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 of 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 versus natural events.

These regional surveys are based on arrays of stations that are randomly selected for each year using the USEPA probability-based EMAP sampling design. The 1994, 1998, and 2003 surveys off San Diego were conducted as part of larger, multi-agency surveys of the entire Southern California Bight (SCB), including the 1994 Southern California Bight Pilot Project (SCBPP), and the Southern California Bight 1998 and 2003 Regional Monitoring Programs (Bight'98, Bight'03, respectively). Results of these three bight wide surveys are available in Bergen et al. (1998, 2001) and Ranasinghe et al. (2003, 2007). The same randomized sampling design was used in surveys limited to the San Diego region in 1995–1997, 1999–2002, and 2005–2007. Additionally, during 2005, 2006 and 2007, the City revisited the same sites sampled 10 years earlier (i.e., 1995–1997, respectively) in order to facilitate comparisons of long-term changes in benthic conditions for the region.

This chapter presents an analysis and interpretation of the benthic macrofaunal data collected during the San Diego 2007 regional survey of randomized sites. Included are descriptions and comparisons of the region's soft-bottom macrobenthic assemblages and analyses of benthic community structure.

Materials and Methods

Collection and Processing of Benthic Samples

The July 2007 survey covered an area from off Del Mar in northern San Diego County southward to the USA/Mexico international border (**Figure 9.1**). Site selection was based on the USEPA probability-based EMAP sampling design used in 1997 (City of San Diego 1997). The monitoring area included the section of the mainland continental shelf ranging from nearshore waters to shallow slope depths (13–216 m). Although 40 sites were initially selected for the 1997 and 2007 surveys, sampling at three sites

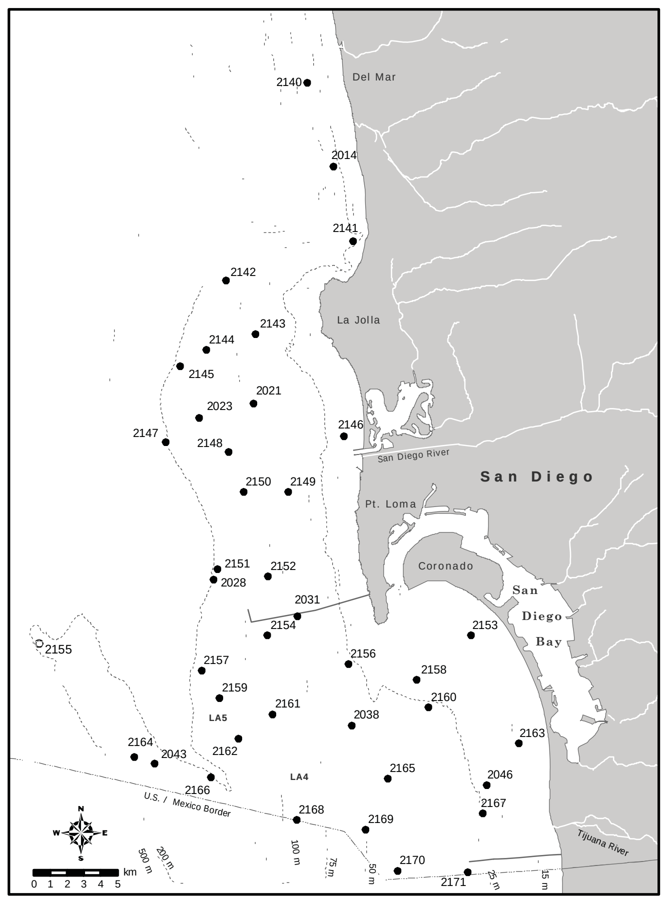


Figure 9.1
Map of regional macrobenthic stations sampled off San Diego, CA in 2007. Open circles represent abandoned stations (see text).

in 1997 and one site in 2007 was unsuccessful due to the presence of rocky reefs. In addition, seven of the sites (stations 2014, 2021, 2023, 2028, 2031, 2038, 2046) were repeat stations that were sampled each year (i.e., 1995–1997, 2005–2007).

Samples for benthic community analyses were collected from one 0.1-m^2 van Veen grab 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 in a magnesium sulfate and seawater solution for 30 minutes and then fixed with 10% buffered formalin. 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 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 per 0.1-m^2 grab: species richness (number of species), abundance (total number of individuals), Shannon diversity index (H'), Pielou's evenness index (J'), Swartz dominance (minimum number of species accounting for 75% of the total abundance in each grab; see Swartz et al. 1986, Ferraro et al. 1994), Infaunal Trophic Index (ITI; see Word 1980), and Benthic Response Index (BRI; see Smith et al. 2001). These data are summarized according to depth strata used in the Bight'98 and Bight'03 surveys: shallow (5–30 m), mid-depth (31–120 m), and deep (121–200 m). The macrofauna data for 2007 were based on one benthic grab sample per station. In contrast, two grabs per station were sampled for macrofauna in 1997; thus data for 1997 are reported as the average of two grabs.

Multivariate analyses were performed using PRIMER V6 software to examine spatiotemporal 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. Patterns in the distribution of macrofaunal assemblages were compared to environmental variables by overlaying the physicochemical data onto MDS plots based on the biotic data (see Field et al. 1982).

Results and Discussion

Community Parameters

Species richness

A total of 693 macrobenthic taxa were identified during 2007. Of these, 32% represented rare taxa that were recorded only once (i.e., rare species or unidentifiable animals). The number of species (taxa) per station ranged from 37 to 200 in 2007 (**Table 9.1a**). This variation in species richness generally is consistent with that observed in recent years and similar to values in 1997 (see **Table 9.1b**). Polychaete worms made up the greatest proportion of species, accounting for 51% during 2007. Crustaceans represented 21% of the species, molluscs 15%, echinoderms 6%, and all other taxa combined about 7%. These percentages generally are similar to those observed during previous years (e.g., City of San Diego 2007).

Macrofaunal abundance

Macrofaunal abundance ranged from 116 to 1385 individuals per 0.1-m^2 grab in 2007 compared to 79–1467 individuals in 1997 (Table 9.1a,b). The greatest number of animals in 2007 occurred at mid-shelf stations 2141 and 2156, both of which contained over 1100 individuals per 0.1 m^2. Four other sites (i.e., stations 2163, 2160, 2171 and 2038) had abundance values greater than 500 individuals

Table 9.1a

Benthic community parameters at regional stations sampled during 2007. Abun=Abundance, number/0.1 m^2; SR=Species richness, no. species/0.1 m^2; H'=Shannon diversity index; J'=Evenness; Dom=Swartz dominance, no. species comprising 75% of a community by abundance; BRI=Benthic response index; ITI=Infaunal trophic index, n=1.

	Station	Depth (m)	Abun	SR	H'	J'	Dom	BRI	ITI
Inner shelf	2153	13	252	61	3.3	0.8	17	26.6	71
	2146	14	144	59	3.6	0.9	23	20.6	75
	2163	15	548	96	3.5	0.8	18	27.1	75
	2158	16	136	37	3.1	0.9	13	4.5	76
	2046	22	257	75	3.7	0.9	25	23.0	77
	2167	25	342	100	4.1	0.9	37	25.7	79
	2160	26	570	119	3.8	0.8	34	27.5	75
	2171	29	516	68	2.2	0.5	6	16.6	72
	Mean	20	346	77	3.4	0.8	22	21.5	75
Mid shelf	2141	36	1101	155	3.2	0.6	13	27.9	69
	2156	36	1385	200	4.4	0.8	51	19.2	82
	2014	38	340	127	4.2	0.9	44	19.4	79
	2140	38	381	97	3.8	0.8	31	18.7	85
	2170	42	227	58	3.4	0.8	19	4.8	75
	2165	43	289	80	3.4	0.8	27	19.1	76
	2169	49	116	42	3.0	0.8	15	4.3	80
	2038	52	710	156	4.3	0.8	45	17.1	80
	2143	57	405	113	4.1	0.9	34	13.3	81
	2149	63	385	101	3.9	0.9	33	11.5	84
	2021	67	458	123	4.1	0.8	40	9.4	82
	2031	74	424	74	3.2	0.7	14	14.5	91
	2150	82	225	79	3.6	0.8	26	9.2	82
	2152	82	308	81	3.4	0.8	21	10.0	86
	2148	83	313	74	3.6	0.8	25	9.5	84
	2154	87	189	73	3.9	0.9	31	7.7	82
	2168	88	321	108	4.2	0.9	41	10.1	75
	2161	89	365	107	4.0	0.9	34	4.9	83
	2023	90	295	109	4.3	0.9	47	3.8	81
	2144	93	192	82	4.0	0.9	35	8.6	80
	2142	96	155	70	4.0	0.9	33	7.0	81
	2145	116	294	97	4.1	0.9	37	10.1	73
	Mean	68	404	100	3.8	0.8	32	11.8	81
Outer shelf	2162	130	280	101	4.2	0.9	44	7.0	79
	2164	136	412	78	3.6	0.8	20	5.3	70
	2159	160	158	69	3.9	0.9	34	14.7	81
	2043	171	378	72	3.3	0.8	19	4.9	71
	2151	177	136	60	3.8	0.9	27	15.6	77
	2157	186	195	65	3.5	0.8	22	14.7	82
	2028	190	173	57	3.6	0.9	22	14.2	78
	2147	193	282	93	3.9	0.9	35	15.3	74
	2166	216	411	121	4.1	0.9	40	7.3	80
	Mean	173	269	80	3.8	0.9	29	11.0	77
All stations	**Mean**	81	361	91	3.7	0.8	29	13.6	79
	Min	13	116	37	2.2	0.5	6	3.8	69
	Max	216	1385	200	4.4	0.9	51	27.9	91

Table 9.1b

Benthic community parameters at regional stations sampled during 1997. SR=Species richness, no. species/0.1 m^2; Abun=Abundance, no. individuals/0.1 m^2; H'=Shannon diversity index; J'=Evenness; Dom=Swartz dominance, no. species comprising 75% of a community by abundance; BRI=Benthic response index; ITI=Infaunal trophic index, n=2.

	Station	Depth (m)	Abun	SR	H'	J'	Dom	BRI	ITI
Inner shelf	2153	13	111	47	3.4	0.9	20	17.5	78
	2146	14	260	55	3.3	0.8	16	5.2	82
	2163	15	79	30	2.9	0.9	13	10.1	74
	2158	16	364	65	3.3	0.8	17	10.4	50
	2046	22	106	48	3.5	0.9	22	12.5	77
	2167	25	113	59	3.8	0.9	31	17.3	83
	2160	26	226	84	4.0	0.9	35	27.8	81
	2171	29	233	66	3.3	0.8	19	19.0	76
	Mean	20	187	57	3.5	0.9	22	15.0	75
Mid shelf	2141	36	1467	161	4.0	0.8	35	22.6	77
	2156	36	1139	165	4.1	0.8	35	16.3	81
	2014	38	379	110	4.2	0.9	40	21.7	80
	2140	38	434	125	4.2	0.9	42	17.1	86
	2170	42	163	55	3.5	0.9	21	5.6	91
	2165	43	562	120	3.9	0.8	33	19.8	85
	2169	49	359	97	4.0	0.9	32	8.4	92
	2038	52	482	118	3.8	0.8	32	18.6	89
	2143	57	402	85	3.5	0.8	22	10.7	90
	2149	63	484	78	3.0	0.7	14	14.1	90
	2021	67	471	111	3.7	0.8	28	6.9	86
	2031	74	323	59	2.6	0.6	8	10.7	95
	2150	82	369	75	3.3	0.8	19	5.7	88
	2152	82	431	78	3.1	0.7	13	8.3	88
	2148	83	313	70	3.3	0.8	17	2.5	90
	2154	87	277	59	2.9	0.7	12	9.2	88
	2168	88	318	77	3.3	0.7	21	3.8	82
	2161	89	349	98	4.1	0.9	34	6.4	84
	2023	90	233	90	4.0	0.9	37	8.0	85
	2144	93	290	80	3.6	0.8	27	1.2	84
	2142	96	321	92	3.8	0.8	30	3.8	81
	2145	116	500	123	4.1	0.9	36	2.1	78
	Mean	68	458	97	3.6	0.8	27	10.2	86
Outer shelf	2162	130	269	92	4.1	0.9	39	4.2	84
	2159	160	290	91	4.0	0.9	34	10.0	85
	2043	171	91	42	3.3	0.9	20	-4.3	82
	2151	177	106	47	3.5	0.9	21	12.9	87
	2157	186	99	47	3.6	0.9	23	13.0	81
	2028	190	169	51	3.4	0.9	18	10.1	80
	2147	193	430	116	3.9	0.8	32	9.5	76
	Mean	172	208	69	3.7	0.9	27	7.9	82
All stations	**Mean**	81	352	83	3.6	0.8	26	10.8	83
	Min	13	79	30	2.6	0.6	8	-4.3	50
	Max	193	1467	165	4.2	0.9	42	27.8	95

per 0.1 m^2, while most sites had abundance values between 200–500 individuals per grab.

Polychaetes were the most abundant animals in the region, accounting for about 59% of the individuals during 2007. Crustaceans averaged 16% of the animals at a station, molluscs about 11%, echinoderms 9%, and all remaining taxa combined about 5%. These values were similar to those observed in previous years (see City of San Diego 2007).

Species diversity and dominance

Species diversity (H') varied among stations, and ranged from 2.2 to 4.4 during the year (Table 9.1a). Although most of the stations had H' values between 3.0 and 4.0, stations with the highest diversity (i.e., H'≥4.0, n=11) were found predominantly at mid-shelf sites. The lowest H' value occurred at station 2171, a shallow-water station located near the USA/Mexico border. Diversity values were similar to averages for 1997 stations that ranged from 2.6 to 4.2 (Table 9.1b).

Species dominance was measured as the minimum number of species whose combined abundance accounts for 75% of the individuals in a sample. Consequently, dominance as discussed herein is inversely proportional to numerical dominance, such that low index values indicate communities dominated by few species. These values varied throughout the region, averaging from 6 to 51 species per station in 2007. The pattern of dominance across depth strata was similar to that of diversity. The eight stations with dominance values <20 also had lower H' values. Dominance at stations in 1997 averaged from 8 to 42 species per station, similar to 2007 (Table 9.1b).

Environmental disturbance indices

Benthic Response Index (BRI) values at most stations were indicative of undisturbed communities or “reference conditions” (see Smith et al. 2001). BRI values <25 suggest undisturbed communities or “reference conditions,” while those between 25–33 represent “a minor deviation from reference condition,” values >44 indicate a loss of community function. BRI values throughout the San Diego region generally were indicative of reference conditions in 2007 (see Table 9.1a). For example, all but one of the mid and outer shelf stations (depths >30 m) had BRI values <25. Index values ≥25 were restricted to five stations located in shallower depths where the BRI is less reliable (see Smith et al. 2001). One station, 2160, located south of the mouth of San Diego Bay, had BRI values ≥25 in 1997 (see Table 9.1b).

Average Infaunal Trophic Index (ITI) values ranged from 69 to 91 throughout the San Diego region during 2007 (Table 9.1a). The lowest value occurred at station 2141. ITI values >60 are generally considered characteristic of “normal” benthic conditions (Bascom et al. 1979, Word 1980). Overall, ITI values in 1997 were very similar to those in 2007, averaging from 50 to 95.

Dominant Species

Most macrofaunal assemblages in the San Diego region were dominated by polychaete worms and brittlestars. For example, the list of dominant animals in **Table 9.2** includes 14 polychaete and four echinoderm species. Unidentified capitellid polychaetes in the genus *Mediomastus* (i.e., *Mediomastus* sp) were the most abundant animals, averaging 21 individuals per sample. The ophiuroid *Amphiodia urtica* averaged 15 individuals per sample. 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*. If values for total *A. urtica* abundance are adjusted to include putative *A. urtica* juveniles, then the estimated density increases from 15 to 21 brittlestars per grab sample. The spionid polychaete, *Spiophanes bombyx*, was third in total abundance for the region. Polychaetes comprised eight of the 10 most frequently collected species per occurrence. Additionally, few polychaete species occurred in high numbers at only a few stations (e.g., *Cossura* sp A, *Mooreonuphis exigua*).

Table 9.2

Summary of dominant macroinvertebrates at regional benthic stations sampled during 2007. Included are the most abundant species per sample, the most abundant per occurrence, and species with the highest percent occurence. Abundance values are expressed as mean number of individuals per 0.1-m^2 grab sample.

Species	Higher taxa	Percent occurence	Abundance per sample	Abundance per occurence
Amphiuridae	Echinodermata: Ophiuroidea	85	4.5	5.4
Mediomastus sp	Polychaeta: Capitellidae	82	21.3	26.1
Prionospio jubata	Polychaeta: Spionidae	80	7.8	9.9
Paraprionospio pinnata	Polychaeta: Spionidae	77	2.7	3.3
Maldanidae	Polychaeta: Maldanidae	69	2.4	3.6
Spiophanes berkeleyorum	Polychaeta: Spionidae	64	8.1	12.9
Amphiodia sp	Echinodermata: Ophiuroidea	64	7.8	12.0
Euclymeninae sp *A*	Polychaeta: Maldanidae	64	3.9	6.0
Aricidea catherinae	Polychaeta: Paraonidae	64	2.7	4.2
Spiophanes duplex	Polychaeta: Spionidae	62	6.0	9.9
Monticellina siblina	Polychaeta: Cirratulidae	54	17.1	31.5
Amphiodia urtica	Echinodermata: Ophiuroidea	51	15.0	29.1
Axinopsida serricata	Mollusca: Bivalvia	49	6.0	12.6
Spiophanes bombyx	Polychaeta: Spionidae	44	17.7	40.2
Diopatra sp	Polychaeta: Onuphidae	23	4.5	19.2
Nematoda	Nematoda	23	4.2	17.7
Paradoneis sp SD1	Polychaeta: Paraonidae	8	1.8	23.1
Cossura sp A	Polychaeta: Cossuridae	3	0.9	36.0
Nephasoma diaphanes	Sipuncula: Golfingiidae	3	0.9	30.0
Mooreonuphis exigua	Polychaeta: Onuphidae	3	0.6	18.0
Dougaloplus sp SD1	Echinodermata: Ophiuroidea	3	0.4	14.0

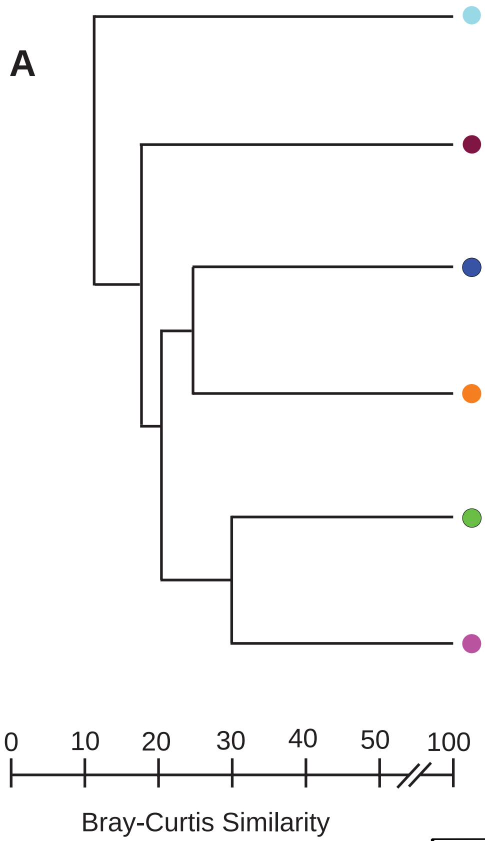
Multivariate analysis

Classification analysis discriminated between six habitat-related benthic assemblages (cluster groups A–F; **Figures 9.2, 9.3**). A MDS ordination of the station/survey entities confirmed the validity of the cluster groups. SIMPER analysis was used to identify species that were characteristic, though not always the most abundant, within each assemblage (Figure 9.2A). The most abundant species within each group are listed in **Table 9.3**. Similar to previous regional surveys off San Diego, station depth, sediment grain size, and organic composition were the primary factors that appeared to affect the distribution of assemblages (e.g., Bergen et al. 1998; see **Figure 9.4**). These assemblages differed in terms of their species composition, including the specific taxa present and their relative abundances. Descriptions of the cluster groups are given below.

Cluster group A represented assemblages from five stations that were characterized by coarse sediments (i.e., mean=3% fine) and TOC concentrations of about 0.1%. These sites averaged 57 species and 257 individuals per grab sample. The dominant species in this group was the spionid polychaete *Spiophanes bombyx*, followed by another spionid, *Spio maculata*, and the tanaid *Leptochelia dubia*.

Cluster group B represented assemblages from two stations located on the Coronado bank at depths of 136–171 m. Sediments at these stations were relatively coarse and contained pea gravel, rock, and shell hash (see Chapter 4 for descriptions of

A



CG	% Fines	TOC	SR	Abun	Dominant taxa
A	3	0.1	57	257	*Spiophanes bombyx* *Spio maculata* *Leptochelia dubia*
B	14	4.8	75	395	*Chaetozone* sp SD3 *Mediomastus* sp *Aphelochaeta glandaria*
C	22	0.4	127	610	*Spiophanes berkeleyorum* *Mediomastus* sp *Monticellina siblina*
D	9	0.2	72	315	*Spiophanes bombyx* *Scoletoma* sp *Mediomastus* sp
E	50	1.1	91	302	*Amphiodia urtica* *Amphiodia* sp *Ampelisca pacifica*
F	56	1.9	81	234	*Mediomastus* sp *Paraprionospio pinnata* *Tellina cadieni*

B

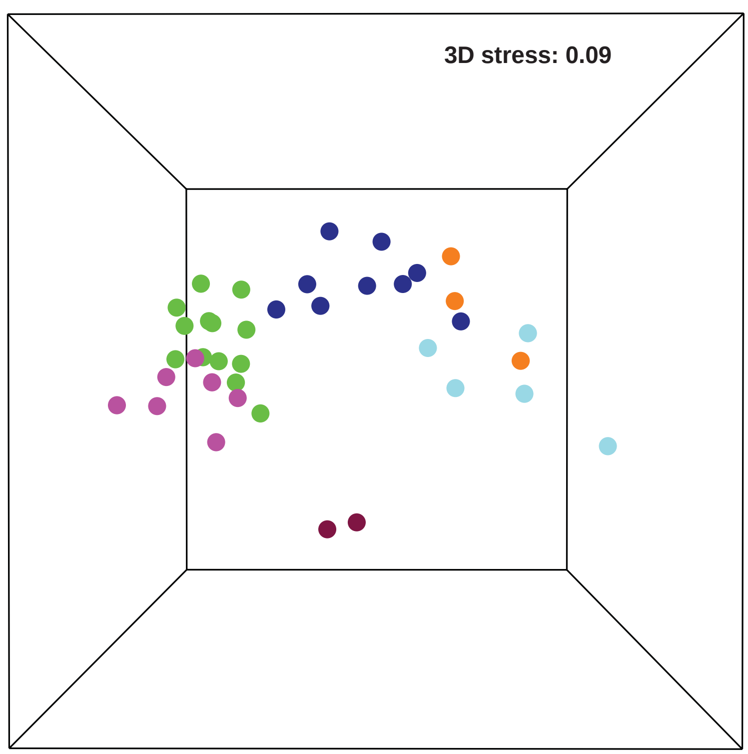


Figure 9.2

(A) Cluster results of the macrofaunal abundance data for the regional benthic stations sampled during July 2007. Data are expressed as mean values per 0.1-m^2 grab over all stations in each group. **(B)** MDS ordination based on square-root transformed macrofaunal abundance data for each station. Cluster groups superimposed on station/surveys illustrate a clear distinction between faunal assemblages.

sediment components at each station). These sites averaged 14% fines and had the highest organic load (e.g., TOC=4.8%). Species richness for this assemblage averaged 75 taxa per grab and abundance averaged 395 individuals per sample. The dominant species included three polychaetes, *Chaetozone* sp SD3, *Mediomastus* sp, and *Aphelochaeta glandaria*.

Cluster group C represented assemblages from nine sites located primarily between depths of 25 and 50 m, and where sediments were composed of about 22% fines. TOC levels at stations within this group averaged 0.4%. This assemblage averaged the highest species richness (127 taxa) and abundance (610 individuals per 0.1 m^2) values. Three polychaetes, *Spiophanes berkeleyorum*, *Mediomastus* sp, and *Monticellina siblina* were the dominant species in group C.

Cluster group D represented assemblages from three nearshore stations that ranged in depth from 13 to 15 m. Sediments at stations within this group averaged 9% fines. Overall, the benthic assemblage at these stations was typical of the shallow-water sites in the region (e.g., see Chapter 5). Group D averaged 72 taxa and 315 individuals per 0.1 m^2 grab. The dominant species included the polychaetes *Spiophanes bombyx*, *Scoletoma* sp, and *Mediomastus* sp.

Cluster group E comprised assemblages from most of the mid-shelf sites (n=13) that ranged in depth from 63 to 116 m. This group, characterized by sites with mixed sediments averaging 50% fines, had the second highest average species richness (91 species), and averaged 302 individuals per sample. This assemblage is typical of the ophiuroid dominated community that occurs along the mainland shelf off southern California (City of San Diego 2007, Mikel et al. 2007). The dominant species representing this mid-shelf group were the ophiuroid *Amphiodia urtica* and the amphipod *Ampelisca pacifica*.

Cluster group F represented assemblages from seven of the nine outer shelf stations, including five of the deepest sites (depths ≥177 m). This group included sites averaging 56% fines and the second highest concentrations of TOC (1.9%). The group F assemblage averaged 81 species and 234 individuals per 0.1-m^2. The dominant species were the polychaetes *Mediomastus* sp and *Paraprionospio pinnata*, and the bivalve *Tellina cadieni*.

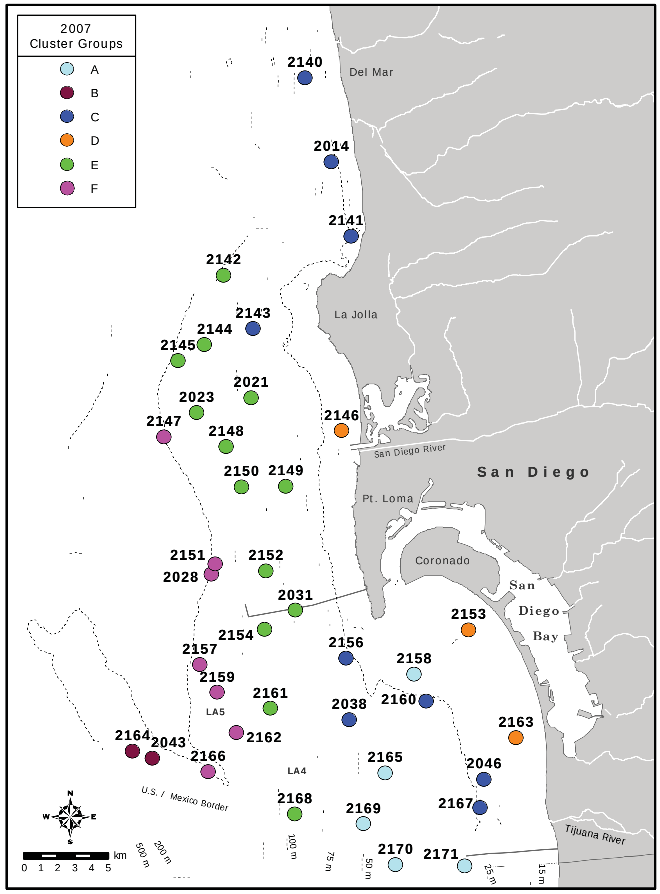


Figure 9.3
Regional benthic stations sampled during July 2007, color-coded to represent affiliation with benthic cluster groups.

Summary and Conclusions

The Southern California Bight benthos has long been considered a “patchy” habitat, with the distribution of species and communities exhibiting considerable spatial variability. Barnard and Ziesenhenne (1961) described the SCB shelf as consisting of an *Amphiodia* “mega-community” with other sub-communities representing variations

Table 9.3

Summary of the most abundant taxa composing cluster groups A–F from the 2007 regional benthic station survey. Data are expressed as mean abundance per cluster group and represent the 10 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					
		A	B	C	D	E	F
Species/Taxa	**Taxa**	(n=5)	(n=2)	(n=9)	(n=3)	(n=13)	(n=7)
Ampharete labrops	Polychaeta	1.2	—	0.6	21.0	—	—
Amphiodia sp	Echinodermata	0.4	—	6.4	0.7	**17.9**	0.9
Amphiodia urtica	Echinodermata	0.6	—	10.0	—	**37.4**	0.1
Amphiuridae	Echinodermata	0.4	2.5	3.3	1.3	7.8	5.0
Aphelochaeta glandaria	Polychaeta	—	**53.0**	3.4	—	0.9	0.3
Axinopsida serricata	Mollusca	—	—	7.1	—	**12.8**	0.9
Caecum crebricinctum	Polychaeta	—	25.0	—	—	0.3	—
Chaetozone sp SD3	Polychaeta	—	**26.0**	1.0	—	—	—
Chaetozone sp SD5	Polychaeta	0.6	10.0	2.6	**27.0**	—	—
Euphilomedes producta	Crustacea	—	—	0.2	—	8.1	1.6
Leptochelia dubia	Crustacea	3.0	18.5	2.3	—	2.8	0.4
Lumbrinerides platypygos	Polychaeta	**7.8**	0.5	—	—	—	—
Mediomastus sp	Polychaeta	0.8	16.0	**49.2**	**29.0**	6.2	**27.0**
Monticellina siblina	Polychaeta	4.4	**28.0**	**60.2**	2.7	2.2	1.1
Paradiopatra parva	Polychaeta	—	—	0.7	—	1.2	7.0
Paraprionospio pinnata	Polychaeta	0.4	1.0	2.7	1.0	1.6	**7.3**
Polycirrus sp	Polychaeta	6.2	2.5	1.4	—	—	0.6
Prionospio jubata	Polychaeta	2.2	3.5	20.4	0.3	6.3	2.9
Scoletoma sp	Polychaeta	—	—	1.6	21.0	1.5	2.1
Spio maculata	Polychaeta	**11.8**	—	—	—	—	—
Spiophanes berkeleyorum	Polychaeta	6.0	—	**27.7**	1.0	2.2	1.1
Spiophanes bombyx	Polychaeta	**92.8**	—	13.7	**32.0**	0.2	—
Spiophanes duplex	Polychaeta	0.8	1.0	19.8	6.0	2.3	0.3
Spiophanes kimballi	Polychaeta	—	1.0	0.1	—	1.1	**10.6**
Tellina cadieni	Mollusca	—	7.0	0.1	—	3.0	6.7

determined by differences in substrate type and microhabitat. Results of the 2007 and previous regional surveys off San Diego generally support this characterization. The 2007 benthic assemblages segregated mostly by habitat characteristics (e.g., depth, sediment grain size, and TOC) and were similar to those sampled in the past.

One third of the benthos sampled in 2007 was characterized by an assemblage dominated by the ophiuroid *Amphiodia urtica*, a common species along the mainland shelf of southern California (cluster group E). Total *Amphiodia urtica* abundance (i.e., adults and juveniles) averaged 21 animals per 0.1 m^2. Co-dominant species within this assemblage included other taxa common to the region such as the mollusc *Axinopsida serricata*.

Nearshore assemblages off San Diego varied depending upon the sediment type and depth, but generally were similar to other shallow, sandy communities in the SCB (see Barnard 1963, Jones 1969, Thompson et al. 1987, 1992, ES Engineering-Science 1988, Mikel et al. 2007). Polychaete species such as *Mediomastus* sp and *Monticellina siblina* were numerically dominant in mixed, sandy sediments such as those found in cluster groups C and D. Sites that constituted another shallow-shelf group (station group A) were characterized by coarser sediments. The assemblage at these stations was dominated by the polychaete *Spiophanes bombyx*.

Sediments at the deepest stations (group F, depth >130 m) had the highest percentage of fine particles and second highest TOC concentrations. These sites had a relatively lower species richness and abundance values and were dominated by polychaetes such as *Mediomastus* sp and *Paraprionospio pinnata*. In contrast, the other deep-water assemblage (group B) occurred at stations where the sediments had a lower percentage of fine particles and much higher TOC concentrations. This assemblage contained high abundances of species found infrequently in other assemblages (e.g. *Aphelochaeta glandaria*, *Chaetozone* sp SD3, *Caecum crebricinctum*).

The results of the 2007 regional survey suggest that benthic assemblages in the vicinity of the South Bay and Point Loma outfalls, as well as dredge spoils disposal sites off San Diego, have maintained an overall community structure consistent with those sampled in the past (e.g., City of San Diego 2005, 2007) and elsewhere throughout the Southern California Bight (e.g., Mikel et al. 2007). While assemblages varied based on depth, sediment composition and TOC concentrations, no patterns of disturbance relative to point sources were evident. Abundances of soft-bottom invertebrates exhibit spatial and temporal variability that may mask the effects of natural or anthropogenic disturbances (Morrisey et al. 1992a, 1992b, Otway 1995). However, region-wide surveys are valuable tools that provide context for localized monitoring and help to establish the baseline conditions necessary to identify any natural or anthropogenic disturbances.

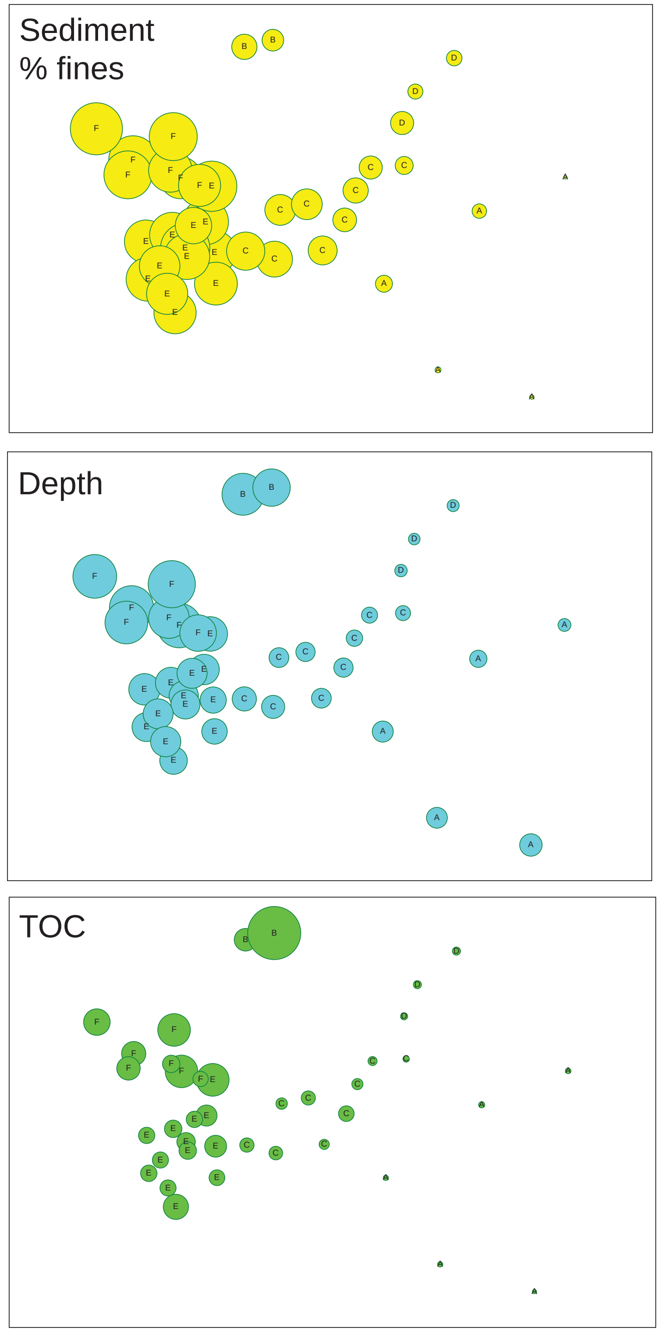


Figure 9.4
MDS ordination of regional benthic stations sampled in July 2007. Cluster groups A–F are superimposed on stations. Percentage of fine particles in the sediments, station depth, and total organic carbon (TOC) are further superimposed as circles that vary in size according to the magnitude of each value. Plots indicate associations of macrobenthic assemblages with habitats that differ in sediment grain size and depth. Stress=0.14.

There were no substantial changes in community parameters between the 1997 and 2007 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 associated diversity indices. However, the similarities between macrofaunal community parameters for 1997 and 2007 suggest that benthic assemblages have not changed substantially over the past decade.

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