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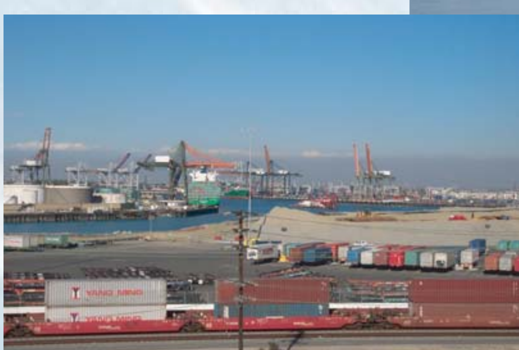
Extending the Southern California Benthic Response Index to Assess Benthic Condition in Bays



Robert Smith
Ananda Ranasinghe
Stephen Weisberg
David Montagne
Donald Cadien
Tim Mikel
Ronald Velarde
Ann Dalkey

Southern California Coastal Water Research Project

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Robert W. Smith[1]
J. Ananda Ranasinghe[2]
Stephen B. Weisberg[2]
David E. Montagne[3]
Donald B. Cadien[3]
Tim K. Mikel[4]
Ronald G. Velarde[5]
Ann Dalkey[6]

[1]P.O. Box 1537, Ojai, CA 93024
[2]Southern California Coastal Water Research Project, 7171 Fenwick Lane, Westminster, CA 92683
[3]County Sanitation Districts of Los Angeles County, P.O. Box 4998, Whittier, CA 90607
[4]Aquatic Bioassay and Consulting Laboratories, Inc., 29 North Olive Street, Ventura, CA, 93001
[5]City of San Diego, 4918 N. Harbor Drive, Suite 101, San Diego, CA 92106
[6]City of Los Angeles, Environmental Monitoring Division, 12000 Vista Del Mar, Playa Del Rey, CA 90293.

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FOREWORD

Regulators often include benthic invertebrate monitoring as a condition for issuing National Pollutant Discharge Elimination System (NPDES) and other permits. Benthic invertebrates are appropriate organisms for use in this manner for several reasons. First, they are biological resources possessing many attributes considered desirable in indicator organisms. Most importantly, (a) they have limited mobility and are indicative of impacts at the site where they are collected unlike, for example, migratory fish; (b) they include several different animal phyla and classes and, therefore, are sensitive to different types of impacts and respond to different impacts in different ways; (c) their life-histories are short enough that the effects of one-time impacts disappear within a year but long enough to integrate the effects of multiple impacts occurring within seasonal time scales; (d) living within the bottom sediments, they have high exposure to sediment contamination, high sediment organic carbon resulting from eutrophication, and low bottom dissolved oxygen, the three most common anthropogenic impacts in bays and harbors. Secondly, they are important components of aquatic food webs, transferring carbon and nutrients from suspended particulates in the water column to the sediments by filter feeding and serving as forage for bottom-feeding fishes. Finally, some benthic organisms, such as abalone and surf clams, are economically important in their own right.

Benthic infaunal monitoring data attain their full potential in regulatory use only when they are interpretable in a regulatory context. Most important is the existence of a scientifically valid criterion or threshold that can be used to distinguish "healthy" and "unhealthy" benthic communities. If the criterion is expressed as a numeric index, it can also be used to test monitoring data for improving or declining trends over time.

Efforts to develop such measures have been successful only in the last decade and the Southern California Coastal Water Research Project (SCCWRP) pioneered one of them. SCCWRP developed the Benthic Response Index (BRI) for the southern California continental shelf. The BRI is the abundance weighted average pollution tolerance of species occurring in a sample. It sets thresholds that can be used to assess whether samples meet reference condition criteria and whether they are impaired in terms of biodiversity, community function, or defaunation.

Although the BRI was successfully developed for continental shelf benthic invertebrates, no similar measure had been developed for southern California bays and harbors despite a pressing need for one. Human habitation and pollution sources are close to bays and harbors and pollutant impacts in bays are widespread and direct.

One of the impediments preventing benthic index development in southern California bays was a lack of the necessary data. To develop benthic indices, water quality, sediment contaminant, and sediment toxicity data must all be collected at the same time and place as benthic invertebrate data; they must be collected from many sites. Until recently, few studies collected all these types of data and none of them were in southern California bays.

In 1998, the Southern California Bight Regional Monitoring Program (Bight`98) collected these types of data from 110 sites in southern California bays and harbors. At about the same time, data became available for 171 sites in southern California bays sampled by the State of California's Bay Protection and Toxic Cleanup Program and 24 sites sampled by the U.S. Environmental Protection Agency's Environmental Monitoring and Assessment Program.

The State Water Resources Control Board used the availability of these data as an opportunity to develop a benthic index that assesses the health of benthic communities in southern California bays, using the BRI approach that was used successfully on the mainland shelf. The board funded the effort through Agreement Number 9-152-250-0 with the Southern California Coastal Water Research Project.

This report describes how the BRI for southern California bays was developed. The proper citation is: Smith, R.W., J.A. Ranasinghe, S.B. Weisberg, D.E. Montagne, D.B. Cadien, T.K. Mikel, R.G. Velarde and A. Dalkey. 2003. Extending the southern California Benthic Response Index to assess benthic condition in bays. Technical Report No. 410. Southern California Coastal Water Research Project. Westminster, CA. 36 p + 4 Appendices

EXECUTIVE SUMMARY

Benthic invertebrate monitoring is often included as a condition for issuing National Pollutant Discharge Elimination System (NPDES) and other permits because the organisms are sensitive indicators of environmental condition. They are also important components of aquatic food webs.

Benthic monitoring data for southern California coastal shelf marine environments were summarized in 2001 using a Benthic Response Index (BRI) approach that established scientifically valid criteria or thresholds for distinguishing “healthy” from “unhealthy” benthic communities. The BRI is one of three types of benthic indices recognized for biocriteria development by the U.S. Environmental Protection Agency. The BRI is the abundance-weighted average pollution tolerance of the species at a site. In application, it is similar to the Hilsenhoff Index that is often used to assess the condition of freshwater benthos.

In this report, we test the BRI approach in southern California’s bays and harbors. Benthic index development in these environments is challenging because they are more complex and variable habitats than the mainland shelf. Sources and types of anthropogenic stress are more diverse and less directional than the pollution gradients around wastewater outfalls on the mainland shelf.

The BRI approach was tested in the southern California bays by assigning pollution tolerance scores to benthic organisms and validating the scores. For this purpose, data from 341 sites in southern California bays were adjusted for compatibility and assembled into a database. Data about macrofaunal species abundances, sediment concentrations of nine trace metals, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), acute sediment toxicity to amphipods, and habitat data such as water depth and sediment type were compiled for each site. The data were collected between 1992 and 2001 for the Southern California Bight Regional Monitoring Program 1998 (Bight`98), the State of California’s Bay Protection and Toxic Cleanup Program, the 1999 U.S. Environmental Protection Agency’s Environmental Monitoring and Assessment Program, and the 2001 San Diego Bay Toxic Hot Spot Spatial Study.

Within the southern California bays, two habitats with distinct naturally occurring assemblages were identified by cluster analysis. In the analysis, assemblages in the northern bays from Point Conception to Newport Bay segregated completely from the southern bays from Dana Point Harbor to the U.S.-Mexico international border. The cluster analysis was performed, after eliminating potentially contaminated sites, on Bight’98 data. It was determined that water depth and fine particle content of the sediments were not primary assemblage determinants.

Species pollution tolerance scores were developed independently in each of these habitats. First, an ordination analysis was performed to quantify species changes along environmental gradients and a pollution vector was identified as the gradient maximally correlated with two indicators of potential pollution effects: (1) the mean effects range median (ERM) quotient, and (2) the acute toxicity of the sediments to amphipods. The mean ERM quotient is an integrated measure of chemical contamination in the sediments.

Pollution tolerance scores were calculated for each species as the weighted-average position of the abundance distribution along the pollution vector. An iterative procedure was used to identify parameter values of the species abundance distribution that maximized the correlation coefficient between BRI index values for each site and the position of the site on the pollution vector. Scores were normalized to a scale of 0-100 that was equivalent among habitats. The results corresponded well with established natural historical principles; *Capitella capitata* and *Streblospio benedicti*, two species that are often associated with disturbance and pollution, had pollution tolerance scores at the polluted end of the scale.

To give index values an ecological context and facilitate their interpretation and use for evaluation of benthic community condition, four thresholds of biological response to pollution were identified. The thresholds were based on changes in biodiversity along the pollution gradient. A reference threshold, below which natural benthic assemblages normally occur, was identified at an index value of 31, the point on the pollution vector where pollution effects first resulted in a net loss of species. Three additional thresholds of response to disturbance were defined at index values of 42, 53 and 73, representing points at which 25%, 50%, and 80% of the species present at the reference threshold were lost. The thresholds were equivalent to the thresholds developed for the southern California mainland shelf BRI.

The BRI was successfully extended to southern California bays, based on four validation methods that achieved results comparable with or better than other benthic index development efforts. First, the indices for the northern and southern habitats were applied to each site in an overlap region. The correlation coefficient between the northern and southern indices was 0.87, indicating that the northern and southern indices had similar values although largely different datasets were used to derive them.

Second, index values were compared with data indicating potential pollution effects. The correlation coefficients between the index and the mean ERM quotients and amphipod mortality were 0.52 and 0.72, respectively, for the northern bay habitat, and 0.65 and 0.50, respectively, for the southern bay habitat. These correlations were highly significant and the indicator variables explained about half of the variation in the index, which is similar to other studies comparing biological and pollution indicator data.

Third, the index classified correctly 87.5% of 32 sites *a priori* designated as undisturbed or disturbed based on indicators of potential pollution effects. All 20 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. In comparison, classification efficiencies of 60.9-100% were achieved during development of other benthic indices.

Finally, 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 habitat variables did not consistently covary with index values.

The BRI worked well in bays, but not as well as the index developed for the mainland shelf. Correlations between index values and the pollution gradient were 0.815 and 0.848 for the northern and southern habitats, respectively. The correlations for the three mainland shelf BRI habitats were 0.970, 0.972, and 0.980, 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.

In extending the BRI to bays, a paucity of data resulted in a need for unusual validation measures. Although our independent methods validated well, we would have preferred to use only data collected using a single set of methods and validate the index by applying it to independent data collected in the same way from the same geographic area.

Other factors may also account for the observed differences in performance between the mainland shelf and bay BRIs. The pollution gradient was defined better during development of the mainland shelf BRI because data from several severely polluted sites near wastewater discharge outfalls were available from as far back as the 1970s to define species abundances at polluted sites. Repeated grid sampling around the outfalls over time accurately characterized biological changes in space and time as conditions improved.

Large amounts of data were available from many well-known sites for mainland shelf BRI development. In contrast, bay BRI development sites were only sampled once and, until recently, few data were available for bay 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 simple temporal or spatial gradients for the purpose of evaluating index response

ACKNOWLEDGMENTS

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We are grateful to Chris Beegan, our Project Manager for the State Water Resources Control Board, and the Southern California Bight 1998 Regional Monitoring Program (Bight`98) Steering Committee for their direction, guidance, and review. Shelly Moore made the maps, Paul Smith solved many computing issues and distributed data and documents across the Internet, Valerie Raco-Rands composed the cover, Linda Fuller edited the document, and Debbie Elmore and Jeff Brown desktop published it. Their efforts made complicated tasks seem easy. Ananda Ranasinghe took the photographs on the cover.

This report is an ancillary product of Bight'98. Many of the samples providing data for this study were collected and processed as part of Bight'98. While space limitations do not allow us to acknowledge all Bight'98 contributors and participants by name, the authors thank each and every one..

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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 mainland 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 mainland shelf (Gibson *et al.* 2000). In this study, we test whether the Smith *et al.* (2001) approach can be applied successfully in southern California's bays and harbors.

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 by cluster analysis. 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. Details of the cluster analysis are provided in Ranasinghe *et al.* (2003). 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 and 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 bays (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.

2. Identify Habitats with Distinct Natural Assemblages

Based on the assemblage analysis of Bight`98 data reported in Ranasinghe *et al.* (2003), 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 mainland 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 Appendix A.

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 Appendix B and C.

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 (Appendix B). 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 Appendix A). 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 Appendix C.

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 established at an index value of 31, the point 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 index values of 42, 53, and 73, the points where 25%, 50%, and 80% of the biodiversity of the reference pool was lost (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 during development of 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 potentially confounding environmental variables. This result is almost identical with the R^2 value for the relationship between our index and both pollution indicator variables (Table 9).

In extending the index to bays, the paucity of available 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 simple 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 performance of the bay BRI will likely improve if the pollution tolerance scores we calculated are refined using additional data from both targeted and random sampling. Incorporation of benthic data from target sites where high levels of sediment contamination or sediment toxicity were measured previously will ensure that pollution tolerance scores are based on the entire pollution gradient; few impacted sites are encountered in random sampling today, due to improvements in habitat condition resulting from protective environmental regulation. Additional data are also necessary to validate the index with data collected independently and processed in the same way as the data used in index development; collecting these data at random increases the likelihood that samples will be widely distributed throughout the region and common habitats well represented.

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. For example, 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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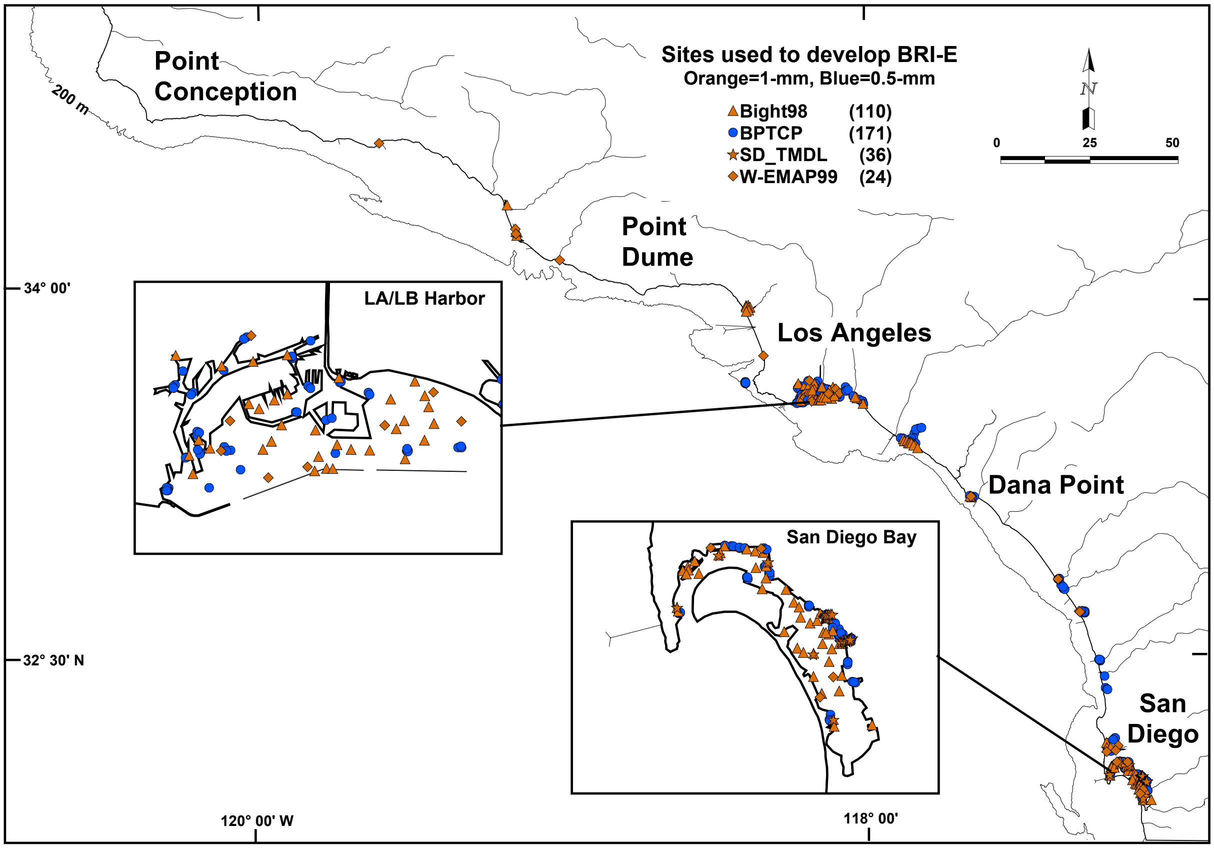

Figure 1. Location of sampling sites for the southern California bays Benthic Response Index.

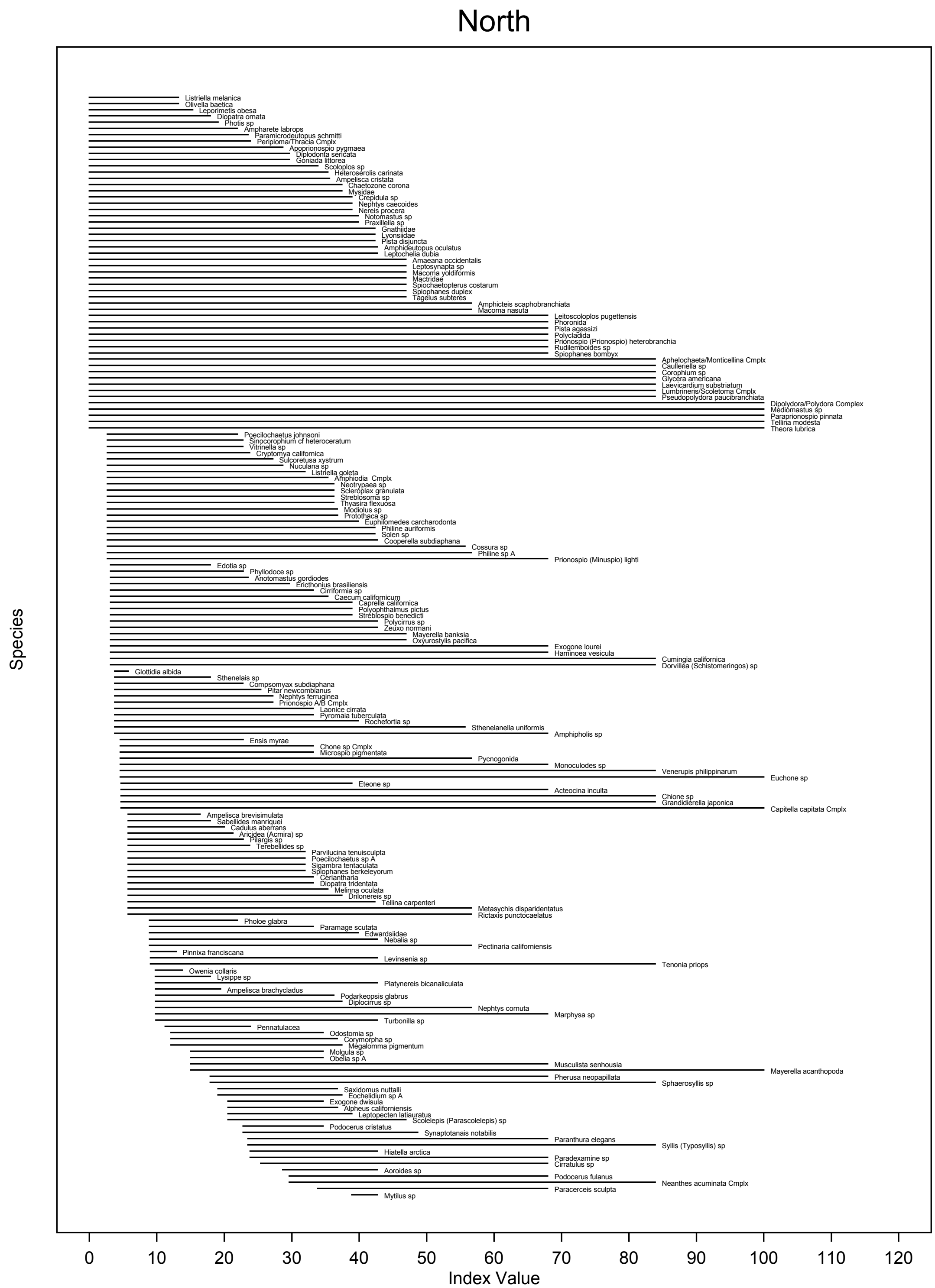

Figure 2. Species ranges along the index pollution gradient for the northern (North) data subset. Species are ordered from top to bottom by their first and last appearance on the gradient. Only species occurring at least three times in the northern data subset are included.

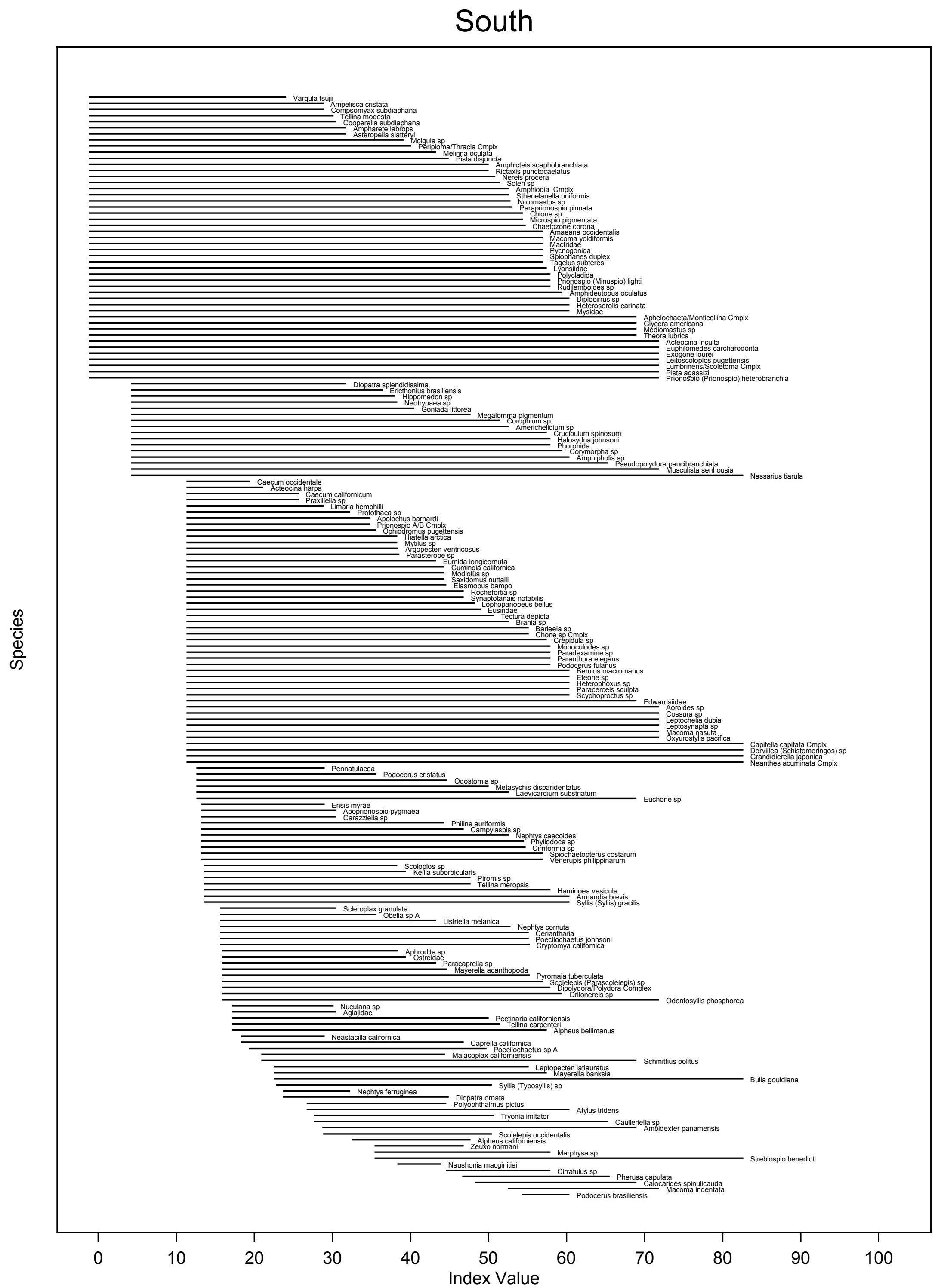

Figure 3. Species ranges along the index pollution gradient for the southern (South) data subset. Species are ordered from top to bottom by their first and last appearance on the gradient. Only species occurring at least three times in the southern data subset are included.

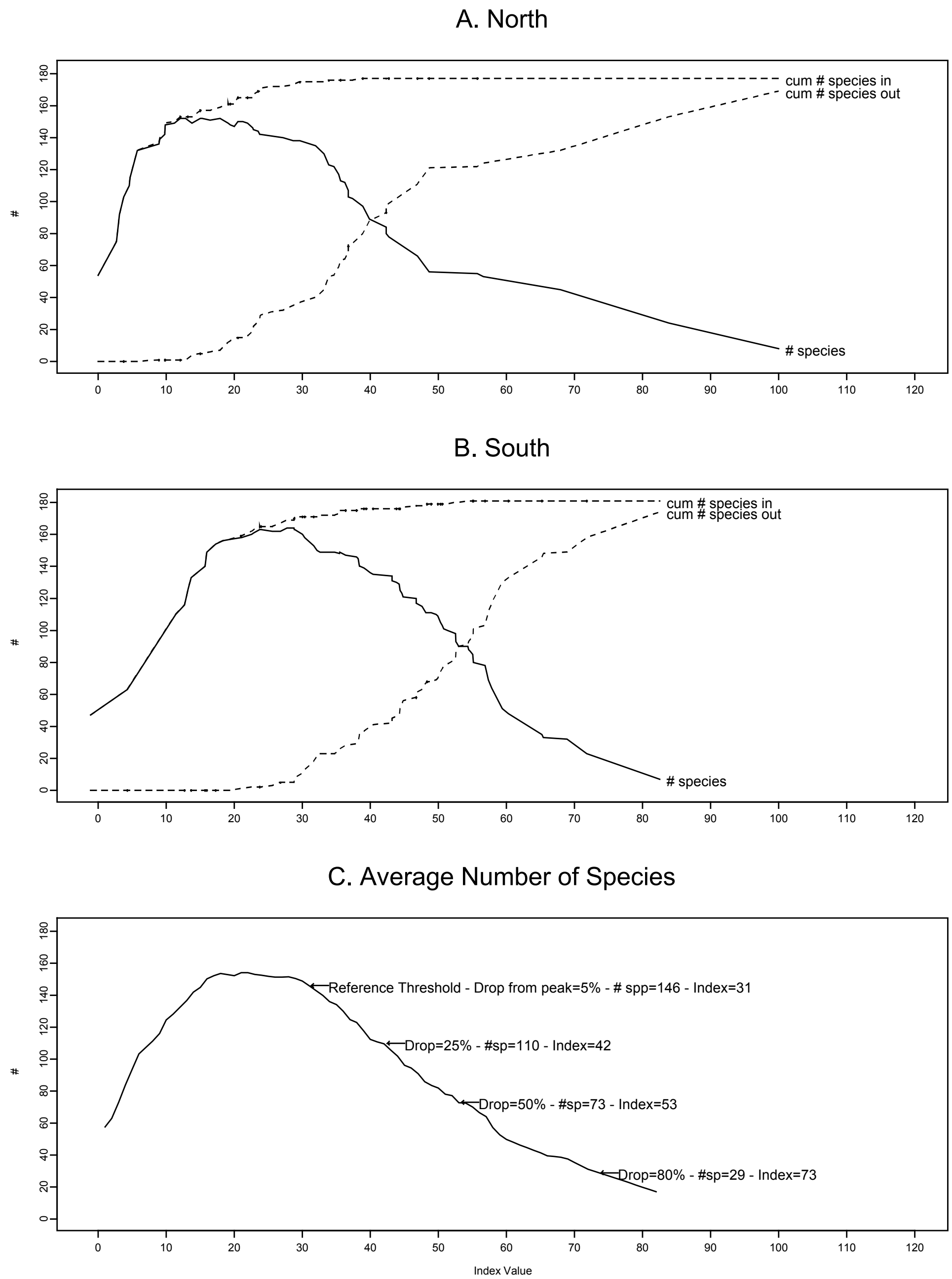

Figure 4. A and B. Summary of species ranges along the index pollution vector for the northern (North) and southern (South) data subsets. The dashed curve labeled "cum # species in" is the cumulative number of species ranges intersecting index values up to and including the index value on the horizontal 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.

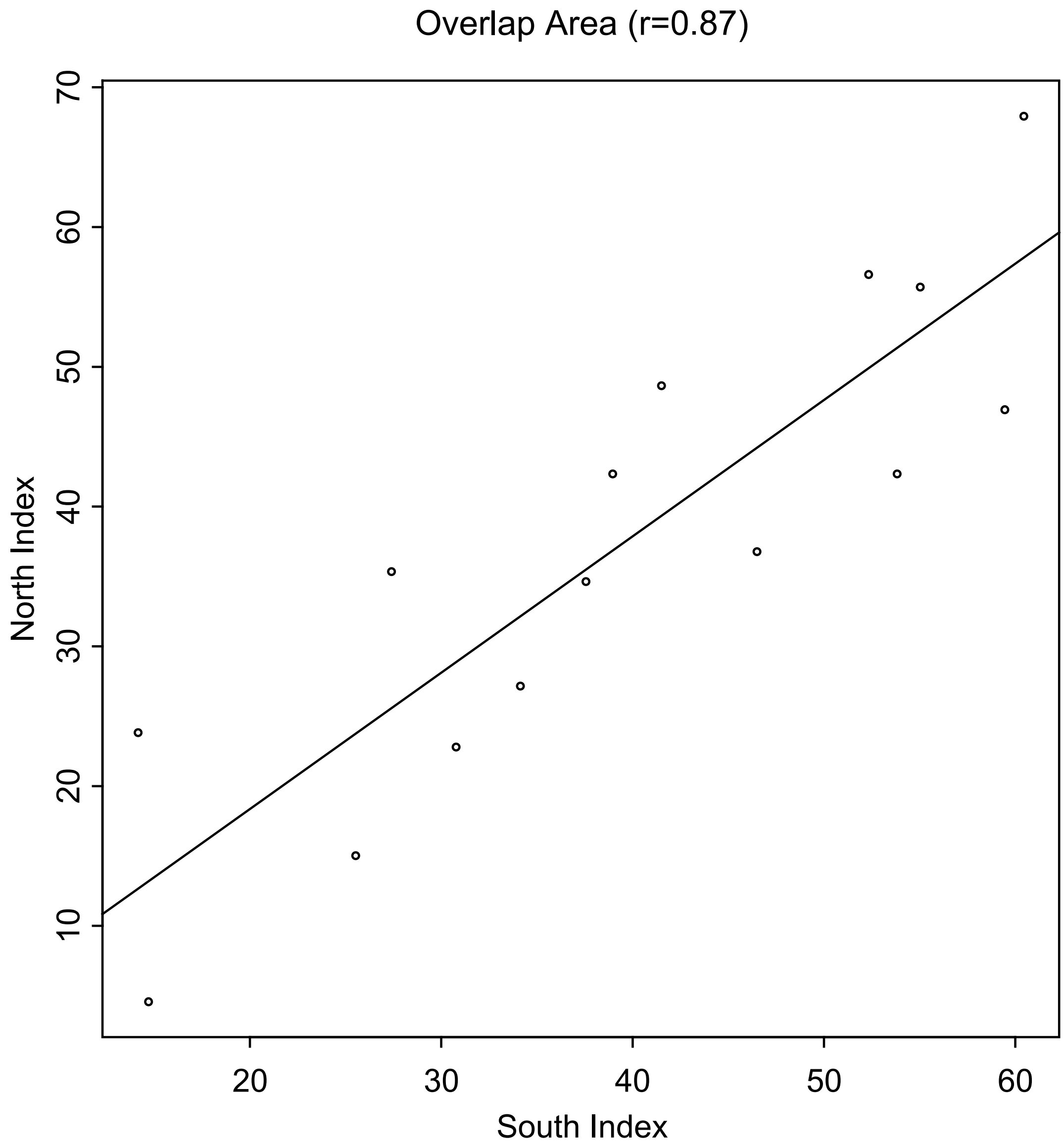

Figure 5. Relationship between index values computed for the southern (South) and northern (North) data subsets for sites in the overlap region. The regression equation is North=1.112+0.975(South).

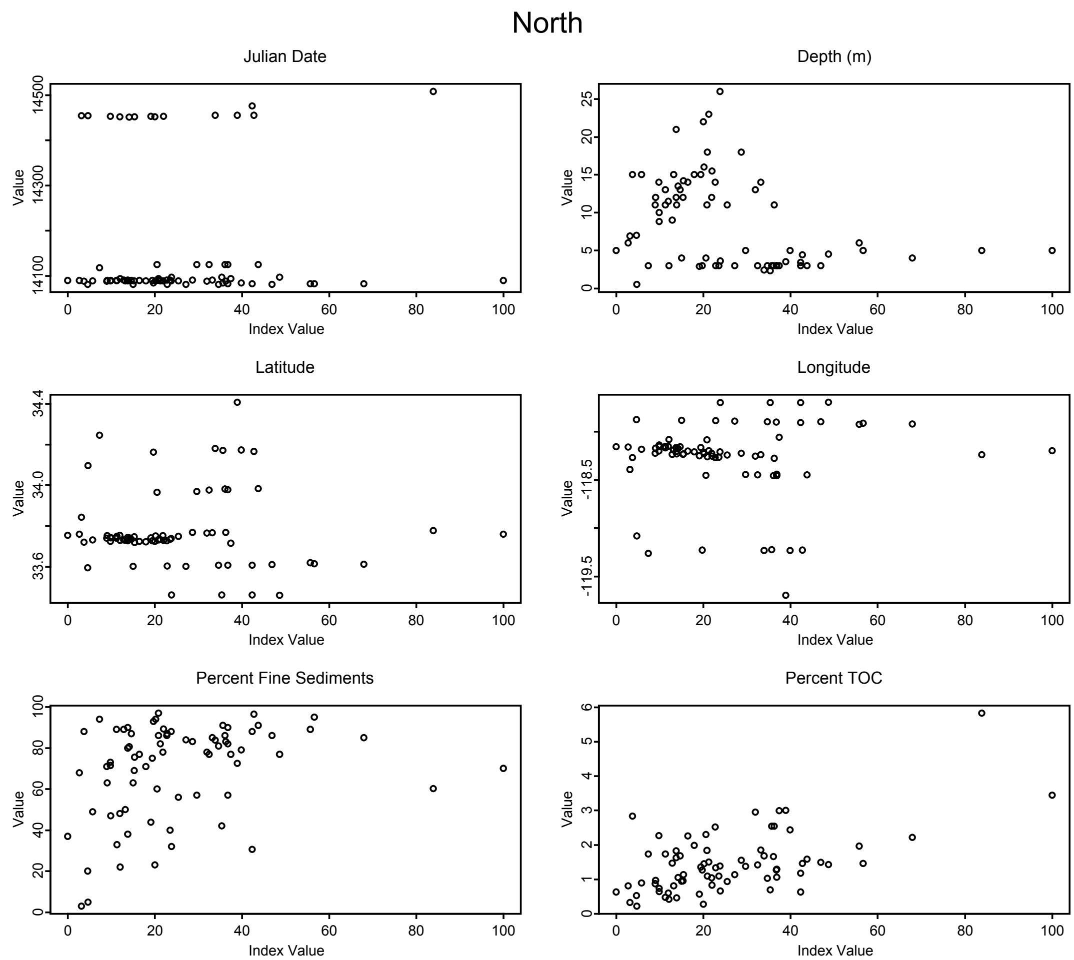

Figure 6. Relationships between habitat measures and index values for the northern (North) data subset.

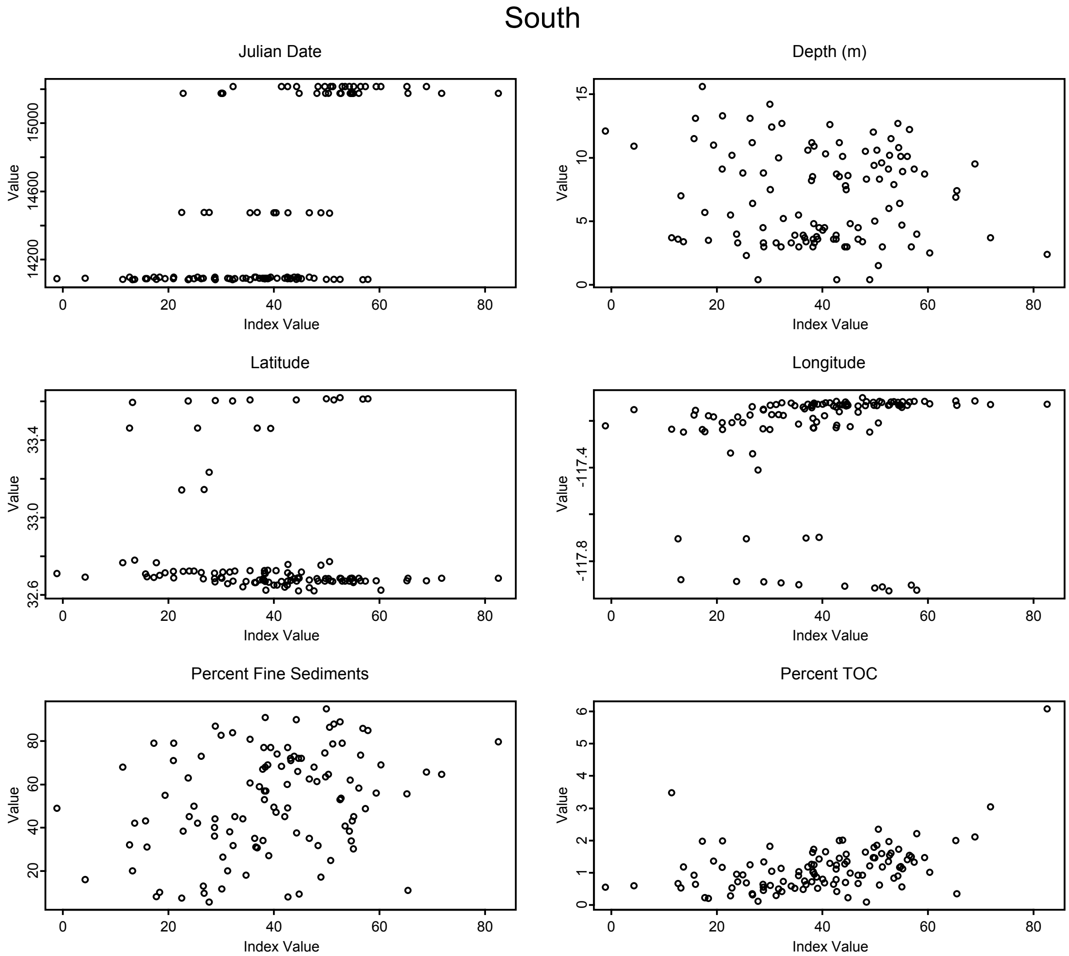

Figure 7. Relationships between habitat measures and index values for the southern (South) data subset.

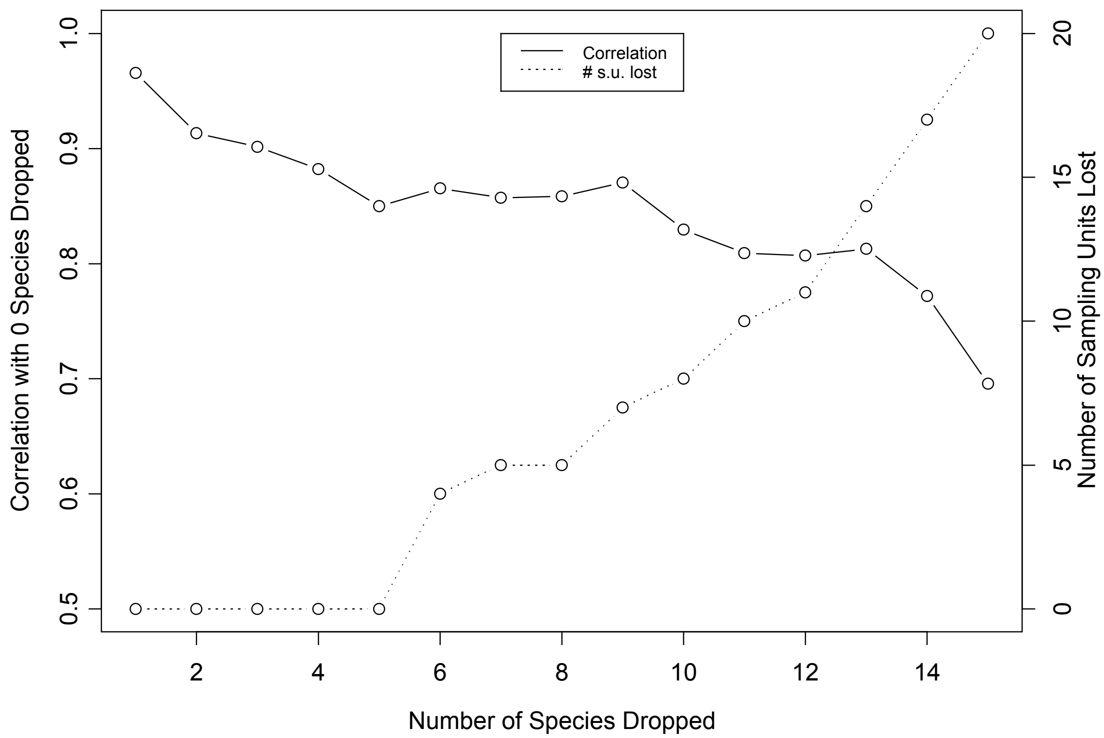

Figure 8. The effect of species elimination on index values. Presented are correlations between the index values with all species and index values with the n most abundant species dropped. As species are dropped, some sampling units become devoid of species with p_i values, and no index can be calculated. 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.

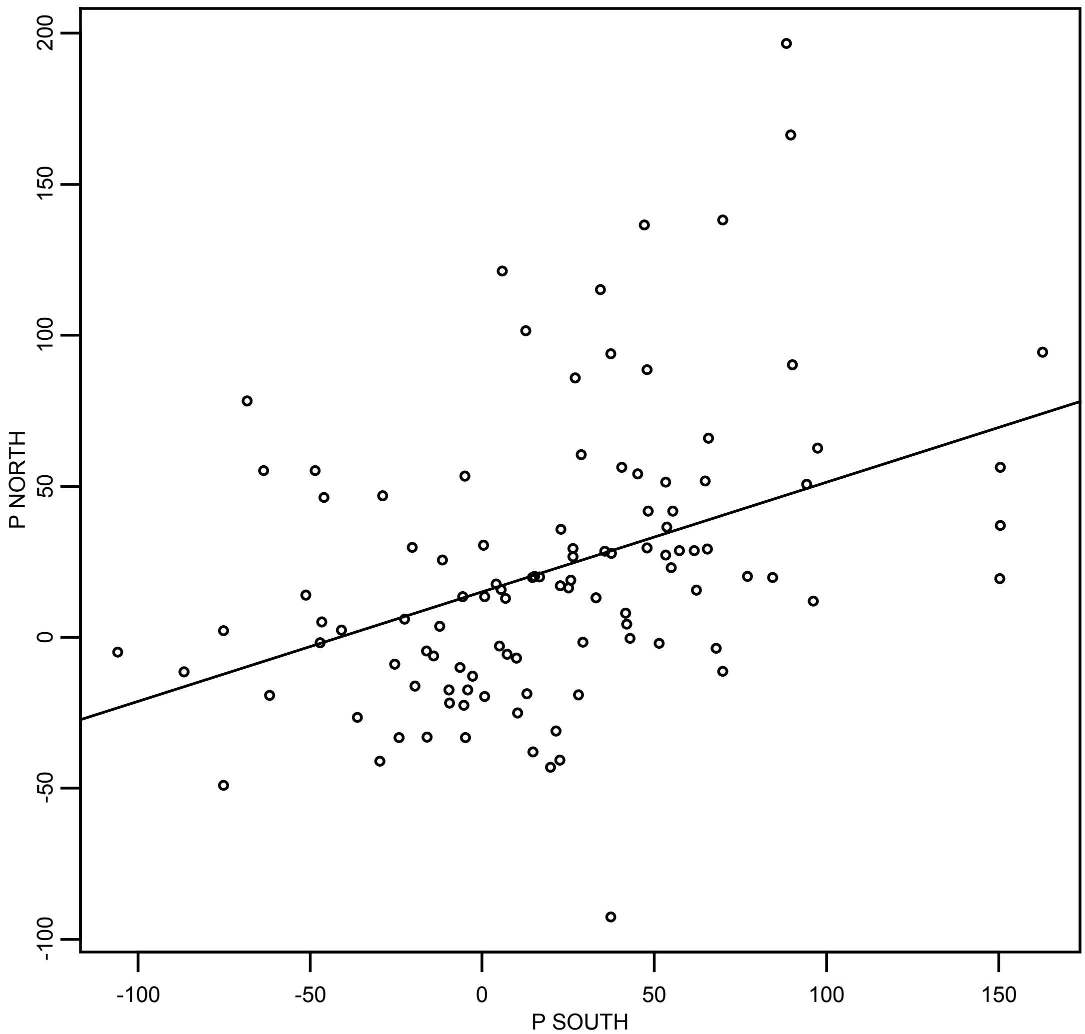

Figure 9. Comparison of p_i values for species used in both the northern (North) and southern (South) categories. The least-squares regression line is shown. The correlation between p_i values in the two categories is 0.39.

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 between the ordination axes and the pollution indicator variables for the 1.0 mm sieve data, 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 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.

No. of Species Dropped	Taxon Dropped	Values in Equation (3)				Optimization Correlations		Index vs. Indicator Correlations	
		$z_{i,c}$	$z_{i,v}$	$z_{i,c}\ z_{i,v}$	$r_{c,v}$	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.

# Species Dropped	Taxon Dropped	Values in FEquation (3)				Optimization Correlations		Index vs. Indicator Correlations	
		$z_{i,c}$	$z_{i,v}$	$z_{i,c}\ z_{i,v}$	$r_{c,v}$	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 mainland shelf 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

APPENDIX A

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 A1 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 A1 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 A1, 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 A1. Example correlations between the indicators and the ordination axes after the canonical correlation analysis. These correlations are presented graphically in Figure A1.

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

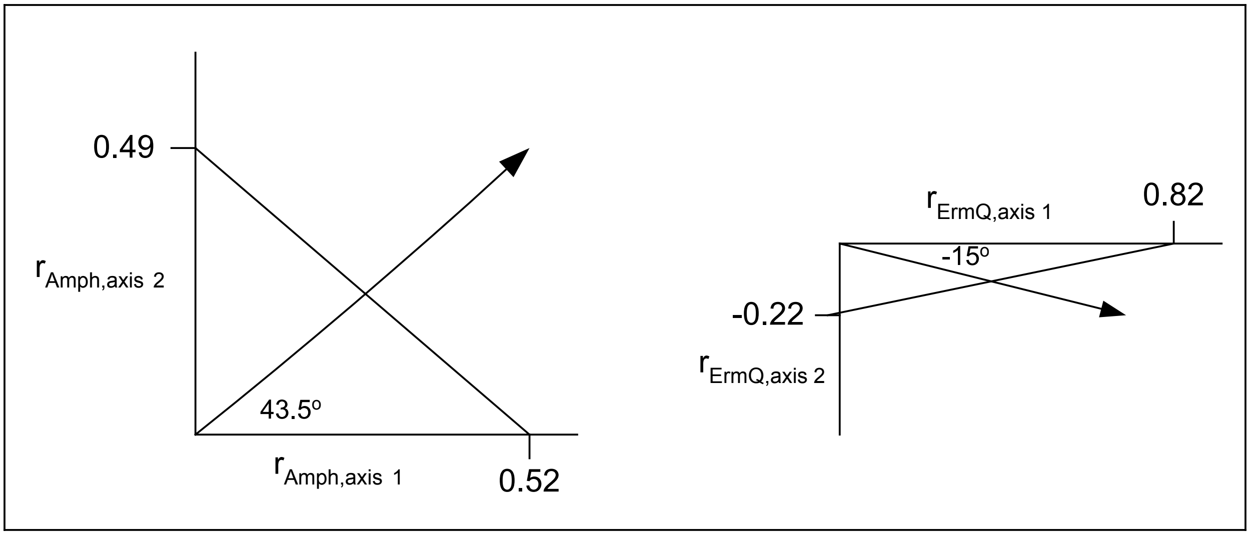

Figure A1. Example of the method for finding resultant vectors for pollution indicators in a two-dimensional ordination space, using the correlations in Table A.1. See text for explanation.

APPENDIX B

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

Appendix B continued

P-Code	P-Name	Included Taxa	Phylum	Family
P152	DIOPATRA ORNATA	Diopatra ornata	Annelida	Onuphidae
P153	DIOPATRA SPLENDIDISSIMA	Diopatra splendidissima	Annelida	Onuphidae
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	Odontosyllis phosphorea	Annelida	Syllidae

Appendix B continued

P-Code	P-Name	Included Taxa	Phylum	Family
	PHOSPHOREA			
P474	SPHAEROSYLLIS SP	Sphaerosyllis; all taxa within the genus	Annelida	Syllidae
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

Appendix B continued

P-Code	P-Name	Included Taxa	Phylum	Family
P320	NEBALIA SP	Nebalia; all taxa within the genus	Arthropoda	Nebaliidae
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

P-Code	P-Name	Included Taxa	Phylum	Family
P576	HAMINOEA VESICULA	Haminoea vesicula	Mollusca	Haminoeidae
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	

APPENDIX C

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

P-Name	North	South
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	
Paranthura elegans	60.508	28.772
Paraprionospio pinnata	13.150	33.071

Appendix C continued

P-Name	North	South
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	

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 D1). 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 D2).

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 D3.
2. Associate the P-Names or P-Codes with pollution tolerance values for the habitat in which the sample was collected using Table D4.
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 D3, 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 D3 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 D2 and D4) 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 D4, 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 3 against the thresholds listed in Table D2. 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 D1. 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 D2. Characterization, definition, and BRI thresholds for levels of Benthic community condition.

	Characterization	Definition		BRI Values	
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 D3. 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
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

Table D3 continued

P-Code	P-Name	Included Taxa	Phylum	Family
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
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

Table D3 continued

P-Code	P-Name	Included Taxa	Phylum	Family
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
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

Table D3 continued

P-Code	P-Name	Included Taxa	Phylum	Family
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
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

Table D3 continued

P-Code	P-Name	Included Taxa	Phylum	Family
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
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	Annelida	Syllidae

Table D3 continued

P-Code	P-Name	Included Taxa	Phylum	Family
		except S. (T.) farallonensis [Exclude S.(T.) sp]		
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
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

Table D3 continued

P-Code	P-Name	Included Taxa	Phylum	Family
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
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	Malacoplax californiensis	Arthropoda	Goneplacidae

Table D3 continued

P-Code	P-Name	Included Taxa	Phylum	Family
	CALIFORNIENSIS			
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
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

Table D3 continued

P-Code	P-Name	Included Taxa	Phylum	Family
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 within 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
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

Table D3 continued

P-Code	P-Name	Included Taxa	Phylum	Family
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
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

Table D3 continued

P-Code	P-Name	Included Taxa	Phylum	Family
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
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	Laevicardium substriatum	Mollusca	Cardiidae

Table D3 continued

P-Code	P-Name	Included Taxa	Phylum	Family
	SUBSTRIATUM			
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
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

Table D3 continued

P-Code	P-Name	Included Taxa	Phylum	Family
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
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

Table D3 continued

P-Code	P-Name	Included Taxa	Phylum	Family
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
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 D4. 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

Table D4 continued

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
P042	AMPHICHONDRIUS GRANULOSUS		-18.63708	-15.27667		
P043	AMPHICTEIS GLABRA		-1.61773			
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		

Table D4 continued

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
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			
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		

Table D4 continued

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
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	
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

Table D4 continued

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
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			
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

Table D4 continued

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
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		
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	-				

Table D4 continued

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
		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			
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

Table D4 continued

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
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			
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			

Table D4 continued

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
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			
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

Table D4 continued

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
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
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		

Table D4 continued

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
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				
P440	RHEPOXYNIUS BICUSPIDATUS	12.52807	-15.02172	-16.27075		
P441	RHEPOXYNIUS	-8.13173	5.50401			

Table D4 continued

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
	HETEROCUSPIDATUS					
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	

Table D4 continued

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
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	
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	

Table D4 continued

		Pollution Tolerance Scores (p_i)				
		Coastal Shelf BRI			Bay BRI	
P_Code	P_Name	Shallow	Mid-Depth	Deep	North	South
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		
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