Chapter 6. Demersal Fishes and Megabenthic Invertebrates

INTRODUCTION

Marine fishes and invertebrates are conspicuous members of continental shelf habitats, and assessment of their communities has become an important focus of ocean monitoring programs throughout the world. Assemblages of bottom dwelling (demersal) fishes and relatively large (megabenthic), mobile invertebrates that live on the surface of the seafloor have been sampled extensively for more than 30 years on the mainland shelf of the Southern California Bight (SCB), primarily by programs associated with municipal wastewater and power plant discharges (Cross and Allen 1993). More than 100 species of demersal fish inhabit the SCB, while the megabenthic invertebrate fauna consists of more than 200 species (Allen 1982, Allen et al. 1998, 2002, 2007). For the region surrounding the Point Loma Ocean Outfall (PLOO), the most common trawl-caught fishes include Pacific sanddab, longfin sanddab, Dover sole, hornyhead turbot, California tonguefish, plainfin midshipman, and yellowchin sculpin. Common trawl-caught invertebrates include relatively large taxa such as the sea urchins *Lytechinus pictus* and *Allocentrotus fragilis*, and the sea stars *Luidia foliata* and *Astropecten verrilli*.

Demersal fish and megabenthic invertebrate communities are inherently variable and may be influenced by both anthropogenic and natural factors. These organisms live in close proximity to the seafloor and are therefore exposed to contaminants of anthropogenic origin that may accumulate in the sediments via both point and non-point sources (e.g., discharges from ocean outfalls and storm drains, surface runoff from watersheds, outflows from rivers and bays, disposal of dredge materials). Natural factors that may affect assemblages of these fish and invertebrates include prey availability (Cross et al. 1985), bottom relief and sediment structure (Helvey and Smith 1985), and changes in water temperatures associated with large scale oceanographic events such as El Niño/La Niña oscillations (Karinen et al. 1985). These factors can affect migration patterns of adult fish or the recruitment of juveniles into an area (Murawski 1993). Population fluctuations that affect species diversity and abundance may also be due to the mobile nature of many species (e.g., schools of fish or aggregations of urchins).

The City of San Diego has been conducting trawl surveys in the area surround the present discharge site for the Point Loma Ocean Outfall (PLOO) since 1991. These surveys are designed to monitor the effects of wastewater discharge on the local marine biota by assessing the structure and stability of trawl-caught fish and invertebrate communities. This chapter presents analyses and interpretations of the demersal fish and megabenthic invertebrate data collected during 2007. A long-term analysis of changes in these communities from 1991 through 2007 is also presented

MATERIALS AND METHODS

Field Sampling

Trawl surveys were conducted at six fixed monitoring sites in the Point Loma region during 2007 (**Figure 6.1**). These surveys were performed during winter (February) and summer (July) for a total of 12 trawls during the year. The six trawl stations, designated SD7, SD8, SD10, SD12, SD13 and SD14, are located along the 100-m isobath, and encompass an area ranging from about 8 km north to 9 km south of the PLOO. A single trawl was performed at each station during both surveys using a 7.6-m Marinovich otter trawl fitted with a 1.3-cm cod-end mesh net. The net was towed for 10 minutes bottom time at a speed of about 2.5 knots along a predetermined heading.

Trawl catches were brought on board for sorting and inspection. All fish and invertebrates were identified to species or to the lowest taxon possible. If an animal could not be identified in the field, it was returned

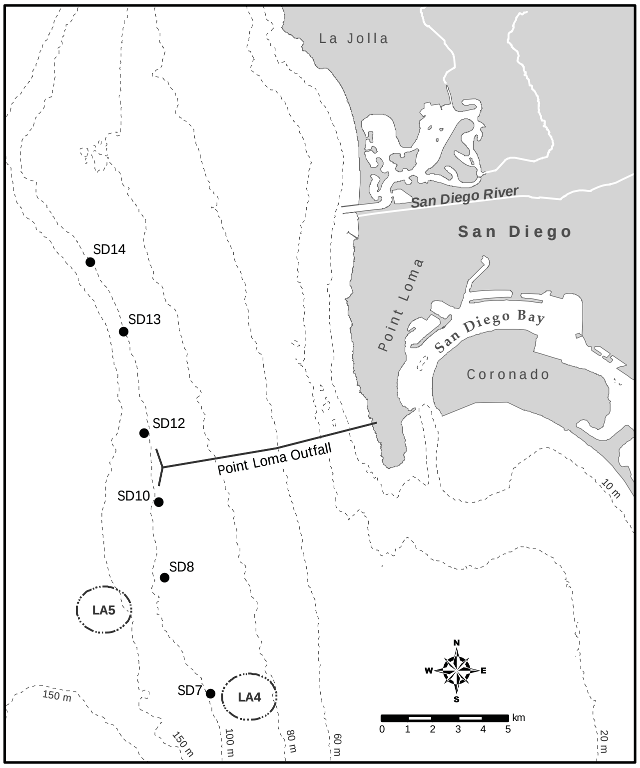

Figure 6.1
Otter trawl station locations, Point Loma Ocean Outfall Monitoring Program.

to the laboratory for further identification. For fishes, the total number of individuals and total biomass (wet weight, kg) were recorded for each species. Additionally, each individual fish was inspected for external parasites or physical anomalies (e.g., tumors, fin erosion, discoloration) and measured to the nearest centimeter size class (standard lengths). For invertebrates, the total number of individuals per species was recorded.

Data Analyses

Populations of each fish and invertebrate species were summarized as percent abundance, frequency of occurrence, mean abundance per haul, and mean abundance per occurrence. In addition, species richness (number of species), total abundance, and Shannon diversity index (H') were calculated for both fish and invertebrate assemblages at each station. Total biomass was also calculated for each fish species by station.

Multivariate analyses were performed on 17 years of demersal fish data from the above six trawl stations (i.e., 1991–2007). The data set was limited to results from just the July surveys conducted each year in order to eliminate seasonal influences. PRIMER software was used to examine spatio-temporal patterns in the overall similarity of fish assemblages (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 fish abundance data were square root transformed, and the Bray-Curtis measure of similarity was used as the basis for classification. Because species composition was sparse at some stations, a dummy species with a value of one was added to all samples prior to computing similarities (see Clarke and Gorley 2006).

Results and Discussion

Fish Community

Thirty-eight species of fish were collected in the area surrounding the PLOO in 2007 along with some unidentified (juvenile) rockfish and flatfish (**Table 6.1**). The total catch for the year was 2454 individuals, representing an average of about 204 fish per trawl. Pacific sanddabs were the dominant fish captured, occurring in every haul and accounting for 45% of the total number of fishes collected during the year. Halfbanded rockfish, longspine combfish, Dover sole, English sole, shortspine combfish, pink seaperch, plainfin midshipman, hornyhead turbot, California tonguefish, and bigmouth sole were also collected frequently (≥75% of the trawls). Pacific sanddabs averaged 92 fish per occurrence, while all other species averaged 20 or less with each contributing to no more than 10% of the total catch. The majority of species tended to be relatively small fish with an average length <20 cm (see **Appendix C.1**). Larger species such as sharks, skates and rays were relatively rare in the trawls. These included the California skate, spotted ratfish, and Pacific electric ray.

Species richness, diversity (H'), abundance and biomass values were all relatively low for trawl-caught fishes off Point Loma during 2007 (**Table 6.2**). No more than 24 species occurred in any one haul, and

Table 6.1

Demersal fish species collected in 12 trawls in the PLOO region during 2007. PA=percent abundance; FO=frequency of occurrence; MAO=mean abundance per occurrence; MAH=mean abundance per haul.

Species	PA	FO	MAO	MAH	Species	PA	FO	MAO	MAH
Pacific sanddab	45	100	92	92	Blackbelly eelpout	<1	25	4	1
Halfbanded rockfish	10	100	20	20	Greenblotched rockfish	<1	25	2	1
Longspine combfish	8	92	19	17	Roughback sculpin	<1	25	2	1
Dover sole	8	100	16	16	Flag rockfish	<1	25	1	<1
English sole	5	92	10	10	Spotted ratfish	<1	25	1	<1
Shortspine combfish	4	92	9	8	White croaker	<1	17	3	1
Pink seaperch	3	92	8	7	California lizardfish	<1	17	3	<1
Plainfin midshipman	3	92	7	7	California skate	<1	17	2	<1
Yellowchin sculpin	2	58	8	5	Blacktip poacher	<1	17	2	<1
Hornyhead turbot	2	92	5	4	Pacific hake	<1	17	1	<1
California tonguefish	2	75	4	3	Bluespotted poacher	<1	8	1	<1
Slender sole	1	50	5	2	Calico rockfish	<1	8	1	<1
Bigmouth sole	1	92	2	2	Chilipepper rockfish	<1	8	1	<1
California scorpionfish	1	42	4	2	Fringed sculpin	<1	8	1	<1
Spotfin sculpin	1	42	3	1	Greenspotted rockfish	<1	8	1	<1
Pygmy poacher	1	42	3	1	Pacific argentine	<1	8	1	<1
Greenstriped rockfish	<1	58	2	1	Pacific electric ray	<1	8	1	<1
Stripetail rockfish	<1	42	2	1	Pink rockfish	<1	8	1	<1
Spotted cuskeel	<1	33	3	1	Squarespot rockfish	<1	8	1	<1
Unidentified rockfish	<1	33	1	<1	Unidentified flatfish	<1	8	1	<1

Table 6.2

Summary of demersal fish community parameters for PLOO stations sampled during 2007. Data are included for species richness (number of species), abundance (number of individuals), diversity (H'), and biomass (kg, wet weight).

			Annual					Annual	
Station	Winter	Summer	Mean	SD	Station	Winter	Summer	Mean	SD
Species Richness					*Abundance*				
SD7	19	19	19	0	SD7	268	118	193	106
SD8	24	21	23	2	SD8	219	208	214	8
SD10	17	15	16	1	SD10	196	257	227	43
SD12	14	14	14	0	SD12	250	208	229	30
SD13	15	14	15	1	SD13	144	161	153	12
SD14	14	21	18	5	SD14	180	250	215	49
Survey Mean	17	17			Survey Mean	210	200		
Survey SD	4	3			Survey SD	46	53		
Diversity					*Biomass*				
SD7	2.08	1.28	1.68	0.57	SD7	8.9	3.4	6.2	3.9
SD8	2.03	1.73	1.88	0.21	SD8	8.1	5.7	6.9	1.7
SD10	1.95	1.79	1.87	0.11	SD10	9.0	8.4	8.7	0.4
SD12	1.98	1.92	1.95	0.04	SD12	10.5	5.4	8.0	3.6
SD13	2.06	1.68	1.87	0.27	SD13	5.4	4.3	4.9	0.8
SD14	1.87	1.62	1.75	0.18	SD14	5.0	12.1	8.6	5.0
Survey Mean	2.00	1.67			Survey Mean	7.8	6.6		
Survey SD	0.08	0.22			Survey SD	2.2	3.2		

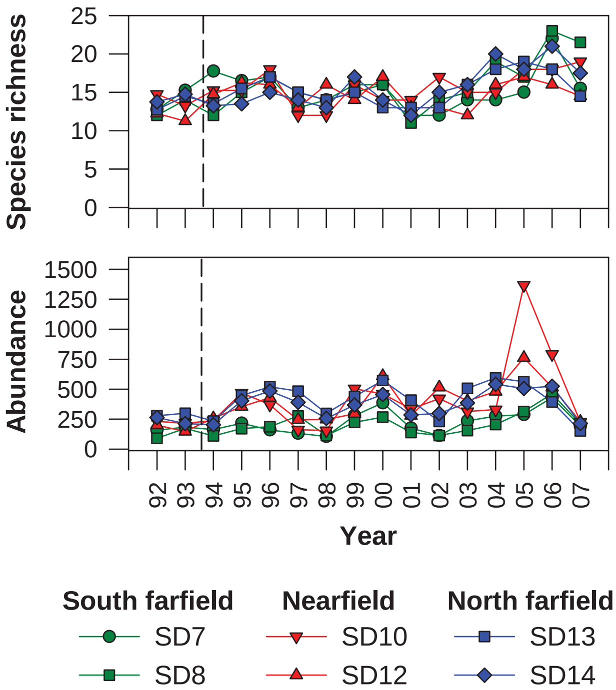

Figure 6.2

Species richness (number of species) and abundance (number of individuals) of demersal fish collected at each PLOO trawl station between 1992 and 2007. Data are annual means (n=4 for 1992–2002; n=3 in 2003; n=2 for 2004–2007). Dotted line represents initiation of wastewater discharge in November 1993.

H' values were less than 2.1 for all assemblages. Total abundance ranged from 118 to 268 fishes per haul, which tended to co-vary with Pacific sanddab populations that ranged between 23–152 fish per catch (**Appendix C.2**). Biomass ranged from 3.4 to 12.1 kg per haul, with higher values coincident either with greater numbers of fishes or the large size of individual fish or fishes. For example, the highest biomass of 12.1 kg occurred for a trawl from station SD14 during the July trawl survey when 9 kg of Pacific sanddabs were captured (**Appendix C.3**).

Large fluctuations in populations of a few dominant species have been the primary factor contributing to the high variation in fish community structure off Point Loma since 1992 (**Figure 6.2**, **Figure 6.3**). For example, species richness has consistently averaged between about 10–23 species per station, while mean abundances have varied between 93 and 1368 individuals. These fluctuations in abundance have been greatest at stations SD10, SD12, SD13 and SD14 and generally reflect differences in

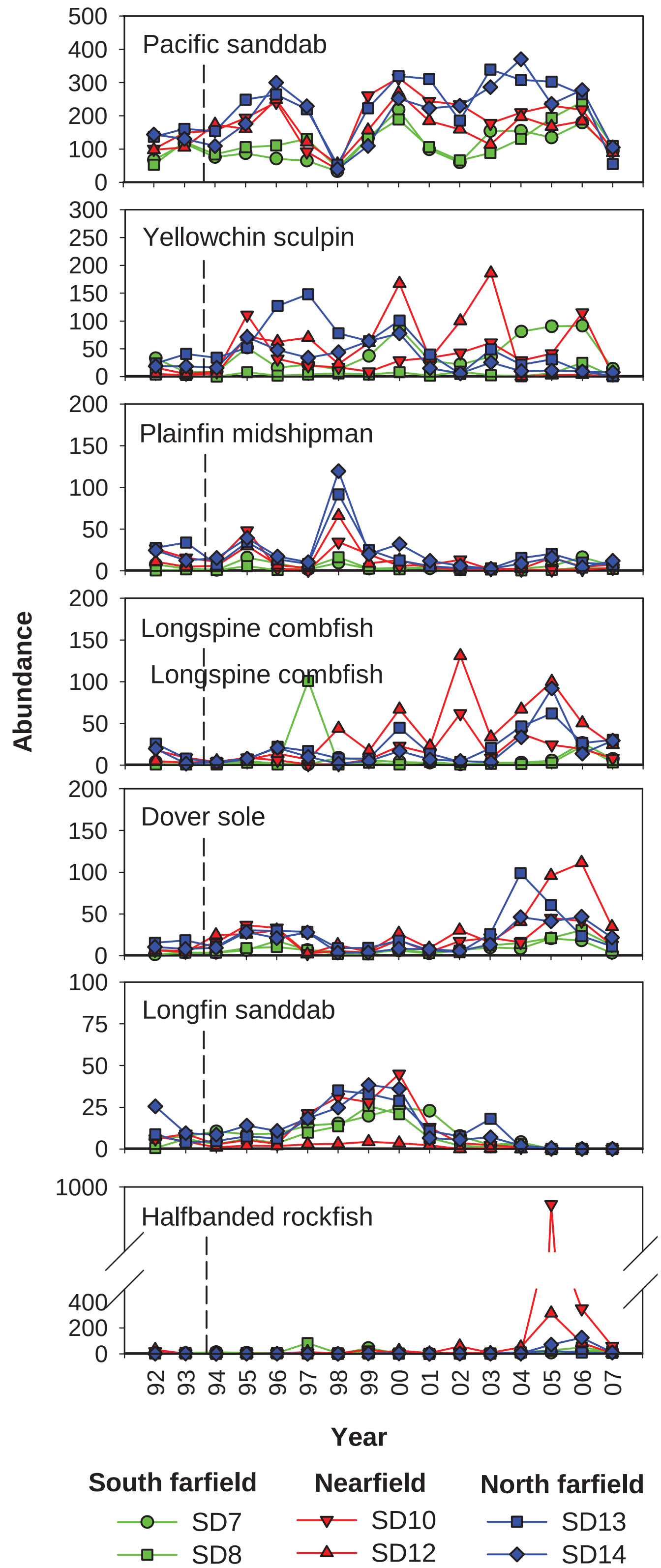

Figure 6.3

Abundance of the seven most abundant fish species collected in the PLOO region from 1992 through 2007. Data are annual means (n=4 for 1992–2002; n=3 in 2003; n=2 for 2004–2007). Dotted line represents initiation of wastewater discharge in November 1993.

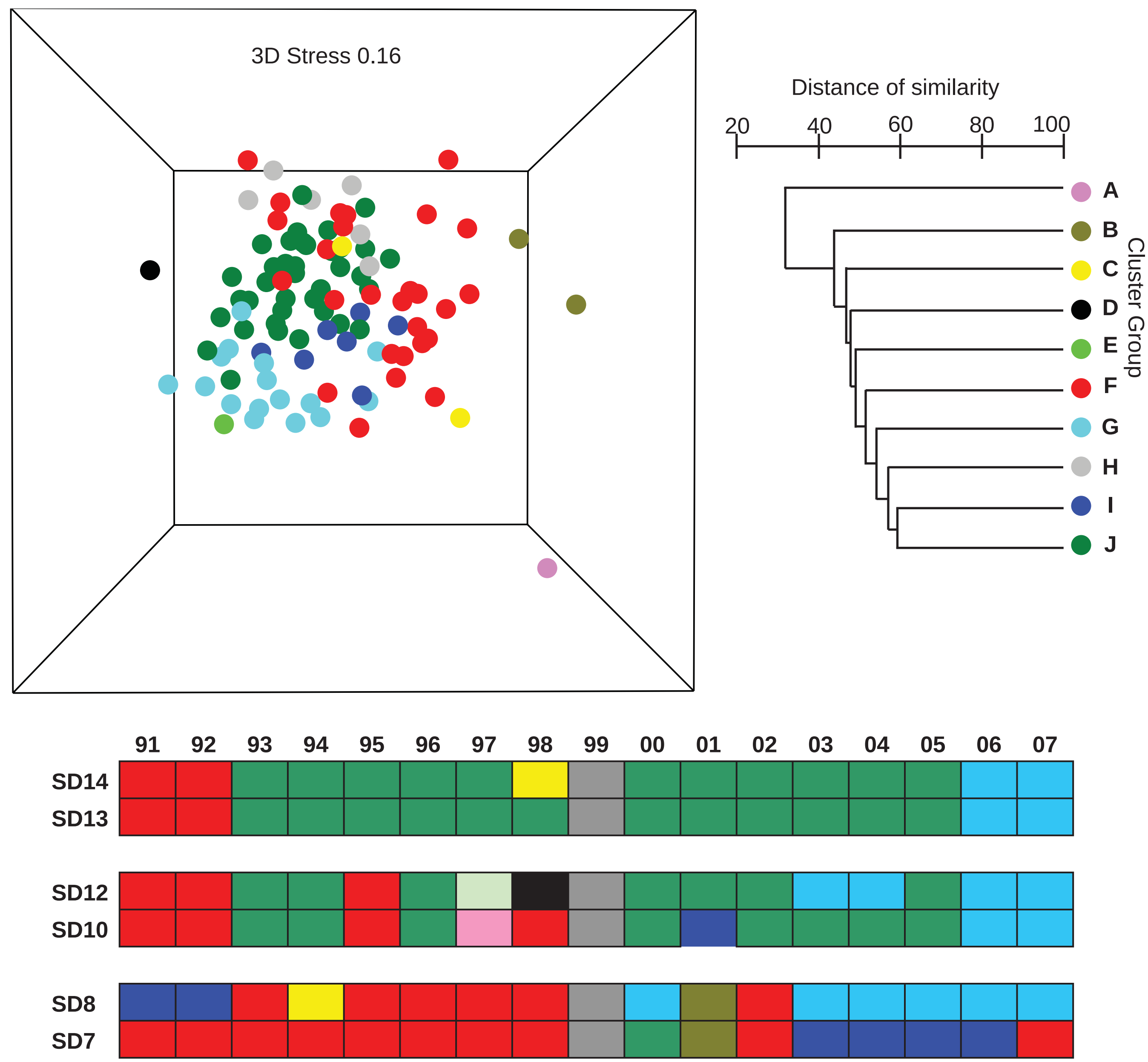

Figure 6.4
Results of classification analysis of demersal fish assemblages collected at PLOO stations SD7–SD14 between 1991 and 2007 (July surveys only). Data are presented as (A) MDS ordination, (B) a dendrogram of major cluster groups and (C) a matrix showing distribution of cluster groups over time.

populations of several dominant species. For example, the overall low abundance in 2007 was due to significantly fewer numbers of Pacific sanddabs, yellowchin sculpin, longspine combfish, Dover sole, and halfbanded rockfish captured during the year. Moreover, patterns of change in the dominant species over time were generally similar among stations closest to the outfall and those at the northern sites. None of the observed changes appear to be associated with wastewater discharge. For example, no changes that have occurred at the trawl stations nearest the outfall were coincident with the onset of discharge in late 1993.

Ordination and classification analyses of fish abundance data from 1991 through 2007 distinguished between 10 major cluster groups or assemblages (cluster groups A–J; see **Figure 6.4**). These results indicate that the demersal fish community off Point Loma remains dominated by

Table 6.3

Description of cluster groups A–J defined in Figure 6.4. Data include number of hauls, mean species richness, mean total abundance, and mean abundance of the five most abundant species for each station group.

	Cluster Group									
	A	B	C	D	E	F	G	H	I	J
Number of hauls	1	2	2	1	1	27	16	6	7	39
Mean species richness	7	11	11	16	19	13	17	16	15	15
Mean abundance	44	68	74	261	231	152	326	362	223	378
Species	**Mean Abundance**									
Greenspotted rockfish	1				1	<1		1		<1
Gulf sanddab	1		1	5				5		
Longfin sanddab	1	3	1			5	1	25		5
Pink seaperch	1	1	2	4	1	1	3	2	3	5
Spotfin sculpin	1		2			2	4			
Halfbanded rockfish	16				60	2	68	5	6	7
Pacific sanddab	23	46	48	75	110	88	164	201	149	254
Bigmouth sole		3			1	1	1	1	<1	1
California tonguefish		3			1	3	3	4	1	1
Dover sole		1	6	36	1	11	28	4	16	34
Greenblotched rockfish		1	2		8	1	1	1	2	1
Longspine combfish		3	2	7	2	1	10	4	4	17
Plainfin midshipman			2	116	4	16	4	13	3	9
Shortspine combfish					3	2	12	1	7	2
Squarespot rockfish		1			23					
Stripetail rockfish			8	1	5	8	2	61	<1	8
Vermilion rockfish					6					
Yellowchin sculpin		5				3	1	21	20	15

Pacific sanddabs, with differences in the relative abundance of this or other commons species discriminating between the different cluster groups (see **Table 6.3**). The overall distribution of assemblages in 2007 was generally similar to that observed in 2006, with both being fairly distinct compared to previous years. There do not appear to be any spatial or temporal patterns that can be attributed to the outfall or the onset of wastewater discharge. Instead, most differences in local fish assemblages appear to be more closely related to large-scale oceanographic events (e.g., El Niño conditions in 1998) or proximity to other potential contaminant sources. For example, fish assemblages at stations SD7 and SD8 located south of the outfall and not far from the LA-4 and LA-5 disposal sites, respectively, often grouped apart from the remaining trawls stations. The composition and characteristics of each cluster group are summarized above (Table 6.3).

Cluster groups A-E comprised five unique assemblages formed by one or two station/survey entities (i.e., trawl catch), accounting for <7% of the total number of trawls. Most of these groups were dominated by Pacific sanddabs, but were unique in terms of lower total abundance and species richness values, and/or relatively high numbers of less common species (e.g, midshipman, rockfish). Cluster group A represented the assemblage from station SD10 sampled in 1997; this assemblage was characterized by the fewest fish (species and abundance) of all hauls (i.e., 44 fishes representing seven species). Cluster groups B and C each consisted of assemblages from only two trawls; group B represented stations SD7 and SD8 sampled in 2001, while group C was comprised of trawls from station SD8 in 1994 and station SD14 in 1998. These two assemblages were characterized by slightly more species than cluster group A (i.e., 11 species), and both also had low total abundances as well as relatively low numbers of Pacific sanddabs. Cluster group D represented the assemblage from station SD12 sampled in 1998; this assemblage was unique because it was dominated by a large population of plainfin midshipman. The second and third most abundant species comprising group D were Pacific sanddabs and Dover sole. Cluster group E represented the assemblage from station SD12 sampled in 1997; this assemblage had the highest number of species overall, and in addition to Pacific sanddabs was characterized by relatively high numbers of halfbanded and squarespot rockfish.

Cluster group F consisted of assemblages from 27 trawls, all but three of which occurred between 1991 and 1998. These included most surveys at stations SD7 and SD8, as well as stations SD10–SD14 sampled during the relatively warm water years of 1991–1992. Overall, this group was characterized by moderate numbers of species and fishes. The dominant species in this group was the Pacific sanddab, which averaged about 88 fish/haul, while plainfin midshipman (~16 fish/haul) and Dover sole (~11 fish/haul) were the next two most abundant species.

Cluster group G was represented the assemblages from about 16% of all trawls. These occurred at stations SD12 in 2003 and 2004, SD8 during 2000 and 2003–2007, and all stations except SD7 during 2006 and 2007. Group G was characterized by the second highest species richness (~17 species/haul), the third highest averages for total abundance (~362 fish/haul) and numbers of Pacific sanddabs (164 fish/haul). The next two most abundant species that characterized this group were halfbanded rockfish (68 fish/haul) and Dover sole (28 fish/haul).

Cluster group H comprised assemblages across all six stations sampled in 1999. This group was characterized by the second highest number of Pacific sanddabs (201 fish/haul), and in contrast to most other groups, relatively higher numbers of stripetail rockfish (61 fish/haul), longfin sanddabs (25 fish/haul), and yellowchin sculpin (21 fish/haual). These three species may have been more prevalent in the region following the warm water conditions associated with the 1998 El Niño.

Cluster group I consisted primarily of assemblages sampled at southern stations SD7 from 2003 to 2006 and SD8 during 1991–1992, as well as from station SD10 in 2001. The group I assemblages were similar to those represented by group G in terms of moderate numbers of species, total abundance, and numbers of Pacific sanddabs, but with fewer numbers of halfbanded rockfish, shortspine combfish, longspine combfish and Dover sole.

Cluster group J comprised assemblages from about 38% of all trawls, most of which were sampled at stations around or north of the PLOO between 1993 and 2005 (i.e., stations SD10–SD14). The main exceptions occurred during and after the 1998 El Niño (i.e., 1998–1999). Group J was characterized by the highest average total abundance, as well the highest number of Pacific sanddabs (254 fish/haul) on average for all cluster groups. The three next most abundant species characterizing this group were Dover sole (34 fish/haul), longspine combfish (17 fish/haul), and yellowchin sculpin (15 fish/haul). Whereas the species characteristic of the group F and H assemblages may have been associated with the warm waters, the high numbers of Pacific sanddabs, Dover sole and combfish characteristic of cluster group J are likely indicative of colder waters that were persistent during the these non-El Niño years.

Physical Abnormalities and Parasitism

Demersal fish populations appeared healthy in the PLOO region during 2007. There were no incidences of fin rot, discoloration, skin lesions, tumors or any other indicators of disease among fishes collected during the year. A single Pacific sanddab collected at station SD14 was found to have a physical deformity; its tail was bent upwards towards its dorsal fin at the caudal peduncle. Evidence of parasitism was also very low for trawl-caught fishes in the region. The copepod eye parasite *Phrixocephalus cincinnatus* occurred on less than 1% of the Pacific sanddabs collected and was present at all stations during all surveys. In addition, the ectoparasitic isopod *Elthusa vulgaris* was observed loose in some trawls. This cymothoid

Table 6.4

Species of megabenthic invertebrates collected in 12 trawls in the PLOO region during 2007. PA=percent abundance; FO=frequency of occurrence; MAO=mean abundance per occurrence; MAH=mean abundance per haul.

Species	PA	FO	MAO	MAH	Species	PA	FO	MAO	MAH
Lytechinus pictus	92	92	1957	1794	*Suberites* sp	<1	25	1	<1
Acanthoptilum sp	4	75	108	81	*Philine alba*	<1	17	2	<1
Allocentrotus fragilis	2	83	53	44	*Podochela lobifrons*	<1	17	2	<1
Luidia foliolata	<1	92	7	6	Porifera	<1	8	3	<1
Parastichopus californicus	<1	83	5	4	*Acanthodoris brunnea*	<1	8	2	<1
Astropecten verrilli	<1	83	4	3	*Neocrangon zacae*	<1	8	2	<1
Spatangus californicus	<1	75	3	3	*Antiplanes catalinae*	<1	8	1	<1
Ophiura luetkenii	<1	67	4	2	*Elthusa vulgaris*	<1	8	1	<1
Sicyonia ingentis	<1	50	4	2	*Euspira draconis*	<1	8	1	<1
Ophiothrix spiculata	<1	25	4	1	*Fusinus barbarensis*	<1	8	1	<1
Luidia armata	<1	25	4	1	*Halocynthia igaboja*	<1	8	1	<1
Octopus rubescens	<1	50	1	1	*Luidia* sp	<1	8	1	<1
Thesea sp B	<1	42	1	1	*Ondontaster crassus*	<1	8	1	<1
Platymera gaudichaudii	<1	42	1	<1	*Paguristes bakeri*	<1	8	1	<1
Luidia asthenosoma	<1	25	2	<1	*Paguristes turgidus*	<1	8	1	<1
Armina californica	<1	17	3	<1	*Paguristes ulreyi*	<1	8	1	<1
Metridium farcimen	<1	17	3	<1	*Platydoris macfarlandi*	<1	8	1	<1
Neosimnia barbarensis	<1	17	3	<1	*Rossia pacifica*	<1	8	1	<1
Pleurobranchaea californica	<1	33	1	<1	*Schmittius politus*	<1	8	1	<1
Florometra serratissima	<1	25	1	<1	*Stylatula elongata*	<1	8	1	<1
Calliostoma turbinum	<1	17	2	<1					

isopod often becomes detached from its host during the sorting of the trawl catch, and therefore it is unknown which fishes were actually parasitized. Although *E. vulgaris* is known to occur on various species of fish in southern California waters, it is especially common on sanddabs and California lizardfish, where it may reach infestation rates of 3% and 80%, respectively (Brusca 1978, 1981).

Invertebrate Community

A total of 23,379 megabenthic invertebrates (~1948 per trawl), representing 40 taxa, were collected during 2007 (**Table 6.4**, **Appendix C.4**). The white sea urchin *Lytechinus pictus* was the most abundant and most frequently captured species. It was present in 92% of the trawls and accounted for 92% of the total invertebrate catch. Other common species that occurred in more than half of the hauls included the sea urchin *Allocentrotus fragilis*, the sea pen *Acanthoptilum* sp, the sea stars *Astropecten verrilli* and *Luidia foliolata*, the brittle star *Ophiura luetkenii*, the sea cucumber *Parastichopus californicus*, and the heart urchin *Spatangus californicus*.

Megabenthic invertebrate community structure varied among stations and between surveys during the year (**Table 6.5**). Species richness ranged from 7 to 18 species per haul, diversity (H') values ranged from 0.06 to 1.13 per haul, and total abundance ranged from 124 to 4033 individuals per haul. Total abundance co-varied with *L. pictus* populations (**Appendix C.5**). For example, stations SD13 and SD14 had much lower abundances (≤964) than the other four stations due to relatively small catches of *L. pictus* (≤925). Diversity values were extremely low (≤1.13) for the entire area due to the numerical dominance of this sea urchin. Dominance of *L. pictus* is typical for these types of habitats throughout the SCB (e.g., Allen et al. 1998).

Invertebrate species richness and abundance have varied over time (**Figure 6.5**). For example, species richness has averaged from 5 to 20 species per year since 1992, although patterns of change have

Table 6.5

Summary of megabenthic invertebrate community parameters for PLOO stations sampled during 2007. Data are included for species richness (number of species), abundance (number of individuals), and diversity (H').

Station	Winter	Summer	Annual Mean	Annual SD
Species Richness				
SD7	12	13	13	1
SD8	18	9	14	6
SD10	10	16	13	4
SD12	10	17	14	5
SD13	9	13	11	3
SD14	7	14	11	5
Survey Mean	11	14		
Survey SD	4	3		
Abundance				
SD7	2417	3225	2821	571
SD8	2905	2462	2684	313
SD10	2338	3175	2757	592
SD12	4033	294	2164	2644
SD13	964	797	881	118
SD14	124	645	385	368
Survey Mean	2130	1766		
Survey SD	1395	1339		
Diversity				
SD7	0.06	0.10	0.08	0.03
SD8	0.14	0.18	0.16	0.03
SD10	0.11	0.11	0.11	0.00
SD12	0.48	0.91	0.70	0.30
SD13	0.24	0.93	0.59	0.49
SD14	1.00	1.13	1.07	0.09
Survey Mean	0.34	0.56		
Survey SD	0.36	0.48		

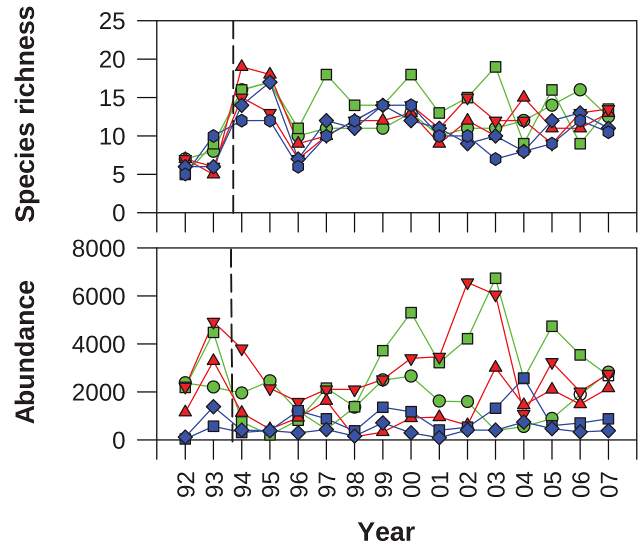

Figure 6.5

Species richness (number of species) and abundance (number of individuals) of megabenthic invertebrates collected at each station between 1992 and 2007. Data are annual means (n=4 for 1992–2002; n=3 in 2003; n=2 for 2004–2007). Dotted line represents initiation of wastewater discharge in November 1993.

been similar among stations. In contrast, changes in abundance have differed greatly among the trawl stations. The average annual invertebrate catches have been consistently low at stations SD13 and SD14, while the remaining stations have demonstrated large fluctuations in abundance. These fluctuations typically reflect changes in *L. pictus* populations, as well as populations of the sea urchin *Allocentrotus fragilis*, and to a lesser degree, the sea pen *Acanthoptilum* sp (**Figure 6.6**). Additionally, abundances of these three taxa are typically much lower at the two northern sites, which likely reflect differences in sediment composition (e.g., fine sands vs. mixed coarse/fine sediments, see Chapter 4). None of the observed variability in the invertebrate community could be attributed to the discharge of wastewater from the PLOO.

Summary and Conclusions

As in previous years, Pacific sanddabs continued to dominate fish assemblages surrounding the Point Loma Ocean Outfall during 2007. These fish were present in relatively high numbers at all stations. Other characteristic, but less abundant species, included halfbanded rockfish, longspine combfish, Dover sole, English sole, shortspine combfish, pink seaperch, plainfin midshipman, hornyhead turbot, California tonguefish, and bigmouth sole. Although the composition and structure of the fish assemblages varied among stations, most differences were due to fluctuations in Pacific sanddab populations.

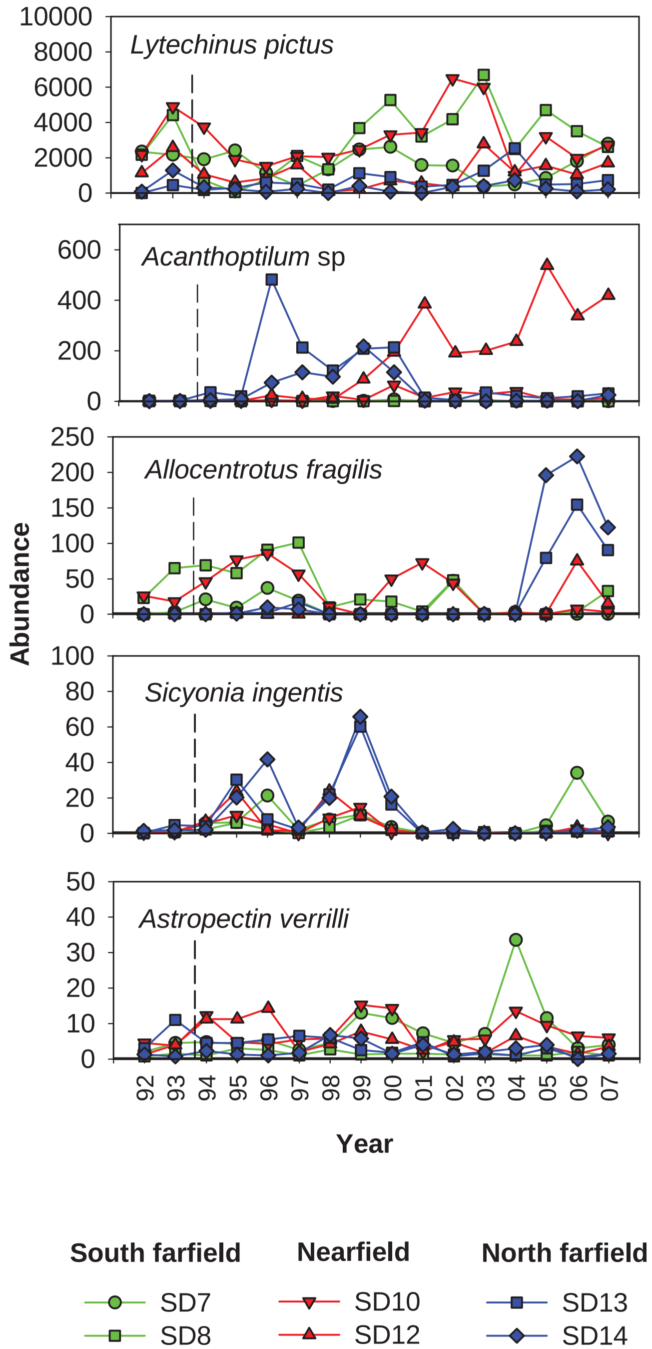

Figure 6.6
Abundance (number of individuals) of the four most abundant megabenthic species collected in the PLOO region from 1992 through 2007. Data are annual means (n=4 for 1992–2002; n=3 in 2003; n=2 for 2004–2007). Dotted line represents initiation of wastewater discharge in November 1993.

Assemblages of megabenthic invertebrates were also dominated by a single prominent species, the white sea urchin *Lytechinus pictus*. Other common species included the sea urchin *Allocentrotus fragilis*, the sea pen *Acanthoptilum* sp, the sea stars *Astropecten verrilli* and *Luidia foliolata*, the brittle star *Ophiura luetkenii*, the sea cucumber *Parastichopus californicus*, and the heart urchin *Spatangus californicus*. Although megabenthic community structure varied between sites, these assemblages were generally characterized by low species richness and diversity. Abundance was proportional to the number of *L. pictus* collected in each haul.

Overall, results of the 2007 trawl surveys provide no evidence that the discharge of wastewater from the Point Loma Ocean Outfall has affected bottom-dwelling fish or megabenthic invertebrate communities in the region. Although highly variable, patterns in the abundance and distribution of species were similar at stations located near the outfall and further away. Changes that have occurred over time in these communities appear to be mostly due to natural factors such as differences in water temperature associated with large scale oceanographic events (El Niño), sediment conditions, and the mobile nature of many species. Finally, the general absence of disease or physical abnormalities suggests that populations of local fishes continue to be healthy off Point Loma.

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