Benthic Macrofauna

SOUTHERN CALIFORNIA BIGHT
1998 REGIONAL MONITORING
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Descriptions and Sources of Photographs on the Cover

Clockwise from bottom right: (1) Benthic sediment sampling with a Van Veen grab; City of Los Angeles Environmental Monitoring Division. **(2)** Bight'98 taxonomist M. Lily identifying and counting macrobenthic invertebrates; City of San Diego Metropolitan Wastewater Department. **(3)** The phyllodocid polychaete worm *Phyllodoce groenlandica* (Orsted, 1843); L. Harris, Los Angeles County Natural History Museum. **(4)** The arcoid bivalve clam *Anadara multicostata* (G.B. Sowerby I, 1833); City of San Diego Metropolitan Wastewater Department. **(5)** The gammarid amphipod crustacean *Ampelisca indentata* (J.L. Barnard, 1954); City of San Diego Metropolitan Wastewater Department. **Center: (6)** Macrobenthic invertebrates and debris on a 1.0 mm sieve screen; www.scamit.org.

Southern California Bight 1998 Regional Monitoring Program: VII. Benthic Macrofauna

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Foreword

The Southern California Bight (SCB) is a 100,000-square-mile body of water and submerged continental shelf that extends from Point Conception, California, in the north to Cabo Colnett, Baja California, Mexico in the south. This area is a unique and important ecological and economic resource in southern California that includes diverse habitats for a broad range of marine life including more than 2,000 species of invertebrates, 500 species of fish, and many marine mammals and birds.

The coastal region along the SCB is one of the most densely populated coastlines in the U.S. and the world. The activities of this dense human population stress the coastal marine environment by introducing pollutants from point and non-point sources, modifying natural habitats and increasing fishing pressure.

Over $10 million is spent annually to monitor coastal environmental quality in the SCB. These monitoring programs provide important site-specific information about the impacts of individual waste discharges, but do not assess the condition of the SCB as a whole. The assessment of environmental quality on a more regional scale is needed to help environmental regulators and resource managers understand the consequences of pollution beyond the immediate vicinity of discharge pipes.

In response to the need for a regional perspective, The Southern California Bight 1998 Regional Monitoring Project (Bight`98) was conducted as a continuation and expansion of the 1994 Southern California Bight Pilot Project (SCBPP). Bight`98, a cooperative effort by 62 organizations, was organized into three technical components: Coastal Ecology, Shoreline Microbiology, and Water Quality. This report presents the results of the benthic macrofauna portion of the Coastal Ecology component of Bight`98. It was concerned with coastal areas from Point Conception, California, to Punta Banda, Baja California, Mexico, including embayments. Copies of this and other Bight`98 reports are available at www.sccwrp.org.

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Acknowledgments

This report is the result of concerted and sustained efforts by the many talented and dedicated individuals who contributed their knowledge and experience to improve the understanding of the Southern California Bight. It is proof that the product of cooperation is greater than the sum of its parts. The authors thank all of those who contributed to this report. While space limitations do not allow us to acknowledge all contributors by name, we are grateful to the following people and agencies whose efforts were crucial to our success.

The members of the Bight`98 Steering Committee provided the impetus, vision, and resources that guided and fueled our efforts. Their critical and timely reviews improved this document.

The field teams collected our samples with efficiency and care. The captains and crew of the *Alguita* (Algalita Marine Research Foundation), the *Crusader* (MEC Analytical Systems), Inc., the *Hey Jude* (Aquatic Bioassay and Consulting Laboratories), the *La Mer* and *Marine Surveyor* (City of Los Angeles), the *Monitor III* and *Metro* (City of San Diego), and the *Ocean Sentinel* (County Sanitation Districts of Los Angeles County) were responsible for field collection and processing. They contributed to our success in no small measure.

We appreciate the efforts and expertise of the taxonomists who produced the primary data on which this report was built. Kelvin Barwick, Cheryl Brantley, Don Cadien, Nancy Carder, Douglas Diener, Thomas Gerlinger, Kathy Langan, Megan Lilly, John Ljubenkov, Lawrence Lovell, Ricardo Martinez Lara, Maricarmen Necoechea Zamora, Thomas Parker, Dean Pasko, Tony Phillips, William Power, Veronica Rodriguez Villanueva, James Roney, Rick Rowe, Timothy Stebbins, Rebeca Vazquez Yeomas, and Ron Velarde identified and counted every one of the 161,865 organisms collected. Special thanks are due to Dave Montagne, who coordinated the data generation process; his efforts ranged from training and auditing field crews to holding meetings to ensure that every taxonomist used each taxon name in the same way.

The Benthic Macrofauna Committee worked cooperatively on all aspects of data collection, sample processing, data analysis, and report preparation. Discussions were open and thoughtful, and the synergy of different perspectives resulted in many new and productive ideas.

The California State Water Resources Control Board supported extension of the Benthic Response Index to southern California embayments through Agreement 9-152-250-0. Dr. Russel Fairey and Larry Cooper provided guidance and data from the State of California's Bay Protection and Toxic Cleanup Program and the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program Western Pilot, respectively. We appreciate their assistance.

We are grateful to Shelly Moore for making maps and maintaining the database, Paul Smith for solving many computing issues and distributing data and documents across the Internet, Linda Fuller for editing this report, Debbie Elmore for graphic design and desktop publishing, and Dave Montagne for selecting photographs for the cover and determining their layout. Their efforts made complicated tasks seem easy.

Executive Summary

Organisms that live in sediments beneath bodies of water (benthic organisms) have many characteristics that make them useful as indicators of environmental stress for monitoring programs. Because they have limited mobility, they respond to many different types of environmental stress and integrate the effects of environmental conditions at a place over time. Benthic organisms are one of the most relevant measures of environmental condition because many environmental laws and regulations were created to protect these and other biological resources. Most benthic monitoring in the Southern California Bight (SCB) is conducted to evaluate the effect of discharges from individual sources such as wastewater outfalls, thermal and industrial outfalls, dredged material, and drilling mud. The low proportion of the SCB monitored by these programs and the differences in methodology between them impede the interpretation of the local patterns and trends measured by each program in a regional perspective. Recognizing the value of regional assessment, 12 agencies joined in a cooperative effort to assess the health of southern California's mainland shelf in 1994. This study was called the Southern California Bight Pilot Project (SCBPP). Based on the success of this regional monitoring survey, a second cooperative regional survey known as Bight`98 was conducted in 1998 by 62 organizations. Bight`98 expanded the spatial scope of the SCBPP in three ways: sampling extended inshore to assess the condition of bays, harbors, and ports (embayments); coastal sampling extended southward to include Mexican waters as far south as Ensenada; and coastal sampling extended westward to include the island shelves.

Benthic macrofauna were collected from 415 sites between Point Conception, California, and Punta Banda, Baja California, Mexico. Sites were selected using three complementary designs. Two random tessellation stratified (RTS) designs were used to estimate the condition of the SCB and its regions. The RTS designs are stratified random designs where samples are distributed more evenly across space, avoiding the "clumping" of sites that often occurs in spatially random designs. In the United States, 323 sites in areas from 3-120 m deep were selected using an RTS design stratified on habitats and potential sources of pollution. In Mexico, 72 sites from 10-200 m deep were selected by an RTS design stratified on latitude. In the third design, 20 U.S. sites were selected to collocate samples with previous or existing programs. At each site, samples were collected with a $0.1m^2$ Van Veen grab, sieved through a 1 mm mesh screen, placed in a relaxant solution for at least 30 minutes and fixed in buffered 10% formalin. In the laboratory, samples were sorted into major animal groups and wet weight biomass was measured for each group. The specimens in each group were then identified to the lowest practical taxon, most often species, and counted.

Extensive quality assurance and quality control measures were implemented. Manuals specifying the field, laboratory, and data submission procedures were prepared. All participating vessels and field crews passed audits to ensure they were capable of carrying out the planned fieldwork. Efforts to ensure consistency among the seven taxonomic teams that processed samples reduced the number of unexpected taxonomic problems by one-third in comparison to the SCBPP. After the SCBPP, the Southern California Association of Invertebrate Taxonomists (SCAMIT) focused on problems detected during the SCBPP and produced keys and other aids facilitating consistent taxonomic treatment. In addition, specialty taxonomists identified organisms that continued to present obstacles in spite of SCAMIT's efforts at standardization.

The mean sorting efficiency was 98.2%, and quality control reanalysis of 10% of the samples identified mean error rates of 4.8%, 3.4%, and 4.1% in abundance, number of taxa, and identification accuracy, respectively. These results meet or surpass the performance of the few other benthic programs that quantify data quality.

Successful completion of two activities was necessary to address the primary Bight`98 objective of estimating the extent of SCB area with altered benthic communities. The first was identifying the benthic macrofaunal assemblages that occur naturally in the SCB and the habitat factors that control them. The numbers and kinds of benthic organisms vary naturally in response to habitat differences, and comparisons to determine altered states should vary accordingly. We identified benthic assemblages by hierarchical cluster analysis and determined whether they occupied different habitats by statistical tests of habitat variables among assemblages. Because our objective was to define natural groupings of stations with similar species composition, we eliminated potentially contaminated sites before analysis, using criteria similar to the SCBPP.

We confirmed the shallow and mid-depth coastal assemblages identified by the SCBPP and identified two new reference assemblages in northern and southern embayments. The northern embayment assemblage occupied bays northward from Newport Bay and the southern embayment assemblage occupied bays southward from Dana Point. As reported in the SCBPP, the shallow and mid-depth assemblage on the coastal shelf segregated at a depth of about 32 m. The SCBPP also identified a fifth assemblage on the mainland shelf in deeper water than that sampled for Bight`98. Sediment grain size distribution was more important for shelf assemblage composition than depth, which was identified as the primary determinant in previous studies. These studies were restricted to the mainland shelf where depth and sediment texture are inextricably confounded because fine sediments occur at depth and coarse sediments occur in shallow waters. Bight`98 included the island shelf, where coarse sediments occur at depth, and identified that the controlling factors are more closely related to sediment texture than depth. The real determinant is probably the current, tide, and wind-driven hydrodynamic energy spectrum at the sediment surface.

The second preliminary activity necessary to address the primary Bight`98 objective was developing definitions of reference condition and ways to measure deviation from it for habitats for which definitions and measures were not available. We extended the Benthic Response Index (BRI) that was available for assessment of the shallow and mid-depth coastal assemblages by developing the BRI-E to assess embayments, for which no biointegrity index was available. We used data from 170 southern California sites sampled by Bight`98, the U.S. EPA's Western EMAP Pilot and the San Diego Regional Water Control Board to develop an ordination space based on the species abundance data. Pollution gradients were defined in this ordination space based on sediment chemical contaminant concentrations and toxicity to amphipods. We then determined the pollution tolerance for each species as its position on the pollution gradient. The BRI-E is calculated as the abundance-weighted pollution tolerance of species present at a site, just like the BRI. If most of the species in a sample are those typically found at reference sites, the index score is low; if most of the species are pollution tolerant, the index value is high. Correlations between pollution gradients in the ordination space and the index values were 0.82 and 0.85 for the northern and southern embayments, respectively. Correlation coefficients between BRI-E species pollution tolerance scores and similar scores developed from data from 171 sites sampled by the State of California's Bay Protection and Toxic Cleanup Program were 0.74 and 0.61, respectively. Finally, threshold values of the BRI-E, comparable in ecological significance to BRI thresholds, were defined for reference condition and four levels of response to disturbance based on the loss of 5%, 25%, 50%, and 80% of potential species.

The primary objective of Bight`98 was to estimate the extent of altered benthic communities. Areas were estimated using a ratio estimator based on the area weights for each sampling site from the RTS design. The BRI or BRI-E, as appropriate, was applied to the species abundance data for each site, the result was evaluated in terms of the level of biotic response, and the proportion of area exceeding the threshold and 95 percent confidence intervals were calculated using the ratio estimator.

Our estimates indicate that benthic macrofauna in almost all of the U.S. portion of the Southern California Bight (SCB) are healthy. Macrofauna in 98.05% of the SCB were in reference condition or deviated only marginally from reference. Disturbed communities occupied only 107 km^2.

There was no evidence of disturbance on the island shelf and hardly any on the mainland shelf. Macrofaunal communities in embayments, on the other hand, were more frequently disturbed. The proportion of disturbed area (17.09%) and the severity of disturbance were higher than in other habitats. Embayments occupy only 4.3% of the SCB but contributed 37.4% of the area with disturbed communities. Another aspect of our analysis compared benthic communities in areas of wastewater discharge and at the mouths of rivers. These areas were not substantially different from other areas with respect to benthic macrofaunal community condition.

Southern California embayments were also evaluated for the presence of non-indigenous species (NIS). The NIS are a potential threat to the integrity of natural ecosystems because they often eliminate native species or change patterns of primary production and nutrient cycling. The NIS were ubiquitous in southern California embayments and disproportionately dominate abundance. They were collected at 121 of 123 sites and, although they accounted for only 4.3% of the species, contributed 27.5% of abundance. Despite their prevalence and in contrast to their effects in other geographic areas, correlation analysis indicated that the NIS did not reduce overall abundance or species richness of the native communities. This was attributed to additional habitat space for native fauna provided by biogenic structures created by the two most abundant NIS. However, the possibility of negative effects on individual species cannot be eliminated without further study.

Macrofaunal community measures and species composition for the SCB and its regions were compared in order to provide context for placing data from smaller spatial scale studies in context. Several community measures and species composition were compared, rather than only the biointegrity indices used to evaluate community condition; all random sampling sites were included rather than undisturbed sites only, as in the assemblage studies. The same ratio estimator used to calculate proportions of area was used to calculate area-weighted means for these comparisons.

Benthic macrofauna on the island shelf and embayments were more than twice as abundant as on the mainland shelf. Twice as many species occurred in island samples as on the mainland shelf but only two-thirds as many species occurred in embayment samples. The high benthic abundances and low diversity observed in embayments may be indicative of intermediate levels of organic enrichment. The island shelf was numerically dominated by polychaetes to a greater extent than the mainland shelf and the relative abundance of ophiuroids and miscellaneous phyla was lower than on the mainland shelf. Hardly any echinoderms were collected in embayments. The relative abundance of miscellaneous phyla was lower and of molluscs higher in embayments than on the mainland shelf.

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1. Introduction

Benthic macrofauna are often used as indicators of the condition of marine (Pearson and Rosenberg 1978, Smith *et al.* 2001) and estuarine (Dauer 1993, Tapp *et al.* 1993, Wilson and Jeffrey 1994, Weisberg *et al.* 1997) environments. They include a diverse mixture of organisms with a wide range of physiological tolerances, and are well suited for use as indicators because they respond to many different types of environmental stress. Their responses also integrate environmental conditions over time because they have limited mobility and cannot avoid adverse conditions.

Most benthic macrofaunal monitoring in the Southern California Bight (SCB) is conducted to evaluate the effect of discharges from individual sources, such as municipal wastewater outfalls (Stull *et al.* 1986, Zmarzly *et al.* 1994, Diener *et al.* 1995, Dorsey *et al.* 1995) thermal and industrial outfalls (Southern California Edison Company 1997), disposal of dredged material and drilling mud (U.S. Environmental Protection Agency 1987), and storm water runoff (Bay and Schiff 1997). The University of Southern California conducted regional studies between 1956 and 1959 (Allan Hancock Foundation 1959, Barnard and Hartman 1959, Barnard and Ziesenhenne 1960, Stevenson 1961, Allan Hancock Foundation 1965, Jones 1969). However, these data were not used for environmental assessment. The Southern California Coastal Water Research Project (SCCWRP) also conducted regional surveys in 1977, 1985, and 1990 (Word and Mearns 1979, Thompson *et al.* 1987, Thompson *et al.* 1993), but their objective was describing reference conditions rather than assessing the condition of the benthic environment.

The spatial limitations of existing programs and the differences in methodology among them are impediments to regional assessments of benthic condition throughout the SCB; they also impede comparisons of local patterns and trends to regional patterns and trends (National Research Council 1990). Regional assessments provide an opportunity to evaluate cumulative effects, particularly effects of episodic and non-point sources that cannot be assessed using local data alone. Regional assessments also provide information that enables managers to make decisions with a broader perspective by comparing the relative importance of different types of pollutant sources and chemicals for the SCB as a whole.

Recognizing the value of regional assessment, 12 agencies joined in a cooperative sampling effort to assess the ecological health of southern California's mainland shelf in the summer of 1994 (Bergen *et al.* 2000). The study, known as the Southern California Bight Pilot Project (SCBPP), yielded several benefits. It enabled scientists and managers to map the extent and assess relative degrees of perturbation at different locations. It also led to standardization of sampling methods when regional monitoring methods were adopted for facility-specific monitoring. Standardization extended beyond data collection to include data management as regional monitoring data were shared among participants. The SCBPP also provided an opportunity for regulators and dischargers to work together to develop assessment tools (e.g., Smith *et al.* 2001) for the interpretation of benthic data on regional and local scales.

Based on the success of the 1994 survey, a second cooperative regional survey known as Bight`98 was conducted by 62 organizations in 1998. Bight`98 expanded the spatial scope of the

SCBPP in three ways: (1) sampling extended inshore to assess the condition of bays, harbors, and ports; (2) coastal sampling extended southward to include the Mexican mainland shelf as far south as Ensenada; and (3) coastal sampling extended westward to include the island shelf.

This report describes the benthic macrofaunal studies of the Bight`98 Survey. The objectives of the report are to estimate the extent and magnitude of altered benthic macrofaunal communities in the SCB, and to compare biointegrity and biotic responses among selected geographic regions (Bight`98 Steering Committee 1998). Appendix A integrates these results with coastal ecology indicators presented in other Bight`98 reports: sediment chemistry (Noblet *et al.* 2002), sediment toxicity (Bay *et al.* 2000), and demersal fish and megabenthic invertebrates (Allen *et al.* 2002). Other reports (Noble *et al.* 2000a, Noble *et al.* 2000b) describe the shoreline microbiology component. An executive summary of all the Bight`98 results has also been prepared.

This report is organized into nine chapters and nine appendices. The chapters comprise the body of the report and are based on Bight-wide data from the Bight`98 Survey. The appendices support the report by providing additional detail or describing the development of assessment techniques and tools based on data from other sources as well. Chapter 2 describes the study design and the field, laboratory, and data analysis methods. Chapter 3 presents the quality assurance procedures that ensured comparability of data produced by participating organizations and the results of quality control audits measuring their success. Chapter 4 assesses the condition of benthic macrofauna in the SCB and its regions. Chapter 5 describes the benthic assemblages of the SCB and habitat factors structuring them. Chapter 6 is a comparison of community measures and macrofauna among selected geographic regions. Chapter 7 presents our conclusions and Chapter 8 presents our recommendations for future studies. Chapter 9 is a list of literature cited in the body of the report.

Appendix A integrates the results of the Bight`98 Coastal Ecology Study elements: sediment chemistry, sediment toxicity, benthic macrofauna, and demersal fish and megabenthic invertebrates. Appendix B is an assessment of non-indigenous species in embayments of the SCB. Appendix C describes the extension of the southern California coastal Benthic Response Index (Smith *et al.* 2001) to include bays and harbors; Appendix D provides instructions for calculating these values. Appendix E describes the effects of taxonomic errors on commonly used assessment measures; it is based on Bight`98 and SCBPP quality control procedures and data and was published in *Environmental Monitoring and Assessment*. Appendix F provides tables with area estimates of benthic macrofaunal condition and Appendix G provides data about community measures for each sampling site; Chapters 4 and 6 were based on these data. Appendix H is a species list with taxonomic information, and Appendix I is a similar list with abundance and distribution information.

2. Methods

This chapter describes the study design, field and laboratory methods, and data analysis methods used to generate benthic data and analysis results for the other chapters of this report. The quality assurance and quality control procedures used to ensure accuracy and verify consistency of our data are described in Chapter 3.

A. Study Design

Benthic samples were collected at 415 sites in the Southern California Bight (SCB) between Point Conception, California, and Ensenada, Mexico. The sites were selected using three complementary designs:

- 323 sites in the United States waters from 5-120 m deep were allocated using a random tessellation stratified (RTS) design (Figures 2-1 and 2-2); 16 strata were defined based on habitat and potential sources (Table 2-1).
- 20 sites in United States waters were selected to collocate samples with previous or existing programs (Figure 2-3; Table 2-2).
- 72 sites in Mexican waters from 10-200 m deep were also allocated using an RTS design (Figures 2-1 and 2-2); three strata were defined based on latitude (Table 2-1).

Sites allocated at random using the RTS designs were used to estimate the condition of the SCB and its components. The RTS designs are similar to stratified random designs but samples are distributed more evenly across strata by subdividing them into hexagons and collecting a sample at a random location in each hexagon (Bergen 1996, Stevens 1997). Imposition of the hexagonal pattern minimizes clustering of the random samples. More information about the strata and numbers of samples is provided in Table 2-1 and Figure 2-1.

Non-random sites were sampled primarily for historical comparisons (Table 2-2, Figure 2-3). Most of these sites were sampled for SCCWRP reference surveys during the 1970s and 1980s. Sampling was repeated here to measure change over time.

B. Field Methods

In July and August of 1998, sediment samples for benthic macrofauna analysis were collected with a 0.1 m^2 Van Veen grab and sieved through a 1 mm mesh screen. Only samples penetrating at least 5 cm into the sediment with no evidence of sediment disturbance (e.g., washout) or slumping were processed. Material retained on the screen was placed for at least 30 minutes in a relaxant solution of 1 kg $MgSO_4$ or 30 ml propylene phenoxytol per 20 L of seawater and preserved in 10% sodium borate buffered formalin. Sediment samples were also collected for analysis of sediment contaminants and sediment toxicity; the results are provided elsewhere (Noblet *et al.* 2002, Bay *et al.* 2000).

C. Laboratory Methods

Samples collected for macrofaunal analysis were distributed to five laboratories for sorting, biomass determination, identification, and enumeration. Samples were rinsed and transferred from formalin to 70% ethanol 3-14 days after collection. Organisms in the samples were sorted into six taxonomic categories (annelids, arthropods, molluscs, ophiuroids, other echinoderms, and other phyla), and the wet weight of each group was measured to provide an estimate of biomass. All echinoderms were weighed together in the Mexican samples; ophiuroids and other echinoderms were not separated. One of two methods was used to remove excess preservative prior to weighing; the organisms were either drained on a fine sieve and air dried for five minutes on absorbent paper or poured onto a fenestrated plate in a funnel and gentle vacuum applied until no liquid was visible in the stem of the funnel. Balances capable of reading to 0.01 gram were used to weigh the samples, and weights were reported to the nearest 0.1 gram. After weighing, specimens were identified to the lowest practical taxonomic level, most often species, and counted.

Table 2-1. Distribution of random samples. Publicly owned treatment works (POTWs) refer to treated waste-water discharges. Small POTWs discharge less than, and large POTWs more than, 100 mgd. Marinas refer to embayments where large numbers of recreational vessels are anchored, ports refer to embayments where large ocean-going vessels anchor, and other embayments refer to all other embayments.

Stratum	Habitat Area (km^2)	Number of Sites
U.S. Mainland Shelf:		
Shallow (10-30 m deep)	1,065.50	32
Mid-Depth (30-120 m deep)	1,838.50	34
Large POTW	159.44	30
Small POTW	24.45	29
River Mouths	146.49	24
Total	**3,256.34**	**149**
U.S. Island Shelf:		
Santa Catalina Island Shelf	262.23	17
Northwest Channel Island Shelf – Shallow	95.00	5
– Mid-Depth	1,314.00	11
Southeast Channel Island Shelf – Shallow	56.00	8
– Mid-Depth	412.00	12
Total	**2,139.23**	**53**
U.S. Embayments:		
Ports: San Diego	9.66	18
Ports: Other	8.02	19
Marinas: San Diego	3.63	9
Marinas: Other	9.58	30
Other Embayments: San Diego	33.52	19
Other Embayments: Other	40.93	19
Small POTW	3.65	4
River Mouths	18.31	3
Total	**105.34**	**121**
U.S. Waters Total	**5,500.91**	**323**
Mexico Coastal Waters:		
Northern	773.70	28
Central	162.90	21
Southern	352.70	23
Total	**1,289.30**	**72**

Table 2-2. Distribution of non-random samples.

Purpose		Sites
Historical Comparisons: 30 m Deep Sites		6
Historical Comparisons: 60 m Deep Sites		7
Small POTW Permit		3
River Gradient		4
	Total	**20**

D. Quality Assurance and Quality Control

In order to ensure the quality of the data produced, quality assurance and quality control procedures were included in our field and laboratory activities. Descriptions of these procedures and the results of quality assurance and control procedures, quality control audits, and inter-team comparisons are presented in Chapter 3. Appendix E describes the effects of taxonomic errors on commonly used assessment measures based on Bight`98 and 1994 Southern California Bight Pilot Project quality assurance procedures; it was published in *Environmental Monitoring and Assessment*.

E. Data Analysis

The following sections describe the data analysis procedures that were used in the chapters that follow.

(i) Chapter 4: Assessment of Benthic Condition

The primary objective of this report was to assess the extent of SCB area with altered benthic assemblages. We also evaluated the magnitude of change in benthic macrofaunal condition at sites sampled sporadically since the 1970s.

The extent of area with benthic assemblages showing clear evidence of disturbance was estimated in three steps. First, a measure of biointegrity, the Benthic Response Index (BRI) that measures the abundance-weighted pollution tolerance of species present, was used to assess the condition of the benthic assemblage at each site. The existing index (Smith *et al.* 2001) was applied to sites on the coastal and island shelf. A conceptually identical index was developed to extend it to bays and harbors (Appendix C) because we found the biota to be different. Both indices define reference condition and four levels of biotic response along a pollution gradient, which, although not identical, are comparable in ecological significance.

These biointegrity data were next transformed to binomial values in relation to thresholds for the levels of biotic response. For example, for reference comparisons, sites with BRI values larger than the reference threshold were scored as one; otherwise, they were scored as zero. Finally, the proportion of area exceeding the threshold was calculated as the mean of the scores using a ratio estimator.

We used Thompson's (1992) ratio estimator to estimate the mean as:

$$m = \sum_{i=1}^{n} (p_i * w_i) \Big/ \sum_{i=1}^{n} w_i$$

where m is the mean score, p_i is the score at station i, w_i is the area weight for station i, and n is the number of stations sampled. It was used instead of a stratified mean because an unknown fraction of each stratum was not sampleable (e.g., hard bottom). The estimated area, a random variable, was used as a divisor in place of the unknown true sampleable area. The standard error of the mean response was calculated as:

$$s = \sqrt{\sum_{i=1}^{n} ((p_i - m) * w_i)^2 \Big/ (\sum_{i=1}^{n} w_i)^2}$$

Confidence intervals were calculated as 1.96 times the standard error. Use of the ratio estimator for the standard error approximates joint inclusion probabilities among samples and assumes negligible spatial covariance, an assumption that, based on the data, appears to be warranted. The assumption is conservative since violation would lead to an overestimate of the confidence interval (Stevens and Kincaid 1997).

We evaluated the magnitude of change in benthic macrofaunal condition at 13 sites sampled in 1977, 1985, and 1990 and repeated for Bight`98 (Figure 2-3). We calculated BRI values from the benthic macrofaunal species abundance data and evaluated magnitudes of BRI change and changes relative to BRI response level thresholds. Seven of the sites were located at depths of 60 m and the other six at 30 m. The 30 m sites were not sampled in 1977. The sample collection and processing methods used previously were identical to the Bight`98 methods.

The Benthic Response Index was developed as a screening tool that discriminates disturbed from undisturbed benthic communities; it also measures the magnitude of disturbance. Since benthic species responses to natural and anthropogenic disturbances are similar, it cannot be used to identify sources of disturbance. For this reason, benthic communities with index values above the reference threshold are referred to as altered rather than impacted.

The BRI identifies four levels of response beyond reference condition (Bergen *et al.* 2000, Smith *et al.* 2001, Appendix C, Appendix D). Three of them (Levels 2 thru 4) are considered to show clear evidence of disturbance. In coastal habitats, the BRI response levels correspond to: (1) marginal deviation, a change in relative abundance of species; (2) loss of biodiversity, the exclusion of sensitive species from the assemblage; (3) loss of community function, where taxonomic groups, particularly arthropods and ophiuroids are, for the most part, excluded; and (4) defaunation, the exclusion of 90% of the species typical of reference condition (Smith *et al.* 2001). In southern California embayments, due to a paucity of echinoderms and the occurrence of fewer species (Chapter 6, Appendix C), response levels were based on the loss of 5%, 25%, 50% and 80% of potential species. These embayment response levels were selected to mimic the community effects of the coastal thresholds as closely as possible.

The coastal and embayment BRIs are calculated as the abundance-weighted pollution tolerance of species. The pollution tolerance was determined for each species as its position on a gradient between the most and the least affected sites in a species abundance ordination of the sites used in index development. If most of the species in a sample are those typically found at reference sites, the index score for the station is low. If most of the species are pollution tolerant, the index value for the station is high.

(ii) Chapter 5: Macrofaunal Assemblages of the Southern California Bight

We used a process similar to Bergen *et al.* (2001) to identify naturally occurring assemblages in the Southern California Bight and the habitat factors that structure them. After eliminating potentially contaminated sites, we identified assemblages using hierarchical cluster analysis and tested habitat variables across dendrogram splits to assess whether the assemblages occupied different habitats.

Because our objective was to define natural groupings of stations with similar species composition, we used criteria similar to those of Bergen *et al.* (2001) to eliminate potentially contaminated sites from the analysis. A site was considered potentially contaminated if more than three chemicals exceeded Long *et al.* (1995) effects range low (ERL) values, one or more chemicals exceeded Long *et al.* (1995) effects range median (ERM) values, or it was within the area of influence of a storm water or municipal waste water outfall. We also excluded sites known to have been disturbed by dredging shortly before sampling occurred. Sites deeper than 126 m were excluded because they were outside our sampling frame. After these exclusions, 240 stations remained for analysis.

Cluster analysis was conducted using flexible sorting of Bray-Curtis dissimilarity values with ß=-0.25 (Bray and Curtis 1957, Lance and Williams 1967, Clifford and Stephenson 1975). For station (Q-mode) analyses, abundances were square-root transformed and then standardized by the species mean of values higher than zero to reduce the influence of dominant species (Smith 1976, Smith *et al.* 1988). The step-across distance re-estimation procedure (Williamson 1978, Bradfield and Kenkel 1987) was applied to dissimilarity values over 0.80 to reduce the distortion of ecological distances caused by joint absences of a high proportion of species; the distortion occurs due to the common non-monotonic truncated nature of species distributions along environmental gradients (Beals 1973). For species (R-mode) analysis, the square-root transformed abundance data were standardized by the species minimum. Prior to cluster analysis, species contributing little information were excluded by eliminating species occurring at fewer than 5 sites unless the total abundance at all 240 sites was more than 50 individuals (Smith 1976). Of the 1,057 taxa in the original data, 487 taxa were included in the analysis.

The number of habitat-defined assemblages was determined by sequentially examining each split of the cluster analysis dendrogram, starting at the top, to assess whether each split reflected habitat differentiation. Habitat differentiation was defined as a significant (Mann-Whitney U-test) difference in habitat variables between the sets of sites defined by the dendrogram split and segregation of more than 90% of the sites in the split by the significant habitat variables. We tested four continuous variables (depth, fine sediment content, latitude, longitude) and a categorical habitat classification variable. This process was conducted along each branch of the dendrogram until a split yielded no significant difference or a split contained fewer than ten sites. Probabilities were not adjusted to account for multiple testing because we were only interested in controlling the comparisonwise error rate.

(iii) Chapter 6: Community Characteristics

Area-weighted means for several benthic community measures were compared among areas and habitats of interest to identify, quantify, and explore biological differences at several spatial scales (Table 2-3). Areas with less than ten sites in a comparison were not included. Abundance, biomass, number of taxa, and Shannon-Wiener diversity (using natural logarithms) (Pielou 1969) were analyzed as measures of the entire community while abundance, biomass, and numbers of taxa were analyzed for six taxonomic groups: annelids, arthropods, molluscs, ophiuroid echninoderms, other echinoderms, and miscellaneous phyla. Area-weighted mean abundances were calculated for each taxon, the abundances were ranked, and the number of occurrences calculated as a percentage of the number of sampling sites. Thompson's (1992) ratio estimator (see *(i)* above) was used to calculate the area-weighted mean, standard error, and 95% confidence interval for each measure. The means were compared graphically and differences were confirmed using analysis of variance.

Table 2-3. Populations for comparisons of community measures. Populations with N<10 were excluded.

	Comparison	Area or Habitat	N
1	Entire U.S. Bight		321
2	U.S. Habitats (n=321)	Embayment Sites	121
		Coastal Shelf Sites	147
		Island Shelf Sites	53
3	Embayments (n=121)	Ports	37
		Marinas	39
		Small POTWs	4
		River Mouths	3
		Other Bay Bottoms	38
4	Coastal Shelf Geographic Regions (n=210)	Northern U.S. Bight	46
		Central U.S. Bight	62
		Southern U.S. Bight	39
		Mexico	63
5	Shallow (<30 m) Coastal Shelf Habitats (n=78)	River Mouths	21
		Island Shelf	13
		Small POTWs	12
		Other Shallow Bottoms	32
6	Mid-depth (30-120 m) Coastal Shelf Habitats (n=122)	Island Shelf	40
		Large POTWs	30
		Small POTWs	15
		River Mouths	3
		Other Mid-depth Bottoms	34
7	Island Shelf (n=53)	Santa Catalina Island Shelf	17
		Northwest Channel Island Shelf	16
		Southeast Channel Island Shelf	20

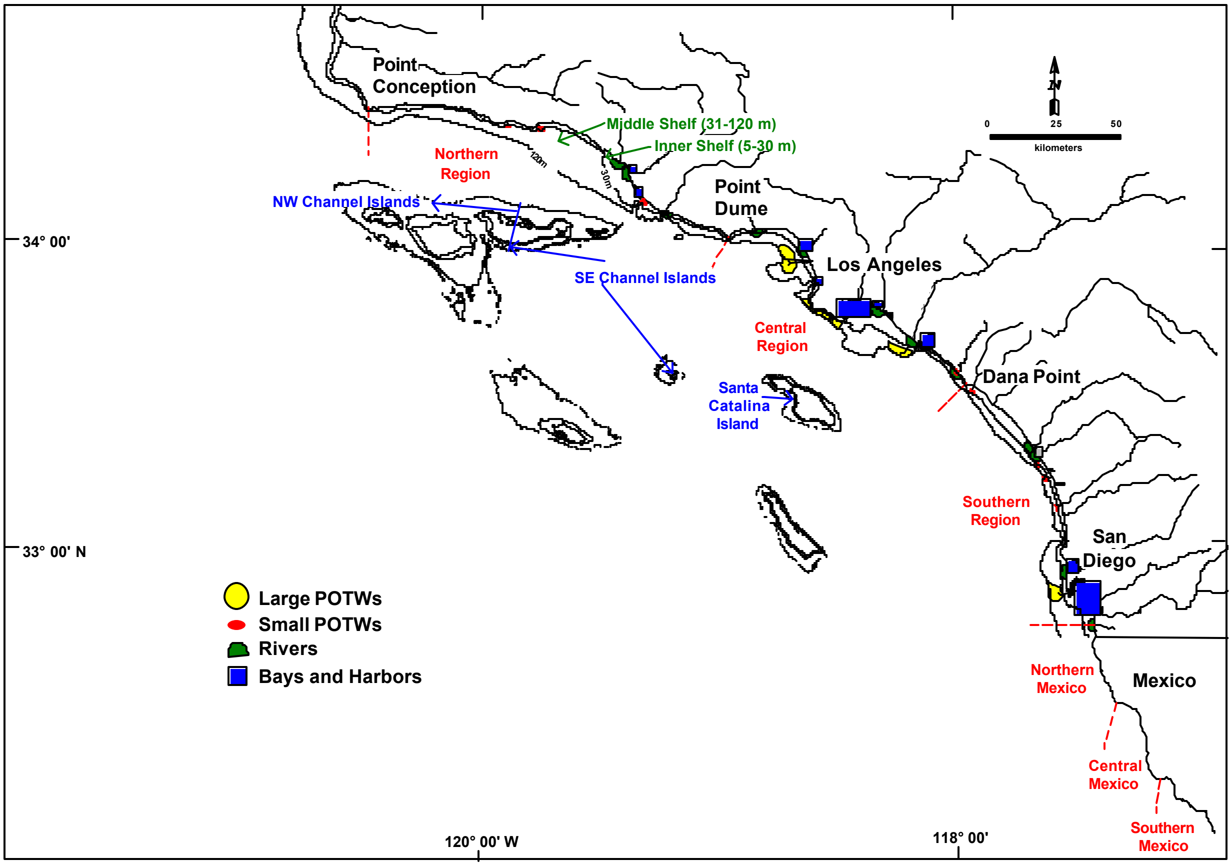


Figure 2-1 Distribution of strata and populations of interest.

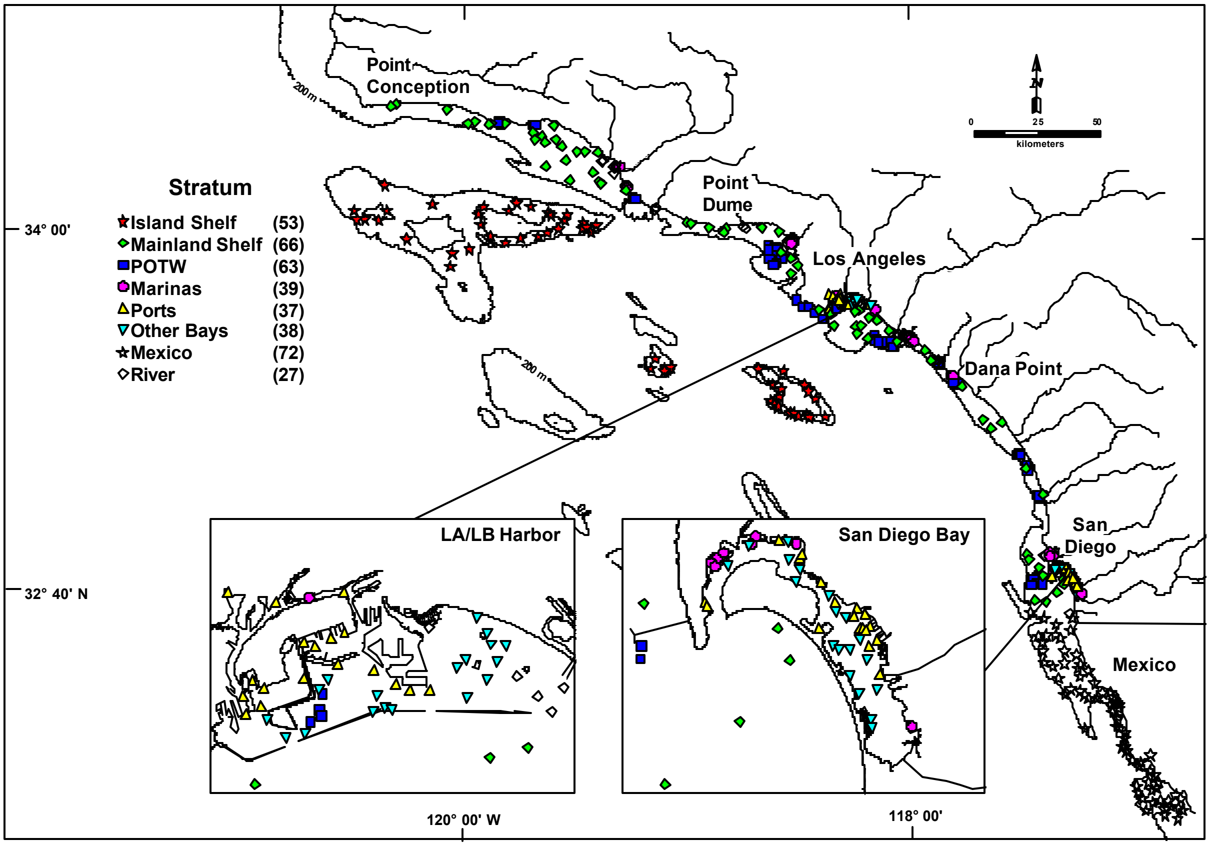


Figure 2-2. Random tessellation stratified design sampling sites.

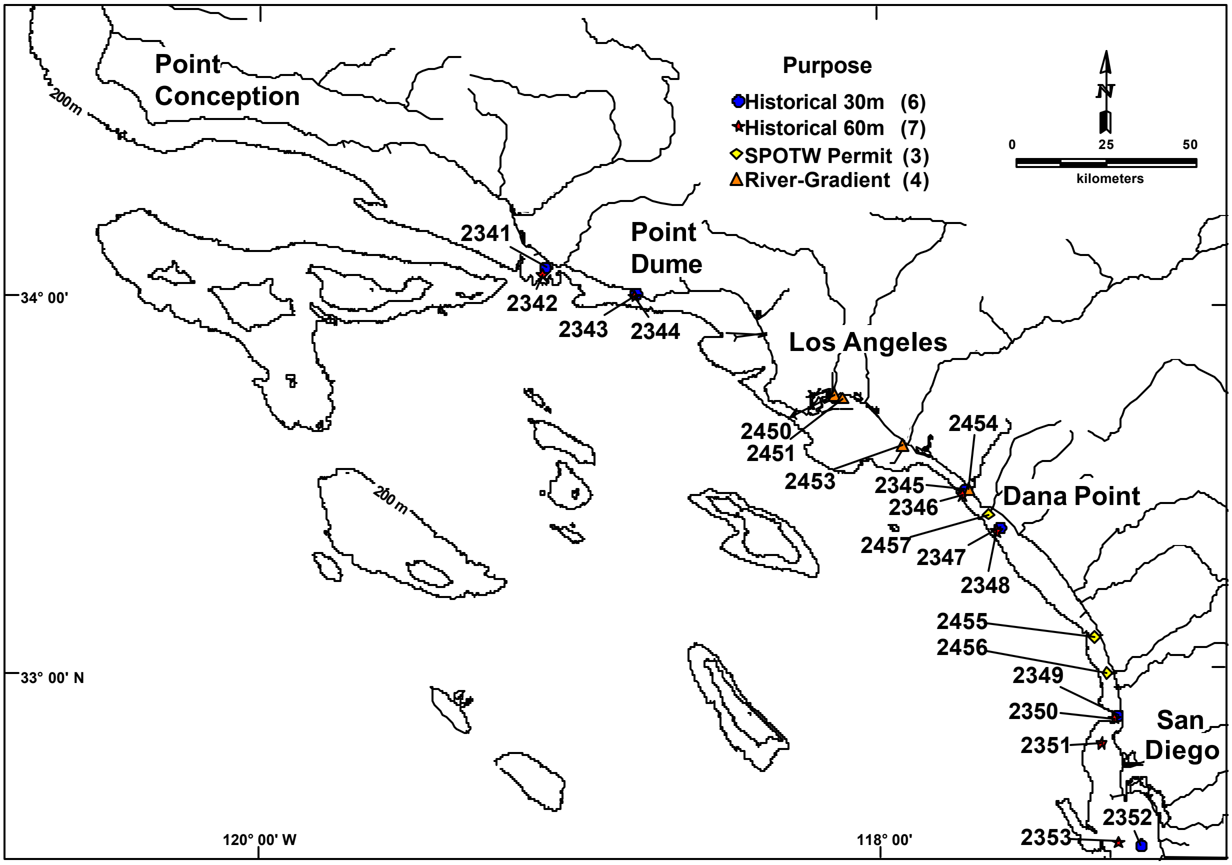


Figure 2-3. Non-random sampling sites.

3. Quality Assurance and Quality Control

Benthic macrofaunal community composition was included in the Bight`98 Coastal Ecology Work Plan (Bight`98 Steering Committee 1998) as an indicator of biotic responses in sediments. Measuring community composition entails accurately collecting, identifying, and counting the organisms in samples. This chapter describes the field and laboratory procedures that ensured the quality of these data and presents the results of quality control audits, inter-team comparisons, and other statistics that document this process. The overall approach was to establish data quality objectives and assessment standards; produce manuals specifying field, laboratory, and data submission procedures; evaluate procedural compliance using field and laboratory audits; and evaluate achievement of data quality objectives using inter-team comparisons and other measures.

A complementary benthic survey of macrofauna in the Mexican waters of the Southern California Bight (SCB) was proposed after the Bight`98 sampling design and procedures were developed. The Mexican survey followed the same field and laboratory procedures as the U.S. component. Taxonomists working on the Mexican samples participated in all Bight`98 Quality Assurance (QA) and Quality Control (QC) activities except the QC re-analysis.

A. Data Objectives

The overall goal of the macrofaunal survey was to provide accurate identifications and counts of all of the benthic invertebrates in the samples within 12 months of sample collection. The identifications were to be as precise as practicable (i.e., to the lowest taxonomic category) with a goal of species-level identification for all specimens whose condition allowed it. The level of precision was driven by the analytical uses of the data, which included description of assemblages, and the development and application of assessment indices that depend on the distribution of species along pollution gradients.

To achieve this goal, measurement quality objectives (MQOs) were specified for several measurements and processes (Table 3-1) in the Work Plan (Bight`98 Steering Committee 1998). An MQO specifies the acceptable level of uncertainty for each measurement or process and is based on assessment standards developed in the Bight`98 Coastal Ecology Work Plan.

Table 3-1. Measurement quality objectives for benthic macrofaunal sample collection and processing. NA: not applicable

Activity	Accuracy	Precision	Completeness
Station Occupation	Within 100 m	NA	NA
Sample Collection	NA	NA	90%; 30 per stratum
Sorting	5%	NA	90%
Total Abundance	10%	NA	90%
Number of Taxa	10%	NA	90%
Identification	10%	NA	90%

B. Field and Laboratory Manuals

As part of the planning effort, manuals were developed that specified procedures to be used for field sampling (Southern California Bight Field Methods Committee 1998) and laboratory activities affecting benthic invertebrate samples (Bight`98 Benthic Committee 1998).

These manuals were designed to produce consistency in the collection, handling, and processing of samples in order to meet Bight`98 survey goals, MQOs, and sample processing timelines.

An Information Management Plan (Bight`98 Information Management Committee 1998) imposed data reporting standards and data screening procedures to ensure that inconsistencies were not introduced as a result of differences in the manner in which species data were reported. The plan included formats and specifications for data submissions that were referenced in the laboratory manual (Bight`98 Benthic Committee 1998).

C. Station Occupation

Prior to sampling, participating vessels were inspected and field crews audited to ensure that they were properly equipped and trained. Experienced biologists familiar with the sampling techniques conducted the audits. All vessels and field crews successfully passed the audits.

The MQO of station occupation accuracy within 100 m of the nominal location was achieved for 88.4% of the stations (Table 3-2). Success rates were highest in bays and harbors (94.7%) and the open coast (94.4%), and lowest (64.2%) on island shelves. The mean distance of sampled sites from nominal locations was inversely related to sampling success. The main reason for failure to meet the MQO was the occurrence of rocky or very coarse substrates that could not be sampled by a Van Veen grab, particularly on island shelves; samples were collected as close to the nominal position as bottom conditions allowed.

Table 3-2. Station occupation accuracy.

Habitat	Sites	Distance from Nominal Location (m)					
		<=100 m	100-200 m	> 200 m	Maximum	Minimum	Mean
Embayments	113	107	3	4	517	2	41
Island Shelf	53	34	14	5	552	2	88
U.S. Mainland Shelf	177	167	8	2	390	<1	42
Mexico Mainland Shelf	72	59	13	0	181	<1	63
Total	**415**	**367**	**38**	**11**	**552**	**<1**	**51.5**

D. Sample Collection

Sampling success was 85% (Table 3-3), marginally failing the MQO by 5%. As with station occupation accuracy, the primary cause for the shortfall was the occurrence of rocky or very coarse substrates that could not be sampled. The island habitat was the most challenging, with samples collected at only 62% of the intended sites. Many of our random samples fell on extensive areas of rocky hard bottom in the shelf depths surrounding the islands and consequently could not be sampled. Sampling success in harbors was reduced because of the difficulty of sampling adjacent to man-made structures; in some parts of San Diego Bay, it was reduced because of the prevalence of coarse sediments. In open coastal habitats, the MQOs were met in all strata except river mouths, where coarse sediments reduced success to 70%. The MQO was based on previous experience in open coastal habitats; it may need revision in light of the results for island shelves and embayments, which were sampled in the regional monitoring program for the first time.

The ability of the program to meet its assessment objectives was not adversely affected by failure to meet this MQO. The minimum number of 30 samples per stratum necessary for area comparisons was achieved or exceeded in all strata (Table 3-3).

Table 3-3. Benthic sample collection success.

	Planned	Sampled	Success
Bays & Harbors			
Marina	47	40	85%
Ports/Industrial	42	37	88%
Other	47	37	79%
Bays & Harbors Total	136	114	84%
Island Shelf			
Santa Catalina Island	22	17	77%
Channel Islands	63	36	57%
Island Shelf Total	85	53	62%
U.S. Mainland Shelf			
River Mouths	44	31	70%
Shallow	33	32	97%
Mid-depth	33	33	100%
POTW	71	67	94%
Historically Sampled	13	13	100%
U.S. Mainland Shelf Total	194	176	91%
Mexico Mainland Shelf	72	72	100%
Total	**487**	**415**	**85%**

E. Sorting

The five U.S. laboratories sorted all of the U.S. samples that were collected and conducted re-sorts as specified in the laboratory manual (Table 3-4); one laboratory lost all supporting documentation after sorting was complete. Ten percent of the residue was re-sorted to verify that the MQO of 5% (i.e., removal of at least 95% of the specimens) was achieved. One of two methods was used. In the aliquot method, 10% of the material of every sample was re-sorted. In the whole sample method, 10% of the samples sorted by each individual were re-sorted in their entirety. Although Bight`98 sorting procedures were followed for the 72-sample Mexico component, samples were not resorted to verify MQO attainment.

Table 3-4. Sample sorting and re-sorting by the five U.S. laboratories. Laboratory B completed all required sorting and re-sorting but lost the documentation.

Labora-tory	Samples Assigned	Aliquot Method		Whole Sample Method			Completeness %
		No. Required	No. Re-sorted	No. of Sorters	No. Required	No. Re-sorted	
A	42	-	-	4	5	5	100
B	77	-	-				100
C	30	-	-	4	4	6	100
D	88	88	88	-	-	-	100
E	106	-	-	9	12	15	100
Total	**343**						**100**

The sorting efficiency of the four laboratories for which results were available met or exceeded the MQO of 95% (Table 3-5). The overall mean sorting efficiency was 98.2%, well above the MQO of 95%. These results meet or surpass the performance of other benthic programs that quantify sorting efficiency.

Table 3-5. Sorting efficiency. MQO of 5% expressed as 95% removal. Laboratory B lost all documentation.

Labora-tory	Sorting Efficiency (%)			MQO (%)
	Low	High	Mean	
A	97.5	100	99.1	95.0
B	-	-	-	95.0
C	95.8	100	98.2	95.0
D	95.0	100	97.9	95.0
E	98.3	100	99.4	95.0
Total	**95.0**	**100**	**98.2**	**95.0**

F. Identification and Enumeration

The goal of the macrofaunal survey was to identify all benthic invertebrates contained in samples to species level and count them. Several obstacles made the description of this task much simpler than its execution. First, macrofaunal communities are very complex, comprising hundreds to thousands of individuals from many different taxa. A recent listing of benthic invertebrates from the SCB continental shelf and slope contains over 2000 species from 15 phyla and 47 classes (Southern California Association of Marine Invertebrate Taxonomists 2001). Second, many of these species are poorly known, and our appreciation of their diversity is limited. Nine percent of the species in the SCAMIT listing have not been formally described. In the Bight`98 survey, 16% of the reported species were undescribed. This state of knowledge contributes to variation in the results related to the taxonomists identifying the specimens. Because of differences in opinion and experience, different taxonomists produce slightly varying accounts of the taxa present in samples of identical composition (Ranasinghe *et al.* 2003). The condition of specimens may be a third obstacle. Specimens are frequently damaged during sampling, increasing the difficulty of recognition. In some cases, the lack of knowledge of ontogenetic effects on morphology prevents species-level identification of juveniles. All of these factors lead to inconsistencies in the reported abundances of individual taxa.

Several steps were taken to mitigate the effects of these obstacles on data quality. They were considered necessary because 22 taxonomists in 8 different teams identified organisms in the samples; each team included taxonomists capable of identifying all taxa likely to occur. First, single “specialty” taxonomists identified four taxonomic groups that were inconsistently identified in a previous survey (Bergen *et al.* 1998). By relying on a single taxonomist, we sought to eliminate inconsistencies introduced by multiple taxonomists. Second, communication among the taxonomic teams was facilitated by an email list-server dedicated to this purpose. Messages posted to the list-server were posted to all participating taxonomists. They used the system to alert each other of unusual or newly encountered species, circulate descriptions of provisional taxa and request information and assistance.

The Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) also helped by focusing activities on Bight`98 needs. The SCAMIT is an organization that promotes the study of marine invertebrate taxonomy in Southern California and standardizes regional taxonomic nomenclature. All Bight`98 taxonomists are members of SCAMIT. In the months prior to Bight`98 SCAMIT focused its efforts on anticipated taxonomic problems, based on problems encountered in the previous survey. During sample processing, SCAMIT increased the frequency of meetings and dedicated them to Bight`98 issues. During the 24 months it took to process samples, SCAMIT organized approximately 30 meetings for participating taxonomists.

While the goal of the study was to identify all organisms to species, only 82% of the specimens were identified to this level (Table 3-6). The primary reason was condition of specimens, which accounted for over 80.6% of the higher taxon identifications (Table 3-7). The remaining 19.4% were the result of insufficient taxonomic knowledge to discriminate species. The level of success at species identification was similar in all habitats (Table 3-6), indicating that the fauna of bays, harbors, and islands, which were sampled for the first time in this survey, did not present many exceptional taxonomic problems.

Table 3-6. Success at species-level identification. Of 1,415 taxa reported, 1,083 were at species level.

Habitat	Number of Organisms	Species-level Identification	
		N	%
Bays & Harbors	73,973	60,099	81.2
Island Shelf	25,681	21,040	81.9
Mainland Shelf (U.S. & Mexico)	62,211	51,643	83.0
Total	**161,865**	**132,782**	**82.0**

Table 3-7. Reasons for failure to achieve species-level identifications.

Reason		Proportion (%)
Condition of Specimens		80.6
Lack of Taxonomic Knowledge	Bight`98 rules stipulated identification at a higher taxonomic level	4.4
	Regionally recognized species complexes	2.8
	Other problems discovered during synoptic data review	12.2

G. Data Submission and Time Line

Upon completion of sample processing, each team submitted results in formats stipulated in the Bight`98 Information Management Plan. The results were combined into a single database.

Not all teams were able to meet the data submission schedule of 12 months after sample collection established in the Coastal Ecology Work Plan. Some teams took 24 months for sample analysis due to conflicts with other programs and priorities. The schedule was also affected by failure to submit data in formats specified in the Information Management Plan. Typically, several iterative data submissions were necessary in order to achieve compliance. After all of the data submissions were accepted, three more months were required to complete the QC reanalysis, nomenclature review, and synoptic data review. The final data set was produced in January 2001, 28 months after sample collection.

Overall, 7.8% of the taxon names submitted did not match names in the third edition of the SCAMIT taxonomic listing (Southern California Association of Marine Invertebrate

Taxonomists 1998) that was used in the nomenclature and spelling standard for data submissions (Table 3-8). The most common sources of error were orthographic and spelling. All deviations from the standard were corrected to assure that each taxon was represented by a unique name.

Table 3-8. Compliance with data submission standards for taxon names. Teams that submitted data through common data systems are combined.

Team	Number of Taxa	Compliance (%)	Reason for Failure to Match Data Submission Rules (%)			
			Synonymy	Nomenclature[1]	Orthography[2]	Misspelling
A & B	522	79.1	2.1	2.3	10.7	5.7
C	863	97.2	0.9	0.9	0.3	0.6
D	729	99.2	0.1	0.1	0.1	0.4
E & F	721	82.5	3.5	2.5	9.2	2.4
G	1,043	97.2	0.6	1.9	100*	0.3
H	490	91.6	2.2	1.6	3.1	2.4
Overall	**4,368**	**92.2**	**1.4**	**1.5**	**3.2**	**1.6**

[1]: e.g., *Prionospio dubia* vs. *Prionospio (Prionospio) dubia* or decapod vs. Decapoda.
[2]: e.g., Amphiuridae sp. Juvenile vs. Amphiuridae.
* All records submitted in upper case; otherwise, no orthographic errors.

H. Synoptic Data Review

After data from all of the teams were combined into a single data set, Bight`98 taxonomists conducted a synoptic data review. The goal of the review was to produce final data that were as consistent and free of taxonomic errors as possible. To achieve this, the data were presented in a form that facilitated the discovery of inconsistencies in taxonomy. Potential inconsistencies were identified, discussed, and resolved. Decisions resolving the inconsistencies were applied to the submitted data to produce the final data set.

The synoptic data review resulted in a number of changes that improved consistency of nomenclature and reduced variation in identification level. Most changes combined taxa to a higher taxonomic category. In some cases, species reporting patterns suggested an uneven distribution of knowledge among the taxonomists (Table 3-9). Others turned on specimen condition and were "smoothed" by lumping to a single taxon name. Other changes corrected violations of identification rules such as the inclusion of pelagic species or specimen fragments. Taxon names in approximately 19% of the data base records were changed after the synoptic data review. Data base records are unique for each species-site combination; they store names and abundances for each species collected at each site.

I. Sample Reanalysis to Assess Data Quality

To evaluate success at meeting identification and enumeration objectives, a subset of samples was re-analyzed. Seven of the eight taxonomy teams participated. The Mexican team did not participate because its component of the survey was on a separate and later schedule than the U.S. Quality control for these samples included identifying and enumerating specimens in collaboration with U.S. taxonomists for some groups and identifications by U.S. taxonomists for others.

Table 3-9. Changes in levels of identification after the synoptic data review. Changes indicate persisting regional taxonomic problems.

Group	Name Adopted After Synoptic Data Review	Level	Number of Taxa Combined
PHYLUM NEMERTEA			
Class Anopla	Palaeonemertea	Order	3
Order Heteronemertea	Lineidae	Family	8
Class Enopla			
Order Hoplonematerea	*Amphiporus* spp.	Genus	4
PHYLUM MOLLUSCA			
Class Aplacophora			
Order Chaetodermatida	Chaetodermatidae	Family	2
Class Gastropoda,			
Order Neotaenioglossa	*Lirobittium* spp.	Genus	3
Order Heterostropha	*Turbonilla* spp.	Genus	4+
Class Bivalvia			
Order Ostreoida	*Ostrea* spp.	Genus	2
PHYLUM ANNELIDA			
Class Polychaeta			
Order Orbiniida	*Paradoneis* spp.	Genus	5
Order Spionida	*Boccardia* spp.	Genus	2
	Cirratulus spp.	Genus	2
Order Phyllodocida	*Eusyllis* spp.	Genus	3
	Aphrodita spp.	Genus	2+
Order Eunicida	*Dorvillea (S.)* spp.	Genus	3
	Arabella spp.	Genus	2
Order Sabellida	*Nothria* spp.	Genus	2
	Bispira spp.	Genus	2
PHYLUM ARTHROPODA			
Class Malacostraca			
Order Amphipoda	*Corophium* spp.	Genus	3
	Synchelidium spp.	Genus	3
PHYLUM PHORONA			
Order Phoronida	Phoronida	Order	2+

For this evaluation, 10% of the samples analyzed by each team were selected at random and distributed to other teams for reanalysis. Taxonomists performing reanalysis had no access to original analysis results. When reanalysis was complete, the original and reanalysis data were compared and a list of discrepancies was compiled. Discrepancies were classified as errors when they were caused by inaccurate identifications, incorrect counts, or specimens overlooked in the original analysis. They were classified as differences, rather than errors, when they resulted from the use of a junior synonym or other unconventional nomenclature, apparent specimen loss, or differences of opinion about the taxonomic level to which an organism could be identified (e.g., *Ampelisca* sp. vs. *Ampelisca lobata*). Error rates for each sample were calculated as ratios of the difference between the original and resolved values to resolved values. The resolved values represented the "truth" by consensus among the original and reanalysis taxonomists. These error rates were used to assess data quality relative to the MQOs.

Re-analysis results are available for only 30 samples (36 samples were selected and distributed, but the results for six samples were lost). The 30 samples amounted to 8.7% of the 343 samples analyzed by the taxonomic teams participating in re-analysis. These 30 samples included 2,226 data records or 10.1% of the 22,057 records produced by the seven teams.

Miscounts were the most common type of error in the original results, comprising 25.8% of the discrepancies and affecting 8.2% of all data records (Table 3-10). Overlooked specimens and misidentifications occurred at one-half the rate of miscounts, while misapplication of identification rules affected less than 1% of records. Discrepancies classified as differences rather than errors of the original taxonomist occurred at frequencies similar to errors (332 vs. 373). Differences in judgment were most common, affecting 10% of the records. Apparent specimen loss affected 3.6% and nomenclature inconsistencies 1.3% of the data records. Most cases of specimen loss could not be distinguished from over-counting errors by the original taxonomist and may be viewed as additional counting errors. If so, the number of records affected by counting errors increases to 11.8%.

Table 3-10. Frequencies and types of discrepancies in re-analysis of 30 samples. Each taxon and its reported abundance constitute a record.

Type of Discrepancy		N	%	Proportion of Records in Entire Data Set (%)
Errors	Miscount*	182	25.8	8.2
	Overlooked specimen(s)	93	13.2	4.2
	Misidentification	87	12.3	3.9
	Misapplication of identification rules	11	1.6	0.5
	Subtotal	**373**	**52.9**	**16.8**
Differences	Judgment differences	222	31.5	10.0
	Apparent specimen loss or long count*	80	11.3	3.6
	Unconventional nomenclature	30	4.3	1.3
	Subtotal	**332**	**47.1**	**14.9**
Total Discrepancies		**705**		**31.7**

*If some of the differences classified as apparent specimen loss are, in fact, counting errors, miscounts range from 25.8-37.2% of discrepancies, affecting 8.2-11.8% of records.

The average performance of each team met the MQO for all three metrics (Table 3-11). However, two of the teams failed to achieve at least one of their objectives in one or more of their samples. One team was not assessed because the results were lost.

Table 3-11. Means (and ranges) of error rates for total abundance, numbers of taxa, and identification accuracy.

Team	Number of Samples		Error Rate (%)		
	Plan	Actual	Total Abundance	Number of Taxa	Identification Accuracy
A	4	4	8.3 (4.1 – 10.5)	4.3 (1.4 – 10.0)	5.2 (0 – 11.4)
B	1	0	-	-	-
C	8	8	6.7 (0 – 15.5)	4.8 (0 – 14.9)	7.2 (3.1 – 14.3)
D	3	2	2.0 (0 – 3.9)	2.7 (2.5 – 2.9)	5.7 (4.8 – 6.6)
E	3	1	1.0	0.5	0
F	6	6	7.2 (2.3 – 9.1)	5.8 (0.7 – 9.1)	2.8 (1.2 – 4.6)
G	11	9	1.1 (0 – 2.1)	1.1 (0.6 – 2.3)	1.8 (0 – 4.6)
All	**36**	**30**	**4.8 (0 – 15.5)**	**3.4 (0 – 13.6)**	**4.1 (0 – 14.3)**

J. Discussion

The challenge of producing an accurate and internally consistent description of the species composition of benthic macrofaunal communities over a wide range of habitats and depths was considerable. The necessity of relying on a large number of taxonomists added to the complexity of the task. However, measures to coordinate and standardize taxonomic practices can effectively meet these challenges.

In this survey, we provided species-level identifications for 82% of the specimens collected. Our results suggest these results may be increased in the future through improved collection techniques to reduce specimen damage during collection and processing. Damaged, juvenile, and aberrant specimens whose condition prevented species-level identification comprised 14.5% of all specimens (Table 3-7) and 81% of the higher level identifications. Condition was the primary obstacle to species-level identification. Another obstacle was the state of taxonomic knowledge, which prevents species-level identification of taxa. Prior to the survey, we agreed not to attempt species-level identification for several taxa (Table 3-12) where knowledge of local fauna was insufficient; but names for only 0.8% of the organisms were affected by this rule. Other unidentified taxa are complexes of poorly defined species, which are locally standardized concepts with standardized designations (i.e., *Amphilochus neapolitanus* Cmplx) (see Southern California Association of Marine Invertebrate Taxonomists 2001); but these only accounted for 0.5% of abundance. An additional 2.2% of species were expected to be identified consistently at the species-level but failed. These records were combined at levels where we were confident that the identifications were consistent and correct (Table 3-9).

Table 3-12. Groups specified for identification to higher taxonomic levels in laboratory procedures.

Group	Level of Identification
Nematoda	Phylum
Oligochaeta	Class
Hirudinea	Class
Podocopida	Order
Harpacticoida	Order

In Bight`98, one-third fewer taxa (57) posed unexpected problems than in the SCBPP survey (169). There were two reasons for this improvement. First, problems detected during the SCBPP survey were used to focus SCAMIT activities in the period between the two surveys. Keys and other identification aids were produced for many problem taxa, facilitating consistent treatment in the Bight`98 survey. Second, we used specialty taxonomists for four groups that presented obstacles to consistent treatment despite these efforts at standardization. The specialty taxonomist treatment of ceriantharian and edwardsiid anemones, and euclymeninaen and lumbrinerid polychaetes separated 35 taxa that were lumped in the 1994 survey.

Performance in species-level identification was essentially the same in the Bight`98 and 1994 SCBPP Regional Surveys with 82% and 81% of the specimens identified to species, respectively. One potential reason for similarity in the results is that 17 of the 22 Bight`98 taxonomists also identified the SCBPP specimens.

The performance of the multiple taxonomists in these regional studies was compared to another local survey where each taxonomic group was the responsibility of a single, specialized, taxonomist. The Los Angeles County Sanitation Districts (LACSD) surveyed 18-44 sites on the Palos Verdes Shelf and slope in a series of 17 surveys from 1991 to 2000 using the same procedures as the regional surveys. The sites are in a smaller area and more uniform habitat and, therefore, greater identification success was expected. Over 17 surveys, LACSD identified 86%

of the organisms to species (Table 3-13) and rates for the individual surveys ranged from 80-91%. Since performance of the regional survey teams is within the range achieved by LACSD, we concluded that variability introduced by multiple taxonomists did not reduce precision in identification in the regional surveys.

Table 3-13. Species-level identification success in three southern California benthic macrofauna surveys

	Bight`98 1998	SCBPP 1994	LACSD 1991-2000
Number of Organisms	161,865	92,570	11,485 – 47,448
Species-Level Identifications	82%	81%	86.1% (80– 91%)

These results suggest that our taxonomic expertise and efforts to ensure communication among taxonomists achieved uniform performance in the habitats sampled. Success at species-level identification was similar in all three habitats (Table 3-6). The frequencies of discrepancies related to taxonomic unfamiliarity were also similar across habitats (Table 3-14). Prior to conducting surveys for Bight`98, taxonomic difficulties were expected because bays, harbors, and shelves around Channel Islands were being sampled for the first time in a regional monitoring program. Our previous experience was primarily with taxonomy of the fauna of the mainland continental shelf and slope. Instead, a slightly higher rate of discrepancies occurred in the coastal habitat than in the less familiar bays, harbors, and islands (Table 3-14). The difficulties did not materialize.

Table 3-14. Comparison of the frequency of discrepancies related to taxonomic knowledge between habitats.

	Frequency (%)	
Habitat	**Judgment Differences**	**Misidentifications**
Bays & Harbors	6.9	4.0
Island Shelf	8.7	4.6
Mainland Shelf (U.S. & Mexico)	10.6	3.7

Discrepancy rates in QC re-analysis were higher in the Bight`98 survey than the SCBPP for all types of discrepancies except misidentifications (Table 3-15). However, these discrepancies were insufficient to affect our conclusions. Based on the SCBPP discrepancy rates, Ranasinghe *et al.* (2003, Appendix E) showed that differences in the results of two independent identifications of the same sample were sufficient to produce statistically significant differences in total abundance, numbers of taxa, and the Shannon–Wiener Index. However, the differences in this study were small relative to the sample means and were unlikely to alter conclusions about community structure. The Benthic Response Index, the abundance-weighted average pollution tolerance of the species in a sample (Smith *et al.* 2001), was not affected. While the error rates found in the current survey have not been subjected to this same analysis, their magnitude is not likely to lead to different conclusions.

Table 3-15. Frequency (%) of discrepancies in QC re-analysis for Bight`98 and the SCBPP.

	Type of Discrepancy	Bight`98	SCBPP
Errors	Miscount*	8.2	4.8
	Overlooked specimen(s)	4.2	3.3
	Misidentification	3.9	4.5
	Misapplication of identification rules	0.5	0.4
Differences	Judgment differences	10.0	7.6
	Apparent specimen loss or long count*	3.6	3.3
	Unconventional nomenclature	1.3	1.3

* Differences classified as apparent specimen loss could be over-count errors; therefore, miscounts affect 8.2 to 11.8% of Bight`98 records and 4.8 to 8.2% of the SCBPP records.

While the MQOs were met on average, a number of failures occurred in all three identification metrics. Most failures resulted from counting errors and overlooked specimens, suggesting insufficient care during sample analysis. Although the average counting error was small (<2) and similar in both Bight`98 and the SCBPP, the percentage of records affected was 34% higher for Bight`98 (Table 3-16). There was as much as a three-fold difference in counting error rates among teams. It may be possible for teams with the highest counting error rates and who exceeded MQOs to lower their error rates by reviewing and modifying laboratory practices and standard operating procedures. The ability of most teams to achieve MQOs, as well as their performance in the SCBPP, indicates that the MQOs are reasonable and achievable.

Table 3-16. Frequency and magnitude of counting errors due to miscounts and overlooked specimens for Bight`98 and the SCBPP. SCBPP values are provided where teams had essentially the same membership up in both surveys.

Team	Bight`98		SCBPP	
	Records (%)	Mean Difference	Records (%)	Mean Difference
A	11.0	1.75		
B	-	-		
C	19.7	2.11	9.7	1.38
D	11.1	1.91	4.3	1.00
E	6.4	1.00	13.4	1.84
F	18.6	1.94		
G	6.3	1.69	4.8	2.09
All Teams	**12.1**	**1.90**	**9.0**	**1.68**

We attempted to compare our identification quality control results with other benthic programs to validate our MQOs, but were unable to find comparable results although several other programs have established similar MQOs. Most programs rely on verification of voucher specimens for quality control of identifications rather than reanalysis of samples. Vouchers are typically limited to the best specimens of each species and there is no guarantee that voucher materials accurately represent all specimens reported under a name.

Another area in which performance can be improved is record keeping. Our quality control re-analysis was hampered by the loss of records for 6 of 36 samples. We were also unable to document sorting quality control for the 77 samples processed at Laboratory B because records were lost. As a matter of good laboratory practice, it may be advisable for teams that lost records to examine their practices and take corrective action.

K. Logistical Recommendations

Our results suggest that Bight`98 data are of very high quality. However, goals established in the Coastal Ecology Work Plan were not achieved with respect to accuracy of station occupation, the time taken to produce the final data set, success in identifying specimens to species, and completeness of quality assessment activities. Performance to achieve these goals can be improved by implementing the following recommendations in future regional surveys.

1. **Keep better records about sampling design and implementation.** Information about the criteria used to define strata and details of nominal station selection and allocation were not readily available to resolve discrepancies identified during data analysis. Efforts should be made to institutionalize this information for easy retrieval during data analysis even if data analysis occurs several years after sample collection.

2. **Shorten the timeline for submission and quality control of field data.** Station occupation data should be submitted and subjected to quality control as soon as possible after returning from the field. This minimizes recording and typographical errors. Many Bight`98 field data were not submitted for over a year and were not scrutinized and compared to nominal locations for at least another year, making it difficult or impossible to satisfactorily resolve discrepancies.

3. **Shorten the analysis timeline.** Efforts should be made to shorten the time interval between sample collection and data submission and to synchronize activity across teams with respect to sample processing. Competing priorities for some of the participating teams resulted in delays during Bight`98. Because several steps in the production of a final data set require completion of sample processing and data submissions by all teams, delays by one team affect the others. The resulting periods of unplanned inactivity exacerbate scheduling and management problems for all teams.

4. **Improve compliance with data submission standards**. Considerable effort was expended correcting initial data submissions. Most errors were failures to conform to specified standards for taxonomic nomenclature. Adherence to standards would substantially reduce the data manipulation necessary to produce a final data set and increase time available for data analysis and reporting.

5. **Continue using regional survey results to focus SCAMIT activities**. The reduction in taxa lumped due to unshared taxonomic knowledge is directly attributable to SCAMIT activities in the years between the SCBPP and Bight`98. These efforts drew upon the results of our QC efforts in the SCBPP. This model should be pursued in the future. Supporting and promoting active participation in SCAMIT by taxonomists within the region will continue to be essential to the success of future surveys.

6. **Continue using specialty taxonomists.** Taxonomic specialization should continue as a means of ensuring consistent treatment of problematic groups. The present practice of producing diagnostic keys and presenting them at SCAMIT meetings to facilitate

consistent treatment by other taxonomists in the future should also continue. The Nemertea are recommended as a candidate group for the next survey.

7. **Provide better process control and record keeping.** Teams that failed to achieve MQOs or experienced record-keeping failures in Bight`98 will benefit by reviewing laboratory procedures and quality assurance programs, identifying points of failure, and taking corrective action.

8. **Establish data formats and controls for sediment grain size distribution data.** Formats for submission of sediment grain size data were not specified in advance because of a change to automated sample processing. As a result, there was considerable manipulation of submitted data and uncertainty about the existence of gravel data for specific samples; gravel data were generated manually. Because sediment grain size distribution information is important for interpreting sediment chemistry and benthic macrofauna, it would be useful to establish procedures to acquire data more directly and reduce uncertainty about the presence of gravel.

9. **Enforce relational integrity for sample location and date information between data tables.** There was some confusion during data analysis because sampling dates in the station occupation, grab event, and benthic macrofauna data tables did not match. The confusion would have been avoided if the information management system forced relational integrity for site identification and date information between the tables.

4. Assessment of Benthic Condition

This chapter presents biointegrity estimates for benthic condition in areas and habitats of the Southern California Bight (SCB) at several spatial scales. Benthic condition is widely used as an indicator of biological responses to disturbances of sediments, including those caused by chemical contamination. Our area estimates were based on the condition of benthic macrofauna at our sampling sites. Each site was designated as reference or one of four levels of disturbance, based on application of the Benthic Response Index (BRI) to the species abundance data. Coastal sites were evaluated with the BRI (Smith *et al.* 2001). Sites in embayments were evaluated with the BRI-E, an extension developed specifically for southern California embayments (Appendix C). The BRI is the abundance-weighted pollution tolerance of the species present at a site. The degree of disturbance increases from Level 1, which indicates marginal deviation from reference condition, to Level 4, which indicates defaunation, defined as the loss of 80-90% of the taxa encountered in reference condition. Response Levels 2 thru 4 are considered to be clear evidence of disturbed benthic communities. The BRI cannot be used to diagnose sources because benthic macrofauna respond in a similar manner to natural and anthropogenic disturbance. More details about the BRI and our area estimation methods are provided in Chapter 2; our estimates are presented in tabular form in Appendix F.

A. Results

We estimated that only 107 km^2 (1.95%) of the United States portion of the SCB showed clear evidence of disturbance (Figure 4-1). Of the balance, we estimated that 4,832 km^2 (87.84%) was in reference condition and 561.64 km^2 (10.21%) was at Response Level 1, indicating only marginal disturbance.

Only one random sample was designated at Response Level 4, the most severe level of disturbance; it was located in the Pier 400 construction area near the mouth of Los Angeles Harbor (Figure 4-2) and represented 1.65 km^2 or 0.03% of the Bight. Another sample located at the mouth of the Los Angeles River was also designated at Response Level 4 but did not contribute to our area estimates because the location was not selected at random; it was the only non-random sample (of 20) that showed clear evidence of disturbance. Three sites in Newport Bay and another site in the Pier 400 construction area were designated at Response Level 3 (Figure 4-2), the second highest level of benthic disturbance; they represented 8.55 km^2 or 0.16% of the U.S. Bight. The 21 sites designated at Response Level 2 represented 97.03 km^2 (1.76% of the SCB); 11 of the sites were located in San Diego Bay and two each in Newport Bay, on the Palos Verdes Shelf, and on the shelf just outside of Los Angeles /Long Beach Harbor (Figure 4-2).

Of the three habitats sampled in the U.S. portion of the SCB, the island shelf was in best condition (0% clear evidence of disturbance); the embayments were in worst condition (17.09% disturbed); and the mainland shelf areas (2.27% disturbed) were in intermediate condition (Figure 4-1). Sites at Response Level 3 and Response Level 4, the highest levels of disturbance, occurred only in embayments.

Within the embayment habitat, greater proportions of marinas and ports showed clear evidence of disturbed macrofaunal communities than other areas with 26.88%, 17.78%, and 8.34% of these areas at Response Levels 2, 3, and 4, respectively (Figure 4-3). The Response Level 4 site near Pier 400 accounted for more than a quarter of the clearly disturbed area in non-port and non-marina embayment areas. None of the embayment sites that were located outside of ports and marinas were disturbed at Response Level 3.

Three of the four mainland shelf regions were almost as pristine as the island shelf, which showed no clear evidence of disturbance. Hardly any of the northern (0.09%) and Mexican (1.23%) mainland shelf and none of the southern region showed clear evidence of disturbance (Figure 4-4). These estimates correspond to 2.8, 15.8, and 0.0 km^2 of disturbed area. The central region had the greatest extent with 6.57% or 213.8 km^2 of disturbed benthic communities. None of the mainland shelf sites were identified as being disturbed at Response Level 3 or Response Level 4.

The extent of disturbed benthic communities was greater at marinas and ports than embayment areas subject to other uses (Figure 4-5); twice and three times as much area was disturbed (26.88% and 17.78% versus 8.34%). Benthic communities at river mouths were about as likely to be disturbed (3.70%) as other coastal areas (2.08%) and less so than other bays (8.34%). No clear evidence of disturbance was identified around small publicly owned treatment works (POTWs), although 6.67% of the area around large POTWs was at Response Level 2. None of the random sites at the river mouths or at POTWs was disturbed at Response Levels 3 or 4; unlike ports and marinas, all the clearly disturbed sites were only at Response Level 2.

No substantial changes in condition over time were observed at reference sites that were sampled periodically from 1977 to 1990 and re-sampled for Bight`98 (Table 4-1). On every sampling visit, benthic communities at all seven sites on the 60 m isobath and three of six sites on the 30 m isobath were in reference condition. The other three 30 m sites were occasionally at Response Level 1, which is only marginally different from reference condition. Response Level 1 is not considered clear evidence of disturbance.

B. Discussion

Our results conform to the paradigm that areas closest to human activities are in worst condition and areas farthest away are in best condition. The proportions of area in reference condition and with no clear evidence of disturbance increase as step functions in the progression from embayments to the mainland shelf to the island shelf (Figure 4-1). These data are the first to demonstrate this progression for benthic habitats, although the relationship has long been suspected. Embayments and the island shelf were sampled for the first time in a regional monitoring program during Bight`98; previous programs were restricted to the mainland shelf.

The condition of benthos in marinas and ports in particular, and embayments in general, is of concern. Bottom areas in the vicinity of marinas supporting recreational boating activity are in poorer condition than ports and industrialized waterways. Only 39.4% of marina bottom areas and 52.9% of ports were in reference condition (Figure 4-3). Apparently, impacts on bottom animals are greater in the narrow, shallow marina waterways with large numbers of small vessels than in deeper, relatively open ports. Conditions in other embayment areas, which are subject to lighter use, were not as severe; but with only 82.4% in reference condition, there is considerable room for improvement. Discounting the Los Angeles Harbor site that was classified at Response Level 4 because it was affected by recent dredging does not substantially improve these results.

Table 4-1. Condition of re-sampled SCCWRP reference survey sites. Benthic community condition was assessed by application of the Benthic Response Index to species abundance data and applying BRI assessment thresholds. Ref: Reference Condition. RL-1: Response Level 1. Station locations are provided in Figure 2-3.

Depth Class	Site	1977		1985		1990		1998	
		BRI Score	Condition	BRI Score	Condition	BRI Score	Condition	BRI Score	Condition
30 m	2,341			19.5	Ref	16.3	Ref	23.4	Ref
	2,343			20.0	Ref	21.9	Ref	15.0	Ref
	2,345			25.1	RL-1	28.7	RL-1	23.1	Ref
	2,347			25.4	RL-1	21.0	Ref	28.8	RL-1
	2,349			18.3	Ref	19.5	Ref	21.6	Ref
	2,352			23.9	Ref	28.6	RL-1	18.1	Ref
60 m	2,342	11.1	Ref	9.8	Ref	12.7	Ref	14.5	Ref
	2,344	21.6	Ref	13.4	Ref	20.3	Ref	15.6	Ref
	2,346	16.6	Ref	15.0	Ref	13.4	Ref	15.8	Ref
	2,348	18.0	Ref	15.2	Ref	13.9	Ref	4.5	Ref
	2,350	18.8	Ref	22.2	Ref	16.1	Ref	7.2	Ref
	2,351	12.4	Ref	12.5	Ref	16.5	Ref	13.2	Ref
	2,353	15.0	Ref	10.8	Ref	16.3	Ref	11.9	Ref

The depth distributions of our sampling sites and our disturbed sites are essentially the same as those for the State of California's Bay Protection and Toxic Cleanup Program sampling sites (Table 4-2). We were concerned that our estimates might be biased because our sampling was restricted by the draft of the vessels we used as platforms. The concern was not justified.

Table 4-2. Depth distribution (m) of southern California benthic macrofaunal sites sampled in embayments for Bight`98 and the Bay Protection and Toxic Cleanup Program (BPTCP). Disturbed sites were defined as sites at BRI Response Levels 2 through 4 for Bight`98 and as sites at moderate and high levels of concern for the BPTCP.

Percentile	Disturbed Sites		All Sites	
	Bight`98 (n=22)	BPTCP (n=55)	Bight`98 (n=123)	BPTCP (n=273)
Minimum	3.0	0.0	2.3	0.0
5	3.0	1.0	3.0	1.0
25	3.6	3.0	3.6	3.0
50 (median)	4.7	5.0	8.8	6.0
75	8.5	9.0	12.1	12.5
95	19.0	69.0	18.0	20.5
Maximum	23.0	75.0	27.0	75.0

The extent of area deviating from reference condition on the Mexican coastal shelf and the southern region of the U.S. SCB is similar. There is no indication of differences parallel to the level of industrialization and population density on land. For the southern region, 99.4% of the area was in reference condition compared to 96.3% in Mexico.

Our results confirm the finding of the 1994 Southern California Bight Pilot Project (SCBPP) (Bergen *et al.* 1998, Bergen *et al.* 2000) that the effects of discharges from river mouths and POTWs are similar and not substantially different from other coastal areas (Figure 4-5). The effects of improvements in wastewater treatment over the last few decades have apparently reduced the area affected by discharges to the point that they are no longer detectable in large-scale spatial studies such as the Bight`98 Regional Monitoring Survey. Effects of discharges at river mouths may not be as pronounced in summer as they are immediately after the rains in early spring. It is conceivable that benthic macrofauna populations recovered to a state that was indistinguishable from background during the months of very low flows that intervened.

Comparison of contributions of disturbed area and area in the SCB for habitats and populations of interest illustrates the disproportionately high extent and intensity of disturbed benthic communities in the embayment habitat (Table 4-3). Embayments occupy only 4.3% of the SCB but contributed 37.4% of the area with disturbed communities. Thus, the area that shows clear evidence of disturbance is nine times the average in embayments. It is twice the average for wastewater discharges and river mouths. Mainland shelf areas are about average, with approximately one-half of the area of the U.S. SCB and one-half of the area showing clear evidence of disturbance. The island shelf contains about 40% of the area and has no clearly disturbed areas.

Table 4-3. Contributions of strata to area and disturbed area in the Southern California Bight (SCB). The sum of each area row is 100. Disproportion quantifies disturbed area as a multiple of the Bight-wide average. A disproportion of 1.0 indicates an average amount of disturbed area and 2.0 indicates twice the average amount of disturbed area. Disturbed area is defined as estimated area with Benthic Response Index (BRI) values at Response Levels 2 thru 4.

	Island Shelf	Other Coastal Areas	Wastewater Discharges	River Mouths	Other Bays	Ports	Marinas
SCB Area (%)	41.9	50.2	3.2	0.5	1.6	1.2	1.5
Disturbed Area (%)	0.0	53.6	8.0	1.0	6.3	9.9	21.2
Disproportion	0.0	1.1	2.5	1.9	4.3	9.1	13.8

Our results for the mainland shelf are similar to the 1994 Southern California Bight Pilot Project (SCBPP) (Bergen *et al.* 1998, Bergen *et al.* 2000). Their estimate of <2 % and ours of 2.7% clearly disturbed area are well within the margins of uncertainty of the study. In both surveys, the three coastal areas with most sites deviating from reference condition were the Palos Verdes Shelf, the Santa Barbara Channel, and northern Santa Monica Bay. The most severe level of mainland shelf disturbance observed in both surveys was at Response Level 2; no mainland shelf sites were classified at Level 3 or Level 4. Although our estimate of 83.3% of the area in reference condition and 14.5% at Response Level 1 differs somewhat from the SCBPP estimates of 91% and 8%, the numbers are not directly comparable because areas 121-200 m deep that were assessed in 1994 were not sampled, and therefore not assessed, in 1998.

The Benthic Response Index (BRI) is not inordinately sensitive to climatic variation. The similarity of our estimates for the coastal shelf in 1994 and 1998 are remarkably similar given that climatic conditions immediately prior to sampling were quite different. The 1994 survey was conducted during a La Nina period while Bight`98 sampling occurred soon after a major El Nino event. Variation in BRI data from annual sampling at several geographically scattered monitoring stations at several depths also was not related to El Nino and La Nina conditions (Figure 4-6).

The assessments of biointegrity provided by the BRI were interpretable and believable. The levels of response identified by the coastal BRI were comparable with levels of response in embayments, although they are stated in slightly different terms. The extent and intensity of disturbance corresponded well with expectations based on previous studies.

The BRI was sensitive to several types of disturbance even though it was developed using only sediment chemistry and toxicity criteria. Several recently dredged sites in the vicinity of Pier 400 were classified as disturbed at Response Levels 2, 3, and 4, although the sediments were not toxic and chemical contamination was similar to other sites close by.

The sensitivity of the BRI to other sources of stress underscores the necessity for evaluating biointegrity in assessments of environmental effects. Many of the 26 sites showing clear evidence of disturbed macrofaunal communities were not designated as disturbed by our habitat measures. Six of these sites had mean ERM quotients less than 0.1, a threshold commonly used to identify chemical contamination (Long and MacDonald 1998), and 15 were not toxic to amphipods. These measures of habitat integrity do not seem to capture all the factors disturbing macrofauna living in the sediments. Therefore, it seems appropriate to require evaluation of biointegrity measures in addition to habitat measures when assessing environmental health because most environmental regulations are intended to protect living resources such as benthic macrofauna.

Testing, improving, and refining the BRI should be viewed as a continuing process intended to increase confidence by quantifying and reducing levels of uncertainty in its results. As exemplified by this chapter, development of the coastal BRI for the SCBPP in 1994 (Smith *et al.* 2001) and its recent extension to embayments (Appendix C) significantly improved the information provided by benthic assessments as a basis for decisions by environmental managers and regulators in southern California. However, there have been few opportunities to apply, test, and refine the index due to the short time that has elapsed since it was developed. The process used for development demonstrated unequivocally and empirically that the BRI works. It may prove to be an even more useful tool if its biological underpinnings, strengths, and limitations are more thoroughly understood.

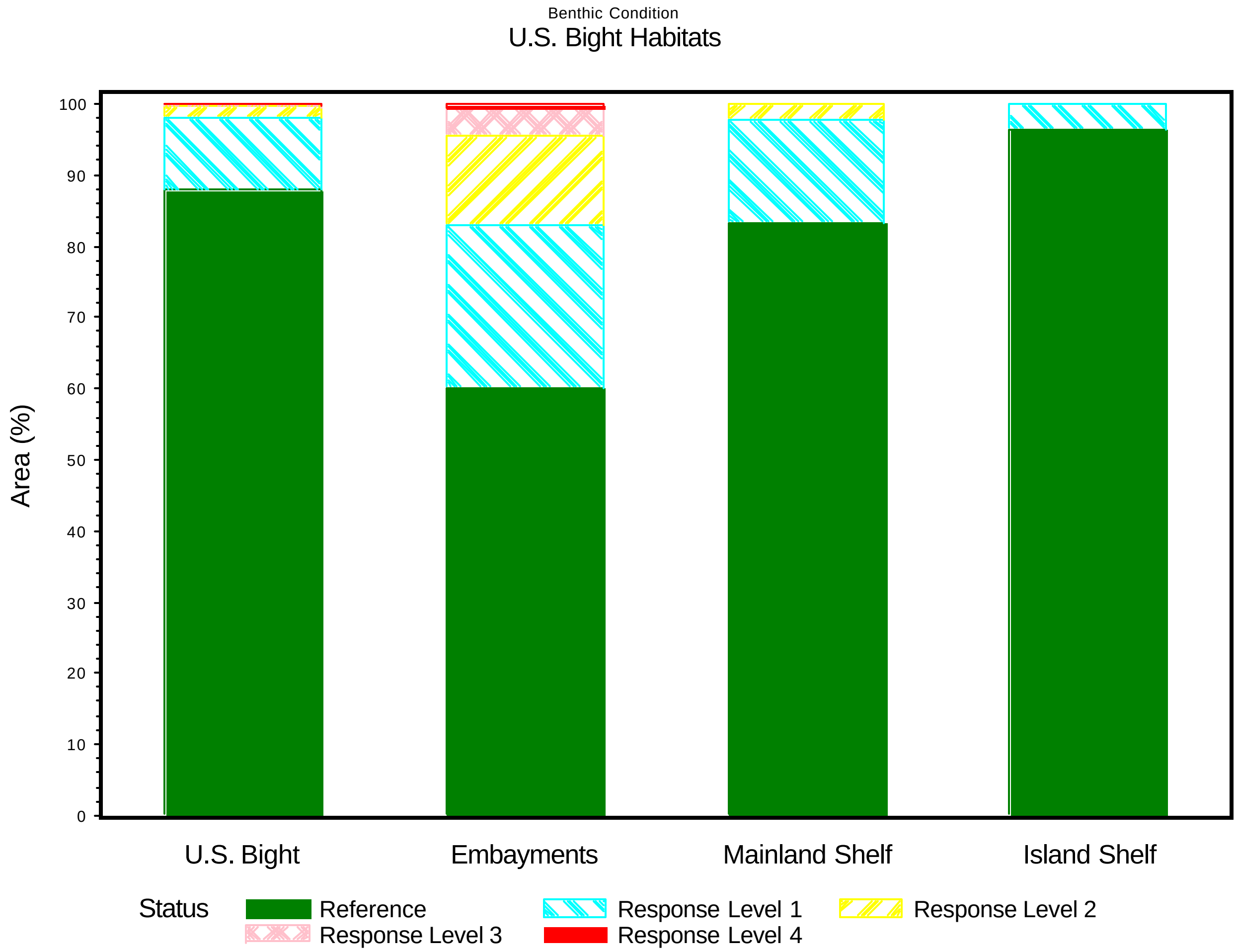


Figure 4-1. Areal estimates of condition for benthic habitats in the U.S. portion of the Southern California Bight.

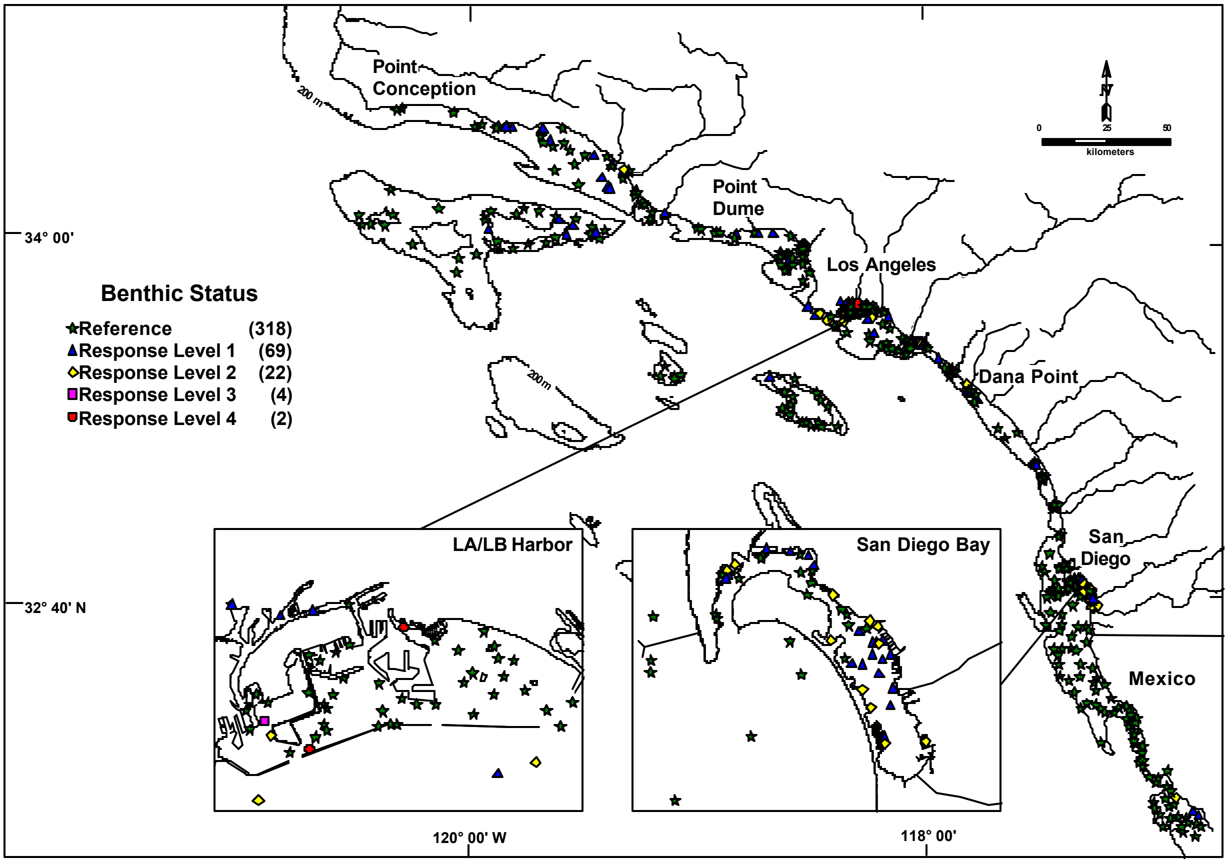


Figure 4-2. Condition of benthic macrofauna at sampling sites.

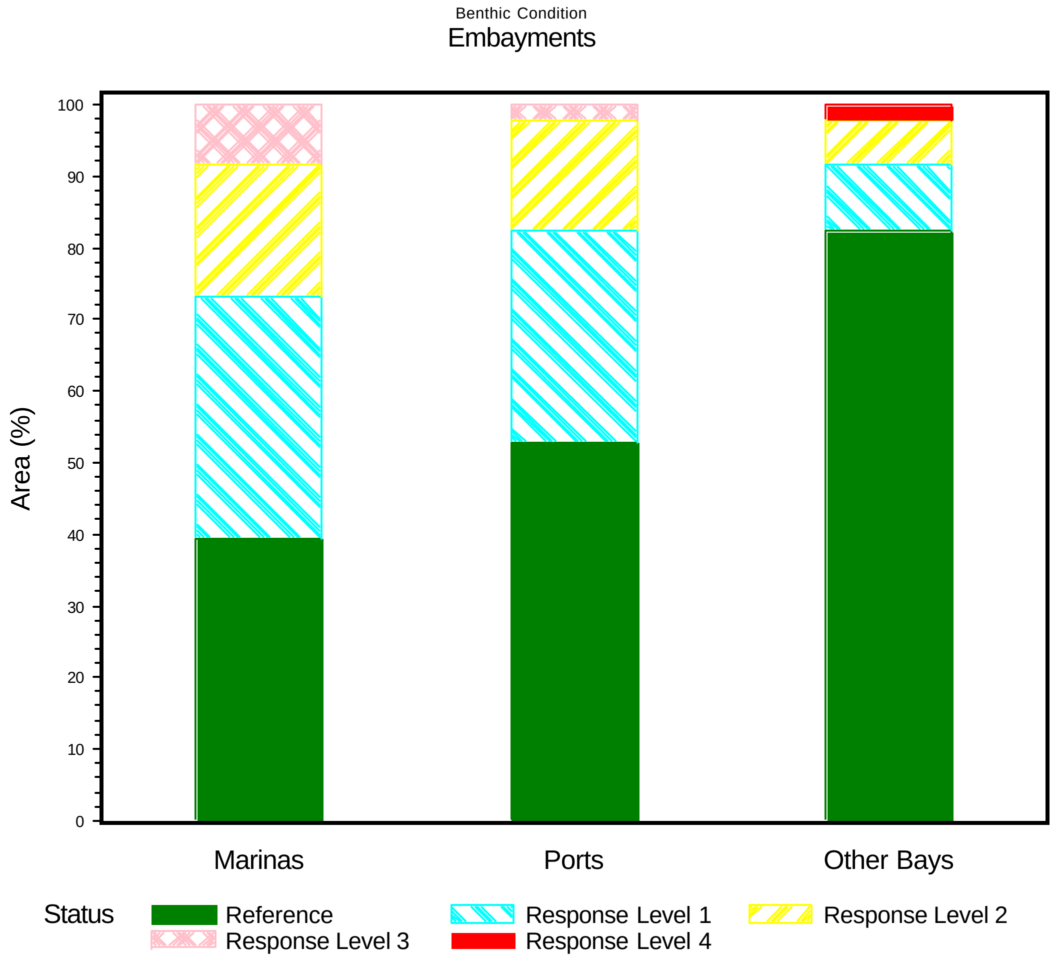


Figure 4-3. Areal estimates of benthic condition for embayments.

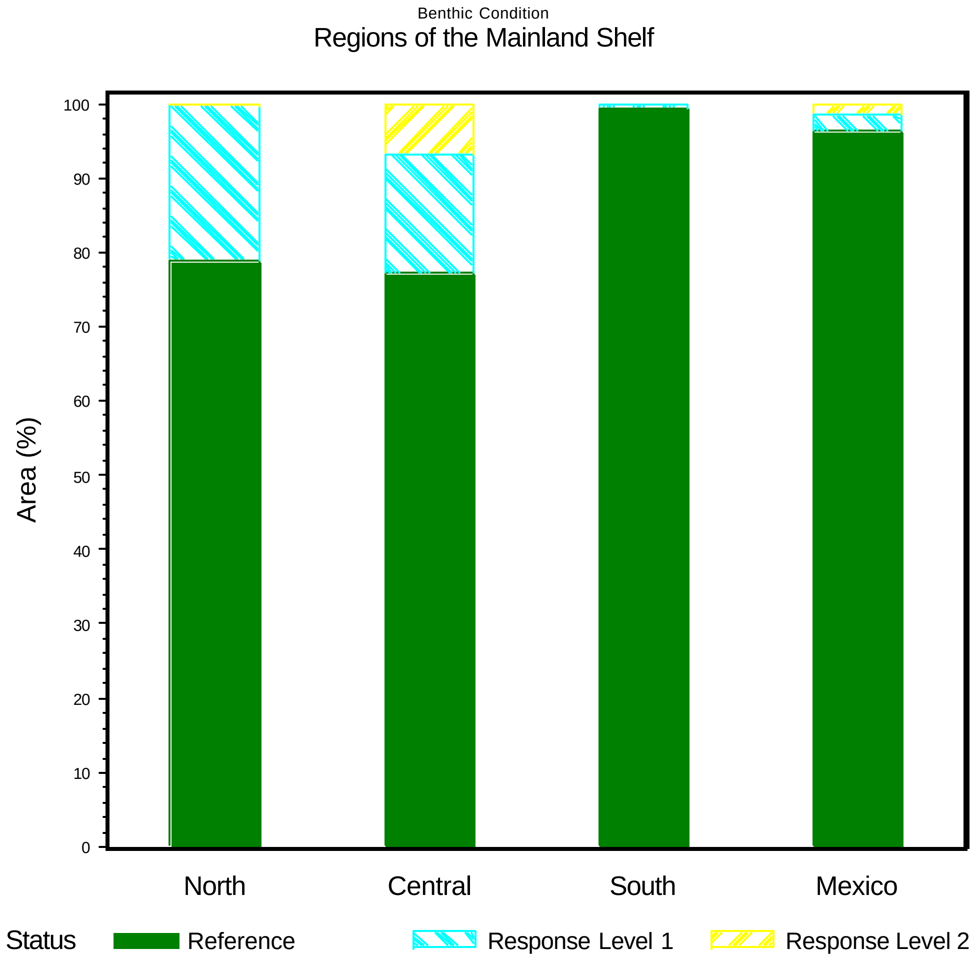


Figure 4-4. Areal estimates of benthic condition for regions of the mainland shelf.

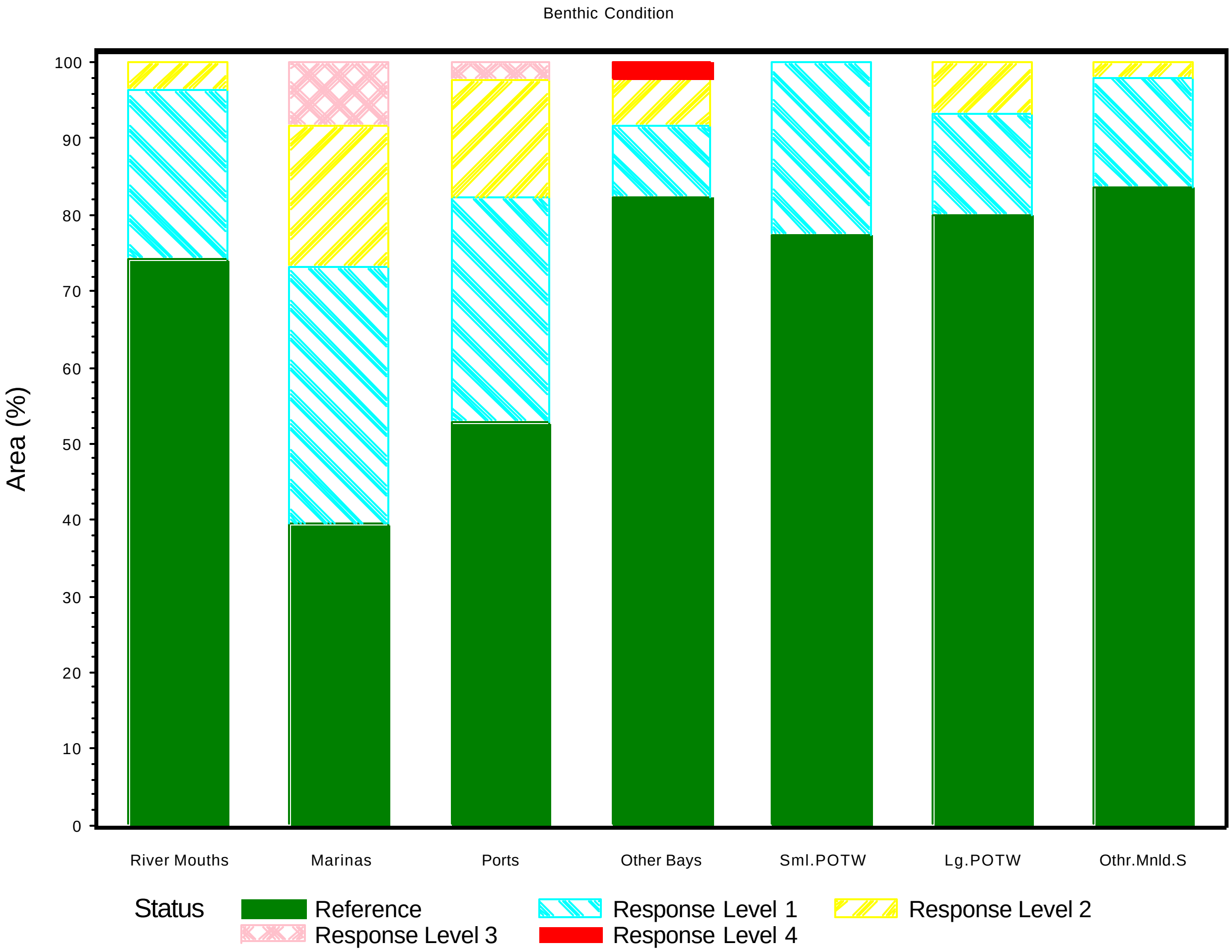


Figure 4-5. Areal estimates of benthic condition for selected populations. Sml.POTW: Wastewater discharges < 100 mgd; Lg.POTW: Wastewater discharges > 100 mgd; Othr.Mnld.S: Other mainland shelf.

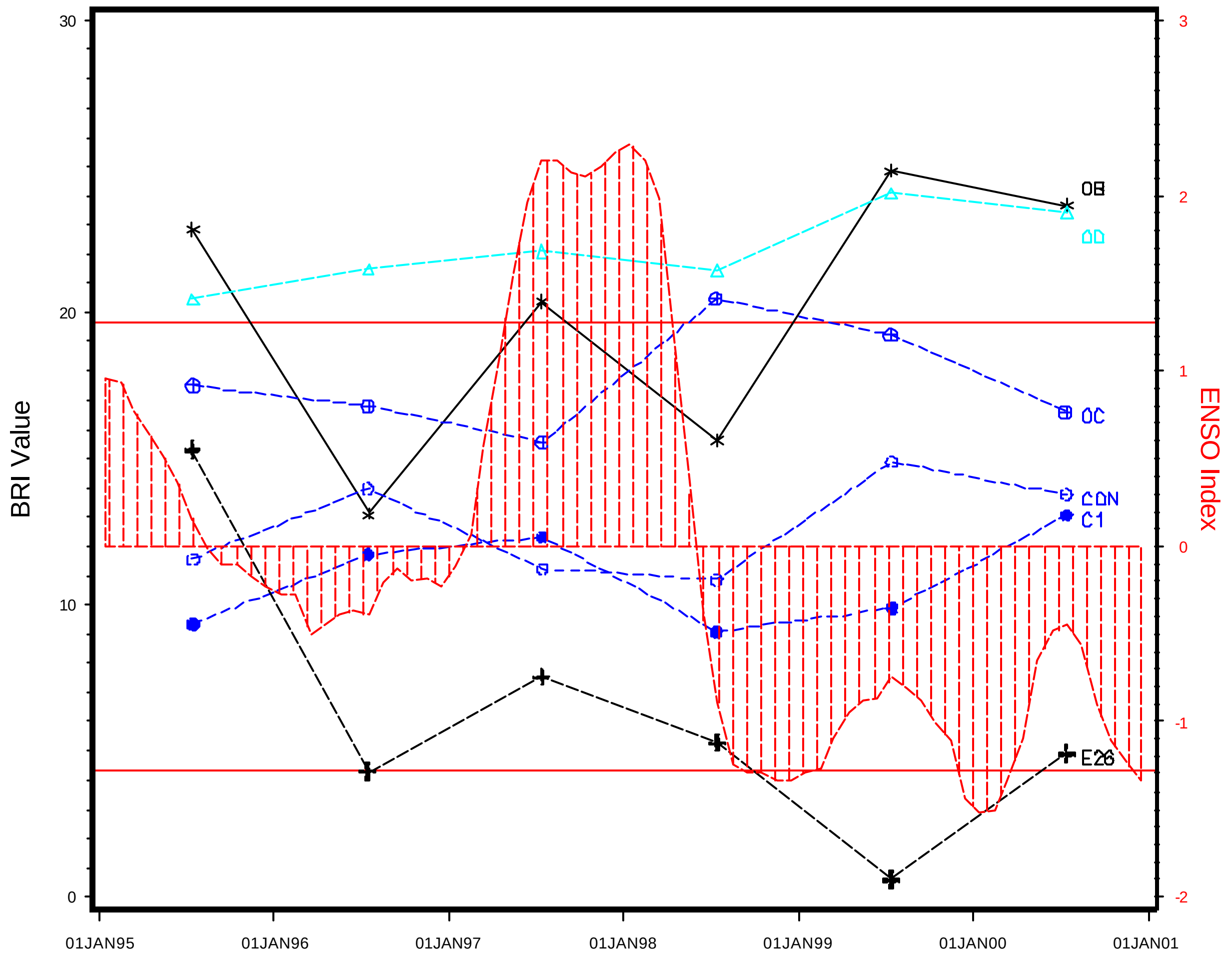


Figure 4-6. Benthic Response Index (BRI) at six reference stations and ENSO Index values from 1995 to 2000. The ENSO Index is a combined Nino3.4/Southern Oscillation Index (Smith and Sardeshmukh 2000); values > 1.24 indicate El Nino conditions and values <-1.24 indicate La Nina conditions. Dotted lines are for stations at 30 m depth, dashed lines at 60 m and solid lines for deep stations at 100-150 m. Stations 0B, 0C, and 0D are on the Palos Verdes Shelf, Station C1 is in Santa Monica Bay, Station CON is off Huntington Beach and Station E26 is near San Diego.

5. Benthic Assemblages

This chapter presents the results of analyses conducted to identify naturally occurring assemblages and the habitat factors associated with them. Disturbance within benthic macrofaunal assemblages is detected by comparisons with reference condition, which has several alternate states. These states are due to habitat differences that result in natural differences in the numbers and kinds of benthic species that occur. The primary objective of this analysis was to determine the appropriate reference state(s) for southern California embayments, which were included in regional monitoring for the first time during Bight'98. Another objective was to understand relationships of the Mexican mainland shelf and U.S. island shelf assemblages, which were also sampled widely for the first time, to U.S. mainland shelf assemblages identified in the 1994 Southern California Bight Pilot Project (SCBPP) (Bergen *et al.* 2001) and other previous studies (Allan Hancock Foundation 1959; Allan Hancock Foundation 1965; Jones 1964, 1969). Benthic assemblages were identified by hierarchical cluster analysis, and statistical tests were performed on habitat variables among assemblages to determine whether they occupied different habitats. Because our objective was to define natural groupings of stations with similar species composition, potentially contaminated sites were eliminated before analysis using criteria similar to those used in the SCBPP assemblage analysis. Details of the methods are provided in Chapter 2.

A. Results

Sequential analysis of the splits on the cluster analysis dendrogram yielded four habitat-related benthic infaunal assemblages along the southern California coast (Table 5-1, Figure 5-1). Although eight site groups met the criteria for habitat differentiation, only four assemblages were identified because the frequencies of occurrence of dominant species led to designating the others as sub-assemblages. Site Groups IA-ID were considered to be sub-assemblages of Site Group I; Site Groups IIA and IIB were considered sub-assemblages of Site Group II.

The first split in the cluster analysis dendrogram (Split 1 of Figure 5-1) was associated with habitat, separating all sites in embayments from the sites on the mainland and island shelves (Table 5-2). The Mann-Whitney U-Test results indicated significant differences in medians

Table 5-1. Summary of assemblage analysis results.

Assemblage			Sub-Assemblage		
Site Group	**Name**	**N**	**Site Group**	**Name**	**N**
I	Mid-Depth	90	IA	52-120 m Northern Shelf and Santa Catalina Island	21
			IB	52-120 m Southern Shelf	34
			IC	52-120 m Northern Channel Islands	21
			ID	32-52 m	14
II	Shallow and Coarse	95	IIA	Shallow, Very Coarse, and Northern Islands	25
			IIB	Shallow and Less Coarse	70
III	Northern Bays	21			
IV	Southern Bays	34			

Table 5-2. Dendrogram splits: Habitat criteria for each split and the number and proportion of sites that met these criteria.

Split	Site Groups	N	Criterion	Met Criterion N	Met Criterion Percent
1	I & II	185	Mainland and Island Shelves	185	100.00
	III & IV	55	Bays and Harbors	55	
2A	I	90	Mid-Depth (>32 m; not coarse 32-80 m; see Figure 5-2)	84	95.08[1]
	II	95	Shallow (< 32m or coarse 32-80 m; See Figure 5-2)	90	
2B	III	21	Latitude >= 33.5°	16	90.91
	IV	34	Latitude < 33.5°	34	
3A	IA & IB	55	Depth > 52 m or Santa Catalina Island	50	90.00
	IC & ID	35	Depth <= 52 m or Northern Channel Islands	31	
3B	IIA	25	Mainland shelf with fines < 1% or island shelf	22	90.32[1]
	IIB	70	Mainland shelf with fines >= 1%	62	
3C	III	7	Fines >= 80%	6	95.24
	IV	14	Fines < 80%	14	
4A	IA	21	Longitude < -118° (West & North; See Figure 5-3)	21	98.18
	IB	34	Longitude >= -118° (East & South; See Figure 5-3)	33	
4B	IC	21	Depth > 62 m	20	97.14
	ID	14	Depth <= 62 m	14	

[1] Silt-clay data unavailable for two samples.

between embayment and shelf sites for water depth, proportion of fine sediments, and longitude (Table 5-3), reflecting the shallower and muddier nature of embayments, which are predominantly landward and to the east of the mainland shelf.

Table 5-3. Mann-Whitney U-Test results for four habitat variables across splits of the cluster analysis. Presented are the site groups on either side of the split (see Figure 5-1), numbers of sites (N), statistical significance levels, and median values for the habitat variables. Sig: Statistical significance level. *: p<0.5; **: p<0.01; ***: p<0.001; ****: p<0.0001; NS: Not significant.

Split	Site Group	N	Depth Sig	Depth Median	Fines Sig	Fines Median	Latitude Sig	Latitude Median	Longitude Sig	Longitude Median
1	I & II	185	****	51.14	****	21.29	NS	33.18	****	118.2
	III & IV	55		8.50		43.95		33.01		117.5
2A	I	90	****	72.39	****	38.01	NS	33.24	NS	118.3
	II	95		31.00		11.98		33.12		118.1
2B	III	21	***	11.94	*	58.52	****	33.46	****	117.9
	IV	34		6.38		44.62		32.73		117.2
3A	IA & IB	55	NS	68.24	****	38.79	****	32.96	****	117.9
	IC & ID	35		61.84		20.76		33.69		119.0
3B	IIA	25	NS	30.46	****	4.80	**	33.63	****	119.1
	IIB	70		31.19		14.61		32.94		117.8
3C	III	7	*	16.43	****	84.27	NS	33.80	*	118.3
	IV	14		9.70		45.64		33.30		117.7
4A	IA	21	NS	72.62	****	63.57	****	33.86	****	119.1
	IB	34		74.53		34.64		32.40		117.2
4B	IC	21	****	86.42	**	20.48	NS	33.81	**	119.5
	ID	14		45.81		34.14		33.50		118.3
4C	None	9	*	20.94	NS	0.55	NS	33.12	**	118.2
		16		35.81		7.19		33.91		119.6
4D	None	8	NS	41.32	NS	14.86	NS	32.56	NS	117.4
		62		29.89		14.58		32.99		117.8

The first split in the mainland and island shelf sites, Split 2A, segregated 95.08% of the sites in Site Groups I and II on a combination of depth and fine sediment content (Table 5-2). Shallow sites less than 32 m deep segregated from deeper sites, except that deep sites between 32 m and approximately 90 m with coarser sediments segregated with shallow sites (Figure 5-2); the depth threshold for segregation increased by about 2 m for every 1% reduction in fine sediment content below 30% (Figure 5-2). The medians for depth and fine sediment content were significantly different across the split (Table 5-3). The characteristics of this split are almost identical to the segregation of mid-depth and shallow assemblages on the mainland shelf by Bergen *et al.* (2001). Site Group I corresponds to their mid-depth assemblage and Site Group II corresponds to their shallow assemblage.

The next three splits (Splits 3A, 4A, and 4B) segregated Site Group I into four sub-assemblages (Figure 5-1). Split 3A segregated 90% of the sites in Site Groups IA and IB from Site Groups IC and ID based on depth and geography. Sites on the Catalina Island shelf or on the mainland shelf deeper than 52 m segregated from sites on the northern Channel Islands shelf and on the mainland shelf shallower than 52 m (Table 5-2). Split 4A separated 98.18% of Site Groups IA and IB based on longitude (see Figure 5-3), while Split 4B segregated 97.14% of Site Groups IC and ID at 63 m depth (see Figure 5-4). For Split 4A, the Mann-Whitney Test for differences in median was significant for longitude, latitude, and fine sediment content; the test for Split 4B was significant for depth and fine sediment content. In all four sub-assemblages of Site Group I, the next split failed the criteria for habitat segregation because one of the branches contained less than ten sites.

The four mid-depth site groups were designated sub-assemblages of a larger mid-depth assemblage because patterns of species occurrence and abundance for dominants (Tables 5-4 and 5-5, respectively) and distinctive species (Table 5-6) were generally consistent within Site Group I and contrasted with the other site groups. For example, *Prionospio (Prionospio) jubata*, Phoronids, *Spiophanes duplex*, *Amphiodia urtica*, *Pectinaria californiensis*, and *Spiophanes fimbriata* were consistently more abundant and occurred more frequently at mid-depth sites than in the other site groups. Bergen *et al.* (2001) considered the first two species distinctive of the mid-depth assemblage.

Split 3B segregated 90.32% of the sites in Site Group II, the shallow assemblage, into Site Groups IIA and IIB based on fine sediment content and habitat (Table 5-2, Figure 5-5). Site Group IIA comprised shallow mainland shelf sites with the coarsest sediments (<1% fines) and island shelf sites, while Site Group IIA contained the mainland shelf sites with less coarse sediments (Table 5-2). The site groups differed significantly in medians for fine sediment content, longitude, and latitude (Table 5-3). Site Groups IIA and IIB were considered sub-assemblages of the shallow assemblage because frequencies of occurrence of several species, such as Euclymeninae sp. A and *Spiophanes bombyx*, were consistent and different from the other site groups (Table 5-4). Hardly any species were distinctive for this habitat (Table 5-6). The next two splits in the shallow assemblage failed the criteria for habitat segregation. Split 4C yielded a split with less than ten sites, while none of the habitat variables were significantly different in median across Split 4D (Table 5-3).

Table 5-4. Occurrences (percent of sites) for the five most abundant taxa in each Site Group.

Overall Rank	Name	Site Group IA	IB	IC	ID	IIA	IIB	III	IV
1	*Spiophanes duplex*	90.5	100.0	100.0	100.0	56.0	81.4	71.4	38.2
2	*Mediomastus* sp.	52.4	23.5	85.7	64.3	56.0	45.7	85.7	100.0
3	*Musculista senhousia*							23.8	91.2
4	*Euchone limnicola*					4.0		47.6	79.4
5	*Pseudopolydora paucibranchiata*							38.1	85.3
6	*Amphideutopus oculatus*	14.3	20.6	28.6	71.4	24.0	37.1	81.0	76.5
7	*Amphiodia urtica*	90.5	94.1	42.9	100.0	8.0	21.4	38.1	2.9
8	*Theora lubrica*	4.8					1.4	95.2	82.4
9	*Prionospio (Prionospio) heterobranchia*			19.0		8.0		38.1	100.0
11	*Spiochaetopterus costarum*	57.1	11.8	76.2	71.4	56.0	31.4	33.3	5.9
13	*Leitoscoloplos pugettensis*	4.8		28.6	14.3	8.0	17.1	90.5	94.1
15	Phoronida	81.0	29.4	76.2	92.9	36.0	42.9	52.4	52.9
19	*Paraprionospio pinnata*	61.9	52.9	85.7	92.9	16.0	71.4	95.2	26.5
20	*Phisidea sanctaemariae*	9.5	55.9	66.7	42.9	4.0	4.3		2.9
21	Oligochaeta	4.8	2.9	28.6		36.0	1.4	14.3	58.8
22	*Prionospio (Prionospio) jubata*	14.3	55.9	95.2	78.6	40.0	27.1		2.9
24	Euclymeninae sp. A	52.4	64.7	95.2	78.6	40.0	42.9	23.8	14.7
26	*Tagelus subteres*							71.4	55.9
27	*Apionsoma misakianum*			14.3	21.4	44.0	2.9	4.8	5.9
28	*Owenia collaris*	4.8	5.9	33.3	14.3	60.0	31.4	9.5	2.9
29	*Spiophanes fimbriata*	61.9	70.6	71.4	7.1		4.3		5.9
31	*Chloeia pinnata*	4.8	11.8	81.0	28.6	16.0	7.1		
32	*Pectinaria californiensis*	38.1	88.2	38.1	64.3		21.4	9.5	2.9
33	*Petaloclymene pacifica*	23.8	17.6	23.8	21.4	4.0	24.3	52.4	
34	*Cossura candida*	19.0		4.8	21.4		1.4	42.9	
35	*Protodorvillea gracilis*					32.0	1.4		
37	*Ampharetidae* sp. SD1	4.8	2.9	85.7	7.1	4.0	1.4		
43	*Spiophanes bombyx*		8.8	23.8		36.0	57.1	4.8	2.9
48	*Aphelochaeta* sp. LA1	4.8		76.2		4.0			
56	*Polydora cirrosa*						5.7	9.5	
121	*Gymnonereis crosslandi*	42.9	11.8	14.3	21.4		1.4		

The 55 embayment sites segregated on latitude across Split 2B; Site Group III included the sites from Newport Bay to the north, and Site Group IV sites from Dana Point Harbor south (Figure 5-3). Although the Mann-Whitney Test was significant for latitude, longitude, and fine sediment content, the site groups segregated only on latitude. In the cluster analysis based on all of the sites, five sites at the mouth of San Diego Bay clustered with the northern bays in Site Group III (Figure 5-3). Although the split met our criteria for habitat differentiation, we were concerned that geography was confounded with other habitat variables. However, based on a two-way table presenting results of a nodal analysis clustering the sites and species simultaneously, we hypothesized that the shallow mainland shelf fauna immediately outside of the bays, whose distributions overlap with several of the organisms found in the bays, were affecting our result. We repeated the cluster analysis including only the embayment sites. Apparently, our hypothesis was correct. Northern bays, from Newport Bay to the north, segregated perfectly from southern bays, from Dana Point Harbor south. The next two splits for the embayments did not meet our criteria for habitat differentiation because each yielded less than ten sites.

The diversity and abundance of benthic organisms in the eight site groups is presented in Figures 5-6 and 5-7, respectively. Mid-depth Site Group IC, which included the northern Channel Islands, and Site Group ID, which included sites from 32 to 52 m deep, supported the most diverse benthic communities; median diversities were 110 and 95 taxa per 0.1 m^2 sample, respectively (Figure 5-6). The median diversity for the other site groups was similar, and ranged between 40 and 60 taxa per sample. Median abundances were highest for Site Group IV, the southern bays, and mid-depth Site Group IC, at about 750 per 0.1 m^2 sample (Figure 5-7). Site Group IC was also one of the two site groups with high diversity; it included sites in the northern Channel Islands.

Table 5-5. Mean abundance per 0.1 m^2 sample for the five most abundant taxa in each Site Group.

Overall Rank	Name	Site Group							
		IA	IB	IC	ID	IIA	IIB	III	IV
1	*Spiophanes duplex*	44.7	19.2	118.9	39.5	12.9	7.6	4.8	1.7
2	*Mediomastus* sp.	1.9	0.6	10.1	2.6	4.6	2.8	15.9	126.2
3	*Musculista senhousia*							1.9	93.2
4	*Euchone limnicola*					0.0		8.8	87.5
5	*Pseudopolydora paucibranchiata*							3.1	83.1
6	*Amphideutopus oculatus*	0.3	0.5	1.7	3.3	3.4	2.1	46.3	29.2
7	*Amphiodia urtica*	17.5	35.9	3.2	27.1	0.1	0.9	0.9	0.0
8	*Theora lubrica*	0.1					0.0	45.7	16.8
9	*Prionospio (Prionospio) heterobranchia*			1.1		0.5		4.9	36.6
11	*Spiochaetopterus costarum*	2.0	0.1	3.1	5.7	37.5	1.0	0.9	0.1
13	*Leitoscoloplos pugettensis*	0.1		0.7	0.2	0.1	0.3	16.2	23.9
15	Phoronida	9.3	1.7	5.1	20.9	2.2	2.2	3.1	3.6
19	*Paraprionospio pinnata*	1.4	1.1	5.1	5.4	0.8	5.7	6.7	0.3
20	*Phisidea sanctaemariae*	0.5	9.1	13.5	11.9	0.0	0.1		0.2
21	Oligochaeta	0.0	0.0	1.5		20.1	0.0	1.4	5.4
22	*Prionospio (Prionospio) jubata*	0.3	1.6	15.4	1.9	9.3	1.1		0.0
24	*Euclymeninae* sp. A	0.8	2.8	4.9	9.9	2.4	1.6	0.5	3.0
26	*Tagelus subteres*							20.4	4.7
27	*Apionsoma misakianum*			0.5	0.6	22.3	0.0	0.0	0.1
28	*Owenia collaris*	0.0	0.1	1.0	0.4	16.6	1.5	0.1	0.0
29	*Spiophanes fimbriata*	8.1	4.8	8.9	0.2		0.1		0.1
31	*Chloeia pinnata*	0.1	0.4	17.7	0.9	0.8	0.9		
32	*Pectinaria californiensis*	0.4	7.5	3.4	7.5		0.3	0.1	0.0
33	*Petaloclymene pacifica*	0.4	0.3	0.4	3.2	0.0	3.0	7.2	
34	*Cossura candida*	0.2		0.0	2.0		0.0	18.5	
35	*Protodorvillea gracilis*					16.5	0.0		
37	*Ampharetidae* sp. SD1	0.1	0.0	18.9	0.1	0.0	0.0		
43	*Spiophanes bombyx*		0.2	4.2		1.9	2.9	0.1	0.0
48	*Aphelochaeta* sp. LA1	0.0		14.0		0.0			
56	*Polydora cirrosa*						3.8	0.3	
121	*Gymnonereis crosslandi*	4.0	0.4	0.3	1.3		0.0		

B. Discussion

We accomplished the objective of identifying the habitat-related reference states for southern California embayments to facilitate identification of disturbed benthic communities by comparisons with those states. Two substantially different geography-related benthic assemblages were identified in the northern bays from Newport Bay north and in the southern bays from Dana Point Harbor south. The benthic assemblages inhabiting southern California

Table 5-6. Average abundance of species with frequency of occurrences greater than 60% and average abundance of at least 2 per 0.1 m^2 in each site group.

Name	IA	IB	IC	ID	IIA	IIB	III	IV
Spiophanes duplex	44.7	19.2	118.9	39.5		7.6	4.8	
Amphiodia urtica	17.5	35.9		27.1				
Phoronida	9.3		5.1	20.9				
Spiophanes fimbriata	8.1	4.8	8.9					
Sternaspis fossor	3.8	3.3		2.5				
Aglaophamus verrilli	2.8							
Paradiopatra parva	2.5							
Pectinaria californiensis		7.5		7.5				
Paramage scutata		4.1		5.7				
Prionospio (Prionospio) dubia		3.5						
Euclymeninae sp. A		2.8	4.9	9.9				
Tellina carpenteri		2.5		4.5				
Rhepoxynius bicuspidatus		2.2						
Ampharetidae sp. SD1			18.9					
Chloeia pinnata			17.7					
Prionospio (Prionospio) jubata			15.4					
Aphelochaeta sp. LA1			14.0					
Phisidea sanctaemariae			13.5					
Euchone incolor			12.7	4.9				
Asabellides lineata			12.5					
Aricidea (Acmira) simplex			12.0					
Mediomastus sp.			10.1	2.6			15.9	126.2
Sthenelanella uniformis			10.0	8.6				
Chaetozone hartmanae			9.0					
Chone sp. B			6.5					
Amygdalum politum			5.7					
Leptochelia dubia			5.4					
Spiophanes berkeleyorum			5.2					
Paraprionospio pinnata			5.1	5.4		5.7	6.7	
Parvilucina tenuisculpta			5.0	3.4				
Photis lacia			4.3					
Chone sp. C			4.2					
Amphipholis squamata			3.8					
Byblis millsi			3.2					
Spiochaetopterus costarum			3.1	5.7				
Phyllodoce pettiboneae			2.5	2.3				
Lineidae			2.4					
Ampelisca pugetica			2.2					
Glottidia albida				7.9				
Monticellina cryptica				7.5				
Streblosoma crassibranchia				7.4				
Streblosoma sp. B				7.4				
Poecilochaetus sp. A				6.2				
Ceriantharia				3.9				
Heterophoxus oculatus				3.6				
Amphideutopus oculatus				3.3			46.3	29.2
Ampelisca indentata				3.1				
Diopatra tridentata				3.0				
Tubulanus polymorphus				2.9			5.7	
Praxillella pacifica				2.9				
Cadulus aberrans				2.6				
Dipolydora socialis				2.4				
Ampelisca brevisimulata				2.3				
Euphilomedes carcharodonta				2.1				12.3
Goniada maculata				2.0				
Owenia collaris					16.6			
Caecum crebricinctum					13.0			
Theora lubrica							45.7	16.8

Table 5-6. (Continued)

Name	IA	IB	IC	ID	IIA	IIB	III	IV
Tagelus subteres							20.4	
Leitoscoloplos pugettensis							16.2	23.9
Cossura sp. A							9.3	
Chaetozone corona							5.1	
Ampharete labrops							2.6	
Notomastus sp. A							2.2	
Musculista senhousia								93.2
Euchone limnicola								87.5
Pseudopolydora paucibranchiata								83.1
Prionospio (Prionospio) heterobranchia								36.6
Exogone lourei								30.9
Pista agassizi								27.7
Scoletoma sp. C								27.1
Lyonsia californica								17.6
Diplocirrus sp. SD1								4.4
Glycera Americana								4.3
Paranemertes californica								2.9

embayments were also substantially different from the two mainland and island shelf assemblages, segregating perfectly at the first split in the cluster analysis for the entire Southern California Bight (SCB). Identification of these differences guided development of a benthic index to enable assessment of benthic condition in SCB embayments. A separate index was developed (Appendix C), rather than optimizing the existing Benthic Response Index (BRI) for the shallow mainland shelf (Smith *et al.* 2001) because the first Bight-wide split segregated the shelf from embayments. The index used different species and scores in the northern and southern bays because they were identified as alternate reference states for embayments. In a parallel manner, the mainland shelf BRI uses different species and scores for three depth-related habitats identified as alternate reference states on the mainland shelf (Bergen *et al.* 2001).

Our analysis confirmed the habitat factors differentiating the shallow and mid-depth assemblages identified by Bergen *et al.* (2001) on the mainland shelf and went further to identify sub-assemblages. The habitat differentiation was almost identical in both studies, with segregation occurring at 32 m, modified by sediment type at depths close to 32 m. We were unable to confirm the deep fine and deep coarse assemblages because, during Bight`98, samples were not collected deeper than 120 m, which is the shallow limit for the deep assemblage.

The species composition of the assemblages identified in areas of the SCB that are relatively well known corresponded well with previous reports. Site Group IIB, one of the two shallow shelf sub-assemblages, corresponds to the "Shallow Assemblage" identified from the 1994 Southern California Bight Pilot Project (Bergen *et al.* 2001). This, in turn, is very similar to the *Nothria-Tellina* Association noted by Jones (1969).

The other shallow shelf sub-assemblage, Site Group IIA, does not appear to have a direct equivalent among previously identified assemblages, although it shares some species with the red sand "*Nothria stigmatis – Spiophanes bombyx*" association (Jones 1969). This sub-assemblage was found in clean coarse sediments predominantly around the northern Channel Islands, and in shallow coarse sediments containing 2% or less fines along the southern inner mainland shelf south into Mexico.

The embayment assemblages also were not previously identified because they were not included in previous sampling efforts (Allan Hancock Foundation 1959, 1965; Jones 1969; Fauchald and Jones 1983; Thompson *et al.* 1987; Thompson and Jones 1987; Thompson *et al.* 1993; Bergen *et al.* 2001). The southern Bays, Site Group IV, included several distinctive taxa including *Musculista senhousia*, *Euchone limnicola*, *Pseudopolydora paucibranchiata*, and *Prionospio (Prionospio) heterobranchia* (Table 5-6). *M. senhousia* and *P. paucibranchiata* are the two most abundant non-indigenous species (NIS) in the SCB (Appendix B). Site Group III, the northern bays, had fewer distinctive taxa, including *Leitoscoloplos pugettensis*, *Chaetozone corona*, and *Ampharete labrops*. Both embayment assemblages shared a few characteristic species with each other and with mid-depth Site Group ID (Table 5-6).

The four mid-depth (Site Group I) sub-assemblages are similar to those reported from mid-depths in previous studies. Site Group IA was evenly divided between the narrow shelf around Catalina Island and the mainland shelf in the Santa Barbara Channel between Santa Barbara and Gaviota. The biota occurring at these sites was dominated by the worm *Spiophanes duplex* (*S. missionensis* in earlier analyses) and the ophiuroid *Amphiodia urtica*. In the 1994 SCBPP analysis, this assemblage and Site Group ID were treated as a single "Mid-depth Assemblage" (Bergen *et al.* 2001), which was the same as Jones' *Amphiodia* association (Jones 1969). While Site Groups IA and ID share the same two dominant species, they are differentiated by the sub-dominant taxa. They fractionate the mid-depth shelf into deeper and siltier (Site Group IA) and shallower and sandier (Site Group ID) zones. They also differed in geographic distribution, with Site Group IA located primarily on the northern mainland shelf and around Santa Catalina Island, while Site Group ID sites were usually more southern.

Site Group IB represents the "Deep Fine Assemblage" of Bergen *et al.* (2001). This is the predominant outer-shelf group in the SCB, and is dominated by the ophiuroid *Amphiodia urtica*, with the polychaete worms *Spiophanes duplex* and *S. fimbriata* as numerical sub-dominants. The two assemblages are not exactly the same because the SCBPP data contained a number of sites deeper than 120 m, which was the depth limit for Bight'98; but they overlap strongly in species composition.

Site Group IC has the same quasi-equivalency with the "Deep Coarse Assemblage" of Bergen *et al.* (2001). The connection here is through sediment type, rather than depth. The relatively coarse sediments of the northern Channel Islands shelf sustain many of the same species found in coarse sediments from 120-208 m depth in the SCBPP.

The bays, island shelf, and Mexican mainland shelf were sampled extensively for the first time during Bight`98 and, therefore, could not be compared with previous studies. The bays proved to be unique environments supporting two assemblages, one in the northern bays and one in the southern bays. The Mexican mainland shelf had affinities with the U.S. mainland shelf. At mid-depth, the Mexican shelf shared a sub-assemblage, Site Group IB, with the southern SCB mid-depth shelf. Its composition was similar to the "Deep Fine Assemblage" of Bergen *et al.* (2001). The shallow Mexican mainland shelf shared sub-assemblage Site Group IIB with other shallow areas throughout the mainland shelf of the SCB.

Affinities of the Channel Islands shelves with other areas were apparently associated with similarities in sediment type. The mid-depth assemblages on the Santa Catalina Island shelf shared sub-assemblage Site Group IA with the relatively broad northern mainland shelf (Figure 2-3); it was part of the “Mid-depth Assemblage” identified by Bergen *et al.* (2001). Sub-assemblage Site Group IC occurred only at the mid-depth northern Channel Islands and had affinities with the “Deep Coarse Assemblage” identified in the SCBPP. The shallow island shelves shared sub-assemblage Site Group IIA with sites with very coarse sediments, wherever they occurred in the SCB; it was reported here for the first time.

Sediment grain size distributions are more important determinants of assemblage composition on the mainland and island shelf zones than previously reported. On the mainland shelf, depth and sediment type are inextricably confounded with coarser sediments in shallow waters and finer sediments at depth. During Bight`98, samples were collected on the Channel Islands shelf and the Mexican mainland shelf, where coarse sediments occur at depth and sediment type appears to be more important than depth in several cases. The “Deep Coarse Assemblage” and “Deep Fine Assemblage” reported by Bergen *et al.* (2001), Site Groups IC and IB, consistently occurred at sites from 52 to 120 m deep, which is shallower than expected. Clearly, sediment type is more important than depth. Site Group IIA includes assemblages inhabiting the coarsest sediments, wherever they occur; it differentiates from Site Group IIB on sediment type independent of depth (Figures 5-4 and 5-5). Although previous studies (Bergen *et al.* 2001, Barnard and Hartman 1959, Barnard and Ziesenhenne 1960) suggested that sediments only slightly modify depth effects, it appears that, in many instances, additional effects are present. First, there is a substantial sediment effect on the numbers and kinds of benthic organisms that occur; and second, the controlling factors are more closely related to sediment texture than depth. The real determinant is probably the current, tide, and wind-driven hydrodynamic energy spectrum at the sediment surface.

Some results indicated that using only the proportion of fine sediments in data analysis may not adequately capture the biological effects of sediment grain size distribution, especially for coarser sediments. The criteria for segregating Splits 3A and 3B include island habitat criteria listed as such. It is likely that the real determinants are the hydrodynamic factors responsible for the presence of coarse sediments at island sampling sites. It may be useful to identify measures of the sediment grain size distribution that are more closely related to assemblage differences than percent of fines.

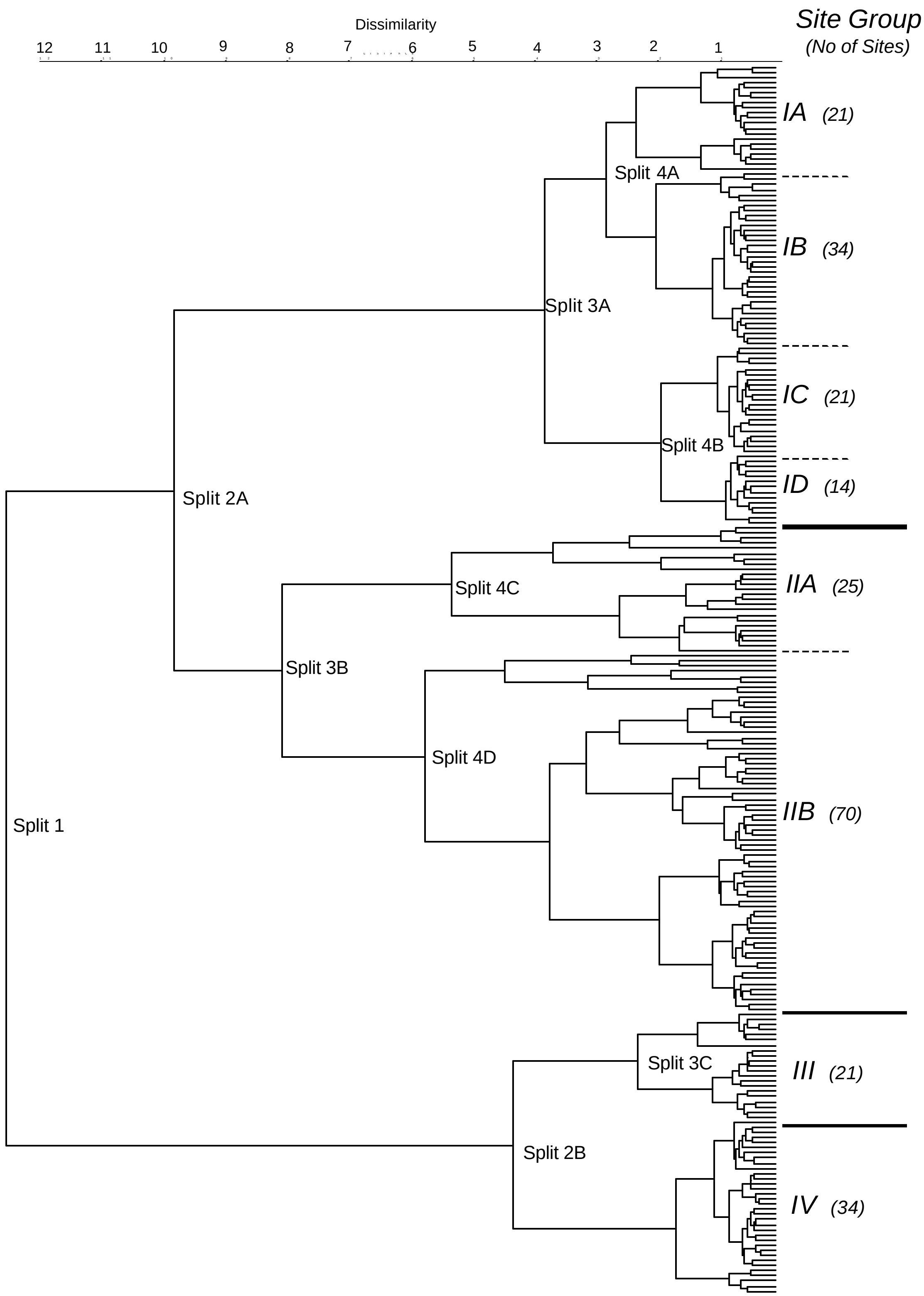


Figure 5-1. Dendrogram illustrating site groups identified by cluster analysis. Splits identify dendrogram branch points referred to elsewhere in the text and figures.

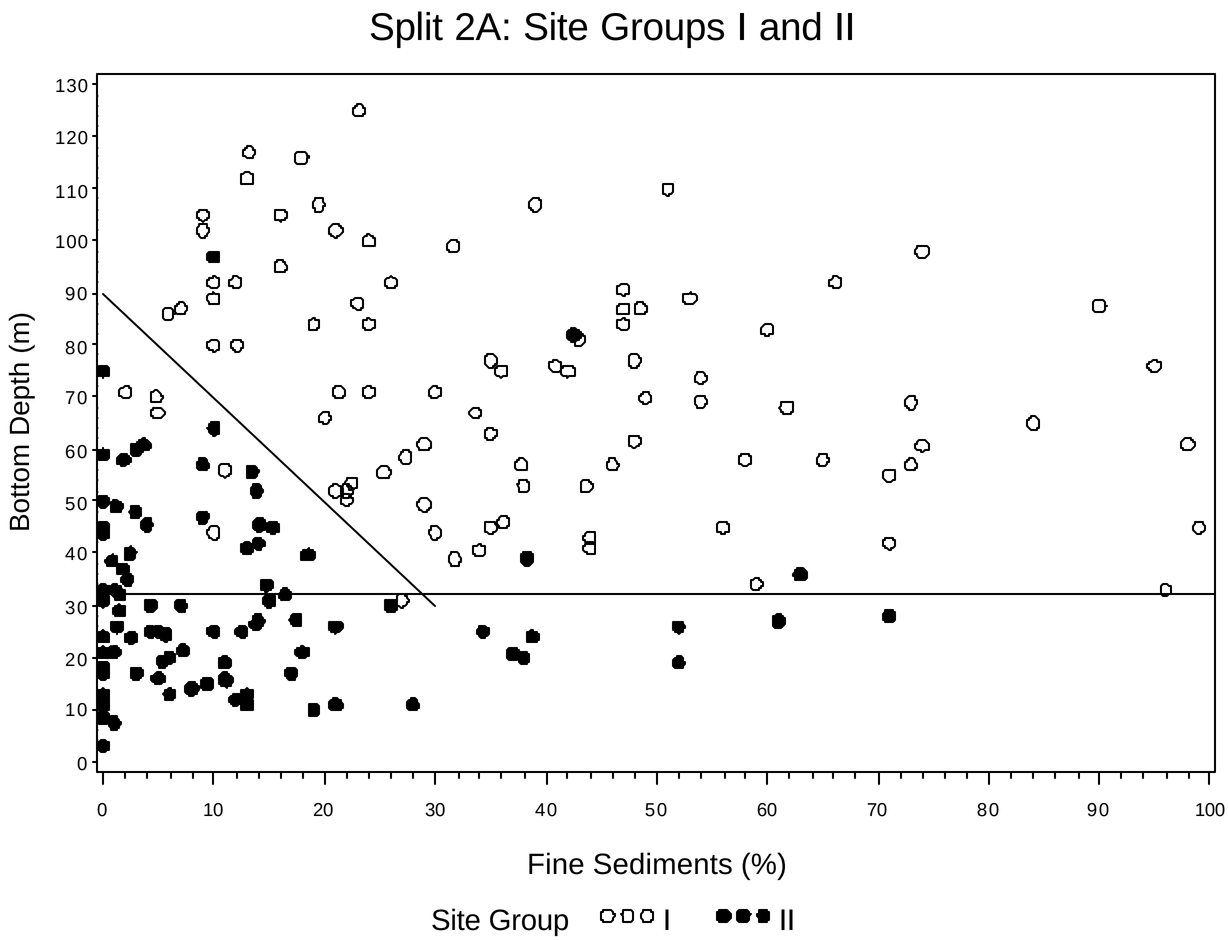


Figure 5-2. Habitat segregation of Site Group I (the mid-depth shelf assemblage) and Site Group II (the shallow shelf assemblage). The assemblages segregate at about 32 m depth, except for sites from 32 – 90 m deep with coarse sediments, which segregate with shallow sites. The coarse sediments modify the depth effect.

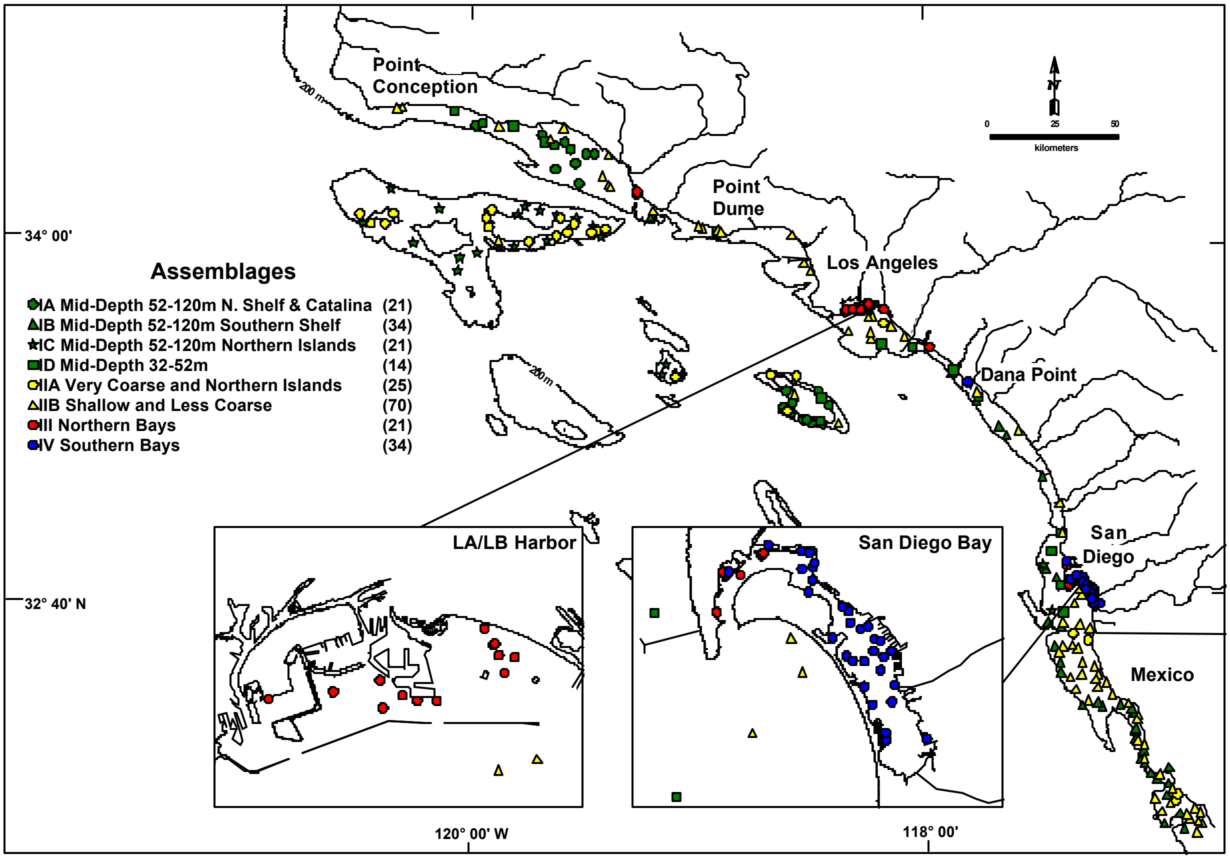


Figure 5-3. Locations of sites in each site group.

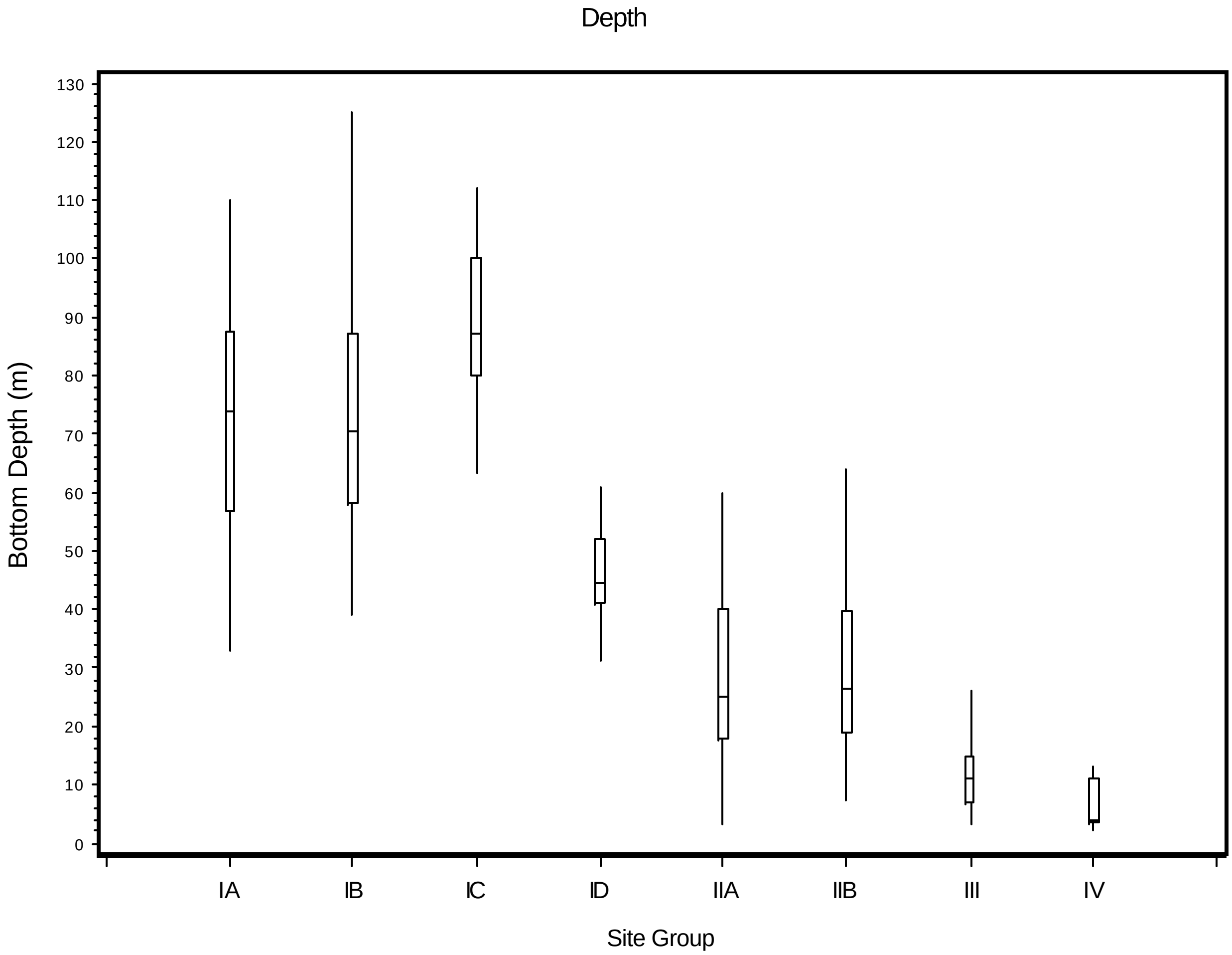


Figure 5-4. Box plot of depth distribution for each site group. The bottom and top edges of the box are located at the sample 25th and 75th percentiles. The center horizontal line is the median. The whiskers are drawn from the box to the most extreme point within 1.5 interquartile ranges. An interquartile range is the distance between the 25th and 75th percentiles.

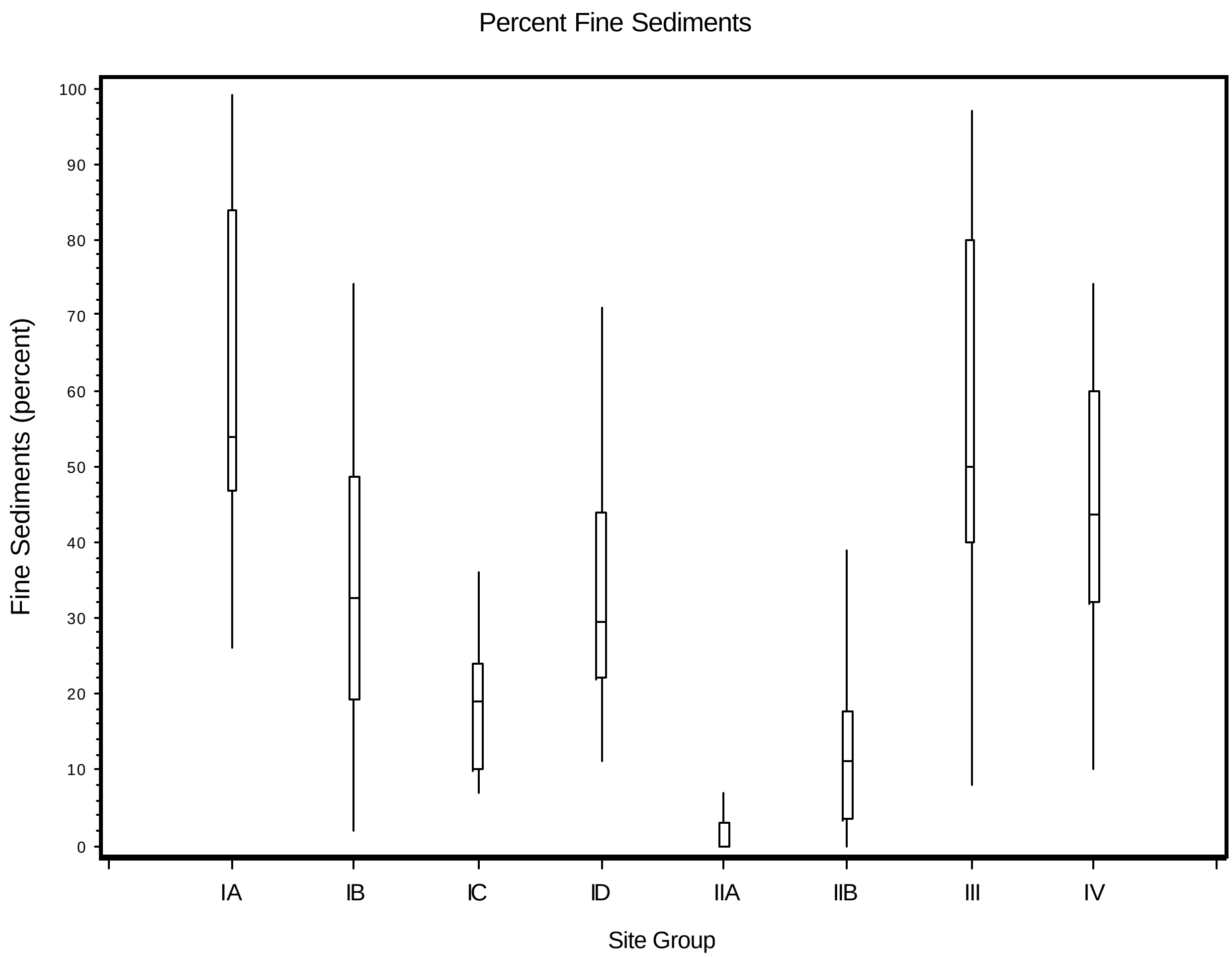


Figure 5-5. Box plot of fine sediment content distribution for each site group. See Figure 5-4 for an explanation.

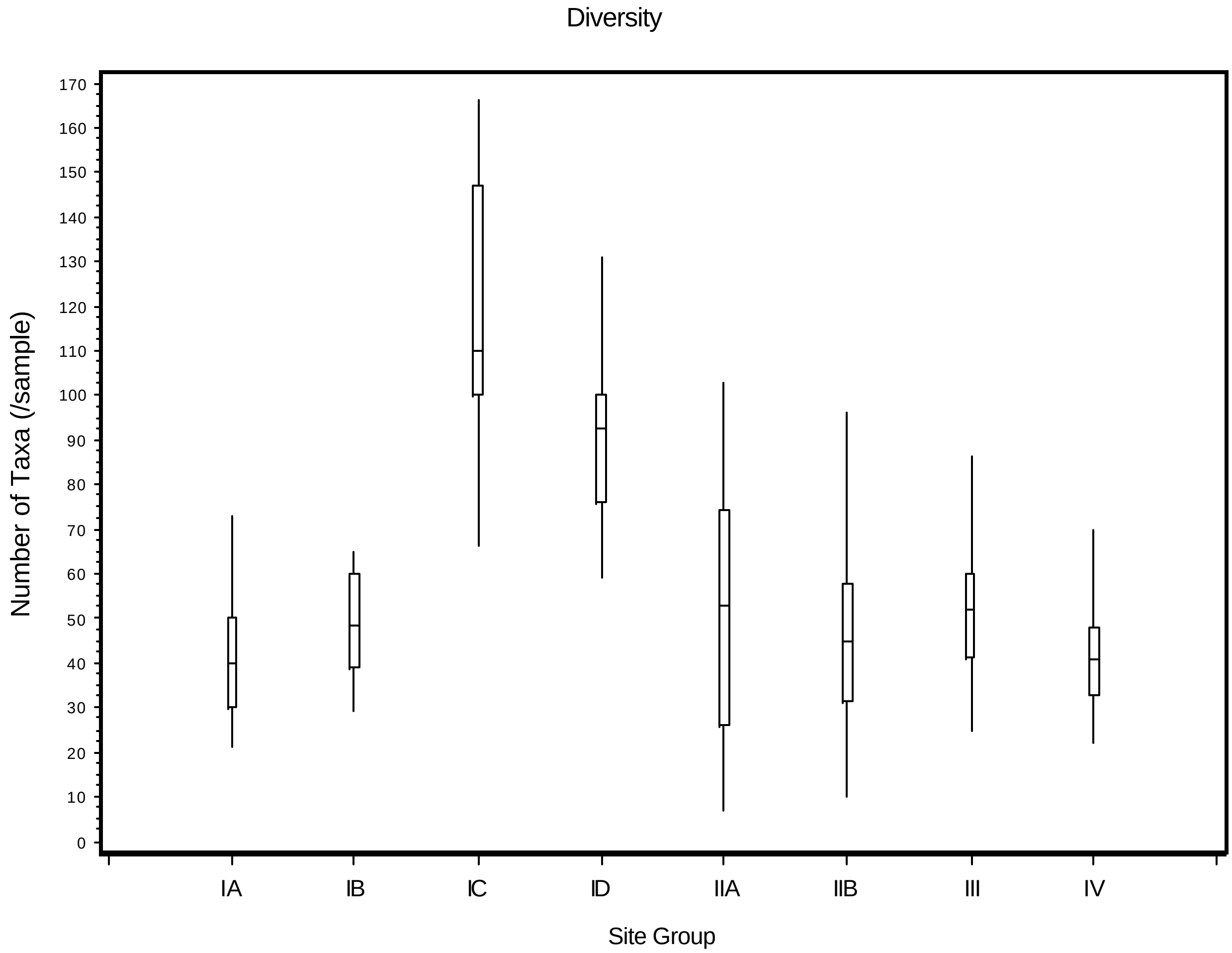


Figure 5-6. Box plot of diversity distribution for each site group. See Figure 5-4 for an explanation.

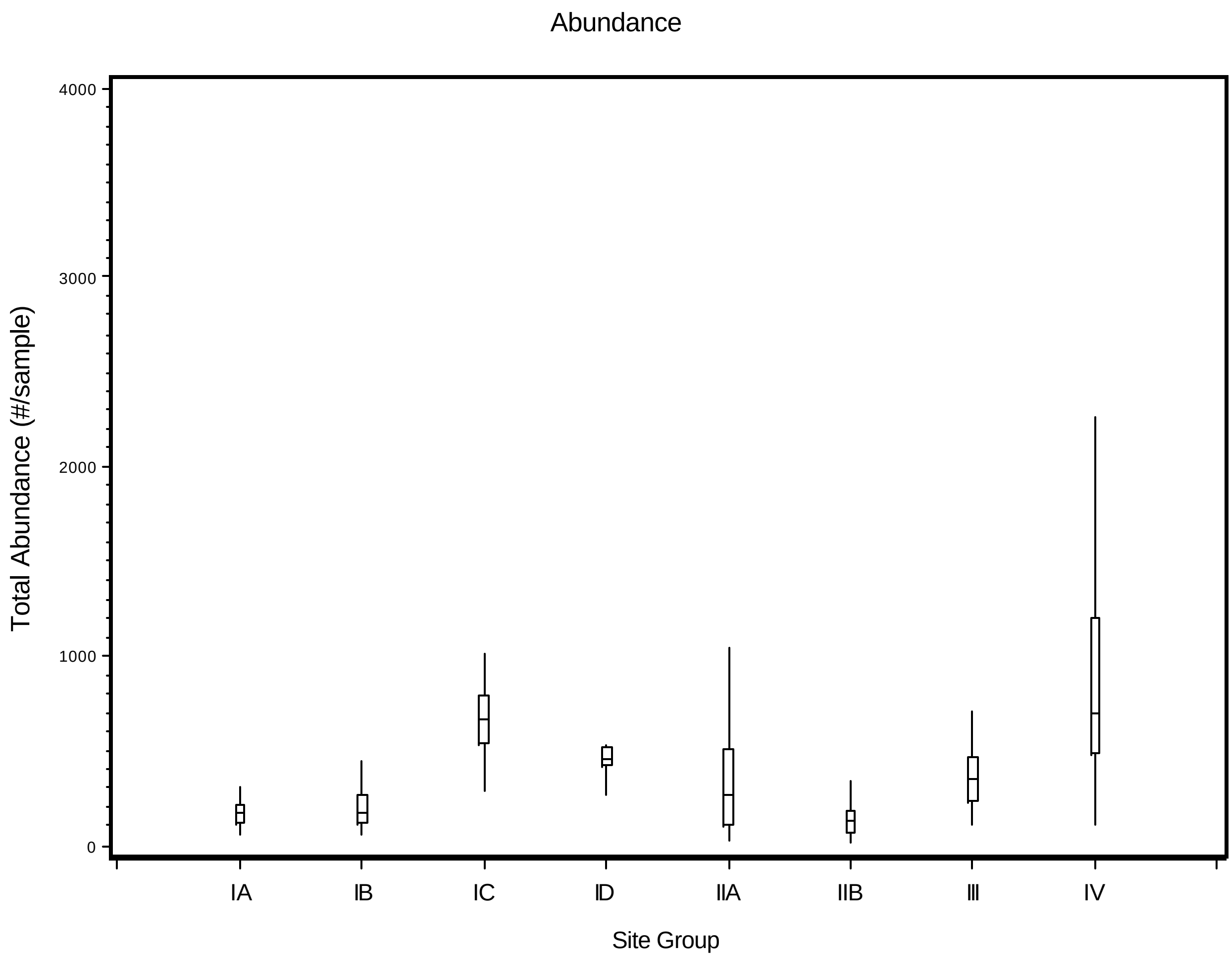


Figure 5-7. Box plot of abundance distribution for each site group. See Figure 5-4 for an explanation.

6. Community Characteristics

This chapter presents the results of comparisons of benthic community characteristics among selected geographic regions to identify biological differences among them. It examines a broader range of biological measures than Chapter 4, which assessed the condition of the Southern California Bight (SCB) by applying a single measure, the Benthic Response Index (Smith *et al.* 2001, Appendix C). It differs from the data used for identification of assemblages in Chapter 5 by including all of the random data; potentially contaminated sites were excluded from analysis in Chapter 5 because our objective was to identify naturally occurring assemblages.

Spatial differences in benthic community measures were measured in seven ways using area-weighted mean values. The first approach calculated mean values for the U.S. portion of the SCB. The second approach compared three of its habitats: embayments, the mainland shelf, and the island shelf. The other five approaches examined within-habitat differences in greater detail. The shelf habitat was examined from three perspectives. First, the northern, central, and southern U.S. mainland shelf regions (Figure 2-1) were compared to each other and to the Mexican mainland shelf; this was the only comparison in which data from Mexico were used. Also, in each of two depth subdivisions of the shelf, benthic communities in areas exposed to potential sources of pollution were compared to areas farther away. Shelf areas shallower than 32 m are known to support a different benthic assemblage than deeper areas (Bergen *et al.* 2001) (Chapter 5). The last two comparisons examined embayment and island shelf habitats in more detail. In embayments, ports were compared to marinas and other areas. Large ocean-going vessels are moored in ports, small recreational vessels in marinas, and none in the other areas. In the island shelf habitat, the northwestern Channel Island shelf that is exposed to the cold California Current was compared to the southeastern Channel Island and Santa Catalina Island shelves that are exposed to the warmer Davidson Countercurrent.

A. Bight-Wide Averages

Average macrofaunal abundance in the SCB was 455 organisms per 0.1 m^2 sample and the average wet-weight biomass was 7.6 g/sample (Figure 6-1). The average sample contained 83 species with a Shannon-Wiener Diversity Index of 5.02 (Figure 6-2). At 62% of abundance, polychaetous annelids dominated numerical counts while the contributions of arthropods, molluscs, ophiuroids, and other phyla were about equal (Figure 6-3a); non-ophiuroid echinoderm counts were lowest. Biomass was more evenly distributed (Figure 6-4a). Annelids contributed 35% of the biomass, ophiuroids 22%, and molluscs and miscellaneous phyla each contributed 16%. Echinoderms other than ophiuroids only contributed 6% of the biomass. The pattern of distribution of numbers of taxa (Figure 6-5a) was similar to the abundance patterns.

Twelve of the 15 most abundant taxa in the SCB were annelids (Table 6-1); 11 were polychaetes and the other included all of the oligochaetes. The ophiuroid echinoderm genus *Amphiodia* contributed to two of the other three. The most abundant taxon was *Spiophanes duplex*, a spionid polychaete, with an area-weighted mean abundance of 54.27 /0.1 m^2 sample. The ophiuroid *Amphiodia urtica* and another spionid polychaete, *Prionospio (Prionospio) jubata*, were second and third most abundant with 12.68/0.1 m^2 and 8.60/0.1 m^2, respectively.

No mollusc or arthropod taxa were sufficiently abundant for inclusion in the 15 most abundant macrofaunal taxa.

Table 6-1. The fifteen most abundant macrofaunal taxa in the U.S. portion of the Southern California Bight. Area-weighted mean abundances and occurrences are presented for 323 sites selected at random in embayments and on the coastal and island shelves up to 120 m deep.

Rank	Taxon	Area-weighted Mean Abundance (number/0.1 m^2)	Occurrences (percent of sites)
1	*Spiophanes duplex*	54.27	70.9
2	*Amphiodia urtica*	12.68	38.7
3	*Prionospio (Prionospio) jubata*	8.60	31.0
4	*Mediomastus* sp.	7.66	74.0
5	Ampharetidae sp. SD1	7.41	6.8
6	Phoronida	6.90	62.2
7	*Phisidea sanctaemariae*	6.27	16.4
8	*Chloeia pinnata*	5.92	12.7
9	*Paraprionospio pinnata*	5.73	67.8
10	*Amphiodia* sp.	5.72	35.9
11	Oligochaeta	5.02	21.7
12	*Paradoneis* sp.	4.98	5.0
13	*Spiophanes fimbriata*	4.98	17.6
14	*Euchone incolor*	4.96	18.9
15	Euclymeninae sp. A	4.88	41.5

B. Embayment, Mainland Shelf, and Island Shelf Habitats

At 651 per sample, area-weighted mean abundance was highest on the island shelf followed by embayments at 593 per sample (Figure 6-1). Abundances on the mainland shelf (291/sample) were less than half of the island shelf and embayments. Average biomass in embayments (14.0 g/sample) was nearly twice that for the island and mainland shelf (7.2 and 7.4 g/sample, respectively). In contrast to abundance and biomass, the area-weighted mean number of taxa per sample in embayments (42) was considerably smaller than the mainland (67) and island (109) shelves (Figure 6-2). The island shelf macrofauna were most diverse. Patterns for Shannon-Wiener diversity were similar to the patterns for numbers of taxa.

Annelids dominated all three habitats numerically with 55-71% of abundance (Figure 6-3b), and echinoderms were the least common. Ophiuroid abundance on the island shelf was low, and they were nearly absent in embayments. The rank order of the other phyla varied among habitats. Arthropods, ophiuroids, molluscs, and miscellaneous phyla contributed approximately equally (13-10%) to abundance on the mainland shelf. Arthropods ranked second for the island shelf and molluscs (12%) were about twice as abundant as ophiuroids and miscellaneous phyla (4-7%). In contrast, molluscs (20%) were second most abundant in bays followed by arthropods (14%) and, at much lower levels, by miscellaneous phyla (3%) and ophiuroids (<1%). The distribution of biomass was similar on the mainland and island shelves with annelids (35-36%) and ophiuroids (20-25%) dominating (Figure 6-4b). In contrast, mollusc (54%) and annelid (33%) biomass dominated embayments. Patterns of distribution of numbers of taxa were similar in all three habitats (Figure 6-5b). Annelids dominated and were followed by arthropods, molluscs, and miscellaneous phyla.

The dominant taxa in embayments were quite different from those on the island and mainland shelves (Table 6-2). Four of the five abundance dominants in bays were absent from the shelf habitats, or nearly so. *Spiophanes duplex* dominated both shelf habitats while *Amphiodia urtica* and *Amphiodia* sp. ranked second and third on the mainland shelf; Ampharetidae sp. SD1 and *Prionospio (prionospio) jubata* ranked second and third on the island shelf.

Table 6-2. Taxa ranked most abundant in habitats of the U.S. portion of the Southern California Bight. Overall ranks, area-weighted mean abundances, occurrences, and individual ranks are presented for 121, 147, and 53 random sites in embayments and on the coastal and island shelves up to 120 m deep, respectively. Taxa ranked in the top five for any habitat were included. Information about the subpopulations is provided in Table 2-1, Table 2-3, and Figure 2-1.

Over all Rank	Taxon	Area-weighted Mean Abundance (#/0.1 m^2)			Occurrence (percent of sites)			Abundance Rank		
		Bays	Coastal Shelf	Island Shelf	Bays	Coastal Shelf	Island Shelf	Bays	Coastal Shelf	Island Shelf
1	*Spiophanes duplex*	2.91	23.44	98.73	47.8	82.6	88.7	31	1	1
2	*Amphiodia urtica*	0.58	21.57	2.20	16.8	55.5	37.7	94	2	56
3	*Prionospio (Prionospio) jubata*	0.02	2.59	17.14	2.7	41.9	60.4	382	17	3
4	*Mediomastus* sp.	46.14	5.49	7.20	83.2	68.4	71.7	3	7	16
5	Ampharetidae sp. SD1	0.00	0.11	17.54	0.0	1.9	34.0	993	291.5	2
6	Phoronida	4.09	8.70	4.82	51.3	71.6	60.4	28	4	30
8	*Chloeia pinnata*	0.00	0.49	13.49	0.0	12.3	41.5	993	117	4
9	*Paraprionospio pinnata*	3.74	7.28	3.87	55.8	80.6	54.7	30	5	34
10	*Amphiodia* sp.	0.20	10.12	0.47	11.5	56.8	28.3	171	3	211
12	*Paradoneis* sp.	0.00	0.07	11.79	0.0	0.6	28.3	993	348.5	5
28	*Pseudopolydora paucibranchiata*	85.24	0.00	0.00	61.1	1.3	0.0	1	768	1,143
41	*Euchone limnicola*	64.18	0.02	0.00	64.6	3.9	1.9	2	629	853.5
65	*Musculista senhousia*	41.63	0.00	0.00	53.1	0.0	0.0	4	1,135	1,143
81	*Theora lubrica*	29.56	0.30	0.00	85.8	7.7	0.0	5	166	1,143

C. Regions of the Mainland Shelf

Macrofaunal abundance was highest in the central (374/sample) and southern (334/sample) regions of the mainland shelf (Figure 6-6). Area-weighted mean abundances on the northern and Mexican shelves were considerably less at 199 and 116 per sample, respectively. The central region was also highest in biomass (8.5 g/sample), but the area-weighted mean for the northern region (8.4 g/sample) was almost as high. At 4.2 and 2.0 g/sample, average biomass values in the southern region and on the Mexican shelf were considerably lower. The patterns for number of taxa and Shannon-Wiener diversity closely followed the pattern for abundance (Figure 6-7), with area-weighted mean values of 82, 68, 54, and 39 taxa per sample in the central, south, north, and Mexican regions, respectively.

The patterns of dominance were strikingly similar in all four regions for abundance (Figure 6-3c), biomass (Figure 6-4c), and numbers of taxa (Figure 6-5c). Annelids dominated abundance and numbers of taxa in all four regions. The dominance pattern for biomass in the southern region differed somewhat from the others. Echinoderm biomass (40%) exceeded annelid biomass (35%), and mollusc and miscellaneous phyla contributions were low (<10%). In the other regions, annelids were second in biomass and the contributions of mollusc and miscellaneous phyla exceeded 10%.

The most abundant taxa were common to all four geographic regions, while less abundant organisms were most similar among the southern and Mexican regions. *Amphiodia urtica* and *Spiophanes duplex* were ranked first or second in all four regions except the north, where *A. urtica* was ranked third. *Pectinaria californiensis* was ranked fifth in both the southern and Mexican regions, while *Phisidea sanctaemariae* was ranked 4th and 8th and *Spiophanes fimbriata* 17th and 16th, respectively.

Table 6-3. Taxa ranked most abundant in geographic regions of the mainland shelf of the Southern California Bight up to 120 m deep. Overall ranks, area-weighted mean abundances, occurrences, and individual ranks are presented for 46, 62, 39, and 63 random sites on the northern U.S. (Nor), central U.S. (Cen), southern U.S. (Sou) and Mexican (Mex) mainland shelves, respectively. Taxa ranked in the top five for any region were included. Information about the subpopulations is provided in Table 2-1, Table 2-3, and Figure 2-1.

Over all Rank	Taxon	Area-weighted Mean Abundance (number/0.1 m^2)				Occurrence (percent of Sites)				Abundance Rank			
		Nor	Cen	Sou	Mex	Nor	Cen	Sou	Mex	Nor	Cen	Sou	Mex
1	*Amphiodia urtica*	11.58	21.38	39.07	9.28	45.7	55.7	66.7	52.4	3	2	1	1
2	*Spiophanes duplex*	17.31	22.73	35.05	6.64	69.6	88.6	87.2	77.8	1	1	2	2
3	*Amphiodia* sp.	4.75	8.73	21.42	0.00	45.7	55.7	71.8	0.0	6	6	3	716.5
4	Phoronida	13.78	5.03	5.30	0.81	67.4	80.0	61.5	12.7	2	13	7	32
5	*Paraprionospio pinnata*	6.17	11.91	2.42	1.49	71.7	90.0	74.4	52.4	4	3	22	14
6	*Phisidea sanctaemariae*	0.00	2.60	20.52	1.91	0.0	24.3	48.7	22.2	740	29	4	8
7	*Pectinaria californiensis*	0.30	4.49	15.80	2.15	21.7	60.0	69.2	42.9	141	16	5	5
8	Amphiuridae	0.56	3.29	4.01	5.04	19.6	51.4	56.4	60.3	83	23	10	3
9	*Mediomastus* sp.	2.73	11.32	1.73	0.13	73.9	70.0	59.0	9.5	9	4	29	155
10	*Petaloclymene pacifica*	1.02	8.85	2.76	1.31	13.0	37.1	23.1	19.0	42	5	18	19
12	*Spiophanes fimbriata*	5.40	3.09	2.79	1.47	15.2	18.6	28.2	31.7	5	25	17	16
18	*Caecum crebricinctum*	0.04	0.71	0.16	3.29	2.2	7.1	5.1	20.6	353	115	227	4

D. The Shallow U.S. Shelf

Shallow areas (less than 32 m deep) on the mainland shelf potentially affected by two types of pollutant sources were compared to other shallow mainland and island shelf areas. The potentially affected areas were at the mouths of rivers and in the discharge plumes of small (<100 mgd discharge) publicly owned treatment plants (POTWs). Shallow areas are known to support a different assemblage than mid-depth areas (Bergen *et al.* 2001) (Chapter 5).

Area-weighted mean abundances on the shallow shelf were highest near islands (320/sample) and other mainland shelf areas (252/sample), followed by small POTWs and river mouths at 217 and 166 per sample, respectively (Figure 6-8). Biomass around small POTWs (15.3 g/sample) was over twice that in the other areas (4.7-5.6 g/sample). Numbers of taxa were highest (62) in mainland shelf areas unaffected by discharge, followed by small POTWs (57), islands (48), and river mouths (35) (Figure 6-9). Shannon-Wiener diversity was similar in all of the areas, with area-weighted mean values ranging from 3.89-4.96. River mouths had the lowest mean values for all four measures.

Similar patterns of abundance dominance were observed for all of the areas (Figure 6-3d). Annelids (48-55%) dominated all four areas, followed by arthropods (19-26%) or molluscs (12-25%). Percentages of miscellaneous phyla (5-9%) and ophiuroids and other echinoderms (<1-2%) were considerably lower. With the exception of the island shelf, biomass dominance patterns were also similar (Figure 6-4d). For the mainland shelf, annelids (40-50%) dominated, followed by molluscs (21-28%), arthropods (7-11%), other echinoderms (6-7%), and ophiuroids

(2-9%). Biomass was more evenly distributed on the island shelf, with annelids (24%) and molluscs (15%) contributing only about half as much as in mainland shelf areas. The contributions of arthropods (16%), ophiuroids (12%), and other echinoderms (15%) around islands were about double those for the mainland shelf. The patterns of dominance in numbers of taxa were similar in all four areas (Figure 6-5d). Annelids contributed approximately half of the taxa (48-51%), arthropods about a quarter (22-27%), and molluscs 10-19%.

Several abundance dominants on the shallow island shelf were absent from the shallow mainland shelf and vice versa (Table 6-4). *Protodorvillea gracilis*, *Lumbrineris latreilli*, and *Hesionura coineaui difficilis* had high abundance ranks on the island shelf but low ranks on the mainland shelf. *Petaloclymene pacifica*, *Polydora cirrosa*, *Siliqua lucida*, and *Pista disjuncta* were common on the shallow mainland shelf but absent from islands. The abundance ranks were variable, but not strikingly different, between small POTWs, river mouths, and other areas on the shallow mainland shelf.

Table 6-4. Taxa ranked most abundant in subdivisions of the shallow (5-30 m) coastal shelf of the U.S. portion of the Southern California Bight. Overall ranks, area-weighted mean abundances, occurrences, and individual ranks are presented for 12, 21, 13, and 32 random sites in areas under the influence of wastewater discharges < 100 mgd (POTWS), at river mouths (River), on the island shelf (Isl.), or in other areas (Oth.), respectively. Taxa ranked in the top five for any area were included.

Over all Rank	Taxon	Area-weighted Mean Abundance (number/0.1 m²)				Occurrence (percent of sites)				Abundance Rank			
		POTWS	River	Isl.	Oth.	POTWS	River	Isl.	Oth.	POTWS	River	Isl.	Oth.
1	*Paraprionospio pinnata*	8.04	6.29	1.94	11.67	81.3	54.2	23.1	87.9	2	4	31	1
2	*Mediomastus* sp.	2.71	24.21	8.48	10.52	50.0	50.0	69.2	81.8	17	1	10	2
3	*Spiophanes duplex*	3.39	2.58	6.67	8.45	56.3	50.0	53.8	87.9	13	13	13	4
4	*Petaloclymene pacifica*	5.16	2.21	0.00	9.06	37.5	12.5	0.0	36.4	6	16	523	3
5	*Polydora cirrosa*	0.72	3.29	0.00	8.09	6.3	25.0	0.0	12.1	70.5	8	523	5
11	*Monticellina siblina*	6.87	1.21	0.10	3.97	68.8	25.0	7.7	72.7	3	31	238	11
15	*Protodorvillea gracilis*	0.00	0.08	36.60	0.00	0.0	8.3	46.2	0.0	526	210	1	606
19	*Owenia collaris*	0.18	3.54	16.02	1.55	12.5	33.3	53.8	42.4	179	7	2	39.5
23	*Diastylopsis tenuis*	6.14	3.92	6.47	1.94	37.5	66.7	15.4	36.4	4	5	14	32
28	*Siliqua lucida*	1.02	18.33	0.00	2.12	25.0	62.5	0.0	39.4	51	2	523	29.5
30	*Pista disjuncta*	5.22	1.50	0.00	2.30	75.0	41.7	0.0	48.5	5	22.5	523	27
35	*Caecum crebricinctum*	3.61	1.38	12.60	0.64	6.3	12.5	61.5	3.0	11	26	5	93
50	*Hesionura coineaui difficilis*	0.00	0.17	13.31	0.12	0.0	4.2	30.8	3.0	526	145	4	238.5
51	*Lumbrineris latreilli*	0.00	0.00	14.20	0.03	0.0	0.0	69.2	3.0	526	536	3	425
88	*Theora lubrica*	21.31	6.71	0.00	0.15	25.0	8.3	0.0	9.1	1	3	523	210.5

E. The Mid-Depth U.S. Shelf

For mid-depth (32-125 m) U.S. waters also, potentially affected areas on the mainland shelf were compared with other areas and the island shelf. Potentially affected areas included large (>100 mgd discharge) and small (<100 mgd discharge) POTWs.

Similar to the shallow-shelf results, mid-depth shelf abundances were highest around islands (666/sample). Abundances around large (488/sample) and small (382/sample) POTWs were also higher than other mid-depth mainland shelf areas (299) (Figure 6-10). Differences in biomass, which ranged from 7.3-11.5 g/sample, were small. The patterns for numbers of taxa and diversity (Figure 6-11) closely followed the pattern for abundance; numbers of taxa ranged from 68 per sample for other mainland shelf areas to 112 for islands. As on the shallow shelf, diversity values hardly differed among the areas.

Although general patterns of abundance dominance were similar, the islands differed somewhat from the mainland shelf (Figure 6-3e). Annelid dominance was greater (72% versus 49-61%) and the ophiuroid contribution was lower (3.7% versus 11-19%) for islands. Unlike other habitats, in all areas of the mid-depth shelf, the biomass contribution of ophiuroids (20-44%) was almost as great as or exceeded that of annelids (25-42%) (Figure 6-4e); it was least for islands where, as in shallow island habitats, the contribution of other echinoderms was high. Dominance patterns in numbers of taxa were similar for all of the mid-depth areas (Figure 6-5e).

The differences in dominant taxa between the mid-depth island and mainland shelves were greater than differences between potentially discharge-affected and other mainland shelf areas (Table 6-5). The most abundant species, *Spiophanes duplex*, was ranked first or second in all habitats. *Amphiodia urtica*, *Amphiodia* sp. and *Pectinaria californiensis* ranked high in all areas of the mainland shelf and low on the island shelf. In contrast, Ampharetidae sp. SD1, *Prionospio (prionospio) jubata*, *Chloeia pinnata*, and *Paradoneis* sp. ranked high in the islands and lower on the mainland shelf. There were no notable differences in abundance ranks between areas potentially affected by discharges and other areas.

Table 6-5. Taxa ranked most abundant in subdivisions of the mid-depth (30-120 m) coastal shelf of the U.S. portion of the Southern California Bight. Overall ranks, area-weighted mean abundances, occurrences, and individual ranks are presented for 40, 30, 15, and 34 random sites on the island shelf (Isl.), areas influenced by wastewater discharges > 100 mgd (POTWL), wastewater discharges < 100 mgd (POTWS), and other areas (Oth.), respectively. Taxa ranked in the top five for any area were included. Information about the subpopulations is provided in Table 2-1, Table 2-3, and Figure 2-1.

Over all Rank	Taxon	Area-weighted Mean Abundance (number/0.1 m^2)				Occurrence (percent of sites)				Abundance Rank			
		POT WL	POT WS	Isl.	Oth.	POT WL	POT WS	Isl.	Oth.	POT WL	POT WS	Isl.	Oth.
1	*Spiophanes duplex*	49.50	38.70	102.89	29.68	97	100	100	94	1	2	1	2
2	*Amphiodia urtica*	26.13	44.90	2.29	30.03	80	93	48	85	2	1	54	1
3	*Prionospio (Prionospio) jubata*	10.77	0.77	17.66	2.71	90	33	68	52	9	94.5	3	15
4	Ampharetidae sp. SD1	0.03	0.00	18.33	0.18	3	0	43	6	492	698	2	220
5	*Phisidea sanctaemariae*	14.83	1.74	7.74	8.38	67	27	38	29	5	45	15	5
6	Phoronida	8.90	8.13	5.02	11.35	77	93	73	94	12	9	29	4
7	*Chloeia pinnata*	3.00	0.00	14.09	0.59	40	0	53	18	31	698	4	98
8	*Amphiodia* sp.	16.60	16.26	0.48	13.44	77	87	35	82	3	3	214	3
11	*Paradoneis* sp.	0.00	0.00	11.84	0.12	0	0	35	3	807	698	5	264
24	*Pectinaria californiensis*	15.70	13.05	0.37	7.29	90	93	25	59	4	4	243	6
66	*Melinna oculata*	1.67	10.76	0.51	2.59	40	73	18	27	61	5	200	18

F. The U.S. Island Shelf

The northwest and southeast Channel Islands and Santa Catalina Island were defined as separate strata for Bight`98 (Figure 2-1, Table 2-1). The objective was to test whether macrobenthos of the northwest areas under the influence of the cold California Current differed from the southeast Channels Islands and Santa Catalina Island that are under the influence of the warmer Davidson Countercurrent.

Abundances (Figure 6-12) and numbers of taxa (Figure 6-13) for the northwestern (698 and 115/sample, respectively) and southeastern Channel Islands (595 and 105/sample) were approximately twice as large as values for Santa Catalina Island (323 and 48/sample, respectively). Differences in biomass were small, although the southeastern Channel Islands had somewhat greater biomass (9.3 g/sample) than the northeastern Channel Islands (6.5 g/sample) or Santa Catalina Island (6.5 g/sample).

The patterns of dominance for abundance and numbers of taxa for higher taxa were indistinguishable among the three island areas (Figures 6-3f and 6-5f). Annelids dominated abundance (64-72%) and numbers of taxa (55-57%), as in many other habitats. Arthropods were second (8-13% and 7-24%). Echinoderms only contributed 5% or less of the taxa. Northwestern Channel Island and Santa Catalina Island biomass was dominated by annelids (36-38%) with miscellaneous phyla (7-13%) and ophiuroids (16-23%) making the next largest contributions (Figure 6-4f). Biomass dominance was reversed in the southeastern Channel Islands; ophiuroids (30%) dominated, followed by annelids (26%), other echinoderms (16%), and molluscs (14%). Arthropods contributed the least biomass (4-6%).

The abundance dominants on the Santa Catalina Island shelf were strikingly different from those on the northwestern and southeastern Channel Islands; there were only small differences between the northwestern and southeastern Channel Islands (Table 6-6). *Spiochaetopterus costarum*, *Apionosoma misakianum*, and *Parvilucina tenuisculpta* were dominant around Santa Catalina Island and less so on the others, while the reverse pattern was observed for Ampharetidae sp. SD1, *Prionospio (Prionospio) jubata*, and *Chloeia pinnata.*

Table 6-6. Taxa ranked most abundant in subdivisions of the island shelf in the U.S. portion of the Southern California Bight. Overall ranks, area-weighted mean abundances, occurrences, and individual ranks are presented for 16, 20, and 17 random sites on the northwest (NW), southeast (SE), and Santa Catalina Island (Cat.) shelves, respectively. Taxa ranked in the top five for any area were included. Information about the subpopulations is provided in Table 2-1, Table 2-3, and Figure 2-1.

Overall Rank	Taxon	Area-weighted Mean Abundance (number/0.1 m^2)			Occurrence (percent of sites)			Abundance Rank		
		NW	SE	Cat.	NW	SE	Cat.	NW	SE	Cat.
1	*Spiophanes duplex*	102.41	98.53	55.06	87.5	85.0	94.1	1	1	2
2	Ampharetidae sp SD1	21.21	11.45	0.18	50.0	45.0	5.9	2	8	170
3	*Prionospio (Prionospio) jubata*	17.01	21.30	0.24	87.5	75.0	17.6	3	2	142
4	*Chloeia pinnata*	13.21	17.10	0.82	62.5	45.0	17.6	5	4	49.5
5	*Paradoneis* sp.	15.13	0.15	23.12	43.8	10.0	35.3	4	363.5	3
6	Oligochaeta	8.95	18.98	1.18	43.8	35.0	5.9	14	3	39.5
8	*Aphelochaeta* sp. LA1	9.06	14.20	0.06	43.8	45.0	5.9	13	5	314
12	*Spiochaetopterus costarum*	6.60	1.58	57.24	68.8	70.0	76.5	24	67	1
24	*Parvilucina tenuisculpta*	5.14	5.31	10.00	62.5	65.0	70.6	31	15	5
37	*Apionsoma misakianum*	3.53	0.38	19.24	37.5	25.0	17.6	42	210	4

G. Embayments

Area-weighted mean abundances, biomass, and numbers of taxa did not differ substantially among marinas, ports, and other embayment areas (Figures 6-14 and 6-15). Mean abundance was highest in marinas (812/sample), followed by ports (585/sample), and other embayment areas (412/sample). Differences in mean biomass were small at 15.5 g/sample in marinas, 15.0 g/sample in ports, and 12.5 g/sample in other embayment areas. Mean numbers of taxa were very similar at 42, 40, and 42 taxa per sample for marinas, ports, and other areas, respectively (Figure 6-15).

Abundance, biomass, and numbers of taxa dominance patterns were similar in all three subdivisions of the embayment habitat (Figures 6-3g, 6-4g, and 6-5g). Abundance was dominated by annelids (61-63%) while arthropods were next in importance in marinas (17%), and molluscs in ports and other embayments (25% and 19%, respectively) (Figure 6-3g). Echinoderms contributed 2% or less to abundance in embayments. Molluscs were universally dominant in biomass (55-56%), followed by annelids (30-33%) and arthropods (6-7%) (Figure 6-4g). Ophiuroid biomass was insignificant (1% or less) in all but "other" embayments (3%). Annelids (50-53%) dominated the number of taxa followed by arthropods (14-20%) and molluscs (18-2%) (Figure 6-5g). All other phyla in each subdivision together contributed fewer than 12% of the taxa.

The dominant taxa in embayment areas with different types of vessel traffic were similar, but there were some differences. *Pseudopolydora paucibranchiata*, *Euchone limnicola*, *Musculista senhousia,* and *Mediomastus* sp. ranked in the top 10 in all three areas. In contrast, *Caecum californicum* ranked 5th in marinas and was absent from ports and other areas; *Synaptotanais notabilis* ranked higher in marinas and ports than other areas. None of the taxa with high abundance ranks in other areas had very low abundance ranks in marinas and ports.

Table 6-7. Taxa ranked most abundant in areas with different types of vessel activity in embayments in the U.S. portion of the Southern California Bight. Overall ranks, area-weighted mean abundances, occurrences, and individual ranks are presented for 39, 37, and 38 random sites in marinas (Mar.), ports, and other bay bottoms, respectively. Taxa with abundance ranks in the top five for any area were included. Information about the subpopulations is provided in Table 2-1, Table 2-3, and Figure 2-1.

Over all Rank	Taxon	Area-weighted Mean Abundance (number/0.1 m^2)			Occurrence (percent of sites)			Abundance Rank		
		Mar.	Ports	Other	Mar.	Ports	Other	Mar.	Ports	Other
1	*Pseudopolydora paucibranchiata*	129.02	76.78	23.74	79.5	48.6	54.1	1	1	6
2	*Euchone limnicola*	86.85	54.95	37.90	76.9	67.6	48.6	2	4	2
3	*Mediomastus* sp.	25.59	57.06	67.06	84.6	86.5	78.4	8	3	1
4	*Musculista senhousia*	31.13	73.20	22.66	61.5	51.4	45.9	6	2	7
5	*Theora lubrica*	21.76	39.19	31.23	76.9	91.9	89.2	11	5	3
6	*Synaptotanais notabilis*	53.10	5.28	0.08	38.5	18.9	2.7	3	20	210
7	*Leitoscoloplos pugettensis*	35.10	18.03	10.16	97.4	78.4	78.4	4	8	13
8	*Amphideutopus oculatus*	15.95	15.63	30.64	41.0	56.8	75.7	12	9	4
9	Lumbrineridae	15.04	19.77	24.62	59.0	56.8	62.2	14	6	5
12	*Caecum californicum*	35.05	0.00	0.00	10.3	0.0	0.0	5	486	496

H. Discussion

Of the three habitats, macrofaunal abundances were highest in islands and embayments; but the islands were most diverse with the largest numbers of taxa. Therefore, islands were richest in abundance and diversity, embayments were rich in abundance, and mainland shelf regions were relatively poor in both. The relationships between abundance and diversity were similar on the mainland and island shelves and different in embayments (Figure 6-16). There were less taxa in embayments for any given level of abundance. The northern and Mexican regions at the extremities of the coastal shelf regions were least abundant and least diverse. The shallow mainland shelf and the island shelf around Santa Catalina Island were poorer in abundance and diversity than the Bight as a whole.

The high abundance and reduced diversity in embayments is suggestive of intermediate levels of organic and nutrient enrichment (e.g., Pearson and Rosenberg 1978, Diaz and Rosenberg 1995). We saw little or no evidence of extreme levels of enrichment where both abundance and diversity were reduced. Within embayments, marinas were highest in abundance but lowest in taxa and diversity; ports were intermediate. The pattern of total organic carbon (TOC) values for the strata conforms to this hypothesis; area-weighted mean values were 1.39%, 1.36%, and 1.08% for marinas, ports, and other bay bottoms, respectively (Noblet *et al.* 2002). This order reflects the extent of impacts of human activities (Chapter 4). The amount of organic material in embayments was also considerably higher than on the mainland shelf; area-weighted mean values were 1.30%, 0.42%, and 0.89% for embayments and the shallow and mid-depth coastal shelf (Noblet *et al.* 2002).

Some of the patterns in abundance and diversity in embayments are attributable to non-indigenous species (NIS) (Appendix B). The NIS are pervasive, occurring at 121 of 123 sites in embayments, and are disproportionately abundant, contributing 4% of the species but 28% of the abundance. The abundance of NIS is positively correlated with the abundance and number of non-NIS taxa, indicating that there is no broad suppression of indigenous taxa as often reported in other areas (Appendix B).

The community characteristics and dominant taxa of areas around wastewater discharges were similar to their equivalent mainland shelf counterparts. Depth, region, and habitat apparently are more important to abundance and diversity of macrofauna than proximity to an outfall. In contrast, areas defined as river mouths were lowest in abundance, diversity, and biomass of the shallow mainland shelf areas. It is likely that these depauperate macrobenthic communities are a direct consequence of river discharge. Our study was not designed to distinguish between the factors associated with river flow, such as pollutant loadings, physical disturbance from scouring, and salinity effects that, acting alone or in combination, could account for them.

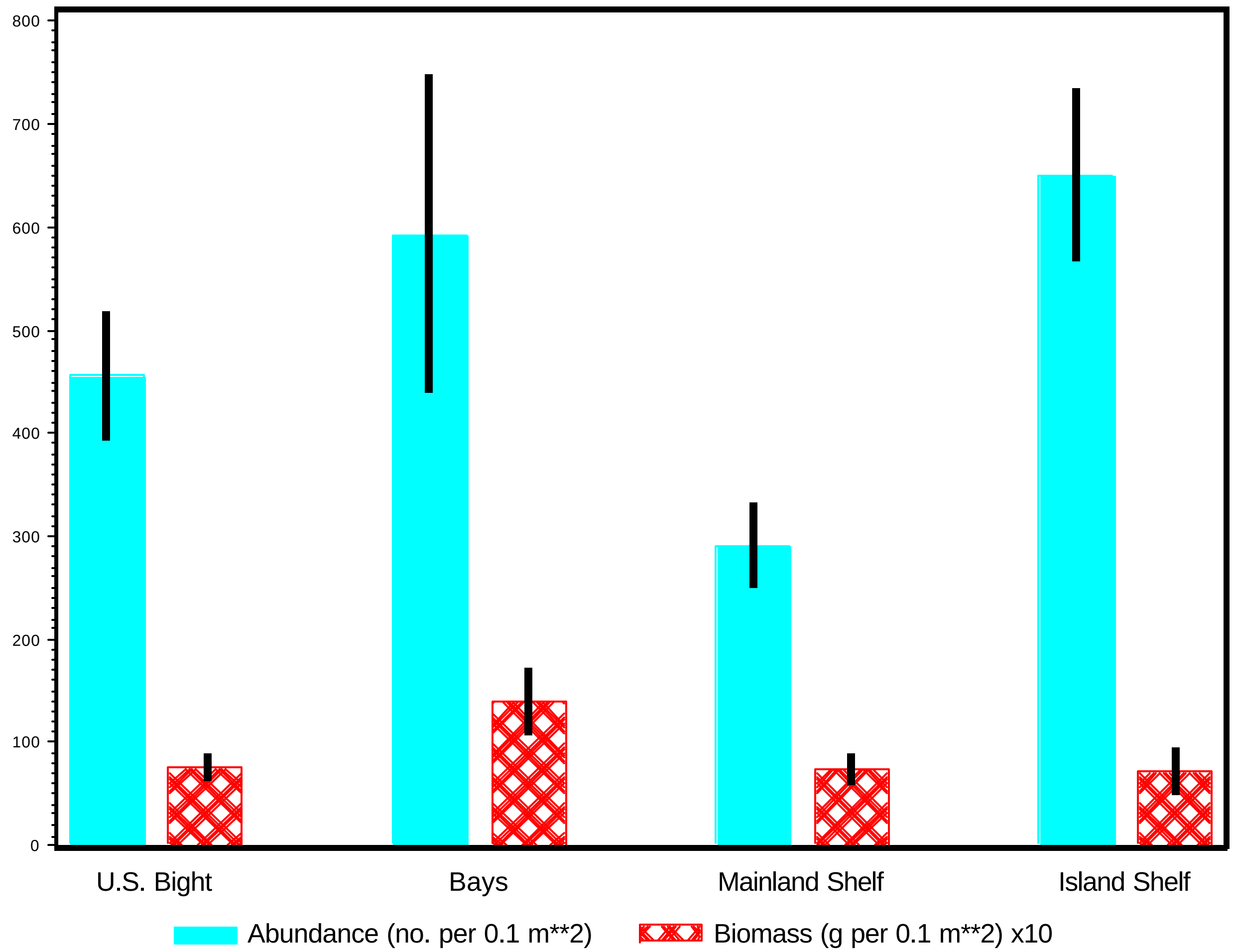


Figure 6-1. Area-weighted mean abundance (number / 0.1 m^2) and wet-weight biomass (g / 0.1 m^2 x10) for the U.S. Southern California Bight and its habitats. Error bars indicate 95% confidence limits.

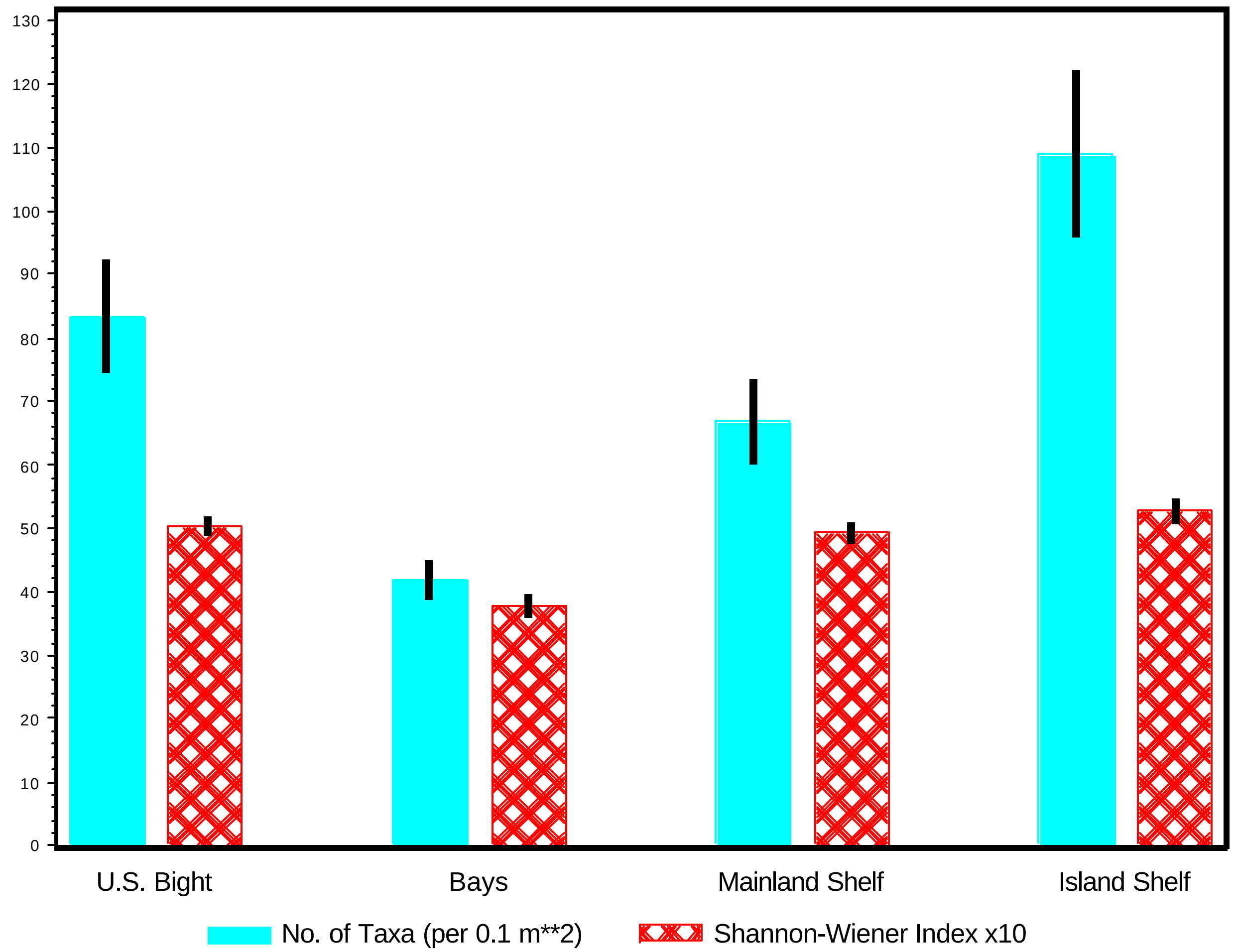


Figure 6-2. Area-weighted mean numbers of taxa (number / 0.1 m^2 sample) and Shannon-Wiener Index (x10) for the U.S. Southern California Bight and its habitats. Error bars indicate 95% confidence limits.

FIGURE 6-3. Area-weighted mean abundance by major phyla groupings

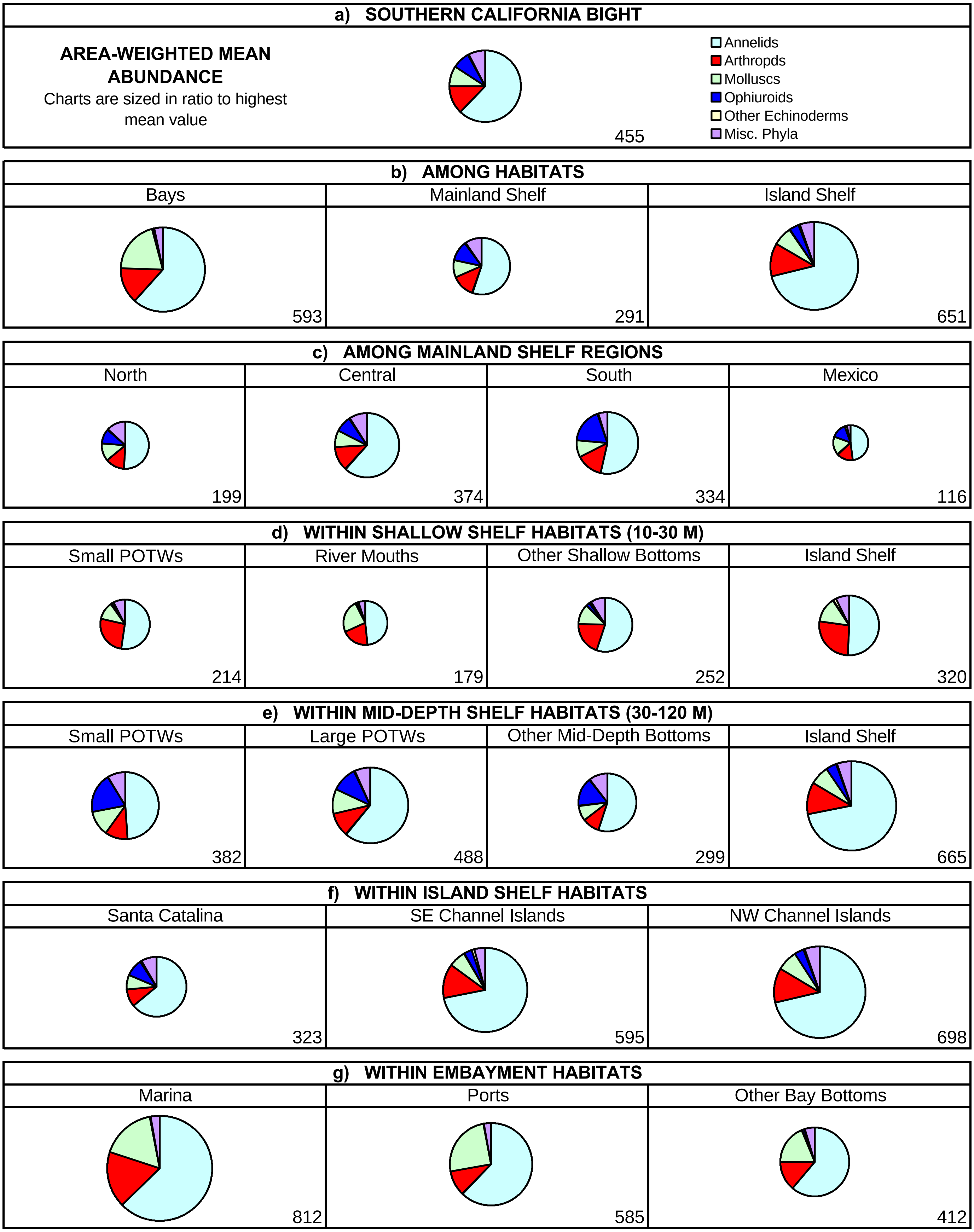
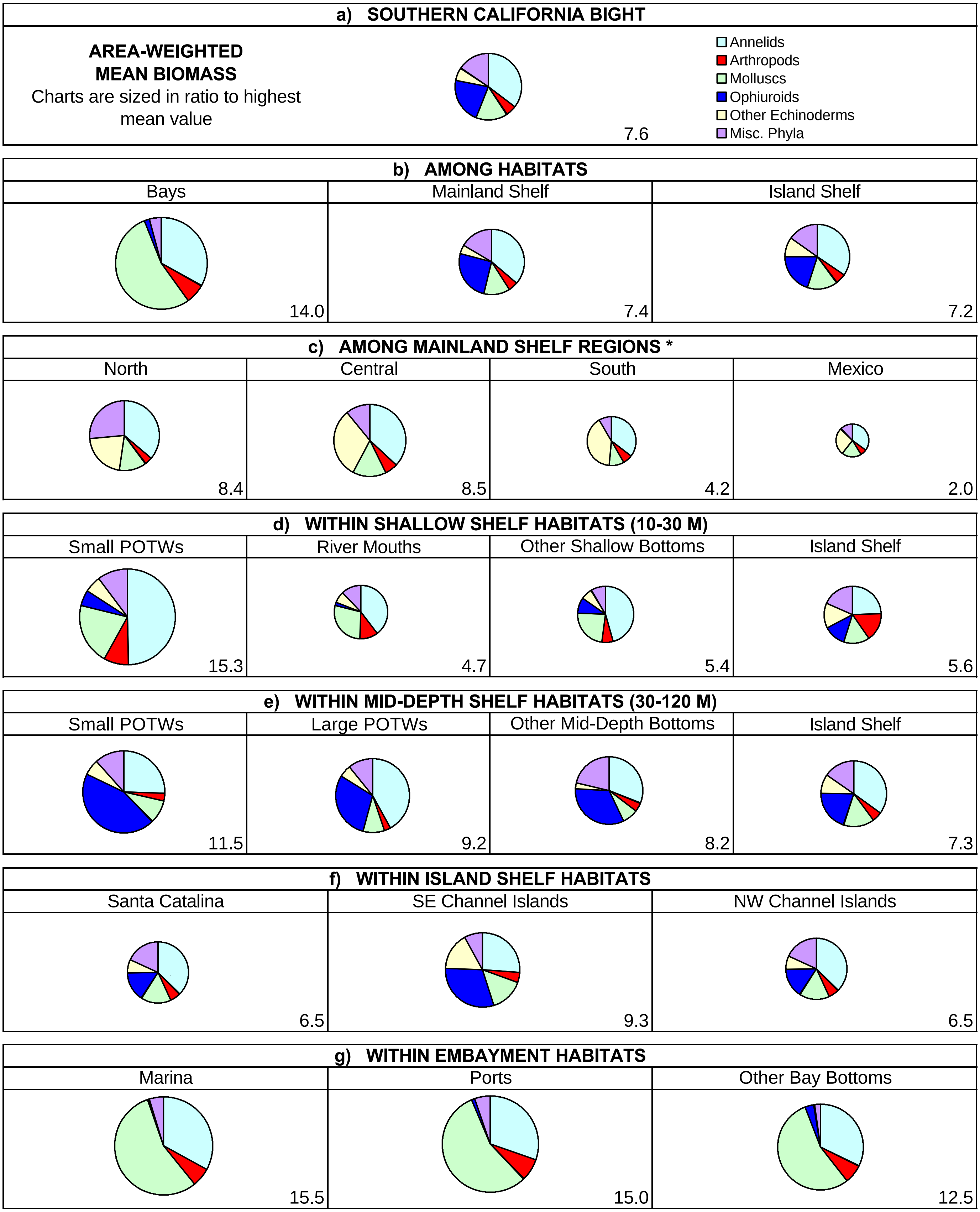
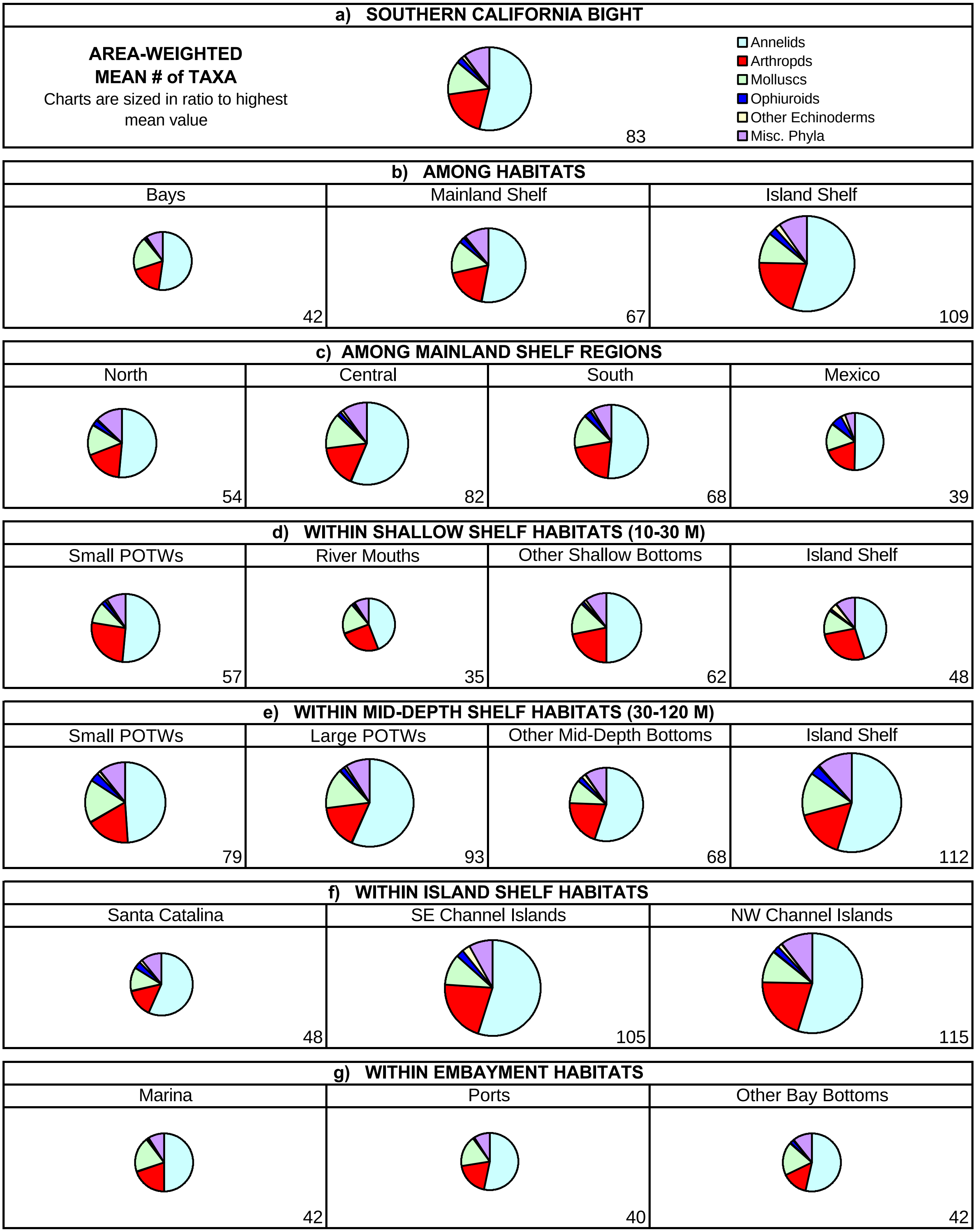


FIGURE 6-4. Area-weighted mean biomass (grams, wet weight) by major phyla groupings



* Ophiuroid and other echinoderm biomass combined as Other Echinoderms in Figure 6-5c

FIGURE 6-5. Area-weighted mean number of taxa by major phyla groupings



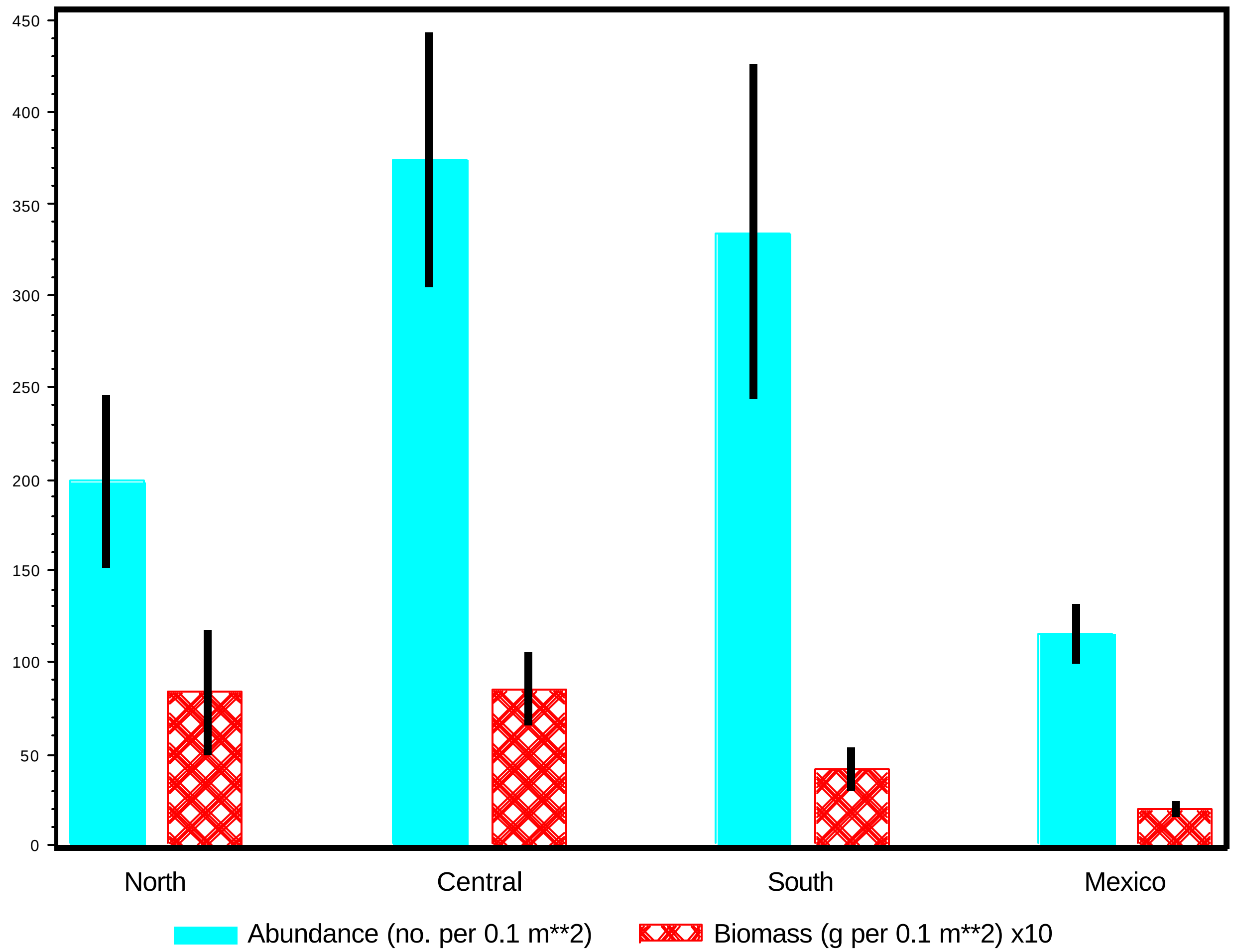


Figure 6-6. Area-weighted mean abundance (number / 0.1 m^2) and wet-weight biomass (g / 0.1 m^2 x10) for geographic regions of the mainland shelf. Error bars indicate 95% confidence limits.

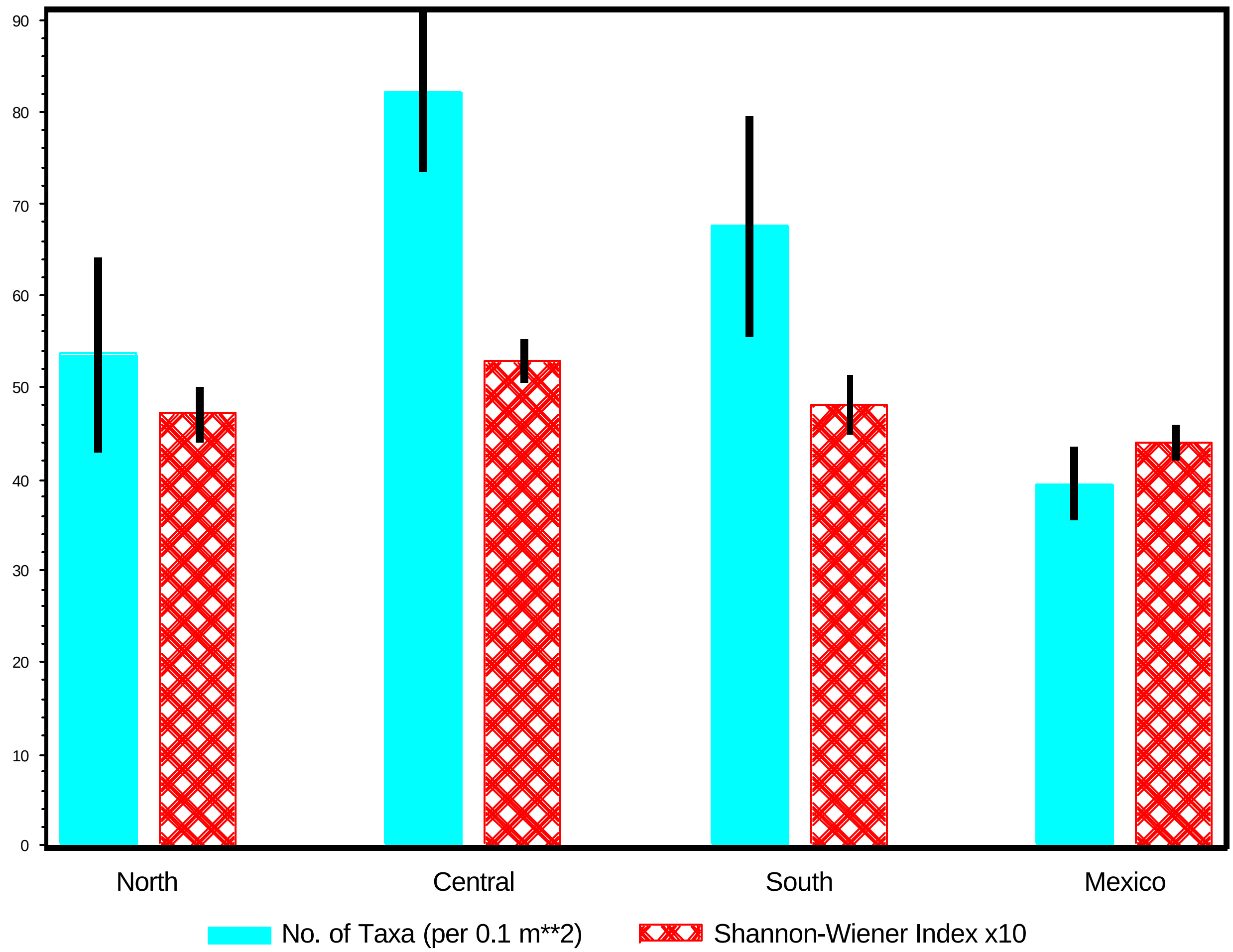


Figure 6-7. Area-weighted mean numbers of taxa (number / 0.1 m^2 sample) and Shannon-Wiener Index (x10) for geographic regions of the mainland shelf. Error bars indicate 95% confidence limits.

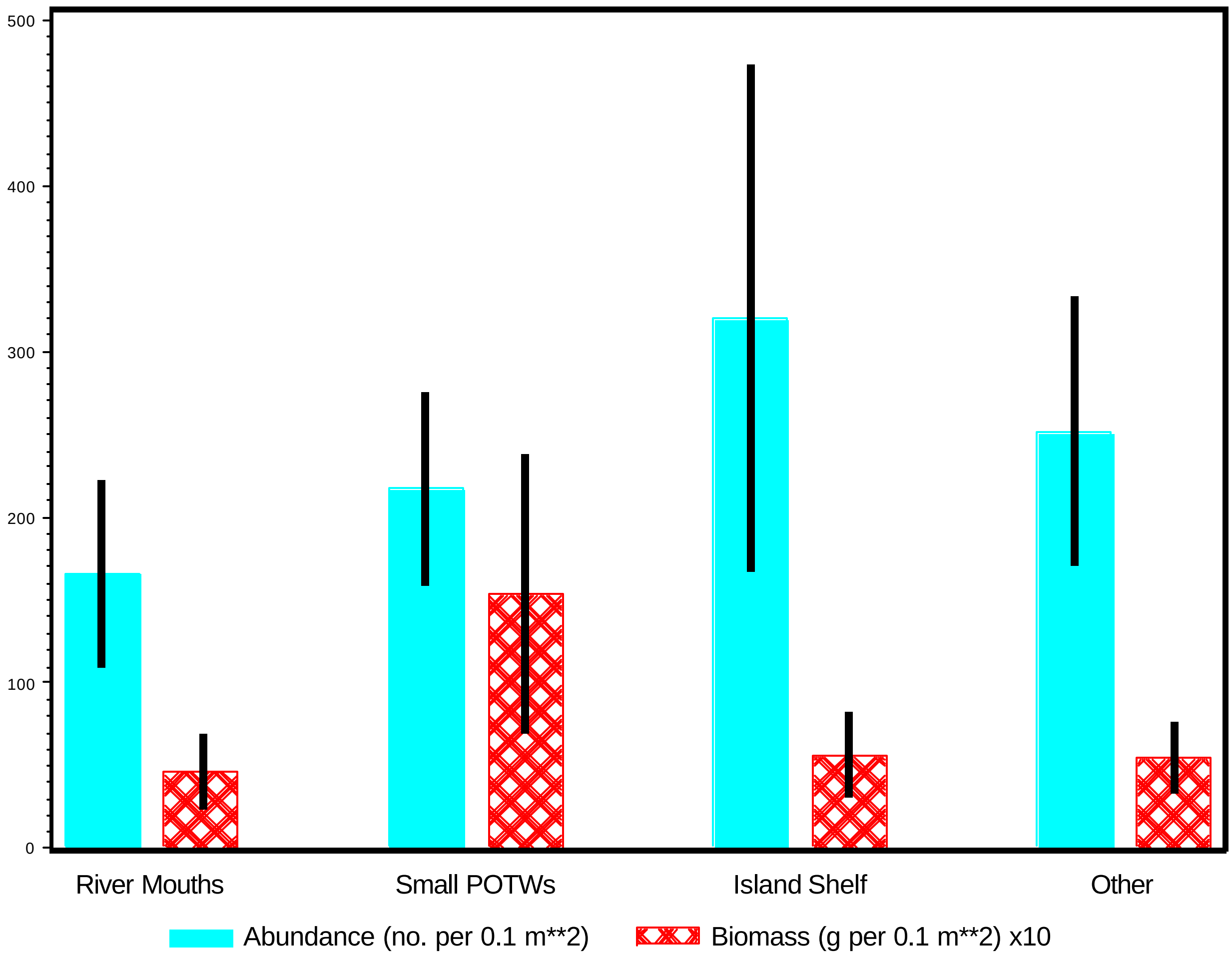


Figure 6-8. Area-weighted mean abundance (no. / 0.1 m^2) and wet-weight biomass (g / 0.1 m^2 x10) for the shallow (5-32 m) U.S. mainland and island shelf. Error bars indicate 95% confidence limits.

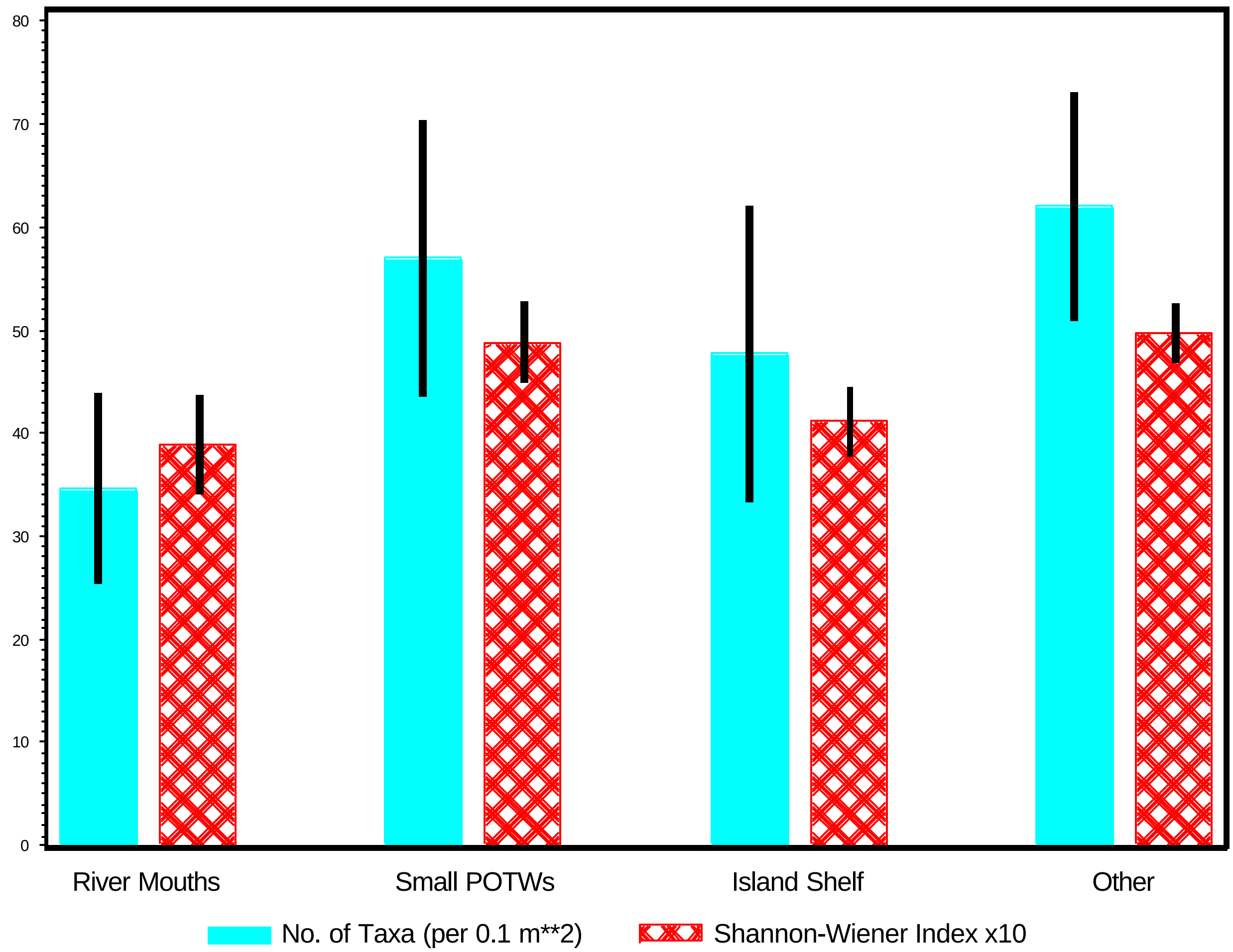


Figure 6-9. Area-weighted mean /0.1 m^2 of taxa (number / 0.1 m^2 sample) and Shannon-Wiener Index (x10) for the shallow (5-32 m) U.S. mainland and island shelf. Error bars indicate 95% confidence limits.

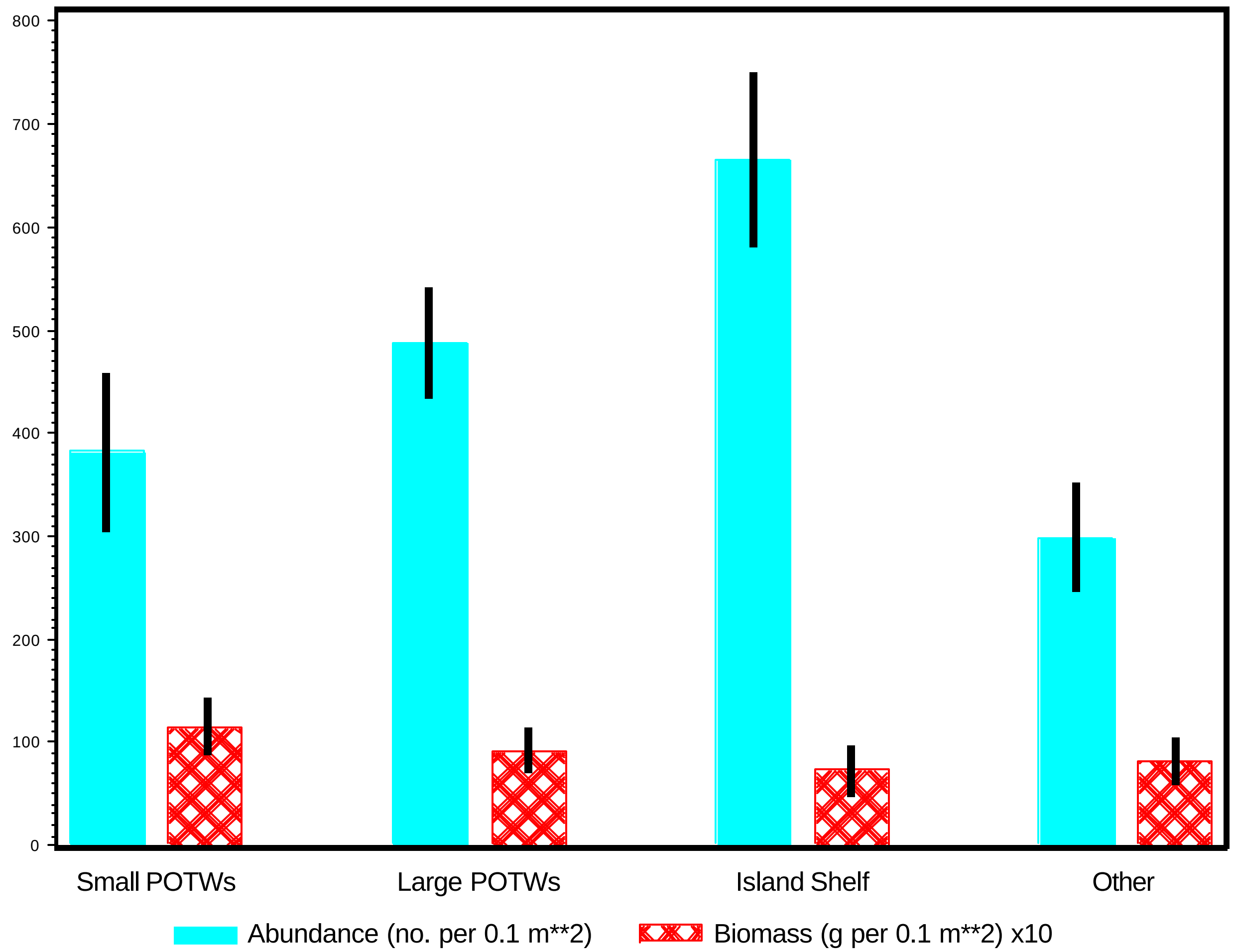


Figure 6-10. Area-weighted mean abundance (number / 0.1 m^2) and wet-weight biomass (g / 0.1 m^2 x10) for the mid-depth (32-125 m) U.S. mainland and island shelf. Error bars indicate 95% confidence limits.

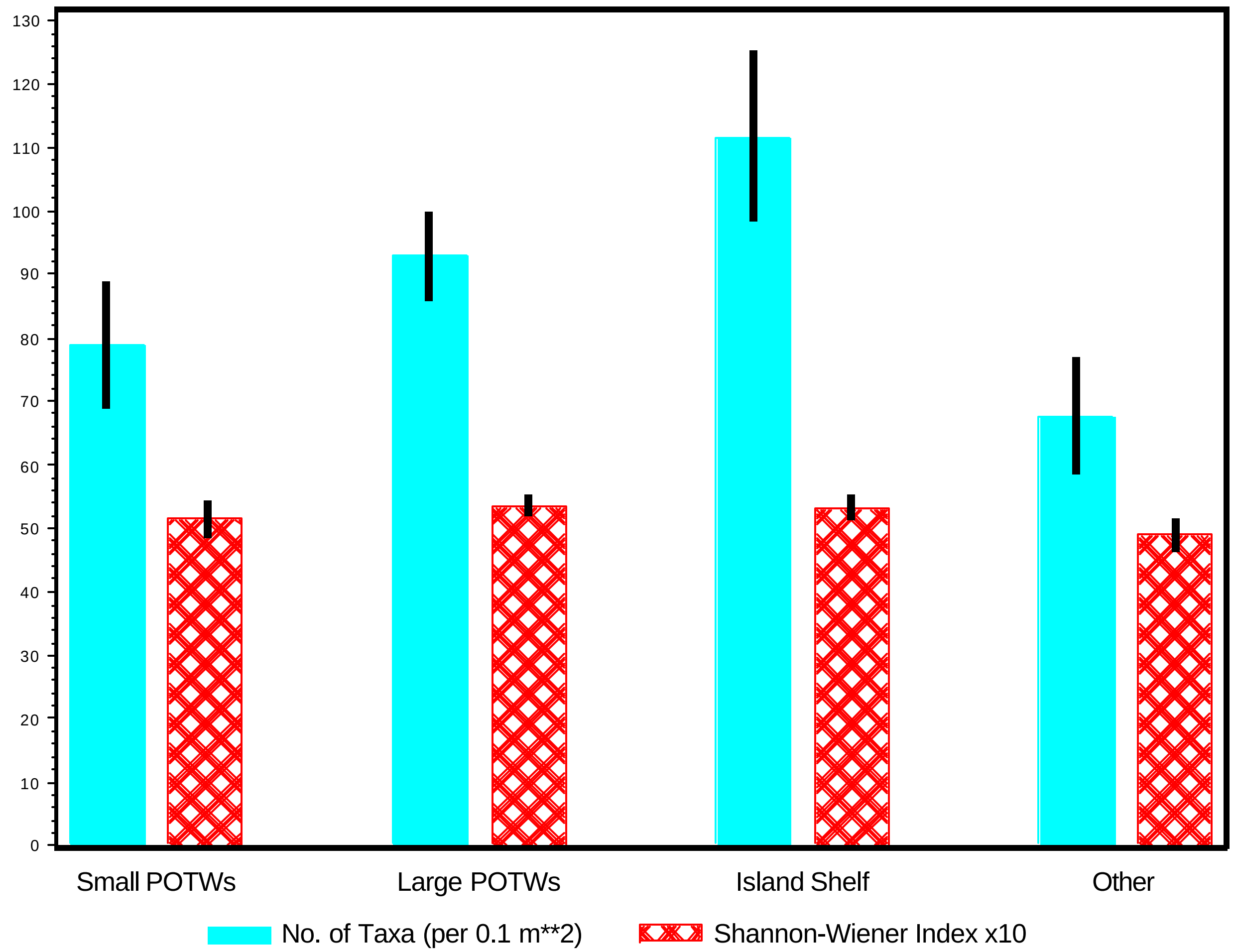


Figure 6-11. Area-weighted mean numbers of taxa (number / 0.1 m^2 sample) and Shannon-Wiener Index (x10) for the mid-depth (32-125 m) U.S. mainland and island shelf. Error bars indicate 95% confidence limits.

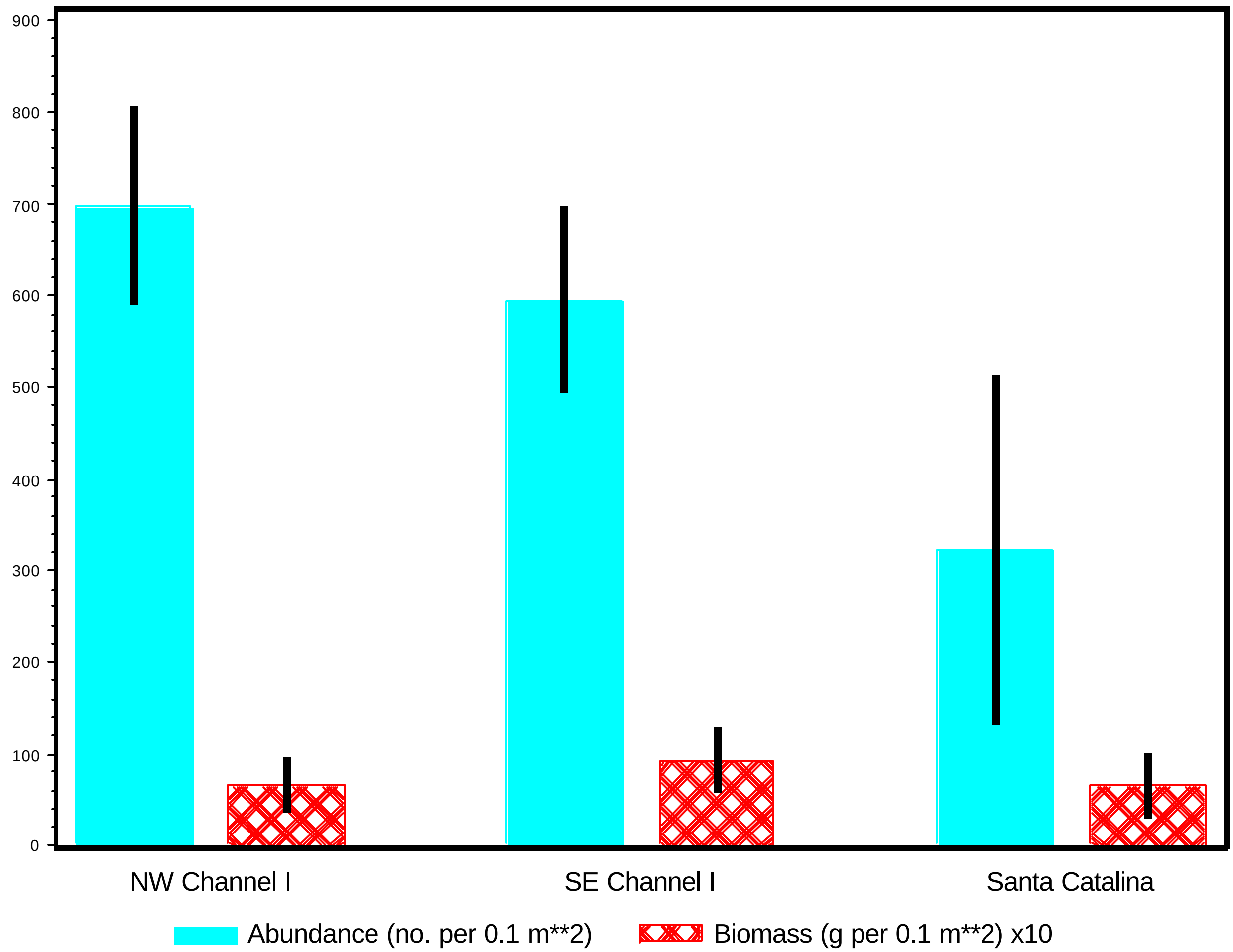


Figure 6-12. Area-weighted mean abundance (number / 0.1 m^2) and wet-weight biomass (g / 0.1 m^2 x10) for the U.S. island shelf. Error bars indicate 95% confidence limits.

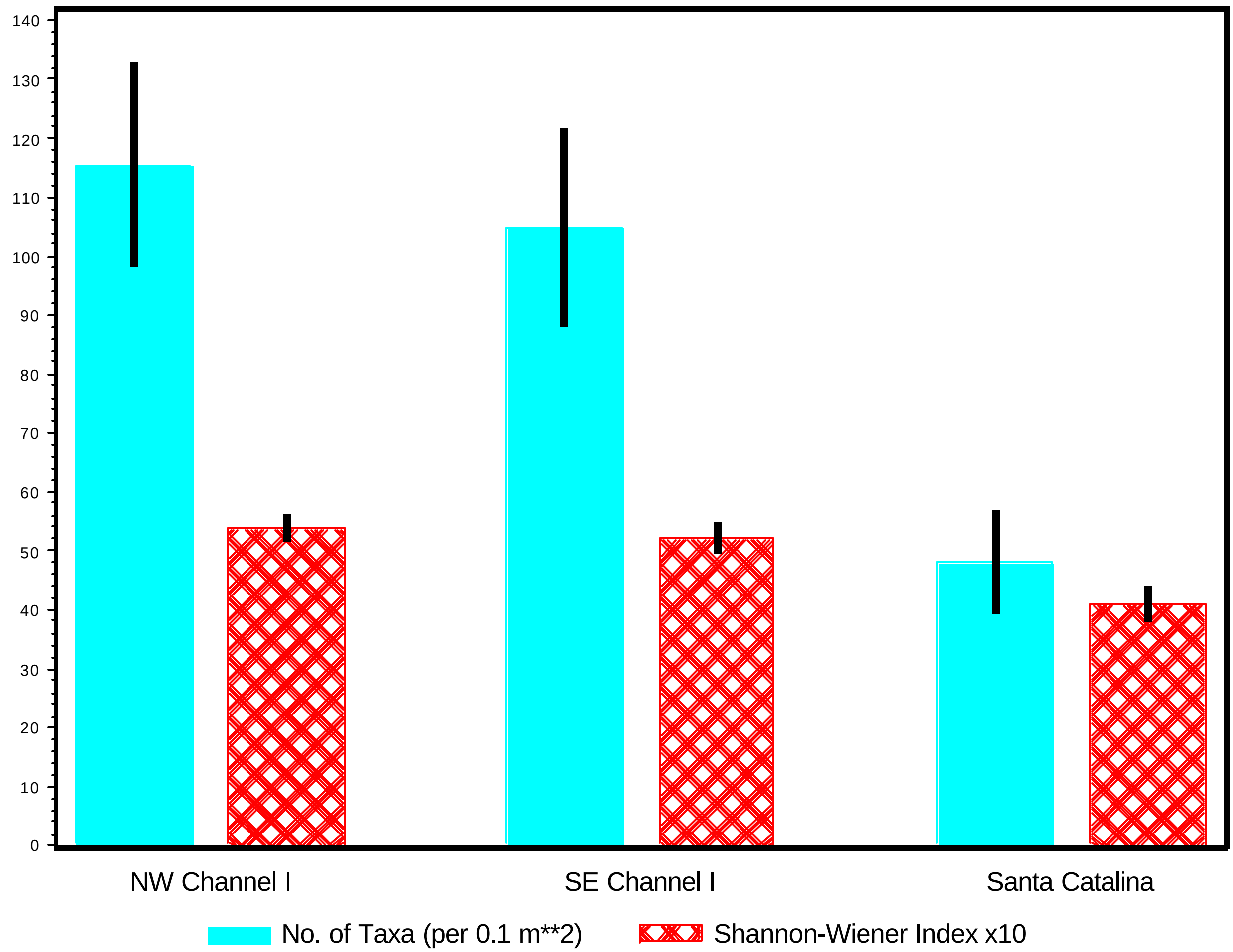


Figure 6-13. Area-weighted mean numbers of taxa (number / 0.1 m^2 sample) and Shannon-Wiener Index (x10) for the U.S. island shelf. Error bars indicate 95% confidence limits.

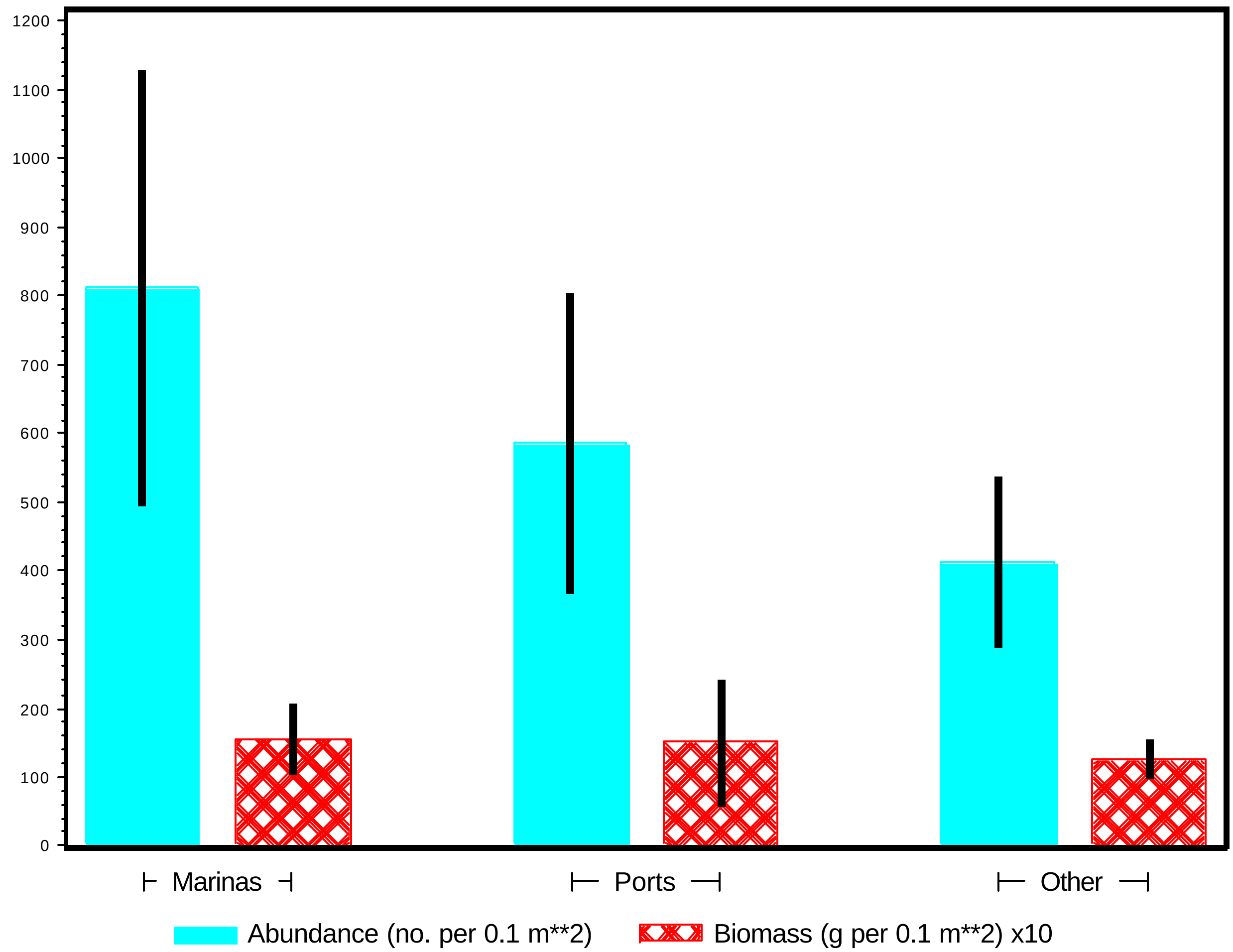


Figure 6-14. Area-weighted mean abundance (number / 0.1 m^2) and wet-weight biomass (g / 0.1 m^2 x10) for U.S. embayments. Error bars indicate 95% confidence limits.

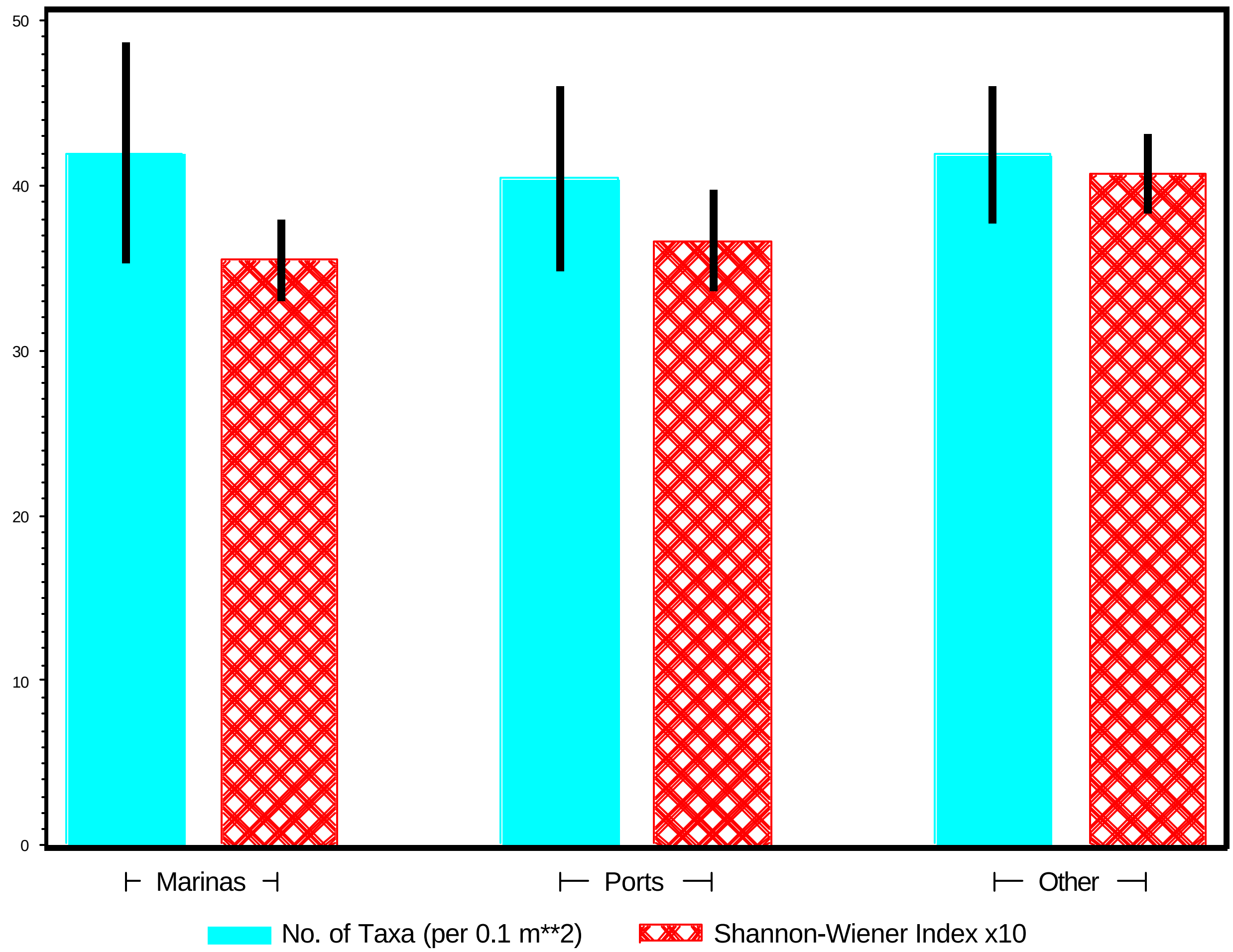


Figure 6-15. Area-weighted mean numbers of taxa (number / 0.1 m^2 sample) and Shannon-Wiener Index (x10) for U.S. embayments. Error bars indicate 95% confidence limits.

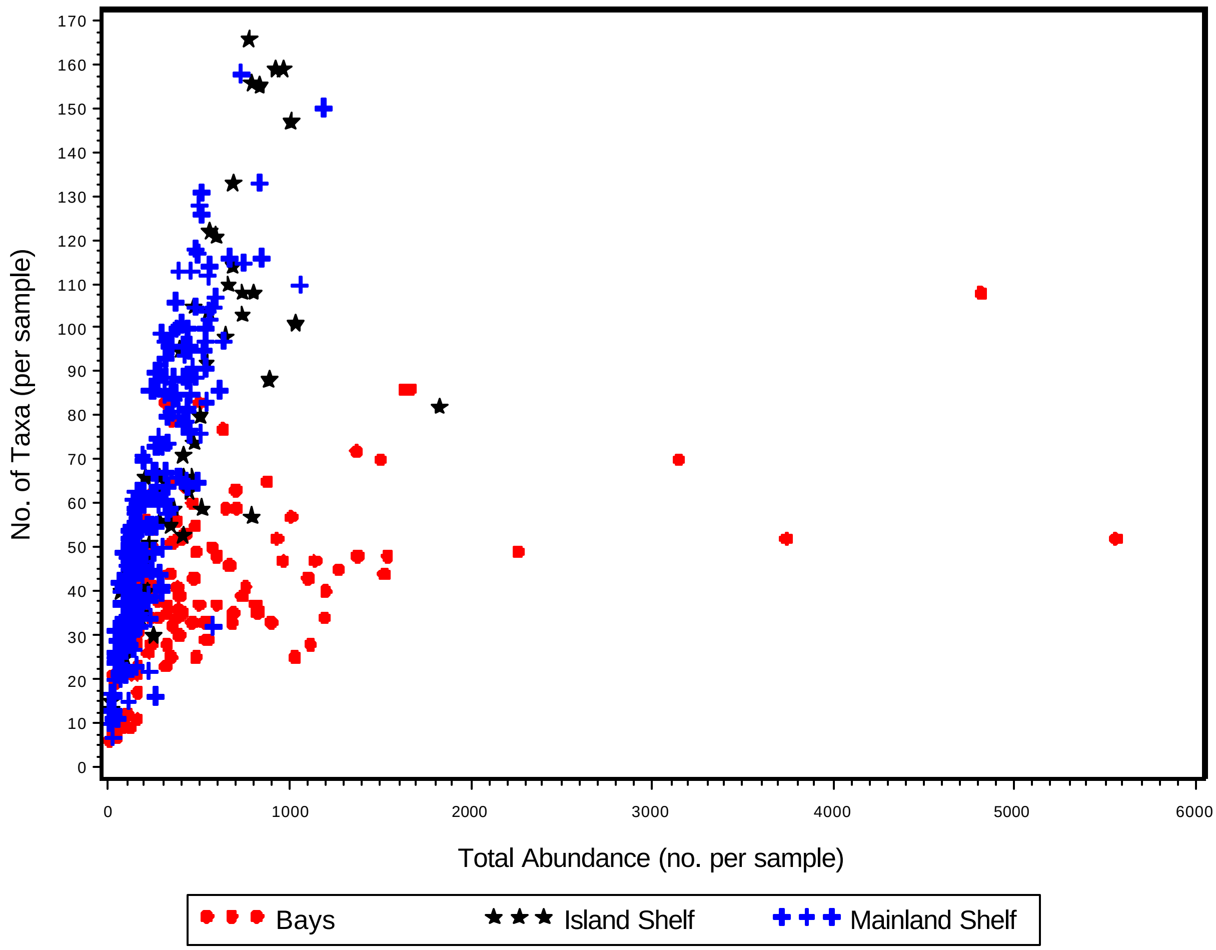


Figure 6-16: Relationship between numbers of taxa and total abundance for habitats sampled by Bight`98.

7. Conclusions

1. **Benthic macrofauna in nearly all of the Southern California Bight are healthy.**
    - Macrofauna in 98.05% of the Southern California Bight (SCB) were in reference condition or deviated only marginally from reference.
    - Of the three SCB habitats assessed (island shelf, mainland shelf, and embayments), there was no evidence of disturbance on the island shelf and almost none on the mainland shelf.
    - Macrofaunal communities in embayments, on the other hand, were frequently disturbed. The proportion of disturbed area (17.09%) and the severity of disturbance were higher than in other habitats. Embayments occupy only 4.3% of the SCB but contributed 37.4% of the area with disturbed communities. High benthic abundances and low diversity in embayments may indicate intermediate levels of organic enrichment.
    - Areas of wastewater discharge and at the mouths of rivers were not substantially different from other areas with respect to the condition of the benthic macrofaunal community.

2. **Non-indigenous species are ubiquitous in southern California embayments and disproportionately dominate abundance**.
    - Non-indigenous species (NIS) were collected at 121 of 123 sites in southern California embayments. They accounted for only 4.3% of the species but contributed 27.5% of abundance.
    - Despite their prevalence, NIS did not reduce overall abundance or species richness of the native communities.

3. **Biointegrity indices continue to improve the interpretability and utility of information from benthic studies**.
    - Biointegrity indices translate complex biological data into simple measures of health of biological resources. The benthic response index (BRI) is a biointegrity index that was developed to measure the health of benthic macrofaunal communities during the 1994 Southern California Bight Pilot Project (SCBPP). It defines reference condition and four levels of response to disturbance for the SCB mainland shelf. For Bight`98, the BRI was extended to provide comparable information for SCB embayments, assessing macrofauna on a similar scale that is interpretable by resource managers. Previously, benthic assessment results were presented as lists of species abundances and community measures that are difficult to evaluate in terms of community disturbance.
    - Extension of the BRI to embayments fills a gap in the ability to assess the effects of human activities on benthic macrofauna of the SCB. The ability to assess macrofauna in embayments is important because contaminated sediments are common, pollution loadings are high, and macrofauna are in the poorest condition in this habitat.

- The BRI extension for embayments achieved an adequate level of validation. Macrofauna in reference condition were identified at all but three of the sites with sediment contaminant concentrations below thresholds of concern. Macrofauna with varying levels of response to disturbance were identified at all sites with sediments that were highly toxic to amphipods.
- The BRI was stable with respect to climatic variation. The 1994 SCBPP, which sampled during a La Nina period, contributed a large proportion of the data used to develop the BRI. However, Bight`98 sampled soon after a major El Nino event, raising a concern that the BRI might be overly sensitive to this climatic variation. The estimates of disturbed coastal area were comparable between Bight`98 and the SCBPP. Our concern was not justified.
- BRI values were uncorrelated with NIS abundances.

4. **There are five habitat-related benthic macrofaunal reference assemblages in the Southern California Bight.**
    - Habitat-related benthic macrofaunal assemblages were identified to ensure appropriate definitions of reference condition. The numbers and kinds of benthic organisms vary in response to habitat differences, and comparisons with reference condition should vary accordingly. Assemblage analyses identify habitat factors that differentiate distinct combinations (assemblages) of benthic macrofaunal species.
    - Bight`98 identified two new reference assemblages in northern and southern embayments of the Southern California Bight and confirmed the presence of the shallow and mid-depth coastal assemblages that were identified by the SCBPP. A fifth reference assemblage identified in deep waters by the SCBPP could not be confirmed because bottoms deeper than 120 m were not sampled for Bight`98.
    - Sediment grain size distribution is a more important determinant of shelf assemblage composition than depth, although depth was identified as the primary determinant in previous studies. Previous studies were restricted to the mainland shelf where depth and sediment texture are inextricably confounded because fine sediments occur at depth and coarse sediments occur in shallow waters. Bight`98 included the island shelf, where coarse sediments occur at depth, and identified that the controlling factors are more closely related to sediment texture than depth. The real determinant is probably the current, tide, and wind-driven hydrodynamic energy spectrum at the sediment surface.
    - Macrofaunal community composition in embayments and on the island shelf differed from the mainland shelf. Benthic macrofauna on the island shelf and embayments were more than twice as abundant as on the mainland shelf. Only two-thirds as many species occurred in embayment samples as in mainland shelf samples; twice as many occurred in island samples. The island shelf was numerically dominated by polychaetes to a greater extent than the mainland shelf; the relative abundance of ophiuroids and miscellaneous phyla was lower than on the mainland shelf. Hardly any echinoderms were collected in embayments; the relative abundance of miscellaneous phyla was lower and of molluscs higher than on the mainland shelf.

5. **Benthic data produced in southern California are of high quality.**
    - Eighty-two percent of the 161,865 organisms collected were identified to species. The mean sorting efficiency was 98.2%. Quality control reanalysis of samples identified errors on 16.8% of the data records, but the errors were primarily small miscounts and single overlooked specimens that were insufficient to affect our conclusions. These results meet or surpass the performance of the few other benthic programs that quantify data quality.
    - Coordination of Bight`98 quality assurance and quality control activities with the Southern California Association of Invertebrate Taxonomists was one of the factors that contributed to data quality.

8. Recommendations

The Bight`98 Regional Monitoring Survey successfully achieved its primary objective: measuring the extent and magnitude of alterations in benthic macrofauna on the mainland shelf and island shelf, and in embayments of the Southern California Bight (SCB). Disturbed and undisturbed communities were differentiated and the magnitude of disturbance measured using a biointegrity index, the Benthic Response Index (BRI). Bight`98 also described SCB macrofaunal communities in detail, measuring community statistics such as diversity and abundance as well as species composition. Data from site-specific programs can be compared with these descriptions to interpret local patterns and trends within a regional context.

We recommend periodic repetition of similar regional monitoring surveys to assess the health of benthic macrofauna in the SCB. While Bight`98 provided useful information on current conditions, benthic communities will change as conditions change. Regional climatic events, such as El Ninos and La Ninas, can affect benthic communities. Inputs from anthropogenic sources may increase or decrease over time. Non-indigenous species that previously were absent may establish populations that dominate communities and modify habitat. Assessing macrofaunal biointegrity Bight-wide provides a perspective for interpreting data from smaller scale monitoring around discharges, comparative information about the extent and severity of impacts from various sources, and information about changes over time. The biointegrity of benthic macrofauna is a direct measure of a living resource that environmental laws and regulations intend to protect. Benthic macrofauna also integrate the effects of multiple types of stress and multiple insults over time. They are one of the most relevant measures of sediment quality.

This chapter presents recommendations for consideration during planning for subsequent regional monitoring programs in an effort to improve on the success of Bight`98. The recommendations are:

1. **Investigate the relationship between non-indigenous and indigenous fauna in embayments.** Bight`98 results indicate that total abundance and the number of other species increase with increasing numbers and abundances of non-indigenous species, at a gross level. It is possible that detailed studies will identify native species that are negatively impacted by increases in non-indigenous fauna, as well as how these species are negatively impacted. The potential deleterious effects of non-indigenous species should not be dismissed without thorough study.

2. **Use and refine the BRI.** Use of a biointegrity index in this survey, the coastal BRI, and its extension to embayments has improved the quality and interpretability of information available to environmental managers and regulators from these benthic assessments. We recommend that managers use BRI information from these and other benthic assessments to support environmental decisions; however, testing, improving, and refining the BRI should be viewed as a continuing process to quantify and reduce levels of uncertainty. The amount of data available for impacted areas in this survey was less than optimal for BRI development for shallow coastal waters and embayments. Data from additional

studies that target impacted areas in shallow coastal areas and embayments should be used to recalibrate the BRI.

3. **Extend regional monitoring to deeper waters.** Little is known about benthic macrofauna of the continental slope and deep basins, although they are sinks for pollutants moving off the mainland shelf. The presence or absence of altered benthic macrofaunal communities in these areas should be examined in order to delimit the spatial extent of impacts of human activities in the SCB. By sampling poorly known habitats, Bight`98 showed that impacts on macrobenthos have not extended as far offshore as the island shelf and that the extent and severity of disturbance in embayments is greater than on the mainland shelf. Prior to sampling in new areas such as slopes and basins, the planning process should evaluate potential sampling protocols and identify those most likely to achieve program objectives.

4. **Eliminate biomass as an indicator.** Measurement of wet weight biomass did not materially add to our understanding of impacts or communities in Bight`98. A similar conclusion was reached by the Southern California Bight Pilot Program (SCBPP) in 1994. We recommend that this measurement be discontinued so that laboratory resources can be applied to more productive efforts.

5. **Implement procedural recommendations.** Procedural recommendations for maintaining data quality, improving record keeping, and reducing the time required to produce final data are listed at the end of Chapter 3. Implementing these recommendations in future regional monitoring efforts will facilitate the attainment of project objectives in a timely fashion.

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Appendix A

Integration of the Coastal Ecology Indicators

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INTRODUCTION

Three types of indicators of anthropogenic impact were used in the Coastal Ecology Component of Bight`98: pollutant exposure (sediment chemistry), toxicity (e.g., amphipod survival), and community health (benthic macrofauna and trawl demersal fish). Although each indicator provides valuable information about the coastal environment, these indicators also have limitations that prevent any one from serving as a comprehensive measure of the status of the Southern California Bight (SCB). For example, sediment chemistry data do not fully account for interactions among contaminants or the effects of geochemical factors affecting biological availability. Toxicity measurements usually do not assess the effects of chronic exposure, and the relationship between test response in the laboratory and ecological effects is often uncertain. Measures of community composition provide an integrated measure of effects on resident biota, but it is sometimes difficult to distinguish between effects due to contamination and those resulting from covarying changes in habitat (e.g., dredging and sediment grain size).

The measurement of multiple indicators of effect provides an opportunity to integrate these different indicators, allowing a more complete determination of the overall condition of a location than can be achieved by any one alone. No standard method exists for the synthesis of data from different indicators. One strategy uses a weight of evidence approach to assign a greater level of confidence to a determination of adverse effects when multiple indicators indicate the presence of an impact at a site. Other data synthesis strategies combine the numerical results of multiple indicators to create a composite score that reflects both the presence and magnitude of response for each indicator (Chapman *et al.* 2002). The degree of correspondence among indicators and their relationship to ecological impacts must be understood before the most appropriate method of data synthesis can be determined.

The analyses described in this report are intended to achieve two objectives: (1) to describe patterns of correspondence among the various Bight`98 coastal ecology assessment tools and (2) to evaluate the ability of individual and integrated assessment tools to predict impacts to benthic macrofauna communities. These analyses are intended to assist scientists and managers in interpreting the findings from the Coastal Ecology Component and also to identify areas in need of additional assessment tool development.

METHODS

An analysis of the coastal ecology indicator results was conducted in three phases. The first phase of analysis described the extent and patterns of concordance among assessment results for different Bight`98 strata. Four assessment tools, each representing different indicators of pollutant exposure or biological response, were compared in this analysis (Table 1). A subset of stations (n=144) that contained data for each of the indicators was used in this analysis. The results were expressed as the percent of area for the Southern California Bight (SCB) or selected strata that showed impacts for various combinations of the assessment tools (calculated using the area weights established for the sediment toxicity sampling design).

Regression analysis was used in the second phase to evaluate the nature and strength of associations among measures of sediment chemistry, toxicity, and biological effect for individual stations. Data from the Fish Response Index were not used in this analysis because the findings of non-reference trawl fish communities in this study were considered to be primarily due to habitat factors other than sediment contamination. The subset of data for these three indicators was larger (n=173 or 241) than the Phase 1 dataset because the fish trawls were conducted at fewer stations than the other types of measurements. Pairwise regressions were calculated using linear or second-order polynomial models. Regressions of the toxicity results were conducted using the results of the three separate tests: percent of amphipod survival following exposure to bulk sediment, percent of dinoflagellate luminescence following exposure to a sediment elutriate (QwikSed test), and results from a human cell reporter gene system (HRGS) test. The HRGS assay measures the presence of carcinogenic organic compounds in sediments (expressed as Benzo[a]pyrene equivalents), which are more likely to produce chronic than acute toxicity (Anderson *et al*. 1999). Results from the joint toxicity classification measure (used to summarize the three sediment toxicity results for assessing the spatial extent of impact) were not used in the regressions because this measure did not contain ordinal data, which was desired for the analyses, and there was relatively low agreement among the individual toxicity test results.

The third analysis phase compared the ability of individual and integrated assessment tools to predict impacts to benthic macrofauna. The individual assessment tools were based on the same sediment chemistry and toxicity indicators used in the concordance and regression analyses described above, although alternate threshold values were examined in some instances. The integrated assessment tools consisted of combined measures of pollutant concentration and toxicity. Each of the assessment tools was applied to a common set of data from 241 stations (except for the QwikSed analyses, where n=173), representing both embayment and coastal habitats. Each station was classified into one of four categories, characterized by the predicted presence or absence of biological impacts (based on comparison to the threshold for each assessment tool), and the presence or absence of impacts to benthic macrofauna, as indicated by the Benthic Response Index (BRI). Impacts to benthic macrofauna were defined as a benthic response level >1 (i.e., coastal BRI >34 or embayment BRI >42), which represented clear evidence of disturbance.

The number of stations in the various categories of predicted and measured effect was used to calculate the sensitivity and efficiency of each assessment tool. Sensitivity is a measure of how effective the assessment tool is in identifying impacted samples. The sensitivity is expressed as the percentage of all stations with benthic impacts that are found to exceed the threshold value. Efficiency is a measure of the accuracy of predictions of impact. The efficiency of an assessment tool is expressed as the percentage of all stations exceeding the threshold value that actually have benthic impacts.

RESULTS AND DISCUSSION

Concordance Among Assessment Tools

An integrated assessment based on the summed results of four indicator types showed that 23% of the SCB had evidence of impact to at least one indicator (Figure 1 and Table 2). A station was classified as impacted if any one of the following conditions was present: (1) elevated sediment chemistry (mean ERMq >0.1), (2) a joint toxicity classification in the high concern category, (3) a non-reference fish community, or (4) a clearly disturbed benthic community. Bays and harbors showed the greatest prevalence of impacts, with 66% of the area showing threshold exceedences for one or two indicators. The prevalence of indicator exceedences was intermediate at POTW and river mouth areas, with approximately 45% of the area showing at least one indicator exceedence.

There was little concordance among the four types of assessment tools. Less than 1% of the SCB was identified as impacted by more than one assessment tool (Table 2). When the results for the various indicator combinations listed in Table 2 are expressed as a percentage of just the SCB area showing exceedences (the impacted area), then 3.8% of the impacted area had an exceedence for more than one indicator. The highest concordance among indicators was present in bays and harbors, where 37% of the impacted area showed an exceedence for more than one assessment tool. There were no stations for which the thresholds of all four assessment tools were exceeded, and the river mouth areas was the only stratum at which any of the stations were identified as impacted by three types of indicators. The relatively low concordance among the assessment results indicates that the scales of response may be different for each assessment tool or that each indicator is responding to different components of the environment. The low degree of concordance also suggests that multiple assessment tools are necessary to describe the full extent of impacts to the coastal ecology.

Exceedences of the sediment contamination threshold (mean ERMq >0.1) were infrequently associated with biological effects. For most habitat types, elevated sediment chemistry was the most common and usually the only type of indicator exceedence observed (Table 2). For the entire SCB, 71% of the area classified as impacted was due solely to elevated sediment chemical concentrations. The best correspondence between chemistry and biological indicators was present in bays and harbors, where 37% of the area classified as impacted exceeded thresholds for both chemistry and one biological effects indicator.

A different pattern of indicator exceedences was present near river mouths. Most of the area classified as impacted near river mouths contained altered fish communities and low sediment contaminant concentrations. These results suggest that fish community impacts in river mouth areas are likely due to factors not associated with contamination, such as changes in salinity or prey species. These biological impacts may also be due to transient events that are not reflected in sediment chemistry measurements, such as seasonal variation in river flow or turbidity.

Associations Between Indicators

Varying degrees of association were present between sediment contamination and biological responses. Regressions of mean ERMq against three toxicity indicators (Figure 2) indicated that increased sediment contamination was weakly associated with reduced amphipod survival (r^2=0.11), not associated with elutriate toxicity, but strongly associated with higher concentrations of carcinogenic organics detected by the HRGS assay (r^2=0.53). The strong relationship between sediment contamination and the response of the HRGS assay is to be expected, as responses in the cells are induced by planar organic compounds (PAHs, PCBs, dioxins, and furans).

All of the Bight`98 stations contained a mean ERMq of <0.5, which represents a low-moderate level of contamination. The weak correspondence between amphipod survival and mean ERMq (Figure 2) is consistent with data from other regions that show approximately a 20% occurrence of amphipod toxicity at similar levels of contamination (Long *et al.* 2000). The mean ERMq is not a reliable predictor of toxicity at values below 0.5, which includes the contamination levels present in most areas of the SCB. The mean ERMq is a much more efficient predictor of toxicity at higher values; sediments with mean quotients of >1.5 are toxic to amphipods approximately 75% of the time (Long *et al.* 2000).

Weak relationships between increased sediment contamination and alterations in benthic macrofauna community health were present for both embayment and coastal habitats (Figure 3). The linear regression results indicated that sediment contamination changes accounted for 8-10% of the variation in the BRI.

Acute sediment toxicity was a better predictor of the occurrence of impacts to benthic macrofauna in embayments than was the mean ERMq. The magnitude of the BRI tended to increase as the percent of survival of amphipods decreased, and regression analysis indicated that 21% of the variation in the embayment BRI could be predicted by the amphipod survival results (Figure 4). Acute sediment toxicity did not show as strong a relationship with the BRI for coastal stations. The lack of an association may be due to limitations in the data that were available; very few coastal stations had BRI values that were above the range for reference conditions and there were no stations with a high level of acute toxicity (<50% amphipod survival).

The other two toxicity indicators used in Bight`98 were less effective in predicting the occurrence of benthic effects. The toxicity of sediment elutriates, measured using the QwikSed test, showed no relationship to the BRI (Figure 5). A weak relationship between the response of the HRGS assay and the BRI was present; variation in the concentration of Benzo[a]pyrene equivalents accounted for only 7% of the change in the BRI for embayment stations (Figure 5). At high (>60 µg/kg) levels of B[a]P equivalents there was generally an increase in the BRI to non-reference values (>31).

Predictive Ability of Assessment Tools

The presence or absence of predicted and observed effects was used to classify each station into one of the following four categories:

- High/Impact – True prediction of benthic impact
- High/No Impact – False prediction of benthic impact
- Low/Impact – False prediction of no benthic impact
- Low/No Impact – True prediction of no benthic impact

The ability of various assessment tools based on sediment chemistry or toxicity to predict the occurrence of impacts to benthic macrofauna varied widely. Among the assessment tools based on a single indicator, three had relativity good sensitivity and were able to identify more than 50% of the stations with disturbed benthic macrofauna communities (Table 3). These tools were low-moderate sediment contamination (mean ERMq >0.1), moderate-high bulk sediment toxicity to amphipods (i.e., <80% survival), and a joint toxicity classification of potential or high concern. These three assessment tools had relatively poor efficiency; however, only 20-26% of the stations exceeding these thresholds actually had evidence of an impacted macrofauna community.

Individual assessment tools based upon the presence of high levels of toxicity showed the greatest efficiency for predicting effects on the benthos. There was a 60% probability of measuring a disturbed benthic community at stations producing severe toxicity to amphipods (<50% survival). Stations producing a high level of HRGS assay response had a 43% occurrence of benthic impacts (Table 3). The use of thresholds based on the elutriate toxicity results had the lowest sensitivity and efficiency of any assessment tool.

Three assessment tools based upon a weight-of-evidence approach were evaluated for sensitivity and efficiency. This approach seeks to improve the efficiency of effect predictions by requiring the concordance of two indicators in order to classify a sample as having a high probability of biological effects. A combination of thresholds-based low-moderate sediment contamination <u>and</u> high HRGS assay response resulted in the highest efficiency among the three indicators (60%), but the performance of this combination was not markedly different than the use of high amphipod toxicity alone (62% efficiency) (Table 3).

An increased sensitivity for detecting benthic macrofauna effects resulted from several combinations of assessment tools based on summing the predictions of impacts using low-moderate sediment contamination or an exceedence of a toxicity threshold. The combination consisting of low-moderate sediment contamination or a joint toxicity classification of potential/high concern resulted in the highest sensitivity. This combination identified 77% of the stations with impacted benthic macrofauna, but also had a relatively low efficiency of 19% (Table 3).

Evaluation of the performance of assessment tools based on various combinations of Bight`98 sediment quality indicators shows that none of them have both high sensitivity and efficiency for predicting impacts to benthic macrofauna. The use of a combination of two thresholds (either elevated sediment contamination or sediment toxicity) provided the most sensitive indicator of benthic impacts. The greatest efficiency was obtained through either the use of a single indicator (high toxicity to amphipods) or a combination of elevated contamination and high HRGS response (Table 3). Thus, the use of different assessment tools may be appropriate for different management applications, such as determining impairment to aquatic life or selecting toxic "hotspots" in need of remediation.

The thresholds compared in this appendix were selected to be consistent with the thresholds used in the various Bight`98 technical reports, so that the analyses presented here would provide an indication of the relative performance of each indicator. Improvements in the efficiency and sensitivity of each assessment tool may be possible though the use of alternate thresholds (e.g., a different mean ERMq value). The performance of alternate thresholds and indicators should be evaluated in order to identify assessment tools having the best performance.

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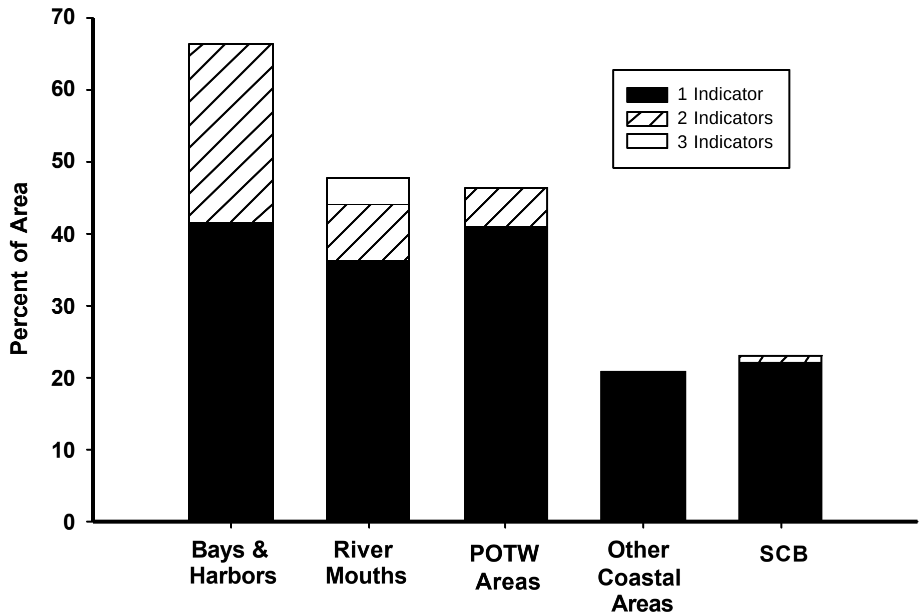


Figure 1. Percent of area of the SCB and selected strata showing impacts to any of four coastal ecology indicators (chemistry, benthic community, toxicity, fish populations).

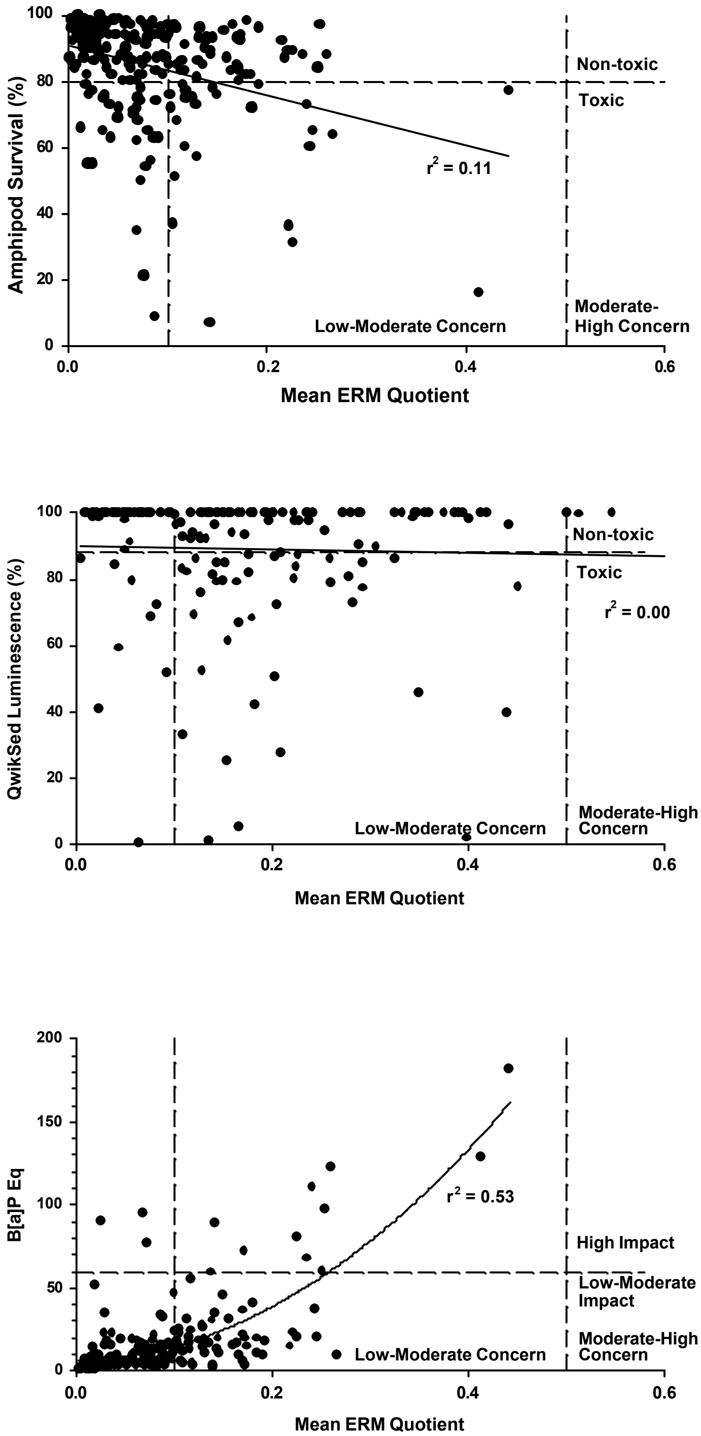
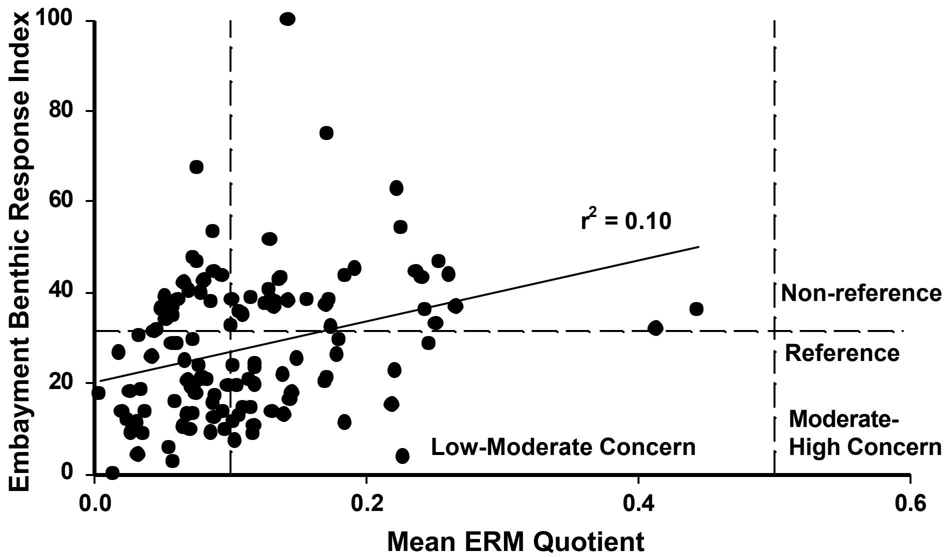


Figure 2. Relationships among three measures of sediment toxicity and the ERM quotient. Dashed lines indicate the primary assessment thresholds for each indicator. Solid lines are linear (amphipod survival and QwikSed) or second-order polynomial regressions.



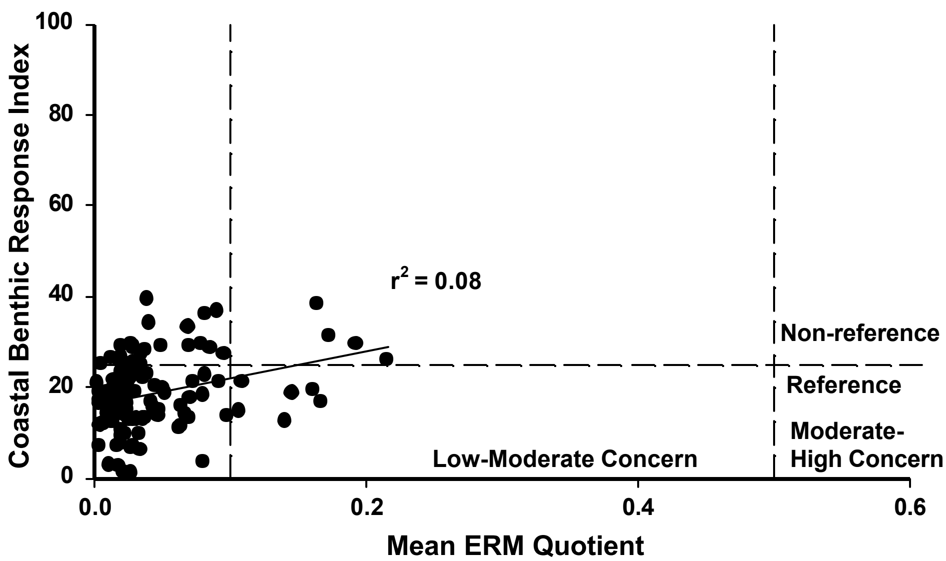
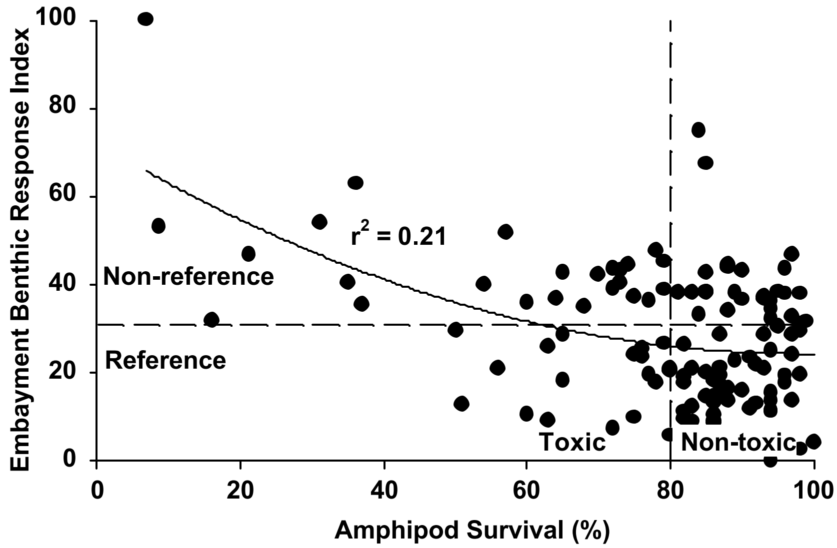


Figure 3. Responses of benthic macrofaunal communities to the ERM quotient sediment contamination indicator. The horizontal dashed line represents the upper limit of the BRI reference category, which was 31 and 25 for the embayment and coastal indices, respectively.



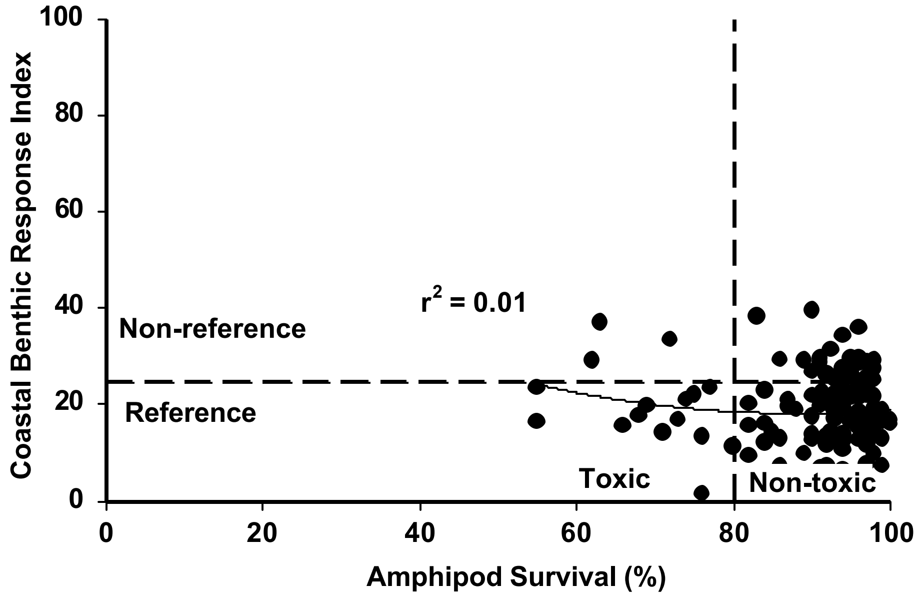
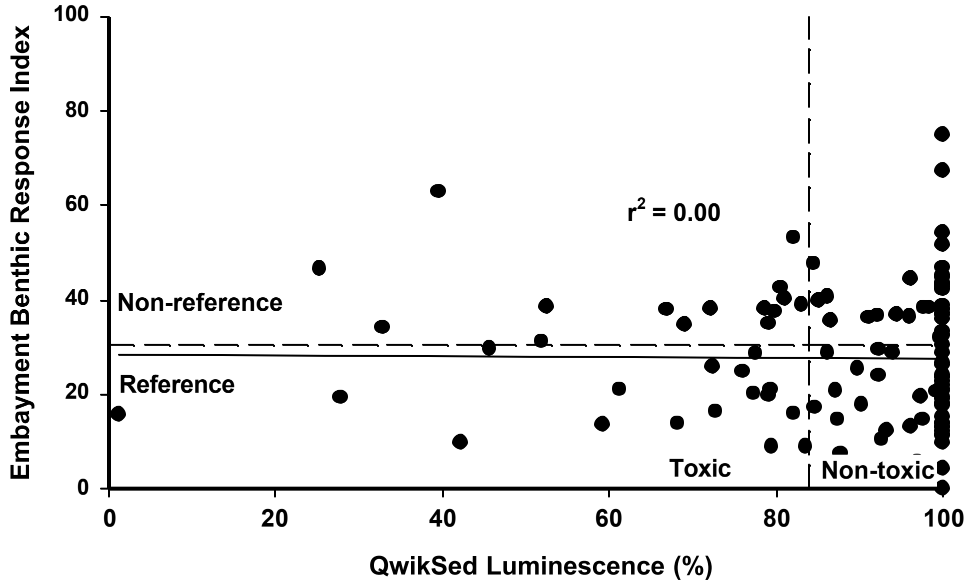


Figure 4. Relationship between amphipod survival and changes in benthic macrofauna for embayment and coastal stations.



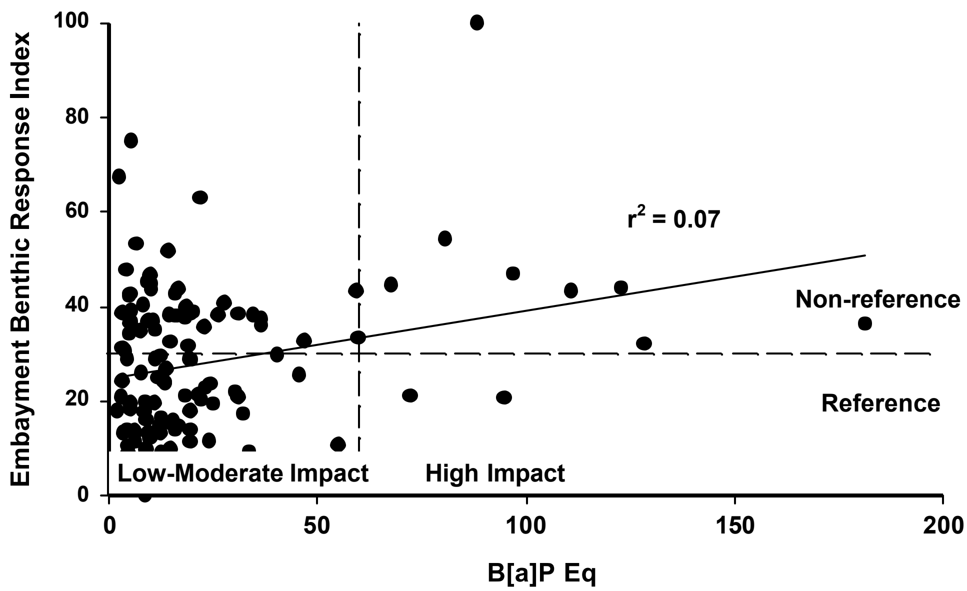


Figure 5. Relationships between measures of toxicity using sediment elutriates (QwikSed) or solvent extracts (HRGS) and changes in benthic macrofauna for embayment stations.

Table 1. Assessment tools used to evaluate concordance among indicators.

Indicator	Assessment Tool[a]	Assessment Threshold
Pollutant Concentration	Mean ERM quotient (ERMq)	Low-Moderate Concern level (>0.1)
Toxicity	Joint toxicity classification	High Concern level
Epibenthic Fish	Fish Response Index (FRI)	Non-reference condition
Benthic Macrofauna	Benthic Response Index (BRI)	Clear evidence of disturbance[b]

[a] The assessment tool calculations are presented in Bight`98 technical reports.
[b] BRI Response Level >1.

Table 2. Indicator threshold exceedences in SCB habitats.

	Percent of Area				
Responding Indicators	**Bays and Harbors**	**River Mouths**	**POTW**	**Other Coastal**	**SCB**
Chemistry Only	39.5	4.0	41.1	14.9	16.3
Chemistry+Toxicity	5.2	3.7	0.0	0.0	0.1
Chemistry+Benthos	12.9	0.0	5.2	0.0	0.5
Chemistry+Fish	6.4	0.0	0.0	0.0	0.1
Chemistry+Toxicity +Benthos	0.0	3.7	0.0	0.0	0.0
Chemistry+Toxicity+Fish	0.0	0.0	0.0	0.0	0.0
Chemistry+Benthos+Fish	0.0	0.0	0.0	0.0	0.0
Chemistry+Toxicity+Benthos+Fish	0.0	0.0	0.0	0.0	0.0
Toxicity Only	0.0	0.0	0.0	2.3	2.1
Benthos Only	2.1	0.0	0.0	1.2	1.2
Fish Only	0.0	32.3	0.0	2.4	2.6
Toxicity+Benthos	0.0	0.0	0.0	0.0	0.0
Toxicity+Fish	0.0	0.0	0.0	0.0	0.0
Benthos+Fish	0.0	4.0	0.0	0.0	0.0
Toxicity+Benthos+Fish	0.0	0.0	0.0	0.0	0.0

Table 3. Predictive ability of sediment quality assessment tools based on individual indicators or combinations of indicators. Analyses were conducted on a common set of data (except for elutriate toxicity results) representing both coastal and embayment stations (n=241). The elutriate data included the same embayment stations and a reduced number of coastal stations (n=173). Boxed cells indicate the assessment tools showing the two highest percentages of sensitivity or efficiency when used singly or in combination.

Assessment Tool	Predicted Effect/Benthos Impact[a] High/Yes	High/No	Low/Yes	Low/No	Sensitivity[b] (%)	Efficiency[c] (%)
Low-Mod Sediment Contamination (mean ERMq >0.1)	14	57	12	158	53.8	19.7
Mod-High Bulk Sediment Toxicity (<80% survival)	13	36	13	179	50.0	26.5
High Bulk Sediment Toxicity (<50% survival)	5	3	21	212	19.2	62.5
Mod-High Elutriate Toxicity (<84% luminescence)	4	33	18	118	18.2	10.8
High Elutriate Toxicity (<50% luminescence)	2	9	20	142	9.1	18.2
Potential-High Impact from HRGS Assay (>32 B[a]P Eq)	7	20	19	195	26.9	25.9
High Impact from HRGS Assay (>60 B[a]P Eq)	6	8	20	207	23.1	42.9
Joint Toxicity Classification of Potential or High Concern	15	45	11	170	57.7	25.0
Joint Toxicity Classification of High Concern	5	13	21	202	19.2	27.8
Low-Mod Sediment Contamination **AND** Mod-High Bulk Sediment Toxicity	6	14	20	201	23.1	30.0
Low-Mod Sediment Contamination **AND** High HRGS Assay	6	4	20	211	23.1	60.0
Low-Mod Sediment Contamination **AND** Potential or High Toxicity Concern	9	18	17	197	34.6	33.3
Low-Mod Sediment Contamination **OR** High Bulk Sediment Toxicity	16	58	10	157	61.5	21.6
Low-Mod Sediment Contamination **OR** High HRGS Assay	14	61	12	154	53.8	18.7
Low-Mod Sediment Contamination **OR** Potential or High Toxicity Concern	20	84	6	131	76.9	19.2

[a] A predicted effect of "High" was assigned when the results for a station exceeded the assessment tool value(s). A designation of benthic impact (Yes) was assigned when the benthic response index provided clear evidence of disturbance in macrofaunal communities (BRI response level >1).
[b] Sensitivity = (number of stations correctly predicted to be impacted/total number of stations with impacted benthos) x 100
[c] Efficiency = (number of stations correctly predicted to be impacted/total number of stations exceeding the benchmark value) x 100

Appendix B

The Prevalence of Non-Indigenous Species in Southern California Embayments and their Effects on Benthic Macroinvertebrate Communities

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Abstract

The prevalence of non-indigenous species (NIS) in southern California embayments was assessed by collecting 123 Van Veen grab samples from nine bays and harbors during the summer of 1998. NIS occurred in all but two samples. They accounted for only 4.3% of the 633 taxa but contributed 27.5% of the abundance. There was no significant difference in the proportion of NIS abundance among ports harboring large vessels, small boat marinas, and areas where boats were not moored. Three species accounted for 92% of the NIS abundance: a spionid polychaete worm *Pseudopolydora paucibranchiata*, a mytilid bivalve *Musculista senhousia*, and a semelid bivalve *Theora lubrica*. The NIS did not appear to have a negative impact at the overall community level since NIS abundance was positively correlated with the abundance and richness of other species. This may be due to biogenic structures built by *P. paucibranchiata* and *M. senhousia* that enhance the abundances of other macrofauna.

Introduction

Non-indigenous species (NIS) represent a potential threat to the integrity of natural ecosystems. They have been known to change community structure through elimination of native species, change primary production and nutrient cycling, and even alter weather patterns (Grosholz *et al.* 2000). The Asian clam *Potamocorbula amurensis* invasion of San Francisco Bay was closely correlated with the shutdown of the spring plankton bloom (Alpine and Cloern 1992); primary production was transferred from the pelagic ecosystem to the benthic ecosystem as a result of suspension feeding by the clam. Intense grazing by the introduced periwinkle *Littorina littorea* in Rhode Island affected sediment accumulation and changed the local environment from soft sediments to hard substrate (Bertness 1984). The estimated cost of NIS-induced damage has been estimated at 314 billion dollars per year (Pimentel *et al.* 2001).

Marine and estuarine systems are particularly vulnerable to NIS invasion, stemming, in part, from human-mediated transport of non-native species in the ballast water of ships (Grosholz 2002). Global movement of ballast water appears to be the largest single vector of NIS (Ruiz *et* *al.* 1997). Fouling organisms such as barnacles, bryozoans and hydroids, and wood-boring bivalves are also transported on the hulls of ships (Cohen and Carlton 1995).

Non-indigenous species assessments of marine and estuarine systems on the west coast of the United States have focused mostly on San Francisco Bay (Carlton 1979, Grosholz 2002). There have been few assessments of southern California since Carlton (1979) recognized the problem, despite the presence of some of the world's largest ports. Los Angeles/Long Beach Harbor is home to the busiest ports in the United States, San Diego is a major base for the U.S. Navy, and Marina Del Rey Harbor is the largest artificial small craft harbor in the world. Here, we assess the prevalence of NIS in benthic macroinvertebrate communities of southern California bays and harbors and their potential impacts on native communities.

Methods

Benthic samples were collected from 123 sites in 9 southern California bays and harbors between July 13 and September 16, 1998. Sampling sites were selected using a stratified random design with port areas that service large ocean-going ships, small boat marinas with recreational vessels, and other areas where boats were not moored as the strata. At each sampling site, sediment samples for benthic infaunal analysis were collected using a 0.1 m^2 Van Veen grab and sieved through a 1 mm mesh screen. Only samples penetrating at least 5 cm into the sediment and with no evidence of washout or slumping were processed. Material retained on the screen was placed in a relaxant solution of 1 kg $MgSO_4$ or 30 ml propylene phenoxytol per 20 L of seawater for at least 30 minutes and preserved in 10% sodium borate buffered formalin. In the laboratory, specimens were transferred to 70% ethanol, sorted, identified to the lowest practical level (most often species), and enumerated.

Native (indigenous) species are populations occurring within their natural range and without the aid of human activities (T N & Associates Inc. 2001). NIS are populations outside their natural range that were introduced intentionally or accidentally by humans. Introduced species are defined as reproductive populations of species or subspecies established by human activities outside their previous natural range. Cryptogenic organisms are neither demonstrably native nor introduced (Cohen and Carlton 1995). We adopted the techniques of Lindroth (1957), Carlton (1979), Chapman (1988), Chapman and Carlton (1991, 1994), and T N & Associates Inc. (2001) to identify NIS on our species list based on their taxonomy, biology, and history of occurrence in southern California (Table 1).

To assess whether NIS had an effect on benthic communities, we used correlation analysis to quantify associations between NIS abundance and two community measures: total abundance and number of taxa. The analysis was repeated with NIS removed to assess the effects on native and cryptogenic species only. All measures were log-transformed prior to correlation analysis. The analysis of variance (ANOVA) was used to assess whether vessel traffic affected the proportion of NIS abundance; the arcsine-transformed proportion of NIS abundance was tested among sites in ports, marinas, and other areas.

Results

Twenty-seven of the 633 species collected (4.3%) were NIS. They occurred at 121 of the 123 sites and accounted for 27.5% of the abundance. The percentage of NIS taxa was relatively consistent among the nine bays and harbors (Figure 1, Table 2). The abundance of NIS was more variable and also showed no pattern with respect to size or the type of vessel traffic. There was no significant difference in the relative abundance of NIS between ports, marinas, and other areas.

Three species (*Pseudopolydora paucibranchiata*, a spionid polychaete worm; *Musculista senhousia*, a mytilid bivalve; and *Theora lubrica*, a semelid bivalve) accounted for 91% of NIS abundance (Table 3). *P. paucibranchiata* was the most abundant species at five embayments (Channel Islands Harbor, Dana Point Harbor, Los Angeles/Long Beach Harbor, Marina Del Rey, and Mission Bay) and *M. senhousia* at two embayments (Newport Bay and San Diego Harbor); *T. lubrica* was the abundance dominant only in Anaheim Bay.

The NIS abundance was strongly and positively correlated with total abundance and numbers of species (Table 4). The strongest relationship was with total abundance ($r = 0.72$). The correlation with number of taxa was weaker ($r = 0.39$), although still significant.

To assess effects on native and cryptogenic species, the correlation between NIS abundance and community abundance was repeated with NIS subtracted from the total abundance. The correlation was still positive ($r = 0.52$) and significant. There was also a significant positive correlation between NIS abundance and the number of native and cryptogenic species ($r = 0.34$).

Discussion

Embayments in southern California are highly invaded by non-native macrofauna with NIS encountered at 121 of 123 sites. More than a quarter of the animals collected were non-indigenous. Relative abundances in San Francisco Bay, the only west coast area that has been intensively studied, are even higher. Lee *et al.* (in preparation) found that over 45% of abundance was due to NIS in six of seven San Francisco Bay habitats; NIS accounted for over 90% of abundance in two of them. Comparable levels of invasion in southern California were observed only in Marina Del Rey and Dana Point Harbor. The proportion of diversity contributed by NIS was also higher in San Francisco Bay, where 11% of the species were classified as NIS in contrast to 4% in our study.

Sampling the same southern California embayments in summer 2000, Cohen *et al.* (2002) found much greater diversity of NIS on hard substrates than in the soft-bottom benthos. They collected 65 NIS from floating structures at 21 sites and only 13 NIS from 13 benthic sampling sites. The 65 species they collected from floating structures at 21 sites was more than double the 27 we found at 123 benthic sampling sites. Unfortunately, their sampling was non-quantitative, so direct comparisons of abundance could not be made.

Ballast water is typically the largest vector of NIS (Ruiz *et al.* 1997), but the patterns of NIS distribution we observed were unrelated to boating and shipping activity. Large ocean-going vessels with ballast water do not enter small-boat marinas such as Marina Del Rey Harbor, so secondary migrations of NIS from initial points of introduction in larger harbors are likely mechanisms. Small boats transiting from larger harbors such as Los Angeles, Long Beach, and San Diego may be a source of NIS invasions, although there is no direct evidence to support this. Secondary movements of NIS from initial points of introduction have been documented frequently, but mechanisms must be established on a case-by-case basis. Applying the recently developed DNA methods (Bagley and Geller 2000) in future studies would be one way to determine whether sources of new populations are native habitat or previously invaded embayments.

The NIS species, while generally very good colonizers with high reproductive potential, are not typically the best competitors. When resources are limiting, better adapted native species should gradually outcompete introduced species. Food and space are probable arenas of conflict between native and NIS taxa. Where disturbance is frequent, opening new space for colonization, NIS should rapidly colonize and monopolize the spatial resource to the detriment and potential exclusion of natives. This imbalance would gradually be redressed in the absence of further disturbance by the competitive disadvantage of NIS taxa. Disturbance at intermediate levels could potentially keep these two opposed influences in balance, allowing persistence of diverse native and large NIS populations within the same benthic community.

In many previous studies, NIS were found to have a negative impact on native species (Englund 2002, Grosholz *et al.* 2000, Nichols *et al.* 1990). In contrast, we found NIS to be associated with higher native and cryptogenic diversity and abundance. There are several possible explanations for the observed coexistence of large NIS populations with a diverse native community. One possibility is that resources are not limiting and, consequently, there is little or no direct competition between NIS and natives. Alternatively, disturbance at intermediate levels, as previously discussed, may be maintaining and enhancing both populations. A third and most likely possibility is that the presence of NIS increases available resources, enhancing native abundance. Gallagher *et al.* (1983) found that several benthic animals, including species of P*seudopolydora* (*P. paucibranchiata* was the most abundant NIS in southern California), enhanced native recruitment on artificially created azoic patches by modifying the physical environment. *Pseudopolydora* is a small tube-dwelling worm and the aggregates of its tubes substantially enhance benthic habitats, especially when present in large numbers, as in our study. *Musculista senhousia*, the second most abundant NIS in our study, weaves thick mats of byssal threads. Crooks and Khim (1999) and Mistri (2002) found that mussel mats of *Musculista senhousia* facilitate the presence of other macrofaunal taxa.

Despite the apparent stimulation of southern California benthic abundance and diversity by NIS, it is possible that one or more individual native species are being negatively impacted. Our results are based on overall abundance and diversity at a gross community level. The possibility that NIS are negatively impacting individual native species or otherwise negatively affecting southern California's bay and harbor macrofaunal communities should not be dismissed without more species-specific examination.

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Table 1. Non-indigenous species in southern California embayments. *: First report of taxon as NIS.

TAXON	Original Locality	References
Annelida: Polychaeta		
*Brania mediodentata**	Galapagos	Westheide 1974
Diplocirrus sp SD1*	Probably Arctic	Rowe 1998; Ruff 1996
*Eteone aestuarina**	El Salvador	Hartmann-Schroder 1959
Neanthes acuminata	Unknown	T N & Associates Inc. 2001
*Nephtys simoni**	Florida	Hilbig 1994
Polydora cornuta	U.S. east coast	T N & Associates Inc. 2001
Pseudopolydora paucibranchiata	Japan	T N & Associates Inc. 2001; Carlton 1979
Streblospio benedicti	U.S. east coast	Carlton 1979
Syllis (Typosyllis) nipponica	Japan	T N & Associates Inc. 2001
Arthropoda: Crustacea: Amphipoda		
Aorides secundus	Japan	Cohen *et al.* 2002
Caprella natalensis	Unknown	T N & Associates Inc. 2001
Eochilidium sp A	Unknown	T N & Associates Inc. 2001
Grandidierella japonica	Japan	T N & Associates Inc. 2001; Chapman and Dorman 1975
Liljeborgia sp (red/white fouling)	Unknown	Cohen *et al.* 2002
Listriella sp A*	Unknown	SCAMIT 1987
Paradexamine sp SD1*	Unknown	Pasko 1999
Sinocorophium heteroceratum	Western Pacific (China)	Chapman and Cole 1994; T N & Associates Inc. 2001
Arthropoda: Crustacea: Isopoda		
Paracerceis sculpta	Unknown	T N & Associates Inc. 2001
Arthropoda: Crustacea: Mysidacea		
Deltamysis sp A*	Unknown	Possibly *D. holmquistae* Bowman and Orsi 1992
Mollusca: Bivalvia		
Musculista senhousia	Japan	T N & Associates Inc. 2001; Carlton 1979
Theora lubrica	Western Pacific (Japan)	T N & Associates Inc. 2001; Carlton 1979
Venerupis phillippinarum	Japan	T N & Associates Inc. 2001; Carlton 1979
Mollusca: Gastropoda		
Philine auriformis	New Zealand	Gosliner 1995; T N & Associates Inc. 2001
Philine sp A*	Unknown	SCAMIT 1988
Cnidaria: Anthozoa		
Bunodeopsis sp A	Gulf of California	Ljubenkov 1998; Cohen *et al.* 2002
Chordata: Ascidiacea		
Microcosmus squamiger	Australia	Lambert and Lambert 1998
Styela plicata	Unknown	Lambert and Lambert 1998

Table 2. Mean abundances and numbers of non-indigenous species in nine southern California embayments.

Embayment	Sites	Abundance		No of taxa	
		Mean (m^{-2})	Percent of Total	Site Mean	Percent of Total
Ventura Harbor	1	0.0	0.0	0	0.0
Channel Islands Harbor	3	440.0	13.9	2.67	9.3
Marina Del Rey	7	5,600.0	30.7	2.43	12.4
Los Angeles/Long Beach Harbor	46	1,165.0	26.2	2.26	7.2
Anaheim Bay	3	560.0	17.3	3.67	9.3
Newport Bay	11	1,033.6	15.9	4.36	10.6
Dana Point Harbor	3	1,143.3	31.9	3.67	10.6
Mission Bay	3	2,503.3	12.5	8.67	9.6
San Diego Bay	46	1,998.5	20.9	5.17	11.7
Overall Mean	**123**	**1,707.6**	**22.6**	**3.76**	**9.7**

Table 3. Mean abundances (m^{-2}) of non-indigenous species in southern California embayments. VH: Ventura Harbor; CIH: Channel Islands Harbor; MDR: Marina Del Rey; LA/LB: Los Angeles/Long Beach Harbor; AB: Anaheim Bay; NB: Newport Bay; DPH: Dana Point Harbor; MB: Mission Bay; San Diego Bay; Percent: Contribution to NIS abundance (%).

Name	VH	CIH	MDR	LA/LB	AB	NB	DPH	MB	SDB	%
Pseudopolydora paucibranchiata		283.3	5,520.0	619.6	83.3	267.3	763.3	773.3	720.0	51.855
Musculista senhousia			2.9	0.2	10.0	434.6		503.3	854.6	21.740
Theora lubrica		13.3	12.9	476.3	353.3	200.0	13.3	336.7	255.9	18.150
Diplocirrus sp. SD1					16.7			100.0	86.7	2.066
Grandidierella japonica		106.7	34.3	9.4		3.6	353.3	76.7	28.7	1.733
Neanthes acuminata Complex		20.0	1.4			0.9	6.7	463.3	2.6	0.767
Sinocorophium cf heteroceratum				33.5						0.733
Polydora cornuta			14.3	10.7		38.2			3.7	0.562
Paradexamine sp. SD1			1.4			40.9	6.7	16.7	9.4	0.457
Bunodeopsis sp. A								120.0	6.7	0.319
Brania mediodentata								40.0	11.5	0.310
Paracerceis sculpta						3.6		50.0	7.0	0.243
Venerupis philippinarum				0.2		35.5				0.190
Philine auriformis		16.7		6.5		1.8				0.176
Eochelidium sp. A				3.3	70.0					0.171
Eteone aestuarina								6.7	5.2	0.124
Philine sp. A				4.4	10.0	2.7				0.124
Streblospio benedicti			12.9			4.6			0.4	0.076
Syllis (Typosyllis) nipponica				0.9					2.2	0.067
Deltamysis sp. A					16.7				0.9	0.043
Nephtys simony									1.7	0.038
Aoroides secundus								13.3		0.019
Listriella sp. A									0.7	0.014
Microcosmus squamiger								3.3	0.2	0.010
Caprella natalensis				0.2						0.005
Liljeborgia sp.									0.2	0.005
Styela plicata									0.2	0.005

Table 4. Pearson correlation coefficients between NIS abundance and numbers of taxa and other community measures. ***: p<0.001; **: p<0.01.

	Total Abundance (sample^{-1})	Non-NIS Abundance (sample^{-1})	No of Taxa (sample^{-1})	Non-NIS Taxa (sample^{-1})
NIS Abundance (sample^{-1})	0.72***	0.52***	0.39***	0.34***
No of NIS taxa (sample^{-1})	0.68***	0.58***	0.32***	0.24**

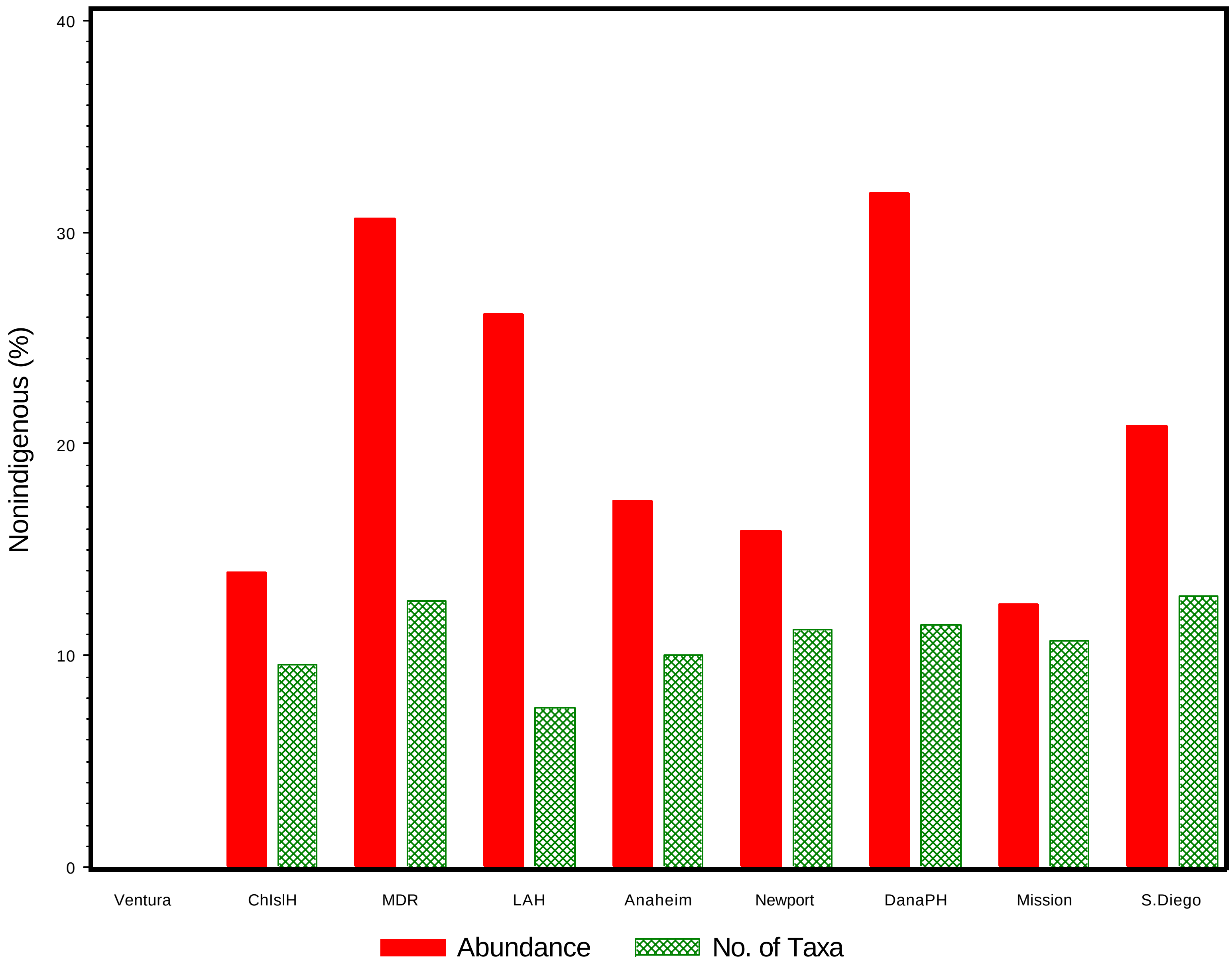

Figure 1. Mean NIS abundance and numbers of taxa for nine southern California embayments. Ventura: Ventura Harbor; ChIslH: Channel Islands Harbor; MDR: Marina Del Rey; LAH: Los Angeles/Long Beach Harbor; Anaheim: Anaheim Bay; Newport: Newport Bay; DanaPH: Dana Point Harbor; Mission: Mission Bay; S. Diego: San Diego Bay.

Appendix C

Extending the Southern California Benthic Response Index to Assess Benthic Condition in Bays

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INTRODUCTION

New benthic index-based approaches to summarizing benthic data (Engle *et al.* 1994, Weisberg *et al.* 1997, Engle and Summers 1999, Van Dolah *et al.* 1999, Paul *et al.* 2001, Smith *et al.* 2001) have facilitated the use of benthic infauna as indicators of environmental condition in marine and estuarine environments (Hyland *et al.* 1999, Bergen *et al.* 2000, Dauer *et al.* 2000, Summers 2001). While reducing complex biological data to a single value has disadvantages, the resulting indices remove much of the subjectivity associated with interpreting data. The indices also provide a simple means of communicating complex information to managers and correlating benthic responses with stressor data (Dauer *et al.* 2000).

The U.S. Environmental Protection Agency's guidance for biocriteria development (Gibson *et al.* 2000) recognizes three types of benthic indices. In one, the Benthic Response Index (BRI) (Smith *et al.* 2001), each species is assigned a pollution tolerance score, and the index is calculated as the abundance-weighted average of the species tolerance scores. In application, it is similar to the Hilsenhoff Index (1987, 1988), which uses pollution tolerance scores to assess the condition of freshwater benthos. However, the BRI approach differs in using multivariate ordination as the basis for assigning pollution tolerance scores. The scores are combined using an approach similar to the weighted-average methodology used in gradient analysis pollution studies (e.g., Whittaker 1973). Multivariate ordination is a powerful tool for assessing perturbations to benthic infaunal assemblages (Smith *et al.* 1988, Norris 1995), but is too complex (Gerritsen 1995) and distant from simple biological explanations (Elliott 1994) to be easily understood, interpreted, or applied. The BRI resolves these issues by using the powerful, but complex, multivariate information to develop pollution tolerance scores for each species that are easy to apply, interpret, and test.

The BRI approach is promising, but previously has only been used in marine environments on the coastal shelf. Bay and estuarine environments are more challenging locations for index development because their habitats and types of anthropogenic stress are more diverse than on the coastal shelf (Gibson *et al.* 2000). In this appendix, we test whether the

Smith *et al.* (2001) approach can be applied successfully in southern California's harbors and embayments.

METHODS

The BRI is the abundance-weighted average pollution tolerance of species occurring in a sample (Smith *et al.* 2001). The general index formula is:

$$BRI_s = \frac{\sum_{i=1}^{n} a_{si}^{f} p_i}{\sum_{i=1}^{n} a_{si}^{f}} \qquad (1)$$

where BRI_s is the BRI value for sampling unit s, n is the number of species in s, p_i is the pollution tolerance of species i, a_{si} is the abundance of species i in s, and f is an exponent used to transform the abundance values.

The primary objective of BRI development is to assign pollution tolerance scores p_i to species based on their position on a pollution gradient. Once assigned, the scores can be used to assess the condition of the benthic community by calculating the BRI. A seven-step process was used to assign and validate pollution tolerance scores for benthic macroinvertebrates in southern California bays:

1. Data were assembled from four projects distributed throughout southern California (Figure 1), with adjustments made for compatibility as necessary. Three of the projects provided data from 170 sites where benthic macroinvertebrate samples were sieved with a 1.0 mm screen; the fourth project provided data from another 171 sites where benthic macroinvertebrate samples were sieved with a 0.5 mm screen (Table 1).

2. Southern California bays were divided into two habitats, northern bays and southern bays, based on differences in naturally occurring benthic assemblages identified in Chapter 5. Northern bays included assemblages from Point Conception to Newport Bay; southern bays included assemblages from Dana Point Harbor to the U.S.-Mexico international border. The index was developed separately in each habitat because the numbers and kinds of benthic organisms vary naturally, and comparisons to determine altered states should vary accordingly. During index development, Newport Bay and Dana Point Harbor were included in both the northern and the southern habitat datasets as areas of habitat overlap where BRI scores could be compared and BRI values normalized between habitats.

3. For each screen size, an ordination analysis was performed to quantify species changes along the environmental gradients, and a pollution vector was identified to quantify species changes along the pollution gradient. In ordination analysis, samples are displayed as points in a multi-dimensional space where the distance between points is proportional to differences in species composition among the samples. Different environmental gradients causing species change often correlate with vectors extending in different directions in this space. The pollution vector was defined as the direction

maximally correlated with two indicators of potential pollution effects: (1) the mean effects range median (ERM) quotient, which is an integrated measure of chemical contamination in the sediments, and (2) the acute toxicity of the sediments to amphipods.

4. For each species, a pollution tolerance score was calculated as the weighted-average position of its abundance distribution along the pollution vector. Up to four pollution tolerance scores were calculated for each species, one for each screen size in each habitat. The pollution vectors were normalized to a scale of 0-100 that was equivalent among habitats within screen sizes.

5. In each habitat, species with pollution tolerance scores that were inconsistent among the 0.5 mm and 1.0 mm screens were eliminated. We had low confidence in the repeatability of scores when correlations between scores in the two independent sets of data were weak.

6. To give index values an ecological context, four thresholds of biological response to pollution were identified. A reference threshold was identified below which natural benthic assemblages normally occur, and three thresholds of response to disturbance were identified that were equivalent to the thresholds developed for the southern California coastal BRI (Smith *et al.* 2001).

7. Finally, the index was validated in three ways. First, the indices for the northern and southern habitats were applied to each site in a region of habitat overlap and the results were compared. Second, index values were compared at each site with data indicating potential pollution effects. Third, the classification efficiency of the index was evaluated by examining index values and response classifications of 32 sites *a priori* designated disturbed or undisturbed prior to index development. In addition, relationships between the index values and several habitat variables were examined to ensure that the index was measuring the pollution gradient as intended, rather than habitat gradients.

The details for each step are provided below.

1. Assemble Data

The index was developed using survey data from 341 sites in bays and harbors between Point Conception, California, and the U.S.-Mexico international border (Table 1, Figure 1). Data for benthic species abundances; chemical contaminants in the sediments; toxicity of the sediments to amphipods; and habitat measures such as bottom depth, sediment grain size composition, and total organic carbon were available for each site. The data were limited to summer samples collected between July 1 and September 30, as for the coastal BRI (Smith *et al.* 2001). They were gathered over several summers (Table 1) from many southern California embayments (Figure 1).

Due to differences in benthic sampling and amphipod toxicity testing methods, the data were segregated into two sets, based on sieve size, and were analyzed separately. The 1.0 mm screen data comprised about one-half of the data (170 sites) where sediments were collected using 0.1 m^2 Van Veen grabs, sieved on 1.0 mm screens, and tested for toxicity using the amphipod *Eohaustorius estuarius* (Table 1). The 0.5 mm screen data were from 171 sites where sediments were collected using 0.0075 m^2 cores, sieved on 0.5 mm screens, and tested for toxicity using the amphipod *Rhepoxynius abronius*. Only one Van Veen grab sample was collected at each 1.0 mm site, but multiple samples were collected at some 0.5 mm sites. Benthic species abundances in the cores were standardized to the area of the Van Veen grabs. The toxicity test results were expressed as the mean control-adjusted amphipod mortality for each site.

At all of the sites, benthic organisms retained when sieving macrofaunal samples were identified to the lowest practical taxon, most often species, and counted. Taxonomic inconsistencies among programs were eliminated by cross-correlating species lists to identify differences in nomenclature or taxonomic level, consulting taxonomists from each program, and resolving discrepancies. In a few cases, multiple taxa were combined to resolve taxonomic inconsistencies in the data.

Also at all of the sites, sediment concentrations of nine trace metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc), polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs) were measured using comparable laboratory analysis methods, and sediment toxicity to amphipods was measured by a 10-day acute toxicity test (Fairey *et al.* 1996; Anderson *et al.* 1997; Anderson *et al.* 1998; Fairey *et al.* 1998; Phillips *et al.* 1998; Heitmuller *et al.* 1999; Bay *et al.* 2000; Noblet *et al.* 2002; Southern California Coastal Water Research Project and SPAWAR System Center, in preparation). Mean ERM quotients (Long and MacDonald 1998) were calculated as an integrated measure of chemical contamination at each site from concentrations of the 11 contaminants. The ERM value for each contaminant is the level at which biological effects are likely (Long *et al.* 1995), and the mean quotient is the mean ratio of observed concentrations to the ERM values. Toxicity test results were expressed as the mean control-adjusted amphipod mortality for each site.

2. Identify Habitats with Distinct Natural Assemblages

Based on the assemblage analysis of Bight`98 data reported in Chapter 5, the southern California bays were divided into two habitats, the northern bays and the southern bays. Pollution tolerance scores were developed independently for each species for each habitat and screen size. The numbers and kinds of benthic organisms vary naturally with habitat, and comparisons to determine altered states should vary accordingly. The assemblage analysis identified naturally occurring assemblages in the Southern California Bight and the habitat factors that structure them by (1) eliminating potentially contaminated sites from the Bight`98 data, (2) identifying assemblages using hierarchical cluster analysis, and (3) testing habitat variables across dendrogram splits to assess whether the assemblages occupied different habitats.

A new BRI for embayments was developed, rather than modifying the coastal BRI (Smith *et al.* 2001), because the analysis indicated substantial differences between benthic assemblages that occur naturally in embayments and those on the coastal shelf. The first split in the dendrogram separated sites in embayments from sites on the mainland and island shelves.

The index was developed separately for the northern and southern bays because the analysis indicated substantial differences between them. The first dendrogram split within embayments separated assemblages in the northern bays from Point Conception to Newport Bay from those in the southern bays from Dana Point Harbor to the U.S.-Mexico international border. Newport Bay and Dana Point Harbor were included in both the northern and the southern index development datasets as areas of habitat overlap where BRI scores could be compared and BRI values normalized between habitats. Newport Bay was the southernmost northern bay and Dana Point Harbor was the northernmost southern bay.

3. Identify the Pollution Vector in Ordination Space

Gradients of species change caused by environmental gradients were quantified using principal coordinates ordination analysis (Gower 1966, Pielou 1984) on a Bray-Curtis dissimilarity matrix (Bray and Curtis 1957). Before calculating the dissimilarity matrix, abundances were square root transformed and standardized by the species mean of values higher than zero, to reduce the influence of dominant species (Smith 1976, Smith *et al.* 1988). The step-across distance re-estimation procedure (Williamson 1978, Bradfield and Kenkel 1987) was applied to dissimilarity values over 0.80 to reduce the distortion of ecological distances caused by joint absences of a high proportion of species; the distortion occurs due to the common non-monotonic truncated nature of species distributions along environmental gradients (Beals 1973). Species occurring only once in the data were dropped prior to calculation of the dissimilarity matrix. The analysis was conducted separately for each sieve size.

Next, canonical correlation analysis (Cooley and Lohnes 1971, Gittins 1979, Dillon and Goldstein 1984) was used to find directions (gradients or vectors) of species change in the ordination space that maximally correlated with two pollution indicator variables. Specifically, the canonical correlation compared the first 20 ordination axes with the mean ERM quotient (Long and MacDonald 1998) and the mean control-adjusted mortality in the amphipod toxicity tests. The overall pollution vector was calculated as the average direction between the ERM quotient and amphipod toxicity vectors. A simple example of our method is presented in Attachment C-1.

4. Identify the Position of Each Species on the Pollution Vector

The pollution tolerance score for each species was defined as its abundance-weighted average position on the pollution vector. For each species p_i, the pollution tolerance score, was calculated as:

$$p_i = \frac{\sum_{j=1}^{t} a_{ij}^{e} g_j}{\sum_{j=1}^{t} a_{ij}^{e}} \qquad (2)$$

where e is an exponent for transforming the abundance, and t is the number of sampling units to be used in the sum, with only the sampling units with highest t species abundance values included. The g_j is the position of the j^{th} sampling unit on the pollution gradient.

An optimization procedure was used to find values for the unspecified parameters f, e, and t in Equations (1) and (2). The optimization consisted of computing correlation coefficients (r_{I_s, g_s}) between final BRI index values for each site and the position of the site on the pollution vector for all combinations of e = 0, 1, 0.5, 0.33, 0.25, and t = 1 to 100 in Equation (2), and f = 0, 1, 0.5, 0.33, 0.25 in Equation (1). The combination of f, e, and t values that maximized the correlation coefficient was chosen and substituted in the general formulae to calculate pollution tolerance scores for each species and BRI index scores for each site. Each data subset consisted of the data for one of the two screen sizes in one of the two habitats. To avoid the higher sampling error associated with rare species, p_i values were computed only for species occurring three or more times in a data subset. These species and taxa are listed in Attachment C-2 and Attachment C-3.

To enhance the interpretability of the index, the scales of the index values from the two habitats were standardized so that a particular index value indicates the same level of effect, regardless of the habitat. This was accomplished by computing a linear regression equation in the region of overlap to predict index values in northern bays from the corresponding index values for southern bays. The index scale was also expanded so that values of zero and 100 corresponded to the lowest and highest index values found in the northern habitat.

5. Eliminate Species with Inconsistent p_i Values

Taxa with inconsistent pollution tolerance values between the 1.0 and 0.5 mm data in each geographical habitat were eliminated using correlation analysis. Taxa with the largest negative contribution to the correlation between species tolerance values in the two datasets were iteratively eliminated by computing:

$$r_{c,v} = \frac{\sum_{i=1}^{n} z_{i,c} z_{i,v}}{n-1} \qquad (3)$$

where $r_{c,v}$ is the correlation between the p_i values in the development and independent datasets, n is the number of taxa common to both datasets, $z_{i,c}$ is the centered (by mean) and standardized (by standard deviation) p_i value for the 1.0 mm index, and $z_{i,v}$ is the centered and standardized p_i value for the 0.5 mm index. The taxon with the most negative $z_{i,c} z_{i,v}$ value was eliminated and new indices derived with the remaining taxa. Taxa were eliminated until $r_{c,v}$ for both the northern and southern categories exceeded 0.60. We had low confidence in the repeatability of pollution tolerance scores when correlations between the two independent sets of data were weak.

6. *Develop Assessment Thresholds*

To give index values an ecological context and facilitate their interpretation and use for evaluation of benthic community condition, a reference threshold and three thresholds of response to disturbance were defined, equivalent to the thresholds established for the mainland shelf BRI (Smith *et al.* 2001). Our goal was to define the reference threshold as a value toward the upper end of the range of index values for sites that had minimal known anthropogenic influence. It was established at the point on the pollution vector where pollution effects first resulted in a net loss of species.

The other three thresholds involved defining increasing levels of deviation from the reference condition. These thresholds were based on determinations of index values at which 25%, 50%, and 80% of the species present at the reference threshold were lost.

7. Validate Index Values and Pollution Tolerance Scores

The index was validated by comparing northern and southern index values in the area of overlap, by comparing index values in each habitat to mean ERM quotients and mean control-adjusted amphipod mortality, and by examining index values and response classifications of 32 sites designated *a priori* as disturbed or undisturbed prior to index development. Finally, we ensured that index values were independent of habitat variables that often affect species distributions.

In the first form of validation, correlation analysis was used to compare northern bay and southern bay index values at sites in the overlap areas. We considered it a form of validation if the two separate indices were highly correlated since they involve separately derived BRI indices applied to the same data.

Correlations between index values and the two pollution indicator variables were used as a second form of validation. Since the index was developed from a linear combination of the two variables, it was necessary to ensure that it adequately reflected habitat alteration.

Third, the classification efficiency of the index was evaluated by examining index values and response classifications of 32 sites *a priori* designated disturbed or undisturbed prior to index development. Twelve sites with mean ERM quotients > 0.3 or amphipod mortality > 20% were designated as disturbed and 20 sites outside of the influence of storm water and municipal wastewater discharges with mean ERM quotients < 0.1 and amphipod mortality < 10% were designated as undisturbed. Sites with mean ERM quotients < 0.1 are considered unlikely to exhibit biological effects due to chemical contamination (Long and MacDonald 1998).

Finally, relationships between the index values and six habitat variables were examined to ensure that the index was measuring the intended pollution gradient rather than one or more of the habitat variables. The habitat variables included sediment grain size composition, total organic carbon, water depth, longitude, latitude, and time. The reason for including time was to determine whether consistent inter-annual differences in index values existed due to climate (e.g., El Nino or La Nina) or other effects.

RESULTS

The Data

As expected, about 50% more organisms were collected in the 171 samples sieved through 0.5 mm screens than the 170 sites sieved with 1.0 mm screens (Table 1). However, the 159,605 organisms in the 0.5 mm data included only 238 taxa while the 107,207 organisms in the 1.0 mm screen data included 418 taxa, even though the taxonomy from both sets of screens was standardized using a common list (Attachment C-2). This somewhat counter-intuitive result with fewer taxa among more organisms was probably related to study design and sampling method. The 0.5 mm data were primarily collected in polluted areas, accounting for a portion of the reduced diversity; in contrast, more than three-quarters (134 of the 170) of the 1.0 mm screen sites were spatially random samples more likely to be in reference areas. The other portion of the reduced diversity is likely due to the small area of bottom sampled by the corer (Table 1). Although abundances can effectively be normalized for gear area, there is no reliable adjustment for decreases in numbers of rare species collected as gear area decreases. These gear differences do not affect our index development because the BRI is based on the position of each species' abundance distribution along the pollution gradient rather than numbers of species or other sampling area or sieve-size dependent measures.

Identify the Pollution Vector in Ordination Space

Table 2 shows the correlations between the first two ordination axes and the two environmental indicators of pollution. These correlations were used to locate the overall pollution vector in ordination space (see Attachment C-1). Since our objective was development of an index for application to the 1.0 mm Bight`98 data, and for simplicity, results are presented only for the 1.0 mm screen data in this and subsequent sections of the results.

Identify the Position of Each Species on the Pollution Vector

The optimization procedure resulted in abundance transformation exponents (f) of 0.33 and 1.0 for the southern and northern data subsets, respectively (Table 3). Since the exponent in all three habitats of the coastal BRI was also 0.33 (Smith *et al.* 2001), we fixed f=0.33 for the northern subset and optimized again for the other parameters. Using f=0.33 for the northern subset instead of f=1 only resulted in lowering the optimization correlation by 0.017 (Table 3), an acceptable deviation from the optimal result. The pollution tolerance scores (p_i values) for the species are presented in Attachment C-3.

The list of 19 species with the 10 highest pollution tolerance scores in both habitats included 8 arthropods, 7 annelids, and 4 molluscs (Table 4). The most pollution-indicative species in the northern bays, *Capitella capitata*, is well known as an indicator of organic pollution (Grassle and Grassle 1984). *Streblospio benedicti*, another species often associated with disturbance and pollution, also had a pollution tolerance score towards the polluted end of the scores; on average, it had the 22nd highest pollution tolerance score.

The list of 19 species with the 10 lowest pollution tolerance scores was more diverse. It included an ascidiacean chordate and a brachiopod as well as 9 molluscs, 5 arthropods, and 3 annelids (Table 5).

Although the pollution tolerance of *Musculista senhousia*, the second-most abundant non-indigenous species (NIS), ranked high, pollution tolerance of the other two abundant NIS was only average. The pollution tolerance score of *M. senhousia* ranked tenth on average and third in the northern bays (Table 4), while the average ranks of the pollution tolerance scores for *Pseudopolydora paucibranchiata* and *Theora lubrica*, the most and third-most abundant NIS (Appendix B), were 68 and 44, respectively.

Eliminate Taxa with Inconsistent p_i Values

Nineteen taxa with pollution tolerance scores that were inconsistent between the 1.0 mm and 0.5 mm screens were removed from the northern bays data (Table 6) and another 19 from the southern bays data (Table 7). Twelve and eleven of the taxa removed from the northern and southern bays, respectively, were multiple species taxon categories combined for taxonomic consistency between projects and over time.

Develop Assessment Thresholds

Assessment thresholds were selected for the index based on changes in biodiversity along the pollution gradient defined by the index values. The portion of the gradient occupied by each species in the northern and southern habitats is presented in Figures 2 and 3 and is summarized in Figure 4. At the unpolluted (reference) end of the pollution gradients, species appeared and few, if any, dropped out. As a result, the number of potential species increased rapidly. Further along the gradient, the number of species dropping out increased until it equaled the number of species entering, and the net number of potential species stabilized. Eventually, the number of species dropping out exceeded the number of species entering and the number of potential species declined.

Threshold values were established for the northern and southern indices on the same scale by averaging the number of species curves in the two habitats (Figures 2 and 3) to create a single curve (Figure 4C). Using this curve, the reference threshold was defined as the point on the index gradient where the number of species falls 5% below the peak net number of species. We chose 5% somewhat arbitrarily for three reasons. First, the peak is somewhat flat, making it difficult to identify the point at which the peak occurs, but is followed by a definite region of decline. Thus, 5% below the peak is a better defined point than the peak. Second, the threshold is appropriately placed where net species loss begins to occur, which would be a small amount past the peak; we chose 5%. Third, choosing 5% also allows for some error in our analyses that might lead to too low of a reference threshold value. We averaged the numbers of species curves for the northern and southern data subsets to avoid defining different thresholds for the northern and southern data subsets.

Three more thresholds were defined at 25%, 50%, and 80% loss of biodiversity (Table 8). The 25% threshold was defined as the index value where the potential number of species drops to 25% below the number of species ranges that cover the reference threshold. Thus, the basis of the 25% is the number of species that have appeared and not yet dropped out at the reference threshold. The 50% and 80% biodiversity loss thresholds were calculated in a similar fashion.

Validate Index Values and Pollution Tolerance Scores

At sites in the overlap area, the correlation coefficient between index values for the northern and southern indices was 0.87 (Figure 5). This implies that the general index approach is valid, since the same process resulted in similar index values even though largely different datasets were used to derive the indices in each habitat. The regression relationship in Figure 5 was used to rescale index values for the southern data subset to the northern scale.

The correlation coefficients between the index and the mean ERM quotients and amphipod mortality were 0.52 and 0.72, respectively, for the northern habitat, and 0.65 and 0.50, respectively, for the southern bay habitat. Both correlations were statistically significant at $p < 0.0001$. The indicator variables explained about half of the variation in the index (Table 9).

The index classified correctly 87.5% of the sites *a priori* designated as undisturbed or disturbed (Table 10). All 20 of the undisturbed sites were classified as reference or Response Level 1, while 67% of the 12 disturbed sites were classified at Response Levels 2, 3, or 4. Response Levels 2, 3, and 4 indicate clearly disturbed benthic communities.

The habitat variables did not consistently covary with index values (Figures 6 and 7), showing that the index did not confound pollution effects with habitat differences. Only total organic carbon tended to increase along the pollution gradient defined by the index. The fact that sediment grain size distribution (% fines) does not follow the same pattern indicates that the increasing TOC is probably from anthropogenic sources rather than organic material naturally adhering to the larger surface area of smaller sized sediments (Newell 1979).

DISCUSSION

We successfully extended the Benthic Response Index (BRI) approach applied in mainland shelf environments to the bays of Southern California, achieving results comparable or better than other benthic index development efforts. The correlation coefficient of 0.87 between values for the independently derived northern and southern bay indices in the overlap region (Figure 5), and the accurate classification of 87.5% of the sites designated *a priori* as undisturbed or disturbed (Table 10) demonstrate this success. Classification efficiencies of 60.9-100% were achieved for other benthic indices (Engle *et al.* 1994, Weisberg *et al.* 1997, Engle and Summers 1999, Van Dolah *et al.* 1999, Paul *et al.* 2001, Llanso *et al.* 2002). At 0.57 and 0.46, correlations of the index with pollution indicator variables were also comparable with other studies. Ferraro and Cole (1997, 2002) found that chemical contamination and sediment toxicity only accounted, at best, for about 50% of the variation in benthic community measures after statistically accounting for the effects of potential confounding environmental variables. This result is almost identical with R^2 value for the relationship between the index and both pollution indicator variables (Table 9).

In extending the index to bays, the paucity of data required unusual validation measures. Although our three independent methods validated well, we would have preferred to only use data collected using a single set of methods and validate the index by applying it to independently collected data. In an effort to do so, we split our 1 mm screen data into two random subsets, intending to use one subset for index development and the other for validation. However, the results were excessively dependent on the allocation of specific severely affected sites to the development data or the validation data. After concluding that it was necessary to incorporate all of the variability in our data to develop a reliable index, and that our data were insufficient to partition in this way, we abandoned the approach.

The BRI worked well in bays, but not as well as the index developed for the mainland shelf. The correlations between the index values and gradients in ordination space were 0.815 and 0.848 for the northern and southern habitats, respectively (Table 3). The same correlations for the three coastal BRI habitats were 0.970, 0.972, and 0.980 (Smith *et al.* 2001), indicating substantially stronger relationships.

The BRI developed for bays was also robust to the presence or absence of particular species but less so than the coastal BRI. The correlation between the index with all species and with five species dropped was 0.85 (Figure 8). With the 10 most abundant species dropped, the correlation was still at 0.85. For the offshore BRI, the correlation with 10 species dropped was as high as 0.96 (Smith *et al.* 2001). This difference is most probably due to the higher diversity of species in the offshore benthic habitats, which provides greater redundancy of species information for index calculations. Although the embayment index is more affected by species removals, it still does not seem to be overly dependent on the presence of just a few species. Our test was the worst possible case since the most dominant species were removed first.

Two other factors also probably account for the differences in performance between the mainland shelf and bay BRI. First, the pollution gradient was probably defined better during development of the mainland shelf BRI because data collected during the 1970s from several severely polluted sites near wastewater discharge outfalls were available to define species abundances at polluted sites. Levels of pollution in the discharges were reduced considerably in subsequent decades, and monitoring programs tracked the resulting changes in species abundances. In addition to these well-defined gradients over time, stations offshore are usually affected almost entirely by one source and contain a distinct spatial gradient of benthic effects against which the index can be evaluated. In contrast, many of the data for development of the bay BRI were collected recently, after conditions in the bays had improved considerably, resulting in a paucity of severely polluted sites. Also, there is an insufficient history of collecting benthic species abundance data, chemical contaminant data, and acute toxicity data synoptically in bays, resulting in few data being available for index development. Southern California's bays are also close to many different point and non-point sources of pollutants, so that patterns of exposure in space and time are too complex to assume temporal or spatial gradients for the purpose of evaluating index response.

Second, for bay BRI development, smaller amounts of data were available from sites that were poorly known, whereas large amounts of coastal data were available from many well-known sites for mainland shelf BRI development. For bays, data for 341 sites were available from brief, episodic, unrepeated, non-overlapping sampling efforts that used different methods. In contrast, the mainland shelf BRI was developed from data for 717 samples from many sites that were sampled repeatedly by the same methods as conditions improved from 1973 to 1994. The coastal index development also had the advantage of data better distributed over many levels of impact. The abundance of data allowed the use of data not used in index development for index validation.

The pollution tolerance scores that we calculated were believable, with two well-known indicators of pollution and disturbance, the polychaete worms *Capitella capitata* and *Streblospio benedicti* receiving high values. There was no clear association between the most abundant non-indigenous species (NIS) and disturbance, although the pollution tolerance score of *Musculista senhousia*, the second most abundant NIS, ranked tenth overall.

We also found that pollution tolerances for species occurring in both the northern and southern bays are less consistent than tolerances of species occurring in multiple depth zones offshore. The correlation coefficient for tolerance values among the northern and southern bays was 0.39 (Figure 9) while higher correlations, 0.73 and 0.79 between the shallow and deep habitats with the mid-depth habitat, respectively, were found in the offshore BRI (Smith *et al*. 2001).

The assessment thresholds selected for interpretation of index values were functionally and ecologically equivalent to the thresholds used for the mainland shelf BRI (Table 11). Differences between the mainland shelf and embayment fauna prevented the use of identical thresholds. Hardly any of the echinoderm species used to establish the threshold for loss of community function in the mainland shelf BRI occur in bays. Instead, like the other thresholds for the mainland shelf BRI, all of the bay BRI thresholds were based on increasing losses in biodiversity from reference condition that were considered equivalent to the mainland shelf thresholds.

In effect, two BRI indices were developed, one for each screen size. In order to eliminate taxa with pollution tolerance scores that were inconsistent between 1.0 mm screens and 0.5 mm screens, an index was developed for each screen and for each habitat. We reasoned that the relative tolerance of species to pollution should be independent of collection method and the species with pollution tolerance scores that were inconsistent between the 1.0 mm and 0.5 mm data were probably not the most consistent pollution indicators. Interestingly, 13 of 19 taxa with inconsistent scores in the north (Table 6) and 11 of 19 in the south (Table 7) were grouped at higher than species level, suggesting that many higher level taxon groupings may contain multiple species with different responses to stress. We chose not to eliminate all higher-level groupings because many taxa were not identified to species and there was a high level of consistency for most of them.

Although there are plausible biological reasons why a species could have different pollution tolerance scores when collected with a 0.5 mm versus a 1.0 mm screen, most are related to differences in pollution tolerance between different life stages. This factor affected few, if any, taxa in our study because most of the organisms collected on both screens were adults.

We had insufficient information to address the question of which combination of sampling methods is most effective to answer assessment questions in bays. The Van Veen grab used to collect 1.0 mm samples had 13.3 times the area of the corer used to collect the 0.5 mm data. Using the smaller screen approximately doubles the cost of laboratory processing due to the larger numbers and smaller organisms to be identified. A more controlled study of the effects of sample and screen size on the index values is necessary to design the most cost-efficient assessment applications. While this cost efficiency may be important for monitoring purposes, smaller screen sizes are necessary to capture smaller individuals in order to quantify recruitment and growth, and understand the population dynamics of benthic species.

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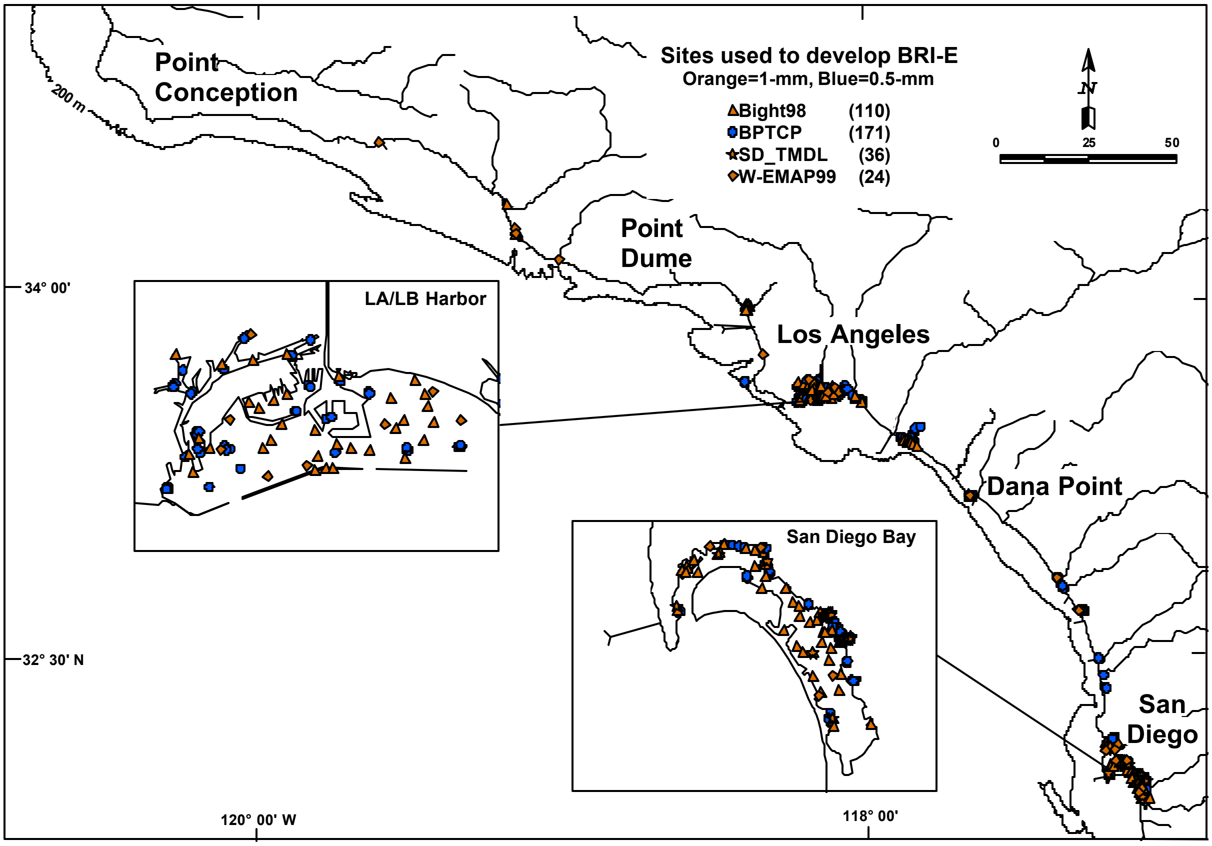

Figure 1. Location of sampling sites for the southern California bays Benthic Response Index.

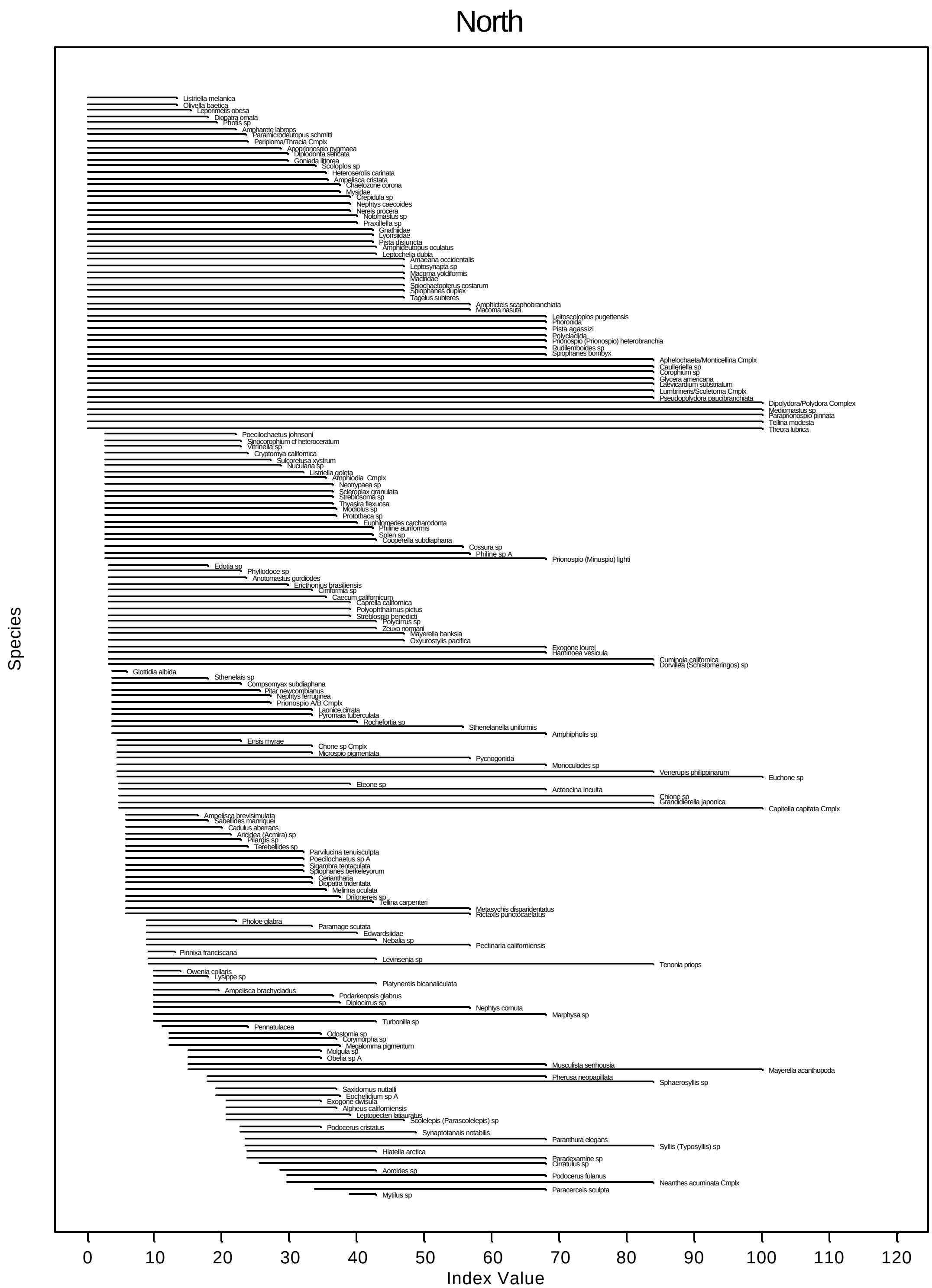

Figure 2. Species ranges along the index pollution gradient for the northern (North) data subset. Species are ordered from top to bottom by their first and last appearance on the gradient. Only species occurring at least three times in the northern data subset are included.

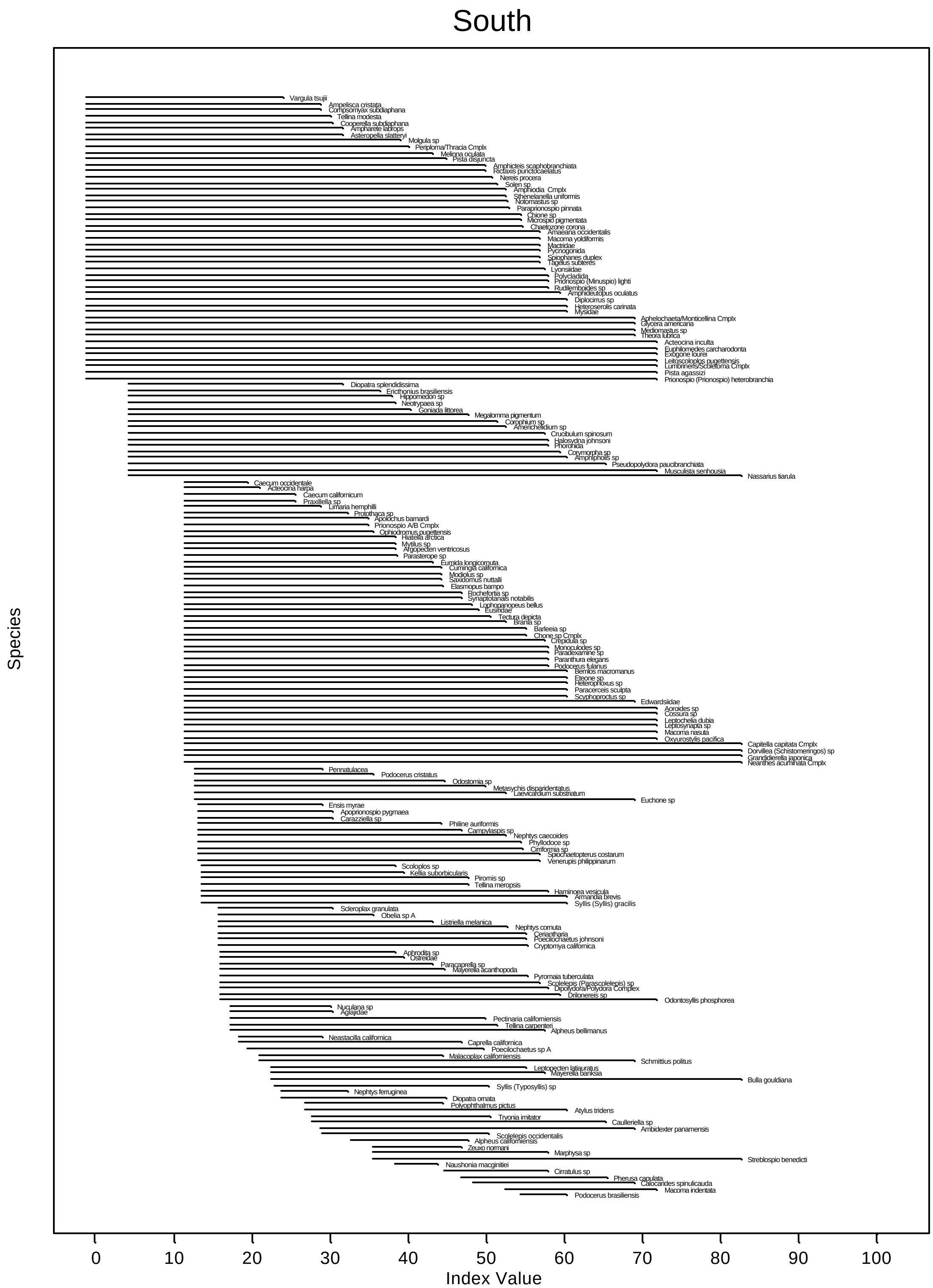

Figure 3. Species ranges along the index pollution gradient for the southern (South) data subset. Species are ordered from top to bottom by their first and last appearance on the gradient. Only species occurring at least three times in the southern data subset are included.

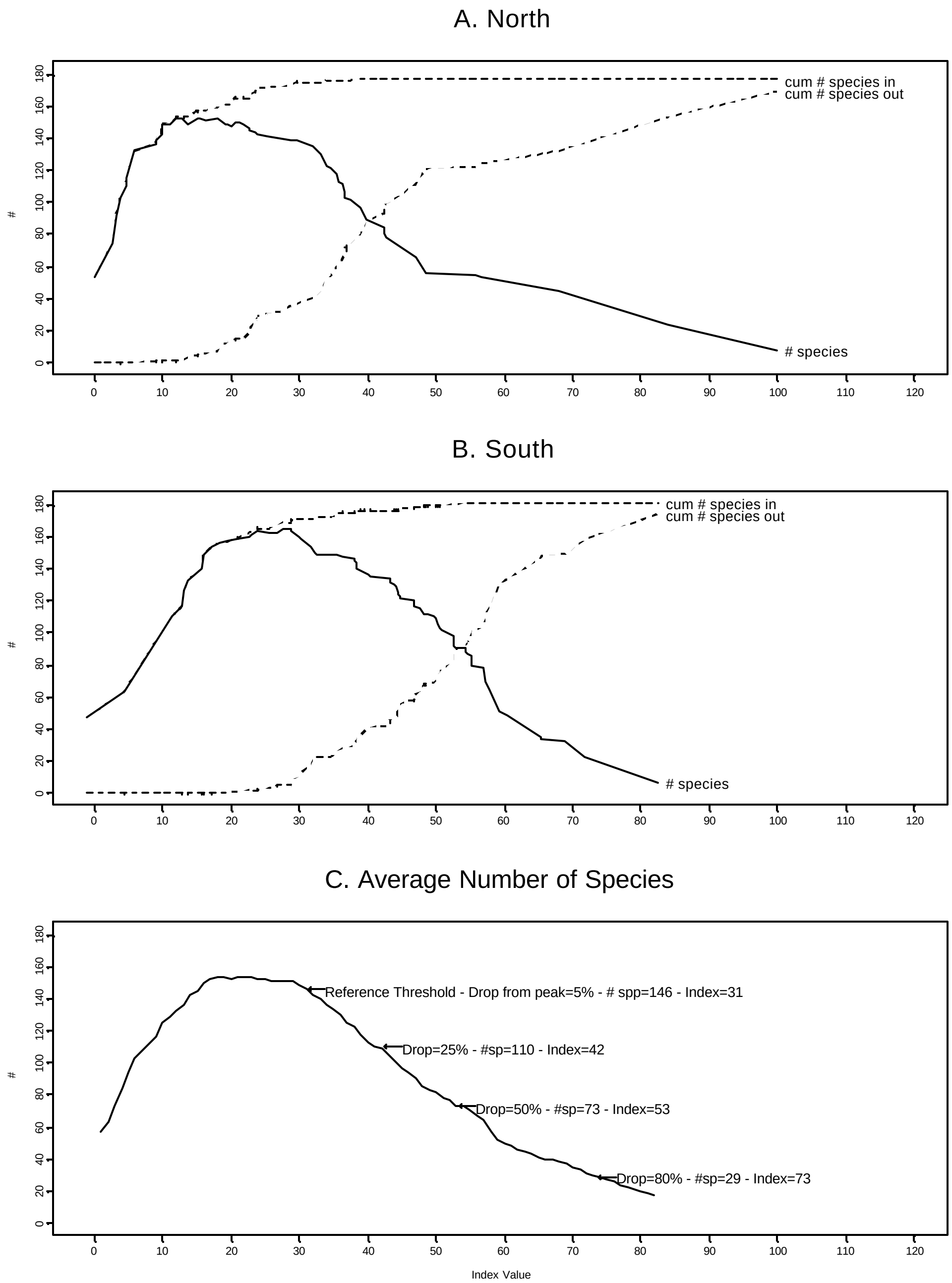

Figure 4. A and B. Summary of species ranges along the index pollution vector for the northern (North) and southern (South) data subsets. The dashed curve labeled “cum # species in” is the cumulative number of species ranges intersecting index values up to and including the index value on the horizontal axis (see Figures 2 and 3). The dashed curve labeled “cum # species out” is the cumulative number of species that have dropped out before the index value on the horizontal axis. The solid curve (labeled “# species”) is the net number of species (the “cumulative # species in” minus the “cumulative # species out”). C. The average of the number of species curves for the northern (North) and southern (South) data subsets. The labeled arrows indicate positions of the assessment thresholds on the curve.

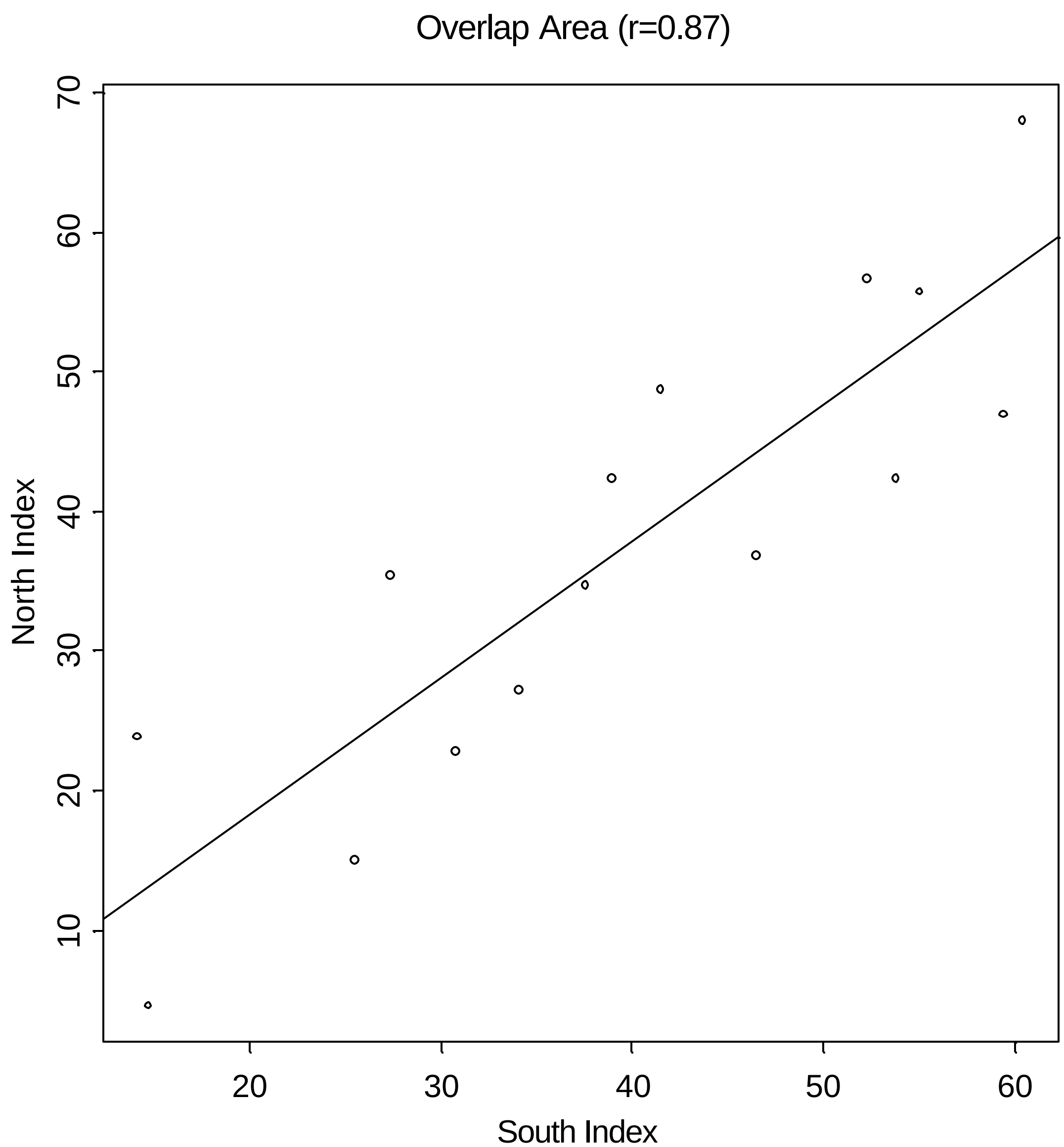

Figure 5. Relationship between index values computed for the southern (South) and northern (North) data subsets for sites in the overlap region. The regression equation is North=1.112+0.975(South).

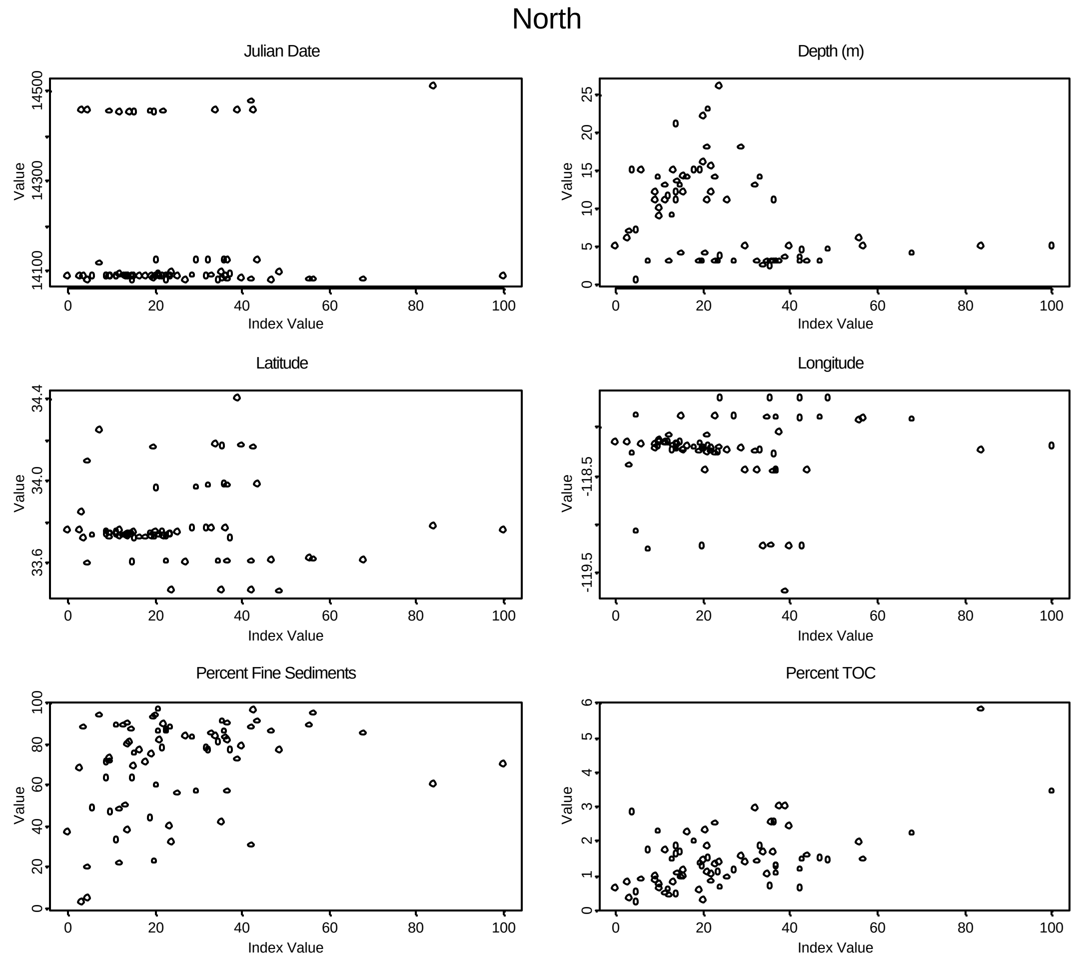

Figure 6. Relationships between habitat measures and index values for the northern (North) data subset.

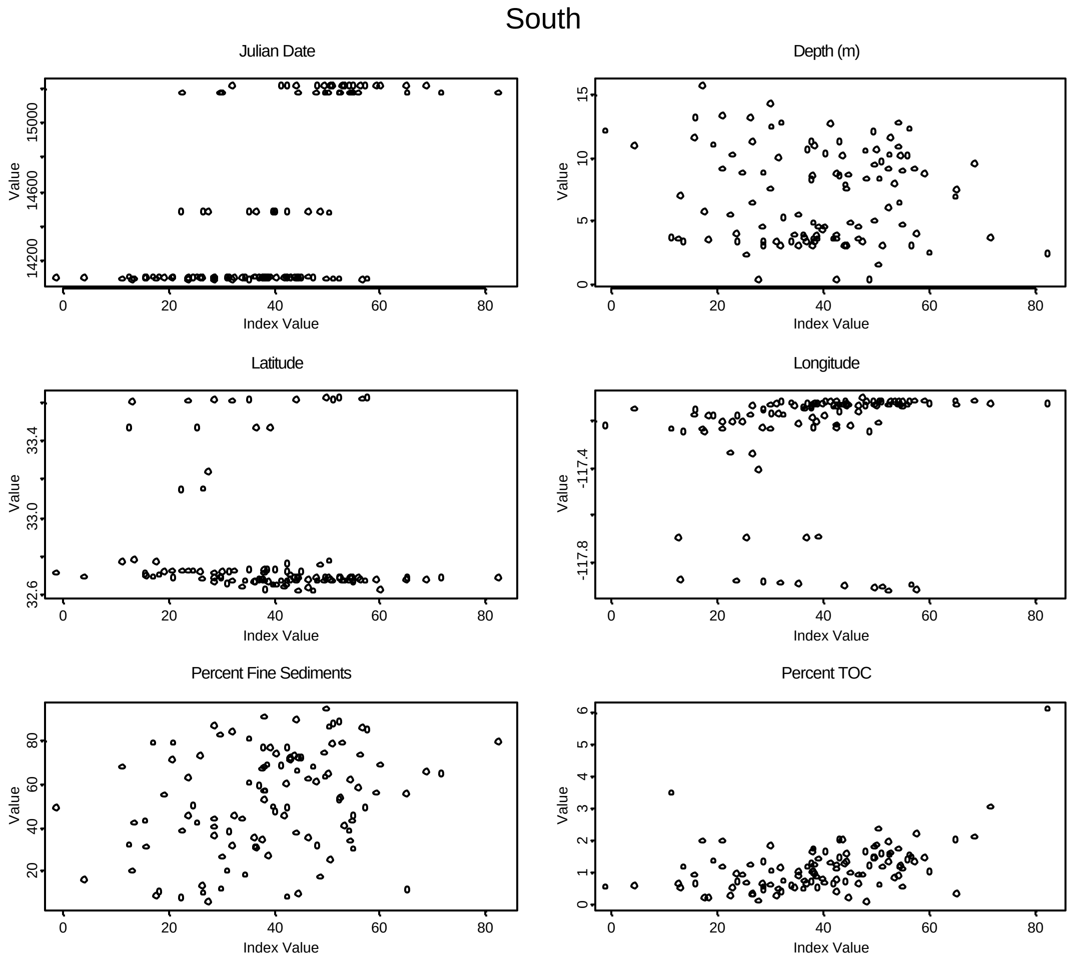

Figure 7. Relationships between habitat measures and index values for the southern (South) data subset.

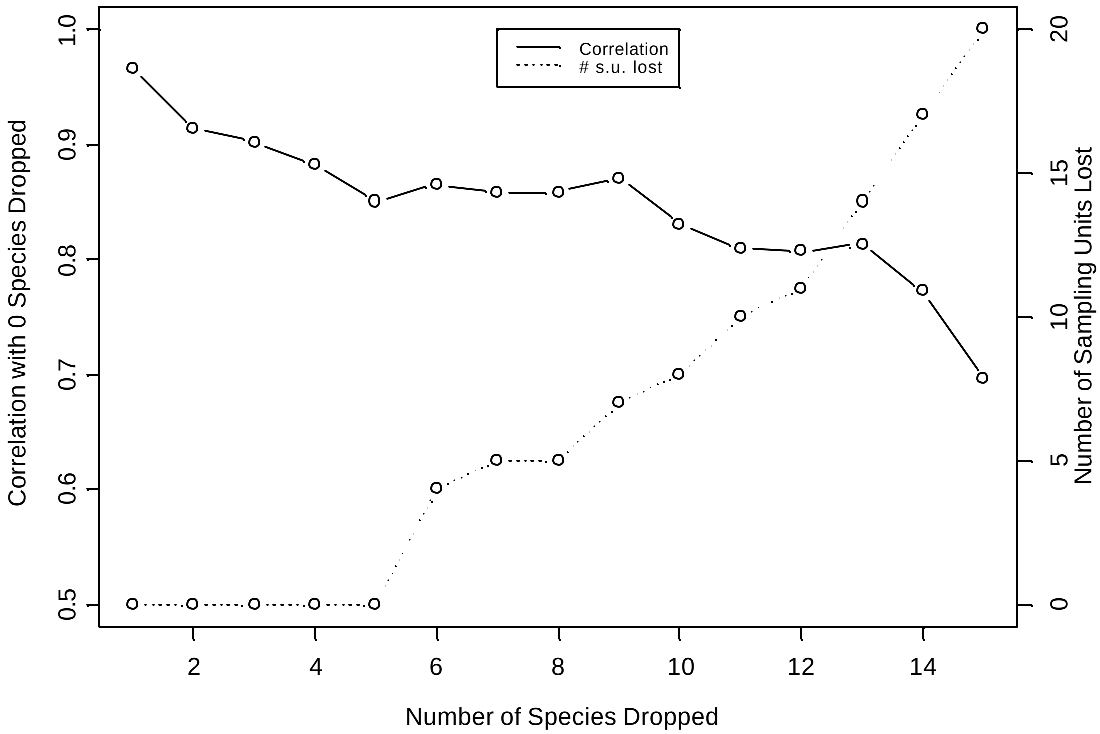

Figure 8. The effect of species elimination on index values. Presented are correlations between the index values with all species and index values with the n most abundant species dropped. As species are dropped, some sampling units become devoid of species with p_i values, and no index can be calculated. The numbers of sampling units lost are shown with the dashed line. Only the first five correlations (1-5 species dropped) are directly comparable since they involve the same sampling units.

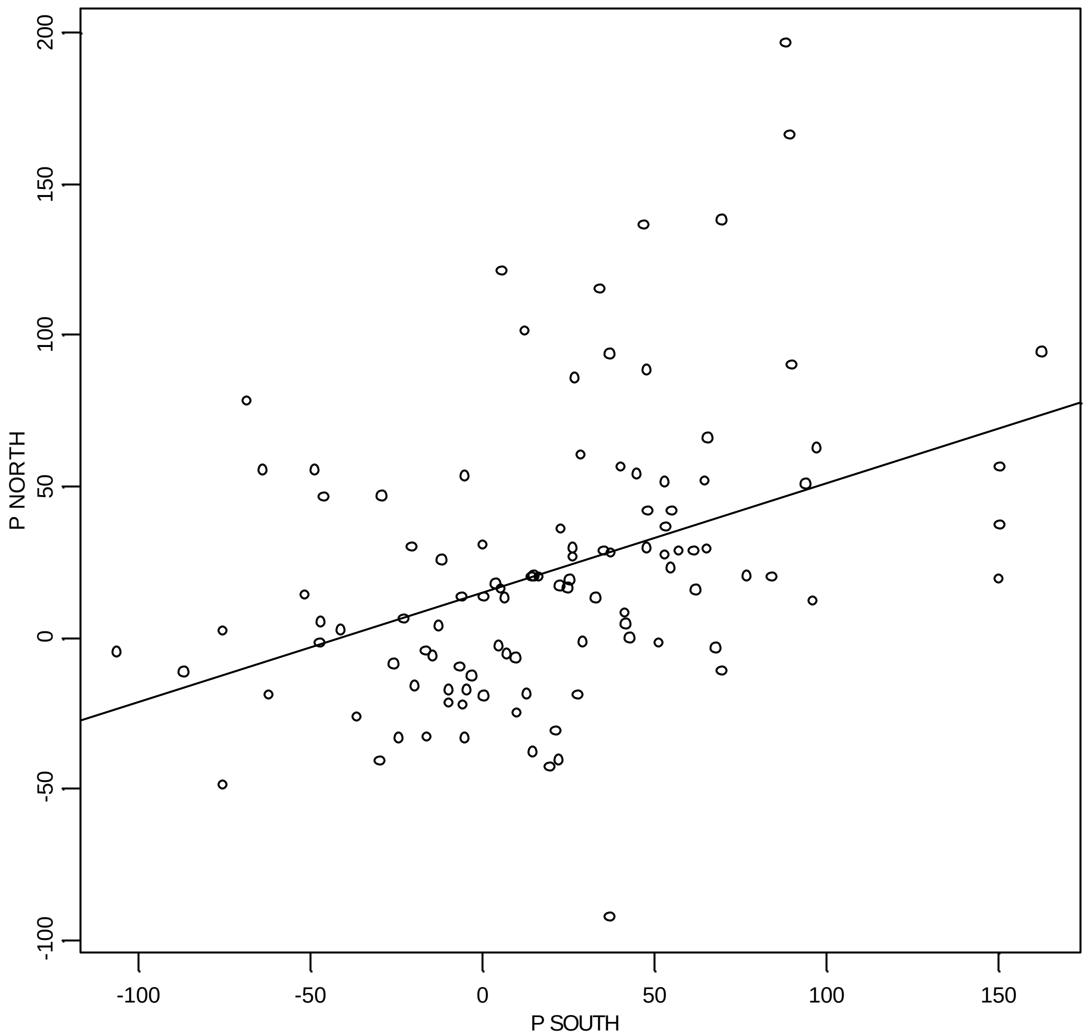

Figure 9. Comparison of p_i values for species used in both the northern (North) and southern (South) categories. The least-squares regression line is shown. The correlation between p_i values in the two categories is 0.39.

Table 1. Data sources.

Sieve Size (mm)	Sampling Area and Device	Program	Year	Sites	No. of Taxa	Abundance
1.0	0.1-m^2 Van Veen Grab	Bight'98	1998	110	418	107,207
		Western EMAP	1999	24		
		San Diego Bay Toxic Hot Spot Spatial Study	2001	36		
0.5	0.0075-m^2 Corer	Bay Protection and Toxic Clean-up Program	1992-97	171	238	159,605

Table 2. Correlations for the 1.0 mm data between the ordination axes and the pollution indicator variables after the canonical correlation analysis.

Analysis	Mean ERM Quotient		Amphipod Mortality	
	Axis 1	Axis 2	Axis 1	Axis 2
North	0.47	0.49	0.75	-0.14
South	0.75	-0.17	0.33	0.64

Table 3. Optimum parameter values and index-pollution vector correlation coefficients from the optimization procedure for the 1.0 mm data (n=170). *f* is the exponent in the index calculations while *t* and *e* are only used to develop species pollution tolerance (p_i) values. *t* is the number of sites with only the *t* highest species abundance values included. *e* is the exponent in the p_i calculations. $r_{I_s \cdot g_s}$ is the Pearson correlation between the optimized index and the pollution vector in the ordination space. Two results are provided for the northern index since the second result with *f*=0.33 was used for consistency with other BRI indices instead of *f*=1.00.

Data subset	*t*	*e*	*f*	$r_{I_s \cdot g_s}$
South	45	0.25	0.33	0.848
North	17	0.33	1.00	0.832
	20	0.50	0.33	0.815

Table 4. Species with the 10 highest pollution tolerance scores in the northern and southern bay habitats. Included are species ranked in the top 10 in either habitat. The mean rank is the rank for the average of the pollution tolerance scores for the northern and southern bays.

Phylum	Name	Pollution Tolerance Score		Rank		
		Northern	Southern	North	South	Mean
Mollusca	*Macoma indentata*		226.764		1	1
Arthropoda	*Acanthaxius spinulicaudus*		148.719		6	2
Arthropoda	*Podocerus brasiliensis*		146.44		7	3
Annelida	*Capitella capitata* Complex	196.587	88.339	1	16	4
Annelida	*Pherusa neopapillata*	130.991		5		5
Annelida	*Cirratulus* sp.	94.373	162.865	9	2	6
Annelida	*Neanthes acuminate* Complex	166.229	89.682	2	15	7
Annelida	*Pherusa capulata*		122.293		8	8
Arthropoda	*Ambidexter panamensis*		120.771		9	9
Mollusca	*Musculista senhousia*	138.19	69.863	3	21.5	10
Annelida	*Marphysa* sp.	56.336	150.452	23	4	11
Arthropoda	*Naushonia macginitiei*		102.751		10	12
Mollusca	*Macoma nasuta*	37.055	150.473	41	3	13
Arthropoda	*Paradexamine* sp.	136.481	47.047	4	44	14
Arthropoda	*Mayerella banksia*	19.371	150.301	66	5	17
Annelida	*Polydora* sp.	115.025	34.328	7	58	19
Arthropoda	*Aoroides* sp.	93.917	37.414	10	54	27
Mollusca	*Cumingia californica*	121.19	5.746	6	93	29
Arthropoda	*Podocerus fulanus*	101.494	12.682	8	87	33

Table 5. Species with the 10 lowest pollution tolerance scores in the northern and southern bay habitats. Included are species ranked in the lowest 10 in either habitat. The mean rank is the rank for the average of the pollution tolerance scores for the northern and southern bays.

Phylum	Name	Pollution Tolerance Score		Rank		
		Northern	Southern	North	South	Mean
Mollusca	*Hiatella arctica*	78.246	-68.361	14	156	119
Chordata	*Molgula* sp.	55.15	-63.455	26	153	140
Mollusca	*Cryptomya californica*	-42.938	19.896	149	79	155
Annelida	*Eteone* sp.	-92.577	37.356	157	55	177
Arthropoda	*Ericthonius brasiliensis*	2.119	-75.217	100	159	190
Annelida	*Anotomastus gordiodes*	-43.655		150		196
Mollusca	*Compsomyax subdiaphana*	-11.515	-86.692	118	160	197
Arthropoda	*Pinnixa franciscana*	-49.367		152		198
Arthropoda	*Ampelisca cristata*	-4.825	-105.945	111	161	203
Mollusca	*Acteocina inculta*	-57.035		153		204
Brachiopoda	*Glottidia albida*	-57.677		154		205
Mollusca	*Caecum californicum*	-48.975	-75.15	151	158	206
Arthropoda	*Asteropella slatteryi*		-63.807		154	207
Mollusca	*Caecum occidentale*		-63.983		155	208
Mollusca	*Diplodonta sericata*	-65.52		155		209
Annelida	*Polyophthalmus pictus*	-70.708		156		210
Mollusca	*Acteocina harpa*		-73.88		157	211
Mollusca	*Leporimetis obesa*	-95.997		158		212
Arthropoda	*Vargula tsujii*		-112.389		162	213

Table 6. Species removed from the northern data subset because of inconsistencies between p_i values for the 1.0 mm and 0.5 mm data. As the species with the most inconsistent p_i values between the 1.0 mm and 0.5 mm data (as indicated by low $z_{i,c}\ z_{i,v}$ values) are removed, the correlation between the p_i values ($r_{c,v}$) increases. The last four columns are correlations from internal validation measures. The optimization correlations are between the index values and the pollution gradient in the ordination space, and the index vs. indicator correlations are the $\sqrt{R^2}$ value from a multiple linear regression analysis with the mean ERM quotient and amphipod mortality as independent variables and index values as the dependent variable.

		Values in Equation (3)				Optimization Correlations		Index vs. Indicator Correlations	
No. of Species Dropped	**Taxon Dropped**	$z_{i,c}$	$z_{i,v}$	$z_{i,c}\ z_{i,v}$	$r_{c,v}$	r_{I_s,g_s} **1.0 mm**	r_{I_s,g_s} **0.5 mm**	$r_{I_s,Amph\&ErmQ}$ **1.0 mm**	$r_{I_s,Amph\&ErmQ}$ **0.5 mm**
0	None				0.325	0.812	0.799	0.678	0.659
1	*Photis* sp.	-1.689	2.181	-3.683	0.378	0.812	0.799	0.679	0.659
2	*Podocerus cristatus*	-1.306	2.645	-3.455	0.435	0.811	0.800	0.678	0.660
3	*Streblospio benedicti*	-1.875	1.915	-3.591	0.494	0.833	0.800	0.715	0.661
4	*Lyonsiidae*	-1.702	1.411	-2.402	0.534	0.831	0.800	0.714	0.661
5	*Diplocirrus* sp.	-1.354	1.079	-1.461	0.559	0.831	0.800	0.714	0.661
6	*Nereis procera*	-0.926	1.170	-1.084	0.578	0.832	0.799	0.713	0.662
7	*Odostomia* sp.	-1.176	0.941	-1.107	0.598	0.832	0.789	0.713	0.640
8	*Polycladida*	-0.753	1.351	-1.017	0.617	0.832	0.789	0.713	0.641
9	*Cirriformia* sp.	-0.463	1.337	-0.619	0.632	0.832	0.787	0.713	0.634
10	*Mysidae*	-0.578	1.030	-0.595	0.644	0.832	0.789	0.713	0.634
11	*Leptochelia dubia*	0.279	-1.968	-0.549	0.666	0.832	0.787	0.713	0.632
12	*Prionospio A/B Cmplx*	0.876	-0.623	-0.546	0.677	0.832	0.788	0.713	0.633
13	*Phoronida*	-0.166	2.163	-0.360	0.701	0.829	0.786	0.707	0.634
14	*Pholoe glabra*	-0.948	0.341	-0.323	0.709	0.829	0.785	0.707	0.634
15	*Poecilochaetus* sp. A	-0.385	0.611	-0.235	0.714	0.829	0.785	0.707	0.634
16	*Chaetozone corona*	-0.578	0.368	-0.213	0.719	0.832	0.785	0.707	0.634
17	*Neotrypaea* sp.	-0.207	1.024	-0.212	0.726	0.832	0.784	0.707	0.633
18	*Streblosoma* sp.	-0.262	0.827	-0.216	0.733	0.832	0.784	0.708	0.633
19	*Chone* sp. *Cmplx*	-0.698	0.313	-0.218	0.738	0.832	0.784	0.708	0.634

Table 7. Species removed from the southern data subset because of inconsistencies between p_i values for the 1.0 mm and 0.5 mm data. See the Table 6 caption for explanation.

		Values in FEquation (3)				Optimization Correlations		Index vs. Indicator Correlations	
# Species Dropped	Taxon Dropped	$z_{i,c}$	$z_{i,v}$	$z_{i,c}\ z_{i,v}$	$r_{c,v}$	r_{I_s,g_s} 1.0 mm	r_{I_s,g_s} 0.5 mm	$r_{I_s,Amph\&ErmQ}$ 1.0 mm	$r_{I_s,Amph\&ErmQ}$ 0.5 mm
0	None				0.226	0.873	0.841	0.731	0.648
1	*Scoloplos* sp.	-1.795	1.083	-1.943	0.253	0.873	0.839	0.732	0.650
2	*Crepidula* sp.	-0.869	2.054	-1.785	0.308	0.873	0.841	0.731	0.652
3	*Odostomia* sp.	-1.524	1.015	-1.547	0.330	0.871	0.842	0.731	0.651
4	*Parasterope* sp.	-1.845	0.867	-1.600	0.362	0.872	0.841	0.730	0.650
5	*Venerupis philippinarum*	1.896	-0.774	-1.468	0.393	0.868	0.841	0.730	0.650
6	*Eusiridae*	-0.909	1.191	-1.083	0.415	0.865	0.842	0.726	0.649
7	*Polycladida*	-1.043	1.045	-1.089	0.437	0.865	0.843	0.727	0.649
8	*Elasmopus bampo*	-1.373	0.643	-0.883	0.457	0.865	0.844	0.728	0.650
9	*Nereis procera*	-0.877	1.013	-0.889	0.476	0.865	0.846	0.727	0.652
10	*Lyonsiidae*	-0.853	0.930	-0.793	0.493	0.864	0.845	0.727	0.651
11	*Acteocina inculta*	0.579	-0.866	-0.501	0.509	0.866	0.844	0.729	0.653
12	*Bulla gouldiana*	1.891	-0.260	-0.492	0.527	0.863	0.844	0.727	0.654
13	*Polyophthalmus pictus*	-0.511	0.750	-0.383	0.536	0.862	0.845	0.727	0.653
14	*Cossura* sp.	0.993	-0.345	-0.342	0.551	0.861	0.847	0.723	0.650
15	*Megalomma pigmentum*	-1.298	0.166	-0.216	0.562	0.857	0.846	0.720	0.649
16	*Mysidae*	-0.146	1.376	-0.201	0.574	0.855	0.845	0.719	0.650
17	*Podocerus cristatus*	-1.260	0.180	-0.227	0.586	0.856	0.846	0.719	0.651
18	*Americhelidium* sp.	-0.900	0.243	-0.218	0.594	0.855	0.847	0.720	0.649
19	*Chone* sp. *Cmplx*	-0.926	0.218	-0.202	0.607	0.848	0.847	0.720	0.649

Table 8. Index threshold values applicable to northern and southern bays.

Threshold	Index Value
Reference	31
25% Biodiversity Loss	42
50% Biodiversity Loss	53
80% Biodiversity Loss	73

Table 9. Relationships between index values and the pollution indicators. Presented are Pearson correlation coefficients between index values and the individual indicators and the R^2 from a multiple regression of index values against both indicators

Habitat	Correlation with Mean ERM Quotient	Correlation with Amphipod Mortality	R^2 with Mean ERM Quotient and Amphipod Mortality
Northern Bays	0.52	0.72	0.50
Southern Bays	0.65	0.50	0.52

Table 10. Assessment of 32 sites classified *a priori* as undisturbed or disturbed. The southern California bays BRI was calculated from benthic species abundances and assessment thresholds were applied to BRI values to assess the sites. Response Level 1 is only marginally different from reference. Response Levels 2 through 4 clearly indicate disturbed benthic assemblages.

Classification	Number of Sites	
	Undisturbed	Disturbed
Reference	18	1
Response Level 1	2	3
Response Level 2	-	3
Response Level 3	-	3
Response Level 4	-	2

Table 11. Comparison of the bay and coastal BRI assessment thresholds.

Level	Characterization	Definition		BRI Thresholds	
	Coast	Coast	Bays	Coast	Bays
Reference	Reference			<25	<31
Response Level 1	Marginal deviation	> 90% tolerance interval for reference index values	> 5% of reference species lost	25-34	31-42
Response Level 2	Biodiversity loss	> 25% of reference species lost	> 25% of reference species lost	34-44	42-53
Response Level 3	Community function loss	> 90% of echinoderm and 75% arthropod species lost	> 50% of reference species lost	44-72	53-73
Response Level 4	Defaunation	> 90% of reference species lost	> 80% of reference species lost	>72	>73

ATTACHMENT C-1

Method for finding the pollution gradient in ordination space

An example of the method used to find the pollution gradient in the ordination space is presented here. Canonical correlation analysis was used to reduce the ordination space to a two-dimensional space that maximally correlates with the pollution gradient. The canonical correlation analysis used the first 20 ordination axes and the two pollution indicator variables, the mean ERM quotient and the control-adjusted amphipod mortality in acute sediment toxicity tests. The canonical correlation analysis produces two-dimensional spaces, one corresponding to the ordination scores and the other corresponding to the indicator variables. The space used for index development corresponds to the ordination scores.

Table C1.1 presents example correlations between the first and second canonical correlation axes and the pollution indicators. The correlations for the amphipod toxicity test are represented graphically on the left of Figure C1.1 as distances along Axis 1 and Axis 2. The resultant direction or vector for the amphipod test is 43.5^{o} from Axis 1, indicated by a line crossing through the origin and a bisection of the line connecting the two correlations. Using the same method, on the right of Figure C1.1, the resultant vector for the mean ERM quotient is found to be at -15^{o}. The overall pollution gradient vector is computed as the average of the two vectors for the pollution indicators, i.e., 14.25 from the horizontal ((43.5-15.0)/2).

Table C1.1. Example correlations between the indicators and the ordination axes after the canonical correlation analysis. These correlations are presented graphically in Figure C1.1.

	Axis 1	Axis 2
Mean ERM Quotient	0.82	-0.22
Amphipod Mortality	0.52	0.49

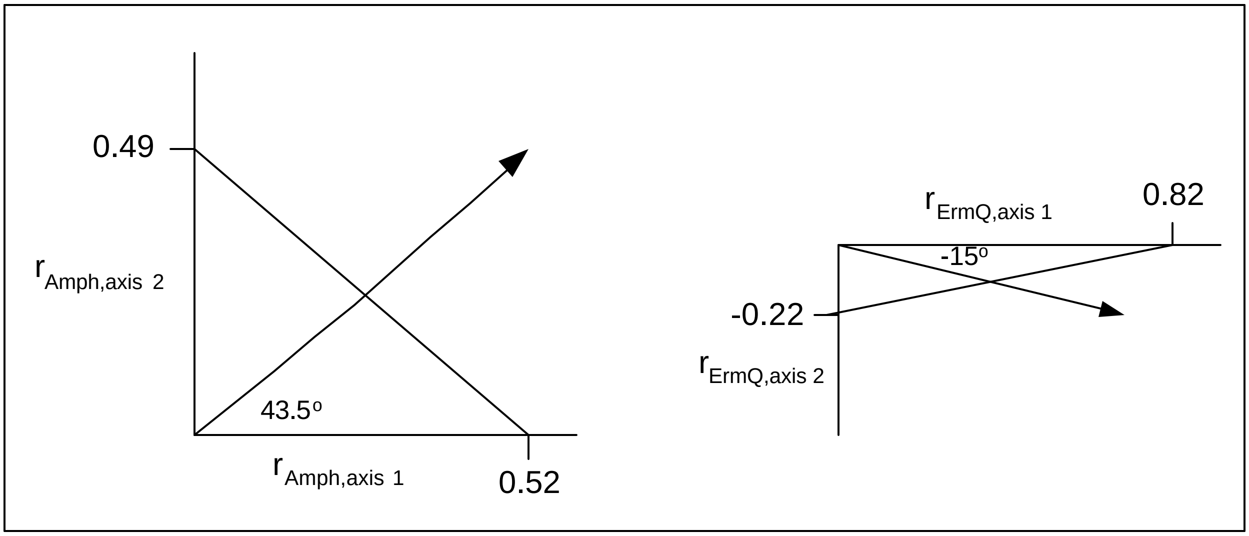

Figure C1.1. Example of the method for finding resultant vectors for pollution indicators in a two-dimensional ordination space, using the correlations in Table A.1. See text for explanation.

ATTACHMENT C-2

Taxa included in the P-Names for which pollution tolerance scores (p_i) are available.

P-Code	P-Name	Included Taxa	Phylum	Family
P041	AMPHARETE LABROPS	Ampharete labrops	Annelida	Ampharetidae
P044	AMPHICTEIS SCAPHOBRANCHIATA	Amphicteis scaphobranchiata	Annelida	Ampharetidae
P272	LYSIPPE SP	Lysippe; all taxa within the genus	Annelida	Ampharetidae
P294	MELINNA OCULATA	Melinna oculata	Annelida	Ampharetidae
P367	PARAMAGE SCUTATA	Paramage scutata	Annelida	Ampharetidae
P451	SABELLIDES MANRIQUEI	Sabellides manriquei	Annelida	Ampharetidae
P060	APHRODITA SP	Aphrodita; all taxa within the genus	Annelida	Aphroditidae
P057	ANOTOMASTUS GORDIODES	Anotomastus gordiodes	Annelida	Capitellidae
P288	MEDIOMASTUS SP	Mediomastus; all taxa within the genus	Annelida	Capitellidae
P336	NOTOMASTUS SP	Notomastus; all taxa within the genus	Annelida	Capitellidae
P476	SPIOCHAETOPTERUS COSTARUM	Spiochaetopterus costarum	Annelida	Chaetopteridae
P059	APHELOCHAETA/MONTICELLINA COMPLEX	Aphelochaeta, Monticellina; all taxa within the genera	Annelida	Cirratulidae
P115	CHAETOZONE CORONA	Chaetozone corona	Annelida	Cirratulidae
P120	CIRRATULUS SP	Cirratulus; all taxa within the genus	Annelida	Cirratulidae
P121	CIRRIFORMIA SP	Cirriformia; all taxa within the genus	Annelida	Cirratulidae
P132	COSSURA SP	Cossura; all taxa within the genus	Annelida	Cossuridae
P155	DORVILLEA (SCHISTOMERINGOS) LONGICORNIS	Dorvillea (Schistomeringos); all taxa within the subgenus	Annelida	Dorvilleidae
P286	MARPHYSA SP	Marphysa: all taxa within the genus	Annelida	Eunicidae
P521	DIPLOCIRRUS SP	Diplocirrus; all taxa within genus	Annelida	Flabelligeridae
P522	PHERUSA CAPULATA	Pherusa capulata	Annelida	Flabelligeridae
P382	PHERUSA NEOPAPILLATA	Pherusa neopapillata	Annelida	Flabelligeridae
P523	PIROMIS SP	Piromis; all taxa within genus	Annelida	Flabelligeridae
P206	GLYCERA AMERICANA	Glycera americana	Annelida	Glyceridae
P214	GONIADA LITTOREA	Goniada littorea	Annelida	Goniadidae
P409	PODARKE PUGETTENSIS	Ophiodromus pugettensis	Annelida	Hesionidae
P410	PODARKEOPSIS GLABRUS	Podarkeopsis glabrus	Annelida	Hesionidae
P270	LUMBRINERIS SP	Lumbrineris & Scoletoma; all taxa within the genera	Annelida	Lumbrineridae
P300	METASYCHIS DISPARIDENTATUS	Metasychis disparidentatus	Annelida	Maldanidae
P422	PRAXILLELLA SP	Praxillella; all taxa within the genus	Annelida	Maldanidae
P326	NEPHTYS CAECOIDES	Nephtys caecoides	Annelida	Nephtyidae
P327	NEPHTYS CORNUTA	Nephtys cornuta	Annelida	Nephtyidae
P328	NEPHTYS FERRUGINEA	Nephtys ferruginea	Annelida	Nephtyidae
P526	NEANTHES ACUMINATA COMPLEX	Neanthes acuminata; all forms referred to under this name	Annelida	Nereididae
P405	PLATYNEREIS BICANALICULATA	Platynereis bicanaliculata	Annelida	Nereididae
P157	DRILONEREIS SP	Drilonereis; all taxa within the genus	Annelida	Oenonidae
P152	DIOPATRA ORNATA	Diopatra ornata	Annelida	Onuphidae
P153	DIOPATRA SPLENDIDISSIMA	Diopatra splendidissima	Annelida	Onuphidae

P-Code	P-Name	Included Taxa	Phylum	Family
P154	DIOPATRA TRIDENTATA	Diopatra tridentata	Annelida	Onuphidae
P070	ARMANDIA BREVIS	Armandia brevis	Annelida	Opheliidae
P524	POLYOPHTHALMUS PICTUS	Polyophthalmus pictus	Annelida	Opheliidae
P248	LEITOSCOLOPLOS PUGETTENSIS	Leitoscoloplos pugettensis	Annelida	Orbiniidae
P525	SCOLOPLOS SP	Scoloplos; all taxa within the genus	Annelida	Orbiniidae
P356	OWENIA COLLARIS	Owenia collaris	Annelida	Oweniidae
P069	ARICIDEA WASSI	Aricidea (Aricidea) wassi	Annelida	Paraonidae
P004	ACMIRA SP	Aricidea (Acmira); all taxa within the subgenus	Annelida	Paraonidae
P258	LEVINSENIA SP	Levinsenia; all taxa within the genus	Annelida	Paraonidae
P378	PECTINARIA CALIFORNIENSIS	Pectinaria californiensis	Annelida	Pectinariidae
P171	ETEONE SP	Eteone; all taxa within the genus	Annelida	Phyllodocidae
P177	EUMIDA LONGICORNUTA	Eumida longicornuta	Annelida	Phyllodocidae
P391	PHYLLODOCE SP	Phyllodoce; all taxa within the genus	Annelida	Phyllodocidae
P527	PILARGIS SP	Pilargis; all taxa within the genus	Annelida	Pilargidae
P464	SIGAMBRA TENTACULATA	Sigambra tentaculata	Annelida	Pilargidae
P414	POECILOCHAETUS JOHNSONI	Poecilochaetus johnsoni	Annelida	Poecilochaetidae
P415	POECILOCHAETUS SP A	Poecilochaetus sp A Martin 1977	Annelida	Poecilochaetidae
P528	HALOSYDNA JOHNSONI	Halosydna johnsoni	Annelida	Polynoidae
P583	STHENELAIS SP	Sthenelais; all taxa within the genus (Bay BRI)	Annelida	Sigalionidae
P172	EUCHONE SP	Euchone; all taxa within the genus	Annelida	Sabellidae
P289	MEGALOMMA PIGMENTUM	Megalomma pigmentum	Annelida	Sabellidae
P063	APOPRIONOSPIO PYGMAEA	Apoprionospio pygmaea	Annelida	Spionidae
P104	CARAZZIELLA SP	Carazziella; all taxa within the genus	Annelida	Spionidae
P247	LAONICE CIRRATA	Laonice cirrata	Annelida	Spionidae
P303	MICROSPIO PIGMENTATA	Microspio pigmentata	Annelida	Spionidae
P373	PARAPRIONOSPIO PINNATA	Paraprionospio pinnata	Annelida	Spionidae
P419	POLYDORA SP	Polydora, Dipolydora; all taxa within the genera	Annelida	Spionidae
P424	PRIONOSPIO A/B COMPLEX	Prionospio dubia and P. jubata	Annelida	Spionidae
P531	PRIONOSPIO (PRIONOSPIO) HETEROBRANCHIA	Prionospio heterobranchia	Annelida	Spionidae
P426	PRIONOSPIO LIGHTI	Prionospio lighti and P. multibranchiata (P. lighti only in bay habitats)	Annelida	Spionidae
P532	PSEUDOPOLYDORA PAUCIBRANCHIATA	Pseudopolydora paucibranchiata	Annelida	Spionidae
P533	SCOLELEPIS (PARASCOLELEPIS) SP	Scolelepis (Parascolelepis); all taxa within subgenus	Annelida	Spionidae
P459	SCOLELEPIS OCCIDENTALIS	Scolelepis (Scolelepis) occidentalis	Annelida	Spionidae
P477	SPIOPHANES BERKELEYORUM	Spiophanes berkeleyorum	Annelida	Spionidae
P478	SPIOPHANES BOMBYX	Spiophanes bombyx	Annelida	Spionidae
P584	STREBLOSPIO BENEDICTI	Streblospio benedicti	Annelida	Spionidae
P529	BRANIA SP	Brania; all taxa within the genus	Annelida	Syllidae
P188	EXOGONE DWISULA	Exogone dwisula	Annelida	Syllidae
P189	EXOGONE LOUREI	Exogone lourei	Annelida	Syllidae
P339	ODONTOSYLLIS PHOSPHOREA	Odontosyllis phosphorea	Annelida	Syllidae
P474	SPHAEROSYLLIS SP	Sphaerosyllis; all taxa within the	Annelida	Syllidae

P-Code	P-Name	Included Taxa	Phylum	Family
		genus		
P585	SYLLIS (SYLLIS) GRACILIS	Syllis (Syllis) gracilis	Annelida	Syllidae
P023	AMAEANA OCCIDENTALIS	Amaeana occidentalis	Annelida	Terebellidae
P401	PISTA ALATA	Pista agassizi	Annelida	Terebellidae
P402	PISTA FASCIATA	Pista disjuncta	Annelida	Terebellidae
P418	POLYCIRRUS SP	Polycirrus; all taxa within the genus	Annelida	Terebellidae
P548	ALPHEUS BELLIMANUS	Alpheus bellimanus	Arthropoda	Alpheidae
P549	ALPHEUS CALIFORNIENSIS	Alpheus californiensis	Arthropoda	Alpheidae
P026	AMPELISCA BRACHYCLADUS	Ampelisca brachycladus	Arthropoda	Ampeliscidae
P027	AMPELISCA BREVISIMULATA	Ampelisca brevisimulata	Arthropoda	Ampeliscidae
P029	AMPELISCA CRISTATA	Ampelisca cristata cristata and A. cristata microdentata	Arthropoda	Ampeliscidae
P534	APOLOCHUS BARNARDI	Apolochus barnardi	Arthropoda	Amphilochidae
P058	AOROIDES SP	Aoroides; all taxa within the genus	Arthropoda	Aoridae
P535	BEMLOS MACROMANUS	Bemlos macromanus	Arthropoda	Aoridae
P536	GRANDIDIERELLA JAPONICA	Grandidierella japonica	Arthropoda	Aoridae
P369	PARAMICRODEUTOPUS SCHMITTI	Paramicrodeutopus schmitti	Arthropoda	Aoridae
P537	RUDILEMBOIDES SP	Rudilemboides; all taxa within the genus	Arthropoda	Aoridae
P319	NEASTACILLA CALIFORNICA	Neastacilla californica	Arthropoda	Arcturidae
P001	ACANTHAXIUS SPINULICAUDUS	Calocarides spinulicauda	Arthropoda	Axiidae
P325	NEOTRYPAEA SP	Neotrypaea; all taxa within the genus	Arthropoda	Callianassidae
P538	CAPRELLA CALIFORNICA	Caprella californica	Arthropoda	Caprellidae
P539	PARACAPRELLA SP	Paracaprella; all taxa within the genus	Arthropoda	Caprellidae
P130	COROPHIUM SP	Corophiinae; all taxa within the subfamily	Arthropoda	Corophiidae
P540	SINOCOROPHIUM CF HETEROCERATUM	Sinocorophium cf heteroceratum	Arthropoda	Corophiidae
P076	ASTEROPELLA SLATTERYI	Asteropella slatteryi	Arthropoda	Cylindroleberididae
P541	ATYLUS TRIDENS	Atylus tridens	Arthropoda	Dexaminidae
P542	PARADEXAMINE SP	Paradexamine; all taxa within the genus	Arthropoda	Dexaminidae
P357	OXYUROSTYLIS PACIFICA	Oxyurostylis pacifica	Arthropoda	Diastylidae
P554	GNATHIIDAE	Gnathiidae; all taxa within the family	Arthropoda	Gnathiidae
P550	MALACOPLAX CALIFORNIENSIS	Malacoplax californiensis	Arthropoda	Goneplacidae
P159	EDOTIA SP	Edotia; all taxa within the genus	Arthropoda	Idoteidae
P045	AMPHIDEUTOPUS OCULATUS	Amphideutopus oculatus	Arthropoda	Isaeidae
P168	ERICTHONIUS BRASILIENSIS	Ericthonius brasiliensis	Arthropoda	Ischyroceridae
P551	NAUSHONIA MACGINITIEI	Naushonia macginitiei	Arthropoda	Laomediidae
P251	LEPTOCHELIA DUBIA	Leptochelia dubia	Arthropoda	Leptochelidae
P261	LISTRIELLA GOLETA	Listriella goleta	Arthropoda	Liljeborgiidae
P262	LISTRIELLA MELANICA	Listriella melanica	Arthropoda	Liljeborgiidae
P231	HIPPOMEDON SP	Hippomedon; all taxa within the genus	Arthropoda	Lysianassidae
P433	PYROMAIA TUBERCULATA	Pyromaia tuberculata	Arthropoda	Majidae
P547	CAMPYLASPIS SP	Campylaspis; all taxa within the genus	Arthropoda	Nannastacidae
P320	NEBALIA SP	Nebalia; all taxa within the genus	Arthropoda	Nebaliidae

P-Code	P-Name	Included Taxa	Phylum	Family
P496	SYNCHELIDIUM SP	Americhelidium; all taxa within the genus	Arthropoda	Oedicerotidae
P543	EOCHELIDIUM SP A	Eochelidium sp A	Arthropoda	Oedicerotidae
P306	MONOCULODES SP	Monoculodes, Hartmanodes, Pacifoculodes, Deflexilodes, all taxa within the genera	Arthropoda	Oedicerotidae
P555	PARANTHURA ELEGANS	Paranthura elegans	Arthropoda	Paranthuridae
P180	EUPHILOMEDES CARCHARODONTA	Euphilomedes carcharodonta	Arthropoda	Philomedidae
P229	HETEROPHOXUS SP	Heterophoxus; all taxa within the genus	Arthropoda	Phoxocephalidae
P393	PINNIXA FRANCISCANA	Pinnixa franciscana	Arthropoda	Pinnotheridae
P458	SCLEROPLAX GRANULATA	Scleroplax granulata	Arthropoda	Pinnotheridae
P544	PODOCERUS BRASILIENSIS	Podocerus brasiliensis	Arthropoda	Podoceridae
P545	PODOCERUS FULANUS	Podocerus fulanus	Arthropoda	Podoceridae
P552	AMBIDEXTER PANAMENSIS	Ambidexter panamensis	Arthropoda	Processidae
P546	MAYERELLA ACANTHOPODA	Mayerella acanthopoda	Arthropoda	Protellidae
P287	MAYERELLA BANKSIA	Mayerella banksia	Arthropoda	Protellidae
P462	SEROLIS CARINATA	Heteroserolis carinata	Arthropoda	Serolidae
P556	PARACERCEIS SCULPTA	Paracerceis sculpta	Arthropoda	Sphaeromatidae
P557	SCHMITTIUS POLITUS	Schmittius politus	Arthropoda	Squillidae
P586	SYNAPTOTANAIS NOTABILIS	Synaptotanais notabilis	Arthropoda	Tanaidae
P593	ZEUXO NORMANI	Zeuxo normani	Arthropoda	Tanaidae
P553	LOPHOPANOPEUS BELLUS	Lophopanopeus bellus	Arthropoda	Xanthidae
P558	PYCNOGONIDA	Pycnogonida; all taxa within the class	Arthropoda	
P205	GLOTTIDIA ALBIDA	Glottidia albida	Brachiopoda	Lingulidae
P561	OBELIA SP A	Obelia sp A	Cnidaria	Campanulariidae
P131	CORYMORPHA SP	Corymorpha; all taxa within the genus	Cnidaria	Corymorphidae
P160	EDWARDSIIDAE	Edwardsiidae; all taxa within the family	Cnidaria	Edwardsiidae
P111	CERIANTHARIA	Ceriantharia; all taxa within the order	Cnidaria	
P560	PENNATULACEA	Pennatulacea; all taxa within the order	Cnidaria	
P048	AMPHIPHOLIS SP	Amphipholis; all taxa within the genus	Echinodermata	Amphiuridae
P495	SYNAPTIDAE	Synaptidae, Chirodotidae; all taxa within the families	Echinodermata	Synaptidae
P447	RICTAXIS PUNCTOCAELATUS	Rictaxis punctocaelatus	Mollusca	Acteonidae
P575	AGLAJIDAE	Aglajidae; all taxa within the family	Mollusca	Aglajidae
P579	BARLEEIA SP	Barleeia; all taxa within the genus	Mollusca	Barleeiidae
P580	CAECUM CALIFORNICUM	Caecum californicum	Mollusca	Caecidae
P581	CAECUM OCCIDENTALE	Caecum occidentale	Mollusca	Caecidae
P135	CREPIDULA SP	Crepidula, Crepipatella; all taxa within the genera	Mollusca	Calyptraeidae
P582	CRUCIBULUM SPINOSUM	Crucibulum spinosum	Mollusca	Calyptraeidae
P567	LAEVICARDIUM SUBSTRIATUM	Laevicardium substriatum	Mollusca	Cardiidae
P007	ACTEOCINA HARPA	Acteocina harpa	Mollusca	Cylichnidae
P008	ACTEOCINA INCULTA	Acteocina inculta	Mollusca	Cylichnidae
P197	GADILA ABERRANS	Cadulus aberrans	Mollusca	Gadilidae
P576	HAMINOEA VESICULA	Haminoea vesicula	Mollusca	Haminoeidae

P-Code	P-Name	Included Taxa	Phylum	Family
P230	HIATELLA ARCTICA	Hiatella arctica	Mollusca	Hiatellidae
P591	TRYONIA IMITATOR	Tryonia imitator	Mollusca	Hydrobiidae
P568	KELLIA SUBORBICULARIS	Kellia suborbicularis	Mollusca	Lasaeidae
P569	ROCHEFORTIA SP	Rochfortia, all taxa within the genus	Mollusca	Lasaeidae
P562	LIMARIA HEMPHILLI	Limaria hemphilli	Mollusca	Limidae
P588	TECTURA DEPICTA	Tectura depicta	Mollusca	Lotiidae
P377	PARVILUCINA TENUISCULPTA	Parvilucina tenuisculpta	Mollusca	Lucinidae
P277	MACTRIDAE	Mactridae; all taxa within the family	Mollusca	Mactridae
P136	CRYPTOMYA CALIFORNICA	Cryptomya californica	Mollusca	Myidae
P304	MODIOLUS SP	Modiolus; all taxa within the genus	Mollusca	Mytilidae
P563	MUSCULISTA SENHOUSIA	Musculista senhousia	Mollusca	Mytilidae
P564	MYTILUS SP	Mytilus; all taxa within the genus	Mollusca	Mytilidae
P578	NASSARIUS TIARULA	Nassarius tiarula	Mollusca	Nassariidae
P338	NUCULANA SP	Nuculana; all taxa within the genus	Mollusca	Nuculanidae
P342	OLIVELLA BAETICA	Olivella baetica	Mollusca	Olividae
P565	OSTREIDAE	Ostreidae; all taxa within the family	Mollusca	Ostreidae
P566	ARGOPECTEN VENTRICOSUS	Argopecten ventricosus	Mollusca	Pectinidae
P253	LEPTOPECTEN LATIAURATUS	Leptopecten latiauratus	Mollusca	Pectinidae
P128	COOPERELLA SUBDIAPHANA	Cooperella subdiaphana	Mollusca	Petricolidae
P162	ENSIS MYRAE	Ensis myrae	Mollusca	Pharidae
P577	PHILINE AURIFORMIS	Philine auriformis	Mollusca	Philinidae
P384	PHILINE SP A	Philine sp A	Mollusca	Philinidae
P570	CUMINGIA CALIFORNICA	Cumingia californica	Mollusca	Semelidae
P590	THEORA LUBRICA	Theora lubrica	Mollusca	Semelidae
P587	TAGELUS SUBTERES	Tagelus subteres	Mollusca	Solecurtidae
P472	SOLEN SP	Solen; all taxa within the genus	Mollusca	Solenidae
P571	LEPORIMETIS OBESA	Leporimetis obesa	Mollusca	Tellinidae
P572	MACOMA INDENTATA	Macoma indentata	Mollusca	Tellinidae
P275	MACOMA NASUTA	Macoma nasuta	Mollusca	Tellinidae
P276	MACOMA YOLDIFORMIS	Macoma yoldiformis	Mollusca	Tellinidae
P589	TELLINA MEROPSIS	Tellina meropsis	Mollusca	Tellinidae
P379	PERIPLOMA/THRACIA COMPLEX	Asthenothareus, Thracia; all taxa within the genera; and Periploma discus (Exclude P. sp.)	Mollusca	Thracidae
P573	DIPLODONTA SERICATA	Diplodonta sericata	Mollusca	Ungulinidae
P117	CHIONE SP	Chione; all taxa within the genus	Mollusca	Veneridae
P126	COMPSOMYAX SUBDIAPHANA	Compsomyax subdiaphana	Mollusca	Veneridae
P574	PITAR NEWCOMBIANUS	Pitar newcombianus	Mollusca	Veneridae
P432	PROTOTHACA SP	Protothaca; all taxa within the genus	Mollusca	Veneridae
P455	SAXIDOMUS NUTTALLI	Saxidomus nuttalli	Mollusca	Veneridae
P592	VENERUPIS PHILIPPINARUM	Venerupis philippinarum	Mollusca	Veneridae
P387	PHORONIDA	Phoronida; all taxa within the order	Phorona	

ATTACHMENT C-3

Pollution Tolerance Scores

P-Name	North	South
Acanthaxus spinulicaudus		148.719
Acmira sp	2.947	
Acteocina harpa		-73.880
Acteocina inculta	-57.035	
Aglajidae		-38.574
Alpheus bellimanus		85.066
Alpheus californiensis	51.341	53.290
Amaeana occidentalis	-17.506	-4.295
Ambidexter panamensis		120.771
Ampelisca brachycladus	26.696	
Ampelisca brevisimulata	-34.190	
Ampelisca cristata	-4.825	-105.945
Ampharete labrops	-19.247	-61.775
Amphicteis scaphobranchiata	13.371	-5.582
Amphideutopus oculatus	-18.710	13.043
Amphiodia Complex	6.003	-22.510
Amphipholis sp	53.369	-5.094
Anotomastus gordiodes	-43.655	
Aoroides sp	93.917	37.414
Aphelochaeta/Monticellina Complex	62.638	97.387
Aphrodita sp		21.632
Apolochus barnardi		-54.791
Apoprionospio pygmaea	-8.968	-25.411
Argopecten ventricosus		18.174
Armandia brevis		32.335
Asteropella slatteryi		-63.807
Atylus tridens		35.925
Barleeia sp		-54.511
Bemlos macromanus		47.994
Brania sp		5.670
Caecum californicum	-48.975	-75.150
Caecum occidentale		-63.983
Campylaspis sp		-1.169
Capitella capitata Complex	196.587	88.339
Caprella californica	-5.581	7.242
Carazziella sp		-19.693
Caulleriella sp	19.842	84.393
Ceriantharia	18.883	25.789
Chaetozone corona		0.065
Chione sp	46.794	-28.846
Cirratulus sp	94.373	162.865
Cirriformia sp		31.255
Compsomyax subdiaphana	-11.515	-86.692
Cooperella subdiaphana	-1.732	-47.136
Corophium sp	30.465	0.356
Corymorpha sp	-19.001	27.948
Cossura sp	42.363	
Crepidula sp	-33.621	
Crucibulum spinosum		-16.324
Cryptomya californica	-42.938	19.896
Cumingia californica	121.190	5.746
Diopatra ornate	-37.903	14.764
Diopatra splendidissima		-54.941
Diopatra tridentate	6.619	
Diplocirrus sp		28.468
Diplodonta sericata	-65.520	
Polydora sp	115.025	34.328
Dorvillea (Schistomeringos) longicornis	90.254	90.093
Drilonereis sp	-11.246	69.863
Edotia sp	-30.271	
Edwardsiidae	20.168	77.062
Ensis myrae	-33.006	-15.948
Eochelidium sp A	56.035	
Ericthonius brasiliensis	2.119	-75.217
Eteone sp	-92.577	37.356
Euchone sp	54.126	45.212
Eumida longicornuta		18.250
Euphilomedes carcharodonta	16.987	22.722
Exogone dwisula	38.105	
Exogone lourei	41.770	48.162
Gadila aberrans	2.521	
Glottidia albida	-57.677	
Glycera americana	17.526	4.060
Gnathiidae	0.118	
Goniada littorea	-33.253	-24.214
Grandidierella japonica	88.541	47.936
Halosydna johnsoni		-3.225
Haminoea vesicula	36.459	53.556
Heterophoxus sp		24.304
Hiatella arctica	78.246	-68.361
Hippomedon sp		-42.082
Kellia suborbicularis		-9.780
Laevicardium substriatum	13.420	0.664
Laonice cirrata	3.240	
Leitoscoloplos pugettensis	50.608	94.277
Leporimetis obesa	-95.997	
Leptochelia dubia		0.733
Leptopecten latiauratus	22.986	54.851
Levinsenia sp	13.857	
Limaria hemphilli		-33.361
Listriella Goleta	8.915	
Listriella melanica	-41.075	-29.760
Lophopanopeus bellus		-2.792
Lumbrineris sp	29.626	47.842
Lysippe sp	13.281	
Macoma indentata		226.764
Macoma nasuta	37.055	150.473
Macoma yoldiformis	4.301	41.930
Mactridae	-16.226	-19.478
Malacoplax californiensis		39.757
Marphysa sp	56.336	150.452
Mayerella acanthopoda	35.813	22.837
Mayerella banksia	19.371	150.301
Mediomastus sp	-1.558	29.193
Megalomma pigmentum	25.680	
Melinna oculata	-6.191	-14.040
Metasychis disparidentatus	12.869	6.715
Microspio pigmentata	-33.163	-4.847
Modiolus sp	-22.517	-5.261
Molgula sp	55.150	-63.455
Monoculodes sp	56.317	40.620
Musculista senhousia	138.190	69.863
Mytilus sp	55.099	-48.531
Nassarius tiarula		52.640
Naushonia macginitiei		102.751
Neanthes acuminata Complex	166.229	89.682
Neastacilla californica		-30.541
Nebalia sp	36.050	
Neotrypaea sp		-4.874
Nephtys caecoides	-17.491	-9.638
Nephtys cornuta	8.017	41.732
Nephtys ferruginea	27.273	53.355
Notomastus sp	-10.039	-6.496
Nuculana sp	2.393	-40.832
Obelia sp A	19.908	16.686
Odontosyllis phosphorea		52.772
Olivella baetica	-37.321	
Ostreidae		-31.128
Owenia collaris	5.012	
Oxyurostylis pacifica	28.639	61.628
Paracaprella sp		-17.461
Paracerceis sculpta	28.758	57.289
Paradexamine sp	136.481	47.047

Paramage scutata	5.161	
Paramicrodeutopus schmitti	-36.737	

P-Name	North	South
Paranthura elegans	60.508	28.772
Paraprionospio pinnata	13.150	33.071
Parvilucina tenuisculpta	18.026	
Pectinaria californiensis	-3.652	67.935
Pennatulacea	-12.891	-2.751
Periploma/Thracia Complex	-26.560	-36.193
Pherusa capulata		122.293
Pherusa neopapillata	130.991	
Philine auriformis	-1.995	51.323
Philine sp A	64.028	
Phoronida		32.809
Phyllodoce sp	-31.051	21.426
Pilargis sp	-31.503	
Pinnixa franciscana	-49.367	
Piromis sp		-22.455
Pista alata	65.897	65.688
Pista fasciata	-19.545	0.789
Pitar newcombianus	-20.603	
Platynereis bicanaliculata	43.726	
Podarke pugettensis		-51.972
Podarkeopsis glabrus	18.883	
Podocerus brasiliensis		146.440
Podocerus fulanus	101.494	12.682
Poecilochaetus johnsoni	-40.703	22.480
Poecilochaetus sp A		46.062
Polycirrus sp	10.521	
Polyophthalmus pictus	-70.708	
Praxillella sp	46.319	-45.950
Prionospio lighti	-2.900	4.949
Prionospio (Prionospio) heterobranchia	29.417	26.309
Prionospio A/B Complex		-14.303
Protothaca sp	5.140	-46.685
Pseudopolydora paucibranchiata	27.823	37.542
Pycnogonida	85.884	27.010
Pyromaia tuberculata	11.973	96.217
Rictaxis punctocaelatus	15.663	62.203
Rochefortia sp	-6.881	9.942
Rudilemboides sp	16.393	25.101
Sabellides manriquei	-12.721	
Saxidomus nuttalli	29.781	-20.394
Schmittius politus		68.492
Scleroplax granulate	20.143	15.229
Scolelepis (Parascolelepis) sp	25.624	-11.479
Scolelepis occidentalis		56.230
Scoloplos sp	-28.300	
Scyphoproctus sp		44.940
Serolis carinata	-24.997	10.319
Sigambra tentaculata	11.606	
Sinocorophium cf heteroceratum	-33.700	
Solen sp	3.559	-12.356
Sphaerosyllis sp	73.669	
Spiochaetopterus costarum	-0.350	42.886
Spiophanes berkeleyorum	5.558	
Spiophanes bombyx	-2.915	
Spiophanes missionensis	19.719	14.573
Sthenelais sp	-12.631	
Sthenelanella uniformis	-4.552	-16.227
Streblospio benedicti		71.422
Sulcoretusa xystrum	43.652	
Syllis (Syllis) gracilis		8.368
Syllis (Typosyllis) spp	51.691	64.715
Synaptidae	29.176	65.464
Synaptotanais notabilis	26.608	26.322
Tagelus subteres	-21.843	-9.515
Tectura depicta		-14.614
Tellina carpenteri	15.779	5.457
Tellina meropsis		-7.542
Tellina modesta	13.947	-51.157
Tenonia priops	57.983	

Terebellides sp	14.443	
Theora lubrica	41.756	55.417

P-Name	North	South
Thyasira flexuosa	33.268	
Tryonia imitator		24.057
Turbonilla sp	67.890	
Vargula tsujii		-112.389
Venerupis philippinarum	61.062	
Vitrinella sp	-3.877	
Zeuxo normani	28.445	35.661

Appendix D

Calculating the Benthic Response Index

Introduction

The Southern California Benthic Response Index (BRI) is a measure of the condition of marine and estuarine benthic communities. It classifies benthic communities as "reference" or one of four levels of response to disturbance. Response Level 1 indicates benthic communities that are only marginally different from reference while Response Levels 2 through 4 indicate clear evidence of disturbance. Although the BRI differentiates between reference and disturbed benthic communities, it does not differentiate between natural and anthropogenic sources of stress.

The BRI is the abundance-weighted average pollution tolerance of species occurring in a sample. The index formula is:

$$BRI_s = \frac{\sum_{i=1}^{n} \sqrt[3]{a_{si}}\, p_i}{\sum_{i=1}^{n} \sqrt[3]{a_{si}}}$$

where BRI_s is the BRI value for sampling unit s, n is the number of species with pollution tolerance scores in s, p_i is the pollution tolerance of species i, and a_{si} is the abundance of species i in s. Species pollution tolerances p_i were determined during BRI development as the position of the abundance distribution of species i on a gradient between the most and least disturbed sites. Species without pollution tolerance values are not included in the calculation. Pollution tolerance values were not assigned to species if the data were insufficient to assign a value.

The BRI was developed for benthic samples collected with a 0.1m^2 Van Veen grab that were sieved through a 1-mm mesh screen. However, as long as the same sieve size is used, it can be applied to samples collected with other devices because it depends only on the relative abundance of species for which pollution tolerance values are available.

In southern California, the numbers and kinds of benthic animals that occur in reference areas vary naturally by habitat: with depth on the coastal shelf and with latitude in bays and harbors. To account for these differences in species distributions, different pollution tolerance values were assigned to species for each of five habitats (Table 1). If a species frequency of occurrence in a particular habitat was too low, a pollution tolerance value was not assigned for that habitat.

The magnitude of the pollution gradients in the BRI development data and the amounts of data that were used to assign pollution tolerance values varied slightly from habitat to habitat. This variation was taken into account during index development and index values for coastal habitats were normalized to a coastal BRI scale while index values for bay habitats were standardized to a bay BRI scale. The two scales were intercalibrated using ecologically and functionally equivalent reference and response level categories (Table 2).

Calculating BRI values and characterizing benthic community condition at a site involves a four-step process:

1. Modify names in the species abundance data for consistency with the P-Names or P-Codes on the list of pollution tolerance values using Table 3.
2. Associate the P-Names or P-Codes with pollution tolerance values for the habitat in which the sample was collected using Table 4.
3. Calculate BRI values.
4. Characterize benthic community condition at the site by applying appropriate thresholds to the BRI value.

Details of the four steps follow.

1. Modify the abundance data by adjusting species names for consistency with P-Names in the list of pollution tolerance values.

Change the names of the taxa according to Table 3, which identifies taxa included under each code (P-Code) and name (P-Name) in the list of pollution tolerances. Add abundances for names that are combined under a single P-Name or P-Code. Delete data for any names with no P-Name or P-Code.

The names in "Included Taxa" column in Table 3 are based on Edition 4 of the SCAMIT list of invertebrate species (Southern California Association of Marine Invertebrate Taxonomists 2001). P-Names, on the other hand, have no formal nomenclatural status; they serve only to link reported taxa to their pollution tolerance values. Multiple taxa are included under P-Names because it was sometimes necessary to combine individual taxa into generic or other higher taxonomic categories to resolve taxonomic inconsistencies while developing the index. Each unique P-Name is associated with a unique P-Code. P-Codes are easier and less confusing to use than P-Names when calculating the BRI. However, P-Names provide taxonomic associations that are informative when more detail is desired.

In most instances, the easiest way to change nomenclature is to create a two-column translation table with the original name in one column and the appropriate P-Name and P-Code in the other. Taxa that are not associated with a P-Name are eliminated. Then taxa are combined by merging the translation table with the abundance data using the original names and calculating the sum of abundances for each P-Name or P-Code.

2. Associate species names with appropriate pollution tolerance values.

Associate the p_i value for the habitat from which the sample was collected (Tables 2 and 4) with the P-Name and abundance in the data. Eliminate abundances and P-Names if no p_i value is provided for a P-name in that habitat. In Table 4, each P-Name is associated with up to five habitat pollution tolerance values; pollution tolerance (p_i) values are provided for each habitat for which the BRI was developed.

The BRI should only be applied in the habitats for which it was developed. Therefore, eliminate coastal samples from waters less than 10 m or more than 324 m deep and bay samples collected north of Point Conception or south of the U.S.-Mexico international border.

3. **Calculate Benthic Response Index (BRI) values.**

- Calculate a product for each P-Name in each sample by multiplying the cube root of the abundance by the pollution tolerance score (p_i) for the habitat in which the sample was collected.

- Add the products for the sample to obtain a sum of products.

- Add together the cube roots of abundance for all the P-Names in each sample to obtain a sum of cube roots.

- Divide the sum of products by the sum of cube roots to obtain the Benthic Response Index (*BRI*) value.

4. **Evaluate benthic community condition by applying appropriate thresholds to the BRI value.**

Evaluate the BRI value calculated in Step 4 against the thresholds listed in Table 2. Evaluate coastal samples using coastal BRI values and coastal BRI thresholds. Evaluate Bay samples using Bay BRI values and Bay BRI thresholds.

Examples

- ***Example 1***

For a coastal sample collected at 20 m depth:

Species	Abundance	Cube Root of Abundance	p_i
Amphiodia complex	2	1.26	51.2
Owenia collaris	10	2.15	24.8
Capitella capitata complex	20	2.71	60.2

$$BRI_s = \frac{\{(1.26)51.2\} + \{(2.15)24.8\} + \{(2.71)60.2\}}{(1.26 + 2.15 + 2.71)} = 45.91$$

This is a coastal sample with a BRI value of 45.91, which is between 44 and 72, indicating a clearly disturbed site at Response Level 3.

- ***Example 2***

For a coastal sample collected at 70 m depth:

Species	Abundance	Cube Root of Abundance	p_i
Amphiodia complex	2	1.26	24.7
Owenia collaris	10	2.15	30.3
Capitella capitata complex	20	2.71	55.1

$$BRI_s = \frac{\{(1.26)24.7\} + \{(2.15)30.3\} + \{(2.71)55.1\}}{(1.26 + 2.15 + 2.71)} = 40.13$$

This is a coastal sample with a BRI value of 40.13, which is between 34 and 44 and, therefore, indicates a clearly disturbed site at Response Level 2.

Literature Cited

Southern California Association of Marine Invertebrate Taxonomists. 2001. A Taxonomic Listing of Soft Bottom Macro- and Megainvertebrates from Infaunal and Epibenthic Programs in the Southern California Bight, Edition 4. Southern California Association of Marine Invertebrate Taxonomists. San Pedro, CA. 192 p.

Table 1. Habitats for which the Southern California Benthic Response Index (BRI) is available.

BRI Version	Habitat	Definition
Coastal BRI	Shallow Coastal Shelf	Coastal shelf 10-30 m deep
	Mid-depth Coastal Shelf	Coastal shelf >30-120 m deep
	Deep Coastal Shelf	Coastal shelf >120-324 m deep
Bay BRI	Northern Bays	Bays and harbors from Point Conception to Newport Bay
	Southern Bays	Bays and harbors from Dana Point to the U.S.-Mexico border

Table 2. Characterization, definition, and BRI thresholds for levels of Benthic community condition.

	Characterization	Definition		BRI Thresholds	
Level	Coastal Shelf	Coastal Shelf	Bays	Coastal Shelf	Bays
Reference	Reference			<25	<31
Response Level 1	Marginal deviation	> 90% tolerance interval for reference index values	> 5% of reference species lost	25-34	31-42
Response Level 2	Biodiversity loss	> 25% of reference species lost	> 25% of reference species lost	34-44	42-53
Response Level 3	Community function loss	> 90% of echinoderm and 75% arthropod species lost	> 50% of reference species lost	44-72	53-73
Response Level 4	Defaunation	> 90% of reference species lost	> 80% of reference species lost	>72	>73

Table 3. Taxa included in the P-Names for which pollution tolerance scores (p_i) are available. Phylum and family information provide taxonomic context.

P-Code	P-Name	Included Taxa	Phylum	Family
P005	ACOETES PACIFICA	Acoetes pacifica	Annelida	Acoetidae
P024	AMAGE ANOPS	Amage anops	Annelida	Ampharetidae
P039	AMPHARETE ACUTIFRONS	Ampharete acutifrons	Annelida	Ampharetidae
P040	AMPHARETE ARCTICA	Ampharete finmarchica	Annelida	Ampharetidae
P041	AMPHARETE LABROPS	Ampharete labrops	Annelida	Ampharetidae
P043	AMPHICTEIS GLABRA	Amphicteis glabra	Annelida	Ampharetidae
P044	AMPHICTEIS SCAPHOBRANCHIATA	Amphicteis scaphobranchiata	Annelida	Ampharetidae
P055	ANOBOTHRUS GRACILIS	Anobothrus gracilis	Annelida	Ampharetidae
P075	ASABELLIDES LINEATA	Asabellides lineata	Annelida	Ampharetidae
P158	ECLYSIPPE TRILOBATA	Eclysippe trilobata	Annelida	Ampharetidae
P272	LYSIPPE SP	Lysippe; all taxa within the genus	Annelida	Ampharetidae
P293	MELINNA HETERODONTA	Melinna heterodonta	Annelida	Ampharetidae
P294	MELINNA OCULATA	Melinna oculata	Annelida	Ampharetidae
P309	MOORESAMYTHA BIOCULATA	Mooresamytha bioculata	Annelida	Ampharetidae
P367	PARAMAGE SCUTATA	Paramage scutata	Annelida	Ampharetidae
P451	SABELLIDES MANRIQUEI	Sabellides manriquei	Annelida	Ampharetidae
P452	SAMYTHA CALIFORNIENSIS	Samytha californiensis	Annelida	Ampharetidae
P473	SOSANE OCCIDENTALIS	Sosane occidentalis and Sosanopsis sp A SCAMIT 1996	Annelida	Ampharetidae
P118	CHLOEIA PINNATA	Chloeia pinnata	Annelida	Amphinomidae
P060	APHRODITA SP	Aphrodita; all taxa within the genus	Annelida	Aphroditidae
P061	APISTOBRANCHUS ORNATUS	Apistobranchus ornatus	Annelida	Apistobranchidae
P057	ANOTOMASTUS GORDIODES	Anotomastus gordiodes	Annelida	Capitellidae
P103	CAPITELLA CAPITATA COMPLEX	Capitella; all taxa within the genus	Annelida	Capitellidae
P142	DECAMASTUS GRACILIS	Decamastus gracilis	Annelida	Capitellidae
P228	HETEROMASTUS FILOBRANCHUS	Heteromastus filobranchus	Annelida	Capitellidae
P288	MEDIOMASTUS SP	Mediomastus; all taxa within the genus	Annelida	Capitellidae

P-Code	P-Name	Included Taxa	Phylum	Family
P336	NOTOMASTUS SP	Notomastus; all taxa within the genus	Annelida	Capitellidae
P179	SCYPHOPROCTUS SP	Scyphoproctus; all taxa within genus	Annelida	Capitellidae
P113	CHAETOPTERUS VARIOPEDATUS	Chaetopterus variopedatus	Annelida	Chaetopteridae
P296	MESOCHAETOPTERUS SP	Mesochaetopterus; all taxa within the genus	Annelida	Chaetopteridae
P389	PHYLLOCHAETOPTERUS LIMICOLUS	Phyllochaetopterus limicolus	Annelida	Chaetopteridae
P390	PHYLLOCHAETOPTERUS PROLIFICA	Phyllochaetopterus prolifica	Annelida	Chaetopteridae
P476	SPIOCHAETOPTERUS COSTARUM	Spiochaetopterus costarum	Annelida	Chaetopteridae
P362	PALEANOTUS BELLIS	Paleanotus bellis	Annelida	Chrysopetalidae
P059	APHELOCHAETA/MONTICELLINA COMPLEX	Aphelochaeta, Monticellina; all taxa within the genera	Annelida	Cirratulidae
P107	CAULLERIELLA ALATA	Caulleriella alata	Annelida	Cirratulidae
P530	CAULLERIELLA SP	Caulleriella; all taxa within the genus	Annelida	Cirratulidae
P114	CHAETOZONE ARMATA	Chaetozone armata	Annelida	Cirratulidae
P115	CHAETOZONE CORONA	Chaetozone corona	Annelida	Cirratulidae
P108	CAULLERIELLA GRACILIS	Chaetozone hartmanae	Annelida	Cirratulidae
P116	CHAETOZONE SETOSA COMPLEX	Chaetozone setosa; all forms referred to under this name	Annelida	Cirratulidae
P120	CIRRATULUS SP	Cirratulus; all taxa within the genus	Annelida	Cirratulidae
P121	CIRRIFORMIA SP	Cirriformia; all taxa within the genus	Annelida	Cirratulidae
P132	COSSURA SP	Cossura; all taxa within the genus	Annelida	Cossuridae
P155	DORVILLEA (SCHISTOMERINGOS) LONGICORNIS	Dorvillea (Schistomeringos); all taxa within the subgenus	Annelida	Dorvilleidae
P349	OPHRYOTROCHA A/B/C COMPLEX	Ophryotrocha sp A SCAMIT 1987, O. sp B SCAMIT 1987, O. sp C SCAMIT 1987 (Exclude O. sp)	Annelida	Dorvilleidae
P376	PAROUGIA CAECA	Parougia caeca	Annelida	Dorvilleidae
P430	PROTODORVILLEA GRACILIS	Protodorvillea gracilis	Annelida	Dorvilleidae
P178	EUNICE AMERICANA	Eunice americana	Annelida	Eunicidae
P286	MARPHYSA SP	Marphysa: all taxa within the genus	Annelida	Eunicidae
P192	FAUVELIOPSIS SP	Fauveliopsis; all taxa within the genus	Annelida	Fauveliopsidae
P088	BRADA PLURIBRANCHIATA	Brada pluribranchiata	Annelida	Flabelligeridae
P089	BRADA VILLOSA	Brada villosa	Annelida	Flabelligeridae
P521	DIPLOCIRRUS SP	Diplocirrus; all taxa within genus	Annelida	Flabelligeridae
P522	PHERUSA CAPULATA	Pherusa capulata	Annelida	Flabelligeridae
P382	PHERUSA NEOPAPILLATA	Pherusa neopapillata	Annelida	Flabelligeridae
P400	PIROMIS SP A	Piromis sp A Harris 1985	Annelida	Flabelligeridae
P523	PIROMIS SP	Piromis; all taxa within genus	Annelida	Flabelligeridae
P206	GLYCERA AMERICANA	Glycera americana	Annelida	Glyceridae
P207	GLYCERA CONVOLUTA	Glycera macrobranchia	Annelida	Glyceridae
P208	GLYCERA NANA	Glycera nana	Annelida	Glyceridae
P209	GLYCERA OXYCEPHALA	Glycera oxycephala	Annelida	Glyceridae
P210	GLYCINDE ARMIGERA	Glycinde armigera	Annelida	Goniadidae
P213	GONIADA BRUNNEA	Goniada brunnea	Annelida	Goniadidae
P214	GONIADA LITTOREA	Goniada littorea	Annelida	Goniadidae
P215	GONIADA MACULATA	Goniada maculata	Annelida	Goniadidae
P302	MICROPODARKE DUBIA	Micropodarke dubia	Annelida	Hesionidae

P-Code	P-Name	Included Taxa	Phylum	Family
P409	PODARKE PUGETTENSIS	Ophiodromus pugettensis	Annelida	Hesionidae
P410	PODARKEOPSIS GLABRUS	Podarkeopsis glabrus	Annelida	Hesionidae
P411	PODARKEOPSIS SP A	Podarkeopsis sp A Velarde & Harris 1987	Annelida	Hesionidae
P167	ERANNO LAGUNAE	Eranno lagunae	Annelida	Lumbrineridae
P269	LUMBRINERIDES PLATYPYGOS	Lumbrinerides platypygos	Annelida	Lumbrineridae
P270	LUMBRINERIS SP	Lumbrineris & Scoletoma; all taxa within the genera	Annelida	Lumbrineridae
P334	NINOE TRIDENTATA	Ninoe tridentata	Annelida	Lumbrineridae
P279	MAGELONA PITELKAI	Magelona pitelkai	Annelida	Magelonidae
P280	MAGELONA SACCULATA	Magelona sacculata	Annelida	Magelonidae
P281	MAGELONA SPP	Magelona; all taxa within the genus except M. pitelkai or M. sacculata [Excludes M. sp]	Annelida	Magelonidae
P124	CLYMENELLA COMPLANATA	Clymenella complanata	Annelida	Maldanidae
P125	CLYMENURA GRACILIS	Clymenura gracilis	Annelida	Maldanidae
P283	MALDANE SARSI	Maldane sarsi	Annelida	Maldanidae
P300	METASYCHIS DISPARIDENTATUS	Metasychis disparidentatus	Annelida	Maldanidae
P337	NOTOPROCTUS PACIFICUS	Notoproctus pacificus	Annelida	Maldanidae
P380	PETALOPROCTUS SP	Petaloproctus; all taxa within the genus	Annelida	Maldanidae
P422	PRAXILLELLA SP	Praxillella; all taxa within the genus	Annelida	Maldanidae
P423	PRAXILLURA MACULATA	Praxillura maculate	Annelida	Maldanidae
P446	RHODINE BITORQUATA	Rhodine bitorquata	Annelida	Maldanidae
P014	AGLAOPHAMUS ERECTANS	Aglaophamus erectans	Annelida	Nephtyidae
P015	AGLOPHAMUS VERRILLI	Aglophamus verrilli	Annelida	Nephtyidae
P326	NEPHTYS CAECOIDES	Nephtys caecoides	Annelida	Nephtyidae
P327	NEPHTYS CORNUTA	Nephtys cornuta	Annelida	Nephtyidae
P328	NEPHTYS FERRUGINEA	Nephtys ferruginea	Annelida	Nephtyidae
P216	GYMNONEREIS CROSSLANDI	Gymnonereis crosslandi	Annelida	Nereididae
P526	NEANTHES ACUMINATA COMPLEX	Neanthes acuminata; all forms referred to under this name	Annelida	Nereididae
P330	NEREIS LATESCENS	Nereis latescens	Annelida	Nereididae
P331	NEREIS PROCERA	Nereis procera	Annelida	Nereididae
P405	PLATYNEREIS BICANALICULATA	Platynereis bicanaliculata	Annelida	Nereididae
P064	ARABELLA SP	Arabella; all taxa within the genus	Annelida	Oenonidae
P157	DRILONEREIS SP	Drilonereis; all taxa within the genus	Annelida	Oenonidae
P335	NOTOCIRRUS CALIFORNIENSIS	Notocirrus californiensis	Annelida	Oenonidae
P152	DIOPATRA ORNATA	Diopatra ornate	Annelida	Onuphidae
P153	DIOPATRA SPLENDIDISSIMA	Diopatra splendidissima	Annelida	Onuphidae
P154	DIOPATRA TRIDENTATA	Diopatra tridentate	Annelida	Onuphidae
P235	HYALINOECIA JUVENALIS	Hyalinoecia juvenalis	Annelida	Onuphidae
P307	MOOREONUPHIS NEBULOSA	Mooreonuphis nebulosa	Annelida	Onuphidae
P308	MOOREONUPHIS SPP	Mooreonuphis; all taxa within the genus except M. nebulosa [Exclude M. sp]	Annelida	Onuphidae
P343	ONUPHIS IRIDESCENS COMPLEX	Onuphis iridescens, O. elegans, O. sp 1 Pt. Loma 1983 [Exclude O. sp)	Annelida	Onuphidae
P365	PARADIOPATRA PARVA	Paradiopatra parva	Annelida	Onuphidae
P438	RHAMPHOBRACHIUM LONGISETOSUM	Rhamphobrachium longisetosum	Annelida	Onuphidae

P-Code	P-Name	Included Taxa	Phylum	Family
P070	ARMANDIA BREVIS	Armandia brevis	Annelida	Opheliidae
P344	OPHELIA PULCHELLA	Ophelia pulchella	Annelida	Opheliidae
P345	OPHELINA ACUMINATA	Ophelina acuminate	Annelida	Opheliidae
P524	POLYOPHTHALMUS PICTUS	Polyophthalmus pictus	Annelida	Opheliidae
P510	TRAVISIA BREVIS	Travisia brevis	Annelida	Opheliidae
P248	LEITOSCOLOPLOS PUGETTENSIS	Leitoscoloplos pugettensis	Annelida	Orbiniidae
P461	SCOLOPLOS ARMIGER COMPLEX	Scoloplos armiger; all forms referred to under this name	Annelida	Orbiniidae
P525	SCOLOPLOS SP	Scoloplos; all taxa within the genus	Annelida	Orbiniidae
P311	MYRIOCHELE SP	Myriochele; all taxa within the genus	Annelida	Oweniidae
P312	MYRIOWENIA CALIFORNIENSIS	Myriowenia californiensis	Annelida	Oweniidae
P356	OWENIA COLLARIS	Owenia collaris	Annelida	Oweniidae
P069	ARICIDEA WASSI	Aricidea (Aricidea) wassi	Annelida	Paraonidae
P004	ACMIRA SP	Aricidea (Acmira); all taxa within the subgenus	Annelida	Paraonidae
P012	AEDICIRA PACIFICA	Aricidea (Aedicira) pacifica	Annelida	Paraonidae
P017	ALLIA ANTENNATA	Aricidea (Allia) antennata	Annelida	Paraonidae
P018	ALLIA CF NOLANI	Aricidea (Allia) hartleyi	Annelida	Paraonidae
P019	ALLIA RAMOSA	Aricidea (Allia) sp A SCAMIT 1996	Annelida	Paraonidae
P122	CIRROPHORUS BRANCHIATUS	Cirrophorus branchiatus	Annelida	Paraonidae
P123	CIRROPHORUS FURCATUS	Cirrophorus furcatus	Annelida	Paraonidae
P258	LEVINSENIA SP	Levinsenia; all taxa within the genus	Annelida	Paraonidae
P366	PARADONEIS ELIASONI	Paradoneis eliasoni	Annelida	Paraonidae
P378	PECTINARIA CALIFORNIENSIS	Pectinaria californiensis	Annelida	Pectinariidae
P385	PHOLOE GLABRA	Pholoe glabra	Annelida	Pholoidae
P386	PHOLOIDES ASPERUS	Pholoides asperus	Annelida	Pholoidae
P171	ETEONE SP	Eteone; all taxa within the genus	Annelida	Phyllodocidae
P175	EULALIA SP	Eulalia; all taxa within the genus	Annelida	Phyllodocidae
P177	EUMIDA LONGICORNUTA	Eumida longicornuta	Annelida	Phyllodocidae
P329	NEREIPHYLLA CASTANEA	Nereiphylla castanea	Annelida	Phyllodocidae
P370	PARANAITIS POLYNOIDES	Paranaitis polynoides	Annelida	Phyllodocidae
P391	PHYLLODOCE SP	Phyllodoce; all taxa within the genus	Annelida	Phyllodocidae
P465	SIGE SP A	Sige sp A SCAMIT 1995	Annelida	Phyllodocidae
P054	ANCISTROSYLLIS SP	Ancistrosyllis; all taxa within the genus	Annelida	Pilargidae
P371	PARANDALIA SP	Parandalia; all taxa within the genus	Annelida	Pilargidae
P392	PILARGIS BERKELEYAE	Pilargis berkeleyae	Annelida	Pilargidae
P527	PILARGIS SP	Pilargis; all taxa within the genus	Annelida	Pilargidae
P464	SIGAMBRA TENTACULATA	Sigambra tentaculata	Annelida	Pilargidae
P414	POECILOCHAETUS JOHNSONI	Poecilochaetus johnsoni	Annelida	Poecilochaetidae
P415	POECILOCHAETUS SP A	Poecilochaetus sp A Martin 1977	Annelida	Poecilochaetidae
P220	HALOSYDNA BREVISETOSA	Halosydna brevisetosa	Annelida	Polynoidae
P528	HALOSYDNA JOHNSONI	Halosydna johnsoni	Annelida	Polynoidae
P226	HESPERONOE LAEVIS	Hesperonoe laevis	Annelida	Polynoidae
P249	LEPIDASTHENIA BERKELEYAE	Lepidasthenia berkeleyae	Annelida	Polynoidae
P284	MALMGRENIELLA BASCHI	Malmgreniella baschi	Annelida	Polynoidae

P-Code	P-Name	Included Taxa	Phylum	Family
P285	MALMGRENIELLA SCRIPTORIA	Malmgreniella scriptoria	Annelida	Polynoidae
P489	SUBADYTE MEXICANA	Subadyte mexicana	Annelida	Polynoidae
P502	TENONIA PRIOPS	Tenonia priops	Annelida	Polynoidae
P324	NEOSABELLARIA CEMENTARIUM	Neosabellaria cementarium	Annelida	Sabellariidae
P119	CHONE COMPLEX	Chone, Fabrisabella , Jasmineria; all taxa within the genera	Annelida	Sabellidae
P172	EUCHONE SP	Euchone; all taxa within the genus	Annelida	Sabellidae
P289	MEGALOMMA PIGMENTUM	Megalomma pigmentum	Annelida	Sabellidae
P314	MYXICOLA INFUNDIBULUM	Myxicola; all taxa within the genus	Annelida	Sabellidae
P420	POTAMETHUS SP A	Potamethus sp A SCAMIT 1986	Annelida	Sabellidae
P456	SCALIBREGMA INFLATUM	Scalibregma californicum	Annelida	Scalibregmatidae
P463	SIGALION SPINOSA	Sigalion spinosus	Annelida	Sigalionidae
P583	STHENELAIS SP	Sthenelais; all taxa within the genus (Bay BRI)	Annelida	Sigalionidae
P484	STHENELAIS SPP	Sthenelais; all taxa within the genus except S. verruculosa (Exclude Sthenelais. sp) (Coastal BRI)	Annelida	Sigalionidae
P485	STHENELAIS VERRUCULOSA	Sthenelais verruculosa (Coastal BRI)	Annelida	Sigalionidae
P486	STHENELANELLA UNIFORMIS	Sthenelanella uniformis	Annelida	Sigalionidae
P165	EPHESIELLA BREVICAPITIS	Ephesiella brevicapitis	Annelida	Sphaerodoridae
P063	APOPRIONOSPIO PYGMAEA	Apoprionospio pygmaea	Annelida	Spionidae
P086	BOCCARDIA BASILARIA	Boccardia basilaria	Annelida	Spionidae
P087	BOCCARDIELLA HAMATA	Boccardiella hamata	Annelida	Spionidae
P104	CARAZZIELLA SP	Carazziella; all taxa within the genus	Annelida	Spionidae
P247	LAONICE CIRRATA	Laonice cirrata	Annelida	Spionidae
P246	LAONICE APPELLOEFI	Laonice nuchala	Annelida	Spionidae
P282	MALACOCEROS PUNCTATA	Malacoceros indicus	Annelida	Spionidae
P303	MICROSPIO PIGMENTATA	Microspio pigmentata	Annelida	Spionidae
P373	PARAPRIONOSPIO PINNATA	Paraprionospio pinnata	Annelida	Spionidae
P419	POLYDORA SP	Polydora, Dipolydora; all taxa within the genera	Annelida	Spionidae
P424	PRIONOSPIO A/B COMPLEX	Prionospio dubia and P. jubata	Annelida	Spionidae
P425	PRIONOSPIO EHLERSI	Prionospio ehlersi	Annelida	Spionidae
P531	PRIONOSPIO (PRIONOSPIO) HETEROBRANCHIA	Prionospio heterobranchia	Annelida	Spionidae
P426	PRIONOSPIO LIGHTI	Prionospio lighti and P. multibranchiata (P. lighti only in bay habitats)	Annelida	Spionidae
P532	PSEUDOPOLYDORA PAUCIBRANCHIATA	Pseudopolydora paucibranchiata	Annelida	Spionidae
P533	SCOLELEPIS (PARASCOLELEPIS) SP	Scolelepis (Parascolelepis); all taxa within subgenus	Annelida	Spionidae
P459	SCOLELEPIS OCCIDENTALIS	Scolelepis (Scolelepis) occidentalis	Annelida	Spionidae
P460	SCOLELEPIS SPP	Scolelepis; all taxa within the genus except S. occidentalis [Exclude S. sp]	Annelida	Spionidae
P475	SPIO SP	Spio; all taxa within the genus	Annelida	Spionidae
P477	SPIOPHANES BERKELEYORUM	Spiophanes berkeleyorum	Annelida	Spionidae
P478	SPIOPHANES BOMBYX	Spiophanes bombyx	Annelida	Spionidae
P480	SPIOPHANES MISSIONENSIS	Spiophanes duplex	Annelida	Spionidae
P479	SPIOPHANES FIMBRIATA	Spiophanes fimbriata	Annelida	Spionidae
P481	SPIOPHANES WIGLEYI	Spiophanes wigleyi	Annelida	Spionidae
P584	STREBLOSPIO BENEDICTI	Streblospio benedicti	Annelida	Spionidae

P-Code	P-Name	Included Taxa	Phylum	Family
P483	STERNASPIS FOSSOR	Sternaspis fossor	Annelida	Sternaspidae
P078	AUTOLYTUS SP	Autolytus; all taxa within the genus	Annelida	Syllidae
P529	BRANIA SP	Brania; all taxa within the genus	Annelida	Syllidae
P186	EUSYLLIS TRANSECTA	Eusyllis transecta	Annelida	Syllidae
P187	EXOGONE BREVISETA	Exogone breviseta	Annelida	Syllidae
P188	EXOGONE DWISULA	Exogone dwisula	Annelida	Syllidae
P189	EXOGONE LOUREI	Exogone lourei	Annelida	Syllidae
P190	EXOGONE MOLESTA	Exogone molesta	Annelida	Syllidae
P339	ODONTOSYLLIS PHOSPHOREA	Odontosyllis phosphorea	Annelida	Syllidae
P399	PIONOSYLLIS SP	Pionosyllis; all taxa within the genus	Annelida	Syllidae
P428	PROCERAEA SP	Proceraea; all taxa within the genus	Annelida	Syllidae
P474	SPHAEROSYLLIS SP	Sphaerosyllis; all taxa within the genus	Annelida	Syllidae
P491	SYLLIS (EHLERSIA) HETEROCHAETA	Syllis (Ehlersia) heterochaeta	Annelida	Syllidae
P492	SYLLIS (EHLERSIA) HYPERIONI	Syllis (Ehlersia) hyperioni	Annelida	Syllidae
P585	SYLLIS (SYLLIS) GRACILIS	Syllis (Syllis) gracilis	Annelida	Syllidae
P493	SYLLIS (TYPOSYLLIS) FARALLONENSIS	Syllis (Typosyllis) farallonensis	Annelida	Syllidae
P494	SYLLIS (TYPOSYLLIS) SPP	Syllis (Typosyllis); all taxa within the subgenus except S. (T.) farallonensis [Exclude S.(T.) sp]	Annelida	Syllidae
P023	AMAEANA OCCIDENTALIS	Amaeana occidentalis	Annelida	Terebellidae
P183	EUPOLYMNIA HETEROBRANCHIA	Eupolymnia heterobranchia	Annelida	Terebellidae
P244	LANASSA SP	Lanassa; all taxa within the genus	Annelida	Terebellidae
P245	LANICE CONCHILEGA	Lanice conchilega	Annelida	Terebellidae
P264	LOIMIA MEDUSA	Loimia sp A SCAMIT 2001	Annelida	Terebellidae
P401	PISTA ALATA	Pista agassizi	Annelida	Terebellidae
P404	PISTA SP B	Pista bansei	Annelida	Terebellidae
P402	PISTA FASCIATA	Pista disjuncta	Annelida	Terebellidae
P403	PISTA MOOREI	Pista moorei	Annelida	Terebellidae
P418	POLYCIRRUS SP	Polycirrus; all taxa within the genus	Annelida	Terebellidae
P429	PROCLEA SP A	Proclea sp A Harris 1992	Annelida	Terebellidae
P487	STREBLOSOMA SP	Streblosoma; all taxa within the genus	Annelida	Terebellidae
P504	THELEPUS SETOSUS	Thelepus setosus	Annelida	Terebellidae
P072	ARTACAMELLA HANCOCKI	Artacamella hancocki	Annelida	Trichobranchidae
P503	TEREBELLIDES SP	Terebellides; all taxa within the genus	Annelida	Trichobranchidae
P448	ROCINELA ANGUSTATA	Rocinela angustata	Arthropoda	Aegidae
P085	BLEPHARIPODA OCCIDENTALIS	Blepharipoda occidentalis	Arthropoda	Albuneidae
P548	ALPHEUS BELLIMANUS	Alpheus bellimanus	Arthropoda	Alpheidae
P549	ALPHEUS CALIFORNIENSIS	Alpheus californiensis	Arthropoda	Alpheidae
P025	AMPELISCA AGASSIZI	Ampelisca agassizi	Arthropoda	Ampeliscidae
P026	AMPELISCA BRACHYCLADUS	Ampelisca brachycladus	Arthropoda	Ampeliscidae
P027	AMPELISCA BREVISIMULATA	Ampelisca brevisimulata	Arthropoda	Ampeliscidae
P028	AMPELISCA CAREYI	Ampelisca careyi	Arthropoda	Ampeliscidae
P029	AMPELISCA CRISTATA	Ampelisca cristata cristata and A. cristata microdentata	Arthropoda	Ampeliscidae
P030	AMPELISCA HANCOCKI COMPLEX	Ampelisca hancocki; all forms referred to under this name	Arthropoda	Ampeliscidae

P-Code	P-Name	Included Taxa	Phylum	Family
P031	AMPELISCA INDENTATA	Ampelisca indentata	Arthropoda	Ampeliscidae
P032	AMPELISCA MILLERI	Ampelisca milleri	Arthropoda	Ampeliscidae
P033	AMPELISCA PACIFICA	Ampelisca pacifica	Arthropoda	Ampeliscidae
P034	AMPELISCA PUGETICA	Ampelisca pugetica	Arthropoda	Ampeliscidae
P035	AMPELISCA ROMIGI	Ampelisca romigi	Arthropoda	Ampeliscidae
P036	AMPELISCA SHOEMAKERI	Ampelisca shoemakeri	Arthropoda	Ampeliscidae
P037	AMPELISCA UNSOCALAE	Ampelisca unsocalae	Arthropoda	Ampeliscidae
P093	BYBLIS VELERONIS	Byblis veleronis	Arthropoda	Ampeliscidae
P534	APOLOCHUS BARNARDI	Apolochus barnardi	Arthropoda	Amphilochidae
P204	GITANA CALITEMPLADO	Gitana calitemplado	Arthropoda	Amphilochidae
P065	ARAPHURA SP A	Araphura breviaria	Arthropoda	Anarthruridae
P066	ARAPHURA SP B	Araphura cuspirostris	Arthropoda	Anarthruridae
P218	HALIOPHASMA GEMINATUM	Haliophasma geminatum	Arthropoda	Anthuridae
P010	ACUMINODEUTOPUS HETERUROPUS	Acuminodeutopus heteruropus	Arthropoda	Aoridae
P058	AOROIDES SP	Aoroides; all taxa within the genus	Arthropoda	Aoridae
P083	BEMLOS AUDBETTIUS	Bemlos audbettius	Arthropoda	Aoridae
P535	BEMLOS MACROMANUS	Bemlos macromanus	Arthropoda	Aoridae
P536	GRANDIDIERELLA JAPONICA	Grandidierella japonica	Arthropoda	Aoridae
P369	PARAMICRODEUTOPUS SCHMITTI	Paramicrodeutopus schmitti	Arthropoda	Aoridae
P449	RUDILEMBOIDES STENOPROPODUS	Rudilemboides sp A	Arthropoda	Aoridae
P537	RUDILEMBOIDES SP	Rudilemboides; all taxa within the genus	Arthropoda	Aoridae
P236	IDARCTURUS ALLELOMORPHUS	Idarcturus allelomorphus	Arthropoda	Arcturidae
P319	NEASTACILLA CALIFORNICA	Neastacilla californica	Arthropoda	Arcturidae
P067	ARGISSA HAMATIPES	Argissa hamatipes	Arthropoda	Argissidae
P001	ACANTHAXIUS SPINULICAUDUS	Calocarides spinulicauda	Arthropoda	Axiidae
P139	CYCLASPIS NUBILA	Cyclaspis nubile	Arthropoda	Bodotriidae
P211	GLYPHOCUMA SP A	Glyphocuma sp A	Arthropoda	Bodotriidae
P325	NEOTRYPAEA SP	Neotrypaea; all taxa within the genus	Arthropoda	Callianassidae
P101	CANCER GRACILIS	Cancer gracilis	Arthropoda	Cancridae
P102	CANCER JORDANI	Cancer jordani	Arthropoda	Cancridae
P538	CAPRELLA CALIFORNICA	Caprella californica	Arthropoda	Caprellidae
P539	PARACAPRELLA SP	Paracaprella; all taxa within the genus	Arthropoda	Caprellidae
P184	EURYDICE CAUDATA	Eurydice caudate	Arthropoda	Cirolanidae
P130	COROPHIUM SP	Corophiinae; all taxa within the subfamily	Arthropoda	Corophiidae
P540	SINOCOROPHIUM CF HETEROCERATUM	Sinocorophium cf heteroceratum	Arthropoda	Corophiidae
P133	CRANGON ALASKENSIS	Crangon alaskensis	Arthropoda	Crangonidae
P297	MESOCRANGON MUNITELLA	Mesocrangon munitella	Arthropoda	Crangonidae
P322	NEOCRANGON ZACAE	Neocrangon zacae	Arthropoda	Crangonidae
P143	DEILOCERUS PLANUS	Deilocerus planus	Arthropoda	Cyclodorippidae
P076	ASTEROPELLA SLATTERYI	Asteropella slatteryi	Arthropoda	Cylindroleberididae
P080	BATHYLEBERIS SP	Bathyleberis, Xenoleberis; all taxa within the genera	Arthropoda	Cylindroleberididae
P257	LEUROLEBERIS SHARPEI	Leuroleberis sharpie	Arthropoda	Cylindroleberididae

P-Code	P-Name	Included Taxa	Phylum	Family
P374	PARASTEROPE SP	Parasterope, Postasterope; all taxa within the genera	Arthropoda	Cylindroleberididae
P515	VARGULA TSUJII	Vargula tsujii	Arthropoda	Cypridinidae
P541	ATYLUS TRIDENS	Atylus tridens	Arthropoda	Dexaminidae
P542	PARADEXAMINE SP	Paradexamine; all taxa within the genus	Arthropoda	Dexaminidae
P053	ANCHICOLURUS OCCIDENTALIS	Anchicolurus occidentalis	Arthropoda	Diastylidae
P147	DIASTYLIS CALIFORNICA	Diastylis californica	Arthropoda	Diastylidae
P150	DIASTYLIS SP A	Diastylis crenelata	Arthropoda	Diastylidae
P149	DIASTYLIS PELLUCIDA	Diastylis pellucida	Arthropoda	Diastylidae
P148	DIASTYLIS PARASPINULOSA	Diastylis sentosa	Arthropoda	Diastylidae
P151	DIASTYLOPSIS TENUIS	Diastylopsis tenuis	Arthropoda	Diastylidae
P255	LEPTOSTYLIS VILLOSA	Leptostylis abdidtis	Arthropoda	Diastylidae
P254	LEPTOSTYLIS SP A	Leptostylis calva	Arthropoda	Diastylidae
P357	OXYUROSTYLIS PACIFICA	Oxyurostylis pacifica	Arthropoda	Diastylidae
P359	PAGURISTES BAKERI	Paguristes bakeri	Arthropoda	Diogenidae
P360	PAGURISTES TURGIDUS	Paguristes turgidus	Arthropoda	Diogenidae
P436	RHACHOTROPIS SP	Rhachotropis; all taxa within the genus	Arthropoda	Eusiridae
P212	GNATHIA CRENULATIFRONS	Caecognathia crenulatifrons	Arthropoda	Gnathiidae
P554	GNATHIIDAE	Gnathiidae; all taxa within the family	Arthropoda	Gnathiidae
P550	MALACOPLAX CALIFORNIENSIS	Malacoplax californiensis	Arthropoda	Goneplacidae
P225	HEPTACARPUS STIMPSONI	Heptacarpus stimpsoni	Arthropoda	Hippolytidae
P234	HYALE SP	Hyale; all taxa within the genus	Arthropoda	Hyalidae
P159	EDOTIA SP	Edotia; all taxa within the genus	Arthropoda	Idoteidae
P497	SYNIDOTEA SP	Synidotea; all taxa within the genus	Arthropoda	Idoteidae
P038	AMPELISCIPHOTIS PODOPHTHALMA	Ampelisciphotis podophthalma	Arthropoda	Isaeidae
P045	AMPHIDEUTOPUS OCULATUS	Amphideutopus oculatus	Arthropoda	Isaeidae
P199	GAMMAROPSIS OCIOSA	Gammaropsis ociosa	Arthropoda	Isaeidae
P200	GAMMAROPSIS THOMPSONI	Gammaropsis thompsoni	Arthropoda	Isaeidae
P388	PHOTIS SP	Photis; all taxa within the genus	Arthropoda	Isaeidae
P431	PROTOMEDEIA SP	Protomedeia; all taxa within the genus	Arthropoda	Isaeidae
P110	CERAPUS TUBULARIS COMPLEX	Cerapus tubularis; all forms referred to under this name	Arthropoda	Ischyroceridae
P168	ERICTHONIUS BRASILIENSIS	Ericthonius brasiliensis	Arthropoda	Ischyroceridae
P169	ERICTHONIUS RUBRICORNIS	Ericthonius rubricornis	Arthropoda	Ischyroceridae
P238	JOEROPSIS DUBIA	Joeropsis dubia	Arthropoda	Joeropsididae
P223	HEMILAMPROPS CALIFORNICA	Hemilamprops californicus	Arthropoda	Lampropidae
P242	LAMPROPS CARINATA	Lamprops carinatus	Arthropoda	Lampropidae
P243	LAMPROPS QUADRIPLICATA	Lamprops quadriplicatus	Arthropoda	Lampropidae
P298	MESOLAMPROPS BISPINOSA	Mesolamprops bispinosus	Arthropoda	Lampropidae
P551	NAUSHONIA MACGINITIEI	Naushonia macginitiei	Arthropoda	Laomediidae
P251	LEPTOCHELIA DUBIA	Leptochelia dubia	Arthropoda	Leptochelidae
P173	EUDORELLA PACIFICA	Eudorella pacifica	Arthropoda	Leuconidae
P174	EUDORELLOPSIS LONGIROSTRIS	Eudorellopsis longirostris	Arthropoda	Leuconidae
P256	LEUCON SUBNASICA	Leucon subnasica	Arthropoda	Leuconidae

P-Code	P-Name	Included Taxa	Phylum	Family
P434	RANDALLIA ORNATA	Randallia ornate	Arthropoda	Leucosiidae
P259	LISTRIELLA DIFFUSA	Listriella diffusa	Arthropoda	Liljeborgiidae
P260	LISTRIELLA ERIOPISA	Listriella eriopisa	Arthropoda	Liljeborgiidae
P261	LISTRIELLA GOLETA	Listriella Goleta	Arthropoda	Liljeborgiidae
P262	LISTRIELLA MELANICA	Listriella melanica	Arthropoda	Liljeborgiidae
P002	ACIDOSTOMA HANCOCKI	Acidostoma hancocki	Arthropoda	Lysianassidae
P056	ANONYX LILLJEBORGI	Anonyx lilljeborgi	Arthropoda	Lysianassidae
P073	ARUGA HOLMESI	Aruga holmesi	Arthropoda	Lysianassidae
P074	ARUGA OCULATA	Aruga oculata	Arthropoda	Lysianassidae
P231	HIPPOMEDON SP	Hippomedon; all taxa within the genus	Arthropoda	Lysianassidae
P250	LEPIDEPECREUM SP A	Lepidepecreum serraculum	Arthropoda	Lysianassidae
P350	OPISA TRIDENTATA	Opisa tridentate	Arthropoda	Lysianassidae
P351	ORCHOMENE ANAQUELUS	Orchomene anaquelus	Arthropoda	Lysianassidae
P352	ORCHOMENE DECIPIENS	Orchomene decipiens	Arthropoda	Lysianassidae
P353	ORCHOMENE PACIFICUS	Orchomene pacificus	Arthropoda	Lysianassidae
P354	ORCHOMENE PINGUIS	Orchomene pinguis	Arthropoda	Lysianassidae
P358	PACHYNUS BARNARDI	Pachynus barnardi	Arthropoda	Lysianassidae
P421	PRACHYNELLA LODO	Prachynella lodo	Arthropoda	Lysianassidae
P170	ERILEPTUS SPINOSUS	Erileptus spinosus	Arthropoda	Majidae
P413	PODOCHELA SP	Podochela; all taxa within the genus	Arthropoda	Majidae
P433	PYROMAIA TUBERCULATA	Pyromaia tuberculata	Arthropoda	Majidae
P203	GIBBEROSUS MYERSI	Gibberosus myersi	Arthropoda	Megaluropidae
P232	HORNELLIA OCCIDENTALIS	Hornellia occidentalis	Arthropoda	Melitidae
P278	MAERA SIMILE	Maera similes	Arthropoda	Melitidae
P295	MELPHISANA BOLA COMPLEX	Melphisana bola; all forms referred to under this name	Arthropoda	Melphidippidae
P237	ILYARACHNA ACARINA	Ilyarachna acarina	Arthropoda	Munnopsidae
P323	NEOMYSIS KADIAKENSIS	Neomysis kadiakensis	Arthropoda	Mysidae
P097	CAMPYLASPIS CANALICULATA	Campylaspis canaliculata	Arthropoda	Nannastacidae
P098	CAMPYLASPIS HARTAE	Campylaspis hartae	Arthropoda	Nannastacidae
P100	CAMPYLASPIS SP D	Campylaspis maculinoduosa	Arthropoda	Nannastacidae
P099	CAMPYLASPIS RUBROMACULATA	Campylaspis rubromaculata	Arthropoda	Nannastacidae
P547	CAMPYLASPIS SP	Campylaspis; all taxa within the genus	Arthropoda	Nannastacidae
P137	CUMELLA SP A	Cumella californica	Arthropoda	Nannastacidae
P427	PROCAMPYLASPIS SP A	Procampylaspis caenosa	Arthropoda	Nannastacidae
P320	NEBALIA SP	Nebalia; all taxa within the genus	Arthropoda	Nebaliidae
P496	SYNCHELIDIUM SP	Americhelidium; all taxa wthin the genus	Arthropoda	Oedicerotidae
P081	BATHYMEDON PUMILUS	Bathymedon pumilus	Arthropoda	Oedicerotidae
P082	BATHYMEDON VULPECULUS	Bathymedon vulpeculus	Arthropoda	Oedicerotidae
P543	EOCHELIDIUM SP A	Eochelidium sp A	Arthropoda	Oedicerotidae
P306	MONOCULODES SP	Monoculodes, Hartmanodes, Pacifoculodes, Deflexilodes, all taxa within the genera	Arthropoda	Oedicerotidae
P520	WESTWOODILLA CAECULA	Westwoodilla caecula	Arthropoda	Oedicerotidae
P341	OGYRIDES SP A	Ogyrides sp A	Arthropoda	Ogyrididae
P355	ORTHOPAGURUS MINIMUS	Orthopagurus minimus	Arthropoda	Paguridae
P361	PAGURUS SP	Pagurus; all taxa within the genus	Arthropoda	Paguridae

P-Code	P-Name	Included Taxa	Phylum	Family
P372	PARAPAGURODES LAURENTAE	Parapagurodes laurentae	Arthropoda	Paguridae
P310	MUNNOGONIUM TILLERAE	Munnogonium tillerae	Arthropoda	Paramunnidae
P407	PLEUROGONIUM CALIFORNIENSE	Pleurogonium californiense	Arthropoda	Paramunnidae
P555	PARANTHURA ELEGANS	Paranthura elegans	Arthropoda	Paranthuridae
P217	HALICOIDES SYNOPIAE	Halicoides synopiae	Arthropoda	Pardaliscidae
P333	NICIPPE TUMIDA	Nicippe tumida	Arthropoda	Pardaliscidae
P375	PARDALISCELLA SP	Pardaliscella; all taxa within the genus	Arthropoda	Pardaliscidae
P227	HETEROCRYPTA OCCIDENTALIS	Heterocrypta occidentalis	Arthropoda	Parthenopidae
P180	EUPHILOMEDES CARCHARODONTA	Euphilomedes carcharodonta	Arthropoda	Philomedidae
P181	EUPHILOMEDES PRODUCTA	Euphilomedes producta	Arthropoda	Philomedidae
P457	SCLEROCONCHA TRITUBERCULATA	Scleroconcha trituberculata	Arthropoda	Philomedidae
P109	CEPHALOPHOXOIDES HOMILIS	Cephalophoxoides homilis	Arthropoda	Phoxocephalidae
P191	EYAKIA ROBUSTA	Eyakia robusta	Arthropoda	Phoxocephalidae
P193	FOXIPHALUS COGNATUS	Foxiphalus cognatus	Arthropoda	Phoxocephalidae
P194	FOXIPHALUS GOLFENSIS	Foxiphalus golfensis	Arthropoda	Phoxocephalidae
P195	FOXIPHALUS OBTUSIDENS	Foxiphalus obtusidens	Arthropoda	Phoxocephalidae
P196	FOXIPHALUS SIMILIS	Foxiphalus similes	Arthropoda	Phoxocephalidae
P222	HARPINIOPSIS FULGENS	Harpiniopsis fulgens	Arthropoda	Phoxocephalidae
P229	HETEROPHOXUS SP	Heterophoxus; all taxa within the genus	Arthropoda	Phoxocephalidae
P299	METAPHOXUS FREQUENS	Metaphoxus frequens	Arthropoda	Phoxocephalidae
P368	PARAMETAPHOXUS FULTONI	Parametaphoxus quaylei	Arthropoda	Phoxocephalidae
P439	RHEPOXYNIUS ABRONIUS	Rhepoxynius abronius	Arthropoda	Phoxocephalidae
P440	RHEPOXYNIUS BICUSPIDATUS	Rhepoxynius bicuspidatus	Arthropoda	Phoxocephalidae
P441	RHEPOXYNIUS HETEROCUSPIDATUS	Rhepoxynius heterocuspidatus	Arthropoda	Phoxocephalidae
P442	RHEPOXYNIUS LUCUBRANS	Rhepoxynius lucubrans	Arthropoda	Phoxocephalidae
P443	RHEPOXYNIUS MENZIESI	Rhepoxynius menziesi	Arthropoda	Phoxocephalidae
P444	RHEPOXYNIUS STENODES	Rhepoxynius stenodes	Arthropoda	Phoxocephalidae
P445	RHEPOXYNIUS VARIATUS	Rhepoxynius variatus	Arthropoda	Phoxocephalidae
P224	HEMIPROTO SP A	Hemiproto sp A	Arthropoda	Phtiscidae
P393	PINNIXA FRANCISCANA	Pinnixa franciscana	Arthropoda	Pinnotheridae
P394	PINNIXA HIATUS	Pinnixa hiatus	Arthropoda	Pinnotheridae
P395	PINNIXA LONGIPES	Pinnixa longipes	Arthropoda	Pinnotheridae
P396	PINNIXA OCCIDENTALIS	Pinnixa occidentalis and P. scamit	Arthropoda	Pinnotheridae
P397	PINNIXA TOMENTOSA	Pinnixa tomentosa	Arthropoda	Pinnotheridae
P398	PINNIXA TUBICOLA	Pinnixa tubicola	Arthropoda	Pinnotheridae
P458	SCLEROPLAX GRANULATA	Scleroplax granulate	Arthropoda	Pinnotheridae
P408	PLEUSYMTES SUBGLABER	Pleusymtes subglaber	Arthropoda	Pleustidae
P544	PODOCERUS BRASILIENSIS	Podocerus brasiliensis	Arthropoda	Podoceridae
P545	PODOCERUS FULANUS	Podocerus fulanus	Arthropoda	Podoceridae
P412	PODOCERUS SP	Podocerus; all taxa within the genus	Arthropoda	Podoceridae
P552	AMBIDEXTER PANAMENSIS	Ambidexter panamensis	Arthropoda	Processidae
P546	MAYERELLA ACANTHOPODA	Mayerella acanthopoda	Arthropoda	Protellidae

P-Code	P-Name	Included Taxa	Phylum	Family
P287	MAYERELLA BANKSIA	Mayerella banksias	Arthropoda	Protellidae
P511	TRITELLA PILIMANA	Tritella pilimana	Arthropoda	Protellidae
P450	RUTIDERMA SP	Rutiderma; all taxa within the genus	Arthropoda	Rutidermatidae
P185	EUSARSIELLA THOMINX	Eusarsiella thominx	Arthropoda	Sarsiellidae
P221	HAMATOSCALPELLUM CALIFORNICUM	Hamatoscalpellum californicum	Arthropoda	Scalpellidae
P462	SEROLIS CARINATA	Heteroserolis carinata	Arthropoda	Serolidae
P556	PARACERCEIS SCULPTA	Paracerceis sculpta	Arthropoda	Sphaeromatidae
P557	SCHMITTIUS POLITUS	Schmittius politus	Arthropoda	Squillidae
P301	METOPA DAWSONI	Metopa dawsoni	Arthropoda	Stenothoidae
P482	STENOTHOIDES BICOMA	Stenothoides bicoma	Arthropoda	Stenothoidae
P498	SYRRHOE SP A	Syrrhoe sp A	Arthropoda	Synopiidae
P507	TIRON BIOCELLATA	Tiron biocellata	Arthropoda	Synopiidae
P586	SYNAPTOTANAIS NOTABILIS	Synaptotanais notabilis	Arthropoda	Tanaidae
P593	ZEUXO NORMANI	Zeuxo normani	Arthropoda	Tanaidae
P513	UPOGEBIA SP	Upogebia; all taxa within the genus	Arthropoda	Upogebiidae
P514	UROTHOE VARVARINI	Urothoe varvarini	Arthropoda	Urothoidae
P553	LOPHOPANOPEUS BELLUS	Lophopanopeus bellus	Arthropoda	Xanthidae
P558	PYCNOGONIDA	Pycnogonida; all taxa within the class	Arthropoda	
P205	GLOTTIDIA ALBIDA	Glottidia albida	Brachiopoda	Lingulidae
P090	BRANCHIOSTOMA CALIFORNIENSE	Branchiostoma californiense	Chordata	Branchiostomatidae
P559	MOLGULA SP	Molgula; all taxa within the genus	Chordata	Molgulidae
P163	ENTEROPNEUSTA	Enteropneusta; all taxa within the class	Chordata	
P561	OBELIA SP A	Obelia sp A	Cnidaria	Campanulariidae
P131	CORYMORPHA SP	Corymorpha; all taxa within the genus	Cnidaria	Corymorphidae
P182	EUPHYSA SP A	Euphysa sp A	Cnidaria	Corymorphidae
P160	EDWARDSIIDAE	Edwardsiidae; all taxa within the family	Cnidaria	Edwardsiidae
P505	THESEA SP B	Thesea sp B	Cnidaria	Muriceidae
P488	STYLATULA ELONGATA	Stylatula elongate	Cnidaria	Virgulariidae
P111	CERIANTHARIA	Ceriantharia; all taxa within the order	Cnidaria	
P560	PENNATULACEA	Pennatulacea; all taxa within the order	Cnidaria	
P042	AMPHICHONDRIUS GRANULOSUS	Amphichondrius granulatus	Echinodermata	Amphiuridae
P046	AMPHIODIA COMPLEX	Amphiodia; all taxa within the genus	Echinodermata	Amphiuridae
P047	AMPHIOPLUS SP	Amphioplus; all taxa within the genus	Echinodermata	Amphiuridae
P048	AMPHIPHOLIS SP	Amphipholis; all taxa within the genus	Echinodermata	Amphiuridae
P051	AMPHIURA ACRYSTATA	Amphiura arcystata	Echinodermata	Amphiuridae
P156	DOUGALOPLUS SP	Dougaloplus; all taxa within the genus	Echinodermata	Amphiuridae
P077	ASTROPECTEN VERRILLI	Astropecten verrilli	Echinodermata	Astropectinidae
P092	BRISSOPSIS PACIFICA	Brissopsis pacifica	Echinodermata	Brissidae
P106	CAUDINA ARENICOLA	Caudina arenicola	Echinodermata	Caudinidae
P145	DENDRASTER EXCENTRICUS	Dendraster terminalis	Echinodermata	Dendrasteridae
P265	LOVENIA CORDIFORMIS	Lovenia cordiformis	Echinodermata	Loveniidae
P268	LUIDIA SP	Luidia; all taxa within the genus	Echinodermata	Luidiidae
P305	MOLPADIA INTERMEDIA	Molpadia intermedia	Echinodermata	Molpadiidae
P348	OPHIUROCONIS BISPINOSA	Ophiuroconis bispinosa	Echinodermata	Ophiodermatidae

P-Code	P-Name	Included Taxa	Phylum	Family
P347	OPHIURA LUETKENI	Ophiura luetkenii	Echinodermata	Ophiuridae
P091	BRISASTER LATIFRONS	Brisaster latifrons	Echinodermata	Schizasteridae
P020	ALLOCENTROTUS FRAGILIS	Allocentrotus fragilis	Echinodermata	Strongylocentrotidae
P495	SYNAPTIDAE	Synaptidae, Chirodotidae; all taxa within the families	Echinodermata	Synaptidae
P273	LYTECHINUS PICTUS	Lytechinus pictus	Echinodermata	Toxopneustidae
P068	ARHYNCHITE CALIFORNICUS	Arhynchite californicus	Echiura	Thalassematidae
P263	LISTRIOLOBUS PELODES	Listriolobus pelodes	Echiura	Thalassematidae
P009	ACTEON TRASKII	Acteon traskii	Mollusca	Acteonidae
P447	RICTAXIS PUNCTOCAELATUS	Rictaxis punctocaelatus	Mollusca	Acteonidae
P013	AGLAJA OCELLIGERA	Aglaja ocelligera	Mollusca	Aglajidae
P575	AGLAJIDAE	Aglajidae; all taxa within the family	Mollusca	Aglajidae
P292	MELANOCHLAMYS DIOMEDEA	Melanochlamys diomedea	Mollusca	Aglajidae
P071	ARMINA CALIFORNICA	Armina californica	Mollusca	Arminidae
P579	BARLEEIA SP	Barleeia; all taxa within the genus	Mollusca	Barleeiidae
P580	CAECUM CALIFORNICUM	Caecum californicum	Mollusca	Caecidae
P094	CAECUM CREBRICINCTUM	Caecum crebricinctum	Mollusca	Caecidae
P581	CAECUM OCCIDENTALE	Caecum occidentale	Mollusca	Caecidae
P096	CALYPTRAEA FASTIGIATA	Calyptraea fastigiata	Mollusca	Calyptraeidae
P135	CREPIDULA SP	Crepidula, Crepipatella; all taxa within the genera	Mollusca	Calyptraeidae
P582	CRUCIBULUM SPINOSUM	Crucibulum spinosum	Mollusca	Calyptraeidae
P567	LAEVICARDIUM SUBSTRIATUM	Laevicardium substriatum	Mollusca	Cardiidae
P321	NEMOCARDIUM CENTIFILOSUM	Nemocardium centifilosum	Mollusca	Cardiidae
P508	TRACHYCARDIUM QUADRAGENARIUM	Trachycardium quadragenarium	Mollusca	Cardiidae
P140	CYCLOCARDIA SPP	Cyclocardia ventricosa and C. barbarensis [Exclude C. sp]	Mollusca	Carditidae
P084	BITTIUM COMPLEX	Bittium, Lirobittium; all taxa within the genera	Mollusca	Cerithiidae
P112	CERITHIOPSIS SP	Cerithiopsis; all taxa within the genus	Mollusca	Cerithiopsidae
P016	ALIA TUBEROSA	Alia tuberose	Mollusca	Columbellidae
P049	AMPHISSA UNDATA	Amphissa undata	Mollusca	Columbellidae
P050	AMPHISSA VERSICOLOR	Amphissa versicolor	Mollusca	Columbellidae
P127	CONUS CALIFORNICUS	Conus californicus	Mollusca	Conidae
P239	KURTZIA ARTEAGA	Kurtzia arteaga	Mollusca	Conidae
P241	KURTZIELLA PLUMBEA	Kurtziella plumbea	Mollusca	Conidae
P240	KURTZIELLA BETA	Kurtzina beta	Mollusca	Conidae
P346	OPHIODERMELLA SP	Ophiodermella; all taxa within the genus	Mollusca	Conidae
P129	CORBULA SP	Caryocorbula, Juliacorbula, all taxa within the genera	Mollusca	Corbulidae
P105	CARDIOMYA SP	Cardiomya; all taxa within the genus	Mollusca	Cuspidariidae
P138	CUSPIDARIA PARAPODEMA	Cuspidaria parapodema	Mollusca	Cuspidariidae
P006	ACTEOCINA CULCITELLA	Acteocina culcitella	Mollusca	Cylichnidae
P007	ACTEOCINA HARPA	Acteocina harpa	Mollusca	Cylichnidae
P008	ACTEOCINA INCULTA	Acteocina inculta	Mollusca	Cylichnidae
P141	CYLICHNA DIEGENSIS	Cylichna diegensis	Mollusca	Cylichnidae
P146	DENTALIUM SP	Dentalium; all taxa within the genus	Mollusca	Dentaliidae

P-Code	P-Name	Included Taxa	Phylum	Family
P166	EPITONIIDAE	Epitoniidae; all taxa within the family	Mollusca	Epitoniidae
P291	MELANELLA SP	Balcis, Polygyreulima, Vitriolina; all taxa within the genus	Mollusca	Eulimidae
P176	EULIMA CALIFORNICUS	Eulima raymondi and E. almo	Mollusca	Eulimidae
P197	GADILA ABERRANS	Cadulus aberrans	Mollusca	Gadilidae
P198	GALEOMMATIDAE SP A	Divariscintilla sp A	Mollusca	Galeommatidae
P202	GASTROPTERON PACIFICUM	Gastropteron pacificum	Mollusca	Gastropteridae
P576	HAMINOEA VESICULA	Haminoea vesicular	Mollusca	Haminoeidae
P230	HIATELLA ARCTICA	Hiatella arctica	Mollusca	Hiatellidae
P453	SAXICAVELLA NYBAKKENI	Saxicavella nybakkeni	Mollusca	Hiatellidae
P454	SAXICAVELLA PACIFICA	Saxicavella pacifica	Mollusca	Hiatellidae
P591	TRYONIA IMITATOR	Tryonia imitator	Mollusca	Hydrobiidae
P435	RHABDUS RECTIUS	Rhabdus rectius	Mollusca	Laevidentaliidae
P568	KELLIA SUBORBICULARIS	Kellia suborbicularis	Mollusca	Lasaeidae
P313	MYSELLA SP	Mysella; Rochfortia; all taxa within the genera	Mollusca	Lasaeidae
P437	RHAMPHIDONTA RETIFERA	Rhamphidonta retifera	Mollusca	Lasaeidae
P569	ROCHEFORTIA SP	Rochfortia, all taxa within the genus	Mollusca	Lasaeidae
P252	LEPTOCHITON SP	Leptochiton; all taxa within the genus	Mollusca	Lepidopleuridae
P562	LIMARIA HEMPHILLI	Limaria hemphilli	Mollusca	Limidae
P588	TECTURA DEPICTA	Tectura depicta	Mollusca	Lotiidae
P266	LUCINISCA NUTTALLI	Lucinisca nuttalli	Mollusca	Lucinidae
P267	LUCINOMA ANNULATUM	Lucinoma annulatum	Mollusca	Lucinidae
P377	PARVILUCINA TENUISCULPTA	Parvilucina tenuisculpta	Mollusca	Lucinidae
P164	ENTODESMA PICTUM	Entodesma pictum	Mollusca	Lyonsiidae
P271	LYONSIA CALIFORNICA	Lyonsia californica	Mollusca	Lyonsiidae
P277	MACTRIDAE	Mactridae; all taxa within the family	Mollusca	Mactridae
P233	HUXLEYIA MUNITA	Huxleyia munita	Mollusca	Manzanellidae
P136	CRYPTOMYA CALIFORNICA	Cryptomya californica	Mollusca	Myidae
P052	AMYGDALUM PALLIDULUM	Amygdalum politum	Mollusca	Mytilidae
P134	CRENELLA DECUSSATA	Crenella decussate	Mollusca	Mytilidae
P304	MODIOLUS SP	Modiolus; all taxa within the genus	Mollusca	Mytilidae
P563	MUSCULISTA SENHOUSIA	Musculista senhousia	Mollusca	Mytilidae
P564	MYTILUS SP	Mytilus; all taxa within the genus	Mollusca	Mytilidae
P469	SOLAMEN COLUMBIANUM	Solamen columbianum	Mollusca	Mytilidae
P315	NASSARIUS FOSSATUS	Nassarius fossatus	Mollusca	Nassariidae
P316	NASSARIUS INSCULPTUS	Nassarius insculptus	Mollusca	Nassariidae
P317	NASSARIUS MENDICUS	Nassarius mendicus	Mollusca	Nassariidae
P318	NASSARIUS PERPINGUIS	Nassarius perpinguis	Mollusca	Nassariidae
P578	NASSARIUS TIARULA	Nassarius tiarula	Mollusca	Nassariidae
P095	CALINATICINA OLDROYDII	Calinaticina oldroydii	Mollusca	Naticidae
P416	POLINICES DRACONIS	Euspira draconis	Mollusca	Naticidae
P417	POLINICES LEWISII	Euspira lewisii	Mollusca	Naticidae
P332	NEVERITA RECLUSIANA	Neverita reclusiana	Mollusca	Naticidae
P467	SINUM SCOPULOSUM	Sinum scopulosum	Mollusca	Naticidae
P338	NUCULANA SP	Nuculana; all taxa within the genus	Mollusca	Nuculanidae
P003	ACILA CASTRENSIS	Acila castrensis	Mollusca	Nuculidae

P-Code	P-Name	Included Taxa	Phylum	Family
P161	ENNUCULA TENUIS	Ennucula tenuis	Mollusca	Nuculidae
P342	OLIVELLA BAETICA	Olivella baetica	Mollusca	Olividae
P565	OSTREIDAE	Ostreidae; all taxa within the family	Mollusca	Ostreidae
P363	PANDORA BILIRATA	Pandora bilirata	Mollusca	Pandoridae
P364	PANDORA FILOSA	Pandora filosa	Mollusca	Pandoridae
P566	ARGOPECTEN VENTRICOSUS	Argopecten ventricosus	Mollusca	Pectinidae
P144	DELECTOPECTEN VANCOUVERENSIS	Delectopecten vancouverensis	Mollusca	Pectinidae
P253	LEPTOPECTEN LATIAURATUS	Leptopecten latiauratus	Mollusca	Pectinidae
P128	COOPERELLA SUBDIAPHANA	Cooperella subdiaphana	Mollusca	Petricolidae
P381	PETRICOLA SP	Petricola; all taxa within the genus	Mollusca	Petricolidae
P162	ENSIS MYRAE	Ensis myrae	Mollusca	Pharidae
P466	SILIQUA LUCIDA	Siliqua lucida	Mollusca	Pharidae
P577	PHILINE AURIFORMIS	Philine auriformis	Mollusca	Philinidae
P383	PHILINE BAKERI	Philine bakeri	Mollusca	Philinidae
P384	PHILINE SP A	Philine sp A	Mollusca	Philinidae
P406	PLEUROBRANCHAEA CALIFORNICA	Pleurobranchaea californica	Mollusca	Pleurobranchaeidae
P201	GARI CALIFORNICA	Gari californica	Mollusca	Psammobiidae
P340	ODOSTOMIA SP	Odostomia; all taxa within the genus	Mollusca	Pyramidellidae
P512	TURBONILLA SP	Turbonilla; all taxa within the genus	Mollusca	Pyramidellidae
P490	SULCORETUSA XYSTRUM	Sulcoretusa xystrum	Mollusca	Retusidae
P517	VOLVULELLA CALIFORNICA	Volvulella californica	Mollusca	Retusidae
P518	VOLVULELLA CYLINDRICA	Volvulella cylindrical	Mollusca	Retusidae
P519	VOLVULELLA PANAMICA	Volvulella panamica	Mollusca	Retusidae
P021	ALVANIA ACUTELIRATA	Alvania compacta	Mollusca	Rissoidae
P022	ALVANIA ROSANA	Alvania rosana	Mollusca	Rissoidae
P570	CUMINGIA CALIFORNICA	Cumingia californica	Mollusca	Semelidae
P590	THEORA LUBRICA	Theora lubrica	Mollusca	Semelidae
P468	SIPHONODENTALIUM QUADRIFISSATUM	Siphonodentalium quadrifissatum	Mollusca	Siphonodentaliidae
P587	TAGELUS SUBTERES	Tagelus subteres	Mollusca	Solecurtidae
P471	SOLEMYA REIDI	Solemya reidi	Mollusca	Solemyidae
P472	SOLEN SP	Solen; all taxa within the genus	Mollusca	Solenidae
P571	LEPORIMETIS OBESA	Leporimetis obesa	Mollusca	Tellinidae
P274	MACOMA CARLOTTENSIS	Macoma carlottensis	Mollusca	Tellinidae
P572	MACOMA INDENTATA	Macoma indentata	Mollusca	Tellinidae
P275	MACOMA NASUTA	Macoma nasuta	Mollusca	Tellinidae
P276	MACOMA YOLDIFORMIS	Macoma yoldiformis	Mollusca	Tellinidae
P499	TELLINA CARPENTERI	Tellina carpenteri and T. sp A	Mollusca	Tellinidae
P500	TELLINA IDAE	Tellina idea	Mollusca	Tellinidae
P589	TELLINA MEROPSIS	Tellina meropsis	Mollusca	Tellinidae
P501	TELLINA MODESTA	Tellina modesta	Mollusca	Tellinidae
P379	PERIPLOMA/THRACIA COMPLEX	Asthenothareus, Thracia; all taxa within the genera; and Periploma discus [Exclude P. sp]	Mollusca	Thracidae
P011	ADONTORHINA CYCLIA	Adontorhina cyclia	Mollusca	Thyasiridae
P079	AXINOPSIDA SERRICATA	Axinopsida serricata	Mollusca	Thyasiridae
P506	THYASIRA FLEXUOSA	Thyasira flexuosa	Mollusca	Thyasiridae

P-Code	P-Name	Included Taxa	Phylum	Family
P219	HALISTYLUS PUPOIDES	Halistylus pupoides	Mollusca	Trochidae
P470	SOLARIELLA PERAMABILIS	Solariella peramabilis	Mollusca	Trochidae
P290	MEGASURCULA CARPENTERIANA	Megasurcula carpenteriana	Mollusca	Turridae
P573	DIPLODONTA SERICATA	Diplodonta sericata	Mollusca	Ungulinidae
P117	CHIONE SP	Chione; all taxa within the genus	Mollusca	Veneridae
P126	COMPSOMYAX SUBDIAPHANA	Compsomyax subdiaphana	Mollusca	Veneridae
P509	TRANSENELLA TANTILLA	Nutricola tantilla	Mollusca	Veneridae
P574	PITAR NEWCOMBIANUS	Pitar newcombianus	Mollusca	Veneridae
P432	PROTOTHACA SP	Protothaca; all taxa within the genus	Mollusca	Veneridae
P455	SAXIDOMUS NUTTALLI	Saxidomus nuttalli	Mollusca	Veneridae
P592	VENERUPIS PHILIPPINARUM	Venerupis philippinarum	Mollusca	Veneridae
P516	VITRINELLA SP	Vitrinella; all taxa within the genus	Mollusca	Vitrinellidae
P062	APLACOPHORA	Chaetoderma, Falcidens, Limifossor; all taxa within the genera	Mollusca	
P387	PHORONIDA	Phoronida; all taxa within the order	Phorona	

Table 4. Pollution tolerance scores for taxa included in the southern California BRI

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
P001	ACANTHAXIUS SPINULICAUDUS		8.76460			148.719
P002	ACIDOSTOMA HANCOCKI	22.50179	16.80141			
P003	ACILA CASTRENSIS		-10.71143	25.25984		
P004	ACMIRA SP	40.79202	32.30160	0.57741	2.947	
P005	ACOETES PACIFICA		-11.32912	-14.79637		
P006	ACTEOCINA CULCITELLA	-2.06105	14.80587	16.97117		
P007	ACTEOCINA HARPA	6.55930	32.76509			-73.880
P008	ACTEOCINA INCULTA	57.34264			-57.035	
P009	ACTEON TRASKII	35.34395	5.71502			
P010	ACUMINODEUTOPUS HETERUROPUS	-13.49358	5.74863			
P011	ADONTORHINA CYCLIA		-21.11558	-7.52579		
P012	AEDICIRA PACIFICA		14.40521			
P013	AGLAJA OCELLIGERA	27.96006	35.63636	57.82386		
P575	AGLAJIDAE					-38.574
P014	AGLAOPHAMUS ERECTANS			18.99415		
P015	AGLOPHAMUS VERRILLI		-16.53768	-0.67027		
P016	ALIA TUBEROSA	120.91935	148.17974			
P017	ALLIA ANTENNATA		-7.95045	9.39005		
P018	ALLIA CF NOLANI		-8.21889			
P019	ALLIA RAMOSA	16.41637	-4.76121	-7.78792		
P020	ALLOCENTROTUS FRAGILIS			23.61781		
P548	ALPHEUS BELLIMANUS					85.066
P549	ALPHEUS CALIFORNIENSIS				51.341	53.290
P021	ALVANIA ACUTELIRATA		-5.60691			
P022	ALVANIA ROSANA		-46.50147	-22.99112		
P023	AMAEANA OCCIDENTALIS	1.42950	27.96298	-11.62162	-17.506	-4.295
P024	AMAGE ANOPS	10.95950	21.93077	-14.18200		
P552	AMBIDEXTER PANAMENSIS					120.771
P025	AMPELISCA AGASSIZI	-3.15856	3.78701	-7.87528		
P026	AMPELISCA BRACHYCLADUS	17.96879	18.38589		26.696	
P027	AMPELISCA BREVISIMULATA	19.94273	17.41833	-5.10456	-34.190	
P028	AMPELISCA CAREYI	16.11326	-11.30255	-7.78881		
P029	AMPELISCA CRISTATA	15.06661	20.01739		-4.825	-105.945
P030	AMPELISCA HANCOCKI COMPLEX	22.38560	-10.34018	-11.70964		
P031	AMPELISCA INDENTATA	17.30664	-10.48290			
P032	AMPELISCA MILLERI	6.10869	2.92140			
P033	AMPELISCA PACIFICA	50.37699	-7.96647	-2.44233		
P034	AMPELISCA PUGETICA	13.23734	-1.66689	-31.24389		
P035	AMPELISCA ROMIGI	43.92832	13.55283			
P036	AMPELISCA SHOEMAKERI		5.26503			
P037	AMPELISCA UNSOCALAE	25.65085	18.98649	28.10018		
P038	AMPELISCIPHOTIS PODOPHTHALMA	12.46267	-0.10959			
P039	AMPHARETE ACUTIFRONS		-8.77057	22.66454		
P040	AMPHARETE ARCTICA	10.09351	14.72626	-5.01967		
P041	AMPHARETE LABROPS	52.32793	52.46280		-19.247	-61.775
P042	AMPHICHONDRIUS GRANULOSUS		-18.63708	-15.27667		
P043	AMPHICTEIS GLABRA		-1.61773			

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
P044	AMPHICTEIS SCAPHOBRANCHIATA	33.30274	29.01422	7.22314	13.371	-5.582
P045	AMPHIDEUTOPUS OCULATUS	-1.14096	8.27882	-5.24423	-18.710	13.043
P046	AMPHIODIA COMPLEX	48.71259	-8.56470	-12.22542	6.003	-22.510
P047	AMPHIOPLUS SP	1.12819	2.34445	-3.79062		
P048	AMPHIPHOLIS SP	19.69362	-9.34082	-10.03965	53.369	-5.094
P049	AMPHISSA UNDATA	3.05122	-20.77629	76.17220		
P050	AMPHISSA VERSICOLOR		0.28595			
P051	AMPHIURA ACRYSTATA	22.06976	-24.90503	-28.86240		
P052	AMYGDALUM PALLIDULUM		-23.37394	-20.05590		
P053	ANCHICOLURUS OCCIDENTALIS	-39.12707				
P054	ANCISTROSYLLIS SP	40.10104	56.32509	25.80314		
P055	ANOBOTHRUS GRACILIS		-11.15637	8.29189		
P056	ANONYX LILLJEBORGI		-24.38119			
P057	ANOTOMASTUS GORDIODES	-11.04299	11.23355		-43.655	
P058	AOROIDES SP	0.80629	14.17370	-25.96555	93.917	37.414
P059	APHELOCHAETA/MONTICELLINA COMPLEX	68.80358	85.58270	39.28050	62.638	97.387
P060	APHRODITA SP	11.37760	3.33951			21.632
P061	APISTOBRANCHUS ORNATUS	6.12230	-21.01641			
P062	APLACOPHORA	37.87627	19.19628	9.93792		
P534	APOLOCHUS BARNARDI					-54.791
P063	APOPRIONOSPIO PYGMAEA	17.20755	26.20346		-8.968	-25.411
P064	ARABELLA SP	48.89289	36.42177			
P065	ARAPHURA SP A	13.83487	-0.35580	6.65311		
P066	ARAPHURA SP B		-3.32721	3.92900		
P067	ARGISSA HAMATIPES	22.75008	26.15345			
P566	ARGOPECTEN VENTRICOSUS					18.174
P068	ARHYNCHITE CALIFORNICUS			59.53693		
P069	ARICIDEA WASSI	12.97301	24.51925			
P070	ARMANDIA BREVIS	129.02650	142.01529	138.46820		32.335
P071	ARMINA CALIFORNICA	43.96745	32.50033			
P072	ARTACAMELLA HANCOCKI	3.05299	-9.90848	-26.74754		
P073	ARUGA HOLMESI		-18.75054	-22.39580		
P074	ARUGA OCULATA	26.52773	10.51259			
P075	ASABELLIDES LINEATA	19.75906	-18.58553	-6.90474		
P076	ASTEROPELLA SLATTERYI	-6.06203	0.32240	16.42499		-63.807
P077	ASTROPECTEN VERRILLI	-5.98155	6.53794	-14.05260		
P541	ATYLUS TRIDENS					35.925
P078	AUTOLYTUS SP		3.83645			
P079	AXINOPSIDA SERRICATA	69.74568	26.96466	60.36019		
P579	BARLEEIA SP					-54.511
P080	BATHYLEBERIS SP	45.95418	30.60999	-15.44546		
P081	BATHYMEDON PUMILUS		-15.11195	-14.91961		
P082	BATHYMEDON VULPECULUS			2.84023		
P083	BEMLOS AUDBETTIUS	-3.38836	-4.47042	-43.21357		
P535	BEMLOS MACROMANUS					47.994
P084	BITTIUM COMPLEX	-3.56657	15.54375	18.10485		
P085	BLEPHARIPODA OCCIDENTALIS	-21.34549				
P086	BOCCARDIA BASILARIA	50.74631	39.31773			
P087	BOCCARDIELLA HAMATA			89.00062		
P088	BRADA PLURIBRANCHIATA		-42.15125			

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	**P_Name**	**Shallow**	**Mid-Depth**	**Deep**	**North**	**South**
P089	BRADA VILLOSA	29.28069	-5.33383			
P090	BRANCHIOSTOMA CALIFORNIENSE	-19.47974				
P529	BRANIA SP					5.670
P091	BRISASTER LATIFRONS			2.95006		
P092	BRISSOPSIS PACIFICA			-8.76975		
P093	BYBLIS VELERONIS	33.43227	-4.66451	-34.45625		
P580	CAECUM CALIFORNICUM				-48.975	-75.150
P094	CAECUM CREBRICINCTUM	2.90643	-15.13319	-34.56798		
P581	CAECUM OCCIDENTALE					-63.983
P095	CALINATICINA OLDROYDII	36.24947	23.88273			
P096	CALYPTRAEA FASTIGIATA	26.78775	19.64749			
P097	CAMPYLASPIS CANALICULATA	-2.01584	-6.27054			
P098	CAMPYLASPIS HARTAE		-16.91750			
P099	CAMPYLASPIS RUBROMACULATA	4.16818	-2.48110	-13.52060		
P547	CAMPYLASPIS SP					-1.169
P100	CAMPYLASPIS SP D	24.64014				
P101	CANCER GRACILIS	3.26023	38.09389			
P102	CANCER JORDANI	8.27584	10.78271			
P103	CAPITELLA CAPITATA COMPLEX	67.14508	83.76981	89.49454	196.587	88.339
P538	CAPRELLA CALIFORNICA				-5.581	7.242
P104	CARAZZIELLA SP	54.94729	29.14069			-19.693
P105	CARDIOMYA SP		-0.67563	9.59975		
P106	CAUDINA ARENICOLA		18.24933			
P107	CAULLERIELLA ALATA	103.33858	137.84628			
P108	CAULLERIELLA GRACILIS		-8.59386	0.11562		
P530	CAULLERIELLA SP				19.842	84.393
P109	CEPHALOPHOXOIDES HOMILIS		-29.65362	-34.18425		
P110	CERAPUS TUBULARIS COMPLEX	-13.82493	12.17697			
P111	CERIANTHARIA	36.18065	12.45713	-18.35194	18.883	25.789
P112	CERITHIOPSIS SP		13.55415			
P113	CHAETOPTERUS VARIOPEDATUS	28.56222				
P114	CHAETOZONE ARMATA	31.05343	28.73412			
P115	CHAETOZONE CORONA	35.96697	51.06825			0.065
P116	CHAETOZONE SETOSA COMPLEX	25.08139	28.68181	2.77379		
P117	CHIONE SP	77.76729	133.33373		46.794	-28.846
P118	CHLOEIA PINNATA	37.60744	19.01865	26.91741		
P119	CHONE COMPLEX	4.61031	14.76184	26.71685		
P120	CIRRATULUS SP	41.27427	26.88225		94.373	162.865
P121	CIRRIFORMIA SP	4.34745	36.39989			31.255
P122	CIRROPHORUS BRANCHIATUS			-2.84420		
P123	CIRROPHORUS FURCATUS	15.53021	20.37528			
P124	CLYMENELLA COMPLANATA	16.85046	-9.61756			
P125	CLYMENURA GRACILIS		-36.01903	-31.43531		
P126	COMPSOMYAX SUBDIAPHANA	51.79102	41.18375		-11.515	-86.692
P127	CONUS CALIFORNICUS	100.21075	132.71608			
P128	COOPERELLA SUBDIAPHANA	47.20803	42.81985		-1.732	-47.136
P129	CORBULA SP		34.17465			
P130	COROPHIUM SP	25.66353	34.04025		30.465	0.356
P131	CORYMORPHA SP	6.57099	-25.34550		-19.001	27.948
P132	COSSURA SP	60.88582	42.21857	20.91036	42.363	

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	**P_Name**	**Shallow**	**Mid-Depth**	**Deep**	**North**	**South**
P133	CRANGON ALASKENSIS	-0.29376				
P134	CRENELLA DECUSSATA	35.88349	8.85929			
P135	CREPIDULA SP	31.33822	30.74217		-33.621	
P582	CRUCIBULUM SPINOSUM					-16.324
P136	CRYPTOMYA CALIFORNICA	83.42579			-42.938	19.896
P137	CUMELLA SP A		-5.01038			
P570	CUMINGIA CALIFORNICA				121.190	5.746
P138	CUSPIDARIA PARAPODEMA		18.09487	20.74576		
P139	CYCLASPIS NUBILA	-5.61124				
P140	CYCLOCARDIA SPP		-31.47276	30.35552		
P141	CYLICHNA DIEGENSIS	26.47398	37.12508	52.20450		
P142	DECAMASTUS GRACILIS	74.77714	54.51865	58.23362		
P143	DEILOCERUS PLANUS	29.63554	0.84604			
P144	DELECTOPECTEN VANCOUVERENSIS		-41.97191	-4.56802		
P145	DENDRASTER EXCENTRICUS	-10.24833	10.44953			
P146	DENTALIUM SP	-2.96448	8.42261	5.74260		
P147	DIASTYLIS CALIFORNICA	13.30331	16.93301			
P148	DIASTYLIS PARASPINULOSA			-0.71219		
P149	DIASTYLIS PELLUCIDA			39.52499		
P150	DIASTYLIS SP A		0.53215	8.11698		
P151	DIASTYLOPSIS TENUIS	-33.16293	18.16787			
P152	DIOPATRA ORNATA	20.15084	35.95112	25.34063	-37.903	14.764
P153	DIOPATRA SPLENDIDISSIMA	12.97752	9.21576			-54.941
P154	DIOPATRA TRIDENTATA	8.48387	15.50314		6.619	
P521	DIPLOCIRRUS SP					28.468
P573	DIPLODONTA SERICATA				-65.520	
P155	DORVILLEA (SCHISTOMERINGOS) LONGICORNIS	114.53263	123.54363	104.05873	90.254	90.093
P156	DOUGALOPLUS SP		-47.68791	-12.45409		
P157	DRILONEREIS SP	13.24962	19.90622	0.30323	-11.246	69.863
P158	ECLYSIPPE TRILOBATA		-30.67243	-41.26853		
P159	EDOTIA SP	-9.76704	8.10908		-30.271	
P160	EDWARDSIIDAE	15.33546	34.73142	5.77962	20.168	77.062
P161	ENNUCULA TENUIS	15.55771	-0.37414	-4.54909		
P162	ENSIS MYRAE	-1.47428	26.47074		-33.006	-15.948
P163	ENTEROPNEUSTA	55.12071	11.42301	2.46644		
P164	ENTODESMA PICTUM		2.21777			
P543	EOCHELIDIUM SP A				56.035	
P165	EPHESIELLA BREVICAPITIS	25.95983	-7.47718			
P166	EPITONIIDAE	1.06970	29.47561			
P167	ERANNO LAGUNAE	32.36670	-7.72370	41.83589		
P168	ERICTHONIUS BRASILIENSIS	36.22516	8.88869		2.119	-75.217
P169	ERICTHONIUS RUBRICORNIS			-4.41075		
P170	ERILEPTUS SPINOSUS		-11.67449			
P171	ETEONE SP	87.00377	26.89570		-92.577	37.356
P172	EUCHONE SP	-11.40330	-11.52127	2.22737	54.126	45.212
P173	EUDORELLA PACIFICA		-9.68618	-8.30600		
P174	EUDORELLOPSIS LONGIROSTRIS		-28.98671	-23.08136		
P175	EULALIA SP	13.93496	7.06725	9.21337		
P176	EULIMA CALIFORNICUS	1.72562	13.04233			

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
P177	EUMIDA LONGICORNUTA	35.12783	60.96135	49.52736		18.250
P178	EUNICE AMERICANA	20.62821	8.11682	25.88824		
P180	EUPHILOMEDES CARCHARODONTA	71.11094	59.53856	42.63525	16.987	22.722
P181	EUPHILOMEDES PRODUCTA		-9.83600	26.78077		
P182	EUPHYSA SP A	14.28751	8.95887			
P183	EUPOLYMNIA HETEROBRANCHIA	45.74364	49.09508			
P184	EURYDICE CAUDATA	26.55390	28.42586			
P185	EUSARSIELLA THOMINX	34.02688	9.69003			
P186	EUSYLLIS TRANSECTA	-8.38594	-7.59765			
P187	EXOGONE BREVISETA	13.05751	0.05952			
P188	EXOGONE DWISULA	-8.49551	11.21665		38.105	
P189	EXOGONE LOUREI	13.46444	10.49860	-2.40542	41.770	48.162
P190	EXOGONE MOLESTA		-10.26071			
P191	EYAKIA ROBUSTA		-40.37801	-28.60944		
P192	FAUVELIOPSIS SP			-11.48925		
P193	FOXIPHALUS COGNATUS	15.97952	36.03796			
P194	FOXIPHALUS GOLFENSIS	12.91026	19.69430			
P195	FOXIPHALUS OBTUSIDENS	15.75432	24.49220	23.17604		
P196	FOXIPHALUS SIMILIS		-22.41830	-36.38118		
P197	GADILA ABERRANS	19.61596	26.02718	-14.54614	2.521	
P198	GALEOMMATIDAE SP A			-5.69168		
P199	GAMMAROPSIS OCIOSA		-30.87899	-48.34410		
P200	GAMMAROPSIS THOMPSONI	16.34342	18.12874			
P201	GARI CALIFORNICA	22.64897				
P202	GASTROPTERON PACIFICUM	15.50137	12.00598	11.13932		
P203	GIBBEROSUS MYERSI	-18.01668				
P204	GITANA CALITEMPLADO	-4.16713	-8.85105			
P205	GLOTTIDIA ALBIDA	7.38645	10.90035		-57.677	
P206	GLYCERA AMERICANA	56.93499	79.29318	55.19531	17.526	4.060
P207	GLYCERA CONVOLUTA	-10.03516				
P208	GLYCERA NANA	50.61239	39.82902	53.63664		
P209	GLYCERA OXYCEPHALA	-4.06962	10.40981	-67.80110		
P210	GLYCINDE ARMIGERA	19.12903	19.12596	38.52583		
P211	GLYPHOCUMA SP A		-64.41946			
P212	GNATHIA CRENULATIFRONS	18.38222	22.64701	9.44004		
P554	GNATHIIDAE				0.118	
P213	GONIADA BRUNNEA	-0.83942	16.61463	22.47248		
P214	GONIADA LITTOREA	22.19497	12.16108		-33.253	-24.214
P215	GONIADA MACULATA	49.29892	19.32708	30.52979		
P536	GRANDIDIERELLA JAPONICA				88.541	47.936
P216	GYMNONEREIS CROSSLANDI	64.07577	14.09060	14.82200		
P217	HALICOIDES SYNOPIAE		-32.46323	-15.39951		
P218	HALIOPHASMA GEMINATUM	26.44202	1.88996	-9.18528		
P219	HALISTYLUS PUPOIDES	-41.94966	-15.50745			
P220	HALOSYDNA BREVISETOSA	28.44425	29.22432			
P528	HALOSYDNA JOHNSONI					-3.225
P221	HAMATOSCALPELLUM CALIFORNICUM	42.68430	2.66149	-21.44150		
P576	HAMINOEA VESICULA				36.459	53.556
P222	HARPINIOPSIS FULGENS			2.16461		

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
P223	HEMILAMPROPS CALIFORNICA	-19.87298	21.19137			
P224	HEMIPROTO SP A		-29.98168	-60.33174		
P225	HEPTACARPUS STIMPSONI	28.45415				
P226	HESPERONOE LAEVIS	54.81291	39.01925	42.58390		
P227	HETEROCRYPTA OCCIDENTALIS	0.91149	10.43982			
P228	HETEROMASTUS FILOBRANCHUS		118.94290	80.19124		
P229	HETEROPHOXUS SP	38.86907	16.35353	-0.68166		24.304
P230	HIATELLA ARCTICA	58.77860	12.69824		78.246	-68.361
P231	HIPPOMEDON SP	-20.04301	-2.86840	-8.71477		-42.082
P232	HORNELLIA OCCIDENTALIS	-17.40419				
P233	HUXLEYIA MUNITA			-66.31852		
P234	HYALE SP	109.00264	135.92867			
P235	HYALINOECIA JUVENALIS	-0.87430	-9.14450			
P236	IDARCTURUS ALLELOMORPHUS		-6.68832			
P237	ILYARACHNA ACARINA			-25.50281		
P238	JOEROPSIS DUBIA	37.12574	29.72342			
P568	KELLIA SUBORBICULARIS					-9.780
P239	KURTZIA ARTEAGA	26.31593	14.29124	3.37003		
P240	KURTZIELLA BETA	23.76250	38.46325	25.59897		
P241	KURTZIELLA PLUMBEA	-1.49176	54.37964			
P567	LAEVICARDIUM SUBSTRIATUM				13.420	0.664
P242	LAMPROPS CARINATA		-17.81916			
P243	LAMPROPS QUADRIPLICATA	-35.75209				
P244	LANASSA SP	5.80910	-37.35350	-19.11280		
P245	LANICE CONCHILEGA	36.96491	33.32308	0.23730		
P246	LAONICE APPELLOEFI		5.50048	8.42455		
P247	LAONICE CIRRATA	24.95542	38.60224	23.24421	3.240	
P248	LEITOSCOLOPLOS PUGETTENSIS	42.48904	47.52981	8.01926	50.608	94.277
P249	LEPIDASTHENIA BERKELEYAE		35.46856	42.90227		
P250	LEPIDEPECREUM SP A	17.85671	7.87922	-23.28679		
P571	LEPORIMETIS OBESA				-95.997	
P251	LEPTOCHELIA DUBIA	11.92286	6.55429	-22.34027		0.733
P252	LEPTOCHITON SP		-36.95127			
P253	LEPTOPECTEN LATIAURATUS	12.48207	21.57475		22.986	54.851
P254	LEPTOSTYLIS SP A	50.53034	8.07997			
P255	LEPTOSTYLIS VILLOSA		-21.20210			
P256	LEUCON SUBNASICA		11.67334			
P257	LEUROLEBERIS SHARPEI	-1.98171	11.20577			
P258	LEVINSENIA SP	59.14143	25.03943	12.64251	13.857	
P562	LIMARIA HEMPHILLI					-33.361
P259	LISTRIELLA DIFFUSA	-17.76206	31.75497			
P260	LISTRIELLA ERIOPISA	35.02671	30.00774			
P261	LISTRIELLA GOLETA	60.71811	63.09993	61.73135	8.915	
P262	LISTRIELLA MELANICA	26.14198	34.34728		-41.075	-29.760
P263	LISTRIOLOBUS PELODES	83.85897	38.60620	63.69943		
P264	LOIMIA MEDUSA	43.06384	19.85501			
P553	LOPHOPANOPEUS BELLUS					-2.792
P265	LOVENIA CORDIFORMIS	-27.14593	8.47098			
P266	LUCINISCA NUTTALLI	107.76364	85.69224			
P267	LUCINOMA ANNULATUM	39.36235	53.29180	80.05915		
P268	LUIDIA SP		-18.92590			
P269	LUMBRINERIDES PLATYPYGOS	-3.06598	-17.63373			

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
P270	LUMBRINERIS SP	49.38062	30.22814	19.07647	29.626	47.842
P271	LYONSIA CALIFORNICA	21.06348	0.14025			
P272	LYSIPPE SP	53.99303	20.06327	4.14423	13.281	
P273	LYTECHINUS PICTUS	8.00886	-9.24896	-16.35877		
P274	MACOMA CARLOTTENSIS	106.03613	115.82167	76.71108		
P572	MACOMA INDENTATA					226.764
P275	MACOMA NASUTA	125.32682	154.56356		37.055	150.473
P276	MACOMA YOLDIFORMIS	19.72587	69.99972	73.70203	4.301	41.930
P277	MACTRIDAE	17.96820			-16.226	-19.478
P278	MAERA SIMILE	20.72696	-22.72200	-40.30324		
P279	MAGELONA PITELKAI		52.91014			
P280	MAGELONA SACCULATA	-8.29883	32.34394			
P281	MAGELONA SPP	26.80840	29.52482	-29.05480		
P282	MALACOCEROS PUNCTATA		-34.40974			
P550	MALACOPLAX CALIFORNIENSIS					39.757
P283	MALDANE SARSI	18.30797	9.27302	17.30948		
P284	MALMGRENIELLA BASCHI	24.33432	-2.57276	9.45852		
P285	MALMGRENIELLA SCRIPTORIA		-0.69543	-0.04984		
P286	MARPHYSA SP	34.58884	23.24032	41.15005	56.336	150.452
P546	MAYERELLA ACANTHOPODA				35.813	22.837
P287	MAYERELLA BANKSIA	4.68922	-15.86540	-36.98135	19.371	150.301
P288	MEDIOMASTUS SP	96.32480	59.25528	20.53446	-1.558	29.193
P289	MEGALOMMA PIGMENTUM	8.68151	21.79690		25.680	
P290	MEGASURCULA CARPENTERIANA		7.15948			
P291	MELANELLA SP	4.10225	16.45857	-6.52559		
P292	MELANOCHLAMYS DIOMEDEA	11.67342	65.17107			
P293	MELINNA HETERODONTA	37.35052	20.79776	24.66106		
P294	MELINNA OCULATA	12.89107	31.64938	-2.05029	-6.191	-14.040
P295	MELPHISANA BOLA COMPLEX	5.33658	6.01742			
P296	MESOCHAETOPTERUS SP		2.54065			
P297	MESOCRANGON MUNITELLA	4.71034				
P298	MESOLAMPROPS BISPINOSA		-0.67833			
P299	METAPHOXUS FREQUENS	20.06901	12.34414	4.99879		
P300	METASYCHIS DISPARIDENTATUS	9.36963	11.83671	14.04291	12.869	6.715
P301	METOPA DAWSONI		-21.61746			
P302	MICROPODARKE DUBIA	50.54668	54.97027			
P303	MICROSPIO PIGMENTATA		0.00473	2.42338	-33.163	-4.847
P304	MODIOLUS SP	48.52629	43.20560		-22.517	-5.261
P559	MOLGULA SP				55.150	-63.455
P305	MOLPADIA INTERMEDIA		-13.40339	8.24198		
P306	MONOCULODES SP	1.26639	-0.93024	12.32330	56.317	40.620
P307	MOOREONUPHIS NEBULOSA	-2.82813	4.45533	-34.38380		
P308	MOOREONUPHIS SPP		-35.36365	-32.40943		
P309	MOORESAMYTHA BIOCULATA	13.04593	19.79139	20.77150		
P310	MUNNOGONIUM TILLERAE		-5.68401			
P563	MUSCULISTA SENHOUSIA				138.190	69.863
P311	MYRIOCHELE SP	-2.07525	-3.22102	-2.63294		
P312	MYRIOWENIA CALIFORNIENSIS		-15.83530			
P313	MYSELLA SP	45.57540	59.19916	51.63273		
P564	MYTILUS SP				55.099	-48.531
P314	MYXICOLA INFUNDIBULUM		0.13253			

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
P315	NASSARIUS FOSSATUS	25.06145				
P316	NASSARIUS INSCULPTUS			104.99088		
P317	NASSARIUS MENDICUS	118.25397	138.79937			
P318	NASSARIUS PERPINGUIS	26.08032	42.87677	77.21433		
P578	NASSARIUS TIARULA					52.640
P551	NAUSHONIA MACGINITIEI					102.751
P526	NEANTHES ACUMINATA COMPLEX				166.229	89.682
P319	NEASTACILLA CALIFORNICA	20.58587	10.46245			-30.541
P320	NEBALIA SP	-2.99533	26.04355		36.050	
P321	NEMOCARDIUM CENTIFILOSUM		-38.96670	-5.53019		
P322	NEOCRANGON ZACAE		-14.63181			
P323	NEOMYSIS KADIAKENSIS	-2.22678	11.08430			
P324	NEOSABELLARIA CEMENTARIUM	16.79083	11.03189			
P325	NEOTRYPAEA SP	45.03496	38.85341	4.89289		-4.874
P326	NEPHTYS CAECOIDES	8.18000	32.78211	24.56646	-17.491	-9.638
P327	NEPHTYS CORNUTA	65.21577	54.36793	51.34704	8.017	41.732
P328	NEPHTYS FERRUGINEA	75.96806	23.52451	15.79148	27.273	53.355
P329	NEREIPHYLLA CASTANEA	22.18482	12.69076	23.66852		
P330	NEREIS LATESCENS	-3.10480				
P331	NEREIS PROCERA	46.22859	71.74661	66.54316		
P332	NEVERITA RECLUSIANA	29.66979	57.13686	54.23315		
P333	NICIPPE TUMIDA		-26.90124	4.31700		
P334	NINOE TRIDENTATA	42.01796	23.23426	41.57715		
P335	NOTOCIRRUS CALIFORNIENSIS	-1.27626	4.52749			
P336	NOTOMASTUS SP	73.85795	96.86492	54.13418	-10.039	-6.496
P337	NOTOPROCTUS PACIFICUS		-31.14479			
P338	NUCULANA SP	13.45867	19.53525	16.82244	2.393	-40.832
P561	OBELIA SP A				19.908	16.686
P339	ODONTOSYLLIS PHOSPHOREA	31.01104	38.64416			52.772
P340	ODOSTOMIA SP	26.95195	30.06751	26.88220		
P341	OGYRIDES SP A	-14.18318				
P342	OLIVELLA BAETICA	37.51753	76.63602		-37.321	
P343	ONUPHIS IRIDESCENS COMPLEX	19.24492	29.72580	35.69447		
P344	OPHELIA PULCHELLA	-20.36808				
P345	OPHELINA ACUMINATA	1.86399	-1.59677	-11.99107		
P346	OPHIODERMELLA SP	7.14347	-2.90853			
P347	OPHIURA LUETKENI		-7.50562	-21.84995		
P348	OPHIUROCONIS BISPINOSA	-2.44512	-17.01900	-26.67259		
P349	OPHRYOTROCHA A/B/C COMPLEX		204.05387	198.79890		
P350	OPISA TRIDENTATA		-5.91961	2.66396		
P351	ORCHOMENE ANAQUELUS	23.11841	7.75341			
P352	ORCHOMENE DECIPIENS	33.45238	8.60687	11.61445		
P353	ORCHOMENE PACIFICUS			-31.48857		
P354	ORCHOMENE PINGUIS		29.91966			
P355	ORTHOPAGURUS MINIMUS	13.58686	22.82494			
P565	OSTREIDAE					-31.128
P356	OWENIA COLLARIS	-9.30526	24.70498		5.012	
P357	OXYUROSTYLIS PACIFICA	-5.66548	25.72251		28.639	61.628
P358	PACHYNUS BARNARDI	16.30498	23.33091	-19.41325		
P359	PAGURISTES BAKERI		55.64245			

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
P360	PAGURISTES TURGIDUS		36.46665			
P361	PAGURUS SP	119.12732	78.62023			
P362	PALEANOTUS BELLIS	4.53275				
P363	PANDORA BILIRATA		-10.83430			
P364	PANDORA FILOSA		-0.25255	7.08387		
P539	PARACAPRELLA SP					-17.461
P556	PARACERCEIS SCULPTA				28.758	57.289
P542	PARADEXAMINE SP				136.481	47.047
P365	PARADIOPATRA PARVA	10.70258	-21.64216	11.83211		
P366	PARADONEIS ELIASONI		-12.09364			
P367	PARAMAGE SCUTATA	21.54351	-13.79859	-2.07699	5.161	
P368	PARAMETAPHOXUS FULTONI	40.51891	35.78165			
P369	PARAMICRODEUTOPUS SCHMITTI	13.94504			-36.737	
P370	PARANAITIS POLYNOIDES		40.89691			
P371	PARANDALIA SP	22.99146	37.99707			
P555	PARANTHURA ELEGANS				60.508	28.772
P372	PARAPAGURODES LAURENTAE		9.53644	-8.79411		
P373	PARAPRIONOSPIO PINNATA	10.60791	21.74618	38.60815	13.150	33.071
P374	PARASTEROPE SP		17.86245			
P375	PARDALISCELLA SP			2.22203		
P376	PAROUGIA CAECA	35.70998	72.89192			
P377	PARVILUCINA TENUISCULPTA	61.34668	84.08423	76.66995	18.026	
P378	PECTINARIA CALIFORNIENSIS	40.76374	28.05438	31.22891	-3.652	67.935
P560	PENNATULACEA				-12.891	-2.751
P379	PERIPLOMA/THRACIA COMPLEX	18.79382	33.78650		-26.560	-36.193
P380	PETALOPROCTUS SP		-7.36768			
P381	PETRICOLA SP	73.57033	100.96707			
P522	PHERUSA CAPULATA					122.293
P382	PHERUSA NEOPAPILLATA	29.33056	18.96244	7.80957	130.991	
P577	PHILINE AURIFORMIS				-1.995	51.323
P383	PHILINE BAKERI	6.24501				
P384	PHILINE SP A	34.32750	12.72589		64.028	
P385	PHOLOE GLABRA	39.88541	-4.77727	15.44570		
P386	PHOLOIDES ASPERUS		-21.14710	-56.58396		
P387	PHORONIDA	17.85902	8.07738	-2.30551		32.809
P388	PHOTIS SP	14.73352	7.94417	-9.39915		
P389	PHYLLOCHAETOPTERUS LIMICOLUS	63.51132	9.37472	12.84119		
P390	PHYLLOCHAETOPTERUS PROLIFICA	-6.24263	-17.83293			
P391	PHYLLODOCE SP	6.24590	35.74006	34.88072	-31.051	21.426
P392	PILARGIS BERKELEYAE	49.47488	43.81798			
P527	PILARGIS SP				-31.503	
P393	PINNIXA FRANCISCANA	67.83970	50.02176		-49.367	
P394	PINNIXA HIATUS	61.61511	79.06246			
P395	PINNIXA LONGIPES	-1.68126				
P396	PINNIXA OCCIDENTALIS	39.22765	24.21556	41.24702		
P397	PINNIXA TOMENTOSA	21.65780				
P398	PINNIXA TUBICOLA	20.10712	22.76130			
P399	PIONOSYLLIS SP		-10.13906			
P523	PIROMIS SP					-22.455

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
P400	PIROMIS SP A		-10.80638			
P401	PISTA ALATA	36.38894	25.07151	-2.89710	65.897	65.688
P402	PISTA FASCIATA	19.91804	36.17716	30.23348	-19.545	0.789
P403	PISTA MOOREI	31.76605	12.07564			
P404	PISTA SP B	27.46744	9.45879	-10.34333		
P574	PITAR NEWCOMBIANUS				-20.603	
P405	PLATYNEREIS BICANALICULATA	5.11805	32.21867		43.726	
P406	PLEUROBRANCHAEA CALIFORNICA		-14.65260			
P407	PLEUROGONIUM CALIFORNIENSE		-24.63667	-21.96947		
P408	PLEUSYMTES SUBGLABER	15.40263	27.05946			
P409	PODARKE PUGETTENSIS	121.36872	156.19022			-51.972
P410	PODARKEOPSIS GLABRUS	51.91242	47.53582	95.60730	18.883	
P411	PODARKEOPSIS SP A	34.54606	24.62233			
P544	PODOCERUS BRASILIENSIS					146.440
P545	PODOCERUS FULANUS				101.494	12.682
P412	PODOCERUS SP		-34.44461			
P413	PODOCHELA SP	26.17832	3.41950			
P414	POECILOCHAETUS JOHNSONI	30.43285	41.98571	8.19096	-40.703	22.480
P415	POECILOCHAETUS SP A	33.36922	16.31852			46.062
P416	POLINICES DRACONIS	25.17679	61.23548			
P417	POLINICES LEWISII		32.76514			
P418	POLYCIRRUS SP	-1.05033	-5.02636	1.85571	10.521	
P419	POLYDORA SP	18.70734	28.91058	-0.35176	115.025	34.328
P524	POLYOPHTHALMUS PICTUS				-70.708	
P420	POTAMETHUS SP A	32.94796	-31.09475	-15.28354		
P421	PRACHYNELLA LODO		19.11906	23.04431		
P422	PRAXILLELLA SP	12.96839	15.64474	10.41648	46.319	-45.950
P423	PRAXILLURA MACULATA	3.73612	6.38508			
P531	PRIONOSPIO (PRIONOSPIO) HETEROBRANCHIA				29.417	26.309
P424	PRIONOSPIO A/B COMPLEX	55.50152	31.46554	32.64677		-14.303
P425	PRIONOSPIO EHLERSI			36.63848		
P426	PRIONOSPIO LIGHTI	63.62194	27.82499	34.55441	-2.900	4.949
P427	PROCAMPYLASPIS SP A		-28.01223	-30.86277		
P428	PROCERAEA SP		-5.40651			
P429	PROCLEA SP A		-58.22143			
P430	PROTODORVILLEA GRACILIS	-9.26445	-1.10781			
P431	PROTOMEDEIA SP		-9.09748	-13.02695		
P432	PROTOTHACA SP	66.47244			5.140	-46.685
P532	PSEUDOPOLYDORA PAUCIBRANCHIATA				27.823	37.542
P558	PYCNOGONIDA				85.884	27.010
P433	PYROMAIA TUBERCULATA	31.56964	40.27045		11.973	96.217
P434	RANDALLIA ORNATA	18.51805	23.78595			
P435	RHABDUS RECTIUS	34.76501	41.91851	29.97804		
P436	RHACHOTROPIS SP		-9.35509	37.45670		
P437	RHAMPHIDONTA RETIFERA		63.50205			
P438	RHAMPHOBRACHIUM LONGISETOSUM		-17.79765			
P439	RHEPOXYNIUS ABRONIUS	-33.46012				

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
P440	RHEPOXYNIUS BICUSPIDATUS	12.52807	-15.02172	-16.27075		
P441	RHEPOXYNIUS HETEROCUSPIDATUS	-8.13173	5.50401			
P442	RHEPOXYNIUS LUCUBRANS		-20.09270			
P443	RHEPOXYNIUS MENZIESI	-11.77401	11.25787			
P444	RHEPOXYNIUS STENODES	-2.41489	4.43407			
P445	RHEPOXYNIUS VARIATUS	-30.81158	-10.13677			
P446	RHODINE BITORQUATA		-20.80804	2.36391		
P447	RICTAXIS PUNCTOCAELATUS	74.70224	76.76972	63.63994	15.663	62.203
P569	ROCHEFORTIA SP				-6.881	9.942
P448	ROCINELA ANGUSTATA			29.96828		
P537	RUDILEMBOIDES SP				16.393	25.101
P449	RUDILEMBOIDES STENOPROPODUS	3.98168	9.20132			
P450	RUTIDERMA SP	10.88970	6.49289	-15.19650		
P451	SABELLIDES MANRIQUEI	-15.24106	-34.57854		-12.721	
P452	SAMYTHA CALIFORNIENSIS		-5.73317	2.67403		
P453	SAXICAVELLA NYBAKKENI	35.80479	12.28777	23.92717		
P454	SAXICAVELLA PACIFICA	54.81909	23.69171	59.53693		
P455	SAXIDOMUS NUTTALLI	51.10138			29.781	-20.394
P456	SCALIBREGMA INFLATUM	11.55457	4.26180	-10.98326		
P557	SCHMITTIUS POLITUS					68.492
P457	SCLEROCONCHA TRITUBERCULATA			-7.27411		
P458	SCLEROPLAX GRANULATA	61.16675	74.45088		20.143	15.229
P533	SCOLELEPIS (PARASCOLELEPIS) SP				25.624	-11.479
P459	SCOLELEPIS OCCIDENTALIS		8.45807			56.230
P460	SCOLELEPIS SPP	7.68615	18.71284			
P461	SCOLOPLOS ARMIGER COMPLEX	-1.53481	-9.15933	-20.70508		
P525	SCOLOPLOS SP				-28.300	
P179	SCYPHOPROCTUS SP					44.940
P462	SEROLIS CARINATA	13.53872	-6.58056		-24.997	10.319
P463	SIGALION SPINOSA	-19.61730	-12.02380			
P464	SIGAMBRA TENTACULATA	79.22898	77.74486	34.79281	11.606	
P465	SIGE SP A	19.69290	23.39287	18.87749		
P466	SILIQUA LUCIDA	36.80675				
P540	SINOCOROPHIUM CF HETEROCERATUM				-33.700	
P467	SINUM SCOPULOSUM	37.36308	29.40374			
P468	SIPHONODENTALIUM QUADRIFISSATUM		-8.19088	-5.35618		
P469	SOLAMEN COLUMBIANUM	22.41365	4.94595			
P470	SOLARIELLA PERAMABILIS			-58.41487		
P471	SOLEMYA REIDI	91.27497	98.83142	133.38689		
P472	SOLEN SP	24.66767	27.54546		3.559	-12.356
P473	SOSANE OCCIDENTALIS		-53.00857			
P474	SPHAEROSYLLIS SP	22.69887			73.669	
P475	SPIO SP	4.94171	-19.95650	-18.32913		
P476	SPIOCHAETOPTERUS COSTARUM	36.41178	54.49154	16.58774	-0.350	42.886
P477	SPIOPHANES BERKELEYORUM	24.19862	33.75282	38.76256	5.558	
P478	SPIOPHANES BOMBYX	-2.30920	12.05458	-23.74597	-2.915	

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
P479	SPIOPHANES FIMBRIATA	22.35393	-17.44967	-2.59216		
P480	SPIOPHANES MISSIONENSIS	6.13138	8.54624	-1.56944	19.719	14.573
P481	SPIOPHANES WIGLEYI			8.46487		
P482	STENOTHOIDES BICOMA	9.45869	10.04370			
P483	STERNASPIS FOSSOR	34.24622	-17.30123	-1.45782		
P583	STHENELAIS SP				-12.631	
P484	STHENELAIS SPP	12.79199	3.43319	3.81306		
P485	STHENELAIS VERRUCULOSA	-7.50184	4.95428			
P486	STHENELANELLA UNIFORMIS	9.81927	-6.64920	-3.41128	-4.552	-16.227
P487	STREBLOSOMA SP	40.35244	25.37804	17.44704		
P584	STREBLOSPIO BENEDICTI					71.422
P488	STYLATULA ELONGATA	28.67862	34.01671			
P489	SUBADYTE MEXICANA		-13.39741	-1.39091		
P490	SULCORETUSA XYSTRUM	25.43838	27.83431		43.652	
P491	SYLLIS (EHLERSIA) HETEROCHAETA	5.10296	5.75440	15.13267		
P492	SYLLIS (EHLERSIA) HYPERIONI	19.94803	9.16813			
P585	SYLLIS (SYLLIS) GRACILIS					8.368
P493	SYLLIS (TYPOSYLLIS) FARALLONENSIS	0.03655				
P494	SYLLIS (TYPOSYLLIS) SPP	7.35711	14.31271	102.72511	51.691	64.715
P495	SYNAPTIDAE	4.29169	-11.24157	-20.57738	29.176	65.464
P586	SYNAPTOTANAIS NOTABILIS				26.608	26.322
P496	SYNCHELIDIUM SP	-6.84977	29.83102	11.74383		
P497	SYNIDOTEA SP	5.95577	13.62057			
P498	SYRRHOE SP A			6.09540		
P587	TAGELUS SUBTERES				-21.843	-9.515
P588	TECTURA DEPICTA					-14.614
P499	TELLINA CARPENTERI	36.78471	51.34422	49.09943	15.779	5.457
P500	TELLINA IDAE	16.60205	35.48735			
P589	TELLINA MEROPSIS					-7.542
P501	TELLINA MODESTA	-2.98312	39.48511	4.19314	13.947	-51.157
P502	TENONIA PRIOPS	14.59568	44.79354		57.983	
P503	TEREBELLIDES SP	24.92658	-6.83457	0.32996	14.443	
P504	THELEPUS SETOSUS		12.84147			
P590	THEORA LUBRICA				41.756	55.417
P505	THESEA SP B		-3.63558			
P506	THYASIRA FLEXUOSA	39.96849	45.54123	42.65486	33.268	
P507	TIRON BIOCELLATA	7.91238	14.58121			
P508	TRACHYCARDIUM QUADRAGENARIUM	18.73796	10.96052			
P509	TRANSENELLA TANTILLA	92.74692	47.85087			
P510	TRAVISIA BREVIS		-37.02607	-11.48984		
P511	TRITELLA PILIMANA		-14.47133			
P591	TRYONIA IMITATOR					24.057
P512	TURBONILLA SP	46.14975	45.78198	13.63559	67.890	
P513	UPOGEBIA SP		1.00296			
P514	UROTHOE VARVARINI		-41.71156	-41.88030		
P515	VARGULA TSUJII		0.03516			-112.389
P592	VENERUPIS PHILIPPINARUM				61.062	
P516	VITRINELLA SP		61.32097		-3.877	
P517	VOLVULELLA CALIFORNICA		-11.55379	-0.63252		

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
P518	VOLVULELLA CYLINDRICA	-2.70568	12.91224			
P519	VOLVULELLA PANAMICA	51.06572	31.79986	22.61811		
P520	WESTWOODILLA CAECULA	40.41873	17.58196	2.47382		
P593	ZEUXO NORMANI				28.445	35.661

Appendix E

VARIABILITY IN THE IDENTIFICATION AND ENUMERATION OF MARINE BENTHIC INVERTEBRATE SAMPLES AND ITS EFFECT ON BENTHIC ASSESSMENT MEASURES

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Abstract

Studies designed to measure anthropogenic impacts on marine benthic communities depend on the ability of taxonomists to consistently discriminate, identify, and count benthic organisms. To quantify errors and discrepancies in identification and enumeration, 20 samples were completely reprocessed by another one of four participating laboratories. Errors were detected in 13.0% of the data records, affecting total abundance by 2.1%, numbers of taxa by 3.4%, and identification accuracy by 4.7%. Paired t-tests were used to test for differences in the Benthic Response Index (BRI), total abundance, numbers of taxa, and the Shannon-Wiener index between the original and the reanalysis data. Differences in the BRI were statistically insignificant. Although statistically significant differences were observed for numbers of taxa, total abundance, and the Shannon Wiener index, the differences were small in comparison to the magnitude of differences typically observed between anthropogenically affected and reference sites.

Keywords: marine benthic invertebrates, identification, enumeration, quality assurance, quality control, inter-laboratory calibration, benthic assessment

1. Introduction

Many approaches to benthic community assessment depend on accurate species identification. Measures based on pollution tolerance ratings of the species in each sample, such as those proposed by Eaton *et al.* (2001) and Smith *et al.* (2001), are most dependent. Ordination and cluster analyses based on species abundance data also require accurate species separation. Many recently developed multi-metric benthic indices include species richness (numbers of species) or diversity (Engle *et al.* 1994, Weisberg *et al.* 1997, Engle and Summers 1999, Van Dolah *et al.* 1999, Paul *et al.* 2001). Traditional methods such as the Abundance Biomass

Comparison (ABC) method (Warwick *et al.* 1987) and diversity indices (Washington 1984) also depend on accurate species identification.

Several steps in benthic sample processing can introduce laboratory error into measurements of species richness and diversity. First, undercounts of organisms and species can result from failure to remove all organisms from the sediment during sorting. Second, misidentification of sorted organisms can cause underestimates of species richness if similar species are not distinguished, or over-counts if a single species is erroneously divided. Errors are also introduced if identified organisms are miscounted.

Most laboratories re-sort a subset of samples to quantify and minimize sorting error; but quality assurance practices to ensure taxonomic accuracy are typically less well developed, although Ellis (1988) identified the need. Many laboratories maintain collections of voucher specimens that are sent to outside experts for confirmation of identifications, but voucher specimens are typically limited to the best specimens for each species. There is also no guarantee that voucher materials accurately represent all specimens reported under a name. Inter-laboratory calibrations, like those of Ellis and Cross (1981), may provide better quality assurance. Here, we present the results of a calibration exercise in which four laboratories reprocessed samples to evaluate taxonomic and counting consistency and their effects on measures used in benthic assessments.

2. Methods

Samples were obtained from a regional survey of benthic infauna in the SCB (Bergen *et al.*, 2000). The samples were collected in August and September 1994 with a 0.1 m^2 Van Veen grab, sieved through 1 mm screens, relaxed for 30 minutes in $MgSO_4$ or propylene phenoxytol and fixed in sodium borate buffered 10% formalin. They were then transported to four laboratories for identification and enumeration analysis.

Taxonomic accuracy was assessed from 20 samples selected at random. Each sample was analyzed at one of the four laboratories and reanalyzed at another, selected at random. Taxonomists performing reanalysis had no access to original analysis results. When reanalysis was complete, the original and reanalysis data were compared and a list of differences was compiled. These differences were classified as errors when they were caused by inaccurate identifications, incorrect counts, or specimens overlooked in the original analysis. They were classified as discrepancies, rather than errors, when they resulted from the use of a junior synonym or other unconventional nomenclature, failure to note removal of specimens for vouchers, or differences in opinion about the taxonomic level to which an organism could be identified (e.g., *Polydora* sp. vs. *Polydora narica*). For each sample, error rates for total abundance and numbers of taxa were calculated as the ratio of the difference between the original and resolved values to the resolved value, expressed as a percentage; original values greater than resolved values resulted in negative rates. Error rates for identification accuracy were calculated as the ratio of misidentifications to resolved identifications, also expressed as a percentage. The resolved value represented “truth” by consensus agreement between the original and reanalysis taxonomists.

To assess the effects of differences in laboratory results on benthic assessments, the number of taxa per sample, total abundance, Shannon-Wiener diversity, and the BRI (Smith *et al.* 2001) were calculated for the original and the reanalysis data. Paired t-tests were then used to test for differences between the original and the re-analyzed data.

3. Results

Differences between original and reanalysis data were detected in 25.3% of the data records (Table 1), where a record consists of a taxon and its reported abundance. The differences were nearly equally divided between errors and discrepancies. Miscounts affected 4.8% of the data records and were the most common type of error; misidentifications (4.5%) and

Table 1. Frequencies of differences in identification and enumeration for 20 samples. The data comprised 1,715 records, each consisting of a taxon and its reported abundance. Negative values indicate that the net result of the error was an understatement of the true value; positive values indicate overstatement of the true value.

Type of Difference		Number	% of Differences	% of Records
Errors	Miscount	83	19.1	4.8
	Misidentification	78	18.0	4.5
	Overlooked specimen(s)	57	13.1	-3.3
	Misapplication of identification rules	5	1.2	0.3
	Total Errors	223	51.4	13.0
Discrepancies	Judgment differences	131	30.2	7.6
	Specimen loss or unrecorded voucher removal	57	13.1	3.3
	Unconventional nomenclature	23	5.3	1.3
	Total Discrepancies	211	48.6	12.3
Total Differences		434		25.3

overlooked specimens (3.3%) were almost as common. The errors yielded total abundances, numbers of taxa, and identifications that differed from "truth," on average, by 2.1%, 3.4%, and 4.7%, respectively (Table 2).

Table 2. Means (and ranges) of error rates for total abundance, numbers of taxa, and identification accuracy.

Original Analysis Laboratory	Number of Reanalyzed Samples	Mean Error Rate (%)		
		Total Abundance	Number of Taxa	Identification Accuracy
A	6	3.1 (2.2 – 6.1)	4.8 (2.9 – 5.9)	6.9 (4.3 - 10.5)
B	2	1.0 (0.3 – 1.5)	1.8 (1.2 – 2.3)	3.6 (2.3 – 5.0)
C	6	2.2 (0 – 3.1)	4.5 (1.0 – 9.2)	3.0 (0 – 4.3)
D	6	1.5 (-1.2 – 4.9)	1.1 (0 – 2.0)	4.6 (2.0 – 11.7)
All	20	2.1 (-1.2 – 6.1)	3.4 (0 – 9.2)	4.7 (0 – 11.7)

Total abundance, numbers of taxa, and Shannon-Wiener Index values were significantly different between the original and reanalysis data (Table 3). Mean differences between the original analysis and reanalysis were 4.75 per sample for total abundance, 2.25 per sample for number of taxa, and 0.037 for the Shannon-Wiener Index. Differences in the BRI were small and not statistically significant.

Table 3. Mean values for the original and reanalysis data and, based on paired t-tests, the probability that the difference > 0. NS = Not significant.

Assessment Measure	Mean Values			Probability
	Original Data	**Reanalysis Data**	**Difference**	
Total Abundance (per sample)	334.25	339.00	4.75	0.040
Number of taxa (per sample)	80.90	83.15	2.25	0.004
Shannon-Wiener Diversity Index	5.162	5.199	0.037	0.006
Benthic Response Index	14.242	14.238	0.004	0.979 ^{NS}

4. Discussion

The data presented in Tables 1 and 3 provide, for the first time, rates at which errors and discrepancies occur when different taxonomists process samples; and their effect on commonly used assessment measures. While the percentage of records affected was high, the overall affect on conclusions that would be reached by application of the data for assessment purposes was not large. The observed differences of 4.75, 2.25, and 0.037 in abundance, numbers of taxa, and the Shannon-Wiener Index were small relative to the sample mean values of 334.25, 80.9, and 5.162, respectively. Moreover, the differences were much smaller than the differences typically observed between anthropogenically affected and reference sites (Weisberg et *al.* 1997, Van Dolah *et al.* 1999). The BRI, which is the abundance-weighted pollution tolerance of the species in the sample (Smith *et al.* 2001), was not affected by the observed differences. Apparently, the BRI is robust to minor taxonomic errors, presumably because similar species have similar pollution tolerance values.

Two factors contributing to the small values of among-laboratory differences are the experience of the taxonomists and the extent of communication among them. Most of the taxonomists have more than two decades of experience working on the benthos of southern California. Moreover, recognizing the need for consistency, in 1982 taxonomists in southern California formed an organization, the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) (http://www.scamit.org), that is dedicated to standardizing taxonomy in the region. The SCAMIT publishes lists of accepted nomenclature, maintains reference collections, produces keys and other taxonomic tools, and fosters communication among its members through monthly workshops, newsletters, a web site and e-mail lists. Throughout the regional survey from which these samples were drawn, and independent of the quality assurance exercise presented here, descriptions and figures of unusual or unknown organisms were distributed using these communication mechanisms to keep other taxonomists abreast of developments as they occurred. Error rates in regions where this communication does not exist may be higher.

Another factor contributing to our low error rates was the methodology used to distinguish between discrepancies and errors. One type of discrepancy was the use of unconventional nomenclature. We chose not to count this as an error because trained taxonomists easily recognize and correct synonymous names while merging data from different sources; however, this is an issue of concern because not all data users have the expertise to recognize synonyms when merging data sets. Although participating taxonomists made efforts to minimize these problems by relying on SCAMIT lists, discrepancies still occurred, suggesting that larger numbers occur in areas where there is no authoritative standardization of nomenclature.

Of greater concern was the prevalence of instances where organisms were identified to different taxonomic levels in analysis and reanalysis. Some of these discrepancies resulted from differences of opinion whether the condition of a specimen was sufficient for species-level identification, while others reflected differences in the experience of the taxonomists. We chose to also classify these instances as discrepancies, rather than errors, because data can be "lumped" to the higher taxonomic level before analysis. However, lumping may affect measures of species richness and diversity (Wu 1982, Wilson and Jefferey 1994); this is of concern when richness and diversity data are compared to threshold values to infer condition of the benthos, as in the case of B-IBI measures (Weisberg *et al.* 1997, Van Dolah *et al.* 1999). Interpretations of assessment results are distorted if the level of taxonomy differs from the level used while developing thresholds.

This issue is of particular concern because taxonomy improves over time and, therefore, benchmarks developed from early data should be re-evaluated over time. Our regional surveys provide an example of improving taxonomy. In the survey providing data for these analyses, it was necessary to lump 43 taxa due to taxonomic uncertainty (Table 4). In a subsequent regional survey involving the same group of taxonomists, it was only necessary to lump 16 taxa (Table 4). Our list does not include taxa that were recognized from the beginning as impractical to identify to species at the current state of knowledge; rather, it lists groups that the taxonomists thought they were identifying consistently and accurately but, after reanalysis and review of species lists and specimens, it became clear that they were not. The improvement between surveys was achieved in two ways. First, "failures" stimulated production of new keys and other identification tools by SCAMIT. Second, in the subsequent survey, all four laboratories referred a few groups (ceriantharian and edwardsiid anemones, and euclymeninaen and lumbrinerid polychaetes) to single "specialty taxonomists" for identification and enumeration. Despite the efforts of SCAMIT, these groups still presented obstacles to consistent treatment unless one taxonomist identified all of them. The challenge is to ensure consistency between assessment tools and levels of taxonomy when the tools are applied.

Our study explored sources of variability and error often ignored when interpreting the results of benthic assessments (Ellis 1985). Most importantly, our results provide a standard against which subsequent efforts may be judged. By integrating reanalysis by sample exchange among external taxonomists into quality assurance plans, multi-laboratory monitoring programs can greatly increase the likelihood of producing results that are accurate and comparable. The levels of error measured in this study provide the first available data points about variability in identification and abundance measures during multi-laboratory taxonomic analysis. As additional data about these errors are accumulated, they can be incorporated as targets and limits in quality assurance and quality control programs to ensure that laboratory data quality are maintained.

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Table 4. Level of taxonomic identification assigned after re-identification of specimens and inter-laboratory comparison of data. Bolded entries indicate taxonomic groups affected (all or in part) by reliance on a single taxonomist for identification in 1998.

Group	Name Adopted after Inter-Laboratory Comparison	Level	Number of Taxa Combined	
			1994	1998
PHYLUM CNIDARIA, Class Anthozoa	**Ceriantharia**	**Order**	**4**	
	Actiniaria	**Order**	**5**	
Order Pennatulacea	*Acanthoptilum* spp.	Genus	3	3
PHYLUM NEMERTEA, Class Anopla	Anopla	Class	7	
	Paleonemertea	Order	2	3
Class Enopla, Order Hoplonemertea	Hoplonemertea	Order	3	
	Lineidae	Family	12	9
	Amphiporus spp.	Genus	4	4
	Tetrastemma spp.	Genus	2	
PHYLUM MOLLUSCA, Class Aplacophora				
Order Aplacophora	Chaetodermatidae	Family	5	3
Class Gastropoda, Order	*Bittium* spp.	Genus	2	
Megagastropoda	*Lirobittium* spp	Genus		3
	Asperiscala spp.	Genus	2	
	Nitidiscala spp.	Genus	2	
	Crepidula spp.	Genus	4	
Order Neogastropoda	*Ophiodermella* spp.	Genus	3	
Class Bivalvia, Order Veneroida	*Solen* spp.	Genus	2	
Order Myoida	*Corbula* spp.	Genus	2	
Order Septibranchida	*Cardiomya* spp.	Genus	2	
PHYLUM ANNELIDA, Class Polychaeta				
Order Orbiniida	*Levinsenia* spp.	Genus	3	
	Paradoneis spp.	Genus		4
Order Cossurida	*Cossura* spp.	Genus	2	
Order Spionida	*Boccardia* spp.	Genus		2
	Protocirrineris spp.	Genus	2	
	Monticellina spp.	Genus	5	
	Mediomastus spp.	Genus	3	3
Order Capitellida	***Clymenella* spp.**	**Genus**	**3**	
	Maldanidae	**Family**	**11**	
Order Opheliida	*Ophelina* spp.	Genus	2	
Order Phyllodocida	*Eusyllis* spp.	Genus		3
	Harmothoinae	Subfamily	15	
	Sthenelais spp.	Genus	3	
	Sphaerosyllis spp.	Genus	2	
Order Eunicida	***Lumbrineris* spp.**	**Genus**	**15**	
	Drilonereis spp.	Genus	3	
	Dorvillea (S.) spp.	Genus		3
	Arabella spp.	Genus		2
	Nothria spp.	Genus		2
Order Fauveliopsida	*Fauveliopsis* spp.	Genus	3	
Order Terebellida	*Terebellides* spp.	Genus	2	
Order Sabellida	*Demonax* spp.	Genus	2	
	Bispira spp.	Genus	2	2
PHYLUM ARTHROPODA, Class Malacostraca				
Order Leptostraca	*Nebalia* spp.	Genus	3	
Order Isopoda	*Edotia* spp.	Genus	2	
	Synidotea spp.	Genus	2	
Order Amphipoda	*Aorides* spp.	Genus	6	
	Corophium spp.	Genus		3
	Photis spp.	Genus	4	
	Protomedeia spp.	Genus	2	
	Synchelidium spp.	Genus		3
PHYLUM ECHINODERMATA	Holothuroidea	Class	2	
PHYLUM CHORDATA	Ascidiacea	Class	4	

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Appendix F

Area Assessment of Benthic Condition

Included are estimates of benthic macrofaunal condition for bottom areas of the Southern California Bight less than 125 m deep. Percentages of area at each level of benthic condition are presented. Open coastal sites were evaluated using the Benthic Response Index (BRI; Smith *et al.* 2001) and sites in embayments using the extension developed for this report (Appendix C). The BRI identifies reference condition and four levels of benthic macrofaunal response to disturbance. Response Levels 2 thru 4 are considered to represent clear evidence of disturbance.

	No. of Sites	**Reference**	**Response Level 1**	**2**	**3**	**4**	**Clearly Disturbed**
			U.S. Southern California Bight (SCB)				
SCB	321	87.84	10.21	1.76	0.16	0.03	1.95
			U.S. Habitats				
Embayments	121	60.07	22.84	12.70	3.65	0.75	17.09
Mainland Shelf	147	83.28	14.45	2.27			2.27
Island Shelf	53	96.49	3.51				0.00
			U.S. Embayments				
Marinas	39	39.40	33.72	18.42	8.45		26.88
Ports	37	52.85	29.38	15.44	2.34		17.78
Other Bays	38	82.37	9.29	6.16		2.18	8.34
			SCB Mainland Shelf				
U.S. North	46	78.87	21.04	0.09			0.09
U.S. Central	62	77.20	16.23	6.57			6.57
U.S. South	39	99.43	0.57				0.00
Mexico	63	96.32	2.45	1.23			1.23
			Other U.S. Areas				
River Mouths	27	74.07	22.22	3.70			3.70
Large POTWs	30	80.00	13.33	6.67			6.67
Small POTWs	33	77.40	22.60				0.00
All POTWs	63	79.29	15.85	4.86			4.86
Other Mainland Shelf	66	83.70	14.22	2.08			2.08

Appendix G

Community Measures

Community measures for each site. RL: Response Level (see Chapter 2). Abundance, number of taxa and biomass are for 0.1 m^2 Van Veen grab samples. Biomass was measured as wet weight. The Shannon-Wiener Index was calculated using $\log_e$; therefore, the units are nats. The BRI is explained in Chapter 2.

Site	Abundance (0.1 m^2)	No. of Taxa (0.1 m^2)	Biomass (g wet/0.1 m^2)	Shannon-Wiener Index (nats)	Coastal BRI	Embayment BRI	Status
2066	1,830	82	34.48	2.270	27.76		RL 1
2068	213	48	2.49	3.155	15.23		Reference
2071	98	25	9.82	2.318	-2.34		Reference
2072	20	15	1.23	2.692	20.48		Reference
2073	117	44	1.63	3.360	10.03		Reference
2075	362	59	10.11	2.671	20.62		Reference
2077	418	66	6.35	2.860	18.10		Reference
2078	54	25	5.60	3.087	6.38		Reference
2081	509	80	2.20	3.538	15.56		Reference
2082	208	66	1.20	3.263	14.95		Reference
2083	187	34	3.20	1.943	5.18		Reference
2086	194	41	6.00	2.619	12.89		Reference
2087	217	40	4.70	2.613	17.88		Reference
2088	522	59	9.40	3.098	17.41		Reference
2089	182	35	5.60	2.391	17.16		Reference
2091	290	56	4.85	2.978	17.85		Reference
2093	71	40	1.07	3.406	15.81		Reference
2128	52	7	0.39	1.820		7.32	Reference
2129	559	33	10.33	2.593		39.86	RL 1
2130	224	26	13.21	2.367		35.61	RL 1
2131	347	25	8.94	1.256		19.70	Reference
2132	38	13	2.16	2.090	-15.77		Reference
2134	356	32	7.36	2.613		37.40	RL 1
2136	161	21	12.04	2.152		54.18	RL 3
2137	741	39	67.00	2.161		62.88	RL 3
2138	317	23	32.32	1.586		53.27	RL 3
2141	1,273	45	13.48	1.923		51.68	RL 2
2142	325	28	11.08	2.141		46.74	RL 2
2143	1,141	47	10.00	2.392		40.34	RL 1
2144	1,103	43	5.60	2.147		35.04	RL 1
2145	878	65	12.30	2.818		25.78	Reference
2146	633	77	27.40	3.361		19.19	Reference
2147	326	35	5.30	2.627		29.50	Reference
2148	355	65	8.89	2.983		9.03	Reference
2149	669	46	4.23	2.659		18.23	Reference
2150	212	35	4.20	2.802		30.45	Reference
2151	128	21	10.40	2.548		43.61	RL 2
2152	482	55	9.18	2.897		2.67	Reference

Site	Abundance (0.1 m^2)	No. of Taxa (0.1 m^2)	Biomass (g wet/0.1 m^2)	Shannon-Wiener Index (nats)	Coastal BRI	Embayment BRI	Status
2153	417	65	5.48	3.207		0.00	Reference
2154	112	31	1.75	3.061		11.29	Reference
2155	221	40	5.18	2.380		13.79	Reference
2156	155	42	2.15	2.730		11.24	Reference
2157	353	56	10.40	3.088		9.86	Reference
2158	196	43	8.90	3.039		13.79	Reference
2159	264	63	6.84	3.738		17.92	Reference
2160	229	62	10.40	3.516		9.78	Reference
2161	191	50	10.83	3.278		16.42	Reference
2162	32	8	0.13	1.109		74.99	RL 4
2163	135	44	4.27	2.995		19.43	Reference
2164	352	51	4.24	3.239		12.07	Reference
2167	235	34	3.62	2.130		14.65	Reference
2168	172	31	5.00	2.437		19.61	Reference
2169	164	17	3.98	2.101		36.24	RL 1
2170	388	36	5.06	2.518		31.96	RL 1
2172	411	52	10.37	2.918		25.41	Reference
2173	414	35	2.95	1.779		15.29	Reference
2174	3,743	52	11.92	1.142		23.52	Reference
2175	223	61	8.56	3.617		8.94	Reference
2176	163	28	4.55	1.933		20.85	Reference
2177	122	9	3.69	0.516		24.20	Reference
2178	276	34	10.99	1.718		22.73	Reference
2179	177	38	9.29	3.009		23.75	Reference
2182	7	6	0.04	1.748		67.40	RL 3
2184	119	42	3.29	3.442		3.74	Reference
2185	240	50	2.93	3.282		21.25	Reference
2186	509	83	7.63	3.659		13.19	Reference
2187	318	83	8.88	4.028		5.76	Reference
2188	231	41	4.77	3.060		20.83	Reference
2189	456	113	6.73	3.936	13.40		Reference
2190	395	113	7.81	4.262	14.79		Reference
2191	511	76	7.09	3.281	19.53		Reference
2192	534	100	8.95	3.957	18.35		Reference
2194	445	81	8.70	3.625	27.23		RL 1
2195	612	86	10.14	3.715	29.44		RL 1
2196	497	117	6.12	3.802	14.37		Reference
2197	377	85	11.12	3.672	16.69		Reference
2198	350	86	5.12	3.817	20.58		Reference
2199	541	91	34.64	3.580	13.55		Reference
2200	567	102	10.60	3.792	28.64		RL 1
2201	454	96	10.90	3.997	26.07		RL 1
2202	464	85	10.80	3.801	38.29		RL 2
2204	1,061	110	14.70	3.521	37.24		RL 2
2205	555	104	12.10	4.016	21.07		Reference

Site	Abundance (0.1 m^2)	No. of Taxa (0.1 m^2)	Biomass (g wet/0.1 m^2)	Shannon-Wiener Index (nats)	Coastal BRI	Embayment BRI	Status
2206	502	128	18.00	4.298	19.66		Reference
2207	207	49	1.40	3.277	18.68		Reference
2208	524	126	5.90	3.943	20.57		Reference
2209	482	105	9.00	3.811	12.97		Reference
2210	597	107	13.00	3.999	19.04		Reference
2211	551	112	13.40	4.170	19.12		Reference
2212	566	114	14.20	4.122	22.77		Reference
2213	129	53	1.00	3.691	14.13		Reference
2214	542	83	6.40	3.045	12.83		Reference
2215	452	77	4.50	3.078	10.53		Reference
2216	433	65	4.30	3.030	7.57		Reference
2217	381	66	5.10	3.222	9.80		Reference
2218	366	84	3.80	3.785	16.48		Reference
2219	644	97	4.00	3.507	6.77		Reference
2220	436	79	5.90	3.421	16.14		Reference
2221	824	35	63.60	2.617		38.85	RL 1
2222	693	35	3.50	1.785		45.22	RL 2
2223	816	37	11.20	2.659		42.60	RL 2
2224	383	41	2.20	2.896		28.76	Reference
2225	3,149	70	34.90	2.302		38.23	RL 1
2226	1,012	57	9.60	2.594		38.35	RL 1
2227	933	52	11.00	2.849		24.89	Reference
2228	251	41	4.70	3.134		32.59	RL 1
2229	705	63	19.70	3.124		15.69	Reference
2230	1,372	72	34.40	2.701		18.37	Reference
2231	1,502	70	20.20	2.753		15.97	Reference
2233	395	39	17.00	2.727		28.81	Reference
2235	551	29	12.60	2.074		42.10	RL 2
2238	760	41	20.60	2.469		38.48	RL 1
2239	1,030	25	4.40	1.663		37.97	RL 1
2240	1,201	40	16.00	2.183		28.83	Reference
2241	1,526	44	4.00	2.305		34.74	RL 1
2242	1,117	28	5.00	1.795		36.61	RL 1
2243	966	47	42.00	2.741		36.36	RL 1
2244	1,376	48	16.40	2.685		31.23	RL 1
2245	487	25	28.00	2.161		42.57	RL 2
2247	900	33	95.00	2.087		34.11	RL 1
2249	600	37	9.20	2.265		44.65	RL 2
2251	1,194	34	27.00	1.852		43.16	RL 2
2252	327	37	9.20	2.806		4.26	Reference
2253	465	33	7.40	2.267		44.52	RL 2
2254	684	33	37.00	2.172		46.75	RL 2
2255	391	30	2.70	2.126		37.25	RL 1
2256	237	28	2.00	2.658		37.90	RL 1
2257	503	37	1.90	2.310		38.10	RL 1

Site	Abundance (0.1 m^2)	No. of Taxa (0.1 m^2)	Biomass (g wet/0.1 m^2)	Shannon-Wiener Index (nats)	Coastal BRI	Embayment BRI	Status
2258	826	36	7.60	2.292		43.20	RL 2
2259	102	22	1.00	2.616		38.39	RL 1
2260	2,263	49	152.00	1.828		39.06	RL 1
2262	542	29	47.00	2.101		40.62	RL 1
2263	343	44	4.60	3.243		26.28	Reference
2264	237	28	3.00	2.719		43.83	RL 2
2265	1,543	48	8.10	2.388		26.68	Reference
2266	280	73	20.12	3.954	22.90		Reference
2267	361	89	18.09	3.927	25.95		RL 1
2268	450	95	33.48	3.991	28.98		RL 1
2269	325	89	19.20	3.968	25.78		RL 1
2272	281	88	32.78	4.025	27.88		RL 1
2273	133	36	5.24	3.222	23.52		Reference
2274	177	37	46.78	3.017	13.46		Reference
2275	145	35	4.56	2.828	12.65		Reference
2276	135	37	3.18	2.914	8.13		Reference
2277	676	116	22.40	4.056	25.22		RL 1
2278	845	116	22.70	4.061	24.21		Reference
2279	88	41	0.60	3.459	19.91		Reference
2280	393	81	7.40	3.638	23.69		Reference
2281	360	81	7.80	3.659	24.75		Reference
2282	113	48	1.20	3.586	17.20		Reference
2283	250	67	6.60	3.517	25.63		RL 1
2284	326	93	10.60	3.911	26.04		RL 1
2285	235	55	17.50	3.312	18.44		Reference
2286	257	62	7.70	3.305	16.37		Reference
2287	222	55	2.90	3.492	20.41		Reference
2288	359	99	12.90	4.070	26.38		RL 1
2289	248	45	5.20	2.680	2.58		Reference
2290	233	34	9.30	2.208	15.63		Reference
2291	290	44	5.80	2.666	7.23		Reference
2292	293	41	11.30	2.315	20.04		Reference
2293	172	32	7.50	2.508	6.96		Reference
2294	433	88	9.19	3.545	17.27		Reference
2295	327	80	12.90	3.818	19.76		Reference
2296	445	82	9.70	3.235	18.56		Reference
2297	137	40	3.30	2.762		12.33	Reference
2298	282	40	4.50	2.380		17.67	Reference
2299	240	55	9.00	3.277		14.66	Reference
2300	214	56	9.44	3.100		13.09	Reference
2301	414	89	37.17	3.792	30.47		RL 1
2302	333	58	7.10	3.404	20.26		Reference
2303	258	61	3.20	3.339	22.85		Reference
2304	35	12	1.90	2.039	20.92		Reference
2305	156	35	1.00	2.849	12.99		Reference

Site	Abundance ($0.1\ m^2$)	No. of Taxa ($0.1\ m^2$)	Biomass (g wet/$0.1\ m^2$)	Shannon-Wiener Index (nats)	Coastal BRI	Embayment BRI	Status
2306	101	21	1.25	2.043	3.58		Reference
2307	61	26	0.97	2.975	6.18		Reference
2308	60	25	5.55	2.972	29.15		RL 1
2310	189	44	17.15	3.318	26.75		RL 1
2311	24	7	0.13	1.524		10.68	Reference
2312	490	118	20.56	4.215	28.58		RL 1
2314	197	60	5.76	3.573	14.89		Reference
2315	130	46	1.40	3.453	7.62		Reference
2317	174	37	3.80	2.927	-0.12		Reference
2318	128	40	12.30	3.194	20.18		Reference
2319	426	64	7.60	2.930		13.11	Reference
2320	120	28	1.20	2.301	10.50		Reference
2321	352	79	9.02	3.738		8.77	Reference
2325	86	41	0.60	3.446	21.64		Reference
2326	108	34	2.55	3.049	17.50		Reference
2328	144	27	3.20	2.678	23.53		Reference
2329	226	22	4.43	1.228	21.38		Reference
2330	259	16	3.09	1.527	28.57		RL 1
2331	119	15	2.12	1.414	29.20		RL 1
2335	42	25	1.00	2.959	16.90		Reference
2338	66	22	2.69	2.853	25.43		RL 1
2339	582	32	6.27	1.401	39.52		RL 2
2340	72	26	5.28	3.116	21.99		Reference
2341	204	70	12.13	3.862	23.37		Reference
2342	328	64	21.89	3.048	14.51		Reference
2343	122	45	29.99	3.409	15.00		Reference
2344	441	100	35.49	4.055	15.58		Reference
2345	489	89	7.62	3.783	23.05		Reference
2346	324	61	7.60	3.213	15.80		Reference
2347	333	74	12.10	3.411	28.85		RL 1
2348	178	37	2.60	2.639	4.49		Reference
2349	255	86	3.40	4.081	21.60		Reference
2350	452	76	8.70	3.066	7.19		Reference
2351	734	158	5.80	4.380	13.19		Reference
2352	70	28	1.10	2.883	18.09		Reference
2353	326	67	1.60	3.540	11.90		Reference
2354	108	46	1.64	3.542	21.98		Reference
2355	121	47	0.80	3.350	22.40		Reference
2356	522	131	13.40	4.164	19.00		Reference
2357	173	47	27.00	3.349	21.07		Reference
2358	306	73	3.30	3.509	13.22		Reference
2359	442	89	5.10	3.920	24.93		Reference
2360	173	61	5.70	3.684	19.76		Reference
2361	120	51	0.90	3.728	21.63		Reference
2362	168	50	11.20	3.121	16.05		Reference

Site	Abundance (0.1 m^2)	No. of Taxa (0.1 m^2)	Biomass (g wet/0.1 m^2)	Shannon-Wiener Index (nats)	Coastal BRI	Embayment BRI	Status
2363	114	47	1.90	3.412	25.27		RL 1
2364	265	90	5.50	3.845	12.41		Reference
2365	150	45	22.10	3.077	16.72		Reference
2366	123	30	2.60	2.707	21.94		Reference
2367	66	21	3.90	2.715	13.41		Reference
2368	68	21	7.10	2.607	17.75		Reference
2369	115	38	3.00	3.294	33.37		RL 1
2370	131	30	3.10	2.561	21.72		Reference
2371	156	23	5.60	2.226	11.19		Reference
2372	301	50	6.30	2.725	12.76		Reference
2373	143	44	3.50	3.364	28.35		RL 1
2374	156	36	3.30	2.777	14.19		Reference
2375	261	73	15.40	3.841	27.39		RL 1
2376	278	75	14.00	3.882	29.67		RL 1
2377	133	55	2.20	3.699	17.13		Reference
2378	286	90	5.30	4.033	20.24		Reference
2379	85	34	1.60	3.292	15.59		Reference
2380	375	106	4.68	4.147	29.49		RL 1
2381	161	59	11.24	3.778	21.27		Reference
2382	326	97	10.45	4.072	27.47		RL 1
2383	297	40	1.68	1.519	13.81		Reference
2384	264	67	4.95	3.477	18.73		Reference
2385	268	64	10.70	3.392	23.14		Reference
2386	127	50	5.20	3.442	19.26		Reference
2387	418	78	15.10	3.328	11.54		Reference
2388	273	38	13.60	2.994		10.40	Reference
2389	156	63	1.00	3.660	18.82		Reference
2390	427	94	10.90	3.910	36.02		RL 2
2391	465	91	8.80	3.639	34.21		RL 2
2392	409	101	8.00	4.035	29.08		RL 1
2393	163	35	5.40	2.998	2.85		Reference
2394	314	85	11.30	3.756	23.05		Reference
2395	144	49	0.80	3.486	18.04		Reference
2396	296	99	7.20	4.173	21.04		Reference
2397	837	133	8.30	3.816	25.33		RL 1
2398	337	96	1.90	4.138	21.28		Reference
2399	133	39	0.80	3.096	17.90		Reference
2400	415	96	7.80	3.954	13.72		Reference
2401	530	95	11.60	3.814	23.62		Reference
2402	1,192	150	31.80	4.059	31.29		RL 1
2403	402	66	8.00	3.367	12.62		Reference
2404	106	43	1.60	3.549	18.94		Reference
2405	248	55	3.50	3.073	9.66		Reference
2406	150	40	0.80	3.287	14.42		Reference
2407	276	60	3.60	3.174	6.58		Reference

Site	Abundance (0.1 m^2)	No. of Taxa (0.1 m^2)	Biomass (g wet/0.1 m^2)	Shannon-Wiener Index (nats)	Coastal BRI	Embayment BRI	Status
2408	345	59	7.30	2.856	1.07		Reference
2409	68	20	1.40	2.450	11.67		Reference
2410	380	100	3.50	3.656	9.24		Reference
2411	496	65	6.80	2.923	1.43		Reference
2412	440	64	5.80	2.873	15.19		Reference
2413	756	115	8.70	4.136	21.15		Reference
2414	39	26	0.90	3.232	19.08		Reference
2415	76	37	0.70	3.331	16.51		Reference
2417	150	58	3.70	3.672	17.25		Reference
2418	536	97	2.20	3.610	7.20		Reference
2419	239	86	2.50	3.984	15.90		Reference
2421	487	49	20.00	2.993		33.20	RL 1
2423	1,633	86	35.00	3.324		13.65	Reference
2424	406	52	3.40	3.145		17.72	Reference
2425	4,816	108	40.90	3.187		11.39	Reference
2426	428	53	6.20	2.875		13.80	Reference
2427	165	31	3.10	2.612		12.84	Reference
2428	37	19	1.20	2.714	36.88		RL 2
2430	240	54	2.80	3.079		28.66	Reference
2431	195	39	3.30	2.780		21.84	Reference
2432	33	21	0.80	2.809		20.17	Reference
2433	709	59	6.70	3.076		20.99	Reference
2434	576	50	18.60	3.305		23.96	Reference
2435	466	60	36.30	3.409		-1.11	Reference
2436	599	48	10.00	3.064		19.38	Reference
2438	384	34	25.60	2.639		47.60	RL 2
2439	536	33	39.10	2.368		38.22	RL 1
2440	651	59	16.80	3.158		31.66	RL 1
2441	1,672	86	32.60	3.234		17.24	Reference
2442	388	52	8.00	2.874		21.07	Reference
2443	35	7	1.02	1.812		36.08	RL 1
2444	42	7	2.61	1.497		43.76	RL 2
2445	107	12	5.22	1.896		36.77	RL 1
2446	76	9	3.55	1.636		36.78	RL 1
2447	163	23	6.09	1.541		32.43	RL 1
2448	5,561	52	5.23	1.329		29.65	Reference
2449	473	43	8.35	2.351		20.54	Reference
2450	162	11	1.80	1.004		100.00	RL 4
2451	380	56	13.90	3.380		9.05	Reference
2453	75	26	0.70	2.788	14.30		Reference
2454	228	38	2.00	2.602	12.12		Reference
2455	358	96	40.80	3.944	19.83		Reference
2456	579	105	30.10	3.863	20.98		Reference
2457	191	63	1.30	3.633	18.94		Reference
2467	174	45	4.20	2.880	18.17		Reference

Site	Abundance (0.1 m^2)	No. of Taxa (0.1 m^2)	Biomass (g wet/0.1 m^2)	Shannon-Wiener Index (nats)	Coastal BRI	Embayment BRI	Status
2469	1,037	101	8.10	3.434	20.56		Reference
2472	742	103	8.70	3.555	29.72		RL 1
2475	796	57	14.70	2.578	19.49		Reference
2476	253	30	3.90	2.167	-2.05		Reference
2479	1,016	147	16.50	4.015	15.62		Reference
2480	559	104	3.20	3.859	11.35		Reference
2482	967	159	6.00	4.113	14.47		Reference
2483	696	133	3.10	3.939	13.78		Reference
2485	601	121	7.00	3.826	6.32		Reference
2487	447	63	18.10	3.230	18.14		Reference
2489	562	122	3.80	3.879	13.31		Reference
2490	649	98	1.00	3.558	20.42		Reference
2491	926	159	3.70	4.110	13.82		Reference
2492	808	108	2.80	3.596	16.72		Reference
2493	481	74	5.40	3.278	18.20		Reference
2511	287	66	2.73	3.170	9.35		Reference
2512	548	92	8.10	3.404	13.71		Reference
2513	397	95	7.90	3.459	12.88		Reference
2514	895	88	25.70	3.220	29.04		RL 1
2515	776	166	12.52	4.253	16.68		Reference
2516	670	110	7.29	3.724	16.16		Reference
2518	690	114	6.40	3.925	16.61		Reference
2519	794	156	18.32	4.116	16.07		Reference
2520	476	105	4.74	3.645	13.46		Reference
2521	741	108	11.20	3.708	17.01		Reference
2522	843	155	3.60	4.161	13.67		Reference
2523	416	71	1.00	3.327	9.70		Reference
2540	415	53	11.94	2.597	13.39		Reference
2542	24	13	0.60	2.474	-6.80		Reference
2543	465	66	9.16	3.212	20.43		Reference
2545	229	51	1.50	3.213	16.25		Reference
2546	345	55	55.40	2.768	25.27		RL 1
2547	270	64	6.60	3.273	26.90		RL 1
2549	117	27	2.70	2.775	-1.33		Reference
2551	77	26	0.70	2.584	26.58		RL 1
2555m	184	54	3.75	3.349	14.99		Reference
2556m	71	33	0.42	3.188	18.62		Reference
2558m	140	48	4.99	3.357	21.57		Reference
2559m	34	16	8.49	2.517	3.88		Reference
2560m	67	42	0.94	3.561	17.05		Reference
2561m	108	48	1.24	3.444	12.80		Reference
2563m	249	49		2.891	2.52		Reference
2565m	118	54	1.34	3.307	11.05		Reference
2567m	15	13	0.11	2.523	8.17		Reference
2568m	23	17	0.21	2.608	17.26		Reference

Site	Abundance (0.1 m^2)	No. of Taxa (0.1 m^2)	Biomass (g wet/0.1 m^2)	Shannon-Wiener Index (nats)	Coastal BRI	Embayment BRI	Status
2569m	90	49	2.68	3.620	15.69		Reference
2570m	50	31	0.95	3.250	12.49		Reference
2572m	314	60	5.19	3.207	5.38		Reference
2574m	124	48	1.50	3.557	22.28		Reference
2575m	78	38	0.27	3.080	18.05		Reference
2576m	94	29	1.79	2.784	14.85		Reference
2577m	11	10	0.86	2.272	15.90		Reference
2578m	163	60	2.28	3.677	0.87		Reference
2579m	43	24	1.69	2.748	20.02		Reference
2582m	69	27	0.69	2.923	19.89		Reference
2583m	56	29	0.17	3.035	10.35		Reference
2584m	154	48	0.77	2.997	4.78		Reference
2585m	203	38	2.35	2.698	4.93		Reference
2587m	202	49	5.63	3.128	20.63		Reference
2588m	172	35	3.07	2.267	2.38		Reference
2589m	68	28	4.26	2.642	1.75		Reference
2590m	41	20	0.24	2.516	21.98		Reference
2591m	122	45	0.72	3.405	2.68		Reference
2592m	104	22	2.77	2.218	-0.70		Reference
2593m	28	17	0.76	2.682	6.95		Reference
2594m	117	48	3.16	3.489	10.42		Reference
2595m	35	20	0.66	2.755	16.90		Reference
2596m	135	40	2.88	2.979	5.73		Reference
2597m	153	41	4.56	2.687	8.22		Reference
2599m	155	55	1.35	3.520	24.47		Reference
2601m	76	40	1.05	3.486	17.97		Reference
2602m	142	61	2.54	3.819	19.58		Reference
2603m	268	55	3.35	3.266	8.42		Reference
2604m	54	25	2.54	2.647	4.69		Reference
2606m	178	63	4.98	3.725	-0.13		Reference
2607m	190	46	1.20	3.074	11.57		Reference
2608m	179	61	5.50	3.394	30.70		RL 1
2609m	198	63	1.45	3.699	24.84		Reference
2610m	20	10	0.30	2.011	20.61		Reference
2611m	161	33	3.39	2.568	1.03		Reference
2613m	34	20	1.22	2.843	21.29		Reference
2614m	126	52	0.56	3.425	9.65		Reference
2615m	46	24	3.64	2.839	17.86		Reference
2616m	149	43	1.97	3.050	11.65		Reference
2617m	137	61	1.91	3.737	2.73		Reference
2618m	77	33	2.67	2.940	4.74		Reference
2619m	52	11	1.99	1.550	2.32		Reference
2620m	88	29	1.39	2.810	26.01		RL 1
2621m	156	36	2.16	2.721	4.51		Reference
2622m	97	37	1.95	3.072	16.02		Reference

Site	Abundance ($0.1\ m^2$)	No. of Taxa ($0.1\ m^2$)	Biomass (g wet/$0.1\ m^2$)	Shannon-Wiener Index (nats)	Coastal BRI	Embayment BRI	Status
2623m	97	42	2.16	3.426	10.71		Reference
2624m	46	26	0.22	3.026	11.13		Reference
2625m	231	39	3.03	2.599	-2.87		Reference
2628m	121	48	0.50	3.526	18.07		Reference
2630m	80	37	2.23	3.195	17.36		Reference
2631m	148	31	3.96	1.907	10.64		Reference
2633m	31	11	1.50	1.913	9.75		Reference
2634m	27	7	0.16	0.928	35.51		RL 2
2636m	22	13	5.72	2.327	21.66		Reference
2637m	87	41	4.28	3.121	3.38		Reference
2638m	110	32	3.77	2.340	10.10		Reference
2639m	156	53	6.06	3.452	13.58		Reference
2640m	151	41	0.67	2.742	15.70		Reference
2641m	82	37	1.19	3.258	21.41		Reference
2643m	189	71	1.45	3.866	14.38		Reference
2644m	307	61	3.65	3.218	10.77		Reference
2645m	173	56	1.54	3.631	20.27		Reference

Appendix H

Species List in Taxonomic Order

Taxonomic information and the number of sites of occurrence are presented for each taxon name. Occurrences at 415 random and fixed sites in the U.S. and Mexico were included. The taxon number is provided for easy cross-reference from Appendix I.

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
			Cnidaria : Hydrozoa			
Corymorpha bigelowi	1	Cnidaria	Hydrozoa	Athecatae	Corymorphidae	4
Corymorpha palma	2	Cnidaria	Hydrozoa	Athecatae	Corymorphidae	13
Corymorphidae	3	Cnidaria	Hydrozoa	Athecatae	Corymorphidae	5
Corymorphidae sp SD1	4	Cnidaria	Hydrozoa	Athecatae	Corymorphidae	4
Euphysa sp A	5	Cnidaria	Hydrozoa	Athecatae	Corymorphidae	4
Hydrozoa	6	Cnidaria	Hydrozoa			8
Obelia sp A	7	Cnidaria	Hydrozoa	Thecatae	Campanulariidae	32
Tubularia crocea	8	Cnidaria	Hydrozoa	Athecatae	Tubulariidae	2
			Cnidaria : Anthozoa			
Acanthoptilum sp	9	Cnidaria	Anthozoa	Pennatulacea	Virgulariidae	5
Actiniaria	10	Cnidaria	Anthozoa	Actiniaria		29
Anemonactis sp	11	Cnidaria	Anthozoa	Actiniaria	Haloclavidae	8
Anthozoa #49	12	Cnidaria	Anthozoa	Actiniaria	Uncertain	1
Bunodeopsis sp A	13	Cnidaria	Anthozoa	Actiniaria	Boloceroididae	8
Ceriantharia	14	Cnidaria	Anthozoa	Ceriantharia		115
Corynactis californica	15	Cnidaria	Anthozoa	Corallimorpharia	Corallimorphidae	1
Edwardsia californica	16	Cnidaria	Anthozoa	Actiniaria	Edwardsiidae	13
Edwardsia sp G	17	Cnidaria	Anthozoa	Actiniaria	Edwardsiidae	10
Edwardsiidae	18	Cnidaria	Anthozoa	Actiniaria	Edwardsiidae	23
Halcampa decemtentaculata	19	Cnidaria	Anthozoa	Actiniaria	Halcampidae	16
Halcampidae	20	Cnidaria	Anthozoa	Actiniaria	Halcampidae	1
Halianthella sp A	21	Cnidaria	Anthozoa	Actiniaria	Halcampidae	15
Limnactiniidae sp A	22	Cnidaria	Anthozoa	Actiniaria	Limnactiniidae	9
Paracyathus stearnsii	23	Cnidaria	Anthozoa	Scleractinia	Caryophylliidae	1
Pentactinia californica	24	Cnidaria	Anthozoa	Actiniaria	Halcampoididae	32
Scolanthus sp A	25	Cnidaria	Anthozoa	Actiniaria	Edwardsiidae	108
Stylatula elongata	26	Cnidaria	Anthozoa	Pennatulacea	Virgulariidae	9
Stylatula sp	27	Cnidaria	Anthozoa	Pennatulacea	Virgulariidae	2
Stylatula sp A	28	Cnidaria	Anthozoa	Pennatulacea	Virgulariidae	5
Thesea sp B	29	Cnidaria	Anthozoa	Alcyonacea	Muriceidae	3
Virgularia agassizi	30	Cnidaria	Anthozoa	Pennatulacea	Virgulariidae	6
Virgularia californica	31	Cnidaria	Anthozoa	Pennatulacea	Virgulariidae	6
Virgulariidae	32	Cnidaria	Anthozoa	Pennatulacea	Virgulariidae	12
Zaolutus actius	33	Cnidaria	Anthozoa	Actiniaria	Isanthidae	14
			Platyhelminthes : Turbellaria			
Cryptocelis occidentalis	34	Platyhelminthes	Turbellaria	Polycladida	Cryptocelididae	5
Euryleptidae	35	Platyhelminthes	Turbellaria	Polycladida	Euryleptidae	1

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Imogine exiguus	36	Platyhelminthes	Turbellaria	Polycladida	Stylochidae	15
Latocestidae	37	Platyhelminthes	Turbellaria	Polycladida	Latocestidae	2
Leptoplanidae sp A	38	Platyhelminthes	Turbellaria	Polycladida	Leptoplanidae	1
Notoplana sp	39	Platyhelminthes	Turbellaria	Polycladida	Leptoplanidae	1
Paraplanocera oligoglena	40	Platyhelminthes	Turbellaria	Polycladida	Planoceridae	1
Parviplana californica	41	Platyhelminthes	Turbellaria	Polycladida	Leptoplanidae	3
Plehnia caeca	42	Platyhelminthes	Turbellaria	Polycladida	Plehniidae	3
Pleioplana inquieta	43	Platyhelminthes	Turbellaria	Polycladida	Leptoplanidae	1
Polycladida	44	Platyhelminthes	Turbellaria	Polycladida		13
Polycladida sp 27	45	Platyhelminthes	Turbellaria	Polycladida	Uncertain	1
Polycladida sp A	46	Platyhelminthes	Turbellaria	Polycladida	Uncertain	1
Pseudoceros sp HYP1	47	Platyhelminthes	Turbellaria	Polycladida	Pseudocerotidae	1
Stylochoplana sp	48	Platyhelminthes	Turbellaria	Polycladida	Leptoplanidae	2
Stylochus sp	49	Platyhelminthes	Turbellaria	Polycladida	Stylochidae	1
			Nemertinea			
Amphinemertes caeca	50	Nemertea	Enopla	Hoplonemertea	Tetrastemmatidae	1
Amphiporus sp	51	Nemertea	Enopla	Hoplonemertea	Amphiporidae	34
Anopla	52	Nemertea	Anopla			21
Anopla sp A	53	Nemertea	Anopla			1
Anopla sp D	54	Nemertea	Anopla			6
Carinoma mutabilis	55	Nemertea	Anopla	Palaeonemertea	Carinomidae	103
Carinomella lactea	56	Nemertea	Anopla	Palaeonemertea	Tubulanidae	5
Cryptonemertes actinophila	57	Nemertea	Enopla	Hoplonemertea	Emplectonematidae	7
Emplectonematidae	58	Nemertea	Enopla	Hoplonemertea	Emplectonematidae	2
Enopla	59	Nemertea	Enopla			6
Enopla sp A	60	Nemertea	Enopla	Uncertain	Uncertain	1
Heteronemertea	61	Nemertea	Anopla	Heteronemertea		3
Hoplonemertea	62	Nemertea	Enopla	Hoplonemertea		15
Lineidae	63	Nemertea	Anopla	Heteronemertea	Lineidae	184
Lineus bilineatus	64	Nemertea	Anopla	Heteronemertea	Lineidae	25
Nemertea	65	Nemertea				47
Oerstedia dorsalis	66	Nemertea	Enopla	Hoplonemertea	Prosorhochmidae	2
Palaeonemertea	67	Nemertea	Anopla	Palaeonemertea		58
Palaeonemertea sp C	68	Nemertea	Anopla	Palaeonemertea		8
Paranemertes californica	69	Nemertea	Enopla	Hoplonemertea	Emplectonematidae	85
Procephalothrix major	70	Nemertea	Anopla	Archinemertea	Cephalothoricidae	1
Prosorhochmus albidus	71	Nemertea	Enopla	Hoplonemertea	Prosorhochmidae	2
Tetrastemma candidum	72	Nemertea	Enopla	Hoplonemertea	Tetrastemmatidae	6
Tetrastemma nigrifrons	73	Nemertea	Enopla	Hoplonemertea	Tetrastemmatidae	1
Tetrastemma sp	74	Nemertea	Enopla	Hoplonemertea	Tetrastemmatidae	3
Tetrastemma sp A	75	Nemertea	Enopla	Hoplonemertea	Tetrastemmatidae	1
Tubulanidae	76	Nemertea	Anopla	Palaeonemertea	Tubulanidae	1
Tubulanus cingulatus	77	Nemertea	Anopla	Palaeonemertea	Tubulanidae	32
Tubulanus nothus	78	Nemertea	Anopla	Palaeonemertea	Tubulanidae	62
Tubulanus polymorphus	79	Nemertea	Anopla	Palaeonemertea	Tubulanidae	231

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Tubulanus sp	80	Nemertea	Anopla	Palaeonemertea	Tubulanidae	1
Tubulanus sp SD1	81	Nemertea	Anopla	Palaeonemertea	Tubulanidae	6
Zygeupolia rubens	82	Nemertea	Anopla	Heteronemertea	Valenciniidae	21
Annelida : Polychaeta						
Acoetes pacifica	83	Annelida	Polychaeta	Phyllodocida	Acoetidae	10
Acrocirrus sp	84	Annelida	Polychaeta	Spionida	Acrocirridae	3
Aglaophamus erectans	85	Annelida	Polychaeta	Phyllodocida	Nephtyidae	1
Aglaophamus sp	86	Annelida	Polychaeta	Phyllodocida	Nephtyidae	1
Aglaophamus verrilli	87	Annelida	Polychaeta	Phyllodocida	Nephtyidae	55
Amaeana occidentalis	88	Annelida	Polychaeta	Terebellida	Terebellidae	117
Amage anops	89	Annelida	Polychaeta	Terebellida	Ampharetidae	7
Amastigos acutus	90	Annelida	Polychaeta	Capitellida	Capitellidae	1
Ampharete acutifrons	91	Annelida	Polychaeta	Terebellida	Ampharetidae	7
Ampharete finmarchica	92	Annelida	Polychaeta	Terebellida	Ampharetidae	18
Ampharete goesi	93	Annelida	Polychaeta	Terebellida	Ampharetidae	1
Ampharete labrops	94	Annelida	Polychaeta	Terebellida	Ampharetidae	107
Ampharete sp	95	Annelida	Polychaeta	Terebellida	Ampharetidae	26
Ampharetidae	96	Annelida	Polychaeta	Terebellida	Ampharetidae	56
Ampharetidae sp SD1	97	Annelida	Polychaeta	Terebellida	Ampharetidae	25
Ampharetinae	98	Annelida	Polychaeta	Terebellida	Ampharetidae	4
Amphicteis glabra	99	Annelida	Polychaeta	Terebellida	Ampharetidae	8
Amphicteis mucronata	100	Annelida	Polychaeta	Terebellida	Ampharetidae	3
Amphicteis scaphobranchiata	101	Annelida	Polychaeta	Terebellida	Ampharetidae	105
Amphicteis sp	102	Annelida	Polychaeta	Terebellida	Ampharetidae	12
Amphitritinae	103	Annelida	Polychaeta	Terebellida	Terebellidae	12
Amphitritinae sp SD1	104	Annelida	Polychaeta	Terebellida	Terebellidae	1
Ancistrosyllis groenlandica	105	Annelida	Polychaeta	Phyllodocida	Pilargidae	1
Ancistrosyllis hamata	106	Annelida	Polychaeta	Phyllodocida	Pilargidae	2
Ancistrosyllis sp	107	Annelida	Polychaeta	Phyllodocida	Pilargidae	1
Anobothrus gracilis	108	Annelida	Polychaeta	Terebellida	Ampharetidae	43
Anotomastus gordiodes	109	Annelida	Polychaeta	Capitellida	Capitellidae	25
Aonides sp SD1	110	Annelida	Polychaeta	Spionida	Spionidae	8
Aphelochaeta glandaria	111	Annelida	Polychaeta	Spionida	Cirratulidae	22
Aphelochaeta monilaris	112	Annelida	Polychaeta	Spionida	Cirratulidae	45
Aphelochaeta petersenae	113	Annelida	Polychaeta	Spionida	Cirratulidae	21
Aphelochaeta phillipsi	114	Annelida	Polychaeta	Spionida	Cirratulidae	4
Aphelochaeta sp	115	Annelida	Polychaeta	Spionida	Cirratulidae	54
Aphelochaeta sp A	116	Annelida	Polychaeta	Spionida	Cirratulidae	18
Aphelochaeta sp LA1	117	Annelida	Polychaeta	Spionida	Cirratulidae	19
Aphelochaeta sp LA2	118	Annelida	Polychaeta	Spionida	Cirratulidae	3
Aphelochaeta sp SD2	119	Annelida	Polychaeta	Spionida	Cirratulidae	3
Aphelochaeta sp SD3	120	Annelida	Polychaeta	Spionida	Cirratulidae	1
Aphelochaeta sp SD5	121	Annelida	Polychaeta	Spionida	Cirratulidae	1
Aphelochaeta tigrina	122	Annelida	Polychaeta	Spionida	Cirratulidae	3
Aphelochaeta williamsae	123	Annelida	Polychaeta	Spionida	Cirratulidae	1

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Aphrodita sp	124	Annelida	Polychaeta	Phyllodocida	Aphroditidae	15
Apistobranchus ornatus	125	Annelida	Polychaeta	Spionida	Apistobranchidae	1
Apomatus timsii	126	Annelida	Polychaeta	Sabellida	Serpulidae	1
Apoprionospio pygmaea	127	Annelida	Polychaeta	Spionida	Spionidae	78
Arabella sp	128	Annelida	Polychaeta	Eunicida	Oenonidae	12
Aricidea (Acmira) catherinae	129	Annelida	Polychaeta	Orbiniida	Paraonidae	74
Aricidea (Acmira) cerrutii	130	Annelida	Polychaeta	Orbiniida	Paraonidae	8
Aricidea (Acmira) horikoshii	131	Annelida	Polychaeta	Orbiniida	Paraonidae	19
Aricidea (Acmira) lopezi	132	Annelida	Polychaeta	Orbiniida	Paraonidae	4
Aricidea (Acmira) rubra	133	Annelida	Polychaeta	Orbiniida	Paraonidae	3
Aricidea (Acmira) simplex	134	Annelida	Polychaeta	Orbiniida	Paraonidae	46
Aricidea (Acmira) sp	135	Annelida	Polychaeta	Orbiniida	Paraonidae	9
Aricidea (Acmira) sp LA1	136	Annelida	Polychaeta	Orbiniida	Paraonidae	2
Aricidea (Acmira) sp SD1	137	Annelida	Polychaeta	Orbiniida	Paraonidae	5
Aricidea (Acmira) taylori	138	Annelida	Polychaeta	Orbiniida	Paraonidae	1
Aricidea (Allia) antennata	139	Annelida	Polychaeta	Orbiniida	Paraonidae	33
Aricidea (Allia) hartleyi	140	Annelida	Polychaeta	Orbiniida	Paraonidae	10
Aricidea (Allia) sp A	141	Annelida	Polychaeta	Orbiniida	Paraonidae	24
Aricidea (Allia) sp LA1	142	Annelida	Polychaeta	Orbiniida	Paraonidae	1
Aricidea (Allia) sp SD1	143	Annelida	Polychaeta	Orbiniida	Paraonidae	1
Aricidea (Aricidea) pseudoarticulata	144	Annelida	Polychaeta	Orbiniida	Paraonidae	7
Aricidea (Aricidea) sp SD1	145	Annelida	Polychaeta	Orbiniida	Paraonidae	5
Aricidea (Aricidea) sp SD2	146	Annelida	Polychaeta	Orbiniida	Paraonidae	1
Aricidea (Aricidea) wassi	147	Annelida	Polychaeta	Orbiniida	Paraonidae	20
Armandia brevis	148	Annelida	Polychaeta	Opheliida	Opheliidae	25
Armandia sp SD1	149	Annelida	Polychaeta	Opheliida	Opheliidae	1
Artacamella hancocki	150	Annelida	Polychaeta	Terebellida	Trichobranchidae	29
Asabellides lineata	151	Annelida	Polychaeta	Terebellida	Ampharetidae	36
Asclerocheilus californicus	152	Annelida	Polychaeta	Opheliida	Scalibregmatidae	1
Autolytus sp	153	Annelida	Polychaeta	Phyllodocida	Syllidae	10
Axiothella rubrocincta	154	Annelida	Polychaeta	Capitellida	Maldanidae	7
Bispira sp	155	Annelida	Polychaeta	Sabellida	Sabellidae	4
Boccardia sp	156	Annelida	Polychaeta	Spionida	Spionidae	9
Boccardiella hamata	157	Annelida	Polychaeta	Spionida	Spionidae	3
Brada villosa	158	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	8
Brania californiensis	159	Annelida	Polychaeta	Phyllodocida	Syllidae	5
Brania mediodentata	160	Annelida	Polychaeta	Phyllodocida	Syllidae	15
Brania sp	161	Annelida	Polychaeta	Phyllodocida	Syllidae	3
Capitella capitata Cmplx	162	Annelida	Polychaeta	Capitellida	Capitellidae	52
Capitellidae	163	Annelida	Polychaeta	Capitellida	Capitellidae	9
Carazziella sp A	164	Annelida	Polychaeta	Spionida	Spionidae	13
Caulleriella pacifica	165	Annelida	Polychaeta	Spionida	Cirratulidae	11
Caulleriella sp	166	Annelida	Polychaeta	Spionida	Cirratulidae	1
Caulleriella sp SD2	167	Annelida	Polychaeta	Spionida	Cirratulidae	1

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Caulleriella sp SD3	168	Annelida	Polychaeta	Spionida	Cirratulidae	1
Chaetopteridae	169	Annelida	Polychaeta	Spionida	Chaetopteridae	6
Chaetopterus variopedatus Cmplx	170	Annelida	Polychaeta	Spionida	Chaetopteridae	1
Chaetozone armata	171	Annelida	Polychaeta	Spionida	Cirratulidae	13
Chaetozone corona	172	Annelida	Polychaeta	Spionida	Cirratulidae	102
Chaetozone hartmanae	173	Annelida	Polychaeta	Spionida	Cirratulidae	46
Chaetozone hedgpethi	174	Annelida	Polychaeta	Spionida	Cirratulidae	11
Chaetozone senticosa	175	Annelida	Polychaeta	Spionida	Cirratulidae	3
Chaetozone setosa Cmplx	176	Annelida	Polychaeta	Spionida	Cirratulidae	42
Chaetozone sp	177	Annelida	Polychaeta	Spionida	Cirratulidae	27
Chaetozone sp HYP1	178	Annelida	Polychaeta	Spionida	Cirratulidae	1
Chaetozone sp HYP2	179	Annelida	Polychaeta	Spionida	Cirratulidae	1
Chaetozone sp HYP3	180	Annelida	Polychaeta	Spionida	Cirratulidae	1
Chaetozone sp HYP6	181	Annelida	Polychaeta	Spionida	Cirratulidae	2
Chaetozone sp SD2	182	Annelida	Polychaeta	Spionida	Cirratulidae	4
Chaetozone sp SD3	183	Annelida	Polychaeta	Spionida	Cirratulidae	7
Chaetozone sp SD5	184	Annelida	Polychaeta	Spionida	Cirratulidae	7
Chaetozone sp SD6	185	Annelida	Polychaeta	Spionida	Cirratulidae	1
Chloeia pinnata	186	Annelida	Polychaeta	Amphinomida	Amphinomidae	49
Chone albocincta	187	Annelida	Polychaeta	Sabellida	Sabellidae	39
Chone minuta	188	Annelida	Polychaeta	Sabellida	Sabellidae	18
Chone mollis	189	Annelida	Polychaeta	Sabellida	Sabellidae	41
Chone sp	190	Annelida	Polychaeta	Sabellida	Sabellidae	11
Chone sp B	191	Annelida	Polychaeta	Sabellida	Sabellidae	33
Chone sp C	192	Annelida	Polychaeta	Sabellida	Sabellidae	30
Chone sp HYP1	193	Annelida	Polychaeta	Sabellida	Sabellidae	1
Chone sp HYP2	194	Annelida	Polychaeta	Sabellida	Sabellidae	2
Chone sp SD1	195	Annelida	Polychaeta	Sabellida	Sabellidae	1
Chone sp SD2	196	Annelida	Polychaeta	Sabellida	Sabellidae	1
Chone veleronis	197	Annelida	Polychaeta	Sabellida	Sabellidae	51
Cirratulidae	198	Annelida	Polychaeta	Spionida	Cirratulidae	72
Cirratulus sp	199	Annelida	Polychaeta	Spionida	Cirratulidae	10
Cirriformia sp	200	Annelida	Polychaeta	Spionida	Cirratulidae	4
Cirriformia sp B	201	Annelida	Polychaeta	Spionida	Cirratulidae	2
Cirriformia sp LA1	202	Annelida	Polychaeta	Spionida	Cirratulidae	2
Cirriformia sp SD1	203	Annelida	Polychaeta	Spionida	Cirratulidae	7
Cirriformia sp SD2	204	Annelida	Polychaeta	Spionida	Cirratulidae	1
Cirriformia spirabrancha	205	Annelida	Polychaeta	Spionida	Cirratulidae	1
Cirrophorus branchiatus	206	Annelida	Polychaeta	Orbiniida	Paraonidae	3
Cirrophorus furcatus	207	Annelida	Polychaeta	Orbiniida	Paraonidae	7
Clymenella complanata	208	Annelida	Polychaeta	Capitellida	Maldanidae	10
Clymenella sp	209	Annelida	Polychaeta	Capitellida	Maldanidae	2
Clymenella sp A	210	Annelida	Polychaeta	Capitellida	Maldanidae	3
Clymenura columbiana	211	Annelida	Polychaeta	Capitellida	Maldanidae	1
Clymenura gracilis	212	Annelida	Polychaeta	Capitellida	Maldanidae	34

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Cossura candida	213	Annelida	Polychaeta	Cossurida	Cossuridae	64
Cossura sp	214	Annelida	Polychaeta	Cossurida	Cossuridae	18
Cossura sp A	215	Annelida	Polychaeta	Cossurida	Cossuridae	95
Crucigera sp	216	Annelida	Polychaeta	Sabellida	Serpulidae	1
Ctenodrilus serratus	217	Annelida	Polychaeta	Ctenodrilida	Ctenodrilidae	2
Decamastus gracilis	218	Annelida	Polychaeta	Capitellida	Capitellidae	26
Demonax pallidus	219	Annelida	Polychaeta	Sabellida	Sabellidae	3
Demonax sp	220	Annelida	Polychaeta	Sabellida	Sabellidae	5
Diopatra ornata	221	Annelida	Polychaeta	Eunicida	Onuphidae	45
Diopatra sp	222	Annelida	Polychaeta	Eunicida	Onuphidae	68
Diopatra splendidissima	223	Annelida	Polychaeta	Eunicida	Onuphidae	16
Diopatra tridentata	224	Annelida	Polychaeta	Eunicida	Onuphidae	104
Diplocirrus sp SD1	225	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	41
Dipolydora barbilla	226	Annelida	Polychaeta	Spionida	Spionidae	5
Dipolydora bidentata	227	Annelida	Polychaeta	Spionida	Spionidae	43
Dipolydora giardi	228	Annelida	Polychaeta	Spionida	Spionidae	2
Dipolydora socialis	229	Annelida	Polychaeta	Spionida	Spionidae	66
Dipolydora sp	230	Annelida	Polychaeta	Spionida	Spionidae	11
Dispio uncinata	231	Annelida	Polychaeta	Spionida	Spionidae	12
Dorvillea (Dorvillea) sp	232	Annelida	Polychaeta	Eunicida	Dorvilleidae	2
Dorvillea (Schistomeringos) sp	233	Annelida	Polychaeta	Eunicida	Dorvilleidae	22
Dorvilleidae	234	Annelida	Polychaeta	Eunicida	Dorvilleidae	3
Drilonereis falcata	235	Annelida	Polychaeta	Eunicida	Oenonidae	16
Drilonereis longa	236	Annelida	Polychaeta	Eunicida	Oenonidae	5
Drilonereis mexicana	237	Annelida	Polychaeta	Eunicida	Oenonidae	11
Drilonereis nuda	238	Annelida	Polychaeta	Eunicida	Oenonidae	1
Drilonereis sp	239	Annelida	Polychaeta	Eunicida	Oenonidae	44
Drilonereis sp A	240	Annelida	Polychaeta	Eunicida	Oenonidae	11
Eclysippe trilobata	241	Annelida	Polychaeta	Terebellida	Ampharetidae	35
Ephesiella brevicapitis	242	Annelida	Polychaeta	Phyllodocida	Sphaerodoridae	15
Eranno bicirrata	243	Annelida	Polychaeta	Eunicida	Lumbrineridae	1
Eranno lagunae	244	Annelida	Polychaeta	Eunicida	Lumbrineridae	17
Eteone aestuarina	245	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	13
Eteone californica	246	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	2
Eteone fauchaldi	247	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	3
Eteone sp	248	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	2
Euchone arenae	249	Annelida	Polychaeta	Sabellida	Sabellidae	21
Euchone hancocki	250	Annelida	Polychaeta	Sabellida	Sabellidae	3
Euchone incolor	251	Annelida	Polychaeta	Sabellida	Sabellidae	68
Euchone limnicola	252	Annelida	Polychaeta	Sabellida	Sabellidae	81
Euchone rosea	253	Annelida	Polychaeta	Sabellida	Sabellidae	2
Euchone sp	254	Annelida	Polychaeta	Sabellida	Sabellidae	3
Euchone sp A	255	Annelida	Polychaeta	Sabellida	Sabellidae	15
Euchone sp LA1	256	Annelida	Polychaeta	Sabellida	Sabellidae	2
Euclymene campanula	257	Annelida	Polychaeta	Capitellida	Maldanidae	1

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Euclymeninae	258	Annelida	Polychaeta	Capitellida	Maldanidae	150
Euclymeninae sp A	259	Annelida	Polychaeta	Capitellida	Maldanidae	174
Eulalia californiensis	260	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	8
Eulalia levicornuta	261	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	14
Eulalia quadrioculata	262	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	1
Eulalia sp	263	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	7
Eumida longicornuta	264	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	22
Eunice americana	265	Annelida	Polychaeta	Eunicida	Eunicidae	43
Eunice sp	266	Annelida	Polychaeta	Eunicida	Eunicidae	2
Eunicidae	267	Annelida	Polychaeta	Eunicida	Eunicidae	9
Eupolymnia heterobranchia	268	Annelida	Polychaeta	Terebellida	Terebellidae	4
Eusyllinae	269	Annelida	Polychaeta	Phyllodocida	Syllidae	5
Eusyllis habei	270	Annelida	Polychaeta	Phyllodocida	Syllidae	8
Eusyllis sp	271	Annelida	Polychaeta	Phyllodocida	Syllidae	5
Eusyllis transecta	272	Annelida	Polychaeta	Phyllodocida	Syllidae	3
Exogone acutipalpa	273	Annelida	Polychaeta	Phyllodocida	Syllidae	3
Exogone breviseta	274	Annelida	Polychaeta	Phyllodocida	Syllidae	13
Exogone dwisula	275	Annelida	Polychaeta	Phyllodocida	Syllidae	11
Exogone lourei	276	Annelida	Polychaeta	Phyllodocida	Syllidae	96
Exogone molesta	277	Annelida	Polychaeta	Phyllodocida	Syllidae	4
Exogone sp	278	Annelida	Polychaeta	Phyllodocida	Syllidae	5
Exogone sp MEC1	279	Annelida	Polychaeta	Phyllodocida	Syllidae	2
Fabricinae	280	Annelida	Polychaeta	Sabellida	Sabellidae	3
Fabricinuda limnicola	281	Annelida	Polychaeta	Sabellida	Sabellidae	25
Fabrisabella sp A	282	Annelida	Polychaeta	Sabellida	Sabellidae	5
Fauveliopsis armata	283	Annelida	Polychaeta	Fauveliopsida	Fauveliopsidae	1
Fauveliopsis sp SD1	284	Annelida	Polychaeta	Fauveliopsida	Fauveliopsidae	2
Flabelligella sp LA1	285	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	1
Flabelligera infundibularis	286	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	1
Flabelligeridae	287	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	7
Galathowenia pygidialis	288	Annelida	Polychaeta	Oweniida	Oweniidae	3
Glycera americana	289	Annelida	Polychaeta	Phyllodocida	Glyceridae	110
Glycera capitata	290	Annelida	Polychaeta	Phyllodocida	Glyceridae	1
Glycera gigantea	291	Annelida	Polychaeta	Phyllodocida	Glyceridae	1
Glycera macrobranchia	292	Annelida	Polychaeta	Phyllodocida	Glyceridae	30
Glycera nana	293	Annelida	Polychaeta	Phyllodocida	Glyceridae	97
Glycera oxycephala	294	Annelida	Polychaeta	Phyllodocida	Glyceridae	26
Glycera sp	295	Annelida	Polychaeta	Phyllodocida	Glyceridae	11
Glycera sp LA1	296	Annelida	Polychaeta	Phyllodocida	Glyceridae	11
Glycera tenuis	297	Annelida	Polychaeta	Phyllodocida	Glyceridae	3
Glycinde armigera	298	Annelida	Polychaeta	Phyllodocida	Goniadidae	55
Goniada brunnea	299	Annelida	Polychaeta	Phyllodocida	Goniadidae	8
Goniada littorea	300	Annelida	Polychaeta	Phyllodocida	Goniadidae	41
Goniada maculata	301	Annelida	Polychaeta	Phyllodocida	Goniadidae	105
Goniada sp	302	Annelida	Polychaeta	Phyllodocida	Goniadidae	2

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Goniadidae	303	Annelida	Polychaeta	Phyllodocida	Goniadidae	1
Gymnonereis crosslandi	304	Annelida	Polychaeta	Phyllodocida	Nereididae	37
Gyptis sp	305	Annelida	Polychaeta	Phyllodocida	Hesionidae	2
Halosydna brevisetosa	306	Annelida	Polychaeta	Phyllodocida	Polynoidae	1
Halosydna johnsoni	307	Annelida	Polychaeta	Phyllodocida	Polynoidae	8
Halosydna latior	308	Annelida	Polychaeta	Phyllodocida	Polynoidae	1
Halosydna sp	309	Annelida	Polychaeta	Phyllodocida	Polynoidae	1
Harmothoe imbricata Cmplx	310	Annelida	Polychaeta	Phyllodocida	Polynoidae	14
Harmothoe sp	311	Annelida	Polychaeta	Phyllodocida	Polynoidae	4
Hemipodus borealis	312	Annelida	Polychaeta	Phyllodocida	Glyceridae	3
Hesionidae	313	Annelida	Polychaeta	Phyllodocida	Hesionidae	3
Hesionura coineaui difficilis	314	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	11
Hesperonoe complanata	315	Annelida	Polychaeta	Phyllodocida	Polynoidae	3
Hesperonoe laevis	316	Annelida	Polychaeta	Phyllodocida	Polynoidae	11
Hesperonoe sp	317	Annelida	Polychaeta	Phyllodocida	Polynoidae	2
Heteromastus filiformis	318	Annelida	Polychaeta	Capitellida	Capitellidae	1
Heteropodarke heteromorpha	319	Annelida	Polychaeta	Phyllodocida	Hesionidae	8
Heterospio catalinensis	320	Annelida	Polychaeta	Spionida	Longosomatidae	7
Hyalinoecia juvenalis	321	Annelida	Polychaeta	Eunicida	Onuphidae	16
Hyalopomatus biformis	322	Annelida	Polychaeta	Sabellida	Serpulidae	2
Hydroides pacificus	323	Annelida	Polychaeta	Sabellida	Serpulidae	1
Isocirrus longiceps	324	Annelida	Polychaeta	Capitellida	Maldanidae	2
Jasmineira sp B	325	Annelida	Polychaeta	Sabellida	Sabellidae	22
Lacydonia sp	326	Annelida	Polychaeta	Phyllodocida	Lacydoniidae	3
Lanassa gracilis	327	Annelida	Polychaeta	Terebellida	Terebellidae	1
Lanassa sp	328	Annelida	Polychaeta	Terebellida	Terebellidae	11
Lanassa venusta venusta	329	Annelida	Polychaeta	Terebellida	Terebellidae	7
Lanice conchilega	330	Annelida	Polychaeta	Terebellida	Terebellidae	35
Laonice cirrata	331	Annelida	Polychaeta	Spionida	Spionidae	77
Laonice nuchala	332	Annelida	Polychaeta	Spionida	Spionidae	29
Laonice sp	333	Annelida	Polychaeta	Spionida	Spionidae	3
Laphania sp	334	Annelida	Polychaeta	Terebellida	Terebellidae	1
Leitoscoloplos panamensis	335	Annelida	Polychaeta	Orbiniida	Orbiniidae	12
Leitoscoloplos pugettensis	336	Annelida	Polychaeta	Orbiniida	Orbiniidae	162
Leitoscoloplos sp	337	Annelida	Polychaeta	Orbiniida	Orbiniidae	5
Lepidasthenia berkeleyae	338	Annelida	Polychaeta	Phyllodocida	Polynoidae	1
Lepidasthenia longicirrata	339	Annelida	Polychaeta	Phyllodocida	Polynoidae	4
Levinsenia gracilis	340	Annelida	Polychaeta	Orbiniida	Paraonidae	56
Levinsenia multibranchiata	341	Annelida	Polychaeta	Orbiniida	Paraonidae	4
Levinsenia oculata	342	Annelida	Polychaeta	Orbiniida	Paraonidae	9
Loimia sp A	343	Annelida	Polychaeta	Terebellida	Terebellidae	3
Lumbrineridae	344	Annelida	Polychaeta	Eunicida	Lumbrineridae	142
Lumbrinerides platypygos	345	Annelida	Polychaeta	Eunicida	Lumbrineridae	22
Lumbrineris californiensis	346	Annelida	Polychaeta	Eunicida	Lumbrineridae	57
Lumbrineris cruzensis	347	Annelida	Polychaeta	Eunicida	Lumbrineridae	61

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Lumbrineris erecta	348	Annelida	Polychaeta	Eunicida	Lumbrineridae	32
Lumbrineris japonica	349	Annelida	Polychaeta	Eunicida	Lumbrineridae	31
Lumbrineris latreilli	350	Annelida	Polychaeta	Eunicida	Lumbrineridae	36
Lumbrineris limicola	351	Annelida	Polychaeta	Eunicida	Lumbrineridae	5
Lumbrineris sp	352	Annelida	Polychaeta	Eunicida	Lumbrineridae	143
Lysippe sp	353	Annelida	Polychaeta	Terebellida	Ampharetidae	1
Lysippe sp A	354	Annelida	Polychaeta	Terebellida	Ampharetidae	56
Lysippe sp B	355	Annelida	Polychaeta	Terebellida	Ampharetidae	50
Macrochaeta sp A	356	Annelida	Polychaeta	Spionida	Acrocirridae	2
Macrochaeta sp SD2	357	Annelida	Polychaeta	Spionida	Acrocirridae	2
Magelona berkeleyi	358	Annelida	Polychaeta	Spionida	Magelonidae	12
Magelona sp	359	Annelida	Polychaeta	Spionida	Magelonidae	2
Magelona sp A	360	Annelida	Polychaeta	Spionida	Magelonidae	2
Magelona sp SD10	361	Annelida	Polychaeta	Spionida	Magelonidae	4
Malacoceros indicus	362	Annelida	Polychaeta	Spionida	Spionidae	12
Maldane sarsi	363	Annelida	Polychaeta	Capitellida	Maldanidae	59
Maldanella robusta	364	Annelida	Polychaeta	Capitellida	Maldanidae	1
Maldanidae	365	Annelida	Polychaeta	Capitellida	Maldanidae	61
Maldanidae sp 1	366	Annelida	Polychaeta	Capitellida	Maldanidae	14
Maldaninae	367	Annelida	Polychaeta	Capitellida	Maldanidae	7
Malmgreniella baschi	368	Annelida	Polychaeta	Phyllodocida	Polynoidae	26
Malmgreniella macginitiei	369	Annelida	Polychaeta	Phyllodocida	Polynoidae	14
Malmgreniella sanpedroensis	370	Annelida	Polychaeta	Phyllodocida	Polynoidae	8
Malmgreniella scriptoria	371	Annelida	Polychaeta	Phyllodocida	Polynoidae	3
Malmgreniella sp	372	Annelida	Polychaeta	Phyllodocida	Polynoidae	58
Malmgreniella sp A	373	Annelida	Polychaeta	Phyllodocida	Polynoidae	23
Malmgreniella sp SD2	374	Annelida	Polychaeta	Phyllodocida	Polynoidae	1
Marphysa disjuncta	375	Annelida	Polychaeta	Eunicida	Eunicidae	16
Marphysa sp	376	Annelida	Polychaeta	Eunicida	Eunicidae	9
Marphysa sp A	377	Annelida	Polychaeta	Eunicida	Eunicidae	20
Marphysa sp HYP1	378	Annelida	Polychaeta	Eunicida	Eunicidae	1
Mediomastus acutus	379	Annelida	Polychaeta	Capitellida	Capitellidae	2
Mediomastus sp	380	Annelida	Polychaeta	Capitellida	Capitellidae	258
Megalomma pigmentum	381	Annelida	Polychaeta	Sabellida	Sabellidae	54
Megalomma sp	382	Annelida	Polychaeta	Sabellida	Sabellidae	3
Megalomma splendida	383	Annelida	Polychaeta	Sabellida	Sabellidae	1
Melinna heterodonta	384	Annelida	Polychaeta	Terebellida	Ampharetidae	4
Melinna oculata	385	Annelida	Polychaeta	Terebellida	Ampharetidae	112
Melinna sp	386	Annelida	Polychaeta	Terebellida	Ampharetidae	1
Mesochaetopterus sp	387	Annelida	Polychaeta	Spionida	Chaetopteridae	3
Metasychis disparidentatus	388	Annelida	Polychaeta	Capitellida	Maldanidae	106
Microphthalmus hystrix	389	Annelida	Polychaeta	Phyllodocida	Hesionidae	1
Microphthalmus sp	390	Annelida	Polychaeta	Phyllodocida	Hesionidae	1
Micropodarke dubia	391	Annelida	Polychaeta	Phyllodocida	Hesionidae	7
Microspio microcera	392	Annelida	Polychaeta	Spionida	Spionidae	1

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Microspio pigmentata	393	Annelida	Polychaeta	Spionida	Spionidae	34
Monticellina cryptica	394	Annelida	Polychaeta	Spionida	Cirratulidae	140
Monticellina serratiseta	395	Annelida	Polychaeta	Spionida	Cirratulidae	1
Monticellina siblina	396	Annelida	Polychaeta	Spionida	Cirratulidae	125
Monticellina sp	397	Annelida	Polychaeta	Spionida	Cirratulidae	21
Monticellina sp HYP1	398	Annelida	Polychaeta	Spionida	Cirratulidae	1
Monticellina sp SD4	399	Annelida	Polychaeta	Spionida	Cirratulidae	14
Monticellina tesselata	400	Annelida	Polychaeta	Spionida	Cirratulidae	25
Mooreonuphis exigua	401	Annelida	Polychaeta	Eunicida	Onuphidae	5
Mooreonuphis nebulosa	402	Annelida	Polychaeta	Eunicida	Onuphidae	65
Mooreonuphis segmentispadix	403	Annelida	Polychaeta	Eunicida	Onuphidae	2
Mooreonuphis sp	404	Annelida	Polychaeta	Eunicida	Onuphidae	8
Mooreonuphis sp SD1	405	Annelida	Polychaeta	Eunicida	Onuphidae	8
Mooresamytha bioculata	406	Annelida	Polychaeta	Terebellida	Ampharetidae	25
Myriochele gracilis	407	Annelida	Polychaeta	Oweniida	Oweniidae	8
Myriochele sp	408	Annelida	Polychaeta	Oweniida	Oweniidae	4
Myriochele striolata	409	Annelida	Polychaeta	Oweniida	Oweniidae	22
Myriowenia californiensis	410	Annelida	Polychaeta	Oweniida	Oweniidae	2
Mystides caeca	411	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	1
Myxicola sp	412	Annelida	Polychaeta	Sabellida	Sabellidae	5
Naineris sp	413	Annelida	Polychaeta	Orbiniida	Orbiniidae	1
Naineris sp HYP1	414	Annelida	Polychaeta	Orbiniida	Orbiniidae	1
Naineris uncinata	415	Annelida	Polychaeta	Orbiniida	Orbiniidae	4
Neanthes acuminata Cmplx	416	Annelida	Polychaeta	Phyllodocida	Nereididae	13
Neosabellaria cementarium	417	Annelida	Polychaeta	Terebellida	Sabellariidae	15
Nephtyidae	418	Annelida	Polychaeta	Phyllodocida	Nephtyidae	1
Nephtys caecoides	419	Annelida	Polychaeta	Phyllodocida	Nephtyidae	125
Nephtys californiensis	420	Annelida	Polychaeta	Phyllodocida	Nephtyidae	4
Nephtys cornuta	421	Annelida	Polychaeta	Phyllodocida	Nephtyidae	26
Nephtys ferruginea	422	Annelida	Polychaeta	Phyllodocida	Nephtyidae	88
Nephtys simoni	423	Annelida	Polychaeta	Phyllodocida	Nephtyidae	12
Nephtys sp	424	Annelida	Polychaeta	Phyllodocida	Nephtyidae	21
Nephtys sp SD2	425	Annelida	Polychaeta	Phyllodocida	Nephtyidae	1
Nephtys squamosa	426	Annelida	Polychaeta	Phyllodocida	Nephtyidae	4
Nereididae	427	Annelida	Polychaeta	Phyllodocida	Nereididae	8
Nereiphylla sp 1	428	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	12
Nereiphylla sp 3	429	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	1
Nereis latescens	430	Annelida	Polychaeta	Phyllodocida	Nereididae	2
Nereis pelagica	431	Annelida	Polychaeta	Phyllodocida	Nereididae	1
Nereis procera	432	Annelida	Polychaeta	Phyllodocida	Nereididae	108
Nereis sp	433	Annelida	Polychaeta	Phyllodocida	Nereididae	1
Nicon moniloceras	434	Annelida	Polychaeta	Phyllodocida	Nereididae	1
Ninoe tridentata	435	Annelida	Polychaeta	Eunicida	Lumbrineridae	14
Nothria sp	436	Annelida	Polychaeta	Eunicida	Onuphidae	3
Notocirrus californiensis	437	Annelida	Polychaeta	Eunicida	Oenonidae	19

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Notomastus hemipodus	438	Annelida	Polychaeta	Capitellida	Capitellidae	5
Notomastus latericeus	439	Annelida	Polychaeta	Capitellida	Capitellidae	10
Notomastus magnus	440	Annelida	Polychaeta	Capitellida	Capitellidae	15
Notomastus sp	441	Annelida	Polychaeta	Capitellida	Capitellidae	13
Notomastus sp A	442	Annelida	Polychaeta	Capitellida	Capitellidae	95
Notoproctus pacificus	443	Annelida	Polychaeta	Capitellida	Maldanidae	7
Novafabricia sp	444	Annelida	Polychaeta	Sabellida	Sabellidae	1
Odontosyllis fragilis	445	Annelida	Polychaeta	Phyllodocida	Syllidae	1
Odontosyllis phosphorea	446	Annelida	Polychaeta	Phyllodocida	Syllidae	32
Odontosyllis sp	447	Annelida	Polychaeta	Phyllodocida	Syllidae	1
Odontosyllis sp LA2	448	Annelida	Polychaeta	Phyllodocida	Syllidae	1
Oenonidae	449	Annelida	Polychaeta	Eunicida	Oenonidae	3
Onuphidae	450	Annelida	Polychaeta	Eunicida	Onuphidae	54
Onuphis eremita parva	451	Annelida	Polychaeta	Eunicida	Onuphidae	12
Onuphis iridescens	452	Annelida	Polychaeta	Eunicida	Onuphidae	7
Onuphis multiannulata	453	Annelida	Polychaeta	Eunicida	Onuphidae	3
Onuphis sp	454	Annelida	Polychaeta	Eunicida	Onuphidae	13
Onuphis sp 1	455	Annelida	Polychaeta	Eunicida	Onuphidae	99
Ophelia limacina	456	Annelida	Polychaeta	Opheliida	Opheliidae	1
Ophelia pulchella	457	Annelida	Polychaeta	Opheliida	Opheliidae	1
Opheliidae	458	Annelida	Polychaeta	Opheliida	Opheliidae	1
Ophelina acuminata	459	Annelida	Polychaeta	Opheliida	Opheliidae	8
Ophelina sp SD1	460	Annelida	Polychaeta	Opheliida	Opheliidae	2
Ophiodromus pugettensis	461	Annelida	Polychaeta	Phyllodocida	Hesionidae	9
Opisthodonta sp SD1	462	Annelida	Polychaeta	Phyllodocida	Syllidae	1
Orbiniidae	463	Annelida	Polychaeta	Orbiniida	Orbiniidae	2
Owenia collaris	464	Annelida	Polychaeta	Oweniida	Oweniidae	95
Paradiopatra parva	465	Annelida	Polychaeta	Eunicida	Onuphidae	66
Paradoneis lyra	466	Annelida	Polychaeta	Orbiniida	Paraonidae	16
Paradoneis sp	467	Annelida	Polychaeta	Orbiniida	Paraonidae	17
Paradoneis spinifera	468	Annelida	Polychaeta	Orbiniida	Paraonidae	4
Paramage scutata	469	Annelida	Polychaeta	Terebellida	Ampharetidae	117
Paranaitis polynoides	470	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	4
Parandalia fauveli	471	Annelida	Polychaeta	Phyllodocida	Pilargidae	9
Paraninoe fusca	472	Annelida	Polychaeta	Eunicida	Lumbrineridae	1
Paraonella platybranchia	473	Annelida	Polychaeta	Orbiniida	Paraonidae	2
Paraonidae	474	Annelida	Polychaeta	Orbiniida	Paraonidae	19
Paraprionospio pinnata	475	Annelida	Polychaeta	Spionida	Spionidae	270
Pareurythoe californica	476	Annelida	Polychaeta	Amphinomida	Amphinomidae	3
Parougia caeca	477	Annelida	Polychaeta	Eunicida	Dorvilleidae	7
Pectinaria californiensis	478	Annelida	Polychaeta	Terebellida	Pectinariidae	149
Petaloclymene pacifica	479	Annelida	Polychaeta	Capitellida	Maldanidae	91
Petaloproctus neoborealis	480	Annelida	Polychaeta	Capitellida	Maldanidae	2
Pherusa capulata	481	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	2
Pherusa negligens	482	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	1

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Pherusa neopapillata	483	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	26
Pherusa sp	484	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	8
Pherusa sp SD1	485	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	1
Phisidea sanctaemariae	486	Annelida	Polychaeta	Terebellida	Terebellidae	75
Phisidia sp	487	Annelida	Polychaeta	Terebellida	Terebellidae	1
Pholoe glabra	488	Annelida	Polychaeta	Phyllodocida	Pholoidae	74
Pholoides asperus	489	Annelida	Polychaeta	Phyllodocida	Pholoidae	9
Phyllochaetopterus limicolus	490	Annelida	Polychaeta	Spionida	Chaetopteridae	14
Phyllochaetopterus prolifica	491	Annelida	Polychaeta	Spionida	Chaetopteridae	16
Phyllochaetopterus sp	492	Annelida	Polychaeta	Spionida	Chaetopteridae	1
Phyllodoce cuspidata	493	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	2
Phyllodoce groenlandica	494	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	4
Phyllodoce hartmanae	495	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	79
Phyllodoce longipes	496	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	50
Phyllodoce medipapillata	497	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	4
Phyllodoce pettiboneae	498	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	88
Phyllodoce sp	499	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	11
Phyllodocidae	500	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	3
Phylo felix	501	Annelida	Polychaeta	Orbiniida	Orbiniidae	2
Pilargidae genus A sp A	502	Annelida	Polychaeta	Phyllodocida	Pilargidae	1
Pilargis berkeleyae	503	Annelida	Polychaeta	Phyllodocida	Pilargidae	8
Pilargis sp	504	Annelida	Polychaeta	Phyllodocida	Pilargidae	1
Pilargis sp 1	505	Annelida	Polychaeta	Phyllodocida	Pilargidae	7
Pionosyllis articulata	506	Annelida	Polychaeta	Phyllodocida	Syllidae	2
Pionosyllis sp	507	Annelida	Polychaeta	Phyllodocida	Syllidae	2
Pionosyllis sp SD1	508	Annelida	Polychaeta	Phyllodocida	Syllidae	4
Pionosyllis sp SD2	509	Annelida	Polychaeta	Phyllodocida	Syllidae	2
Piromis sp	510	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	1
Piromis sp A	511	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	12
Piromis sp SD1	512	Annelida	Polychaeta	Flabelligerida	Flabelligeridae	4
Pisione remota	513	Annelida	Polychaeta	Phyllodocida	Pisionidae	4
Pista agassizi	514	Annelida	Polychaeta	Terebellida	Terebellidae	147
Pista bansei	515	Annelida	Polychaeta	Terebellida	Terebellidae	43
Pista disjuncta	516	Annelida	Polychaeta	Terebellida	Terebellidae	107
Pista elongata	517	Annelida	Polychaeta	Terebellida	Terebellidae	1
Pista moorei	518	Annelida	Polychaeta	Terebellida	Terebellidae	40
Pista sp	519	Annelida	Polychaeta	Terebellida	Terebellidae	25
Plakosyllis sp	520	Annelida	Polychaeta	Phyllodocida	Syllidae	4
Platynereis bicanaliculata	521	Annelida	Polychaeta	Phyllodocida	Nereididae	20
Podarkeopsis glabrus	522	Annelida	Polychaeta	Phyllodocida	Hesionidae	44
Podarkeopsis sp A	523	Annelida	Polychaeta	Phyllodocida	Hesionidae	17
Poecilochaetus johnsoni	524	Annelida	Polychaeta	Spionida	Poecilochaetidae	46
Poecilochaetus sp	525	Annelida	Polychaeta	Spionida	Poecilochaetidae	63
Poecilochaetus sp A	526	Annelida	Polychaeta	Spionida	Poecilochaetidae	82
Polycirrinae	527	Annelida	Polychaeta	Terebellida	Terebellidae	2

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Polycirrus californicus	528	Annelida	Polychaeta	Terebellida	Terebellidae	21
Polycirrus sp	529	Annelida	Polychaeta	Terebellida	Terebellidae	46
Polycirrus sp A	530	Annelida	Polychaeta	Terebellida	Terebellidae	38
Polycirrus sp I	531	Annelida	Polychaeta	Terebellida	Terebellidae	5
Polycirrus sp III	532	Annelida	Polychaeta	Terebellida	Terebellidae	1
Polydora cirrosa	533	Annelida	Polychaeta	Spionida	Spionidae	14
Polydora cornuta	534	Annelida	Polychaeta	Spionida	Spionidae	13
Polydora limicola	535	Annelida	Polychaeta	Spionida	Spionidae	2
Polydora nuchalis	536	Annelida	Polychaeta	Spionida	Spionidae	1
Polydora sp	537	Annelida	Polychaeta	Spionida	Spionidae	11
Polynoidae	538	Annelida	Polychaeta	Phyllodocida	Polynoidae	18
Polyodontes panamensis	539	Annelida	Polychaeta	Phyllodocida	Acoetidae	6
Polyophthalmus pictus	540	Annelida	Polychaeta	Opheliida	Opheliidae	3
Potamethus sp	541	Annelida	Polychaeta	Sabellida	Sabellidae	1
Potamethus sp A	542	Annelida	Polychaeta	Sabellida	Sabellidae	21
Potamethus sp LA1	543	Annelida	Polychaeta	Sabellida	Sabellidae	3
Praxillella gracilis	544	Annelida	Polychaeta	Capitellida	Maldanidae	3
Praxillella pacifica	545	Annelida	Polychaeta	Capitellida	Maldanidae	122
Praxillura maculata	546	Annelida	Polychaeta	Capitellida	Maldanidae	9
Prionospio (Minuspio) lighti	547	Annelida	Polychaeta	Spionida	Spionidae	82
Prionospio (Minuspio) multibranchiata	548	Annelida	Polychaeta	Spionida	Spionidae	3
Prionospio (Prionospio) dubia	549	Annelida	Polychaeta	Spionida	Spionidae	77
Prionospio (Prionospio) heterobranchia	550	Annelida	Polychaeta	Spionida	Spionidae	82
Prionospio (Prionospio) jubata	551	Annelida	Polychaeta	Spionida	Spionidae	135
Prionospio (Prionospio) sp	552	Annelida	Polychaeta	Spionida	Spionidae	26
Proceraea sp	553	Annelida	Polychaeta	Phyllodocida	Syllidae	7
Procerastea sp	554	Annelida	Polychaeta	Phyllodocida	Syllidae	1
Proclea sp A	555	Annelida	Polychaeta	Terebellida	Terebellidae	4
Protocirrineris sp	556	Annelida	Polychaeta	Spionida	Cirratulidae	1
Protocirrineris sp B	557	Annelida	Polychaeta	Spionida	Cirratulidae	4
Protocirrineris sp SD1	558	Annelida	Polychaeta	Spionida	Cirratulidae	2
Protodorvillea gracilis	559	Annelida	Polychaeta	Eunicida	Dorvilleidae	11
Protodrilidae	560	Annelida	Polychaeta	Uncertain	Protodrilidae	1
Protomystides sp SD1	561	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	2
Pseudofabriciola californica	562	Annelida	Polychaeta	Sabellida	Sabellidae	1
Pseudoleiocapitella sp HYP1	563	Annelida	Polychaeta	Capitellida	Capitellidae	1
Pseudopolydora paucibranchiata	564	Annelida	Polychaeta	Spionida	Spionidae	72
Pseudopotamilla socialis	565	Annelida	Polychaeta	Sabellida	Sabellidae	1
Pseudopotamilla sp	566	Annelida	Polychaeta	Sabellida	Sabellidae	2
Pseudopotamilla sp LA1	567	Annelida	Polychaeta	Sabellida	Sabellidae	1
Pterocirrus sp A	568	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	2
Questa caudicirra	569	Annelida	Polychaeta	Orbiniida	Questidae	4

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Rhamphobrachium longisetosum	570	Annelida	Polychaeta	Eunicida	Onuphidae	14
Rhodine bitorquata	571	Annelida	Polychaeta	Capitellida	Maldanidae	28
Rhynchospio glutaea	572	Annelida	Polychaeta	Spionida	Spionidae	1
Sabellaria gracilis	573	Annelida	Polychaeta	Terebellida	Sabellariidae	2
Sabellaria nanella	574	Annelida	Polychaeta	Terebellida	Sabellariidae	2
Sabellaria sp	575	Annelida	Polychaeta	Terebellida	Sabellariidae	3
Sabellariidae	576	Annelida	Polychaeta	Terebellida	Sabellariidae	3
Sabellidae	577	Annelida	Polychaeta	Sabellida	Sabellidae	7
Sabellides manriquei	578	Annelida	Polychaeta	Terebellida	Ampharetidae	46
Sabellinae	579	Annelida	Polychaeta	Sabellida	Sabellidae	7
Saccocirrus sp	580	Annelida	Polychaeta	Uncertain	Saccocirridae	7
Salmacina sp	581	Annelida	Polychaeta	Sabellida	Serpulidae	1
Samytha californiensis	582	Annelida	Polychaeta	Terebellida	Ampharetidae	16
Scalibregma californicum	583	Annelida	Polychaeta	Opheliida	Scalibregmatidae	35
Scalibregmatidae	584	Annelida	Polychaeta	Opheliida	Scalibregmatidae	1
Schistocomus hiltoni	585	Annelida	Polychaeta	Terebellida	Ampharetidae	1
Schistocomus sp A	586	Annelida	Polychaeta	Terebellida	Ampharetidae	10
Scionella japonica	587	Annelida	Polychaeta	Terebellida	Terebellidae	1
Scolelepis occidentalis	588	Annelida	Polychaeta	Spionida	Spionidae	3
Scolelepis sp	589	Annelida	Polychaeta	Spionida	Spionidae	8
Scolelepis sp HYP1	590	Annelida	Polychaeta	Spionida	Spionidae	1
Scolelepis sp SD1	591	Annelida	Polychaeta	Spionida	Spionidae	14
Scolelepis squamata	592	Annelida	Polychaeta	Spionida	Spionidae	4
Scolelepis tridentata	593	Annelida	Polychaeta	Spionida	Spionidae	2
Scoletoma sp A	594	Annelida	Polychaeta	Eunicida	Lumbrineridae	42
Scoletoma sp B	595	Annelida	Polychaeta	Eunicida	Lumbrineridae	19
Scoletoma sp C	596	Annelida	Polychaeta	Eunicida	Lumbrineridae	80
Scoletoma tetraura Cmplx	597	Annelida	Polychaeta	Eunicida	Lumbrineridae	30
Scoloplos acmeceps	598	Annelida	Polychaeta	Orbiniida	Orbiniidae	14
Scoloplos armiger Cmplx	599	Annelida	Polychaeta	Orbiniida	Orbiniidae	30
Scoloplos sp	600	Annelida	Polychaeta	Orbiniida	Orbiniidae	1
Scyphoproctus oculatus	601	Annelida	Polychaeta	Capitellida	Capitellidae	6
Serpulidae	602	Annelida	Polychaeta	Sabellida	Serpulidae	1
Sigalion spinosus	603	Annelida	Polychaeta	Phyllodocida	Sigalionidae	68
Sigalionidae	604	Annelida	Polychaeta	Phyllodocida	Sigalionidae	1
Sigambra bassi	605	Annelida	Polychaeta	Phyllodocida	Pilargidae	2
Sigambra tentaculata	606	Annelida	Polychaeta	Phyllodocida	Pilargidae	29
Sige sp A	607	Annelida	Polychaeta	Phyllodocida	Phyllodocidae	26
Sosane occidentalis	608	Annelida	Polychaeta	Terebellida	Ampharetidae	1
Sphaerodoridium sp A	609	Annelida	Polychaeta	Phyllodocida	Sphaerodoridae	1
Sphaerodorum papillifer	610	Annelida	Polychaeta	Phyllodocida	Sphaerodoridae	1
Sphaerosyllis bilineata	611	Annelida	Polychaeta	Phyllodocida	Syllidae	2
Sphaerosyllis californiensis	612	Annelida	Polychaeta	Phyllodocida	Syllidae	8
Sphaerosyllis ranunculus	613	Annelida	Polychaeta	Phyllodocida	Syllidae	2
Sphaerosyllis sp	614	Annelida	Polychaeta	Phyllodocida	Syllidae	2

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Sphaerosyllis sp HYP1	615	Annelida	Polychaeta	Phyllodocida	Syllidae	1
Sphaerosyllis sp LA1	616	Annelida	Polychaeta	Phyllodocida	Syllidae	2
Sphaerosyllis sp LA2	617	Annelida	Polychaeta	Phyllodocida	Syllidae	2
Spinosphaera sp SD1	618	Annelida	Polychaeta	Terebellida	Terebellidae	1
Spio filicornis	619	Annelida	Polychaeta	Spionida	Spionidae	6
Spiochaetopterus costarum	620	Annelida	Polychaeta	Spionida	Chaetopteridae	159
Spionidae	621	Annelida	Polychaeta	Spionida	Spionidae	13
Spiophanes berkeleyorum	622	Annelida	Polychaeta	Spionida	Spionidae	120
Spiophanes bombyx	623	Annelida	Polychaeta	Spionida	Spionidae	91
Spiophanes duplex	624	Annelida	Polychaeta	Spionida	Spionidae	301
Spiophanes fimbriata	625	Annelida	Polychaeta	Spionida	Spionidae	86
Spiophanes sp	626	Annelida	Polychaeta	Spionida	Spionidae	16
Spiophanes wigleyi	627	Annelida	Polychaeta	Spionida	Spionidae	26
Sternaspis fossor	628	Annelida	Polychaeta	Sternaspida	Sternaspidae	104
Sthenelais sp	629	Annelida	Polychaeta	Phyllodocida	Sigalionidae	7
Sthenelais tertiaglabra	630	Annelida	Polychaeta	Phyllodocida	Sigalionidae	64
Sthenelais verruculosa	631	Annelida	Polychaeta	Phyllodocida	Sigalionidae	16
Sthenelanella uniformis	632	Annelida	Polychaeta	Phyllodocida	Sigalionidae	152
Streblosoma crassibranchia	633	Annelida	Polychaeta	Terebellida	Terebellidae	52
Streblosoma sp	634	Annelida	Polychaeta	Terebellida	Terebellidae	15
Streblosoma sp B	635	Annelida	Polychaeta	Terebellida	Terebellidae	114
Streblospio benedicti	636	Annelida	Polychaeta	Spionida	Spionidae	3
Subadyte mexicana	637	Annelida	Polychaeta	Phyllodocida	Polynoidae	3
Syllidae	638	Annelida	Polychaeta	Phyllodocida	Syllidae	2
Syllides mikeli	639	Annelida	Polychaeta	Phyllodocida	Syllidae	1
Syllides minutus	640	Annelida	Polychaeta	Phyllodocida	Syllidae	3
Syllides reishi	641	Annelida	Polychaeta	Phyllodocida	Syllidae	1
Syllides sp	642	Annelida	Polychaeta	Phyllodocida	Syllidae	2
Syllinae	643	Annelida	Polychaeta	Phyllodocida	Syllidae	2
Syllis (Ehlersia) heterochaeta	644	Annelida	Polychaeta	Phyllodocida	Syllidae	28
Syllis (Ehlersia) hyperioni	645	Annelida	Polychaeta	Phyllodocida	Syllidae	17
Syllis (Syllis) gracilis	646	Annelida	Polychaeta	Phyllodocida	Syllidae	4
Syllis (Typosyllis) farallonensis	647	Annelida	Polychaeta	Phyllodocida	Syllidae	5
Syllis (Typosyllis) nipponica	648	Annelida	Polychaeta	Phyllodocida	Syllidae	7
Syllis (Typosyllis) sp	649	Annelida	Polychaeta	Phyllodocida	Syllidae	5
Syllis (Typosyllis) sp LA1	650	Annelida	Polychaeta	Phyllodocida	Syllidae	1
Syllis (Typosyllis) sp SD1	651	Annelida	Polychaeta	Phyllodocida	Syllidae	3
Synelmis albini	652	Annelida	Polychaeta	Phyllodocida	Pilargidae	1
Tenonia priops	653	Annelida	Polychaeta	Phyllodocida	Polynoidae	56
Terebellidae	654	Annelida	Polychaeta	Terebellida	Terebellidae	71
Terebellides californica	655	Annelida	Polychaeta	Terebellida	Trichobranchidae	86
Terebellides reishi	656	Annelida	Polychaeta	Terebellida	Trichobranchidae	11
Terebellides sp	657	Annelida	Polychaeta	Terebellida	Trichobranchidae	14
Terebellides sp Type C	658	Annelida	Polychaeta	Terebellida	Trichobranchidae	11

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Terebellides sp Type D	659	Annelida	Polychaeta	Terebellida	Trichobranchidae	7
Thelepus hamatus	660	Annelida	Polychaeta	Terebellida	Terebellidae	2
Thelepus setosus	661	Annelida	Polychaeta	Terebellida	Terebellidae	2
Timarete sp	662	Annelida	Polychaeta	Spionida	Cirratulidae	3
Travisia brevis	663	Annelida	Polychaeta	Opheliida	Opheliidae	15
Travisia gigas	664	Annelida	Polychaeta	Opheliida	Opheliidae	3
Trichobranchus sp HYP1	665	Annelida	Polychaeta	Terebellida	Trichobranchidae	2
Ysideria hastata	666	Annelida	Polychaeta	Phyllodocida	Polynoidae	3
Annelida : Oligochaeta						
Oligochaeta	667	Annelida	Oligochaeta			72
Mollusca						
Mollusca	668	Mollusca				12
Mollusca : Gastropoda						
Acanthodoris rhodoceras	669	Mollusca	Gastropoda	Nudibranchia	Onchidorididae	1
Aclis occidentalis	670	Mollusca	Gastropoda	Neotaenioglossa	Aclididae	1
Acteocina carinata	671	Mollusca	Gastropoda	Cephalaspidea	Scaphandridae	1
Acteocina eximia	672	Mollusca	Gastropoda	Cephalaspidea	Scaphandridae	13
Acteocina harpa	673	Mollusca	Gastropoda	Cephalaspidea	Scaphandridae	5
Acteocina inculta	674	Mollusca	Gastropoda	Cephalaspidea	Scaphandridae	28
Acteocina sp	675	Mollusca	Gastropoda	Cephalaspidea	Scaphandridae	2
Acteon traskii	676	Mollusca	Gastropoda	Lower Heterobranchia	Acteonidae	2
Aeolidoida	677	Mollusca	Gastropoda	Nudibranchia		3
Aglaja ocelligera	678	Mollusca	Gastropoda	Cephalaspidea	Aglajidae	15
Akera sp	679	Mollusca	Gastropoda	Anaspidea	Akeridae	1
Alabina phalacra	680	Mollusca	Gastropoda	Neotaenioglossa	Obtortionidae	1
Alderia modesta	681	Mollusca	Gastropoda	Sacoglossa	Hermaeidae	1
Alia carinata	682	Mollusca	Gastropoda	Neogastropoda	Columbellidae	1
Alia sp	683	Mollusca	Gastropoda	Neogastropoda	Columbellidae	2
Alia tuberosa	684	Mollusca	Gastropoda	Neogastropoda	Columbellidae	1
Alvania compacta	685	Mollusca	Gastropoda	Neotaenioglossa	Rissoidae	1
Alvania rosana	686	Mollusca	Gastropoda	Neotaenioglossa	Rissoidae	3
Amphissa undata	687	Mollusca	Gastropoda	Neogastropoda	Columbellidae	14
Antiplanes catalinae	688	Mollusca	Gastropoda	Neogastropoda	Turridae	1
Antiplanes thalea	689	Mollusca	Gastropoda	Neogastropoda	Turridae	1
Aplysiopsis enteromorphae	690	Mollusca	Gastropoda	Sacoglossa	Stiligeridae	1
Armina californica	691	Mollusca	Gastropoda	Nudibranchia	Arminidae	6
Assiminea californica	692	Mollusca	Gastropoda	Neotaenioglossa	Assimineidae	1
Astyris aurantiaca	693	Mollusca	Gastropoda	Neogastropoda	Columbellidae	1
Astyris gausapata	694	Mollusca	Gastropoda	Neogastropoda	Columbellidae	1
Balcis micans	695	Mollusca	Gastropoda	Neotaenioglossa	Eulimidae	4
Balcis oldroydae	696	Mollusca	Gastropoda	Neotaenioglossa	Eulimidae	9
Barleeia subtenuis	697	Mollusca	Gastropoda	Neotaenioglossa	Barleeidae	2
Bulla gouldiana	698	Mollusca	Gastropoda	Cephalaspidea	Bullidae	6
Caecidae	699	Mollusca	Gastropoda	Neotaenioglossa	Caecidae	1
Caecum californicum	700	Mollusca	Gastropoda	Neotaenioglossa	Caecidae	4

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Caecum crebricinctum	701	Mollusca	Gastropoda	Neotaenioglossa	Caecidae	43
Caecum occidentale	702	Mollusca	Gastropoda	Neotaenioglossa	Caecidae	4
Calyptraea fastigiata	703	Mollusca	Gastropoda	Neotaenioglossa	Calyptraeidae	6
Calyptraeidae	704	Mollusca	Gastropoda	Neotaenioglossa	Calyptraeidae	2
Cancellaria cooperii	705	Mollusca	Gastropoda	Neogastropoda	Cancellariidae	1
Cephalaspidea	706	Mollusca	Gastropoda	Cephalaspidea		3
Cerithiopsis sp	707	Mollusca	Gastropoda	Neotaenioglossa	Cerithiopsidae	1
Columbellidae	708	Mollusca	Gastropoda	Neogastropoda	Columbellidae	1
Conidae	709	Mollusca	Gastropoda	Neogastropoda	Conidae	1
Conus californicus	710	Mollusca	Gastropoda	Neogastropoda	Conidae	2
Crepidula glottidiarum	711	Mollusca	Gastropoda	Neotaenioglossa	Calyptraeidae	13
Crepidula naticarum	712	Mollusca	Gastropoda	Neotaenioglossa	Calyptraeidae	3
Crepidula onyx	713	Mollusca	Gastropoda	Neotaenioglossa	Calyptraeidae	5
Crepidula sp	714	Mollusca	Gastropoda	Neotaenioglossa	Calyptraeidae	13
Crockerella lowei	715	Mollusca	Gastropoda	Neogastropoda	Conidae	1
Crucibulum spinosum	716	Mollusca	Gastropoda	Neotaenioglossa	Calyptraeidae	9
Cuthona divae	717	Mollusca	Gastropoda	Nudibranchia	Tergipedidae	2
Cylichna diegensis	718	Mollusca	Gastropoda	Cephalaspidea	Cylichnidae	56
Dendronotus sp	719	Mollusca	Gastropoda	Nudibranchia	Dendronotidae	2
Diaphorodoris lirulatocauda	720	Mollusca	Gastropoda	Nudibranchia	Onchidorididae	1
Doto kya	721	Mollusca	Gastropoda	Nudibranchia	Dotoidae	2
Epitonium berryi	722	Mollusca	Gastropoda	Neotaenioglossa	Epitoniidae	2
Epitonium hindsii	723	Mollusca	Gastropoda	Neotaenioglossa	Epitoniidae	1
Epitonium lowei	724	Mollusca	Gastropoda	Neotaenioglossa	Epitoniidae	2
Epitonium sawinae	725	Mollusca	Gastropoda	Neotaenioglossa	Epitoniidae	5
Epitonium sp	726	Mollusca	Gastropoda	Neotaenioglossa	Epitoniidae	11
Erato sp	727	Mollusca	Gastropoda	Neotaenioglossa	Triviidae	1
Eulima raymondi	728	Mollusca	Gastropoda	Neotaenioglossa	Eulimidae	17
Eulithidium substriatum	729	Mollusca	Gastropoda	Vetigastropoda	Turbinidae	1
Euspira lewisii	730	Mollusca	Gastropoda	Neotaenioglossa	Naticidae	1
Gastropoda	731	Mollusca	Gastropoda			22
Gastropteron pacificum	732	Mollusca	Gastropoda	Cephalaspidea	Gastropteridae	5
Granulina margaritula	733	Mollusca	Gastropoda	Neogastropoda	Marginellidae	1
Halistylus pupoideus	734	Mollusca	Gastropoda	Vetigastropoda	Trochidae	5
Haminoea vesicula	735	Mollusca	Gastropoda	Cephalaspidea	Haminoeidae	8
Iselica ovoidea	736	Mollusca	Gastropoda	Heterostropha	Pyramidellidae	2
Kurtzia arteaga	737	Mollusca	Gastropoda	Neogastropoda	Conidae	14
Kurtziella plumbea	738	Mollusca	Gastropoda	Neogastropoda	Conidae	5
Kurtzina beta	739	Mollusca	Gastropoda	Neogastropoda	Conidae	23
Lirobarleeia kelseyi	740	Mollusca	Gastropoda	Neotaenioglossa	Barleeidae	1
Lirobittium sp	741	Mollusca	Gastropoda	Neotaenioglossa	Cerithiidae	22
Margarites sp	742	Mollusca	Gastropoda	Vetigastropoda	Trochidae	1
Megalomphalus californicus	743	Mollusca	Gastropoda	Neotaenioglossa	Vanikoridae	1
Megastraea undosa	744	Mollusca	Gastropoda	Vetigastropoda	Turbinidae	1
Melanochlamys diomedea	745	Mollusca	Gastropoda	Cephalaspidea	Aglajidae	3

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Mitrella sp	746	Mollusca	Gastropoda	Neogastropoda	Columbellidae	1
Nassarius perpinguis	747	Mollusca	Gastropoda	Neogastropoda	Nassariidae	9
Nassarius tiarula	748	Mollusca	Gastropoda	Neogastropoda	Nassariidae	26
Neverita reclusiana	749	Mollusca	Gastropoda	Neotaenioglossa	Naticidae	11
Nodiscala spongiosa	750	Mollusca	Gastropoda	Neotaenioglossa	Epitoniidae	1
Notaspidea	751	Mollusca	Gastropoda	Notaspidea		1
Odostomia sp	752	Mollusca	Gastropoda	Heterostropha	Pyramidellidae	22
Olea hansineensis	753	Mollusca	Gastropoda	Sacoglossa	Oleidae	1
Olivella baetica	754	Mollusca	Gastropoda	Neogastropoda	Olividae	36
Olivella sp	755	Mollusca	Gastropoda	Neogastropoda	Olividae	4
Onchidorididae	756	Mollusca	Gastropoda	Nudibranchia	Onchidorididae	1
Ophiodermella cancellata	757	Mollusca	Gastropoda	Neogastropoda	Conidae	5
Ophiodermella inermis	758	Mollusca	Gastropoda	Neogastropoda	Conidae	14
Ophiodermella sp	759	Mollusca	Gastropoda	Neogastropoda	Conidae	3
Opisthobranchia	760	Mollusca	Gastropoda			1
Parvaplustrum sp A	761	Mollusca	Gastropoda	Architectibranchia	Hydatinidae	5
Philine auriformis	762	Mollusca	Gastropoda	Cephalaspidea	Philinidae	39
Philine californica	763	Mollusca	Gastropoda	Cephalaspidea	Philinidae	1
Philine sp	764	Mollusca	Gastropoda	Cephalaspidea	Philinidae	7
Philine sp A	765	Mollusca	Gastropoda	Cephalaspidea	Philinidae	20
Pleurobranchaea californica	766	Mollusca	Gastropoda	Notaspidea	Pleurobranchidae	3
Polygireulima rutila	767	Mollusca	Gastropoda	Neotaenioglossa	Eulimidae	14
Psammodoris thompsoni	768	Mollusca	Gastropoda	Nudibranchia	Corambidae	1
Rictaxis punctocaelatus	769	Mollusca	Gastropoda	Lower Heterobranchia	Acteonidae	48
Rissoella sp SD1	770	Mollusca	Gastropoda	Heterostropha	Rissoellidae	1
Scaphandridae	771	Mollusca	Gastropoda	Cephalaspidea	Scaphandridae	1
Sinum scopulosum	772	Mollusca	Gastropoda	Neotaenioglossa	Naticidae	3
Skenea coronadoensis	773	Mollusca	Gastropoda	Heterostropha	Pyramidellidae	1
Solariella peramabilis	774	Mollusca	Gastropoda	Vetigastropoda	Trochidae	9
Sulcoretusa xystrum	775	Mollusca	Gastropoda	Cephalaspidea	Retusidae	7
Tectura depicta	776	Mollusca	Gastropoda	Patellogastropoda	Acmaeidae	2
Teinostoma supravallatum	777	Mollusca	Gastropoda	Neotaenioglossa	Adeorbidae	1
Terebra hemphilli	778	Mollusca	Gastropoda	Neogastropoda	Terebridae	1
Terebra pedroana	779	Mollusca	Gastropoda	Neogastropoda	Terebridae	1
Tritonia sp	780	Mollusca	Gastropoda	Nudibranchia	Tritoniidae	2
Trivia californiana	781	Mollusca	Gastropoda	Neotaenioglossa	Triviidae	1
Turbinidae	782	Mollusca	Gastropoda	Vetigastropoda	Turbinidae	1
Turbonilla sp	783	Mollusca	Gastropoda	Heterostropha	Pyramidellidae	66
Turbonilla sp A	784	Mollusca	Gastropoda	Heterostropha	Pyramidellidae	10
Vitreolina macra	785	Mollusca	Gastropoda	Neotaenioglossa	Eulimidae	1
Vitreolina yod	786	Mollusca	Gastropoda	Neotaenioglossa	Eulimidae	1
Vitrinella oldroydi	787	Mollusca	Gastropoda	Neotaenioglossa	Vitrinellidae	10
Volvulella californica	788	Mollusca	Gastropoda	Cephalaspidea	Retusidae	9
Volvulella catharia	789	Mollusca	Gastropoda	Cephalaspidea	Retusidae	4
Volvulella cylindrica	790	Mollusca	Gastropoda	Cephalaspidea	Retusidae	6

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Volvulella panamica	791	Mollusca	Gastropoda	Cephalaspidea	Retusidae	63
Volvulella sp	792	Mollusca	Gastropoda	Cephalaspidea	Retusidae	2
Mollusca : Aplacophora						
Chaetodermatidae	793	Mollusca	Aplacophora	Chaetodermatida	Chaetodermatidae	36
Heathia porosa	794	Mollusca	Aplacophora	Pholidoskepia	Dondersiidae	1
Limifossor fratula	795	Mollusca	Aplacophora	Limifossorida	Limifossoridae	2
Mollusca : Polyplacophora						
Lepidozona sp	796	Mollusca	Polyplacophora	Neoloricata	Ischnochitonidae	2
Leptochiton rugatus	797	Mollusca	Polyplacophora	Neoloricata	Leptochitonidae	5
Polyplacophora	798	Mollusca	Polyplacophora			1
Mollusca : Bivalvia						
Acila castrensis	799	Mollusca	Bivalvia	Nuculoida	Nuculidae	5
Adontorhina cyclia	800	Mollusca	Bivalvia	Veneroida	Thyasiridae	5
Adula sp	801	Mollusca	Bivalvia	Mytiloida	Mytilidae	1
Americardia biangulata	802	Mollusca	Bivalvia	Veneroida	Cardiidae	1
Amygdalum politum	803	Mollusca	Bivalvia	Mytiloida	Mytilidae	67
Anadara multicostata	804	Mollusca	Bivalvia	Arcoida	Arcidae	1
Argopecten ventricosus	805	Mollusca	Bivalvia	Ostreoida	Pectinidae	4
Asthenothaerus diegensis	806	Mollusca	Bivalvia	Pholadomyoida	Thraciidae	30
Axinopsida serricata	807	Mollusca	Bivalvia	Veneroida	Thyasiridae	64
Bivalvia	808	Mollusca	Bivalvia			121
Cardiomya pectinata	809	Mollusca	Bivalvia	Septibranchida	Cuspidariidae	3
Caryocorbula porcella	810	Mollusca	Bivalvia	Myoida	Corbulidae	2
Chama arcana	811	Mollusca	Bivalvia	Veneroida	Chamidae	1
Chione californiensis	812	Mollusca	Bivalvia	Veneroida	Veneridae	2
Chione sp	813	Mollusca	Bivalvia	Veneroida	Veneridae	2
Chione undatella	814	Mollusca	Bivalvia	Veneroida	Veneridae	6
Compsomyax subdiaphana	815	Mollusca	Bivalvia	Veneroida	Veneridae	98
Cooperella subdiaphana	816	Mollusca	Bivalvia	Veneroida	Petricolidae	59
Crenella decussata	817	Mollusca	Bivalvia	Mytiloida	Mytilidae	2
Cryptomya californica	818	Mollusca	Bivalvia	Myoida	Myidae	16
Cumingia californica	819	Mollusca	Bivalvia	Veneroida	Semelidae	13
Cuspidaria parapodema	820	Mollusca	Bivalvia	Septibranchida	Cuspidariidae	3
Cyathodonta pedroana	821	Mollusca	Bivalvia	Pholadomyoida	Thraciidae	1
Cyclocardia sp	822	Mollusca	Bivalvia	Veneroida	Carditidae	7
Cyclopecten catalinensis	823	Mollusca	Bivalvia	Ostreoida	Propeamussidae	1
Cymatioa electilis	824	Mollusca	Bivalvia	Veneroida	Lasaeidae	1
Diplodonta orbella	825	Mollusca	Bivalvia	Veneroida	Ungulinidae	1
Diplodonta sericata	826	Mollusca	Bivalvia	Veneroida	Ungulinidae	6
Divariscintilla sp A	827	Mollusca	Bivalvia	Veneroida	Galeommatidae	1
Ennucula tenuis	828	Mollusca	Bivalvia	Nuculoida	Nuculidae	18
Ensis myrae	829	Mollusca	Bivalvia	Veneroida	Pharidae	41
Eucrassatella fluctuata	830	Mollusca	Bivalvia	Veneroida	Crassatellidae	1
Gari sp	831	Mollusca	Bivalvia	Veneroida	Psammobiidae	4
Grippina californica	832	Mollusca	Bivalvia	Myoida	Spheniopsidae	2

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Hiatella arctica	833	Mollusca	Bivalvia	Myoida	Hiatellidae	18
Huxleyia munita	834	Mollusca	Bivalvia	Nuculoida	Nucinellidae	11
Irusella lamellifera	835	Mollusca	Bivalvia	Veneroida	Veneridae	1
Isorobitella trigonalis	836	Mollusca	Bivalvia	Veneroida	Lasaeidae	2
Juliacorbula luteola	837	Mollusca	Bivalvia	Myoida	Corbulidae	4
Kellia suborbicularis	838	Mollusca	Bivalvia	Veneroida	Lasaeidae	5
Laevicardium substriatum	839	Mollusca	Bivalvia	Veneroida	Cardiidae	23
Lasaeidae	840	Mollusca	Bivalvia	Veneroida	Lasaeidae	1
Leporimetis obesa	841	Mollusca	Bivalvia	Veneroida	Tellinidae	3
Leptopecten latiauratus	842	Mollusca	Bivalvia	Ostreoida	Pectinidae	36
Limaria hemphilli	843	Mollusca	Bivalvia	Limoida	Limidae	5
Limatula saturna	844	Mollusca	Bivalvia	Limoida	Limidae	11
Lucinisca nuttalli	845	Mollusca	Bivalvia	Veneroida	Lucinidae	6
Lucinoma annulatum	846	Mollusca	Bivalvia	Veneroida	Lucinidae	10
Lyonsia californica	847	Mollusca	Bivalvia	Pholadomyoida	Lyonsiidae	76
Lyonsiidae	848	Mollusca	Bivalvia	Pholadomyoida	Lyonsiidae	17
Macoma indentata	849	Mollusca	Bivalvia	Veneroida	Tellinidae	2
Macoma nasuta	850	Mollusca	Bivalvia	Veneroida	Tellinidae	18
Macoma sp	851	Mollusca	Bivalvia	Veneroida	Tellinidae	21
Macoma yoldiformis	852	Mollusca	Bivalvia	Veneroida	Tellinidae	87
Mactridae	853	Mollusca	Bivalvia	Veneroida	Mactridae	7
Mactromeris hemphilli	854	Mollusca	Bivalvia	Veneroida	Mactridae	3
Mactrotoma californica	855	Mollusca	Bivalvia	Veneroida	Mactridae	28
Modiolus capax	856	Mollusca	Bivalvia	Mytiloida	Mytilidae	6
Modiolus neglectus	857	Mollusca	Bivalvia	Mytiloida	Mytilidae	1
Modiolus rectus	858	Mollusca	Bivalvia	Mytiloida	Mytilidae	11
Modiolus sp	859	Mollusca	Bivalvia	Mytiloida	Mytilidae	81
Musculista senhousia	860	Mollusca	Bivalvia	Mytiloida	Mytilidae	60
Myidae sp SD1	861	Mollusca	Bivalvia	Myoida	Myidae	1
Mysella sp C	862	Mollusca	Bivalvia	Veneroida	Lasaeidae	2
Mytilus sp	863	Mollusca	Bivalvia	Mytiloida	Mytilidae	6
Neaeromya rugifera	864	Mollusca	Bivalvia	Veneroida	Lasaeidae	1
Nemocardium centifilosum	865	Mollusca	Bivalvia	Veneroida	Cardiidae	43
Neolepton salmonea	866	Mollusca	Bivalvia	Veneroida	Bernardinidae	1
Nucula carlottensis	867	Mollusca	Bivalvia	Nuculoida	Nuculidae	1
Nuculana elenensis	868	Mollusca	Bivalvia	Nuculoida	Nuculanidae	12
Nuculana hamata	869	Mollusca	Bivalvia	Nuculoida	Nuculanidae	10
Nuculana penderi	870	Mollusca	Bivalvia	Nuculoida	Nuculanidae	9
Nuculana taphria	871	Mollusca	Bivalvia	Nuculoida	Nuculanidae	91
Nutricola cymata	872	Mollusca	Bivalvia	Veneroida	Veneridae	3
Nutricola lordi	873	Mollusca	Bivalvia	Veneroida	Veneridae	3
Nutricola sp	874	Mollusca	Bivalvia	Veneroida	Veneridae	1
Nutricola tantilla	875	Mollusca	Bivalvia	Veneroida	Veneridae	3
Orobitella californica	876	Mollusca	Bivalvia	Veneroida	Lasaeidae	2
Ostrea sp	877	Mollusca	Bivalvia	Ostreoida	Ostreidae	3

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Pandora bilirata	878	Mollusca	Bivalvia	Pholadomyoida	Pandoridae	8
Panopea abrupta	879	Mollusca	Bivalvia	Myoida	Hiatellidae	1
Parvilucina tenuisculpta	880	Mollusca	Bivalvia	Veneroida	Lucinidae	131
Periploma discus	881	Mollusca	Bivalvia	Pholadomyoida	Periplomatidae	32
Petricola carditoides	882	Mollusca	Bivalvia	Veneroida	Petricolidae	1
Pitar newcombianus	883	Mollusca	Bivalvia	Veneroida	Veneridae	5
Poromya sp	884	Mollusca	Bivalvia	Septibranchida	Poromyidae	1
Pristes sp	885	Mollusca	Bivalvia	Veneroida	Lasaeidae	1
Protothaca laciniata	886	Mollusca	Bivalvia	Veneroida	Veneridae	1
Protothaca sp	887	Mollusca	Bivalvia	Veneroida	Veneridae	7
Protothaca staminea	888	Mollusca	Bivalvia	Veneroida	Veneridae	17
Pseudochama granti	889	Mollusca	Bivalvia	Veneroida	Chamidae	1
Rhamphidonta retifera	890	Mollusca	Bivalvia	Veneroida	Lasaeidae	4
Rochefortia coani	891	Mollusca	Bivalvia	Veneroida	Lasaeidae	13
Rochefortia compressa	892	Mollusca	Bivalvia	Veneroida	Lasaeidae	7
Rochefortia grippi	893	Mollusca	Bivalvia	Veneroida	Lasaeidae	31
Rochefortia mortoni	894	Mollusca	Bivalvia	Veneroida	Lasaeidae	26
Rochefortia sp	895	Mollusca	Bivalvia	Veneroida	Lasaeidae	1
Rochefortia tumida	896	Mollusca	Bivalvia	Veneroida	Lasaeidae	107
Saxicavella nybakkeni	897	Mollusca	Bivalvia	Myoida	Hiatellidae	29
Saxicavella pacifica	898	Mollusca	Bivalvia	Myoida	Hiatellidae	7
Saxicavella sp	899	Mollusca	Bivalvia	Myoida	Hiatellidae	2
Saxidomus nuttalli	900	Mollusca	Bivalvia	Veneroida	Veneridae	7
Semele venusta	901	Mollusca	Bivalvia	Veneroida	Semelidae	5
Siliqua lucida	902	Mollusca	Bivalvia	Veneroida	Pharidae	35
Simomactra falcata	903	Mollusca	Bivalvia	Veneroida	Mactridae	6
Simomactra planulata	904	Mollusca	Bivalvia	Veneroida	Mactridae	10
Simomactra sp	905	Mollusca	Bivalvia	Veneroida	Mactridae	1
Solamen columbianum	906	Mollusca	Bivalvia	Mytiloida	Mytilidae	30
Solemya reidi	907	Mollusca	Bivalvia	Solemyoida	Solemyidae	11
Solen rostriformis	908	Mollusca	Bivalvia	Veneroida	Solenidae	43
Solen sicarius	909	Mollusca	Bivalvia	Veneroida	Solenidae	75
Sphenia luticola	910	Mollusca	Bivalvia	Myoida	Myidae	3
Tagelus subteres	911	Mollusca	Bivalvia	Veneroida	Solecurtidae	62
Tellina bodegensis	912	Mollusca	Bivalvia	Veneroida	Tellinidae	1
Tellina cadieni	913	Mollusca	Bivalvia	Veneroida	Tellinidae	19
Tellina carpenteri	914	Mollusca	Bivalvia	Veneroida	Tellinidae	147
Tellina idae	915	Mollusca	Bivalvia	Veneroida	Tellinidae	7
Tellina meropsis	916	Mollusca	Bivalvia	Veneroida	Tellinidae	15
Tellina modesta	917	Mollusca	Bivalvia	Veneroida	Tellinidae	76
Tellina nuculoides	918	Mollusca	Bivalvia	Veneroida	Tellinidae	1
Tellina sp	919	Mollusca	Bivalvia	Veneroida	Tellinidae	2
Tellina sp HYP1	920	Mollusca	Bivalvia	Veneroida	Tellinidae	1
Theora lubrica	921	Mollusca	Bivalvia	Veneroida	Semelidae	111
Thracia curta	922	Mollusca	Bivalvia	Pholadomyoida	Thraciidae	3

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Thracia sp	923	Mollusca	Bivalvia	Pholadomyoida	Thraciidae	4
Thracia trapezoides	924	Mollusca	Bivalvia	Pholadomyoida	Thraciidae	5
Thyasira flexuosa	925	Mollusca	Bivalvia	Veneroida	Thyasiridae	53
Thyasiridae sp LA1	926	Mollusca	Bivalvia	Veneroida	Thyasiridae	2
Trachycardium quadragenarium	927	Mollusca	Bivalvia	Veneroida	Cardiidae	10
Tresus nuttallii	928	Mollusca	Bivalvia	Veneroida	Mactridae	1
Trigonulina pacifica	929	Mollusca	Bivalvia	Septibranchida	Verticordiidae	4
Veneridae	930	Mollusca	Bivalvia	Veneroida	Veneridae	3
Venerupis philippinarum	931	Mollusca	Bivalvia	Veneroida	Veneridae	9
Mollusca : Scaphopoda						
Antalis pretiosum	932	Mollusca	Scaphopoda	Dentaliida	Dentaliidae	1
Cadulus aberrans	933	Mollusca	Scaphopoda	Gadilida	Gadilidae	96
Dentalium vallicolens	934	Mollusca	Scaphopoda	Dentaliida	Dentaliidae	6
Rhabdus rectius	935	Mollusca	Scaphopoda	Dentaliida	Laevidentaliidae	2
Scaphopoda	936	Mollusca	Scaphopoda			26
Siphonodentalium quadrifissatum	937	Mollusca	Scaphopoda	Gadilida	Siphonodentaliidae	77
Arthropoda : Pycnogonida						
Ammothea hilgendorfi	938	Arthropoda	Pycnogonida	Pegmata	Ammotheidae	1
Anoplodactylus californicus	939	Arthropoda	Pycnogonida	Pegmata	Phoxichilidiidae	1
Anoplodactylus erectus	940	Arthropoda	Pycnogonida	Pegmata	Phoxichilidiidae	56
Anoplodactylus nodosus	941	Arthropoda	Pycnogonida	Pegmata	Phoxichilidiidae	3
Anoplodactylus sp	942	Arthropoda	Pycnogonida	Pegmata	Phoxichilidiidae	1
Anoropallene palpida	943	Arthropoda	Pycnogonida	Pegmata	Callipallenidae	8
Callipallene pacifica	944	Arthropoda	Pycnogonida	Pegmata	Callipallenidae	4
Prototrygaeus jordanae	945	Arthropoda	Pycnogonida	Pegmata	Ammotheidae	6
Pycnogonida	946	Arthropoda	Pycnogonida			1
Arthropoda : Ostracoda						
Asteropella slatteryi	947	Arthropoda	Ostracoda	Myodocopida	Cylindroleberididae	20
Bathyleberis sp	948	Arthropoda	Ostracoda	Myodocopida	Cylindroleberididae	9
Cylindroleberididae	949	Arthropoda	Ostracoda	Myodocopida	Cylindroleberididae	1
Euphilomedes carcharodonta	950	Arthropoda	Ostracoda	Myodocopida	Philomedidae	176
Euphilomedes producta	951	Arthropoda	Ostracoda	Myodocopida	Philomedidae	13
Eusarsiella sp A	952	Arthropoda	Ostracoda	Myodocopida	Sarsiellidae	2
Eusarsiella thominx	953	Arthropoda	Ostracoda	Myodocopida	Sarsiellidae	5
Harbansus mayeri	954	Arthropoda	Ostracoda	Myodocopida	Philomedidae	1
Harbansus sp SD1	955	Arthropoda	Ostracoda	Myodocopida	Philomedidae	1
Leuroleberis sharpei	956	Arthropoda	Ostracoda	Myodocopida	Cylindroleberididae	26
Ostracoda	957	Arthropoda	Ostracoda			2
Philomedes dentata	958	Arthropoda	Ostracoda	Myodocopida	Philomedidae	1
Philomedes sp A	959	Arthropoda	Ostracoda	Myodocopida	Philomedidae	2
Podocopida	960	Arthropoda	Ostracoda	Podocopida		2
Postasterope barnesi	961	Arthropoda	Ostracoda	Myodocopida	Cylindroleberididae	7
Rutiderma hartmanni	962	Arthropoda	Ostracoda	Myodocopida	Rutidermatidae	1
Rutiderma judayi	963	Arthropoda	Ostracoda	Myodocopida	Rutidermatidae	2

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Rutiderma lomae	964	Arthropoda	Ostracoda	Myodocopida	Rutidermatidae	14
Rutiderma rostratum	965	Arthropoda	Ostracoda	Myodocopida	Rutidermatidae	7
Scleroconcha trituberculata	966	Arthropoda	Ostracoda	Myodocopida	Philomedidae	2
Vargula tsujii	967	Arthropoda	Ostracoda	Myodocopida	Cypridinidae	5
Xenoleberis californica	968	Arthropoda	Ostracoda	Myodocopida	Cylindroleberididae	13
Arthropoda : Copepoda						
Harpacticoida	969	Arthropoda	Copepoda	Harpacticoida		5
Arthropoda : Cirripedia						
Hamatoscalpellum californicum	970	Arthropoda	Cirripedia	Thoracica	Scalpellidae	17
Arthropoda : Leptostraca						
Nebalia daytoni	971	Arthropoda	Malacostraca	Leptostraca	Nebaliidae	33
Nebalia pugettensis Cmplx	972	Arthropoda	Malacostraca	Leptostraca	Nebaliidae	8
Arthropoda : Stomatopoda						
Hemisquilla ensigera californiensis	973	Arthropoda	Malacostraca	Stomatopoda	Hemisquillidae	4
Schmittius politus	974	Arthropoda	Malacostraca	Stomatopoda	Squillidae	11
Stomatopoda	975	Arthropoda	Malacostraca	Stomatopoda		1
Arthropoda : Mysidacea						
Alienacanthomysis macropsis	976	Arthropoda	Malacostraca	Mysidacea	Mysidae	18
Archaeomysis grebnitzkii	977	Arthropoda	Malacostraca	Mysidacea	Mysidae	1
Cubanomysis mysteriosa	978	Arthropoda	Malacostraca	Mysidacea	Mysidae	1
Deltamysis sp A	979	Arthropoda	Malacostraca	Mysidacea	Mysidae	4
Exacanthomysis davisi	980	Arthropoda	Malacostraca	Mysidacea	Mysidae	5
Heteromysis odontops	981	Arthropoda	Malacostraca	Mysidacea	Mysidae	7
Metamysidopsis elongata	982	Arthropoda	Malacostraca	Mysidacea	Mysidae	15
Mysidacea	983	Arthropoda	Malacostraca	Mysidacea		12
Mysidella americana	984	Arthropoda	Malacostraca	Mysidacea	Mysidae	4
Mysidopsis californica	985	Arthropoda	Malacostraca	Mysidacea	Mysidae	4
Mysidopsis cathengelae	986	Arthropoda	Malacostraca	Mysidacea	Mysidae	2
Mysidopsis cf onofrensis	987	Arthropoda	Malacostraca	Mysidacea	Mysidae	1
Mysidopsis intii	988	Arthropoda	Malacostraca	Mysidacea	Mysidae	13
Mysidopsis sp	989	Arthropoda	Malacostraca	Mysidacea	Mysidae	1
Neomysis kadiakensis	990	Arthropoda	Malacostraca	Mysidacea	Mysidae	8
Pacifacanthomysis nephrophthalma	991	Arthropoda	Malacostraca	Mysidacea	Mysidae	8
Pseudomma berkeleyi	992	Arthropoda	Malacostraca	Mysidacea	Mysidae	2
Arthropoda : Cumacea						
Anchicolurus occidentalis	993	Arthropoda	Malacostraca	Cumacea	Diastylidae	13
Campylaspis blakei	994	Arthropoda	Malacostraca	Cumacea	Nannastacidae	1
Campylaspis canaliculata	995	Arthropoda	Malacostraca	Cumacea	Nannastacidae	5
Campylaspis cf maculinodulosa	996	Arthropoda	Malacostraca	Cumacea	Nannastacidae	1
Campylaspis hartae	997	Arthropoda	Malacostraca	Cumacea	Nannastacidae	1
Campylaspis rubromaculata	998	Arthropoda	Malacostraca	Cumacea	Nannastacidae	10
Campylaspis rufa	999	Arthropoda	Malacostraca	Cumacea	Nannastacidae	3
Cumacea	1000	Arthropoda	Malacostraca	Cumacea		5

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Cumella californica	1001	Arthropoda	Malacostraca	Cumacea	Nannastacidae	2
Cumella sp	1002	Arthropoda	Malacostraca	Cumacea	Nannastacidae	3
Cyclaspis nubila	1003	Arthropoda	Malacostraca	Cumacea	Bodotriidae	4
Cyclaspis sp	1004	Arthropoda	Malacostraca	Cumacea	Bodotriidae	1
Cyclaspis sp A	1005	Arthropoda	Malacostraca	Cumacea	Bodotriidae	6
Cyclaspis sp C	1006	Arthropoda	Malacostraca	Cumacea	Bodotriidae	2
Diastylidae	1007	Arthropoda	Malacostraca	Cumacea	Diastylidae	1
Diastylis californica	1008	Arthropoda	Malacostraca	Cumacea	Diastylidae	17
Diastylis crenellata	1009	Arthropoda	Malacostraca	Cumacea	Diastylidae	16
Diastylis pellucida	1010	Arthropoda	Malacostraca	Cumacea	Diastylidae	5
Diastylopsis tenuis	1011	Arthropoda	Malacostraca	Cumacea	Diastylidae	44
Eudorella pacifica	1012	Arthropoda	Malacostraca	Cumacea	Leuconidae	22
Eudorellopsis longirostris	1013	Arthropoda	Malacostraca	Cumacea	Leuconidae	1
Glyphocuma sp A	1014	Arthropoda	Malacostraca	Cumacea	Bodotriidae	6
Glyphocuma sp LA1	1015	Arthropoda	Malacostraca	Cumacea	Bodotriidae	1
Hemilamprops californicus	1016	Arthropoda	Malacostraca	Cumacea	Lampropidae	50
Lamprops carinatus	1017	Arthropoda	Malacostraca	Cumacea	Lampropidae	3
Lamprops quadriplicatus	1018	Arthropoda	Malacostraca	Cumacea	Lampropidae	3
Leptocuma forsmani	1019	Arthropoda	Malacostraca	Cumacea	Bodotriidae	7
Leptostylis calva	1020	Arthropoda	Malacostraca	Cumacea	Diastylidae	20
Leucon subnasica	1021	Arthropoda	Malacostraca	Cumacea	Leuconidae	2
Mesolamprops bispinosus	1022	Arthropoda	Malacostraca	Cumacea	Lampropidae	8
Nannastacidae	1023	Arthropoda	Malacostraca	Cumacea	Nannastacidae	1
Oxyurostylis pacifica	1024	Arthropoda	Malacostraca	Cumacea	Diastylidae	38
Oxyurostylis tertia	1025	Arthropoda	Malacostraca	Cumacea	Diastylidae	1
Procampylaspis caenosa	1026	Arthropoda	Malacostraca	Cumacea	Nannastacidae	24
Vaunthompsonia sp	1027	Arthropoda	Malacostraca	Cumacea	Bodotriidae	2
Arthropoda : Tanaidacea						
Araphura breviaria	1028	Arthropoda	Malacostraca	Tanaidacea	Anarthruridae	16
Araphura cuspirostris	1029	Arthropoda	Malacostraca	Tanaidacea	Anarthruridae	7
Araphura sp	1030	Arthropoda	Malacostraca	Tanaidacea	Anarthruridae	1
Chauliopleona dentata	1031	Arthropoda	Malacostraca	Tanaidacea	Anarthruridae	4
Imitapseudes glebosus	1032	Arthropoda	Malacostraca	Tanaidacea	Apseudidae	1
Leptochelia dubia	1033	Arthropoda	Malacostraca	Tanaidacea	Leptocheliidae	88
Pseudotanais californiensis	1034	Arthropoda	Malacostraca	Tanaidacea	Pseudotanaidae	1
Pseudotanais makrothrix	1035	Arthropoda	Malacostraca	Tanaidacea	Pseudotanaidae	2
Scoloura phillipsi	1036	Arthropoda	Malacostraca	Tanaidacea	Anarthruridae	1
Siphonolabrum californiensis	1037	Arthropoda	Malacostraca	Tanaidacea	Anarthruridae	1
Synaptotanais notabilis	1038	Arthropoda	Malacostraca	Tanaidacea	Tanaidae	24
Tanaella propinquus	1039	Arthropoda	Malacostraca	Tanaidacea	Anarthruridae	3
Tanaidacea	1040	Arthropoda	Malacostraca	Tanaidacea		9
Tanaopsis cadieni	1041	Arthropoda	Malacostraca	Tanaidacea	Anarthruridae	6
Typhlotanais crassus	1042	Arthropoda	Malacostraca	Tanaidacea	Typhlotanaidae	3
Typhlotanais williamsi	1043	Arthropoda	Malacostraca	Tanaidacea	Typhlotanaidae	1

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Arthropoda : Isopoda						
Amakusanthura californiensis	1044	Arthropoda	Malacostraca	Isopoda	Anthuridae	6
Ancinus granulatus	1045	Arthropoda	Malacostraca	Isopoda	Ancinidae	2
Bathycopea daltonae	1046	Arthropoda	Malacostraca	Isopoda	Ancinidae	1
Caecianiropsis sp	1047	Arthropoda	Malacostraca	Isopoda	Janiridae	3
Edotia sp	1048	Arthropoda	Malacostraca	Isopoda	Idoteidae	1
Edotia sp B	1049	Arthropoda	Malacostraca	Isopoda	Idoteidae	9
Edotia sp SD1	1050	Arthropoda	Malacostraca	Isopoda	Idoteidae	2
Edotia sublittoralis	1051	Arthropoda	Malacostraca	Isopoda	Idoteidae	35
Eurydice caudata	1052	Arthropoda	Malacostraca	Isopoda	Cirolanidae	10
Excirolana linguifrons	1053	Arthropoda	Malacostraca	Isopoda	Cirolanidae	1
Exosphaeroma rhomburum	1054	Arthropoda	Malacostraca	Isopoda	Sphaeromatidae	3
Gnathiidae	1055	Arthropoda	Malacostraca	Isopoda	Gnathiidae	114
Haliophasma geminatum	1056	Arthropoda	Malacostraca	Isopoda	Anthuridae	49
Heteroserolis carinata	1057	Arthropoda	Malacostraca	Isopoda	Serolidae	36
Idarcturus allelomorphus	1058	Arthropoda	Malacostraca	Isopoda	Arcturidae	5
Isopoda	1059	Arthropoda	Malacostraca	Isopoda		1
Janiralata sp	1060	Arthropoda	Malacostraca	Isopoda	Janiridae	1
Joeropsididae	1061	Arthropoda	Malacostraca	Isopoda	Joeropsididae	1
Joeropsis concava	1062	Arthropoda	Malacostraca	Isopoda	Joeropsididae	1
Joeropsis dubia	1063	Arthropoda	Malacostraca	Isopoda	Joeropsididae	3
Kupellonura sp	1064	Arthropoda	Malacostraca	Isopoda	Hyssuridae	1
Munnogonium tillerae	1065	Arthropoda	Malacostraca	Isopoda	Paramunnidae	4
Neastacilla californica	1066	Arthropoda	Malacostraca	Isopoda	Arcturidae	14
Paracerceis sculpta	1067	Arthropoda	Malacostraca	Isopoda	Sphaeromatidae	7
Paranthura elegans	1068	Arthropoda	Malacostraca	Isopoda	Paranthuridae	10
Pleurogonium sp	1069	Arthropoda	Malacostraca	Isopoda	Paramunnidae	2
Sphaeromatidae	1070	Arthropoda	Malacostraca	Isopoda	Sphaeromatidae	1
Synidotea magnifica	1071	Arthropoda	Malacostraca	Isopoda	Idoteidae	2
Synidotea media	1072	Arthropoda	Malacostraca	Isopoda	Idoteidae	1
Synidotea sp	1073	Arthropoda	Malacostraca	Isopoda	Idoteidae	1
Uromunna ubiquita	1074	Arthropoda	Malacostraca	Isopoda	Munnidae	1
Arthropoda : Amphipoda						
Acidostoma hancocki	1075	Arthropoda	Malacostraca	Amphipoda	Lysianassidae	3
Americhelidium rectipalmum	1076	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	23
Ampelisca agassizi	1077	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	67
Ampelisca brachycladus	1078	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	26
Ampelisca brevisimulata	1079	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	143
Ampelisca careyi	1080	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	58
Ampelisca cristata cristata	1081	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	21
Ampelisca cristata microdentata	1082	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	70
Ampelisca cucullata	1083	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	1
Ampelisca hancocki Cmplx	1084	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	26
Ampelisca indentata	1085	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	46

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Ampelisca milleri	1086	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	4
Ampelisca pacifica	1087	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	62
Ampelisca pugetica	1088	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	76
Ampelisca romigi	1089	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	3
Ampelisca sp	1090	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	33
Ampeliscidae	1091	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	1
Ampelisciphotis podophthalma	1092	Arthropoda	Malacostraca	Amphipoda	Isaeidae	15
Amphideutopus oculatus	1093	Arthropoda	Malacostraca	Amphipoda	Isaeidae	163
Ampithoe plumulosa	1094	Arthropoda	Malacostraca	Amphipoda	Ampithoidae	1
Anonyx lilljeborgi	1095	Arthropoda	Malacostraca	Amphipoda	Lysianassidae	2
Aoridae	1096	Arthropoda	Malacostraca	Amphipoda	Aoridae	2
Aoroides columbiae	1097	Arthropoda	Malacostraca	Amphipoda	Aoridae	1
Aoroides exilis	1098	Arthropoda	Malacostraca	Amphipoda	Aoridae	3
Aoroides inermis	1099	Arthropoda	Malacostraca	Amphipoda	Aoridae	4
Aoroides intermedia	1100	Arthropoda	Malacostraca	Amphipoda	Aoridae	2
Aoroides secundus	1101	Arthropoda	Malacostraca	Amphipoda	Aoridae	1
Aoroides sp	1102	Arthropoda	Malacostraca	Amphipoda	Aoridae	10
Aoroides sp A	1103	Arthropoda	Malacostraca	Amphipoda	Aoridae	2
Aoroides spinosa	1104	Arthropoda	Malacostraca	Amphipoda	Aoridae	8
Apolochus barnardi	1105	Arthropoda	Malacostraca	Amphipoda	Amphilochidae	3
Argissa hamatipes	1106	Arthropoda	Malacostraca	Amphipoda	Argissidae	12
Aruga holmesi	1107	Arthropoda	Malacostraca	Amphipoda	Lysianassidae	3
Aruga oculata	1108	Arthropoda	Malacostraca	Amphipoda	Lysianassidae	4
Atylus tridens	1109	Arthropoda	Malacostraca	Amphipoda	Dexaminidae	1
Batea transversa	1110	Arthropoda	Malacostraca	Amphipoda	Bateidae	1
Bathymedon pumilus	1111	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	6
Bemlos audbettius	1112	Arthropoda	Malacostraca	Amphipoda	Aoridae	3
Bemlos concavus	1113	Arthropoda	Malacostraca	Amphipoda	Aoridae	1
Bemlos macromanus	1114	Arthropoda	Malacostraca	Amphipoda	Aoridae	7
Bemlos sp	1115	Arthropoda	Malacostraca	Amphipoda	Aoridae	4
Byblis millsi	1116	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	62
Byblis veleronis	1117	Arthropoda	Malacostraca	Amphipoda	Ampeliscidae	2
Caprella californica	1118	Arthropoda	Malacostraca	Amphipoda	Caprellidae	11
Caprella equilibra	1119	Arthropoda	Malacostraca	Amphipoda	Caprellidae	9
Caprella gracilior	1120	Arthropoda	Malacostraca	Amphipoda	Caprellidae	2
Caprella mendax	1121	Arthropoda	Malacostraca	Amphipoda	Caprellidae	10
Caprella natalensis	1122	Arthropoda	Malacostraca	Amphipoda	Caprellidae	1
Caprella sp	1123	Arthropoda	Malacostraca	Amphipoda	Caprellidae	5
Caprellidea	1124	Arthropoda	Malacostraca	Amphipoda		2
Cerapus tubularis Cmplx	1125	Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	36
Chromopleustes oculatus	1126	Arthropoda	Malacostraca	Amphipoda	Pleustidae	1
Corophium sp	1127	Arthropoda	Malacostraca	Amphipoda	Corophiidae	27
Deflexilodes norvegicus	1128	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	35
Elasmopus bampo	1129	Arthropoda	Malacostraca	Amphipoda	Melitidae	4
Elasmopus sp 1	1130	Arthropoda	Malacostraca	Amphipoda	Melitidae	1

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Eobrolgus chumashi	1131	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	4
Eobrolgus spinosus	1132	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	1
Eochelidium sp A	1133	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	10
Eohaustorius barnardi	1134	Arthropoda	Malacostraca	Amphipoda	Haustoriidae	7
Ericthonius brasiliensis	1135	Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	31
Ericthonius rubricornis	1136	Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	2
Ericthonius sp	1137	Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	3
Ericthonius sp SD1	1138	Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	2
Eyakia robusta	1139	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	4
Foxiphalus golfensis	1140	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	12
Foxiphalus obtusidens	1141	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	59
Foxiphalus similis	1142	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	19
Foxiphalus sp	1143	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	1
Gammaridea	1144	Arthropoda	Malacostraca	Amphipoda		21
Gammaropsis ociosa	1145	Arthropoda	Malacostraca	Amphipoda	Isaeidae	1
Gammaropsis sp	1146	Arthropoda	Malacostraca	Amphipoda	Isaeidae	3
Gammaropsis spinosa	1147	Arthropoda	Malacostraca	Amphipoda	Isaeidae	1
Gammaropsis thompsoni	1148	Arthropoda	Malacostraca	Amphipoda	Isaeidae	18
Garosyrrhoe bigarra	1149	Arthropoda	Malacostraca	Amphipoda	Synopiidae	1
Gibberosus myersi	1150	Arthropoda	Malacostraca	Amphipoda	Megaluropidae	30
Gitana calitemplado	1151	Arthropoda	Malacostraca	Amphipoda	Amphilochidae	2
Grandidierella japonica	1152	Arthropoda	Malacostraca	Amphipoda	Aoridae	20
Guernea reduncans	1153	Arthropoda	Malacostraca	Amphipoda	Dexaminidae	3
Halicoides synopiae	1154	Arthropoda	Malacostraca	Amphipoda	Pardaliscidae	7
Harpiniopsis galera	1155	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	1
Hartmanodes hartmanae	1156	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	56
Hartmanodes murrius	1157	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	1
Hartmanodes sp	1158	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	1
Hemiproto sp A	1159	Arthropoda	Malacostraca	Amphipoda	Phtiscidae	14
Heterophoxus affinis	1160	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	1
Heterophoxus ellisi	1161	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	19
Heterophoxus oculatus	1162	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	95
Heterophoxus sp	1163	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	22
Hippomedon columbianus	1164	Arthropoda	Malacostraca	Amphipoda	Lysianassidae	2
Hippomedon granulosus	1165	Arthropoda	Malacostraca	Amphipoda	Lysianassidae	1
Hippomedon sp A	1166	Arthropoda	Malacostraca	Amphipoda	Lysianassidae	4
Hippomedon zetesimus	1167	Arthropoda	Malacostraca	Amphipoda	Lysianassidae	12
Hornellia occidentalis	1168	Arthropoda	Malacostraca	Amphipoda	Melitidae	2
Hyale sp	1169	Arthropoda	Malacostraca	Amphipoda	Hyalidae	2
Isaeidae	1170	Arthropoda	Malacostraca	Amphipoda	Isaeidae	3
Ischyrocerus anguipes	1171	Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	1
Ischyrocerus pelagops	1172	Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	1
Ischyrocerus sp	1173	Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	1
Lepidepecreum gurjanovae	1174	Arthropoda	Malacostraca	Amphipoda	Lysianassidae	2
Lepidepecreum serraculum	1175	Arthropoda	Malacostraca	Amphipoda	Lysianassidae	1

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Liljeborgia geminata	1176	Arthropoda	Malacostraca	Amphipoda	Liljeborgiidae	1
Liljeborgia sp	1177	Arthropoda	Malacostraca	Amphipoda	Liljeborgiidae	1
Liljeborgiidae	1178	Arthropoda	Malacostraca	Amphipoda	Liljeborgiidae	1
Listriella diffusa	1179	Arthropoda	Malacostraca	Amphipoda	Liljeborgiidae	2
Listriella eriopisa	1180	Arthropoda	Malacostraca	Amphipoda	Liljeborgiidae	4
Listriella goleta	1181	Arthropoda	Malacostraca	Amphipoda	Liljeborgiidae	72
Listriella melanica	1182	Arthropoda	Malacostraca	Amphipoda	Liljeborgiidae	33
Listriella sp	1183	Arthropoda	Malacostraca	Amphipoda	Liljeborgiidae	4
Listriella sp A	1184	Arthropoda	Malacostraca	Amphipoda	Liljeborgiidae	3
Maera similis	1185	Arthropoda	Malacostraca	Amphipoda	Melitidae	7
Mandibulophoxus gilesi	1186	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	3
Mayerella acanthopoda	1187	Arthropoda	Malacostraca	Amphipoda	Protellidae	30
Mayerella banksia	1188	Arthropoda	Malacostraca	Amphipoda	Protellidae	31
Megaluropidae sp A	1189	Arthropoda	Malacostraca	Amphipoda	Megaluropidae	8
Melita sulca	1190	Arthropoda	Malacostraca	Amphipoda	Melitidae	1
Melphisana bola Cmplx	1191	Arthropoda	Malacostraca	Amphipoda	Melphidippidae	14
Metaphoxus frequens	1192	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	11
Metatiron tropakis	1193	Arthropoda	Malacostraca	Amphipoda	Synopiidae	9
Metharpinia coronadoi	1194	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	1
Metharpinia jonesi	1195	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	4
Metopa dawsoni	1196	Arthropoda	Malacostraca	Amphipoda	Stenothoidae	7
Metopella aporpis	1197	Arthropoda	Malacostraca	Amphipoda	Stenothoidae	2
Microjassa litotes	1198	Arthropoda	Malacostraca	Amphipoda	Ischyroceridae	2
Micropleustes nautilus	1199	Arthropoda	Malacostraca	Amphipoda	Pleustidae	1
Monoculodes emarginatus	1200	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	2
Monoculodes sp	1201	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	1
Monoculodes sp SD1	1202	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	8
Najna kitamati	1203	Arthropoda	Malacostraca	Amphipoda	Najnidae	1
Nasagenia quinsana	1204	Arthropoda	Malacostraca	Amphipoda	Eusiridae	1
Nicippe tumida	1205	Arthropoda	Malacostraca	Amphipoda	Pardaliscidae	20
Oedicerotidae	1206	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	8
Orchomene anaquelus	1207	Arthropoda	Malacostraca	Amphipoda	Lysianassidae	2
Orchomene decipiens	1208	Arthropoda	Malacostraca	Amphipoda	Lysianassidae	1
Pachynus barnardi	1209	Arthropoda	Malacostraca	Amphipoda	Lysianassidae	3
Paracaprella sp	1210	Arthropoda	Malacostraca	Amphipoda	Caprellidae	3
Paradexamine sp SD1	1211	Arthropoda	Malacostraca	Amphipoda	Dexaminidae	21
Parametaphoxus quaylei	1212	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	1
Paramicrodeutopus schmitti	1213	Arthropoda	Malacostraca	Amphipoda	Aoridae	4
Peramphithoe sp	1214	Arthropoda	Malacostraca	Amphipoda	Ampithoidae	1
Photis bifurcata	1215	Arthropoda	Malacostraca	Amphipoda	Isaeidae	3
Photis brevipes	1216	Arthropoda	Malacostraca	Amphipoda	Isaeidae	54
Photis californica	1217	Arthropoda	Malacostraca	Amphipoda	Isaeidae	34
Photis lacia	1218	Arthropoda	Malacostraca	Amphipoda	Isaeidae	17
Photis linearmanus	1219	Arthropoda	Malacostraca	Amphipoda	Isaeidae	1
Photis macinerneyi	1220	Arthropoda	Malacostraca	Amphipoda	Isaeidae	5

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Photis parvidons	1221	Arthropoda	Malacostraca	Amphipoda	Isaeidae	5
Photis sp	1222	Arthropoda	Malacostraca	Amphipoda	Isaeidae	36
Photis sp B	1223	Arthropoda	Malacostraca	Amphipoda	Isaeidae	1
Photis sp C	1224	Arthropoda	Malacostraca	Amphipoda	Isaeidae	11
Photis sp OC1	1225	Arthropoda	Malacostraca	Amphipoda	Isaeidae	13
Phoxocephalidae	1226	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	8
Pleustidae	1227	Arthropoda	Malacostraca	Amphipoda	Pleustidae	2
Pleusym tes subglaber	1228	Arthropoda	Malacostraca	Amphipoda	Pleustidae	1
Podocerus brasiliensis	1229	Arthropoda	Malacostraca	Amphipoda	Podoceridae	1
Podocerus cristatus	1230	Arthropoda	Malacostraca	Amphipoda	Podoceridae	7
Podocerus fulanus	1231	Arthropoda	Malacostraca	Amphipoda	Podoceridae	13
Pontogeneia rostrata	1232	Arthropoda	Malacostraca	Amphipoda	Eusiridae	1
Prachynella lodo	1233	Arthropoda	Malacostraca	Amphipoda	Lysianassidae	3
Protomedeia articulata Cmplx	1234	Arthropoda	Malacostraca	Amphipoda	Isaeidae	14
Rhachotropis sp A	1235	Arthropoda	Malacostraca	Amphipoda	Eusiridae	4
Rhepoxynius abronius	1236	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	10
Rhepoxynius bicuspidatus	1237	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	65
Rhepoxynius daboius	1238	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	5
Rhepoxynius fatigans	1239	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	1
Rhepoxynius heterocuspidatus	1240	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	13
Rhepoxynius lucubrans	1241	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	11
Rhepoxynius menziesi	1242	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	71
Rhepoxynius sp	1243	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	5
Rhepoxynius sp A	1244	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	2
Rhepoxynius stenodes	1245	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	30
Rhepoxynius variatus	1246	Arthropoda	Malacostraca	Amphipoda	Phoxocephalidae	10
Rudilemboides sp	1247	Arthropoda	Malacostraca	Amphipoda	Aoridae	27
Rudilemboides sp A	1248	Arthropoda	Malacostraca	Amphipoda	Aoridae	13
Rudilemboides sp HYP1	1249	Arthropoda	Malacostraca	Amphipoda	Aoridae	1
Rudilemboides stenopropodus	1250	Arthropoda	Malacostraca	Amphipoda	Aoridae	41
Sinocorophium cf heteroceratum	1251	Arthropoda	Malacostraca	Amphipoda	Corophiidae	8
Stenothoe estacola	1252	Arthropoda	Malacostraca	Amphipoda	Stenothoidae	1
Stenothoe frecanda	1253	Arthropoda	Malacostraca	Amphipoda	Stenothoidae	1
Stenothoides bicoma	1254	Arthropoda	Malacostraca	Amphipoda	Stenothoidae	5
Synchelidium sp	1255	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	40
Tiburonella viscana	1256	Arthropoda	Malacostraca	Amphipoda	Platyischnopidae	4
Tiron biocellata	1257	Arthropoda	Malacostraca	Amphipoda	Synopiidae	9
Tiron sp	1258	Arthropoda	Malacostraca	Amphipoda	Synopiidae	1
Tritella sp	1259	Arthropoda	Malacostraca	Amphipoda	Protellidae	1
Urothoe varvarini	1260	Arthropoda	Malacostraca	Amphipoda	Urothoidae	13
Westwoodilla caecula	1261	Arthropoda	Malacostraca	Amphipoda	Oedicerotidae	72
Arthropoda : Decapoda						
Alpheidae	1262	Arthropoda	Malacostraca	Decapoda	Alpheidae	2

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Alpheopsis equidactylus	1263	Arthropoda	Malacostraca	Decapoda	Alpheidae	2
Alpheus bellimanus	1264	Arthropoda	Malacostraca	Decapoda	Alpheidae	2
Alpheus californiensis	1265	Arthropoda	Malacostraca	Decapoda	Alpheidae	9
Alpheus sp	1266	Arthropoda	Malacostraca	Decapoda	Alpheidae	1
Ambidexter panamensis	1267	Arthropoda	Malacostraca	Decapoda	Processidae	5
Anomura	1268	Arthropoda	Malacostraca	Decapoda		1
Betaeus ensenadensis	1269	Arthropoda	Malacostraca	Decapoda	Alpheidae	1
Betaeus harrimani	1270	Arthropoda	Malacostraca	Decapoda	Alpheidae	1
Blepharipoda occidentalis	1271	Arthropoda	Malacostraca	Decapoda	Albuneidae	4
Brachyura	1272	Arthropoda	Malacostraca	Decapoda		3
Calocarides spinulicauda	1273	Arthropoda	Malacostraca	Decapoda	Axiidae	2
Cancer gracilis	1274	Arthropoda	Malacostraca	Decapoda	Cancridae	4
Cancer jordani	1275	Arthropoda	Malacostraca	Decapoda	Cancridae	3
Cancer productus	1276	Arthropoda	Malacostraca	Decapoda	Cancridae	1
Cancer sp	1277	Arthropoda	Malacostraca	Decapoda	Cancridae	13
Crangon nigricauda	1278	Arthropoda	Malacostraca	Decapoda	Crangonidae	1
Crangon nigromaculata	1279	Arthropoda	Malacostraca	Decapoda	Crangonidae	2
Crangon sp	1280	Arthropoda	Malacostraca	Decapoda	Crangonidae	1
Crangonidae	1281	Arthropoda	Malacostraca	Decapoda	Crangonidae	3
Decapoda	1282	Arthropoda	Malacostraca	Decapoda		14
Deilocerus decorus	1283	Arthropoda	Malacostraca	Decapoda	Cyclodorippidae	7
Deilocerus planus	1284	Arthropoda	Malacostraca	Decapoda	Cyclodorippidae	18
Deilocerus sp	1285	Arthropoda	Malacostraca	Decapoda	Cyclodorippidae	2
Enallopaguropsis guatemoci	1286	Arthropoda	Malacostraca	Decapoda	Paguridae	1
Erileptus spinosus	1287	Arthropoda	Malacostraca	Decapoda	Majidae	7
Eualus sp	1288	Arthropoda	Malacostraca	Decapoda	Hippolytidae	1
Fabia subquadrata	1289	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	1
Heterocrypta occidentalis	1290	Arthropoda	Malacostraca	Decapoda	Parthenopidae	22
Lepidopa californica	1291	Arthropoda	Malacostraca	Decapoda	Albuneidae	2
Lophopanopeus bellus	1292	Arthropoda	Malacostraca	Decapoda	Xanthidae	3
Lophopanopeus leucomanus	1293	Arthropoda	Malacostraca	Decapoda	Xanthidae	1
Lophopanopeus sp	1294	Arthropoda	Malacostraca	Decapoda	Xanthidae	3
Majidae	1295	Arthropoda	Malacostraca	Decapoda	Majidae	9
Malacoplax californiensis	1296	Arthropoda	Malacostraca	Decapoda	Xanthidae	4
Mesocrangon munitella	1297	Arthropoda	Malacostraca	Decapoda	Crangonidae	2
Natantia	1298	Arthropoda	Malacostraca	Decapoda		1
Naushonia macginitiei	1299	Arthropoda	Malacostraca	Decapoda	Laomediidae	3
Neocrangon zacae	1300	Arthropoda	Malacostraca	Decapoda	Crangonidae	2
Neotrypaea californiensis	1301	Arthropoda	Malacostraca	Decapoda	Callianassidae	32
Neotrypaea gigas	1302	Arthropoda	Malacostraca	Decapoda	Callianassidae	1
Neotrypaea sp	1303	Arthropoda	Malacostraca	Decapoda	Callianassidae	10
Ogyrides sp A	1304	Arthropoda	Malacostraca	Decapoda	Ogyrididae	8
Orthopagurus minimus	1305	Arthropoda	Malacostraca	Decapoda	Paguridae	1
Paguridae	1306	Arthropoda	Malacostraca	Decapoda	Paguridae	3
Paguristes parvus	1307	Arthropoda	Malacostraca	Decapoda	Diogenidae	1

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Paguristes sp HYP1	1308	Arthropoda	Malacostraca	Decapoda	Diogenidae	1
Paguristes ulreyi	1309	Arthropoda	Malacostraca	Decapoda	Diogenidae	1
Paguroidea	1310	Arthropoda	Malacostraca	Decapoda		1
Pagurus sp	1311	Arthropoda	Malacostraca	Decapoda	Paguridae	2
Palaemonella holmesi	1312	Arthropoda	Malacostraca	Decapoda	Palaemonidae	1
Parapagurodes hartae	1313	Arthropoda	Malacostraca	Decapoda	Paguridae	1
Parapagurodes laurentae	1314	Arthropoda	Malacostraca	Decapoda	Paguridae	3
Penaeidae	1315	Arthropoda	Malacostraca	Decapoda	Penaeidae	1
Petrolisthes cinctipes	1316	Arthropoda	Malacostraca	Decapoda	Porcellanidae	1
Pinnixa barnharti	1317	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	1
Pinnixa forficulimanus	1318	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	2
Pinnixa franciscana	1319	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	14
Pinnixa hiatus	1320	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	2
Pinnixa longipes	1321	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	11
Pinnixa occidentalis	1322	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	40
Pinnixa schmitti	1323	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	2
Pinnixa sp	1324	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	42
Pinnixa tubicola	1325	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	3
Pinnotheridae	1326	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	15
Platymera gaudichaudii	1327	Arthropoda	Malacostraca	Decapoda	Calappidae	3
Podochela hemphillii	1328	Arthropoda	Malacostraca	Decapoda	Majidae	2
Portunus xantusii	1329	Arthropoda	Malacostraca	Decapoda	Portunidae	1
Pylopagurus holmesi	1330	Arthropoda	Malacostraca	Decapoda	Paguridae	3
Pyromaia tuberculata	1331	Arthropoda	Malacostraca	Decapoda	Majidae	22
Randallia ornata	1332	Arthropoda	Malacostraca	Decapoda	Leucosiidae	18
Scleroplax granulata	1333	Arthropoda	Malacostraca	Decapoda	Pinnotheridae	29
Solenocera mutator	1334	Arthropoda	Malacostraca	Decapoda	Solenoceridae	2
Spirontocaris prionota	1335	Arthropoda	Malacostraca	Decapoda	Hippolytidae	1
Thalassinidea	1336	Arthropoda	Malacostraca	Decapoda		1
Upogebia sp	1337	Arthropoda	Malacostraca	Decapoda	Upogebiidae	5
Xanthidae	1338	Arthropoda	Malacostraca	Decapoda	Xanthidae	1
			Sipuncula			
Apionsoma misakianum	1339	Sipuncula	Phascolo-somatidea	Phascolo-somatiformes	Phascolosomatidae	34
Golfingiidae	1340	Sipuncula	Sipunculidea	Golfingiiformes	Golfingiidae	4
Nephasoma sp	1341	Sipuncula	Sipunculidea	Golfingiiformes	Golfingiidae	4
Phascolion sp A	1342	Sipuncula	Sipunculidea	Golfingiiformes	Phascolionidae	22
Siphonosoma ingens	1343	Sipuncula	Sipunculidea	Sipunculiformes	Sipunculidae	8
Sipuncula	1344	Sipuncula				29
Sipuncula sp SD2	1345	Sipuncula				2
Sipunculidae	1346	Sipuncula	Sipunculidea	Sipunculiformes	Sipunculidae	3
Sipunculus nudus	1347	Sipuncula	Sipunculidea	Sipunculiformes	Sipunculidae	3
Thysanocardia nigra	1348	Sipuncula	Sipunculidea	Golfingiiformes	Golfingiidae	34
			Echiura			
Arhynchite californicus	1349	Echiura	Echiurida	Echiuroinea	Thalassematidae	1
Echiura	1350	Echiura				1

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Listriolobus pelodes	1351	Echiura	Echiurida	Echiuroinea	Thalassematidae	63
			Phoronida			
Phoronida	1352	Phorona		Phoronida		224
			Brachiopoda			
Glottidia albida	1353	Brachiopoda	Inarticulata	Lingulida	Lingulidae	103
			Echinodermata : Asteroidea			
Asteroidea	1354	Echinodermata	Asteroidea			10
Astropecten armatus	1355	Echinodermata	Asteroidea	Paxillosida	Astropectinidae	2
Astropecten ornatissimus	1356	Echinodermata	Asteroidea	Paxillosida	Astropectinidae	3
Astropecten sp	1357	Echinodermata	Asteroidea	Paxillosida	Astropectinidae	13
Astropecten verrilli	1358	Echinodermata	Asteroidea	Paxillosida	Astropectinidae	7
			Echinodermata : Ophiuroidea			
Amphichondrius granulatus	1359	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	22
Amphiodia digitata	1360	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	61
Amphiodia psara	1361	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	18
Amphiodia sp	1362	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	126
Amphiodia urtica	1363	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	173
Amphioplus macraspis	1364	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	2
Amphioplus sp	1365	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	5
Amphioplus sp LA1	1366	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	40
Amphioplus strongyloplax	1367	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	9
Amphipholis pugetana	1368	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	8
Amphipholis sp	1369	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	2
Amphipholis squamata	1370	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	103
Amphiura arcystata	1371	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	54
Amphiuridae	1372	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	150
Dougaloplus amphacanthus	1373	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	14
Dougaloplus sp 1	1374	Echinodermata	Ophiuroidea	Ophiurida	Amphiuridae	2
Ophiopsila californica	1375	Echinodermata	Ophiuroidea	Ophiurida	Ophiocomidae	3
Ophiothrix spiculata	1376	Echinodermata	Ophiuroidea	Ophiurida	Ophiotricidae	5
Ophiura luetkenii	1377	Echinodermata	Ophiuroidea	Ophiurida	Ophiuridae	4
Ophiuroconis bispinosa	1378	Echinodermata	Ophiuroidea	Ophiurida	Ophiodermatidae	29
Ophiuroidea	1379	Echinodermata	Ophiuroidea			35
			Echinodermata : Echinoidea			
Brisaster latifrons	1380	Echinodermata	Echinoidea	Spatangoida	Schizasteridae	3
Brissopsis pacifica	1381	Echinodermata	Echinoidea	Spatangoida	Brissidae	6
Dendraster excentricus	1382	Echinodermata	Echinoidea	Clypeasteroida	Dendrasteridae	1
Dendraster sp	1383	Echinodermata	Echinoidea	Clypeasteroida	Dendrasteridae	5
Dendraster terminalis	1384	Echinodermata	Echinoidea	Clypeasteroida	Dendrasteridae	10
Echinoidea	1385	Echinodermata	Echinoidea			13
Lovenia cordiformis	1386	Echinodermata	Echinoidea	Spatangoida	Loveniidae	18
Lytechinus pictus	1387	Echinodermata	Echinoidea	Temnopleuroida	Toxopneustidae	23
Spatangoida	1388	Echinodermata	Echinoidea	Spatangoida		1
Spatangus californicus	1389	Echinodermata	Echinoidea	Spatangoida	Spatangidae	2
Strongylocentrotus franciscanus	1390	Echinodermata	Echinoidea	Echinoida	Strongylocentrotidae	8

Taxon Name	Taxon No.	Phylum	Class	Order	Family	Sites
Echinodermata : Holothuroidea						
Chiridota sp	1391	Echinodermata	Holothuroidea	Apodida	Chiridotidae	25
Dendrochirotida	1392	Echinodermata	Holothuroidea	Dendrochirotida		7
Havelockia benti	1393	Echinodermata	Holothuroidea	Dendrochirotida	Phyllophoridae	9
Holothuroidea	1394	Echinodermata	Holothuroidea			6
Leptosynapta sp	1395	Echinodermata	Holothuroidea	Apodida	Synaptidae	93
Molpadia intermedia	1396	Echinodermata	Holothuroidea	Molpadida	Molpadiidae	10
Pachythyone rubra	1397	Echinodermata	Holothuroidea	Dendrochirotida	Sclerodactylidae	1
Paracaudina chilensis	1398	Echinodermata	Holothuroidea	Molpadida	Caudinidae	2
Pentamera lissoplaca	1399	Echinodermata	Holothuroidea	Dendrochirotida	Phyllophoridae	1
Pentamera populifera	1400	Echinodermata	Holothuroidea	Dendrochirotida	Phyllophoridae	4
Pentamera pseudopopulifera	1401	Echinodermata	Holothuroidea	Dendrochirotida	Phyllophoridae	6
Pentamera sp	1402	Echinodermata	Holothuroidea	Dendrochirotida	Phyllophoridae	6
Phyllophoridae	1403	Echinodermata	Holothuroidea	Dendrochirotida	Phyllophoridae	11
Synaptidae	1404	Echinodermata	Holothuroidea	Apodida	Synaptidae	1
Hemichordata						
Enteropneusta	1405	Chordata	Enteropneusta			88
Chordata : Ascidiacea						
Agnezia septentrionalis	1406	Chordata	Ascidiacea	Phlebobranchiata	Agneziidae	7
Ascidiacea	1407	Chordata	Ascidiacea			14
Cnemidocarpa rhizopus	1408	Chordata	Ascidiacea	Stolidobranchiata	Styelidae	3
Eugyra arenosa californica	1409	Chordata	Ascidiacea	Stolidobranchiata	Molgulidae	3
Microcosmus squamiger	1410	Chordata	Ascidiacea	Stolidobranchiata	Pyuridae	2
Molgula pugetiensis	1411	Chordata	Ascidiacea	Stolidobranchiata	Molgulidae	1
Molgula regularis	1412	Chordata	Ascidiacea	Stolidobranchiata	Molgulidae	1
Molgula sp	1413	Chordata	Ascidiacea	Stolidobranchiata	Molgulidae	13
Stolidobranchiata	1414	Chordata	Ascidiacea	Stolidobranchiata		1
Styela plicata	1415	Chordata	Ascidiacea	Stolidobranchiata	Styelidae	1
Chordata : Cephalochordata						
Branchiostoma californiense	1416	Chordata	Cephalo-chordata	Amphioxiformes	Branchiostomatidae	6

Appendix I

Species List with Occurrence and Abundance Information

Names are listed in decreasing order of occurrence and abundance at 321 random sites in U.S. waters. Occurrences indicate the percentage of sites at which the taxon occurred. Abundances are area-weighted means m^{-2}. The taxon number is provided for easy cross-reference with taxonomic information in Appendix H. Occ.: occurrences; Abun.: Abundance.

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Mediomastus sp	380	74.1	76.617	81.0	387.747	69.4	55.498	71.7	72.045
Spiophanes duplex	624	71.3	542.926	48.8	26.283	83.7	237.247	88.7	987.343
Paraprionospio pinnata	475	67.6	57.260	57.9	43.050	80.3	72.836	54.7	38.736
Phoronida	1352	62.6	69.059	52.1	43.227	72.1	87.382	60.4	48.198
Tubulanus polymorphus	79	60.1	22.901	64.5	33.055	62.6	24.515	43.4	19.799
Leitoscoloplos pugettensis	336	48.9	12.870	85.1	199.375	31.3	4.794	15.1	4.255
Lineidae	63	47.4	17.886	29.8	3.625	59.9	13.200	52.8	25.344
Euphilomedes carcharodonta	950	45.2	19.768	53.7	83.450	42.2	9.534	34.0	26.411
Spiochaetopterus costarum	620	44.9	43.018	23.1	3.334	53.1	15.637	71.7	82.155
Amphideutopus oculatus	1093	43.6	27.021	58.7	167.826	36.7	18.180	28.3	24.034
Euclymeninae	258	43.0	37.775	28.1	34.455	46.9	29.116	66.0	49.212
Pista agassizi	514	42.4	15.135	65.3	109.783	36.1	18.876	7.5	0.714
Euclymeninae sp A	259	41.7	48.775	12.4	13.391	56.5	41.593	67.9	61.582
Lumbrineridae	344	41.7	16.531	58.7	170.994	31.3	7.027	32.1	13.004
Amphiodia urtica	1363	38.9	126.902	19.0	6.081	55.8	218.354	37.7	21.954
Lumbrineris sp	352	38.0	12.245	57.9	93.303	23.8	8.003	32.1	9.437
Parvilucina tenuisculpta	880	36.8	30.714	11.6	1.090	46.9	14.457	66.0	54.568
Amphiodia sp	1362	36.1	57.189	11.6	1.751	59.2	102.528	28.3	4.704
Sthenelanella uniformis	632	35.8	45.006	14.0	3.026	43.5	21.019	64.2	80.026
Monticellina cryptica	394	35.5	23.341	17.4	4.315	53.1	36.984	28.3	7.788
Ampelisca brevisimulata	1079	34.0	17.538	5.8	1.526	51.7	22.408	49.1	12.924
Theora lubrica	921	34.0	12.218	85.1	275.225	4.1	0.882		
Bivalvia	808	34.0	10.579	33.1	12.224	35.4	15.784	32.1	3.739
Spiophanes berkeleyorum	622	33.3	26.470	12.4	3.448	45.6	14.380	47.2	44.310
Pectinaria californiensis	478	32.4	31.308	14.0	2.848	52.4	55.231	18.9	3.534
Glycera americana	289	32.4	2.423	61.2	14.751	13.6	2.256	18.9	1.383
Monticellina siblina	396	32.1	13.456	37.2	23.363	30.6	19.400	24.5	4.830
Nephtys caecoides	419	31.8	5.327	19.8	3.978	46.9	7.994	17.0	2.044
Prionospio (Prionospio) jubata	551	31.2	86.016	2.5	0.207	44.2	26.238	60.4	171.378
Ceriantharia	14	30.2	10.767	19.0	2.741	29.9	5.707	56.6	18.070
Amphiuridae	1372	29.9	18.044	12.4	2.305	45.6	23.662	26.4	12.442
Tellina carpenteri	914	29.3	10.186	17.4	7.106	42.2	11.716	20.8	8.537
Rochefortia tumida	896	29.0	37.734	12.4	1.642	42.9	10.462	28.3	76.368
Cossura sp A	215	28.3	11.870	46.3	123.568	21.8	11.169	5.7	1.407
Scolanthus sp A	25	28.3	6.341	20.7	5.081	34.7	7.039	28.3	5.574
Streblosoma sp B	635	28.0	15.227	22.3	31.980	36.7	23.148	17.0	3.368
Nereis procera	432	28.0	7.751	26.4	11.650	36.7	11.615	7.5	2.400

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Glottidia albida	1353	27.7	27.971	2.5	0.500	49.0	40.106	26.4	15.208
Paramage scutata	469	27.7	25.833	14.9	3.642	40.8	42.824	20.8	6.308
Chaetozone corona	172	27.7	7.563	34.7	25.386	30.6	11.987	3.8	0.078
Amaeana occidentalis	88	27.7	6.891	13.2	2.704	42.9	8.779	18.9	4.897
Exogone lourei	276	27.4	24.568	44.6	142.179	8.2	2.376	41.5	41.054
Praxillella pacifica	545	27.4	13.857	14.9	19.294	38.1	16.273	26.4	10.206
Metasychis disparidentatus	388	27.1	6.078	20.7	6.641	36.1	9.640	17.0	1.454
Ampharete labrops	94	27.1	5.776	25.6	6.939	35.4	9.916	7.5	0.352
Gnathiidae	1055	26.8	6.992	14.0	4.112	38.1	8.000	24.5	5.993
Pista disjuncta	516	26.5	10.263	19.0	3.476	37.4	10.802	13.2	10.264
Melinna oculata	385	26.2	15.723	24.0	5.432	32.7	24.985	13.2	4.895
Goniada maculata	301	26.2	9.019	1.7	0.119	46.3	8.838	26.4	10.155
Paranemertes californica	69	26.2	4.796	43.0	10.658	10.2	0.911	32.1	9.181
Owenia collaris	464	25.9	31.714	4.1	0.362	37.4	10.392	43.4	62.237
Prionospio (Prionospio) heterobranchia	550	25.5	8.654	61.2	128.967	1.4	0.018	11.3	7.487
Macoma yoldiformis	852	25.5	5.773	24.0	9.195	36.1	10.004		
Notomastus sp A	442	25.2	5.463	26.4	9.091	24.5	4.298	24.5	6.586
Euchone limnicola	252	24.9	23.034	62.0	537.386	2.7	0.158	1.9	0.045
Scoletoma sp C	596	24.9	4.442	62.0	102.907	2.0	0.034	3.8	0.078
Amphipholis squamata	1370	24.6	19.404	19.8	3.626	21.1	3.879	45.3	40.911
Glycera nana	293	24.6	6.836	3.3	0.401	42.2	8.195	24.5	5.748
Carinoma mutabilis	55	24.3	7.122	7.4	1.108	38.1	7.087	24.5	7.778
Diopatra tridentata	224	24.0	13.139	10.7	1.381	38.1	11.203	15.1	16.816
Amphicteis scaphobranchiata	101	23.7	18.381	25.6	10.721	25.2	5.972	15.1	35.067
Enteropneusta	1405	23.4	10.653	1.7	0.407	34.0	8.198	43.4	14.842
Phyllodoce pettiboneae	498	23.1	15.630	1.7	0.121	34.7	10.472	39.6	23.820
Heterophoxus oculatus	1162	23.1	9.748	3.3	0.429	43.5	14.518	11.3	4.580
Nephtys ferruginea	422	23.1	8.805	4.1	0.526	34.0	7.337	35.8	11.529
Compsomyax subdiaphana	815	23.1	7.982	11.6	2.949	38.1	13.812	7.5	1.020
Prionospio (Minuspio) lighti	547	23.1	4.997	22.3	14.366	26.5	6.541	15.1	2.065
Petaloclymene pacifica	479	22.7	24.970	24.8	90.451	23.1	36.100	17.0	4.042
Poecilochaetus sp A	526	22.7	11.913	19.0	8.105	32.7	21.455	3.8	0.067
Modiolus sp	859	22.4	6.726	8.3	1.207	37.4	10.408	13.2	2.566
Tellina modesta	917	22.4	5.105	15.7	2.012	32.0	8.847	11.3	0.622
Pseudopolydora paucibranchiata	564	22.1	30.456	57.0	713.479	1.4	0.023		
Leptosynapta sp	1395	22.1	6.228	14.0	12.340	19.0	2.389	49.1	10.527
Solen sicarius	909	22.1	6.192	21.5	8.341	29.3	10.795	3.8	0.071
Oligochaeta	667	21.8	50.223	32.2	56.727	10.9	2.743	28.3	110.428
Leptochelia dubia	1033	21.2	21.044	12.4	5.480	22.4	8.732	37.7	38.410
Aricidea (Acmira) catherinae	129	21.2	10.788	5.0	0.491	28.6	10.637	37.7	12.029
Terebellides californica	655	21.2	5.036	9.9	1.456	32.0	7.569	17.0	2.154
Cirratulidae	198	20.9	11.730	12.4	1.739	14.3	3.319	58.5	23.528
Apoprionospio pygmaea	127	20.6	7.331	13.2	4.264	32.0	13.070	5.7	0.285
Phyllodoce hartmanae	495	20.6	5.939	2.5	0.249	33.3	4.214	26.4	8.729
Sternaspis fossor	628	20.2	15.317			32.7	15.059	32.1	17.204

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Lyonsia californica	847	20.2	3.496	34.7	49.075	12.9	1.265	7.5	1.720
Spiophanes bombyx	623	19.9	31.420	4.1	0.391	29.9	11.803	28.3	59.725
Onuphis sp 1	455	19.9	9.882	0.8	0.045	36.1	10.792	18.9	9.717
Terebellidae	654	19.9	5.660	18.2	11.121	19.0	3.799	26.4	7.491
Listriella goleta	1181	19.9	3.853	16.5	9.901	29.3	6.343	1.9	0.045
Nuculana taphria	871	19.9	3.528	18.2	9.190	28.6	5.832		
Euchone incolor	251	19.0	49.603	5.8	6.487	23.1	5.959	37.7	109.939
Siphonodentalium quadrifissatum	937	19.0	12.584	0.8	0.075	26.5	6.865	39.6	21.187
Ampelisca cristata microdentata	1082	19.0	6.710	15.7	4.144	25.9	11.714	7.5	0.555
Cossura candida	213	19.0	5.357	25.6	62.135	19.0	4.532	3.8	0.640
Tagelus subteres	911	19.0	2.852	50.4	66.833				
Musculista senhousia	860	18.7	14.871	49.6	348.504				
Dipolydora socialis	229	18.4	11.231	6.6	0.630	28.6	7.766	17.0	16.752
Pholoe glabra	488	18.1	15.803	1.7	0.134	25.2	6.456	35.8	29.380
Ampelisca pugetica	1088	18.1	9.281			24.5	4.180	41.5	16.763
Laonice cirrata	331	18.1	4.860	19.0	3.680	17.7	1.938	17.0	8.725
Tubulanus nothus	78	18.1	2.981	14.9	4.605	25.9	5.126	3.8	0.067
Cadulus aberrans	933	17.4	5.975	8.3	1.561	29.3	9.759	5.7	1.573
Sthenelais tertiaglabra	630	17.4	5.255	4.1	0.505	29.9	4.201	13.2	7.089
Turbonilla sp	783	17.4	4.205	7.4	1.031	17.7	2.752	39.6	6.391
Poecilochaetus sp	525	17.4	3.147	10.7	1.028	27.2	5.120	5.7	0.834
Spiophanes fimbriata	625	17.1	49.445	1.7	0.148	21.1	40.223	41.5	66.282
Listriolobus pelodes	1351	17.1	6.245	2.5	0.192	32.0	6.947	9.4	5.959
Malmgreniella sp	372	17.1	3.731	4.1	0.457	25.2	4.251	24.5	3.398
Palaeonemertea	67	16.8	8.850	4.1	1.304	19.7	3.351	37.7	16.667
Diopatra sp	222	16.8	6.667	7.4	0.704	25.2	9.183	15.1	4.047
Westwoodilla caecula	1261	16.8	6.326			26.5	3.386	28.3	10.738
Phisidea sanctaemariae	486	16.5	62.751	0.8	0.610	24.5	58.840	30.2	74.085
Lumbrineris cruzensis	347	16.5	3.635	2.5	0.196	29.9	4.681	11.3	2.645
Mooreonuphis nebulosa	402	16.2	9.629			34.7	17.301	1.9	0.773
Levinsenia gracilis	340	16.2	9.587	4.1	3.117	21.8	6.316	28.3	14.439
Capitella capitata Cmplx	162	15.9	4.879	15.7	8.082	11.6	2.918	28.3	7.066
Cooperella subdiaphana	816	15.9	1.238	17.4	2.136	20.4	2.133		
Amygdalum politum	803	15.6	18.893			18.4	9.132	43.4	33.329
Aphelochaeta sp	115	15.6	12.010	16.5	9.983	8.2	1.782	34.0	25.329
Volvulella panamica	791	15.6	4.758	4.1	0.459	30.6	8.810		
Thyasira flexuosa	925	15.6	1.906	15.7	1.819	19.0	3.321	5.7	0.101
Maldane sarsi	363	15.3	6.944	0.8	0.059	27.2	10.108	15.1	3.589
Paradiopatra parva	465	15.0	10.332	0.8	0.203	21.1	9.325	30.2	12.652
Onuphidae	450	15.0	6.309	0.8	0.102	25.2	8.289	18.9	4.404
Axinopsida serricata	807	15.0	3.939			30.6	6.200	5.7	1.441
Hartmanodes hartmanae	1156	15.0	1.758	17.4	3.691	12.9	1.699	15.1	1.637
Ampharetidae	96	14.6	16.348	5.0	0.789	18.4	4.702	26.4	32.859
Prionospio (Prionospio) dubia	549	14.3	15.220			21.1	7.404	28.3	26.788
Ampelisca pacifica	1087	14.3	6.575			26.5	6.712	13.2	7.069

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Megalomma pigmentum	381	14.3	3.378	21.5	5.689	9.5	1.070	11.3	6.103
Glycinde armigera	298	14.3	3.030	1.7	0.305	27.9	4.163	5.7	1.854
Ampelisca agassizi	1077	14.0	8.353			23.8	11.374	18.9	5.328
Anoplodactylus erectus	940	14.0	7.957	22.3	5.657	5.4	1.535	18.9	16.423
Rhepoxynius menziesi	1242	14.0	5.129			27.9	8.591	7.5	1.212
Aglaophamus verrilli	87	13.7	13.298			16.3	11.054	37.7	17.526
Streblosoma crassibranchia	633	13.4	11.799	5.0	1.124	22.4	21.010	7.5	1.076
Rhepoxynius bicuspidatus	1237	13.1	10.870			25.2	17.988	9.4	2.850
Lumbrineris californiensis	346	13.1	4.332	0.8	0.045	19.0	2.374	24.5	7.279
Chloeia pinnata	186	12.8	59.258			12.9	4.980	41.5	134.867
Byblis millsi	1116	12.8	16.200			17.0	2.764	30.2	35.073
Lysippe sp A	354	12.8	13.391	4.1	0.664	14.3	2.648	28.3	28.456
Aphelochaeta monilaris	112	12.8	7.891	7.4	1.157	14.3	4.867	20.8	12.453
Polycirrus sp	529	12.8	5.937	2.5	0.180	17.0	3.399	24.5	9.776
Sigalion spinosus	603	12.8	4.586			21.1	4.730	18.9	4.868
Scoletoma sp A	594	12.8	2.180	25.6	15.231	6.8	2.845		
Tenonia priops	653	12.8	1.653	3.3	0.316	23.8	2.864	3.8	0.238
Diplocirrus sp SD1	225	12.8	1.558	33.1	36.450	0.7	0.005		
Rudilemboides stenopropodus	1250	12.8	1.319	29.8	17.048	1.4	0.033	5.7	1.368
Podarkeopsis glabrus	522	12.5	1.453	9.9	1.990	16.3	1.747	7.5	1.020
Amphiura arcystata	1371	12.1	24.782	0.8	0.075	15.6	3.752	28.3	54.254
Photis brevipes	1216	12.1	9.851	2.5	2.731	18.4	9.532	17.0	10.984
Maldanidae	365	12.1	6.866	1.7	5.596	16.3	4.162	24.5	10.463
Philine auriformis	762	12.1	3.781	15.7	2.983	8.2	2.726	15.1	5.215
Rictaxis punctocaelatus	769	12.1	1.973	9.9	1.631	17.0	3.185	3.8	0.453
Drilonereis sp	239	12.1	1.615	6.6	0.535	19.0	2.311	5.7	0.834
Chaetozone hartmanae	173	11.8	37.375			11.6	4.431	39.6	83.408
Foxiphalus obtusidens	1141	11.8	7.234	0.8	0.078	17.0	8.246	22.6	6.665
Sabellides manriquei	578	11.8	7.114	1.7	0.134	23.1	13.040	3.8	0.227
Ampelisca indentata	1085	11.8	5.700			17.0	6.198	24.5	5.641
Nemertea	65	11.8	2.106	4.1	0.424	19.7	3.474	7.5	0.523
Goniada littorea	300	11.8	1.624	10.7	3.442	17.0	2.746		
Dipolydora bidentata	227	11.5	8.272			20.4	7.872	13.2	9.625
Diastylopsis tenuis	1011	11.5	4.961	0.8	0.102	23.1	7.037	3.8	2.794
Cylichna diegensis	718	11.5	1.559	1.7	0.237	22.4	2.578	3.8	0.386
Chone veleronis	197	11.2	11.492			19.7	17.849	13.2	4.512
Haliophasma geminatum	1056	11.2	7.226	0.8	0.178	15.6	3.762	22.6	12.383
Hemilamprops californicus	1016	11.2	6.235			19.0	3.128	15.1	10.853
Phyllodoce longipes	496	11.2	2.222	0.8	0.045	22.4	4.024	3.8	0.134
Lumbrineris latreilli	350	10.9	13.553	9.1	1.323	2.0	0.141	39.6	31.990
Pinnixa sp	1324	10.6	9.597	8.3	0.887	13.6	1.478	7.5	20.891
Lysippe sp B	355	10.6	7.583	0.8	0.078	16.3	8.686	17.0	6.933
Pista bansei	515	10.6	7.451	0.8	0.059	12.2	2.310	28.3	14.794
Siliqua lucida	902	10.6	4.562	0.8	0.075	22.4	8.477		
Chone albocincta	187	10.6	4.525	1.7	0.105	15.6	3.435	17.0	6.372

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Ophiuroidea	1379	10.6	3.979	0.8	0.102	17.7	2.518	13.2	6.247
Aricidea (Acmira) simplex	134	10.3	41.896			5.4	2.623	47.2	96.504
Eunice americana	265	10.3	6.394			21.8	10.942	1.9	1.214
Ampelisca careyi	1080	10.3	3.888			16.3	2.108	17.0	6.566
Olivella baetica	754	10.3	2.712	5.0	1.107	12.9	2.380	15.1	3.300
Synchelidium sp	1255	10.3	1.220	5.8	1.554	9.5	0.892	22.6	1.605
Apionsoma misakianum	1339	10.0	16.798	7.4	1.692	6.1	2.822	26.4	36.250
Gymnonereis crosslandi	304	10.0	11.762			17.7	19.768	11.3	2.694
Polycirrus sp A	530	10.0	5.346			16.3	2.882	15.1	9.049
Chaetozone setosa Cmplx	176	10.0	4.837			15.0	4.943	18.9	5.192
Pista moorei	518	10.0	2.302			19.7	2.559	5.7	2.207
Microspio pigmentata	393	10.0	1.480	13.2	2.577	4.1	0.622	18.9	2.468
Odontosyllis phosphorea	446	10.0	1.448	16.5	3.620	2.0	0.389	17.0	2.585
Listriella melanica	1182	10.0	1.200	14.9	3.055	5.4	0.326	11.3	2.131
Heteroserolis carinata	1057	10.0	0.708	22.3	8.429	2.7	0.586	1.9	0.080
Lumbrineris erecta	348	10.0	0.338	25.6	5.617	0.7	0.183		
Lanice conchilega	330	9.7	7.562			12.2	1.293	24.5	16.367
Nemocardium centifilosum	865	9.7	5.825			12.2	3.138	24.5	9.863
Deflexilodes norvegicus	1128	9.7	2.912			13.6	1.312	20.8	5.260
Poecilochaetus johnsoni	524	9.7	2.870	5.0	1.062	15.0	4.780	5.7	0.606
Photis sp	1222	9.7	2.711	1.7	0.279	14.3	1.570	15.1	4.421
Amphiporus sp	51	9.7	2.042	3.3	0.320	12.2	1.668	17.0	2.695
Oxyurostylis pacifica	1024	9.7	1.475	14.9	13.084	6.8	1.614	5.7	0.116
Pinnixa occidentalis	1322	9.7	1.150			20.4	2.112	1.9	0.034
Scalibregma californicum	583	9.3	6.789	0.8	0.075	9.5	2.073	28.3	13.518
Aricidea (Allia) antennata	139	9.3	4.488	0.8	0.059	11.6	2.606	22.6	7.351
Tubulanus cingulatus	77	9.3	4.343	3.3	0.296	8.8	1.712	24.5	8.128
Ampelisca sp	1090	9.3	2.249	1.7	0.163	16.3	2.545	7.5	2.081
Lumbrineris japonica	349	9.3	1.682	6.6	0.671	10.9	1.883	11.3	1.527
Neotrypaea californiensis	1301	9.3	0.835	20.7	14.128	3.4	0.432		
Asthenothaerus diegensis	806	9.3	0.695	21.5	13.291	2.7	0.238		
Asabellides lineata	151	9.0	41.294			7.5	2.639	34.0	95.048
Thysanocardia nigra	1348	9.0	4.245	4.1	0.440	9.5	3.294	18.9	5.852
Ericthonius brasiliensis	1135	9.0	4.006	10.7	12.243	9.5	4.417	3.8	2.640
Amphiodia digitata	1360	9.0	2.917	7.4	2.719	10.2	2.281	9.4	3.751
Mayerella acanthopoda	1187	9.0	1.518	23.1	33.267	0.7	0.183		
Periploma discus	881	9.0	0.940	14.0	3.398	7.5	1.436	1.9	0.053
Chone sp B	191	8.7	24.057			8.2	1.467	30.2	55.462
Caecum crebricinctum	701	8.7	23.055	1.7	0.480	5.4	3.067	34.0	50.975
Mayerella banksia	1188	8.7	8.886	5.8	6.886	8.2	1.099	17.0	19.071
Anobothrus gracilis	108	8.7	6.422			10.9	2.307	22.6	12.351
Scleroplax granulata	1333	8.7	1.724	22.3	40.217	0.7	0.015		
Ensis myrae	829	8.7	0.883	9.9	1.785	10.9	1.500		
Acteocina inculta	674	8.7	0.594	23.1	13.914				
Chone sp C	192	8.4	16.006			8.2	1.112	28.3	36.728

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		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Obelia sp A	7	8.4	13.579	5.0	0.885	10.2	18.462	11.3	8.609
Pentactinia californica	24	8.4	8.937			6.8	1.168	32.1	19.806
Sipuncula	1344	8.4	7.050	3.3	1.010	4.1	0.569	32.1	15.972
Chone mollis	189	8.4	3.267	5.8	0.772	7.5	0.853	17.0	6.615
Rudilemboides sp	1247	8.4	0.855	22.3	20.047				
Sigambra tentaculata	606	8.4	0.561	13.2	4.141	7.5	0.715		
Solen rostriformis	908	8.4	0.532	21.5	12.378	0.7	0.007		
Mactrotoma californica	855	8.4	0.392	20.7	7.633	0.7	0.097	1.9	0.034
Photis californica	1217	8.1	13.493	0.8	0.059	10.9	0.685	17.0	31.277
Rhepoxynius stenodes	1245	8.1	4.666			17.0	3.941	1.9	6.070
Nebalia daytoni	971	8.1	2.326	0.8	0.059	15.6	4.134	3.8	0.239
Scoletoma tetraura Cmplx	597	8.1	1.937	7.4	1.198	8.8	2.959	7.5	0.702
Corophium sp	1127	8.1	0.875	19.0	16.155	1.4	0.194	1.9	0.193
Rochefortia grippi	893	8.1	0.740	8.3	1.878	9.5	1.020	3.8	0.266
Nassarius tiarula	748	8.1	0.161	21.5	3.774				
Chaetozone sp	177	7.8	8.177			4.8	0.770	34.0	18.503
Prionospio (Prionospio) sp	552	7.8	6.081	4.1	0.480	8.8	3.964	13.2	9.365
Ampelisca hancocki Cmplx	1084	7.8	3.002			13.6	1.923	9.4	4.690
Fabricinuda limnicola	281	7.8	2.949	19.0	58.386	0.7	0.550	1.9	0.386
Cerapus tubularis Cmplx	1125	7.8	2.675			14.3	2.836	7.5	2.741
Pista sp	519	7.8	2.039	8.3	4.530	6.1	0.738	11.3	3.455
Actiniaria	10	7.8	1.508	5.0	0.974	4.8	0.538	22.6	2.806
Nephtys cornuta	421	7.8	0.911	13.2	2.707	6.1	1.480		
Synaptotanais notabilis	1038	7.5	14.515	19.0	205.354			1.9	13.712
Gibberosus myersi	1150	7.5	2.305	0.8	0.048	12.9	2.926	7.5	1.739
Sige sp A	607	7.5	1.894			15.0	1.477	3.8	2.621
Scaphopoda	936	7.5	1.303	4.1	0.449	9.5	1.665	9.4	0.927
Diopatra ornata	221	7.5	1.276	3.3	0.762	13.6	2.312		
Edotia sublittoralis	1051	7.5	1.238	1.7	0.252	12.9	1.767	5.7	0.660
Glycera macrobranchia	292	7.5	1.081	1.7	0.093	15.0	2.002		
Armandia brevis	148	7.5	0.474	16.5	6.983	1.4	0.281	3.8	0.060
Ophiuroconis bispinosa	1378	7.2	8.619			4.1	0.139	32.1	20.365
Clymenura gracilis	212	7.2	4.056			11.6	4.945	11.3	3.329
Saxicavella nybakkeni	897	7.2	2.748	1.7	0.103	12.2	2.777	5.7	2.980
Americhelidium rectipalmum	1076	7.2	1.446	5.8	0.983	3.4	0.400	20.8	2.835
Laevicardium substriatum	839	7.2	0.172	19.0	4.040				
Aphelochaeta glandaria	111	6.9	7.603	0.8	0.102	8.2	4.746	17.0	12.029
Ampharete sp	95	6.9	5.473	1.7	0.313	9.5	1.249	11.3	11.412
Dorvillea (Schistomeringos) sp	233	6.9	3.630	13.2	37.458	1.4	0.292	7.5	4.469
Heterophoxus sp	1163	6.9	1.780	5.0	1.446	8.8	1.274	5.7	2.461
Ampelisca brachycladus	1078	6.9	1.729	5.8	1.400	10.2	3.104		
Aricidea (Allia) sp A	141	6.9	1.316			11.6	2.166	9.4	0.361
Ampharetidae sp SD1	97	6.5	74.182			2.0	1.114	34.0	175.398
Myriochele striolata	409	6.5	10.636			8.8	14.004	15.1	7.400
Artacamella hancocki	150	6.5	6.146			4.1	0.256	28.3	14.321

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Solamen columbianum	906	6.5	5.520			7.5	2.575	18.9	9.857
Edwardsiidae	18	6.5	3.514	5.0	1.865	4.1	0.534	17.0	7.501
Syllis (Ehlersia) heterochaeta	644	6.5	3.298			10.2	3.236	11.3	3.713
Chiridota sp	1391	6.5	1.965			4.1	0.583	28.3	3.937
Kurtzina beta	739	6.5	1.330			11.6	1.672	7.5	1.027
Leptopecten latiauratus	842	6.5	1.040	4.1	0.442	9.5	1.399	3.8	0.640
Aphelochaeta petersenae	113	6.5	0.635	9.1	2.611	2.7	0.299	11.3	0.865
Paradexamine sp SD1	1211	6.5	0.365	15.7	8.321	1.4	0.018		
Pyromaia tuberculata	1331	6.5	0.341	11.6	1.575	4.8	0.509		
Laonice nuchala	332	6.2	9.851	1.7	0.177	4.8	1.920	20.8	21.002
Eudorella pacifica	1012	6.2	6.040			6.8	0.986	18.9	13.133
Anopla	52	6.2	2.557	1.7	0.382	6.8	0.483	15.1	5.435
Marphysa sp A	377	6.2	1.881	5.0	1.234	9.5	3.400		
Malmgreniella baschi	368	6.2	1.729	0.8	0.075	7.5	1.285	15.1	2.466
Lytechinus pictus	1387	6.2	1.605	0.8	0.075	4.8	0.387	22.6	3.321
Anotomastus gordiodes	109	6.2	1.551	4.1	1.483	9.5	2.731	1.9	0.045
Grandidierella japonica	1152	6.2	1.490	16.5	34.925				
Gastropoda	731	6.2	1.344	6.6	2.334	4.1	0.394	11.3	2.460
Odostomia sp	752	6.2	1.246	4.1	0.403	8.2	1.037	5.7	1.600
Gammaridea	1144	6.2	1.110	8.3	1.353	4.8	0.484	5.7	1.888
Philine sp A	765	6.2	0.610	10.7	1.904	4.8	0.983		
Macoma sp	851	6.2	0.574	9.1	1.110	6.1	0.978		
Aphelochaeta sp LA1	117	5.9	42.033			1.4	1.341	32.1	98.475
Tellina cadieni	913	5.9	6.341			4.8	0.745	22.6	14.160
Rochefortia mortoni	894	5.9	3.894	0.8	0.102	11.6	6.759	1.9	0.607
Monticellina sp	397	5.9	1.812	0.8	0.104	5.4	0.912	18.9	3.139
Heterocrypta occidentalis	1290	5.9	1.658			10.2	2.054	7.5	1.319
Rhodine bitorquata	571	5.9	1.569			10.9	2.563	5.7	0.453
Spiophanes wigleyi	627	5.9	1.328			8.2	1.263	13.2	1.547
Nephtys sp	424	5.9	0.836			6.1	0.255	18.9	1.666
Zygeupolia rubens	82	5.9	0.822	9.9	4.923	3.4	0.165	3.8	1.247
Scoletoma sp B	595	5.9	0.497	13.2	4.290	2.0	0.584		
Leptostylis calva	1020	5.9	0.382			12.2	0.560	1.9	0.193
Decamastus gracilis	218	5.6	7.483	1.7	0.407	3.4	1.158	20.8	16.312
Euchone arenae	249	5.6	5.449			2.7	0.396	26.4	12.483
Foxiphalus similis	1142	5.6	4.032			6.1	0.826	17.0	8.552
Polycirrus californicus	528	5.6	3.998	0.8	0.203	8.2	2.123	9.4	6.787
Phascolion sp A	1342	5.6	3.618			6.1	2.869	17.0	4.945
Scoloplos armiger Cmplx	599	5.6	2.310			8.8	1.536	9.4	3.537
Lineus bilineatus	64	5.6	1.305			10.2	1.652	5.7	0.993
Asteropella slatteryi	947	5.6	1.247	7.4	2.312	2.7	0.299	9.4	2.353
Chaetodermatidae	793	5.6	1.213			8.2	1.079	11.3	1.508
Heterophoxus ellisi	1161	5.6	1.113	9.9	16.854	2.7	0.561	3.8	0.220
Leuroleberis sharpei	956	5.6	1.071			7.5	0.912	13.2	1.384
Aricidea (Acmira) horikoshii	131	5.6	0.826	4.1	2.679	7.5	1.268	3.8	0.071

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		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Cossura sp	214	5.6	0.731	9.1	7.633	3.4	0.254	3.8	0.640
Alienacanthomysis macropsis	976	5.6	0.179	10.7	1.465	3.4	0.216		
Macoma nasuta	850	5.6	0.101	13.2	2.146	1.4	0.018		
Photis lacia	1218	5.3	14.766			2.7	0.490	24.5	34.570
Procampylaspis caenosa	1026	5.3	5.877			4.8	0.768	18.9	13.025
Monticellina tesselata	400	5.3	4.323	0.8	0.104	2.7	0.493	22.6	9.662
Aricidea (Aricidea) wassi	147	5.3	3.539			8.8	3.618	7.5	3.798
Lirobittium sp	741	5.3	3.333	1.7	1.730	6.1	0.376	11.3	7.287
Syllis (Ehlersia) hyperioni	645	5.3	2.596			8.8	3.251	7.5	2.020
Paraonidae	474	5.3	2.125			1.4	0.029	28.3	5.027
Amphioplus sp LA1	1366	5.3	2.053			11.6	3.817		
Potamethus sp A	542	5.3	1.775			10.2	2.204	3.8	1.407
Nicippe tumida	1205	5.3	1.310			8.2	1.905	9.4	0.680
Malmgreniella sp A	373	5.3	1.039	0.8	0.075	5.4	0.627	15.1	1.664
Pherusa neopapillata	483	5.3	0.633	2.5	0.279	8.2	0.854	3.8	0.386
Podarkeopsis sp A	523	5.3	0.581			11.6	1.080		
Protothaca staminea	888	5.3	0.284	11.6	2.860	2.0	0.301		
Paradoneis sp	467	5.0	49.867			0.7	0.733	28.3	117.928
Phyllochaetopterus prolifica	491	5.0	4.686			5.4	2.704	15.1	7.704
Eclysippe trilobata	241	5.0	2.671	0.8	0.102	10.2	4.959		
Lyonsiidae	848	5.0	2.112	0.8	0.102	5.4	0.961	13.2	3.791
Chone minuta	188	5.0	2.108	2.5	0.579	4.8	2.132	11.3	2.234
Hiatella arctica	833	5.0	1.926	4.1	2.139	4.1	0.249	9.4	4.055
Marphysa disjuncta	375	5.0	1.363	7.4	1.423	4.8	2.422		
Polynoidae	538	5.0	1.322	1.7	0.161	9.5	2.445		
Deilocerus planus	1284	4.7	5.453					28.3	12.997
Glycera oxycephala	294	4.7	5.178			7.5	2.421	7.5	9.239
Aphelochaeta sp A	116	4.7	3.118	0.8	0.078	6.8	2.072	7.5	4.769
Euchone sp A	255	4.7	2.232			3.4	0.073	18.9	5.226
Gammaropsis thompsoni	1148	4.7	1.857	0.8	0.407	6.8	1.669	7.5	2.247
Ennucula tenuis	828	4.7	1.598			9.5	2.821	1.9	0.193
Platynereis bicanaliculata	521	4.7	0.819	1.7	0.177	8.2	1.474	1.9	0.045
Hoplonemertea	62	4.7	0.720	2.5	0.151	3.4	0.454	13.2	1.119
Metamysidopsis elongata	982	4.7	0.275	2.5	0.195	8.2	0.495		
Brania mediodentata	160	4.7	0.224	12.4	5.243				
Imogine exiguus	36	4.7	0.154	9.1	0.934	2.7	0.213		
Tellina meropsis	916	4.7	0.103	12.4	2.407				
Amphissa undata	687	4.4	6.258			1.4	0.381	22.6	14.430
Diastylis californica	1008	4.4	3.899			5.4	0.449	11.3	8.717
Diastylis crenellata	1009	4.4	1.803	0.8	0.102	6.1	1.570	7.5	2.274
Ampelisca cristata cristata	1081	4.4	1.635	2.5	2.253	4.1	2.029	9.4	1.067
Melphisana bola Cmplx	1191	4.4	1.415			6.1	0.883	9.4	2.241
Neastacilla californica	1066	4.4	1.094	1.7	0.193	6.8	0.529	3.8	1.910
Aglaja ocelligera	678	4.4	0.905	0.8	0.075	4.1	0.238	13.2	1.844
Halianthella sp A	21	4.4	0.827			6.1	0.380	9.4	1.485

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Eumida longicornuta	264	4.4	0.762	1.7	0.180	7.5	1.251	1.9	0.193
Decapoda	1282	4.4	0.525	4.1	0.327	3.4	0.292	7.5	0.844
Eranno lagunae	244	4.4	0.385	0.8	0.075	6.8	0.631	5.7	0.101
Pinnotheridae	1326	4.4	0.343	4.1	0.461	5.4	0.580	1.9	0.027
Harmothoe imbricata Cmplx	310	4.4	0.280	11.6	6.554				
Notomastus magnus	440	4.4	0.150	5.8	0.488	4.8	0.240		
Scolelepis sp SD1	591	4.4	0.078	11.6	1.817				
Polydora cirrosa	533	4.0	14.183	1.7	0.526	7.5	26.330		
Hamatoscalpellum californicum	970	4.0	7.751			5.4	3.582	9.4	13.884
Neosabellaria cementarium	417	4.0	5.746	1.7	0.164	5.4	8.154	5.7	3.228
Lumbrinerides platypygos	345	4.0	4.939	0.8	0.046	0.7	0.073	20.8	11.675
Rutiderma lomae	964	4.0	3.776			4.1	0.285	13.2	8.636
Ampharete finmarchica	92	4.0	3.455			4.8	0.441	11.3	7.670
Maldanidae sp 1	366	4.0	2.599	0.8	0.075	6.8	3.578	3.8	1.600
Terebellides sp	657	4.0	2.596			2.7	1.103	17.0	4.773
Euphilomedes producta	951	4.0	2.515	0.8	0.237	4.8	1.322	9.4	4.276
Notomastus sp	441	4.0	2.325	4.1	0.737	0.7	0.004	13.2	5.462
Streblosoma sp	634	4.0	2.071			8.2	2.903	1.9	1.214
Araphura breviaria	1028	4.0	2.028	0.8	0.102	2.7	0.310	15.1	4.426
Ephesiella brevicapitis	242	4.0	1.863	0.8	0.075	6.8	3.137	3.8	0.413
Eulalia levicornuta	261	4.0	1.829			4.1	0.608	13.2	3.581
Ampelisciphotis podophthalma	1092	4.0	1.334			8.8	2.480		
Crepidula sp	714	4.0	1.116	1.7	0.161	6.1	1.553	3.8	0.652
Halcampa decemtentaculata	19	4.0	1.055	1.7	0.206	3.4	0.211	11.3	2.224
Phyllochaetopterus limicolus	490	4.0	0.991			4.8	0.293	11.3	1.986
Mooresamytha bioculata	406	4.0	0.984			8.2	1.795	1.9	0.045
Neanthes acuminata Cmplx	416	4.0	0.690	10.7	16.162				
Podocerus fulanus	1231	4.0	0.636	10.7	14.904				
Scoloplos acmeceps	598	4.0	0.324	5.8	1.929	2.0	0.212	5.7	0.303
Mysidopsis intii	988	4.0	0.293	3.3	0.385	6.1	0.514		
Pinnixa franciscana	1319	4.0	0.280	6.6	2.605	3.4	0.315		
Diopatra splendidissima	223	4.0	0.277	5.8	1.362	4.1	0.407		
Cryptomya californica	818	4.0	0.230	7.4	1.300	2.7	0.324		
Cumingia californica	819	4.0	0.210	6.6	2.566	3.4	0.187		
Corymorpha palma	2	4.0	0.183	9.9	2.392			1.9	0.193
Edwardsia californica	16	4.0	0.179	9.9	2.958	0.7	0.097		
Ascidiacea	1407	4.0	0.123	7.4	1.204	1.4	0.073	3.8	0.078
Eteone aestuarina	245	4.0	0.061	10.7	1.425				
Spiophanes sp	626	3.7	7.003			4.8	3.960	9.4	11.616
Exogone breviseta	274	3.7	2.771	1.7	1.369	0.7	0.015	17.0	6.447
Leitoscoloplos panamensis	335	3.7	2.649			6.1	2.123	5.7	3.593
Polygireulima rutila	767	3.7	1.523			5.4	0.334	7.5	3.200
Spionidae	621	3.7	1.420	5.0	0.442			11.3	3.341
Xenoleberis californica	968	3.7	1.253			4.8	0.260	9.4	2.655
Onuphis sp	454	3.7	1.156			5.4	0.449	7.5	2.180

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Kurtzia arteaga	737	3.7	1.064			5.4	0.854	7.5	1.441
Carazziella sp A	164	3.7	0.986	3.3	0.284	4.8	1.770	1.9	0.053
Travisia brevis	663	3.7	0.817			4.1	0.578	11.3	1.205
Ninoe tridentata	435	3.7	0.768			7.5	1.127	1.9	0.386
Argissa hamatipes	1106	3.7	0.745	0.8	0.203	6.8	0.896	1.9	0.607
Photis sp OC1	1225	3.7	0.646			8.2	1.201		
Polycladida	44	3.7	0.624	3.3	0.274	1.4	0.102	11.3	1.328
Amphitritinae	103	3.7	0.551	5.8	1.318	2.0	0.295	3.8	0.800
Rochefortia coani	891	3.7	0.477	0.8	0.102	6.8	0.774	1.9	0.134
Amphiodia psara	1361	3.7	0.350	2.5	0.579	6.1	0.606		
Polydora cornuta	534	3.7	0.272	9.1	6.184	0.7	0.015		
Sthenelais verruculosa	631	3.7	0.183	0.8	0.075	7.5	0.334		
Monticellina sp SD4	399	3.7	0.090	8.3	1.741	0.7	0.009	1.9	0.027
Mysidacea	983	3.7	0.052	5.0	0.604	4.1	0.049		
Chaetozone hedgpethi	174	3.4	29.930			0.7	0.015	18.9	71.324
Protodorvillea gracilis	559	3.4	7.371			1.4	0.007	17.0	17.561
Jasmineira sp B	325	3.4	6.378			2.7	0.512	13.2	14.546
Amphicteis sp	102	3.4	5.719			4.1	0.755	9.4	12.664
Rhepoxynius lucubrans	1241	3.4	4.751			2.0	1.482	15.1	9.424
Hesionura coineaui difficilis	314	3.4	4.642			1.4	0.404	17.0	10.548
Hemiproto sp A	1159	3.4	3.038	1.7	0.161	2.7	0.468	9.4	6.626
Caulleriella pacifica	165	3.4	1.588	2.5	0.408			15.1	3.743
Eulima raymondi	728	3.4	1.476			5.4	2.293	5.7	0.579
Amphichondrius granulatus	1359	3.4	1.356			5.4	0.478	5.7	2.621
Samytha californiensis	582	3.4	1.296			6.8	0.989	1.9	1.821
Caprella californica	1118	3.4	1.144	5.8	22.897	2.7	0.311		
Zaolutus actius	33	3.4	1.057			4.1	0.670	9.4	1.660
Aphrodita sp	124	3.4	0.868	4.1	0.375	1.4	0.112	7.5	1.888
Anchicolurus occidentalis	993	3.4	0.747			5.4	0.952	5.7	0.559
Phyllodoce sp	499	3.4	0.686	0.8	0.104	4.8	1.084	5.7	0.235
Hippomedon zetesimus	1167	3.4	0.629	2.5	0.385	5.4	1.139		
Hesperonoe laevis	316	3.4	0.556	0.8	0.075	6.1	0.878	1.9	0.193
Virgulariidae	32	3.4	0.494	2.5	0.223	4.1	0.414	3.8	0.624
Epitonium sp	726	3.4	0.491			6.1	0.809	3.8	0.134
Drilonereis mexicana	237	3.4	0.368	3.3	0.465	4.1	0.621	1.9	0.034
Nephtys simoni	423	3.4	0.338	2.5	0.529	1.4	0.297	11.3	0.371
Metaphoxus frequens	1192	3.4	0.316			5.4	0.136	5.7	0.579
Malmgreniella macginitiei	369	3.4	0.311	2.5	0.260	5.4	0.557		
Glycera sp LA1	296	3.1	22.398			0.7	0.015	17.0	53.370
Urothoe varvarini	1260	3.1	3.269					18.9	7.792
Chaetozone armata	171	3.1	2.529			1.4	0.241	15.1	5.718
Autolytus sp	153	3.1	1.523	0.8	0.046	2.7	0.310	9.4	3.228
Exogone dwisula	275	3.1	1.098	4.1	16.024	2.0	0.271	3.8	0.640
Drilonereis sp A	240	3.1	0.957	0.8	0.075	5.4	1.623	1.9	0.193
Glycera sp	295	3.1	0.783	2.5	0.194	3.4	0.494	3.8	1.214

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Asteroidea	1354	3.1	0.758			2.7	0.141	11.3	1.626
Protomedeia articulata Cmplx	1234	3.1	0.756			4.8	0.954	5.7	0.579
Cirratulus sp	199	3.1	0.528	5.0	1.351	2.7	0.874		
Cancer sp	1277	3.1	0.523	0.8	0.102	4.1	0.305	5.7	0.845
Chone sp	190	3.1	0.475	1.7	0.194	3.4	0.217	5.7	0.834
Ophiodermella inermis	758	3.1	0.448			6.1	0.682	1.9	0.193
Neotrypaea sp	1303	3.1	0.344	5.0	1.589	2.0	0.040	1.9	0.607
Acteocina eximia	672	3.1	0.326			6.1	0.455	1.9	0.193
Turbonilla sp A	784	3.1	0.318	0.8	0.075	2.7	0.073	9.4	0.658
Foxiphalus golfensis	1140	3.1	0.292	0.8	0.075	6.1	0.537		
Neverita reclusiana	749	3.1	0.281	1.7	0.105	5.4	0.514		
Paranthura elegans	1068	3.1	0.195	8.3	4.568				
Molgula sp	1413	3.1	0.180	5.8	1.686	2.0	0.201		
Lanassa sp	328	3.1	0.155			6.1	0.262	1.9	0.034
Vitrinella oldroydi	787	3.1	0.154	5.8	1.099	2.0	0.198		
Eochelidium sp A	1133	3.1	0.114	8.3	2.676				
Modiolus rectus	858	3.1	0.102	3.3	0.321	4.1	0.163		
Terebellides sp Type C	658	2.8	5.258			1.4	0.733	13.2	11.594
Ophiodromus pugettensis	461	2.8	2.506	3.3	0.384	1.4	0.029	5.7	5.897
Aricidea (Acmira) sp	135	2.8	1.161	0.8	0.059	2.7	0.282	7.5	2.400
Nereiphylla sp 1	428	2.8	1.078			1.4	0.112	13.2	2.427
Malacoceros indicus	362	2.8	1.066			2.0	0.464	11.3	1.946
Tanaidacea	1040	2.8	0.850	3.3	0.807	1.4	1.128	5.7	0.498
Tiron biocellata	1257	2.8	0.828	0.8	0.075	3.4	0.135	5.7	1.793
Echinoidea	1385	2.8	0.783			3.4	0.508	7.5	1.214
Lovenia cordiformis	1386	2.8	0.730			2.0	0.198	11.3	1.487
Simomactra planulata	904	2.8	0.723			2.0	0.707	11.3	0.818
Dipolydora sp	230	2.8	0.664	0.8	0.075	1.4	0.199	11.3	1.320
Marphysa sp	376	2.8	0.618	2.5	1.017	3.4	0.595	1.9	0.607
Capitellidae	163	2.8	0.587	2.5	0.276	1.4	0.366	7.5	0.901
Arabella sp	128	2.8	0.462	0.8	0.225	3.4	0.408	5.7	0.555
Trachycardium quadragenarium	927	2.8	0.436	1.7	0.121	3.4	0.301	3.8	0.640
Edwardsia sp G	17	2.8	0.429	1.7	0.117	4.1	0.488	1.9	0.386
Crucibulum spinosum	716	2.8	0.413	7.4	9.673				
Dispio uncinata	231	2.8	0.339			3.4	0.119	7.5	0.656
Venerupis philippinarum	931	2.8	0.330	6.6	4.043	0.7	0.292		
Campylaspis rubromaculata	998	2.8	0.265	2.5	0.388	1.4	0.008	7.5	0.580
Solemya reidi	907	2.8	0.244	0.8	0.058	5.4	0.450		
Boccardia sp	156	2.8	0.191	0.8	0.059	5.4	0.350		
Phyllophoridae	1403	2.8	0.158			5.4	0.142	1.9	0.193
Schmittius politus	974	2.8	0.121	5.0	0.405	2.0	0.192		
Alpheus californiensis	1265	2.8	0.039	7.4	0.913				
Dougaloplus amphacanthus	1373	2.5	7.455			1.4	0.044	11.3	17.715
Aonides sp SD1	110	2.5	4.214			0.7	0.292	13.2	9.669
Heteropodarke heteromorpha	319	2.5	3.797			0.7	0.097	13.2	8.925

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		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Eulalia californiensis	260	2.5	2.687			1.4	0.058	11.3	6.330
Myriochele gracilis	407	2.5	1.724			3.4	2.081	5.7	1.441
Amphicteis glabra	99	2.5	1.668			2.7	0.175	7.5	3.752
Nuculana hamata	869	2.5	1.650			1.4	0.916	11.3	2.759
Onuphis eremita parva	451	2.5	1.612			3.4	1.078	5.7	2.461
Pherusa sp	484	2.5	1.562			2.7	0.397	7.5	3.214
Aricidea (Acmira) cerrutii	130	2.5	1.528			0.7	0.097	13.2	3.518
Metatiron tropakis	1193	2.5	1.477			1.4	0.205	11.3	3.258
Sphaerosyllis californiensis	612	2.5	1.357	2.5	0.236	1.4	0.195	5.7	2.960
Piromis sp A	511	2.5	1.185			4.1	0.864	3.8	1.717
Magelona berkeleyi	358	2.5	1.141			3.4	1.197	5.7	1.186
Rudilemboides sp A	1248	2.5	0.966	0.8	0.045	1.4	0.198	9.4	2.043
Pholoides asperus	489	2.5	0.945	0.8	0.119	0.7	0.044	11.3	2.186
Pandora bilirata	878	2.5	0.851			2.0	0.033	9.4	1.986
Aoroides spinosa	1104	2.5	0.841	0.8	0.102	2.7	0.114	5.7	1.848
Eunicidae	267	2.5	0.723			4.1	0.420	3.8	1.186
Edotia sp B	1049	2.5	0.664	0.8	0.075	4.8	1.228		
Aricidea (Allia) hartleyi	140	2.5	0.570			3.4	0.410	5.7	0.834
Crepidula glottidiarum	711	2.5	0.516	0.8	0.059	4.8	0.954		
Acoetes pacifica	83	2.5	0.511			3.4	0.747	5.7	0.260
Notocirrus californiensis	437	2.5	0.509			5.4	0.947		
Sinocorophium cf heteroceratum	1251	2.5	0.485	6.6	11.366				
Bathyleberis sp	948	2.5	0.483			3.4	0.146	5.7	0.966
Palaeonemertea sp C	68	2.5	0.440	2.5	0.440	2.7	0.310	1.9	0.607
Nuculana elenensis	868	2.5	0.384	0.8	0.075	2.7	0.058	5.7	0.834
Pilargis berkeleyae	503	2.5	0.357	0.8	0.078	4.1	0.507	1.9	0.193
Clymenella complanata	208	2.5	0.333			5.4	0.619		
Rhepoxynius variatus	1246	2.5	0.330			4.1	0.510	3.8	0.133
Randallia ornata	1332	2.5	0.313			4.1	0.499	3.8	0.106
Bunodeopsis sp A	13	2.5	0.260	6.6	6.088				
Rhepoxynius abronius	1236	2.5	0.223			5.4	0.415		
Siphonosoma ingens	1343	2.5	0.222			2.7	0.042	7.5	0.476
Limnactiniidae sp A	22	2.5	0.208			4.1	0.317	3.8	0.089
Scolelepis sp	589	2.5	0.189	3.3	0.568	2.7	0.307		
Aoroides sp	1102	2.5	0.125	0.8	0.059	4.8	0.228		
Polydora sp	537	2.5	0.104	3.3	0.386	2.7	0.163		
Haminoea vesicula	735	2.5	0.098	5.8	2.247	0.7	0.004		
Hydrozoa	6	2.5	0.096	3.3	0.353	2.0	0.115	1.9	0.045
Halosydna johnsoni	307	2.5	0.035	6.6	0.819				
Chaetozone sp SD5	184	2.2	9.319			0.7	0.044	11.3	22.157
Deilocerus decorus	1283	2.2	7.616					13.2	18.154
Micropodarke dubia	391	2.2	2.837			0.7	0.195	11.3	6.513
Cyclocardia sp	822	2.2	2.523					13.2	6.015
Eulalia sp	263	2.2	2.385			1.4	0.366	9.4	5.215
Limatula saturna	844	2.2	1.950			0.7	0.011	11.3	4.634

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		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Saccocirrus sp	580	2.2	1.687	0.8	0.102	1.4	0.105	7.5	3.876
Solariella peramabilis	774	2.2	1.685			0.7	0.058	11.3	3.941
Mesolamprops bispinosus	1022	2.2	1.538			2.0	0.212	7.5	3.394
Postasterope barnesi	961	2.2	1.464	4.1	22.384			3.8	1.214
Maera similis	1185	2.2	1.403	0.8	0.078	0.7	0.195	9.4	3.087
Rutiderma rostratum	965	2.2	1.193			3.4	1.998	3.8	0.283
Chaetozone sp SD3	183	2.2	1.121			2.0	0.044	7.5	2.617
Volvulella californica	788	2.2	1.058			2.7	0.396	5.7	2.014
Monoculodes sp SD1	1202	2.2	1.010	1.7	0.092			9.4	2.398
Terebellides reishi	656	2.2	0.969			2.7	0.554	5.7	1.600
Rhamphobrachium longisetosum	570	2.2	0.967			2.7	0.227	5.7	2.014
Anemonactis sp	11	2.2	0.923	1.7	0.606	0.7	0.097	7.5	2.014
Halicoides synopiae	1154	2.2	0.904					13.2	2.154
Parougia caeca	477	2.2	0.899			3.4	0.574	3.8	1.407
Cirrophorus furcatus	207	2.2	0.837	1.7	0.194	2.0	0.292	3.8	1.600
Podocerus cristatus	1230	2.2	0.801	3.3	2.213	1.4	0.366	1.9	1.214
Nereididae	427	2.2	0.757	3.3	12.316	1.4	0.281	1.9	0.193
Rochefortia compressa	892	2.2	0.738			4.1	1.222	1.9	0.193
Astropecten verrilli	1358	2.2	0.730			3.4	0.389	3.8	1.241
Maldaninae	367	2.2	0.646			3.4	0.749	3.8	0.579
Proceraea sp	553	2.2	0.599			3.4	0.339	3.8	0.993
Mooreonuphis sp	404	2.2	0.581			1.4	0.192	9.4	1.137
Eurydice caudata	1052	2.2	0.396			2.0	0.385	7.5	0.450
Hyalinoecia juvenalis	321	2.2	0.391			4.1	0.577	1.9	0.193
Sabellidae	577	2.2	0.381	0.8	0.104	2.7	0.210	3.8	0.629
Parandalia fauveli	471	2.2	0.377	0.8	0.075	4.1	0.695		
Tellina idae	915	2.2	0.263	1.7	0.121	3.4	0.480		
Caprella mendax	1121	2.2	0.237	0.8	0.102	2.0	0.227	5.7	0.264
Flabelligeridae	287	2.2	0.236	1.7	0.149	2.0	0.126	3.8	0.386
Pilargis sp 1	505	2.2	0.218	3.3	1.507	2.0	0.285		
Molpadia intermedia	1396	2.2	0.214			4.8	0.398		
Sulcoretusa xystrum	775	2.2	0.191	3.3	0.745	2.0	0.295		
Oedicerotidae	1206	2.2	0.190	2.5	0.261	0.7	0.005	5.7	0.420
Saxidomus nuttalli	900	2.2	0.178	5.8	4.173				
Bemlos macromanus	1114	2.2	0.174	5.8	4.079				
Paracerceis sculpta	1067	2.2	0.147	5.8	3.456				
Cirriformia sp SD1	203	2.2	0.128	4.1	0.548	1.4	0.195		
Anoropallene palpida	943	2.2	0.127	0.8	0.102	4.1	0.228		
Nassarius perpinguis	747	2.2	0.080	4.1	0.563	1.4	0.105		
Mactridae	853	2.2	0.079	5.0	0.621	0.7	0.097		
Heteromysis odontops	981	2.2	0.070	5.8	1.644				
Syllis (Typosyllis) nipponica	648	2.2	0.060	5.8	1.406				
Protothaca sp	887	2.2	0.042	5.8	0.973				
Mooreonuphis sp SD1	405	1.9	6.388					11.3	15.228
Photis sp C	1224	1.9	5.124			1.4	0.381	7.5	11.726

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Levinsenia oculata	342	1.9	4.464			1.4	0.101	7.5	10.512
Scyphoproctus oculatus	601	1.9	1.827	5.0	42.820				
Araphura cuspirostris	1029	1.9	1.528					11.3	3.642
Ampharete acutifrons	91	1.9	1.476			1.4	0.550	7.5	2.814
Bathymedon pumilus	1111	1.9	1.431			3.4	0.767	1.9	2.428
Saxicavella pacifica	898	1.9	1.377			4.1	2.560		
Lanassa venusta venusta	329	1.9	1.194			3.4	1.274	1.9	1.214
Agnezia septentrionalis	1406	1.9	1.141	0.8	0.059	2.0	0.073	3.8	2.621
Pinnixa longipes	1321	1.9	1.116	2.5	0.199	2.0	2.059		
Tanaopsis cadieni	1041	1.9	0.877			1.4	0.550	7.5	1.385
Tetrastemma candidum	72	1.9	0.873	0.8	0.102	1.4	0.029	5.7	2.033
Sthenelais sp	629	1.9	0.867			1.4	0.188	7.5	1.827
Diplodonta sericata	826	1.9	0.833	1.7	1.175			7.5	1.866
Malmgreniella sanpedroensis	370	1.9	0.821			3.4	0.107	1.9	1.821
Nebalia pugettensis Cmplx	972	1.9	0.791	0.8	1.831	3.4	1.326		
Metopa dawsoni	1196	1.9	0.748			2.0	0.241	5.7	1.474
Leptocuma forsmani	1019	1.9	0.698			4.1	1.298		
Spio filicornis	619	1.9	0.697			1.4	0.044	7.5	1.606
Enopla	59	1.9	0.670	0.8	0.203	2.7	0.756	1.9	0.607
Stylatula elongata	26	1.9	0.621			2.7	0.647	3.8	0.652
Sabellinae	579	1.9	0.523			3.4	0.671	1.9	0.386
Anopla sp D	54	1.9	0.493			3.4	0.897	1.9	0.027
Virgularia californica	31	1.9	0.483			3.4	0.747	1.9	0.193
Pentamera sp	1402	1.9	0.389			3.4	0.688	1.9	0.045
Holothuroidea	1394	1.9	0.349	1.7	0.161	1.4	0.012	3.8	0.800
Heterospio catalinensis	320	1.9	0.289			3.4	0.386	1.9	0.193
Cyclaspis sp A	1005	1.9	0.261			0.7	0.097	9.4	0.498
Pacifacanthomysis nephrophthalma	991	1.9	0.220	0.8	0.075	3.4	0.403		
Cryptonemertes actinophila	57	1.9	0.217	1.7	0.206	2.0	0.326	1.9	0.080
Virgularia agassizi	30	1.9	0.188			3.4	0.323	1.9	0.034
Phoxocephalidae	1226	1.9	0.187	1.7	0.150	0.7	0.015	5.7	0.413
Simomactra falcata	903	1.9	0.135	3.3	2.645	1.4	0.042		
Lucinoma annulatum	846	1.9	0.061			3.4	0.073	1.9	0.053
Bulla gouldiana	698	1.9	0.028	5.0	0.653				
Tubulanus sp SD1	81	1.9	0.016	5.0	0.379				
Ophiothrix spiculata	1376	1.6	3.326			0.7	0.366	7.5	7.457
Rhepoxynius heterocuspidatus	1240	1.6	2.300			1.4	0.297	5.7	5.102
Schistocomus sp A	586	1.6	2.280					9.4	5.435
Eusyllis habei	270	1.6	1.921					9.4	4.580
Fabrisabella sp A	282	1.6	1.748					9.4	4.166
Dendraster terminalis	1384	1.6	1.580			1.4	2.473	5.7	0.595
Paradoneis lyra	466	1.6	1.542					9.4	3.676
Eusyllinae	269	1.6	1.399					9.4	3.335
Aricidea (Acmira) sp SD1	137	1.6	1.181					9.4	2.815
Huxleyia munita	834	1.6	1.150			1.4	0.416	5.7	2.207

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Demonax sp	220	1.6	0.871			2.0	0.199	3.8	1.821
Branchiostoma californiense	1416	1.6	0.805	0.8	0.078	2.0	1.449	1.9	0.053
Rhepoxynius daboius	1238	1.6	0.799			1.4	0.281	5.7	1.545
Dipolydora barbilla	226	1.6	0.790			0.7	0.044	7.5	1.827
Myxicola sp	412	1.6	0.788	0.8	0.059	0.7	0.015	5.7	1.854
Amakusanthura californiensis	1044	1.6	0.753			0.7	0.044	7.5	1.739
Polyodontes panamensis	539	1.6	0.607			0.7	0.005	7.5	1.441
Gastropteron pacificum	732	1.6	0.601			1.4	0.019	5.7	1.407
Cryptocelis occidentalis	34	1.6	0.572			0.7	0.004	7.5	1.359
Eusarsiella thominx	953	1.6	0.572	1.7	0.120	1.4	0.107	1.9	1.214
Amage anops	89	1.6	0.523			1.4	0.198	5.7	0.993
Ophelina acuminata	459	1.6	0.494			2.0	0.295	3.8	0.800
Carinomella lactea	56	1.6	0.422			3.4	0.785		
Majidae	1295	1.6	0.395			2.0	0.130	3.8	0.774
Upogebia sp	1337	1.6	0.389	0.8	0.208	0.7	0.366	5.7	0.436
Diastylis pellucida	1010	1.6	0.368			3.4	0.684		
Notomastus latericeus	439	1.6	0.364			1.4	0.018	5.7	0.845
Astropecten sp	1357	1.6	0.364			2.7	0.376	1.9	0.386
Exogone sp	278	1.6	0.357	1.7	0.161			5.7	0.834
Axiothella rubrocincta	154	1.6	0.349	0.8	0.102	1.4	0.017	3.8	0.800
Goniada brunnea	299	1.6	0.332			2.0	0.564	3.8	0.067
Dendraster sp	1383	1.6	0.325			2.7	0.583	1.9	0.027
Brania californiensis	159	1.6	0.320	2.5	3.093			3.8	0.447
Cumacea	1000	1.6	0.304	0.8	0.203	0.7	0.015	5.7	0.685
Volvulella cylindrica	790	1.6	0.304			3.4	0.565		
Aricidea (Aricidea) sp SD1	145	1.6	0.295			1.4	0.009	5.7	0.692
Idarcturus allelomorphus	1058	1.6	0.228			2.0	0.284	3.8	0.180
Drilonereis falcata	235	1.6	0.223	0.8	0.091	2.7	0.407		
Praxillura maculata	546	1.6	0.221			3.4	0.410		
Kurtziella plumbea	738	1.6	0.216	0.8	0.075	2.7	0.397		
Notomastus hemipodus	438	1.6	0.216	4.1	5.057				
Prototrygaeus jordanae	945	1.6	0.207			2.0	0.199	3.8	0.238
Dendrochirotida	1392	1.6	0.153			1.4	0.029	5.7	0.327
Polycirrus sp I	531	1.6	0.119			3.4	0.221		
Photis macinerneyi	1220	1.6	0.118	0.8	0.046	2.0	0.112	1.9	0.134
Exacanthomysis davisi	980	1.6	0.117			3.4	0.217		
Philine sp	764	1.6	0.115	1.7	0.218	2.0	0.197		
Harpacticoida	969	1.6	0.112	2.5	0.388			3.8	0.227
Limaria hemphilli	843	1.6	0.111	2.5	0.511	0.7	0.015	1.9	0.193
Semele venusta	901	1.6	0.099	2.5	0.353			3.8	0.201
Nuculana penderi	870	1.6	0.086	1.7	0.373	2.0	0.131		
Pitar newcombianus	883	1.6	0.084	3.3	1.314			1.9	0.067
Chaetopteridae	169	1.6	0.043			2.0	0.027	3.8	0.067
Leitoscoloplos sp	337	1.6	0.042	2.5	0.470	0.7	0.015	1.9	0.034
Kellia suborbicularis	838	1.6	0.031	4.1	0.718				

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Acanthoptilum sp	9	1.6	0.026	1.7	0.305	2.0	0.024		
Crepidula onyx	713	1.6	0.024	4.1	0.561				
Ambidexter panamensis	1267	1.6	0.015	4.1	0.352				
Questa caudicirra	569	1.2	24.597					7.5	58.630
Pisione remota	513	1.2	5.626			0.7	0.004	5.7	13.407
Caecum californicum	700	1.2	5.401	3.3	126.576				
Leptochiton rugatus	797	1.2	4.827					7.5	11.505
Erileptus spinosus	1287	1.2	3.391					7.5	8.084
Metharpinia jonesi	1195	1.2	1.867			1.4	0.102	3.8	4.319
Pionosyllis sp SD1	508	1.2	1.391	0.8	0.046			5.7	3.311
Glyphocuma sp A	1014	1.2	1.315					7.5	3.135
Caprella equilibra	1119	1.2	1.181					7.5	2.814
Golfingiidae	1340	1.2	1.156			0.7	0.183	5.7	2.521
Bispira sp	155	1.2	1.043			2.0	1.466	1.9	0.607
Phyllodoce groenlandica	494	1.2	1.032			1.4	0.198	3.8	2.207
Ampelisca milleri	1086	1.2	0.961			1.4	0.366	3.8	1.821
Terebellides sp Type D	659	1.2	0.958			0.7	0.183	5.7	2.048
Havelockia benti	1393	1.2	0.932			0.7	0.183	5.7	1.986
Photis parvidons	1221	1.2	0.913			1.4	0.126	3.8	2.014
Aricidea (Aricidea) pseudoarticulata	144	1.2	0.830			0.7	0.015	5.7	1.959
Nephtys californiensis	420	1.2	0.806	0.8	0.059			5.7	1.915
Magelona sp SD10	361	1.2	0.758			2.0	0.935	1.9	0.607
Pentamera populifera	1400	1.2	0.697			1.4	0.198	3.8	1.407
Protocirrineris sp B	557	1.2	0.696			0.7	0.015	5.7	1.640
Plakosyllis sp	520	1.2	0.673					7.5	1.605
Myriochele sp	408	1.2	0.651			2.0	0.737	1.9	0.607
Chauliopleona dentata	1031	1.2	0.604					7.5	1.441
Adontorhina cyclia	800	1.2	0.599			2.7	1.114		
Paradoneis spinifera	468	1.2	0.595					7.5	1.419
Proclea sp A	555	1.2	0.555			2.7	1.033		
Caecum occidentale	702	1.2	0.524	2.5	10.526			1.9	0.179
Campylaspis canaliculata	995	1.2	0.443			0.7	0.015	5.7	1.038
Aphelochaeta phillipsi	114	1.2	0.435					7.5	1.038
Notoproctus pacificus	443	1.2	0.398			1.4	0.117	3.8	0.800
Corymorpha bigelowi	1	1.2	0.380			1.4	0.198	3.8	0.652
Nephtys squamosa	426	1.2	0.369					7.5	0.879
Gari sp	831	1.2	0.362			2.7	0.673		
Neomysis kadiakensis	990	1.2	0.359			2.7	0.668		
Scolelepis squamata	592	1.2	0.352	0.8	0.102	0.7	0.097	3.8	0.704
Munnogonium tillerae	1065	1.2	0.345	0.8	0.046	0.7	0.015	3.8	0.800
Cancer gracilis	1274	1.2	0.334	0.8	0.102	0.7	0.097	3.8	0.660
Euphysa sp A	5	1.2	0.321			1.4	0.281	3.8	0.406
Vargula tsujii	967	1.2	0.268	2.5	0.320			1.9	0.607
Juliacorbula luteola	837	1.2	0.267	0.8	0.058	1.4	0.019	1.9	0.607
Naineris uncinata	415	1.2	0.265	0.8	0.102	0.7	0.183	3.8	0.386

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Eohaustorius barnardi	1134	1.2	0.223			1.4	0.011	3.8	0.519
Eusyllis sp	271	1.2	0.221	0.8	0.305	0.7	0.183	3.8	0.260
Epitonium sawinae	725	1.2	0.219			2.0	0.381	1.9	0.034
Paranaitis polynoides	470	1.2	0.195			2.0	0.212	1.9	0.193
Elasmopus bampo	1129	1.2	0.187	3.3	4.390				
Stenothoides bicoma	1254	1.2	0.185			2.0	0.310	1.9	0.045
Rhepoxynius sp	1243	1.2	0.165			2.7	0.307		
Exogone molesta	277	1.2	0.149			0.7	0.183	5.7	0.120
Syllis (Typosyllis) farallonensis	647	1.2	0.148			1.4	0.198	3.8	0.098
Aricidea (Acmira) lopezi	132	1.2	0.136			2.0	0.218	1.9	0.045
Aoroides inermis	1099	1.2	0.111			2.0	0.055	1.9	0.193
Tiburonella viscana	1256	1.2	0.111			1.4	0.032	3.8	0.222
Chaetozone sp SD2	182	1.2	0.102			2.7	0.189		
Nephasoma sp	1341	1.2	0.087	0.8	0.059	1.4	0.007	1.9	0.193
Lumbrineris limicola	351	1.2	0.071	2.5	0.665			1.9	0.101
Ogyrides sp A	1304	1.2	0.061	0.8	0.075	2.0	0.108		
Piromis sp SD1	512	1.2	0.059	3.3	1.378				
Paramicrodeutopus schmitti	1213	1.2	0.055	3.3	1.285				
Ampharetinae	98	1.2	0.053			2.0	0.073	1.9	0.034
Deltamysis sp A	979	1.2	0.040	2.5	0.750	0.7	0.015		
Mysidopsis californica	985	1.2	0.040	3.3	0.927				
Chione undatella	814	1.2	0.037	3.3	0.869				
Acteocina harpa	673	1.2	0.031	3.3	0.718				
Lucinisca nuttalli	845	1.2	0.021	1.7	0.134	1.4	0.029		
Argopecten ventricosus	805	1.2	0.021	3.3	0.488				
Corymorphidae	3	1.2	0.020	2.5	0.295	0.7	0.015		
Rhamphidonta retifera	890	1.2	0.020	2.5	0.285	0.7	0.015		
Harmothoe sp	311	1.2	0.019	3.3	0.444				
Malacoplax californiensis	1296	1.2	0.016	3.3	0.383				
Mysidella americana	984	1.2	0.016	0.8	0.045	2.0	0.027		
Corymorphidae sp SD1	4	1.2	0.016	3.3	0.378				
Syllis (Syllis) gracilis	646	1.2	0.015	3.3	0.341				
Bemlos sp	1115	1.2	0.014	3.3	0.328				
Cnemidocarpa rhizopus	1408	0.9	2.064			1.4	0.524	1.9	4.249
Acrocirrus sp	84	0.9	2.026					5.7	4.828
Anoplodactylus nodosus	941	0.9	1.798	0.8	0.046			3.8	4.282
Potamethus sp LA1	543	0.9	1.690					5.7	4.028
Nutricola lordi	873	0.9	1.609					5.7	3.835
Laonice sp	333	0.9	1.235			1.4	0.188	1.9	2.704
Aphelochaeta sp SD2	119	0.9	1.100					5.7	2.621
Nothria sp	436	0.9	1.100					5.7	2.621
Sipunculus nudus	1347	0.9	1.019					5.7	2.428
Pylopagurus holmesi	1330	0.9	1.007					5.7	2.400
Typhlotanais crassus	1042	0.9	0.903					5.7	2.152
Mooreonuphis exigua	401	0.9	0.902					5.7	2.151

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Glycera tenuis	297	0.9	0.816			1.4	1.491	1.9	0.034
Tanaella propinquus	1039	0.9	0.780			0.7	0.029	3.8	1.821
Malmgreniella scriptoria	371	0.9	0.775					5.7	1.848
Aphelochaeta sp LA2	118	0.9	0.741					5.7	1.766
Phyllodoce medipapillata	497	0.9	0.691			0.7	1.099	3.8	0.238
Guernea reduncans	1153	0.9	0.661					5.7	1.575
Paguridae	1306	0.9	0.656			0.7	0.015	3.8	1.545
Ophiopsila californica	1375	0.9	0.653			0.7	0.233	3.8	1.259
Praxillella gracilis	544	0.9	0.649			1.4	0.733	1.9	0.607
Parapagurodes laurentae	1314	0.9	0.604					5.7	1.441
Hesperonoe complanata	315	0.9	0.596	0.8	0.102	1.4	1.099		
Subadyte mexicana	637	0.9	0.590					5.7	1.407
Lacydonia sp	326	0.9	0.584					5.7	1.393
Amphipholis pugetana	1368	0.9	0.579					5.7	1.380
Caecianiropsis sp	1047	0.9	0.528					5.7	1.259
Acila castrensis	799	0.9	0.518			0.7	0.183	3.8	0.999
Stylatula sp A	28	0.9	0.514			1.4	0.009	1.9	1.214
Nutricola cymata	872	0.9	0.498					5.7	1.186
Euchone sp	254	0.9	0.498					5.7	1.186
Prionospio (Minuspio) multibranchiata	548	0.9	0.460					5.7	1.096
Calyptraea fastigiata	703	0.9	0.460			1.4	0.381	1.9	0.607
Lepidasthenia longicirrata	339	0.9	0.434			0.7	0.183	3.8	0.800
Alvania rosana	686	0.9	0.417					5.7	0.993
Cumella sp	1002	0.9	0.417					5.7	0.993
Brachyura	1272	0.9	0.388			0.7	0.097	3.8	0.800
Ophiura luetkenii	1377	0.9	0.361			1.4	0.198	1.9	0.607
Euchone hancocki	250	0.9	0.359			1.4	0.195	1.9	0.607
Bemlos audbettius	1112	0.9	0.359			1.4	0.366	1.9	0.386
Ophiodermella sp	759	0.9	0.355			1.4	0.187	1.9	0.607
Sphenia luticola	910	0.9	0.351			0.7	0.029	3.8	0.800
Acidostoma hancocki	1075	0.9	0.338			0.7	0.005	3.8	0.800
Crangonidae	1281	0.9	0.326			0.7	0.097	3.8	0.652
Campylaspis rufa	999	0.9	0.280					5.7	0.667
Onuphis iridescens	452	0.9	0.278			1.4	0.366	1.9	0.193
Pleurobranchaea californica	766	0.9	0.277			0.7	0.015	3.8	0.640
Dorvilleidae	234	0.9	0.272	1.7	0.396			1.9	0.607
Thracia curta	922	0.9	0.264	0.8	0.203	1.4	0.475		
Lophopanopeus sp	1294	0.9	0.263	1.7	0.191			1.9	0.607
Pentamera pseudopopulifera	1401	0.9	0.262			1.4	0.014	1.9	0.607
Demonax pallidus	219	0.9	0.247	0.8	0.102			3.8	0.579
Mesochaetopterus sp	387	0.9	0.243					5.7	0.579
Clymenella sp A	210	0.9	0.209			2.0	0.388		
Ysideria hastata	666	0.9	0.205			2.0	0.381		
Mytilus sp	863	0.9	0.182	2.5	4.276				
Mandibulophoxus gilesi	1186	0.9	0.159			2.0	0.296		

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Sipunculidae	1346	0.9	0.158	0.8	0.075	1.4	0.287		
Sabellaria sp	575	0.9	0.157			2.0	0.292		
Eupolymnia heterobranchia	268	0.9	0.154	0.8	0.075	1.4	0.281		
Aruga holmesi	1107	0.9	0.139	0.8	0.104	0.7	0.015	1.9	0.302
Hemipodus borealis	312	0.9	0.124			1.4	0.209	1.9	0.027
Exogone acutipalpa	273	0.9	0.123					5.7	0.294
Listriella sp	1183	0.9	0.116	0.8	0.078	0.7	0.183	1.9	0.034
Megalomma sp	382	0.9	0.114	0.8	0.183	1.4	0.198		
Syllis (Typosyllis) sp	649	0.9	0.112	0.8	0.078	0.7	0.097	1.9	0.134
Hesionidae	313	0.9	0.111	0.8	0.059	0.7	0.097	1.9	0.134
Thracia sp	923	0.9	0.110	0.8	0.075	1.4	0.198		
Oenonidae	449	0.9	0.108			2.0	0.201		
Amphioplus sp	1365	0.9	0.106			2.0	0.197		
Thesea sp B	29	0.9	0.103			0.7	0.015	3.8	0.227
Rhachotropis sp A	1235	0.9	0.091			1.4	0.019	1.9	0.193
Armina californica	691	0.9	0.091			1.4	0.018	1.9	0.193
Drilonereis longa	236	0.9	0.088	0.8	0.045	0.7	0.009	1.9	0.193
Halistylus pupoideus	734	0.9	0.083			1.4	0.119	1.9	0.045
Lophopanopeus bellus	1292	0.9	0.074	1.7	0.415			1.9	0.134
Exosphaeroma rhomburum	1054	0.9	0.074	1.7	0.414			1.9	0.134
Pareurythoe californica	476	0.9	0.073	0.8	1.017			3.8	0.071
Brania sp	161	0.9	0.071	0.8	0.075			3.8	0.161
Aphelochaeta tigrina	122	0.9	0.070					5.7	0.168
Levinsenia multibranchiata	341	0.9	0.067			2.0	0.125		
Crepidula naticarum	712	0.9	0.064	0.8	0.225	1.4	0.101		
Mactromeris hemphilli	854	0.9	0.060			2.0	0.112		
Pachynus barnardi	1209	0.9	0.058			2.0	0.108		
Melanochlamys diomedea	745	0.9	0.058	1.7	0.470			1.9	0.089
Isaeidae	1170	0.9	0.057			1.4	0.043	1.9	0.080
Blepharipoda occidentalis	1271	0.9	0.052					5.7	0.124
Leporimetis obesa	841	0.9	0.051	2.5	1.186				
Heteronemertea	61	0.9	0.049	0.8	0.078	0.7	0.015	1.9	0.089
Streblospio benedicti	636	0.9	0.047	2.5	1.095				
Syllides minutus	640	0.9	0.041					5.7	0.098
Cephalaspidea	706	0.9	0.034	0.8	0.102			3.8	0.071
Ostrea sp	877	0.9	0.029	2.5	0.671				
Apolochus barnardi	1105	0.9	0.027	2.5	0.633				
Boccardiella hamata	157	0.9	0.025	1.7	0.417	0.7	0.014		
Aeolidoida	677	0.9	0.025	1.7	0.150			1.9	0.045
Volvulella catharia	789	0.9	0.024			1.4	0.019	1.9	0.034
Listriella eriopisa	1180	0.9	0.021	1.7	0.305	0.7	0.015		
Timarete sp	662	0.9	0.020	2.5	0.464				
Paracaprella sp	1210	0.9	0.020	2.5	0.464				
Veneridae	930	0.9	0.019	2.5	0.453				
Thracia trapezoides	924	0.9	0.018	0.8	0.059	1.4	0.029		

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Polyophthalmus pictus	540	0.9	0.017	2.5	0.409				
Eteone fauchaldi	247	0.9	0.015	1.7	0.305	0.7	0.004		
Eugyra arenosa californica	1409	0.9	0.014			2.0	0.027		
Gammaropsis sp	1146	0.9	0.014	0.8	0.104	1.4	0.018		
Naushonia macginitiei	1299	0.9	0.013	2.5	0.313				
Caprella sp	1123	0.9	0.010	2.5	0.236				
Parviplana californica	41	0.9	0.009	1.7	0.148	0.7	0.005		
Cancer jordani	1275	0.9	0.009	0.8	0.102	1.4	0.008		
Lamprops quadriplicatus	1018	0.9	0.008			2.0	0.015		
Sphaerosyllis sp LA2	617	0.6	21.135					3.8	50.380
Pinnixa schmitti	1323	0.6	5.355			0.7	0.015	1.9	12.747
Barleeia subtenuis	697	0.6	3.630	1.7	85.062				
Sphaerosyllis ranunculus	613	0.6	1.852					3.8	4.414
Saxicavella sp	899	0.6	1.781			1.4	3.312		
Edotia sp SD1	1050	0.6	1.367					3.8	3.259
Petaloproctus neoborealis	480	0.6	1.305			0.7	0.058	1.9	3.035
Pionosyllis sp SD2	509	0.6	1.292					3.8	3.080
Aricidea (Acmira) rubra	133	0.6	1.273					3.8	3.035
Sphaerosyllis sp LA1	616	0.6	1.273					3.8	3.035
Pleurogonium sp	1069	0.6	1.019					3.8	2.428
Aricidea (Acmira) sp LA1	136	0.6	0.914					3.8	2.180
Sphaerosyllis bilineata	611	0.6	0.903					3.8	2.152
Mesocrangon munitella	1297	0.6	0.845					3.8	2.014
Aoroides intermedia	1100	0.6	0.723					3.8	1.724
Callipallene pacifica	944	0.6	0.608			0.7	0.183	1.9	1.214
Galathowenia pygidialis	288	0.6	0.608			0.7	0.183	1.9	1.214
Tellina sp	919	0.6	0.591			1.4	1.099		
Brissopsis pacifica	1381	0.6	0.590					3.8	1.407
Cirrophorus branchiatus	206	0.6	0.590					3.8	1.407
Deilocerus sp	1285	0.6	0.590					3.8	1.407
Microjassa litotes	1198	0.6	0.562			0.7	0.097	1.9	1.214
Ampelisca romigi	1089	0.6	0.523					3.8	1.247
Monoculodes emarginatus	1200	0.6	0.521			0.7	0.366	1.9	0.773
Clymenella sp	209	0.6	0.509					3.8	1.214
Euchone sp LA1	256	0.6	0.509					3.8	1.214
Loimia sp A	343	0.6	0.509					3.8	1.214
Ophelina sp SD1	460	0.6	0.509					3.8	1.214
Philomedes sp A	959	0.6	0.509					3.8	1.214
Prosorhochmus albidus	71	0.6	0.509					3.8	1.214
Pagurus sp	1311	0.6	0.498					3.8	1.186
Polycirrinae	527	0.6	0.498					3.8	1.186
Hornellia occidentalis	1168	0.6	0.433			0.7	0.004	1.9	1.029
Euchone rosea	253	0.6	0.417					3.8	0.993
Eusarsiella sp A	952	0.6	0.417					3.8	0.993
Thelepus setosus	661	0.6	0.417					3.8	0.993

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Thyasiridae sp LA1	926	0.6	0.417					3.8	0.993
Dougaloplus sp 1	1374	0.6	0.394			1.4	0.733		
Acteon traskii	676	0.6	0.353			0.7	0.183	1.9	0.607
Polydora limicola	535	0.6	0.353			0.7	0.183	1.9	0.607
Hyalopomatus biformis	322	0.6	0.338					3.8	0.806
Lepidepecreum gurjanovae	1174	0.6	0.336					3.8	0.800
Ericthonius rubricornis	1136	0.6	0.307			0.7	0.097	1.9	0.607
Eteone sp	248	0.6	0.307			0.7	0.097	1.9	0.607
Balcis oldroydae	696	0.6	0.295			0.7	0.097	1.9	0.579
Spatangus californicus	1389	0.6	0.283					3.8	0.674
Pherusa capulata	481	0.6	0.279	0.8	0.572			1.9	0.607
Eteone californica	246	0.6	0.278			0.7	0.366	1.9	0.193
Iselica ovoidea	736	0.6	0.268	0.8	0.305			1.9	0.607
Pionosyllis articulata	506	0.6	0.253			0.7	0.366	1.9	0.134
Eobrolgus chumashi	1131	0.6	0.248			0.7	0.009	1.9	0.579
Amphicteis mucronata	100	0.6	0.243					3.8	0.579
Isocirrus longiceps	324	0.6	0.243					3.8	0.579
Pseudomma berkeleyi	992	0.6	0.243					3.8	0.579
Aruga oculata	1108	0.6	0.211			0.7	0.366	1.9	0.034
Anonyx lilljeborgi	1095	0.6	0.205			1.4	0.381		
Sabellariidae	576	0.6	0.199			1.4	0.370		
Doto kya	721	0.6	0.197			1.4	0.366		
Ostracoda	957	0.6	0.197			1.4	0.366		
Protomystides sp SD1	561	0.6	0.175					3.8	0.417
Ericthonius sp SD1	1138	0.6	0.173					3.8	0.413
Sabellaria nanella	574	0.6	0.167			1.4	0.310		
Dorvillea (Dorvillea) sp	232	0.6	0.162					3.8	0.386
Pionosyllis sp	507	0.6	0.162					3.8	0.386
Rhepoxynius sp A	1244	0.6	0.159			1.4	0.296		
Dentalium vallicolens	934	0.6	0.157			1.4	0.292		
Tetrastemma sp	74	0.6	0.137					3.8	0.327
Cuthona divae	717	0.6	0.133			0.7	0.097	1.9	0.193
Leucon subnasica	1021	0.6	0.133			0.7	0.097	1.9	0.193
Magelona sp	359	0.6	0.133			0.7	0.097	1.9	0.193
Sphaerosyllis sp	614	0.6	0.131					3.8	0.313
Grippina californica	832	0.6	0.127					3.8	0.303
Dendronotus sp	719	0.6	0.123			0.7	0.195	1.9	0.045
Cuspidaria parapodema	820	0.6	0.114			1.4	0.212		
Nutricola tantilla	875	0.6	0.109			0.7	0.097	1.9	0.134
Mysidopsis cathengelae	986	0.6	0.107			1.4	0.198		
Cirriformia sp LA1	202	0.6	0.106			1.4	0.198		
Oerstedia dorsalis	66	0.6	0.106			1.4	0.198		
Solenocera mutator	1334	0.6	0.106			1.4	0.198		
Volvulella sp	792	0.6	0.106			1.4	0.198		
Astropecten armatus	1355	0.6	0.105			1.4	0.195		

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Chione sp	813	0.6	0.105			1.4	0.195		
Eyakia robusta	1139	0.6	0.101			1.4	0.188		
Prachynella lodo	1233	0.6	0.101			1.4	0.188		
Calocarides spinulicauda	1273	0.6	0.100			1.4	0.187		
Aoroides sp A	1103	0.6	0.100					3.8	0.238
Gitana calitemplado	1151	0.6	0.098					3.8	0.235
Vaunthompsonia sp	1027	0.6	0.095					3.8	0.227
Ericthonius sp	1137	0.6	0.092					3.8	0.220
Isorobitella trigonalis	836	0.6	0.092					3.8	0.220
Pinnixa forficulimanus	1318	0.6	0.090			0.7	0.097	1.9	0.089
Orchomene anaquelus	1207	0.6	0.089			0.7	0.015	1.9	0.193
Pleustidae	1227	0.6	0.088			0.7	0.014	1.9	0.193
Podocopida	960	0.6	0.085	0.8	0.104			1.9	0.193
Syllides sp	642	0.6	0.085	0.8	0.102			1.9	0.193
Tubularia crocea	8	0.6	0.076			1.4	0.141		
Pseudotanais makrothrix	1035	0.6	0.074	1.7	1.730				
Trichobranchus sp HYP1	665	0.6	0.070					3.8	0.168
Protocirrineris sp SD1	558	0.6	0.067	1.7	1.562				
Chaetozone sp HYP6	181	0.6	0.062			1.4	0.115		
Sinum scopulosum	772	0.6	0.060			1.4	0.112		
Parvaplustrum sp A	761	0.6	0.059	0.8	0.102	0.7	0.102		
Phyllodocidae	500	0.6	0.057	0.8	0.102	0.7	0.097		
Lamprops carinatus	1017	0.6	0.056					3.8	0.134
Ancistrosyllis hamata	106	0.6	0.055			1.4	0.102		
Brada villosa	158	0.6	0.055			1.4	0.102		
Goniada sp	302	0.6	0.055			1.4	0.102		
Hesperonoe sp	317	0.6	0.054			1.4	0.101		
Scolelepis tridentata	593	0.6	0.054			1.4	0.101		
Lepidopa californica	1291	0.6	0.049					3.8	0.116
Paraonella platybranchia	473	0.6	0.047					3.8	0.112
Crenella decussata	817	0.6	0.045			0.7	0.058	1.9	0.034
Tectura depicta	776	0.6	0.043	1.7	1.017				
Conus californicus	710	0.6	0.042					3.8	0.101
Macrochaeta sp SD2	357	0.6	0.039	1.7	0.916				
Macrochaeta sp A	356	0.6	0.038					3.8	0.089
Mediomastus acutus	379	0.6	0.037			1.4	0.069		
Exogone sp MEC1	279	0.6	0.035	1.7	0.814				
Chone sp HYP2	194	0.6	0.031	0.8	0.075			1.9	0.067
Hyale sp	1169	0.6	0.030	1.7	0.702				
Amphipholis sp	1369	0.6	0.030			0.7	0.029	1.9	0.034
Sigambra bassi	605	0.6	0.023			1.4	0.044		
Calyptraeidae	704	0.6	0.023	1.7	0.549				
Cyclaspis sp C	1006	0.6	0.022					3.8	0.053
Pterocirrus sp A	568	0.6	0.022			0.7	0.015	1.9	0.034
Cyclaspis nubila	1003	0.6	0.021			0.7	0.004	1.9	0.045

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Aoridae	1096	0.6	0.020	0.8	0.203			1.9	0.027
Macoma indentata	849	0.6	0.019			1.4	0.036		
Balcis micans	695	0.6	0.019			0.7	0.015	1.9	0.027
Thelepus hamatus	660	0.6	0.018	0.8	0.104			1.9	0.034
Fabricinae	280	0.6	0.017	0.8	0.203	0.7	0.015		
Phyllodoce cuspidata	493	0.6	0.016			1.4	0.029		
Plehnia caeca	42	0.6	0.016			1.4	0.029		
Chaetozone senticosa	175	0.6	0.016	1.7	0.365				
Alia sp	683	0.6	0.015	0.8	0.102			1.9	0.027
Acteocina sp	675	0.6	0.013	1.7	0.305				
Listriella sp A	1184	0.6	0.012	1.7	0.287				
Stylochoplana sp	48	0.6	0.011	1.7	0.251				
Rutiderma judayi	963	0.6	0.011	1.7	0.249				
Caprella gracilior	1120	0.6	0.009	0.8	0.102	0.7	0.009		
Joeropsis dubia	1063	0.6	0.009	0.8	0.102	0.7	0.009		
Ctenodrilus serratus	217	0.6	0.009	1.7	0.203				
Podochela hemphillii	1328	0.6	0.008	1.7	0.183				
Microcosmus squamiger	1410	0.6	0.008	1.7	0.180				
Pinnixa tubicola	1325	0.6	0.007			1.4	0.014		
Pinnixa hiatus	1320	0.6	0.007	0.8	0.045	0.7	0.009		
Scolelepis occidentalis	588	0.6	0.007	0.8	0.102	0.7	0.005		
Chione californiensis	812	0.6	0.006	0.8	0.059	0.7	0.007		
Lepidozona sp	796	0.6	0.006	0.8	0.102	0.7	0.004		
Alpheopsis equidactylus	1263	0.6	0.005	1.7	0.124				
Alpheidae	1262	0.6	0.005	1.7	0.121				
Crangon nigromaculata	1279	0.6	0.005	0.8	0.075	0.7	0.004		
Caryocorbula porcella	810	0.6	0.005	1.7	0.119				
Nereis latescens	430	0.6	0.005	0.8	0.059	0.7	0.005		
Stylatula sp	27	0.6	0.005			1.4	0.009		
Caprellidea	1124	0.6	0.004	1.7	0.092				
Laphania sp	334	0.3	12.223					1.9	29.135
Myidae sp SD1	861	0.3	5.347					1.9	12.747
Molgula regularis	1412	0.3	3.056					1.9	7.284
Chaetozone sp HYP3	180	0.3	2.269					1.9	5.408
Pseudofabriciola californica	562	0.3	2.037					1.9	4.856
Mooreonuphis segmentispadix	403	0.3	1.019					1.9	2.428
Photis sp B	1223	0.3	1.019					1.9	2.428
Gammaropsis ociosa	1145	0.3	0.764					1.9	1.821
Lepidepecreum serraculum	1175	0.3	0.764					1.9	1.821
Mystides caeca	411	0.3	0.764					1.9	1.821
Scionella japonica	587	0.3	0.764					1.9	1.821
Aphelochaeta sp SD3	120	0.3	0.600					1.9	1.431
Campylaspis blakei	994	0.3	0.509					1.9	1.214
Gammaropsis spinosa	1147	0.3	0.509					1.9	1.214
Parapagurodes hartae	1313	0.3	0.509					1.9	1.214

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Phylo felix	501	0.3	0.509					1.9	1.214
Pontogeneia rostrata	1232	0.3	0.509					1.9	1.214
Scleroconcha trituberculata	966	0.3	0.509					1.9	1.214
Syllides reishi	641	0.3	0.509					1.9	1.214
Trigonulina pacifica	929	0.3	0.509					1.9	1.214
Syllis (Typosyllis) sp SD1	651	0.3	0.394					1.9	0.939
Rudilemboides sp HYP1	1249	0.3	0.368					1.9	0.876
Caulleriella sp SD2	167	0.3	0.356					1.9	0.850
Ampharete goesi	93	0.3	0.324					1.9	0.773
Aoroides columbiae	1097	0.3	0.324					1.9	0.773
Microphthalmus sp	390	0.3	0.324					1.9	0.773
Eusyllis transecta	272	0.3	0.296			0.7	0.550		
Antalis pretiosum	932	0.3	0.255					1.9	0.607
Anthozoa #49	12	0.3	0.255					1.9	0.607
Antiplanes thalea	689	0.3	0.255					1.9	0.607
Aphelochaeta williamsae	123	0.3	0.255					1.9	0.607
Clymenura columbiana	211	0.3	0.255					1.9	0.607
Erato sp	727	0.3	0.255					1.9	0.607
Fabia subquadrata	1289	0.3	0.255					1.9	0.607
Fauveliopsis sp SD1	284	0.3	0.255					1.9	0.607
Flabelligella sp LA1	285	0.3	0.255					1.9	0.607
Glyphocuma sp LA1	1015	0.3	0.255					1.9	0.607
Harbansus mayeri	954	0.3	0.255					1.9	0.607
Maldanella robusta	364	0.3	0.255					1.9	0.607
Molgula pugetiensis	1411	0.3	0.255					1.9	0.607
Nicon moniloceras	434	0.3	0.255					1.9	0.607
Novafabricia sp	444	0.3	0.255					1.9	0.607
Paguroidea	1310	0.3	0.255					1.9	0.607
Philine californica	763	0.3	0.255					1.9	0.607
Photis linearmanus	1219	0.3	0.255					1.9	0.607
Pista elongata	517	0.3	0.255					1.9	0.607
Platymera gaudichaudii	1327	0.3	0.255					1.9	0.607
Polycladida sp 27	45	0.3	0.255					1.9	0.607
Procerastea sp	554	0.3	0.255					1.9	0.607
Pseudochama granti	889	0.3	0.255					1.9	0.607
Pseudopotamilla socialis	565	0.3	0.255					1.9	0.607
Pseudopotamilla sp LA1	567	0.3	0.255					1.9	0.607
Salmacina sp	581	0.3	0.255					1.9	0.607
Scalibregmatidae	584	0.3	0.255					1.9	0.607
Sipuncula sp SD2	1345	0.3	0.255					1.9	0.607
Sphaerodoridium sp A	609	0.3	0.255					1.9	0.607
Sphaerodorum papillifer	610	0.3	0.255					1.9	0.607
Syllides mikeli	639	0.3	0.255					1.9	0.607
Syllinae	643	0.3	0.255					1.9	0.607
Synelmis albini	652	0.3	0.255					1.9	0.607

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Synidotea sp	1073	0.3	0.255					1.9	0.607
Tetrastemma nigrifrons	73	0.3	0.255					1.9	0.607
Vitreolina yod	786	0.3	0.255					1.9	0.607
Lanassa gracilis	327	0.3	0.243					1.9	0.579
Microphthalmus hystrix	389	0.3	0.243					1.9	0.579
Tiron sp	1258	0.3	0.243					1.9	0.579
Chaetozone sp SD6	185	0.3	0.225					1.9	0.537
Ancinus granulatus	1045	0.3	0.209			0.7	0.389		
Cymatioa electilis	824	0.3	0.197			0.7	0.366		
Nasagenia quinsana	1204	0.3	0.174	0.8	4.070				
Chaetozone sp HYP1	178	0.3	0.162					1.9	0.386
Melinna heterodonta	384	0.3	0.162					1.9	0.386
Odontosyllis sp LA2	448	0.3	0.162					1.9	0.386
Orobitella californica	876	0.3	0.162					1.9	0.386
Pristes sp	885	0.3	0.157			0.7	0.292		
Anomura	1268	0.3	0.131					1.9	0.313
Batea transversa	1110	0.3	0.113					1.9	0.268
Atylus tridens	1109	0.3	0.105			0.7	0.195		
Heteromastus filiformis	318	0.3	0.105			0.7	0.195		
Dendraster excentricus	1382	0.3	0.105			0.7	0.195		
Apomatus timsii	126	0.3	0.099			0.7	0.183		
Bemlos concavus	1113	0.3	0.099			0.7	0.183		
Chaetopterus variopedatus Cmplx	170	0.3	0.099			0.7	0.183		
Diaphorodoris lirulatocauda	720	0.3	0.099			0.7	0.183		
Drilonereis nuda	238	0.3	0.099			0.7	0.183		
Halosydna brevisetosa	306	0.3	0.099			0.7	0.183		
Halosydna latior	308	0.3	0.099			0.7	0.183		
Megalomma splendida	383	0.3	0.099			0.7	0.183		
Myriowenia californiensis	410	0.3	0.099			0.7	0.183		
Panopea abrupta	879	0.3	0.099			0.7	0.183		
Paraninoe fusca	472	0.3	0.099			0.7	0.183		
Petrolisthes cinctipes	1316	0.3	0.099			0.7	0.183		
Pseudopotamilla sp	566	0.3	0.099			0.7	0.183		
Schistocomus hiltoni	585	0.3	0.099			0.7	0.183		
Syllidae	638	0.3	0.099			0.7	0.183		
Tritonia sp	780	0.3	0.099			0.7	0.183		
Eulithidium substriatum	729	0.3	0.094					1.9	0.224
Apistobranchus ornatus	125	0.3	0.087	0.8	2.035				
Paracyathus stearnsii	23	0.3	0.084					1.9	0.201
Ampeliscidae	1091	0.3	0.081					1.9	0.193
Anoplodactylus sp	942	0.3	0.081					1.9	0.193
Antiplanes catalinae	688	0.3	0.081					1.9	0.193
Arhynchite californicus	1349	0.3	0.081					1.9	0.193
Asclerocheilus californicus	152	0.3	0.081					1.9	0.193
Cancellaria cooperii	705	0.3	0.081					1.9	0.193

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Chaetozone sp HYP2	179	0.3	0.081					1.9	0.193
Chone sp HYP1	193	0.3	0.081					1.9	0.193
Chromopleustes oculatus	1126	0.3	0.081					1.9	0.193
Enallopaguropsis guatemoci	1286	0.3	0.081					1.9	0.193
Garosyrrhoe bigarra	1149	0.3	0.081					1.9	0.193
Harpiniopsis galera	1155	0.3	0.081					1.9	0.193
Heathia porosa	794	0.3	0.081					1.9	0.193
Joeropsis concava	1062	0.3	0.081					1.9	0.193
Monticellina sp HYP1	398	0.3	0.081					1.9	0.193
Notaspidea	751	0.3	0.081					1.9	0.193
Onchidorididae	756	0.3	0.081					1.9	0.193
Opisthobranchia	760	0.3	0.081					1.9	0.193
Opisthodonta sp SD1	462	0.3	0.081					1.9	0.193
Paguristes sp HYP1	1308	0.3	0.081					1.9	0.193
Pherusa negligens	482	0.3	0.081					1.9	0.193
Photis bifurcata	1215	0.3	0.081					1.9	0.193
Phyllochaetopterus sp	492	0.3	0.081					1.9	0.193
Piromis sp	510	0.3	0.081					1.9	0.193
Pleusymtes subglaber	1228	0.3	0.081					1.9	0.193
Psammodoris thompsoni	768	0.3	0.081					1.9	0.193
Pseudotanais californiensis	1034	0.3	0.081					1.9	0.193
Scoloura phillipsi	1036	0.3	0.081					1.9	0.193
Siphonolabrum californiensis	1037	0.3	0.081					1.9	0.193
Sosane occidentalis	608	0.3	0.081					1.9	0.193
Spatangoida	1388	0.3	0.081					1.9	0.193
Spinosphaera sp SD1	618	0.3	0.081					1.9	0.193
Stenothoe estacola	1252	0.3	0.081					1.9	0.193
Tubulanus sp	80	0.3	0.081					1.9	0.193
Typhlotanais williamsi	1043	0.3	0.081					1.9	0.193
Vitreolina macra	785	0.3	0.081					1.9	0.193
Elasmopus sp 1	1130	0.3	0.061	0.8	1.424				
Lirobarleeia kelseyi	740	0.3	0.058			0.7	0.108		
Campylaspis hartae	997	0.3	0.056					1.9	0.134
Notoplana sp	39	0.3	0.056					1.9	0.134
Procephalothrix major	70	0.3	0.056					1.9	0.134
Pilargidae genus A sp A	502	0.3	0.056					1.9	0.134
Araphura sp	1030	0.3	0.052			0.7	0.097		
Cirriformia sp	200	0.3	0.052			0.7	0.097		
Cirriformia sp SD2	204	0.3	0.052			0.7	0.097		
Crangon sp	1280	0.3	0.052			0.7	0.097		
Epitonium lowei	724	0.3	0.052			0.7	0.097		
Ischyrocerus pelagops	1172	0.3	0.052			0.7	0.097		
Mysidopsis cf onofrensis	987	0.3	0.052			0.7	0.097		
Neocrangon zacae	1300	0.3	0.052			0.7	0.097		
Nephtys sp SD2	425	0.3	0.052			0.7	0.097		

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Nereiphylla sp 3	429	0.3	0.052			0.7	0.097		
Ophelia limacina	456	0.3	0.052			0.7	0.097		
Parametaphoxus quaylei	1212	0.3	0.052			0.7	0.097		
Pentamera lissoplaca	1399	0.3	0.052			0.7	0.097		
Phisidia sp	487	0.3	0.052			0.7	0.097		
Podocerus brasiliensis	1229	0.3	0.052			0.7	0.097		
Poromya sp	884	0.3	0.052			0.7	0.097		
Terebra hemphilli	778	0.3	0.052			0.7	0.097		
Terebra pedroana	779	0.3	0.052			0.7	0.097		
Fauveliopsis armata	283	0.3	0.042					1.9	0.101
Travisia gigas	664	0.3	0.042					1.9	0.101
Tellina bodegensis	912	0.3	0.038					1.9	0.089
Tellina nuculoides	918	0.3	0.038					1.9	0.089
Cubanomysis mysteriosa	978	0.3	0.033					1.9	0.080
Ampithoe plumulosa	1094	0.3	0.030	0.8	0.712				
Aglaophamus erectans	85	0.3	0.028					1.9	0.067
Corynactis californica	15	0.3	0.028					1.9	0.067
Polycirrus sp III	532	0.3	0.028					1.9	0.067
Protocirrineris sp	556	0.3	0.028					1.9	0.067
Uromunna ubiquita	1074	0.3	0.028					1.9	0.067
Kupellonura sp	1064	0.3	0.023			0.7	0.044		
Betaeus harrimani	1270	0.3	0.023	0.8	0.548				
Glycera capitata	290	0.3	0.022					1.9	0.053
Hartmanodes murrius	1157	0.3	0.022	0.8	0.509				
Acanthodoris rhodoceras	669	0.3	0.019					1.9	0.045
Aoroides exilis	1098	0.3	0.019					1.9	0.045
Archaeomysis grebnitzkii	977	0.3	0.019					1.9	0.045
Armandia sp SD1	149	0.3	0.019					1.9	0.045
Bathycopea daltonae	1046	0.3	0.019					1.9	0.045
Crangon nigricauda	1278	0.3	0.019					1.9	0.045
Harbansus sp SD1	955	0.3	0.019					1.9	0.045
Irusella lamellifera	835	0.3	0.019					1.9	0.045
Nannastacidae	1023	0.3	0.019					1.9	0.045
Nephtyidae	418	0.3	0.019					1.9	0.045
Orthopagurus minimus	1305	0.3	0.019					1.9	0.045
Paguristes ulreyi	1309	0.3	0.019					1.9	0.045
Protodrilidae	560	0.3	0.019					1.9	0.045
Serpulidae	602	0.3	0.019					1.9	0.045
Sphaeromatidae	1070	0.3	0.019					1.9	0.045
Spirontocaris prionota	1335	0.3	0.019					1.9	0.045
Tritella sp	1259	0.3	0.019					1.9	0.045
Aclis occidentalis	670	0.3	0.018	0.8	0.417				
Neolepton salmonea	866	0.3	0.017			0.7	0.032		
Aoroides secundus	1101	0.3	0.017	0.8	0.407				
Teinostoma supravallatum	777	0.3	0.017	0.8	0.407				

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Scolelepis sp HYP1	590	0.3	0.016	0.8	0.376				
Cyathodonta pedroana	821	0.3	0.016			0.7	0.029		
Cyclopecten catalinensis	823	0.3	0.016			0.7	0.029		
Malmgreniella sp SD2	374	0.3	0.016			0.7	0.029		
Megalomphalus californicus	743	0.3	0.016			0.7	0.029		
Assiminea californica	692	0.3	0.016	0.8	0.366				
Akera sp	679	0.3	0.014					1.9	0.034
Americardia biangulata	802	0.3	0.014					1.9	0.034
Aricidea (Allia) sp LA1	142	0.3	0.014					1.9	0.034
Cancer productus	1276	0.3	0.014					1.9	0.034
Cardiomya pectinata	809	0.3	0.014					1.9	0.034
Chone sp SD2	196	0.3	0.014					1.9	0.034
Divariscintilla sp A	827	0.3	0.014					1.9	0.034
Eucrassatella fluctuata	830	0.3	0.014					1.9	0.034
Eulalia quadrioculata	262	0.3	0.014					1.9	0.034
Hippomedon columbianus	1164	0.3	0.014					1.9	0.034
Imitapseudes glebosus	1032	0.3	0.014					1.9	0.034
Margarites sp	742	0.3	0.014					1.9	0.034
Najna kitamati	1203	0.3	0.014					1.9	0.034
Nutricola sp	874	0.3	0.014					1.9	0.034
Odontosyllis sp	447	0.3	0.014					1.9	0.034
Potamethus sp	541	0.3	0.014					1.9	0.034
Pseudoleiocapitella sp HYP1	563	0.3	0.014					1.9	0.034
Rutiderma hartmanni	962	0.3	0.014					1.9	0.034
Stolidobranchiata	1414	0.3	0.014					1.9	0.034
Caulleriella sp	166	0.3	0.013	0.8	0.312				
Janiralata sp	1060	0.3	0.013	0.8	0.312				
Aplysiopsis enteromorphae	690	0.3	0.012	0.8	0.275				
Aphelochaeta sp SD5	121	0.3	0.011					1.9	0.027
Astyris aurantiaca	693	0.3	0.011					1.9	0.027
Cyclaspis sp	1004	0.3	0.011					1.9	0.027
Cylindroleberididae	949	0.3	0.011					1.9	0.027
Lasaeidae	840	0.3	0.011					1.9	0.027
Neaeromya rugifera	864	0.3	0.011					1.9	0.027
Scoloplos sp	600	0.3	0.011					1.9	0.027
Caulleriella sp SD3	168	0.3	0.009	0.8	0.208				
Cerithiopsis sp	707	0.3	0.009	0.8	0.208				
Amphitritinae sp SD1	104	0.3	0.009	0.8	0.203				
Columbellidae	708	0.3	0.009	0.8	0.203				
Joeropsididae	1061	0.3	0.009	0.8	0.203				
Naineris sp HYP1	414	0.3	0.009	0.8	0.203				
Tresus nuttallii	928	0.3	0.009	0.8	0.203				
Adula sp	801	0.3	0.008			0.7	0.015		
Anopla sp A	53	0.3	0.008			0.7	0.015		
Aricidea (Acmira) taylori	138	0.3	0.008			0.7	0.015		

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Aricidea (Aricidea) sp SD2	146	0.3	0.008			0.7	0.015		
Cumella californica	1001	0.3	0.008			0.7	0.015		
Diastylidae	1007	0.3	0.008			0.7	0.015		
Echiura	1350	0.3	0.008			0.7	0.015		
Goniadidae	303	0.3	0.008			0.7	0.015		
Lepidasthenia berkeleyae	338	0.3	0.008			0.7	0.015		
Lysippe sp	353	0.3	0.008			0.7	0.015		
Monoculodes sp	1201	0.3	0.008			0.7	0.015		
Mysella sp C	862	0.3	0.008			0.7	0.015		
Orbiniidae	463	0.3	0.008			0.7	0.015		
Orchomene decipiens	1208	0.3	0.008			0.7	0.015		
Skenea coronadoensis	773	0.3	0.008			0.7	0.015		
Syllis (Typosyllis) sp LA1	650	0.3	0.008			0.7	0.015		
Synidotea magnifica	1071	0.3	0.008			0.7	0.015		
Synidotea media	1072	0.3	0.008			0.7	0.015		
Amastigos acutus	90	0.3	0.007			0.7	0.014		
Rhynchospio glutaea	572	0.3	0.007	0.8	0.157				
Amphioplus strongyloplax	1367	0.3	0.006	0.8	0.150				
Metharpinia coronadoi	1194	0.3	0.006			0.7	0.011		
Listriella diffusa	1179	0.3	0.005	0.8	0.119				
Neotrypaea gigas	1302	0.3	0.005	0.8	0.119				
Campylaspis cf maculinodulosa	996	0.3	0.005			0.7	0.009		
Emplectonematidae	58	0.3	0.005			0.7	0.009		
Foxiphalus sp	1143	0.3	0.005			0.7	0.009		
Monticellina serratiseta	395	0.3	0.005			0.7	0.009		
Rhepoxynius fatigans	1239	0.3	0.005			0.7	0.009		
Sabellaria gracilis	573	0.3	0.005			0.7	0.009		
Hippomedon granulosus	1165	0.3	0.004	0.8	0.104				
Isopoda	1059	0.3	0.004	0.8	0.104				
Mitrella sp	746	0.3	0.004	0.8	0.104				
Philomedes dentata	958	0.3	0.004	0.8	0.104				
Pleioplana inquieta	43	0.3	0.004	0.8	0.104				
Alderia modesta	681	0.3	0.004	0.8	0.102				
Alia carinata	682	0.3	0.004	0.8	0.102				
Ammothea hilgendorfi	938	0.3	0.004	0.8	0.102				
Anadara multicostata	804	0.3	0.004	0.8	0.102				
Ancistrosyllis sp	107	0.3	0.004	0.8	0.102				
Caprella natalensis	1122	0.3	0.004	0.8	0.102				
Chama arcana	811	0.3	0.004	0.8	0.102				
Cirriformia spirabrancha	205	0.3	0.004	0.8	0.102				
Diplodonta orbella	825	0.3	0.004	0.8	0.102				
Eobrolgus spinosus	1132	0.3	0.004	0.8	0.102				
Granulina margaritula	733	0.3	0.004	0.8	0.102				
Hydroides pacificus	323	0.3	0.004	0.8	0.102				
Latocestidae	37	0.3	0.004	0.8	0.102				

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Liljeborgia geminata	1176	0.3	0.004	0.8	0.102				
Marphysa sp HYP1	378	0.3	0.004	0.8	0.102				
Megastraea undosa	744	0.3	0.004	0.8	0.102				
Nereis sp	433	0.3	0.004	0.8	0.102				
Olea hansineensis	753	0.3	0.004	0.8	0.102				
Peramphithoe sp	1214	0.3	0.004	0.8	0.102				
Pherusa sp SD1	485	0.3	0.004	0.8	0.102				
Polydora nuchalis	536	0.3	0.004	0.8	0.102				
Polyplacophora	798	0.3	0.004	0.8	0.102				
Portunus xantusii	1329	0.3	0.004	0.8	0.102				
Scaphandridae	771	0.3	0.004	0.8	0.102				
Simomactra sp	905	0.3	0.004	0.8	0.102				
Euclymene campanula	257	0.3	0.004			0.7	0.007		
Paracaudina chilensis	1398	0.3	0.004			0.7	0.007		
Petricola carditoides	882	0.3	0.004			0.7	0.007		
Hartmanodes sp	1158	0.3	0.004	0.8	0.092				
Opheliidae	458	0.3	0.004	0.8	0.092				
Anoplodactylus californicus	939	0.3	0.004			0.7	0.007		
Polycladida sp A	46	0.3	0.004			0.7	0.007		
Pseudoceros sp HYP1	47	0.3	0.004			0.7	0.007		
Alabina phalacra	680	0.3	0.003	0.8	0.078				
Alpheus bellimanus	1264	0.3	0.003	0.8	0.078				
Alvania compacta	685	0.3	0.003	0.8	0.078				
Liljeborgia sp	1177	0.3	0.003	0.8	0.078				
Liljeborgiidae	1178	0.3	0.003	0.8	0.078				
Melita sulca	1190	0.3	0.003	0.8	0.078				
Palaemonella holmesi	1312	0.3	0.003	0.8	0.078				
Rissoella sp SD1	770	0.3	0.003	0.8	0.078				
Acteocina carinata	671	0.3	0.003	0.8	0.075				
Ancistrosyllis groenlandica	105	0.3	0.003	0.8	0.075				
Epitonium hindsii	723	0.3	0.003	0.8	0.075				
Modiolus neglectus	857	0.3	0.003	0.8	0.075				
Sphaerosyllis sp HYP1	615	0.3	0.003	0.8	0.075				
Tubulanidae	76	0.3	0.003	0.8	0.075				
Alia tuberosa	684	0.3	0.003	0.8	0.059				
Flabelligera infundibularis	286	0.3	0.003	0.8	0.059				
Stomatopoda	975	0.3	0.003	0.8	0.059				
Tellina sp HYP1	920	0.3	0.003	0.8	0.059				
Ampelisca cucullata	1083	0.3	0.002			0.7	0.005		
Caecidae	699	0.3	0.002	0.8	0.058				
Cirriformia sp B	201	0.3	0.002			0.7	0.005		
Excirolana linguifrons	1053	0.3	0.002			0.7	0.005		
Glycera gigantea	291	0.3	0.002			0.7	0.005		
Gyptis sp	305	0.3	0.002			0.7	0.005		
Halosydna sp	309	0.3	0.002			0.7	0.005		

Taxon Name	Taxon No.	U.S. Sites (n=321)		Embayments (n=121)		Mainland Shelf (n=147)		Island Shelf (n=53)	
		Occ.	Abun.	Occ.	Abun.	Occ.	Abun.	Occ.	Abun.
Ischyrocerus anguipes	1171	0.3	0.002			0.7	0.005		
Ischyrocerus sp	1173	0.3	0.002			0.7	0.005		
Magelona sp A	360	0.3	0.002			0.7	0.005		
Natantia	1298	0.3	0.002			0.7	0.005		
Pilargis sp	504	0.3	0.002			0.7	0.005		
Turbinidae	782	0.3	0.002			0.7	0.005		
Alpheus sp	1266	0.3	0.002	0.8	0.046				
Euryleptidae	35	0.3	0.002	0.8	0.046				
Lophopanopeus leucomanus	1293	0.3	0.002	0.8	0.046				
Micropleustes nautilus	1199	0.3	0.002	0.8	0.046				
Microspio microcera	392	0.3	0.002	0.8	0.046				
Oxyurostylis tertia	1025	0.3	0.002	0.8	0.046				
Protothaca laciniata	886	0.3	0.002	0.8	0.046				
Styela plicata	1415	0.3	0.002	0.8	0.046				
Stylochus sp	49	0.3	0.002	0.8	0.046				
Xanthidae	1338	0.3	0.002	0.8	0.046				
Conidae	709	0.3	0.002			0.7	0.004		
Crucigera sp	216	0.3	0.002			0.7	0.004		
Edotia sp	1048	0.3	0.002			0.7	0.004		
Enopla sp A	60	0.3	0.002			0.7	0.004		
Eranno bicirrata	243	0.3	0.002			0.7	0.004		
Eualus sp	1288	0.3	0.002			0.7	0.004		
Euspira lewisii	730	0.3	0.002			0.7	0.004		
Ophelia pulchella	457	0.3	0.002			0.7	0.004		
Pinnixa barnharti	1317	0.3	0.002			0.7	0.004		