Chapter 6. Demersal Fishes and Megabenthic Invertebrates

Introduction

Bottom dwelling (demersal) fishes and relatively large (megabenthic) mobile invertebrates are monitored by the City of San Diego (City) to examine potential effects of wastewater discharge on marine environments around both the Point Loma and South Bay Ocean Outfalls (PLOO and SBOO, respectively). These fish and invertebrate communities are conspicuous members of continental shelf habitats and are targeted for monitoring because they are known to play critical ecological roles on the southern California coastal shelf, serving vital functions in wide ranging capacities (Allen et al. 2006, Thompson et al. 1993a, b). Because such organisms live in close proximity to the seafloor, they can be impacted by changes in sediments affected by 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; see Chapter 4). For these reasons, their assessment has become an important focus of ocean monitoring programs throughout the world, but especially in the Southern California Bight (SCB) where they have been sampled extensively on the mainland shelf for the past three decades (Stein and Cadien 2009).

In healthy ecosystems, fish and invertebrate communities are known to be inherently variable and influenced by many natural factors. These factors 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, Stein and Cadien 2009). The mobile nature of many species allows them to migrate toward or away from different habitats, and natural ambient conditions throughout the SCB affect migration patterns of adult fishes and the recruitment of juveniles into different areas (Murawski 1993). Therefore, an understanding of background or reference conditions is necessary before determining whether observed differences in community structure may be related to anthropogenic activities. Such information is available for the monitoring area surrounding the PLOO (e.g., City of San Diego 2007b) and the San Diego region in general (e.g., Allen et al. 1998, 2002, 2007, 2011).

The City relies on a suite of scientifically-accepted indices and statistical analyses to evaluate changes in local fish and invertebrate communities. These include community structure metrics such as species richness, abundance and the Shannon diversity index, while multivariate analyses are used to detect spatial and temporal differences among communities (e.g., Warwick 1993). The use of multiple analyses provides better resolution than single parameters for determining anthropogenically-induced environmental impacts. In addition, trawled organisms are inspected for evidence of fin rot, tumors, skeletal abnormalities, exoskeletal lesions, spine loss, or other anomalies that have been found previously to be indicators of degraded habitats (e.g., Cross and Allen 1993, Stull et al. 2001). All together, the data are used to determine whether fish and invertebrate assemblages near outfalls are similar to those from habitats with similar depth and sediment characteristics, or whether observable impacts from the outfalls or other sources occur.

This chapter presents analyses and interpretations of trawl survey data collected during 2011, as well as a long-term assessment of these communities from 1991 through 2011. The primary goals are to: (1) document the demersal fish and megabenthic invertebrate communities present during the year, (2) determine the presence or absence of biological impacts associated with wastewater discharge, and (3) identify other potential natural

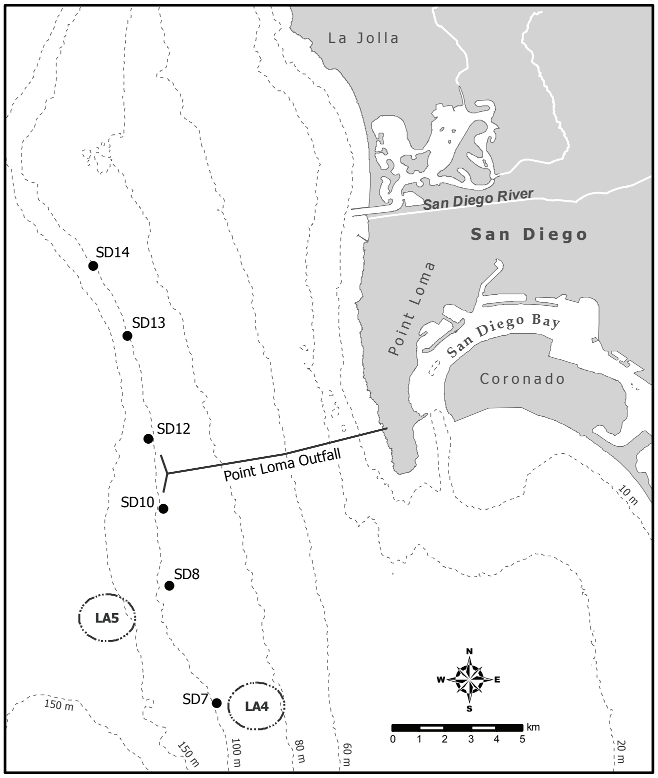

Figure 6.1
Otter trawl station locations sampled around the Point Loma Ocean Outfall as part of the City of San Diego's Ocean Monitoring Program.

and anthropogenic sources of variability to the local marine ecosystem.

Materials and Methods

Field Sampling

Trawl surveys were conducted at six fixed monitoring sites in the PLOO region during January and July 2011 (Figure 6.1). These trawl stations, designated SD7, SD8, SD10, SD12, SD13 and SD14, are located along the 100-m depth contour, and encompass an area ranging from 9 km south to 8 km north of the PLOO. The two stations considered to represent "nearfield" conditions (i.e., SD10, SD12) are located within 1000 m of the outfall wye. A single trawl was performed at each station during each survey 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 of bottom time at a speed of about 2.0 knots along a predetermined heading.

The total catch from each trawl was brought onboard the ship for sorting and inspection. All fishes and invertebrates captured were identified to species or to the lowest taxon possible. If an animal could not be identified in the field, it was returned to the laboratory for further identification. For fishes, the total number of individuals and total biomass (kg, wet weight) were recorded for each species. Additionally, each individual fish was inspected for physical anomalies, indicators of disease (e.g., tumors, fin erosion, discoloration), as well as the presence of external parasites. Lengths of individual fish were measured to centimeter size class on measuring boards; total length (TL) was measured for cartilaginous fishes and standard length (SL) was measured for bony fishes. For invertebrates, the total number of individuals was recorded per species.

Data Analyses

Populations of each fish and invertebrate species were summarized as percent abundance (number of individuals of a single species per total number of individuals of all species), frequency of occurrence (percentage of stations at which a species was collected), mean abundance per haul (number of individuals of a single species per total number sites sampled), and mean abundance per occurrence (number of individuals of a single species per number of sites at which the species was collected). Additionally, the following community structure parameters were calculated for each trawl for fishes and invertebrates: species richness (number of species), total abundance (number of individuals), and Shannon diversity index (H'). Total biomass was also calculated for each fish species captured.

Multivariate analyses of demersal fish communities sampled in the region were performed using data collected from 1991 through 2011. In order to reduce statistical noise due to seasonal variation in population abundances, analyses were limited to data from summer (mostly July) surveys only. PRIMER software was used to examine spatio-temporal patterns among fish assemblages

Table 6.1

Demersal fish species collected in 12 trawls conducted in the PLOO region during 2011. PA = percent abundance; FO = frequency of occurrence; MAH = mean abundance per haul; MAO = mean abundance per occurrence.

Species	PA	FO	MAH	MAO	Species	PA	FO	MAH	MAO
Pacific sanddab	40	100	153	153	Bigmouth sole	<1	33	<1	2
Stripetail rockfish	15	100	57	57	Greenspotted rockfish	<1	25	<1	3
Halfbanded rockfish	14	92	56	61	Spotfin sculpin	<1	8	<1	7
California lizardfish	12	100	45	45	Slender sole	<1	42	<1	1
Longspine combfish	5	100	18	18	Roughback sculpin	<1	33	<1	2
Dover sole	5	100	18	18	Spotted cusk-eel	<1	17	<1	3
Pink seaperch	3	92	10	11	California skate	<1	8	<1	5
Shortspine combfish	2	100	8	8	Pygmy poacher	<1	25	<1	1
English sole	1	100	4	4	Blackbelly eelpout	<1	17	<1	1
Yellowchin sculpin	<1	42	3	7	Greenblotched rockfish	<1	17	<1	1
Squarespot rockfish	<1	17	2	14	Tiger rockfish	<1	17	<1	1
Greenstriped rockfish	<1	58	2	3	Blacktip poacher	<1	8	<1	1
California tonguefish	<1	58	2	3	Roundel batfish	<1	8	<1	1
Plainfin midshipman	<1	50	2	3	Shortbelly rockfish	<1	8	<1	1
California scorpionfish	<1	42	2	4	Thornback	<1	8	<1	1
Hornyhead turbot	<1	50	1	3					

(Clarke 1993, Warwick 1993, Clarke and Gorley 2006). Abundance data were square-root transformed to lessen the influence of abundant species and increase the importance of rare species, and a Bray-Curtis similarity matrix was created using station and year as factors. Because species composition was sparse at some stations, a "dummy" species with an abundance value of 1 was added to all samples prior to computing similarities (Clarke and Gorley 2006). A 2-way crossed ANOSIM (max. no. of permutations = 9999) was conducted to determine whether communities varied by station or year across the region. To visually depict the relationship of individual trawls to each other based on fish composition, hierarchical agglomerative clustering (cluster analysis) with group-average linking was conducted. Similarity profile (SIMPROF) analyses were used to confirm the non-random structure of the resultant cluster dendrograms (Clarke et al. 2008). Major ecologically-relevant SIMPROF-supported clades with < 61.29% similarity were retained. Similarity percentages (SIMPER) analysis was used to identify which species were responsible for the greatest contribution to within group similarities (i.e., characteristic species).

Results

Demersal Fish Communities

Thirty-one species of fish were collected in the area surrounding the PLOO in 2011 (Table 6.1). A single tiger rockfish (*Sebastes nigroinetus*) collected at SD13 in July represented a new record for the region (Appendix E.1). The total catch for the year was 4646 individuals (Appendix E.2), representing an average of 387 fish per trawl. As in previous years, Pacific sanddabs were dominant. This species occurred in every haul and accounted for 40% of all fishes collected at an average of 153 individuals per trawl. No other species contributed to more than 15% of the total catch during the year. For example, California lizardfish, stripetail rockfish, longspine combfish, shortspine combfish, Dover sole, and English sole also occurred in every trawl, but at much lower numbers (~4–57 individuals per haul). Other species collected frequently (≥50% of the trawls) but in relatively low numbers (≤56 individuals per haul) included halfbanded rockfish, pink seaperch, greenstriped rockfish, California tonguefish, plainfin midshipman, and hornyhead turbot. The

Table 6.2

Summary of demersal fish community parameters for PLOO trawl stations sampled during 2011. Data are included for species richness, abundance, diversity (H'), and biomass (kg, wet weight). SD = standard deviation.

Station	January	July
Species Richness		
SD7	17	14
SD8	14	15
SD10	15	14
SD12	16	13
SD13	14	16
SD14	14	15
Survey Mean	15	15
Survey SD	1	1
Abundance		
SD7	267	337
SD8	294	520
SD10	561	441
SD12	383	190
SD13	532	297
SD14	297	527
Survey Mean	389	385
Survey SD	128	134
Diversity		
SD7	1.9	1.3
SD8	1.9	1.4
SD10	1.7	1.6
SD12	1.7	2.0
SD13	1.9	1.7
SD14	1.5	1.4
Survey Mean	1.8	1.6
Survey SD	0.2	0.3
Biomass		
SD7	5.9	5.4
SD8	4.6	9.9
SD10	8.7	10.6
SD12	11.2	4.9
SD13	14.7	11.8
SD14	16.1	25.8
Survey Mean	10.2	7.2
Survey SD	4.7	2.6

majority of fishes captured in the region tended to be relatively small with an average length ≤21 cm (Appendix E.1). The only exception was the California skate, which averaged 38 cm in length for the five specimens collected.

No more than 17 species of fish occurred in any one haul during 2011, and the corresponding diversity (H') values were all ≤2.0 (Table 6.2). Total abundance for all species combined ranged from 190 to 561 fishes per haul. This high variation in abundance was mostly due to differences in the numbers of Pacific sanddab, halfbanded rockfish, stripetail rockfish, and California lizardfish captured at each station (Appendix E.2). Total fish biomass ranged from 4.6 to 25.8 kg per haul, with higher values coincident with either greater numbers of fishes or the presence of large individuals (Appendix E.3). For example, one roundel batfish accounted for 2.1 kg of the total biomass at station SD12 in January, whereas 225 Pacific sanddab and 213 halfbanded rockfish accounted for about 21.8 kg of the biomass at station SD14 in July. No spatial patterns related to the outfall were observed for species richness, diversity, abundance, or biomass.

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 1991 (Figures 6.2, 6.3). Over the years, species richness values for individual trawls have ranged from 7 to 26 species, while total abundance per haul has varied from 44 to 2322 individuals per station per survey. Oscillations of overall abundance primarily reflect changes in Pacific sanddab, longfin sanddab, and Dover sole populations that tend to occur across large portions of the study area (i.e., over multiple stations). In addition, intra-station variability has been due to large hauls of species such as yellowchin sculpin, longspine combish, and halfbanded rockfish that occur infrequently at one or two stations. Overall, none of the observed changes appear to be associated with wastewater discharge.

Classification of Fish Assemblages

Multivariate analyses performed on data collected between 1991 and 2011 (summer surveys only) discriminated between ten main types of fish assemblages in the Point Loma outfall region (Figure 6.4). ANOSIM results revealed that fish

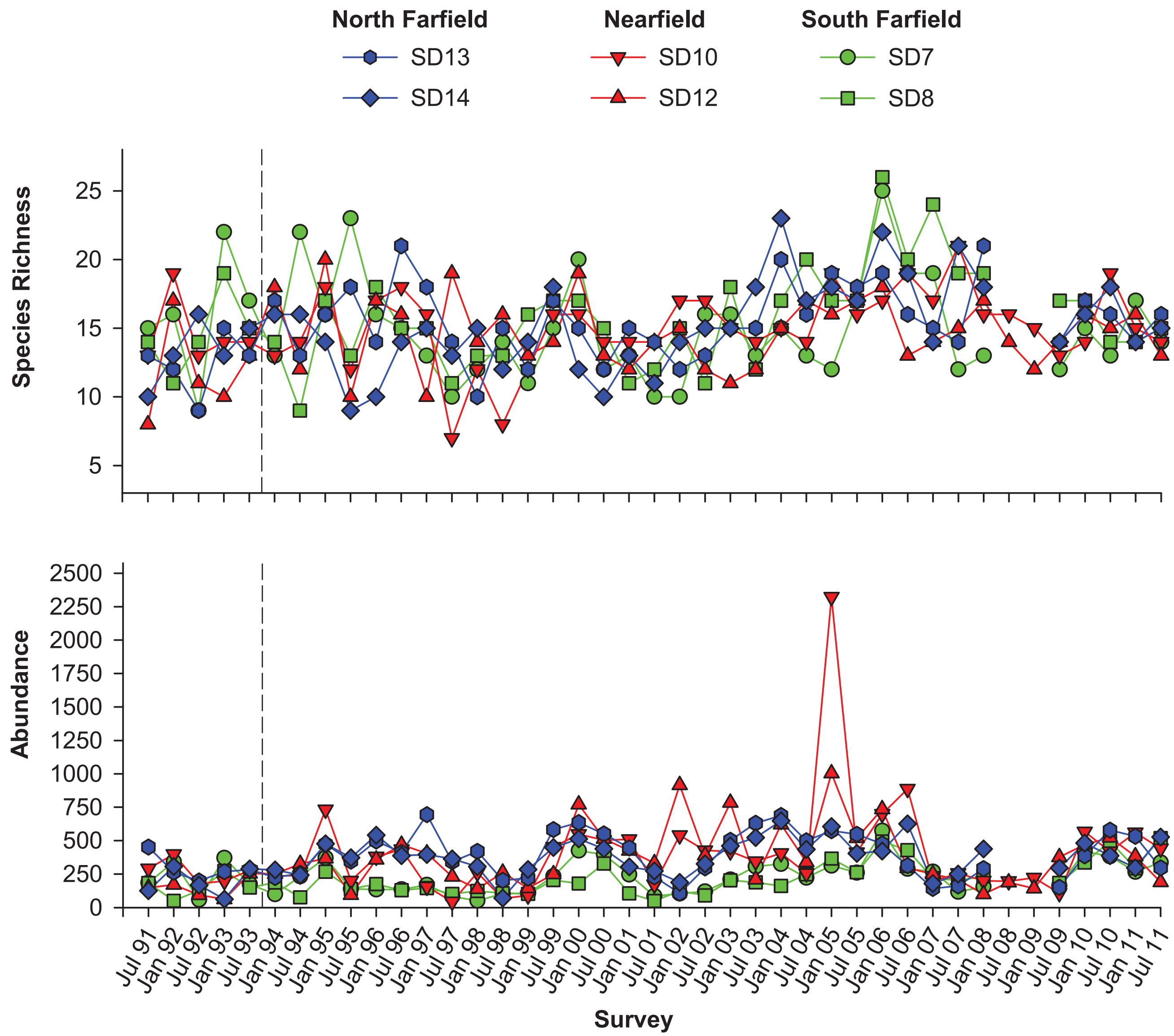

Figure 6.2

Species richness and abundance of demersal fishes collected at each PLOO trawl station between 1991–2011. Data are total number of species and total number of individuals per haul, respectively. Dashed lines indicate onset of wastewater discharge. Only stations SD10 and SD12 were sampled during July 2008 and January 2009 due to a Bight'08 resource exchange.

communities in the region differed significantly by site and by year (Appendix E.4). However, the distribution of assemblages in 2011 was generally similar to that seen in previous years, especially between 2006–2010, and there were no discernible patterns associated with proximity to the outfall. Instead, most differences appear more closely related to large-scale oceanographic events (e.g., El Niño in 1998) or the unique characteristics of a specific station location. For example, stations SD7 and SD8 located south of the outfall often grouped apart from the remaining stations. These assemblages (cluster groups A–J) were distinguished by differences in the relative abundances of the common species present, although most were dominated by Pacific sanddabs. The composition and main characteristics of each cluster group are described below.

Cluster groups A, B and E each comprised a single trawl outlier (Figure 6.4). Together, they accounted for ~3% of all hauls included in the analysis. Although most of these catches were

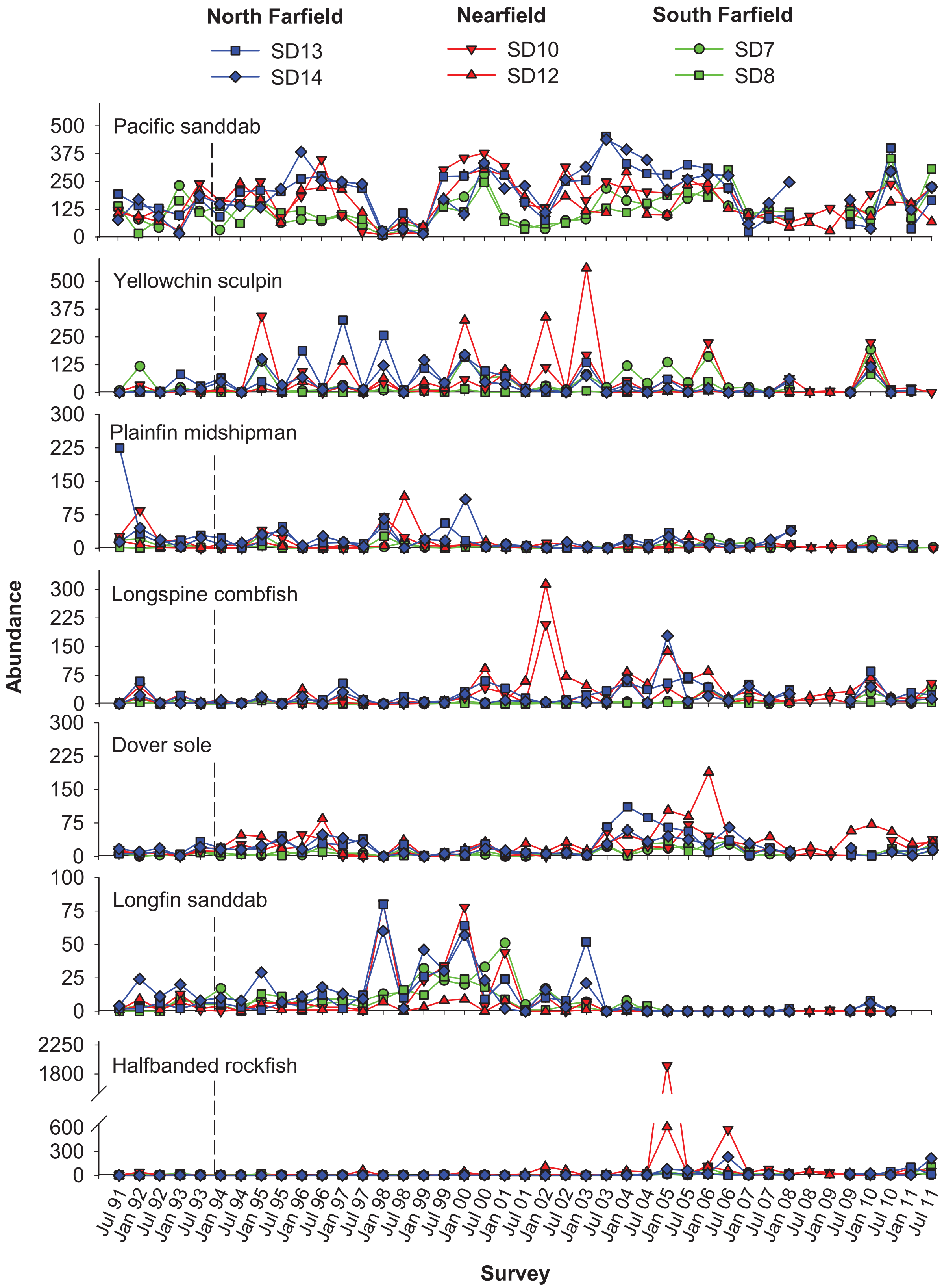

Figure 6.3

The seven most abundant fish species collected in the PLOO region between 1991–2011. Data are total number of individuals per haul. Dashed lines indicate onset of wastewater discharge. Only stations SD10 and SD12 were sampled during July 2008 and January 2009 due to a Bight'08 resource exchange.

dominated by Pacific sanddabs, they were unique compared to the other assemblages in terms of either low mean abundance, fewer species, or relatively high numbers of less common fishes (e.g., midshipman, rockfish) (Table 6.3). The assemblage at station SD10 in 1997 (group A) was characterized by the fewest species and lowest abundance of any cluster group (i.e., 7 species, 44 fishes), as well as the fewest Pacific sanddabs. The assemblage at SD12 in 1998 (group B) was unique because it contained high numbers of plainfin midshipman (116 individuals). The assemblage at SD12 in 1997 (group E) had the highest species richness of any cluster group, and relatively high numbers of halfbanded rockfish (60 individuals) and squarespot rockfish (23 individuals).

Cluster groups C, G and H comprised 4, 3 and 6 outlier trawls, respectively (Figure 6.4). Combined, these groups accounted for ~11% of all hauls included in the analysis. Group C occurred at the following stations: (a) station SD8 in 1994, (b) station SD14 in 1998, and (c) stations SD7 and SD8 in 2001. This group had the second lowest mean abundance (~71 fishes per haul) and species richness (~11 species per haul) of any cluster group (Table 6.3). SIMPER revealed that relative abundances of Pacific sanddabs (~47 individuals per haul), longfin sanddab (~2 individuals per haul), Dover sole (~3 individuals per haul), and greenblotched rockfish (~1 individual per haul) were characteristic of the assemblages represented by this group. Group G occurred during 1999 at stations SD10, SD13, and SD14. This group had the most species on average (~17 species per haul), the highest mean abundance (~495 fishes per haul), and was characterized by relative abundances of Pacific sanddabs (~248 individuals per haul), stripetail rockfish (~102 individuals per haul), longfin sanddab (~32 individuals per haul), yellowchin sculpin (~31 individuals per haul), and plainfin midshipman (~26 individuals per haul). Group H occurred at stations SD7 in 2003–05, SD8 in 1991–92, and SD10 in 2001, and was characterized by relative abundances of Pacific sanddab (~150 individuals per haul), yellowchin sculpin (~20 individuals per haul), Dover sole (~15 individuals per haul), shortspine combfish (~5 individuals per haul), and plainfin midshipman (~2 individuals per haul).

Cluster group D comprised 30 trawls, including 18 of 24 hauls from stations SD7 and SD8 sampled between 1991–2002, as well as hauls from: (a) every station sampled during 1991–1992 except SD8, (b) stations SD10 and SD12 sampled in 1995, (c) station SD10 sampled in 1998, and (d) station SD7 sampled in 2007 (Figure 6.4). Overall, this group averaged 13 species per haul and ~162 fishes per haul (Table 6.3). SIMPER revealed that relative abundances of Pacific sanddab (~97 individuals per haul), plainfin midshipman (~15 individuals per haul), Dover sole (~10 individuals per haul), longfin sanddab (~7 individuals per haul), and California tonguefish were characteristic of the assemblages represented by this group.

Cluster group F included 97% of the trawls conducted in the PLOO region over the past six years (Figure 6.4). It also included two hauls from SD12 sampled in 2003 and 2004 and three from SD8 sampled between 2003 and 2005. Assemblages represented by group F were characterized by ~16 species per haul, ~332 fishes per haul, and the relative abundances of Pacific sanddabs (~175 individuals per haul), halfbanded rockfish (~49 individuals per haul), Dover sole (~24 individuals per haul), longspine combfish (~13 individuals per haul), and shortspine combfish (~10 individuals per haul) (Table 6.3).

Cluster groups I and J represented most assemblages sampled at stations around or north of the PLOO between 1993 and 2005 (i.e., stations SD10-SD14). Exceptions included some of the outliers described above (i.e., all or parts of groups A, B, C, E, G) that occurred around the time of the 1998 El Niño. Group I averaged 14 species and 307 fishes per haul, and was characterized by relative abundances of Pacific sanddab (~215 individuals per haul), Dover sole (~23 individuals per haul), yellowchin sculpin (~15 individuals per haul), stripetail rockfish (~10 individuals per haul), and longfin

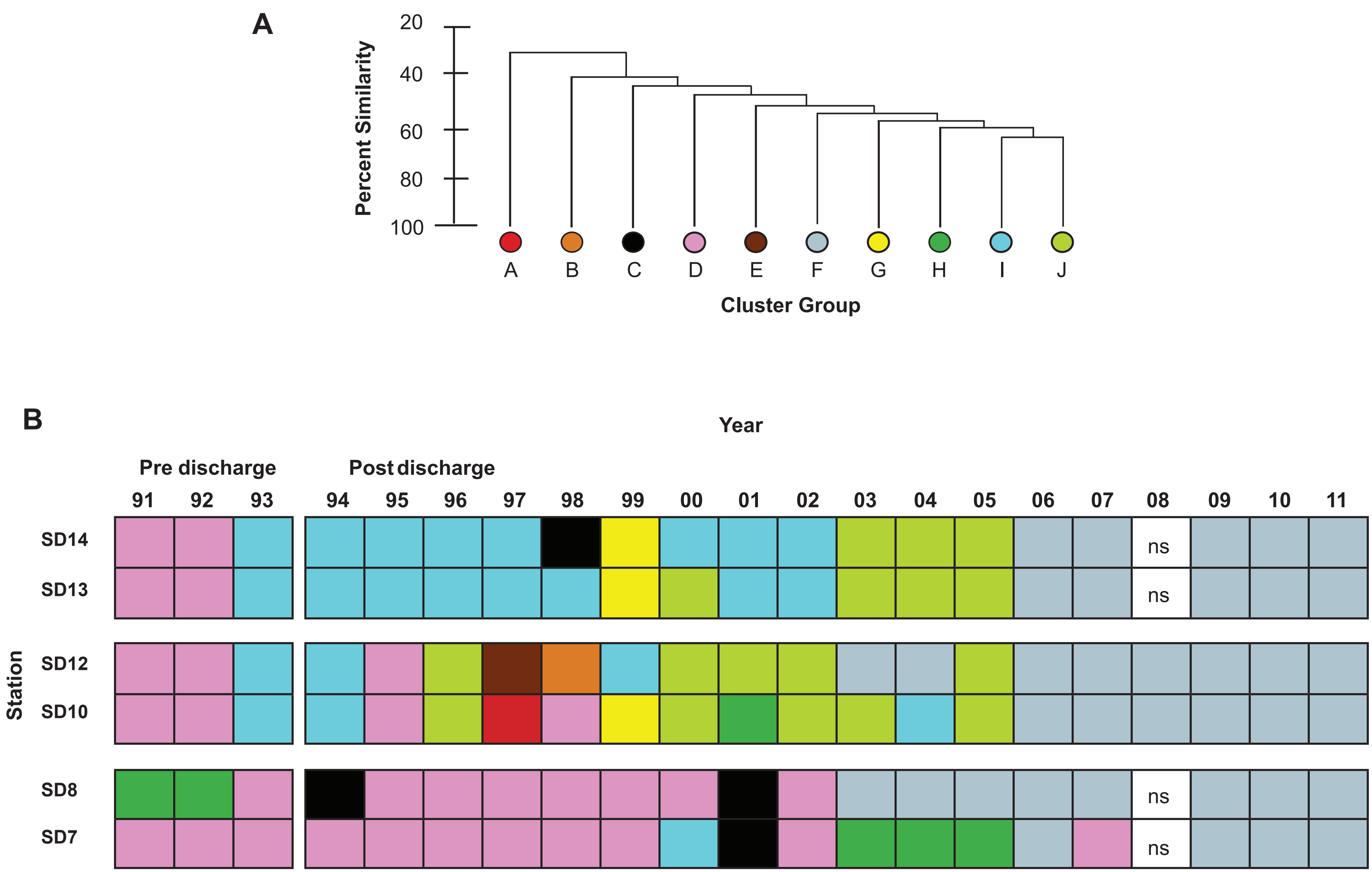

Figure 6.4
Results of cluster analysis of demersal fish assemblages at PLOO trawl stations between 1991 and 2011 (summer surveys only). Data are presented as (A) a dendrogram of major cluster groups and (B) a matrix showing distribution of cluster groups over time.

Table 6.3

Description of demersal fish 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 top five most abundant species. Bold values indicate species that were considered most characteristic of that group according to SIMPER analysis.

	Cluster Groups									
	A[a]	B[a]	C	D	E[a]	F	G	H	I	J
Number of Hauls	1	1	4	30	1	36	3	6	23	17
Mean Species Richness	7	16	11	13	19	16	17	14	14	16
Mean Abundance	44	261	71	162	231	332	495	213	307	467
Species	**Mean Abundance**									
Pacific sanddab	23	75	**47**	**97**	110	**175**	**248**	**150**	**215**	**301**
Halfbanded rockfish	16			2	60	**49**	7	3	1	**16**
Longfin sanddab	1		**2**	**7**		<1	**32**		**8**	1
Pink seaperch	1	4	1	1	1	4	4	2	6	4
Spotfin sculpin	1		1	2		1				1
Gulf sanddab	1	5	1	<1			10	<1	<1	<1
Greenspotted rockfish	1			<1	1	<1	<1		1	<1
Stripetail rockfish		1	4	8	5	7	**102**	<1	**10**	6
Dover sole		36	**3**	**10**	1	**24**	5	**15**	**23**	**48**
Yellowchin sculpin			3	4		2	**31**	**20**	**15**	**16**
Longspine combfish		7	**2**	1	2	**13**	5	3	5	**33**
Greenblotched rockfish			**1**	1	8	<1	1	2	1	1
Plainfin midshipman		116	1	**15**	4	4	**26**	**2**	11	6
California lizardfish			1	<1		21	6			
California tonguefish			1	**3**	1	1	3	2	<1	1
Greenstriped rockfish			1	<1		3	<1	1	<1	1
Squarespot rockfish			<1	<1	23	1				
Slender sole		2	<1	1		5	6	1	2	12
Shortspine combfish				2	3	**10**		**5**	<1	4
Vermilion rockfish					6					

[a] SIMPER analyses only conducted on cluster groups that contained more than one trawl.

sanddab (~8 individuals per haul). Group J averaged 16 species and 467 fishes per haul, and was characterized by relative abundances of Pacific sanddab (~301 individuals per haul), Dover sole (~48 individuals per haul), longspine combfish (~33 individuals per haul), yellowchin sculpin and halfbanded rockfish (both ~16 individuals per haul).

Physical Abnormalities and Parasitism

Demersal fish populations appeared healthy in the PLOO region during 2011. There were no incidences of fin rot, discoloration, or skin lesions among fishes collected during the year; however, tumors were observed on 4.1% of Dover sole (6 individuals) collected in July. Five of these individuals were taken at station SD8. Evidence of parasitism was also very low for trawl-caught fishes off Point Loma. The copepod *Phrixocephalus cincinnatus* infected <1.0% of the Pacific sanddabs collected during the year; this eye parasite was found on fish from all stations sampled except for SD8. Additionally, four individuals of the cymothoid isopod, *Elthusa vulgaris*, were identified as part of the trawl catch during the year (see Appendix E.5). Since cymothoids often become detached from

Table 6.4
Species of megabenthic invertebrates collected in 12 trawls conducted in the PLOO region during 2011. PA=percent abundance; FO=frequency of occurrence; MAH=mean abundance per haul; MAO=mean abundance per occurrence.

Species	PA	FO	MAH	MAO	Species	PA	FO	MAH	MAO
Lytechinus pictus	85	100	949	949	*Ophiopholis bakeri*	< 1	17	< 1	3
Strongylocentrotus fragilis	6	42	65	155	*Arctonoe pulchra*	< 1	8	< 1	4
Ophiura luetkenii	5	100	54	54	*Elthusa vulgaris*	< 1	25	< 1	1
Luidia foliolata	1	100	13	13	*Calliostoma tricolor*	< 1	8	< 1	3
Acanthoptilum sp	< 1	42	6	14	*Cancellaria crawfordiana*	< 1	25	< 1	1
Pleurobranchaea californica	< 1	100	5	5	*Calliostoma turbinum*	< 1	25	< 1	1
Luidia asthenosoma	< 1	83	3	4	*Antiplanes catalinae*	< 1	8	< 1	3
Astropecten californicus	< 1	92	3	3	*Paguristes bakeri*	< 1	17	< 1	1
Parastichopus californicus	< 1	75	2	3	*Rossia pacifica*	< 1	17	< 1	1
Thesea sp B	< 1	50	2	4	*Metridium farcimen*	< 1	17	< 1	1
Philine auriformis	< 1	58	1	2	*Cancellaria cooperii*	< 1	8	< 1	1
Neosimnia barbarensis	< 1	25	1	5	*Tritonia diomedea*	< 1	8	< 1	1
Nymphon pixellae	< 1	17	1	7	*Amphiodia* sp	< 1	8	< 1	1
Octopus rubescens	< 1	50	< 1	2	*Amphichondrius granulatus*	< 1	8	< 1	1
Acanthodoris brunnea	< 1	25	< 1	3	*Parapagurodes laurentae*	< 1	8	< 1	1
Florometra serratissima	< 1	17	< 1	5	*Podochela lobifrons*	< 1	8	< 1	1
Sicyonia ingentis	< 1	42	< 1	2	*Barbarofusus barbarensis*	< 1	8	< 1	1
Philine alba	< 1	17	< 1	4	*Leptogorgia chilensis*	< 1	8	< 1	1
Hinea insculpta	< 1	33	< 1	2	*Dendronotus frondosus*	< 1	8	< 1	1
Crangon alaskensis	< 1	25	< 1	2	*Telesto californica*	< 1	8	< 1	1
Megasurcula carpenteriana	< 1	17	< 1	3	*Suberites latus*	< 1	8	< 1	1
Armina californica	< 1	17	< 1	3					

their hosts during retrieval and sorting of the trawl catch, it is unknown which fishes were actually parasitized by these isopods. However, *E. vulgaris* is known to be especially common on sanddabs and California lizardfish in southern California waters, where it may reach infestation rates of 3% and 80%, respectively (see Brusca 1978, 1981).

Megabenthic Invertebrate Communities

A total of 13,378 megabenthic invertebrates (~1115 per trawl) representing 43 taxa were collected in 2011, with no new species recorded (Table 6.4, Appendix E.5). The sea urchin *Lytechinus pictus* was the most abundant and most frequently captured species (~949 individuals per haul), accounting for 85% of the total invertebrate abundance and occurring in 100% of the trawls. The brittle star *Ophiura luetkenii*, the sea star *Luidia foliolata*, and the nudibranch *Pleurobranchaea californica* were also collected in every haul, but in much lower numbers (≤54 individuals per haul). Other species collected frequently (≥50% of the trawls) but in relatively low numbers (≤3 per haul) included the sea stars *Astropecten californicus* and *Luidia asthenosoma*, the octocoral *Thesea* sp. B, the sea cucumber *Parastichopus californicus,* the gastropod *Philine auriformis*, and the octopus *Octopus rubescens*.

Megabenthic invertebrate community structure varied among stations and between surveys during the year (Table 6.5). For each haul, species richness ranged from 10 to 22 species, diversity (H') ranged from 0.2 to 1.3 units, and total abundance ranged from 279 to 2107 individuals. Patterns in total invertebrate abundance mirrored variation in populations of *Lytechinus pictus* because of its overwhelming dominance at all but

Table 6.5
Summary of megabenthic invertebrate community parameters for PLOO trawl stations sampled during 2011. Data are included for species richness, abundance, and diversity (H'). SD = standard deviation.

Station	January	July
Species Richness		
SD7	15	22
SD8	14	14
SD10	13	12
SD12	18	13
SD13	12	12
SD14	11	10
Survey Mean	14	14
Survey SD	2	4
Abundance		
SD7	1494	2107
SD8	1250	1858
SD10	1307	1878
SD12	1006	279
SD13	447	538
SD14	572	642
Survey Mean	1013	1217
Survey SD	422	814
Diversity		
SD7	0.2	0.4
SD8	0.3	0.3
SD10	0.3	0.2
SD12	0.6	1.1
SD13	1.2	1.3
SD14	1.3	1.2
Survey Mean	0.6	0.7
Survey SD	0.5	0.5

one station (Appendix E.6). For example, in July, stations SD7, SD8 and SD10 had much higher invertebrate abundances than the other three stations due to relatively large catches of *L. pictus* (i.e., ≥1700 per haul versus ≤300 per haul). Similarly, low diversity values (≤1.3) for the region were caused by the numerical dominance of this single species.

Variations in megabenthic invertebrate community structure in the Point Loma outfall region generally reflect changes in species abundance (Figures 6.5, 6.6). Both species richness and total abundance have varied over the years (e.g., 3–29 species per trawl, 16–11,177 individuals per haul). These large differences typically have been due to fluctuations in populations of several dominant species, including the sea urchins *Lytechinus pictus* and *Strongylocentrotus fragilis*, the sea pen *Acanthoptilum* sp, the shrimp *Sicyonia ingentis*, and the sea star *Astropectin californicus*. For example, stations SD8 and SD10 have among the highest average abundances of invertebrates since 1991 due to relatively large hauls of *L. pictus*. Additionally, abundances of *L. pictus* and *A. californicus* are typically much lower at the two northern sites, which likely reflects differences in sediment composition (e.g., fine sands versus mixed coarse per fine sediments, see Chapter 4). None of the observed variability in the trawl-caught invertebrate communities appears to be related to the Point Loma outfall.

Discussion

Pacific sanddabs dominated fish assemblages surrounding the PLOO in 2011 as they have since monitoring began in 1991. This species occurred at all stations and accounted for 40% of the total catch. Other commonly captured, but less abundant species, included California lizardfish, stripetail rockfish, longspine combfish, shortspine combfish, Dover sole, English sole, halfbanded rockfish, pink seaperch, greenstriped rockfish, California tonguefish, plainfin midshipman, and hornyhead turbot. The majority these fishes tended to be relatively small with an average length ≤20 cm. Although the composition and structure of the fish assemblages varied among stations, these differences were mostly due to natural fluctuations of common fish populations.

Assemblages of megabenthic, trawl-caught invertebrates in the region were dominated by the sea urchin *Lytechinus pictus*, which occurred in all trawls and accounted for 85% of the total invertebrate abundance. Other species collected frequently included the brittle star *Ophiura luetkenii*, the sea stars *Luidia foliolata*, *L. asthenosoma*

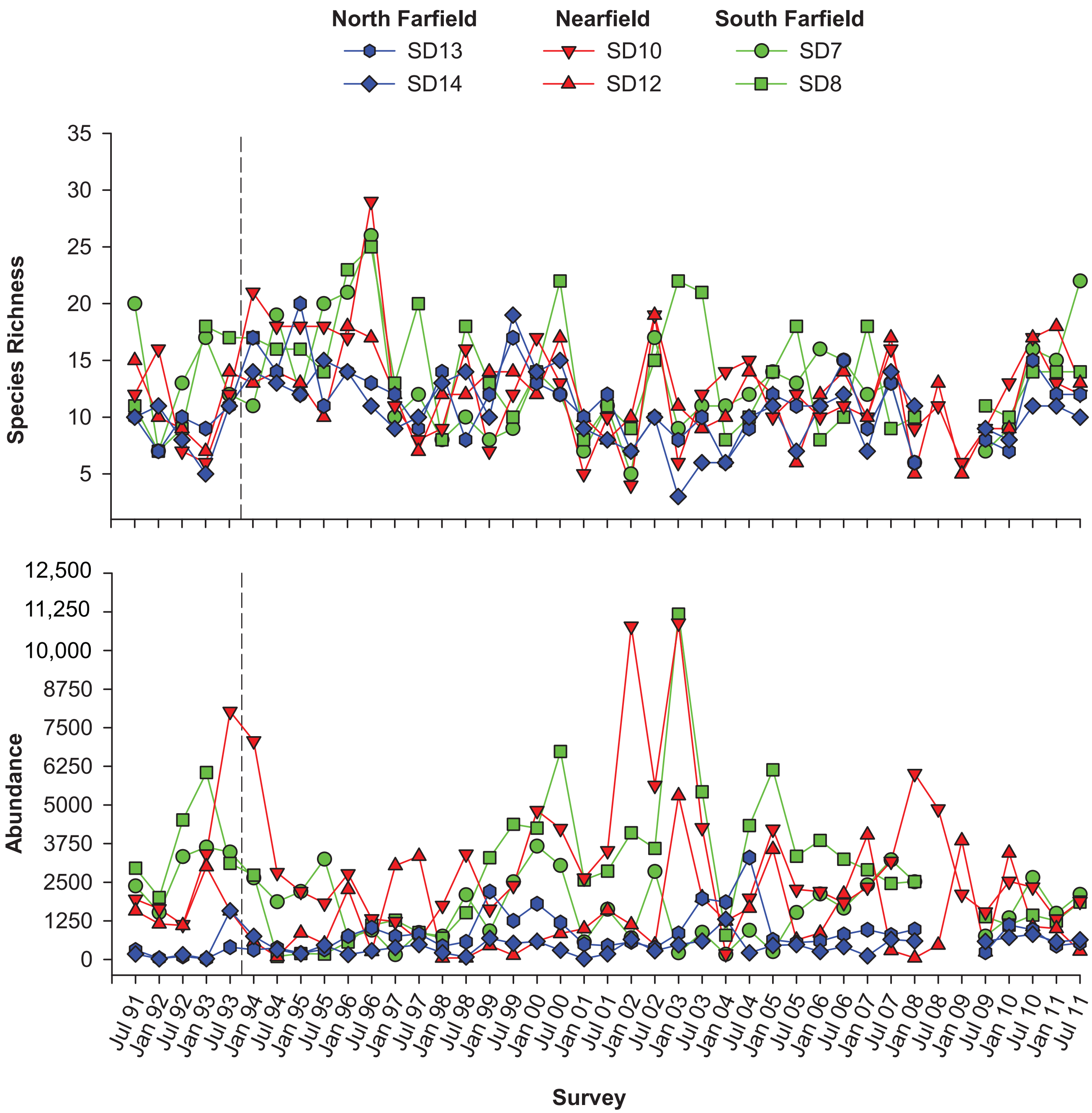

Figure 6.5
Species richness and abundance of megabenthic invertebrates collected at each trawl station between 1991–2011. Data are total number of species and total number of individuals per haul, respectively. Dashed lines indicate onset of wastewater discharge. Only stations SD10 and SD12 were sampled during July 2008 and January 2009 due to a Bight'08 resource exchange.

and *Astropecten californicus*, the nudibranch *Pleurobranchaea californica,* the octocoral *Thesea* sp. B, the sea cucumber *Parastichopus californicus,* the gastropod *Philine auriformis*, and the octopus *Octopus rubescens*. As with demersal fishes in the PLOO region, the composition and structure of megabenthic assemblages varied among stations, reflecting population fluctuations in the species mentioned above.

Overall, results of the 2011 trawl surveys provide no evidence that wastewater discharged through

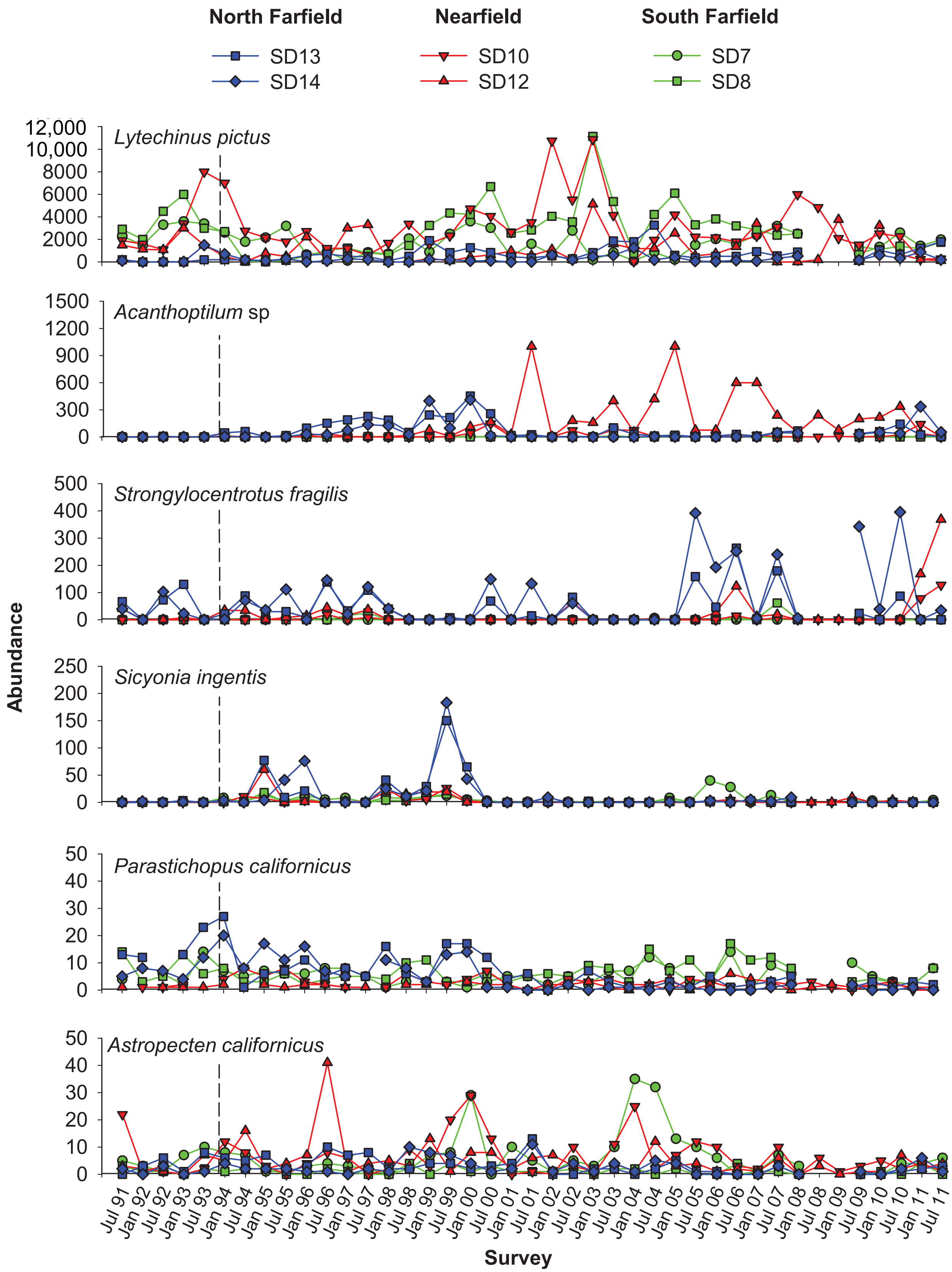

Figure 6.6

The six most abundant megabenthic invertebrate species collected in the PLOO region between 1991–2011. Data are total number of individuals per haul. Dashed lines indicate onset of wastewater discharge. Only stations SD10 and SD12 were sampled during July 2008 and January 2009 due to a Bight'08 resource exchange.

the PLOO has affected either demersal 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 farther away, with no discernible changes in the region following the onset of wastewater discharge through the PLOO in 1994. Instead, the high degree of variability present during the year was similar to that observed in previous years (e.g., City of San Diego 2005–2011), including the period before initiation of wastewater discharge (City of San Diego 2007b). Changes in these communities appear to be more likely due to natural factors such as changes in ocean water temperatures associated with large-scale oceanographic events (e.g., El Niño or La Niña) or to the mobile nature of many of the resident species collected. Finally, the absence of disease or other physical abnormalities in local fishes suggests that populations in the area continue to be healthy.

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