Chapter 9. San Diego Regional Survey Macrobenthic Communities

INTRODUCTION

The City of San Diego has conducted regional benthic monitoring surveys off the coast of San Diego since 1994 (see Chapter 1). The main objectives of these surveys are: (1) to characterize benthic conditions for the large and diverse coastal region off San Diego; (2) to characterize the ecological health of the marine benthos in the area; (3) to gain a better understanding of regional conditions in order to distinguish between areas impacted by anthropogenic and natural events. These annual surveys are based on an array of stations randomly selected each year by the United States Environmental Protection Agency (USEPA) using the USEPA probability-based EMAP design. The 1994, 1998, and 2003 surveys off San Diego were conducted as part of the Southern California Bight 1994 Pilot Project (SCBPP) and the Southern California Bight 1998 and 2003 Regional Monitoring Project (Bight '98, Bight '03). These large-scale surveys included other major southern California dischargers, and included sampling sites representing the entire Southern California Bight (i.e., Cabo Colnett, Mexico to Point Conception, U.S.A.). The same randomized sampling design was used in the surveys limited to the San Diego region (1995–1997 and 1999–2002). A regional (random) survey was not conducted in 2004 in order to conduct a special strategic process study pursuant to an agreement with the SDRWQCB and USEPA (see City of San Diego 2005a,b). The results from Phase I of the San Diego Sediment Mapping Study are currently being analyzed (see Stebbins et al. 2004). In July 2005, the City revisited the 1995 survey sites in order to compare conditions 10 years later.

This chapter presents an analysis and interpretation of the benthic macrofaunal data collected during the San Diego 2005 regional survey with a comparison to those data from the 1995 survey. Included are descriptions and comparisons of the region's soft-bottom macrobenthic assemblages, and analysis of benthic community structure. Results of the sediment quality analyses for this survey are provided in Chapter 8 of this report.

MATERIALS AND METHODS

Collection and Processing of Benthic Samples

The July 2005 survey covered an area off San Diego, CA from Del Mar south to the United States/Mexico border (**Figure 9.1**). This survey revisited the sites sampled during the1995 regional survey. Site selection was based on the USEPA probability-based EMAP sampling design. A hexagonal grid was randomly placed over a map of the region and one sample site was then randomly selected from within each grid cell. This randomization helps to ensure an unbiased estimate of ecological condition. The area sampled included the section of the mainland shelf from nearshore to shallow slope depths (12–202 m). Although 40 sites were initially selected for the 1995 and 2005 survey, sampling at 3 sites in 1995 and 4 sites in 2005 were unsuccessful due to the presence of rocky substrata.

Samples for benthic community analysis were collected from 2 replicate 0.1 m^2 van Veen grabs at each station. The criteria established by the USEPA to ensure consistency of grab samples were followed with regard to sample disturbance and depth of penetration (USEPA 1987). All samples were sieved aboard ship through a 1.0 mm mesh screen. Organisms retained on the screen were relaxed for 30 minutes in a magnesium sulfate solution and then fixed in buffered formalin (see City of San Diego 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 groups by a subcontractor and identified to

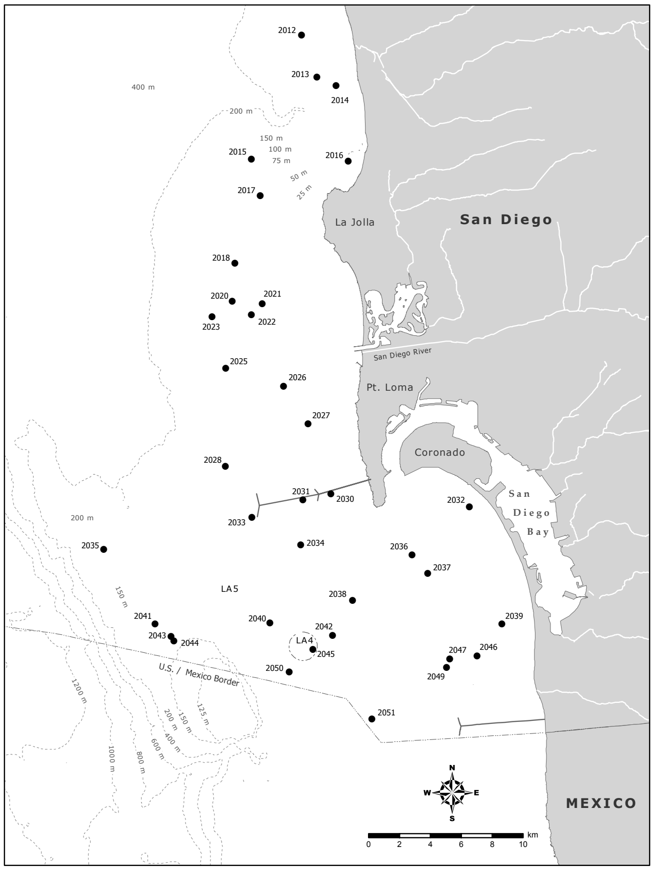


Figure 9.1
2005 regional macrobenthic station locations.

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), total number of species per station, abundance (number of individuals per grab), Shannon diversity index (H' per grab), Pielou's evenness index (J' per grab), Swartz dominance (minimum number of species accounting for 75% of the total abundance in each grab), Infaunal Trophic Index (ITI per grab, see Word 1980), and Benthic Response Index (mean BRI per grab, see Smith et al. 2001). These data are summarized according to depth strata used in the Bight '98 and Bight '03 surveys: shallow water (5–30m), mid-depth (30–120m), and deep (120–200m).

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 (similarity percentage) analysis was used to identify individual species that typified each cluster group. Analyses were run on 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). Univariate and multivariate data collected from both the 1995 and 2005 surveys were analyzed and compared to evaluate any changes in infaunal community structure over a 10-year period. Classification analysis was first run on the 1995 and 2005 surveys independently. The resulting cluster patterns from 1995 and 2005 were nearly identical. In the absence of any obvious temporal differences data from the two surveys were combined and analyzed together.

RESULTS AND DISCUSSION

Community Parameters

Number of Species

A total of 856 macrobenthic taxa were identified during 2005. Of these, 28% represented rare or unidentifiable taxa that were recorded only once. The average number of taxa per 0.1 m^2 grab ranged from 41 to 163, and the cumulative number of taxa per station ranged from 60 to 234 (**Table 9.1**). This wide variation in species richness generally is consistent with recent years, but represents a 24–29% increase relative to 1995. For example, mean species richness among all stations was~83 species in 1995 versus 120 in 2005. Although the varied habitat types in the area contribute to a diverse community, some of the

Table 9.1

Benthic community parameters at regional 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, no. individuals/0.1 m^2 (Abun); Shannon diversity index (H'); evenness (J'); Swartz dominance, no. species comprising 75% of a community by abundance (Dom); benthic response index (BRI); infaunal trophic index (ITI).

Station	Depth (m)	SR	Tot spp	Abun	H'	J'	Dom	BRI	ITI
Inner shelf									
2032	12	41	60	120	3.3	0.9	17	23	86
2036	16	62	97	881	3.1	0.8	12	13	60
2039	16	47	77	194	3.2	0.8	16	21	78
2046	22	72	108	143	4.0	0.9	37	19	77
2037	24	74	111	429	2.7	0.6	12	22	71
2016	25	142	218	727	3.8	0.8	35	20	73
2047	29	73	109	218	3.6	0.8	25	23	76
Mean		73	111	387	3.4	0.8	22	20	74
Mid shelf									
2049	31	81	116	253	3.7	0.8	30	21	77
2014	38	119	168	397	4.2	0.9	44	15	79
2030	47	163	234	587	4.4	0.9	55	20	78
2051	49	110	155	398	3.9	0.8	36	14	74
2038	52	155	222	526	4.3	0.9	53	16	83
2027	58	115	174	453	3.9	0.8	34	12	83
2012	59	111	157	424	3.9	0.8	33	6	80
2021	67	159	229	859	3.7	0.7	36	8	76
2026	68	98	137	443	3.5	0.8	26	3	91
2042	68	157	213	587	4.5	0.9	56	12	79
2017	68	111	150	434	3.9	0.8	32	7	80
2022	72	105	146	746	2.8	0.6	14	5	74
2013	73	102	141	393	3.8	0.8	29	2	84
2031	74	93	132	484	3.4	0.8	21	10	90
2034	81	81	111	469	3.2	0.7	18	5	92
2020	82	112	163	368	4.0	0.9	38	3	83
2045	84	116	171	415	4.0	0.8	36	6	85
2018	84	84	119	306	3.7	0.8	27	4	82
2023	90	119	165	427	4.2	0.9	41	5	78
2025	95	119	161	422	4.2	0.9	41	6	77
2050	101	98	132	315	4.0	0.9	37	5	76
2040	102	116	167	380	4.3	0.9	47	6	80
2033	104	116	158	450	4.2	0.9	39	7	79
2015	108	90	130	298	4.1	0.9	37	8	76
Mean		114	160	451	3.9	0.8	36	9	81
Outer shelf									
2041	136	72	102	286	3.5	0.8	22	4	71
2035	152	82	127	228	3.9	0.9	32	-6	77
2043	171	79	114	254	3.7	0.9	26	-0	76
2044	179	43	63	138	2.8	0.7	13	3	74
2028	190	72	104	202	3.7	0.9	29	16	79
Mean		70	102	222	3.5	0.8	24	3	75
All stations									
Mean		99	143	407	3.7	0.8	31	10	78
Min		41	60	120	2.7	0.6	12	-6	60
Max		163	234	881	4.5	0.9	56	23	92

change in species richness between 1995 and 2005 can be attributed to increased taxonomic resolution of certain taxa. One example is that polynoid polychaetes recorded as *Malmgreniella* sp in 1995 were split into 4 separate taxa by 2005.

Polychaete worms made up the greatest proportion of species, accounting for 37–59% of the taxa per sites during 2005. Crustaceans composed 13–37% of the species, molluscs from 6 to 31%, echinoderms from 1 to 9%, and all other taxa combined about 1–20%. These percentages are generally similar to those observed during previous years (e.g., see City of San Diego 2002, 2004).

Macrofaunal Abundance

Macrofaunal abundance ranged from a mean of 120 to 881 animals per grab in 2005 (Table 9.1). The greatest number of animals occurred at stations 2036, 2021, 2022, and 2016 all of which averaged over 700 individuals per sample. In contrast to 1995, high abundances at station 2036 in 2005 primarily were due to large numbers of nematodes and several species of polychaetes (i.e., *Polycirrus* sp, *Hesionura coineaui difficilis*, and *Spiophanes bombyx*). Overall, average abundance among all stations in 2005 was about 15% higher than in 1995.

Polychaetes were the most abundant animals in the region, accounting for 33–73% of the different assemblages during 2005. Crustaceans averaged 6–46% of the animals at a station, molluscs from 1 to 32%, echinoderms from <1 to 46%, and all remaining taxa about <1–19% combined. These values remained similar to those in previous years and to those in 1995.

Species Diversity and Dominance

Species diversity (H') varied among stations, and ranged from 2.7 to 4.5 (Table 9.1). Although most of the stations had values between 3.0 and 4.0, stations with the highest diversity (i.e., $\geq$4.0) were found along the mainland shelf. The lowest values (<3.0) occurred at 3 disjointed stations, one each from the deep, mid-shelf, and shallow water strata. Station 2044, a deepwater site, along the Coronado Bank, was dominated by the bivalve mollusc *Huxleyia munita* and the polychaete *Aphelochaeta glandaria*. Station 2022, a mid-shelf station northwest of Mission Bay was dominated by *Myriochele striolata*, an owenid polychaete that accounted for over 44% of the total abundance. Finally, station 2037, a shallow, sandy station south of Coronado, was dominated by the polychaete *Spiophanes bombyx*, which accounted for approximately 42% of this station's total abundance. Two of theses sites (2022 and 2037), along with 5 others (2018, 2021, 2026, 2036, 2039) also had low diversity values (<3.0) in 1995.

Dominance, measured as the minimum number of species comprising 75% of a community by abundance (see Swartz 1978), is inversely proportional to numerical dominance. These values varied widely throughout the region, averaging from 12 to 56 species per station. The pattern of dominance across depth strata was similar to that of diversity. Dominance (i.e., low values for Swartz dominance) was highest among those stations with low diversity values, such as those mentioned above.

Environmental Disturbance Indices: ITI and BRI

Average Infaunal Trophic Index (ITI) values generally were similar to those of recent years and, with one exception (station 2036), averaged between 71 to 92 throughout the San Diego region (Table 9.1). The lowest value occurred at station 2036 (ITI=60) and is likely due to the high abundance of oligochaetes and the dorvilleid polychaete *Protodorvillea gracilis*. All other stations, as well as every station sampled in 1995, had mean ITI values >70. ITI values >60 are generally considered characteristic of "normal" benthic conditions (Bascom et al. 1979, Word 1980).

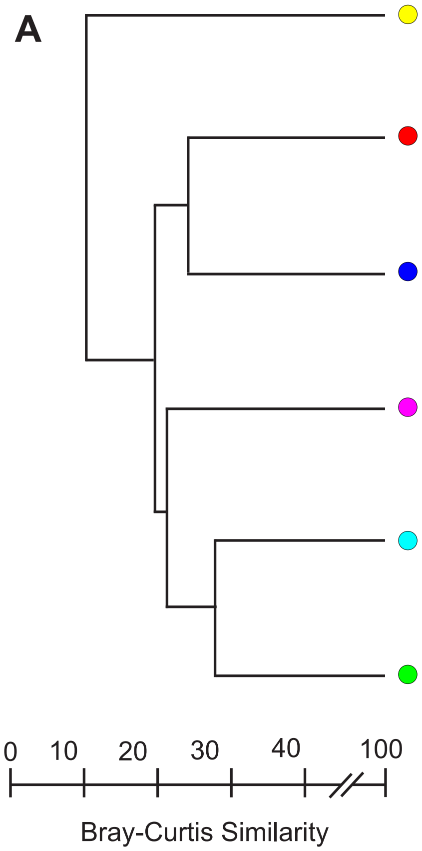
Similarly, Benthic Response Index (BRI) values at most stations were indicative of undisturbed communities or "reference conditions." Index values below 25 (on a scale of 100) suggest undisturbed communities or "reference conditions," and those in the range of 25–33 only represent "a minor deviation from reference condition," which may or may not reflect anthropogenic impact (Smith et al. 2001). Values greater than 44 indicate a loss of community function. No stations sampled in

Table 9.2

Dominant macroinvertebrates at regional benthic stations sampled during 2005. Included are the 10 most abundant species overall, the 10 most abundant per occurrence, and the 10 most frequently collected (or widely distributed) species. 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. *Amphiodia urtica*	Echinodermata: Amphiuridae	49.0	41.5	6.5	64
2. *Spiophanes duplex*	Polychaeta: Spionidae	10.8	22.3	5.3	97
3. *Myriochele striolata*	Polychaeta: Oweniidae	9.9	45.6	6.5	39
4. *Amphiodia* sp	Echinodermata: Ophiuroidea	6.8	18.7	5.3	67
5. *Spiophanes bombyx*	Polychaeta: Spionidae	5.8	22.9	4.4	50
6. *Prionospio* (*Prionospio*) *jubata*	Polychaeta: Spionidae	5.1	8.5	3.1	92
7. *Spiophanes berkeleyorum*	Polychaeta: Spionidae	4.9	8.3	2.8	89
8. *Monticellina siblina*	Polychaeta: Cirratulidae	4.5	11.6	1.9	58
9. *Paraprionospio pinnata*	Polychaeta: Spionidae	4.2	6.1	1.8	94
10. *Euphilomedes carcharodonta*	Crustacea: Ostracoda	3.9	8.3	1.7	69
Most Abundant per Occurrence					
1. *Hesionura coineaui difficilis*	Polychaeta: Phyllodocidae	4.1	73.0	1.0	6
2. *Pareurythoe californica*	Polychaeta: Amphinomidae	1.7	61.0	0.4	3
3. *Myriochele striolata*	Polychaeta: Oweniidae	17.7	45.6	4.4	39
4. *Amphiodia urtica*	Echinodermata: Ophiuroidea	26.5	41.5	6.5	64
5. *Pisione* sp	Polychaeta: Pisionidae	1.7	29.8	0.4	6
6. *Polycirrus* sp SD3	Polychaeta: Terebellidae	0.8	29.5	0.2	3
7. *Anchicolurus occidentalis*	Crustacea: Camacea	0.8	27.5	0.2	3
8. *Cnemidocarpa rhizopus*	Chordata: Styelidae	1.4	25.8	0.4	6
9. *Spiophanes bombyx*	Polychaeta: Spionidae	11.5	22.9	2.8	50
10. *Spiophanes duplex*	Polychaeta: Spionidae	21.7	22.3	5.3	97
Most Frequently Collected					
1. *Spiophanes duplex*	Polychaeta: Spionidae	21.7	22.3	5.3	97
2. *Paraprionospio pinnata*	Polychaeta: Spionidae	5.8	6.1	1.4	94
3. *Mediomastus* sp	Polychaeta: Capitellidae	5.1	5.4	1.2	94
4. *Prionospio* (*Prionospio*) *jubata*	Polychaeta: Spionidae	7.8	8.5	1.9	92
5. *Spiochaetopterus costarum*	Polychaeta: Chaetopteridae	2.0	2.2	0.5	92
6. *Spiophanes berkeleyorum*	Polychaeta: Spionidae	7.4	8.3	1.8	89
7. Amphiuridae	Echinodermata: Ophiuroidea	5.5	6.2	1.4	89
8. *Paradiopatra parva*	Polychaeta: Onuphidae	3.5	4.2	0.9	83
9. *Ampelisca careyi*	Crustacea: Amphipoda	2.2	2.6	0.5	83
10. Lineidae	Nermertea: Lineidae	0.9	1.1	0.2	83

A



Cluster group	Species richness	Abund.	% Fines	Top three taxa
A	86 (53–114)	640 (358–1404)	1.2 (0.0–2.3)	*Hesionura coineaui difficilis*, Nematoda, *Spiophanes bombyx*
B	44 (40–51)	157 (86–302)	12.3 (11.8–12.7)	*Ampharete labrops*, *Scoletoma tetraura*, *Carinoma mutabilis*
C	88 (65–174)	354 (142–887)	10.1 (5.0–15.4)	*Spiophanes bombyx*, *Monticellina siblina*, *Edwardsia* sp G (MEC)
D	69 (38–89)	226 (129–358)	14.3 (8.5–21.4)	*Aphelochaeta glandaria*, *Monticellina siblina*, *Huxleyia munita*
E	72 (60–84)	203 (183–222)	61.4 (61.4)	*Spiophanes berkeleyorum*, *Spiophanes kimballi*, *Paradiopatra parva*
F	115 (74–191)	463 (251–947)	39.2 (11.3–54.3)	*Amphiodia urtica*, *Spiophanes duplex*, *Myriochele striolata*

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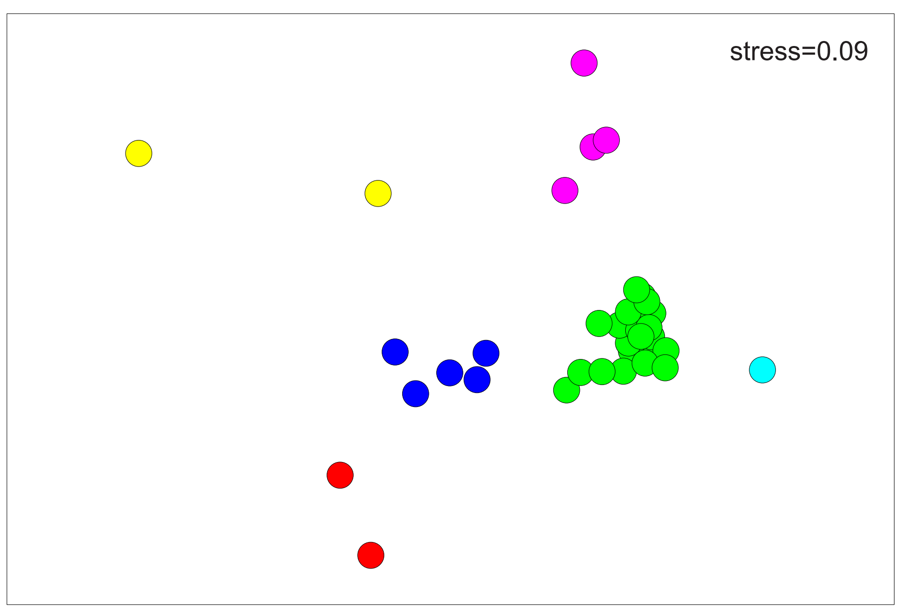

Figure 9.2
(A) Cluster results of the macrofaunal abundance data for the regional benthic stations sampled during July 2005. Data are expressed as mean values per 0.1 m^2 grab over all stations in each group. Ranges in parentheses are for individual grab samples. **(B)** MDS ordination based on square-root transformed macrofaunal abundance data for each station/survey entity. Cluster groups superimposed on station/surveys illustrate a clear distinction between macrofaunal assemblages.

2005 had a BRI that exceeded the threshold of 25. However, Stations 2047 and 2049 had values of about 30 in 1995.

Dominant Species

Most assemblages in the San Diego region were dominated by polychaete worms and brittlestars. For example, the list of dominant fauna in **Table 9.2** includes 14 polychaetes, 3 echinoderms, 3 crustaceans, a single chordate and a single nemertean.

The ophiuroid *Amphiodia urtica* was the most numerous ubiquitous species, averaging about 49 individuals per sample. The second most abundant taxa was the spionid polychaete *Spiophanes duplex*. The oweniid polychaete, *Myriochele striolata,* was third in total abundance.

Polychaetes comprised 7 of the top 10 most abundant species per occurrence. Several polychaete species were found in high numbers at only a few stations (e.g. *Hesionura coineaui difficilis*, *Pareurythoe californica, Polycirrus* sp SD3). Several macrobenthic species were widely distributed, and the top three, *Spiophanes bombyx*, *Paraprionospio pinnata* and *Mediomastus* sp, occurred in more than 93% of the samples.

Classification of Assemblages and Dominant Macrofauna

Classification analysis discriminated between six habitat-related benthic assemblages (cluster groups A–F) during 2005 (**Figures 9.2, 9.3**). 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 9.3**. An MDS ordination of the station/survey entities confirmed the validity of cluster groups A–F (Figure 9.2). Similar to previous random sample surveys of the region, depth and sediment composition were the primary factors affecting the distribution of assemblages (see **Figure 9.4**, e.g., Bergen et al. 1998, City of San Diego 1999a, 2000a, 2001, 2002, 2003, 2005).

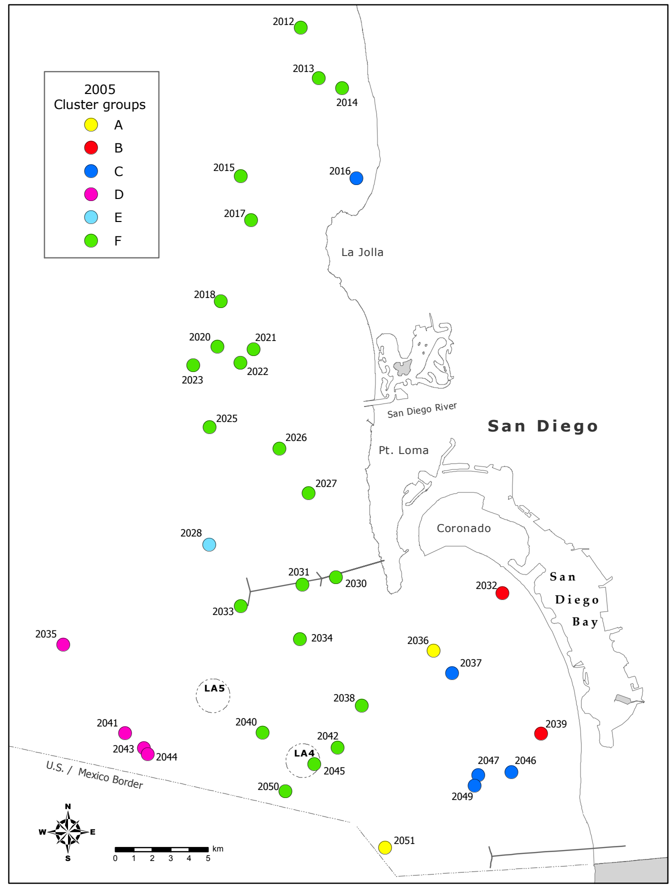

Figure 9.3
Regional benthic stations sampled during July 2005, color-coded to represent affiliation with benthic cluster groups.

<u>Cluster group A</u> consisted of 2 stations (2036, 2051) made up of sediments with few fine particles (i.e.,1.2% fines). This assemblage was quite different from the others and was dominated by nematode worms and polychaetes. Of the top dominant species, the polychaete, *Hesionura coineaui difficilis* was unique to these stations. Two other polychaetes, *Pisione* sp and *Polycirrus californicus,* were also limited to this station group.

<u>Cluster group B</u> comprised the 2 shallowest stations 2039 (16 m) and 2032 (12 m). The sediments at these sites were generally fine sands (~12% fines). Dominate species included the polychaetes *Ampharete labrops* and *Scoletoma tetraura* (=spp complex), and the nemertean *Carinoma mutabilis*.

Table 9.3

Summary of the most abundant taxa composing cluster groups A–F from the 2005 regional benthic station survey. Data are expressed as mean abundance per sample (no./0.1m^2) and represent the ten most abundant taxa in each group. Values for the three most abundant species in each cluster group are bolded. n=number of station/survey entities per cluster group

		Cluster Group					
Species/Taxa	**Taxa**	**A** (n=2)	**B** (n=2)	**C** (n=5)	**D** (n=4)	**E** (n=1)	**F** (n=22)
Adontorhina cyclia	Mollusca	—	—	—	—	5.5	1.2
Amaeana occidentalis	Polychaeta	—	5.0	0.2	—	—	0.2
Ampelisca careyi	Crustacea	—		1.2	6.6	2.5	2.0
Ampharete labrops	Polychaeta	0.5	23.8	0.6	0.3	—	0.1
Amphiodia sp	Echinodermata	—	0.3	0.1	0.5	0.5	20.2
Amphiodia urtica	Echinodermata	—	—	0.1	—	—	43.4
Amphiuridae	Echinodermata	0.3	0.8	1.6	3.0	—	8.0
Aoroides sp A	Crustacea	—	—		4.6	—	0.1
Aphelochaeta glandaria	Polychaeta	0.3	—	0.3	20.4	—	1.0
Axinopsida serricata	Mollusca	—	—	—	—	1.0	8.6
Caecum crebricinctum	Mollusca	1.0	—	—	13.1	—	0.0
Carinoma mutabilis	Nemertea	—	9.3	8.9	0.3	—	0.3
Chaetozone sp SD3	Polychaeta	—	—	—	6.6	—	0.2
Cnemidocarpa rhizopus	Chordata	25.8	—	—	—	—	—
Compressidens stearnsii	Mollusca	—	—	—	0.6	4.0	0.1
Diastylopsis tenuis	Crustacea	—	5.8	0.1	—	—	—
Edwardsia sp G (MEC)	Cnidaria	—	0.3	23.1	—	—	0.0
Euphilomedes carcharodonta	Crustacea	—	3.0	5.3	—	—	8.0
Glycera oxycephala	Polychaeta	0.3	—	6.2	2.6	—	—
Hemilamprops californicus	Crustacea	0.5	—	4.6	—	—	0.4
Hesionura coineaui difficilis	Polychaeta	73.0	—	—	—	—	—
Huxleyia munita	Mollusca	—	—	—	13.4	—	0.0
Leptochelia dubia	Crustacea	0.5	0.3	1.8	6.3	—	3.5
Mediomastus sp	Polychaeta	3.0	3.3	8.9	0.8	4.5	5.4
Melinna heterodonta	Polychaeta	—	—	—	—	5.0	—
Monticellina siblina	Polychaeta	—	—	23.5	14.9	—	3.0
Myriochele striolata	Polychaeta	—	—	0.3	8.5	—	27.4
Nematoda	Nematoda	51.5	0.5	0.4	0.3	—	0.4
Oligochaeta	Annelida	31.5	—	—	0.1	—	0.0
Olivella baetica	Mollusca	2.3	8.5	0.2	—	—	—
Paradiopatra parva	Polychaeta	—	—	0.9	0.6	16.0	4.6
Paraprionospio pinnata	Polychaeta	—	1.0	1.6	2.6	8.0	8.2
Pareurythoe californica	Polychaeta	30.5	—	—	—	—	—
Petaloclymene pacifica	Polychaeta	—	—	—	—	4.5	0.6
Phyllochaetopterus limicolus	Polychaeta	—	—	0.1	—	10.5	0.1
Pisione sp	Polychaeta	29.8	—	—	—	—	—
Polycirrus californicus	Polychaeta	20.3	—	—	—	—	0.0
Polycirrus sp	Polychaeta	39.8	—	0.3	0.9	—	1.0
Prionospio (*Prionospio*) *jubata*	Polychaeta	1.3	—	9.8	6.3	0.5	9.3
Protodorvillea gracilis	Polychaeta	29.8	—	—	0.6	—	—
Rhepoxynius menziesi	Crustacea	—	7.5	3.5	—	—	0.7
Scoletoma tetraura (=spp complex)	Polychaeta	—	13.3	1.8	—	2.0	1.0
Spiophanes berkeleyorum	Polychaeta	0.3	0.3	3.4	0.4	25.0	10.1
Spiophanes bombyx	Polychaeta	43.0	2.8	60.4	—	—	0.9
Spiophanes duplex	Polychaeta	1.5	4.0	18.8	4.5	3.0	29.7
Spiophanes kimballi	Polychaeta	—	—	0.1	2.5	21.5	7.9
Tellina modesta	Mollusca	—	8.8	2.9	—	—	—

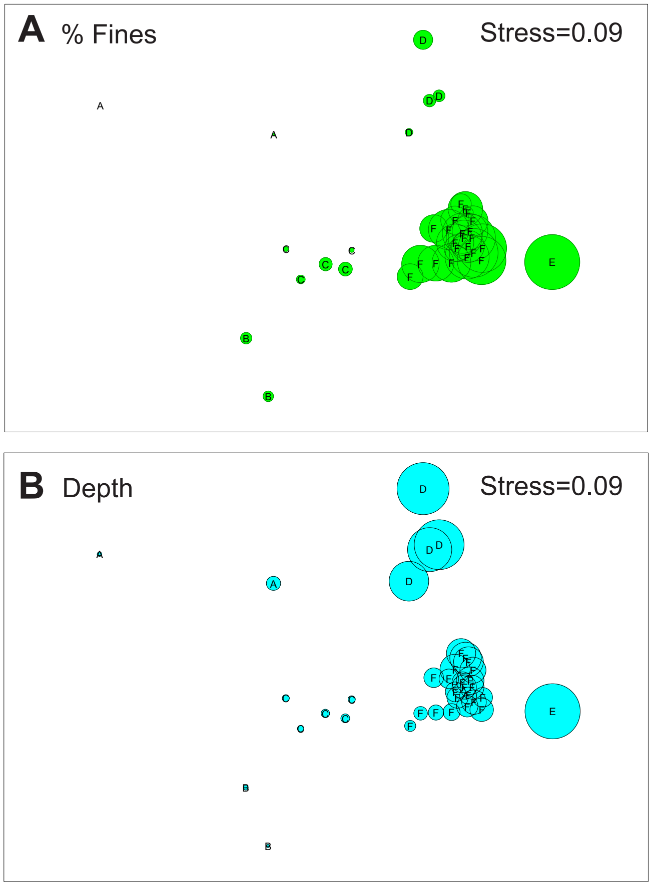

Figure 9.4
MDS ordination of regional benthic stations sampled July 2005. Cluster groups A–F are superimposed on station/surveys. Percentage of fine particles in the sediments and station depth are further superimposed as circles that vary in size according to the magnitude of each value. Plots indicate associations of macrobenthic assemblages with habitats that differ in sediment grain size and depth.

Cluster group C consisted of 5 nearshore stations ranging in depth from 22 to 31 m. Four were located in the South Bay gyre area, north of the Tijuana River and SBOO, and 1 north of La Jolla. Sediments at stations within this group averaged approximately 10% fines (i.e., similar to cluster group B). Overall, the benthic assemblage at these stations was typical of the shallow water sites in the region the region (e.g., see Chapter 4 in City of San Diego 2001, 2002, 2003, 2005). The dominant species included the polychaetes *Spiophanes bombyx* and *Monticellina siblina* an the cnidarian *Edwardsia* sp G.

Cluster group D consisted of 4 stations along the Coronado bank (i.e., 136–179 m). Sediments at this group were relatively coarse (2.1 phi) and contained pea gravel, rock, and shell hash. These sites averaged about 14% fines and had the highest organic load (e.g. TOC=4.4%, see Chapter 8). The dominant species included two polychaetes, *Aphelochaeta glandaria* and *Monticellina siblin*a, as well as two molluscs, *Huxleyia munita* and *Caecum crebricinctum* (Table 9.3).

Cluster group E consisted of the deepest station (2028, 190m) by itself, which contained over 60% fines along with some of the highest concentrations of associated contaminants (e.g., organics and trace metals). Many of the most abundant and frequently occurring species were polychaetes, including *Spiophanes berkrleyorum*, *S. kimballi*, *Paradiopatra parva,* and *Phyllochaetopterus limicolus*. Most other included taxa were poorly represented at this site.

Cluster group F comprised most of the mid-shelf sites ranging in depth from 38 to 108 m. This cluster group, characterized by mixed sediments averaging 39% fines (11–54%), had the highest average species richness, and second highest values for abundance, diversity, and dominance. This main assemblage type is typical of the ophiuroid dominated community that occurs along the mainland shelf off southern California (City of San Diego 2001, 2002, 2003, 2004). The most abundant species representing this mid-shelf group were the ophiuroid *Amphiodia urtica,* and the polychaetes *Spiophanes bombyx* and *Myriochele striolata*. *Myriochele striolata* is an opportunistic species whose populations vary spatially and temporally (see City of San Diego 2002). *Amphiodia urtica,* a dominant species along the mainland shelf of southern California, averaged about 43 animals per 0.1 m^2 (Table 9.2). However, since juvenile ophiuroids usually cannot be identified to species and are recorded at the generic or familial level (i.e., *Amphiodia* sp or Amphiuridae, respectively), this number underestimates actual populations of *A. urtica*. The only other species of *Amphiodia* that occurred in 2005 was *A. digitata*, which accounted for about 6% of ophiuroids in the genus *Amphiodia* that could be identified to species (i.e., *A. urtica* = about 94%). If the values for these taxa are adjusted accordingly, then the estimated population size for *A. urtica* off Point Loma becomes about 60 animals per 0.1 m^2.

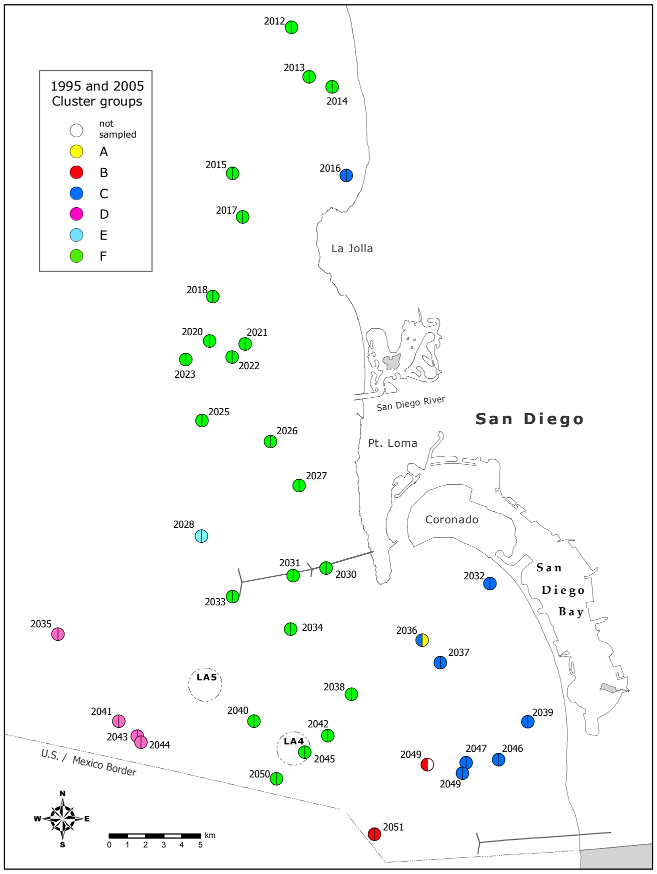

Figure 9.5
Results of ordination and classification analyses of macrofaunal abundance data from 1995 (left half) and 2005 (right half). Cluster groups are color-coded on the map to reveal spatial patterns in the distribution of

Classification analysis of the 1995 and 2005 surveys also combined discriminated between 6 habitat-related benthic assemblages (cluster groups A–F) that closely resembled the results of the 2005 analysis (**Figure 9.5**). With 1 exception (station 2036) all sites surveyed in 1995 clustered with its 2005 counterpart. Station 2048 in cluster group B of the combined analysis was sampled in 1995 but not 2005.

SUMMARY AND CONCLUSIONS

The Southern California Bight (SCB) benthos has long been considered a "patchy" habitat, with the distribution of species and communities varying in space and time. Barnard and Ziesenhenne (1961) described the SCB shelf as consisting of an *Amphiodia* "mega-community" with other sub-communities representing simple variations determined by differences in substrate type and microhabitat. Results of the 2005 and previous regional surveys off San Diego generally support this characterization. The 2005 benthic assemblages segregated mostly due to differences in habitat (e.g., depth and sediment grain size) and were very similar to those sampled 10 years earlier. The biological data provide little evidence of anthropogenic impact in the region despite apparent changes in sediment chemistry (see chapter 8). Over 50% of the benthos off San Diego was characterized by an assemblage dominated by the ophiuroid *Amphiodia urtica* (Station group F). The co-dominant species within this assemblage included other taxa common to the region such as the polychaetes *Myriochele striolata*, and *Spiophanes duplex*. This group occurred at depths from 44 to 94 m in sediments composed of relatively fine particles (e.g., ~40% fines).

In contrast, the dominant species of other assemblages occurring in the region varied according to sediment type or depth. Shallow water assemblages (e.g., <30 m) were highly variable depending upon their sediment type and station depths. For example, these assemblages generally were similar to other shallow, sandy sediment communities in the SCB. At many of these stations, polychaete species such as *Spiophanes duplex* and *S. bombyx*, *Hesionura coineaui difficilis, Ampharete labrops,* and *Monticellina siblina* were numerically dominant. A deep water assemblage (group E), located at a depth >180 m, was dominated by the polychaetes *Aphelochaeta glandaria* and *Monticellina siblina,* and the mollusc *Huxleyia munita*. This site had the highest percentage of fine particles with the lowest species richness, diversity, and abundance. Overall, the influence of increased organic loading or metals contamination detected in 2005 (see chapter 8) appears to have had little impact on overall structure of the benthos, though the higher organic load may be a factor contributing to an increase in the number of individuals.

There was a general increase in the number of species and individuals as well as changes in community parameters between the 1995 and 2005 random surveys. Over the 10 year period, changes in taxonomic resolution created some disparity in nomenclature among select species. For example, certain species complexes (e.g., *Americhelidium*, *Chaetozone*) have been further resolved into individual species. These types of changes can account for some of the differences in species richness and the associated diversity indexes; however, the two surveys identified identical assemblages based on depth and sediment type. SIMPER analysis confirmed that the major species driving the discrimination between groups were ones with taxonomic integrity. A single exception, the polychaete *Aphelochaeta glandaria*, contributed ~1% of the difference between cluster groups C and D. Overall, the similarities between macrofaunal communities from 1995 and 2005 suggest that benthic assemblages have not changed substantially in recent years.

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