Chapter 5. Macrobenthic Communities

INTRODUCTION

Benthic macroinvertebrates along the coastal shelf of southern California represent a diverse faunal community that is important to the marine ecosystem (Fauchald and Jones 1979, Thompson et al. 1993a, Bergen et al. 2001). These animals serve vital functions in wide ranging capacities. Some species decompose organic material as a crucial step in nutrient cycling, other species filter suspended particles from the water column, thus affecting water clarity. Many species of benthic macrofauna also are essential prey for fish and other organisms.

Human activities that impact the benthos can sometimes result in toxic contamination, oxygen depletion, nutrient loading, or other forms of environmental degradation. Certain macrofaunal species are highly sensitive to such changes and rarely occur in impacted areas. Others are opportunistic and can thrive under altered conditions. Various species respond differently to environmental stress, so monitoring macrobenthic assemblages can help to identify anthropogenic impact (Pearson and Rosenberg 1978, Warwick 1993, Smith et al. 2001). Also, since the animals in theses assemblages are relatively stationary and long-lived, they integrate environmental conditions spatially and over time. Consequently, the assessment of benthic community structure is a major component of many marine monitoring programs, which document both existing conditions and trends over time.

The structure of benthic communities is influenced by many factors including sediment conditions (e.g., particle size and sediment chemistry), water conditions (e.g., temperature, salinity, dissolved oxygen, and current velocity), and biological factors (e.g., food availability, competition, and predation). For example, benthic assemblages on the coastal shelf off San Diego typically vary along gradients in sediment particle size and/or depth. However, both human activities and natural processes can influence the structure of invertebrate communities in marine sediments. Therefore, in order to determine whether changes in community structure are related to human impacts, it is necessary to have documentation of background or reference conditions for an area. Such information is available for the SBOO discharge area and the San Diego region in general (e.g., City of San Diego 1999, 2000).

This chapter presents analyses and interpretations of the macrofaunal data collected at fixed stations surrounding the SBOO during 2005. Included are descriptions and comparisons of soft-bottom macrofaunal assemblages in the area, and analysis of benthic community structure.

MATERIALS AND METHODS

Collection and Processing of Samples

Benthic samples were collected during January and July, 2005 at 27 stations surrounding the SBOO (**Figure 5.1**). These stations range in depth from 18 to 60 m and are distributed along 4 main depth contours. Listed from north to south along each contour, these stations include: 19-m contour: stations I35, I34, I31, I23, I18, I10, I4; 28-m contour: stations I33, I30, I27, I22, I14, I16, I15, I12, I9, I6, I2, I3; 38-m contour: stations I29, I21, I13, I8; 55-m contour: stations I28, I20, I7, I1.

Samples for benthic community analysis were collected from 2 replicate 0.1-m^2 van Veen grabs per station during the January and July surveys. An additional grab was collected at each station for analysis of sediment quality (see chapter 4). The criteria established by the United States Environmental Protection Agency (USEPA) to ensure consistency of grab samples were followed with regard to sample disturbance and depth of

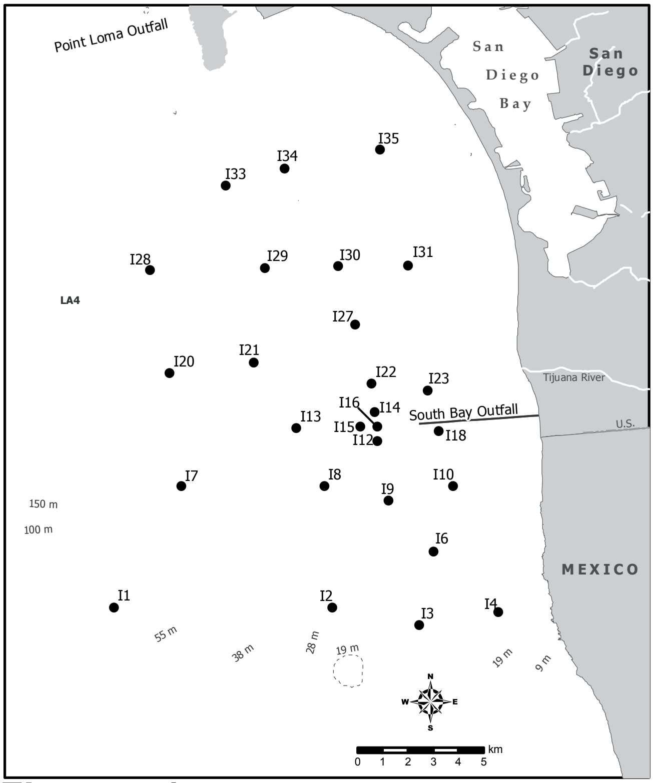


Figure 5.1
Macrobenthic station locations, South Bay Ocean Outfall Monitoring Program.

penetration (USEPA 1987). All samples were sieved aboard ship through a 1.0-mm mesh screen. Organisms retained on the screen were relaxed for 30 minutes in a magnesium sulfate solution and then fixed in buffered formalin (see City of San Diego in prep.). After a minimum of 72 hours, each sample was rinsed with fresh water and transferred to 70% ethanol. All organisms were sorted from the debris into major taxonomic groups by a subcontractor. Biomass was measured as the wet weight in grams per sample for each of the following taxonomic categories: Annelida (mostly polychaetes), Arthropoda (mostly crustaceans), Mollusca, Ophiuroidea, non-ophiuroid Echinodermata, and other miscellaneous phyla combined (e.g. Chordata, Cnidaria, Nemertea, Platyhelminthes, Phoronida, Sipuncula). Values for ophiuroids and all other echinoderms were later combined to give a total echinoderm biomass. After biomassing, all animals were identified to species or the lowest taxon possible and enumerated by City of San Diego marine biologists.

Data Analyses

The following community structure parameters were calculated for each station: species richness (mean number of species per 0.1-m^2 grab), annual total number of species per station, abundance (mean number of individuals per grab), biomass (mean grams per grab, wet weight), Shannon diversity index (mean H' per grab), Pielou's evenness index (mean J' per grab), Swartz dominance (mean minimum number of species accounting for 75% of the total abundance in each grab), Infaunal Trophic Index (mean ITI per grab, see Word 1980) and Benthic Response Index (mean BRI per grab (see Smith et al. 2001).

Multivariate analyses were performed using PRIMER v5 (Plymouth Routines in Multivariate Ecological Research) software to examine spatio-temporal patterns in the overall similarity of benthic assemblages in the region (see Clarke 1993, Warwick 1993). These analyses included classification (cluster analysis) by hierarchical agglomerative clustering with group-average linking and ordination by non-metric multidimensional scaling (MDS). The macrofaunal abundance data were square-root transformed and the Bray-Curtis measure of similarity was used as the basis for both classification and ordination. SIMPER analysis was used to identify individual species that typified each cluster group. Analyses were run on individual grab samples and on the mean of the 2 replicate grabs per station/survey. The results of these analyses showed negligible differences; thus for clarity and simplicity, results presented herein are for mean abundances of replicate grabs per station/survey. Patterns in the distribution of macrofaunal assemblages were compared to environmental variables by overlaying the physico-chemical data onto MDS plots based on the biotic data (see Field et al. 1982).

RESULTS AND DISCUSSION

Community Parameters

Number of Species
A total of 863 macrobenthic taxa were identified during 2005. Of these, 26% represented rare or

Table 5.1

Benthic community parameters at SBOO stations sampled during 2005. Data are expressed as annual means for: species richness, no. species/0.1 m^2 (SR); total cumulative no. species for the year (Tot Spp); abundance/0.1 m^2 (Abun); biomass, g/0.1 m^2; diversity (H'); evenness (J'); Swartz dominance, no. species comprising 75% of a community by abundance (Dom); benthic response index (BRI); infaunal trophic index (ITI).

	N	SR	Tot spp	Abun	Biomass	H'	J'	Dom	BRI	ITI
19 m stations										
I-35	4	79	115	250	4.6	3.9	0.90	30	28	80
I-34	4	68	97	747	5.1	2.9	0.70	12	13	64
I-31	4	51	74	133	2.0	3.4	0.88	22	19	78
I-23	4	71	123	408	3.4	3.4	0.84	22	20	73
I-18	4	55	77	124	4.5	3.6	0.91	25	20	76
I-10	4	63	94	140	4.4	3.9	0.94	30	16	80
I-4	4	42	68	124	2.8	3.2	0.86	17	8	75
28 m stations										
I-33	4	107	148	399	10.1	3.8	0.81	33	24	75
I-30	4	66	98	186	1.2	3.7	0.89	26	24	78
I-27	4	64	94	158	3.3	3.7	0.91	28	21	82
I-22	4	81	116	274	2.2	3.8	0.86	28	25	79
I-14	4	72	102	213	3.4	3.7	0.88	28	25	76
I-16	4	78	121	260	6.6	3.5	0.82	26	21	80
I-15	4	65	95	371	3.4	2.7	0.66	13	20	74
I-12	4	66	103	271	2.2	3.0	0.74	18	19	75
I-9	4	101	142	405	3.4	3.7	0.82	29	27	78
I-6	4	57	88	397	5.2	2.7	0.70	12	11	73
I-2	4	57	83	239	3.6	3.1	0.76	18	13	76
I-3	4	49	71	214	15.5	2.7	0.69	13	9	74
38 m stations										
I-29	4	121	168	478	3.5	4.1	0.85	38	18	82
I-21	4	62	87	366	5.4	2.7	0.66	11	9	86
I-13	4	85	131	400	4.6	3.3	0.75	21	16	83
I-8	4	65	93	327	37.8	3.3	0.79	17	17	81
55 m stations										
I-28	4	173	236	656	6.3	4.5	0.88	58	13	77
I-20	4	100	146	529	4.6	3.7	0.82	28	10	89
I-7	4	102	148	479	5.2	3.9	0.85	32	11	85
I-1	4	83	120	294	1.7	3.7	0.85	26	13	81
All stations										
Mean	108	77	112	327	5.8	3.5	0.81	24	17	78
Min	108	42	68	124	1.2	2.7	0.66	11	8	64
Max	108	173	236	747	37.8	4.5	0.94	58	28	89

unidentifiable taxa that were recorded only once. The average number of taxa per 0.1 m^2 grab ranged from 42 to 173, and the cumulative number of taxa per station ranged from 68 to 236 (**Table 5.1**). This wide variation in species richness is consistent with previous years, and can probably be attributed to different habitat types in the area (see City of San Diego 2004b). Higher numbers of species, for example, are common at stations such as I28 and I29 where sediments are finer than most other SBOO sites (see Chapter 4). In addition, species richness varied between surveys, averaging about 27% higher in July than in January (see **Figure 5.2**). Although species richness varied both spatially and temporally, there were no apparent patterns relative to distance from the outfall.

Polychaete worms made up the greatest proportion of species, accounting for 32–54% of the taxa per sites during 2005. Crustaceans composed 12–33% of the species, molluscs from 9 to 24%, echinoderms from 1 to 10%, and all other taxa combined about 7–23%. These percentages are generally similar to those observed during previous years, including prior to discharge (e.g., see City of San Diego 2000, 2004b).

Macrofaunal Abundance

Macrofaunal abundance ranged from a mean of 124 to 747 animals per grab in 2005 (Table 5.1). The greatest number of animals occurred at stations I7, I20, I28, I29, and I34, which averaged over 450 individuals per sample. Station I28 is typically characterized by high abundance, with a variety of different taxa accounting for the high numbers (see City of San Diego 2004). In contrast, high abundances at station I34 primarily were due to large numbers of nematodes and several species of polychaetes (i.e., *Polycirrus* sp SD 3, *Hesionura coineaui difficilis*, and *Protodorvillea gracilis*). Macrofaunal abundance varied between surveys, averaging about 66% higher in July than in January (Figure 5.2). Much of that increase is attributed to high abundance of polychaete worms as well as nematodes from the July survey of I34. Overall, abundance values were within the range of historical variation (Figure 5.2) and there were no clear spatial patterns relative to the outfall.

Similar to past years, polychaetes were the most abundant animals in the region, accounting for 36–78% of the different assemblages during 2005. Crustaceans averaged 2–47% of the animals at a station, molluscs from 3 to 23%, echinoderms from <1 to 10%, and all remaining taxa about 2–23% combined.

Biomass

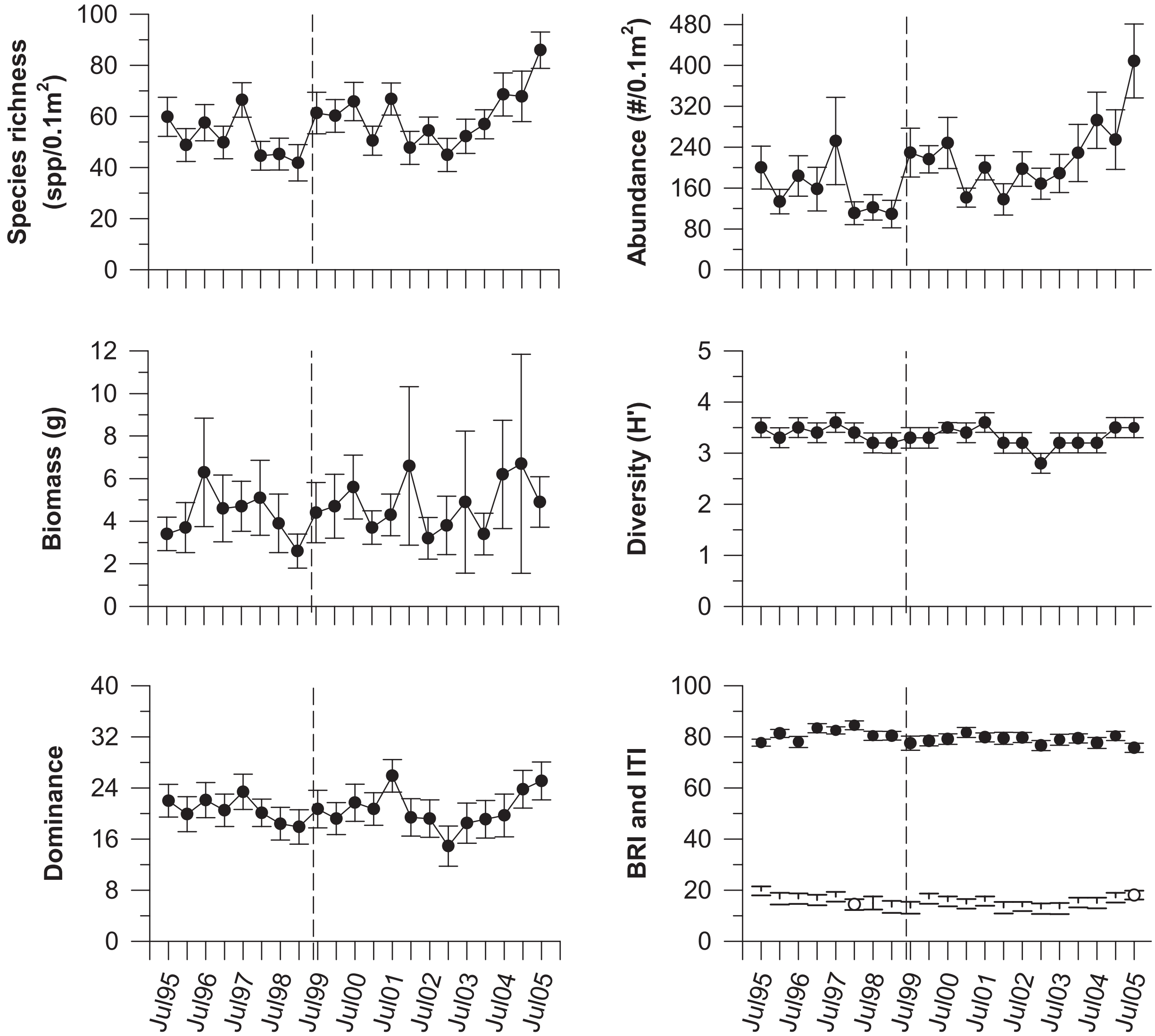
Total biomass averaged from 1.2 to 37.8 grams per 0.1 m^2 (Table 5.1). High biomass values are often due to the collection of large motile organisms such as sand dollars, sea stars, crabs, and snails. For example, during 2005 a single specimen of the mollusc *Crossata californica* weighed 140.5 grams, accounting for over 99% of the annual biomass at station I8, and over 37% of the biomass for all stations during the January survey. Although these large animals introduced considerable variability, overall biomass at the SBOO stations during the year was similar to historical values (Figure 5.2).

Overall, polychaetes accounted for 3–82% of the biomass at a station, crustaceans 1–81%, molluscs 3–93%, echinoderms <1–80%, and all other taxa combined 1–34%. In the absence of large individual molluscs or echinoderms, polychaetes dominated most stations in terms of biomass.

Species Diversity and Dominance

Species diversity (H') varied during 2005, ranging from 2.7 at several stations to 4.5 at I28 (Table 5.1). Average diversity in the region generally was similar to previous years (Figure 5.2), and no patterns relative to distance from the outfall were apparent. Also, the relatively wide range of evenness values (0.66–0.94) reflects the dominance of a few species at some of the SBOO stations. Most sites with evenness values below the mean (0.81) were dominated by polychaetes. The spatial patterns in evenness were similar to those for diversity.

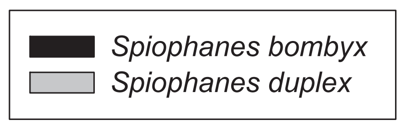
Species dominance was measured as the minimum number of species accounting for 75% of a community by abundance (see Swartz 1978). Consequently, dominance as discussed herein is inversely proportional to numerical dominance, such that low index values indicate communities dominated by few species. Values at individual stations varied widely, averaging from 11 to 58 species per station during the year (Table 5.1). Dominance values for 2005 were similar to historical values (Figure 5.2). No clear patterns relative to the outfall were evident in dominance values.



Environmental Disturbance Indices

The benthic response index (BRI) during 2005 averaged from 8 to 28 at the various SBOO stations (Table 5.1). Index values below 25 (on a scale of 100) suggest undisturbed communities or "reference conditions," while those in the range of 25–33 represent "a minor deviation from reference condition," which may or may not reflect anthropogenic impact (Smith et al. 2001). Station I9 (27) and I35 (28) had the highest BRI, and were the only 2 stations above a value of 25, while stations I22 and I14 had BRI values at 25. There were no patterns in BRI relative to distance from the outfall, and index values at sites nearest the discharge did not suggest significant environmental disturbance.

The infaunal trophic index (ITI) averaged from 64 to 89 at the various sites in 2005 (Table 5.1). There were no patterns with respect to the outfall, and all values at sites near the discharge were characteristic of undisturbed sediments (i.e., ITI >60). In addition, average ITI over all sites has changed little since monitoring began (see Figure 5.2).



Dominant Species

Most assemblages in the SBOO region were dominated by polychaete worms. For example, the list of dominant fauna in **Table 5.2** includes 15 polychaetes, 3 crustaceans, 1 nemertean, and nematodes (not identified beyond phylum).

The spionid polychaete *Spiophanes bombyx* was the most numerous and the most ubiquitous species, averaging about 49 worms per sample and occurring in 100% of the samples. A closely related species, *S. duplex*, was third in total abundance. Together, these 2 species accounted for 18% of all individuals collected during 2005. Both were found in higher numbers than some past years, and the abundance of these taxa has increased substantially since January 2002 (**Figure 5.3**). The second most abundant taxa was the cirratulid polychaete *Monticellina siblina*.

Polychaetes comprised the top 10 most abundant species per occurrence. Several polychaete species were found in high numbers at only a few stations (e.g., *Polycirrus* sp SD 3, *Hesionura coineaui difficilis*, and *Pareuthoe californica*). Few macrobenthic species were widely distributed, and of these only *Spiophanes bombyx*, *S. duplex*, and *Mediomastus* sp occurred in more than 80% of the samples. Four of the most frequently collected species were also among the 10 taxa in terms of abundance (i.e., *S. bombyx*, *S. duplex*, *Mediomastus* sp, and *Ampelisca cristata cristata*).

Table 5.2

Dominant macroinvertebrates at the SBOO benthic stations sampled during 2005. The 10 most abundant species overall, the 10 most abundant per occurrence, and the 10 most frequently collected (or widely distributed) species are included. Abundance values are expressed as mean number of individuals per 0.1 m^2 grab sample.

Species	Higher taxa	Abundance per sample	Abundance per occurence	Percent abundance	Percent occurence
Most Abundant					
1. *Spiophanes bombyx*	Polychaeta: Spionidae	49.0	49.0	15.0	100
2. *Monticellina siblina*	Polychaeta: Cirratulidae	10.8	16.7	3.3	65
3. *Spiophanes duplex*	Polychaeta: Spionidae	9.9	10.5	3.0	94
4. Nematoda	Nematoda	6.8	9.9	2.1	69
5. *Mediomastus* sp	Polychaeta: Capitellidae	5.8	7.2	1.8	81
6. *Mooreonuphis* sp SD 1	Polychaeta: Onuphidae	5.1	22.8	1.5	22
7. *Ampelisca cristata cristata*	Crustacea: Amphipoda	4.9	6.4	1.5	78
8. *Euphilomedes carcharodonta*	Crustacea: Ostracoda	4.5	6.0	1.4	74
9. *Lanassa venusta venusta*	Polychaeta: Terebellidae	4.2	20.6	1.3	20
10. *Protodorvillea gracilis*	Polychaeta: Dorvillidae	3.9	9.7	1.2	41
Most Abundant per Occurrence					
1. *Polycirrus* sp SD 3	Polychaeta: Terebellidae	3.8	103.3	1.2	4
2. *Spiophanes bombyx*	Polychaeta: Spionidae	49.0	49.0	15.0	100
3. *Hesionura coineaui difficilis*	Polychaeta: Phyllodocidae	3.6	39.3	1.1	9
4. *Pareurythoe californica*	Polychaeta: Amphinomidae	2.1	38.5	0.7	6
5. *Mooreonuphis* sp SD 1	Polychaeta: Onuphidae	5.1	22.8	1.5	22
6. *Lanassa venusta venusta*	Polychaeta: Terebellidae	4.2	20.6	1.3	20
7. *Pisione* sp	Polychaeta: Pisionidae	2.2	17.1	0.7	13
8. *Monticellina siblina*	Polychaeta: Cirratulidae	10.8	16.7	3.3	65
9. *Micropodarke dubia*	Polychaeta: Hesionidae	1.5	15.9	0.5	9
10. *Notomastus lineatus*	Polychaeta: Capitellidae	0.2	13.0	0.1	2
Most Frequently Collected					
1. *Spiophanes bombyx*	Polychaeta: Spionidae	49.0	49.0	15.0	100
2. *Spiophanes duplex*	Polychaeta: Spionidae	9.9	10.5	3.0	94
3. *Mediomastus* sp	Polychaeta: Capitellidae	5.8	7.2	1.8	81
4. *Spiochaetopterus costarum*	Polychaeta: Chaetopteridae	2.7	3.4	0.8	80
5. *Hemilamprops californicus*	Crustacea: Cumacea	2.3	2.8	0.7	80
6. *Ampelisca cristata cristata*	Crustacea: Amphipoda	4.9	6.4	1.5	78
7. Amphiuridae	Echinodermata: Amphiuridae	1.8	2.3	0.5	78
8. *Sigalion spinosus*	Polychaeta: Sigalionidae	1.6	2.0	0.5	78
9. *Leptochelia dubia*	Crustacea: Leptocheliidae	3.0	3.9	0.9	76
10. *Glycinde armigera*	Polychaeta: Goniadidae	1.6	2.1	0.5	76

A

Cluster Group	Species Richness	Abund.	% Fines	Top Three Taxa
A	101 (84-118)	1038 (504-1497)	2.3 (1.9-2.8)	Nematoda *Polycirrus* sp SD 3 *Hesionura coineaui difficilis*
B	89 (49-156)	433 (210-1176)	7.0 (0.0-13.6)	*Lanassa venusta venusta* *Moorenuphis* sp SD 1 *Euchone arenae*
C	64 (26-125)	323 (93-1050)	2.6 (0.0-8.8)	*Spiophanes bombyx* Euclymeninae *Lumbrinerides platypygos*
D	38 (27-54)	72 (56-92)	7.8 (7.0-8.6)	*Spiophanes bombyx* *Olivella baetica* *Ampharete labrops*
E	71 (33-142)	220 (52-738)	15.3 (2.7-44.8)	*Monticellina siblina* *Spiophanes bombyx* *Spiophanes duplex*
F	125 (64-192)	476 (195-798)	21.0 (10.1-30.5)	*Spiophanes bombyx* *Spiophanes duplex* *Ampelisca agassizi*

Bray-Curtis Similarity

B

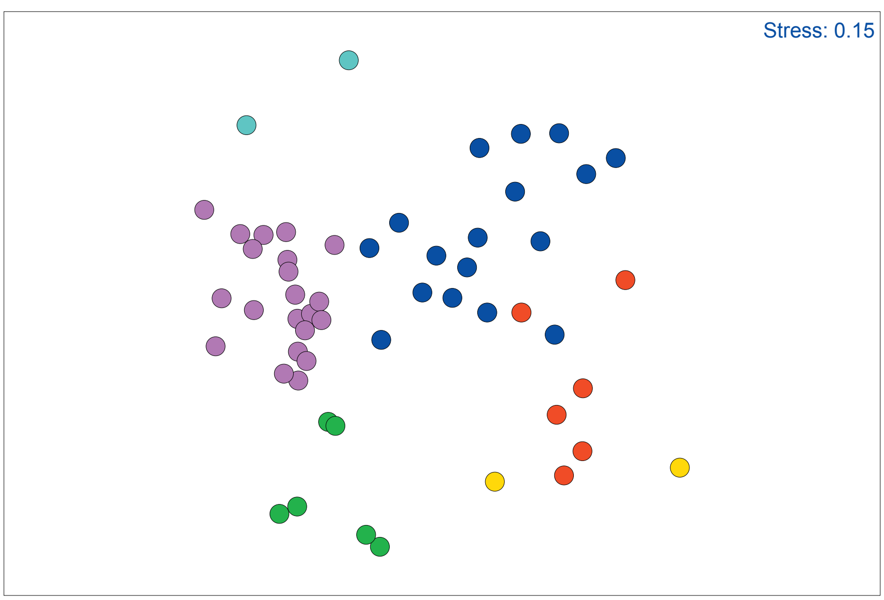


Figure 5.4

(A) Cluster results
expressed as mean values per 0.1 m^2 grab over all stations in each group. Ranges in parentheses are for individual grab samples. **(B)** MDS ordination of SBOO benthic stations sampled during 2004. Plot based on square-root transformed macrofaunal abundance data for each station/survey entity. Cluster groups superimposed on station/surveys illustrate a clear distinction between faunal assemblages.

Multivariate Analyses

Classification analysis discriminated between 6 habitat-related benthic assemblages (cluster groups A–F) during 2005 (**Figure 5.4**). These assemblages differed in terms of their species composition, including the specific taxa present and their relative abundances. The dominant species composing each group are listed in **Table 5.3**. An MDS ordination of the station/survey entities confirmed the validity of cluster groups A–F (Figure 5.4). These analyses identified no significant patterns regarding proximity to the discharge (**Figure 5.5**).

<u>Cluster group A</u> represented the July surveys from 2 stations, I23 and I34 located on the 19-m depth contour. Sediments at these sites were characterized by a relatively low percentage of fine particles. As in previous years (City of San Diego 2004, 2005) this assemblage was somewhat unique for the region; it had more than twice the mean abundance of any other assemblage and was dominated by nematode worms and several relatively uncommon polychaete species (e.g., *Hesionura coineaui difficilis*, *Polycirrus* sp SD 3, *Protodorvillea gracilis*, *Pareurythoe californica*, and *Pisione* sp).

<u>Cluster group B</u> comprised 2 stations characterized by coarse relict red sand sediments located along the 55-m depth contour and the January samples from 2 stations along the 38-m contour. In contrast to the other deeper-water assemblage described (see group F), this group had fewer taxa but about the same number of individual organisms per grab. Polychaetes numerically dominated this group including: *Lanassa venusta venusta* (Terebellidae), *Euchone arenae* (Sabellidae), and *Moorenuphis* sp SD1 (Onuphidae). Other species that were less abundant but more evenly distributed among stations within this group included the glycerid polychaete *Glycera oxycephala* and bodotriid crustacean *Cyclaspis nubila*.

<u>Cluster group C</u> comprised sites that were located on or near the 28-m depth contour, mostly south of the SBOO. These sites averaged a low percentage of fines, with some stations containing relict red sands and shell hash. The group C assemblage averaged 64 taxa and 323 individuals per grab. *Spiophanes bombyx* was numerically dominant in this group, followed by the polychaetes Euclymeninae (unidentified juveniles) and *Lumbrinerides platypygos*. Though present in lower abundances, the lampropid cumacean *Hemilamprops californicus* and Amphiuridae (unidentified juvenile ophiuroid echinoderms) were typically found across most samples within this cluster group.

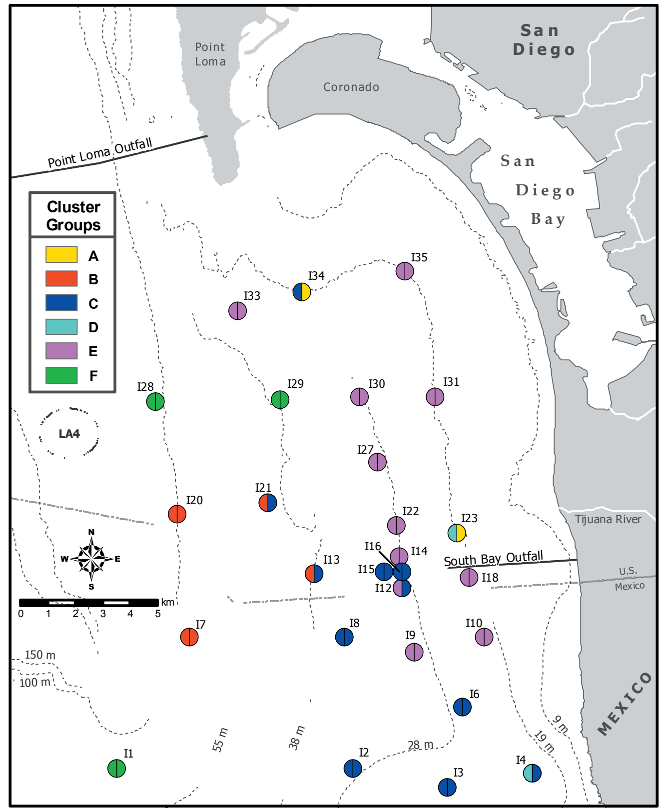


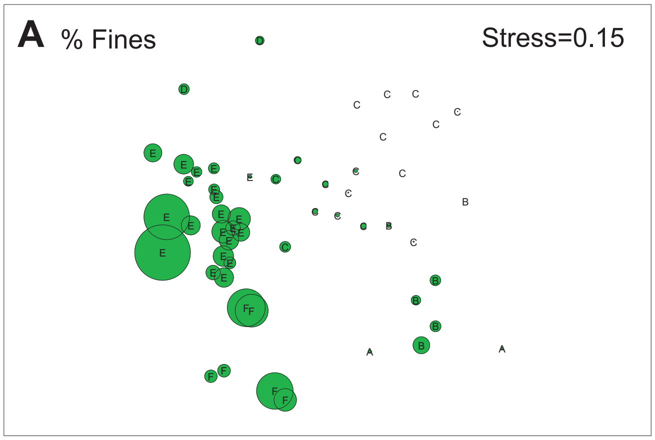
Figure 5.5
SBOO benthic stations sampled during January and July 2005, are color-coded to represent affiliation with benthic cluster groups. Left half of the circle represents cluster group affiliation for the January survey; the right half represents the July survey.

<u>Cluster group D</u> represented the January surveys for stations I4 and I23, both along the 19-m contour. The sediment habitat for this assemblage was relatively sandy. Group D contained the fewest number of species and the lowest densities among all the groups. *Spiophanes bombyx* was the most

Table 5.3

Summary of the most abundant taxa comprising cluster groups A–E from the 2005 survey of SBOO benthic stations. Data are expressed as mean abundance per sample (no./0.1m^2) and represent the 10 most abundant taxa in each group. Values for the 3 most abundant species in each cluster group are in bold. n=number of station/survey entities per cluster group

		Cluster group					
Species/Taxa	Taxa	A (n=2)	B (n=6)	C (n=17)	D (n=2)	E (n=21)	F (n=6)
Amaeana occidentalis	Polychaeta	—	—	0.16	2.75	0.30	0.25
Ampelisca agassizi	Crustacea	—	—	—	—	0.05	**16.00**
Ampelisca brachycladus	Crustacea	—	0.08	1.34	3.25	2.66	0.08
Ampelisca cristata cristata	Crustacea	0.25	17.58	5.41	0.50	2.75	2.17
Ampharete labrops	Polychaeta	2.50	0.08	1.78	**3.50**	1.66	1.33
Ampharetidae	Polychaeta	0.25	—	—	2.00	0.45	0.67
Amphiuridae	Echinodermata	—	0.25	3.56	—	1.02	2.67
Axiothella sp	Polychaeta	—	0.58	3.66	0.50	0.23	0.25
Cadulus aberrans	Mollusca	—	—	0.06	1.25	3.23	2.83
Carinoma mutabilis	Nemertea	8.00	0.42	1.09	1.50	1.34	1.17
Diastylopsis tenuis	Crustacea	—	—	—	1.75	0.18	—
Euchone arenae	Polychaeta	9.25	**25.50**	0.72	—	0.14	1.00
Euclymeninae	Polychaeta	—	0.08	**9.88**	—	0.45	0.50
Euclymeninae sp A	Polychaeta	1.75	1.50	0.50	0.25	5.41	2.75
Euphilomedes carcharodonta	Crustacea	0.25	0.83	2.78	0.75	5.86	10.08
Glycera oxycephala	Polychaeta	—	2.42	3.59	0.25	0.25	0.17
Hesionura coineaui difficilis	Polychaeta	**87.25**	3.58	0.03	—	—	—
Lanassa venusta venusta	Polychaeta	—	**36.25**	0.53	—	—	0.08
Laticorophium baconi	Crustacea	—	6.08	0.19	—	—	—
Leptochelia dubia	Crustacea	0.50	3.67	1.44	—	2.07	11.33
Lumbrinerides platypygos	Polychaeta	8.25	4.00	**6.84**	—	0.25	—
Mediomastus sp	Polychaeta	14.75	3.83	0.97	1.00	7.16	14.67
Micropodarke dubia	Polychaeta	38.75	0.17	—	—	0.02	0.08
Monticellina siblina	Polychaeta	0.75	—	2.50	0.25	**23.43**	4.42
Mooreonuphis sp	Polychaeta	0.25	21.92	3.25	—	0.25	0.42
Mooreonuphis sp SD1	Polychaeta	—	**30.58**	5.59	—	—	—
Myriochele gracilis	Polychaeta	—	0.08	0.13	—	—	8.00
Nematoda	Nematoda	**113.50**	9.92	1.19	0.75	1.16	5.75
Oligochaeta	Polychaeta	18.00	1.67	0.13	—	—	—
Olivella baetica	Mollusca	0.50	2.92	1.19	**3.75**	0.50	0.08
Onuphidae	Polychaeta	—	15.58	3.25	1.75	0.77	1.08
Pareurythoe californica	Polychaeta	57.50	—	—	—	0.02	—
Photis californica	Crustacea	—	5.00	—	—	0.02	9.50
Pisione sp	Polychaeta	54.50	1.75	0.03	—	—	—
Polycirrus sp SD 3	Polychaeta	**103.25**	—	—	—	—	—
Prionospio (*Prionospio*) *jubata*	Polychaeta	2.00	5.17	2.59	—	2.16	7.92
Protodorvillea gracilis	Polychaeta	81.75	2.92	1.78	0.25	0.11	0.08
Rhepoxynius menziesi	Crustacea	0.50	—	1.13	1.50	3.61	1.67
Sige sp A	Polychaeta	26.00	—	0.19	—	0.05	0.08
Siphonodentalium quadrifissatum	Mollusca	0.25	2.25	4.69	—	0.25	—
Spiochaetopterus costarum	Polychaeta	1.75	3.33	4.25	—	1.20	4.42
Spiophanes berkeleyorum	Polychaeta	0.25	0.92	2.97	—	4.55	6.75
Spiophanes bombyx	Polychaeta	25.25	18.50	**122.25**	**4.50**	**17.77**	**21.75**
Spiophanes duplex	Polychaeta	1.50	5.67	3.25	0.50	**9.57**	**39.00**
Sthenelanella uniformis	Polychaeta	—	0.42	0.03	—	0.25	7.42
Syllis (*Typosyllis*) sp SD1	Polychaeta	13.75	11.00	0.09	—	—	—
Tellina modesta	Mollusca	0.25	0.17	0.84	3.00	4.00	0.17



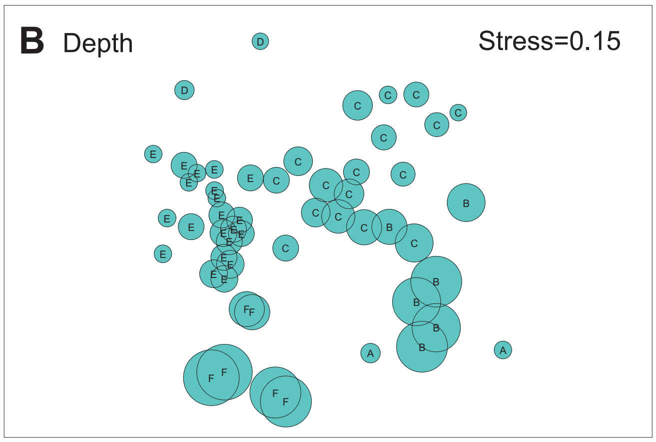


Figure 5.6
MDS ordination of SBOO benthic stations sampled during January and July 2005. Cluster groups A–F are superimposed on station/surveys. Percentage of fine particles in the sediments and station depth are further superimposed as circles that vary in size according to the magnitude of each value. Plots indicate associations of benthic assemblages with habitats that differ in sediment grain size and depth.

abundant species in the group followed by *Olivella baetica*, the only mollusc within all the cluster groups defining an assemblage.

Cluster group E included sites primarily located along the 19 and 28-m depth contours, where sediments also contained the second highest amount of fine particles. This assemblage averaged 71 taxa and 220 individuals per 0.1 m^2. The numerically dominant species in this group were the cirratulid polychaete *Monticellina siblina, Spiophanes bombyx,* and *S. duplex*. The spionid *Paraprionospio pinnata* and the onuphid *Onuphis* sp A had relatively low average abundances per sample but were widespread among samples within this assemblage.

Cluster group F comprised 2 stations located along the 55-m depth contour and 1 at the 38-m contour. Sediments at these deepwater sites contained a relatively high percentage of fine particles (**Figure 5.6**). The group F assemblage was characterized by high species richness and abundance, averaging 125 taxa and 476 individuals per grab (Figure 5.4). The 3 most abundant species were *Spiophanes bombyx* and *S. duplex* and the amphipod crustacean *Ampelisca agassizi*. The following species were also characteristic of this assemblage, but relatively uncommon in other groups: the oweniid polychaete *Myriochele gracilis*, the ostracod crustacean *Euphilomedes carcharodonta*, the tanaid crustacean *Leptochelia dubia*, and the sigalionid polychaete *Sthenelanella uniformis* (Table 5.3).

SUMMARY AND CONCLUSIONS

Benthic macrofaunal assemblages surrounding the South Bay Ocean Outfall were similar in 2005 to those that occurred during previous years (City of San Diego 2000, 2005). In addition, these assemblages were generally typical of those occurring in other sandy, shallow-water habitats throughout the Southern California Bight (SCB) (e.g., Thompson et al. 1987, 1993b, City of San Diego 1999, Bergen et al. 2001). For example, the 2 assemblages found at the majority of stations (e.g., groups C and E) contained high numbers of the spionid polychaete *Spiophanes bombyx*, a species characteristic of shallow-water environments in the SCB (see Bergen et al. 2001). These 2 groups represented sub-assemblages of the shallow SCB benthos that differed in the relative abundances of dominant and co-dominant species. Such differences probably reflect variation in sediment structure, such as the presence of a fine component (i.e., group E), or coarse, relict red sands (i.e., group C). Consistent with historical values, sediments in the shallow SBOO region generally were coarser south of the outfall relative to northern stations (see chapter 4). In contrast, the group F assemblage occurs in mid-depth shelf habitats that probably represent a transition between the shallow sandy sediments common in the area and the finer mid-depth sediments characteristic of much of the SCB mainland shelf (see Barnard and Ziesenhenne 1961, Jones 1969, Fauchald and Jones 1979, Thompson et al. 1987, 1993a, b, EcoAnalysis et al. 1993, Zmarzly et al. 1994, Diener and Fuller 1995, Bergen et al. 2001). A second deeper-water assemblage (group B) occurred where relict red sands were present. Polychaetes dominated group B, including the ubiquitous *S. bombyx.* Finally, the group A assemblage characteristic of station I23 and I34 during the July surveys was quite dissimilar from assemblages found at any other station. Nematode worms and several abundant polychaete species in these samples were not common elsewhere in the region. This assemblage is similar to that sampled previously at I23 during July 2003 and 2004. Analysis of the sediment chemistry data provided no evidence to explain the occurrence of this assemblage though mean sediments grain size were the highest measured among all stations for 2005 (see chapter 4). The presence of these animals may reflect the particular components of the sediments such as variation in microhabitats or types and amounts of shell hash or algal detritus.

Multivariate analyses revealed no clear spatial patterns relative to the outfall. Comparisons of the biotic data to the physico-chemical data indicated that macrofaunal distribution and abundance in the region varied primarily along gradients of sediment type and depth. Relatively high numbers of *S. bombyx* and *S. duplex* were collected during 2005 as in 2004. However, temporal fluctuations in the populations of these taxa are similar in magnitude to those that occur elsewhere in the region and that often correspond to large-scale oceanographic conditions (see Zmarzly et al. 1994). Overall, temporal patterns suggest that the benthic community has not been significantly impacted by wastewater discharge via the SBOO. For example, the range of values for species richness and abundance during 2005 was similar to that seen in previous years (see City of San Diego 2000, 2004b). In addition, environmental disturbance indices such as mean BRI and mean ITI generally were characteristic of assemblages from undisturbed sediments.

Anthropogenic impacts have spatial and temporal dimensions that can vary depending on a range of biological and physical factors. Such impacts can be difficult to detect, and specific effects of the SBOO discharge could not be identified during 2005. Furthermore, benthic invertebrate populations exhibit substantial spatial and temporal variability that may mask the effects of any disturbance event (Morrisey et al. 1992a, b, Otway 1995). Although some changes likely have occurred near the SBOO, benthic assemblages in the area remain similar to those observed prior to discharge and to natural indigenous communities characteristic of similar habitats on the southern California continental shelf.

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