considered characteristic of undisturbed

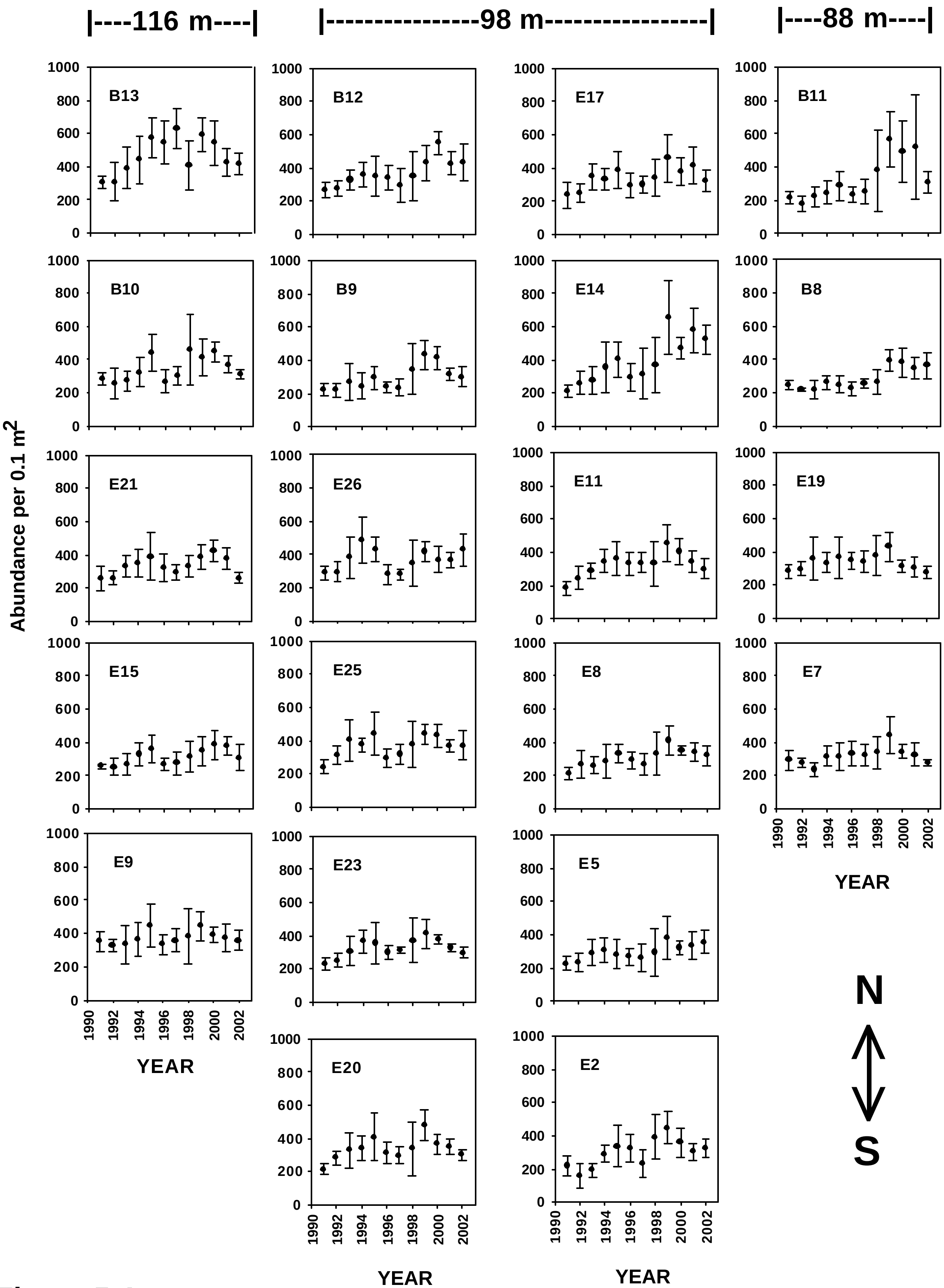


Figure 5.4
Abundance of infaunal organisms at the PLOO benthic stations from 1991 to 2002. Data are expressed as annual means ± 1 SD.

Table 5.2

Dominant macroinvertebrates at PLOO benthic stations sampled during 2002. Included are the 10 most abundant taxa overall and per occurrence, and the 10 most widely occurring taxa. Data are expressed as: MS = mean number per 0.1 m^2 over all stations; MO = mean number per 0.1 m^2 per occurrence; and PO = percent occurrence.

Species	Higher taxa	MS	MO	PO
Top 10 Species Overall				
1. *Myriochele* sp M	Polychaeta: Oweniidae	35.5	38.3	93%
2. *Amphiodia urtica*	Echinodermata: Ophiuroidea	33.1	34.3	96%
3. *Proclea* sp A	Polychaeta: Terebellidae	23.0	23.3	99%
4. *Myriochele gracilis*	Polychaeta: Oweniidae	11.2	11.3	99%
5. *Chaetozone hartmanae*	Polychaeta: Cirratulidae	10.3	10.6	98%
6. *Amphiodia* sp †	Echinodermata: Ophiuroidea	9.4	9.4	100%
7. *Euphilomedes carcharodonta*	Crustacea: Ostracoda	7.7	8.6	89%
8. *Paradiopatra parva*	Polychaeta: Onuphidae	6.0	6.0	100%
9. *Euphilomedes producta*	Crustacea: Ostracoda	5.1	5.4	95%
10. *Sternaspis fossor*	Polychaeta: Sternaspidae	5.0	5.3	95%
Top 10 Species per Occurrence				
1. *Caecum crebricinctum*	Mollusca: Gastropoda	4.2	43.8	10%
2. *Myriochele* sp M	Polychaeta: Oweniidae	35.5	38.3	93%
3. *Amphiodia urtica*	Echinodermata: Ophiuroidea	33.1	34.3	96%
4. *Proclea* sp A	Polychaeta: Terebellidae	23.0	23.3	99%
5. *Myriochele gracilis*	Polychaeta: Oweniidae	11.2	11.3	99%
6. *Chaetozone hartmanae*	Polychaeta: Cirratulidae	10.3	10.6	98%
7. *Photis macrotica*	Crustacea: Amphipoda	0.2	9.5	2%
8. *Amphiodia* sp †	Echinodermata: Ophiuroidea	9.4	9.4	100%
9. *Euphilomedes carcharodonta*	Crustacea: Ostracoda	7.7	8.6	89%
10. *Paradiopatra parva*	Polychaeta: Onuphidae	6.0	6.0	100%
Top 10 Widespread Species				
1. *Amphiodia* sp †	Echinodermata: Ophiuroidea	9.4	9.4	100%
2. *Paradiopatra parva*	Polychaeta: Onuphidae	6.0	6.0	100%
3. *Proclea* sp A	Polychaeta: Terebellidae	23.0	23.3	99%
4. *Myriochele gracilis*	Polychaeta: Oweniidae	11.2	11.3	99%
5. Amphiuridae †	Echinodermata: Ophiuroidea	4.8	4.9	99%
6. Maldanidae †	Polychaeta: Maldanidae	4.3	4.3	99%
7. *Clymenura gracilis*	Polychaeta: Maldanidae	3.6	3.6	99%
8. *Chaetozone hartmanae*	Polychaeta: Cirratulidae	10.3	10.6	98%
9. *Ampelisca pacifica*	Crustacea: Amphipoda	3.4	3.4	98%
10. *Spiophanes fimbriata*	Polychaeta: Spionidae	3.2	3.3	98%

† = unidentified juveniles and/or damaged specimens

sediments or "normal" environmental conditions (see Bascom et al. 1979).

Dominant Species

The dominant taxa that occurred off Point Loma during 2002 are listed in **Table 5.2**. Ophiuroids of the family Amphiuridae and various polychaete species continued to dominate benthic assemblages in the region. *Amphiodia urtica* was the most abundant ophiuroid, averaging about 33 animals per 0.1 m^2. However, since juveniles cannot be identified to species and are usually recorded at the generic or familial level (i.e., *Amphiodia* sp or Amphiuridae, respectively), this number underestimates actual populations of *A. urtica*. The only other species of *Amphiodia* that occurred in the area was *A. digitata*, which accounted for about 7% of ophiuroids in the genus *Amphiodia* that could be identified to species (i.e., *A. urtica* = about 93%). Other amphiurid brittle stars accounted for less than

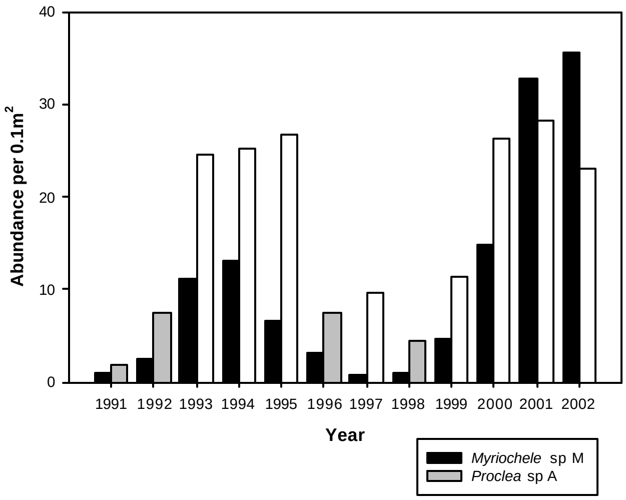


Figure 5.5

Average annual abundance of *Myriochele* sp M and *Proclea* sp A at the PLOO benthic stations from 1991 to 2002.

5% of the total. If the values for these taxa are adjusted accordingly, then the estimated population size for *A. urtica* off Point Loma is about 46 animals per sample, making this the most abundant species in the region. The two most abundant polychaetes were the oweniid *Myriochele* sp M (about 36 per sample) and the terebellid *Proclea* sp A (about 23 per sample). Seven other polychaetes were among the dominant species in terms of overall abundance, abundance per occurrence, or frequency of occurrence during the year. The remaining dominant species included the ostracods *Euphilomedes carcharodonta* and *Euphilomedes producta,* and the amphipods *Photis macrotica* and *Ampelisca pacifica*. Finally, the gastropod *Caecum crebricinctum* occurred in relatively high densities at two northern sites (i.e., stations B12 and B13).

Many of these abundant taxa were also dominant prior to discharge and during the first eight years of outfall operation (e.g., City of San Diego 1999, 2002). For example, *A. urtica* has been the first or second most abundant and among the most commonly occurring species along the outer shelf since sampling began. In contrast, densities of some numerically dominant polychaetes have been far more cyclical. For example, while *Myriochele* sp M and *Proclea* sp A were the most abundant polychaetes during 2002, their populations have varied considerably over time (see **Figure 5.5**).

Table 5.3

Results of BACIP t-tests for number of species, infaunal abundance, ITI and the abundance of several representative taxa around the Point Loma Ocean Outfall (1991-2002). Impact site (I) = near-ZID station E14; Control sites (C) = far-field station E26 or reference station B9. Before Impact period = July 1991 to October 1993 (n=10); After Impact period = January 1994 to October 2002 (n=36). Critical t values = 1.680 for *a* = 0.05 and 1.301 for a = 0.10 (one-tailed t-tests, n-2 = 44). H_0 : ns = not significant (accept H_0); * = significant, p < 0.5 (reject H_0).

Variable	Comparision C vs I	t	H_0
Number of species	E26 vs E14	-3.235	*
	B9 vs E14	-3.680	*
Infaunal abundance	E26 vs E14	-1.227	ns
	B9 vs E14	-2.686	*
ITI	E26 vs E14	-4.089	*
	B9 vs E14	-2.003	*
Amphiodia spp	E26 vs E14	-6.761	*
	B9 vs E14	-4.654	*
Ampelisca spp	E26 vs E14	-0.949	ns
	B9 vs E14	-0.738	ns
Rhepoxynius spp	E26 vs E14	-0.265	ns
	B9 vs E14	-0.493	ns

Such variation can have significant effects on other descriptive statistics (e.g., dominance, diversity, abundance) and environmental indicies such as ITI and BRI which use the abundance of "indicator" species (e.g., *Myriochele* sp M and *Proclea* sp A) in their equations.

BACIP Analyses

Significant differences were found between the "impact" site (station E14) and the "control" sites (stations E26 and B9) in seven out of twelve BACIP t-tests (see **Table 5.3** and **Figure 5.6**). For example, there has been a net change in the mean difference between impact and control sites in species richness, ITI values and ophiuroid abundance (*Amphiodia* spp). The difference in species richness may be due to the increased variability and higher numbers of species at the impact site. Results for *Amphiodia* populations

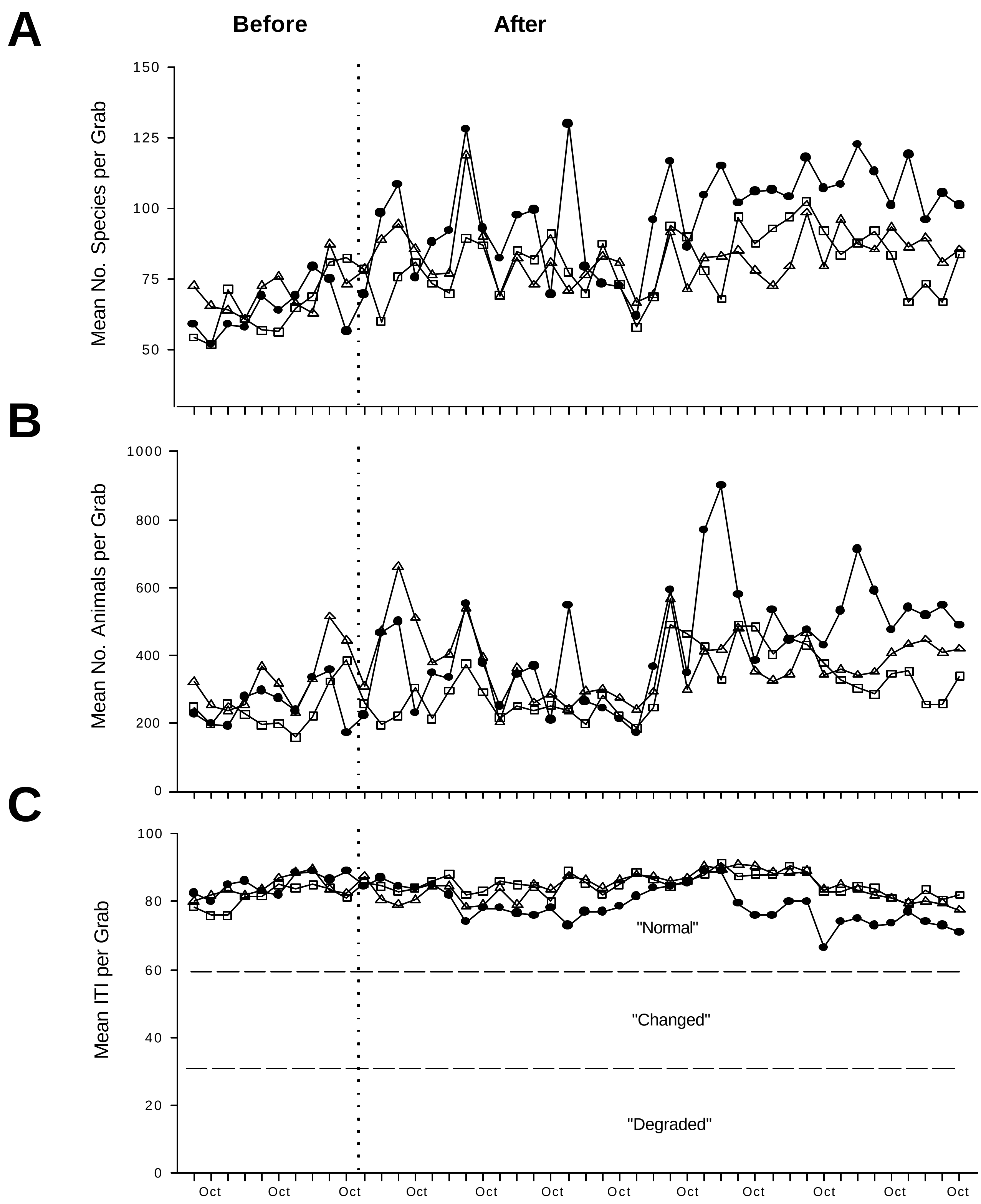


Figure 5.6

Comparison of several parameters at "impact" station E14 (●) and "control" stations E26 (△) and B9 (□) used in BACIP analyses (see Table 5.3). Data for each station are expressed as quarterly means per 0.1 m^2 (n=2). (A) Number of infaunal species; (B) infaunal abundance; (C) infaunal trophic index (ITI); (D) abundance of *Ampelisca* spp (Amphipoda); (E) abundance of *Amphiodia* spp (Ophiuroidea).

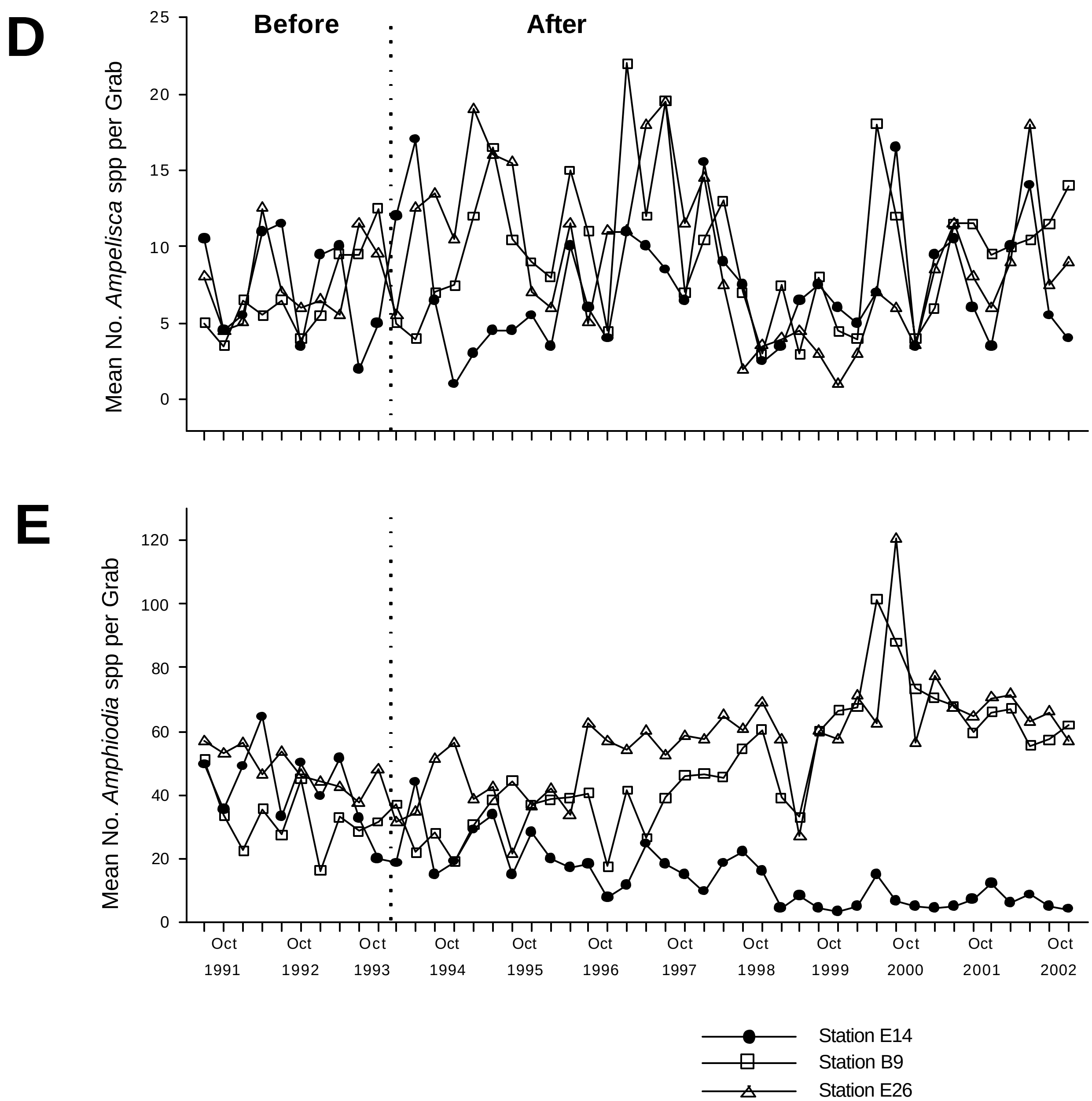


Figure 5.6 Continued

mostly reflect a decrease in the number of these ophiuroids collected at the impact site since discharge began. Similarly, the difference in ITI is due to a decrease in index values at station E14 since the outfall began operation . These decreased ITI values may in part be explained by the lower numbers of *Amphiodia*. The results for infaunal abundances were more ambiguous. Although a significant change was indicated between the impact site and station B9, no such pattern was found regarding the second “control” site (E26). Finally, there was no net change in the average difference between impact and control sites in numbers of phoxocephalid or ampeliscid amphipods.

Classification of Benthic Assemblages

Although the infaunal community varies little throughout the PLOO sampling region, ordination and classification analyses discriminated subtle differences between seven benthic assemblages (cluster groups A-G) during 2002 (see **Figure 5.7**). These assemblages differed in terms of their species

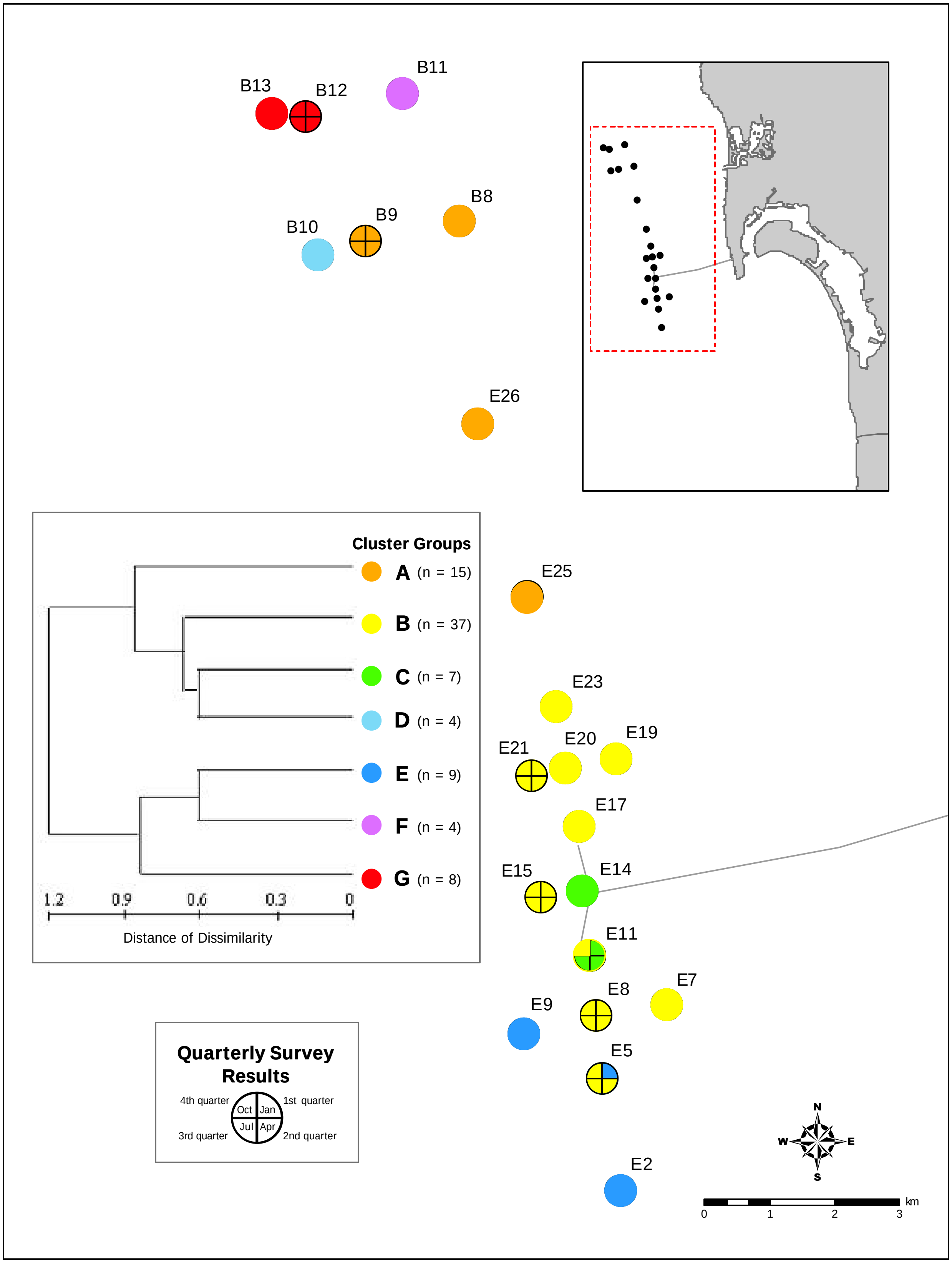


Figure 5.7

Results of ordination and classification analyses of infaunal abundance data during 2002. Infaunal cluster groups are color-coded on the map to reveal spatial patterns in the distribution of infaunal assemblages.

Table 5.4

Summary of the most abundant taxa composing cluster groups A-G from the 2002 infaunal survey of PLOO benthic stations. Data are expressed as mean abundance per sample (no./0.1m^2) and represent the ten most abundant taxa in each group. Values for the three most abundant taxa (bolded) in each cluster group are underlined.

		Cluster Group						
Species/Taxa	Higher Taxa	A (n=15)	B (n=37)	C (n=7)	D (n=4)	E (n=9)	F (n=4)	G (n=8)
Capitella capitata (=spp complex)	Polychaeta, Capitellidae	<0.1	0.1	7.3	.	0.2	0.4	0.2
Polycirrus sp A	Polychaeta, Terebellidae	1.2	2.9	6.9	0.9	3.9	0.4	0.5
Chaetozone hartmanae	Polychaeta, Cirratulidae	7.6	10.6	17.4	16.1	9.3	16.0	3.7
Rhepoxynius bicuspidatus	Crustacea, Amphipoda	6.0	6.8	4.3	1.9	0.5	1.0	0.3
Amphiodia urtica	Echinodermata, Ophiuroidea	61.7	39.4	12.4	6.9	22.6	17.6	0.9
***Amphiodia* sp**	Echinodermata, Ophiuroidea	11.8	12.6	4.1	3.0	7.7	3.0	2.9
***Proclea* sp A**	Polychaeta, Terebellidae	26.2	29.2	18.1	4.9	31.0	1.5	3.1
Sternaspis fossor	Polychaeta, Sternaspidae	5.3	4.6	6.1	12.0	4.7	7.9	1.0
Aphelochaeta monilaris	Polychaeta, Cirratulidae	2.2	2.6	1.4	7.4	1.9	1.9	0.9
Amphiuridae	Echinodermata, Ophiuroidea	4.3	5.4	4.6	2.8	7.7	2.9	1.7
Parvilucina tenuisculpta	Mollusca, Bivalvia	7.8	3.7	5.4	13.0	0.9	3.9	4.4
Maldanidae	Polychaeta, Maldanidae	3.4	4.5	5.0	3.6	6.9	2.9	2.6
Myriochele gracilis	Polychaeta, Oweniidae	17.7	8.0	18.4	13.5	10.5	7.8	8.4
Paradiopatra parva	Polychaeta, Onuphidae	6.0	5.6	6.1	8.5	6.5	3.8	7.3
Prionospio dubia	Polychaeta, Spionidae	1.4	2.8	2.0	2.0	6.1	3.0	1.8
Euphilomedes carcharodonta	Crustacea, Ostracoda	0.7	7.7	30.7	1.1	1.3	1.6	13.9
***Myriochele* sp M**	Polychaeta, Oweniidae	78.7	8.8	78.4	7.5	28.9	46.8	56.6
Ampelisca pugetica	Crustacea, Amphipoda	1.6	0.9	1.5	0.6	0.8	4.0	1.6
Tellina cadieni	Mollusca, Bivalvia	2.6	3.4	6.8	17.0	4.2	1.6	3.5
Mediomastus sp	Polychaeta, Capitellidae	2.0	2.4	3.8	2.4	5.1	6.4	4.7
Prionospio jubata	Polychaeta, Spionidae	1.5	3.4	4.6	2.0	3.0	2.6	10.2
Euphilomedes producta	Crustacea, Ostracoda	1.9	4.0	8.1	15.0	5.9	0.4	10.3
Leptochelia dubia	Crustacea, Tanaidacea	1.5	2.2	1.6	2.4	3.7	4.6	5.9
Huxleyia munita	Mollusca, Bivalvia	<0.1	1.5	2.7	0.3	3.2	.	9.4
Amphiodia digitata	Echinodermata, Ophiuroidea	0.9	0.7	1.1	8.3	3.7	1.4	13.0
Exogone lourei	Polychaeta, Syllidae	0.1	<0.1	0.3	.	4.2	5.0	2.5
Urothoe varvarini	Crustacea, Amphipoda	0.4	.	.	0.8	0.2	0.3	11.2
Caecum crebricinctum	Mollusca, Gastropoda	.	.	.	.	.	.	43.8

composition, including the specific taxa present and their relative abundances. The dominant species for each group are listed in **Table 5.4**. Overall, the distribution and structure of these assemblages were similar to that observed in previous years (e.g., City of San Diego 2002).

Cluster group A included sites that were primarily located along the 98-m depth contour and north of the PLOO (see Figure 5.7 and **Table 5.5**). Sediments here contained a relatively low percentage of coarse materials, and supported an assemblage that averaged 77 species per 0.1 m^2. The most abundant species were the oweniid polychaete *Myriochele* sp M, followed by the ophiuroid *Amphiodia urtica*, and the terebellid polychaete *Proclea* sp A.

Cluster group B included sites from various depths surrounding the outfall. This group averaged 304 individuals and 85 species per sample. Dominant species in this assemblage included *Amphiodia urtica*, *Proclea* sp A, and the cirratulid polychaete *Chaetozone hartmanae*.

Cluster group C comprised samples from stations E14 and E11 located nearest to the PLOO discharge site. This assemblage was dominated by the oweniid polychaetes *Myriochele* sp M and *M. gracilis*, and the ostracod *Euphilomedes carcharodonta.* The opportunistic polychaete *Capitella capitata* was also present in this assemblage. When present in high numbers, *Capitella capitata* is considered an indicator of organic enrichment. It was the eighth most numerous taxa in the group C assemblage, with a mean abundance of about seven individuals per sample. Although the ophiuroid *Amphiodia urtica* was present, it occurred in relatively low numbers compared with nearby stations.

Cluster group D represented the four surveys from station B10. The sediments at this station were generally sandy, averaging around 70% sand and 30% fines during 2002 (see Table 5.5 and Appendix B). The bivalve *Tellina cadieni* dominated this assemblage, followed by *Chaetozone hartmanae* and the ostracod *Euphilomedes producta. Amphiodia urtica* and *Myriochele* sp M were less abundant at this station than at most other sites in the region.

Cluster group E comprised all samples from stations E2 and E9, as well as the January samples from station E5. The sediment at these southern-most stations was about 50% sand, 40% fines and nearly 10% coarse material (see Table 5.5 and Appendix B). *Proclea* sp A, *Myriochele* sp M, and *Amphiodia urtica* were the most common animals in the group E assemblage.

Cluster group F comprised all four surveys at station B11, which is located along the 88-m depth contour. Species richness was relatively high in this assemblage, averaging 112 taxa per grab (see Table 5.5). The dominant organisms in terms of abundance were *Myriochele* sp M, *Amphiodia urtica* and *Chaetozone hartmanae*.

Cluster group G included all samples from northern stations B12 and B13. As is typical of these sites, species richness was relatively high, approximately 111 species per sample. The gastropod *Caecum crebricinctum*, found nowhere else during 2002, was among the dominant animals in this assemblage. Other numerical dominants included *Myriochele* sp M and *Euphilomedes carcharodonta.*

SUMMARY & CONCLUSIONS

Benthic communities around the Point Loma Ocean Outfall (PLOO) continue to be dominated by ophiuroid-polychaete based assemblages, with few major changes having occurred since monitoring began (see City of San Diego 1995, 2002). Polychaete worms continue to dominate the fauna in numbers of species and abundance, while ophiuroids compose the largest biomass fraction. Although many assemblages were dominated by similar species, the relative abundance of these species varied between sites. *Amphiodia urtica* was the most abundant and one of the most widespread benthic invertebrates in the region, being a dominant or co-dominant species in four of the seven assemblages described herein. Two polychaetes, the oweniid *Myriochele* sp M and the terebellid *Proclea* sp A, were also abundant at many

Table 5.5

Average sediment composition, depth and community parameters for each group of PLOO stations (from cluster analysis) with similar benthic assemblages in 2002. Station designations: a=January survey, b=April survey, c= July survey, d= October survey, no letter designation=all surveys. Data are expressed as means per 0.1 m^2 grab over all stations in each group. CSF = coarse sieved fraction of sediments (i.e., particles > 1.0 mm); Fines=silt+clay fraction; SR=number of species; ABUN=number of individuals; Top Three Species are by abundance. Ranges in parentheses are for individual grab samples.

Cluster Group	Stations	Depth (m)	Mean Phi	CSF (%)	Sand (%)	Fines (%)	SR	ABUN	Top Three Species
A (n=15)	B8; B9; E26; E25a-c	95 (88-98)	4.4 (4.0-4.8)	0.1 (0-0.6)	52.8 (37.2-71.2)	47 (28.6-62.7)	77 (51-95)	364 (217-540)	*Myriochele* sp M *Amphiodia urtica* *Proclea* sp A
B (n=37)	E7; E8; E15; E17; E19; E20; E21; E23; E5a,c,d; E11a; E25d	100 (88-116)	4.1 (3.4-4.5)	0.8 (0-15.2)	62.3 (47-82.1)	37 (17.5-53)	85 (65-110)	304 (207-472)	*Amphiodia urtica* *Proclea* sp A *Amphiodia sp*
C (n=7)	E14; E11b-d	98	3.7 (2.8-4)	7.1 (0-42.7)	63.7 (27.1-77.4)	29.1 (18.7-34.6)	96 (68-123)	418 (201-630)	*Myriochele* sp M *Euphilomedes carcharodonta* *Myriochele gracilis*
D (n=4)	B10	116	4.0 (3.9-4.2)	0.4 (0-1.2)	68.5 (64.3-72.5)	31.1 (27.4-35.1)	97 (81-111)	310 (277-360)	*Tellina cadieni* *Chaetozone hartmanae* *Euphilomedes producta*
E (n=9)	E2; E9; E5b	106 (98-116)	3.9 (3.1-4.5)	9.1 (0-17.2)	50.9 (42.6-75.3)	39.9 (14.2-51.6)	104 (87-126)	351 (265-431)	*Proclea* sp A *Myriochele* sp M *Amphiodia urtica*
F (n=4)	B11	88	4.6 (4.5-4.7)	4 (2.6-5.9)	41.9 (41.4-43.3)	54 (52.7-55.8)	112 (85-129)	310 (240-458)	*Myriochele* sp M *Amphiodia urtica* *Chaetozone hartmanae*
G (n=8)	B12; B13	107 (98-116)	4.0 (3.1-4.4)	4.9 (1.5-9.5)	56.8 (50.2-60.7)	38.3 (29.9-46.5)	111 (86-139)	427 (284-613)	*Myriochele* sp M *Caecum crebricinctum* *Euphilomedes carcharodonta*

sites. Assemblages similar to those surrounding the PLOO have been described for other areas in the Southern California Bight (SCB) by Barnard and Ziesenhenne (1961), Jones (1969), Fauchald and Jones (1979), Thompson et al. (1987, 1992, 1993), Zmarzly et al. (1994), Diener and Fuller (1995), and Bergen et al. (1998, 2001).

Although variable, benthic communities off Point Loma have generally remained similar between years in terms of the number of species, number of individuals, biomass, and dominance (City of San Diego 1995, 2002). In addition, values for these parameters are similar to those described for other sites throughout the SCB (e.g., Thompson et al. 1992, Bergen et al. 1998, 2001). In spite of this overall stability, comparisons of pre- and post-discharge data do indicate some general trends. There has been an overall increase in the number of species and infaunal abundances since discharge began. However, the increase in species has been most pronounced nearest the outfall, a pattern opposite that expected if environmental degradation were occurring. In addition, increases in abundance at most stations have been accompanied by decreases in dominance, patterns also inconsistent with predicted pollution effects. Whatever the cause, it seems clear that benthic communities around the PLOO are not numerically dominated by a few pollution tolerant species. There also was no pattern in total biomass that would suggest an outfall effect. However, there has been a shift in biomass composition near the outfall, with the relative contribution of ophiuroids decreasing and that of polychaetes increasing since the onset of discharge.

Other changes near the outfall may also suggest some effects coincident with anthropogenic activities. For example, the increased variability in number of species and infaunal abundance at near-ZID station E14 since discharge began may be indicative of community destabilization (see Warwick and Clarke 1993, Zmarzly et al. 1994). Also indicative of organic enrichment or disturbance was a decrease in the infaunal trophic index (ITI) at station E14 after discharge began. In addition, benthic response index (BRI) values are higher at E14 than at other sites in the region. However, both ITI and BRI values at this and all other sites are still characteristic of undisturbed areas. Finally, the instability or patchiness of sediments near the PLOO and the corresponding shifts in assemblages suggest that changes in this area may be related to localized physical disturbance (e.g., shifting sediment types) associated with the structure of the outfall pipe as well as to organic enrichment associated with the discharge of effluent.

Populations of some indicator taxa revealed changes that may reflect organic enrichment near the outfall, while populations of others revealed no evidence of impact. For example, there has been a significant change in the difference between ophiuroid (*Amphiodia* spp) populations that occur near the outfall (i.e., station E14) and those present at reference sites. This difference is due mostly to a decrease in numbers of ophiuroids near the outfall as compared to those at the "control" sites during the post-discharge period. Increases in populations of the ostracod *Euphilomedes carcharodonta* and the polychaete *Capitella* "*capitata*" also suggest a slight enrichment effect near the outfall, although densities of these organisms are still characteristic of natural environmental conditions (see Stebbins and Groce 2001). In addition, natural population fluctuations of these and other resident organisms (e.g. *Myriochele* sp M and *Proclea* sp A) are common off San Diego (Zmarzly et al. 1994, Stebbins and Pasko in prep). Further complicating the picture, patterns of change in populations of pollution sensitive amphipods (i.e., *Rhepoxynius*, *Ampelisca*) have shown no outfall-related effects.

While it is difficult to detect specific effects of the Point Loma Ocean Outfall on the offshore benthos, it is possible to see some changes occurring near the discharge site (i.e., at station E14). Perhaps because of the minimal extent of these changes, it is not possible at this time to determine whether any effect is due to the physical structure of the outfall pipe or to organic enrichment associated with the discharge of effluent. Such impacts have spatial and temporal dimensions that vary depending on a range of biological and physical factors. In addition, abundances of soft bottom invertebrates exhibit substantial spatial and temporal variability that may mask the effects of any disturbance event (Morrisey et al. 1992a, 1992b, Otway 1995). The effects associated with the discharge of advanced primary treated (APT) and secondary treated sewage may also be negligible or difficult to detect in areas subjected to strong currents that facilitate the dispersion of the wastewater plume (see Diener and Fuller 1995). The high level of wastewater treatment (APT), combined with an increased minimum dilution factor of 204:1 (vs. 113:1 at the old outfall), and the deepwater location of the discharge may decrease the chances that the PLOO will significantly impact the nearby benthos. The minimal impact reported for the original shallower discharge area off Point Loma supports this conclusion (e.g., Zmarzly et al. 1994). Although some changes in benthic assemblages have appeared near the outfall, assemblages in the near-ZID area and beyond are still similar to those observed prior to discharge and to natural indigenous communities characteristic of the southern California continental shelf.

LITERATURE CITED

Barnard, J.L., and F.C. Ziesenhenne. (1961). Ophiuroidea communities of southern Californian coastal bottoms. Pac. Nat., 2: 131-152

Bascom, W., A.J. Mearns, and J.Q. Word. (1979). Establishing boundaries between normal, changed, and degraded areas. In: Southern California Coastal Water Research Project Annual Report, 1978. Long Beach, CA. pp. 81-95

Bergen, M., S.B. Weisberg, D. Cadien, A. Dalkey, D. Montagne, R.W. Smith, J.K. Stull, and R.G. Velarde. (1998). Southern California Bight 1994 Pilot Project: IV. Benthic Infauna. Southern California Coastal Water Research Project, Westminster, CA. 260 pp.

Bergen, M., S.B. Weisberg, R.W. Smith, D.B. Cadien, A. Dalkey, D.E. Montagne, J.K. Stull, R.G. Velarde, and J.A. Ranasinghe. (2001). Relationship between depth, sediment, latitude, and the structure of benthic infaunal assemblages on the mainland shelf of southern California. Mar. Biol., 138: 637-647

Bernstein, B.B., and J. Zalinski. (1983). An optimum sampling design and power tests for environmental biologists. J. Environ. Manage., 16: 35-43

City of San Diego. (1995). Outfall Extension Pre Construction Monitoring Report. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (1999). San Diego Regional Monitoring Report for 1994-1997. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2002). Annual Receiving Waters Monitoring Report for the Point Loma Ocean Outfall, 2001. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2003). 2002 Quality Assurance Manual. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

Diener, D.R., and S.C. Fuller. (1995). Infaunal patterns in the vicinity of a small coastal wastewater outfall and the lack of infaunal community response to secondary treatment. Bull. Southern Cal. Acad. Sci., 94: 5-20

Fauchald, K., and G.F. Jones. (1979). Variation in community structures on shelf, slope, and basin macrofaunal communities of the Southern California Bight. In: Southern California outer continental shelf environmental baseline study, 1976/1977 (second year) benthic program. Vol. II, Principal Invest. Reps., Ser. 2, Rep. 19. Available from: NTIS, Springfield, Virginia; PB80 16601. Science Applications, Inc., La Jolla, CA.

Jones, G.F. (1969). The benthic macrofauna of the mainland shelf of southern California. Allan Hancock Monogr. Mar. Biol., 4: 1-219

Morrisey, D.J., L. Howitt, A.J. Underwood, and J.S. Stark. (1992a). Spatial variation in soft sediment benthos. Mar. Ecol. Prog. Ser., 81: 197-204

Morrisey, D.J., A.J. Underwood, L. Howitt, and J.S. Stark. (1992b). Temporal variation in soft sediment benthos. J. Exp. Mar. Biol. Ecol., 164: 233-245

Osenberg, C.W., R.J. Schmitt, S.J. Holbrook, K.E. Abu Saba, and R. Flegel. (1994). Detection of environmental impacts: Natural variability, effect size, and power analysis. Ecol. Appl., 4: 16-30

Otway, N.M. (1995). Assessing impacts of deepwater sewage disposal: a case study from New South Wales, Australia. Mar. Poll. Bull., 31: 347-354

Pearson, T.H., and R. Rosenberg. (1978). Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanogr. Mar. Biol. Ann. Rev., 16: 229-311

Smith, R.W. (1982). Analysis of ecological survey data with SAS and EAP. Proc. 7th Annual SAS Users= Group International, 705 pp. (SUGI). SAS Institute, Inc., Cary, North Carolina, p. 610-615

Smith, R.W., M. Bergen, S.B. Weisberg, D. Cadien, A. Dalkey, D. Montagne, J.K. Stull, and R.G. Velarde. (2001). Benthic response index for assessing infaunal communities on the southern California mainland shelf. Ecological Applications, 11(4): 1073-1087

Smith, R.W., B.B. Bernstein, and R.L. Cimberg. (1988). Community environmental relationships in the benthos: Applications of multivariate techniques. In: Soule, D.F., and G.S. Kleppel (eds.). Marine organisms as indicators. Springer Verlag, New York, pp. 247-326

Smith, R.W., and L. Riege. (1994). Optimization and power analyses for the Point Loma monitoring design. Unpublished report to City of San Diego, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

Stebbins, T.D., and A.K. Groce. (2001). Appendix E. Benthic Sediments and Organisms. In: City of San Diego Application for Modification of Secondary Treatment. Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

Stebbins, T.D., and D. Pasko. (In prep). Long-term variation in soft-bottom crustacean assemblages near a deepwater ocean outfall. City of San Diego Marine Biology Laboratory, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

Stewart-Oaten, A., J.R. Bence, and C.W. Osenberg. (1992). Assessing effects of unreplicated perturbations: No simple solutions. Ecology, 73: 1396-1404

Stewart-Oaten, A., W.W. Murdoch, and K.R. Parker. (1986). Environmental impact assessment: "Pseudoreplication" in time? Ecology, 67: 929-940

Swartz, R.C. (1978). Techniques for sampling and analyzing the marine macrobenthos. U.S. Environmental Protection Agency (EPA), Doc. EPA-600/3-78-030, EPA, Corvallis, Oregon. 27 p.

Thompson, B., J. Dixon, S. Schroeter, and D.J. Reish. (1993). Chapter 8. Benthic invertebrates. In: Dailey, M.D., D.J. Reish, and J.W. Anderson (eds.). Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press, Berkeley, p. 369-458

Thompson, B.E., J.D. Laughlin, and D.T. Tsukada. (1987). 1985 reference site survey. Tech. Rep. No. 221, Southern California Coastal Water Research Project, Long Beach, CA.

Thompson, B.E., D. Tsukada, and D. O'Donohue. (1992). 1990 reference survey. Tech. Rep. No. 355, Southern California Coastal Water Research Project, Long Beach, CA.

USEPA (United States Environmental Protection Agency). (1987). Quality Assurance and Quality Control (QA/QC) for 301(h) Monitoring Programs: Guidance on Field and Laboratory Methods. EPA Document

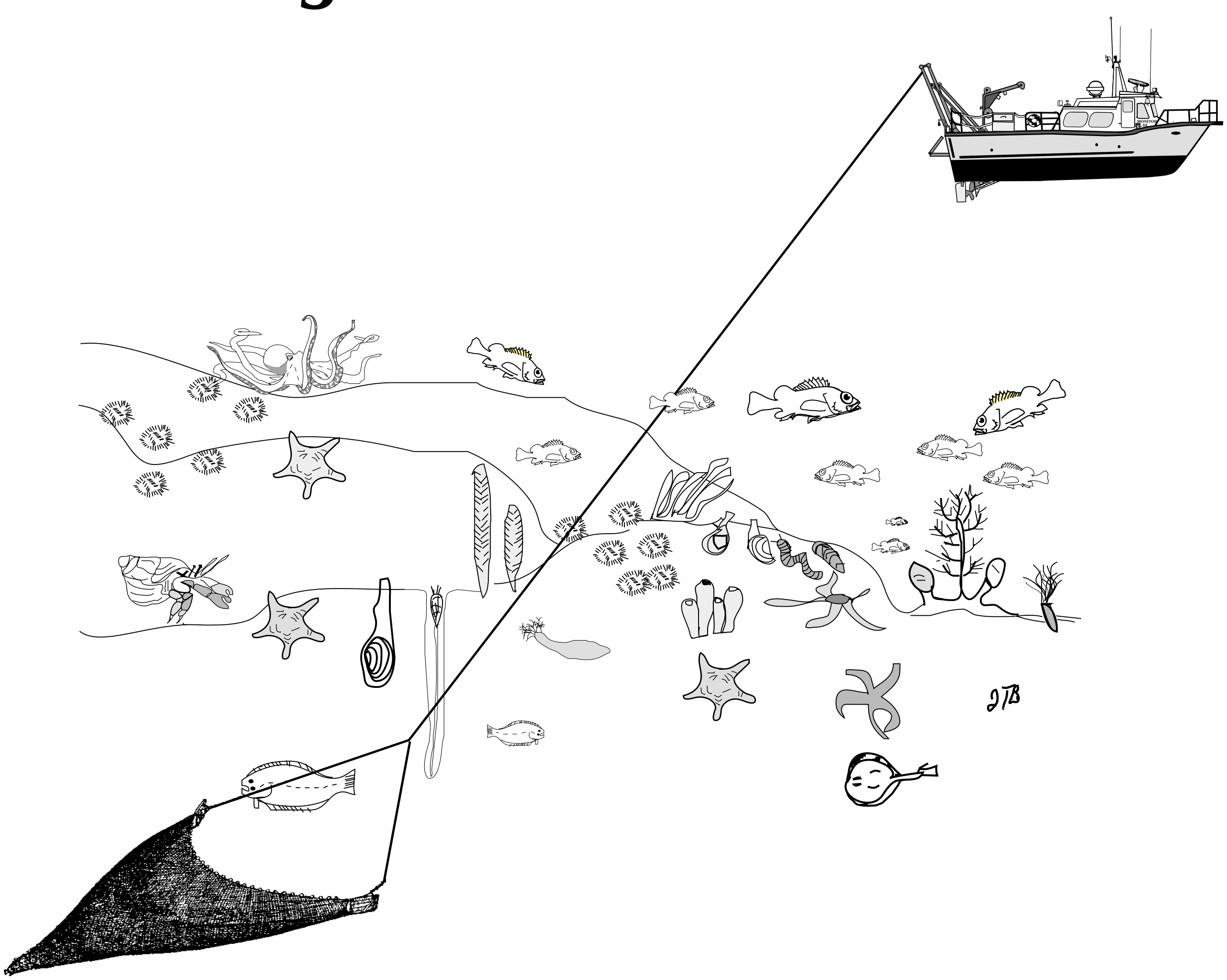
430/9-86-004. Office of Marine and Estuarine Protection. 267 p.

Warwick, R.M., and K.R. Clarke. (1993). Increased variability as a symptom of stress in marine communities. J. Exp. Mar. Biol. Ecol., 172: 215-226

Word, J.Q. (1980). Classification of benthic invertebrates into infaunal trophic index feeding groups. In: Bascom, W. (ed.). Biennial Report for the Years 1979 1980, Southern California Coastal Water Research Project, Long Beach, CA. p. 103-121

Zmarzly, D.L., T.D. Stebbins, D. Pasko, R.M. Duggan, and K.L. Barwick. (1994). Spatial patterns and temporal succession in soft bottom macroinvertebrate assemblages surrounding an ocean outfall on the southern San Diego shelf: Relation to anthropogenic and natural events. Mar. Biol., 118: 293-307

Demersal Fishes and Megabenthic Invertebrates



Chapter 6. Demersal Fishes and Megabenthic Invertebrates

INTRODUCTION

Demersal fishes and megabenthic invertebrates are conspicuous components of soft-bottom habitats of the mainland shelves and slopes off southern California. More than 100 species of fish inhabit the Southern California Bight (SCB) (Allen 1982, Allen et al. 1998), while the megabenthic invertebrate fauna consists of more than 200 species (Allen et al. 1998). For the Point Loma region off San Diego, the most common trawl-caught fishes include Pacific sanddab, longfin sanddab, Dover sole, hornyhead turbot, California tonguefish, plainfin midshipman and yellowchin sculpin. The common trawl-caught invertebrates include relatively large species such as sea urchins and sea stars.

Communities of bottom dwelling fish and invertebrates have become an important focus of monitoring programs throughout the world. For example, these organisms have been sampled extensively on the SCB mainland shelf for more than 30 years, primarily by programs associated with municipal wastewater and power plant discharges (Cross and Allen 1993). Although much is known about the condition of these types of assemblages (e.g., Allen et al. 1998), additional studies are useful in documenting community structure and stability, and may provide insight into the effects associated with anthropogenic and natural influences.

The City of San Diego Ocean Monitoring Program was designed to monitor the effects of the Point Loma Ocean Outfall (PLOO) on the local marine biota. This chapter presents analyses and interpretation of demersal fish and megabenthic invertebrate data collected under this program during 2002. A long-term analysis of changes in these communities from October 1991 through October 2002 is also presented.

MATERIALS & METHODS

Field Sampling

A total of 38 trawls were performed during four surveys off Point Loma in 2002. These surveys were conducted at three inshore stations (SD1, SD3, SD6) during January and July and at eight offshore stations (SD7 - SD14) during January, April, July and October (**Figure 6.1**). The inshore stations are located along the 60-m depth contour, while the offshore stations are located along the 100-m contour. The trawling area extends from about eight km north to nine km south of the outfall. During these surveys, a single trawl was performed at each station using a 7.6-m Marinovich otter trawl fitted with a 1.3-cm cod-end mesh net. The net was towed for 10 minutes bottom time at a speed of about 2.5 knots along a predetermined heading. Detailed methods for locating the stations and conducting trawls are described in the City of San Diego Quality Assurance Manual (City of San Diego 2003).

Trawl catches were brought on board for sorting and inspection. All organisms were identified to species or to the lowest taxon possible. If an animal could not be identified in the field, it was returned to the laboratory for further identification. The total number of individuals and the total biomass (wet weight, kg) were recorded for each species of fish. Additionally, each fish was inspected for the presence of external parasites or physical anomalies (e.g., tumors, fin erosion, discoloration) and measured to the nearest centimeter according to standard protocols (see City of San Diego 2003). The total number of individuals was also recorded for each species of invertebrate. Due to the small size of most organisms, invertebrate biomass was typically measured as a composite wet weight (kg) of all species combined; however, large or exceptionally abundant species were weighed separately. When the white sea urchin *Lytechinus pictus* was collected in large numbers, its abundance was estimated by

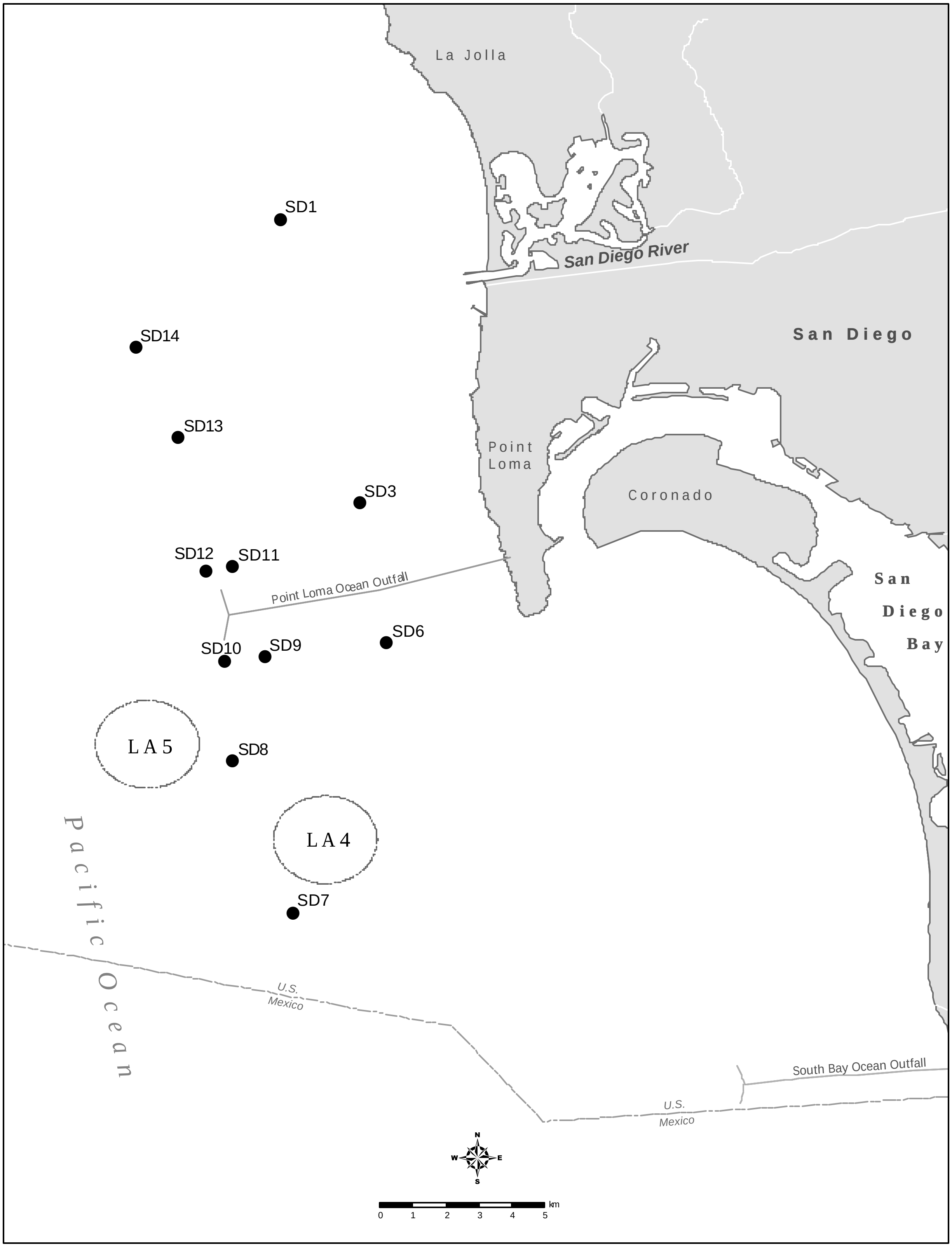


Figure 6.1

Otter trawl station locations surrounding the Point Loma Ocean Outfall.

Table 6.1

Demersal fish species collected in 38 trawls off Point Loma, San Diego during 2002. Data for each species are expressed as: (1) percent abundance (PA); (2) frequency of occurrence (FO); (3) mean abundance per occurrence (MAO).

Species	PA	FO	MAO	Species	PA	FO	MAO
Pacific sanddab	50	100	146	Pacific argentine	<1	13	2
Yellowchin sculpin	11	95	35	Greenspotted rockfish	<1	13	2
Longspine combfish	11	87	38	Greenstriped rockfish	<1	13	1
Longfin sanddab	5	82	16	Pygmy poacher	<1	11	2
Dover sole	4	87	12	Bluespotted poacher	<1	11	1
Halfbanded rockfish	3	45	20	Spotfin sculpin	<1	8	4
Stripetail rockfish	3	71	12	Blackbelly eelpout	<1	8	2
Plainfin midshipman	2	87	8	Rockfish unidentified	<1	8	1
Pink seaperch	2	76	7	California skate	<1	8	1
California tonguefish	2	92	5	Shiner perch	<1	5	5
Slender sole	1	34	8	Shortbelly rockfish	<1	5	1
Shortspine combfish	1	47	4	Flag rockfish	<1	5	1
California scorpionfish	1	39	4	Northern anchovy	<1	3	31
Bigmouth sole	<1	68	2	Queenfish	<1	3	4
Bay goby	<1	39	3	Vermilion rockfish	<1	3	3
English sole	<1	34	4	Big skate	<1	3	1
Roughback sculpin	<1	34	4	Blackeye goby	<1	3	1
California lizardfish	<1	32	2	Cowcod	<1	3	1
Hornyhead turbot	<1	32	1	Fringed sculpin	<1	3	1
Spotted cuskeel	<1	29	2	Gulf sanddab	<1	3	1
Greenblotched rockfish	<1	29	1	Ocean whitefish	<1	3	1
Flatfish unidentified	<1	16	1	Spotted ratfish	<1	3	1
White croaker	<1	13	6	Squarespot rockfish	<1	3	1

multiplying the total number of individuals per 1.0 kg subsample by the total urchin biomass.

Data Analyses

Populations of each fish and invertebrate species were summarized in terms of percent abundance (number of individuals/total of all individuals caught x 100), frequency of occurrence (number of occurrences/total number of trawls x 100) and mean abundance per occurrence (number of individuals/number of occurrences). In addition, the following parameters were calculated for both the fish and invertebrate assemblages at each station: (1) species richness (number of species); (2) total abundance; (3) Shannon diversity index (H'); (4) total biomass.

Ordination (principal coordinates) and classification (hierarchical agglomerative clustering) analyses were performed to examine spatio-temporal patterns in the dissimilarity of demersal fish and megabenthic invertebrate assemblages in the region. Data were limited to October surveys in order to exclude seasonal effects. The total abundance per trawl for each species was square-root transformed and standardized by species mean of values greater than zero prior to analyses. All analyses were performed using Ecological Analysis Package (EAP) software (see Smith 1982, Smith et al. 1988).

RESULTS

Fish Community

Forty-four species of fish were collected in the area surrounding the PLOO during 2002 (**Table 6.1**). The total catch for the year was 11,003 individuals, representing an average of about 290 fish per trawl. The Pacific sanddab was the most abundant fish collected. This species comprised 50% of the total

Table 6.2

Summary of demersal fish community parameters sampled during 2002. Data are expressed as (1) total number of species; (2) mean number of species; (3) mean abundance; (4) mean diversity (H'); (5) mean biomass (BM) (kg, wet weight).

Station	Number of Species Total	Number of Species Mean	Abund	H'	BM
Inshore (N=2)					
SD1	18	11	142	1.43	3.3
SD3	14	12	117	1.82	2.8
SD6	23	17	289	1.98	6.2
Offshore (N=4)					
SD7	20	12	115	1.57	2.9
SD8	24	14	114	1.58	3.2
SD9	26	15	270	1.51	5.0
SD10	30	17	422	1.34	7.9
SD11	24	16	510	1.68	10.3
SD12	25	13	516	1.59	8.4
SD13	22	13	231	0.98	5.3
SD14	25	15	299	1.10	6.1

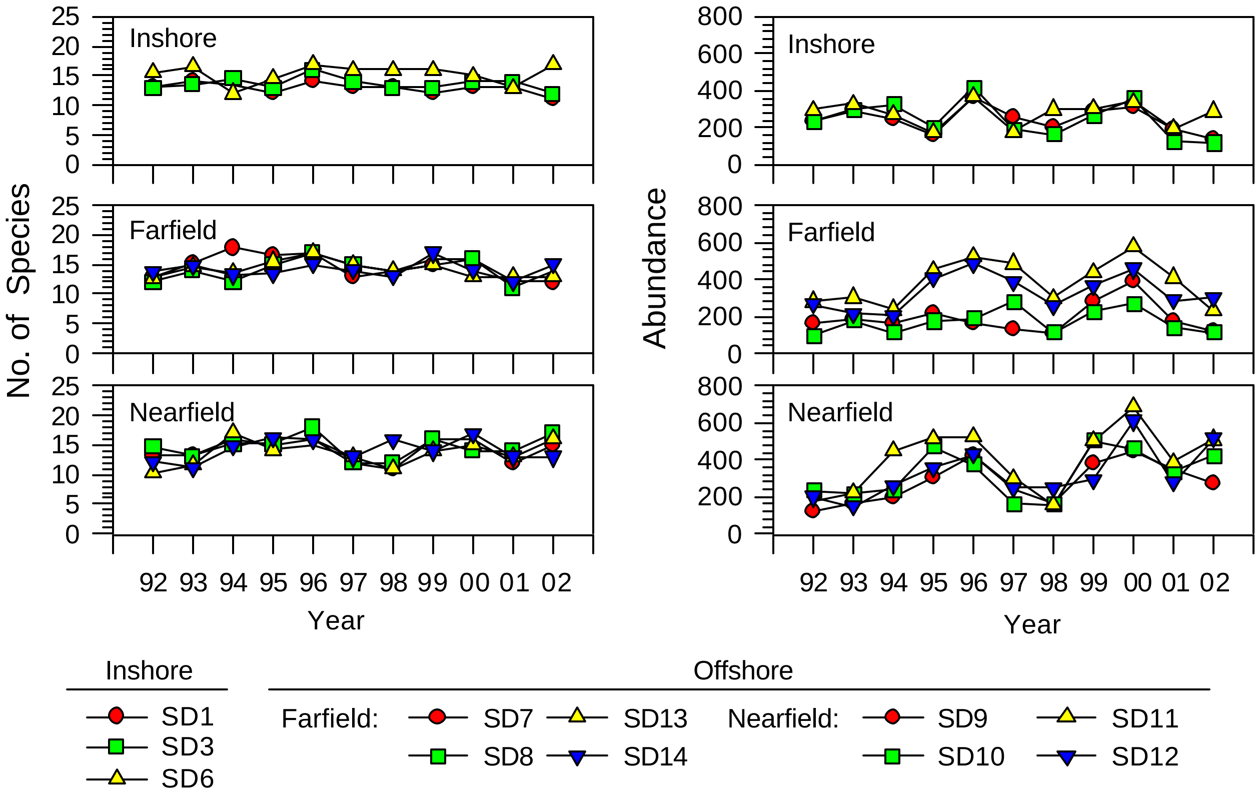


Figure 6.2

Annual mean number of fish species and abundance per station, 1992 through 2002. Inshore stations, n=2; offshore stations, n=4.

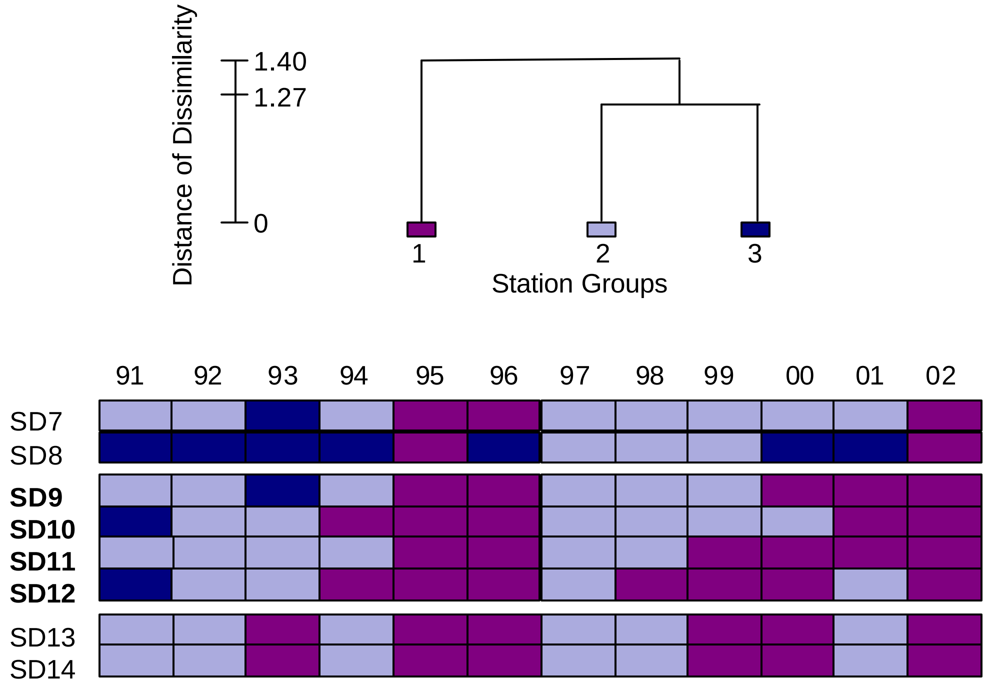


Figure 6.3

Classification analyses of demersal fish collected from offshore stations sampled during October from 1992 through 2002. Data are presented as a dendrogram of major station groups and a matrix showing distribution over time.

catch for the year and was the only species present in all hauls. Other fishes captured in at least 50% of the trawls were yellowchin sculpin, longspine combfish, longfin sanddab, Dover sole, stripetail rockfish, plainfin midshipman, pink seaperch, California tonguefish, and bigmouth sole. All of these common species tended to be relatively small (< 18 cm in length on average, **Appendix C.1**). In contrast, species greater than 20 cm in length were collected infrequently and included spotted ratfish, big skate, California skate, California lizardfish and vermilion rockfish.

Community structure varied among the stations during the year (**Table 6.2**). For example, abundance ranged from 114 to 516 fish per haul at the different stations. The largest hauls, which occurred at stations SD10 - SD12 in January, reflected substantial numbers of yellowchin sculpin and longspine combfish. Biomass was also highly variable due to hauls with high numbers of fish or a few large fish that occurred at various times. While species richness and diversity (H') values differed among stations, both were relatively low. The average number of species per station was 17 or less at all stations. Diversity values were below 2.

Demersal fish communities have varied over time off Point Loma, although there do not appear to be any changes associated with the initiation of discharge from the PLOO at the end of 1993 (**Figure 6.2**). Although species richness has remained fairly consistent (between 10-20 species) for all stations (inshore, farfield, nearfield), abundances have fluctuated substantially over the years (between 93 and 690 individuals), especially at stations SD9-SD14. These fluctuations in abundance generally reflected differences in the populations of the dominant species, particularly the Pacific sanddab.

Ordination and classification of sites sampled in October of each year discriminated between three major cluster groups that most likely reflect the influence of different oceanographic conditions (**Figure 6.3**, **Table 6.3**). For example, almost all of the stations sampled in October of 1992, 1997 and 1998 fall into station group SG2, which coincides with El Niño

Table 6.3

Summary of the main station cluster groups for October, 1991-2002. Data include number of hauls, mean number of species, mean number of individuals, as well as the distribution of abundant and frequently occurring fish species in each group.

	SG1	SG2	SG3
Number of hauls	40	45	11
Mean no. of species per haul	16	13	13
Mean no. of individuals per haul	438.6	250.6	175.7
Species	**Mean Abundance**		
Pacific sanddab	**217.4**	**126.4**	**113.9**
Yellowchin sculpin	**81.3**	**36.4**	3.5
Longspine combfish	**31.5**	**6.8**	1.4
Longfin sanddab	**22.3**	**27.4**	**6.2**
Dover sole	**18.2**	1.0	2.2
Plainfin midshipman	13.9	4.3	1.1
Stripetail rockfish	13.4	2.9	0.5
California tonguefish	8.3	4.7	2.7
English sole	4.9	1.9	1.0
Halfbanded rockfish	4.6	**20.0**	**17.5**
Pink seaperch	3.4	3.4	1.3
Bay goby	3.2	2.3	1.2
Pacific argentine	2.7	4.0	**7.8**
Bigmouth sole	2.2	1.0	1.0
Shortspine combfish	1.9	0.4	**4.5**
Spotfin sculpin	0.7	0.1	2.0
Squarespot rockfish	0.0	1.3	2.3

conditions present during these times (NOAA-CIRES 2003). The three cluster groups primarily represent different numbers of the most abundant and frequently occurring species (Table 6.3). These species include the Pacific sanddab, yellowchin sculpin, longspine combfish, longfin sanddab, Dover sole, halfbanded rockfish, shortspine rockfish and Pacific argentine. No patterns were evident that suggest changes in the assemblages following the initiation of the discharge.

Physical Abnormalities and Parasitism

No physical abnormalities were found on any fish collected off Point Loma in 2002. The presence of external parasites on local fishes was also rare, with the rate of parasitism being less than < 5% overall. Pacific sanddabs had the highest rate of infestation (4%). The copepod eye parasite *Phrixocephalus cincinnatus* occurred on Pacific sanddabs collected at all stations during all surveys. Other parasites included an unidentified eye parasite found on two bay gobies and a leech found on a bigmouth sole. The ectoparasitic isopod, *Elthusa vulgaris,* also occurred in several trawls. However its host fish is unknown because this isopod becomes detached from its host during sorting. Although *E. vulgaris* occurs on a wide variety of fish species off of southern California, it is especially common on sanddabs and California lizardfish, where it may reach infestation rates of 3% and 80%, respectively (Brusca 1978, 1981).

Invertebrate Community

A total of 22,520 megabenthic invertebrates (593/trawl) were collected during 2002, representing 74 taxa (**Table 6.4**). The white sea urchin *Lytechinus pictus*

Table 6.4

Megabenthic invertebrate species collected in 38 trawls off Point Loma, San Diego during 2002. Data for each species are expressed as: (1) percent abundance (PA); (2) frequency of occurrence (FO); (3) mean abundance per occurrence (MAO).

Species	PA	FO	MAO	Species	PA	FO	MAO
Lytechinus pictus	95	89	2043	*Acanthodoris brunnea*	< 1	5	2
Acanthoptilum sp	2	82	48	*Virgularia agassizii*	< 1	5	2
Allocentrotus fragilis	1	32	47	*Calliostoma turbinum*	< 1	5	1
Astropecten verrilli	< 1	84	8	*Excorallana truncata*	< 1	5	1
Parastichopus californicus	< 1	74	4	*Lovenia cordiformis*	< 1	5	1
Luidia foliolata	< 1	66	5	*Metacrangon spinosissima*	< 1	5	1
Thesea sp B	< 1	55	5	*Ophiothrix spiculata*	< 1	5	1
Ophiura luetkenii	< 1	50	2	*Panulirus interruptus*	< 1	5	1
Octopus rubescens	< 1	47	2	*Platydoris macfarlandi*	< 1	5	1
Rossia pacifica	< 1	45	2	*Philine alba*	< 1	3	3
Sicyonia ingentis	< 1	42	3	*Schmittius politus*	< 1	3	3
Pleurobranchaea californica	< 1	39	2	*Loxorhynchus grandis*	< 1	3	2
Loligo opalescens	< 1	34	10	*Moloha faxoni*	< 1	3	2
Nymphon pixellae	< 1	32	8	PORIFERA	< 1	3	2
Megasurcula carpenteriana	< 1	29	2	*Addisonia brophyi*	< 1	3	1
Crangon alaskensis	< 1	26	2	*Amphiodia urtica*	< 1	3	1
Philine auriformis	< 1	24	3	*Antiplanes catalinae*	< 1	3	1
*Metridium senile**	< 1	24	2	*Aphrodita* sp	< 1	3	1
Amphichondrius granulatus	< 1	21	2	ASCIDIACEA	< 1	3	1
Luidia armata	< 1	18	2	*Astropecten ornatissimus*	< 1	3	1
Luidia asthenosoma	< 1	18	1	*Cancellaria cooperii*	< 1	3	1
Florometra serratissima	< 1	16	3	*Doriopsilla albopunctata*	< 1	3	1
Platymera gaudichaudii	< 1	16	2	*Euvola diegensis*	< 1	3	1
Paguristes turgidus	< 1	13	1	*Flabellina iodinea*	< 1	3	1
Pleuroncodes planipes	< 1	11	2	*Gorgonocephalus eucnemis*	< 1	3	1
Armina californica	< 1	11	1	*Loxorhynchus crispatus*	< 1	3	1
Elthusa vulgaris	< 1	11	1	*Nassarius insculptus*	< 1	3	1
Neocrangon zacae	< 1	8	4	*Neocrangon resima*	< 1	3	1
Ophiopholis bakeri	< 1	8	2	*Octopus californicus*	< 1	3	1
Stylatula elongata	< 1	8	2	*Okenia* sp	< 1	3	1
Cancellaria crawfordiana	< 1	8	1	*Podochela lobifrons*	< 1	3	1
Hemisquilla ensigera californiensis	< 1	8	1	*Polinices draconis*	< 1	3	1
Neosimnia barbarensis	< 1	8	1	POLYCHAETA	< 1	3	1
Tritonia diomedea	< 1	8	1	*Protula superba*	< 1	3	1
Arctonoe pulchra	< 1	5	3	*Pugettia venetiae*	< 1	3	1
Pandalus platyceros	< 1	5	3	*Pylopagurus holmesi*	< 1	3	1
Spatangus californicus	< 1	5	2	*Strongylocentrotus franciscanus*	< 1	3	1

(= SPP complex)*

Table 6.5

Megabenthic invertebrate community parameters sampled during 2002. Data are expressed as (1) total number of species; (2) mean number of species; (3) mean abundance (Abund); (4) mean diversity (H'); (5) mean biomass (BM) (kg, wet weight).

Station	Number of Species Total	Number of Species Mean	Abund	H'	BM
Inshore (N=2)					
SD1	19	11	52	1.42	0.5
SD3	6	5	27	0.78	0.3
SD6	19	11	31	2.10	1.0
Offshore (N=4)					
SD7	24	11	1597	0.19	5.6
SD8	31	15	4223	0.08	9.6
SD9	29	14	611	1.55	5.7
SD10	24	12	6561	0.09	15.3
SD11	28	15	3566	0.19	12.5
SD12	33	15	620	0.91	8.2
SD13	19	9	534	0.55	9.3
SD14	22	10	417	0.72	7.5

was the most abundant and most frequently captured species. It was captured in 89% of the trawls and accounted for 95% of the total invertebrate catch. Other species that occurred in at least half of the hauls included the sea pen *Acanthoptilum* sp, the sea stars *Astropecten verrilli* and *Luida foliolata*, the sea cucumber *Parastichopus californicus*, and the sea twig *Thesea* sp B.

Invertebrate community structure varied among the stations during the year (**Table 6.5**). For example, the total number of species per station ranged from 6 to 33, while abundance per station averaged from 27 to 6,561 individuals. Generally, hauls with the fewest number of species and fewest individuals occurred at the inshore stations. The largest hauls occurred at the offshore stations SD7, SD8, SD10, and SD11, primarily due to large numbers of *L. pictus*. Large hauls of *L. pictus* and those containing a few large individuals such as the holothroid *P. californicus*, also contributed to the highly variable biomass values.

Invertebrate species richness varied over time (**Figure 6.4**). Species richness ranged from 5 to 20 species at most stations, and was generally lower at the inshore stations than at the offshore sites. The patterns of change in the number of species at the offshore stations (i.e., nearfield and farfield) were similar. Abundance was also highly variable over time and among stations. For example, three stations (i.e., SD6, SD13, SD14) had relatively small catches of invertebrates during each years, while the other eight stations demonstrated large peaks in abundance at various times. These fluctuations typically reflect changes in echinoderm populations, especially that of *L. pictus.* None of the observed variability in the invertebrate community was associated with the initiation of discharge from the Point Loma outfall.

SUMMARY & CONCLUSIONS

As in previous years, the structure of the demersal fish and megabenthic invertebrate communities varied among stations, generally due to population fluctuations of various dominant species. Pacific sanddabs, which was present in every haul, dominated the fish assemblages surrounding the Point Loma Ocean Outfall during 2002. Other fish, such as the yellowchin sculpin, longspine combfish, longfin sanddab, Dover sole, stripetail rockfish, plainfin midshipman, pink seaperch, California tonguefish, and bigmouth sole were also collected frequently, but in much lower numbers.

Invertebrate assemblages were also dominated by a few species. The white sea urchin *Lytechinus pictus* was the most wide-spread and most abundant species, representing 95% of the total invertebrate catch. The sea pen *Acanthoptilum* sp, the sea stars *Astropecten verrilli* and *Luida foliolata*, the sea cucumber *Parastichopus californicus*, and the sea twig *Thesea* sp B also occurred frequently but in much lower numbers.

These communities are inherently variable, and subject to influences of both anthropogenic and natural factors. Anthropogenic influences include inputs from ocean outfalls and storm drain runoff. Natural factors may include prey availability (Cross et al. 1985), bottom relief and sediment structure (Helvey and Smith 1985), and changes in water temperature associated with large scale oceanographic events such as El Niño

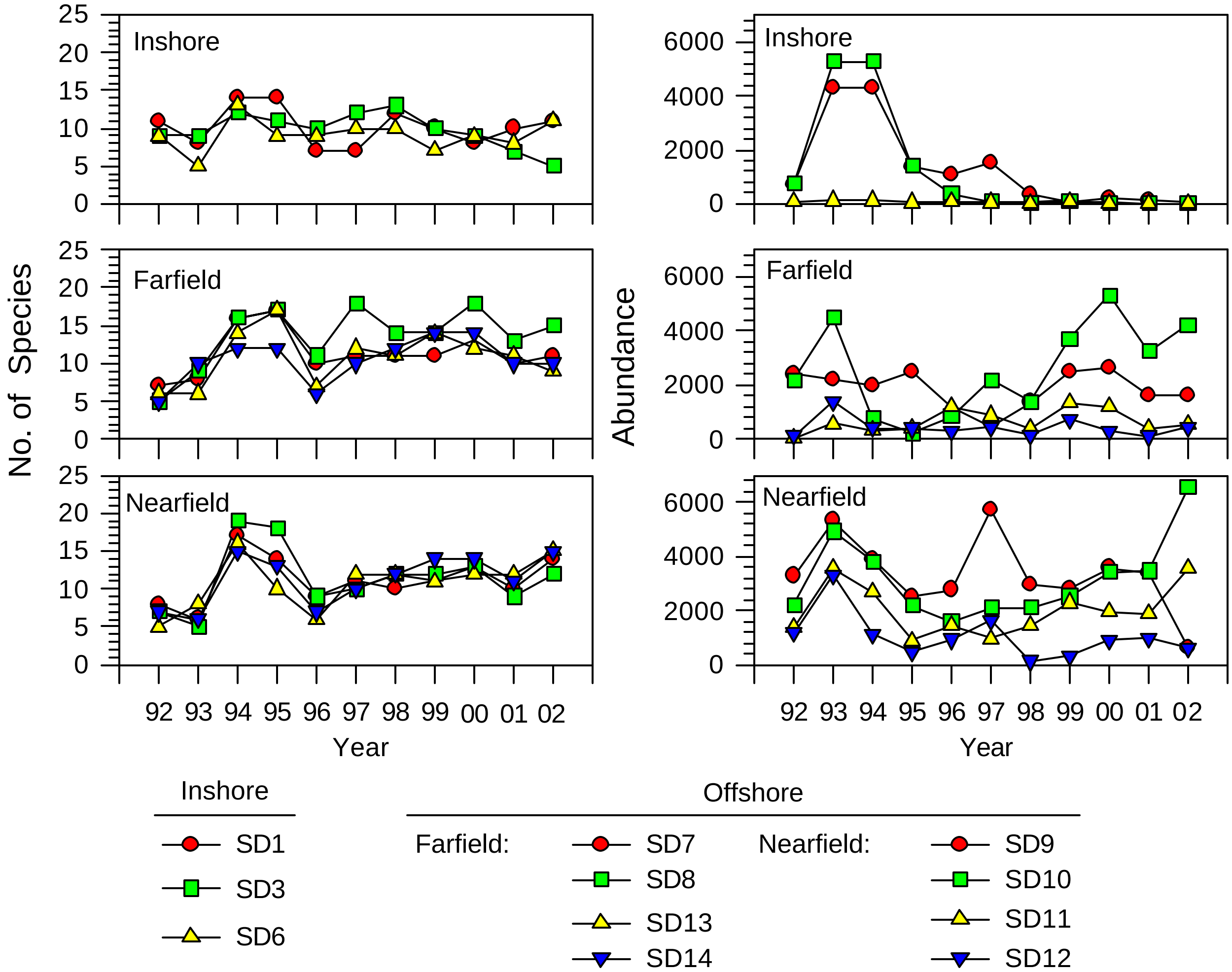


Figure 6.4

Annual mean number of species and abundance of megabenthic invertebrates sampled at the inshore (n=2) and the offshore (n=4) stations, 1992 through 2002.

(Karinen et al. 1985). The observed changes in the communities were more likely due to natural factors, which can impact the migration of adult fish or the recruitment of juveniles into an area (Murawski 1993). Population fluctuations may also be due to the mobile nature of many species (e.g., schools of fish or aggregations of urchins).

Overall, the monitoring data provided no evidence that the discharge of waste water from the Point Loma Ocean Outfall in 2002 affected either the fish or megabenthic invertebrate communities in the region. Despite the variable structure of these assemblages, patterns of species diversity, abundance and biomass at stations near the outfall were similar to those located further away. In addition, no changes have been found in these assemblages that correspond to the initiation of wastewater discharge. Furthermore, the absence physical abnormalities on local fishes suggest that populations in the area are healthy.

LITERATURE CITED

Allen, M.J. (1982). Functional structure of soft-bottom fish communities of the southern California shelf. Ph.D. dissertation. University of California, San Diego. La Jolla, CA. 577 pp.

Allen, M.J., S.L. Moore, K.C. Schiff, S.B. Weisberg, D. Diener, J.K. Stull, A. Groce, J. Mubarak, C.L. Tang, and R. Gartman. (1998). Southern California Bight 1994 Pilot Project: Chapter V. Demersal Fishes and

Megabenthic Invertebrates. Southern California Coastal Water Research Project, Westminister, CA. 324 pp.

Brusca, R.C. (1978). Studies on the cymothoid fish symbionts of the eastern Pacific (Crustacea: Cymothoidae). II. Systematics and biology of *Livoneca vulgaris* Stimpson 1857. Occ. Pap. Allan Hancock Fdn. (New Ser.), 2: 1-19

Brusca, R.C. (1981). A monograph on the Isopoda Cymothoidae (Crustacea) of the eastern Pacific. Zool. J. Linn. Soc., 73: 117-199

City of San Diego. (2003). 2002 Quality Assurance Manual. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division. San Diego, CA.

Cross, J.N., and L.G. Allen. (1993). Chapter 9. Fishes. In: Dailey, M.D., D.J. Reish, and J.W. Anderson, eds. Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press, Berkeley, CA. p. 459-540

Cross, J.N., J.N. Roney, and G.S. Kleppel. (1985). Fish food habitats along a pollution gradient. California Fish and Game, 71: 28-39

Helvey, M., and R.W. Smith. (1985). Influence of habitat structure on the fish assemblages associated with two cooling-water intakestructures in southern California. Bull. Mar. Sci., 37: 189-199

Karinen, J.B., B.L. Wing, and R.R. Straty. (1985). Records and sightings of fish and invertebrates in the eastern Gulf of Alaska and oceanic phenomena related to the 1983 El Niño event. In: Wooster, W.S. and D.L. Fluharty, eds. El Niño North: El Niño Effects in the Eastern Subarctic Pacific Ocean. Washington Sea Grant Program. p. 253-267

Murawski, S.A. (1993). Climate change and marine fish distribution: forecasting from historical analogy. Trans. Amer. Fish. Soc., 122: 647-658

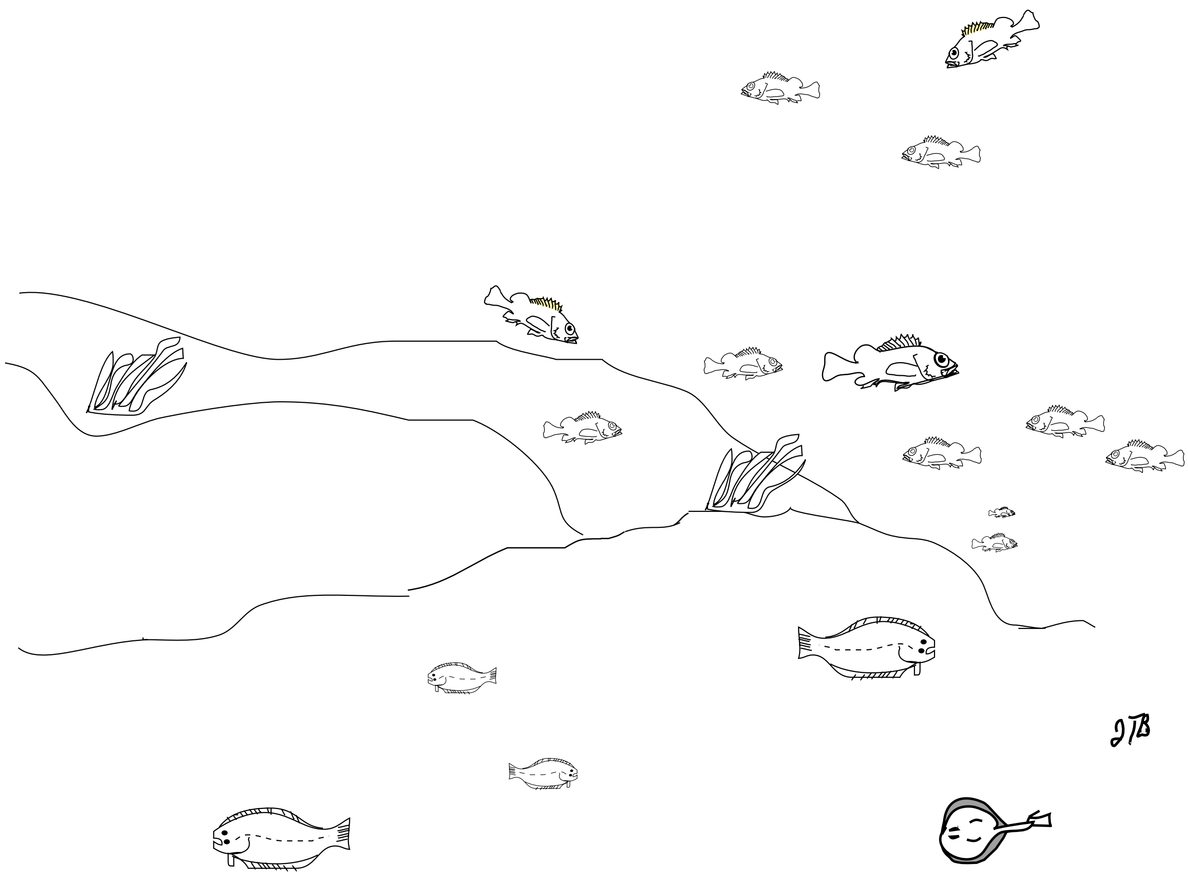
Nelson, J.S. (1994). Fishes of the World - Third Edition. John Wiley & Sons, Inc. New York, NY. 600 pp.

NOAA-CIRES. (2003). Multivariate ENSO Index (MEI). http://www.cdc.noaa.gov/~kew/MEI

Smith, R.W. (1982). The Analysis of Ecological Survey data with SAS and EAP. Proc. 7th Annual SAS Users' Group International, (SUGI). SAS Institute Inc., Cary, N C. 705 pp.

Smith, R.W., B.B. Bernstein, and R.L. Cimberg. (1988). Community-environmental relationships in the benthos: applications of multivariate techniques. In: Soule, D.F. and G.S. Kleppel, eds. Marine Organisms as Indicators. Springer-Verlag, New York, p. 247-326. structures in southern California. Bull. Mar. Sci., 37: 189-199

Bioaccumulation of Contaminants in Fish Tissues



Chapter 7: Bioaccumulation of Contaminants in Fish Tissues

INTRODUCTION

Bottom dwelling (i.e., demersal) fishes are collected as part of the Point Loma Ocean Outfall (PLOO) monitoring program to assess the accumulation of contaminants in their tissues. The bioaccumulation of contaminants in fish occurs through biological uptake and retention of chemical contaminants derived from various exposure pathways (Tetra Tech 1985). Exposure routes for these fishes include the adsorption or absorption of dissolved chemical constituents from the water and the ingestion and assimilation of pollutants from food sources. They also accumulate pollutants by ingesting pollutant-containing suspended particulate matter or sediment particles. Demersal fish are particularly useful in biomonitoring programs because of their proximity to bottom sediments. For this reason, levels of contaminants in tissues of demersal fish are often related to those found in the environment (Schiff and Allen 1997).

The bioaccumulation portion of the PLOO monitoring program consists of two components: (1) contaminants measured in tissues from trawl-caught fishes and (2) contaminants measured in tissues from fishes collected by rig fishing. Fishes collected from trawls are considered representative of the demersal fish community, and certain species are targeted based on their ecological significance (i.e., prevalence in the community). Fishes targeted for collection by rig fishing represent a typical sport fisher's catch, and therefore have recreational and commercial importance. Liver and muscle tissues are dissected from fish and analyzed for levels of contaminants specified in the City's NPDES permit. Analyses are performed using livers because this is where contaminants are typically concentrated due to the liver's physiological role and high lipid levels. Muscle tissues are important because they are the tissue most often consumed by humans and therefore the results are pertinent to human health concerns. This chapter presents the results of the bioaccumulation analyses of fishes collected off San Diego, California during 2002.

MATERIALS & METHODS

Collection

Fishes were collected during April and October surveys of 2002 at eight trawl stations and two rig fishing stations (**Figure 7.1**). Trawl-caught fishes were collected, measured and weighed following established guidelines as described in Chapter 6 of this report. Fishes were collected at rig fishing sites using rod and reel fishing tackle following standard procedures (City of San Diego 2003). Fish >11 cm standard length were retained for tissue analyses. After collection, fish were sorted into no more than three composite samples per station, each containing a minimum of three individuals. The fish were then wrapped in aluminum foil, labeled, put in ziplock bags, and placed on dry ice for transport to the Marine Biology laboratory freezer. The species that were analyzed from each station are summarized in **Table 7.1**.

Tissue Processing and Chemical Analyses

All dissections were performed according to standard techniques for tissue analysis (see City of San Diego 2003). Each fish was partially defrosted and then cleaned with a paper towel to remove loose scales and excess mucus prior to dissection. The standard length (cm) and weight (g) of each fish were recorded (**Appendix D.1**). Dissections were carried out on Teflon pads that were cleaned between samples. Tissue samples were then placed in glass jars, sealed, labeled and stored in a freezer at -20°C prior to chemical analyses. All samples were subsequently delivered to the City of San Diego Wastewater Chemistry Laboratory within seven days of dissection.

All tissue samples were analyzed for the permit-required chemical constituents, including heavy metals, chlorinated pesticides, PCBs and PAHs (see **Appendix D.2**). A summary of all parameters detected at each station during each survey is listed in **Appendix D.3**.

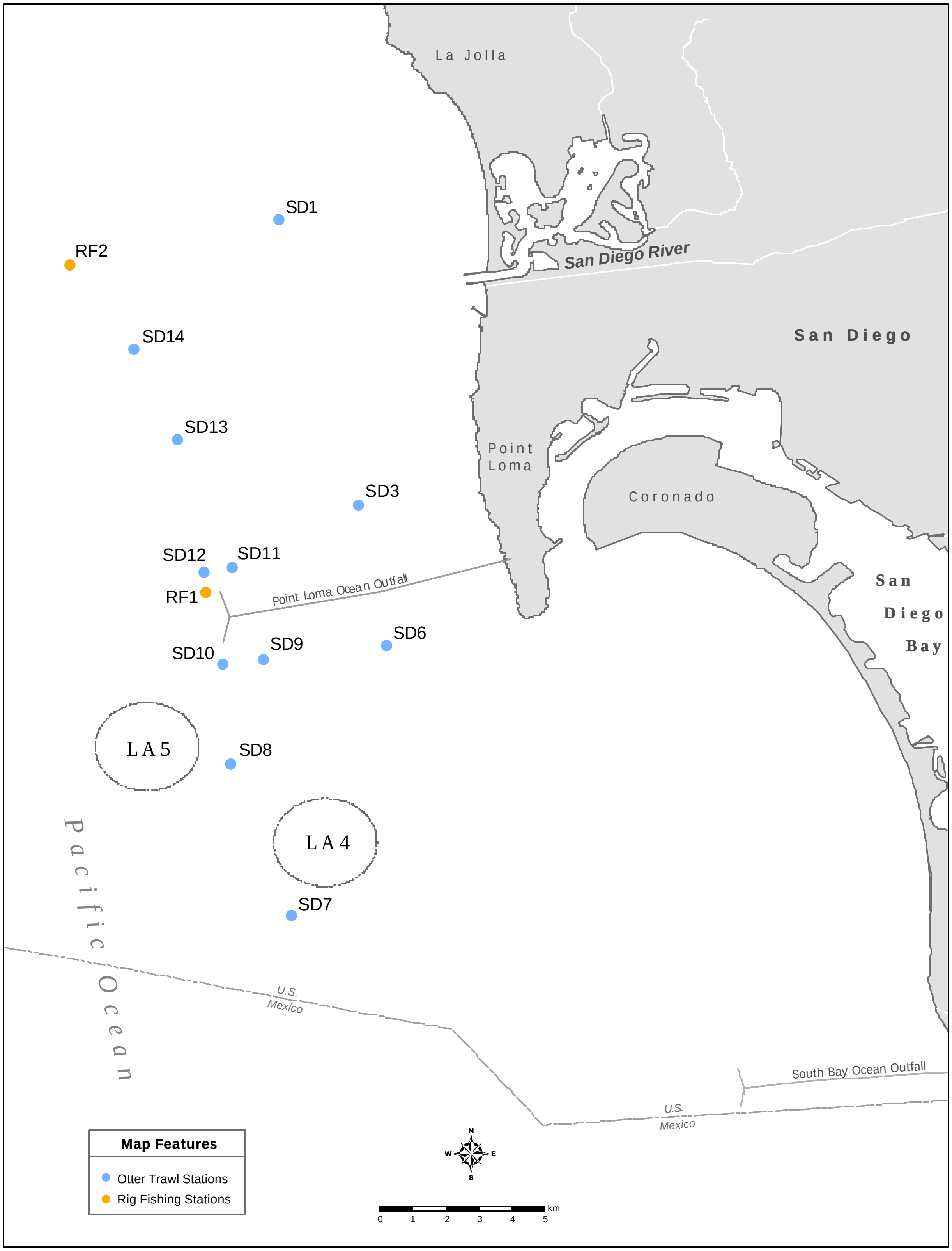


Figure 7.1
Otter trawl and rig fishing stations surrounding the Point Loma Ocean Outfall.

Table 7.1

Species collected at each PLOO trawl and rig fishing station during April and October 2002; ns = samples not collected due to insufficient numbers of fish.

Station	Rep 1	Rep 2	Rep 3
April 2002			
SD7	Pacific sanddab	English sole	California scorpionfish
SD8	Pacific sanddab	Greenblotched rockfish*	Longfin sanddab
SD9	California scorpionfish	Longfin sanddab	Hornyhead turbot
SD10	Pacific sanddab	California scorpionfish*	California scorpionfish
SD11	California scorpionfish	Pacific sanddab	Longfin sanddab
SD12	Longfin sanddab	Pacific sanddab	California scorpionfish
SD13	Longfin sanddab	Pacific sanddab	California scorpionfish
SD14	Pacific sanddab	Pacific sanddab	California scorpionfish
RF1	Vermilion rockfish	Copper rockfish	California scorpionfish
RF2	Mixed rockfish	Vermilion rockfish	Flag rockfish
October 2002			
SD7	Longfin sanddab	Dover sole**	Longfin sanddab
SD8	California scorpionfish	Longfin sanddab	Pacific sanddab
SD9	Longfin sanddab	Longfin sanddab	English sole
SD10	Longfin sanddab	Pacific sanddab	California scorpionfish
SD11	Longfin sanddab	California scorpionfish	California scorpionfish
SD12	California scorpionfish	Dover sole	Pacific sanddab
SD13	Longfin sanddab	California scorpionfish	California scorpionfish
SD14	Pacific sanddab	Pacific sanddab	Pacific sanddab
RF1	Copper rockfish	Copper rockfish	Mixed rockfish
RF2	Flag rockfish	Vermilion rockfish***	ns

* no mercury data available for muscle samples
** no metals analyzed for liver sample
*** only two fish used in this sample

Detected parameters include some that were determined to be present in a sample with high confidence (i.e., peaks are confirmed by mass-spectrometry), but at levels below the MDL. These were included in the data as estimated values. A detailed description of the analytical protocols may be obtained from the City of San Diego Wastewater Chemistry Laboratory.

RESULTS

Contaminants in Trawl-Caught Species

Metals

Aluminum, arsenic, cadmium, copper, iron, manganese, mercury, selenium, and zinc occurred frequently in the liver samples of all trawl-caught species of fish (**Table 7.2**). Each of these metals was detected in over 65% of the samples, although in highly variable concentrations. For example, zinc occurred in all species with concentrations ranging from about 14 to 182 ppm. Beryllium, chromium, nickel, and silver were detected much less frequently, with all values below 25 ppm.

Species-specific comparisons of the frequently detected metals were made between the stations closest to the discharge (SD9-SD12) and those farther away (SD7, SD8, SD13-SD14). Although values varied substantially, the concentrations of some metals (i.e., aluminum, cadmium, manganese, mercury) were slightly higher in fishes collected at the discharge stations than at the non-discharge stations (**Figure 7.2**). However, long term comparisons of longfin sanddab samples suggest that there is no clear relationship between contaminant levels and proximity to the outfall (**Figure 7.3**).

Chlorinated Pesticides

Although all samples were tested for the presence of 24 pesticides (Appendix D.2), only seven were detected in liver tissues from fishes collected in the Point Loma coastal region (**Table 7.3**, Appendix D.3). DDT was the most prevalent and it occurred in all samples with concentrations of total DDT between 40 ppb and 15,079 ppb. Chlordane, BHC, dieldrin endrin, hexachlorobenzene (HCB), and nonachlor were also detected, but at concentrations less than 100 ppb. Of these, chlordane, HCB and trans nonachlor were the most common, with detection rates greater than 45%.

DDT, chlordane, HCB and trans nonachlor were detected in fishes collected from all stations (**Figure 7.4**). As with the metals, there was no clear relationship between concentrations of these parameters and proximity to the outfall. Moreover, there is no evidence that total DDT has increased at outfall stations since 1995 (**Figure 7.5**). All concentrations of DDT in fish liver samples collected during 2002 were below maximum values reported for this area prior to discharge (City of San Diego 1996).

PCBs

Polychlorinated biphenyls (PCBs) occurred in all fish samples (**Table 7.4** and Appendix D.3). Total PCB concentrations were variable and ranged from 39.1 to 1,180.7 ppb. The highest longfin and Pacific sanddab PCB concentrations occurred at station SD8, located near the LA5 dredge spoils dumpsite (Figure 7.4). Elevated PCB concentrations have been found in longfins at this station several times since 1995 (Figure 7.5). No clear relationship was evident between concentrations of PCBs in fish liver samples and proximity to the outfall.

PAHs

Twenty-four polyaromatic hydrocarbons (PAHs) were investigated in all of the samples from the PLOO program (Appendix D.2). Phenanthrene was the only detected PAH in 2002. It occurred in a single longfin sanddab liver sample from station SD12 in April at a concentration of 79 ppb (Table 7.4).

Contaminants in Rig-Caught Fish

Concentrations of contaminants in muscle tissue samples from rig-caught fishes were compared to national and international limits and standards to address human health concerns (**Table 7.5**). In 2002, arsenic, copper, mercury, selenium, and zinc were detected in 45% or more of the fishes collected. Of these, arsenic, mercury, and selenium had concentrations higher than their median international standards. All values of mercury and total DDT were below United States Food and Drug Administration (FDA) action limits. Both the FDA limits and international standards apply to the sale of seafood for human consumption (Mearns et al. 1991).

Spatial patterns were assessed for chlorinated pesticides and PCBs, as well as all metals that occurred frequently in fish muscle tissue samples (**Figure 7.6**). Concentrations of these parameters were variable and samples from the nearfield station (RF1) had values similar to those of the farfield station (RF2). For example, fish from both sites had concentrations of arsenic, mercury, and selenium that exceeded the international standards.

SUMMARY and CONCLUSIONS

Demersal fish collected around the Point Loma Ocean Outfall in 2002 were characterized by contaminant values within the range of those reported previously for other Southern California Bight (SCB) fish assemblages (see Mearns et al. 1991, Allen et al. 1998). In addition, concentrations of these contaminants were generally similar to those reported previously by the City of San Diego (City of San Diego 1996-2002).

The frequent occurrence of metals and chlorinated hydrocarbons in PLOO fish tissues may be due to many factors. Mearns et al. (1991) described the distribution of several contaminants, including arsenic, mercury, DDT, and PCBs as being ubiquitous in the

Table 7.2

Metals detected in liver samples from fish collected at PLOO trawl stations during 2002. Values are expressed as parts per million (ppm). N = number of detected values.

	Al	As	Be	Cd	Cr	Cu	Fe	Mn	Hg	Ni	Se	Ag	Zn
Ca. Scorpionfish													
N (out of 15)	9	11	0	12	2	15	15	7	15	0	15	1	15
Min	3.5	2.2	—-	0.4	0.2	7.9	65.9	0.2	0.013	—-	0.7	0.8	31.3
Max	27.4	14.1	—-	5.4	0.8	67.0	242.0	0.9	0.419	—-	2.3	0.8	182.0
Mean	11.4	5.6	—-	2.6	0.5	27.6	138.6	0.4	0.128	—-	0.9	0.8	88.3
Pacific sanddab													
N (out of 14)	12	9	1	10	0	13	14	14	12	0	14	1	14
Min	3.4	1.6	0.1	0.5	—-	3.1	27.5	0.2	0.008	—-	0.7	1.7	16.7
Max	36.6	12.4	0.1	5.0	—-	16.1	126.0	1.2	0.579	—-	1.1	1.7	28.5
Mean	11.4	5.7	0.1	2.1	—-	8.3	77.4	0.6	0.087	—-	0.9	1.7	22.9
Longfin sanddab													
N (out of 13)	12	11	0	9	2	13	13	12	13	1	13	1	13
Min	4.0	1.5	—-	0.4	1.2	3.1	74.0	0.3	0.008	18.9	1.6	0.9	13.8
Max	13.0	14.9	—-	6.3	22.8	16.0	233.0	5.5	0.144	18.9	3.4	0.9	31.4
Mean	8.7	8.3	—-	2.0	12.0	9.7	160.6	1.3	0.071	18.9	2.3	0.9	23.8
English sole													
N (out of 2)	2	2	0	0	0	2	2	2	2	0	2	0	2
Min	2.9	5.9	—-	—-	—-	4.6	89.2	1.2	0.063	—-	2.7	—-	45.4
Max	5.2	33.9	—-	—-	—-	14.5	173.0	2.3	0.066	—-	2.8	—-	66.4
Mean	4.1	19.9	—-	—-	—-	9.5	131.1	1.8	0.064	—-	2.8	—-	55.9
Dover sole													
N (out of 1)	1	0	0	0	0	1	1	1	1	0	1	0	1
Min	3.4	—-	—-	—-	—-	3.4	165.0	0.4	0.139	—-	2.8	—-	19.4
Max	3.4	—-	—-	—-	—-	3.4	165.0	0.4	0.139	—-	2.8	—-	19.4
Mean	3.4	—-	—-	—-	—-	3.4	165.0	0.4	0.139	—-	2.8	—-	19.4
Hornyhead turbot													
N (out of 1)	1	1	0	1	0	1	1	1	1	0	1	0	1
Min	18.6	10.3	—-	3.2	—-	10.7	112.0	1.0	0.025	—-	1.9	—-	32.9
Max	18.6	10.3	—-	3.2	—-	10.7	112.0	1.0	0.025	—-	1.9	—-	32.9
Mean	18.6	10.3	—-	3.2	—-	10.7	112.0	1.0	0.025	—-	1.9	—-	32.9
Greenspotted rockfish													
N (out of 1)	1	0	0	0	0	1	1	1	1	0	1	0	1
Min	7.1	—-	—-	—-	—-	22.2	76.6	1.2	0.070	—-	2.8	—-	46.8
Max	7.1	—-	—-	—-	—-	22.2	76.6	1.2	0.070	—-	2.8	—-	46.8
Mean	7.1	—-	—-	—-	—-	22.2	76.6	1.2	0.070	—-	2.8	—-	46.8
ALL SPECIES													
% Detect.	81	72	2	68	9	98	100	81	96	2	100	6	100

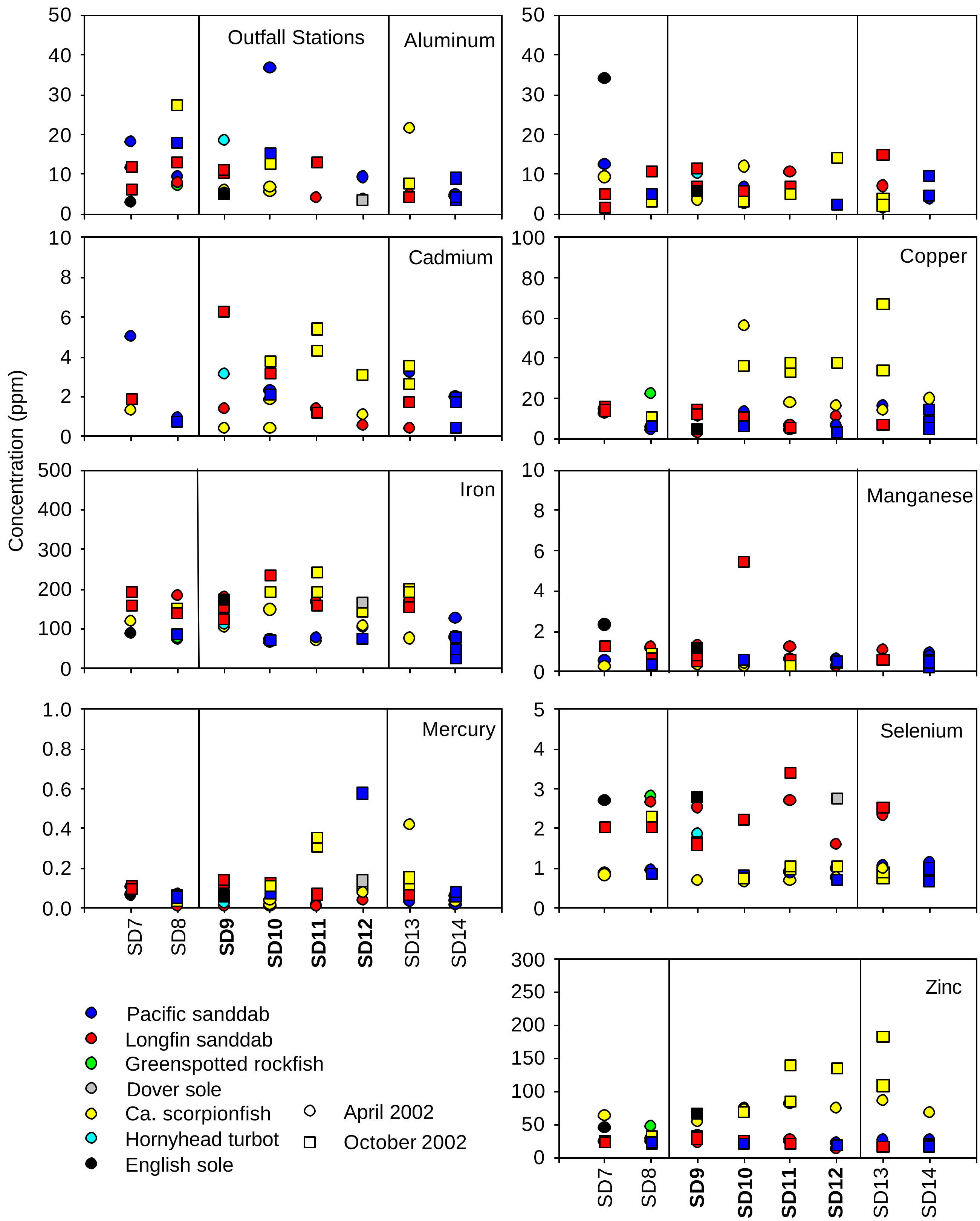


Figure 7.2

Concentrations of metals detected frequently in liver tissues of fish collected at PLOO trawl stations during 2002.

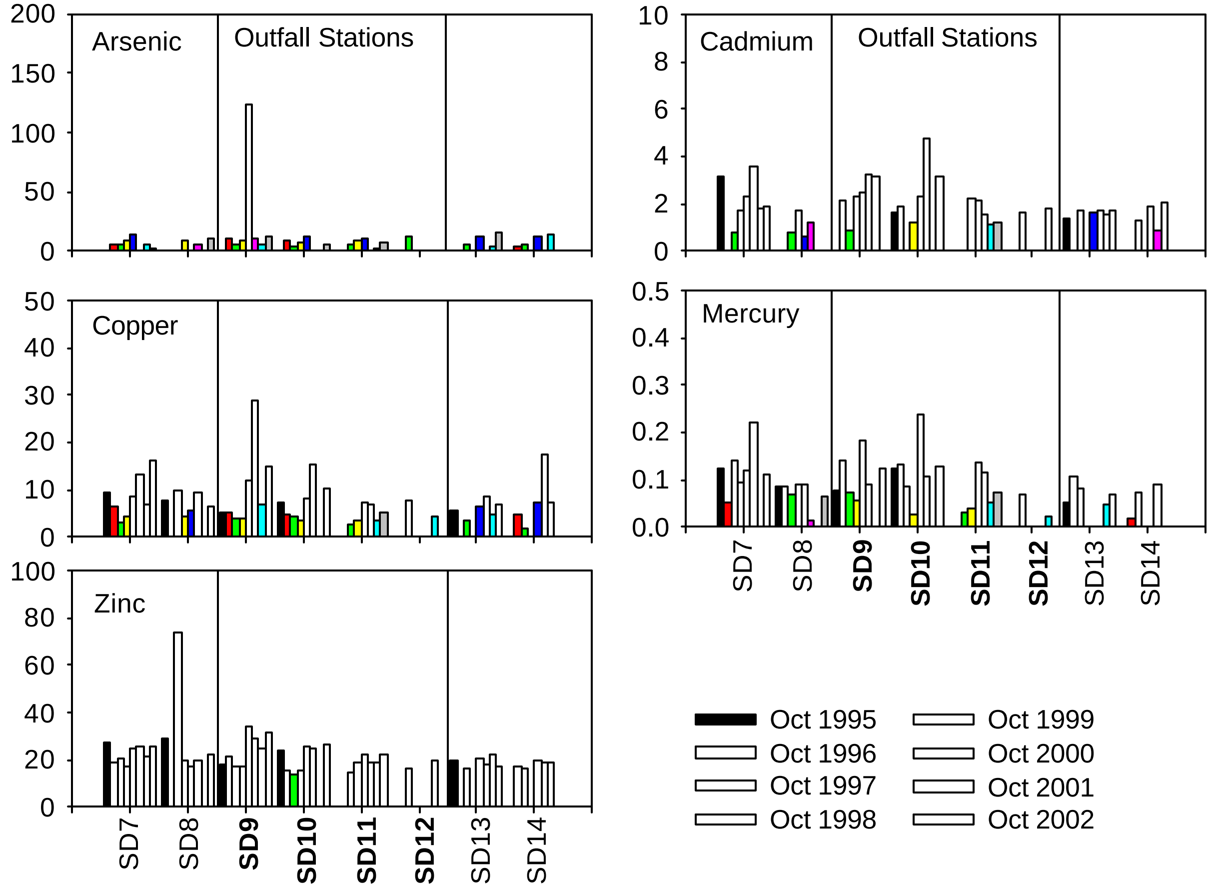


Figure 7.3

Concentrations of metals detected frequently in liver tissues of longfin sanddab collected during October surveys from 1995 to 2002.

SCB. In fact, many metals (e.g., aluminum and iron) occur naturally in the environment, although little information is available on their background levels in fish tissues. Brown et al. (1986) determined that no areas of the SCB are sufficiently free of chemical contaminants to be considered reference sites. This has been supported by more recent work regarding PCBs and DDTs (e.g., Allen et al. 1998).

Other factors that affect the accumulation and distribution of contaminants include the physiology and life history of different fish species. For example, exposure to contaminants can vary greatly between species and among individuals of the same species depending on migration habits (Otway 1991). Fish may be exposed to contaminants in one highly contaminated area and then move into an area that is less contaminated. This may explain why many of the metals, pesticides and PCBs detected in the fish tissues during 2002 were rarely or not detected in the sediments immediately surrounding the PLOO (see Chapter 4). In addition, differences in feeding habits, age, reproductive status, and gender can affect the amount of contaminants a fish will retain (e.g., Connell 1987, Evans et al. 1993). These factors make comparisons of contaminants among species and between stations difficult.

Overall, there was no evidence that fishes collected in 2002 were contaminated by the discharge of waste water from the Point Loma Ocean Outfall. Concentrations of mercury and DDT in muscle tissues from sport fish collected in the area were below FDA human consumption limits. Finally, there was no other indication of poor fish health in the region, such as the presence of fin rot or other physical anomalies (see Chapter 6).

Table 7.3

Chlorinated pesticides detected in liver samples from fish collected at PLOO trawl stations during 2002. BHC = Lindane, HCB = hexachlorobenzene. Values are expressed as parts per billion (ppb) . N = number of detected values

	Chlorinated Pesticides:									
	Chlordane		BHC					Nonachlor		Total
	Alpha	Gamma	Alpha	Beta	Dieldrin	Endrin	HCB	Trans	Cis	DDT
Ca. Scorpionfish										
N (out of 15)	3	1	1	1	2	2	15	14	0	15
Min	5.0	27.0	5.4	74.0	14.3	7.6	1.0	6.5	—-	137.8
Max	9.9	27.0	5.4	74.0	36.0	68.0	5.0	23.0	—-	15079.0
Mean	7.3	27.0	5.4	74.0	25.2	37.8	2.5	12.1	—-	1618.4
Pacific sanddab										
N (out of 14)	8	0	1	1	0	0	14	11	0	14
Min	5.4	—-	7.7	22.0	—-	—-	1.7	7.5	—-	273.0
Max	9.4	—-	7.7	22.0	—-	—-	7.6	16.0	—-	687.9
Mean	7.8	—-	7.7	22.0	—-	—-	4.0	10.4	—-	456.5
Longfin sanddab										
N (out of 13)	10	0	0	0	0	0	12	13	1	13
Min	4.0	—-	—-	—-	—-	—-	1.2	4.2	6.4	461.9
Max	8.2	—-	—-	—-	—-	—-	5.2	19.0	6.4	1391.3
Mean	6.2	—-	—-	—-	—-	—-	3.3	10.8	6.4	860.2
English sole										
N (out of 2)	1	0	0	0	0	0	1	0	0	2
Min	2.5	—-	—-	—-	—-	—-	1.5	—-	—-	132.5
Max	2.5	—-	—-	—-	—-	—-	1.5	—-	—-	2713.2
Mean	2.5	—-	—-	—-	—-	—-	1.5	—-	—-	1422.9
Dover sole										
N (out of 2)	0	0	0	0	0	0	2	0	0	2
Min	—-	—-	—-	—-	—-	—-	0.7	—-	—-	39.8
Max	—-	—-	—-	—-	—-	—-	1.1	—-	—-	59.9
Mean	—-	—-	—-	—-	—-	—-	0.9	—-	—-	49.9
Hornyhead turbot										
N (out of 1)	0	0	0	0	0	0	0	0	0	1
Min	—-	—-	—-	—-	—-	—-	—-	—-	—-	86.4
Max	—-	—-	—-	—-	—-	—-	—-	—-	—-	86.4
Mean	—-	—-	—-	—-	—-	—-	—-	—-	—-	86.4
Greenspotted rockfish										
N (out of 1)	0	0	0	0	0	0	1	0	0	1
Min	—-	—-	—-	—-	—-	—-	0.8	—-	—-	228.1
Max	—-	—-	—-	—-	—-	—-	0.8	—-	—-	228.1
Mean	—-	—-	—-	—-	—-	—-	0.8	—-	—-	228.1
ALL SPECIES										
% Dect.	46	2	4	4	4	4	94	79	2	100

Table 7.4

Polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAH: phenanthrene) and lipids detected in liver samples from fish collected at PLOO trawl stations during 2002. Values are expressed as parts per billion (ppb) for all parameters except lipids, which are presented as percent weight (% wt). N = number of detected values.

	Total PCB	PAH	Lipids
Ca. Scorpionfish			
N (out of 15)	15	0	15
Min	71.6	—-	14.4
Max	1104.3	—-	38.1
Mean	350.5	—-	27.2
Pacific sanddab			
N (out of 14)	14	0	14
Min	74.1	—-	25.5
Max	750.7	—-	49.7
Mean	243.7	—-	36.5
Longfin sanddab			
N (out of 13)	13	1	13
Min	364.4	78.8	15.5
Max	1180.7	78.8	43.9
Mean	705.7	78.8	30.1
English sole			
N (out of 2)	1	0	2
Min	54.3	—-	6.8
Max	54.3	—-	11.4
Mean	54.3	—-	9.1
Dover sole			
N (out of 2)	1	0	2
Min	294.3	—-	5.2
Max	294.3	—-	9.0
Mean	294.3	—-	7.1
Hornyhead turbot			
N (out of 1)	2	0	1
Min	177.8	—-	6.4
Max	355.4	—-	6.4
Mean	266.6	—-	6.4
Greenspotted rockfish			
N (out of 1)	2	0	1
Min	39.1	—-	11.0
Max	72.4	—-	11.0
Mean	55.8	—-	11.0
ALL SPECIES			
% Dect.	100	2	

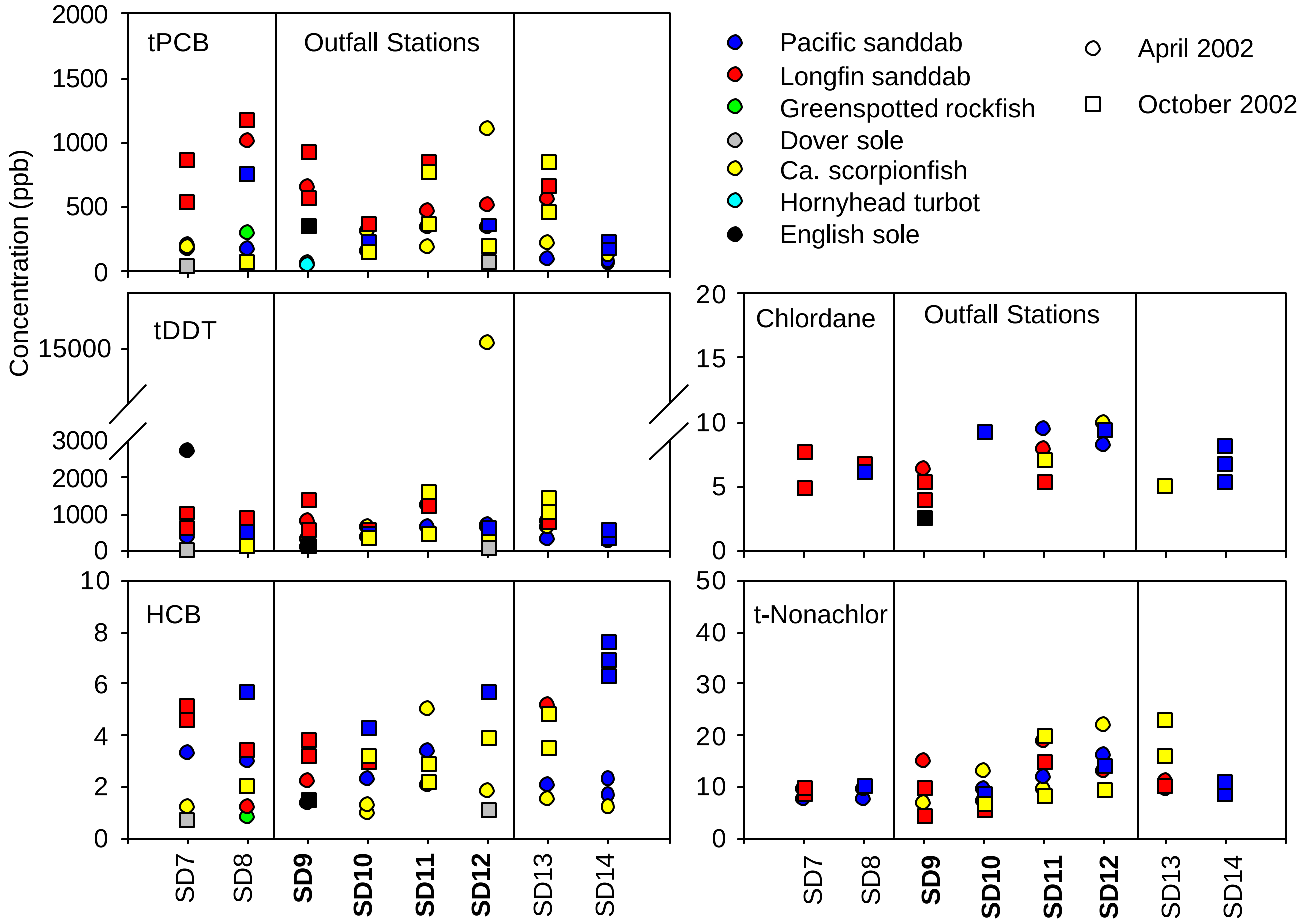


Figure 7.4

Concentrations of frequently detected chlorinated pesticides and total PCB detected in liver tissues of fish collected at PLOO trawl stations during 2002.

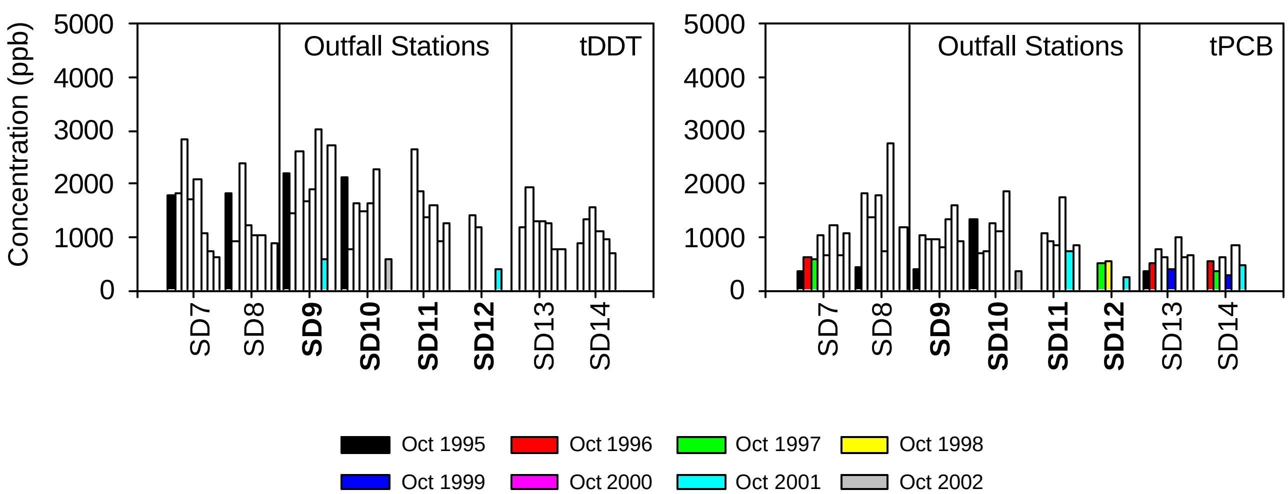


Figure 7.5

Concentrations of total PCB and total DDT in liver tissues of longfin sanddab collected during October surveys from 1995 to 2002.

Table 7.5

Concentrations of various metals and total DDT detected in muscle samples from fish collected at PLOO rig fishing stations during 2002. Values are parts per million (ppm) for all parameters. Also included are US FDA action limits and median international standards. Bolded values exceed standards.

	As	Cd	Cr	Cu	Pb	Hg	Se	Tn	Zinc	tDDT
Copper rockfish										
N (out of 3)	1	0	0	1	0	3	3	0	3	3
Min	**1.7**	—-	—-	3.1	—-	0.310	0.28	—-	2.0	0.027
Max	**1.7**	—-	—-	3.1	—-	**0.790**	**0.47**	—-	3.9	0.051
Mean	**1.7**	—-	—-	3.1	—-	0.496	**0.40**	—-	2.9	0.039
Vermilion rockfish										
N (out of 3)	2	0	0	0	0	2	3	0	3	3
Min	**4.7**	—-	—-	—-	—-	0.046	0.28	—-	1.0	0.004
Max	**6.1**	—-	—-	—-	—-	0.100	**0.37**	—-	3.9	0.011
Mean	**5.4**	—-	—-	—-	—-	0.073	**0.32**	—-	2.9	0.007
Flag rockfish										
N (out of 2)	1	0	0	2	0	2	2	0	2	2
Min	**2.2**	—-	—-	1.2	—-	0.149	**0.32**	—-	2.9	0.001
Max	**2.2**	—-	—-	1.3	—-	**0.648**	**0.38**	—-	3.4	0.071
Mean	**2.2**	—-	—-	1.3	—-	0.399	**0.35**	—-	3.1	0.036
Mixed rockfish										
N (out of 2)	0	0	0	2	0	2	2	0	2	2
Min	—-	—-	—-	4.6	—-	0.036	0.25	—-	3.7	0.028
Max	—-	—-	—-	9.0	—-	**0.595**	**0.51**	—-	4.7	0.043
Mean	—-	—-	—-	6.8	—-	0.315	**0.38**	—-	4.2	0.035
CA. scorpionfish										
N (out of 1)	1	0	0	1	0	1	1	0	1	1
Min	**10.6**	—-	—-	1.1	—-	0.100	0.26	—-	3.4	0.004
Max	**10.6**	—-	—-	1.1	—-	0.100	0.26	—-	3.4	0.004
Mean	**10.6**	—-	—-	1.1	—-	0.100	0.26	—-	3.4	0.004
ALL SPECIES										
% Dect.	45	0	0	55	0	91	100	0	100	100
US FDA Action Limit*						1				5
Median International Standard*	1.4	1.0	1.0	20.0	2.0	0.5	0.3	175.0	70.0	5.0

*From Table 2.3 in Mearns et al. (1991). USFDA action limit for total DDT is for fish muscle tissue, US FDA mercury action limits and all international standards are for shellfish, but are often applied to fish. All limits apply to the sale of seafood for human consumption.

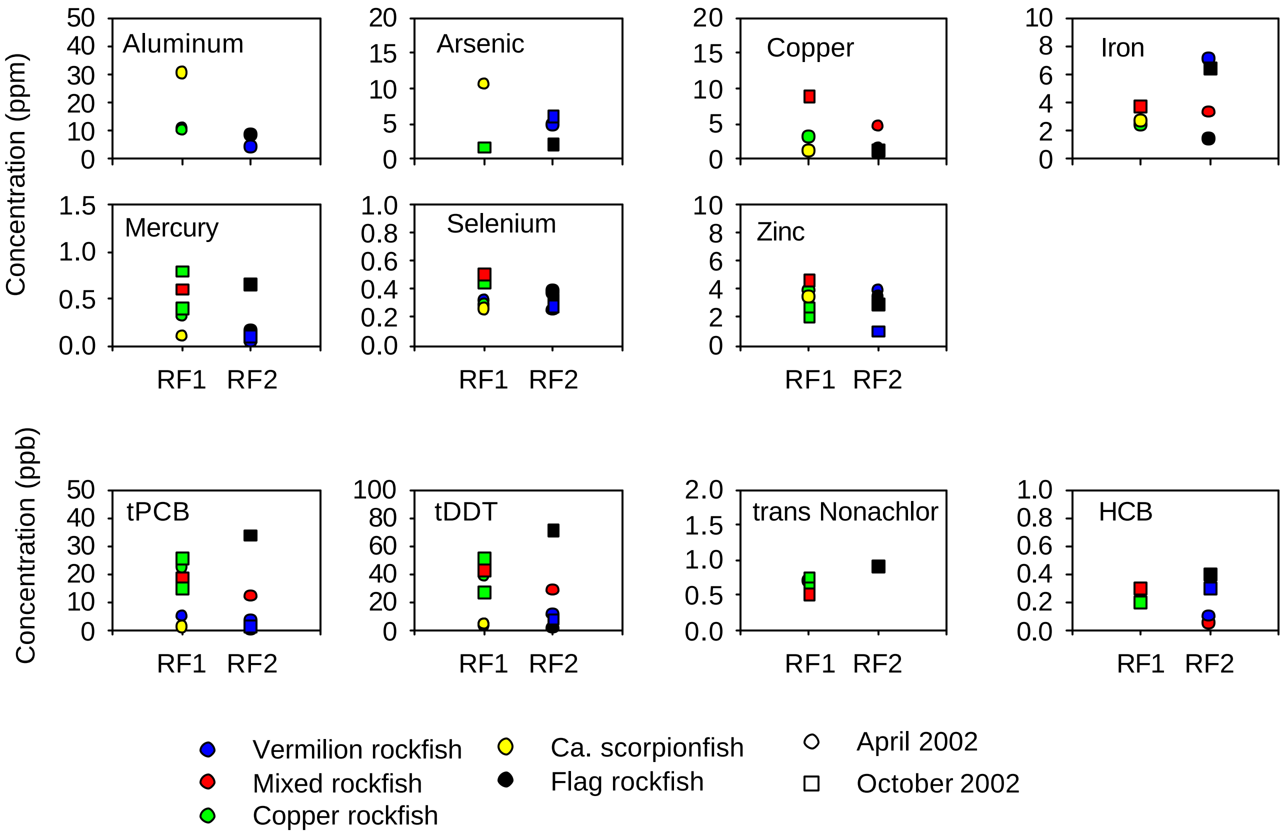


Figure 7.6

Concentrations of frequently detected metals (ppm), pesticides (ppb) and total PCB (ppb) detected in muscle tissues of fish collected at PLOO rig fishing stations during 2002.

LITERATURE CITED

Allen, M. J., S.L. Moore, K.C. Schiff, D. Diener, S.B. Weisburg, J.K. Stull, A. Groce, E. Zeng, J. Mubarak, C.L. Tang, R. Gartman, and C.I. Haydock. (1998). Assessment of demersal fish and megabenthic invertebrate assemblages on the mainland shelf of Southern California in 1994. Southern California Coastal Water Research Project, Westminster, CA.

Brown, D. A., R.W. Gossett, G.P. Hershelman, C.G. Word, A.M. Westcott, and J.N. Cross. (1986). Municipal wastewater contamination in the Southern California Bight: Part I-Metal and Organic Contaminants in Sediments and Organisms. Mar. Environ. Res., 18:291-310.

City of San Diego. (1996). 1995 Receiving Waters Monitoring Report for the Point Loma Ocean Outfall. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (1997). 1996 Receiving Waters Monitoring Report for the Point Loma Ocean Outfall. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (1998). 1997 Receiving Waters Monitoring Report for the Point Loma Ocean Outfall. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (1999). 1998 Receiving Waters Monitoring Report for the Point Loma Ocean Outfall. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2000). 1999 Receiving Waters Monitoring Report for the Point Loma Ocean Outfall. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2001a). 2000 Receiving Waters Monitoring Report for the Point Loma Ocean Outfall. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2001b). City of San Diego Point Loma Ocean Outfall Annual Monitoring Report, January - December 2000. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

City of San Diego. (2003). 2002 Quality Assurance Manual. City of San Diego Ocean Monitoring Program, Metropolitan Wastewater Department, Environmental Monitoring and Technical Services Division, San Diego, CA.

Connell, D.W. (1987). Age to PCB concentration relationship with the striped bass (*Morone saxatilis*) in the Hudson River and Long Island Sound. Chemosphere, 16: 1469-1474

Evans, D.W., D.K. Dodoo, and P.J. Hanson. (1993). Trace element concentrations in fish livers: Implications of variations with fish size in pollution monitoring. Mar. Poll. Bull., 26: 329-334

Mearns, A.J., M. Matta, G. Shigenaka, D. MacDonald, M. Buchman, H. Harris, J. Golas, and G. Lauenstein. (1991). Contaminant Trends in the Southern California Bight: Inventory and Assessment. NOAA Technical Memorandum NOS ORCA 62. Seattle, WA.

Otway, N. (1991). Bioaccumulation studies on fish: choice of species, sampling designs, problems and implications for environmental management. In: Miskiewicz, A. G. (ed). Proceedings of a Bioaccumulation Workshop: Assessment of the Distribution, Impacts, and Bioaccumulation of Contaminants in Aquatic Environments. Australian Marine Science Association, Inc./WaterBoard. 334 pages

Schiff, K., and M.J. Allen. (1997). Bioaccumulation of chlorinated hydrocarbons in livers of flatfishes from the Southern California Bight. In: S.B. Weisberg, C. Francisco, and D. Hallock (eds.) Southern California Coastal Water Research Project Annual Report 1995-1996. Southern California Coastal Water Research Project, Westminster, CA.

Tetra Tech. (1985). Commencement Bay Nearshore/ Tideflats Remedial Investigation. Final report prepared for the Washington Department of Ecology and the EPA. Tetra Tech, Inc., Bellevue, WA.

This page intentionally left blank

Appendices

APPENDIX A

2002 PLOO Stations

Sediment Chemistry

“Supplemental Data”

This page intentionally left blank

Appendix A.1

Sediment chemistry constituents analyzed during 2002.

Chlorinated Pesticides			
Aldrin	BHC, Delta isomer	Heptachlor	o,p-DDT
Alpha (cis) Chlordane	BHC, Gamma isomer	Heptachlor epoxide	p,p-DDD
Gamma (trans) Chlordane	Cis Nonachlor	Hexachlorobenzene	p,p-DDE
Alpha Endosulfan	Dieldrin	Mirex	p,p-DDT
Beta Endosulfan	Endrin	Methoxychlor	Oxychlordane
BHC, Alpha isomer	Endosulfan Sulfate	o,p-DDD	Trans Nonachlor
BHC, Beta isomer	Endrin aldehyde	o,p-DDE	
Polycyclic Aromatic Hydrocarbons			
1-methylnaphthalene	Acenaphthene	Benzo(G,H,I)perylene	Fluorene
1-methylphenanthrene	Acenaphthylene	Benzo(K)fluoranthene	Indeno(1,2,3-CD)pyrene
2,3,5-trimethylnaphthalene	Anthracene	Biphenyl	Naphthalene
2,6-dimethylnaphthalene	Benzo(A)anthracene	Chrysene	Perylene
2-methylnaphthalene	Benzo(A)pyrene	Dibenzo(A,H)anthracene	Phenanthrene
3,4-benzo(B)fluoranthene	Benzo(e)pyrene	Fluoranthene	Pyrene
Metals			
Aluminum (Al)	Chromium (Cr)	Manganese (Mn)	Silver (Ag)
Antimony (Sb)	Copper (Cu)	Mercury (Hg)	Thallium (Ti)
Arsenic (As)	Iron (Fe)	Nickel (Ni)	Tin (Sn)
Beryllium (Be)	Lead (Pb)	Selenium (Se)	Zinc (Zn)
Cadmium (Cd)			
PCB Congeners			
PCB 18	PCB 81	PCB 126	PCB 169
PCB 28	PCB 87	PCB 128	PCB 170
PCB 37	PCB 99	PCB 138	PCB 177
PCB 44	PCB 101	PCB 149	PCB 180
PCB 49	PCB 105	PCB 151	PCB 183
PCB 52	PCB 110	PCB 153/168	PCB 187
PCB 66	PCB 114	PCB 156	PCB 189
PCB 70	PCB 118	PCB 157	PCB 194
PCB 74	PCB 119	PCB 158	PCB 201
PCB 77	PCB 123	PCB 167	PCB 206
Organic Indicators			
	BOD	Total Solids	
	Total Nitrogen	Total Sulfides	
	Total Organic Carbon	Total Volatile Solids	

Appendix A.2

Particle size statistics for PLOO sediments, January 2002 survey.

Station	Depth	Phi					Percent Composition				Sediment Notes
		Mean	Std Dev	Median	Skewness	Kurtosis	Coarse	Sand	Silt	Clay	
North Reference Stations											
B11	88	4.7	2.0	4.3	0.2	1.4	4.9	41.5	47.5	6.1	silty clay, coarse sand, pea gravel
B8	88	4.8	1.5	4.3	0.4	1.1	0.0	37.2	57.6	5.1	silty clay
B12	98	4.1	2.2	3.5	0.4	1.2	1.5	59.6	32.4	6.5	shell hash, coarse sand, silty sand,
B9	98	4.4	1.7	3.9	0.5	1.1	0.0	53.0	41.9	5.1	silt, "pea gravel" mud balls
B13	116	4.2	2.1	3.6	0.4	1.1	4.0	56.0	32.1	7.8	sand, coarse sand, shell hash
B10	116	4.2	1.5	3.7	0.5	1.6	1.2	67.2	27.6	4.1	silty sand, shell hash
Stations North of the Outfall											
E19	88	4.4	1.4	4.0	0.5	1.3	0.0	49.4	46.8	3.7	silt
E23	98	4.3	1.5	3.8	0.5	1.4	0.0	56.1	40.2	3.6	silt, shell hash
E20	98	4.1	1.4	3.7	0.5	1.5	0.0	60.6	35.9	3.5	silt w/ clay
E25	98	4.4	1.5	3.9	0.5	1.3	0.0	53.8	41.9	4.3	silt, shell hash
E26	98	4.5	1.6	4.0	0.5	1.1	0.0	49.6	45.9	4.5	silt, shell hash
E21	116	4.2	1.5	3.6	0.7	1.3	0.0	63.9	32.2	3.8	silt w/ sulfide odor; silt w/ clay, shell
Outfall Stations											
E11	98	4.0	1.1	3.7	0.6	2.6	1.4	72.0	23.8	2.8	sandy silt, shell hash
E14	98	3.9	1.2	3.7	0.5	2.9	2.3	73.0	21.9	2.7	sandy silt, shell hash
E17	98	4.0	1.4	3.7	0.4	1.4	0.8	63.7	32.5	3.1	silty sand w/ sulfide odor; shell hash
E15	116	3.4	1.2	3.3	0.3	2.1	3.9	78.6	15.3	2.2	silty sand, coarse black sand
Stations South of the Outfall											
E1	88	4.0	2.1	3.7	0.1	1.7	11.5	51.8	32.8	3.9	
E7	88	4.3	1.4	3.9	0.5	1.4	0.0	54.2	42.1	3.7	silt
E2	98	4.5	2.2	4.1	0.2	1.3	5.4	43.0	46.1	5.5	silty sand, coarse sand, shell hash
E5	98	4.0	1.5	3.6	0.5	1.4	0.0	64.1	32.0	3.9	silty sand
E8	98	4.0	1.4	3.6	0.6	1.6	0.0	65.6	31.0	3.3	silt; coarse black sand, shell hash
E3	116	3.4	2.8	3.9	-0.1	1.9	16.8	36.6	42.0	4.5	
E9	116	4.3	2.2	3.9	0.1	1.8	8.8	46.5	39.1	5.6	sandy silt w/ shell hash, coarse sand
Area Mean		4.2	1.7	3.8	0.4	1.5	2.7	56.4	36.5	4.3	

Note: Coarse was determined separately from sand, silt and clay (see Materials and Methods: Laboratory Analysis).

Appendix A.2 *continued.*

Particle size statistics for PLOO sediments, April 2002 survey.

Station	Depth	Phi Mean	Phi Std Dev	Phi Median	Phi Skewness	Phi Kurtosis	Percent Composition Coarse	Percent Composition Sand	Percent Composition Silt	Percent Composition Clay	Sediment Notes
North Reference Stations											
B11	88	4.5	2.3	4.1	0.1	1.4	5.9	41.4	46.5	6.2	pea gravel, mud balls/rocks, rock, gravel, silt, clay, sulfide odor
B8	88	4.5	1.5	4.2	0.4	1.2	0.0	42.9	52.9	4.1	silt, sulfide odor
B12	98	4.2	2.1	3.7	0.4	1.2	2.7	54.8	36.0	6.4	silt, shell hash
B9	98	4.6	1.2	4.0	0.8	4.1	0.0	49.2	47.0	3.8	pea gravel mud balls/ mud rocks, silt
B13	116	3.8	2.4	3.3	0.3	1.2	9.3	53.9	30.6	6.1	shell hash, silty sand
B10	116	3.9	1.5	3.3	0.6	1.5	0.0	69.9	26.4	3.7	shell hash, silt
Stations North of the Outfall											
E19	88	4.2	1.4	3.8	0.5	1.4	0.0	56.4	40.0	3.6	silt
E20	98	3.9	1.3	3.4	0.7	1.5	0.0	68.1	28.9	3.0	silt, humic odor
E23	98	4.2	1.5	3.8	0.5	1.4	0.0	57.7	38.4	3.9	silt, clay
E25	98	4.0	1.1	3.8	0.6	2.2	0.6	70.7	26.0	2.7	shell hash, silt
E26	98	4.3	1.5	3.9	0.5	1.3	0.0	55.3	40.9	3.9	shell hash, silt
E21	116	4.0	1.4	3.4	0.7	1.4	0.0	67.4	29.1	3.5	shell hash, silt
Outfall Stations											
E11	98	4.0	1.4	3.6	0.5	1.5	0.0	65.4	31.4	3.2	coarse black sand, silt
E14	98	4.0	1.4	3.6	0.5	1.6	0.0	65.9	31.0	3.2	coarse black sand, shell hash, sandy silt, silt
E17	98	3.5	1.0	3.4	0.5	2.1	0.0	82.1	15.7	2.2	silt
E15	116	4.1	1.6	3.7	0.5	1.4	1.1	62.8	32.0	4.1	coarse black sand, sandy silt
Stations South of the Outfall											
E1	88	4.1	1.8	3.8	0.3	1.1	1.4	55.8	38.6	4.2	
E7	88	4.3	1.5	3.9	0.4	1.3	0.8	52.5	43.0	3.8	small rocks, silt, clay
E2	98	4.4	1.8	3.9	0.4	1.0	0.0	52.3	42.9	4.8	gravel, coarse sand, shell hash, silt, clay
E5	98	3.1	1.5	3.1	0.0	2.5	10.5	75.3	12.4	1.8	silt, clay, sulfide odor
E8	98	3.7	1.2	3.1	0.9	1.8	0.0	74.5	22.9	2.6	silt
E3	116	3.7	2.0	3.2	0.4	1.1	0.0	65.8	30.1	4.1	
E9	116	3.3	2.7	3.7	-0.1	1.5	17.2	42.6	35.6	4.6	coarse black sand, shell hash, sandy silt
Area Mean		4.0	1.6	3.6	0.5	1.6	2.2	60.1	33.8	3.9	

Note: Coarse was determined separately from sand, silt and clay (see Materials and Methods: Laboratory Analysis).

Appendix A.2 *continued.*

Particle size statistics for PLOO sediments, July 2002 survey.

Station	Depth	Phi Mean	Phi Std Dev	Phi Median	Phi Skewness	Phi Kurtosis	Percent Composition Coarse	Percent Composition Sand	Percent Composition Silt	Percent Composition Clay	Sediment Notes
North Reference Stations											
B11	88	4.7	1.8	4.2	0.4	1.0	2.6	43.3	47.8	6.3	gravel, pea gravel, coarse sand, silty sand
B8	88	4.7	1.6	4.3	0.4	1.1	0.0	38.2	56.6	5.1	silt, sulfide odor
B12	98	4.4	2.1	3.9	0.3	1.0	3.3	50.2	40.1	6.5	shell hash, coarse sand, silty sand
B9	98	4.2	1.2	3.8	0.7	2.6	0.0	71.2	25.5	3.3	gravel, coarse sand, sitly sand
B13	116	4.0	2.3	3.6	0.2	1.3	5.8	58.3	30.2	5.8	shell hash, coarse sand, sand
B10	116	3.9	1.4	3.0	0.9	1.6	0.0	72.5	23.8	3.6	shell hash, silty sand
Stations North of the Outfall											
E19	88	4.5	1.5	4.1	0.5	1.3	0.0	47.0	48.9	4.0	silt, sulfide odor
E20	98	4.3	1.5	3.8	0.5	1.4	0.0	56.5	39.7	3.8	silt
E23	98	4.2	1.5	3.8	0.5	1.4	0.7	61.3	34.3	3.7	shell hash, silt, clay
E25	98	4.1	1.4	3.8	0.4	1.4	0.6	58.2	37.6	3.6	shell hash, silt
E26	98	4.2	1.6	3.7	0.5	1.3	0.6	60.8	34.5	4.1	rock, shell hash, silt
E21	116	4.2	1.6	3.7	0.5	1.3	0.0	61.2	34.7	4.1	silt
Outfall Stations											
E11	98	3.8	1.3	3.3	0.7	1.8	0.0	72.8	24.0	3.1	coarse black sand, shell hash, silt
E14	98	3.5	1.2	3.4	0.4	2.1	3.8	77.4	16.5	2.3	coarse black sand, shell hash, silt,
E17	98	4.0	1.4	3.6	0.5	1.6	0.0	65.6	31.1	3.3	shell hash, silt
E15	116	3.9	1.3	3.2	0.9	1.5	0.0	71.7	24.9	3.4	coarse sand, shell hash, silt
Stations South of the Outfall											
E1	88	4.0	2.0	3.8	0.3	1.1	3.3	54.0	37.9	4.8	
E7	88	4.3	1.5	3.8	0.5	1.3	0.0	57.1	39.0	3.9	silt
E2	98	4.1	2.4	3.9	0.0	1.7	5.5	50.3	39.1	5.1	pea gravel, coarse sand, clay
E5	98	3.8	1.2	3.4	0.6	2.2	0.0	76.6	20.5	2.8	silt
E8	98	4.0	1.5	3.7	0.4	1.4	0.8	62.9	33.0	3.3	silt
E3	116	4.1	2.4	3.8	0.1	1.0	8.8	45.2	40.1	5.8	
E9	116	4.0	2.1	3.7	0.2	2.2	14.0	53.1	28.7	4.2	coarse black sand, silty sand
Area Mean		4.1	1.6	3.7	0.5	1.5	2.2	59.4	34.3	4.2	

Note: Coarse was determined separately from sand, silt and clay (see Materials and Methods: Laboratory Analysis).

Appendix A.2 *continued.*

Particle size statistics for PLOO sediments, October 2002 survey.

Station	Depth	Phi Mean	Phi Std Dev	Phi Median	Phi Skewness	Phi Kurtosis	Percent Composition Coarse	Percent Composition Sand	Percent Composition Silt	Percent Composition Clay	Sediment Notes
North Reference Stations											
B11	88	4.7	2.1	4.2	0.2	1.2	2.6	41.6	49.0	6.7	shell hash, pea gravel, gravel, silty sand, clay
B8	88	4.6	1.4	4.2	0.4	1.2	0.0	41.3	54.4	4.3	silt
B12	98	3.9	2.2	3.4	0.3	1.7	3.4	60.6	30.7	5.2	shell hash, pea gravel, silty sand
B9	98	4.4	1.6	3.9	0.5	1.2	0.0	54.3	41.3	4.4	pea gravel, silt
B13	116	3.1	2.6	3.0	0.1	1.3	9.5	60.7	25.4	4.5	shell hash, coarse sand, sandy silt
B10	116	4.2	1.6	3.7	0.5	1.3	0.6	64.3	30.8	4.3	shell hash, silt
Stations North of the Outfall											
E19	88	4.3	1.3	4.0	0.5	1.5	0.0	49.6	46.8	3.6	silt
E20	98	3.5	1.9	3.5	0.0	1.8	15.2	53.2	29.0	2.7	silt, black oily residue
E23	98	4.1	1.4	3.8	0.4	1.5	0.0	56.9	39.6	3.4	silt
E25	98	4.0	1.6	3.9	0.2	1.8	1.7	58.2	36.5	3.6	shell hash, silt
E26	98	4.2	1.5	3.8	0.5	1.4	0.0	57.0	39.2	3.7	shell hash, silt
E21	116	4.1	1.4	3.7	0.5	1.5	0.0	62.9	33.5	3.6	silt
Outfall Stations											
E11	98	4.0	1.3	3.7	0.4	1.5	0.9	64.5	31.4	3.2	shell hash, sandy silt
E14	98	2.8	2.6	3.0	0.0	0.7	42.7	27.1	27.1	3.0	shell hash, coarse sand, coarse sandy silt
E17	98	3.9	1.3	3.6	0.5	1.7	0.0	66.6	30.2	3.1	shell hash, silt
E15	116	4.2	1.5	3.8	0.5	1.5	1.6	61.9	32.6	3.9	shell hash, coarse sand, silt
Stations South of the Outfall											
E1	88	4.2	2.0	3.7	0.3	1.5	4.0	52.4	39.6	4.1	
E7	88	4.2	1.4	3.9	0.4	1.4	0.0	55.8	40.9	3.3	silt
E2	98	3.6	2.4	3.6	0.0	1.2	14.6	44.0	37.6	3.8	shell hash, coarse sand, sand, silt, clay
E5	98	4.0	1.4	3.6	0.5	1.5	0.0	64.0	32.6	3.4	silt
E8	98	3.9	1.4	3.6	0.5	1.5	0.0	65.4	31.6	2.9	silt
E3	116	3.4	2.0	3.0	0.3	1.4	3.8	66.6	26.1	3.5	
E9	116	4.2	2.1	3.9	0.1	2.2	6.3	51.1	38.1	4.5	coarse black sand, coarse sand
Area Mean		4.0	1.7	3.7	0.3	1.5	4.6	55.7	35.8	3.9	

Note: Coarse was determined separately from sand, silt and clay (see Materials and Methods: Laboratory Analysis).

Appendix A.3

Mean annual concentrations of indicators of organic loading for PLOO monitoring stations from 1991 through 2002. Data for each year are pooled over all stations, and include: BOD (mg/L); sulfides (ppm); TN (%wt); TOC (%wt); TVS (%wt). Missing values (-) represent organic indicators not analyzed.

	Pre-discharge			Post-discharge								
Indicator	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
BOD	230	207	270	249	320	278	302	316	325	300	319	311
Sulfides	0.4	9.1	2.4	3.2	3.2	3.8	5.9	5.7	9.0	3.0	2.8	3.9
TN	–	0.044	0.033	0.050	0.040	0.059	0.056	0.056	0.054	0.058	0.052	0.054
TOC	–	0.530	0.533	0.813	0.652	0.805	0.741	0.531	0.514	0.528	0.524	0.606
TVS	2.53	2.25	2.35	2.40	2.65	2.67	2.62	2.58	2.78	2.74	2.63	2.75

Appendix A.4

Summary of annual mean concentrations of trace metals (ppm) for PLOO monitoring stations from 1991 to 2002. Data for each year are pooled over all stations. Values below detection limits are designated as “nd”. Missing values (-) represent metals not analyzed.

	Pre-discharge			Post-discharge								
Metal	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Al	–	–	–	9689	10426	9744	10603	11487	11560	9714	10152	10206
Sb	nd	nd	0.25	nd	1.02	2.04	2.53	3.93	0.46	1.04	1.96	1.63
As	1.98	2.58	2.98	3.72	3.95	3.77	3.85	3.91	3.88	3.37	3.45	3.77
Be	0.77	0.21	0.01	0.03	0.17	0.18	0.33	0.74	0.72	nd	0.10	0.03
Cd	0.15	0.28	2.54	1.71	0.02	nd	0.04	0.01	0.08	0.01	0.05	0.02
Cr	21.6	12.1	18.3	20.3	19.9	20.2	19.1	15.4	16.4	14.8	17.8	16.3
Cu	8.7	5.9	7.9	10.2	9.7	9.3	10.8	8.9	8.6	9.4	10.1	10.4
Fe	–	–	13023	13874	14946	13871	13677	14391	14864	13938	13964	13902
Pb	3.09	2.87	0.74	4.21	2.05	2.25	1.11	2.84	0.57	1.71	1.69	0.98
Mn	–	–	–	–	–	92.0	95.1	105.0	103.0	108.0	97.6	95.0
Hg	0.017	0.021	0.004	0.011	0.007	0.030	0.032	0.021	0.005	0.007	0.009	0.017
Ni	8.2	4.2	6.9	8.5	7.3	8.3	7.9	7.9	7.7	7.2	6.9	5.7
Se	0.16	0.10	0.28	0.23	0.24	0.23	0.28	0.23	0.22	0.25	0.20	0.13
Ag	nd	0.28	nd	nd	0.08	0.06	nd	nd	nd	nd	nd	0.09
Tl	nd	1.5	13.1	nd	0.3	nd	nd	0.5	0.1	nd	0.2	0.4
Sn	–	–	–	nd	nd	2.1	4.4	nd	nd	nd	nd	nd
Zn	33.9	21.7	27.5	31.5	31.7	29.0	36.0	33.4	33.2	30.6	29.6	29.6

APPENDIX B

2002 PLOO Stations

Benthic Infauna

"Supplemental Data"

This page intentionally left blank

APPENDIX B. Station characteristics for PLOO benthic infaunal cluster groups A-G during 2002 (see Chapter 5)

Cluster Group	Station	Survey	Depth (m)	Mean Phi	CSF (%)	Sand (%)	Silt (%)	Clay (%)	Fines (%)	Sediment Notes "Field Observations"	Sediment Notes "Lab Observations (Grunge)"
A	B8	Jan, 2002	88	4.8	0.0	37.2	57.6	5.1	62.7	Silty Clay	
A	B8	Apr, 2002	88	4.5	0.0	42.9	52.9	4.1	57.0	Silt, Silt - Sulfide odor	
A	B8	Jul, 2002	88	4.7	0.0	38.2	56.6	5.1	61.7	Silt - Sulfide Odor	
A	B8	Oct, 2002	88	4.6	0.0	41.3	54.4	4.3	58.7	Silt	
A	B9	Jan, 2002	98	4.4	0.0	53.0	41.9	5.1	47.0	Silt	"Pea Gravel" Mud Balls
A	B9	Apr, 2002	98	4.6	0.0	49.2	47.0	3.8	50.8	Silt	Pea Gravel Mud Balls/ "Mud Rocks"
A	B9	Jul, 2002	98	4.2	0.0	71.2	25.5	3.3	28.8	Silty Sand w/ Gravel	
A	B9	Oct, 2002	98	4.4	0.0	54.3	41.3	4.4	45.7	Silt	Some Pea Gravel
A	E25	Jan, 2002	98	4.4	0.0	53.8	41.9	4.3	46.1	Silt	Shell Hash
A	E25	Apr, 2002	98	4.0	0.6	70.7	26.0	2.7	28.6	Silt	some Shell Hash
A	E25	Jul, 2002	98	4.1	0.6	58.2	37.6	3.6	41.2	Silt	Some Shell Hash
A	E26	Jan, 2002	98	4.5	0.0	49.6	45.9	4.5	50.4	Silt	Shell Hash
A	E26	Apr, 2002	98	4.3	0.0	55.3	40.9	3.9	44.7	Silt	some Shell Hash
A	E26	Jul, 2002	98	4.2	0.6	60.8	34.5	4.1	38.6	Silt	Some Shell Hash, Some Shell Hash/Rock
A	E26	Oct, 2002	98	4.2	0.0	57.0	39.2	3.7	42.9	Silt	Some Shell Hash
		MEAN=	**95.3**	**4.4**	**0.1**	**52.8**	**42.9**	**4.1**	**47.0**		
B	E11	Jan, 2002	98	4.0	1.4	72.0	23.8	2.8	26.6	Sandy Silt	Shell Hash
B	E15	Jan, 2002	116	3.4	3.9	78.6	15.3	2.2	17.5	Silty Sand	Coarse Black Sand
B	E15	Apr, 2002	116	4.1	1.1	62.8	32.0	4.1	36.1	Sandy Silt	some Coarse Black Sand
B	E15	Jul, 2002	116	3.9	0.0	71.7	24.9	3.4	28.3	Silt	Some Coarse Sand- Shell Hash
B	E15	Oct, 2002	116	4.2	1.6	61.9	32.6	3.9	36.5	Silt	Some Coarse Sand and Shell Hash
B	E17	Jan, 2002	98	4.0	0.8	63.7	32.5	3.1	35.5	Silty Sand (Sulfide odor in Chem grab)	Shell Hash
B	E17	Apr, 2002	98	3.5	0.0	82.1	15.7	2.2	17.9	Silt	
B	E17	Jul, 2002	98	4.0	0.0	65.6	31.1	3.3	34.4	Silt	Some Shell Hash
B	E17	Oct, 2002	98	3.9	0.0	66.6	30.2	3.1	33.3	Silt	Some Shell Hash
B	E19	Jan, 2002	88	4.4	0.0	49.4	46.8	3.7	50.6	Silt	
B	E19	Apr, 2002	88	4.2	0.0	56.4	40.0	3.6	43.6	Silt	
B	E19	Jul, 2002	88	4.5	0.0	47.0	48.9	4.0	53.0	Silt, Silt / Sulfide Odor	
B	E19	Oct, 2002	88	4.3	0.0	49.6	46.8	3.6	50.4	Silt	
B	E20	Jan, 2002	98	4.1	0.0	60.6	35.9	3.5	39.4	Silt w/ Clay	
B	E20	Apr, 2002	98	3.9	0.0	68.1	28.9	3.0	31.9	Silt - Humic odor	
B	E20	Jul, 2002	98	4.3	0.0	56.5	39.7	3.8	43.5	Silt	

Fines = silt + clay; CSF = coarse sieved fraction (particles > 1.0mm in diameter)

APPENDIX B. Station characteristics for PLOO benthic infaunal cluster groups A-G during 2002 (see Chapter 5)

Cluster Group	Station	Survey	Depth (m)	Mean Phi	CSF (%)	Sand (%)	Silt (%)	Clay (%)	Fines (%)	Sediment Notes "Field Observations"	Sediment Notes "Lab Observations (Grunge)"
B	E20	Oct, 2002	98	3.5	15.2	53.2	29.0	2.7	31.6	Silt	Black Oily Residue (NO FORMALIN!)
B	E21	Jan, 2002	116	4.2	0.0	63.9	32.2	3.8	36.0	Silt (Sulfide odor in Chem grab), Silt w/ Clay	Shell Hash
B	E21	Apr, 2002	116	4.0	0.0	67.4	29.1	3.5	32.6	Silt	Shell Hash
B	E21	Jul, 2002	116	4.2	0.0	61.2	34.7	4.1	38.8	Silt	
B	E21	Oct, 2002	116	4.1	0.0	62.9	33.5	3.6	37.1	Silt	
B	E23	Jan, 2002	98	4.3	0.0	56.1	40.2	3.6	43.8	Silt	Shell Hash
B	E23	Apr, 2002	98	4.2	0.0	57.7	38.4	3.9	42.3	Silt w/ Clay, Silt	
B	E23	Jul, 2002	98	4.2	0.7	61.3	34.3	3.7	38.0	Silt w/ Clay and Some Shell Hash	Some Shell Hash
B	E23	Oct, 2002	98	4.1	0.0	56.9	39.6	3.4	43.0	Silt	
B	E25	Oct, 2002	98	4.0	1.7	58.2	36.5	3.6	40.1	Silt	Some Shell Hash
B	E5	Jan, 2002	98	4.0	0.0	64.1	32.0	3.9	35.8	Silty Sand	
B	E5	Jul, 2002	98	3.8	0.0	76.6	20.5	2.8	23.3	Silt	
B	E5	Oct, 2002	98	4.0	0.0	64.0	32.6	3.4	36.0	Silt	
B	E7	Jan, 2002	88	4.3	0.0	54.2	42.1	3.7	45.8	Silt	
B	E7	Apr, 2002	88	4.3	0.8	52.5	43.0	3.8	46.8	Silt w/ Clay	Few Small Rocks
B	E7	Jul, 2002	88	4.3	0.0	57.1	39.0	3.9	42.9	Silt	
B	E7	Oct, 2002	88	4.2	0.0	55.8	40.9	3.3	44.2	Silt	
B	E8	Jan, 2002	98	4.0	0.0	65.6	31.0	3.3	34.3	Silt	Coarse Black Sand/ Shell Hash
B	E8	Apr, 2002	98	3.7	0.0	74.5	22.9	2.6	25.5	Silt	
B	E8	Jul, 2002	98	4.0	0.8	62.9	33.0	3.3	36.3	Silt	
B	E8	Oct, 2002	98	3.9	0.0	65.4	31.6	2.9	34.5	Silt	
		MEAN=	**99.7**	**4.1**	**0.8**	**62.3**	**33.5**	**3.4**	**37.0**		
C	E11	Apr, 2002	98	4.0	0.0	65.4	31.4	3.2	34.6	Silt	some Coarse Black Sand
C	E11	Jul, 2002	98	3.8	0.0	72.8	24.0	3.1	27.1	Silt	Some Coarse Black Sand- Shell Hash
C	E11	Oct, 2002	98	4.0	0.9	64.5	31.4	3.2	34.5	Sandy Silt w/ Shell Hash	Some Shell Hash
C	E14	Jan, 2002	98	3.9	2.3	73.0	21.9	2.7	24.6	Sandy Silt	Shell Hash
C	E14	Apr, 2002	98	4.0	0.0	65.9	31.0	3.2	34.1	Sandy Silt w/ Shell Hash, Silt	some Coarse Black Sand
C	E14	Jul, 2002	98	3.5	3.8	77.4	16.5	2.3	18.7	Silt, Sulfide odor	Some Coarse Sand- Shell Hash
C	E14	Oct, 2002	98	2.8	42.7	27.1	27.1	3.0	30.1	Coarse Sandy Silt, Silt w/Shell Hash	Coarse Sand and Shell Hash
		MEAN=	**98**	**3.7**	**7.1**	**63.7**	**26.2**	**3.0**	**29.1**		

Fines = silt + clay; CSF = coarse sieved fraction (particles > 1.0mm in diameter)

APPENDIX B. Station characteristics for PLOO benthic infaunal cluster groups A-G during 2002 (see Chapter 5)

Cluster Group	Station	Survey	Depth (m)	Mean Phi	CSF (%)	Sand (%)	Silt (%)	Clay (%)	Fines (%)	Sediment Notes "Field Observations"	Sediment Notes "Lab Observations (Grunge)"
D	B10	Jan, 2002	116	4.2	1.2	67.2	27.6	4.1	31.6	Silty Sand	Shell Hash
D	B10	Apr, 2002	116	3.9	0.0	69.9	26.4	3.7	30.1	Silt	Shell Hash
D	B10	Jul, 2002	116	3.9	0.0	72.5	23.8	3.6	27.4	Silty Sand w/ Shell Hash	Some Shell Hash
D	B10	Oct, 2002	116	4.2	0.6	64.3	30.8	4.3	35.1	Silt	Some Shell Hash
		MEAN=	**116.0**	**4.0**	**0.4**	**68.5**	**27.1**	**3.9**	**31.1**		
E	E2	Jan, 2002	98	4.5	5.4	43.0	46.1	5.5	51.6	Silty Sand	Coarse Sand/ Shell Hash
E	E2	Apr, 2002	98	4.4	0.0	52.3	42.9	4.8	47.7	Coarse Sand/ Clay and Silt/ Gravel, Silt w/Clay	Coarse Sand/ Shell Hash
E	E2	Jul, 2002	98	4.1	5.5	50.3	39.1	5.1	44.2	Clay and Coarse Sand	Coarse Sand- Pea Gravel
E	E2	Oct, 2002	98	3.6	14.6	44.0	37.6	3.8	41.4	Clay and Silt w/ Sand	Coarse Sand and Shell Hash
E	E5	Apr, 2002	98	3.1	10.5	75.3	12.4	1.8	14.2	Silt w/ Clay, Sulfide odor	
E	E9	Jan, 2002	116	4.3	8.8	46.5	39.1	5.6	44.7	Sandy Silt w/ Shell Hash	Coarse Sand/ Shell Hash
E	E9	Apr, 2002	116	3.3	17.2	42.6	35.6	4.6	40.2	Sandy Silt w/ Shell Hash	Coarse Black Sand/ Shell Hash
E	E9	Jul, 2002	116	4.0	14.0	53.1	28.7	4.2	32.9	Silty Sand	Coarse Black Sand
E	E9	Oct, 2002	116	4.2	6.3	51.1	38.1	4.5	42.6	Coarse Sand	Coarse Black Sand
		MEAN=	**106.0**	**3.9**	**9.1**	**50.9**	**35.5**	**4.4**	**39.9**		
F	B11	Jan, 2002	88	4.7	4.9	41.5	47.5	6.1	53.5	Silty Clay w/ Shell Hash	Coarse Sand/ Pea Gravel/ Shell Hash
F	B11	Apr, 2002	88	4.5	5.9	41.4	46.5	6.2	52.7	Silt w/Clay/Gravel/ Rock (Sulfide odor)	Pea Gravel Mud Balls/ "Mud Rocks"
F	B11	Jul, 2002	88	4.7	2.6	43.3	47.8	6.3	54.0	Silty Sand w/ Gravel	Coarse Sand- Pea Gravel WEIRD!
F	B11	Oct, 2002	88	4.7	2.6	41.6	49.0	6.7	55.8	Silty Sand w/ Clay, Gravel, Shell Hash	Pea Gravel and Shell Hash
		MEAN=	**88.0**	**4.6**	**4.0**	**41.9**	**47.7**	**6.3**	**54.0**		
G	B12	Jan, 2002	98	4.1	1.5	59.6	32.4	6.5	38.9	Silty Sand (Sulfide odor)	Coarse Sand/ Shell Hash
G	B12	Apr, 2002	98	4.2	2.7	54.8	36.0	6.4	42.4	Silt w/ Shell Hash	Shell Hash
G	B12	Jul, 2002	98	4.4	3.3	50.2	40.1	6.5	46.5	Silt Sand w/ Shell Hash	Coarse Sand- Shell Hash
G	B12	Oct, 2002	98	3.9	3.4	60.6	30.7	5.2	35.9	Silty Sand w/ Shell Hash	Pea Gravel and Shell Hash
G	B13	Jan, 2002	116	4.2	4.0	56.0	32.1	7.8	39.9	Sand w/ Shell Hash	Coarse Sand/ Shell Hash
G	B13	Apr, 2002	116	3.8	9.3	53.9	30.6	6.1	36.7	Silty Sand w/ Shell Hash	Shell Hash
G	B13	Jul, 2002	116	4.0	5.8	58.3	30.2	5.8	36.0	Sand w/ Shell Hash	Coarse Sand- Shell Hash
G	B13	Oct, 2002	116	3.1	9.5	60.7	25.4	4.5	29.9	Sandy Silt w/ Shell Hash	Coarse Sand and Shell Hash
		MEAN=	**107.0**	**4.0**	**4.9**	**56.8**	**32.2**	**6.1**	**38.3**		

Fines = silt + clay; CSF = coarse sieved fraction (particles > 1.0mm in diameter)

APPENDIX C

2002 PLOO Stations

Demersal Fishes and Megabenthic Invertebrates

"Supplemental Data"

Appendix C.1

Summary of demersal fish species captured during 2002 at PLOO stations. Data are number of fish collected (N) and minimum, maximum, and mean length.

			LENGTH		
Taxon/Species	**Common Name**	**N**	**Min**	**Max**	**Mean**
CHIMAERIFORMIS					
Chimaeridae					
Hydrolagus colliei	spotted ratfish	1	32	32	32
RAJIFORMES					
Rajidae					
Raja binoculata	big skate	1	47	47	47
Raja inornata	California skate	4	16	30	24
CLUPEIFORMES					
Engraulidae					
Engraulis mordax	northern anchovy	31	9	12	10
OSMERIFORMES					
Argentinidae					
Argentina sialis	Pacific argentine	12	7	11	9
AULOPIFORMES					
Synodontidae					
Synodus lucioceps	California lizardfish	21	11	43	23
OPHIDIIFORMES					
Ophidiidae					
Chilara taylori	spotted cuskeel	17	10	21	15
BATRACHOIDIFORMES					
Batrachoididae					
Porichthys notatus	plainfin midshipman	265	5	18	11
SCORPAENIFORMES					
Scorpaenidae	(juv. rockfish unid.)	4	4	6	5
Scorpaena guttata	California scorpionfish	66	13	26	19
Sebastes chlorostictus	greenspotted rockfish	10	5	15	8
Sebastes elongatus	greenstriped rockfish	7	4	14	7
Sebastes hopkinsi	squarespot rockfish	1	15	15	15
Sebastes jordani	shortbelly rockfish	2	10	10	10
Sebastes levis	cowcod	1	8	8	8
Sebastes miniatus	vermilion rockfish	3	26	33	30
Sebastes rosenblatti	greenblotched rockfish	16	6	18	10
Sebastes rubrivinctus	flag rockfish	2	9	13	11
Sebastes saxicola	stripetail rockfish	336	4	16	9
Sebastes semicinctus	halfbanded rockfish	343	7	17	10
Hexagrammidae					
Zaniolepis frenata	shortspine combfish	66	9	17	13
Zaniolepis latipinnis	longspine combfish	1257	6	17	12
Cottidae					
Chitonotus pugetensis	roughback sculpin	48	6	12	9
Icelinus fimbriatus	fringed sculpin	1	11	11	11
Icelinus quadriseriatus	yellowchin sculpin	1264	4	8	6
Icelinus tenuis	spotfin sculpin	11	8	10	9
Agonidae					
Odontopyxis trispinosa	pygmy poacher	8	7	11	9
Xeneretmus triacanthus	bluespotted poacher	5	9	14	12

Appendix C.1

Continued.

Taxon/Species	Common Name	N	LENGTH Min	Max	Mean
PERCIFORMES					
Malacanthidae					
Caulolatilus princeps	ocean whitefish	1	4	4	4
Sciaenidae					
Genyonemus lineatus	white croaker	32	14	27	20
Seriphus politus	Queenfish	4	15	16	16
Embiotocidae					
Cymatogaster aggregata	shiner perch	10	8	12	10
Zalembius rosaceus	pink seaperch	205	5	17	9
Zoarcidae					
Lycodopsis pacifica	blackbelly eelpout	6	18	22	20
Gobiidae					
Coryphoterus nicholsii	blackeye goby	1	6	6	6
Lepidogobius lepidus	bay goby	40	4	8	6
PLEURONECTIFORMES	(juv. flatfish unid.)	8	3	5	4
Paralichthyidae					
Citharichthys fragilis	gulf sanddab	1	11	11	11
Citharichthys sordidus	Pacific sanddab	5556	3	24	9
Citharichthys xanthostigma	longfin sanddab	511	4	20	12
Hippoglossina stomata	bigmouth sole	54	12	22	17
Pleuronectidae					
Eopsetta exilis	slender sole	107	10	17	13
Microstomus pacificus	Dover sole	410	5	23	10
Pleuronectes vetulus	English sole	50	9	29	19
Pleuronichthys verticalis	hornyhead turbot	14	13	22	17
Cynoglossidae					
Symphurus atricauda	California tonguefish	109	8	16	13

Taxonomic arrangement from Nelson 1994.

APPENDIX D

2002 PLOO Stations

Bioaccumulation of Contaminants in Fish Tissues

"Supplemental Data"

Appendix D.1

Lengths and weights of fishes used in composite samples for April and October 2002.

Station	Rep	Species	N	min lnth	max lnth	avg lnth	min wt	max wt	avg wt
April 2002									
SD7	1	Pacific sanddab	5	16	24	20	59.6	265.0	137.3
SD7	2	English sole	4	24	28	26	280.2	433.8	344.9
SD7	3	Ca. scorpionfish	3	22	25	24	397.1	568.0	482.6
SD8	1	Pacific sanddab	10	14	20	16	40.8	128.7	61.1
SD8	2	Greenspotted rockfish	3	22	28	26	214.8	595.3	420.5
SD8	3	Longfin sanddab	13	12	15	13	36.0	62.6	44.9
SD9	1	Ca. scorpionfish	3	16	19	17	140.0	260.5	183.2
SD9	2	Longfin sanddab	22	12	14	13	32.7	59.2	42.7
SD9	3	Hornyhead turbot	5	16	18	17	103.0	170.7	137.0
SD10	1	Pacific sanddab	16	12	19	13	28.5	117.7	41.8
SD10	2	Ca. scorpionfish	3	21	22	21	281.5	356.3	327.3
SD10	3	Ca. scorpionfish	3	21	25	23	329.8	600.0	448.9
SD11	1	Ca. scorpionfish	3	21	26	23	352.0	700.0	496.0
SD11	2	Pacific sanddab	18	12	16	14	26.5	62.0	38.4
SD11	3	Longfin sanddab	15	13	17	14	38.9	92.9	60.4
SD12	1	Longfin sanddab	7	14	15	15	65.8	81.1	71.5
SD12	2	Pacific sanddab	26	12	15	13	27.5	50.5	34.0
SD12	3	Ca. scorpionfish	3	21	24	23	382.8	563.2	497.3
SD13	1	Longfin sanddab	11	13	18	14	37.5	120.3	59.1
SD13	2	Pacific sanddab	6	17	21	19	71.6	149.3	113.1
SD13	3	Ca. scorpionfish	3	22	29	25	332.9	750.0	513.4
SD14	1	Pacific sanddab	7	15	21	17	48.4	151.4	77.6
SD14	2	Pacific sanddab	7	14	21	18	34.1	151.4	93.1
SD14	3	Ca. scorpionfish	3	20	28	23	261.0	800.0	492.0
RF1	1	Vermilion rockfish	3	31	35	33	725.0	1400.0	1041.7
RF1	2	Copper rockfish	3	39	41	40	1750.0	2100.0	1916.7
RF1	3	Ca. scorpionfish	3	21	24	22	314.3	499.9	409.7
RF2	1	Mixed rockfish	3	27	36	32	493.6	1100.0	764.5
RF2	2	Vermilion rockfish	3	31	38	36	800.0	1700.0	1316.7
RF2	3	Flag rockfish	3	23	29	26	329.8	650.0	453.7

Appendix D.2

Analyzed constituents for fish tissue samples for April and October 2002.

Chlorinated Pesticides			
Aldrin	BHC, Delta isomer	Heptachlor epoxide	p,p-DDD
Alpha (cis) Chlordane	BHC, Gamma isomer	Hexachlorobenzene	p,p-DDE
Gamma (trans) Chlordane	Cis Nonachlor	Mirex	p,p-DDT
Alpha Endosulfan	Dieldrin	o,p-DDD	Oxychlordane
BHC, Alpha isomer	Endrin	o,p-DDE	Trans Nonachlor
BHC, Beta isomer	Heptachlor	o,p-DDT	Toxaphene

Polycyclic Aromatic Hydrocarbons			
1-methylnaphthalene	Acenaphthene	Benzo(e)pyrene	Fluorene
1-methylphenanthrene	Acenaphthylene	Benzo(G,H,I)perylene	Indeno(1,2,3-CD)pyrene
2,3,5-trimethylnaphthalene	Anthracene	Benzo(K)fluoranthene	Naphthalene
2,6-dimethylnaphthalene	Benzo(A)anthracene	Biphenyl	Perylene
2-methylnaphthalene	Dibenzo(A,H)anthracene	Chrysene	Phenanthrene
3,4-benzo(B)fluoranthene	Benzo(A)pyrene	Fluoranthene	Pyrene

Metals			
Aluminum	Chromium	Manganese	Silver
Antimony	Copper	Mercury	Thallium
Arsenic	Iron	Nickel	Tin
Beryllium	Lead	Selenium	Zinc
Cadmium			

PCB Congeners			
PCB 18	PCB 81	PCB 126	PCB 169
PCB 28	PCB 87	PCB 128	PCB 170
PCB 37	PCB 99	PCB 138	PCB 177
PCB 44	PCB 101	PCB 149	PCB 180
PCB 49	PCB 105	PCB 151	PCB 183
PCB 52	PCB 110	PCB 153/168	PCB 187
PCB 66	PCB 114	PCB 156	PCB 189
PCB 70	PCB 118	PCB 157	PCB 194
PCB 74	PCB 119	PCB 158	PCB 201
PCB 77	PCB 123	PCB 167	PCB 206

Appendix D.3

April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
RF1	1	Vermilion rockfish	Liver	Aluminum	18		mg/kg	2.6
RF1	1	Vermilion rockfish	Muscle	Aluminum	10.9		mg/kg	2.6
RF1	1	Vermilion rockfish	Liver	Copper	1.63		mg/kg	0.76
RF1	1	Vermilion rockfish	Liver	Hexachlorobenzene	1.6	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	Iron	40.1		mg/kg	1.3
RF1	1	Vermilion rockfish	Muscle	Iron	3.15		mg/kg	1.3
RF1	1	Vermilion rockfish	Liver	Lipids	24.9		wt%	0.005
RF1	1	Vermilion rockfish	Muscle	Lipids	0.56		wt%	0.005
RF1	1	Vermilion rockfish	Liver	p,p-DDD	6.9	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	p,p-DDE	230		ug/kg	13.3
RF1	1	Vermilion rockfish	Muscle	p,p-DDE	3.6		ug/kg	1.33
RF1	1	Vermilion rockfish	Liver	p,p-DDT	8.7	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 101	8.6	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 101	0.4	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 105	3.4	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 110	0.2	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 118	13	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 118	0.4	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 119	0.1	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 128	4.2	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 138	16		ug/kg	13.3
RF1	1	Vermilion rockfish	Muscle	PCB 138	0.4	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 149	9	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 149	0.3	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 151	2.5	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 151	0.1	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 153/168	26		ug/kg	13.3
RF1	1	Vermilion rockfish	Muscle	PCB 153/168	0.7	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 156	2.2	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 156	0.2	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 158	1.8	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 177	3.2	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 180	12	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 180	0.3	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 183	4.4	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 183	0.2	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 187	11	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 187	0.3	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 194	3	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 194	0.2	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 206	4.2	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 206	0.3	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 66	1.6	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 66	0.2	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 74	0.2	E	ug/kg	
RF1	1	Vermilion rockfish	Liver	PCB 99	8	E	ug/kg	
RF1	1	Vermilion rockfish	Muscle	PCB 99	0.3	E	ug/kg	

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
RF1	1	Vermilion rockfish	Liver	Selenium	1.37		mg/kg	0.17
RF1	1	Vermilion rockfish	Muscle	Selenium	0.32		mg/kg	0.13
RF1	1	Vermilion rockfish	Liver	Total Solids	52.3		wt%	0.4
RF1	1	Vermilion rockfish	Muscle	Total Solids	23.3		wt%	0.4
RF1	1	Vermilion rockfish	Liver	Zinc	22.5		mg/kg	0.58
RF1	1	Vermilion rockfish	Muscle	Zinc	3.79		mg/kg	0.58
RF1	2	Copper rockfish	Liver	Alpha (cis) Chlordane	9.4	E	ug/kg	
RF1	2	Copper rockfish	Liver	Aluminum	8.3		mg/kg	2.6
RF1	2	Copper rockfish	Muscle	Aluminum	10		mg/kg	2.6
RF1	2	Copper rockfish	Liver	Cadmium	5.55		mg/kg	0.34
RF1	2	Copper rockfish	Liver	Copper	8.51		mg/kg	0.76
RF1	2	Copper rockfish	Muscle	Copper	3.09		mg/kg	0.76
RF1	2	Copper rockfish	Liver	Hexachlorobenzene	2.1	E	ug/kg	
RF1	2	Copper rockfish	Liver	Iron	46.6		mg/kg	1.3
RF1	2	Copper rockfish	Muscle	Iron	2.4		mg/kg	1.3
RF1	2	Copper rockfish	Liver	Lipids	19.7		wt%	0.005
RF1	2	Copper rockfish	Muscle	Lipids	1.63		wt%	0.005
RF1	2	Copper rockfish	Liver	Manganese	0.24		mg/kg	0.23
RF1	2	Copper rockfish	Liver	Mercury	0.691		mg/kg	0.03
RF1	2	Copper rockfish	Muscle	Mercury	0.31		mg/kg	0.03
RF1	2	Copper rockfish	Liver	o,p-DDE	9.6	E	ug/kg	
RF1	2	Copper rockfish	Muscle	o,p-DDE	0.3	E	ug/kg	
RF1	2	Copper rockfish	Liver	o,p-DDT	4.4	E	ug/kg	
RF1	2	Copper rockfish	Liver	p,p-DDD	18		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	p,p-DDD	0.5	E	ug/kg	
RF1	2	Copper rockfish	Liver	p,p-DDE	1320		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	p,p-DDE	37		ug/kg	1.33
RF1	2	Copper rockfish	Liver	p,p-DDT	30		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	p,p-DDT	0.9	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 101	37		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 101	1.3	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 105	17		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 105	0.4	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 110	20		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 110	0.8	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 118	56		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 118	2		ug/kg	1.33
RF1	2	Copper rockfish	Liver	PCB 119	2.5	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 123	6.1	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 128	17		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 128	0.7	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 138	89		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 138	2.8		ug/kg	1.33
RF1	2	Copper rockfish	Liver	PCB 149	29		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 149	1	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 151	13	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 151	0.4	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 153/168	140		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 153/168	4.3		ug/kg	1.33
RF1	2	Copper rockfish	Liver	PCB 156	10	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 156	0.3	E	ug/kg	

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
RF1	2	Copper rockfish	Liver	PCB 157	2.4	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 158	6.3	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 158	0.2	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 167	4.8	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 167	0.1	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 170	26		ug/kg	13.3
RF1	2	Copper rockfish	Liver	PCB 177	10	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 177	0.4	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 180	63		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 180	2.2		ug/kg	1.33
RF1	2	Copper rockfish	Liver	PCB 183	16		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 183	0.6	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 187	51		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 187	1.8		ug/kg	1.33
RF1	2	Copper rockfish	Liver	PCB 194	11	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 194	0.4	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 201	16		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 201	0.5	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 206	7.1	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 206	0.3	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 49	5.7	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 66	7.5	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 66	0.2	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 70	4.2	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 74	5.6	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 87	7	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 87	0.3	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 99	34		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 99	1.2	E	ug/kg	
RF1	2	Copper rockfish	Liver	Selenium	1.69		mg/kg	0.22
RF1	2	Copper rockfish	Muscle	Selenium	0.28		mg/kg	0.13
RF1	2	Copper rockfish	Liver	Total Solids	50.1		wt%	0.4
RF1	2	Copper rockfish	Muscle	Total Solids	24.3		wt%	0.4
RF1	2	Copper rockfish	Liver	Trans Nonachlor	22		ug/kg	20
RF1	2	Copper rockfish	Muscle	Trans Nonachlor	0.7	E	ug/kg	
RF1	2	Copper rockfish	Liver	Zinc	40.2		mg/kg	0.58
RF1	2	Copper rockfish	Muscle	Zinc	3.92		mg/kg	0.58
RF1	3	Ca. scorpionfish	Liver	Aluminum	22.8		mg/kg	2.6
RF1	3	Ca. scorpionfish	Muscle	Aluminum	30.4		mg/kg	2.6
RF1	3	Ca. scorpionfish	Muscle	Arsenic	10.6		mg/kg	1.4
RF1	3	Ca. scorpionfish	Liver	Beryllium	0.044		mg/kg	0.035
RF1	3	Ca. scorpionfish	Liver	Cadmium	2.24		mg/kg	0.34
RF1	3	Ca. scorpionfish	Liver	Copper	19.2		mg/kg	0.76
RF1	3	Ca. scorpionfish	Muscle	Copper	1.1		mg/kg	0.76
RF1	3	Ca. scorpionfish	Liver	Hexachlorobenzene	1.3		ug/kg	
RF1	3	Ca. scorpionfish	Liver	Iron	147		mg/kg	1.3
RF1	3	Ca. scorpionfish	Muscle	Iron	2.7		mg/kg	1.3
RF1	3	Ca. scorpionfish	Liver	Lipids	23.3		wt%	0.005
RF1	3	Ca. scorpionfish	Muscle	Lipids	0.96		wt%	0.005
RF1	3	Ca. scorpionfish	Liver	Mercury	0.0384		mg/kg	0.03
RF1	3	Ca. scorpionfish	Muscle	Mercury	0.1		mg/kg	0.03

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
RF1	3	Ca. scorpionfish	Liver	p,p-DDD	4.7		ug/kg	
RF1	3	Ca. scorpionfish	Liver	p,p-DDE	285		ug/kg	13.3
RF1	3	Ca. scorpionfish	Muscle	p,p-DDE	3.9		ug/kg	1.33
RF1	3	Ca. scorpionfish	Liver	p,p-DDT	2.6		ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 101	6.35		ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 105	3.3		ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 110	4.5		ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 118	13		ug/kg	13.3
RF1	3	Ca. scorpionfish	Muscle	PCB 118	0.2	E	ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 128	3.9		ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 138	17		ug/kg	13.3
RF1	3	Ca. scorpionfish	Muscle	PCB 138	0.3	E	ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 149	4.7		ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 151	3.25		ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 153/168	30		ug/kg	13.3
RF1	3	Ca. scorpionfish	Muscle	PCB 153/168	0.3	E	ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 156	1.55		ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 158	1.1	E	ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 177	3.2		ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 180	11.5		ug/kg	
RF1	3	Ca. scorpionfish	Muscle	PCB 180	0.2	E	ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 183	4.6	E	ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 187	13		ug/kg	13.3
RF1	3	Ca. scorpionfish	Liver	PCB 194	2.9		ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 206	2.95		ug/kg	
RF1	3	Ca. scorpionfish	Muscle	PCB 206	0.2	E	ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 66	2		ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 74	1.2		ug/kg	
RF1	3	Ca. scorpionfish	Liver	PCB 99	6.3		ug/kg	
RF1	3	Ca. scorpionfish	Liver	Selenium	0.79		mg/kg	0.17
RF1	3	Ca. scorpionfish	Muscle	Selenium	0.26		mg/kg	0.13
RF1	3	Ca. scorpionfish	Liver	Total Solids	46.8		wt%	0.4
RF1	3	Ca. scorpionfish	Muscle	Total Solids	22.1		wt%	0.4
RF1	3	Ca. scorpionfish	Liver	Trans Nonachlor	6.2		ug/kg	
RF1	3	Ca. scorpionfish	Liver	Zinc	82.2		mg/kg	0.58
RF1	3	Ca. scorpionfish	Muscle	Zinc	3.42		mg/kg	0.58
RF2	1	Mixed rockfish	Liver	Aluminum	16.1		mg/kg	2.6
RF2	1	Mixed rockfish	Muscle	Aluminum	8.8		mg/kg	2.6
RF2	1	Mixed rockfish	Liver	Cadmium	0.67		mg/kg	0.34
RF2	1	Mixed rockfish	Liver	Chromium	0.317		mg/kg	0.3
RF2	1	Mixed rockfish	Liver	Copper	9.34		mg/kg	0.76
RF2	1	Mixed rockfish	Muscle	Copper	4.59		mg/kg	0.76
RF2	1	Mixed rockfish	Liver	Hexachlorobenzene	1.5	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	Hexachlorobenzene	0.05		ug/kg	1.33
RF2	1	Mixed rockfish	Liver	Iron	178		mg/kg	1.3
RF2	1	Mixed rockfish	Muscle	Iron	3.3		mg/kg	1.3
RF2	1	Mixed rockfish	Liver	Lipids	19.7		wt%	0.005
RF2	1	Mixed rockfish	Muscle	Lipids	1.47		wt%	0.005
RF2	1	Mixed rockfish	Liver	Manganese	0.77		mg/kg	0.23
RF2	1	Mixed rockfish	Muscle	Mercury	0.0357		mg/kg	0.03
RF2	1	Mixed rockfish	Liver	o,p-DDE	3.8	E	ug/kg	

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
RF2	1	Mixed rockfish	Muscle	o,p-DDE	0.4	E	ug/kg	
RF2	1	Mixed rockfish	Liver	o,p-DDT	1.5	E	ug/kg	
RF2	1	Mixed rockfish	Liver	p,p-DDD	8.7	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	p,p-DDD	0.6	E	ug/kg	
RF2	1	Mixed rockfish	Liver	p,p-DDE	320		ug/kg	13.3
RF2	1	Mixed rockfish	Muscle	p,p-DDE	26		ug/kg	1.33
RF2	1	Mixed rockfish	Liver	p,p-DDT	13	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	p,p-DDT	1	E	ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 101	11	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	PCB 101	0.95		ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 105	3.1	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	PCB 105	0.2	E	ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 110	6	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	PCB 110	0.3		ug/kg	1.33
RF2	1	Mixed rockfish	Liver	PCB 118	12	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	PCB 118	0.95		ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 123	1.9	E	ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 128	3.1	E	ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 138	19		ug/kg	13.3
RF2	1	Mixed rockfish	Muscle	PCB 138	1.65		ug/kg	1.33
RF2	1	Mixed rockfish	Liver	PCB 149	10	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	PCB 149	0.8	E	ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 151	3.4	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	PCB 151	0.4	E	ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 153/168	27		ug/kg	13.3
RF2	1	Mixed rockfish	Muscle	PCB 153/168	2.5		ug/kg	1.33
RF2	1	Mixed rockfish	Muscle	PCB 156	0.1	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	PCB 158	0.05		ug/kg	1.33
RF2	1	Mixed rockfish	Liver	PCB 177	2.2	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	PCB 177	0.2	E	ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 180	14		ug/kg	13.3
RF2	1	Mixed rockfish	Muscle	PCB 180	1.1	E	ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 183	4	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	PCB 183	0.3	E	ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 187	11	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	PCB 187	1.05		ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 194	2.4	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	PCB 194	0.3	E	ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 206	2.8	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	PCB 206	0.3	E	ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 66	1.6	E	ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 87	2.9	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	PCB 87	0.2	E	ug/kg	
RF2	1	Mixed rockfish	Liver	PCB 99	6.5	E	ug/kg	
RF2	1	Mixed rockfish	Muscle	PCB 99	0.7	E	ug/kg	
RF2	1	Mixed rockfish	Liver	Selenium	1.63		mg/kg	0.26
RF2	1	Mixed rockfish	Muscle	Selenium	0.25		mg/kg	0.13
RF2	1	Mixed rockfish	Liver	Total Solids	51.7		wt%	0.4
RF2	1	Mixed rockfish	Muscle	Total Solids	21.9		wt%	0.4
RF2	1	Mixed rockfish	Liver	Trans Nonachlor	5.7	E	ug/kg	
RF2	1	Mixed rockfish	Liver	Zinc	30.5		mg/kg	0.58

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value	Units	MDL
RF2	1	Mixed rockfish	Muscle	Zinc	3.74	mg/kg	0.58
RF2	2	Vermilion rockfish	Liver	Aluminum	16.9	mg/kg	2.6
RF2	2	Vermilion rockfish	Muscle	Aluminum	4.2	mg/kg	2.6
RF2	2	Vermilion rockfish	Muscle	Arsenic	4.7	mg/kg	1.4
RF2	2	Vermilion rockfish	Liver	Cadmium	1.07	mg/kg	0.34
RF2	2	Vermilion rockfish	Liver	Copper	3.79	mg/kg	0.76
RF2	2	Vermilion rockfish	Liver	Hexachlorobenzene	3.4 E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	Hexachlorobenzene	0.1 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	Iron	97.2	mg/kg	1.3
RF2	2	Vermilion rockfish	Muscle	Iron	7.1	mg/kg	1.3
RF2	2	Vermilion rockfish	Liver	Lipids	40.4	wt%	0.005
RF2	2	Vermilion rockfish	Muscle	Lipids	2.38	wt%	0.005
RF2	2	Vermilion rockfish	Muscle	Mercury	0.0463	mg/kg	0.03
RF2	2	Vermilion rockfish	Liver	o,p-DDD	280	ug/kg	13.3
RF2	2	Vermilion rockfish	Liver	o,p-DDE	2.8 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	p,p-DDD	11 E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	p,p-DDD	0.4 E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	p,p-DDE	10	ug/kg	1.33
RF2	2	Vermilion rockfish	Liver	p,p-DDT	11 E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	p,p-DDT	0.5 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 101	6.5 E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	PCB 101	0.4 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 105	2.3 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 110	4.3 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 118	7.9 E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	PCB 118	0.4 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 138	8.8 E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	PCB 138	0.4 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 149	7 E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	PCB 149	0.3 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 151	2.1 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 153/168	15	ug/kg	13.3
RF2	2	Vermilion rockfish	Muscle	PCB 153/168	0.7 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 180	5.3 E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	PCB 180	0.3 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 187	6.3 E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	PCB 187	0.2 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 206	1.3 E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	PCB 206	0.2 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 66	1.8 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 99	5.3 E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	PCB 99	0.3 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	Selenium	1.31	mg/kg	0.26
RF2	2	Vermilion rockfish	Muscle	Selenium	0.37	mg/kg	0.13
RF2	2	Vermilion rockfish	Liver	Total Solids	59.1	wt%	0.4
RF2	2	Vermilion rockfish	Muscle	Total Solids	23	wt%	0.4
RF2	2	Vermilion rockfish	Liver	Trans Nonachlor	8.9 E	ug/kg	
RF2	2	Vermilion rockfish	Liver	Zinc	25.7	mg/kg	0.58
RF2	2	Vermilion rockfish	Muscle	Zinc	3.93	mg/kg	0.58
RF2	3	Flag rockfish	Liver	Aluminum	4.2	mg/kg	2.6
RF2	3	Flag rockfish	Muscle	Aluminum	8.2	mg/kg	2.6

Appendix D.3 continued

April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
RF2	3	Flag rockfish	Liver	Arsenic	1.9		mg/kg	1.4
RF2	3	Flag rockfish	Liver	Beryllium	0.046		mg/kg	0.035
RF2	3	Flag rockfish	Liver	Copper	14.6		mg/kg	0.76
RF2	3	Flag rockfish	Muscle	Copper	1.31		mg/kg	0.76
RF2	3	Flag rockfish	Liver	Hexachlorobenzene	1.3	E	ug/kg	
RF2	3	Flag rockfish	Liver	Iron	123		mg/kg	1.3
RF2	3	Flag rockfish	Muscle	Iron	1.4		mg/kg	1.3
RF2	3	Flag rockfish	Liver	Lipids	21		wt%	0.005
RF2	3	Flag rockfish	Muscle	Lipids	0.4		wt%	0.005
RF2	3	Flag rockfish	Liver	Manganese	0.47		mg/kg	0.23
RF2	3	Flag rockfish	Liver	Mercury	0.247		mg/kg	0.03
RF2	3	Flag rockfish	Muscle	Mercury	0.149		mg/kg	0.03
RF2	3	Flag rockfish	Liver	o,p-DDE	13	E	ug/kg	
RF2	3	Flag rockfish	Liver	p,p-DDD	15		ug/kg	13.3
RF2	3	Flag rockfish	Liver	p,p-DDE	980		ug/kg	13.3
RF2	3	Flag rockfish	Muscle	p,p-DDE	1.3	E	ug/kg	
RF2	3	Flag rockfish	Liver	p,p-DDT	32		ug/kg	13.3
RF2	3	Flag rockfish	Liver	PCB 101	42		ug/kg	13.3
RF2	3	Flag rockfish	Liver	PCB 105	24		ug/kg	13.3
RF2	3	Flag rockfish	Liver	PCB 110	26		ug/kg	13.3
RF2	3	Flag rockfish	Liver	PCB 118	62		ug/kg	13.3
RF2	3	Flag rockfish	Muscle	PCB 118	0.1	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 119	1.5	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 123	4.9	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 128	20		ug/kg	13.3
RF2	3	Flag rockfish	Liver	PCB 138	84		ug/kg	13.3
RF2	3	Flag rockfish	Liver	PCB 149	26		ug/kg	13.3
RF2	3	Flag rockfish	Liver	PCB 151	10	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 153/168	110		ug/kg	13.3
RF2	3	Flag rockfish	Liver	PCB 156	12	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 157	2.7	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 158	7.5	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 167	3.4	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 177	6.9	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 180	47		ug/kg	13.3
RF2	3	Flag rockfish	Liver	PCB 183	12	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 187	35		ug/kg	13.3
RF2	3	Flag rockfish	Liver	PCB 194	7.4	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 206	5.5	E	ug/kg	
RF2	3	Flag rockfish	Muscle	PCB 206	0.2	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 44	2.4	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 49	3.5	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 52	7.8	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 66	2.9	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 70	2.2	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 74	5.5	E	ug/kg	
RF2	3	Flag rockfish	Liver	PCB 87	15		ug/kg	13.3
RF2	3	Flag rockfish	Liver	PCB 99	37		ug/kg	13.3
RF2	3	Flag rockfish	Liver	Selenium	3.01		mg/kg	0.33
RF2	3	Flag rockfish	Muscle	Selenium	0.38		mg/kg	0.13
RF2	3	Flag rockfish	Liver	Total Solids	47.6		wt%	0.4

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
RF2	3	Flag rockfish	Muscle	Total Solids	22.7		wt%	0.4
RF2	3	Flag rockfish	Liver	Trans Nonachlor	15	E	ug/kg	
RF2	3	Flag rockfish	Liver	Zinc	101		mg/kg	0.58
RF2	3	Flag rockfish	Muscle	Zinc	3.39		mg/kg	0.58
SD7	1	Pacific sanddab	Liver	Aluminum	18.2		mg/kg	2.6
SD7	1	Pacific sanddab	Muscle	Aluminum	3.9		mg/kg	2.6
SD7	1	Pacific sanddab	Liver	Arsenic	12.4		mg/kg	1.4
SD7	1	Pacific sanddab	Muscle	Arsenic	4.9		mg/kg	1.4
SD7	1	Pacific sanddab	Liver	Cadmium	5.03		mg/kg	0.34
SD7	1	Pacific sanddab	Muscle	Copper	3.59		mg/kg	0.76
SD7	1	Pacific sanddab	Liver	Hexachlorobenzene	3.3	E	ug/kg	
SD7	1	Pacific sanddab	Muscle	Hexachlorobenzene	0.5	E	ug/kg	
SD7	1	Pacific sanddab	Liver	Iron	89.7		mg/kg	1.3
SD7	1	Pacific sanddab	Muscle	Iron	1.4		mg/kg	1.3
SD7	1	Pacific sanddab	Liver	Lipids	36.6		wt%	0.005
SD7	1	Pacific sanddab	Muscle	Lipids	0.22		wt%	0.005
SD7	1	Pacific sanddab	Liver	Manganese	0.55		mg/kg	0.23
SD7	1	Pacific sanddab	Muscle	Mercury	0.032		mg/kg	0.012
SD7	1	Pacific sanddab	Liver	o,p-DDE	3.7	E	ug/kg	
SD7	1	Pacific sanddab	Liver	p,p-DDD	6	E	ug/kg	
SD7	1	Pacific sanddab	Liver	p,p-DDE	380		ug/kg	
SD7	1	Pacific sanddab	Muscle	p,p-DDE	1.1	E	ug/kg	
SD7	1	Pacific sanddab	Liver	p,p-DDT	13	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 101	11	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 105	5.2	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 110	9	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 118	18		ug/kg	13.3
SD7	1	Pacific sanddab	Liver	PCB 123	2	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 128	4.4	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 138	25		ug/kg	13.3
SD7	1	Pacific sanddab	Liver	PCB 149	8.7	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 151	5	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 153/168	38		ug/kg	13.3
SD7	1	Pacific sanddab	Liver	PCB 156	2	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 158	1.6	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 167	1.5	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 170	7.4	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 177	3.5	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 180	14		ug/kg	13.3
SD7	1	Pacific sanddab	Liver	PCB 183	4.4	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 187	15		ug/kg	13.3
SD7	1	Pacific sanddab	Liver	PCB 194	3	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 206	3.4	E	ug/kg	
SD7	1	Pacific sanddab	Muscle	PCB 206	0.2	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 66	3.2	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 70	3.6	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 74	2.2	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 87	3.1	E	ug/kg	
SD7	1	Pacific sanddab	Liver	PCB 99	11	E	ug/kg	
SD7	1	Pacific sanddab	Liver	Selenium	0.86		mg/kg	0.13
SD7	1	Pacific sanddab	Muscle	Selenium	0.16		mg/kg	0.13

Appendix D.3 continued

April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD7	1	Pacific sanddab	Liver	Total Solids	55.7		wt%	0.4
SD7	1	Pacific sanddab	Muscle	Total Solids	19.8		wt%	0.4
SD7	1	Pacific sanddab	Liver	Trans Nonachlor	7.5	E	ug/kg	
SD7	1	Pacific sanddab	Liver	Zinc	24.3		mg/kg	0.58
SD7	1	Pacific sanddab	Muscle	Zinc	2.98		mg/kg	0.58
SD7	2	English sole	Liver	Aluminum	2.9		mg/kg	2.6
SD7	2	English sole	Muscle	Aluminum	4.1		mg/kg	2.6
SD7	2	English sole	Liver	Arsenic	33.9		mg/kg	1.4
SD7	2	English sole	Muscle	Arsenic	13.7		mg/kg	1.4
SD7	2	English sole	Liver	Copper	14.5		mg/kg	0.76
SD7	2	English sole	Liver	Iron	89.2		mg/kg	1.3
SD7	2	English sole	Muscle	Iron	4		mg/kg	1.3
SD7	2	English sole	Liver	Lipids	6.8		wt%	0.005
SD7	2	English sole	Muscle	Lipids	0.15		wt%	0.005
SD7	2	English sole	Liver	Manganese	2.3		mg/kg	0.23
SD7	2	English sole	Liver	Mercury	0.066		mg/kg	0.012
SD7	2	English sole	Muscle	Mercury	0.013		mg/kg	0.012
SD7	2	English sole	Liver	o,p-DDE	49		ug/kg	13.3
SD7	2	English sole	Liver	p,p-DDD	17		ug/kg	13.3
SD7	2	English sole	Liver	p,p-DDE	2640		ug/kg	13.3
SD7	2	English sole	Muscle	p,p-DDE	3.5		ug/kg	1.33
SD7	2	English sole	Liver	p,p-DDT	7.2	E	ug/kg	
SD7	2	English sole	Liver	PCB 101	13	E	ug/kg	
SD7	2	English sole	Liver	PCB 105	4.8	E	ug/kg	
SD7	2	English sole	Liver	PCB 110	6.7	E	ug/kg	
SD7	2	English sole	Liver	PCB 118	21		ug/kg	13.3
SD7	2	English sole	Liver	PCB 123	3.9	E	ug/kg	
SD7	2	English sole	Liver	PCB 128	0.9	E	ug/kg	
SD7	2	English sole	Liver	PCB 138	20		ug/kg	13.3
SD7	2	English sole	Liver	PCB 149	9.3	E	ug/kg	
SD7	2	English sole	Liver	PCB 151	3.4	E	ug/kg	
SD7	2	English sole	Liver	PCB 153/168	33		ug/kg	13.3
SD7	2	English sole	Liver	PCB 167	1.6	E	ug/kg	
SD7	2	English sole	Liver	PCB 177	2.9	E	ug/kg	
SD7	2	English sole	Liver	PCB 180	13	E	ug/kg	
SD7	2	English sole	Liver	PCB 183	4.4	E	ug/kg	
SD7	2	English sole	Liver	PCB 187	12	E	ug/kg	
SD7	2	English sole	Liver	PCB 206	1.8	E	ug/kg	
SD7	2	English sole	Muscle	PCB 206	0.1	E	ug/kg	
SD7	2	English sole	Liver	PCB 66	4.2	E	ug/kg	
SD7	2	English sole	Liver	PCB 70	3.3	E	ug/kg	
SD7	2	English sole	Liver	PCB 74	2.7	E	ug/kg	
SD7	2	English sole	Liver	PCB 87	4.9	E	ug/kg	
SD7	2	English sole	Liver	PCB 99	11	E	ug/kg	
SD7	2	English sole	Liver	Selenium	2.71		mg/kg	0.65
SD7	2	English sole	Muscle	Selenium	0.63		mg/kg	0.33
SD7	2	English sole	Liver	Total Solids	24.9		wt%	0.4
SD7	2	English sole	Muscle	Total Solids	19.1		wt%	0.4
SD7	2	English sole	Liver	Zinc	45.4		mg/kg	0.58
SD7	2	English sole	Muscle	Zinc	2.97		mg/kg	0.58
SD7	3	Ca. scorpionfish	Liver	Aluminum	11.6		mg/kg	2.6

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD7	3	Ca. scorpionfish	Liver	Arsenic	9.2		mg/kg	1.4
SD7	3	Ca. scorpionfish	Muscle	Arsenic	6.5		mg/kg	1.4
SD7	3	Ca. scorpionfish	Liver	Cadmium	1.34		mg/kg	0.34
SD7	3	Ca. scorpionfish	Liver	Copper	12.4		mg/kg	0.76
SD7	3	Ca. scorpionfish	Muscle	Copper	1.08		mg/kg	0.76
SD7	3	Ca. scorpionfish	Liver	Hexachlorobenzene	1.2	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	Iron	117		mg/kg	1.3
SD7	3	Ca. scorpionfish	Muscle	Iron	4.3		mg/kg	1.3
SD7	3	Ca. scorpionfish	Liver	Lipids	23.3		wt%	0.005
SD7	3	Ca. scorpionfish	Muscle	Lipids	0.44		wt%	0.005
SD7	3	Ca. scorpionfish	Liver	Manganese	0.26		mg/kg	0.23
SD7	3	Ca. scorpionfish	Liver	Mercury	0.109		mg/kg	0.012
SD7	3	Ca. scorpionfish	Muscle	Mercury	0.108		mg/kg	0.012
SD7	3	Ca. scorpionfish	Liver	o,p-DDE	2.7	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	p,p-DDD	7.9	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	p,p-DDE	560		ug/kg	13.3
SD7	3	Ca. scorpionfish	Muscle	p,p-DDE	9.3		ug/kg	1.33
SD7	3	Ca. scorpionfish	Liver	p,p-DDT	4.2	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 101	9.7	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 105	5	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 110	5.3	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 118	16		ug/kg	13.3
SD7	3	Ca. scorpionfish	Muscle	PCB 118	0.3	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 123	2.8	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 128	5.3	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 138	23		ug/kg	13.3
SD7	3	Ca. scorpionfish	Muscle	PCB 138	0.3	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 149	5.5	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 151	4	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 153/168	41		ug/kg	13.3
SD7	3	Ca. scorpionfish	Muscle	PCB 153/168	0.6	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 158	1.5	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 167	1.4	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 177	4.1	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 180	19		ug/kg	13.3
SD7	3	Ca. scorpionfish	Muscle	PCB 180	0.2	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 183	6	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 187	14		ug/kg	13.3
SD7	3	Ca. scorpionfish	Muscle	PCB 187	0.2	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 194	3	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 206	2.9	E	ug/kg	
SD7	3	Ca. scorpionfish	Muscle	PCB 206	0.1	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 52	2.2	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 66	1.9	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 74	1.3	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 87	2	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	PCB 99	7.9	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	Selenium	0.82		mg/kg	0.13
SD7	3	Ca. scorpionfish	Muscle	Selenium	0.35		mg/kg	0.13
SD7	3	Ca. scorpionfish	Liver	Total Solids	44.4		wt%	0.4
SD7	3	Ca. scorpionfish	Muscle	Total Solids	23.1		wt%	0.4

Appendix D.3 continued

April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD7	3	Ca. scorpionfish	Liver	Trans Nonachlor	9.6	E	ug/kg	
SD7	3	Ca. scorpionfish	Liver	Zinc	64		mg/kg	0.58
SD7	3	Ca. scorpionfish	Muscle	Zinc	3.83		mg/kg	0.58
SD8	1	Pacific sanddab	Liver	Aluminum	9.4		mg/kg	2.6
SD8	1	Pacific sanddab	Liver	Cadmium	0.94		mg/kg	0.34
SD8	1	Pacific sanddab	Liver	Copper	4.23		mg/kg	0.76
SD8	1	Pacific sanddab	Muscle	Heptachlor	0.3	E	ug/kg	
SD8	1	Pacific sanddab	Muscle	Hexachlorobenzene	0.2	E	ug/kg	
SD8	1	Pacific sanddab	Liver	Hexachlorobenzene	3	E	ug/kg	
SD8	1	Pacific sanddab	Muscle	Iron	6		mg/kg	1.3
SD8	1	Pacific sanddab	Liver	Iron	73.2		mg/kg	1.3
SD8	1	Pacific sanddab	Muscle	Lipids	0.37		wt%	0.005
SD8	1	Pacific sanddab	Liver	Lipids	29.9		wt%	0.005
SD8	1	Pacific sanddab	Liver	Manganese	1.15		mg/kg	0.23
SD8	1	Pacific sanddab	Muscle	Mercury	0.0295		mg/kg	0.012
SD8	1	Pacific sanddab	Liver	Mercury	0.0075		mg/kg	0.012
SD8	1	Pacific sanddab	Liver	o,p-DDE	6.9	E	ug/kg	
SD8	1	Pacific sanddab	Liver	o,p-DDT	2.7	E	ug/kg	
SD8	1	Pacific sanddab	Liver	p,p-DDD	6.8	E	ug/kg	
SD8	1	Pacific sanddab	Muscle	p,p-DDE	1.5		ug/kg	1.33
SD8	1	Pacific sanddab	Liver	p,p-DDE	360		ug/kg	13.3
SD8	1	Pacific sanddab	Liver	p,p-DDT	14		ug/kg	13.3
SD8	1	Pacific sanddab	Liver	PCB 101	8.5	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 105	4.7	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 110	7.9	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 118	15		ug/kg	13.3
SD8	1	Pacific sanddab	Liver	PCB 123	1.8	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 128	3.7	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 138	22		ug/kg	13.3
SD8	1	Pacific sanddab	Liver	PCB 149	5.3	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 151	4.3	E	ug/kg	
SD8	1	Pacific sanddab	Muscle	PCB 153/168	0.2	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 153/168	34		ug/kg	13.3
SD8	1	Pacific sanddab	Liver	PCB 156	2.1	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 158	1.2	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 177	2.2	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 180	13	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 183	4.3	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 187	13	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 194	3.7	E	ug/kg	
SD8	1	Pacific sanddab	Muscle	PCB 206	0.1	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 206	3.4	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 66	2.3	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 70	2.5	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 74	1.4	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 87	2.7	E	ug/kg	
SD8	1	Pacific sanddab	Liver	PCB 99	11	E	ug/kg	
SD8	1	Pacific sanddab	Liver	Selenium	0.95		mg/kg	0.13
SD8	1	Pacific sanddab	Muscle	Total Solids	19.2		wt%	0.4
SD8	1	Pacific sanddab	Liver	Total Solids	48.8		wt%	0.4
SD8	1	Pacific sanddab	Liver	Trans Nonachlor	7.8	E	ug/kg	

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD8	1	Pacific sanddab	Muscle	Zinc	2.92		mg/kg	0.58
SD8	1	Pacific sanddab	Liver	Zinc	28.5		mg/kg	0.58
SD8	2	Greenspotted rockfish	Liver	Aluminum	7.1		mg/kg	2.6
SD8	2	Greenspotted rockfish	Muscle	Copper	3.85		mg/kg	0.76
SD8	2	Greenspotted rockfish	Liver	Copper	22.2		mg/kg	0.76
SD8	2	Greenspotted rockfish	Muscle	Hexachlorobenzene	0.3	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	Hexachlorobenzene	0.8	E	ug/kg	
SD8	2	Greenspotted rockfish	Muscle	Iron	6		mg/kg	1.3
SD8	2	Greenspotted rockfish	Liver	Iron	76.6		mg/kg	1.3
SD8	2	Greenspotted rockfish	Muscle	Lipids	0.21		wt%	0.005
SD8	2	Greenspotted rockfish	Liver	Lipids	11		wt%	0.005
SD8	2	Greenspotted rockfish	Liver	Manganese	1.21		mg/kg	0.23
SD8	2	Greenspotted rockfish	Liver	Mercury	0.0695		mg/kg	0.012
SD8	2	Greenspotted rockfish	Liver	p,p-DDD	3.2	E	ug/kg	
SD8	2	Greenspotted rockfish	Muscle	p,p-DDE	3.4		ug/kg	1.33
SD8	2	Greenspotted rockfish	Liver	p,p-DDE	220		ug/kg	13.3
SD8	2	Greenspotted rockfish	Liver	p,p-DDT	4.9	E	ug/kg	
SD8	2	Greenspotted rockfish	Muscle	PCB 101	0.3	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 101	18		ug/kg	13.3
SD8	2	Greenspotted rockfish	Liver	PCB 105	8.3	E	ug/kg	
SD8	2	Greenspotted rockfish	Muscle	PCB 110	0.1	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 110	7.5	E	ug/kg	
SD8	2	Greenspotted rockfish	Muscle	PCB 118	0.5	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 118	32		ug/kg	13.3
SD8	2	Greenspotted rockfish	Liver	PCB 123	2.4	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 128	9.5	E	ug/kg	
SD8	2	Greenspotted rockfish	Muscle	PCB 138	0.6	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 138	43		ug/kg	13.3
SD8	2	Greenspotted rockfish	Muscle	PCB 149	0.2	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 149	13	E	ug/kg	
SD8	2	Greenspotted rockfish	Muscle	PCB 153/168	0.9	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 153/168	64		ug/kg	13.3
SD8	2	Greenspotted rockfish	Liver	PCB 158	3.9	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 167	1.9	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 177	3.2	E	ug/kg	
SD8	2	Greenspotted rockfish	Muscle	PCB 180	0.3	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 180	27		ug/kg	13.3
SD8	2	Greenspotted rockfish	Liver	PCB 183	7.4	E	ug/kg	
SD8	2	Greenspotted rockfish	Muscle	PCB 187	0.3	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 187	23		ug/kg	13.3
SD8	2	Greenspotted rockfish	Liver	PCB 194	4.7	E	ug/kg	
SD8	2	Greenspotted rockfish	Muscle	PCB 206	0.2	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 206	3.7	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 74	1.7	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 87	5.1	E	ug/kg	
SD8	2	Greenspotted rockfish	Muscle	PCB 99	0.3	E	ug/kg	
SD8	2	Greenspotted rockfish	Liver	PCB 99	15		ug/kg	13.3
SD8	2	Greenspotted rockfish	Muscle	Selenium	0.16		mg/kg	0.13
SD8	2	Greenspotted rockfish	Liver	Selenium	2.81		mg/kg	0.43
SD8	2	Greenspotted rockfish	Muscle	Total Solids	19.8		wt%	0.4
SD8	2	Greenspotted rockfish	Liver	Total Solids	37.7		wt%	0.4

Appendix D.3 continued

April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD8	2	Greenspotted rockfish	Muscle	Zinc	3.41		mg/kg	0.58
SD8	2	Greenspotted rockfish	Liver	Zinc	46.8		mg/kg	0.58
SD8	3	Longfin sanddab	Liver	Aluminum	7.7		mg/kg	2.6
SD8	3	Longfin sanddab	Muscle	Arsenic	15.1		mg/kg	1.4
SD8	3	Longfin sanddab	Liver	Cis Nonachlor	6.4	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	Copper	3.2		mg/kg	0.76
SD8	3	Longfin sanddab	Liver	Copper	5.9		mg/kg	0.76
SD8	3	Longfin sanddab	Muscle	Hexachlorobenzene	0.2	E	ug/kg	
SD8	3	Longfin sanddab	Liver	Hexachlorobenzene	1.2	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	Iron	4.6		mg/kg	1.3
SD8	3	Longfin sanddab	Liver	Iron	183		mg/kg	1.3
SD8	3	Longfin sanddab	Muscle	Lipids	0.23		wt%	0.005
SD8	3	Longfin sanddab	Liver	Lipids	15.5		wt%	0.005
SD8	3	Longfin sanddab	Liver	Manganese	1.24		mg/kg	0.23
SD8	3	Longfin sanddab	Muscle	Mercury	0.0535		mg/kg	0.012
SD8	3	Longfin sanddab	Liver	Mercury	0.0095		mg/kg	0.012
SD8	3	Longfin sanddab	Liver	o,p-DDE	9	E	ug/kg	
SD8	3	Longfin sanddab	Liver	p,p-DDD	4.5	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	p,p-DDE	3.3		ug/kg	1.33
SD8	3	Longfin sanddab	Liver	p,p-DDE	440		ug/kg	13.3
SD8	3	Longfin sanddab	Liver	p,p-DDT	8.4	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	PCB 101	0.4	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 101	25		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 105	0.4	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 105	23		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 110	0.4	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 110	29		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 114	0.2	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	PCB 118	1	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 118	97		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 119	0.2	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 119	2.5	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	PCB 123	0.3	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 123	5.5	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	PCB 128	0.4	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 128	27		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 138	1.1	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 138	150		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 149	0.3	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 149	26		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 151	0.4	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 151	22		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 153/168	1.7		ug/kg	1.33
SD8	3	Longfin sanddab	Liver	PCB 153/168	200		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 156	0.4	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 156	14		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 157	0.2	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 157	3.6	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	PCB 158	0.3	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 158	10	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	PCB 167	0.3	E	ug/kg	

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD8	3	Longfin sanddab	Liver	PCB 167	7.8	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 170	32		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 177	0.2	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 177	15		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 180	0.7	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 180	81		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 183	0.4	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 183	25		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 187	0.7	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 187	76		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 189	0.2	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	PCB 194	0.3	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 194	18		ug/kg	13.3
SD8	3	Longfin sanddab	Liver	PCB 201	21		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	PCB 206	0.4	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 206	11	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 49	2.8	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 52	7.9	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	PCB 66	0.3	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 66	6.8	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	PCB 70	0.2	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 70	2	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	PCB 74	0.3	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 74	4.7	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 87	5.2	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	PCB 99	0.8	E	ug/kg	
SD8	3	Longfin sanddab	Liver	PCB 99	59		ug/kg	13.3
SD8	3	Longfin sanddab	Muscle	Selenium	1.73		mg/kg	0.43
SD8	3	Longfin sanddab	Liver	Selenium	2.67		mg/kg	0.43
SD8	3	Longfin sanddab	Muscle	Total Solids	19.8		wt%	0.4
SD8	3	Longfin sanddab	Liver	Total Solids	33.3		wt%	0.4
SD8	3	Longfin sanddab	Liver	Trans Nonachlor	9.4	E	ug/kg	
SD8	3	Longfin sanddab	Muscle	Zinc	2.91		mg/kg	0.58
SD8	3	Longfin sanddab	Liver	Zinc	24.9		mg/kg	0.58
SD9	1	Ca. scorpionfish	Liver	Aluminum	6.1		mg/kg	2.6
SD9	1	Ca. scorpionfish	Muscle	Arsenic	5.4		mg/kg	1.4
SD9	1	Ca. scorpionfish	Liver	Arsenic	3.5		mg/kg	1.4
SD9	1	Ca. scorpionfish	Liver	Cadmium	0.42		mg/kg	0.34
SD9	1	Ca. scorpionfish	Liver	Copper	11.7		mg/kg	0.76
SD9	1	Ca. scorpionfish	Muscle	Hexachlorobenzene	2.2		ug/kg	1.33
SD9	1	Ca. scorpionfish	Liver	Hexachlorobenzene	1.4	E	ug/kg	
SD9	1	Ca. scorpionfish	Muscle	Iron	7.4		mg/kg	1.3
SD9	1	Ca. scorpionfish	Liver	Iron	104		mg/kg	1.3
SD9	1	Ca. scorpionfish	Muscle	Lipids	0.81		wt%	0.005
SD9	1	Ca. scorpionfish	Liver	Lipids	25.4		wt%	0.005
SD9	1	Ca. scorpionfish	Liver	Manganese	0.33		mg/kg	0.23
SD9	1	Ca. scorpionfish	Muscle	Mercury	0.104		mg/kg	0.012
SD9	1	Ca. scorpionfish	Liver	Mercury	0.015		mg/kg	0.012
SD9	1	Ca. scorpionfish	Liver	o,p-DDE	2.4	E	ug/kg	
SD9	1	Ca. scorpionfish	Muscle	p,p-DDD	0.2	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	p,p-DDD	7.5	E	ug/kg	

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD9	1	Ca. scorpionfish	Muscle	p,p-DDE	9		ug/kg	1.33
SD9	1	Ca. scorpionfish	Liver	p,p-DDE	330		ug/kg	13.3
SD9	1	Ca. scorpionfish	Liver	p,p-DDT	3.3	E	ug/kg	
SD9	1	Ca. scorpionfish	Muscle	PCB 101	0.2	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	PCB 101	5.5	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	PCB 105	1.7	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	PCB 110	3.3	E	ug/kg	
SD9	1	Ca. scorpionfish	Muscle	PCB 118	0.3	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	PCB 118	7.7	E	ug/kg	
SD9	1	Ca. scorpionfish	Muscle	PCB 138	0.3	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	PCB 138	10	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	PCB 149	3.8	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	PCB 151	2.2	E	ug/kg	
SD9	1	Ca. scorpionfish	Muscle	PCB 153/168	0.4	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	PCB 153/168	16		ug/kg	13.3
SD9	1	Ca. scorpionfish	Muscle	PCB 180	0.2	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	PCB 180	5.7	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	PCB 187	6.2	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	PCB 194	1.5	E	ug/kg	
SD9	1	Ca. scorpionfish	Muscle	PCB 206	0.1	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	PCB 206	2.1	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	PCB 66	2	E	ug/kg	
SD9	1	Ca. scorpionfish	Muscle	PCB 99	0.2	E	ug/kg	
SD9	1	Ca. scorpionfish	Liver	PCB 99	3.9	E	ug/kg	
SD9	1	Ca. scorpionfish	Muscle	Selenium	0.25		mg/kg	0.13
SD9	1	Ca. scorpionfish	Liver	Selenium	0.68		mg/kg	0.13
SD9	1	Ca. scorpionfish	Muscle	Total Solids	22.9		wt%	0.4
SD9	1	Ca. scorpionfish	Liver	Total Solids	43		wt%	0.4
SD9	1	Ca. scorpionfish	Liver	Trans Nonachlor	7	E	ug/kg	
SD9	1	Ca. scorpionfish	Muscle	Zinc	4.09		mg/kg	0.58
SD9	1	Ca. scorpionfish	Liver	Zinc	54.3		mg/kg	0.58
SD9	2	Longfin sanddab	Liver	Alpha (cis) Chlordane	6.4	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	Aluminum	6.5		mg/kg	2.6
SD9	2	Longfin sanddab	Liver	Aluminum	5.3		mg/kg	2.6
SD9	2	Longfin sanddab	Muscle	Arsenic	8.8		mg/kg	1.4
SD9	2	Longfin sanddab	Liver	Arsenic	10.4		mg/kg	1.4
SD9	2	Longfin sanddab	Liver	Cadmium	1.36		mg/kg	0.34
SD9	2	Longfin sanddab	Liver	Copper	3.09		mg/kg	0.76
SD9	2	Longfin sanddab	Liver	Hexachlorobenzene	2.2	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	Iron	2.4		mg/kg	1.3
SD9	2	Longfin sanddab	Liver	Iron	177		mg/kg	1.3
SD9	2	Longfin sanddab	Muscle	Lipids	0.09		wt%	0.005
SD9	2	Longfin sanddab	Liver	Lipids	20.6		wt%	0.005
SD9	2	Longfin sanddab	Liver	Manganese	1.29		mg/kg	0.23
SD9	2	Longfin sanddab	Muscle	Mercury	0.045		mg/kg	0.012
SD9	2	Longfin sanddab	Liver	Mercury	0.008		mg/kg	0.012
SD9	2	Longfin sanddab	Liver	o,p-DDE	17		ug/kg	13.3
SD9	2	Longfin sanddab	Liver	o,p-DDT	2.9	E	ug/kg	
SD9	2	Longfin sanddab	Liver	p,p-DDD	9.6	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	p,p-DDE	1.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	p,p-DDE	790		ug/kg	13.3

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD9	2	Longfin sanddab	Liver	p,p-DDT	21		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 101	0.3	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 101	15		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 105	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 105	13	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 110	15		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 114	0.3	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	PCB 118	0.3	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 118	49		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 119	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	PCB 123	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 123	5.3	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 128	18		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 138	0.3	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 138	89		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 149	0.3	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 149	16		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 151	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 151	14		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 153/168	0.5	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 153/168	130		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 156	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 156	8.2	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	PCB 157	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	PCB 158	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 158	6.6	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	PCB 167	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 167	4.6	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 170	25		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 177	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 177	11	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	PCB 180	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 180	65		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 183	0.3	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 183	20		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 187	0.3	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 187	56		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 189	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	PCB 194	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 194	17		ug/kg	13.3
SD9	2	Longfin sanddab	Liver	PCB 201	17		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 206	0.3	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 206	10	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 52	3	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	PCB 66	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 66	4.4	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	PCB 70	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 70	1.7	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	PCB 74	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 74	2.9	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	PCB 87	0.2	E	ug/kg	

Appendix D.3 continued

April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD9	2	Longfin sanddab	Liver	PCB 87	3.1	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	PCB 99	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 99	30		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	Selenium	0.46		mg/kg	0.13
SD9	2	Longfin sanddab	Liver	Selenium	2.53		mg/kg	0.43
SD9	2	Longfin sanddab	Liver	Silver	0.89		mg/kg	0.62
SD9	2	Longfin sanddab	Muscle	Total Solids	18.5		wt%	0.4
SD9	2	Longfin sanddab	Liver	Total Solids	38.4		wt%	0.4
SD9	2	Longfin sanddab	Liver	Trans Nonachlor	15	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	Zinc	2.36		mg/kg	0.58
SD9	2	Longfin sanddab	Liver	Zinc	23.3		mg/kg	0.58
SD9	3	Hornyhead turbot	Liver	Aluminum	18.6		mg/kg	2.6
SD9	3	Hornyhead turbot	Muscle	Arsenic	19.9		mg/kg	1.4
SD9	3	Hornyhead turbot	Liver	Arsenic	10.3		mg/kg	1.4
SD9	3	Hornyhead turbot	Liver	Cadmium	3.15		mg/kg	0.34
SD9	3	Hornyhead turbot	Muscle	Copper	2.54		mg/kg	0.76
SD9	3	Hornyhead turbot	Liver	Copper	10.7		mg/kg	0.76
SD9	3	Hornyhead turbot	Muscle	Iron	4.7		mg/kg	1.3
SD9	3	Hornyhead turbot	Liver	Iron	112		mg/kg	1.3
SD9	3	Hornyhead turbot	Muscle	Lipids	0.23		wt%	0.005
SD9	3	Hornyhead turbot	Liver	Lipids	6.38		wt%	0.005
SD9	3	Hornyhead turbot	Liver	Manganese	0.97		mg/kg	0.23
SD9	3	Hornyhead turbot	Muscle	Mercury	0.017		mg/kg	0.03
SD9	3	Hornyhead turbot	Liver	Mercury	0.025		mg/kg	0.012
SD9	3	Hornyhead turbot	Liver	p,p-DDD	2.3	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	p,p-DDE	0.8	E	ug/kg	
SD9	3	Hornyhead turbot	Liver	p,p-DDE	81		ug/kg	13.3
SD9	3	Hornyhead turbot	Liver	p,p-DDT	3.1	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 101	0.2	E	ug/kg	
SD9	3	Hornyhead turbot	Liver	PCB 101	2.3	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 105	0.2	E	ug/kg	
SD9	3	Hornyhead turbot	Liver	PCB 110	2	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 118	0.2	E	ug/kg	
SD9	3	Hornyhead turbot	Liver	PCB 118	4.8	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 138	0.1	E	ug/kg	
SD9	3	Hornyhead turbot	Liver	PCB 138	5.5	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 149	0.2	E	ug/kg	
SD9	3	Hornyhead turbot	Liver	PCB 149	3.3	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 151	0.1	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 153/168	0.4	E	ug/kg	
SD9	3	Hornyhead turbot	Liver	PCB 153/168	11	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 156	0.2	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 158	0.1	E	ug/kg	
SD9	3	Hornyhead turbot	Liver	PCB 158	1	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 167	0.2	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 177	0.1	E	ug/kg	
SD9	3	Hornyhead turbot	Liver	PCB 180	6.9	E	ug/kg	
SD9	3	Hornyhead turbot	Liver	PCB 183	3.5	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 187	0.2	E	ug/kg	
SD9	3	Hornyhead turbot	Liver	PCB 187	7.2	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 189	0.1	E	ug/kg	

Appendix D.3 continued

April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD9	3	Hornyhead turbot	Muscle	PCB 194	0.1	E	ug/kg	
SD9	3	Hornyhead turbot	Liver	PCB 194	1.6	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 206	0.3	E	ug/kg	
SD9	3	Hornyhead turbot	Liver	PCB 206	2.9	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 66	0.1	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 74	0.1	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	PCB 99	0.2	E	ug/kg	
SD9	3	Hornyhead turbot	Liver	PCB 99	2.3	E	ug/kg	
SD9	3	Hornyhead turbot	Muscle	Selenium	0.28		mg/kg	0.13
SD9	3	Hornyhead turbot	Liver	Selenium	1.88		mg/kg	0.43
SD9	3	Hornyhead turbot	Muscle	Total Solids	19.2		wt%	0.4
SD9	3	Hornyhead turbot	Liver	Total Solids	26.2		wt%	0.4
SD9	3	Hornyhead turbot	Muscle	Zinc	2.77		mg/kg	0.58
SD9	3	Hornyhead turbot	Liver	Zinc	32.9		mg/kg	0.58
SD10	1	Pacific sanddab	Liver	Aluminum	36.6		mg/kg	2.6
SD10	1	Pacific sanddab	Muscle	Aluminum	14.7		mg/kg	2.6
SD10	1	Pacific sanddab	Liver	Arsenic	6.6		mg/kg	1.4
SD10	1	Pacific sanddab	Liver	Cadmium	2.26		mg/kg	0.34
SD10	1	Pacific sanddab	Muscle	Chromium	0.37		mg/kg	0.3
SD10	1	Pacific sanddab	Liver	Copper	13		mg/kg	0.76
SD10	1	Pacific sanddab	Muscle	Copper	8.39		mg/kg	0.76
SD10	1	Pacific sanddab	Liver	Hexachlorobenzene	2.3	E	ug/kg	
SD10	1	Pacific sanddab	Muscle	Hexachlorobenzene	15		ug/kg	1.33
SD10	1	Pacific sanddab	Liver	Iron	72.5		mg/kg	1.3
SD10	1	Pacific sanddab	Muscle	Iron	5.3		mg/kg	1.3
SD10	1	Pacific sanddab	Liver	Lipids	26.5		wt%	0.005
SD10	1	Pacific sanddab	Muscle	Lipids	0.32		wt%	0.005
SD10	1	Pacific sanddab	Liver	Manganese	0.52		mg/kg	0.23
SD10	1	Pacific sanddab	Liver	Mercury	0.008		mg/kg	0.012
SD10	1	Pacific sanddab	Muscle	Mercury	0.042		mg/kg	0.012
SD10	1	Pacific sanddab	Liver	o,p-DDE	7	E	ug/kg	
SD10	1	Pacific sanddab	Liver	p,p-DDD	6.7	E	ug/kg	
SD10	1	Pacific sanddab	Liver	p,p-DDE	350		ug/kg	13.3
SD10	1	Pacific sanddab	Muscle	p,p-DDE	1	E	ug/kg	
SD10	1	Pacific sanddab	Liver	p,p-DDT	17		ug/kg	13.3
SD10	1	Pacific sanddab	Liver	PCB 101	7.4	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 105	4.4	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 110	6.7	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 118	15		ug/kg	13.3
SD10	1	Pacific sanddab	Liver	PCB 123	2.4	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 128	4.6	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 138	21		ug/kg	13.3
SD10	1	Pacific sanddab	Liver	PCB 149	5.5	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 151	4.1	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 153/168	29		ug/kg	13.3
SD10	1	Pacific sanddab	Liver	PCB 156	1.8	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 158	1.4	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 177	3	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 180	13	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 183	3.5	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 187	12	E	ug/kg	

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD10	1	Pacific sanddab	Liver	PCB 194	3.2	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 206	2.9	E	ug/kg	
SD10	1	Pacific sanddab	Muscle	PCB 206	0.1	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 66	2.4	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 70	2.9	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 74	2.1	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 87	3.1	E	ug/kg	
SD10	1	Pacific sanddab	Liver	PCB 99	11	E	ug/kg	
SD10	1	Pacific sanddab	Liver	Selenium	0.8		mg/kg	0.13
SD10	1	Pacific sanddab	Muscle	Selenium	0.19		mg/kg	0.13
SD10	1	Pacific sanddab	Liver	Total Solids	45.7		wt%	0.4
SD10	1	Pacific sanddab	Muscle	Total Solids	19		wt%	0.4
SD10	1	Pacific sanddab	Liver	Trans Nonachlor	9.7	E	ug/kg	
SD10	1	Pacific sanddab	Liver	Zinc	23.8		mg/kg	0.58
SD10	1	Pacific sanddab	Muscle	Zinc	3.44		mg/kg	0.58
SD10	2	Ca. scorpionfish	Liver	Aluminum	5.5		mg/kg	2.6
SD10	2	Ca. scorpionfish	Liver	Arsenic	2.5		mg/kg	1.4
SD10	2	Ca. scorpionfish	Muscle	Arsenic	4.4		mg/kg	1.4
SD10	2	Ca. scorpionfish	Liver	BHC, Alpha isomer	5.4	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	BHC, Beta isomer	74		ug/kg	20
SD10	2	Ca. scorpionfish	Liver	Cadmium	0.41		mg/kg	0.34
SD10	2	Ca. scorpionfish	Liver	Copper	7.86		mg/kg	0.76
SD10	2	Ca. scorpionfish	Liver	Dieldrin	36		ug/kg	20
SD10	2	Ca. scorpionfish	Liver	Endrin	68		ug/kg	20
SD10	2	Ca. scorpionfish	Liver	Gamma (trans) Chlordane	27		ug/kg	13.3
SD10	2	Ca. scorpionfish	Liver	Hexachlorobenzene	1	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	Iron	65.9		mg/kg	1.3
SD10	2	Ca. scorpionfish	Muscle	Iron	1.5		mg/kg	1.3
SD10	2	Ca. scorpionfish	Liver	Lipids	29		wt%	0.005
SD10	2	Ca. scorpionfish	Muscle	Lipids	0.53		wt%	0.005
SD10	2	Ca. scorpionfish	Liver	Manganese	0.24		mg/kg	0.23
SD10	2	Ca. scorpionfish	Liver	Mercury	0.0155		mg/kg	0.012
SD10	2	Ca. scorpionfish	Liver	p,p-DDD	36		ug/kg	13.3
SD10	2	Ca. scorpionfish	Liver	p,p-DDE	340		ug/kg	13.3
SD10	2	Ca. scorpionfish	Muscle	p,p-DDE	4.2		ug/kg	1.33
SD10	2	Ca. scorpionfish	Liver	p,p-DDT	28		ug/kg	13.3
SD10	2	Ca. scorpionfish	Liver	PCB 101	8	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 105	4	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 110	5.3	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 118	14		ug/kg	13.3
SD10	2	Ca. scorpionfish	Liver	PCB 123	1.8	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 128	4.3	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 138	19		ug/kg	13.3
SD10	2	Ca. scorpionfish	Muscle	PCB 138	0.2	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 149	5.1	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 151	4	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 153/168	34		ug/kg	13.3
SD10	2	Ca. scorpionfish	Muscle	PCB 153/168	0.5	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 158	1.5	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 177	3	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 180	14		ug/kg	13.3

Appendix D.3 continued

April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD10	2	Ca. scorpionfish	Muscle	PCB 180	0.2	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 183	3.9	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 187	12	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 194	2.8	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 206	2.3	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 66	2.4	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 74	1.8	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	PCB 99	8.5	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	Selenium	0.65		mg/kg	0.13
SD10	2	Ca. scorpionfish	Muscle	Selenium	0.26		mg/kg	0.13
SD10	2	Ca. scorpionfish	Liver	Total Solids	52.3		wt%	0.4
SD10	2	Ca. scorpionfish	Muscle	Total Solids	22.4		wt%	0.4
SD10	2	Ca. scorpionfish	Liver	Trans Nonachlor	7.3	E	ug/kg	
SD10	2	Ca. scorpionfish	Liver	Zinc	75.2		mg/kg	0.58
SD10	2	Ca. scorpionfish	Muscle	Zinc	3.17		mg/kg	0.58
SD10	3	Ca. scorpionfish	Liver	Aluminum	6.7		mg/kg	2.6
SD10	3	Ca. scorpionfish	Muscle	Aluminum	5.45		mg/kg	2.6
SD10	3	Ca. scorpionfish	Liver	Arsenic	11.8		mg/kg	1.4
SD10	3	Ca. scorpionfish	Muscle	Arsenic	6.85		mg/kg	1.4
SD10	3	Ca. scorpionfish	Liver	Cadmium	1.82		mg/kg	0.34
SD10	3	Ca. scorpionfish	Liver	Chromium	0.8		mg/kg	0.3
SD10	3	Ca. scorpionfish	Liver	Copper	56.3		mg/kg	0.76
SD10	3	Ca. scorpionfish	Muscle	Copper	3.09		mg/kg	0.76
SD10	3	Ca. scorpionfish	Liver	Hexachlorobenzene	1.3	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	Hexachlorobenzene	0.5	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	Iron	147		mg/kg	1.3
SD10	3	Ca. scorpionfish	Muscle	Iron	5.45		mg/kg	1.3
SD10	3	Ca. scorpionfish	Liver	Lipids	24.9		wt%	0.005
SD10	3	Ca. scorpionfish	Muscle	Lipids	0.3		wt%	0.005
SD10	3	Ca. scorpionfish	Liver	Manganese	0.395		mg/kg	0.23
SD10	3	Ca. scorpionfish	Liver	Mercury	0.039		mg/kg	0.012
SD10	3	Ca. scorpionfish	Muscle	Mercury	0.307		mg/kg	0.012
SD10	3	Ca. scorpionfish	Liver	p,p-DDD	8	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	p,p-DDE	660		ug/kg	13.3
SD10	3	Ca. scorpionfish	Muscle	p,p-DDE	4.7		ug/kg	1.33
SD10	3	Ca. scorpionfish	Liver	p,p-DDT	5.6	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 101	13	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 105	7.5	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 110	6.9	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 118	27		ug/kg	13.3
SD10	3	Ca. scorpionfish	Liver	PCB 123	3.5	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 128	8.7	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 138	41		ug/kg	13.3
SD10	3	Ca. scorpionfish	Muscle	PCB 138	0.3	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 149	4.7	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 151	7.3	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 153/168	64		ug/kg	13.3
SD10	3	Ca. scorpionfish	Muscle	PCB 153/168	0.4	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 156	5.2	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 158	3.8	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 167	3	E	ug/kg	

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD10	3	Ca. scorpionfish	Liver	PCB 177	7.7	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 180	34		ug/kg	13.3
SD10	3	Ca. scorpionfish	Muscle	PCB 180	0.2	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 183	9.3	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 187	25		ug/kg	13.3
SD10	3	Ca. scorpionfish	Muscle	PCB 187	0.1	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 194	6	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 206	4	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	PCB 206	0.2	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 66	3.7	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 74	2.7	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 87	5.1	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 99	15		ug/kg	13.3
SD10	3	Ca. scorpionfish	Liver	Selenium	0.75		mg/kg	0.13
SD10	3	Ca. scorpionfish	Muscle	Selenium	0.433		mg/kg	0.33
SD10	3	Ca. scorpionfish	Liver	Silver	0.8		mg/kg	0.62
SD10	3	Ca. scorpionfish	Liver	Total Solids	47.9		wt%	0.4
SD10	3	Ca. scorpionfish	Muscle	Total Solids	22.6		wt%	0.4
SD10	3	Ca. scorpionfish	Liver	Trans Nonachlor	13	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	Zinc	71.8		mg/kg	0.58
SD10	3	Ca. scorpionfish	Muscle	Zinc	3.79		mg/kg	0.58
SD11	1	Ca. scorpionfish	Muscle	Arsenic	8.5		mg/kg	1.4
SD11	1	Ca. scorpionfish	Liver	Copper	18		mg/kg	0.76
SD11	1	Ca. scorpionfish	Muscle	Copper	2.04		mg/kg	0.76
SD11	1	Ca. scorpionfish	Liver	Hexachlorobenzene	5	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	Iron	70.2		mg/kg	1.3
SD11	1	Ca. scorpionfish	Muscle	Iron	5.4		mg/kg	1.3
SD11	1	Ca. scorpionfish	Liver	Lipids	14.4		wt%	0.005
SD11	1	Ca. scorpionfish	Muscle	Lipids	0.49		wt%	0.005
SD11	1	Ca. scorpionfish	Liver	Mercury	0.013		mg/kg	0.012
SD11	1	Ca. scorpionfish	Muscle	Mercury	0.208		mg/kg	0.03
SD11	1	Ca. scorpionfish	Liver	o,p-DDE	5.4	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	p,p-DDD	14		ug/kg	13.3
SD11	1	Ca. scorpionfish	Muscle	p,p-DDD	0.3	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	p,p-DDE	650		ug/kg	13.3
SD11	1	Ca. scorpionfish	Muscle	p,p-DDE	13		ug/kg	1.33
SD11	1	Ca. scorpionfish	Liver	p,p-DDT	5.9	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 101	11	E	ug/kg	
SD11	1	Ca. scorpionfish	Muscle	PCB 101	0.3	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 105	5.5	E	ug/kg	
SD11	1	Ca. scorpionfish	Muscle	PCB 105	0.1	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 110	6.4	E	ug/kg	
SD11	1	Ca. scorpionfish	Muscle	PCB 110	0.2	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 118	19		ug/kg	13.3
SD11	1	Ca. scorpionfish	Muscle	PCB 118	0.5	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 128	4.8	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 138	26		ug/kg	13.3
SD11	1	Ca. scorpionfish	Muscle	PCB 138	0.4	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 149	6.6	E	ug/kg	
SD11	1	Ca. scorpionfish	Muscle	PCB 149	0.2	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 151	3.9	E	ug/kg	

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD11	1	Ca. scorpionfish	Liver	PCB 153/168	37		ug/kg	13.3
SD11	1	Ca. scorpionfish	Muscle	PCB 153/168	0.8	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 156	2	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 158	1.6	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 167	1.5	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 177	3.3	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 180	17		ug/kg	13.3
SD11	1	Ca. scorpionfish	Muscle	PCB 180	0.3	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 183	6.2	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 187	13	E	ug/kg	
SD11	1	Ca. scorpionfish	Muscle	PCB 187	0.3	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 194	3.5	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 206	3.5	E	ug/kg	
SD11	1	Ca. scorpionfish	Muscle	PCB 206	0.2	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 66	4.3	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 74	2.1	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 87	2.9	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	PCB 99	12	E	ug/kg	
SD11	1	Ca. scorpionfish	Muscle	PCB 99	0.3	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	Selenium	0.68		mg/kg	0.13
SD11	1	Ca. scorpionfish	Muscle	Selenium	0.35		mg/kg	0.13
SD11	1	Ca. scorpionfish	Liver	Total Solids	45.2		wt%	0.4
SD11	1	Ca. scorpionfish	Muscle	Total Solids	22.1		wt%	0.4
SD11	1	Ca. scorpionfish	Liver	Trans Nonachlor	9.6	E	ug/kg	
SD11	1	Ca. scorpionfish	Liver	Zinc	80.6		mg/kg	0.58
SD11	1	Ca. scorpionfish	Muscle	Zinc	3.67		mg/kg	0.58
SD11	2	Pacific sanddab	Liver	Alpha (cis) Chlordane	9.4	E	ug/kg	
SD11	2	Pacific sanddab	Muscle	Aluminum	3		mg/kg	2.6
SD11	2	Pacific sanddab	Muscle	Arsenic	3.2		mg/kg	1.4
SD11	2	Pacific sanddab	Liver	Copper	4.31		mg/kg	0.76
SD11	2	Pacific sanddab	Muscle	Copper	4.18		mg/kg	0.76
SD11	2	Pacific sanddab	Liver	Hexachlorobenzene	3.4	E	ug/kg	
SD11	2	Pacific sanddab	Liver	Iron	77.2		mg/kg	1.3
SD11	2	Pacific sanddab	Muscle	Iron	8		mg/kg	1.3
SD11	2	Pacific sanddab	Liver	Lipids	31.8		wt%	0.005
SD11	2	Pacific sanddab	Muscle	Lipids	0.23		wt%	0.005
SD11	2	Pacific sanddab	Liver	Manganese	0.64		mg/kg	0.23
SD11	2	Pacific sanddab	Liver	Mercury	0.0095		mg/kg	0.012
SD11	2	Pacific sanddab	Liver	o,p-DDE	9.8	E	ug/kg	
SD11	2	Pacific sanddab	Liver	o,p-DDT	3.5	E	ug/kg	
SD11	2	Pacific sanddab	Liver	p,p-DDD	9.8	E	ug/kg	
SD11	2	Pacific sanddab	Liver	p,p-DDE	620		ug/kg	13.3
SD11	2	Pacific sanddab	Muscle	p,p-DDE	4.8		ug/kg	1.33
SD11	2	Pacific sanddab	Liver	p,p-DDT	21		ug/kg	13.3
SD11	2	Pacific sanddab	Liver	PCB 101	14		ug/kg	13.3
SD11	2	Pacific sanddab	Liver	PCB 105	8.6	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 110	13	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 118	30		ug/kg	13.3
SD11	2	Pacific sanddab	Muscle	PCB 118	0.2	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 123	3.3	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 128	9.3	E	ug/kg	

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD11	2	Pacific sanddab	Liver	PCB 138	47		ug/kg	13.3
SD11	2	Pacific sanddab	Muscle	PCB 138	0.3	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 149	8.1	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 151	7.1	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 153/168	64		ug/kg	13.3
SD11	2	Pacific sanddab	Muscle	PCB 153/168	0.4	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 156	4.1	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 157	1.3	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 158	4	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 167	3	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 177	4.8	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 180	31		ug/kg	13.3
SD11	2	Pacific sanddab	Muscle	PCB 180	0.3	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 183	9.2	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 187	25		ug/kg	13.3
SD11	2	Pacific sanddab	Muscle	PCB 187	0.2	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 194	7.3	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 201	9.2	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 206	6.6	E	ug/kg	
SD11	2	Pacific sanddab	Muscle	PCB 206	0.1	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 49	2.1	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 52	4.1	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 66	3.5	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 70	4.1	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 74	2.2	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 87	3.6	E	ug/kg	
SD11	2	Pacific sanddab	Liver	PCB 99	18		ug/kg	13.3
SD11	2	Pacific sanddab	Muscle	PCB 99	0.1	E	ug/kg	
SD11	2	Pacific sanddab	Liver	Selenium	0.9		mg/kg	0.13
SD11	2	Pacific sanddab	Muscle	Selenium	0.15		mg/kg	0.13
SD11	2	Pacific sanddab	Liver	Total Solids	50		wt%	0.4
SD11	2	Pacific sanddab	Muscle	Total Solids	18.9		wt%	0.4
SD11	2	Pacific sanddab	Liver	Trans Nonachlor	12	E	ug/kg	
SD11	2	Pacific sanddab	Liver	Zinc	24.2		mg/kg	0.58
SD11	2	Pacific sanddab	Muscle	Zinc	2.94		mg/kg	0.58
SD11	3	Longfin sanddab	Liver	Alpha (cis) Chlordane	7.9	E	ug/kg	
SD11	3	Longfin sanddab	Liver	Aluminum	4		mg/kg	2.6
SD11	3	Longfin sanddab	Liver	Arsenic	10.5		mg/kg	1.4
SD11	3	Longfin sanddab	Muscle	Arsenic	2.8		mg/kg	1.4
SD11	3	Longfin sanddab	Liver	Cadmium	1.37		mg/kg	0.34
SD11	3	Longfin sanddab	Liver	Copper	6.76		mg/kg	0.76
SD11	3	Longfin sanddab	Liver	Hexachlorobenzene	2.1	E	ug/kg	
SD11	3	Longfin sanddab	Muscle	Hexachlorobenzene	0.1		ug/kg	1.33
SD11	3	Longfin sanddab	Liver	Iron	168		mg/kg	1.3
SD11	3	Longfin sanddab	Muscle	Iron	6		mg/kg	1.3
SD11	3	Longfin sanddab	Liver	Lipids	22.3		wt%	0.005
SD11	3	Longfin sanddab	Muscle	Lipids	0.26		wt%	0.005
SD11	3	Longfin sanddab	Liver	Manganese	1.22		mg/kg	0.23
SD11	3	Longfin sanddab	Liver	Mercury	0.0085		mg/kg	0.012
SD11	3	Longfin sanddab	Muscle	Mercury	0.079		mg/kg	0.03
SD11	3	Longfin sanddab	Liver	o,p-DDE	35		ug/kg	13.3

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD11	3	Longfin sanddab	Liver	o,p-DDT	3.7	E	ug/kg	
SD11	3	Longfin sanddab	Liver	p,p-DDD	16		ug/kg	13.3
SD11	3	Longfin sanddab	Liver	p,p-DDE	1160		ug/kg	13.3
SD11	3	Longfin sanddab	Muscle	p,p-DDE	2.4		ug/kg	1.33
SD11	3	Longfin sanddab	Liver	p,p-DDT	21		ug/kg	13.3
SD11	3	Longfin sanddab	Muscle	p,p-DDT	0.2		ug/kg	1.33
SD11	3	Longfin sanddab	Liver	PCB 101	12	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 105	9.8	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 110	9.8	E	ug/kg	
SD11	3	Longfin sanddab	Muscle	PCB 110	0.05		ug/kg	1.33
SD11	3	Longfin sanddab	Liver	PCB 118	34		ug/kg	13.3
SD11	3	Longfin sanddab	Muscle	PCB 118	0.2	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 123	4.9	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 128	13	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 138	62		ug/kg	13.3
SD11	3	Longfin sanddab	Muscle	PCB 138	0.1	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 149	10	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 151	9.7	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 153/168	97		ug/kg	13.3
SD11	3	Longfin sanddab	Muscle	PCB 153/168	0.25		ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 156	6.1	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 158	4.9	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 167	3.3	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 170	19		ug/kg	13.3
SD11	3	Longfin sanddab	Liver	PCB 177	7.2	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 180	50		ug/kg	13.3
SD11	3	Longfin sanddab	Liver	PCB 183	15		ug/kg	13.3
SD11	3	Longfin sanddab	Liver	PCB 187	40		ug/kg	13.3
SD11	3	Longfin sanddab	Muscle	PCB 187	0.1		ug/kg	1.33
SD11	3	Longfin sanddab	Liver	PCB 194	11	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 201	16		ug/kg	13.3
SD11	3	Longfin sanddab	Liver	PCB 206	7.2	E	ug/kg	
SD11	3	Longfin sanddab	Muscle	PCB 206	0.15		ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 66	4.6	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 74	2.9	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 87	2.9	E	ug/kg	
SD11	3	Longfin sanddab	Liver	PCB 99	20		ug/kg	13.3
SD11	3	Longfin sanddab	Liver	Selenium	2.71		mg/kg	0.43
SD11	3	Longfin sanddab	Muscle	Selenium	0.55		mg/kg	0.13
SD11	3	Longfin sanddab	Liver	Total Solids	34.3		wt%	0.4
SD11	3	Longfin sanddab	Muscle	Total Solids	18.5		wt%	0.4
SD11	3	Longfin sanddab	Liver	Trans Nonachlor	19	E	ug/kg	
SD11	3	Longfin sanddab	Liver	Zinc	25.8		mg/kg	0.58
SD11	3	Longfin sanddab	Muscle	Zinc	2.31		mg/kg	0.58
SD12	1	Longfin sanddab	Liver	Alpha (cis) Chlordane	8.2	E	ug/kg	
SD12	1	Longfin sanddab	Muscle	Aluminum	2.9		mg/kg	2.6
SD12	1	Longfin sanddab	Muscle	Arsenic	9.5		mg/kg	1.4
SD12	1	Longfin sanddab	Liver	Cadmium	0.55		mg/kg	0.34
SD12	1	Longfin sanddab	Liver	Copper	11.3		mg/kg	0.76
SD12	1	Longfin sanddab	Liver	Hexachlorobenzene	1.8	E	ug/kg	
SD12	1	Longfin sanddab	Muscle	Hexachlorobenzene	0.1	E	ug/kg	

Appendix D.3 continued

April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD12	1	Longfin sanddab	Liver	Iron	74		mg/kg	1.3
SD12	1	Longfin sanddab	Muscle	Iron	5.3		mg/kg	1.3
SD12	1	Longfin sanddab	Liver	Lipids	26.8		wt%	0.005
SD12	1	Longfin sanddab	Muscle	Lipids	0.19		wt%	0.005
SD12	1	Longfin sanddab	Liver	Manganese	0.25		mg/kg	0.23
SD12	1	Longfin sanddab	Liver	Mercury	0.0425		mg/kg	0.03
SD12	1	Longfin sanddab	Muscle	Mercury	0.071		mg/kg	0.03
SD12	1	Longfin sanddab	Liver	o,p-DDE	8.6	E	ug/kg	
SD12	1	Longfin sanddab	Liver	p,p-DDD	4.2	E	ug/kg	
SD12	1	Longfin sanddab	Liver	p,p-DDE	630		ug/kg	13.3
SD12	1	Longfin sanddab	Muscle	p,p-DDE	3.5		ug/kg	1.33
SD12	1	Longfin sanddab	Liver	p,p-DDT	9	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 101	7.8	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 105	10	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 110	6.7	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 118	51		ug/kg	13.3
SD12	1	Longfin sanddab	Muscle	PCB 118	0.2	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 123	4.2	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 128	13	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 138	77		ug/kg	13.3
SD12	1	Longfin sanddab	Muscle	PCB 138	0.3	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 149	5.1	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 151	7.4	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 153/168	110		ug/kg	13.3
SD12	1	Longfin sanddab	Muscle	PCB 153/168	0.4	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 156	7.1	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 158	4	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 167	4.9	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 170	20		ug/kg	13.3
SD12	1	Longfin sanddab	Liver	PCB 177	5.4	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 180	59		ug/kg	13.3
SD12	1	Longfin sanddab	Muscle	PCB 180	0.2	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 183	15		ug/kg	13.3
SD12	1	Longfin sanddab	Liver	PCB 187	34		ug/kg	13.3
SD12	1	Longfin sanddab	Muscle	PCB 187	0.1	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 194	11	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 201	12	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 206	6.5	E	ug/kg	
SD12	1	Longfin sanddab	Muscle	PCB 206	0.2	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 66	5	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 70	2.4	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 74	4.2	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 87	2.1	E	ug/kg	
SD12	1	Longfin sanddab	Liver	PCB 99	30		ug/kg	13.3
SD12	1	Longfin sanddab	Liver	Phenanthrene	78.8		ug/kg	31.3
SD12	1	Longfin sanddab	Liver	Selenium	1.61		mg/kg	0.13
SD12	1	Longfin sanddab	Muscle	Selenium	0.49		mg/kg	0.13
SD12	1	Longfin sanddab	Liver	Total Solids	57.7		wt%	0.4
SD12	1	Longfin sanddab	Muscle	Total Solids	19		wt%	0.4
SD12	1	Longfin sanddab	Liver	Trans Nonachlor	13	E	ug/kg	
SD12	1	Longfin sanddab	Liver	Zinc	13.8		mg/kg	0.58

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD12	1	Longfin sanddab	Muscle	Zinc	2.73		mg/kg	0.58
SD12	2	Pacific sanddab	Liver	Alpha (cis) Chlordane	8.2	E	ug/kg	
SD12	2	Pacific sanddab	Liver	Aluminum	9.2		mg/kg	2.6
SD12	2	Pacific sanddab	Muscle	Aluminum	4		mg/kg	2.6
SD12	2	Pacific sanddab	Muscle	Arsenic	2.4		mg/kg	1.4
SD12	2	Pacific sanddab	Liver	Copper	6.63		mg/kg	0.76
SD12	2	Pacific sanddab	Muscle	Copper	3.7		mg/kg	0.76
SD12	2	Pacific sanddab	Liver	Hexachlorobenzene	1.8	E	ug/kg	
SD12	2	Pacific sanddab	Muscle	Hexachlorobenzene	0.4		ug/kg	
SD12	2	Pacific sanddab	Liver	Iron	103		mg/kg	1.3
SD12	2	Pacific sanddab	Muscle	Iron	3.6		mg/kg	1.3
SD12	2	Pacific sanddab	Liver	Lipids	25.5		wt%	0.005
SD12	2	Pacific sanddab	Muscle	Lipids	0.17		wt%	0.005
SD12	2	Pacific sanddab	Liver	Manganese	0.61		mg/kg	0.23
SD12	2	Pacific sanddab	Liver	o,p-DDE	7.3	E	ug/kg	
SD12	2	Pacific sanddab	Liver	o,p-DDT	3.6	E	ug/kg	
SD12	2	Pacific sanddab	Liver	p,p-DDD	7	E	ug/kg	
SD12	2	Pacific sanddab	Liver	p,p-DDE	650		ug/kg	13.3
SD12	2	Pacific sanddab	Muscle	p,p-DDE	2.3		ug/kg	1.33
SD12	2	Pacific sanddab	Liver	p,p-DDT	20		ug/kg	13.3
SD12	2	Pacific sanddab	Liver	PCB 101	12	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 105	9.4	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 110	12	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 118	34		ug/kg	13.3
SD12	2	Pacific sanddab	Liver	PCB 123	3.1	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 128	8.7	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 138	48		ug/kg	13.3
SD12	2	Pacific sanddab	Muscle	PCB 138	0.05		ug/kg	1.33
SD12	2	Pacific sanddab	Liver	PCB 149	7.3	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 151	7.3	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 153/168	68		ug/kg	13.3
SD12	2	Pacific sanddab	Muscle	PCB 153/168	0.1		ug/kg	1.33
SD12	2	Pacific sanddab	Liver	PCB 156	5.1	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 158	3.5	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 167	2.4	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 177	4.1	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 180	35		ug/kg	13.3
SD12	2	Pacific sanddab	Liver	PCB 183	7.9	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 187	23		ug/kg	13.3
SD12	2	Pacific sanddab	Liver	PCB 194	7.6	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 206	5.3	E	ug/kg	
SD12	2	Pacific sanddab	Muscle	PCB 206	0.15		ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 66	3.3	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 70	3.6	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 74	3	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 87	4.6	E	ug/kg	
SD12	2	Pacific sanddab	Liver	PCB 99	21		ug/kg	13.3
SD12	2	Pacific sanddab	Liver	Selenium	1		mg/kg	0.13
SD12	2	Pacific sanddab	Muscle	Selenium	0.25		mg/kg	0.13
SD12	2	Pacific sanddab	Liver	Total Solids	42.7		wt%	0.4
SD12	2	Pacific sanddab	Muscle	Total Solids	19.3		wt%	0.4

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD12	2	Pacific sanddab	Liver	Trans Nonachlor	16	E	ug/kg	
SD12	2	Pacific sanddab	Liver	Zinc	21.8		mg/kg	0.58
SD12	2	Pacific sanddab	Muscle	Zinc	2.85		mg/kg	0.58
SD12	3	Ca. scorpionfish	Liver	Alpha (cis) Chlordane	9.9	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	Aluminum	3.48		mg/kg	2.6
SD12	3	Ca. scorpionfish	Muscle	Aluminum	7.8		mg/kg	2.6
SD12	3	Ca. scorpionfish	Muscle	Arsenic	4.1		mg/kg	1.4
SD12	3	Ca. scorpionfish	Liver	Cadmium	1.08		mg/kg	0.34
SD12	3	Ca. scorpionfish	Liver	Copper	16.4		mg/kg	0.76
SD12	3	Ca. scorpionfish	Liver	Hexachlorobenzene	1.8	E	ug/kg	
SD12	3	Ca. scorpionfish	Muscle	Hexachlorobenzene	0.1	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	Iron	108		mg/kg	1.3
SD12	3	Ca. scorpionfish	Muscle	Iron	1.7		mg/kg	1.3
SD12	3	Ca. scorpionfish	Liver	Lipids	30.9		wt%	0.005
SD12	3	Ca. scorpionfish	Muscle	Lipids	0.96		wt%	0.005
SD12	3	Ca. scorpionfish	Liver	Mercury	0.078		mg/kg	0.03
SD12	3	Ca. scorpionfish	Muscle	Mercury	0.359		mg/kg	0.03
SD12	3	Ca. scorpionfish	Liver	o,p-DDE	180		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	o,p-DDE	11		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	p,p-DDD	270		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	p,p-DDD	14		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	p,p-DDE	14600		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	p,p-DDE	800		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	p,p-DDT	29		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	p,p-DDT	1.7		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	PCB 101	80		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 101	4.2		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	PCB 105	45		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 105	2.4		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	PCB 110	57		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 110	2.7		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	PCB 118	150		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 118	7.4		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	PCB 119	4.3	E	ug/kg	
SD12	3	Ca. scorpionfish	Muscle	PCB 119	0.2	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 123	12	E	ug/kg	
SD12	3	Ca. scorpionfish	Muscle	PCB 123	0.7	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 128	20		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 128	1.1	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 138	110		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 138	5.1		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	PCB 149	23		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 149	1.2	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 151	14		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 151	0.8	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 153/168	140		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 153/168	7.3		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	PCB 156	13	E	ug/kg	
SD12	3	Ca. scorpionfish	Muscle	PCB 156	0.6	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 157	3.1	E	ug/kg	
SD12	3	Ca. scorpionfish	Muscle	PCB 157	0.1	E	ug/kg	

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD12	3	Ca. scorpionfish	Liver	PCB 158	11	E	ug/kg	
SD12	3	Ca. scorpionfish	Muscle	PCB 158	0.6	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 167	5.9	E	ug/kg	
SD12	3	Ca. scorpionfish	Muscle	PCB 167	0.3	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 170	19		ug/kg	13.3
SD12	3	Ca. scorpionfish	Liver	PCB 177	12	E	ug/kg	
SD12	3	Ca. scorpionfish	Muscle	PCB 177	0.7	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 180	58		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 180	2.9		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	PCB 183	17		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 183	0.8	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 187	42		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 187	2.3		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	PCB 194	9.3	E	ug/kg	
SD12	3	Ca. scorpionfish	Muscle	PCB 194	0.5	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 201	14		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 201	0.7	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 206	4.7	E	ug/kg	
SD12	3	Ca. scorpionfish	Muscle	PCB 206	0.3	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 28	3.8	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 44	9.5	E	ug/kg	
SD12	3	Ca. scorpionfish	Muscle	PCB 44	0.6	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 49	17		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 49	0.8	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 52	26		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 52	1.5		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	PCB 66	50		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 66	2.5		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	PCB 70	4.7	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 74	35		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 74	2		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	PCB 87	25		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 87	1.2	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	PCB 99	69		ug/kg	13.3
SD12	3	Ca. scorpionfish	Muscle	PCB 99	3.8		ug/kg	1.33
SD12	3	Ca. scorpionfish	Liver	Selenium	0.77		mg/kg	0.13
SD12	3	Ca. scorpionfish	Muscle	Selenium	0.37		mg/kg	0.13
SD12	3	Ca. scorpionfish	Liver	Total Solids	54.1		wt%	0.4
SD12	3	Ca. scorpionfish	Muscle	Total Solids	24.1		wt%	0.4
SD12	3	Ca. scorpionfish	Liver	Trans Nonachlor	22		ug/kg	20
SD12	3	Ca. scorpionfish	Muscle	Trans Nonachlor	1.2	E	ug/kg	
SD12	3	Ca. scorpionfish	Liver	Zinc	75		mg/kg	0.58
SD12	3	Ca. scorpionfish	Muscle	Zinc	3.55		mg/kg	0.58
SD13	1	Longfin sanddab	Liver	Aluminum	4.6		mg/kg	2.6
SD13	1	Longfin sanddab	Liver	Arsenic	6.9		mg/kg	1.4
SD13	1	Longfin sanddab	Muscle	Arsenic	10.6		mg/kg	1.4
SD13	1	Longfin sanddab	Liver	Cadmium	0.37		mg/kg	0.34
SD13	1	Longfin sanddab	Liver	Copper	13.9		mg/kg	0.76
SD13	1	Longfin sanddab	Liver	Hexachlorobenzene	5.2	E	ug/kg	
SD13	1	Longfin sanddab	Muscle	Hexachlorobenzene	0.1	E	ug/kg	
SD13	1	Longfin sanddab	Liver	Iron	173		mg/kg	1.3

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD13	1	Longfin sanddab	Liver	Lipids	23.7		wt%	0.005
SD13	1	Longfin sanddab	Muscle	Lipids	0.46		wt%	0.005
SD13	1	Longfin sanddab	Liver	Manganese	1.09		mg/kg	0.23
SD13	1	Longfin sanddab	Liver	Mercury	0.054		mg/kg	0.03
SD13	1	Longfin sanddab	Muscle	Mercury	0.081		mg/kg	0.03
SD13	1	Longfin sanddab	Liver	o,p-DDE	16		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	p,p-DDD	6.2	E	ug/kg	
SD13	1	Longfin sanddab	Liver	p,p-DDE	800		ug/kg	13.3
SD13	1	Longfin sanddab	Muscle	p,p-DDE	2.2		ug/kg	1.33
SD13	1	Longfin sanddab	Liver	p,p-DDT	17		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 101	11	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 105	12	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 110	14		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 118	45		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 123	5.9	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 128	15		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 138	76		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 149	9.5	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 151	11	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 153/168	110		ug/kg	13.3
SD13	1	Longfin sanddab	Muscle	PCB 153/168	0.2	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 156	7.4	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 157	1.6	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 158	3.5	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 167	3.4	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 170	24		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 177	10	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 180	54		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 183	16		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 187	48		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 194	14		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 201	17		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 206	10	E	ug/kg	
SD13	1	Longfin sanddab	Muscle	PCB 206	0.1	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 52	2.6	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 66	3.5	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 74	2.5	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 87	3.4	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 99	28		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	Selenium	2.34		mg/kg	0.26
SD13	1	Longfin sanddab	Muscle	Selenium	0.51		mg/kg	0.13
SD13	1	Longfin sanddab	Liver	Total Solids	33.6		wt%	0.4
SD13	1	Longfin sanddab	Muscle	Total Solids	18.5		wt%	0.4
SD13	1	Longfin sanddab	Liver	Trans Nonachlor	11	E	ug/kg	
SD13	1	Longfin sanddab	Liver	Zinc	24.1		mg/kg	0.58
SD13	1	Longfin sanddab	Muscle	Zinc	2.57		mg/kg	0.58
SD13	2	Pacific sanddab	Liver	Aluminum	4.1		mg/kg	2.6
SD13	2	Pacific sanddab	Muscle	Aluminum	6.8		mg/kg	2.6
SD13	2	Pacific sanddab	Liver	Arsenic	1.6		mg/kg	1.4
SD13	2	Pacific sanddab	Muscle	Arsenic	6.5		mg/kg	1.4
SD13	2	Pacific sanddab	Liver	Cadmium	3.23		mg/kg	0.34

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD13	2	Pacific sanddab	Liver	Copper	16.1		mg/kg	0.76
SD13	2	Pacific sanddab	Liver	Hexachlorobenzene	2.1	E	ug/kg	
SD13	2	Pacific sanddab	Liver	Iron	74.1		mg/kg	1.3
SD13	2	Pacific sanddab	Muscle	Iron	6.2		mg/kg	1.3
SD13	2	Pacific sanddab	Liver	Lipids	26.5		wt%	0.005
SD13	2	Pacific sanddab	Muscle	Lipids	0.28		wt%	0.005
SD13	2	Pacific sanddab	Liver	Manganese	0.64		mg/kg	0.23
SD13	2	Pacific sanddab	Liver	Mercury	0.031		mg/kg	0.03
SD13	2	Pacific sanddab	Muscle	Mercury	0.045		mg/kg	0.03
SD13	2	Pacific sanddab	Liver	o,p-DDE	3.9	E	ug/kg	
SD13	2	Pacific sanddab	Liver	p,p-DDD	5.4	E	ug/kg	
SD13	2	Pacific sanddab	Liver	p,p-DDE	320		ug/kg	13.3
SD13	2	Pacific sanddab	Muscle	p,p-DDE	1.9		ug/kg	1.33
SD13	2	Pacific sanddab	Liver	p,p-DDT	15		ug/kg	13.3
SD13	2	Pacific sanddab	Liver	PCB 101	4.5	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 105	2	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 110	3.7	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 118	10	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 138	15		ug/kg	13.3
SD13	2	Pacific sanddab	Liver	PCB 149	2	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 151	2.8	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 153/168	22		ug/kg	13.3
SD13	2	Pacific sanddab	Liver	PCB 156	1.2	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 158	0.6	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 180	9.8	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 183	3.8	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 187	8.3	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 194	2.1	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 206	2.4	E	ug/kg	
SD13	2	Pacific sanddab	Muscle	PCB 206	0.2	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 66	1.9	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 74	1.1	E	ug/kg	
SD13	2	Pacific sanddab	Liver	PCB 99	6	E	ug/kg	
SD13	2	Pacific sanddab	Liver	Selenium	1.06		mg/kg	0.17
SD13	2	Pacific sanddab	Muscle	Selenium	0.19		mg/kg	0.13
SD13	2	Pacific sanddab	Liver	Total Solids	47.3		wt%	0.4
SD13	2	Pacific sanddab	Muscle	Total Solids	17.8		wt%	0.4
SD13	2	Pacific sanddab	Liver	Zinc	25.9		mg/kg	0.58
SD13	2	Pacific sanddab	Muscle	Zinc	3.63		mg/kg	0.58
SD13	3	Ca. scorpionfish	Liver	Aluminum	21.4		mg/kg	2.6
SD13	3	Ca. scorpionfish	Liver	Arsenic	3.15		mg/kg	1.4
SD13	3	Ca. scorpionfish	Muscle	Arsenic	10		mg/kg	1.4
SD13	3	Ca. scorpionfish	Muscle	BHC, Beta isomer	1.4		ug/kg	1.33
SD13	3	Ca. scorpionfish	Liver	Cadmium	3.48		mg/kg	0.34
SD13	3	Ca. scorpionfish	Liver	Chromium	0.158		mg/kg	0.3
SD13	3	Ca. scorpionfish	Liver	Copper	14.3		mg/kg	0.76
SD13	3	Ca. scorpionfish	Muscle	Dieldrin	1.39		ug/kg	1.33
SD13	3	Ca. scorpionfish	Muscle	Endrin	2.09		ug/kg	1.33
SD13	3	Ca. scorpionfish	Muscle	Gamma (trans) Chlordane	1	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	Hexachlorobenzene	1.5	E	ug/kg	
SD13	3	Ca. scorpionfish	Muscle	Hexachlorobenzene	0.2	E	ug/kg	

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD13	3	Ca. scorpionfish	Liver	Iron	74.7		mg/kg	1.3
SD13	3	Ca. scorpionfish	Muscle	Iron	3.6		mg/kg	1.3
SD13	3	Ca. scorpionfish	Liver	Lipids	20.8		wt%	0.005
SD13	3	Ca. scorpionfish	Muscle	Lipids	0.83		wt%	0.005
SD13	3	Ca. scorpionfish	Liver	Mercury	0.419		mg/kg	0.03
SD13	3	Ca. scorpionfish	Muscle	Mercury	0.378		mg/kg	0.03
SD13	3	Ca. scorpionfish	Liver	o,p-DDE	2.7	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	p,p-DDD	7.3	E	ug/kg	
SD13	3	Ca. scorpionfish	Muscle	p,p-DDD	0.7	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	p,p-DDE	660		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	p,p-DDE	11		ug/kg	1.33
SD13	3	Ca. scorpionfish	Liver	p,p-DDT	5.9	E	ug/kg	
SD13	3	Ca. scorpionfish	Muscle	p,p-DDT	0.5	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 101	11	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 105	5.2	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 110	7.7	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 118	23		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	PCB 118	0.3	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 123	2.5	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 128	6.3	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 138	32		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	PCB 138	0.4	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 149	4.5	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 151	4.9	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 153/168	44		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	PCB 153/168	0.6	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 156	2.9	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 158	1.8	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 167	1.6	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 177	3.9	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 180	21		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	PCB 180	0.3	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 183	5.9	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 187	18		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	PCB 187	0.2	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 194	4	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 206	3.4	E	ug/kg	
SD13	3	Ca. scorpionfish	Muscle	PCB 206	0.2	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 66	2.7	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 74	2.2	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 87	3.2	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 99	11	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	Selenium	0.98		mg/kg	0.17
SD13	3	Ca. scorpionfish	Muscle	Selenium	0.22		mg/kg	0.13
SD13	3	Ca. scorpionfish	Liver	Total Solids	41.5		wt%	0.4
SD13	3	Ca. scorpionfish	Muscle	Total Solids	21.1		wt%	0.4
SD13	3	Ca. scorpionfish	Liver	Trans Nonachlor	9.4	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	Zinc	86.2		mg/kg	0.58
SD13	3	Ca. scorpionfish	Muscle	Zinc	3.55		mg/kg	0.58
SD14	1	Pacific sanddab	Liver	Aluminum	4.3		mg/kg	2.6
SD14	1	Pacific sanddab	Muscle	Aluminum	6.2		mg/kg	2.6

Appendix D.3 continued

April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD14	1	Pacific sanddab	Muscle	Arsenic	2.4		mg/kg	1.4
SD14	1	Pacific sanddab	Liver	Copper	6.22		mg/kg	0.76
SD14	1	Pacific sanddab	Liver	Hexachlorobenzene	1.7	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	Hexachlorobenzene	0.3	E	ug/kg	
SD14	1	Pacific sanddab	Liver	Iron	126		mg/kg	1.3
SD14	1	Pacific sanddab	Muscle	Iron	2		mg/kg	1.3
SD14	1	Pacific sanddab	Liver	Lipids	30		wt%	0.005
SD14	1	Pacific sanddab	Muscle	Lipids	0.87		wt%	0.005
SD14	1	Pacific sanddab	Liver	Manganese	0.88		mg/kg	0.23
SD14	1	Pacific sanddab	Liver	Mercury	0.064		mg/kg	0.03
SD14	1	Pacific sanddab	Liver	p,p-DDD	4.6	E	ug/kg	
SD14	1	Pacific sanddab	Liver	p,p-DDE	260		ug/kg	13.3
SD14	1	Pacific sanddab	Muscle	p,p-DDE	0.7	E	ug/kg	
SD14	1	Pacific sanddab	Liver	p,p-DDT	8.4	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 101	5.3	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 101	0.5	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 105	1.5	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 105	0.5	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 110	3	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 110	0.4	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 114	0.5	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 118	7.9	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 118	0.5	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 119	0.4	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 123	0.6	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 126	0.5	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 128	2.3	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 128	0.5	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 138	10	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 138	0.6	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 149	2.3	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 149	0.6	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 151	1.9	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 151	0.5	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 153/168	15		ug/kg	13.3
SD14	1	Pacific sanddab	Muscle	PCB 153/168	1.1	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 156	0.5	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 157	0.4	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 158	0.5	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 167	0.5	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 177	0.4	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 18	0.1	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 180	6.9	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 180	0.6	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 183	1.8	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 183	0.6	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 187	6.3	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 187	0.6	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 189	0.4	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 194	1.8	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 194	0.4	E	ug/kg	

Appendix D.3 continued

April 2002

Station	Rep	Species	Tissue	Parameter	Value	Units	MDL
SD14	1	Pacific sanddab	Liver	PCB 206	2 E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 206	0.4 E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 37	0.5 E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 44	0.3 E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 66	0.4 E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 70	0.4 E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 74	0.4 E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 87	0.5 E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 99	6.1 E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 99	0.5 E	ug/kg	
SD14	1	Pacific sanddab	Liver	Selenium	1.14	mg/kg	0.17
SD14	1	Pacific sanddab	Muscle	Selenium	0.18	mg/kg	0.13
SD14	1	Pacific sanddab	Liver	Total Solids	46.2	wt%	0.4
SD14	1	Pacific sanddab	Muscle	Total Solids	18.9	wt%	0.4
SD14	1	Pacific sanddab	Liver	Zinc	24	mg/kg	0.58
SD14	1	Pacific sanddab	Muscle	Zinc	2.8	mg/kg	0.58
SD14	2	Pacific sanddab	Liver	Aluminum	4.7	mg/kg	2.6
SD14	2	Pacific sanddab	Muscle	Aluminum	7.7	mg/kg	2.6
SD14	2	Pacific sanddab	Liver	Arsenic	3.7	mg/kg	1.4
SD14	2	Pacific sanddab	Muscle	Arsenic	4.6	mg/kg	1.4
SD14	2	Pacific sanddab	Liver	Cadmium	2.01	mg/kg	0.34
SD14	2	Pacific sanddab	Liver	Copper	14.2	mg/kg	0.76
SD14	2	Pacific sanddab	Liver	Hexachlorobenzene	2.3 E	ug/kg	
SD14	2	Pacific sanddab	Muscle	Hexachlorobenzene	0.2 E	ug/kg	
SD14	2	Pacific sanddab	Liver	Iron	78.5	mg/kg	1.3
SD14	2	Pacific sanddab	Muscle	Iron	2.2	mg/kg	1.3
SD14	2	Pacific sanddab	Liver	Lipids	27.2	wt%	0.005
SD14	2	Pacific sanddab	Muscle	Lipids	0.39	wt%	0.005
SD14	2	Pacific sanddab	Liver	Manganese	0.76	mg/kg	0.23
SD14	2	Pacific sanddab	Liver	Mercury	0.0195	mg/kg	0.03
SD14	2	Pacific sanddab	Liver	o,p-DDE	5.7 E	ug/kg	
SD14	2	Pacific sanddab	Liver	p,p-DDD	4.8 E	ug/kg	
SD14	2	Pacific sanddab	Liver	p,p-DDE	270	ug/kg	13.3
SD14	2	Pacific sanddab	Muscle	p,p-DDE	1.2 E	ug/kg	
SD14	2	Pacific sanddab	Liver	p,p-DDT	12 E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 101	4.2 E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 105	2.6 E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 110	3.6 E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 118	7.8 E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 138	11 E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 149	2.4 E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 151	1.6 E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 153/168	15	ug/kg	13.3
SD14	2	Pacific sanddab	Liver	PCB 180	6.6 E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 183	1.5 E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 187	6.2 E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 206	2.1 E	ug/kg	
SD14	2	Pacific sanddab	Muscle	PCB 206	0.2 E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 66	1.6 E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 70	2.1 E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 74	1.1 E	ug/kg	

Appendix D.3 continued

April 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD14	2	Pacific sanddab	Liver	PCB 99	5.9	E	ug/kg	
SD14	2	Pacific sanddab	Liver	Selenium	1.13		mg/kg	0.17
SD14	2	Pacific sanddab	Muscle	Selenium	0.19		mg/kg	0.13
SD14	2	Pacific sanddab	Liver	Total Solids	48.2		wt%	0.4
SD14	2	Pacific sanddab	Muscle	Total Solids	19		wt%	0.4
SD14	2	Pacific sanddab	Liver	Zinc	26.8		mg/kg	0.58
SD14	2	Pacific sanddab	Muscle	Zinc	2.99		mg/kg	0.58
SD14	3	Ca. scorpionfish	Muscle	Aluminum	3.7		mg/kg	2.6
SD14	3	Ca. scorpionfish	Muscle	Arsenic	2.6		mg/kg	1.4
SD14	3	Ca. scorpionfish	Liver	Copper	19.6		mg/kg	0.76
SD14	3	Ca. scorpionfish	Liver	Hexachlorobenzene	1.25		ug/kg	
SD14	3	Ca. scorpionfish	Muscle	Hexachlorobenzene	0.3	E	ug/kg	
SD14	3	Ca. scorpionfish	Liver	Iron	76.3		mg/kg	1.3
SD14	3	Ca. scorpionfish	Muscle	Iron	2.3		mg/kg	1.3
SD14	3	Ca. scorpionfish	Liver	Lipids	25.9		wt%	0.005
SD14	3	Ca. scorpionfish	Muscle	Lipids	1.08		wt%	0.005
SD14	3	Ca. scorpionfish	Liver	Manganese	0.42		mg/kg	0.23
SD14	3	Ca. scorpionfish	Liver	Mercury	0.035		mg/kg	0.03
SD14	3	Ca. scorpionfish	Muscle	Mercury	0.279		mg/kg	0.03
SD14	3	Ca. scorpionfish	Liver	o,p-DDE	2.2		ug/kg	
SD14	3	Ca. scorpionfish	Liver	p,p-DDD	6.7		ug/kg	
SD14	3	Ca. scorpionfish	Liver	p,p-DDE	385		ug/kg	13.3
SD14	3	Ca. scorpionfish	Muscle	p,p-DDE	6.5		ug/kg	1.33
SD14	3	Ca. scorpionfish	Liver	p,p-DDT	3.15		ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 101	9.8		ug/kg	
SD14	3	Ca. scorpionfish	Muscle	PCB 101	0.1	E	ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 105	2.95		ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 110	4.35		ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 118	13	E	ug/kg	
SD14	3	Ca. scorpionfish	Muscle	PCB 118	0.2	E	ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 123	1.9	E	ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 128	2.55		ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 138	15		ug/kg	13.3
SD14	3	Ca. scorpionfish	Muscle	PCB 138	0.2	E	ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 149	4.25		ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 151	3.05		ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 153/168	25.5		ug/kg	13.3
SD14	3	Ca. scorpionfish	Muscle	PCB 153/168	0.5	E	ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 158	1.05		ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 167	0.55		ug/kg	13.3
SD14	3	Ca. scorpionfish	Liver	PCB 177	2.3		ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 180	10.5		ug/kg	
SD14	3	Ca. scorpionfish	Muscle	PCB 180	0.2	E	ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 183	3.2		ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 187	10	E	ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 194	2.05		ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 206	2.4		ug/kg	
SD14	3	Ca. scorpionfish	Muscle	PCB 206	0.2	E	ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 49	2.6	E	ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 52	4.2		ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 66	2.45		ug/kg	

Appendix D.3 continued
April 2002

Station	Rep	Species	Tissue	Parameter	Value	Units	MDL
SD14	3	Ca. scorpionfish	Liver	PCB 74	1.5	ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 87	2.15	ug/kg	
SD14	3	Ca. scorpionfish	Liver	PCB 99	6.55	ug/kg	
SD14	3	Ca. scorpionfish	Liver	Selenium	0.675	mg/kg	0.17
SD14	3	Ca. scorpionfish	Muscle	Selenium	0.28	mg/kg	0.13
SD14	3	Ca. scorpionfish	Liver	Total Solids	46.7	wt%	0.4
SD14	3	Ca. scorpionfish	Muscle	Total Solids	22	wt%	0.4
SD14	3	Ca. scorpionfish	Liver	Trans Nonachlor	8.45	ug/kg	
SD14	3	Ca. scorpionfish	Liver	Zinc	67.5	mg/kg	0.58
SD14	3	Ca. scorpionfish	Muscle	Zinc	4.26	mg/kg	0.58

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
RF1	1	Copper rockfish	Liver	Alpha (cis) Chlordane	8.75		ug/kg	
RF1	1	Copper rockfish	Liver	Arsenic	5.2		mg/kg	1.4
RF1	1	Copper rockfish	Liver	Cadmium	2.83		mg/kg	0.34
RF1	1	Copper rockfish	Liver	Copper	6.52		mg/kg	0.76
RF1	1	Copper rockfish	Liver	Hexachlorobenzene	4.1	E	ug/kg	
RF1	1	Copper rockfish	Muscle	Hexachlorobenzene	0.2	E	ug/kg	
RF1	1	Copper rockfish	Liver	Iron	8.2		mg/kg	1.3
RF1	1	Copper rockfish	Liver	Lipids	21.4		wt%	0.005
RF1	1	Copper rockfish	Muscle	Lipids	1.09		wt%	0.005
RF1	1	Copper rockfish	Liver	Manganese	0.41		mg/kg	0.23
RF1	1	Copper rockfish	Liver	Mercury	0.878		mg/kg	0.03
RF1	1	Copper rockfish	Muscle	Mercury	0.389		mg/kg	0.03
RF1	1	Copper rockfish	Liver	o,p-DDE	9.4		ug/kg	
RF1	1	Copper rockfish	Muscle	o,p-DDE	0.4	E	ug/kg	
RF1	1	Copper rockfish	Liver	p,p-DDD	14		ug/kg	13.3
RF1	1	Copper rockfish	Muscle	p,p-DDD	0.6	E	ug/kg	
RF1	1	Copper rockfish	Liver	p,p-DDE	530		ug/kg	13.3
RF1	1	Copper rockfish	Muscle	p,p-DDE	25		ug/kg	1.33
RF1	1	Copper rockfish	Liver	p,p-DDT	21		ug/kg	13.3
RF1	1	Copper rockfish	Muscle	p,p-DDT	0.8	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 101	23		ug/kg	13.3
RF1	1	Copper rockfish	Muscle	PCB 101	0.9	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 105	11	E	ug/kg	
RF1	1	Copper rockfish	Muscle	PCB 105	0.5	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 110	14.5		ug/kg	13.3
RF1	1	Copper rockfish	Muscle	PCB 110	0.7	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 118	32.5		ug/kg	13.3
RF1	1	Copper rockfish	Muscle	PCB 118	1.3	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 119	1.05		ug/kg	
RF1	1	Copper rockfish	Liver	PCB 123	3.3	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 128	8.4	E	ug/kg	
RF1	1	Copper rockfish	Muscle	PCB 128	0.3	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 138	44.5		ug/kg	13.3
RF1	1	Copper rockfish	Muscle	PCB 138	1.7		ug/kg	1.33
RF1	1	Copper rockfish	Liver	PCB 149	19.5		ug/kg	13.3
RF1	1	Copper rockfish	Muscle	PCB 149	0.9	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 151	7.25		ug/kg	
RF1	1	Copper rockfish	Muscle	PCB 151	0.3	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 153/168	70		ug/kg	13.3
RF1	1	Copper rockfish	Muscle	PCB 153/168	2.7		ug/kg	1.33
RF1	1	Copper rockfish	Muscle	PCB 156	0.2	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 158	3.7		ug/kg	
RF1	1	Copper rockfish	Muscle	PCB 158	0.1	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 167	2.45		ug/kg	
RF1	1	Copper rockfish	Liver	PCB 177	3.95		ug/kg	
RF1	1	Copper rockfish	Muscle	PCB 177	0.3	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 180	39		ug/kg	13.3
RF1	1	Copper rockfish	Muscle	PCB 180	1.4		ug/kg	1.33
RF1	1	Copper rockfish	Liver	PCB 183	10.5		ug/kg	

Appendix D.3 continued

October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
RF1	1	Copper rockfish	Muscle	PCB 183	0.4	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 187	32		ug/kg	13.3
RF1	1	Copper rockfish	Muscle	PCB 187	1.2	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 194	14.5		ug/kg	13.3
RF1	1	Copper rockfish	Muscle	PCB 194	0.5	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 206	10.5		ug/kg	
RF1	1	Copper rockfish	Muscle	PCB 206	0.3	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 28	1.55		ug/kg	
RF1	1	Copper rockfish	Liver	PCB 44	1.05		ug/kg	13.3
RF1	1	Copper rockfish	Liver	PCB 49	3.35		ug/kg	
RF1	1	Copper rockfish	Liver	PCB 52	4.6		ug/kg	
RF1	1	Copper rockfish	Liver	PCB 66	5.25		ug/kg	
RF1	1	Copper rockfish	Liver	PCB 70	3.2	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 74	2.6		ug/kg	
RF1	1	Copper rockfish	Liver	PCB 87	5.55		ug/kg	
RF1	1	Copper rockfish	Muscle	PCB 87	0.2	E	ug/kg	
RF1	1	Copper rockfish	Liver	PCB 99	17.5		ug/kg	13.3
RF1	1	Copper rockfish	Muscle	PCB 99	0.8	E	ug/kg	
RF1	1	Copper rockfish	Liver	Selenium	1.75		mg/kg	0.06
RF1	1	Copper rockfish	Muscle	Selenium	0.471		mg/kg	0.06
RF1	1	Copper rockfish	Liver	Total Solids	47.7		wt%	0.4
RF1	1	Copper rockfish	Muscle	Total Solids	23.3		wt%	0.4
RF1	1	Copper rockfish	Liver	Trans Nonachlor	12.5		ug/kg	
RF1	1	Copper rockfish	Muscle	Trans Nonachlor	0.6	E	ug/kg	
RF1	1	Copper rockfish	Liver	Zinc	45.9		mg/kg	0.58
RF1	1	Copper rockfish	Muscle	Zinc	2.7		mg/kg	0.58
RF1	2	Copper rockfish	Liver	Alpha (cis) Chlordane	7.2	E	ug/kg	
RF1	2	Copper rockfish	Liver	Aluminum	3.2		mg/kg	2.6
RF1	2	Copper rockfish	Muscle	Arsenic	1.65		mg/kg	1.4
RF1	2	Copper rockfish	Liver	Cadmium	5.64		mg/kg	0.34
RF1	2	Copper rockfish	Liver	Copper	8.48		mg/kg	0.76
RF1	2	Copper rockfish	Muscle	Hexachlorobenzene	0.3	E	ug/kg	
RF1	2	Copper rockfish	Liver	Iron	34.8		mg/kg	1.3
RF1	2	Copper rockfish	Liver	Lipids	18.4		wt%	0.005
RF1	2	Copper rockfish	Muscle	Lipids	1.51		wt%	0.005
RF1	2	Copper rockfish	Liver	Manganese	0.77		mg/kg	0.23
RF1	2	Copper rockfish	Liver	Mercury	0.775		mg/kg	0.03
RF1	2	Copper rockfish	Muscle	Mercury	0.79		mg/kg	0.03
RF1	2	Copper rockfish	Liver	o,p-DDE	9.3	E	ug/kg	
RF1	2	Copper rockfish	Muscle	o,p-DDE	0.4	E	ug/kg	
RF1	2	Copper rockfish	Liver	p,p-DDD	13	E	ug/kg	
RF1	2	Copper rockfish	Muscle	p,p-DDD	0.6	E	ug/kg	
RF1	2	Copper rockfish	Liver	p,p-DDE	1100		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	p,p-DDE	49		ug/kg	1.33
RF1	2	Copper rockfish	Liver	p,p-DDT	28		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	p,p-DDT	1.1		ug/kg	
RF1	2	Copper rockfish	Liver	PCB 101	30		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 101	1.4		ug/kg	1.33
RF1	2	Copper rockfish	Liver	PCB 105	19		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 105	0.8	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 110	20		ug/kg	13.3

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
RF1	2	Copper rockfish	Muscle	PCB 110	0.85		ug/kg	
RF1	2	Copper rockfish	Liver	PCB 118	54		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 118	2.25		ug/kg	1.33
RF1	2	Copper rockfish	Liver	PCB 119	1.2	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 123	5.3	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 123	0.2	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 128	13	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 128	0.6	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 138	73		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 138	3.05		ug/kg	1.33
RF1	2	Copper rockfish	Liver	PCB 149	24		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 149	1.15		ug/kg	
RF1	2	Copper rockfish	Liver	PCB 151	8.5	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 151	0.45		ug/kg	
RF1	2	Copper rockfish	Liver	PCB 153/168	110		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 153/168	5		ug/kg	1.33
RF1	2	Copper rockfish	Liver	PCB 156	8.4	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 156	0.4	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 158	5.6	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 158	0.25		ug/kg	
RF1	2	Copper rockfish	Liver	PCB 167	4.4	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 167	0.2	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 177	6.7	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 177	0.4	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 180	54		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 180	2.6		ug/kg	1.33
RF1	2	Copper rockfish	Liver	PCB 183	15		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 183	0.7	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 187	45		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 187	2		ug/kg	1.33
RF1	2	Copper rockfish	Liver	PCB 194	17		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 194	0.75		ug/kg	
RF1	2	Copper rockfish	Liver	PCB 206	9.3	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 206	0.45		ug/kg	
RF1	2	Copper rockfish	Liver	PCB 28	1.5	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 49	3.3	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 52	4.5	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 66	5.5	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 66	0.15		ug/kg	1.33
RF1	2	Copper rockfish	Liver	PCB 70	3.5	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 74	3.8	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 74	0.1		ug/kg	1.33
RF1	2	Copper rockfish	Liver	PCB 87	7.6	E	ug/kg	
RF1	2	Copper rockfish	Muscle	PCB 87	0.4	E	ug/kg	
RF1	2	Copper rockfish	Liver	PCB 99	26		ug/kg	13.3
RF1	2	Copper rockfish	Muscle	PCB 99	1.25		ug/kg	
RF1	2	Copper rockfish	Liver	Selenium	1.93		mg/kg	0.06
RF1	2	Copper rockfish	Muscle	Selenium	0.442		mg/kg	0.06
RF1	2	Copper rockfish	Liver	Total Solids	40.8		wt%	0.4
RF1	2	Copper rockfish	Muscle	Total Solids	23.5		wt%	0.4
RF1	2	Copper rockfish	Liver	Trans Nonachlor	15	E	ug/kg	

Appendix D.3 continued

October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
RF1	2	Copper rockfish	Muscle	Trans Nonachlor	0.75		ug/kg	
RF1	2	Copper rockfish	Liver	Zinc	55.2		mg/kg	0.58
RF1	2	Copper rockfish	Muscle	Zinc	2.01		mg/kg	0.58
RF1	3	Mixed rockfish	Muscle	Alpha (cis) Chlordane	0.5	E	ug/kg	
RF1	3	Mixed rockfish	Liver	Aluminum	3.5		mg/kg	2.6
RF1	3	Mixed rockfish	Liver	Cadmium	0.85		mg/kg	0.34
RF1	3	Mixed rockfish	Liver	Copper	8.82		mg/kg	0.76
RF1	3	Mixed rockfish	Muscle	Copper	8.96		mg/kg	0.76
RF1	3	Mixed rockfish	Liver	Hexachlorobenzene	2.1	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	Hexachlorobenzene	0.3	E	ug/kg	
RF1	3	Mixed rockfish	Liver	Iron	56		mg/kg	1.3
RF1	3	Mixed rockfish	Muscle	Iron	3.7		mg/kg	1.3
RF1	3	Mixed rockfish	Liver	Lipids	15.9		wt%	0.005
RF1	3	Mixed rockfish	Muscle	Lipids	1.61		wt%	0.005
RF1	3	Mixed rockfish	Liver	Manganese	0.84		mg/kg	0.23
RF1	3	Mixed rockfish	Liver	Mercury	0.212		mg/kg	0.03
RF1	3	Mixed rockfish	Muscle	Mercury	0.595		mg/kg	0.03
RF1	3	Mixed rockfish	Liver	o,p-DDE	22		ug/kg	13.3
RF1	3	Mixed rockfish	Muscle	o,p-DDE	0.7	E	ug/kg	
RF1	3	Mixed rockfish	Liver	p,p-DDD	11	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	p,p-DDD	0.6	E	ug/kg	
RF1	3	Mixed rockfish	Liver	p,p-DDE	1300		ug/kg	13.3
RF1	3	Mixed rockfish	Muscle	p,p-DDE	40		ug/kg	1.33
RF1	3	Mixed rockfish	Liver	p,p-DDT	23		ug/kg	13.3
RF1	3	Mixed rockfish	Muscle	p,p-DDT	1.2	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 101	20		ug/kg	13.3
RF1	3	Mixed rockfish	Muscle	PCB 101	1.2	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 105	11	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	PCB 105	0.6	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 110	11	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	PCB 110	0.8	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 118	32		ug/kg	13.3
RF1	3	Mixed rockfish	Muscle	PCB 118	1.7		ug/kg	1.33
RF1	3	Mixed rockfish	Liver	PCB 123	2.6	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	PCB 123	0.2	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 128	7.2	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	PCB 128	0.4	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 138	43		ug/kg	13.3
RF1	3	Mixed rockfish	Muscle	PCB 138	2.2		ug/kg	1.33
RF1	3	Mixed rockfish	Liver	PCB 149	11	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	PCB 149	0.9	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 151	6.3	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	PCB 151	0.4	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 153/168	67		ug/kg	13.3
RF1	3	Mixed rockfish	Muscle	PCB 153/168	3.4		ug/kg	1.33
RF1	3	Mixed rockfish	Liver	PCB 156	4.3	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	PCB 156	0.3	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 158	4.3	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	PCB 158	0.2	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 167	2.1	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 177	2.8	E	ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
RF1	3	Mixed rockfish	Muscle	PCB 177	0.3	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 180	36		ug/kg	13.3
RF1	3	Mixed rockfish	Muscle	PCB 180	1.9		ug/kg	1.33
RF1	3	Mixed rockfish	Liver	PCB 183	9.5	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	PCB 183	0.5	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 187	24		ug/kg	13.3
RF1	3	Mixed rockfish	Muscle	PCB 187	1.4		ug/kg	1.33
RF1	3	Mixed rockfish	Liver	PCB 194	12	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	PCB 194	0.5	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 206	6.5	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	PCB 206	0.3	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 66	5.9	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	PCB 66	0.3	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 70	2.4	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 74	3.3	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 87	4.3	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	PCB 87	0.3	E	ug/kg	
RF1	3	Mixed rockfish	Liver	PCB 99	19		ug/kg	13.3
RF1	3	Mixed rockfish	Muscle	PCB 99	1	E	ug/kg	
RF1	3	Mixed rockfish	Liver	Selenium	1.92		mg/kg	0.06
RF1	3	Mixed rockfish	Muscle	Selenium	0.507		mg/kg	0.06
RF1	3	Mixed rockfish	Liver	Total Solids	41		wt%	0.4
RF1	3	Mixed rockfish	Muscle	Total Solids	23.9		wt%	0.4
RF1	3	Mixed rockfish	Liver	Trans Nonachlor	11	E	ug/kg	
RF1	3	Mixed rockfish	Muscle	Trans Nonachlor	0.5	E	ug/kg	
RF1	3	Mixed rockfish	Liver	Zinc	45.3		mg/kg	0.58
RF1	3	Mixed rockfish	Muscle	Zinc	4.65		mg/kg	0.58
RF2	1	Flag rockfish	Muscle	Arsenic	2.15		mg/kg	1.4
RF2	1	Flag rockfish	Liver	Cadmium	1.4		mg/kg	0.34
RF2	1	Flag rockfish	Liver	Copper	3.54		mg/kg	0.76
RF2	1	Flag rockfish	Muscle	Copper	1.2		mg/kg	0.76
RF2	1	Flag rockfish	Liver	Hexachlorobenzene	2	E	ug/kg	
RF2	1	Flag rockfish	Muscle	Hexachlorobenzene	0.4	E	ug/kg	
RF2	1	Flag rockfish	Liver	Iron	126		mg/kg	1.3
RF2	1	Flag rockfish	Muscle	Iron	6.4		mg/kg	1.3
RF2	1	Flag rockfish	Liver	Lipids	10.3		wt%	0.005
RF2	1	Flag rockfish	Muscle	Lipids	2.4		wt%	0.005
RF2	1	Flag rockfish	Liver	Mercury	1.16		mg/kg	0.03
RF2	1	Flag rockfish	Muscle	Mercury	0.648		mg/kg	0.03
RF2	1	Flag rockfish	Liver	o,p-DDE	4.9	E	ug/kg	
RF2	1	Flag rockfish	Muscle	o,p-DDE	0.6	E	ug/kg	
RF2	1	Flag rockfish	Liver	p,p-DDD	6	E	ug/kg	
RF2	1	Flag rockfish	Muscle	p,p-DDD	0.7	E	ug/kg	
RF2	1	Flag rockfish	Liver	p,p-DDE	590		ug/kg	13.3
RF2	1	Flag rockfish	Muscle	p,p-DDE	67		ug/kg	1.33
RF2	1	Flag rockfish	Liver	p,p-DDT	35		ug/kg	13.3
RF2	1	Flag rockfish	Muscle	p,p-DDT	2.7		ug/kg	1.33
RF2	1	Flag rockfish	Liver	PCB 101	15		ug/kg	13.3
RF2	1	Flag rockfish	Muscle	PCB 101	1.7		ug/kg	1.33
RF2	1	Flag rockfish	Liver	PCB 105	10	E	ug/kg	
RF2	1	Flag rockfish	Muscle	PCB 105	1	E	ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
RF2	1	Flag rockfish	Liver	PCB 110	4.4	E	ug/kg	
RF2	1	Flag rockfish	Muscle	PCB 110	0.5	E	ug/kg	
RF2	1	Flag rockfish	Liver	PCB 118	29		ug/kg	13.3
RF2	1	Flag rockfish	Muscle	PCB 118	2.6		ug/kg	1.33
RF2	1	Flag rockfish	Liver	PCB 123	2.5	E	ug/kg	
RF2	1	Flag rockfish	Muscle	PCB 123	0.3	E	ug/kg	
RF2	1	Flag rockfish	Liver	PCB 128	6	E	ug/kg	
RF2	1	Flag rockfish	Muscle	PCB 128	0.6	E	ug/kg	
RF2	1	Flag rockfish	Liver	PCB 138	45		ug/kg	13.3
RF2	1	Flag rockfish	Muscle	PCB 138	4.2		ug/kg	1.33
RF2	1	Flag rockfish	Liver	PCB 149	12	E	ug/kg	
RF2	1	Flag rockfish	Muscle	PCB 149	1.6		ug/kg	1.33
RF2	1	Flag rockfish	Liver	PCB 151	7	E	ug/kg	
RF2	1	Flag rockfish	Muscle	PCB 151	0.7	E	ug/kg	
RF2	1	Flag rockfish	Liver	PCB 153/168	70		ug/kg	13.3
RF2	1	Flag rockfish	Muscle	PCB 153/168	7.1		ug/kg	1.33
RF2	1	Flag rockfish	Liver	PCB 156	5.2	E	ug/kg	
RF2	1	Flag rockfish	Muscle	PCB 156	0.6	E	ug/kg	
RF2	1	Flag rockfish	Muscle	PCB 157	0.2	E	ug/kg	
RF2	1	Flag rockfish	Liver	PCB 158	3.4	E	ug/kg	
RF2	1	Flag rockfish	Muscle	PCB 158	0.3	E	ug/kg	
RF2	1	Flag rockfish	Liver	PCB 167	2.3	E	ug/kg	
RF2	1	Flag rockfish	Muscle	PCB 167	0.2	E	ug/kg	
RF2	1	Flag rockfish	Liver	PCB 177	2.8	E	ug/kg	
RF2	1	Flag rockfish	Muscle	PCB 177	0.6	E	ug/kg	
RF2	1	Flag rockfish	Liver	PCB 180	40		ug/kg	13.3
RF2	1	Flag rockfish	Muscle	PCB 180	4		ug/kg	1.33
RF2	1	Flag rockfish	Liver	PCB 183	11	E	ug/kg	
RF2	1	Flag rockfish	Muscle	PCB 183	1.1	E	ug/kg	
RF2	1	Flag rockfish	Liver	PCB 187	28		ug/kg	13.3
RF2	1	Flag rockfish	Muscle	PCB 187	2.9		ug/kg	1.33
RF2	1	Flag rockfish	Liver	PCB 194	14		ug/kg	13.3
RF2	1	Flag rockfish	Muscle	PCB 194	1.2	E	ug/kg	
RF2	1	Flag rockfish	Liver	PCB 206	7.1	E	ug/kg	
RF2	1	Flag rockfish	Muscle	PCB 206	0.6	E	ug/kg	
RF2	1	Flag rockfish	Liver	PCB 74	2	E	ug/kg	
RF2	1	Flag rockfish	Liver	PCB 87	2.9	E	ug/kg	
RF2	1	Flag rockfish	Muscle	PCB 87	0.3	E	ug/kg	
RF2	1	Flag rockfish	Liver	PCB 99	15		ug/kg	13.3
RF2	1	Flag rockfish	Muscle	PCB 99	1.4		ug/kg	1.33
RF2	1	Flag rockfish	Liver	Selenium	3.36		mg/kg	0.06
RF2	1	Flag rockfish	Muscle	Selenium	0.321		mg/kg	0.06
RF2	1	Flag rockfish	Liver	Total Solids	31.7		wt%	0.4
RF2	1	Flag rockfish	Muscle	Total Solids	21.8		wt%	0.4
RF2	1	Flag rockfish	Liver	Trans Nonachlor	7.5	E	ug/kg	
RF2	1	Flag rockfish	Muscle	Trans Nonachlor	0.9	E	ug/kg	
RF2	1	Flag rockfish	Liver	Zinc	79.2		mg/kg	0.58
RF2	1	Flag rockfish	Muscle	Zinc	2.89		mg/kg	0.58
RF2	2	Vermilion rockfish	Liver	Alpha (cis) Chlordane	7.1	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	Aluminum	9.4		mg/kg	2.6
RF2	2	Vermilion rockfish	Liver	Arsenic	2.2		mg/kg	1.4

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
RF2	2	Vermilion rockfish	Muscle	Arsenic	6.1		mg/kg	1.4
RF2	2	Vermilion rockfish	Liver	Cadmium	1.3		mg/kg	0.34
RF2	2	Vermilion rockfish	Liver	Copper	12.9		mg/kg	0.76
RF2	2	Vermilion rockfish	Liver	Hexachlorobenzene	5.3	E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	Hexachlorobenzene	0.3	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	Iron	29.7		mg/kg	1.3
RF2	2	Vermilion rockfish	Liver	Lipids	30.9		wt%	0.005
RF2	2	Vermilion rockfish	Muscle	Lipids	1.24		wt%	0.005
RF2	2	Vermilion rockfish	Liver	Manganese	0.47		mg/kg	0.23
RF2	2	Vermilion rockfish	Liver	Mercury	0.114		mg/kg	0.03
RF2	2	Vermilion rockfish	Muscle	Mercury	0.0998		mg/kg	0.03
RF2	2	Vermilion rockfish	Liver	o,p-DDE	2.4	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	p,p-DDD	8.2	E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	p,p-DDD	0.3	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	p,p-DDE	240		ug/kg	13.3
RF2	2	Vermilion rockfish	Muscle	p,p-DDE	7.1		ug/kg	1.33
RF2	2	Vermilion rockfish	Liver	p,p-DDT	10	E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	p,p-DDT	0.3	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 101	6.6	E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	PCB 101	0.2	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 105	3	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 110	3.7	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 118	9	E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	PCB 118	0.2	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 138	9.3	E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	PCB 138	0.2	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 149	5.5	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 151	1.9	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 153/168	17		ug/kg	13.3
RF2	2	Vermilion rockfish	Muscle	PCB 153/168	0.3	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 158	0.7	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 180	6.6	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 183	1.9	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 187	5.2	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 206	3.8	E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	PCB 206	0.2	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	PCB 99	5.1	E	ug/kg	
RF2	2	Vermilion rockfish	Muscle	PCB 99	0.1	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	Selenium	1.84		mg/kg	0.06
RF2	2	Vermilion rockfish	Muscle	Selenium	0.28		mg/kg	0.06
RF2	2	Vermilion rockfish	Liver	Total Solids	51		wt%	0.4
RF2	2	Vermilion rockfish	Muscle	Total Solids	21.7		wt%	0.4
RF2	2	Vermilion rockfish	Liver	Trans Nonachlor	7.1	E	ug/kg	
RF2	2	Vermilion rockfish	Liver	Zinc	30.4		mg/kg	0.58
RF2	2	Vermilion rockfish	Muscle	Zinc	1.02		mg/kg	0.58
SD7	1	Longfin sanddab	Liver	Alpha (cis) Chlordane	4.9	E	ug/kg	
SD7	1	Longfin sanddab	Liver	Aluminum	6.2		mg/kg	2.6
SD7	1	Longfin sanddab	Muscle	Aluminum	4.4		mg/kg	2.6
SD7	1	Longfin sanddab	Liver	Arsenic	1.5		mg/kg	1.4
SD7	1	Longfin sanddab	Muscle	Arsenic	12.5		mg/kg	1.4
SD7	1	Longfin sanddab	Liver	Cadmium	1.91		mg/kg	0.34

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD7	1	Longfin sanddab	Liver	Chromium	1.19		mg/kg	0.3
SD7	1	Longfin sanddab	Liver	Copper	16		mg/kg	0.76
SD7	1	Longfin sanddab	Liver	Hexachlorobenzene	4.6	E	ug/kg	
SD7	1	Longfin sanddab	Liver	Iron	194		mg/kg	1.3
SD7	1	Longfin sanddab	Liver	Lipids	27.7		wt%	0.005
SD7	1	Longfin sanddab	Muscle	Lipids	0.28		wt%	0.005
SD7	1	Longfin sanddab	Liver	Manganese	1.29		mg/kg	0.23
SD7	1	Longfin sanddab	Liver	Mercury	0.112		mg/kg	0.03
SD7	1	Longfin sanddab	Muscle	Mercury	0.107		mg/kg	0.03
SD7	1	Longfin sanddab	Liver	o,p-DDE	9	E	ug/kg	
SD7	1	Longfin sanddab	Liver	o,p-DDT	1.4	E	ug/kg	
SD7	1	Longfin sanddab	Liver	p,p-DDD	7.1	E	ug/kg	
SD7	1	Longfin sanddab	Liver	p,p-DDE	610		ug/kg	13.3
SD7	1	Longfin sanddab	Muscle	p,p-DDE	2.7		ug/kg	1.33
SD7	1	Longfin sanddab	Liver	p,p-DDT	15		ug/kg	13.3
SD7	1	Longfin sanddab	Liver	PCB 101	14		ug/kg	13.3
SD7	1	Longfin sanddab	Liver	PCB 105	16		ug/kg	13.3
SD7	1	Longfin sanddab	Liver	PCB 110	15		ug/kg	13.3
SD7	1	Longfin sanddab	Liver	PCB 118	49		ug/kg	13.3
SD7	1	Longfin sanddab	Muscle	PCB 118	0.2	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 123	5.1	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 128	17		ug/kg	13.3
SD7	1	Longfin sanddab	Liver	PCB 138	78		ug/kg	13.3
SD7	1	Longfin sanddab	Muscle	PCB 138	0.3	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 149	12	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 151	11	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 153/168	110		ug/kg	13.3
SD7	1	Longfin sanddab	Muscle	PCB 153/168	0.5	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 156	8.1	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 157	2.3	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 158	5.9	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 167	4.5	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 177	8.8	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 180	55		ug/kg	13.3
SD7	1	Longfin sanddab	Muscle	PCB 180	0.3	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 183	17		ug/kg	13.3
SD7	1	Longfin sanddab	Liver	PCB 187	49		ug/kg	13.3
SD7	1	Longfin sanddab	Liver	PCB 194	19		ug/kg	13.3
SD7	1	Longfin sanddab	Liver	PCB 206	10	E	ug/kg	
SD7	1	Longfin sanddab	Muscle	PCB 206	0.2	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 66	4.4	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 70	2	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 74	2.5	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 87	2.4	E	ug/kg	
SD7	1	Longfin sanddab	Liver	PCB 99	28		ug/kg	13.3
SD7	1	Longfin sanddab	Muscle	PCB 99	0.1	E	ug/kg	
SD7	1	Longfin sanddab	Liver	Selenium	2.04		mg/kg	0.06
SD7	1	Longfin sanddab	Muscle	Selenium	1.65		mg/kg	0.06
SD7	1	Longfin sanddab	Liver	Total Solids	46		wt%	0.4
SD7	1	Longfin sanddab	Muscle	Total Solids	20.6		wt%	0.4
SD7	1	Longfin sanddab	Liver	Trans Nonachlor	8.7	E	ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD7	1	Longfin sanddab	Liver	Zinc	25.8		mg/kg	0.58
SD7	1	Longfin sanddab	Muscle	Zinc	3.21		mg/kg	0.58
SD7	2	Dover sole	Muscle	Aluminum	9		mg/kg	2.6
SD7	2	Dover sole	Muscle	Arsenic	5.4		mg/kg	1.4
SD7	2	Dover sole	Liver	Hexachlorobenzene	0.7	E	ug/kg	
SD7	2	Dover sole	Liver	Lipids	5.17		wt%	0.005
SD7	2	Dover sole	Muscle	Lipids	0.4		wt%	0.005
SD7	2	Dover sole	Muscle	Mercury	0.0445		mg/kg	0.03
SD7	2	Dover sole	Liver	o,p-DDD	1.8	E	ug/kg	
SD7	2	Dover sole	Liver	p,p-DDE	38		ug/kg	13.3
SD7	2	Dover sole	Muscle	p,p-DDE	1.9		ug/kg	1.33
SD7	2	Dover sole	Liver	PCB 101	2.3	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 101	0.3	E	ug/kg	
SD7	2	Dover sole	Liver	PCB 105	1	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 105	0.4	E	ug/kg	
SD7	2	Dover sole	Liver	PCB 110	1.8	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 110	0.3	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 114	0.3	E	ug/kg	
SD7	2	Dover sole	Liver	PCB 118	2.9	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 118	0.4	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 119	0.2	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 123	0.3	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 126	0.3	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 128	0.3	E	ug/kg	
SD7	2	Dover sole	Liver	PCB 138	3.9	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 138	0.4	E	ug/kg	
SD7	2	Dover sole	Liver	PCB 149	2.9	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 149	0.3	E	ug/kg	
SD7	2	Dover sole	Liver	PCB 151	1.4	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 151	0.2	E	ug/kg	
SD7	2	Dover sole	Liver	PCB 153/168	6.1	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 153/168	0.7	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 156	0.5	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 157	0.3	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 158	0.3	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 167	0.3	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 177	0.2	E	ug/kg	
SD7	2	Dover sole	Liver	PCB 180	5	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 180	0.5	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 183	0.3	E	ug/kg	
SD7	2	Dover sole	Liver	PCB 187	4	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 187	0.2	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 189	0.4	E	ug/kg	
SD7	2	Dover sole	Liver	PCB 194	1.9	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 194	0.4	E	ug/kg	
SD7	2	Dover sole	Liver	PCB 206	4.1	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 206	0.5	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 66	0.3	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 70	0.2	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 74	0.3	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 77	0.3	E	ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD7	2	Dover sole	Muscle	PCB 81	0.3	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 87	0.2	E	ug/kg	
SD7	2	Dover sole	Liver	PCB 99	1.8	E	ug/kg	
SD7	2	Dover sole	Muscle	PCB 99	0.3	E	ug/kg	
SD7	2	Dover sole	Muscle	Selenium	0.755		mg/kg	0.06
SD7	2	Dover sole	Muscle	Total Solids	19.2		wt%	0.4
SD7	2	Dover sole	Muscle	Zinc	2.9		mg/kg	0.58
SD7	3	Longfin sanddab	Liver	Alpha (cis) Chlordane	7.7	E	ug/kg	
SD7	3	Longfin sanddab	Liver	Aluminum	11.9		mg/kg	2.6
SD7	3	Longfin sanddab	Muscle	Aluminum	6.1		mg/kg	2.6
SD7	3	Longfin sanddab	Liver	Arsenic	5		mg/kg	1.4
SD7	3	Longfin sanddab	Muscle	Arsenic	9.8		mg/kg	1.4
SD7	3	Longfin sanddab	Liver	Copper	14		mg/kg	0.76
SD7	3	Longfin sanddab	Liver	Hexachlorobenzene	5.1	E	ug/kg	
SD7	3	Longfin sanddab	Muscle	Hexachlorobenzene	0.2	E	ug/kg	
SD7	3	Longfin sanddab	Liver	Iron	158		mg/kg	1.3
SD7	3	Longfin sanddab	Muscle	Iron	2.7		mg/kg	1.3
SD7	3	Longfin sanddab	Liver	Lipids	31.2		wt%	0.005
SD7	3	Longfin sanddab	Muscle	Lipids	0.28		wt%	0.005
SD7	3	Longfin sanddab	Liver	Mercury	0.0947		mg/kg	0.03
SD7	3	Longfin sanddab	Muscle	Mercury	0.113		mg/kg	0.03
SD7	3	Longfin sanddab	Liver	o,p-DDE	16		ug/kg	13.3
SD7	3	Longfin sanddab	Liver	o,p-DDT	3.3	E	ug/kg	
SD7	3	Longfin sanddab	Liver	p,p-DDD	16		ug/kg	13.3
SD7	3	Longfin sanddab	Liver	p,p-DDE	980		ug/kg	13.3
SD7	3	Longfin sanddab	Muscle	p,p-DDE	2.1		ug/kg	1.33
SD7	3	Longfin sanddab	Liver	p,p-DDT	22		ug/kg	13.3
SD7	3	Longfin sanddab	Liver	PCB 101	28		ug/kg	13.3
SD7	3	Longfin sanddab	Liver	PCB 105	23		ug/kg	13.3
SD7	3	Longfin sanddab	Liver	PCB 110	28		ug/kg	13.3
SD7	3	Longfin sanddab	Liver	PCB 118	68		ug/kg	13.3
SD7	3	Longfin sanddab	Muscle	PCB 118	0.2	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 119	1.8	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 123	7	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 128	23		ug/kg	13.3
SD7	3	Longfin sanddab	Liver	PCB 138	110		ug/kg	13.3
SD7	3	Longfin sanddab	Muscle	PCB 138	0.3	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 149	24		ug/kg	13.3
SD7	3	Longfin sanddab	Liver	PCB 151	17		ug/kg	13.3
SD7	3	Longfin sanddab	Liver	PCB 153/168	150		ug/kg	13.3
SD7	3	Longfin sanddab	Muscle	PCB 153/168	0.3	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 156	10	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 157	3.3	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 158	8	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 167	7	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 170	34		ug/kg	13.3
SD7	3	Longfin sanddab	Liver	PCB 177	16		ug/kg	13.3
SD7	3	Longfin sanddab	Liver	PCB 180	75		ug/kg	13.3
SD7	3	Longfin sanddab	Muscle	PCB 180	0.2	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 183	24		ug/kg	13.3
SD7	3	Longfin sanddab	Liver	PCB 187	64		ug/kg	13.3

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD7	3	Longfin sanddab	Liver	PCB 194	28		ug/kg	13.3
SD7	3	Longfin sanddab	Liver	PCB 201	22		ug/kg	13.3
SD7	3	Longfin sanddab	Liver	PCB 206	15		ug/kg	13.3
SD7	3	Longfin sanddab	Muscle	PCB 206	0.2	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 52	9.6	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 66	9.4	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 70	4.2	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 74	4.4	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 87	6.6	E	ug/kg	
SD7	3	Longfin sanddab	Liver	PCB 99	45		ug/kg	13.3
SD7	3	Longfin sanddab	Muscle	PCB 99	0.1	E	ug/kg	
SD7	3	Longfin sanddab	Liver	Selenium	2.05		mg/kg	0.06
SD7	3	Longfin sanddab	Muscle	Selenium	1.43		mg/kg	0.06
SD7	3	Longfin sanddab	Liver	Total Solids	50.2		wt%	0.4
SD7	3	Longfin sanddab	Muscle	Total Solids	20.1		wt%	0.4
SD7	3	Longfin sanddab	Liver	Trans Nonachlor	9.9	E	ug/kg	
SD7	3	Longfin sanddab	Liver	Zinc	23		mg/kg	0.58
SD7	3	Longfin sanddab	Muscle	Zinc	2.77		mg/kg	0.58
SD8	1	Ca. scorpionfish	Liver	Aluminum	27.4		mg/kg	2.6
SD8	1	Ca. scorpionfish	Muscle	Aluminum	4.8		mg/kg	2.6
SD8	1	Ca. scorpionfish	Liver	Arsenic	3.2		mg/kg	1.4
SD8	1	Ca. scorpionfish	Muscle	Arsenic	4.7		mg/kg	1.4
SD8	1	Ca. scorpionfish	Liver	Copper	10.9		mg/kg	0.76
SD8	1	Ca. scorpionfish	Liver	Hexachlorobenzene	2		ug/kg	
SD8	1	Ca. scorpionfish	Liver	Iron	151		mg/kg	1.3
SD8	1	Ca. scorpionfish	Muscle	Iron	4.25		mg/kg	1.3
SD8	1	Ca. scorpionfish	Liver	Lipids	17.5		wt%	0.005
SD8	1	Ca. scorpionfish	Muscle	Lipids	0.86		wt%	0.005
SD8	1	Ca. scorpionfish	Liver	Manganese	0.88		mg/kg	0.23
SD8	1	Ca. scorpionfish	Liver	Mercury	0.0399		mg/kg	0.03
SD8	1	Ca. scorpionfish	Muscle	Mercury	0.106		mg/kg	0.03
SD8	1	Ca. scorpionfish	Liver	p,p-DDD	3.2	E	ug/kg	
SD8	1	Ca. scorpionfish	Liver	p,p-DDE	130		ug/kg	13.3
SD8	1	Ca. scorpionfish	Muscle	p,p-DDE	4.15		ug/kg	1.33
SD8	1	Ca. scorpionfish	Liver	p,p-DDT	4.6		ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 101	6.25		ug/kg	
SD8	1	Ca. scorpionfish	Muscle	PCB 101	0.25		ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 105	3.35		ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 110	4.9		ug/kg	
SD8	1	Ca. scorpionfish	Muscle	PCB 110	0.2	E	ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 118	8.7		ug/kg	
SD8	1	Ca. scorpionfish	Muscle	PCB 118	0.35		ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 128	2.4		ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 138	9		ug/kg	
SD8	1	Ca. scorpionfish	Muscle	PCB 138	0.35		ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 149	5.5		ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 151	1.75		ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 153/168	15		ug/kg	13.3
SD8	1	Ca. scorpionfish	Muscle	PCB 153/168	0.5	E	ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 156	1	E	ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 180	6.65		ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD8	1	Ca. scorpionfish	Muscle	PCB 180	0.3	E	ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 183	1.7		ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 187	4.65		ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 194	0.75		ug/kg	13.3
SD8	1	Ca. scorpionfish	Liver	PCB 206	3.6		ug/kg	
SD8	1	Ca. scorpionfish	Muscle	PCB 206	0.3	E	ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 87	1.4		ug/kg	
SD8	1	Ca. scorpionfish	Liver	PCB 99	4.9		ug/kg	
SD8	1	Ca. scorpionfish	Muscle	PCB 99	0.2	E	ug/kg	
SD8	1	Ca. scorpionfish	Liver	Selenium	2.29		mg/kg	0.06
SD8	1	Ca. scorpionfish	Muscle	Selenium	0.525		mg/kg	0.06
SD8	1	Ca. scorpionfish	Liver	Total Solids	42.4		wt%	0.4
SD8	1	Ca. scorpionfish	Muscle	Total Solids	21.7		wt%	0.4
SD8	1	Ca. scorpionfish	Liver	Zinc	31.3		mg/kg	0.58
SD8	1	Ca. scorpionfish	Muscle	Zinc	3.66		mg/kg	0.58
SD8	2	Longfin sanddab	Liver	Alpha (cis) Chlordane	6.8	E	ug/kg	
SD8	2	Longfin sanddab	Liver	Aluminum	13		mg/kg	2.6
SD8	2	Longfin sanddab	Muscle	Aluminum	21.7		mg/kg	2.6
SD8	2	Longfin sanddab	Liver	Arsenic	10.6		mg/kg	1.4
SD8	2	Longfin sanddab	Muscle	Arsenic	14		mg/kg	1.4
SD8	2	Longfin sanddab	Liver	Copper	6.47		mg/kg	0.76
SD8	2	Longfin sanddab	Liver	Hexachlorobenzene	3.4	E	ug/kg	
SD8	2	Longfin sanddab	Liver	Iron	140		mg/kg	1.3
SD8	2	Longfin sanddab	Muscle	Iron	3.4		mg/kg	1.3
SD8	2	Longfin sanddab	Liver	Lipids	37.5		wt%	0.005
SD8	2	Longfin sanddab	Muscle	Lipids	0.14		wt%	0.005
SD8	2	Longfin sanddab	Liver	Manganese	0.65		mg/kg	0.23
SD8	2	Longfin sanddab	Liver	Mercury	0.0632		mg/kg	0.03
SD8	2	Longfin sanddab	Muscle	Mercury	0.118		mg/kg	0.03
SD8	2	Longfin sanddab	Liver	o,p-DDE	11	E	ug/kg	
SD8	2	Longfin sanddab	Liver	p,p-DDD	12	E	ug/kg	
SD8	2	Longfin sanddab	Liver	p,p-DDE	850		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	p,p-DDE	4.7		ug/kg	1.33
SD8	2	Longfin sanddab	Liver	p,p-DDT	22		ug/kg	13.3
SD8	2	Longfin sanddab	Liver	PCB 101	36		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	PCB 101	0.3	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 105	36		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	PCB 105	0.4	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 110	40		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	PCB 110	0.4	E	ug/kg	
SD8	2	Longfin sanddab	Muscle	PCB 114	0.3	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 118	110		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	PCB 118	0.7	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 119	2.2	E	ug/kg	
SD8	2	Longfin sanddab	Muscle	PCB 119	0.3	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 123	9.3	E	ug/kg	
SD8	2	Longfin sanddab	Muscle	PCB 123	0.4	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 128	34		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	PCB 128	0.2	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 138	150		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	PCB 138	0.7	E	ug/kg	

October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD8	2	Longfin sanddab	Liver	PCB 149	29		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	PCB 149	0.3	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 151	23		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	PCB 151	0.3	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 153/168	220		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	PCB 153/168	1.3	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 156	18		ug/kg	13.3
SD8	2	Longfin sanddab	Liver	PCB 157	5.3	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 158	11	E	ug/kg	
SD8	2	Longfin sanddab	Muscle	PCB 158	0.2	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 167	9.3	E	ug/kg	
SD8	2	Longfin sanddab	Muscle	PCB 167	0.2	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 170	39		ug/kg	13.3
SD8	2	Longfin sanddab	Liver	PCB 177	18		ug/kg	13.3
SD8	2	Longfin sanddab	Liver	PCB 180	93		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	PCB 180	0.5	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 183	28		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	PCB 183	0.3	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 187	85		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	PCB 187	0.3	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 189	2.1	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 194	27		ug/kg	13.3
SD8	2	Longfin sanddab	Liver	PCB 201	26		ug/kg	13.3
SD8	2	Longfin sanddab	Liver	PCB 206	16		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	PCB 206	0.4	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 28	2.8	E	ug/kg	
SD8	2	Longfin sanddab	Muscle	PCB 28	0.5	E	ug/kg	
SD8	2	Longfin sanddab	Muscle	PCB 37	0.7	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 44	1.9	E	ug/kg	
SD8	2	Longfin sanddab	Muscle	PCB 44	0.2	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 49	5.1	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 52	12	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 66	11	E	ug/kg	
SD8	2	Longfin sanddab	Muscle	PCB 66	0.5	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 70	5.6	E	ug/kg	
SD8	2	Longfin sanddab	Muscle	PCB 70	0.4	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 74	5.9	E	ug/kg	
SD8	2	Longfin sanddab	Muscle	PCB 74	0.5	E	ug/kg	
SD8	2	Longfin sanddab	Muscle	PCB 81	0.4	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 87	8.2	E	ug/kg	
SD8	2	Longfin sanddab	Muscle	PCB 87	0.3	E	ug/kg	
SD8	2	Longfin sanddab	Liver	PCB 99	61		ug/kg	13.3
SD8	2	Longfin sanddab	Muscle	PCB 99	0.6	E	ug/kg	
SD8	2	Longfin sanddab	Liver	Selenium	2.05		mg/kg	0.06
SD8	2	Longfin sanddab	Muscle	Selenium	1.41		mg/kg	0.06
SD8	2	Longfin sanddab	Liver	Total Solids	51.8		wt%	0.4
SD8	2	Longfin sanddab	Muscle	Total Solids	19.5		wt%	0.4
SD8	2	Longfin sanddab	Liver	Trans Nonachlor	10	E	ug/kg	
SD8	2	Longfin sanddab	Liver	Zinc	21.8		mg/kg	0.58
SD8	2	Longfin sanddab	Muscle	Zinc	2.99		mg/kg	0.58
SD8	3	Pacific sanddab	Liver	Alpha (cis) Chlordane	6.1	E	ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD8	3	Pacific sanddab	Liver	Aluminum	18		mg/kg	2.6
SD8	3	Pacific sanddab	Muscle	Aluminum	4.6		mg/kg	2.6
SD8	3	Pacific sanddab	Liver	Arsenic	5.1		mg/kg	1.4
SD8	3	Pacific sanddab	Muscle	Arsenic	4		mg/kg	1.4
SD8	3	Pacific sanddab	Liver	BHC, Alpha isomer	7.7	E	ug/kg	
SD8	3	Pacific sanddab	Liver	Cadmium	0.72		mg/kg	0.34
SD8	3	Pacific sanddab	Liver	Copper	6.15		mg/kg	0.76
SD8	3	Pacific sanddab	Liver	Hexachlorobenzene	5.7	E	ug/kg	
SD8	3	Pacific sanddab	Liver	Iron	87.8		mg/kg	1.3
SD8	3	Pacific sanddab	Liver	Lipids	49.7		wt%	0.005
SD8	3	Pacific sanddab	Muscle	Lipids	0.09		wt%	0.005
SD8	3	Pacific sanddab	Liver	Manganese	0.39		mg/kg	0.23
SD8	3	Pacific sanddab	Liver	Mercury	0.0553		mg/kg	0.03
SD8	3	Pacific sanddab	Muscle	Mercury	0.0551		mg/kg	0.03
SD8	3	Pacific sanddab	Liver	o,p-DDE	4.4	E	ug/kg	
SD8	3	Pacific sanddab	Liver	o,p-DDT	2.7	E	ug/kg	
SD8	3	Pacific sanddab	Liver	p,p-DDD	8.9	E	ug/kg	
SD8	3	Pacific sanddab	Liver	p,p-DDE	490		ug/kg	13.3
SD8	3	Pacific sanddab	Muscle	p,p-DDE	1.3	E	ug/kg	
SD8	3	Pacific sanddab	Liver	p,p-DDT	19		ug/kg	13.3
SD8	3	Pacific sanddab	Liver	PCB 101	40		ug/kg	13.3
SD8	3	Pacific sanddab	Muscle	PCB 101	0.2	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 105	26		ug/kg	13.3
SD8	3	Pacific sanddab	Muscle	PCB 105	0.3	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 110	42		ug/kg	13.3
SD8	3	Pacific sanddab	Muscle	PCB 110	0.3	E	ug/kg	
SD8	3	Pacific sanddab	Muscle	PCB 114	0.3	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 118	70		ug/kg	13.3
SD8	3	Pacific sanddab	Muscle	PCB 118	0.4	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 119	2.2	E	ug/kg	
SD8	3	Pacific sanddab	Muscle	PCB 119	0.1	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 123	6.8	E	ug/kg	
SD8	3	Pacific sanddab	Muscle	PCB 123	0.3	E	ug/kg	
SD8	3	Pacific sanddab	Muscle	PCB 126	0.2	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 128	20		ug/kg	13.3
SD8	3	Pacific sanddab	Muscle	PCB 128	0.3	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 138	83		ug/kg	13.3
SD8	3	Pacific sanddab	Muscle	PCB 138	0.4	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 149	24		ug/kg	13.3
SD8	3	Pacific sanddab	Muscle	PCB 149	0.2	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 151	13	E	ug/kg	
SD8	3	Pacific sanddab	Muscle	PCB 151	0.2	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 153/168	120		ug/kg	13.3
SD8	3	Pacific sanddab	Muscle	PCB 153/168	0.6	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 156	9.9	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 157	2.9	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 158	7.5	E	ug/kg	
SD8	3	Pacific sanddab	Muscle	PCB 158	0.2	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 167	5.6	E	ug/kg	
SD8	3	Pacific sanddab	Muscle	PCB 167	0.3	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 170	21		ug/kg	13.3

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD8	3	Pacific sanddab	Liver	PCB 177	11	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 180	50		ug/kg	13.3
SD8	3	Pacific sanddab	Muscle	PCB 180	0.4	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 183	13	E	ug/kg	
SD8	3	Pacific sanddab	Muscle	PCB 183	0.2	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 187	44		ug/kg	13.3
SD8	3	Pacific sanddab	Muscle	PCB 189	0.1	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 194	13	E	ug/kg	
SD8	3	Pacific sanddab	Muscle	PCB 194	0.2	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 201	13	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 206	8.9	E	ug/kg	
SD8	3	Pacific sanddab	Muscle	PCB 206	0.3	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 44	4.2	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 49	7	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 52	15		ug/kg	13.3
SD8	3	Pacific sanddab	Liver	PCB 66	7.3	E	ug/kg	
SD8	3	Pacific sanddab	Muscle	PCB 66	0.2	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 70	11	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 74	5.4	E	ug/kg	
SD8	3	Pacific sanddab	Muscle	PCB 74	0.2	E	ug/kg	
SD8	3	Pacific sanddab	Muscle	PCB 81	0.3	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 87	13	E	ug/kg	
SD8	3	Pacific sanddab	Muscle	PCB 87	0.2	E	ug/kg	
SD8	3	Pacific sanddab	Liver	PCB 99	41		ug/kg	13.3
SD8	3	Pacific sanddab	Muscle	PCB 99	0.3	E	ug/kg	
SD8	3	Pacific sanddab	Liver	Selenium	0.88		mg/kg	0.06
SD8	3	Pacific sanddab	Muscle	Selenium	0.464		mg/kg	0.06
SD8	3	Pacific sanddab	Liver	Silver	1.66		mg/kg	0.62
SD8	3	Pacific sanddab	Liver	Total Solids	56.4		wt%	0.4
SD8	3	Pacific sanddab	Muscle	Total Solids	19.4		wt%	0.4
SD8	3	Pacific sanddab	Liver	Trans Nonachlor	10	E	ug/kg	
SD8	3	Pacific sanddab	Liver	Zinc	23.6		mg/kg	0.58
SD8	3	Pacific sanddab	Muscle	Zinc	3.56		mg/kg	0.58
SD9	1	Longfin sanddab	Liver	Alpha (cis) Chlordane	5.4	E	ug/kg	
SD9	1	Longfin sanddab	Liver	Aluminum	10.5		mg/kg	2.6
SD9	1	Longfin sanddab	Muscle	Aluminum	4.9		mg/kg	2.6
SD9	1	Longfin sanddab	Liver	Antimony	4.8		mg/kg	3.7
SD9	1	Longfin sanddab	Liver	Arsenic	11.6		mg/kg	1.4
SD9	1	Longfin sanddab	Muscle	Arsenic	6.6		mg/kg	1.4
SD9	1	Longfin sanddab	Liver	Copper	14.7		mg/kg	0.76
SD9	1	Longfin sanddab	Liver	Hexachlorobenzene	3.8	E	ug/kg	
SD9	1	Longfin sanddab	Liver	Iron	123		mg/kg	1.3
SD9	1	Longfin sanddab	Muscle	Iron	1.8		mg/kg	1.3
SD9	1	Longfin sanddab	Liver	Lipids	39.9		wt%	0.005
SD9	1	Longfin sanddab	Muscle	Lipids	0.18		wt%	0.005
SD9	1	Longfin sanddab	Liver	Manganese	0.53		mg/kg	0.23
SD9	1	Longfin sanddab	Liver	Mercury	0.125		mg/kg	0.03
SD9	1	Longfin sanddab	Muscle	Mercury	0.0838		mg/kg	0.03
SD9	1	Longfin sanddab	Liver	o,p-DDE	12	E	ug/kg	
SD9	1	Longfin sanddab	Liver	o,p-DDT	4.3	E	ug/kg	
SD9	1	Longfin sanddab	Liver	p,p-DDD	25		ug/kg	13.3

Appendix D.3 continued

October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD9	1	Longfin sanddab	Liver	p,p-DDE	1300		ug/kg	13.3
SD9	1	Longfin sanddab	Muscle	p,p-DDE	4.2		ug/kg	1.33
SD9	1	Longfin sanddab	Liver	p,p-DDT	50		ug/kg	13.3
SD9	1	Longfin sanddab	Liver	PCB 101	21		ug/kg	13.3
SD9	1	Longfin sanddab	Liver	PCB 105	22		ug/kg	13.3
SD9	1	Longfin sanddab	Liver	PCB 110	13	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 118	70		ug/kg	13.3
SD9	1	Longfin sanddab	Muscle	PCB 118	0.2	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 119	1.6	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 123	7.2	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 128	25		ug/kg	13.3
SD9	1	Longfin sanddab	Liver	PCB 138	130		ug/kg	13.3
SD9	1	Longfin sanddab	Muscle	PCB 138	0.2	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 149	20		ug/kg	13.3
SD9	1	Longfin sanddab	Liver	PCB 151	17		ug/kg	13.3
SD9	1	Longfin sanddab	Liver	PCB 153/168	190		ug/kg	13.3
SD9	1	Longfin sanddab	Muscle	PCB 153/168	0.5	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 156	10	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 157	3.6	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 158	9.2	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 167	7.4	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 170	40		ug/kg	13.3
SD9	1	Longfin sanddab	Liver	PCB 177	18		ug/kg	13.3
SD9	1	Longfin sanddab	Liver	PCB 180	81		ug/kg	13.3
SD9	1	Longfin sanddab	Muscle	PCB 180	0.3	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 183	27		ug/kg	13.3
SD9	1	Longfin sanddab	Liver	PCB 187	76		ug/kg	13.3
SD9	1	Longfin sanddab	Liver	PCB 189	2.1	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 194	30		ug/kg	13.3
SD9	1	Longfin sanddab	Liver	PCB 201	24		ug/kg	13.3
SD9	1	Longfin sanddab	Liver	PCB 206	12	E	ug/kg	
SD9	1	Longfin sanddab	Muscle	PCB 206	0.2	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 66	7.1	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 70	2.5	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 74	4.2	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 87	4.1	E	ug/kg	
SD9	1	Longfin sanddab	Liver	PCB 99	50		ug/kg	13.3
SD9	1	Longfin sanddab	Liver	Selenium	1.64		mg/kg	0.06
SD9	1	Longfin sanddab	Muscle	Selenium	0.267		mg/kg	0.06
SD9	1	Longfin sanddab	Liver	Total Solids	51.5		wt%	0.4
SD9	1	Longfin sanddab	Muscle	Total Solids	20.7		wt%	0.4
SD9	1	Longfin sanddab	Liver	Trans Nonachlor	9.8	E	ug/kg	
SD9	1	Longfin sanddab	Liver	Zinc	31.4		mg/kg	0.58
SD9	1	Longfin sanddab	Muscle	Zinc	3.85		mg/kg	0.58
SD9	2	Longfin sanddab	Liver	Alpha (cis) Chlordane	4	E	ug/kg	
SD9	2	Longfin sanddab	Liver	Aluminum	11		mg/kg	2.6
SD9	2	Longfin sanddab	Muscle	Aluminum	3.4		mg/kg	2.6
SD9	2	Longfin sanddab	Liver	Arsenic	7.1		mg/kg	1.4
SD9	2	Longfin sanddab	Muscle	Arsenic	5.2		mg/kg	1.4
SD9	2	Longfin sanddab	Liver	Cadmium	6.25		mg/kg	0.34
SD9	2	Longfin sanddab	Liver	Copper	11.9		mg/kg	0.76

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD9	2	Longfin sanddab	Liver	Hexachlorobenzene	3.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	Iron	154		mg/kg	1.3
SD9	2	Longfin sanddab	Liver	Lipids	41		wt%	0.005
SD9	2	Longfin sanddab	Muscle	Lipids	0.11		wt%	0.005
SD9	2	Longfin sanddab	Liver	Manganese	0.81		mg/kg	0.23
SD9	2	Longfin sanddab	Liver	Mercury	0.144		mg/kg	0.03
SD9	2	Longfin sanddab	Muscle	Mercury	0.097		mg/kg	0.03
SD9	2	Longfin sanddab	Liver	o,p-DDE	9.5	E	ug/kg	
SD9	2	Longfin sanddab	Liver	o,p-DDT	2.3	E	ug/kg	
SD9	2	Longfin sanddab	Liver	p,p-DDD	14		ug/kg	13.3
SD9	2	Longfin sanddab	Liver	p,p-DDE	530		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	p,p-DDE	2.4		ug/kg	1.33
SD9	2	Longfin sanddab	Liver	p,p-DDT	25		ug/kg	13.3
SD9	2	Longfin sanddab	Liver	PCB 101	20		ug/kg	13.3
SD9	2	Longfin sanddab	Liver	PCB 105	18		ug/kg	13.3
SD9	2	Longfin sanddab	Liver	PCB 110	14		ug/kg	13.3
SD9	2	Longfin sanddab	Liver	PCB 118	37		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 118	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 119	5.6	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 123	11	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 126	5.5	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 128	14		ug/kg	13.3
SD9	2	Longfin sanddab	Liver	PCB 138	49		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 138	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 149	18		ug/kg	13.3
SD9	2	Longfin sanddab	Liver	PCB 151	12	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 153/168	86		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 153/168	0.3	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 156	10	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 157	7.6	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 158	9.6	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 167	10	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 170	20		ug/kg	13.3
SD9	2	Longfin sanddab	Liver	PCB 177	13	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 180	37		ug/kg	13.3
SD9	2	Longfin sanddab	Muscle	PCB 180	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 183	17		ug/kg	13.3
SD9	2	Longfin sanddab	Liver	PCB 187	38		ug/kg	13.3
SD9	2	Longfin sanddab	Liver	PCB 189	5	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 194	17		ug/kg	13.3
SD9	2	Longfin sanddab	Liver	PCB 206	9.4	E	ug/kg	
SD9	2	Longfin sanddab	Muscle	PCB 206	0.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 28	6.1	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 37	6.5	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 44	3.4	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 49	5	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 52	7	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 66	11	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 70	6.5	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 74	7.3	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 77	7	E	ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD9	2	Longfin sanddab	Liver	PCB 87	7.9	E	ug/kg	
SD9	2	Longfin sanddab	Liver	PCB 99	25		ug/kg	13.3
SD9	2	Longfin sanddab	Liver	Selenium	1.6		mg/kg	0.06
SD9	2	Longfin sanddab	Muscle	Selenium	0.285		mg/kg	0.06
SD9	2	Longfin sanddab	Liver	Total Solids	54.1		wt%	0.4
SD9	2	Longfin sanddab	Muscle	Total Solids	20.5		wt%	0.4
SD9	2	Longfin sanddab	Liver	Trans Nonachlor	4.2	E	ug/kg	
SD9	2	Longfin sanddab	Liver	Zinc	29.1		mg/kg	0.58
SD9	2	Longfin sanddab	Muscle	Zinc	3.53		mg/kg	0.58
SD9	3	English sole	Liver	Alpha (cis) Chlordane	2.5	E	ug/kg	
SD9	3	English sole	Liver	Aluminum	5.2		mg/kg	2.6
SD9	3	English sole	Muscle	Aluminum	4		mg/kg	2.6
SD9	3	English sole	Liver	Arsenic	5.9		mg/kg	1.4
SD9	3	English sole	Muscle	Arsenic	10.1		mg/kg	1.4
SD9	3	English sole	Liver	Copper	4.58		mg/kg	0.76
SD9	3	English sole	Liver	Hexachlorobenzene	1.5	E	ug/kg	
SD9	3	English sole	Liver	Iron	173		mg/kg	1.3
SD9	3	English sole	Liver	Lipids	11.4		wt%	0.005
SD9	3	English sole	Muscle	Lipids	0.11		wt%	0.005
SD9	3	English sole	Liver	Manganese	1.2		mg/kg	0.23
SD9	3	English sole	Liver	Mercury	0.0627		mg/kg	0.03
SD9	3	English sole	Muscle	Mercury	0.063		mg/kg	0.03
SD9	3	English sole	Liver	o,p-DDE	2.5	E	ug/kg	
SD9	3	English sole	Liver	p,p-DDD	4.9	E	ug/kg	
SD9	3	English sole	Liver	p,p-DDE	120		ug/kg	13.3
SD9	3	English sole	Muscle	p,p-DDE	1.8		ug/kg	1.33
SD9	3	English sole	Liver	p,p-DDT	5.1	E	ug/kg	
SD9	3	English sole	Liver	PCB 101	22		ug/kg	13.3
SD9	3	English sole	Muscle	PCB 101	0.4	E	ug/kg	
SD9	3	English sole	Liver	PCB 105	9.3	E	ug/kg	
SD9	3	English sole	Muscle	PCB 105	0.1	E	ug/kg	
SD9	3	English sole	Liver	PCB 110	18		ug/kg	13.3
SD9	3	English sole	Muscle	PCB 110	0.3	E	ug/kg	
SD9	3	English sole	Liver	PCB 118	25		ug/kg	13.3
SD9	3	English sole	Muscle	PCB 118	0.4	E	ug/kg	
SD9	3	English sole	Liver	PCB 119	2.4	E	ug/kg	
SD9	3	English sole	Liver	PCB 123	3.6	E	ug/kg	
SD9	3	English sole	Liver	PCB 128	8	E	ug/kg	
SD9	3	English sole	Liver	PCB 138	34		ug/kg	13.3
SD9	3	English sole	Muscle	PCB 138	0.4	E	ug/kg	
SD9	3	English sole	Liver	PCB 149	24		ug/kg	13.3
SD9	3	English sole	Muscle	PCB 149	0.4	E	ug/kg	
SD9	3	English sole	Liver	PCB 151	8.3	E	ug/kg	
SD9	3	English sole	Liver	PCB 153/168	55		ug/kg	13.3
SD9	3	English sole	Muscle	PCB 153/168	0.7	E	ug/kg	
SD9	3	English sole	Liver	PCB 156	3.8	E	ug/kg	
SD9	3	English sole	Liver	PCB 158	3.9	E	ug/kg	
SD9	3	English sole	Liver	PCB 167	3.4	E	ug/kg	
SD9	3	English sole	Liver	PCB 177	4.9	E	ug/kg	
SD9	3	English sole	Liver	PCB 180	27		ug/kg	13.3
SD9	3	English sole	Muscle	PCB 180	0.4	E	ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD9	3	English sole	Liver	PCB 183	9.2	E	ug/kg	
SD9	3	English sole	Liver	PCB 187	23		ug/kg	13.3
SD9	3	English sole	Muscle	PCB 187	0.2	E	ug/kg	
SD9	3	English sole	Liver	PCB 194	11	E	ug/kg	
SD9	3	English sole	Muscle	PCB 194	0.1	E	ug/kg	
SD9	3	English sole	Liver	PCB 206	12	E	ug/kg	
SD9	3	English sole	Muscle	PCB 206	0.3	E	ug/kg	
SD9	3	English sole	Liver	PCB 49	4.8	E	ug/kg	
SD9	3	English sole	Liver	PCB 52	5.8	E	ug/kg	
SD9	3	English sole	Liver	PCB 66	5.5	E	ug/kg	
SD9	3	English sole	Liver	PCB 70	4.5	E	ug/kg	
SD9	3	English sole	Liver	PCB 74	3.2	E	ug/kg	
SD9	3	English sole	Liver	PCB 87	6.8	E	ug/kg	
SD9	3	English sole	Liver	PCB 99	17		ug/kg	13.3
SD9	3	English sole	Muscle	PCB 99	0.3	E	ug/kg	
SD9	3	English sole	Liver	Selenium	2.8		mg/kg	0.06
SD9	3	English sole	Muscle	Selenium	0.683		mg/kg	0.06
SD9	3	English sole	Liver	Total Solids	30		wt%	0.4
SD9	3	English sole	Muscle	Total Solids	21.2		wt%	0.4
SD9	3	English sole	Liver	Zinc	66.4		mg/kg	0.58
SD9	3	English sole	Muscle	Zinc	2.98		mg/kg	0.58
SD10	1	Longfin sanddab	Liver	Aluminum	12.6		mg/kg	2.6
SD10	1	Longfin sanddab	Muscle	Aluminum	13.5		mg/kg	2.6
SD10	1	Longfin sanddab	Liver	Arsenic	5.8		mg/kg	1.4
SD10	1	Longfin sanddab	Muscle	Arsenic	7.8		mg/kg	1.4
SD10	1	Longfin sanddab	Liver	Cadmium	3.16		mg/kg	0.34
SD10	1	Longfin sanddab	Liver	Chromium	22.8		mg/kg	0.3
SD10	1	Longfin sanddab	Liver	Copper	10.4		mg/kg	0.76
SD10	1	Longfin sanddab	Muscle	Copper	1.3		mg/kg	0.76
SD10	1	Longfin sanddab	Liver	Hexachlorobenzene	3	E	ug/kg	
SD10	1	Longfin sanddab	Liver	Iron	233		mg/kg	1.3
SD10	1	Longfin sanddab	Muscle	Iron	4.2		mg/kg	1.3
SD10	1	Longfin sanddab	Liver	Lipids	33.7		wt%	0.005
SD10	1	Longfin sanddab	Muscle	Lipids	0.44		wt%	0.005
SD10	1	Longfin sanddab	Liver	Manganese	5.47		mg/kg	0.23
SD10	1	Longfin sanddab	Liver	Mercury	0.127		mg/kg	0.03
SD10	1	Longfin sanddab	Muscle	Mercury	0.109		mg/kg	0.03
SD10	1	Longfin sanddab	Liver	Nickel	18.9		mg/kg	0.79
SD10	1	Longfin sanddab	Liver	o,p-DDE	7.1	E	ug/kg	
SD10	1	Longfin sanddab	Liver	p,p-DDD	8.8	E	ug/kg	
SD10	1	Longfin sanddab	Liver	p,p-DDE	570		ug/kg	13.3
SD10	1	Longfin sanddab	Muscle	p,p-DDE	2.6		ug/kg	1.33
SD10	1	Longfin sanddab	Liver	p,p-DDT	9.8	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 101	9.7	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 105	9.7	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 110	7	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 118	28		ug/kg	13.3
SD10	1	Longfin sanddab	Liver	PCB 123	2.4	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 128	8.8	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 138	46		ug/kg	13.3
SD10	1	Longfin sanddab	Muscle	PCB 138	0.1	E	ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD10	1	Longfin sanddab	Liver	PCB 149	8.6	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 151	6.4	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 153/168	75		ug/kg	13.3
SD10	1	Longfin sanddab	Muscle	PCB 153/168	0.3	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 156	4.1	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 158	3.2	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 167	2.9	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 170	16		ug/kg	13.3
SD10	1	Longfin sanddab	Liver	PCB 177	5.9	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 180	37		ug/kg	13.3
SD10	1	Longfin sanddab	Muscle	PCB 180	0.2	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 183	9.2	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 187	30		ug/kg	13.3
SD10	1	Longfin sanddab	Liver	PCB 194	11	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 201	10	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 206	6.4	E	ug/kg	
SD10	1	Longfin sanddab	Muscle	PCB 206	0.2	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 66	3.9	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 74	2.2	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 87	2	E	ug/kg	
SD10	1	Longfin sanddab	Liver	PCB 99	19		ug/kg	13.3
SD10	1	Longfin sanddab	Liver	Selenium	2.22		mg/kg	0.06
SD10	1	Longfin sanddab	Muscle	Selenium	1.7		mg/kg	0.06
SD10	1	Longfin sanddab	Muscle	Silver	0.93		mg/kg	0.62
SD10	1	Longfin sanddab	Liver	Total Solids	49.7		wt%	0.4
SD10	1	Longfin sanddab	Muscle	Total Solids	20		wt%	0.4
SD10	1	Longfin sanddab	Liver	Trans Nonachlor	5.4	E	ug/kg	
SD10	1	Longfin sanddab	Liver	Zinc	26.8		mg/kg	0.58
SD10	1	Longfin sanddab	Muscle	Zinc	3.23		mg/kg	0.58
SD10	2	Pacific sanddab	Liver	Alpha (cis) Chlordane	9.2	E	ug/kg	
SD10	2	Pacific sanddab	Liver	Aluminum	15.3		mg/kg	2.6
SD10	2	Pacific sanddab	Muscle	Aluminum	15.6		mg/kg	2.6
SD10	2	Pacific sanddab	Muscle	Arsenic	4.7		mg/kg	1.4
SD10	2	Pacific sanddab	Liver	BHC, Beta isomer	22		ug/kg	20
SD10	2	Pacific sanddab	Muscle	BHC, Beta isomer	0.5	E	ug/kg	
SD10	2	Pacific sanddab	Liver	Cadmium	2.12		mg/kg	0.34
SD10	2	Pacific sanddab	Liver	Copper	6.29		mg/kg	0.76
SD10	2	Pacific sanddab	Liver	Hexachlorobenzene	4.3	E	ug/kg	
SD10	2	Pacific sanddab	Liver	Iron	72		mg/kg	1.3
SD10	2	Pacific sanddab	Muscle	Iron	3.5		mg/kg	1.3
SD10	2	Pacific sanddab	Liver	Lipids	45		wt%	0.005
SD10	2	Pacific sanddab	Muscle	Lipids	0.61		wt%	0.005
SD10	2	Pacific sanddab	Liver	Manganese	0.59		mg/kg	0.23
SD10	2	Pacific sanddab	Liver	Mercury	0.0707		mg/kg	0.03
SD10	2	Pacific sanddab	Muscle	Mercury	0.0394		mg/kg	0.03
SD10	2	Pacific sanddab	Liver	o,p-DDE	1.7	E	ug/kg	
SD10	2	Pacific sanddab	Liver	p,p-DDD	14		ug/kg	13.3
SD10	2	Pacific sanddab	Liver	p,p-DDE	450		ug/kg	13.3
SD10	2	Pacific sanddab	Muscle	p,p-DDE	1.5		ug/kg	1.33
SD10	2	Pacific sanddab	Liver	p,p-DDT	19		ug/kg	13.3
SD10	2	Pacific sanddab	Liver	PCB 101	13	E	ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD10	2	Pacific sanddab	Liver	PCB 105	7.8	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 110	9.8	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 118	21		ug/kg	13.3
SD10	2	Pacific sanddab	Liver	PCB 123	2.4	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 128	6.9	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 138	28		ug/kg	13.3
SD10	2	Pacific sanddab	Muscle	PCB 138	0.1	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 149	8.3	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 151	4.7	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 153/168	42		ug/kg	13.3
SD10	2	Pacific sanddab	Muscle	PCB 153/168	0.2	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 156	2.4	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 158	2.3	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 167	1.8	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 177	4	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 180	22		ug/kg	13.3
SD10	2	Pacific sanddab	Liver	PCB 183	5.6	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 187	18		ug/kg	13.3
SD10	2	Pacific sanddab	Liver	PCB 194	6.7	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 206	5.4	E	ug/kg	
SD10	2	Pacific sanddab	Muscle	PCB 206	0.3	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 66	3.6	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 70	3	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 74	2	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 87	3.7	E	ug/kg	
SD10	2	Pacific sanddab	Liver	PCB 99	14		ug/kg	13.3
SD10	2	Pacific sanddab	Liver	Selenium	0.814		mg/kg	0.06
SD10	2	Pacific sanddab	Muscle	Selenium	0.376		mg/kg	0.06
SD10	2	Pacific sanddab	Liver	Total Solids	63.1		wt%	0.4
SD10	2	Pacific sanddab	Muscle	Total Solids	19.6		wt%	0.4
SD10	2	Pacific sanddab	Liver	Trans Nonachlor	8.6	E	ug/kg	
SD10	2	Pacific sanddab	Liver	Zinc	21.1		mg/kg	0.58
SD10	2	Pacific sanddab	Muscle	Zinc	3.64		mg/kg	0.58
SD10	3	Ca. scorpionfish	Liver	Aluminum	12.5		mg/kg	2.6
SD10	3	Ca. scorpionfish	Muscle	Aluminum	13.6		mg/kg	2.6
SD10	3	Ca. scorpionfish	Liver	Arsenic	3		mg/kg	1.4
SD10	3	Ca. scorpionfish	Liver	Cadmium	3.75		mg/kg	0.34
SD10	3	Ca. scorpionfish	Liver	Copper	36.1		mg/kg	0.76
SD10	3	Ca. scorpionfish	Liver	Dieldrin	14.3	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	Endrin	7.61	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	Hexachlorobenzene	3.2	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	Hexachlorobenzene	0.2	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	Iron	193		mg/kg	1.3
SD10	3	Ca. scorpionfish	Muscle	Iron	3.7		mg/kg	1.3
SD10	3	Ca. scorpionfish	Liver	Lipids	33.3		wt%	0.005
SD10	3	Ca. scorpionfish	Muscle	Lipids	2.05		wt%	0.005
SD10	3	Ca. scorpionfish	Liver	Mercury	0.113		mg/kg	0.03
SD10	3	Ca. scorpionfish	Muscle	Mercury	0.143		mg/kg	0.03
SD10	3	Ca. scorpionfish	Liver	p,p-DDD	5.4	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	p,p-DDD	0.4	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	p,p-DDE	310		ug/kg	13.3

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD10	3	Ca. scorpionfish	Muscle	p,p-DDE	27		ug/kg	1.33
SD10	3	Ca. scorpionfish	Liver	p,p-DDT	36		ug/kg	13.3
SD10	3	Ca. scorpionfish	Muscle	p,p-DDT	0.5	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 101	5.9	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	PCB 101	0.6	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 105	5.1	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	PCB 105	0.4	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 110	3.7	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	PCB 110	0.3	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 118	14		ug/kg	13.3
SD10	3	Ca. scorpionfish	Muscle	PCB 118	1.3	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 123	1.8	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 128	3.2	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	PCB 128	0.4	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 138	18		ug/kg	13.3
SD10	3	Ca. scorpionfish	Muscle	PCB 138	1.6		ug/kg	1.33
SD10	3	Ca. scorpionfish	Liver	PCB 149	3	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 151	2.8	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	PCB 151	0.2	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 153/168	31		ug/kg	13.3
SD10	3	Ca. scorpionfish	Muscle	PCB 153/168	2.9		ug/kg	1.33
SD10	3	Ca. scorpionfish	Liver	PCB 156	2.1	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 158	1.4	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	PCB 158	0.2	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 167	1.8	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 177	3.1	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	PCB 177	0.2	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 180	19		ug/kg	13.3
SD10	3	Ca. scorpionfish	Muscle	PCB 180	1.5		ug/kg	1.33
SD10	3	Ca. scorpionfish	Liver	PCB 183	4.8	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	PCB 183	0.5	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 187	13	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	PCB 187	1.3	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 194	4.9	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	PCB 194	0.3	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 206	4.4	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	PCB 206	0.4	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 66	2.4	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 87	2.1	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	PCB 99	7.4	E	ug/kg	
SD10	3	Ca. scorpionfish	Muscle	PCB 99	0.7	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	Selenium	0.75		mg/kg	0.06
SD10	3	Ca. scorpionfish	Muscle	Selenium	0.493		mg/kg	0.06
SD10	3	Ca. scorpionfish	Liver	Total Solids	54.6		wt%	0.4
SD10	3	Ca. scorpionfish	Muscle	Total Solids	22.6		wt%	0.4
SD10	3	Ca. scorpionfish	Liver	Trans Nonachlor	6.5	E	ug/kg	
SD10	3	Ca. scorpionfish	Liver	Zinc	68.8		mg/kg	0.58
SD10	3	Ca. scorpionfish	Muscle	Zinc	4.62		mg/kg	0.58
SD11	1	Longfin sanddab	Liver	Alpha (cis) Chlordane	5.3	E	ug/kg	
SD11	1	Longfin sanddab	Liver	Aluminum	13		mg/kg	2.6
SD11	1	Longfin sanddab	Liver	Arsenic	6.8		mg/kg	1.4

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD11	1	Longfin sanddab	Muscle	Arsenic	10.4		mg/kg	1.4
SD11	1	Longfin sanddab	Liver	Cadmium	1.17		mg/kg	0.34
SD11	1	Longfin sanddab	Liver	Copper	5.28		mg/kg	0.76
SD11	1	Longfin sanddab	Liver	Iron	158		mg/kg	1.3
SD11	1	Longfin sanddab	Liver	Lipids	43.9		wt%	0.005
SD11	1	Longfin sanddab	Muscle	Lipids	0.58		wt%	0.005
SD11	1	Longfin sanddab	Liver	Manganese	0.59		mg/kg	0.23
SD11	1	Longfin sanddab	Liver	Mercury	0.0704		mg/kg	0.03
SD11	1	Longfin sanddab	Muscle	Mercury	0.082		mg/kg	0.03
SD11	1	Longfin sanddab	Liver	o,p-DDE	10	E	ug/kg	
SD11	1	Longfin sanddab	Liver	o,p-DDT	3	E	ug/kg	
SD11	1	Longfin sanddab	Liver	p,p-DDD	9.8	E	ug/kg	
SD11	1	Longfin sanddab	Liver	p,p-DDE	1200		ug/kg	13.3
SD11	1	Longfin sanddab	Muscle	p,p-DDE	2.2		ug/kg	1.33
SD11	1	Longfin sanddab	Liver	p,p-DDT	24		ug/kg	13.3
SD11	1	Longfin sanddab	Liver	PCB 101	13	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 105	21		ug/kg	13.3
SD11	1	Longfin sanddab	Liver	PCB 110	15		ug/kg	13.3
SD11	1	Longfin sanddab	Liver	PCB 118	67		ug/kg	13.3
SD11	1	Longfin sanddab	Muscle	PCB 118	0.2	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 119	0.9	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 123	6.6	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 128	22		ug/kg	13.3
SD11	1	Longfin sanddab	Liver	PCB 138	110		ug/kg	13.3
SD11	1	Longfin sanddab	Muscle	PCB 138	0.3	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 149	13	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 151	15		ug/kg	13.3
SD11	1	Longfin sanddab	Liver	PCB 153/168	170		ug/kg	13.3
SD11	1	Longfin sanddab	Muscle	PCB 153/168	0.4	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 156	14		ug/kg	13.3
SD11	1	Longfin sanddab	Liver	PCB 157	3.1	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 158	6.9	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 167	7.1	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 170	40		ug/kg	13.3
SD11	1	Longfin sanddab	Liver	PCB 177	13	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 180	87		ug/kg	13.3
SD11	1	Longfin sanddab	Muscle	PCB 180	0.2	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 183	25		ug/kg	13.3
SD11	1	Longfin sanddab	Liver	PCB 187	72		ug/kg	13.3
SD11	1	Longfin sanddab	Liver	PCB 189	2.4	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 194	31		ug/kg	13.3
SD11	1	Longfin sanddab	Liver	PCB 201	24		ug/kg	13.3
SD11	1	Longfin sanddab	Liver	PCB 206	17		ug/kg	13.3
SD11	1	Longfin sanddab	Muscle	PCB 206	0.2	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 66	5.8	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 70	1.6	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 74	4.3	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 87	2.7	E	ug/kg	
SD11	1	Longfin sanddab	Liver	PCB 99	37		ug/kg	13.3
SD11	1	Longfin sanddab	Liver	Selenium	3.41		mg/kg	0.06
SD11	1	Longfin sanddab	Muscle	Selenium	1.41		mg/kg	0.06

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD11	1	Longfin sanddab	Liver	Total Solids	55.4		wt%	0.4
SD11	1	Longfin sanddab	Muscle	Total Solids	19.8		wt%	0.4
SD11	1	Longfin sanddab	Liver	Trans Nonachlor	15	E	ug/kg	
SD11	1	Longfin sanddab	Liver	Zinc	22.2		mg/kg	0.58
SD11	1	Longfin sanddab	Muscle	Zinc	2.54		mg/kg	0.58
SD11	2	Ca. scorpionfish	Muscle	Arsenic	4.3		mg/kg	1.4
SD11	2	Ca. scorpionfish	Liver	Cadmium	4.34		mg/kg	0.34
SD11	2	Ca. scorpionfish	Liver	Copper	33.3		mg/kg	0.76
SD11	2	Ca. scorpionfish	Liver	Hexachlorobenzene	2.9	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	Hexachlorobenzene	0.2	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	Iron	194		mg/kg	1.3
SD11	2	Ca. scorpionfish	Muscle	Iron	5.7		mg/kg	1.3
SD11	2	Ca. scorpionfish	Liver	Lipids	38.1		wt%	0.005
SD11	2	Ca. scorpionfish	Muscle	Lipids	2.09		wt%	0.005
SD11	2	Ca. scorpionfish	Liver	Manganese	0.29		mg/kg	0.23
SD11	2	Ca. scorpionfish	Liver	Mercury	0.311		mg/kg	0.03
SD11	2	Ca. scorpionfish	Muscle	Mercury	0.199		mg/kg	0.03
SD11	2	Ca. scorpionfish	Liver	o,p-DDE	1.5	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	p,p-DDD	6.6	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	p,p-DDD	0.4	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	p,p-DDE	450		ug/kg	13.3
SD11	2	Ca. scorpionfish	Muscle	p,p-DDE	24		ug/kg	1.33
SD11	2	Ca. scorpionfish	Liver	p,p-DDT	5.6	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 101	12	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	PCB 101	0.5	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 105	9.9	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	PCB 105	0.4	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 110	7.3	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	PCB 110	0.4	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 118	30		ug/kg	13.3
SD11	2	Ca. scorpionfish	Muscle	PCB 118	1.1	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 123	3.1	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 128	9.4	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	PCB 128	0.4	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 138	45		ug/kg	13.3
SD11	2	Ca. scorpionfish	Muscle	PCB 138	1.7		ug/kg	1.33
SD11	2	Ca. scorpionfish	Liver	PCB 149	5.3	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	PCB 149	0.3	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 151	5.6	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	PCB 151	0.2	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 153/168	75		ug/kg	13.3
SD11	2	Ca. scorpionfish	Muscle	PCB 153/168	2.8		ug/kg	1.33
SD11	2	Ca. scorpionfish	Liver	PCB 156	5.4	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 157	2.1	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 158	3.8	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	PCB 158	0.1	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 167	3.2	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 170	19		ug/kg	13.3
SD11	2	Ca. scorpionfish	Liver	PCB 177	6.6	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	PCB 177	0.3	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 180	39		ug/kg	13.3

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD11	2	Ca. scorpionfish	Muscle	PCB 180	1.4		ug/kg	1.33
SD11	2	Ca. scorpionfish	Liver	PCB 183	11	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	PCB 183	0.4	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 187	30		ug/kg	13.3
SD11	2	Ca. scorpionfish	Muscle	PCB 187	1.3	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 194	12	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	PCB 194	0.3	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 206	6.6	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	PCB 206	0.3	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 66	3.2	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 74	1.8	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 87	2.6	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	PCB 87	0.1	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	PCB 99	14		ug/kg	13.3
SD11	2	Ca. scorpionfish	Muscle	PCB 99	0.6	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	Selenium	0.965		mg/kg	0.06
SD11	2	Ca. scorpionfish	Muscle	Selenium	0.54		mg/kg	0.06
SD11	2	Ca. scorpionfish	Liver	Total Solids	48		wt%	0.4
SD11	2	Ca. scorpionfish	Muscle	Total Solids	23.8		wt%	0.4
SD11	2	Ca. scorpionfish	Liver	Trans Nonachlor	8.1	E	ug/kg	
SD11	2	Ca. scorpionfish	Muscle	Trans Nonachlor	0.5	E	ug/kg	
SD11	2	Ca. scorpionfish	Liver	Zinc	84.5		mg/kg	0.58
SD11	2	Ca. scorpionfish	Muscle	Zinc	4		mg/kg	0.58
SD11	3	Ca. scorpionfish	Liver	Alpha (cis) Chlordane	7	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	Arsenic	5.2		mg/kg	1.4
SD11	3	Ca. scorpionfish	Muscle	Arsenic	9.1		mg/kg	1.4
SD11	3	Ca. scorpionfish	Liver	Cadmium	5.41		mg/kg	0.34
SD11	3	Ca. scorpionfish	Liver	Copper	37.9		mg/kg	0.76
SD11	3	Ca. scorpionfish	Liver	Hexachlorobenzene	2.2	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	Iron	242		mg/kg	1.3
SD11	3	Ca. scorpionfish	Liver	Lipids	34.8		wt%	0.005
SD11	3	Ca. scorpionfish	Muscle	Lipids	0.41		wt%	0.005
SD11	3	Ca. scorpionfish	Liver	Mercury	0.354		mg/kg	0.03
SD11	3	Ca. scorpionfish	Muscle	Mercury	0.317		mg/kg	0.03
SD11	3	Ca. scorpionfish	Liver	o,p-DDE	2.2	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	p,p-DDD	11	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	p,p-DDE	1600		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	p,p-DDE	14		ug/kg	1.33
SD11	3	Ca. scorpionfish	Liver	p,p-DDT	9.8	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 101	27		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	PCB 101	0.3	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 105	24		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	PCB 105	0.3	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 110	18		ug/kg	13.3
SD11	3	Ca. scorpionfish	Liver	PCB 118	71		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	PCB 118	0.8	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 123	7.4	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 128	20		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	PCB 128	0.2	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 138	96		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	PCB 138	1	E	ug/kg	

Appendix D.3 continued

October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD11	3	Ca. scorpionfish	Liver	PCB 149	14		ug/kg	13.3
SD11	3	Ca. scorpionfish	Liver	PCB 151	14		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	PCB 151	0.1	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 153/168	150		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	PCB 153/168	1.5		ug/kg	1.33
SD11	3	Ca. scorpionfish	Liver	PCB 156	15		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	PCB 156	0.2	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 157	4.2	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 158	8.5	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 167	6.4	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 170	33		ug/kg	13.3
SD11	3	Ca. scorpionfish	Liver	PCB 177	16		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	PCB 177	0.1	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 180	76		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	PCB 180	1	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 183	22		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	PCB 183	0.3	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 187	56		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	PCB 187	0.6	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 194	20		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	PCB 194	0.2	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 201	17		ug/kg	13.3
SD11	3	Ca. scorpionfish	Liver	PCB 206	9.1	E	ug/kg	
SD11	3	Ca. scorpionfish	Muscle	PCB 206	0.2	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 66	6.1	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 70	1.4	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 74	3.2	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 87	7.5	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	PCB 99	30		ug/kg	13.3
SD11	3	Ca. scorpionfish	Muscle	PCB 99	0.4	E	ug/kg	
SD11	3	Ca. scorpionfish	Liver	Selenium	1.04		mg/kg	0.06
SD11	3	Ca. scorpionfish	Muscle	Selenium	0.548		mg/kg	0.06
SD11	3	Ca. scorpionfish	Liver	Total Solids	51.3		wt%	0.4
SD11	3	Ca. scorpionfish	Muscle	Total Solids	23.1		wt%	0.4
SD11	3	Ca. scorpionfish	Liver	Trans Nonachlor	20		ug/kg	20
SD11	3	Ca. scorpionfish	Liver	Zinc	140		mg/kg	0.58
SD11	3	Ca. scorpionfish	Muscle	Zinc	2.5		mg/kg	0.58
SD12	1	Ca. scorpionfish	Liver	Arsenic	14.1		mg/kg	1.4
SD12	1	Ca. scorpionfish	Muscle	Arsenic	2.6		mg/kg	1.4
SD12	1	Ca. scorpionfish	Liver	Cadmium	3.1		mg/kg	0.34
SD12	1	Ca. scorpionfish	Liver	Copper	37.8		mg/kg	0.76
SD12	1	Ca. scorpionfish	Liver	Hexachlorobenzene	3.9	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	Iron	142		mg/kg	1.3
SD12	1	Ca. scorpionfish	Liver	Lipids	27		wt%	0.005
SD12	1	Ca. scorpionfish	Muscle	Lipids	3.5		wt%	0.005
SD12	1	Ca. scorpionfish	Liver	Mercury	0.11		mg/kg	0.03
SD12	1	Ca. scorpionfish	Muscle	Mercury	0.194		mg/kg	0.03
SD12	1	Ca. scorpionfish	Liver	o,p-DDE	2.2	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	o,p-DDE	0.3	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	p,p-DDD	7	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	p,p-DDD	1.1	E	ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD12	1	Ca. scorpionfish	Liver	p,p-DDE	390		ug/kg	13.3
SD12	1	Ca. scorpionfish	Muscle	p,p-DDE	59		ug/kg	1.33
SD12	1	Ca. scorpionfish	Liver	p,p-DDT	8.8	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	p,p-DDT	1.1	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 101	7.9	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 101	1.4		ug/kg	1.33
SD12	1	Ca. scorpionfish	Liver	PCB 105	6	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 105	0.8	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 110	5.1	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 110	0.7	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 118	17		ug/kg	13.3
SD12	1	Ca. scorpionfish	Muscle	PCB 118	2.3		ug/kg	1.33
SD12	1	Ca. scorpionfish	Liver	PCB 123	1.9	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 123	0.3	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 128	4.5	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 128	0.6	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 138	24		ug/kg	13.3
SD12	1	Ca. scorpionfish	Muscle	PCB 138	2.6		ug/kg	1.33
SD12	1	Ca. scorpionfish	Liver	PCB 149	4.2	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 149	0.7	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 151	3.7	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 151	0.4	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 153/168	43		ug/kg	13.3
SD12	1	Ca. scorpionfish	Muscle	PCB 153/168	5.1		ug/kg	1.33
SD12	1	Ca. scorpionfish	Liver	PCB 156	2.3	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 156	0.3	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 158	2	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 158	0.2	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 167	1.7	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 177	3.2	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 177	0.5	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 180	23		ug/kg	13.3
SD12	1	Ca. scorpionfish	Muscle	PCB 180	2.5		ug/kg	1.33
SD12	1	Ca. scorpionfish	Liver	PCB 183	6.1	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 183	0.6	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 187	18		ug/kg	13.3
SD12	1	Ca. scorpionfish	Muscle	PCB 187	1.9		ug/kg	1.33
SD12	1	Ca. scorpionfish	Liver	PCB 194	7.2	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 194	0.5	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 206	4.4	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 206	0.4	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 66	2.7	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 66	0.4	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 74	0.2	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 87	2.3	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 87	0.3	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	PCB 99	8.4	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	PCB 99	1	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	Selenium	1.06		mg/kg	0.06
SD12	1	Ca. scorpionfish	Muscle	Selenium	0.351		mg/kg	0.06
SD12	1	Ca. scorpionfish	Liver	Total Solids	58.6		wt%	0.4

Appendix D.3 continued

October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD12	1	Ca. scorpionfish	Muscle	Total Solids	21		wt%	0.4
SD12	1	Ca. scorpionfish	Liver	Trans Nonachlor	9.4	E	ug/kg	
SD12	1	Ca. scorpionfish	Muscle	Trans Nonachlor	1.3	E	ug/kg	
SD12	1	Ca. scorpionfish	Liver	Zinc	134		mg/kg	0.58
SD12	1	Ca. scorpionfish	Muscle	Zinc	1.36		mg/kg	0.58
SD12	2	Dover sole	Liver	Aluminum	3.4		mg/kg	2.6
SD12	2	Dover sole	Muscle	Arsenic	5		mg/kg	1.4
SD12	2	Dover sole	Liver	Copper	3.37		mg/kg	0.76
SD12	2	Dover sole	Liver	Hexachlorobenzene	1.1	E	ug/kg	
SD12	2	Dover sole	Liver	Iron	165		mg/kg	1.3
SD12	2	Dover sole	Liver	Lipids	9.04		wt%	0.005
SD12	2	Dover sole	Muscle	Lipids	0.18		wt%	0.005
SD12	2	Dover sole	Liver	Manganese	0.43		mg/kg	0.23
SD12	2	Dover sole	Liver	Mercury	0.139		mg/kg	0.03
SD12	2	Dover sole	Liver	o,p-DDE	1.5	E	ug/kg	
SD12	2	Dover sole	Liver	p,p-DDD	1.4	E	ug/kg	
SD12	2	Dover sole	Liver	p,p-DDE	57		ug/kg	13.3
SD12	2	Dover sole	Muscle	p,p-DDE	2.1		ug/kg	1.33
SD12	2	Dover sole	Liver	PCB 101	4.2	E	ug/kg	
SD12	2	Dover sole	Muscle	PCB 101	0.1		ug/kg	1.33
SD12	2	Dover sole	Liver	PCB 105	1.8	E	ug/kg	
SD12	2	Dover sole	Liver	PCB 110	3.2	E	ug/kg	
SD12	2	Dover sole	Liver	PCB 118	5.1	E	ug/kg	
SD12	2	Dover sole	Muscle	PCB 118	0.2	E	ug/kg	
SD12	2	Dover sole	Liver	PCB 128	2.1	E	ug/kg	
SD12	2	Dover sole	Liver	PCB 138	7.8	E	ug/kg	
SD12	2	Dover sole	Muscle	PCB 138	0.2	E	ug/kg	
SD12	2	Dover sole	Liver	PCB 149	4.5	E	ug/kg	
SD12	2	Dover sole	Liver	PCB 151	1.7	E	ug/kg	
SD12	2	Dover sole	Liver	PCB 153/168	14		ug/kg	13.3
SD12	2	Dover sole	Muscle	PCB 153/168	0.3	E	ug/kg	
SD12	2	Dover sole	Liver	PCB 180	8	E	ug/kg	
SD12	2	Dover sole	Muscle	PCB 180	0.15		ug/kg	1.33
SD12	2	Dover sole	Liver	PCB 183	1.8	E	ug/kg	
SD12	2	Dover sole	Liver	PCB 187	6	E	ug/kg	
SD12	2	Dover sole	Muscle	PCB 187	0.05		ug/kg	1.33
SD12	2	Dover sole	Liver	PCB 194	3.2	E	ug/kg	
SD12	2	Dover sole	Liver	PCB 206	5.2	E	ug/kg	
SD12	2	Dover sole	Muscle	PCB 206	0.3	E	ug/kg	
SD12	2	Dover sole	Liver	PCB 99	3.8	E	ug/kg	
SD12	2	Dover sole	Muscle	PCB 99	0.1	E	ug/kg	
SD12	2	Dover sole	Liver	Selenium	2.77		mg/kg	0.06
SD12	2	Dover sole	Muscle	Selenium	0.437		mg/kg	0.06
SD12	2	Dover sole	Liver	Total Solids	27.1		wt%	0.4
SD12	2	Dover sole	Muscle	Total Solids	19		wt%	0.4
SD12	2	Dover sole	Liver	Zinc	19.4		mg/kg	0.58
SD12	2	Dover sole	Muscle	Zinc	2.69		mg/kg	0.58
SD12	3	Pacific sanddab	Liver	Alpha (cis) Chlordane	9.4	E	ug/kg	
SD12	3	Pacific sanddab	Liver	Arsenic	2.5		mg/kg	1.4
SD12	3	Pacific sanddab	Muscle	Arsenic	4.6		mg/kg	1.4
SD12	3	Pacific sanddab	Liver	Copper	3.12		mg/kg	0.76

Appendix D.3 continued

October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD12	3	Pacific sanddab	Liver	Hexachlorobenzene	5.7	E	ug/kg	
SD12	3	Pacific sanddab	Liver	Iron	74.4		mg/kg	1.3
SD12	3	Pacific sanddab	Liver	Lead	5.6		mg/kg	2.5
SD12	3	Pacific sanddab	Liver	Lipids	43.1		wt%	0.005
SD12	3	Pacific sanddab	Muscle	Lipids	0.09		wt%	0.005
SD12	3	Pacific sanddab	Liver	Manganese	0.5		mg/kg	0.23
SD12	3	Pacific sanddab	Liver	Mercury	0.579		mg/kg	0.03
SD12	3	Pacific sanddab	Liver	o,p-DDE	6.3	E	ug/kg	
SD12	3	Pacific sanddab	Liver	o,p-DDT	2.5	E	ug/kg	
SD12	3	Pacific sanddab	Liver	p,p-DDD	9.7	E	ug/kg	
SD12	3	Pacific sanddab	Liver	p,p-DDE	570		ug/kg	13.3
SD12	3	Pacific sanddab	Muscle	p,p-DDE	1.4		ug/kg	1.33
SD12	3	Pacific sanddab	Liver	p,p-DDT	22		ug/kg	13.3
SD12	3	Pacific sanddab	Liver	PCB 101	13	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 105	12	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 110	13	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 118	32		ug/kg	13.3
SD12	3	Pacific sanddab	Muscle	PCB 118	0.1	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 123	3.3	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 128	11	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 138	47		ug/kg	13.3
SD12	3	Pacific sanddab	Muscle	PCB 138	0.2	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 149	9.9	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 151	6.3	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 153/168	70		ug/kg	13.3
SD12	3	Pacific sanddab	Muscle	PCB 153/168	0.2	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 156	4.4	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 157	1.9	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 158	3.7	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 167	3.1	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 177	5.3	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 180	33		ug/kg	13.3
SD12	3	Pacific sanddab	Liver	PCB 183	9.2	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 187	28		ug/kg	13.3
SD12	3	Pacific sanddab	Liver	PCB 194	10	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 206	6.7	E	ug/kg	
SD12	3	Pacific sanddab	Muscle	PCB 206	0.2	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 52	5.2	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 66	4.3	E	ug/kg	
SD12	3	Pacific sanddab	Muscle	PCB 66	0.1	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 70	3.8	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 74	2.8	E	ug/kg	
SD12	3	Pacific sanddab	Muscle	PCB 74	0.2	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 87	4.1	E	ug/kg	
SD12	3	Pacific sanddab	Liver	PCB 99	19		ug/kg	13.3
SD12	3	Pacific sanddab	Muscle	PCB 99	0.1	E	ug/kg	
SD12	3	Pacific sanddab	Liver	Selenium	0.721		mg/kg	0.06
SD12	3	Pacific sanddab	Muscle	Selenium	0.263		mg/kg	0.06
SD12	3	Pacific sanddab	Liver	Total Solids	61.6		wt%	0.4
SD12	3	Pacific sanddab	Muscle	Total Solids	19.6		wt%	0.4
SD12	3	Pacific sanddab	Liver	Trans Nonachlor	14	E	ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD12	3	Pacific sanddab	Liver	Zinc	19		mg/kg	0.58
SD12	3	Pacific sanddab	Muscle	Zinc	1.22		mg/kg	0.58
SD13	1	Longfin sanddab	Liver	Alpha (cis) Chlordane	5	E	ug/kg	
SD13	1	Longfin sanddab	Liver	Aluminum	4.3		mg/kg	2.6
SD13	1	Longfin sanddab	Liver	Arsenic	14.9		mg/kg	1.4
SD13	1	Longfin sanddab	Muscle	Arsenic	9.9		mg/kg	1.4
SD13	1	Longfin sanddab	Liver	Cadmium	1.74		mg/kg	0.34
SD13	1	Longfin sanddab	Liver	Copper	6.87		mg/kg	0.76
SD13	1	Longfin sanddab	Liver	Hexachlorobenzene	3.5	E	ug/kg	
SD13	1	Longfin sanddab	Muscle	Hexachlorobenzene	0.1	E	ug/kg	
SD13	1	Longfin sanddab	Liver	Iron	153		mg/kg	1.3
SD13	1	Longfin sanddab	Liver	Lipids	27.7		wt%	0.005
SD13	1	Longfin sanddab	Muscle	Lipids	0.32		wt%	0.005
SD13	1	Longfin sanddab	Liver	Manganese	0.57		mg/kg	0.23
SD13	1	Longfin sanddab	Liver	Mercury	0.0666		mg/kg	0.03
SD13	1	Longfin sanddab	Muscle	Mercury	0.0861		mg/kg	0.03
SD13	1	Longfin sanddab	Liver	o,p-DDE	14		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	p,p-DDD	8.7	E	ug/kg	
SD13	1	Longfin sanddab	Liver	p,p-DDE	730		ug/kg	13.3
SD13	1	Longfin sanddab	Muscle	p,p-DDE	3.3		ug/kg	1.33
SD13	1	Longfin sanddab	Liver	p,p-DDT	11	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 101	15		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 105	18		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 110	16		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 118	57		ug/kg	13.3
SD13	1	Longfin sanddab	Muscle	PCB 118	0.2	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 119	1.6	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 123	5.9	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 128	18		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 138	91		ug/kg	13.3
SD13	1	Longfin sanddab	Muscle	PCB 138	0.3	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 149	15		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 151	14		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 153/168	130		ug/kg	13.3
SD13	1	Longfin sanddab	Muscle	PCB 153/168	0.5	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 156	9.3	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 157	3.3	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 158	6.9	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 167	6.1	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 177	13	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 180	64		ug/kg	13.3
SD13	1	Longfin sanddab	Muscle	PCB 180	0.3	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 183	21		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 187	60		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 189	2.6	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 194	30		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	PCB 206	14		ug/kg	13.3
SD13	1	Longfin sanddab	Muscle	PCB 206	0.3	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 66	6.6	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 70	3	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 74	4.4	E	ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD13	1	Longfin sanddab	Liver	PCB 87	3.6	E	ug/kg	
SD13	1	Longfin sanddab	Liver	PCB 99	34		ug/kg	13.3
SD13	1	Longfin sanddab	Liver	Selenium	2.53		mg/kg	0.06
SD13	1	Longfin sanddab	Muscle	Selenium	2.62		mg/kg	0.06
SD13	1	Longfin sanddab	Liver	Total Solids	44.8		wt%	0.4
SD13	1	Longfin sanddab	Muscle	Total Solids	19.1		wt%	0.4
SD13	1	Longfin sanddab	Liver	Trans Nonachlor	10	E	ug/kg	
SD13	1	Longfin sanddab	Liver	Zinc	16.8		mg/kg	0.58
SD13	1	Longfin sanddab	Muscle	Zinc	1.52		mg/kg	0.58
SD13	2	Ca. scorpionfish	Liver	Aluminum	7.8		mg/kg	2.6
SD13	2	Ca. scorpionfish	Liver	Arsenic	3.9		mg/kg	1.4
SD13	2	Ca. scorpionfish	Muscle	Arsenic	7		mg/kg	1.4
SD13	2	Ca. scorpionfish	Liver	Cadmium	2.64		mg/kg	0.34
SD13	2	Ca. scorpionfish	Muscle	Chromium	0.51		mg/kg	0.3
SD13	2	Ca. scorpionfish	Liver	Copper	67		mg/kg	0.76
SD13	2	Ca. scorpionfish	Muscle	Copper	5.77		mg/kg	0.76
SD13	2	Ca. scorpionfish	Liver	Hexachlorobenzene	4.8	E	ug/kg	
SD13	2	Ca. scorpionfish	Muscle	Hexachlorobenzene	0.1	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	Iron	202		mg/kg	1.3
SD13	2	Ca. scorpionfish	Muscle	Iron	6.3		mg/kg	1.3
SD13	2	Ca. scorpionfish	Liver	Lipids	32		wt%	0.005
SD13	2	Ca. scorpionfish	Muscle	Lipids	0.4		wt%	0.005
SD13	2	Ca. scorpionfish	Muscle	Manganese	0.39		mg/kg	0.23
SD13	2	Ca. scorpionfish	Liver	Mercury	0.119		mg/kg	0.03
SD13	2	Ca. scorpionfish	Muscle	Mercury	0.298		mg/kg	0.03
SD13	2	Ca. scorpionfish	Liver	o,p-DDE	3.7	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	p,p-DDD	13	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	p,p-DDE	1400		ug/kg	13.3
SD13	2	Ca. scorpionfish	Muscle	p,p-DDE	3.5		ug/kg	1.33
SD13	2	Ca. scorpionfish	Liver	p,p-DDT	11	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 101	27		ug/kg	13.3
SD13	2	Ca. scorpionfish	Liver	PCB 105	24		ug/kg	13.3
SD13	2	Ca. scorpionfish	Liver	PCB 110	15		ug/kg	13.3
SD13	2	Ca. scorpionfish	Liver	PCB 118	73		ug/kg	13.3
SD13	2	Ca. scorpionfish	Muscle	PCB 118	0.1	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 123	7	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 128	26		ug/kg	13.3
SD13	2	Ca. scorpionfish	Liver	PCB 138	120		ug/kg	13.3
SD13	2	Ca. scorpionfish	Muscle	PCB 138	0.3	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 149	13	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 151	14		ug/kg	13.3
SD13	2	Ca. scorpionfish	Liver	PCB 153/168	160		ug/kg	13.3
SD13	2	Ca. scorpionfish	Muscle	PCB 153/168	0.3	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 156	11	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 157	4.4	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 158	9.9	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 167	7.6	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 170	39		ug/kg	13.3
SD13	2	Ca. scorpionfish	Liver	PCB 177	18		ug/kg	13.3
SD13	2	Ca. scorpionfish	Liver	PCB 180	85		ug/kg	13.3
SD13	2	Ca. scorpionfish	Muscle	PCB 180	0.2	E	ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD13	2	Ca. scorpionfish	Liver	PCB 183	27		ug/kg	13.3
SD13	2	Ca. scorpionfish	Liver	PCB 187	75		ug/kg	13.3
SD13	2	Ca. scorpionfish	Liver	PCB 194	29		ug/kg	13.3
SD13	2	Ca. scorpionfish	Liver	PCB 206	12	E	ug/kg	
SD13	2	Ca. scorpionfish	Muscle	PCB 206	0.3	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 28	1.4	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 44	1.5	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 49	2.7	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 52	3.6	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 66	6.7	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 74	3.3	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 87	7.5	E	ug/kg	
SD13	2	Ca. scorpionfish	Liver	PCB 99	33		ug/kg	13.3
SD13	2	Ca. scorpionfish	Liver	Selenium	0.762		mg/kg	0.06
SD13	2	Ca. scorpionfish	Muscle	Selenium	0.507		mg/kg	0.06
SD13	2	Ca. scorpionfish	Liver	Total Solids	60		wt%	0.4
SD13	2	Ca. scorpionfish	Muscle	Total Solids	21.3		wt%	0.4
SD13	2	Ca. scorpionfish	Liver	Trans Nonachlor	23		ug/kg	20
SD13	2	Ca. scorpionfish	Liver	Zinc	182		mg/kg	0.58
SD13	2	Ca. scorpionfish	Muscle	Zinc	2.43		mg/kg	0.58
SD13	3	Ca. scorpionfish	Liver	Alpha (cis) Chlordane	5	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	Arsenic	2.2		mg/kg	1.4
SD13	3	Ca. scorpionfish	Muscle	Arsenic	7.9		mg/kg	1.4
SD13	3	Ca. scorpionfish	Liver	Cadmium	3.55		mg/kg	0.34
SD13	3	Ca. scorpionfish	Liver	Copper	34.1		mg/kg	0.76
SD13	3	Ca. scorpionfish	Muscle	Copper	1.04		mg/kg	0.76
SD13	3	Ca. scorpionfish	Liver	Hexachlorobenzene	3.5	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	Iron	192		mg/kg	1.3
SD13	3	Ca. scorpionfish	Liver	Lipids	30.5		wt%	0.005
SD13	3	Ca. scorpionfish	Muscle	Lipids	0.25		wt%	0.005
SD13	3	Ca. scorpionfish	Liver	Mercury	0.154		mg/kg	0.03
SD13	3	Ca. scorpionfish	Muscle	Mercury	0.22		mg/kg	0.03
SD13	3	Ca. scorpionfish	Liver	o,p-DDE	5.8	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	o,p-DDT	2	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	p,p-DDD	18		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	p,p-DDD	0.5	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	p,p-DDE	1000		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	p,p-DDE	23		ug/kg	1.33
SD13	3	Ca. scorpionfish	Liver	p,p-DDT	15		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	p,p-DDT	0.4	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 101	25		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	PCB 101	0.5	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 105	17		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	PCB 105	0.4	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 110	20		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	PCB 110	0.3	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 118	48		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	PCB 118	0.7	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 123	4.9	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 128	12	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 138	59		ug/kg	13.3

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD13	3	Ca. scorpionfish	Muscle	PCB 138	0.7	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 149	13	E	ug/kg	
SD13	3	Ca. scorpionfish	Muscle	PCB 149	0.3	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 151	8.4	E	ug/kg	
SD13	3	Ca. scorpionfish	Muscle	PCB 151	0.2	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 153/168	82		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	PCB 153/168	1.2	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 156	5.6	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 157	2.3	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 158	5.3	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 167	3.6	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 177	7.7	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 180	39		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	PCB 180	0.6	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 183	11	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 187	31		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	PCB 187	0.4	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 194	13	E	ug/kg	
SD13	3	Ca. scorpionfish	Muscle	PCB 194	0.2	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 206	6	E	ug/kg	
SD13	3	Ca. scorpionfish	Muscle	PCB 206	0.3	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 66	6.9	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 70	3.8	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 74	3.5	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 87	9	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	PCB 99	23		ug/kg	13.3
SD13	3	Ca. scorpionfish	Muscle	PCB 99	0.5	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	Selenium	0.886		mg/kg	0.06
SD13	3	Ca. scorpionfish	Muscle	Selenium	0.441		mg/kg	0.06
SD13	3	Ca. scorpionfish	Liver	Total Solids	51.5		wt%	0.4
SD13	3	Ca. scorpionfish	Muscle	Total Solids	21.4		wt%	0.4
SD13	3	Ca. scorpionfish	Liver	Trans Nonachlor	16	E	ug/kg	
SD13	3	Ca. scorpionfish	Liver	Zinc	109		mg/kg	0.58
SD13	3	Ca. scorpionfish	Muscle	Zinc	2.5		mg/kg	0.58
SD14	1	Pacific sanddab	Liver	Alpha (cis) Chlordane	8.1	E	ug/kg	
SD14	1	Pacific sanddab	Liver	Aluminum	3.4		mg/kg	2.6
SD14	1	Pacific sanddab	Liver	Arsenic	4.8		mg/kg	1.4
SD14	1	Pacific sanddab	Muscle	Arsenic	5.3		mg/kg	1.4
SD14	1	Pacific sanddab	Liver	Beryllium	0.059		mg/kg	0.035
SD14	1	Pacific sanddab	Liver	Cadmium	0.46		mg/kg	0.34
SD14	1	Pacific sanddab	Liver	Copper	8.43		mg/kg	0.76
SD14	1	Pacific sanddab	Liver	Hexachlorobenzene	6.9	E	ug/kg	
SD14	1	Pacific sanddab	Liver	Iron	27.5		mg/kg	1.3
SD14	1	Pacific sanddab	Muscle	Iron	1.9		mg/kg	1.3
SD14	1	Pacific sanddab	Liver	Lipids	47.8		wt%	0.005
SD14	1	Pacific sanddab	Muscle	Lipids	0.31		wt%	0.005
SD14	1	Pacific sanddab	Liver	Manganese	0.24		mg/kg	0.23
SD14	1	Pacific sanddab	Liver	Mercury	0.064		mg/kg	0.03
SD14	1	Pacific sanddab	Liver	o,p-DDE	3.8	E	ug/kg	
SD14	1	Pacific sanddab	Liver	o,p-DDT	1.6	E	ug/kg	
SD14	1	Pacific sanddab	Liver	p,p-DDD	6.9	E	ug/kg	

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD14	1	Pacific sanddab	Liver	p,p-DDE	420		ug/kg	13.3
SD14	1	Pacific sanddab	Muscle	p,p-DDE	1.7		ug/kg	1.33
SD14	1	Pacific sanddab	Liver	p,p-DDT	16		ug/kg	13.3
SD14	1	Pacific sanddab	Liver	PCB 101	8	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 105	7.5	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 110	7.3	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 118	18		ug/kg	13.3
SD14	1	Pacific sanddab	Liver	PCB 128	4.6	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 138	25		ug/kg	13.3
SD14	1	Pacific sanddab	Liver	PCB 149	2.8	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 151	3.3	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 153/168	35		ug/kg	13.3
SD14	1	Pacific sanddab	Muscle	PCB 153/168	0.2	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 156	1.4	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 158	1.6	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 167	1.4	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 177	2.7	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 180	18		ug/kg	13.3
SD14	1	Pacific sanddab	Liver	PCB 183	4.8	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 187	14		ug/kg	13.3
SD14	1	Pacific sanddab	Liver	PCB 194	5.4	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 206	4.2	E	ug/kg	
SD14	1	Pacific sanddab	Muscle	PCB 206	0.3	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 66	3.1	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 70	2.7	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 74	1.7	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 87	2.2	E	ug/kg	
SD14	1	Pacific sanddab	Liver	PCB 99	11	E	ug/kg	
SD14	1	Pacific sanddab	Liver	Selenium	0.995		mg/kg	0.06
SD14	1	Pacific sanddab	Muscle	Selenium	0.244		mg/kg	0.06
SD14	1	Pacific sanddab	Liver	Total Solids	63.4		wt%	0.4
SD14	1	Pacific sanddab	Muscle	Total Solids	19.4		wt%	0.4
SD14	1	Pacific sanddab	Liver	Trans Nonachlor	9.1	E	ug/kg	
SD14	1	Pacific sanddab	Liver	Zinc	21.7		mg/kg	0.58
SD14	1	Pacific sanddab	Muscle	Zinc	5.12		mg/kg	0.58
SD14	2	Pacific sanddab	Liver	Alpha (cis) Chlordane	5.4	E	ug/kg	
SD14	2	Pacific sanddab	Liver	Aluminum	9		mg/kg	2.6
SD14	2	Pacific sanddab	Liver	Antimony	4.6		mg/kg	3.7
SD14	2	Pacific sanddab	Liver	Arsenic	9.4		mg/kg	1.4
SD14	2	Pacific sanddab	Muscle	Arsenic	6.3		mg/kg	1.4
SD14	2	Pacific sanddab	Liver	Cadmium	1.98		mg/kg	0.34
SD14	2	Pacific sanddab	Liver	Copper	14.2		mg/kg	0.76
SD14	2	Pacific sanddab	Muscle	Copper	5.25		mg/kg	0.76
SD14	2	Pacific sanddab	Liver	Hexachlorobenzene	6.3	E	ug/kg	
SD14	2	Pacific sanddab	Liver	Iron	77.9		mg/kg	1.3
SD14	2	Pacific sanddab	Liver	Lead	3		mg/kg	2.5
SD14	2	Pacific sanddab	Liver	Lipids	44.6		wt%	0.005
SD14	2	Pacific sanddab	Muscle	Lipids	0.1		wt%	0.005
SD14	2	Pacific sanddab	Liver	Manganese	0.6		mg/kg	0.23
SD14	2	Pacific sanddab	Liver	Mercury	0.0572		mg/kg	0.03
SD14	2	Pacific sanddab	Muscle	Mercury	0.0484		mg/kg	0.03

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD14	2	Pacific sanddab	Liver	o,p-DDE	3.8	E	ug/kg	
SD14	2	Pacific sanddab	Liver	p,p-DDD	5.5	E	ug/kg	
SD14	2	Pacific sanddab	Liver	p,p-DDE	310		ug/kg	13.3
SD14	2	Pacific sanddab	Muscle	p,p-DDE	1	E	ug/kg	
SD14	2	Pacific sanddab	Liver	p,p-DDT	11	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 101	8.1	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 105	6.8	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 110	8.1	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 118	16		ug/kg	13.3
SD14	2	Pacific sanddab	Liver	PCB 119	2.8	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 123	4.3	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 126	2.4	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 128	5.7	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 138	21		ug/kg	13.3
SD14	2	Pacific sanddab	Liver	PCB 149	6.5	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 151	5.2	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 153/168	35		ug/kg	13.3
SD14	2	Pacific sanddab	Liver	PCB 156	3	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 157	2.9	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 158	3.3	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 167	2.9	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 177	3.7	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 180	16		ug/kg	13.3
SD14	2	Pacific sanddab	Liver	PCB 183	5.2	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 187	15		ug/kg	13.3
SD14	2	Pacific sanddab	Liver	PCB 189	2.7	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 194	6.2	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 206	5.1	E	ug/kg	
SD14	2	Pacific sanddab	Muscle	PCB 206	0.3	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 28	5.2	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 66	5.3	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 70	4.5	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 74	4.6	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 77	3.2	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 87	3.6	E	ug/kg	
SD14	2	Pacific sanddab	Liver	PCB 99	12	E	ug/kg	
SD14	2	Pacific sanddab	Liver	Selenium	0.713		mg/kg	0.06
SD14	2	Pacific sanddab	Muscle	Selenium	0.306		mg/kg	0.06
SD14	2	Pacific sanddab	Liver	Total Solids	60.9		wt%	0.4
SD14	2	Pacific sanddab	Muscle	Total Solids	18.9		wt%	0.4
SD14	2	Pacific sanddab	Liver	Trans Nonachlor	8.5	E	ug/kg	
SD14	2	Pacific sanddab	Liver	Zinc	19.1		mg/kg	0.58
SD14	2	Pacific sanddab	Muscle	Zinc	1.54		mg/kg	0.58
SD14	3	Pacific sanddab	Liver	Alpha (cis) Chlordane	6.8	E	ug/kg	
SD14	3	Pacific sanddab	Liver	Aluminum	4.2		mg/kg	2.6
SD14	3	Pacific sanddab	Liver	Arsenic	4.8		mg/kg	1.4
SD14	3	Pacific sanddab	Muscle	Arsenic	5.1		mg/kg	1.4
SD14	3	Pacific sanddab	Liver	Cadmium	1.75		mg/kg	0.34
SD14	3	Pacific sanddab	Liver	Copper	5.04		mg/kg	0.76
SD14	3	Pacific sanddab	Liver	Hexachlorobenzene	7.6	E	ug/kg	
SD14	3	Pacific sanddab	Liver	Iron	50.1		mg/kg	1.3

Appendix D.3 continued
October 2002

Station	Rep	Species	Tissue	Parameter	Value		Units	MDL
SD14	3	Pacific sanddab	Liver	Lipids	46.4		wt%	0.005
SD14	3	Pacific sanddab	Muscle	Lipids	0.07		wt%	0.005
SD14	3	Pacific sanddab	Liver	Manganese	0.47		mg/kg	0.23
SD14	3	Pacific sanddab	Liver	Mercury	0.0794		mg/kg	0.03
SD14	3	Pacific sanddab	Muscle	Mercury	0.0376		mg/kg	0.03
SD14	3	Pacific sanddab	Liver	o,p-DDE	4.2	E	ug/kg	
SD14	3	Pacific sanddab	Liver	p,p-DDD	6.9	E	ug/kg	
SD14	3	Pacific sanddab	Liver	p,p-DDE	530		ug/kg	13.3
SD14	3	Pacific sanddab	Muscle	p,p-DDE	1.8		ug/kg	1.33
SD14	3	Pacific sanddab	Liver	p,p-DDT	16		ug/kg	13.3
SD14	3	Pacific sanddab	Liver	PCB 101	8.5	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 105	6	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 110	7.6	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 118	18		ug/kg	13.3
SD14	3	Pacific sanddab	Liver	PCB 128	4.6	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 138	23		ug/kg	13.3
SD14	3	Pacific sanddab	Liver	PCB 149	4.3	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 151	3.8	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 153/168	35		ug/kg	13.3
SD14	3	Pacific sanddab	Liver	PCB 158	1.7	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 180	16		ug/kg	13.3
SD14	3	Pacific sanddab	Liver	PCB 183	3.9	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 187	13	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 194	4.6	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 206	4.1	E	ug/kg	
SD14	3	Pacific sanddab	Muscle	PCB 206	0.3	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 66	3.4	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 70	2.8	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 74	2.1	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 87	2.7	E	ug/kg	
SD14	3	Pacific sanddab	Liver	PCB 99	11	E	ug/kg	
SD14	3	Pacific sanddab	Liver	Selenium	0.669		mg/kg	0.06
SD14	3	Pacific sanddab	Muscle	Selenium	0.344		mg/kg	0.06
SD14	3	Pacific sanddab	Liver	Total Solids	62.5		wt%	0.4
SD14	3	Pacific sanddab	Muscle	Total Solids	18.9		wt%	0.4
SD14	3	Pacific sanddab	Liver	Trans Nonachlor	11	E	ug/kg	
SD14	3	Pacific sanddab	Liver	Zinc	16.7		mg/kg	0.58
SD14	3	Pacific sanddab	Muscle	Zinc	1.68		mg/kg	0.58

APPENDIX E

Coastal Remote Sensing of the San Diego/Tijuana Region

Appendix E

Coastal Remote Sensing of the San Diego/Tijuana Region

INTRODUCTION

Imagery from satellite data and aerial sensors produces a synoptic look at surface water clarity that is not possible using shipboard sampling alone. Analysis of seawater samples requires various laboratory tests while CTD casts require further data processing, both of which can add considerable time to the interpretation of water quality conditions. Sampling at fixed stations once a week or once a month results in inconvenient, albeit unavoidable, gaps in assembled time series of coastal water quality data. With public health issues a paramount concern of ocean monitoring programs, any information that helps to provide a clearer and more complete picture of water conditions is of benefit to the general public as well as to program managers and researchers. Having access to a large-scale visual overview of surface waters within a few hours of image collection also has the potential to bring the monitoring program closer to real-time diagnosis of possible contamination conditions.

For the above reasons, the City of San Diego, the United States International Boundary and Water Commission, and the San Diego Regional Water Quality Control Board have contracted with Ocean Imaging Corporation (Solana Beach, CA) to conduct an aerial/satellite remote sensing program for the San Diego/Tijuana region to complement the on-going ocean monitoring programs for the Point Loma and South Bay ocean outfalls. One objective of this multi-year project is to determine if any relationship exists between the various types of imagery data and field-collected data. The investigators and sponsors of this research recognize that remotely-sensed data will only provide information about surface waters (~0 to 15 m) without providing any direct information regarding water movements, water color, or water clarity in deeper layers. However, the data is proving useful despite its limitation to surface waters.

Although quantitative measures are still under development, early results have demonstrated interesting surface turbidity patterns in the waters off Point Loma. Since the Point Loma Ocean Outfall (PLOO) was extended in 1994, researchers have contended that most incidents of elevated bacterial counts along the shoreline were likely due to land-based contamination (e.g., terrestrial and riverine runoff) rather than the onshore transport of the wastewater plume from the outfall. However, there was little direct evidence to either support or reject this hypothesis. Now, images captured coincident with field samples as part of the remote sensing project are adding support to the land-based source hypothesis. For example, expansive views of the coastline following rainfall events have identified up to 10 separate point sources of significant turbidity plumes to coastal waters off San Diego (Ocean Imaging, 2000). The extent of these plumes can exceed 10 km from shore and at times have been witnessed in surface waters near the outfall terminus.

Satellite and aerial images often geographically pinpoint the origin of different plumes and help to differentiate between the turbidity contributions of river discharges, storm drain effluents, or sediment resuspension events that may be due to tides, currents, or wind-driven surf or swell (Figure E.1). For example, turbidity emanating from a river mouth instead of a headland and accompanied by calm wind and swell conditions strongly implicates riverine sources and not bottom sediment resuspension. In addition, the images will elucidate how turbidity-causing materials from terrestrial sources tend to disperse in surface waters over time. Various images have already shown the visible impacts of lagoon dredging, the extent and longevity of plankton blooms, and the net movements of surface waters. As land-based sources of contamination gain increased attention, the importance of determining net water movement becomes clear. Visible net northward versus net southward surface flow can be an early indication of the potential for such sources to contaminate local beaches.

Continuing analyses of images collected in concert with field sampling should begin to show how often land-based plumes are correlated with samples that register elevated bacterial counts, high total suspended solids, high chlorophyll concentrations or low transmissivity values. Further analysis into the effects of rainfall events may continue to elucidate the role of terrestrial sources in beach contamination events. For instance, an image acquired on December 18 (following substantial rains on December 16) clearly highlights large areas of high turbidity from coastal runoff plumes which persisted in nearshore waters for at least three days (see Ocean Imaging, 2003).

Still to be determined is whether or not images will be useful in tracking the dispersion of the PLOO wastewater discharge. Satellite images from November and December did not show a visible plume at the surface around the outfall. This seems to corroborate the 2002 oceanographic and microbiology field sampling finding that, even with the minimal water column stratification conditions present during winter, there was no plume transport to the surface (see Chapter 3). Quantitative data explorations currently underway should confirm whether or not discharged material has a spectral signature that distinguishes it from the surrounding naturally-occurring marine waters. However, due to the fact that surface waters surrounding the PLOO rarely exhibit high bacterial values, it may be impossible to determine whether or not plume material would be spectrally distinct in remotely-sensed images.

Finally, future research combining the results of image interpretation with the Scripps Institution of Oceanography's CODAR surface current measurement system should provide a clear picture of how surface currents influence the distribution of suspended materials. Surface currents, however, have been shown by previous research projects to be of limited use in determining bottom water currents (Hendricks, 1994). It is also unlikely that aerial or satellite imagery will provide definitive differentiation between land-based contamination and outfall contamination. Remote sensing data, and specifically surface water turbidity tracking, should provide useful information regarding the sources, dispersal trends, and relative quantities of suspended matter, but how much it will divulge about the fate of outfall discharges that originate in deeper waters remains to be seen.

LITERATURE CITED

Hendricks, T.J. (1994). Near bottom currents off southern California. In: Cross, J.N., C. Francisco, and D. Hallock, eds. Southern California Coastal Water Research Project Annual Report 1992-93. Southern California Coastal Water Research Project, Westminster, CA. p. 65 - 80

Ocean Imaging. (2003). Satellite and aerial coastal water quality monitoring in the San Diego/Tijuana region: Monthly report for December 2002 & January 2003. Ocean Imaging Corporation, Solana Beach, CA. 22 pp.

Ocean Imaging. (2000). Utilization of remotely-sensed imagery for detection and tracking of coastal sewage discharge: Final report submitted to the City of San Diego Metropolitan Wastewater Department, January 25, 2000. Ocean Imaging Corporation, Solana Beach, CA. 22 pp.

Figure E.1

Landsat Thematic Mapper visible wavelength image of the San Diego/Tijuana region January 24, 2002.

APPENDIX F

Stability of the Point Loma Kelp Forest

Appendix F

Stability of the Point Loma Kelp Forest

Paul K. Dayton, Kristin L. Riser, L. Ignacio Vilchis
Scripps Institution of Oceanography

INTRODUCTION

The Point Loma kelp forest, one of the largest kelp forests in California, is located offshore of the City of San Diego. This urban setting is located between the entrances to two large bays, Mission Bay, a recreational park, and the much larger San Diego Bay, a major naval and commercial port. The kelp forest is crossed by the Point Loma Ocean Outfall, which discharges wastewater from the Point Loma Wastewater Treatment Plant; discharge takes place 4.5 miles offshore through multiple diffusers at depths of about 310-320 feet. Within the kelp forest there is intense sport and commercial fishing for sea urchins, spiny lobsters, and fin fishes, and the kelp itself is harvested for the production of alginates. This multi-use resource is also important to San Diego's large diving community. Thus, the health of this ecosystem is of concern to all aspects of society.

Like all kelp forests, the Point Loma forest is highly dynamic (Dayton et al. 1992). Dredging the bays in the early 20th century transported sand onto the kelp habitat and restricted both the north and south sides of the kelp forest. In the 1950s the kelp forest was stressed by poorly treated sewage released within San Diego Bay, and finally the giant kelp itself virtually collapsed in the face of a massive El Niño in the late 1950s. In the early 1950s the Scripps Institution of Oceanography began some of the first coordinated scientific diving research in the world with various projects headed by Connie Limbaugh, Wheeler North, Jim Stewart and many others. The Scripps kelp forest research has continued through the present. Since 1970 the long-term study has focused on permanent transects and study sites that cover all the habitats within the forest. In addition, many of these sites were chosen to correspond as closely as possible to those areas studied by the earlier workers. The study of these permanent sites is now well into its fourth decade, and because the sites were chosen to be as close as possible to earlier sites there is even longer continuity. Except for the CalCOFI program of the California Current, now in its sixth decade, the Point Loma kelp program may be the longest continued marine time-series in the world.

The present Point Loma kelp program was started in 1971 (Dayton et al. 1984). It was expanded in 1983 to include population data on kelp plants and benthic macroinvertebrates at five permanent sites. This program was further expanded in the early 1990s to include many more sites throughout the kelp forest. Natural disturbances, notably storms, El Niños, and grazing, caused major fluctuations in the distribution and abundance of kelps, especially the giant kelp, *Macrocystis pyrifera*. Plants in this large forest are affected by gradients in depth, light, temperature, water motion, nutrient availability, and planktonic propagule supply. Storm mortality is strongly depth dependent; the inner edge of the *Macrocystis* forest appears to be defined by the height of breaking waves (Dayton et al. 1992, Seymour et al. 1989). Kelp recruitment density also decreases with depth. In addition to cross-shore gradients, there is significant longshore variability as well. Giant kelp plants on the two longshore ends of the forest suffered much higher mortality than plants in the center of the forest at the same depth during two major storm episodes. Conversely, the sites at the end of the forest had dramatically better kelp survivorship than the central site at the same depth during the 1983 El Niño summer; these sites face into longshore currents where they may be exposed to water not depleted of nutrients by the rest of the forest (Tegner & Dayton 1987).

The Point Loma kelp forest continues to face potential threats from both natural disturbances and anthropogenic impacts (e.g., Dayton et al. 1992, Tegner et al., 1995). There has been a long-term increase in ocean temperatures since 1977. The productivity of the forest is strongly affected by the low nutrients associated with higher temperatures. Average giant kelp plant size and productivity have declined significantly since the early 1970s, and will continue to decline if the warming continues. The strong El Niño of 1997/1998 devastated the Point Loma kelp forest, but was quickly followed by a La Niña event which initiated recovery. Intense fish trapping of important sea urchin predators has the potential to lead to more destructive grazing events. Non-point source pollution from terrestrial runoff and the bays that bracket Point Loma remain a concern. It is important to understand all sources of variability affecting the kelp community at Point Loma to separate potential outfall impacts from other disturbances.

MATERIALS AND METHODS

Long-Term Monitoring

The Point Loma kelp forest (**Figure 1**), approximately 8-10 km long by 1 km wide, is located on a broad, mudstone-sandstone terrace offshore of San Diego, California (32° 42’ N; 117° 16’ W). Permanent stations have been used for longterm population studies (Tegner & Dayton 1981, 1991, Dayton et al. 1984, 1992). There are four parallel 25-m transects oriented perpendicular to shore at eleven sites in the Point Loma kelp forest. These include three sites adjacent to the shipping channel (18, 15, and 12 m depths), two sites in the south (18 and 15 m), five sites in the center (21, 18, 15, 12, and 8 m), and one site in the north end of the forest (18 m). A 15 m site in the La Jolla kelp forest serves as a reference station. The five central sites are marked with permanent buoys; a line attached to chain wrapped around a reef leads to subsurface floats and a separate surface float. All sites are marked with GPS coordinates.

Giant kelps are mapped within 2 m to each side of each line, so that a total area of 400 m^2 is surveyed per site. All *Macrocystis pyrifera* that have at least four stipes per plant are mapped, and the total numbers of stipes are counted. These maps are updated quarterly to evaluate recruitment, survivorship, and growth of individual *M. pyrifera* plants. Maximum densities are not recorded because initial densities of newly recruited adults

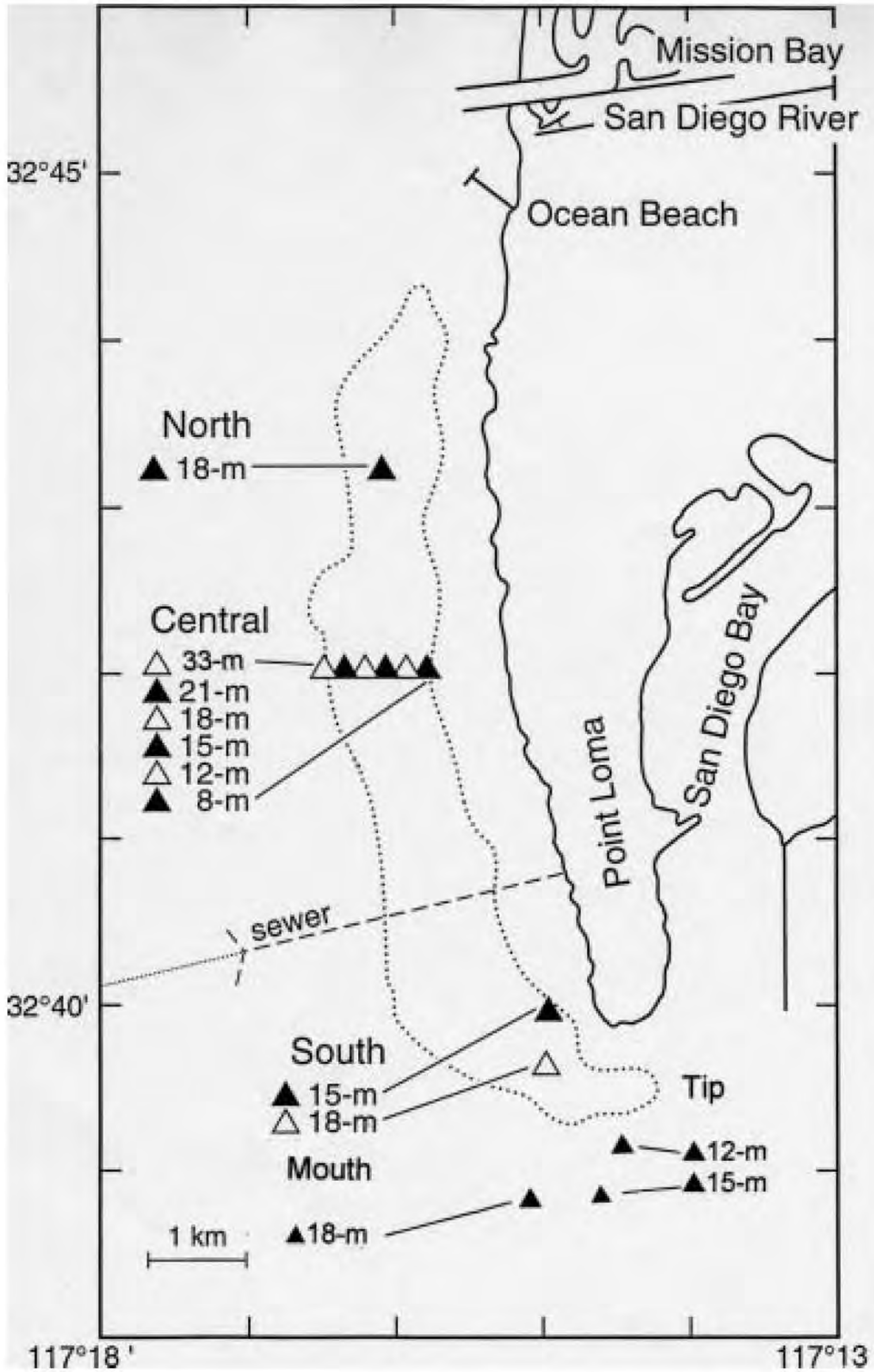


Figure F.1

Long term study sites in the Point Loma kelp forest. The dotted line represents a general outline of the *Macrocystis pyrifera* canopy.

(defined as four or more stipes, Dayton et al. 1984, 1992) are often so dense that the sampling itself would cause mortalities from diver entanglement.

In addition to the quarterly giant kelp sampling, monthly sampling of kelp populations in the center of the forest across the 8-21 m depth gradient was instituted in July of 1997. The monthly sampling involves following the growth and reproduction of three kelp species, including *Macrocystis pyrifera*, *Laminaria farlowii* and *Pterygophora californica*.

To measure growth in *Macrocystis pyrifera*, the number of stipes per plant at a height of 1 m above the substratum is recorded monthly. The volume of the bundle of sporophyll blades at the base of each plant was determined, assuming a cylinder from in situ measurements of height and diameter of the bundle. Although this is an indirect measure of reproductive effort, Reed (1987) has shown that sporophyll biomass is closely related to zoospore production. We ranked the reproductive state for each plant according to the following scale:

0 = no sporophylls present.
1 = sporophylls present but no sorus development.
2 = sporophylls with sori only at the base of sporophylls.
3 = sporophylls with sori over most sporophyll surfaces.
4 = sporophylls with sori over all sporophyll surfaces.
5 = sporophylls with sori over all sporophyll surfaces, releasing zoospores.

Growth of *Pterygophora californica* was determined by the method of DeWreede (1984). A 6 mm diameter hole was punched in the midrib of the terminal blade 30 mm from the base of the blade, and every month another hole was punched at the same location; the distance between the two holes was interpreted to represent linear growth of the blade. Reproductive effort for *P. californica* was evaluated by counting the total number of sporophylls per plant and the total number of those with sori.

Growth of *Laminaria farlowii* was determined in a manner similar to that for *P. californica*. A 13 mm diameter hole was punched 100 mm from the base of the blade and then re-punched in the same place every month; the distance between the two holes was the linear growth of the blade. Reproductive potential of *L. farlowii* was then evaluated as the percent of each blade covered by sori.

Benthic macroinvertebrate density was determined annually during the spring along the permanent transects at each site. All animals which could be seen with the use of a light, but without disrupting individuals or the substrate, were counted in 10 quadrats (5 x 2 m) along the permanent lines. This procedure misses many small individuals.

Recruitment of red (*Strongylocentrotus franciscanus*) and purple (*S. purpuratus*) sea urchins was assessed from size-frequency distributions generated biannually during the spring and fall. A 1 m^2 frame was haphazardly placed over aggregations of urchins away from the transects at each permanent site as well as at two additional sites (one west of the 18 m Central site, and one west of the 18 m South site); all rocks were overturned to search for urchins. We attempted to measure 100 individuals of each urchin species. When one species greatly outnumbered the other, additional 1 m^2 samples of only the latter species were searched to obtain an adequate sample size. The test diameter of each sea urchin was measured to the nearest millimeter with vernier calipers. Urchins smaller than 10 mm in diameter are not quantitatively sampled by this method (Tegner & Dayton 1981, 1991).

We define recruitment rate as that portion of the population of red urchins up to 35 mm and purple urchins to 25 mm test diameter at each site (Tegner & Dayton 1991). Sea urchin density is highly variable among sites at Point Loma, partly due to differences in habitat structure where the size-frequency distributions are taken, although density has remained fairly constant at most sites during the last decade (see Results). Thus, it would be misleading to compare recruitment rates in terms of density in the size-frequency distributions among the sites. Similarly, because of high variability in the habitats where the urchin aggregations are sampled, the results from the square meter samples are pooled and one value of percent recruitment is calculated per sampling period per site.

Urchin recruitment is also followed using a bimonthly settlement assay at the 21 m Central site. Four settlement brushes are attached to the bottom, bristles up, for a period of 2-4 weeks (weather dependent). After retrieval from the field, the brushes are placed in a sonicator to loosen any attached settlers. The samples are then filtered through a 500 micron sieve, and examined under a dissecting microscope. The urchins are identified to species and measured.

Physical Parameters

Temperature is inversely related to the concentration of nitrate, the nutrient which limits kelp growth; nitrate is not detectable above about 16° C in this region (Jackson 1977, Gerard 1982, Zimmerman & Kremer 1984). This strong inverse relationship allows use of temperature as a surrogate for nitrogen availability or nutrient stress. In situ bottom temperatures were recorded with Ryan TempMentors (Ryan Instruments, Redmond, WA) and Hobo-Temp Temperature Loggers (Onset Computer Corporation, Pocasset, MA). Temperatures at the longterm sites were determined every three hours from the continuous record (8 values per day) and averaged by month. Occasional equipment loss/failures caused gaps in the data.

Strings of thermistors at four sites crossing the center of the kelp forest (33, 21, 15, and 8 m depths) are used to study internal wave activity. Data are collected at 10 minute intervals; daily means are taken from these data and isotherm depths are calculated, assuming a linear constant change in temperature across depth. Data are analyzed rigorously by John Largier, Scripps Institution of Oceanography, looking for internal wave/internal tide activity.

Water samples are analyzed for dissolved nutrients (samples sent to the Oceanographic Data Facility, at Scripps Institution of Oceanography for analysis). The nitrogen content of *M. pyrifera* tissue is analyzed using the Perkin-Elmer 2400 CHN Elemental Analyzer. These data are correlated to temperature to better understand the health of the kelps.

What Structures the Outer Edge of the Forest?

In order to evaluate the processes that determine the edge of the kelp forest, we contrast recruitment, growth, reproduction, and survivorship of kelp populations under different climate regimes at 21 m Central. Frequent monitoring of white sea urchin (*Lytechinus anamesus*) densities are a part of this monitoring. The evidence to date suggests that grazing by this urchin is the major factor controlling recruitment and survival of algal populations at this site. This important new observation contradicts the common wisdom based on considerable historic experience that species of the genus *Strongylocentrotus* are responsible for the urchin barren.

RESULTS

Kelp Community Population Dynamics

Long-term Monitoring

Macrocystis pyrifera densities have varied over time off Point Loma (**Figure 2**). For example, densities of *M. pyrifera* plants declined steadily throughout the 1997-1998 El Niño at all sites except 21 m Central, the latter which did not have adult recruitment until well after this El Niño event). These densities approached zero by June of 1998 (**Figure 3**). There was a pulse of juvenile *M. pyrifera* recruitment during this same period, which was considerably higher at 15 m Central compared to the other sites (**Figure 4**). This pattern continued when these recruits were first mapped as adults in January of 1999. Recruitment at the 21 m site lagged behind the other sites by almost one year. After July 1999, adult *M. pyrifera* densities began to decrease at 18 and 15 m, while densities continued to increase at 21, 12 and 8 m. The three deeper sites had significantly higher giant kelp densities than did the two shallow sites. All sites showed a steady decline in the *M. pyrifera* density beginning in early 2000, and the differences between the sites disappeared by November 2000. The density of *M. pyrifera* at the three deeper sites remains slightly higher than at the two shallow sites.

The number of stipes per *M. pyrifera* plant indicates individual growth, and stipe density per square meter is an index of environmental carrying capacity (Dayton et al. 1992). All sites showed a general increase in the mean number of stipes per plant after La Niña, with a seasonal signal of stipe loss each winter. There was a large difference in stipe density between the intermediate depths (15, 12 m) and the deep and shallow depths (18, 8 m) before El Niño. This difference disappeared during El Niño, when stipe density approached zero at all sites. After the large recruitment event at 15 m Central there was a difference in stipe density between that site and the other four sites. By the summer of 2000 there was a significant difference between the three deeper sites and the two shallow sites. Plants at the deeper sites had almost twice the stipe density of those at the shallow sites until the summer of 2001. Although we didn't employ light meters during this study, results from a previous study (Dayton et al. 1999) show that stipe density, as well as depth, has a direct effect on irradiance levels on the bottom.

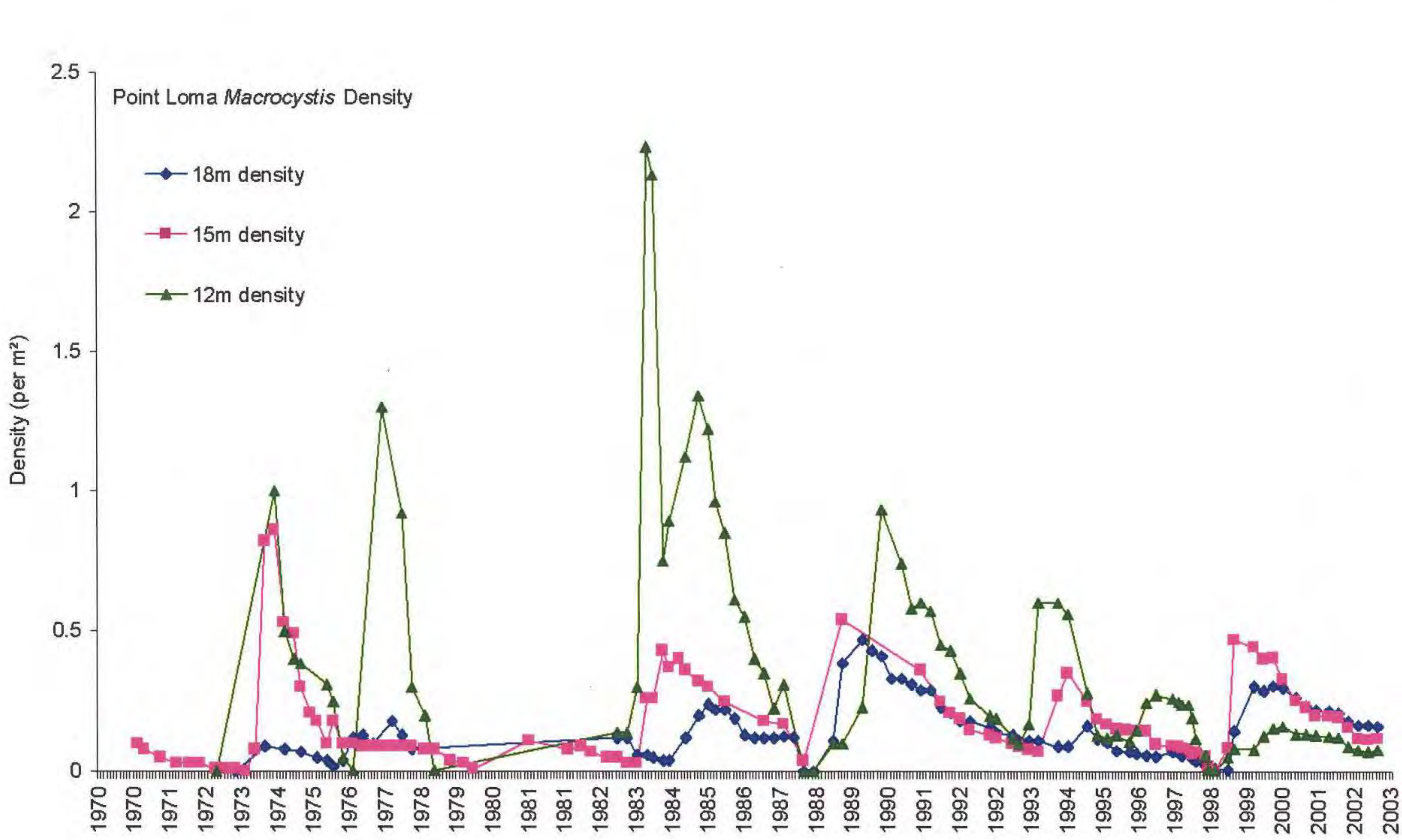


Figure F.2

Long term *Macrocystis* densities off Point Loma.

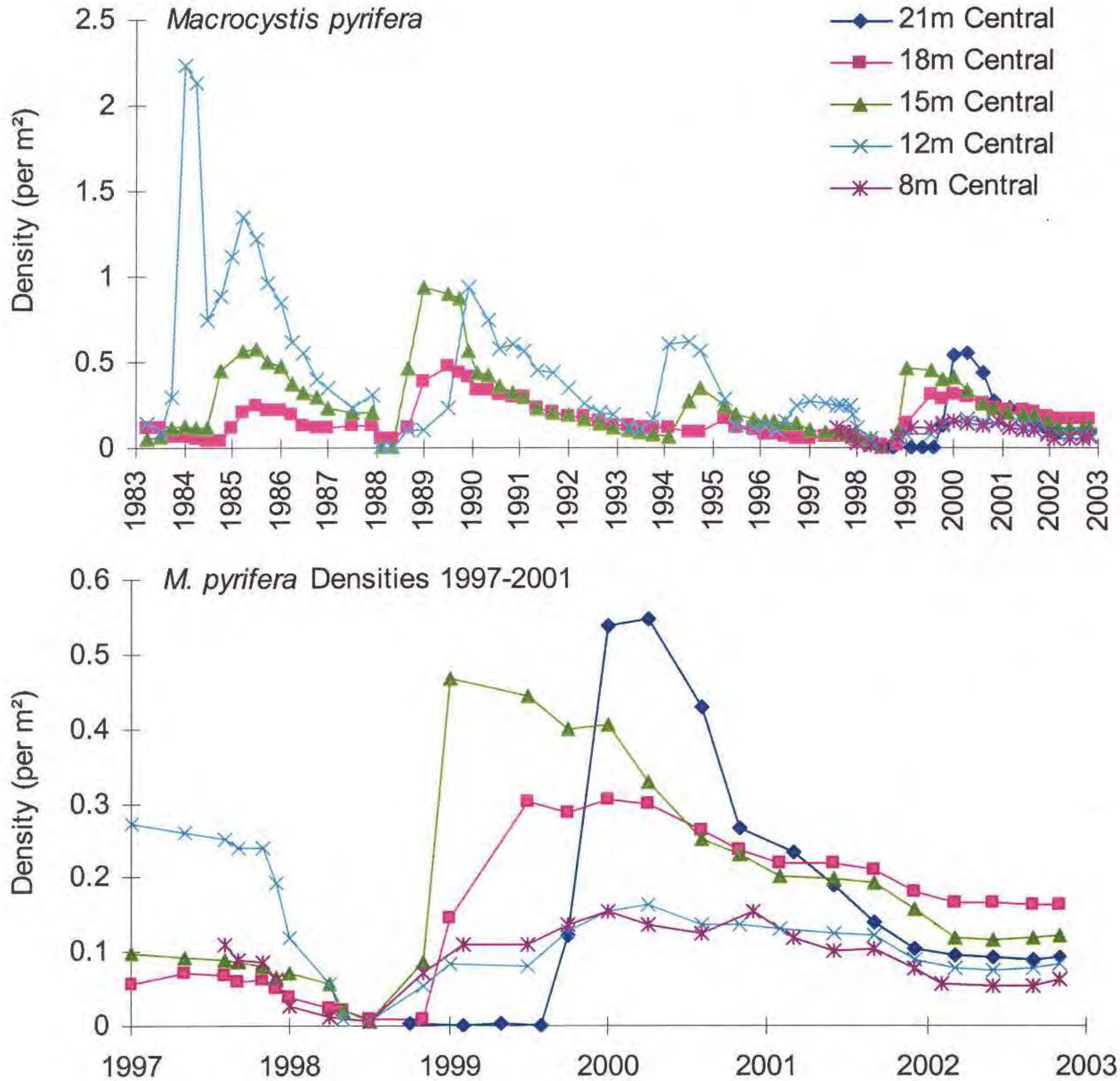


Figure F.3

Abundance of adult (defined as four or more stipes, Dayton et al. 1992) *Macrocystis pyrifera* determined quarterly at the central long term study sites off Point Loma: Top, 1983-2002; Bottom, 1997-2002.

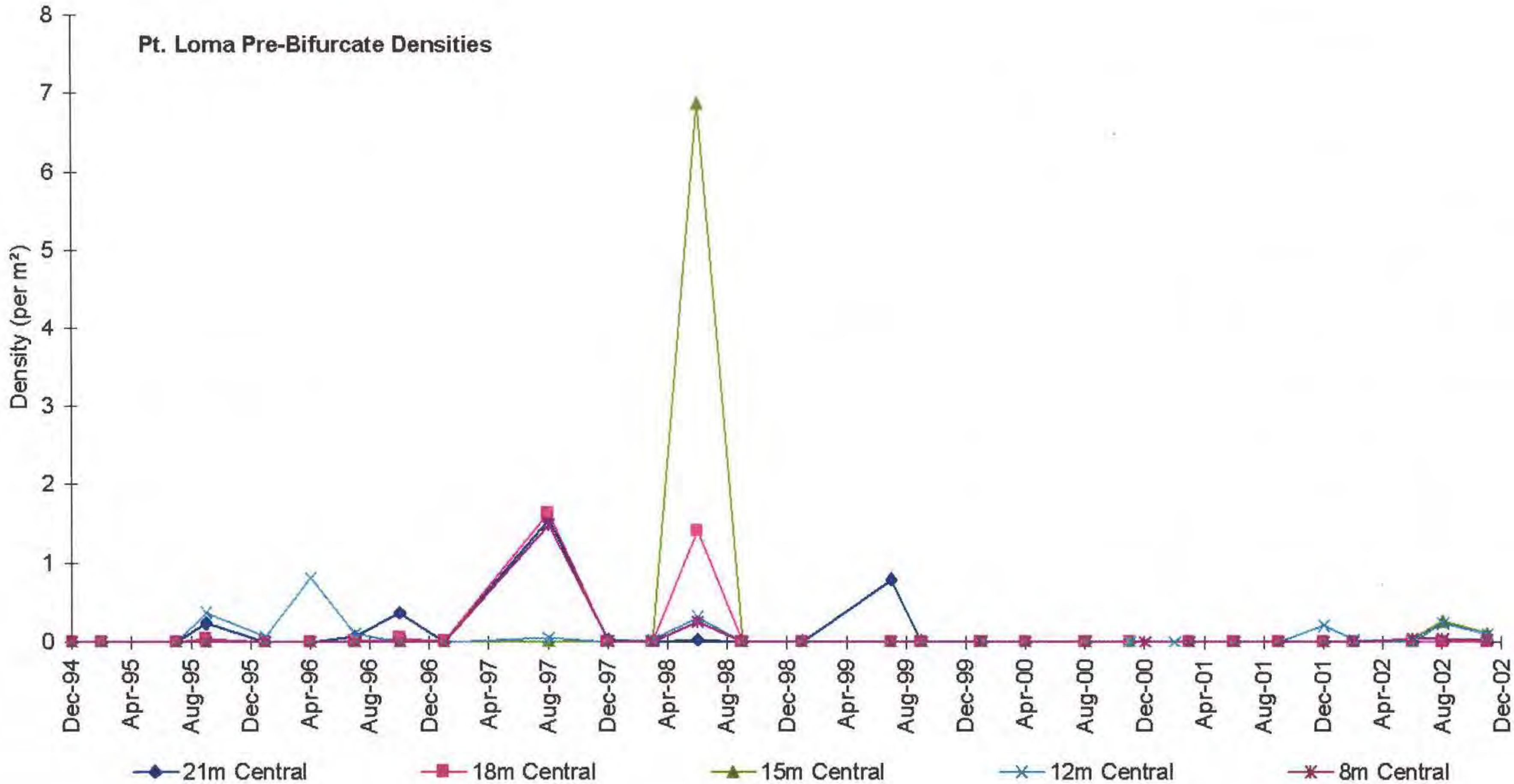


Figure F.4

Density of juvenile *Macrocystis pyrifera* at the central long term study sites off Point Loma, December 1994-December 2002.

Pterygophora californica is a stipitate kelp species which is often outcompeted by *M. pyrifera* for light and is most common in shallow water (Dayton et al. 1984, 1992). Its abundance surged after El Niño, apparently released by decimated *M. pyrifera* stipe densities. The *Pterygophora* recruitment at 15 m was significantly higher than at the other four sites. Densities of this kelp declined considerably at the deeper sites as the *M. pyrifera* canopies recovered (**Figure 5**), especially at 18 m where the stipe density of giant kelp is now the highest.

Laminaria farlowii is a prostrate kelp species which is outcompeted by both *M. pyrifera* and *P. californica* (where they co-occur) for light (Dayton et al. 1984). Prior to the 1997/98 El Niño, percent cover of *L. farlowii* was generally higher at the18 and 15 m sites, than at the 12 m site. This pattern changed after the El Niño (**Figure 6**). The two shallow sites (8 m and 12 m) now have higher densities of *L. farlowii* than the three deeper sites. Late in 2002 there was some recruitment at the 15 m site, where densities are no longer significantly different than at the 21 and 18 m sites (**Figure 7**).

There was a bloom of the brown alga *Desmarestia ligulata* at 12 m Central between June and September 1998, with mean percent cover reaching 42%. This ephemeral alga can have massive population explosions that interfere with recruitment of other kelp species. These populations quickly died off, and by February 1999, the percent cover of *D. ligulata* was back to 7%, and it then continued to decrease to trace levels. While this algal outbreak was in place it hindered recruitment and growth of *M. pyrifera*.

After El Niño the percent cover of *Dictyotales*, another important understory alga, increased from an average of 4% to 9% at 8 m Central. Coverage of this alga continued to increase until October of 1999, when it reached a maximum cover of 30%. It has since decreased to trace levels. After El Niño there was also a bloom of foliose red algae, which reached a maximum percent cover of 76% in June of 1998. These algae then hovered around 30% coverage for a year and then dropped again to around 15% (**Figure 8**). Although articulated coralline algae coverage decreased during El Niño, it has since increased, reaching a maximum of 72% cover in the spring of 2001. Articulated coralline algae cover has remained at this level since that time. The 8 m Central site generally has almost 100% cover of algae; there is very little ‘clean’ substrate visible.

Reproductive Index

<u>*Macrocystis pyrifera*</u>

Macrocystis pyrifera tends to reproduce throughout the year, rather than having a well defined reproductive season (Reed et al. 1996). The reproduction of *M. pyrifera* off Point Loma was followed in two ways: measuring sporophyll bundle volume, and rating sporophyll condition. Even though *M. pyrifera* tend to have sori present year round, the only time they are actually reproductive is when they actively shed their sori (Graham, unpub. data). While there appears to be a continuous period release at several sites (several months with a mean rating of 5), pulses of recruitment seem to follow large drops in the reproductive rating. There was one successful reproductive period for *M. pyrifera* at all sites during our study. Between December 1997 and March 1998 the mean sporophyll condition went from 4.90 to 1.90. This change implies that a

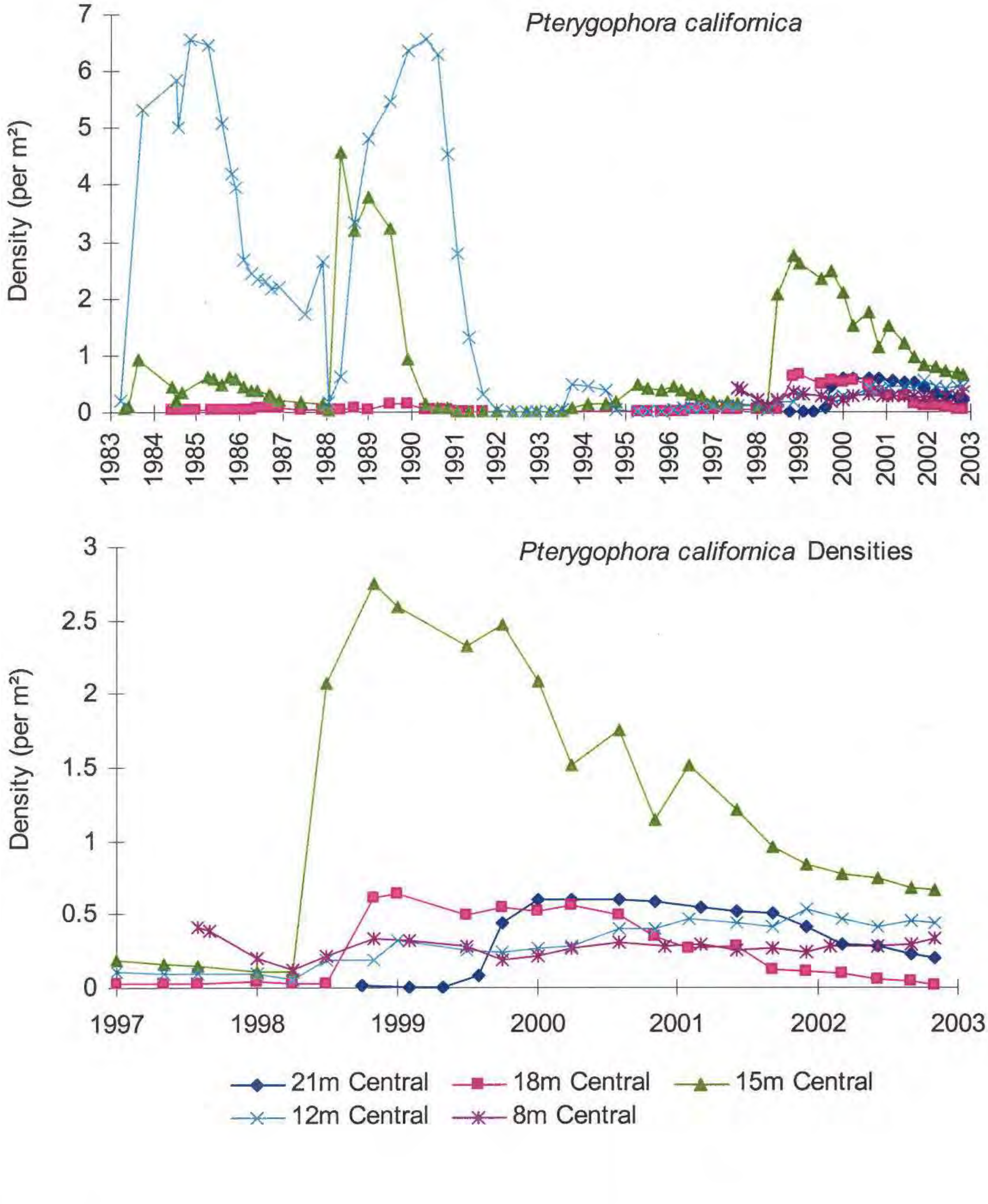


Figure F.5

Changes in the density of *Pterygophora californica* off Point Loma: Top, 1983-2002; Bottom, 1997-2002.

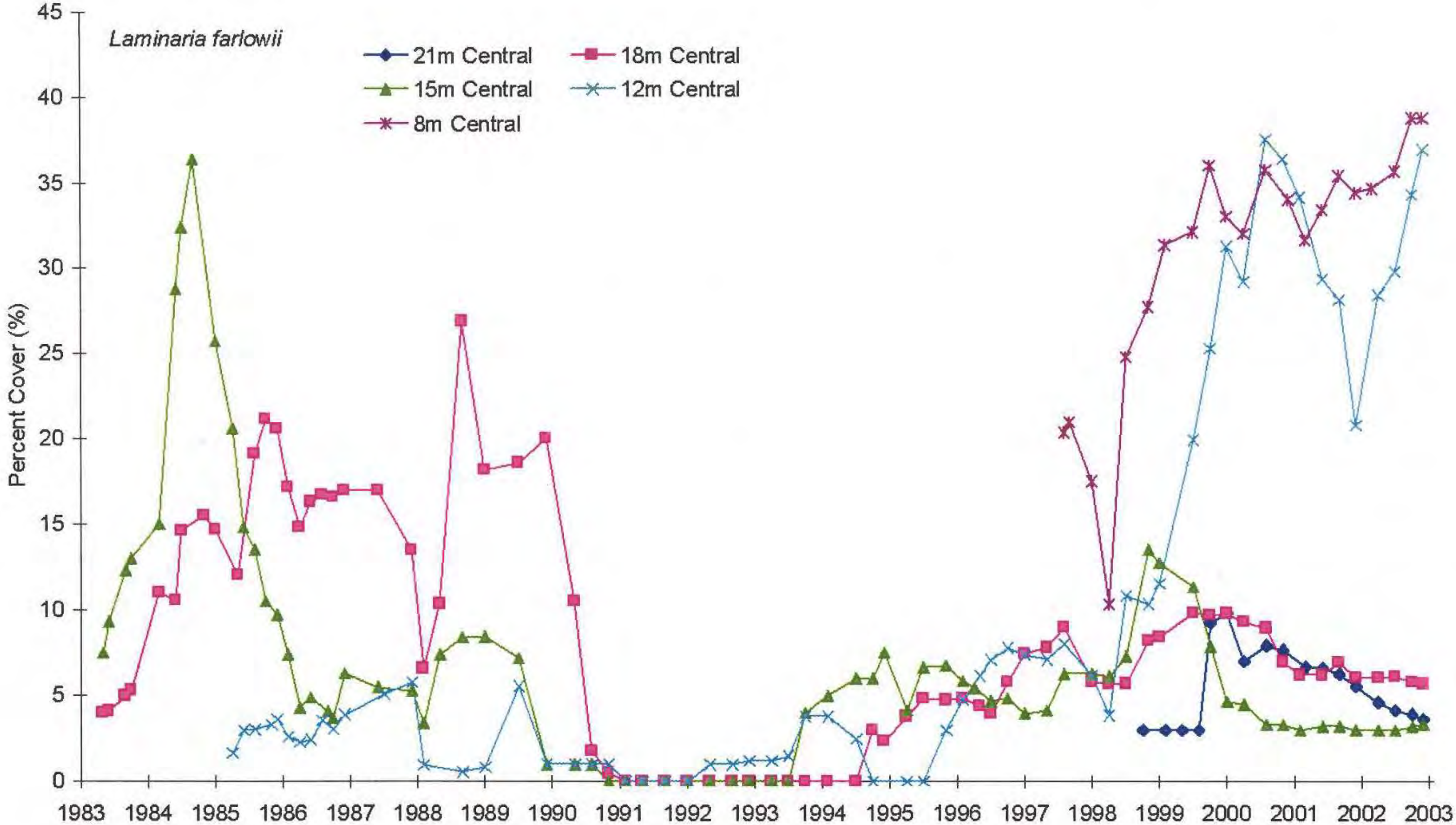


Figure F.6

Changes in the percent cover of *Laminaria farlowii* off Point Loma, 1983-2002.

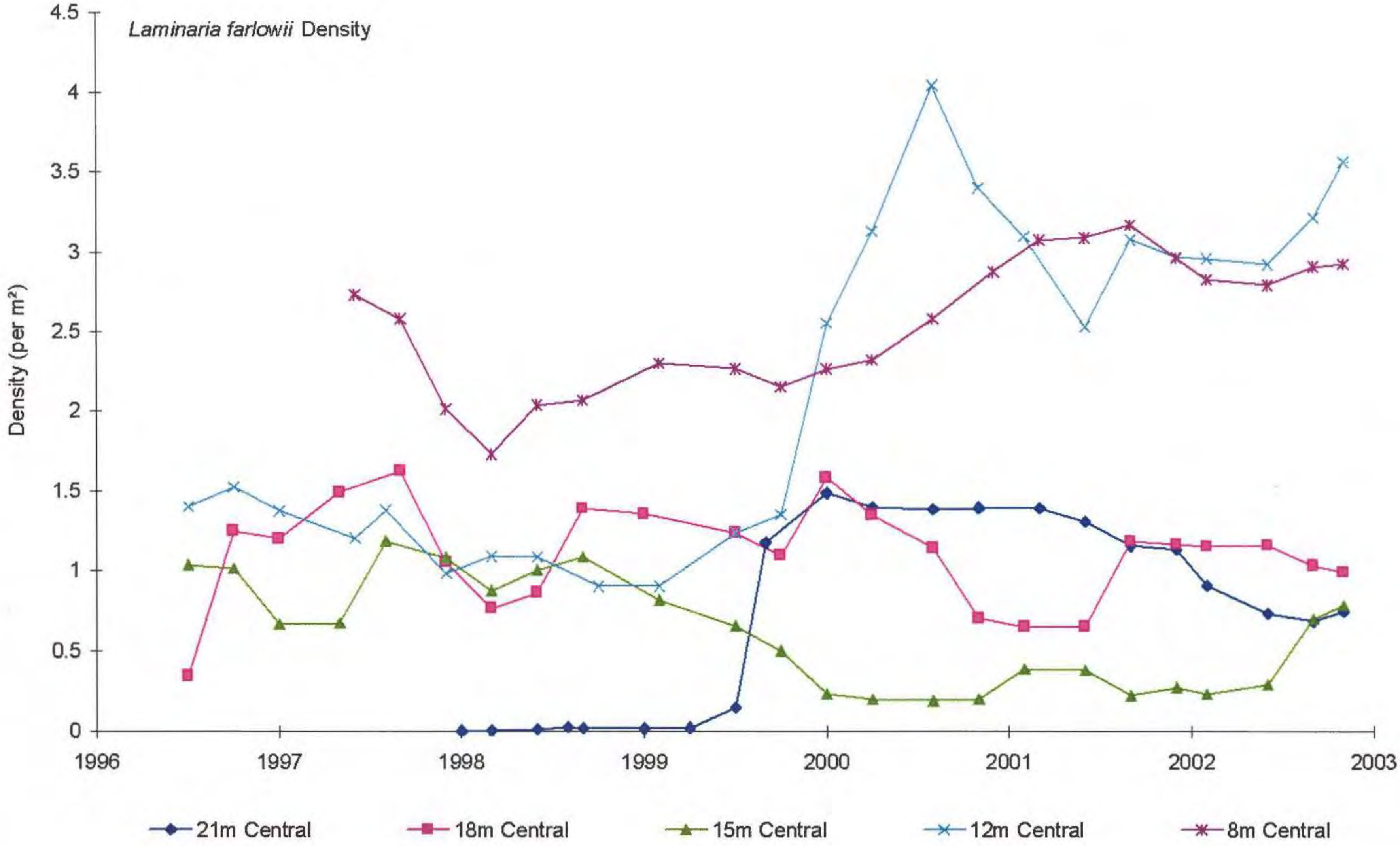


Figure F.7

Changes in the density of *Laminaria farlowii* off Point Loma, 1996-2002.

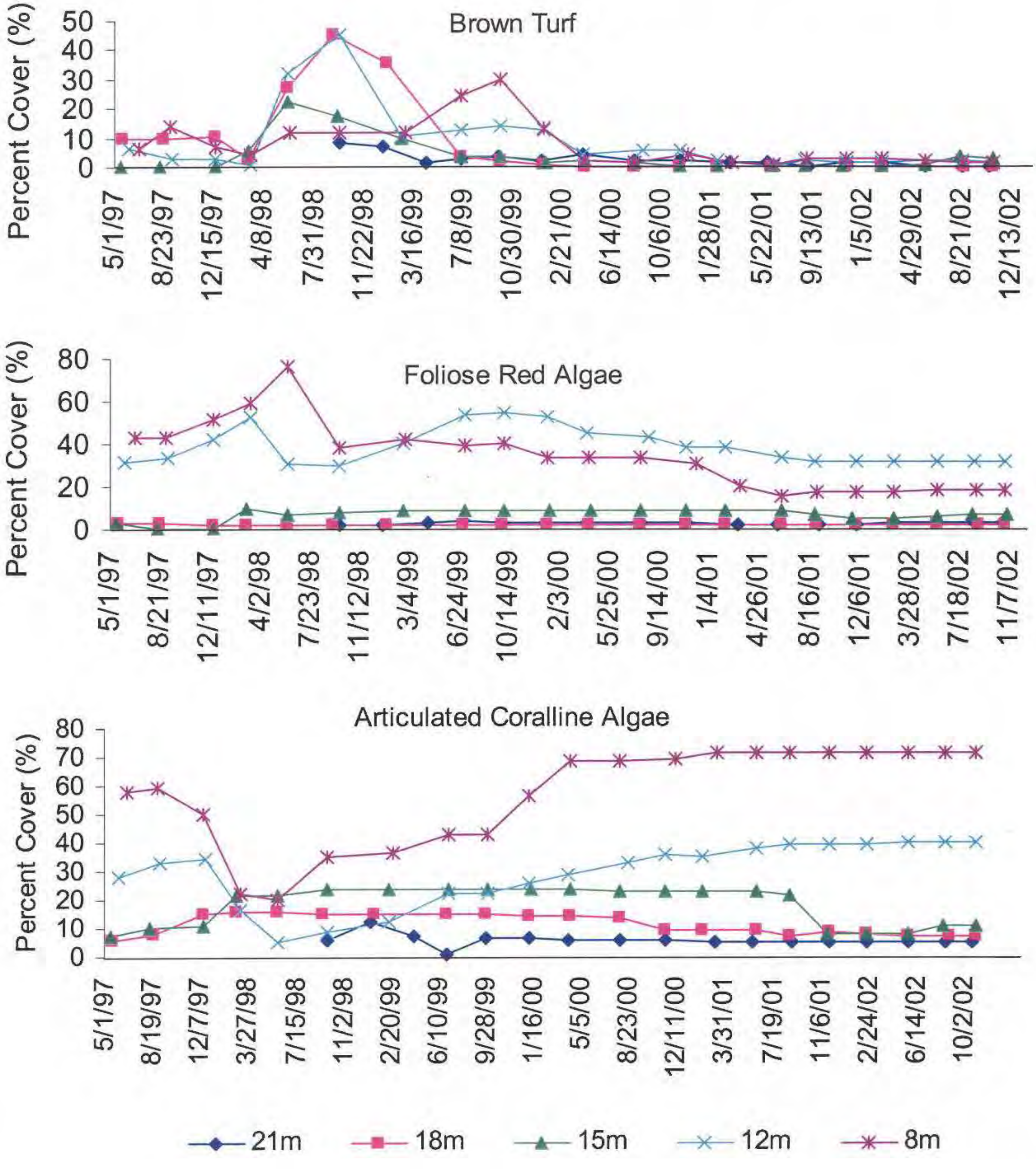


Figure F.8

Changes in the percent cover of brown turf, foliose red algae, and articulated coralline algae, at the central sites off Point Loma, 1997-2002.

majority of plants at all sites went from a rating that indicated spore release to a rating that indicated only partial soral cover. There was considerable recruitment at all sites in early June 1998. Reed (1990) found that outplanted *M. pyrifera* sporophytes took 10-15 weeks to reach a size large enough to distinguish them from *P. californica* plants (i.e., 2 mm). This was reflected in a large spore release that occurred before March 1998. There haven't been any large drops in sporophyll condition since that time, nor have there been any large recruitment events.

There were large fluctuations in sporophyll condition at all sites during El Niño and the year that followed. The periods of greater fluctuation occurred mainly when there was very low stipe density (potentially high light availability). As stipe density increases at all sites, the sporophyll condition fluctuates much less. Comparatively, the sites with lower stipe density have a higher mean rating. Sporophyll bundle volume is affected by stipe density (proxy for light availability), temperature, and age.

Pterygophora californica

Pterygophora californica have distinct seasons of both growth and reproduction. In southern California, growth peaks generally occur during the summer, with peaks in reproduction occurring during the late fall and winter (McPeak 1974, Reed 1990). *P. californica* reproduction behaved differently both temporally and spatially. Temperature (nutrient availability) generally does not strongly affect *P. californica* reproduction (Dayton et al. 1999), so it was not surprising to see reproductive *P. californica* present during El Niño. All sites had decent reproduction (mean % sporophyll blades with sori per plant) during El Niño, with 12 m having the lowest reproductive output. The following year, the peak was similar at all sites except for 18 m. This is not surprising, due to the fact that only four of the 32 tagged *P. californica* plants at 18 m were older than two years. Most plants do not mature until their second year (DeWreede 1986). The winter reproductive period of 1999 showed peaks at the 12 m and 8 m sites, but there were no peaks in reproduction at either the 18 m or 15 m Central site. These plants were older than during El Niño, and the nutrient conditions were much better, but the plants were still not reproductive. This pattern continued through 2001. There was a small peak in reproductive output at 15 m in 2001, and a larger peak in 2002. The 18 m site has not shown any reproduction of *P. californica* since 2000. Stipe densities were much higher at the deeper sites following La Niña than at the shallow sites.

Growth of *P. californica* (determined by the hole punch method) displayed peaks in the late spring to early summer during all five years of this study. These peaks were higher during El Niño than the following years at all sites except for 8 m Central. Growth rates the following three years were significantly higher at the shallow sites compared to the deeper. Growth rates for the tagged plants at 15 m Central in spring of 2002 were similar to the two shallow sites, while the two deeper sites still lagged behind.

Looking at *P. californica* growth as a function of sporophyll blades per plant, we saw a decrease at all sites during El Niño. At the beginning of the study the difference in sporophyll blades per plant was significantly different at all sites (all $p<.05$, Bonferroni/Dunn; 8m>18m>12m>15m). This difference disappeared by March of 1998. *P. californica* add new sporophylls during the spring. After releasing sori, older blades are shed, although this process is less defined in southern California as compared to more northerly populations (McPeak

1974, Reed 1987, 1990, Dayton et al. 1999). The plants in shallow water (12 and 8 m Central) continue to add sporophyll blades in the spring, while the deeper water plants showed a steady decline in the number of sporophyll blades per plant throughout the length of the study. There is now a significant difference in the number of sporophyll blades per plant between the 8 m site and all sites, and between the 12 m site and all sites (all p<.0001, Bonferroni/Dunn). There is no significant difference between the deeper sites (i.e., 8>>12>>15, 18).

Laminaria farlowii

Laminaria farlowii also has distinct seasons of growth and reproduction. This kelp puts most effort into growth during the summer months (usually March through November), with a peak in July. They then switch effort to reproduction, with a peak usually occurring in January/February.

Laminaria plants were reproductive during the winter/spring at all of the shallow sites throughout the period of this study. There was no significant difference in the magnitude of reproduction between any of the sites during either El Niño or La Niña. During the third, fourth and fifth years, however, there were significant differences in both, due primarily to the differences in stipe density between the deep and shallow sites. The tagged *L. farlowii* at 12 and 8 m Central were significantly more reproductive than those at 18 and 15 m (2000 and 2001; p<.0001, Bonferroni/Dunn).

Growth rates of *L. farlowii* peaked in July/August 1998, shortly before El Niño conditions dissipated. Stipe density was very low at all sites during this time. Growth rates peaked again in June of 1999, with there being a significant difference between the deep and shallow sites (all p<.0001, Bonferroni/Dunn). This pattern continued during the third and fourth years, but the differences were diminished. The *L. farlowii* growth rates at 15 m Central increased further in the fifth year (2002).

Population Dynamics of Sea Urchins

Our historical data show that both red and purple sea urchins, *Strongylocentrotus franciscanus* and *S. purpuratus*, respectively, are most abundant at the 18 m sites along the outer edge of the Point Loma kelp forest. In 1997, *S. franciscanus* densities were the highest at our 18 m Central site and our 2 1m Central site. The *S. franciscanus* densities were much lower at all the other sites. Invertebrate sampling along the lines usually occurs in the late spring/early summer, so the sampling in 1998 reflects changes that occurred during the peak of El Niño. Densities dropped dramatically at 18 m Central, and somewhat less at 21 m Central. Densities actually increased at three of the five southern sites (18 m Mouth, 15 m Tip, and 12 m Tip), with no change at the other two (18 m South, and 15 m South). The largest increase was at our 12 m Tip site (adjacent to the shipping channel).

Densities of *S. purpuratus* also increased at three of the five southern sites (18 m South, 18 m Mouth, and 15 m Tip), with decreases at all other sites. Populations at 18 m Mouth, 15 m Tip, and 12 m Tip all showed notable increases in the last two years. These densities are substantially higher than at any of the other sites.

Recruitment rates for *S. franciscanus* fluctuated greatly during El Niño and La Niña. They peaked in the spring of 2000 and have decreased at most sites since then. During the early part of El Niño from fall 1997 to spring 1998, seven of 14 sites showed a decrease in recruitment rate, five had an increase, and two remained unchanged (no recruitment during either). On average, the magnitude of decrease was greater than the magnitude of increase. Between spring 1998 and fall 1998, all sites had an increase in recruitment, with the exception of 15 m South and 15 m Tip, which had very slight decreases. *S. franciscanus* recruitment rates decreased at all sites between spring and fall 2000, and have continued to decrease at all the central sites. The southern sites have had increases in recruitment rates at 18 m Mouth, 15 m Tip, and 15 m South.

Urchin recruitment is generally much higher at 18 m Mouth (south of 18 m South), and west of 18 m South, as compared to 18 m South. There are no permanent transect lines west of 18 m South, but the lines at 18 m Mouth have much higher *S. franciscanus* densities. The 15 m Tip and 12 m Tip sites, both of which are southwest of 15 m South, generally have higher recruitment rates than 15 m South, 15 m Central and 12 m Central. These sites also have higher densities of *S. franciscanus* along the permanent transect lines.

For the period of this study, *S. franciscanus* recruitment peaked at the shallow central sites during the spring of 1999 (i.e., 15, 12 and 8 m sites). Recruitment at the deeper sites did not peak until the spring of 2000. Recruitment was much higher at the deeper sites than the shallow sites.

The southern sites did not have this same pattern; recruitment peaked at three sites in fall of 1997 (18 m Mouth, west of 18 m South, and 15 m Tip), and three sites in the spring of 2000 (18 m South, 15 m South, and 12 m Tip).

Recruitment of *S. purpuratus* increased at all sites except 12 m Central, 12 m Tip and 8 m Central during the beginning of El Niño (spring to fall 1997), and then decreased at all sites except 12 m Central and 12 m Tip from fall 1997 to spring 1998. Recruitment rates continued to decrease at most sites through spring 1999, when rates increased at all sites. The southern sites began to follow the same pattern beginning in 1998, and by spring 1999, recruitment rates were not very different at any of the sites. All sites (central and southern) had large decreases in *S. purpuratus* recruitment rate by spring 2001.

Beginning in the spring of 1998 (during El Niño), we began to encounter *Arbacia incisia* and *Centrostephanus coronatus* in our urchin quadrats. These two urchin species are representative of much warmer waters to the south. They were found primarily at the southern sites, as well as the western (deeper) sites. A few individuals were also found along the inner edge of the kelp forest (12 and 8 m Central). *Arbacia* is very common in the Gulf of California, with the only California record (according to Morris et al. 1980) being six specimens from Newport Bay, Orange Co. (H.L. Clark, 1948). The geographic range of *Centrostephanus* extends from southern California to Mexico and Galapagos Islands. Although we continue to find some individuals during our sampling for strongylocentrotids, test diameters of these two species indicate that they are probably no longer recruiting to these waters, but are persisting and growing.

The urchin settlement data show a peak in settlement during the spring/early summer in all years of this study. There was more non-spring recruitment during 1998 than any other year. This period was characterized by higher bottom temperatures than during the other years. Recruitment in the springs of 2000 and 2001 was greater than the other three years, and was characterized by lower mean bottom temperature.

Physical Measurements

Bottom Temperature

Monthly mean bottom temperatures were consistently higher with decreasing depth throughout the study (**Figure 9**). From April 1997 through October 1998, mean bottom temperatures were higher than the 1987-1996 average, except at the 8 m Central site (**Figure 10**). For the period from September 1997 through February 1998, the bottom temperature never fell below 15° C, and only rarely got below 16° C. The National Centers for Environmental Prediction/Climate Prediction Center (NCEP/CPC) classified this period as a strong El Niño, which weakened over the next three months. From November 1998 through May 2000, temperatures were below the 9-year mean at all sites except during May and July at 8 and 12 m Central, and April-July at 15 and 18 m Central. During this period temperatures have generally been within one standard deviation of the mean, and could therefore be considered normal. The period from October 1998 through November 2002 had temperatures above this mean, but only slightly, and all had gone below the mean again. In December 2002 temperatures were higher than the long-term mean, but still within one standard deviation.

Water samples were collected between February 1998 and November 1999, and water temperature was measured at the time of collection. These samples were analyzed for nitrate concentration. The relationship between nitrate concentration and temperature was fairly constant (**Figure 11**). Nitrate concentrations in water colder than 15.9° C were generally higher than those in water warmer than 15.9° C. Results of CHN analyses showed a strong relationship between both surface temperature and bottom temperature on the carbon:nitrogen ratio in *M. pyrifera* at Point Loma. The surface C:N ratio is always higher than the bottom, indicating higher nitrogen content in the bottom blades. The bottom blades spend more time in colder water than the surface blades. This is especially true in the summer, when there is generally a strong thermocline. The strongest correlation is between bottom temperature and surface blade C:N ratios.

What Defines the Edges of the Outer Edge of the Forest?

The 21 m Central (outer edge) site was established in June of 1995. There have been three main pulses of *M. pyrifera* recruitment since establishment (October 1996, August 1997, and July 1999). The recruits from October 1996 did not persist long along the transect lines, but they had better survivorship on the tops of the reefs. This was due in part to extremely high *Lytechinus anamesus* (white sea urchin) densities on the substrate in September 1997. Although *L. anamesus* is not an important grazer on adult stages of *M. pyrifera*, they consume the smaller algae (e.g., recruit stages) so effectively that reestablishment of algal growth occurs only when populations of these urchins are below approximately $10/m^2$ (Morris et al. 1980).

The next large pulse of juvenile *M. pyrifera* recruitment occurred in August of 1997. None of these plants reached adult stage, or even persisted as juveniles past June of 1998. The extremely high densities of *Ectocarpus*,

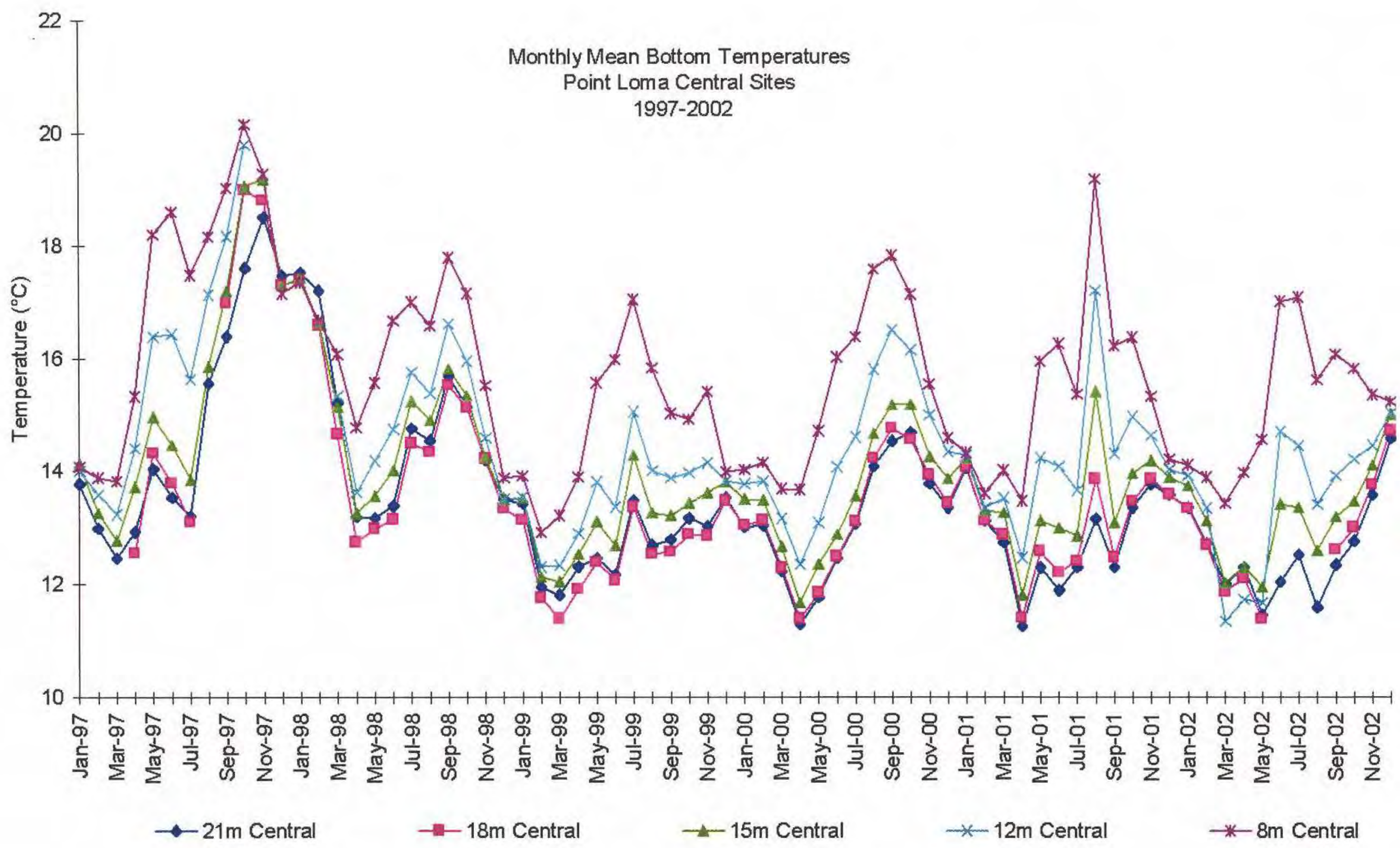


Figure F.9
Monthly mean bottom temperatures, Point Loma central sites, 1997-2002.

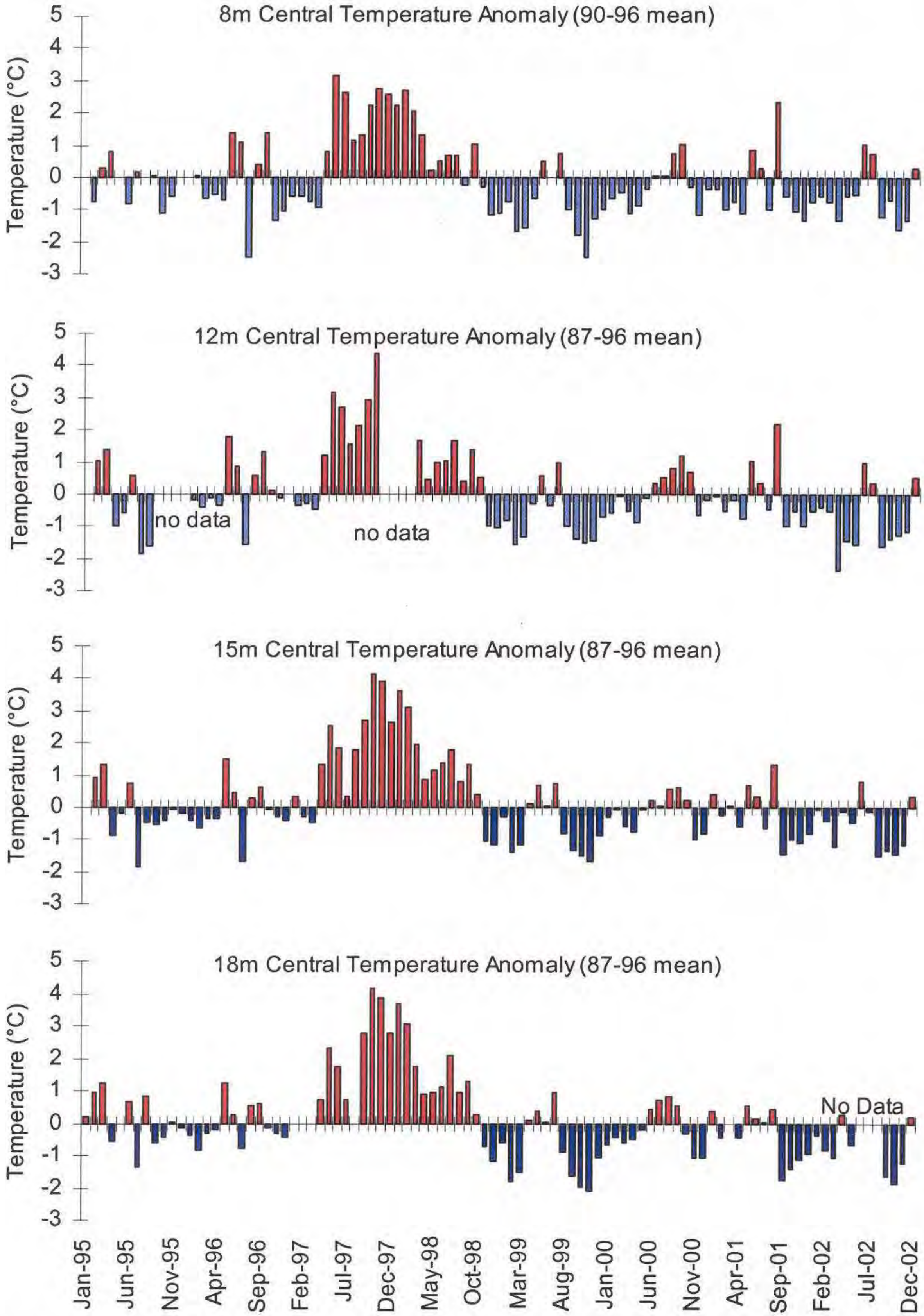


Figure F.10

Temperature anomaly at four central sites in the Point Loma kelp forest.

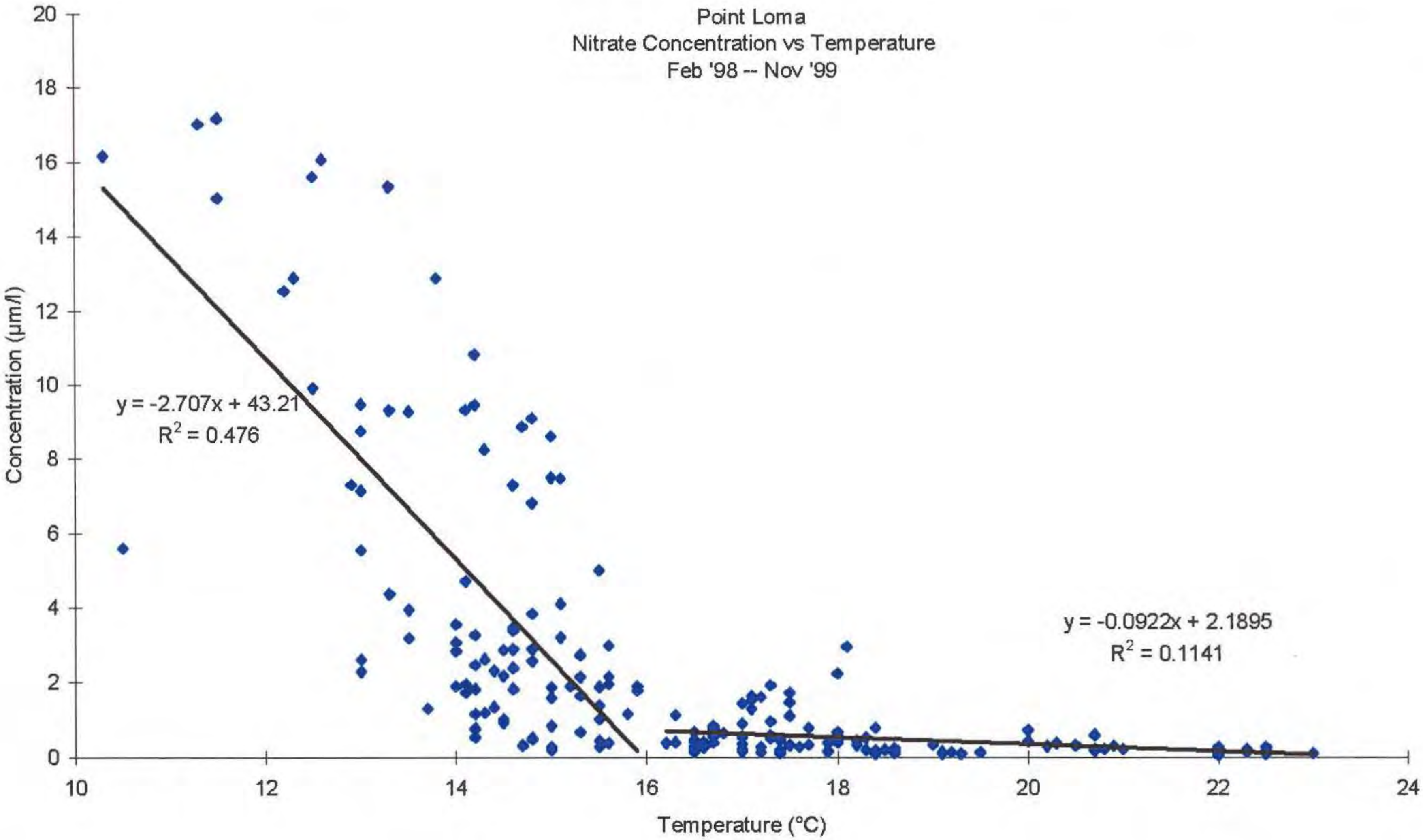


Figure F.11

Relationship between temperature and nitrogen concentration, Point Loma kelp bed.

which is commonly epiphytic on Laminariales and Desmarestiales (Abbott and Hollenberg 1976), may have kept the pre-bifurcates and bifurcates (juvenile stages of *M. pyrifera*) from reaching the adult (4 stipe) stage. This period was also characterized by extremely high bottom temperatures (i.e., monthly means > 16° C from September 1997 through February 1998).

There was a strong recruitment pulse of *M. pyrifera* in July 1999. *Because L. anamesus* densities declined greatly during this time, most *Macrocystis* recruits reached adult stage by September 1999. These plants were also aided by the cooler than normal bottom temperatures that were present July through December.

Laminaria farlowii first appeared along the transect lines in January of 1998, and their density remained fairly constant until July 1999 when they began to increase. Densities of this kelp then increased steadily until January 2000, after which they have slowly declined.

Pterygophora californica first recruited to the transect lines in August of 1998, and then followed the same pattern as seen for *L. farlowii*. Their densities remained the same from January 2000 until September 2001, after which they began to decline.

The *Macrocystis pyrifera* canopy around this site has expanded several hundred meters to the west and north. The south end of the site is bounded by a large drop off and softer sediment. The establishment of the adult *M. pyrifera* plants has resulted in greater species diversity (both fish and invertebrates), and higher densities of those animals present (personal observation).

DISCUSSION

Kelp Community Population Dynamics

The recent period of study from 1997 through 2002 was dominated by three very different climate regimes. The first was a strong El Niño, characterized by warm, nutrient-poor water. This period was followed immediately by La Niña, characterized by cold, nutrient-rich water. The final three years of this study are considered to be normal oceanic conditions. The warm water period lasted from the spring of 1997 through at least spring 1998. At its peak, bottom temperatures were 3-4° C warmer than a 10 year average. Temperature is inversely related to the concentration of nitrate, the nutrient which limits kelp growth; nitrate is not detectable above about 16° C in this region (Jackson 1977, Gerard 1982, Zimmerman & Kremer 1984). This strong relationship allows use of temperature as a surrogate for nitrogen availability or nutrient stress. At least 50% of the biomass of a healthy *Macrocystis* plant is typically found in the upper 1 m of the water column (North et al. 1982), where nutrient depletion is much more severe than below the thermocline. As a result, *Macrocystis* plants are often much more nutrient stressed near the surface than are the understory kelps below the thermocline. The adult *Macrocystis* population was decimated at all of our permanent Point Loma study sites and at our reference site off La Jolla, while there was only minor understory mortality. The loss of adult *Macrocystis* plants also meant a release from competition for the surviving understory plants, as well as a potential window for general recruitment. The cold, nutrient-rich period that followed El Niño, and the 'hole in the canopy' allowed the *Macrocystis* to recover and thrive, thus making possible the substantial recruitment of all kelps. Adult *Macrocystis* densities at most sites were at a pre-El Niño high within 18 months after recruitment as juveniles.

While adult *Macrocystis* is the competitive dominant species off Point Loma, understory kelps and turf algae can hinder actual recruitment. The two deep sites (18 m and 15 m Central) had approximately 40% cover of turf algae (articulated corallines, foliose red algae, *Dictyotales*, and *Desmarestia* spp), while the shallow 12 m Central had about 70% cover of turf and 8 m Central had over 80% turf cover. In the face of this competition, *Macrocystis* recruitment was lower at the two shallow sites, and the plants took longer to reach the adult stage, compared to the deeper sites.

The difference in adult *Macrocystis* recruitment resulted in a significant difference in stipe density between the deep and shallow sites. Using stipe density as a proxy for light limitation, we are better able to see the effects of shading on the growth and reproduction of the understory kelps. Light limitation was so great at the deeper sites, that tagged *Pterygophora* failed to reproduce during the reproductive season in 2000, 2001, and 2002 (15 m Central is showing signs of recovery). The growth rates for both *Laminaria* and *Pterygophora* at the deeper sites were significantly slowed in all years following the recovery of the *Macrocystis* canopy. This, and the fact that they both reproduced during El Niño, show that production of the reproductive soral material is more limited by light than by nutrients.

El Niño conditions did not appear to have major effects on the density of *Strongylocentrotus franciscanus* or *S. purpuratus*. These conditions, however, likely contributed to the recruitment of two warmer water sea urchin species, *Arbacia incisia* and *Centrostephanus coronatus*. La Niña conditions may have had an effect on the recruitment of both *S. franciscanus* and *S. purpuratus*, however, as our data indicate higher recruitment was associated with cold water.

The extent or appearance of the *Macrocystis* canopy is, perhaps, the most obvious indicator of the health of the kelp forest. It is very important to be able to determine whether large holes in the canopy are due to natural or anthropogenic factors. During the period of this study we have seen, and continue to see, open patches in the canopy away from our permanent sites. Many months after the complete recovery of the *Macrocystis* canopy at our central sites, we noticed that the area to the north of our sites, off of Sunset Cliffs, had yet to recover. This area is potentially more susceptible to anthropogenic effects, as it is offshore of a densely populated area, while the central sites are located offshore from sparsely inhabited military owned land. Transects were run at haphazardly chosen sites with little or no apparent canopy, to try to determine the reason for the delayed recovery. These sites were all marked with GPS coordinates so that they may be revisited in the future. Of the eight sites sampled, three had no plants reaching the surface, four had scattered plants reaching the surface, and one had a thin canopy. The transects covered an area of 400 m^2, so that these data could be compared to data from our permanent study sites. Mostly we observed areas with healthy plants that had yet to reach the surface. The three sites with no canopy had some of the highest densities of *Desmarestia* and foliose red algae. These sites also had the highest densities of the juvenile stages of *Macrocystis*. It is probable that initial recruitment was delayed by a *Desmarestia* bloom (see Dayton et al. 1992) and took significantly longer to reach adult stage. Another possibility for the delay in recovery is amphipod infestation. Amphipod grazing completely removed all stipes from a site approximately 200 m to the south of our 15 m Central site in April of 1999. The loss of canopy was followed by a *Desmarestia* bloom, which was later followed by *Macrocystis* recruitment.

Based on the restricted physiological requirements of the life history stages, there is a very limited window for *Macrocystis* recruitment (Deysher and Dean 1986). Fortunately, temperature, light and water motion conditions were favorable for recovery. Under different conditions (warmer water, low light availability due to a plankton bloom, grazing pressure, etc.) it is possible that this large area may not have recovered.

Another continuing problem is the urchin grazing in the southern end of the kelp forest. During our regular urchin sampling in the fall of 1999, we encountered a large urchin front approximately 300 m to the west of our 18 m South site. This site is marked with GPS coordinates. To the west of this site was a classic urchin barren with no brown algae at all, and to the east was a healthy forest. At the front there were *Pterygophora* plants with urchins consuming the stipes, and *Macrocystis* holdfast scars (what remains of the holdfast attached to the substrate after an adult plant has been ripped off the bottom) filled with urchins. This entire area is now a complete urchin barren with no algae present. Our permanent transect lines at 18 m Mouth, 15 m Tip, and 12 m Tip have not had much brown algae since spring 2001. The recruitment rates and adult densities for both *S. purpuratus* and *S. franciscanus* at these three sites are still high. Consequently, the likelihood of successful algal recruitment to these sites is slim in the near future.

The inshore, shallow limit for *Macrocystis pyrifera* is controlled by an interaction between biotic and abiotic factors (Graham 1997). Along the Monterey Peninsula, wave exposure explained much of the spatial and temporal variability in depth of the upper limit of giant kelp. The lower limit for *Macrocystis* is also likely controlled by an interaction between abiotic (storm, light availability) and biotic (competition, predation) factors. At Point Loma, while the outer edge of the kelp bed is constantly shifting, the inshore edge remains reasonably constant. The inshore edge appears to reflect several environmental variables such as sedimentation, sand scour, competition for light with dense understory canopies and probably most important, the destructive energy of breaking waves ripping off floating stipes (Seymour et al. 1989).

It is extremely important to maintain a long term data series: “The strong effects of ocean climate on kelp forest succession, competitive interactions, and kelp population dynamics underscore the importance of long-term studies for understanding how communities are structured. Interannual variability in temperature would have produced very different results in short-term studies at various time intervals within this study. El Niños and La Niñas are large-scale, low-frequency events with dramatic effects on the kelp forests of southern California, effects which require the tools of both pelagic and benthic ecology to be understood. The challenge to ecologists concerned with the regulation of community structure is how to integrate large-scale, low-frequency variation into our studies of local processes in times of scarce resources for research.” (Tegner et al. 1997).

ACKNOWLEDGEMENTS

We thank N. Barger, A. Coyac, J. Riffell, and C. Taylor for field assistance, E. Parnell and J. Leichter for their help with the analyses of the temperature data. This research was supported by the City of San Diego.

REFERENCES

Dayton, P. K., V. G. Currie, T, T. Gerrodetta, B. D. Keller, R. Rosenthal, and D. Van Tresca. (1984). Patch dynamics and stability of some California kelp communities. Ecological Monographs, 54(3): 253-289

Dayton, P. K., M. J. Tegner, et al. (1999). Temporal and spatial scales of kelp demography: The Role of Oceanographic Climate. Ecological Monographs, 69(2): 219-250

Dayton, P. K., M. J. Tegner, P. E. Parnell, and P. B. Edwards. (1992). Temporal and spatial patterns of disturbance and recovery in a kelp forest community. Ecological Monographs, 62(3): 421-445

DeWreede, R. E. (1984). Growth and age class distribution of *Pterygophora californica* (Phaeophyta). Marine Ecology Progress Series, 19: 93-100

DeWreede, R. E. (1986). Demographic characteristics of *Pterygophora californica* (*Laminaria*les, Phaeophyta). Phycologia, 25(1): 11-17

Deysher, L. and T. A. Dean (1986). In situ recruitment of the giant kelp, *Macrocystis pyrifera*: effects of physical factors. Journal of Experimental Marine Biology and Ecology, 103: 41-63

Gerard, V. (1982). Growth and utilization of internal nitrogen reserves by the giant kelp *Macrocystis pyrifera* in a low-nitrogen environment. Marine Biology, 66: 27-35

Graham, M. H. (1997). Factors determining the upper limit of giant kelp, *Macrocystis pyrifera* Agardh, along the Monterey Peninsula, central California, USA. Journal of Experimental Marine Biology and Ecology, 218: 127-149

Hollenberg, G. J. and I. A. Abbott (1976). Marine Algae of California. Stanford University Press, Stanford, CA.

Jackson, G. A. (1977). Nutrients and production of giant kelp, *Macrocystis pyrifera*, off southern California. Limnology and Oceanography 22(6): 979-995.

McPeak, R. H. (1974). Fruiting in several species of Laminariales from southern California. Eighth International Seaweed Symposium, Bangor, North Wales, The Marine Science Laboratories, Menai Bridge.

Morris, R. H., D. P. Abbott, and E. C. Haderlie. (1980). Intertidal Invertebrates of California. Stanford University Press, Stanford, CA.

North, W. J., V. Gerard, and K. Kuwabara. (1982). Farming *Macrocystis* at coastal and oceanic sites. In: L. M. Srivastava (ed.), Synthetic and Degradative Processes in Marine Macrophytes. Walter de Gruyter and Co., Berlin, pp. 247-262

Reed, D. C. (1987). Factors affecting the production of sporophylls in the giant kelp *Macrocystis pyrifera*. Journal of Experimental Marine Biology and Ecology, 113: 61-69

Reed, D. C. (1990). The effects of variable settlement and early competition on patterns of kelp recruitment. Ecology, 71(2): 776-787

Reed, D. C., A. W. Ebeling, et al. (1996). Differential reproductive responses to fluctuating resources in two seaweeds with different reproductive strategies. Ecology, 77(1): 300-316

Seymour, R. J., M. J. Tegner, P. K. Dayton, and P. E. Parnell. (1989). Storm wave induced mortality of giant kelp, *Macrocystis pyrifera*, in Southern California. Estuarine, Coastal, and Shelf Science, 28: 277-292

Tegner, M. J. and P. K. Dayton (1981). Population structure, recruitment and mortality of two sea urchins (Strongylocentrotus franciscanus and *S. purpuratus*) in a kelp forest. Marine Ecology Progress Series, 5: 255-268

Tegner, M. J. and P. K. Dayton (1987). El Niño effects on southern California kelp forest communities. Advances in Ecological Research, 17: 243-279

Tegner, M. J. and P. K. Dayton (1991). Sea urchins, El Niños, and the long term stability of Southern California kelp forests. Marine Ecology Progress Series, 77: 49-63

Tegner, M. J., P. K. Dayton, P. B. Edwards, K. L. Riser, D. B. Chadwick, T. A. Dean, and L. Deysher, (1995). Effects of a large sewage spill on a kelp forest community: catastrophe or disturbance? Marine Environmental Research, 40(2): 181-224

Tegner, M. J., P. K. Dayton, et al. (1996). Is there evidence for long-term climatic change in southern California kelp forests? CalCOFI Report, 37: 111-12.

Tegner, M. J., P. K. Dayton, et al. (1997). Large-scale, low-frequency oceanographic effects on kelp forest succession: a tale of two cohorts. Marine Ecology Progress Series, 146: 117-134

Zimmerman, R. C. and J. N. Kremer (1984). Episodic nutrient supply to a kelp forest ecosystem in southern California. Journal of Marine Research, 42: 591-604