chapter 5

MACROBENTHIC INVERTEBRATE COMMUNITIES

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INTRODUCTION

The District monitors the composition of the macrobenthic infaunal invertebrate community (small organisms, such as worms, clams, and burrowing shrimps) that lives in ocean sediments to assess the possible effects of the wastewater discharge. Infauna are sensitive indicators of environmental change due to their limited mobility and susceptibility to the effects of changes in sediment quality resulting from both natural (e.g., depth, grain size, and geochemistry) and anthropogenic (e.g., organic enrichment and chemical contaminants) influences (Pearson and Rosenberg 1978). In accordance with the District's NPDES ocean discharge permit the macrobenthic communities are monitored to determine if the wastewater discharge has degraded the biological community in the monitoring area beyond the zone of initial dilution (ZID), which is the area within 60 m in any direction of the outfall diffuser (See box).

The District's outfall pipe sits on the San Pedro Shelf between the Newport and San Gabriel submarine canyons (Figure 5-1). Since natural processes strongly influence infaunal assemblages, outfall effects are discerned from natural influences by comparing invertebrate communities near the outfall to reference sites located away from the outfall. The outfall pipe and the associated ballast rock make one of the largest artificial reefs in southern California. The outfall structure alters current flow and sediment characteristics near the pipe (e.g., grain size and sediment geochemistry), which in turn influences the structure of the infaunal community. The physical structure of the pipe, as well as the predatory fish and invertebrates that it attracts, also affect the macrobenthic community in the surrounding area (OCSD 1995, 1996; Diener and Riley 1996; Diener et al. 1997). Release of the treated wastewater produces direct effects, such as organic enrichment that tends to enhance infaunal abundances.

Natural features of the environment account for most of the variability in the distribution of infaunal species in the monitoring area, with depth-related factors being the most important (OCSD 1996, 2003). However, there is a distinct assemblage near the outfall that is influenced by the wastewater discharge (e.g., OCSD 2007–2010). Previous monitoring efforts and special studies have shown that impacts from the discharge are generally localized near the outfall and can be characterized as either reef effects related to the outfall structure or as direct and/or indirect effects of the wastewater discharge.

Compliance Criteria Pertaining to Benthic Infaunal Communities Contained in the District's NPDES Ocean Discharge Permit (Order No. R8-2004-0062, Permit No. CAO110604.

Criteria		Description
C.5.a	Marine Biological Communities	Marine communities, including vertebrates, invertebrates, and algae shall not be degraded.

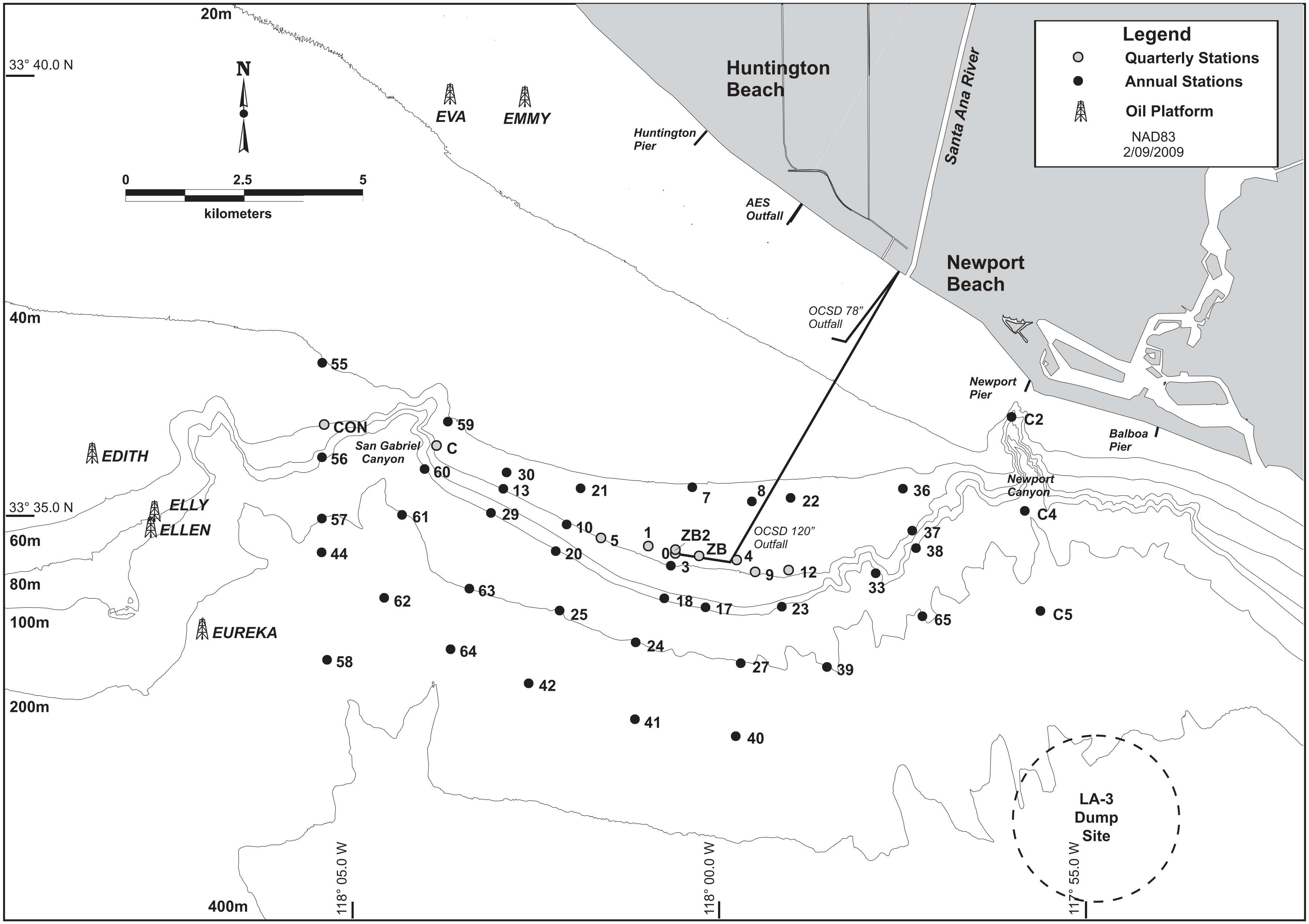

Figure 5-1. Benthic infauna sampling stations for annual and quarterly surveys, 2010-11.

Orange County Sanitation District, California.

Since 2005, infaunal community structure at the point of discharge has changed to the point of being classified as degraded. Changes in benthic assemblages are now being observed beyond the zone of initial dilution (ZID), though not to the point of degradation. As a result, the District is conducting an investigation into these changes. Efforts include: (1) a sediment mapping study, (2) a redistribution and increased density of sampling sites near the discharge in July 2011 and January 2012 in order to assess the spatial extent of these changes, (3) statistical correlation analyses of treatment plant operations and environmental monitoring data to identify potential causes (i.e., polymer and bleach usage, final effluent flow rates), (4) the potential effect of wastewater reclamation (e.g., decreased final effluent volume and reverse osmosis reject stream constituents), and (5) the formation of chlorination by-products from effluent disinfection. Results to date are discussed throughout this chapter where appropriate.

The District has undertaken three treatment process changes in the last 9 years that have altered effluent characteristics. The first was the initiation of effluent disinfection by chlorination with hypochlorite bleach followed by de-chlorination with sodium bisulfate, which began in August 2002. Second, the District is under a consent decree issued in 2002 to achieve secondary treatment standards by 2012. This effort has involved significant construction and changes in treatment processes that have resulted in effluent quality that is near the 30 mg/L secondary treatment levels for total suspended solids (TSS) and biological oxygen demand (BOD). Lastly, the Ground Water Replenishment System (GWRS) water reclamation project was initiated in January 2008. This project has decreased the volume of effluent discharged into the ocean from 237 MGD in 2006-07 to 167 MGD in 2009-10. While the effluent volume has decreased the mass balance of contaminants being discharged is approximately the same, resulting in a more concentrated effluent. What affect these treatment changes have had or might have on the surrounding biota are still being assessed. Additional details of these changes in treatment and plant processes are provided in Chapter 1.

METHODS

A 0.1 m^2 modified paired Van Veen sediment grab sampler was used to collect infaunal samples. Three replicate samples were collected quarterly (July and October 2010 and January and April 2011) at 10 stations of depths between 55–60 m (referred to herein as the 60 m or outfall-depth sites). An additional 39 "annual" stations, with depths ranging from 40 to 303 m, were sampled in July 2010 (Figure 5-1). The purpose of the quarterly surveys is to determine long-term trends and potential effects along the 60-m depth contour, while the annual survey is primarily to assess the spatial extent of the influence of the effluent discharge. Analysis of the annual survey data included the first replicate sample from the July quarterly stations as well as the 39 annual stations (n=49 stations).

Nine measures are used to assess infaunal community health and function: (1) total number of species, (2) total abundance of individuals, (3) total biomass, (4) Shannon-Wiener Diversity (H'), (5) Margalef Species Richness (d), (6) Schwartz' 75% Dominance Index (Dominance), (7) Species Evenness (J'), (8) Infaunal Trophic Index (ITI), and (9) Benthic Response Index (BRI). Shannon-Wiener Diversity and Evenness, which is the ratio of the observed Shannon-Wiener Diversity to the maximum given the same number of taxa, were calculated using $\log_e$ (Pielou 1969). Dominance was calculated as the minimum number of species with combined abundance equal to 75% of the individuals in the sample (Swartz *et al.* 1986). Biomass measurements are sometimes influenced by the occurrence of occasional, large organisms, so they tend to be much more variable than other community measures. For that reason, organisms having large biomass (e.g., sea stars and large snails) are removed from the sample calculation. The measures of diversity are based on the number of species and the equitability of their distribution. H', J', and Dominance are more sensitive to the distribution of species within a sample, while d is more sensitive to the number of species.

The Infaunal Trophic Index (ITI) is an index developed by Word (1978; 1990) to provide a measure of infaunal community "health" based on a species mode of feeding (e.g., primarily suspension vs. deposit feeder). ITI values greater than 60 are considered indicative of a "normal" community; 30–60 represent a "changed" community, while values less than 30 indicate a "degraded" community. The Benthic Response Index (BRI) measures the pollution tolerance of species on an abundance-weighted average basis (Bergen et al. 1998). This measure is scaled inversely to ITI with low values (<25) representing reference conditions and high values (>72) representing the defaunation or exclusion of most species; The intermediate value ranges of 25–34 indicates a marginal deviation from reference conditions, 35–44 indicates a loss of biodiversity, and 45–72 indicates a loss of community function. The BRI was used to determine compliance with NPDES permit conditions. It is a commonly used southern California benchmark for infaunal community structure and was developed with the input of regulators.

The presence or absence of certain indicator species (pollution sensitive and pollution tolerant) was also determined for each station. Indicator species are those organisms that show strong abundance gradients relative to the wastewater discharge and some can dominate the calculation of community measures (e.g., *Capitella capitata* Cmplx). Patterns of these species are used to assess the spatial and temporal influence of the wastewater discharge in the receiving environment. The presence of the pollution sensitive species tends to indicate the existence of a healthy environment, while the occurrence of the pollution tolerant species may indicate stressed or organically enriched environments. Pollution sensitive species include the red brittle star *Amphiodia urtica* (Lyman 1860, echinoderm) and amphipod crustaceans from the genera *Ampelisca* spp and *Rhepoxynius* spp. The pollution tolerant species include *Capitella capitata* Cmplx (polychaete) and *Euphilomedes carcharodonta* (Smith 1952, ostracod crustacean).

PRIMER v6 (Plymouth Routines in Multivariate Ecological Research) multivariate statistical software was used to examine the spatial patterns of infaunal invertebrate communities in the monitoring area. Analyses included hierarchical clustering with group-average linking based on Bray-Curtis similarity indices, and ordination clustering of the data using non-metric multidimensional scaling (MDS). Data were truncated to include only the shallow- and mid-shelf stations since depth is a strong environmental factor in delineating species clusters (OCSD 2010). Clarke and Warwick (2001) warn that clustering is less useful and may be misleading where there is a strong environmental forcing, such as depth. Prior to the calculation of the Bray-Curtis indices, the data were 4th-root transformed in order to down-weight the highly abundant species and incorporate the importance of the less common species (Clarke and Warwick 2001). The SIMPER ("similarity percentages") routine was also used to determine inter- and intra-group species differences.

Relationships of species and community metrics with sediment concentrations of the sewage marker total linear alkylbenzenes (tLAB), percent fine sediments, percent total organic carbon (TOC), and dissolved sulfides were assessed using Pearson Product Moment Correlation with the Minitab® Statistical Software package. Regression analysis was used to measure relationships to station depth. Data was transformed where appropriate. Statistical significance was set at $p \leq 0.05$.

Temporal trends were evaluated graphically at the quarterly stations. Each community measure was represented as a line graph to show the inter-annual variability. The quarterly stations were divided into two station groups: within-ZID (0, 4, ZB, and ZB2) and non-ZID stations (1, 5, 9, 12, C, and CON).

Infaunal organisms are classified into five "major taxa" for ease of comparison between stations and depth strata: polychaeta (worms), mollusca (snails, clams, etc.), crustaceans (shrimps, crabs, etc.), echinodermata (sea stars, sea urchins, sea cucumbers), and minor phyla (cnidaria, nemertea, echiura, etc.).

A more complete summary of methods for the analyses and the indices used in this chapter are presented in Appendix A.

RESULTS AND DISCUSSION

Taxa and Abundance

A total of 618 taxa comprising 58,800 individuals were collected in the 2010-11 monitoring year. This represents a decrease of 92 taxa and a slight increase of 27 individuals from the 710 taxa and 58,773 individuals collected in 2009-10. The number of species and/or the number of individuals within a major taxonomic group was largely related to depth with proximity to the outfall having less of an effect than in 2009-10 (Table 5-1). For example, the mean number of crustacean taxa and abundance generally decreased with increased station depth, but was comparable at within-ZID and non-ZID mid-shelf stations. In addition, there was an increase in crustacean taxa and abundance at stations within the ZID relative to the previous year (i.e., from 14 to 23 and 43 to 75, respectively). During the same time period the non-ZID stations showed only a slight decrease from a mean of 73 individuals in 2009-10 to 71 in 2010-11. Polychaete diversity was similar at ZID and non-ZID stations with mean number of species of 50 and 47 and mean abundances of 250 and 220, respectively. This represents an increase of 14 species and a decrease of 93 individuals at ZID stations from 2009-10. The mean number of species at non-ZID stations remained the same (47), but mean abundance increased by 53 individuals from 2009-10. The decrease in abundance at ZID stations was due primarily to decreased abundances of Capitellid species, particularly *Capitella capitata* Cmplx (see the discussion later in this chapter on indicator species). These changes suggest some improvement in infaunal assemblage near the outfall from the prior year, though these changes are within the inter-annual variability for these measures.

Community Indicators

Results and spatial trends from the July 2010 annual survey are discussed broadly in terms of station depth zones (e.g., shallow-shelf, mid-shelf within-ZID, etc.) with discussion of specific stations as appropriate (Table 5-2). Correlations of community measures to sediment physical (gran size-percent fines) and chemical (tLAB, percent TOC, and dissolved sulfides) parameters were made only on shallow- and mid-shelf stations to eliminate depth-related factors.

Number of species

The number of species collected across all 49 stations in July 2010 was greatest at shallow- and outer-shelf stations and generally decreased with increasing depth (Tables 5-2; Figure 5-2). The mean number of species was lower at the 60 m within-ZID stations (60) relative to mid-shelf non-ZID stations (91). Correlation analysis showed a significant negative relationship between number of species and tLAB (r=-0.69) indicating a strong influence from discharged particulates, particularly at sites within and near the ZID (Figure 4-2). There was no correlation to percent fines, percent TOC, or sediment sulfide concentration.

Along the 60 m contour, quarterly within-ZID stations had lower species richness than non-ZID stations. The mean number of species at quarterly non-ZID station was 103, but only 63 at within-ZID stations (Table 5-3). The mean number of species at within-ZID stations was approximately two-thirds the Bight'03 large POTW (LPOTW) and slightly less than the mid-shelf non-POTW (MSN-POTW) means. This was due to Stations 0 and ZB2, which had the two lowest species counts (46 and 45, respectively), while Stations 4 and ZB had species counts similar to regional values. The mean number of species was comparable among non-ZID stations and showed an increase of 9 species from last year. The mean number of species at the 60 m stations were within historical ranges.

Historically, there is a difference in community indicators between the within-ZID stations based on their location relative to the outfall pipe. For example, the least impact is generally seen at downcoast Station 4 and the greatest at upcoast Stations 0 and ZB2. This pattern is consistent with the predominant upcoast-flowing sub-tidal currents below 30 m influencing wastewater solids deposition (SAIC, 2009).

Table 5-1. Major taxonomic groups by station depth and location within or outside the zone of initial dilution (ZID). Values represent the mean and (range) of values for stations within a depth range.

Orange County Sanitation District, California.

Community Measure	Depth (m)	Crustacea	Echinodermata	Misc. Phyla	Mollusca	Polychaeta
Number of Species	Shallow shelf (40–46)	14 (2–35)	2 (0–7)	5 (1–13)	14 (8–23)	35 (15–65)
	Mid-shelf ZID (56–60)	23 (6–36)	5 (0–9)	7 (1–15)	16 (9–29)	50 (15–70)
	Mid-shelf non-ZID (56–60)	22 (2–28)	5 (1–7)	5 (2–9)	14 (4–21)	47 (29–58)
	Outer shelf (91–100)	18 (10–29)	4. (3–7)	7 (3–11)	17 (12–20)	58 (45–72)
	Slope (187–241)	7 (2–20)	2 (0–3)	1 (0–3)	10 (5–15)	18 (10–23)
	Basin (296–300)	2 (0–6)	1 (0–3)	1 (0–1)	7 (4–10)	11 (10–14)
Abundance of Individuals	Shallow shelf (40–46)	41 (5–95)	12 (0–82)	14 (1–46)	42 (10–85)	471 (87–1435)
	Mid-shelf ZID (56–60)	75 (16–177)	30 (0–84)	16 (1–39)	44 (13–184)	250 (111–1435)
	Mid-shelf non-ZID (56–60)	71 (4–101)	37 (6–73)	14 (4–28)	37 (5–57)	220 (108–374)
	Outer shelf (91–100)	57 (21–100)	107 (30–196)	14 (4–21)	114 (70–204)	339 (226–562)
	Slope (187–241)	19 (3–86)	3 (0–8)	2 (0–5)	29 (12–71)	48 (19–116)
	Basin (296–300)	5 (0–18)	2 (0–4)	1 (0–2)	28 (12–39)	27 (17–41)

ZID = Zone of Initial Dilution

Table 5-2. Summary of infaunal community measures for all stations, July 2010 annual survey sorted by depth.

Orange County Sanitation District, California.

Station	Depth (m)	Total Number of Species	Total Abundance	Total Biomass (g)	Shannon-Wiener Diversity (H')	Margalef Species Richness (d)	Schwartz' 75% Dominance Index	Species Evenness (J')	Infaunal Trophic Index (ITI)	Benthic Response Index (BRI)
Shallow Shelf (40 – 46 meters)										
7	41	97	248	3.54	4.32	18.9	47	0.93	77	13
8	44	113	391	2.991	4.34	20.8	47	0.90	88	15
21	44	106	453	8.41	4.01	19.6	37	0.84	86	15
22	45	97	301	5.883	4.10	18.2	39	0.88	94	14
30	46	109	426	6.595	4.06	19.2	36	0.85	86	15
36	45	89	269	4.469	3.98	17.2	39	0.87	88	11
55	40	76	317	2.679	3.78	14.4	29	0.85	89	16
59	40	131	680	4.022	3.99	22.2	40	0.80	76	14
	Mean	102	386	4.82	4.07	18.8	39	0.86	85	14
Mid-Shelf Within-ZID (56 – 60 meters)										
0 *	56	40	1376	1.777	0.49	5.95	1	0.13	2	45
4 *	56	93	474	2.16	3.61	16.4	28	0.78	66	18
ZB *	56	76	443	1.618	3.34	13.0	16	0.76	47	32
ZB2 *	56	32	1492	2.492	0.36	4.38	1	0.10	2	51
	Mean	60	946	2.01	1.95	9.92	12	0.44	29	36
Mid-Shelf Non-ZID (56 – 60 meters)										
1 *	56	110	525	9.054	4.00	19.0	35	0.84	71	20
3	60	103	507	4.618	3.82	17.8	28	0.81	58	24
5 *	59	78	286	2.238	3.86	14.4	30	0.87	82	14
9 *	59	96	475	2.981	3.78	16.9	30	0.81	71	16
10	60	87	417	5.369	3.84	16.4	29	0.83	84	14
12 *	58	93	374	3.442	3.65	16.7	29	0.79	66	15
13	59	96	391	4.613	4.08	17.3	34	0.88	88	15
37	56	106	353	5.222	3.95	19.4	38	0.83	83	15
C *	56	104	369	6.208	4.11	19.1	42	0.87	85	14
C2	56	42	149	7.1	3.41	9.2	20	0.89	68	38
CON *	59	91	319	3.499	3.95	16.3	33	0.87	88	10
	Mean	91	379	4.94	3.86	16.6	32	0.84	77	18
Outer Shelf (91–-100 meters)										
17	91	125	609	6.952	4.23	20.9	38	0.86	76	17
18	91	86	438	4.996	3.87	15.5	31	0.85	76	12
20	100	109	773	8.027	3.91	19.4	28	0.80	81	17
23	100	96	516	7.604	3.79	16.8	28	0.81	79	16
29	100	106	742	7.884	3.80	17.6	27	0.80	82	16
33	100	102	423	2.969	4.04	17.9	37	0.86	64	18
38	100	99	728	6.474	3.62	16.4	23	0.77	72	19
56	100	127	807	9.705	3.57	21.8	28	0.71	84	16
60	100	87	648	7.022	3.61	15.5	19	0.78	77	18
	Mean	104	632	6.85	3.83	18.0	29	0.81	77	17

Table 5-2 Continues.

Table 5-2 Continued.

Station	Depth (m)	Total Number of Species	Total Abundance	Total Biomass (g)	Shannon-Wiener Diversity (H’)	Margalef Species Richness (d)	Schwartz’ 75% Dominance Index	Species Evenness (J’)	Infaunal Trophic Index (ITI)	Benthic Response Index (BRI)
Slope (187 – 241 meters)										
24	200	47	119	8.91	3.54	10.5	22	0.90	70	22
25	200	45	97	3.988	3.55	9.8	22	0.93	85	17
27	200	42	116	2.848	3.28	8.8	18	0.87	68	21
39	200	56	286	4.542	3.33	11.1	17	0.80	68	21
44	241	24	37	2.93	2.97	6.4	15	0.93	42	29
57	200	34	54	4.047	3.43	8.8	23	0.96	72	24
61	200	30	65	2.715	3.12	6.9	15	0.92	62	25
63	200	40	85	2.556	3.35	9.9	24	0.88	89	14
65	200	37	75	2.702	3.36	8.3	19	0.93	65	24
C4	187	26	72	7.25	3.01	6.1	12	0.91	65	35
	Mean	38	101	4.25	3.29	8.7	19	0.90	69	23
Basin (296 – 300 meters)										
40	303	24	60	3.304	2.98	6.6	13	0.90	59	33
41	303	16	33	5.2	2.68	4.6	9	0.95	50	33
42	303	26	65	7.1	2.78	6.0	10	0.85	73	25
58	300	24	62	1.845	2.83	6.1	11	0.87	57	38
62	300	17	50	0.723	2.31	4.3	8	0.80	33	42
64	300	29	94	5.252	2.95	6.4	12	0.87	61	25
C5	296	18	68	9.499	2.39	4.3	7	0.81	41	28
	Mean	22	62	4.70	2.70	5.5	10	0.86	54	32

* Quarterly Station

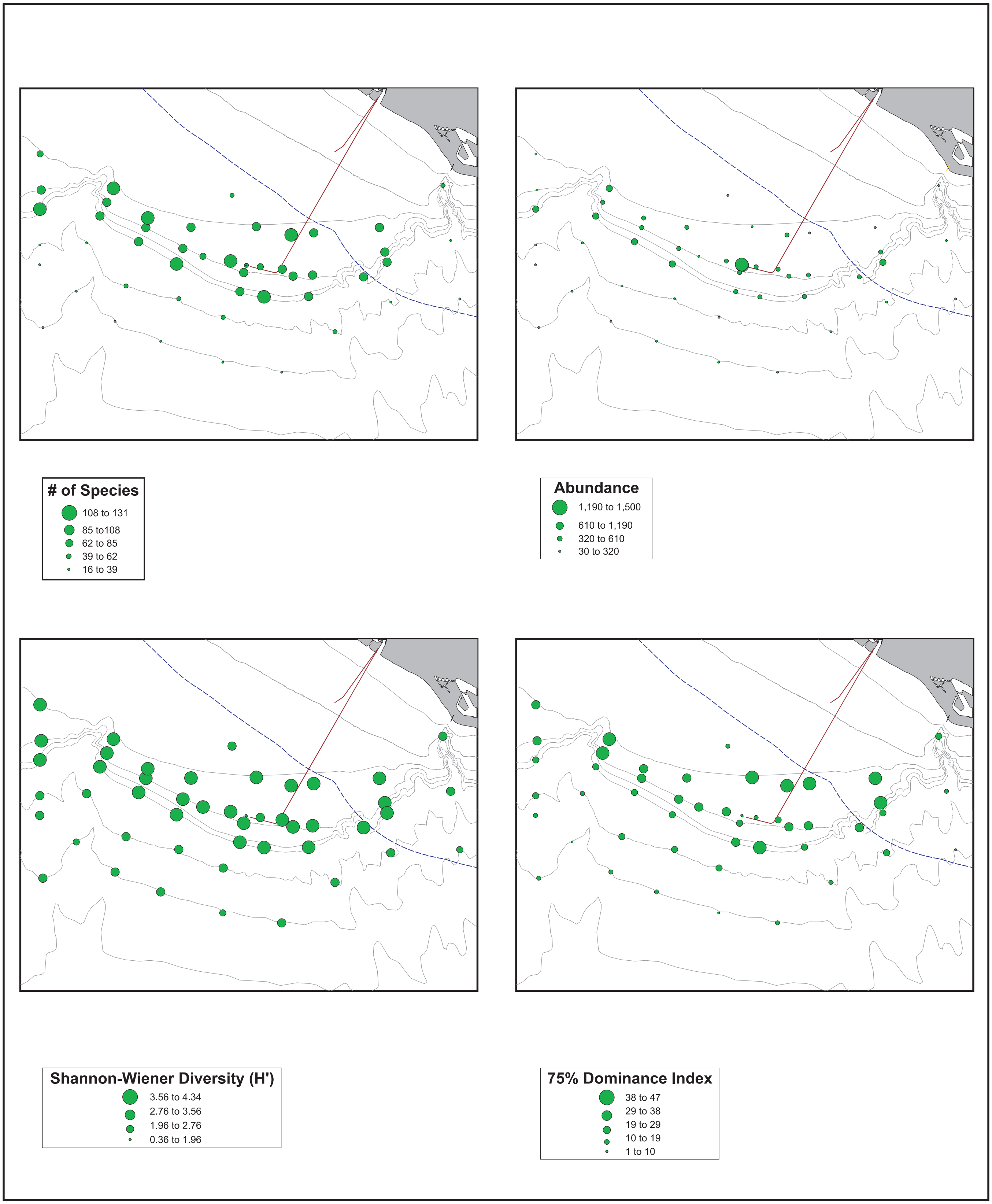

Figure 5-2. **Spatial distributions of number of species, abundance, Shannon-Wiener diversity (H’), and 75% Dominance Index during July 2010.**

Orange County Sanitation District, California.

Table 5-3. Station means of community measures and diversity indices for quarterly 60 m stations in 2010-11 compared to regional and historical values.

Orange County Sanitation District, California.

Station	Number of Species	Total Abundance	Total Biomass (g)	Shannon-Wiener Diversity (H')	Margalef Species Richness (d)	Schwartz' 75% Dominance Index	Species Evenness (J')	Infaunal Trophic Index (ITI)	Benthic Response Index (BRI)
Within-ZID Stations									
0	46	888	2.70	0.96	7.17	2	0.25	3	44
ZB2	45	866	3.02	1.22	8.21	3	0.30	4	43
4	87	332	2.70	3.95	17.05	35	0.86	70	20
ZB	74	381	1.71	3.49	13.33	21	0.80	51	32
Mean	63	617	2.53	2.41	11.44	15	0.55	32	35
Non-ZID Stations									
1	108	461	4.92	4.00	18.84	34	0.84	66	22
5	104	380	4.48	4.04	17.33	36	0.88	81	15
9	87	299	2.50	3.98	17.49	37	0.86	73	17
12	103	344	3.75	3.99	18.28	37	0.86	72	15
C	111	411	7.43	4.18	20.17	42	0.87	81	16
CON	107	370	4.56	4.23	19.75	45	0.89	82	13
Mean	103	378	4.60	4.07	18.64	39	087	76	16
Regional Reference Values									
Bight'03 LPOTW*	90	396	NC	3.68	NC	29	NC	NC	17
Bight'03 MSN-POTW*	76	321	NC	3.60	NC	26	NC	NC	14
OCSD ZID-Station Min.–Max. 1998-2010	40–137	184–2686	0.67–47.05	0.78–4.19	4.69–19.50	1–41	0.19–0.91	1–84	20–43
OCSD Non-ZID Station Min.–Max. 1998-2010	65–142	163–1055	1.38–46.80	2.99–4.31	11.29–21.12	11–46	0.68–0.93	42–94	9–30

n=10

ZID = Zone of Initial Dilution.

LPOTW = Large POTW

MSN-POTW = Mid-shelf non-POTW

NC = Not Calculated
* Ranasinghe et al. 2006

Abundance

Mean station abundances during the July 2010 annual survey were greatest at mid-shelf within-ZID and outer-shelf stations and decreased with increasing depth (Table 5-2; Figure 5-2). The high mean abundance at within-ZID stations (946) was driven primarily by high abundances of the polychaete *C. capitata* Cmplx at Stations 0 and ZB2. In contrast, abundances were high at outer shelf stations due to high abundances of echinoderms, mollusks, and polychaetes (Table 5-1). There was a significant positive correlation with total abundance and tLAB (r=0.91) and a negative one with percent fines (r=-0.50). This indicates that abundance is affected largely by the effluent discharge and to a lesser extent by sediment grain size. Abundance was not correlated with percent TOC or sediment sulfides.

The quarterly non-ZID station mean abundance was 378 compared to 617 at the within-ZID stations (Table 5-3). Mean abundances at within-ZID stations increased from 553 in 2009-10 to 617 in 2010-11. The increase was primarily due to the continued high abundances of *C. capitata* Cmplx and increased abundances of other polychaetes, which were absent or in lower numbers last year. Converse to the number of species, abundances at Stations 0 and ZB2 were more than twice that of Stations 4 and ZB. This was due to the high abundance of *C. capitata* Cmplx and the low abundance of crustaceans at Stations 0 and ZB2. All quarterly stations had mean abundances comparable to or greater than the Bight'03 LPOTW and MSN-POTW means. The mean abundances at non-ZID stations this year was comparable to the 2009-10 surveys (378 and 319 individuals, respectively).

Biomass

Mean biomass at the annual stations ranged from 2.01 g at mid-shelf within-ZID stations to 6.85 g in outer-shelf stations (Table 5-2). Despite the high total abundance at Station 0 and ZB2, the biomass was still low for the within-ZID stations. This apparent contradiction is due to individuals of *C. capitata* Cmplx, which do not contribute much to the overall Polychaete biomass because of their small size. Biomass was comparable among the shallow-shelf, mid-shelf non-ZID, slope, and basin strata ranging from 4.25 g to 4.94 g. Biomass was negatively correlated with tLAB (r=-0.42) and positively correlated with percent fines (r=0.47), indicating that both the outfall discharge and sediment grain size influence biomass.

Mean biomass was reduced at the quarterly ZID stations (2.53 g) relative to the non-ZID stations (4.60 g; Table 5-3). This is likely due to the exclusion of species by *C. capitata*. For example, in July 2010, Station 0 had 40 species and 1375 individuals; *C. capitata* accounted for 93% (1280 individuals) of the abundance. In contrast, polychaetes comprised 50% of the species and 53% of the total abundance at Station C, which also had the highest mean biomass of the quarterly stations. All biomass measurements were within the historical range for the quarterly stations.

Diversity Indices

Four diversity (H' and d) and species equitability (J' and 75% Dominance) indices are calculated. All results are reported in tables and figures, but due to the high correlation of results only Shannon-Wiener Diversity (H') and Schwartz' 75% Dominance (Dominance) are discussed.

Shannon-Wiener Diversity (H')

Mean H' scores ranged from 1.95 at mid-shelf within-ZID stations to 4.07 at shallow-shelf stations (Table 5-2; Figure 5-2). Consistent with previous annual surveys (e.g., OCSD 2011), the July 2010 annual survey showed a pattern of higher values at the shallow- and non-ZID mid-shelf stations with values generally decreasing with increasing depth and proximity to the outfall (Table 5-2; Figure 5-2). Correlation analysis showed a strong inverse relationship of H' to tLAB (R=-0.94), indicating a strong outfall influence on species diversity. This is likely due to the high abundances of *C. capitata* Cmplx at within-ZID Stations 0 and ZB2 and high tLAB concentrations at these stations compared to other stations (see Chapter 4).

The quarterly non-ZID station mean diversity was nearly twice that of the within-ZID stations (4.07 compared to 2.41; Table 5-3). H' scores at ZID Stations 0 and ZB2 was three to four times lower than Stations 4 and ZB; scores at Stations 4 and ZB were comparable to non-ZID stations. All non-ZID stations exceeded both Bight'03 LPOTW and MSN-POTW values and were within the long-term range of values at OCSD quarterly stations. H' values at within-ZID Stations 0 and ZB2 were below Bight'03 LPOTW and MSN-POTW values, and below the long-term quarterly station means.

Schwartz' 75% Dominance (Dominance)

Dominance scores were highest in the shallow-shelf stations and tended to decrease with increasing depth or proximity to the outfall (Table 5-2; Figure 5-2). ZID Stations 0 and ZB2 each had Dominance scores of 1 due to the high abundances of *C. capitata* Cmplx*,* which comprised 93% and 95% of the abundances, respectively. The Dominance score at within-ZID Station 4 (28) was comparable to the mid-shelf non-ZID stations mean (32), while the Station ZB score (16) was half that. Correlation analysis showed a strong inverse relationship to tLAB (r=-0.85), indicating a strong outfall influence, likely due to the low scores at Stations 0 and ZB2.

Mean Dominance at the quarterly stations was generally low at within-ZID stations and increased with increasing distance from the outfall (Table 5-3). All non-ZID stations and within-ZID Station 4 exceeded the Bight'03 scores. The mean scores at Stations C (42) and CON (45) were comparable to the historical mean high value of 46 for non-ZID stations. Conversely, the means for Stations 0 (2) and ZB2 (3) were just above the lower historical ZID-station mean of 1.

Infaunal Trophic Index and Benthic Response Index

Infaunal Trophic Index (ITI)

In July 2010, mean Infaunal Trophic Index (ITI) scores ranged from 29 at mid-shelf within-ZID stations to 85 at shallow-shelf stations (Table 5-2; Figure 5-3). ITI scores generally decreased with increased depth and were lower in the San Gabriel and Newport Canyons, in the basin, and near the ZID. Scores tend to increase with distance upcoast and inshore from the outfall. The majority of ITI scores at stations outside the ZID indicated a normal community with the exception of mid-shelf Station 3, slope Station 44, and basin Stations 40, 41, 58, 62, and C5, which had scores indicating a changed community. Mid-shelf Station 3, located only 0.3 km offshore from the outfall terminus, has generally characterized as normal per the ITI, but began showing a changed community in July 2009 (OCSD, 2011). Correlation analysis showed an inverse correlation of ITI scores and sediment tLAB (R=-0.95), indicating a strong outfall influence on infaunal community structure.

Quarterly station mean ITI scores were 32 at within-ZID stations and 76 at non-ZID stations (Table 5-3). The ITI scores at within-ZID Stations 0 and ZB2 indicated degraded communities (ITI<30) and a changed community at Station ZB (ITI<60). The ITI scores at all non-ZID stations and ZID-Station 4 indicated normal infaunal communities were present and all fell within the long-term range of values. ITI scores at Station 1 improved from last year increasing the station mean from 57 to 66; only 1 of 10 samples scored below 60 (55 in April 2010). Station 1 is located 0.6 km upcoast from the outfall terminus, the predominant direction of current flow at outfall depth. The higher ITI scores suggest improvement in sediment quality near the outfall.

Benthic Response Index (BRI)

Benthic Response Index (BRI) scores in the July 2010 annual survey ranged from 14 at shallow-shelf stations to 32 at basin station (Table 5-2). With the exception of the mid-shelf within-ZID stations and basin stations, BRI scores were fairly uniform on the San Pedro Shelf. BRI scores generally increased with station depth and decreased with distance from the outfall (Figure 5-3). Shallow and mid-depth stations beyond the ZID had BRI scores indicating reference conditions, except Station C2 (38). Station C2 is located at the head of the Newport Canyon and differs from other mid-shelf depth stations in sediment characteristics (e.g., percent fines) and contaminant concentrations (see Chapter 4), which affect species distributions.

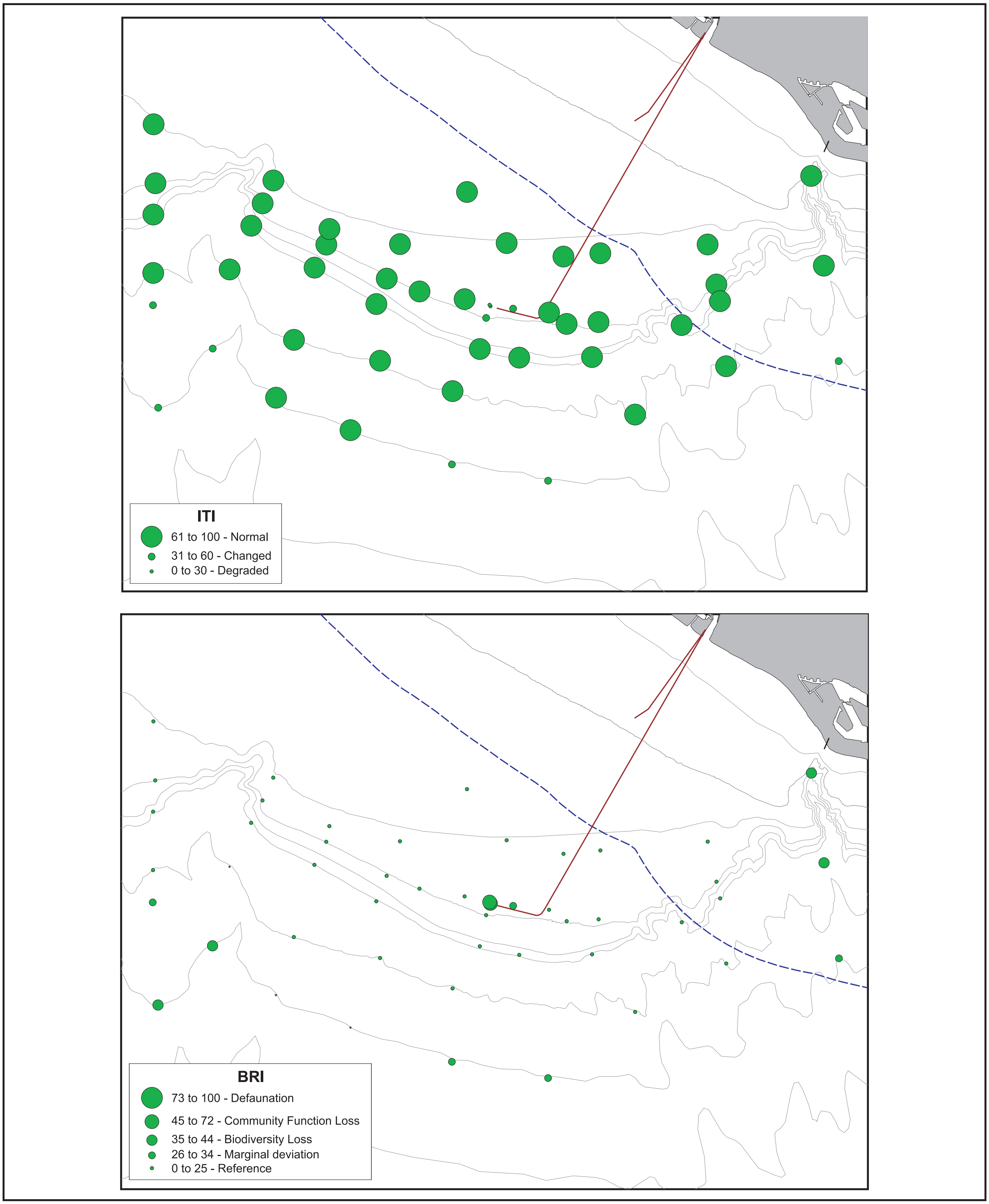

Figure 5-3. **Spatial distributions of infaunal trophic index (ITI) and benthic response index (BRI) during July 2010.**

Orange County Sanitation District, California.

Several slope and basin stations had BRI scores indicating marginal deviation from reference conditions, while Stations 58, 62, and C4 had scores representative of a loss of biodiversity (Table 5-2, Figure 5-3). Stations 58 and 62 are showing change that appears related to what is occurring near the outfall. Correlation analysis showed a relationship of BRI to sediment tLAB (r=0.85), indicating a strong outfall influence on infaunal community structure.

The mean BRI scores at quarterly non-ZID stations was 16, indicating reference conditions, while the within-ZID station mean score of 35 indicates a loss of biodiversity (Table 5-3). ZID-Station 4 characterized as reference with a BRI score of 20, Station ZB characterized as marginal deviation from reference (32), and Stations 0 and ZB2 characterized as having a loss of biodiversity (44 and 43, respectively). The latter scores met or exceeded the long-term high range of 43. Mean BRI scores at non-ZID stations were within the long-term range and comparable to Bight'03 MSN-POTW and LPOTW means.

While the mean ITI score at Station 1 suggests improvement, there was no change in mean BRI scores from last year to this year. BRI scores at Stations 0 and ZB2 increased from 2009 to 2010 (2009 BRI=41 and 37, and 2010 BRI=44 and 43, respectively) indicating a decrease in community condition.

Temporal (long-term) Trend Analysis

Over the last several years, long-term trends for several community measures along the 60-m contour have changed relative to previous years. The majority of these changes occurred at the within-ZID station group, but some changes have occurred at non-ZID stations (Figure 5-4). The number of species at non-ZID stations has remained relatively constant, showing expected inter-annual variability. ZID stations exhibit a greater degree of variability and a decline in the number of species. Downcoast Station 4 was less affected than mid-diffuser Station ZB, while upcoast Stations 0 and ZB2 showed the greatest decline. Stations 0 and ZB2 had values that extended below the historical range in both 2009-10 and 2010-11. H' and Dominance showed similar patterns of increase over time at all non-ZID stations; the increase was more pronounced and the variability greater for Dominance. At Stations 4 and ZB, both measures show high variability over time, but all values are within the long-term ranges for those stations. These measures extend below the long-term ranges for Stations 0 and ZB2 in 2009-10 and 2010-11. BRI has decreased slightly at all non-ZID stations and ZID-Station 4 indicating improving conditions. Conversely, BRI scores at Stations 0, ZB, and ZB2 decreased slightly from 1985 to 2001, but have since increased through this year with the greatest increases seen from 2009 to 2011. ITI scores at non-ZID stations, while indicating normal communities, began declining in 2005 at the four stations closest to the outfall with the largest decline occurring at Station 1. In 2009-10, ITI scores at Station 1 were low enough to classify the infaunal community as “changed” and they extended below the historical range of scores for that station. Some improvement was noted in 2010-11. Total abundance has been declining gradually at all stations since 1985.

Overall, community parameters at within-ZID Stations 0, ZB, and ZB2 began changing in 2002, and non-ZID Stations 1 and 9 in 2005, although to a lesser extent. This change greatly accelerated in 2009. The possible causes of this change may include effluent chlorination for pathogen reduction and decreased final effluent volume due to wastewater reclamation efforts.

Indicator Species

Pollution Tolerant Species

Capitella capitata Cmplx

The July annual survey, as in previous years, included high abundances of *Capitella capitata* Cmplx at within-ZID stations where they were a major factor in the low ITI and high BRI scores (Figure 5-5). Abundances were significantly correlated to tLAB concentrations (r=0.94) indicating a wastewater influence.

Abundances of *C. capitata* Cmplx in summer surveys at the ten 60 m stations and annual Station 3 from 2000 to 2010 were reviewed for

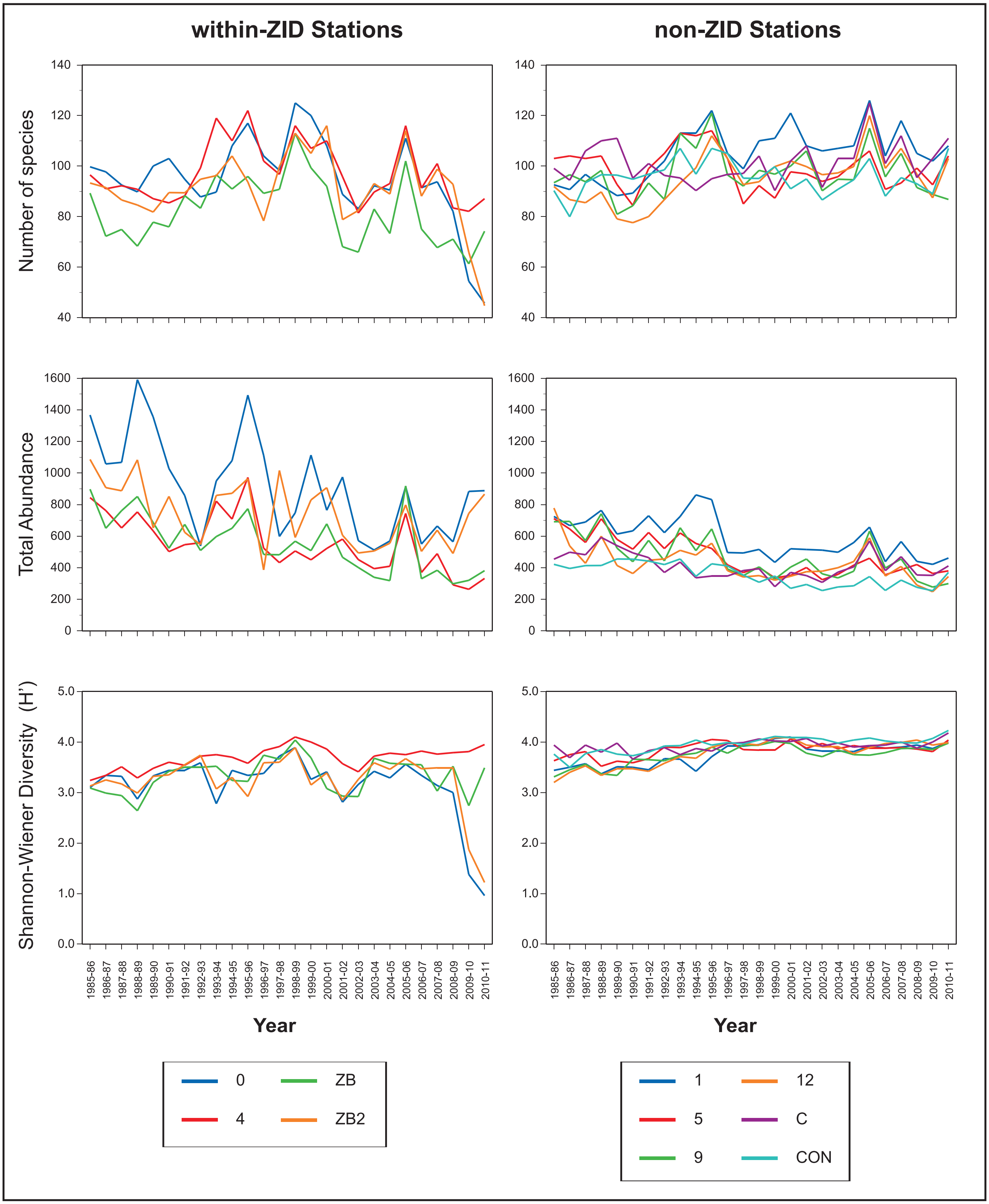

Figure 5-4. **Annual mean values for benthic infauna parameters for the period 1985–2010: No. of species, abundance, Shannon-Wiener diversity (H'), Schwartz's 75% dominance, infaunal trophic index (ITI), and benthic response index (BRI).**

Orange County Sanitation District, California.

Figure 5-4 continued.

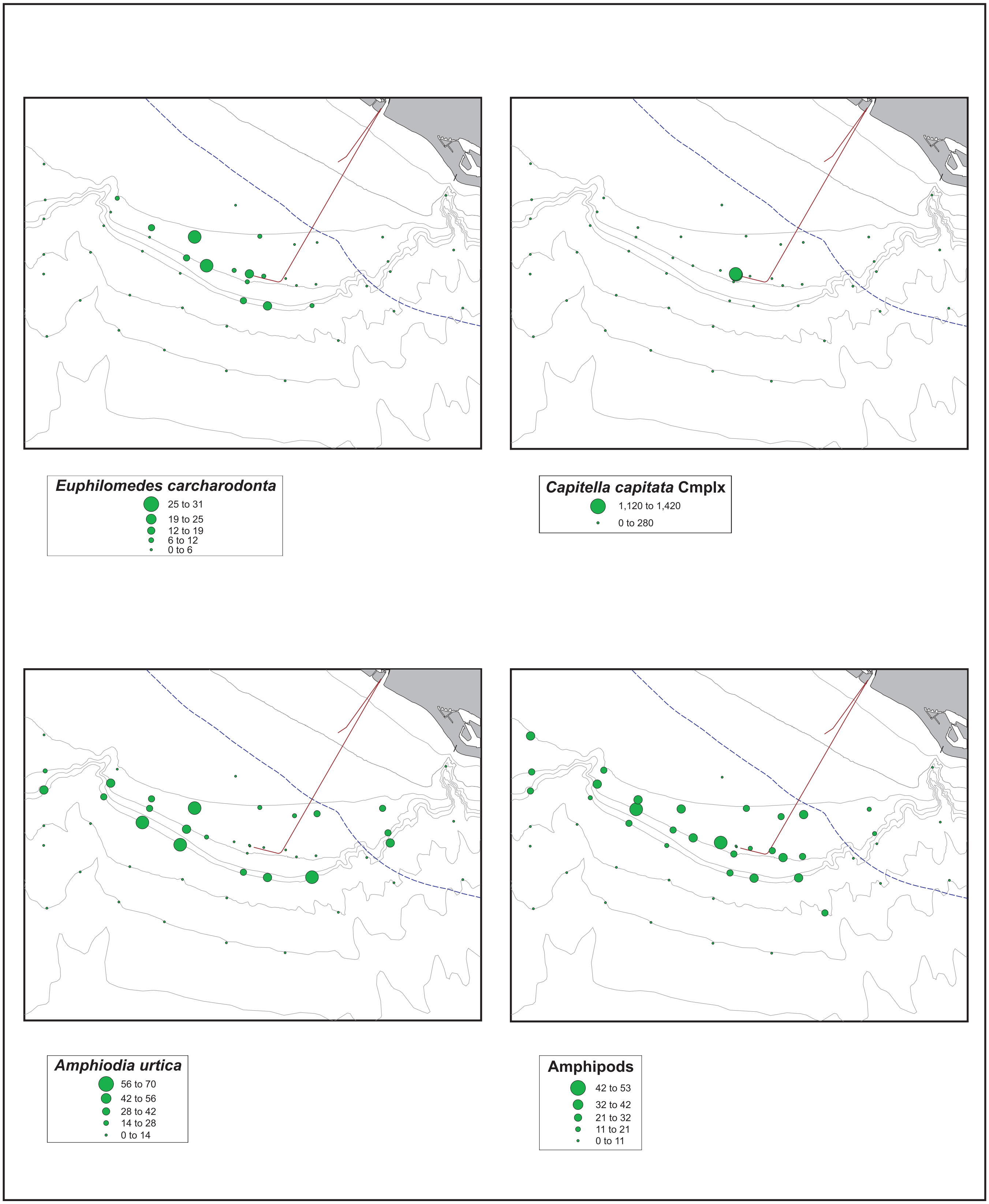

Figure 5-5. **Spatial distribution of abundance of *Euphilomedes carcharodonta*, *Capitella capitata* Cmplx, *Amphiodia urtica,* and selected amphipods during July 2010.**

Orange County Sanitation District, California.

trends (Figure 5-6). Station 3 was included due to its close proximity (0.3 km) to the outfall and observed changes in the infaunal community in the last several years. Within-ZID Stations 0 and ZB2 showed increased abundances from approximately two- to four-fold (584 to 1,280 and 317 to 1,412, respectively), from 2009-10 to 2010-11. Conversely, abundance at within-ZID Station ZB decreased by half (174 to 82), while Station 4 abundance was only 7 in 2009. There has been a slight increase at Station 3 and, to a lesser extent at Station 1. There were large abundances of *C. capitata* Cmplx at within-ZID stations from 2000 to 2002, which decreased in 2003, and then slowly increased again beginning in 2006. Large increases occurred at Stations 0, ZB, and ZB2 in 2008 and 2009. The overall increasing trend at Stations 0 and ZB2 is driven by the large recruitment event beginning in 2009, while the decreasing trends at the other within-ZID sites are due to the high abundances in 2000 to 2002.

The large abundances of *C. capitata* Cmplx within the ZID from 2000 to 2002 were not accompanied by a significant decrease in community diversity as measured by the BRI and ITI, indicating that other species were not excluded. There was also no change in community structure outside the ZID. Since 2007, there has been a decrease in species and degradation of community health at the within-ZID Stations 0, ZB2, and ZB concomitant with the increases in *C. capitata* Cmplx abundances indicating that this opportunistic, pollution-tolerant species is now excluding species. The slight increase at nearfield Station 3 (14) indicate changing conditions outside the ZID.

Euphilomedes carcharodonta

Abundances during the annual survey were highest in the areas just offshore and upcoast of the outfall diffuser (Figure 5-5). Distribution was related to depth (r^2=0.43), but not sediment tLAB concentrations indicating no relationship with the District's effluent discharge even though *E. carcharodonta* abundances are generally higher near the outfall and in the general direction of effluent plume movement. *E. carcharodonta* abundances were highest at sites within the ZID and at non-ZID Stations 1, 3, and 9 from 2000 through 2003 (Figure 5-6). Similar to *C. capitata* Cmplx, *E. carcharodonta* abundances decreased from 2004 to 2007 at most sites, but began to rise at Station 3 beginning in 2005. Since 2008, *E. carcharodonta* abundances have increased at within-ZID stations and non-ZID nearfield upcoast Stations 1, 3, and 5 suggesting changing conditions outside the ZID.

Pollution Sensitive Species

Amphiodia urtica

In July 2010, *A. urtica* distribution was influenced by station depth (r^2=0.22). While all stations are within their published depth range, the slope and basin stations are beyond the common depth range (15–85 m) for this species (Bergen 1995), which may explain their absence in the deeper strata. At shelf stations, abundances were fairly uniform except near the outfall (Figure 5-5). There was a negative correlation to tLAB (R=-0.45), indicating an effluent discharge influence on *A. urtica* distribution on the San Pedro Shelf.

From July 2009 to July 2010 *A. urtica* abundances increased slightly at each non-ZID station except Station 5, which was unchanged (Figure 5-6). There was no change at the within-ZID stations in the same time period.

Amphipods (*Rhepoxynius* spp and *Ampelisca* spp)

Abundances in the July 2010 survey were lowest in the canyons and slope areas, and highest on the San Pedro Shelf upcoast and inshore of the outfall pipe (Figure 5-5). Regression analysis showed that amphipod abundance significantly decreased with increasing depth (r^2=0.50). Many of the species found routinely at shelf stations are not found at slope and basin stations because it is beyond their depth range. Correlation analysis showed a moderate inverse relationship between amphipod abundance and sediment tLAB concentrations (R=-0.57) at the shallow- and mid-shelf stations indicating that the effluent discharge is affecting amphipod distribution.

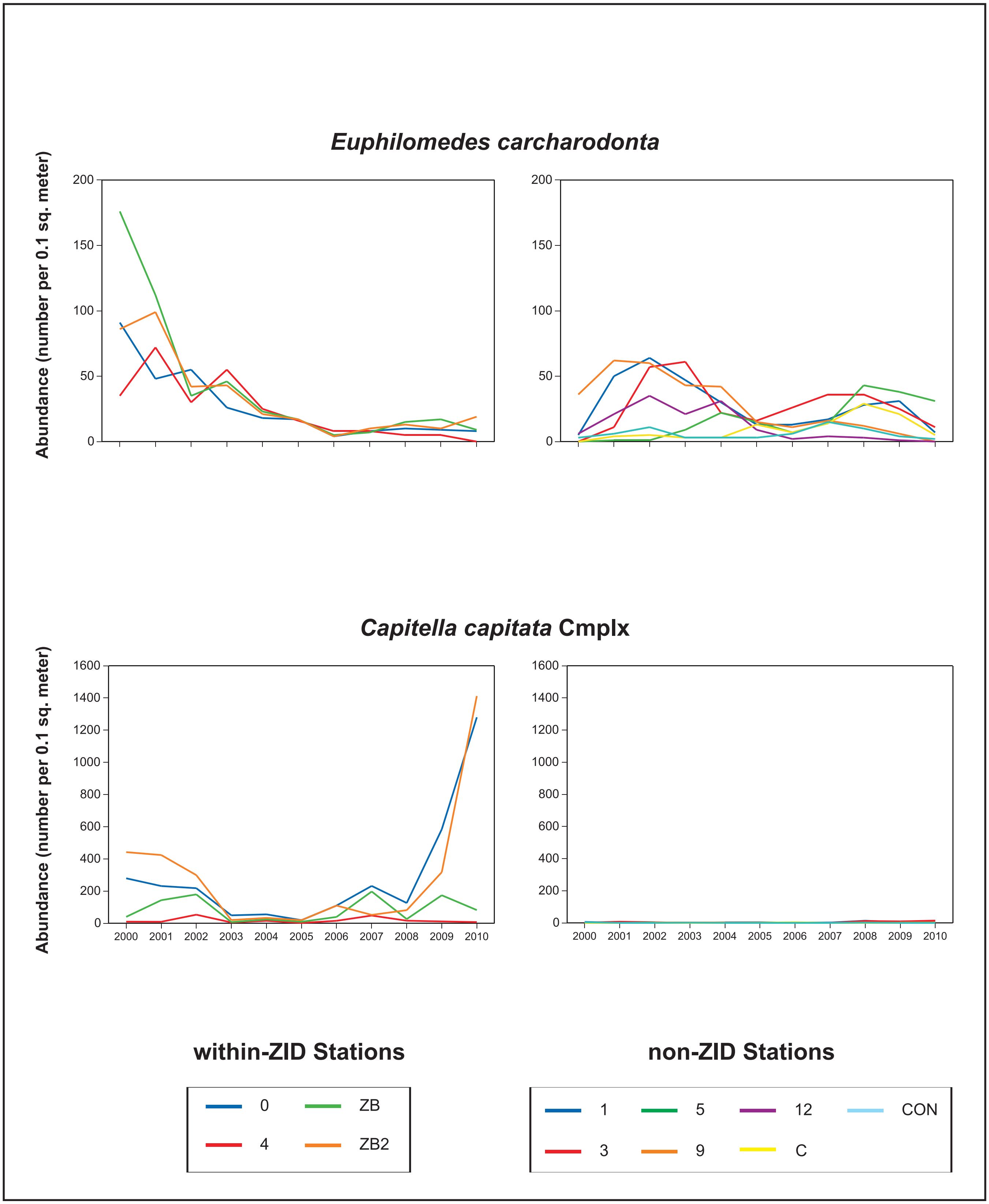

Figure 5-6. **Annual mean values of abundance for the period 2000–2010: *Euphilomedes carcharodonta*, *Capitella capitata* Cmplx, *Amphiodia urtica*, and amphipods.**

Orange County Sanitation District, California.

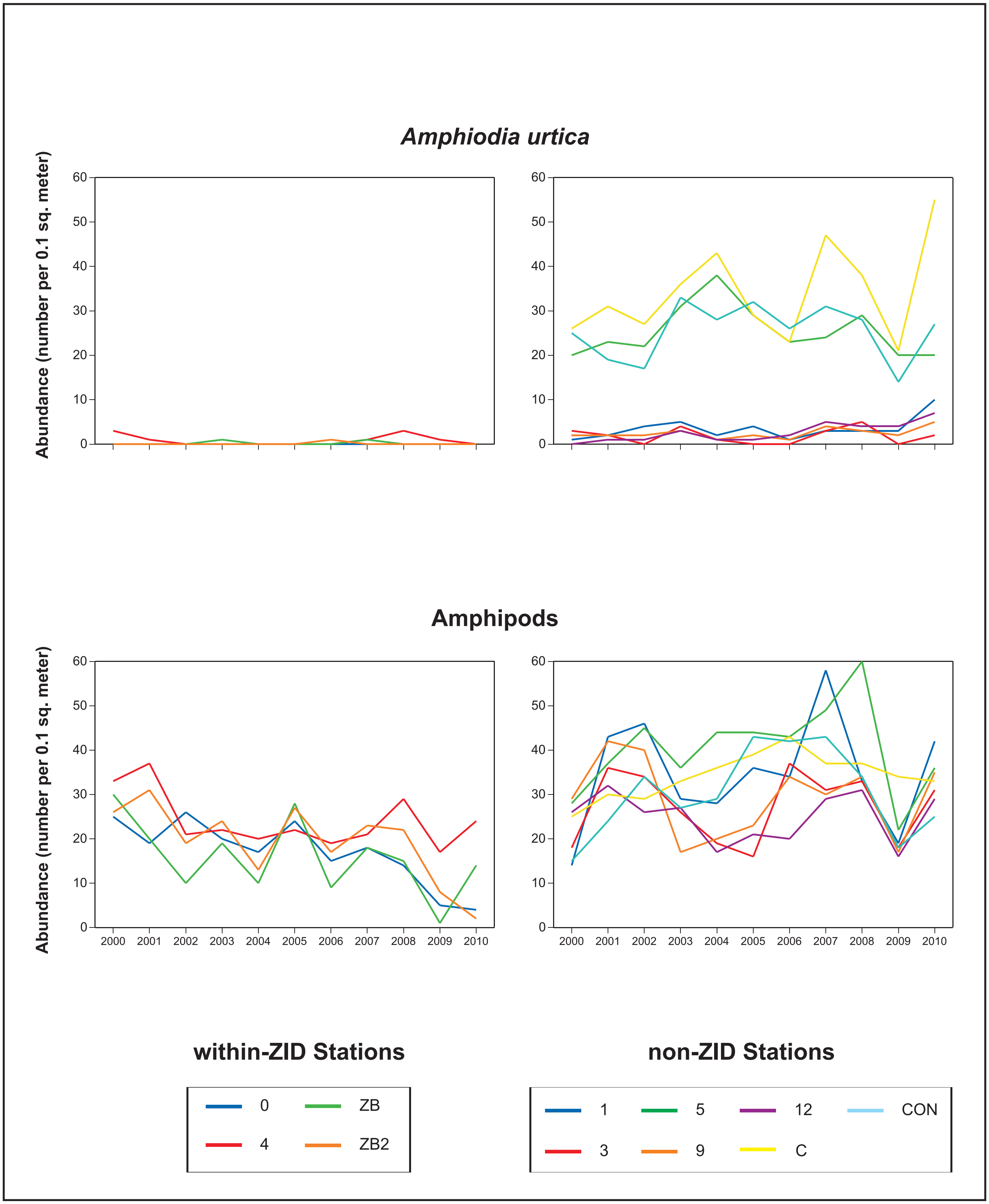

Figure 5-6 continued.

From 2000 to 2009, abundances of amphipods are decreasing at all stations except Stations 3, 5, C, and CON (Figure 5-6). However, all stations showed either an increase or no significant change in amphipod abundances from 2009 to 2010. The smallest changes occurred at within-ZID Station 0 (-1) and ZB2 (-6) and non-ZID Station C (-1), and largest at non-ZID Station 1 (+23).

Spatial Analysis

Cluster Analysis

Cluster analysis on the July 2010 abundance data identified eight major station clusters and several sub-clusters within three of those clusters (Figure 5-7). The station clusters generally follow distance and direction from the outfall diffuser. These station groups were corroborated through non-metric multidimensional scaling (MDS) using 4th root transformed data and Bray-Curtis similarity as the resemblance matrix. The output stress was low (2D = 0.10; 3D = 0.08) indicating good ordination. The 10 most numerically abundant species from each station cluster group are presented in Table 5-4.

Station Cluster 1 (SC1) includes only Station C2, located at the head of the Newport Submarine Canyon near the Newport Pier at a depth of 54 m. SIMPER analysis, used to determine characteristic species, cannot be applied to clusters composed of a single site (Clarke and Warwick 2001). Polychaetes dominated this station comprising 69% of the species and 73% of the individuals. The five most abundant species were the polychaetes *Aphelochaeta glandaria* Cmplx, *Scalibregma californicum* Blake 2000, *Nereis* sp A*,* SCAMIT 2007 *Petaloclymene pacifica,* Green 1997 and the Nemertean *Tubulanus polymorphus* Renier 1804. These five taxa comprised 40% of the total abundance of individuals at this station.

Station Cluster 2 (SC2) consists of within-ZID Stations 0 and ZB2 only, and is suggestive of the greater impact of the outfall at the end of the pipe. Polychaetes dominated this station cluster comprising 44% of the species and 96% of the individuals. The pollution tolerant polychaete *C. capitata* Cmplx accounted for 94% of the total abundance. SC2 contains the lowest abundance of crustaceans comprising only 16% of the species and 2% of the individuals. SIMPER analysis showed that SC2 was characterized by the polychaete *C. capitata* Cmplx, the ostracod crustacean *E. carcharodonta*, and the molluscs *Tellina modesta* (Carpenter 1864), *Axinopsida serricata* (Carpenter 1864), and *Lirobittium* spp.

Station Cluster 3 (SC3) is composed of Station 55 only, which is located 8.4 km upcoast from the outfall at a depth of 40 m. Polychaetes dominated SC3 with 47% of the species and 64% of the total abundance, while crustaceans accounted for 27% and 25%, respectively. The top five numerically dominate species in this station cluster were the polychaetes *Chaetozone columbiana* Blake 1996*, Spiophanes berkeleyorum* Pettibone 1962, *Chloeia pinnata* Moore, 1911, *Spiophanes bombyx*, and *Pista estevanica* Berkeley & Berkeley 1942. These five taxa comprised 39% of the abundance of individuals.

Station Cluster 4 (SC4) consists of mid-shelf non-ZID Stations 1, 3, 9, 12, and within-ZID Stations 4 and ZB. Polychaetes dominated SC4 comprising 48% of the species and 73% of the total abundance, respectively. SIMPER analysis showed that SC4 was characterized by the polychaetes *C. pinnata*, *C. columbiana*, *Aricidea (Acmira) catherinae* Laubier 1967, *Mediomastus* sp, and *Lumbrineris cruzensis* Hartman 1944. The primary factors separating SC2 from SC4 are the presence of large abundances of C. capitata Cmplx and the decreased numbers of crustaceans at SC2.

Station Cluster 5 (SC5) consisted of Station 37 only, which is located approximately 3.7 km downcoast of the outfall near the Newport Submarine Canyon. Polychaetes dominated this station accounting for 55% of the species and 57% of the total abundance. The top five numerically dominate species were the polychaetes *C. pinnata*, *Polycirrus* sp A SCAMIT 1995, *Prionospio jubata* Blake 1996, the echinoderm *A. urtica*, and the mollusk *Amphissa undata* (Carpenter 1864).

Station Cluster 6 (SC6) consisted of Stations 5, 10, 13, and CON. This station cluster had the highest biodiversity and higher proportions of crustaceans, echinoderms, and mollusks than

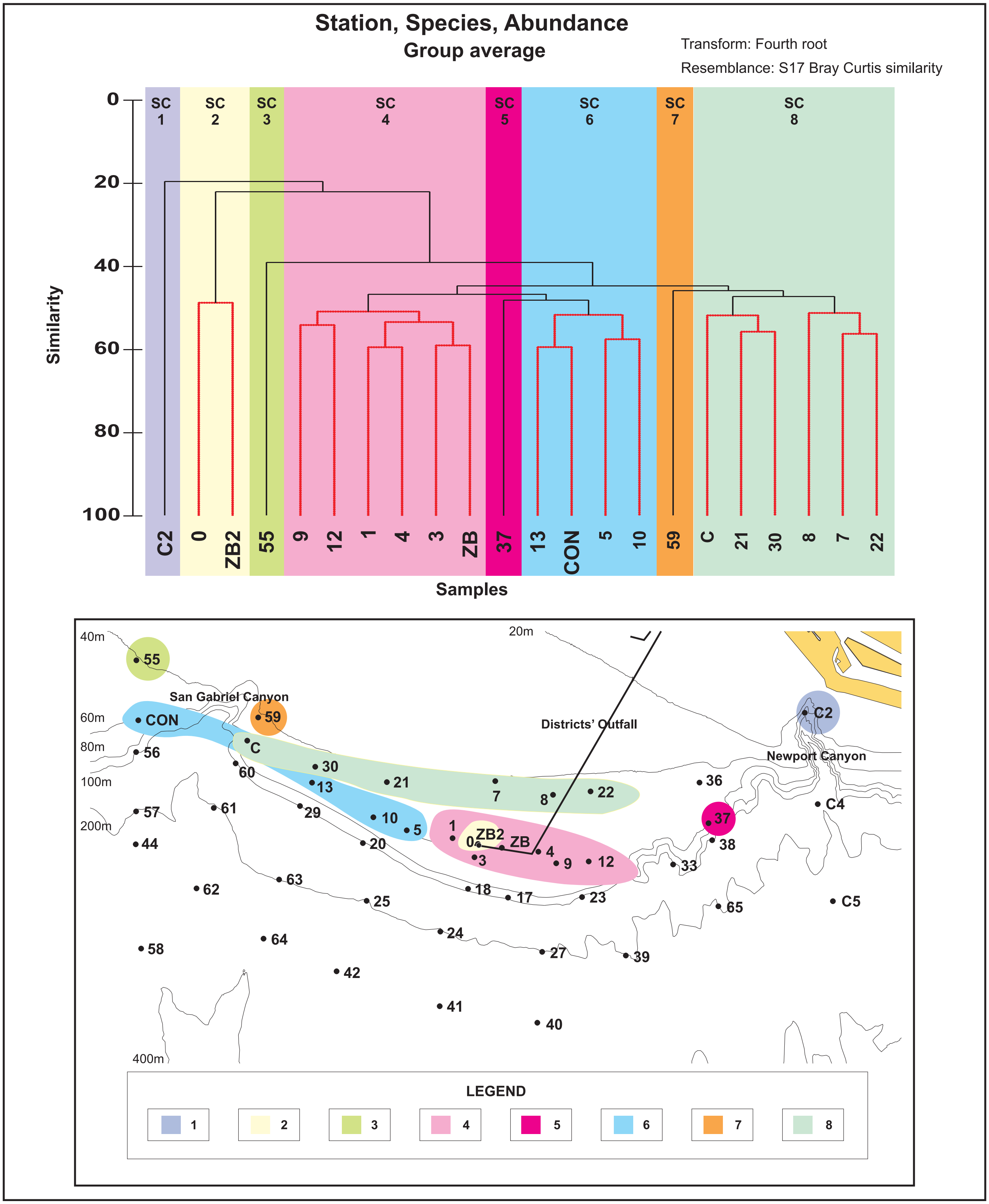

Figure 5-7. **Dendrogram of cluster analysis results (a), map of station groups from cluster analysis (b), and non-metric multi-dimensional scaling (MDS) station plot with cluster analysis overlay (c) for July 2010.**

Station symbols correspond to cluster analysis station groupings (group numbers).

Orange County Sanitation District, California.

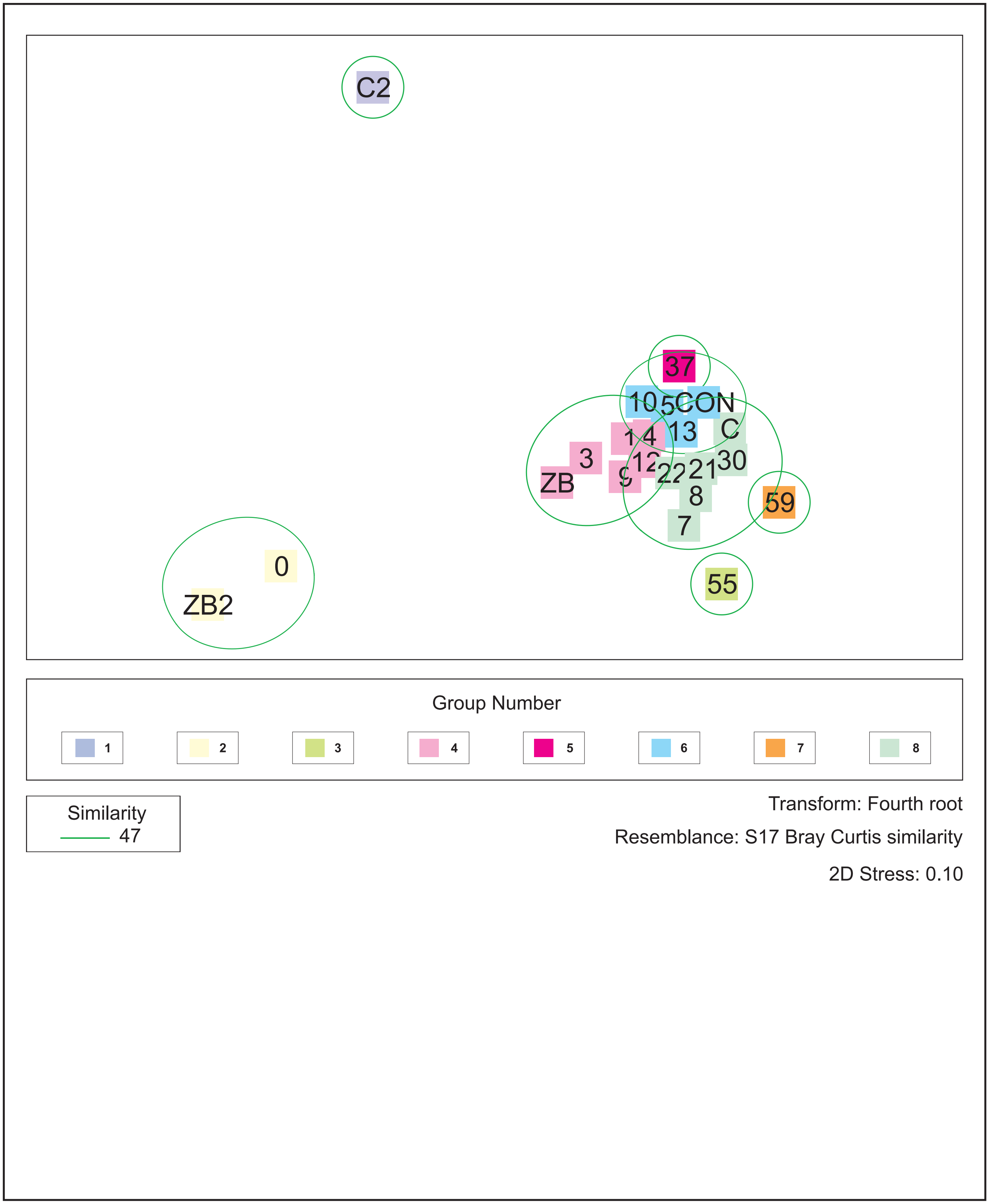

Figure 5-7 continued.

Table 5-4. Description of station clusters (SC1 to SC8) defined in Figure 5-7. Data include the number of stations per cluster, number of species, and mean abundance per station of the 10 most abundance species. Bold values indicate species that were considered "characteristic" of a cluster by SIMPER analysis.

Orange County Sanitation District, California

Parameter	SC1*	SC2	SC3*	SC4	SC5*	SC6	SC7*	SC8
Number of Stations	1	2	1	6	1	4	1	6
Number of Species	42	55	76	214	106	162	131	252
Mean Abundance/Station	149	1433	317	465	353	355	680	365
Species	**Total Abundance per Station Cluster**							
Ampelisca brevisimulata J.L. Barnard 1954								37
Ampelisca careyi Dickenson 1982			6					
Amphiodia urtica Lyman 1860	5				38	**128**		**229**
Amphissa undata Carpenter 1864					12			
Amphiuridae						37		
Aphelochaeta glandaria Cmplx	26			108				
Aphelochaeta williamsae Blake 1996	4							
Aricidia (Acmira) catherinae Laubier 1967		5		**154**	6			58
Artacamella hancocki Hartman 1955							14	
Axinopsida serricata Carpenter 1864		**17**				**75**		
Capitella capitata Cpmlx		**1692**		107				
Chaetozone Columbiana Blake 1996			40	**333**	6		16	**152**
Chloeia pinnata Moore 1911			23	**338**	58	**76**	22	
Euphilomedes carcharodonta Smith 1952		**27**				50		53
Glycera Americana Leidy 1855		6						
Glycera nana Johnson 1901	4				6			
Hemilamprops californicus Zimmer 1936			12					
Leptochelia dubia Kroyer 1842							14	
Lirobittium sp		**8**						
Listriolobus pelodes Fisher 1946							22	
Lumbrineris cruzensis Hartman 1944				**79**		36		46
Malmgreniella sp						34		
Mediomastus sp				**111**				**46**
Neastacilla californica Boone 1918		5						
Nereis sp A SCAMIT 2007	8							
Ophiuroconis bispinosa Ziesenhenne 1937							13	
Parvilucina tenuisculpta Carpenter 1864		4						
Petaloclymene pacifica Green 1997	7							
Pista estavanica Berkeley & Berkeley 1942			15					
Pista wui Saphronova 1988	5							
Polycirrus sp A SCAMIT 1995				88	15	**47**		40
Prionospio (Prionospio) jubata Blake 1996				63	8			**79**
Pseudofabricola californica Fitzhugh 1991							132	
Rhepoxynius bicuspidatus J.L. Barnard 1960					7	**38**		**40**
Rhepoxynius lubricans J.L. Barnard 1960			8					
Rhepoxynius menziesi Barnard & Barnard 1982				55				
Sabellides manriquei Salazar-Vallejo 1996							64	
Scalibregma californicum Blake 2000	10				6			
Scoletoma tetraura Cmplx	5							
Scoloplos armiger Cmplx		4	8					
Solamen columbianum Dall 1897					8			
Spiophanes berkeleyorum Pettibone 1962		4	27			36		
Spiophanes bombyx Claparede 1870			18				14	
Spiophanes duplex Chamberlin 1919			7				17	
Tellina modesta Carpenter 1864		**17**						
Travesia brevis Moore 1923					8			
Tubulanus polymorphus Renier 1804	8							

*SIMPER was not applied due to too few samples in the cluster.

other clusters. Polychaetes still dominated comprising 49% and 46% of the species and total abundance, respectively. Crustaceans accounted for 25% of the species and 27% of the abundance, and mollusks for 16% and 13%, respectively. The pollution tolerant polychaete *C. capitata* Cmplx was absent and the pollution sensitive *A. urtica* was found at all four stations (mean=32, range=20 to 53 per station). There were two sub-clusters: Sub-cluster A consists of Stations 5 and 10, and Sub-cluster B consists of Stations 13 and CON. Stations 5 and 10 are closest to the outfall located approximately 1.6 and 2.4 km upcoast, respectively, while Stations 13 and CON are 3.9 and 7.9 km upcoast of the outfall. All four sites are located in the predominate direction of bottom current flow and presumed deposition of wastewater particles, which may account for the two closest stations (5 and 10) forming a sub-cluster from the two stations father away. The sub-clusters separated at the 52% resemblance level. SIMPER analysis showed that SC6 was characterized by the amphiurid *A. urtica*, polychaetes *C. pinnata* and *Polycirrus* sp A, the mollusk *A. serricata*, and the crustacean *Rhepoxynius bicuspidatus* (J. L. Barnard 1960).

Station Cluster 7 (SC7) consisted of Station 59 only. Polychaetes dominated SC7 representing 50% of the species and 71% of the total abundance, while crustaceans accounted for 27% of the species, but only 15% of the abundance. The top five numerically dominate species were the polychaetes *Pseudofabriciola californica* Fitzhugh 1991, *Sabellides manriquei* Salazar-Vallejo 1996, *C. pinnata*, *Spiophanes duplex* (Chamberlin 1919), and the Echiuran *Listriolobus pelodes* Fisher 1946.

Station Cluster 8 (SC8) consisted of Stations 7, 8, 21, 22, 30, and C. Polychaetes dominated SC8 with 49% of the species and 52% of the abundance, followed by crustaceans (25% and 22%, respectively). Echinoderms only represented 5% of the species, but comprised 16% of the total abundance, primarily due to relatively high abundances of A. urtica, which was found at all six stations (mean=38, range=18 to 58 per station). SIMPER analysis showed that SC8 was characterized by the brittlestar *A. urtica*, the polychaetes *C. columbiana*, *P. jubata*, and *Mediomastus* sp, and the amphipod crustacean *R. bicuspidatus*. There were two sub-clusters: Sub-cluster A consists of Stations 7, 8, and 22, and Sub-cluster B consists of Stations 21, 30, and C. Sub-cluster A stations are located approximately 1.5 km inshore of the outfall diffuser at depths of 41 m to 44 m and bracket the outfall pipe. Sub-cluster B stations are located 2.4 to 5.5 km upcoast and inshore of the outfall at depths ranging from 45 m to 56 m. Distance from the outfall and station depths may account for these sub-groupings.

Overall, depth and sediment-related factors continue to be the most significant in determining infaunal distribution and abundance throughout the entire monitoring area. On the San Pedro Shelf, proximity to the outfall appears to be the dominant factor with diversity and community health generally increasing with distance from the outfall diffuser. The main factors determining the station clusters were primarily the abundances of polychaetes (e.g., *C. capitata* Cmplx) and the brittlestar *A. urtica*. Historically, the within-ZID stations, particularly Stations 0, ZB, and ZB2, form a separate station cluster from the non-ZID shelf stations (OCSD 2009); while the other 60-m stations have typically clustered together. However, since 2009-10 the nearfield stations (represented by SC4) have clustered separately from the other shelf stations (OCSD 2010). This occurrence appears to correlate with changes in species assemblages at nearfield stations.

CONCLUSIONS

Monitoring data have documented a general decline in community health at stations within the ZID since 2005 (OCSD 2007-10). The 2010-11 data indicate that degraded conditions exist at the three ZID stations located from the middle to the upcoast end of the outfall diffuser, but more severely at the outfall terminus (Stations 0 and ZB2). This includes loss of community biodiversity and large increases in pollution-tolerant species. The 2010-11 monitoring results showed minor impacts at stations beyond the ZID, with nearfield upcoast Station 1 and mid-shelf Station 3 classifying as changed per the ITI. This was coupled with decreases in pollution-sensitive species and increases in pollution-tolerant species at several nearfield stations. Some community measures at Station 1 suggest improved conditions relative to last year, though it is too soon to know whether this is improvement or natural community variability. However, conditions declined at within-ZID Stations 0 and ZB2 indicating no recovery. The cause of these changes is not known since there were no strong correlations to the suite of contaminants and sediment physical parameters measured in the District's core monitoring program. Other stations in the monitoring area classify as either reference or marginally deviated from reference. District staff is conducting an investigation into the extent and cause(s) of these changes in benthic assemblages.

The majority of stations outside the ZID classified as reference condition per the BRI and ITI. Minor impacts were observed at several stations immediately outside the ZID, but there were no strong correlations to measured sediment contaminants. This indicates that sediments and biota outside the ZID were not degraded and that permit criterion 5.3.a. was met.

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