chapter 6

TRAWL COMMUNITIES AND ORGANISM HEALTH

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INTRODUCTION

The Orange County Sanitation District (District) Ocean Monitoring Program (OMP) samples the demersal (bottom-dwelling) fish and epibenthic macroinvertebrate (large invertebrates that live on the bottom) organisms to assess effects of the wastewater discharge on these communities and the health of the individual fish within the monitoring area (Figure 6-1). The District's National Pollutant Discharge Elimination System (NPDES) permit requires evaluation of these organisms to demonstrate that the biological community within the influence of the discharge is not degraded and that the outfall is not an epicenter of diseased fish (see box below). The monitoring area includes populations of commercially and recreationally important species, such as California halibut (*Paralichthys californicus*), California scorpionfish (*Scorpaena guttata*), and ridgeback rockshrimp (*Sicyonia ingentis*).

Past monitoring findings have shown that the wastewater outfall has two primary impacts to the biota of the receiving waters: reef and discharge effects (OCSD 2001, 2004). Reef effects are changes related to the habitat modification by the physical presence of the outfall structure and associated rock ballast. This structure provides a three dimensional hard substrate habitat that harbors a different suite of species than that found on the surrounding soft bottom. As a result, the area near the outfall pipe can have greater species diversity.

Compliance criteria pertaining to trawl communities and organism health contained in the District's NPDES Ocean Discharge Permit (Order No. R8-2004-0062, Permit No. CAO110604).

Criteria		Description
C.5.a	Marine Communities	Marine communities, including vertebrates, invertebrates, and algae shall not be degraded.
C.5.b	Marine Resources	The natural taste, odor, and color of fish, shellfish, or other marine resources used for human consumption shall not be altered.
C.5.c	Human Health Concerns	The concentration of organic materials in fish, shellfish, or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.

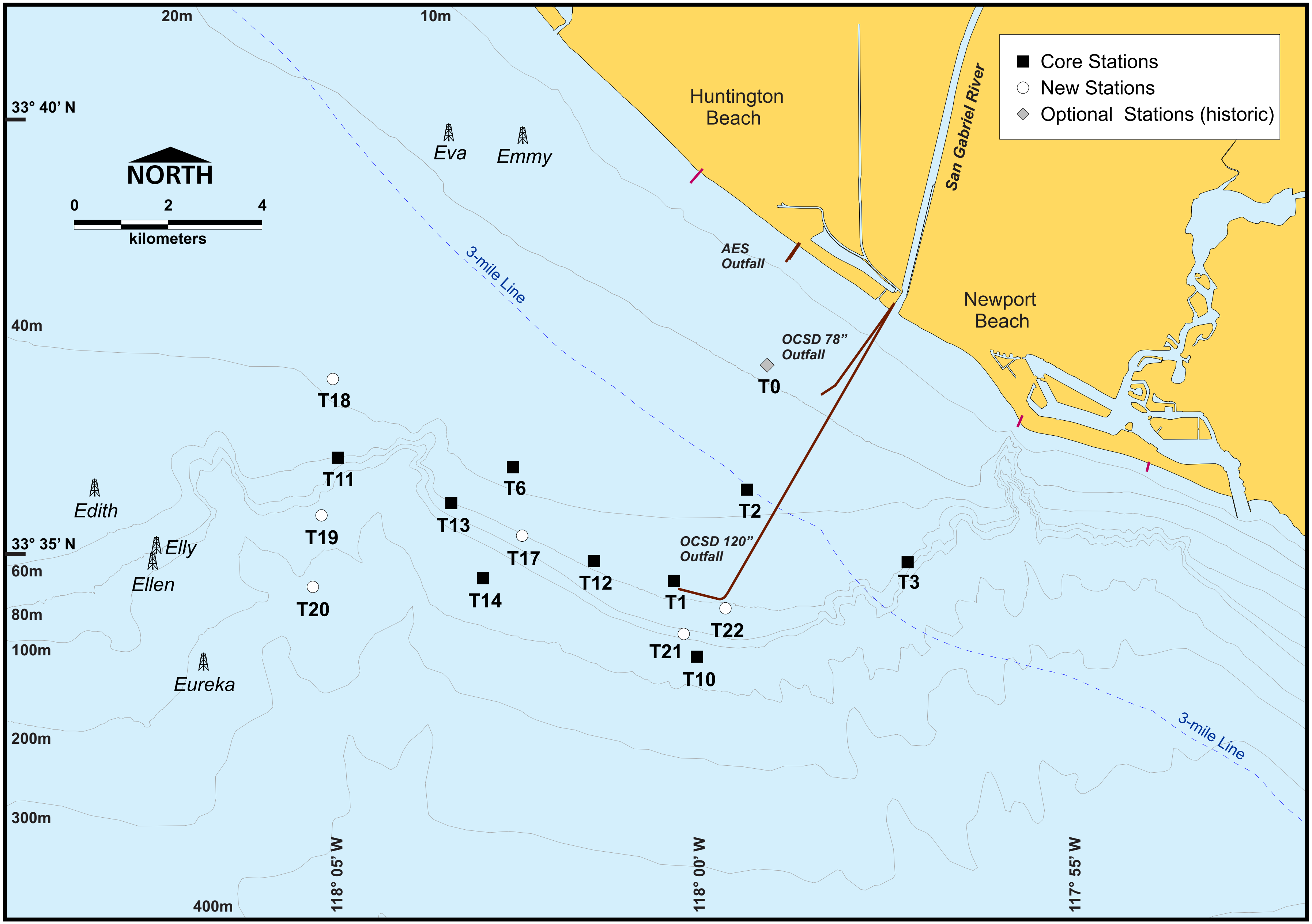

Figure 6-1. **Otter trawl stations for semi-annual surveys, 2011-12.**

Orange County Sanitation District, California.

Discharge effects are changes in water and sediment quality caused by the release of treated effluent. Organic effluent particles sink to the ocean bottom where they become available as a food resource for many invertebrate species. This year OCSD completed construction of full secondary treatment facilities for all effluent, thereby reducing the number of these particles significantly. However, if particles discharged in previous years, contain elevated contaminate loads, then the contaminants can continue to bioaccumulate in these invertebrates. Many demersal fish feed directly or indirectly on these invertebrates. Additionally, demersal fish live in close association with these sediments and consequently, have an increased probability of direct exposure to sediments containing discharged particles. This transfer of chemical contaminants through consumption and adsorption make demersal fish species particularly susceptible to physical abnormalities and disease (Johnson *et al.* 1992, 1993; Moore *et al.* 1997; Myers *et al.* 1993; Stehr *et al.* 1997, 1998).

These contaminants, especially lipid-soluble (lipophilic) compounds, such as chlorinated pesticides (e.g., DDT) and polychlorinated biphenyls (PCBs) that accumulate in organisms may be transferred up the food chain to other fish, mammals, and birds at concentrations several orders of magnitude higher than in surrounding sediments or water through the process of biomagnification. Whether bioaccumulated or biomagnified, high tissue contaminant concentrations may result in greater susceptibility to disease or reproductive impairment (Arkoosh *et al.* 1998).

To assess these issues, the District uses tissue contaminant data to evaluate the following aspects of permit compliance: 1) are there temporal and/or spatial patterns in the demersal fish and epibenthic macroinvertebrate communities relative to the ocean outfall; 2); are contaminant concentrations in fish muscle tissue sufficient to pose a potential human health concern and; 3) are the marine organisms in the monitoring area generally healthy?

METHODS

Field Methods

Demersal fish and epibenthic macroinvertebrates (EMI) species were collected in August 2011 and February 2012 using a 7.6 meter wide, Marinovich, semi-balloon otter trawl net fitted with a 0.64 cm cod-end mesh net. The net was towed on the ocean bottom for 450 m at approximately 2 knots along a pre-determined course. Sampling was conducted at 16 stations: shallow (18m) Station T0, inner shelf (36 m) Stations T2, T6, and T18; middle shelf (60 m) Stations T1, T3, T11, T12, T13, T17, and T22; outer shelf (137 m) Stations T10, T14, and T19; and deep station T20 (220 m) (Figure 6-1). One haul from each of these stations was collected. Six of these stations were new to the OCSD trawl program (T17, T18, T19, T20, T21, and T22). These six new stations were added as part of an ongoing ZID investigation, or as interim stations prior to the issuance of a new NPDES permit that was finalized at the end of fiscal year 2011-12.

Trawl caught specimens were identified to the lowest possible taxon, typically to species. A minimum of 30 individuals of each fish species were measured individually to the nearest millimeter and weighed to the nearest gram. Fish in excess of 30 individuals were enumerated in 1-cm size classes and batch weighed. All fish specimens were examined for external tumors, other lesions, parasites, and skeletal deformations since gross external manifestations may indicate contaminated sediments (Murchelano 1982). The first 100 EMI of each species were also enumerated and weighed to the nearest gram. Species with abundance greater than 100 individuals were weighed in batches and abundance calculated based on the weight/abundance ratio. Fish and EMI specimens that could not be identified in the field were retained for further identification, weighed, and measured in the laboratory.

Fish from two target species were retained for tissue chemistry (bioaccumulation) analysis. These were: hornyhead turbot (*Pleuronichthys verticalis*) and English sole (*Parophrys vetulus*). The sampling objective was to collect 10 individuals of the two target species at both outfall (T1/T12) and farfield (T11/T13) station group sites for analysis of muscle and liver contaminant concentrations. The analytes include mercury, total DDT (tDDT; the sum of 7 DDT isomers), total PCB (tPCB; the sum of 45 PCB congeners), and 12 other chlorinated pesticides. Organic analyte data was lipid normalized to reduce within sample variability; organics concentrate in lipid tissue and lipid tissue concentrations vary considerably between fish. A complete list of analytes tested is presented in Appendix A.

Data Analyses

Fish and EMI populations were summarized for total abundance, total number of species, percent abundance, and frequency of occurrence. In addition, abundance per haul, biomass, number of species, and diversity indices including Shannon-Wiener (H'), Margalef's Species Richness (d), and Swartz's 75% Dominance Index (SDI) were calculated for both fish and EMI. Dominance (the minimum number of species accounting for 75% of abundance) is inversely proportional to numerical dominance, such that low index values indicate high dominance (i.e., communities are dominated by a few species).

PRIMER v6 (2001) multivariate statistical software was used to examine the spatial patterns of the fish assemblages in the District's monitoring area (Clarke 1993, Warwick 1993). Analysis consisted of hierarchical clustering with group-average linking based on Bray-Curtis similarity indices. Data were totaled by station and truncated to include only the middle shelf (60 m) stations since depth is a strong environmental factor in delineating species clusters (OCSD 2004, 2011). Clarke and Warwick (2001) warn that clustering is less useful and may be misleading where there is strong environmental forcing, such as depth. Prior to the calculation of the Bray-Curtis indices, the data were square-root transformed in order to down-weight the highly abundant species and incorporate the importance of the less common species (Clarke and Warwick 2001). The SIMPER ("similarity percentages") routine was also used to determine inter- and intra-group species differences.

Community measures from Station T1 and Station T11 were evaluated for long-term temporal and spatial patterns, and compared with regional reference values from the 1994 Southern California Bight Pilot Project (SCBPP), Bight'98, Bight'03, and Bight'08 regional monitoring programs (Allen *et al*. 1998, 2002, 2007).

Fish biointegrity was assessed using the fish response index (FRI). The Fish Response Index is a biointegrity index developed by Allen *et al.* (2001). The index was developed using the abundances of all species relative to the pollution gradient away from the Palos Verdes shelf during the 1970s. Allen *et al*. (2001) noted that the FRI was an effective surrogate of fish community assemblages, especially in the middle shelf zone of the SCB.

FRI scores less than 45 are classified as reference (normal) and those greater than 45 are non-reference (abnormal or disturbed). The FRI was calculated for all sixteen stations in 2011-12. For a historical perspective, FRI was calculated from 1985 to 2012 for Stations T1 and T11.

In order to evaluate human health risks from eating fish caught near the outfall, the muscle tissue concentrations of hornyhead turbot and English sole were compared to state and federal human consumption guidelines. Liver concentrations from these two species were used to evaluate the potential of various chemicals to bioaccumulate and biomagnify. These data, except mercury, were lipid-normalized prior to the calculation of summary statistics. Non-detected analytes were treated as a zero value for summed constituents (e.g. total DDT) and as one-half the detection limit for single constituents, such as mercury. While enumerated during each survey, external parasites and other abnormalities in fish are not prevalent either regionally or in the District's monitoring area.

RESULTS AND DISCUSSION

Fish Community

Abundance

A total of 16,663 fish were collected in 2011-12 (Tables 6-1, 6-2 and B-13). Pacific sanddab (*Citharichthys sordidus; 36%*), yellowchin sculpin (*Icelinus quadriseriatus; 13%*) California lizardfish (*Synodus lucioceps; 7%*), Longspine combfish (*Zaniolepis latipinnis; 7%*) and Slender sole (*Lyopsetta exilis; 6%*) were the most abundant fish collected, representing 69% of the total catch. Of the 26 families represented, six families Paralichthidae (sand flounders), Pleuronectidae (right-eye flounders), Cottidae (sculpins), Hexagrammidae (greenlings), Synodontidae (Lizardfish), and (Scorpaenidae (scorpionfishes) accounted for 58% of the species and 91% of the total abundance (Tables 6-2 and B-13).

Fish abundance has historically been highly variable, although some patterns are consistent (see OCSD 2011 Figure 6-2). Generally, the shallow stations have the lowest abundances, while the deep and farfield downcoast stations have the highest. Abundance patterns in 2011-12 were generally consistent with previous years. Two new stations T21 (90 m) and T22 (60 m) had abundances well below what would be expected at these stations and even lower than the shallow (37 m) stations. Since these stations have not been sampled before it is not known if these low abundances are normal for these sites.

Biomass

A total of 434 kg of fish was collected in 2011-12, with Pacific sanddabs accounting for 37% of the fish biomass. As with abundance, biomass data were highly variable (ranging from 4 to 32 kg per haul) due to population fluctuations of dominant species and variability in the size of individuals collected. Mean biomass per survey was greater in summer than winter due to large catches of Pacific sanddabs at T1, T3, T10, T11, and T14 (Figure 6-2 and Table B-14).

Increased fish biomass in the outfall area may be due to both a reef effect as well as a discharge effect (Diener et al 1997). Artificial reefs, such as the outfall structure, enhance habitat diversity and support higher fish biomass. The wastewater discharge contains

Table 6-1. Summary of demersal fish species collected during the summer (August 2011) and winter (February 2012) surveys. Data for each species are expressed as total abundance (Total), percent abundance (%A), percent frequency of occurrence (%FO), and mean abundance per haul (MAH).

Orange County Sanitation District, California.

Common name	Scientific name	Total	%A	%FO	MAH
Pacific sanddab	*Citharichthys sordidus*	6,030	36	94	116
yellowchin sculpin	*Icelinus quadriseriatus*	2,156	13	81	41
California lizardfish	*Synodus lucioceps*	1,214	7	94	23
longspine combfish	*Zaniolepis latipinnis*	1,107	7	94	21
slender sole	*Lyopsetta exilis*	1,035	6	31	20
English sole	*Parophrys vetulus*	654	4	94	13
Dover sole	*Microstomus pacificus*	581	3	69	11
stripetail rockfish	*Sebastes saxicola*	564	3	69	11
California tonguefish	*Symphurus atricaudus*	404	2	81	8
speckled sanddab	*Citharichthys stigmaeus*	365	2	31	7
longfin sanddab	*Citharichthys xanthostigma*	318	2	56	6
blackbelly eelpout	*Lycodes pacificus*	299	2	31	6
pink seaperch	*Zalembius rosaceus*	283	2	69	5
shortspine combfish	*Zaniolepis frenata*	228	1	50	4
hornyhead turbot	*Pleuronichthys verticalis*	224	1	81	4
roughback sculpin	*Chitonotus pugetensis*	223	1	81	4
halfbanded rockfish	*Sebastes semicinctus*	210	1	56	4
plainfin midshipman	*Porichthys notatus*	143	1	63	3
bigmouth sole	*Hippoglossina stomata*	110	1	88	2
rex sole	*Glyptocephalus zachirus*	77	< 1	25	1
pygmy poacher	*Odontopyxis trispinosa*	68	< 1	63	1
Pacific argentine	*Argentina sialis*	41	< 1	19	1
splitnose rockfish	*Sebastes diploproa*	39	< 1	6	1
fantail sole	*Xystreurys liolepis*	37	< 1	50	1
bearded eelpout	*Lyconema barbatum*	35	< 1	13	1
hundred-fathom codling	*Physiculus rastrelliger*	34	< 1	19	1
California scorpionfish	*Scorpaena guttata*	33	< 1	50	1
spotted cuskeel	*Chilara taylori*	29	< 1	44	1
greenstriped rockfish	*Sebastes elongatus*	21	< 1	19	< 1
California skate	*Raja inornata*	16	< 1	63	< 1
Pacific hake	*Merluccius productus*	13	< 1	6	< 1
calico rockfish	*Sebastes dallii*	13	< 1	25	< 1
southern spearnose poacher	*Agonopsis sterletus*	11	< 1	25	< 1
curlfin sole	*Pleuronichthys decurrens*	8	< 1	19	< 1

Table 6-1 continues.

Table 6-1 Continued.

Common name	Scientific name	Total	%A	%FO	MAH
greenblotched rockfish	*Sebastes rosenblatti*	6	< 1	13	< 1
blacksmith	*Chromis punctipinnis*	5	< 1	6	< 1
white croaker	*Genyonemus lineatus*	5	< 1	6	< 1
swell shark	*Cephaloscyllium ventriosum*	3	< 1	6	< 1
sanddab genus (UI)	*Citharichthys* sp	3	< 1	6	< 1
petrale sole	*Eopsetta jordani*	3	< 1	13	< 1
lingcod	*Ophiodon elongatus*	3	< 1	19	< 1
cowcod	*Sebastes levis*	2	< 1	13	< 1
sablefish	*Anoplopoma fimbria*	1	< 1	6	< 1
red brotula	*Brosmophycis marginata*	1	< 1	6	< 1
smooth stargazer	*Kathetostoma averruncus*	1	< 1	6	< 1
kelp bass	*Paralabrax clathratus*	1	< 1	6	< 1
bluebarred prickleback	*Plectobranchus evides*	1	< 1	6	< 1
spotted turbot	*Pleuronichthys ritteri*	1	< 1	6	< 1
blackeye goby	*Rhinogobiops nicholsii*	1	< 1	6	< 1
pink rockfish	*Sebastes eos*	1	< 1	6	< 1
vermillion rockfish	*Sebastes miniatus*	1	< 1	6	< 1
Pacific electric ray	*Torpedo californica*	1	< 1	6	< 1
	Total	**16,663**	**100**		
	Total no. of species	**52**			

n = 32 hauls
UI – Unidentified
* Unidentified species are not included in the total number of species calculation

Table 6-2. Summary of demersal fish species and abundance by family for the summer (August 2011) and winter (February 2012) surveys.

Orange County Sanitation District

Family	Number of Species		Family Abundance	
	Total	Percentage	Total	Percentage
Paralichthyidae (Sand Flounders)	6	12	6,863	41
Pleuronectidae (Righteye flounders)	8	15	2,583	16
Cottidae (Sculpins)	2	4	2,379	14
Hexagrammidae (Greenlings)	3	6	1,338	8
Synodontidae (Lizardfish)	1	2	1,214	7
Scorpaenidae (Scorpionfishes)	10	19	890	5
Soleidae (Soles)	1	2	404	2
Zoarcidae (Eelpouts)	2	4	334	2
Embiotocidae (Surfperches)	1	2	283	2
Batrachoididae (Toadfishes)	1	2	143	1
Agonidae (Poachers)	2	4	79	< 1
Argentinidae (Argentines)	1	2	41	< 1
Moridae (Codlings)	1	2	34	< 1
Ophidiidae (Cusk-eels)	1	2	29	< 1
Rajidae (Skates)	1	2	16	< 1
Gadidae (Cods)	1	2	13	< 1
Sciaenidae (Drums)	1	2	5	< 1
Pomacentridae (Damselfishes)	1	2	5	< 1
Scyliorhinidae (Cat sharks)	1	2	3	< 1
Anoplopomatidae (sablefishes)	1	2	1	< 1
Bythitidae (viviparous brotulas)	1	2	1	< 1
Gobiidae (Gobies)	1	2	1	< 1
Serranidae (Sea basses and Groupers)	1	2	1	< 1
Stichaeidae (Pricklebacks)	1	2	1	< 1
Torpedinidae (torpedo electric rays)	1	2	1	< 1
Uranoscopidae (stargazers)	1	2	1	< 1
Total	52	100	16,663	100

Data for each family are ranked by number of species and abundance for all stations and surveys combined.

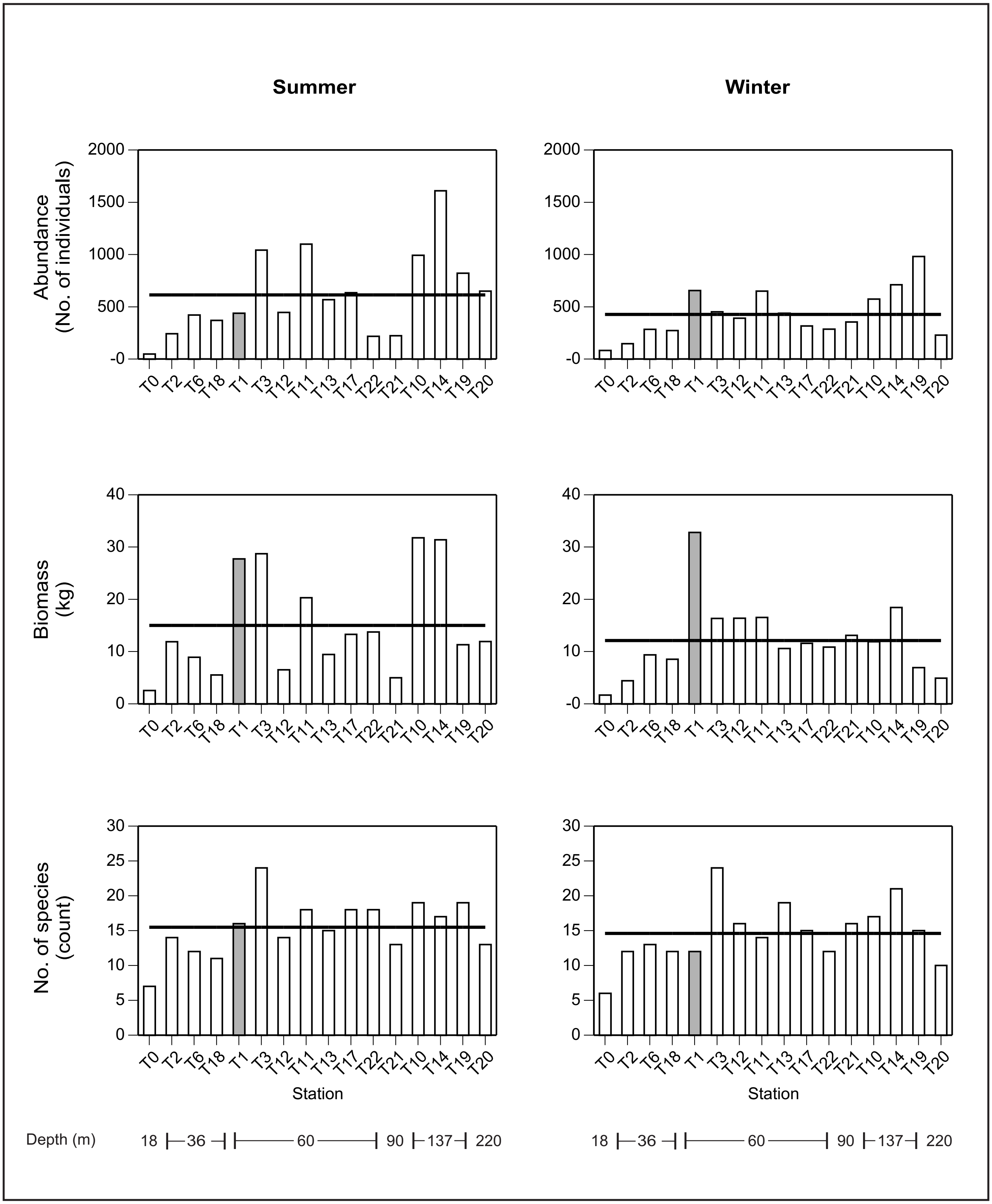

Figure 6-2. **Number of individuals (abundance), biomass, and number of species of demersal fish collected during the summer (August 2011) and winter (February 2012) surveys.**
Outfall Station T1 indicated in gray. Survey mean indicated by heavy line.

organic particles that serve as a direct or indirect food source, thereby, enhancing fish biomass. Invertebrates feed upon the increased concentrations of organic particles in the outfall area and fish, in turn, feed upon the abundant invertebrates. Over time, biomass has followed the same patterns as for abundance described above (see OCSD 2010 Figure 6-2). Since 2005, the abundance of polychaetes near the outfall has increased, despite lessened solids discharge due to increased treatment, while other types of infauna (e.g., crustaceans) have decreased. The fish community has responded to this with an increased number of polychaetivorous (worm eating) fish. This may be a factor in the increased fish biomass in 2010-11. The fish community at Station T1 clustered differently from the other outfall-depth stations. However, this year Station T1 clustered with all other 60 m station in winter indicating no significant difference from these other sites, suggesting a return to a normal fish community. For more information on the issue, see Ordination and Classification section below. The changes in infaunal communities near the outfall are discussed in Chapters 5 and 7.

Number of Species

A total of 52 fish species representing 26 families were collected in the District's study area in 2011-12 (Tables 6-1, 6-2, and B-13). The eight most frequently occurring species were the Pacific sanddab, California lizardfish, longspine combfish, English sole, hornyhead turbot, bigmouth sole, California tonguefish (*Symphurus atricaudus*), and roughback sculpin (*Chitonotus pugetensis*). None of these occurred at 100% of the stations, although the Pacific sanddab was only absent at Station T2 in summer and Station T20 in winter and the longspine combfish was only absent at Stations T19 and T20 in summer.

During 2011-12, the number of species per station ranged from 10 to 24 (Figure 6-2 and Table B-13). Differences between seasons were minimal. The three shallow stations T2, T6, and T18 and deep station T20 had the lowest number of species, and mid-shelf Station T3 had the highest. Station T1 had slightly more species than the mean in summer and slightly less than the mean in winter. Annual number of species by station group has been variable since 1985 and is depth-dependent (see OCSD 2010 Figure 6-3). Overall, the fewest number of species occur at the shallow station group, while the greatest numbers of species occur at the deep station group and farfield downcoast Station T3.

Diversity

There was no evidence of significant impact on species diversity near the outfall (Station T1) relative to the other stations (Figure 6-3). Shannon-Wiener diversity index values at Station T1 were comparable to the other 60-m stations. Shannon-Wiener diversity is based on the number of species and their relative abundances in a sample. Station T14 in summer had a very low Shannon-Wiener value because there were 1,374 Pacific sanddabs caught, while the next closest in abundance were stripetail rockfish at 53 individuals.

Margalef Species richness for Station T1 was near the survey means in both summer and winter, while station T3 was highest in both summer and winter. Station T3 is an ecotone station because it is on the edge of the Newport Canyon and the shelf, so it comprises both canyon and shelf species.

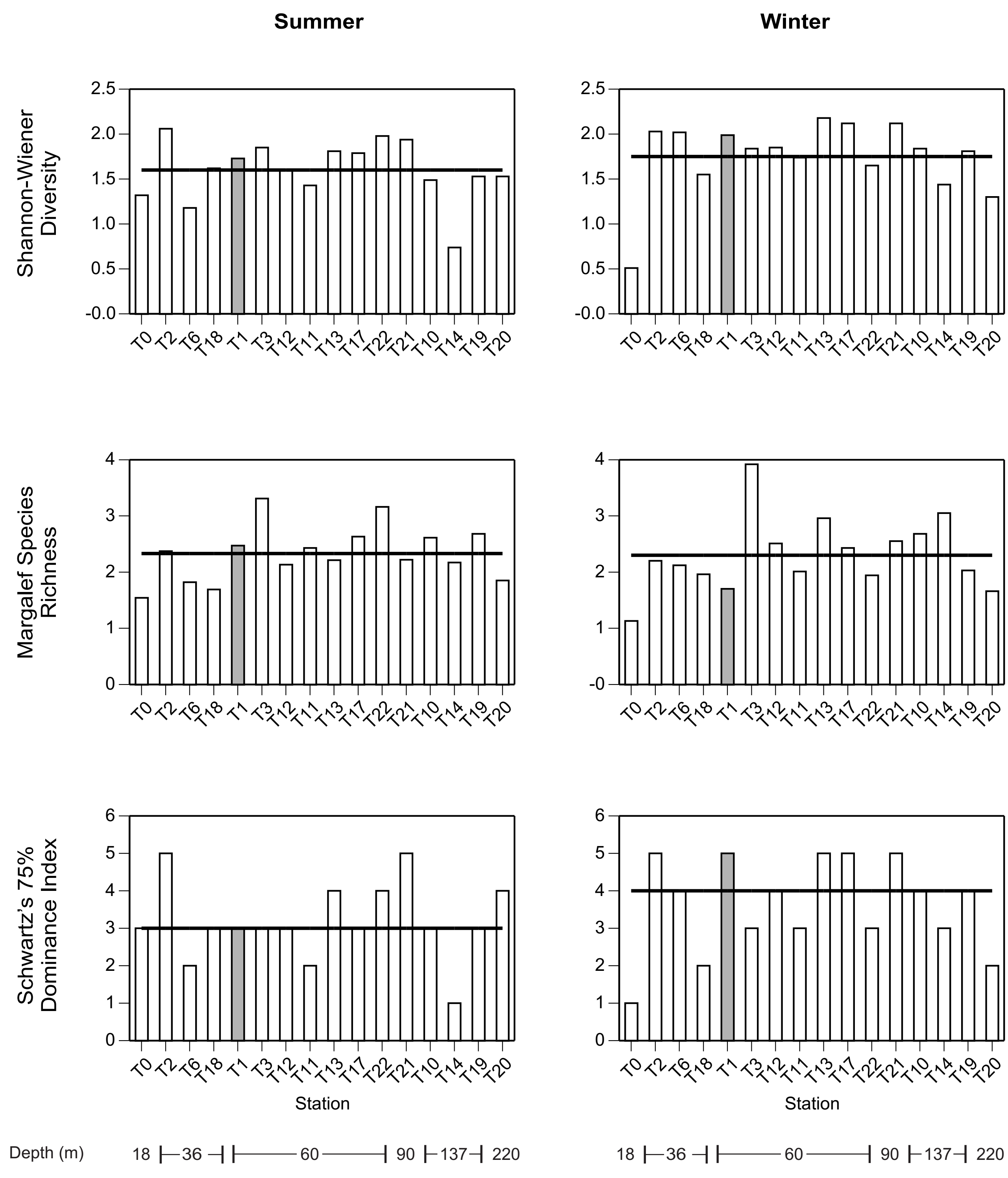

Figure 6-3. **Diversity indices values — Shannon-Wiener Diversity Index (H'), Margalef Species Richness (SR), and Schwartz's 75% Dominance Index of demersal fish collected during the summer (August 2011) and winter (February 2012) surveys.**
Outfall Station T1 indicated in gray. Survey mean indicated by heavy line.

Schwartz' 75% Dominance Index (SDI) is the minimum number of species comprising 75% of the total abundance in a given sample. Station T1 was average for summer and above average in winter for this analysis, indicating a normal demersal fish community was present.

Ordination and Classification

Ordination and classification analyses of 2011-12 trawl fish data at the 60 m stations resulted in five cluster groups with 60% similarity: A (T1 in summer and all stations in winter), B (T3 in summer), C (T22 in summer), D (T11 in summer), and E (T12, T13, and T17 in summer) (Figure 6-4). Single hauls were conducted at each station in summer and winter (n=2 hauls per station for 2011-12), except for Station T22 which was only sampled in summer. The composition of each station group and the species characteristics of each assemblage are described in Table 6-3. Figure 6-5 shows the mean abundance per station and survey over time for select dominant species from the 60m stations.

Table 6-3. Description of cluster groups (A, B, C, D, and E) defined in Figure 6-4. Data include number of hauls, species richness, mean total abundance, and mean abundance of the five most abundant species for each station group. Bold values indicate species that were considered "characteristic" of that group according to SIMPER analyses (i.e. similarity/standard deviation >2.0).

Orange County Sanitation District, California.

Parameter	Cluster Group A	*Cluster Group B	*Cluster Group C	*Cluster Group D	Cluster Group E
Number of Hauls	7	1	1	1	3
Species Richness	17	24	18	18	16
Mean Abundance/Haul	519	1043	218	1100	550
Species			**Mean Abundance**		
California lizardfish	**41**	430		36	**13**
English sole	**37**		22	47	**52**
Longspine combfish	**41**	127	11		**123**
Pacific sanddab	**177**	235	84	427	**49**
Pink Seaperch	**16**	65			**10**
Roughback sculpin	3		14	45	**25**
Yellowchin sculpin	**108**	51	49	468	**252**

* Note that Simper was not applied due to too few samples in the group.

Cluster Group A was significantly different from all other groups. The group consisted of all 60 m trawl stations in winter and Station T1 in summer. Group A had a mean species richness of 17 species and a mean abundance of 519 individuals. SIMPER analysis determined that California lizardfish, English sole, longspine combfish, Pacific sanddabs, pink seaperch (*Zalembius rosaceus*), and yellowchin sculpin characterize this group. Group A separated from the summer trawl samples (groups B through E) at the 65%

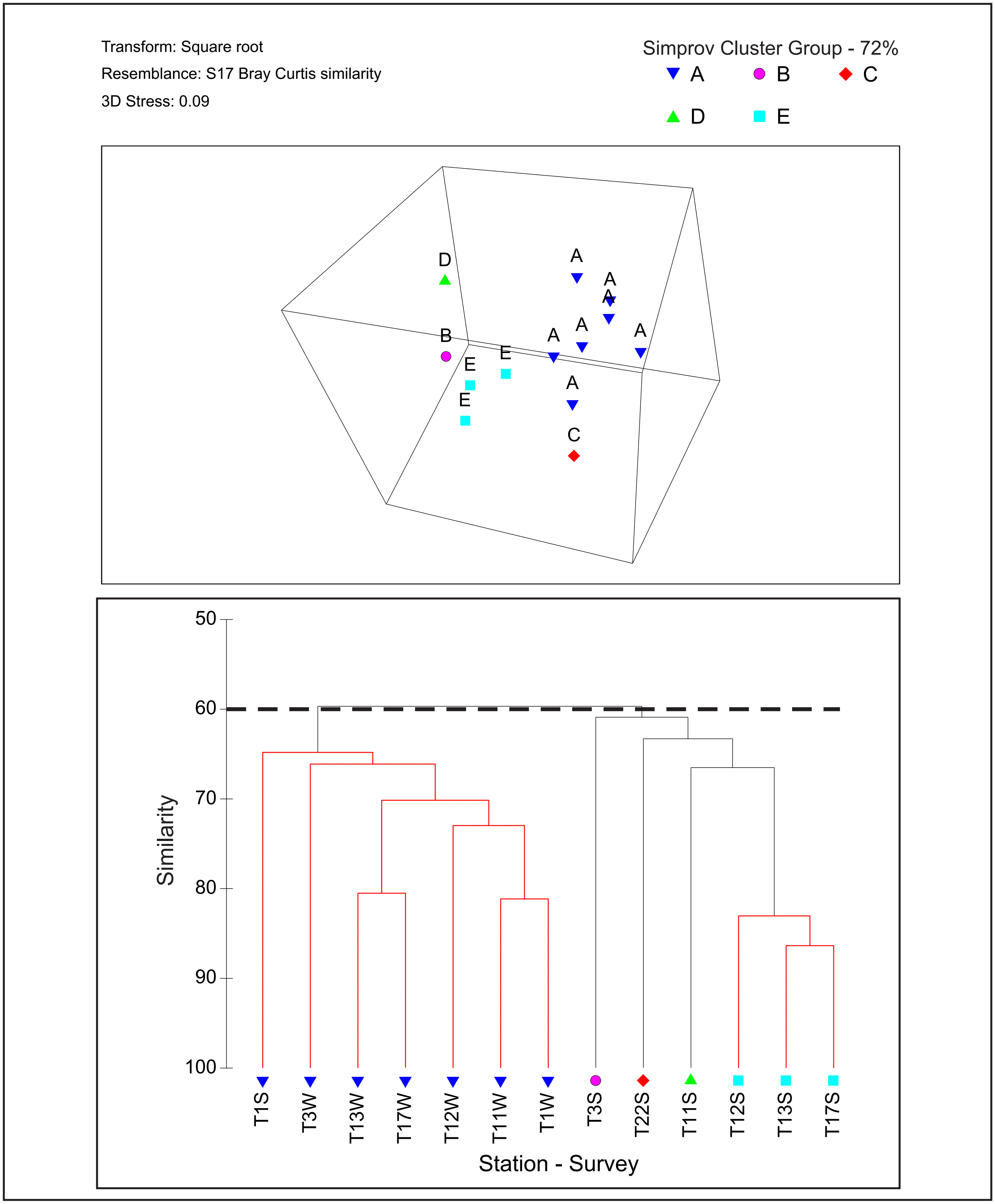

Figure 6-4. **Results of classification analysis of demersal fish assemblages collected at the seven 60-m stations during the summer (August 2011) and winter (February 2012) trawl surveys. Data are presented as a dendrogram of major station clusters. Stations-surveys are denoted by S for summer and W for winter.**

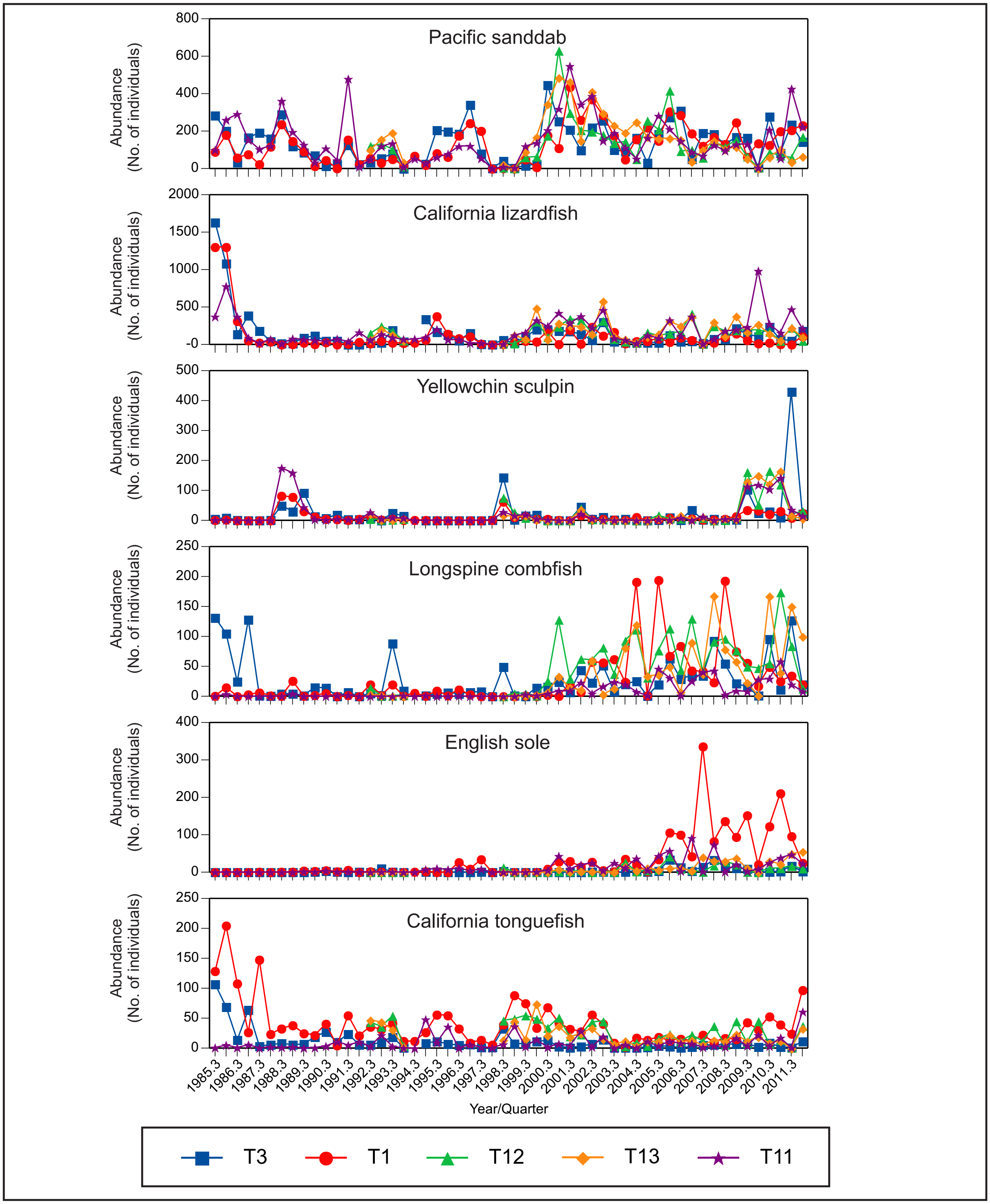

Figure 6-5. **Comparison of demersal fish mean abundance for select species at stations located along the 60 meter depth contour for 1985–2012.**

Orange County Sanitation District, California.

resemblance level. This was likely due to large catches of Pacific sanddabs and California lizardfish, and lower abundances of longspine combfish, yellowchin sculpin, and roughback sculpin.

Cluster Group B consisted of downcoast Station T3 in summer. It consisted of 24 species with a mean abundance of 1043 individuals per haul (Table 6-3). SIMPER could not be applied to this group to determine characteristic species because there were too few samples in the group. The five most abundant species were California lizardfish, longspine combfish, Pacific sanddabs, pink seaperch, and yellowchin sculpin. This station likely formed a unique cluster due to the large number of California lizardfish (430) and pink seaperch (65), as compared to other cluster groups, and the presence of several species unique to this group, including blackbelly eelpout (*Lycodes pacificus*), cowcod (*Sebastes levis*), and halfbanded rockfish (*Sebastes semicinctus*).

Station T3 often differs from other middle shelf stations, possibly due to location, habitat, and difficulty in sampling. Station T3 is located in close proximity to Newport Canyon, has variable bottom topography, and is depositional in nature, as opposed to the rest of the middle shelf trawl stations in the study area that are erosional (Maurer et al. 1993). Station T3 in summer differed from T3 in winter (in Cluster Group A) due to large differences in the number of California lizardfish (430 in summer vs. 22 in winter) and longspine combfish (127 in summer vs. 20 in winter).

Cluster group C was comprised solely of Station T22 in summer (not sampled in winter). SIMPER could not be applied to this group to determine characteristic species because there were too few samples in the group. The most abundant species were English sole, longspine combfish, Pacific sanddab, roughback sculpin, and yellowchin sculpin. T22 had 18 species, but only 218 individuals, about half that of the next lowest station abundance and less than half that of the other cluster group means. Seven of 18 species had 2 or fewer individuals and two species, sablefish (*Anoplopoma fimbria*) and slender sole, which were not found in the other station groups. Slender sole have historically been collected predominantly only at the 137 m stations and sablefish are uncommon. The presence of these two rare species and the low station abundance were the likely factors in this station separating from the rest.

Cluster group D consisted of only Station T11 in summer. This group consisted of 18 species with an abundance of 1100 individuals. SIMPER could not be applied to this group to determine characteristic species because there were too few samples in the group. The most abundant species were California lizardfish, English sole, Pacific sanddab, roughback sculpin, and yellowchin sculpin. Two species, Pacific sanddab and yellowchin sculpin, comprised over 80% of the total abundance. Further, eight of the 18 species had 2 or fewer individuals and one, southern spearnose poacher (*Agonopsis sterletus*), that was unique to this sample. These factors likely caused the separation of T11 in summer from the other cluster groups.

Cluster group E consisted of three stations: T12, T13, and T17 all in summer. These three stations are located upcoast from the outfall at an intermediate distance between the outfall and farfield Station T11. Group E had a mean species richness of 16 species and a mean abundance of 550 individuals. SIMPER analysis determined that California lizardfish, English sole, longspine combfish, Pacific sanddabs, pink seaperch, roughback sculpin, and yellowchin sculpin characterize this group. The high mean abundance of longspine combfish, the low mean abundance of Pacific sanddabs, generally among the most abundant species in the monitoring area, and the presence of two species unique to this cluster group, California skate (*Raja inornata*) and Pacific electric ray (*Torpedo californica*), likely determined the clustering of these three stations.

Unlike the 2010-11 results (OCSD 2012), there was no clear outfall group identified in this analysis. This may be due to the improvement in benthic community health observed near the outfall (see Chapter 5). Differences appeared to be more related to season and the high abundances of some species and the presence of some rare species at a few stations. Demersal fish species abundances can spatially be very patchy and appear to have been a factor in some cluster groupings. These results suggest that the outfall was not a significant factor in determining demersal fish community structure.

Regional Comparisons

FRI scores exceeded the threshold of 45 on the Palos Verdes shelf from 1970 to 1983 when sediment contamination by organics and other constituents was high (Allen 2006b). By 1990, FRI scores at Palos Verdes decreased to about 25 and remained near this value through 2002. Allen *et al.* (2007) also reported that 96% of the SCB area in 1998 was classified as reference (the remaining 4% of non-reference areas occurred on the inner shelf and in bays and harbors). Mean FRI scores at the District's 60 meter stations ranged from 21 to 25 in 2011-12, indicating reference conditions. Station T20's FRI mean is close to threshold limits. This station is a new deep station (200 M) that has not been surveyed until this reporting year. The FRI statistic works best on mid-shelf stations so the FRI statistic may not accurately measure fish community health at this station (Figure 6-6).

The summer 2011 data at Stations T1 and T11 followed trends in abundance and biomass similar to those described previously for regional surveys (OCSD 2008). Summer data only was used for comparison with regional surveys which were all completed during summer months. The SCBPP, Bight'98, Bight'03, and Bight'08 regional monitoring surveys reported no degraded areas, but found enhancement of mean fish abundance and biomass at some locations near wastewater outfalls. The values for the number of species, abundance, biomass, and Shannon-Weiner Diversity were all within the range of regional values for these measures (Figure 6-7). The fish populations at the District's outfall Station T1 also showed enhanced abundance and biomass. In 2011, mean abundance at T1 was higher than the mean abundance for regional non-POTW stations (publically owned treatment works) in 2003 and 2008, but it did fall within the regional ranges. Biomass at T1 was at the high end of regional values due to a number of large individuals of Pacific sanddab and a large catch of English sole. Such patterns were observed in the regional studies and are expected at near-discharge areas (Allen et al. 2002, 2007).

The regional surveys reported slightly more species at large POTWs compared to non-POTW areas in 1994 and 1998, though the number of species was similar between the two groups in 2003. The mean number of species at T1 was equal to or lower than the Bight non-POTW areas for all surveys except 2008; while T11 was less than all of the regional survey values. In 2011, the mean number of species at the District's sites was similar to regional values in 1994, 1998, and 2008, though slightly less than the 2003 regional mean. Diversity at Station T1 has been consistently high and similar to other SCB stations in the regional surveys. Since fish community measures at outfall Station T1 approximately

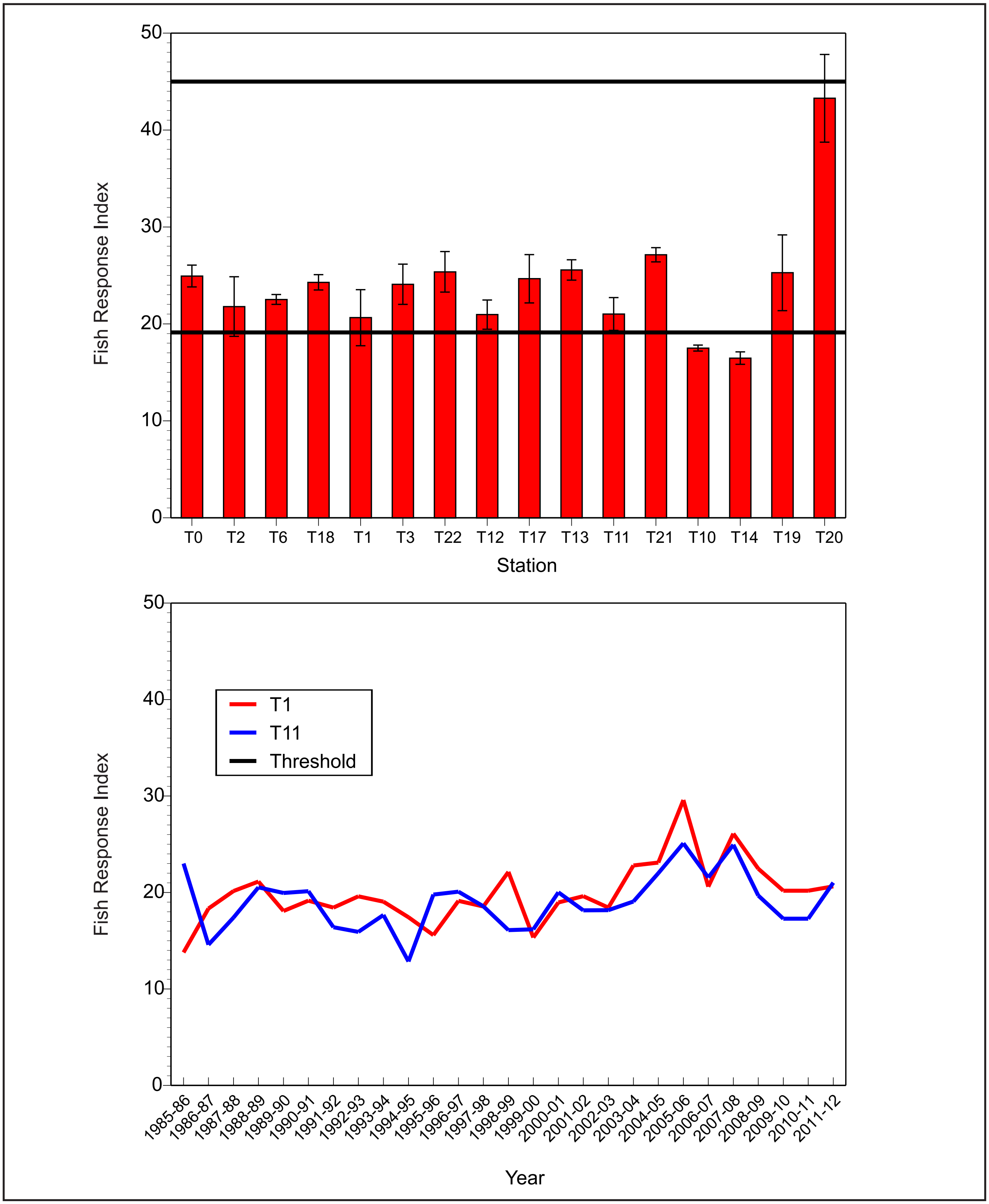

Figure 6-6. **Mean Fish Response Index (FRI) by station in 2011-12 and annual mean FRI for outfall Station T1 and farfield upcoast Station T11.**
Solid black line represents threshold value.

Orange County Sanitation District, California.

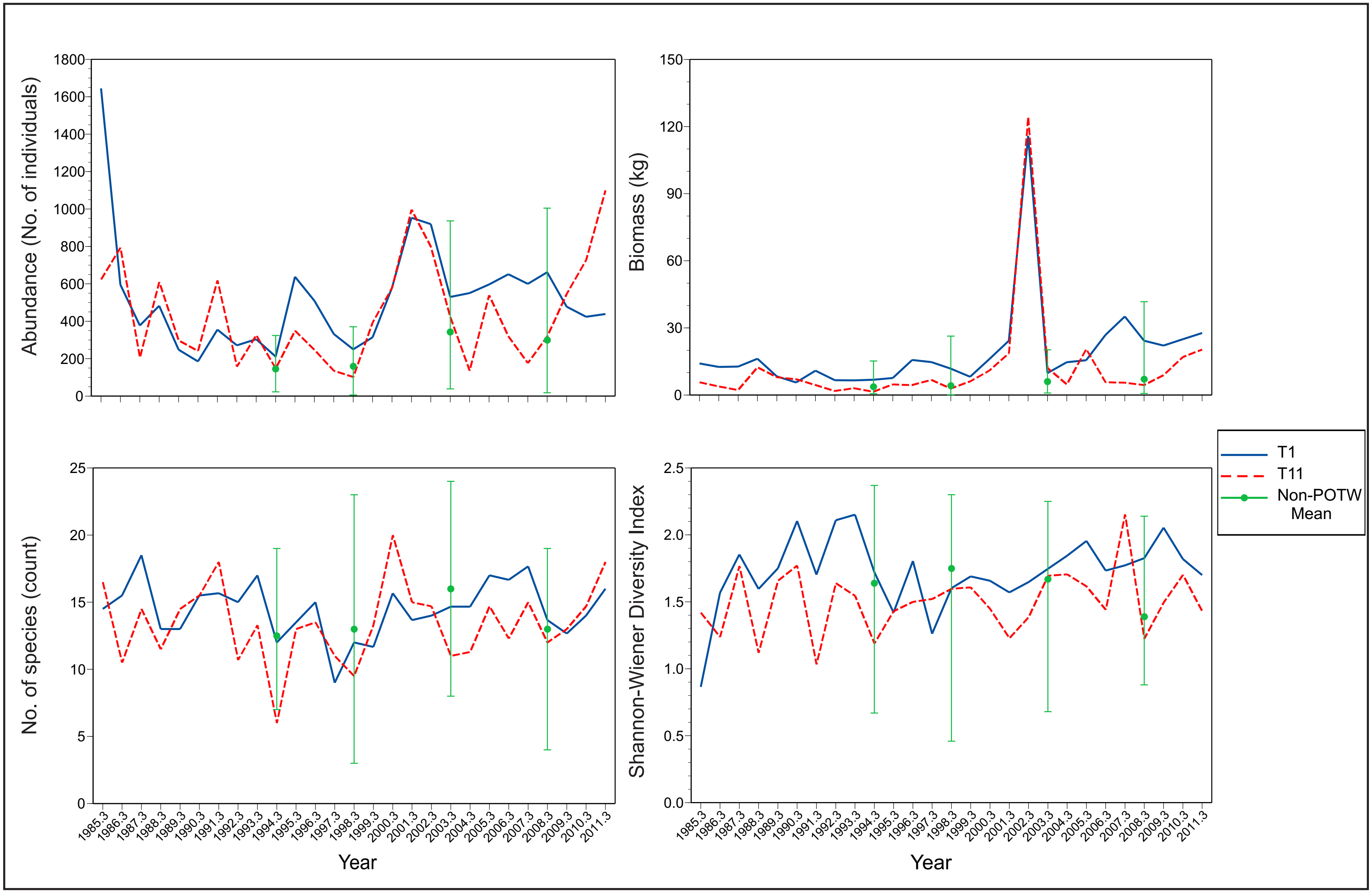

Figure 6-7. **Comparison of demersal fish parameters at OCSD stations T1 and T11 from 1985 to 2011 and regional non-POTW stations from the 1994, 1998, 2003, and 2008 regional monitoring surveys. All data for mean abundance, biomass, number of species, and Shannon-Wiener diversity (H') are for summer surveys only. Range bars represent the range of values (minimum and maximum) for the non-POTW areas per survey.**

Note: non-POTW N values: 1994=3, 1998=15, 2003=13, 2008=13 equaled or exceeded values characterizing the SCB at similar depths, the fish community does not appear to be degraded by the wastewater discharge.

Epibenthic Macroinvertebrate Community

<u>Abundance</u>

A total of 11,663 epibenthic macroinvertebrates (EMI) were collected during 2011-12 (Tables 6-4 and B-15). The total abundance increased by 7,107 individuals from the previous year (2010-11) due to an explosive population growth of the brittle star *Ophiura luetkenii* and an increase in heart urchin abundances due to the sampling of a new deep station (T20) (Table 6-4). *O. luetkenii* accounted for 40% of the total abundance for 2011-12, with 72% of these animals collected at outfall station T1 and shallow station T2 (Figure 6-8 and Table B-15). Boom and bust population variations are common with invertebrates. In 2008-9, the sea pen *Acanthoptilum* sp abundance was 8,265 in contrast to only 16 in 2011-12.

In 2011-12, three species accounted for 72% of the total abundance: *O. luetkenii*, followed by the *Lytichinus pictus* (the white sea urchin) at 17% and *Brisaster townsendi* (heart urchin) at 15% (Table 6-4). In some instances, these species dominated a station. For example, *L. pictus* was responsible for 72% of the winter abundance at Stations T13. Other generally abundant species included *Hamatoscalpellum californicum* (the California blade barnacle), *Pleurobranchaea californica* (California sea slug), *Luidia foliolata* (sand star), and *Thesea* sp (yellow sea twig).

Two of the 73 species occurred at all stations except shallow Station T0: *L. foliolata* and *P. californica*. Another four species, *L. pictus*, *Acanthodoris brunnea, Syconia ingentis,* and *Thesea* sp were wide-ranging and occurred at over 75% of the stations. By contrast, 61 (84%) species occurred at fewer than half of the sixteen stations sampled. The number of species generally increased with station depth, but there was no relationship between station depth and the abundance of individuals. This likely reflects the patchy nature of species assemblages on the San Pedro Shelf.

The number of individuals per haul ranged from 7 to 2106 in 2011-12. Historically, abundance is highly variably from year to year. These fluctuations typically reflect changes in several dominant species, such as the *O. luetkenii*, *Thesea* sp, *L. pictus*, *P. californica*, *S. ingentis*, and *H. californicum* (Figure 6-9). Overall, there were no strong indications of potential impact at the discharge site with respect to total or individual species abundances. For example, increases in abundances of the suspension feeding sea pen *Acanthoptilum* sp. at outfall Station T1 from 2002–2008, and the subsequent decline from 2009 through January 2012, has not been linked to an outfall effect.

<u>Biomass</u>

In 2011-12, the total EMI biomass was 172.8 kg, which was nearly twice that of the 90.7 kg of the previous year (Table B-16). Most of the difference was due to large hauls of heart urchins at Station T20, which was not trawled in previous years (Figure 6-8). Overall, the biomass at outfall Station T1 was similar to the other middle shelf stations and there were no indications of change that could be attributed to the outfall.

Table 6-4. Summary of epibenthic macroinvertebrates species collected during the summer (August 2011) and winter (February 2012) surveys. Data for each species are expressed as total abundance (Total), percent abundance (%A), frequency of occurrence (%FO), and mean abundance per haul (MAH).

Orange County Sanitation District, California.

Species	Total	%A	%FO	MAH
Ophiura luetkenii	4,676	40	63	64
Lytechinus pictus	1,982	17	88	27
Brisaster townsendi	1,788	15	19	24
Sicyonia ingentis	518	4	81	7
Strongylocentrotus fragilis	495	4	13	7
Hamatoscalpellum californicum	372	3	63	5
Thesea sp	313	3	75	4
Brissopsis pacifica	193	2	13	3
Neocrangon resima	180	2	13	2
Luidia foliolata	178	2	94	2
Spatangus californicus	162	1	13	2
Pleurobranchaea californica	129	1	94	2
Philine auriformis	84	1	50	1
Acanthodoris brunnea	75	1	81	1
Neocrangon zacae	65	1	25	1
Hinea insculpta	44	< 1	31	1
Astropecten verrilli	37	< 1	69	1
Dromalia alexandri	36	< 1	6	< 1
Spirontocaris holmesi	31	< 1	6	< 1
Luidia asthenosoma	30	< 1	69	< 1
Ophiothrix spiculata	29	< 1	50	< 1
Parastichopus californicus	28	< 1	50	< 1
Rossia pacifica	25	< 1	19	< 1
Octopus rubescens	22	< 1	56	< 1
Acanthoptilum sp	16	< 1	19	< 1
Pandalus platyceros	16	< 1	6	< 1
Octopus californicus	13	< 1	25	< 1
Orthopagurus minimus	13	< 1	6	< 1
Parastichopus sp A	12	< 1	19	< 1
Amphichondrius granulatus	8	< 1	31	< 1
Corynactis californica	6	< 1	13	< 1
Loxorhynchus crispatus	6	< 1	25	< 1
Crangon nigromaculata	5	< 1	6	< 1
Megasurcula carpenteriana	4	< 1	19	< 1
Metacarcinus anthonyi	4	< 1	25	< 1
Neosimnia sp	4	< 1	6	< 1
Ptilosarcus gurneyi	4	< 1	6	< 1

Table 6-4 continues.

Table 6-4 continued.

Species	Total	%A	%FO	MAH
Cancellaria cooperii	3	< 1	13	< 1
Lamellaria diegoensis	3	< 1	13	< 1
Neocrangon sp	3	< 1	6	< 1
Paguristes turgidus	3	< 1	19	< 1
Pentamera pseudocalcigera	3	< 1	6	< 1
Platymera gaudichaudii	3	< 1	19	< 1
Podochela hemphillii	3	< 1	6	< 1
Podochela lobifrons	3	< 1	19	< 1
Boreotrophon bentleyi	2	< 1	6	< 1
Dendronotus frondosus	2	< 1	13	< 1
Heterocrypta occidentalis	2	< 1	13	< 1
Luidia armata	2	< 1	6	< 1
Metacrangon spinosissima	2	< 1	6	< 1
Metridium gigantea	2	< 1	13	< 1
Muricea californica	2	< 1	6	< 1
Stylatula elongata	2	< 1	6	< 1
Aglaophenia sp	1	< 1	6	< 1
Amphiodia urtica	1	< 1	6	< 1
Antiplanes catalinae	1	< 1	6	< 1
Asteroidea	1	< 1	6	< 1
Barbarofusus barbarensis	1	< 1	6	< 1
Calliostoma gloriosum	1	< 1	6	< 1
Crangon sp	1	< 1	6	< 1
Dendronotus iris	1	< 1	6	< 1
Erileptus spinosus	1	< 1	6	< 1
Heterogorgia tortuosa	1	< 1	6	< 1
Leptogorgia chilensis	1	< 1	6	< 1
Paralithodes rathbuni	1	< 1	6	< 1
Parastichopus sp	1	< 1	6	< 1
Pisaster brevispinus	1	< 1	6	< 1
Scyra acutifrons	1	< 1	6	< 1
Sicyonia penicillata	1	< 1	6	< 1
Spirontocaris sp	1	< 1	6	< 1
Synidotea magnifica	1	< 1	6	< 1
Tritonia diomedea	1	< 1	6	< 1
Zonaria spadicea	1	< 1	6	< 1
Total	**11,663**	**100**		
Total no. of species	**73**			

n = 32 hauls

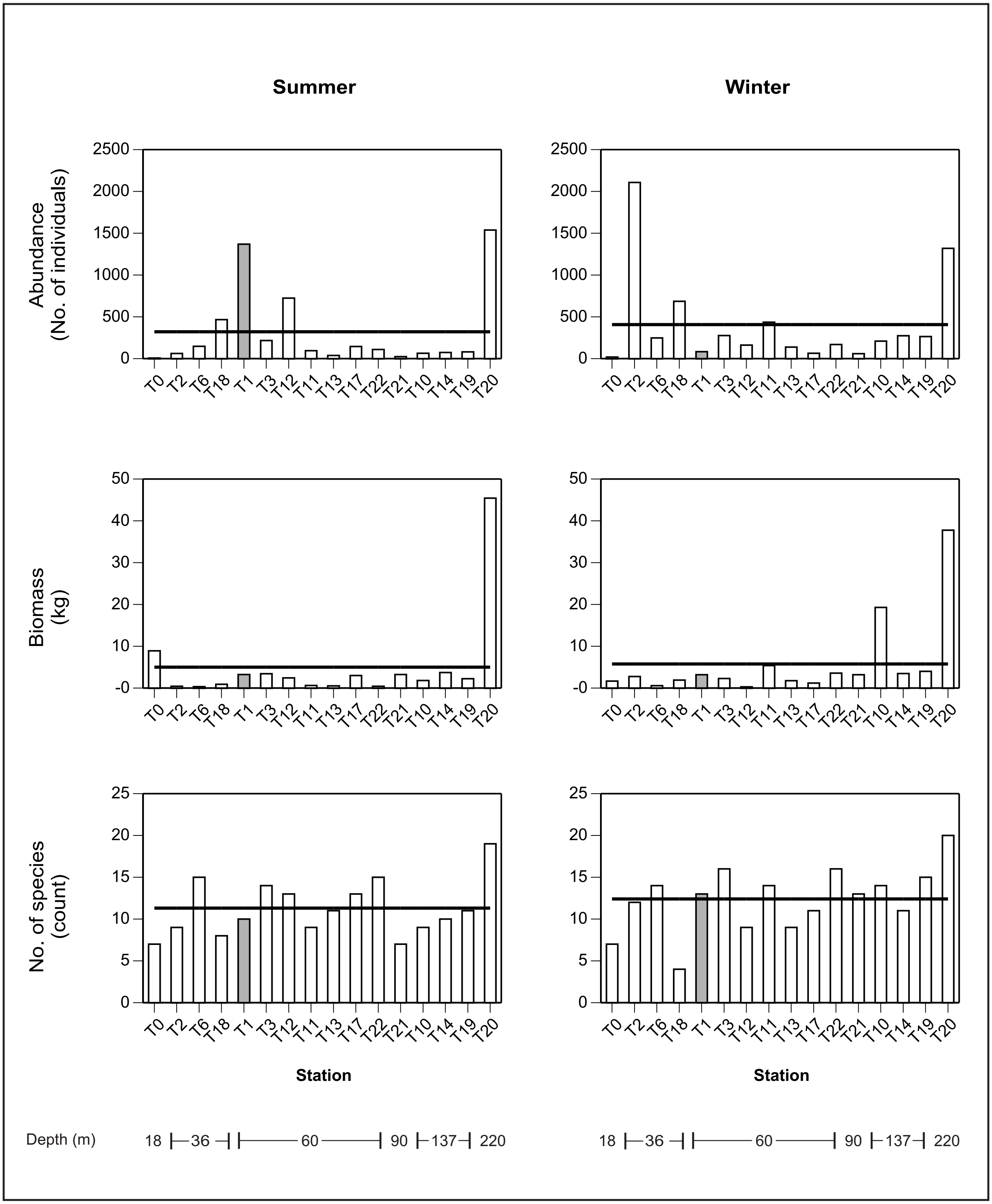

Figure 6-8. Number of individuals (abundance), biomass, and number of species of epibenthic macroinvertebrates collected during the summer (August 2011) and winter (February 2012) surveys.
Outfall Station T1indicated in gray. Survey mean indicated by heavy line.

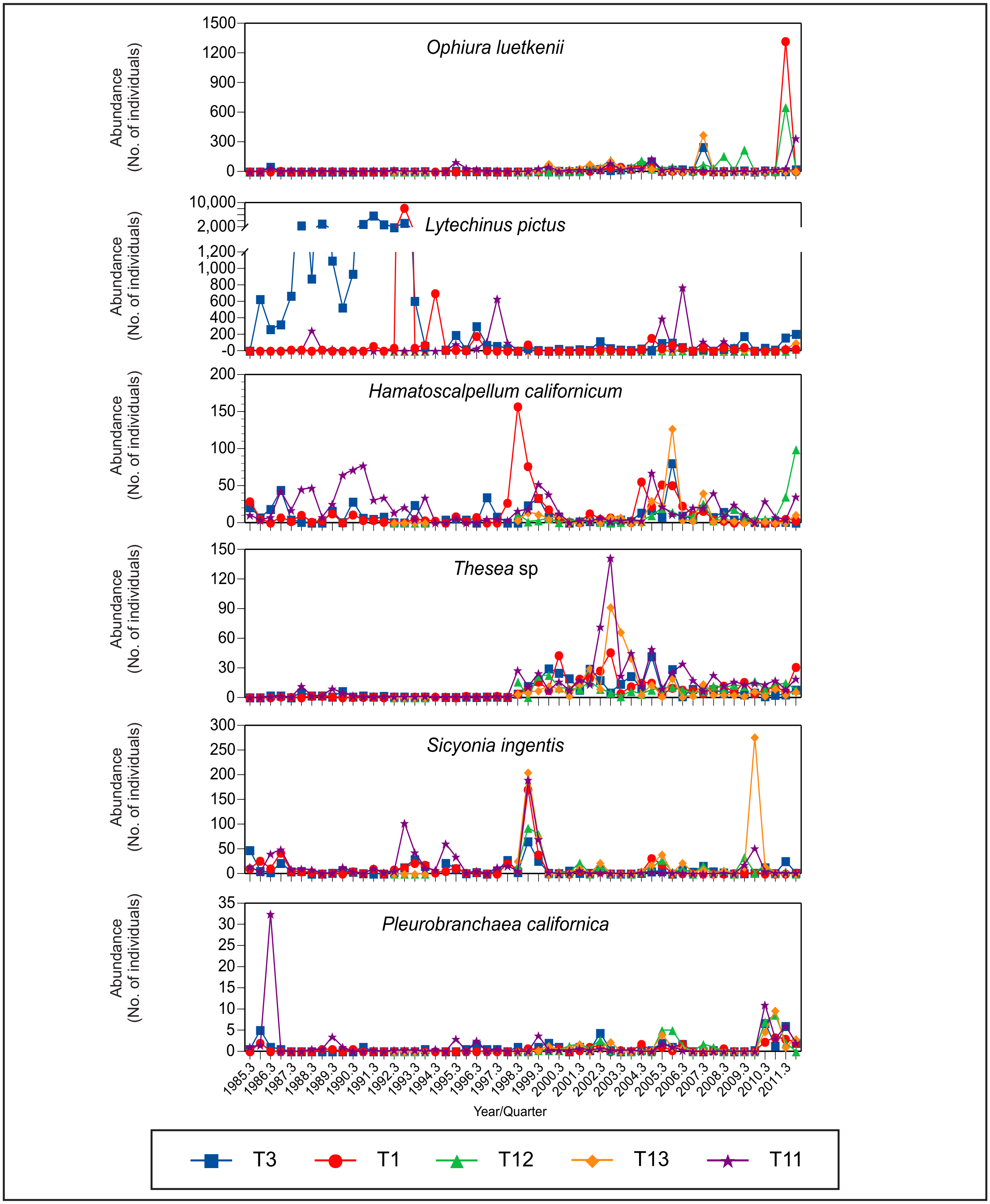

Figure 6-9. Comparison of epibenthic macroinvertebrate mean abundance for select species at stations located along the 60 meter depth contour for 1985–2012.

Orange County Sanitation District, California.

Number of Species

A total of 73 EMI taxa were collected during 2011-12 (Table B-15). The number of species was highest at station T20 with 20 species in winter and 19 in summer. Outfall Station T1 was close to the mean in both summer (10 species) and winter (13 species) surveys and comparable to the other 60 meter stations.

Diversity

Shannon-Wiener (H') was very low for T1 in summer due to huge numbers of *O. luetkenii* compared to other species collected at T1. The number of species collected at all stations raged from 4 at T18 to 20 at T20. This small range kept the Margalef Species Richness ratio fairly tight except for Station T18 in winter where only four species were collected and 99% of the abundance was *L. pictus*. Swartz's 75% Dominance Index (Dominance) ranged from 1–5 species with *O. luetkenii* again driving down this statistic with huge numbers at stations T1, T11, and T2 (Figure 6-10).

Regional Comparisons

The District's summer 2011 EMI data for Stations T1 and T11 were compared to regional data collected during the 1994 SCBPP, Bight'98, Bight'03, and Bight'08 surveys (Figure 6-11). These regional studies have established several general conclusions: that invertebrate population attributes at large POTW areas and non-POTW sites were generally similar (Allen *et al.* 2007) and differences in the EMI assemblages between surveys were likely due to the prevailing oceanographic regime associated with the Pacific Decadal Oscillation (Francis *et al*. 1998).

Mean community measures at stations T1 and T11 in 2011 fell within the range of values for the regional Bight stations, but with slight differences (Figure 6-11). For example, the District's outfall (T1) and farfield (T11) trawl sights have generally followed regional variation in abundance, biomass, number of species, and diversity values, but were affected in 2011-12 by large numbers of *O. luetkenii* at outfall station T1. Meaningful comparisons among the regional surveys and the District's trawl data are limited due to the high variability in the ranges observed for trawl invertebrate data. Historically, the EMI population attributes at the District's outfall and within the SCB were highly variable, mostly due to changes in oceanographic conditions, but also due to fluctuations in the dominant species.

Fish Tissue Contaminants

High fish tissue contaminate concentrations are produced by two worst-case scenarios. The first is the top predator scenario, where tissue contaminates are biomagnified by moving up the food web. In this case, large fish like sharks and tuna have the highest tissue contaminate concentrations. The second worst-case scenario involves fish that live and feed on the bottom where they are continually exposed to sediment contaminates. For this study, fish from the second scenario were used. Hornyhead turbot and English sole are both flat fish that live on the bottom near the Districts outfall. They both feed on organisms that live in or on bottom sediment and are almost always caught readily and in large enough numbers to produce usable data.

In previous reports, whole fish tissue analyses of Pacific sanddabs were completed. These analyses were not done this year.

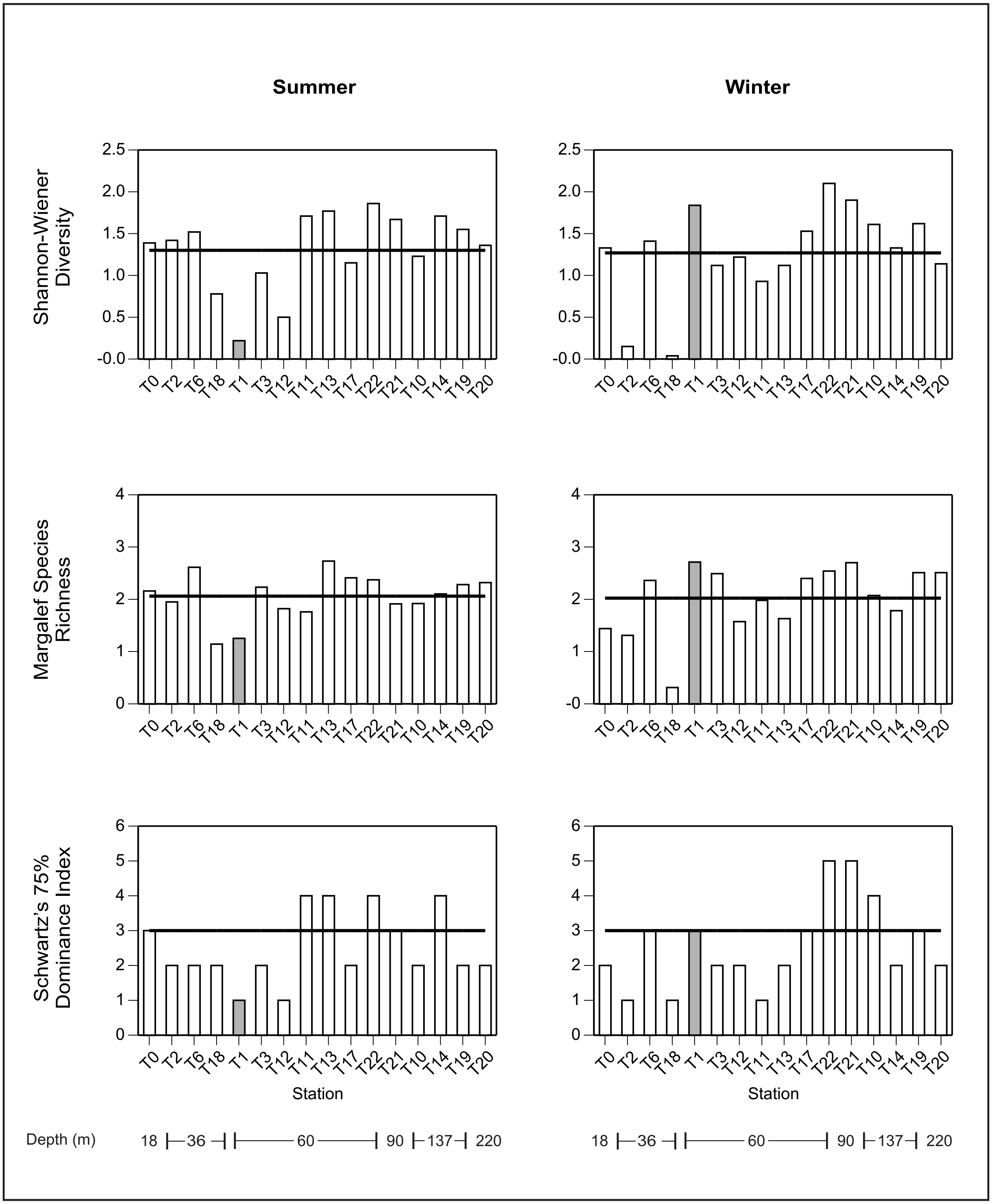

Figure 6-10. **Diversity indices values — Shannon-Wiener Diversity Index (H'), Margalef Species Richness (SR), and Schwartz's 75% Dominance Index of epibenthic macroinvertebrates collected during the summer (August 2011) and winter (February 2012) surveys.**
Outfall Station T1 indicated in gray. Survey mean indicated by heavy line.

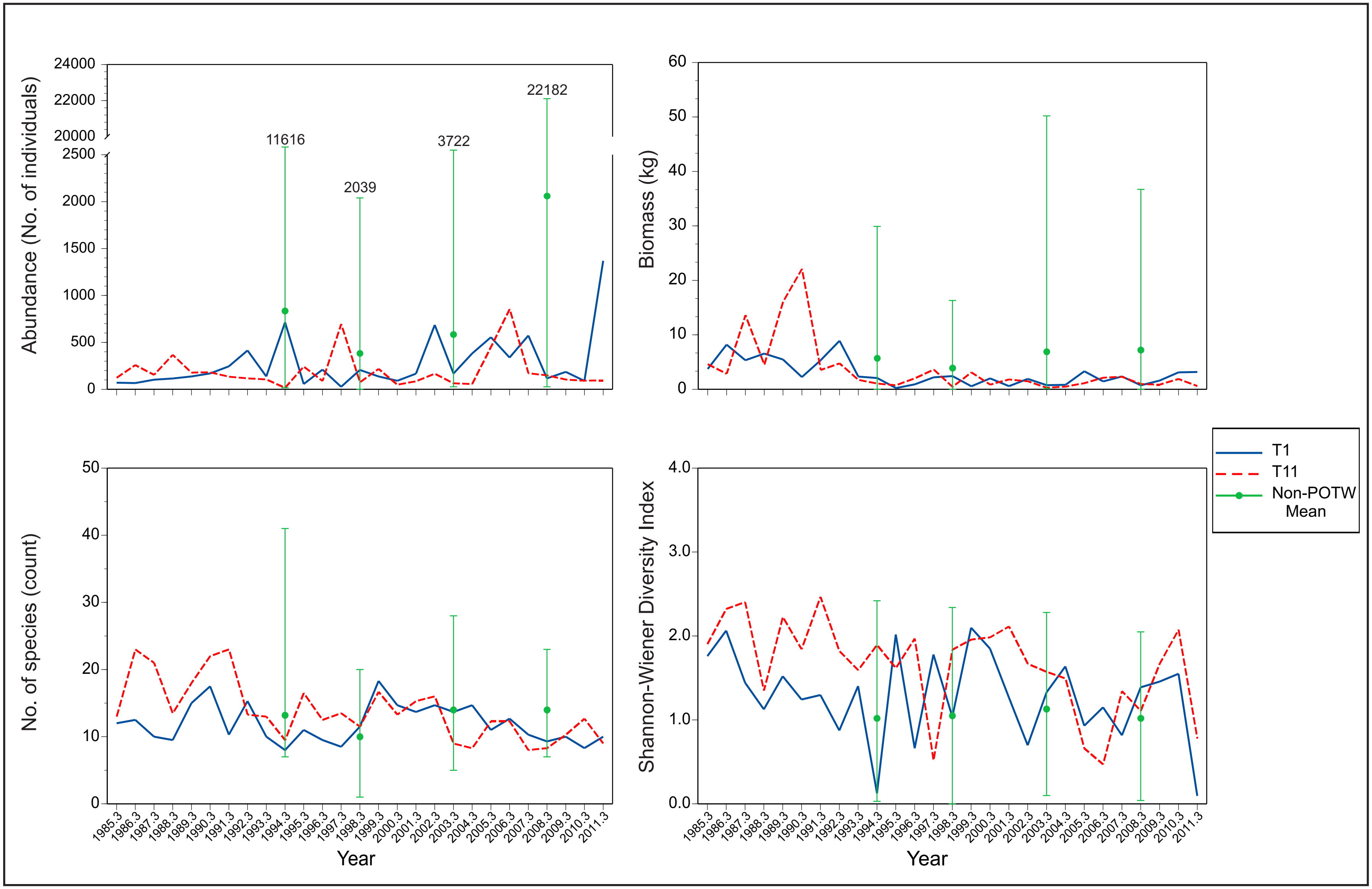

Figure 6-11. **Comparison of epibenthic macroinvertebrate parameters at OCSD stations T1 and T11 from 1985 to 2011 and regional non-POTW stations from the 1994, 1998, 2003, and 2008 regional monitoring surveys. All data for mean abundance, biomass, number of species, and Shannon-Wiener diversity (H') are for summer surveys only. Range bars represent the range of values (minimum and maximum) for the non-POTW areas per survey.**

Note: non-POTW N values: 1994=3, 1998=15, 2003=13, 2008=13

Outfall vs. Farfield Stations Comparisons

Hornyhead turbot

Hornyhead turbots collected at the outfall stations were about 6% bigger than at farfield stations. Size matters because contaminant concentrations can relate to the age/size of the fish. For example, Phillips *et al.* (1997) found that tissue concentrations of mercury in barred sandbass (*Paralabrax nebulifer*) were highest in larger, older fish and that size/age was more important to the contaminate level than location of capture.

Overall, contaminants in hornyhead turbot muscle tissues were low in 2011-12 (Table 6-5; Figures 6-12 through 6-15). Percent lipid (fatty tissue where contaminants concentrate) were low in muscle tissue at both outfall and farfield stations. Muscle tissue tDDT levels were three times higher at the farfield (74.92 ug/kg) compared to outfall (27.61 ug/kg) stations. Concentrations of tPCB were four times higher in farfield fish. Mean muscle mercury concentrations have increased slightly since 2007-08 and this year mercury levels in hornyhead turbot were three times higher at the outfall site than the farfield site (0.11 mg/kg and 0.03 mg/kg, respectively). However, these values are much less than state and federal health advisory action level concentrations. Chlorinated pesticides concentrations were non-detectable at both stations.

Overall, contaminant concentrations in non-regulated liver tissue were low (Table 6-5, Figure 6-15). Fish collected near the outfall had mean lipid concentrations of 11% compared to 8% in farfield fish. Liver tissue mercury was comparable at outfall and farfield stations. Total PCB levels were approximately five times higher at the outfall versus farfield sites (23 and 4 ug/kg, respectively), while tDDT was about the same at farfield stations compared to outfall stations (70 and 76 ug/kg, respectively). The higher levels of tPCB in outfall collected fish is consistent with sediment tPCB concentrations (see Chapter 4). Pesticides were non-detected at farfield stations and were 1.7 ug/kg at the outfall.

English sole

The mean standard lengths of English sole collected at the outfall were 9 % larger than farfield fish this year. Muscle lipid concentrations were similar (Table 6-5). Muscle tissue concentrations of tDDT, tPCB, and mercury were also similar (Figures 6-12 through 6-15). No fish at either site had measurable chlorinated pesticide concentrations in muscle tissue. All parameters measured were well below any federal or state action or advisory levels.

Long-term Trends

Muscle tissue contaminant data has been consistently collected and analyzed for hornyhead turbot since July 2004 and English sole since July 2005. Contaminant concentrations have been generally well below any action limits for all analytes, but certain contaminants have shown high interannual and interspecies variability.

Total DDT

Muscle tissue tDDT concentrations have been well below action limits in both species with occasional periods of increased concentrations (e.g., in 2008-09; Figure 6-12). There has been no consistent pattern of higher concentrations of tDDT in fish collected at the outfall compared to the farfield site nor is there any relationship to age. Elevated station

Table 6-5. Results of tissue contaminant analysis of trawl fish collected at outfall and farfield station groups.

Orange County Sanitation District, California.

Species	Tissue	Station Group	n	Mean Standard Length (mm)	Mean Percent Lipid	Mean Mercury (mg/kg)	Mean Total DDT (ug/kg)	Mean Total PCB (ug/kg)	Mean Chlorinated Pest (ug/kg)
Hornyhead Turbot	Muscle	Outfall	10	165	0.07	0.11	27.61	2.91	N/D
		Farfield	4	155	0.05	0.03	74.92	14.97	N/D
	Liver	Outfall	10	165	11.27	0.18	76.47	23.13	1.7
		Farfield	4	155	8.16	0.08	70.33	3.63	N/D
English Sole	Muscle	Outfall	10	223	0.58	0.04	90.78	11.36	N/D
		Farfield	10	203	0.51	0.04	99.87	7.26	N/D
	Liver	Outfall	10	223	11.99	0.04	51.67	14.55	0.66
		Farfield	10	203	13.47	0.03	44.62	10.23	N/D
California Advisory Limit for muscle tissue						0.5	N/A	100	N/A
FDA Action Level for muscle tissue						1.0	5000	2000	N/A

Data for total DDT, total PCB, and total other pesticides are lipid-normalized; mercury is not lipid-normalized.
ND = not detected, NS = no sample.

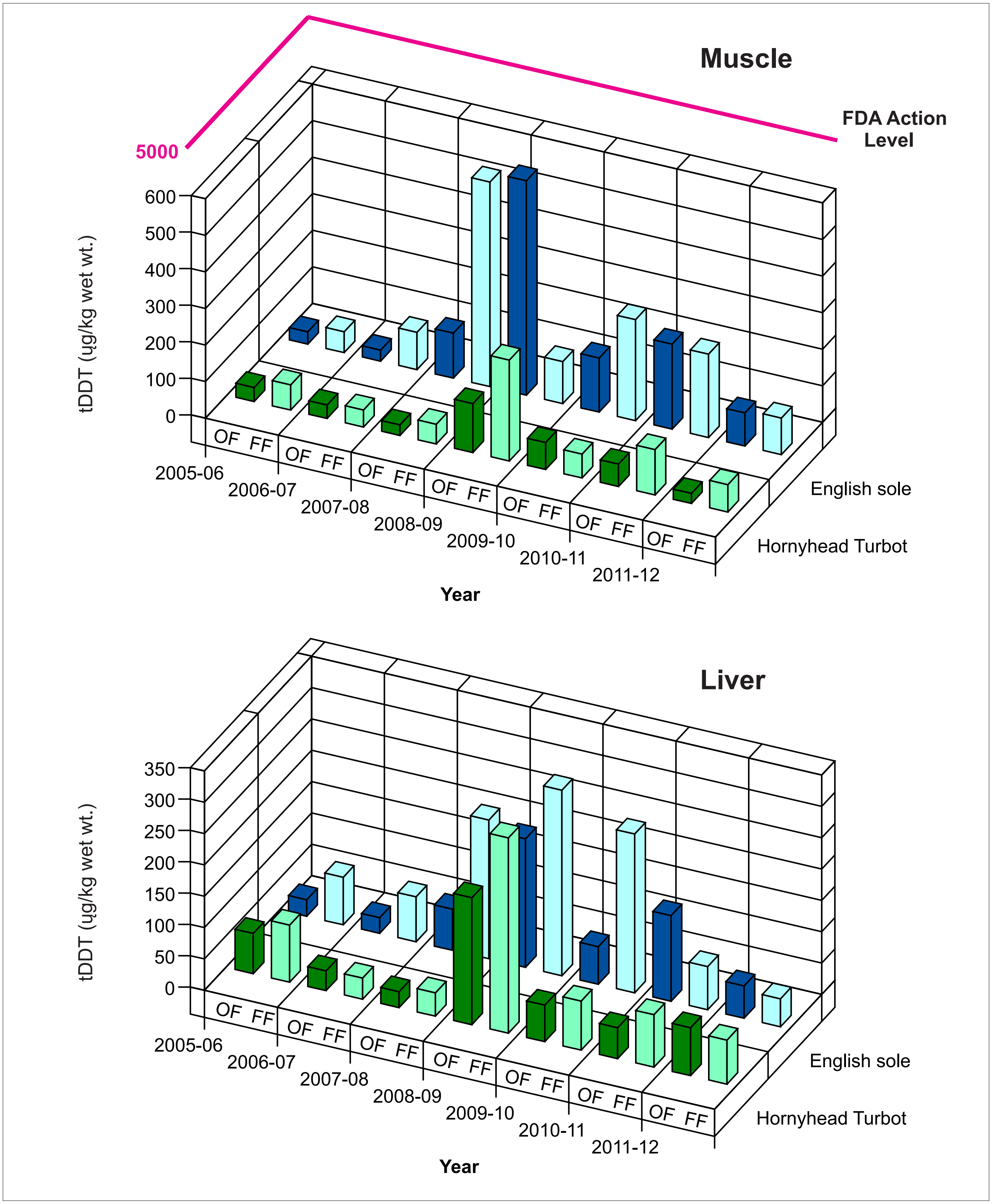

Figure 6-12. **Mean concentrations of total DDT (ųg/kg wet weight) in hornyhead turbot (*Pleuronichthys verticalis*) and English sole (*Parophrys vetulus*) muscle tissue *and* liver in August 2011 at outfall (OF) versus farfield (FF) sites.**
Data normalized to % lipids.

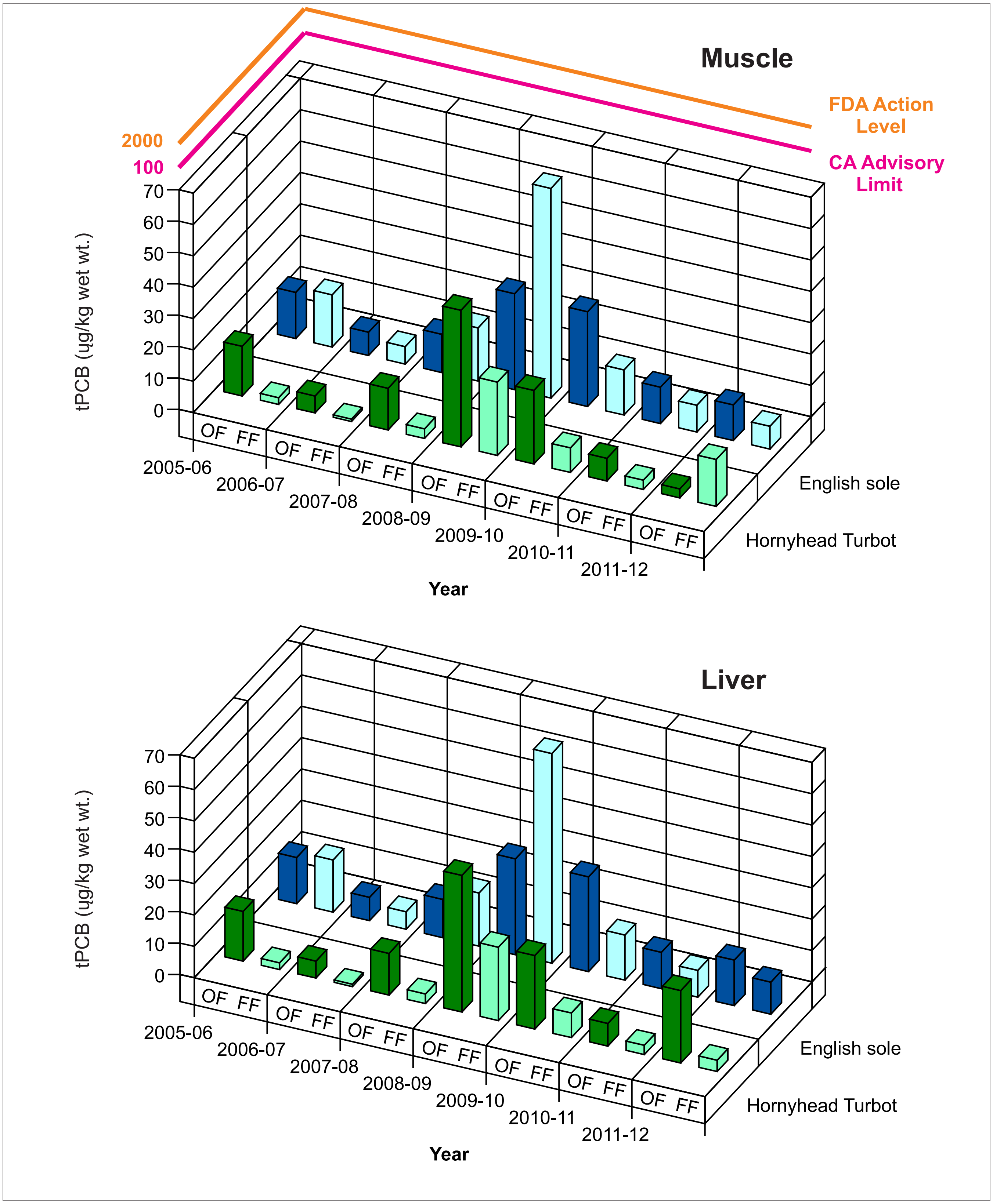

Figure 6-13. **Mean concentrations of total PCB (ųg/kg wet weight) in hornyhead turbot (*Pleuronichthys verticalis*) and English sole (*Parophrys vetulus*) muscle and liver tissue in August 2011 at outfall (OF) versus farfield (FF) sites.**
Data normalized to % lipids.

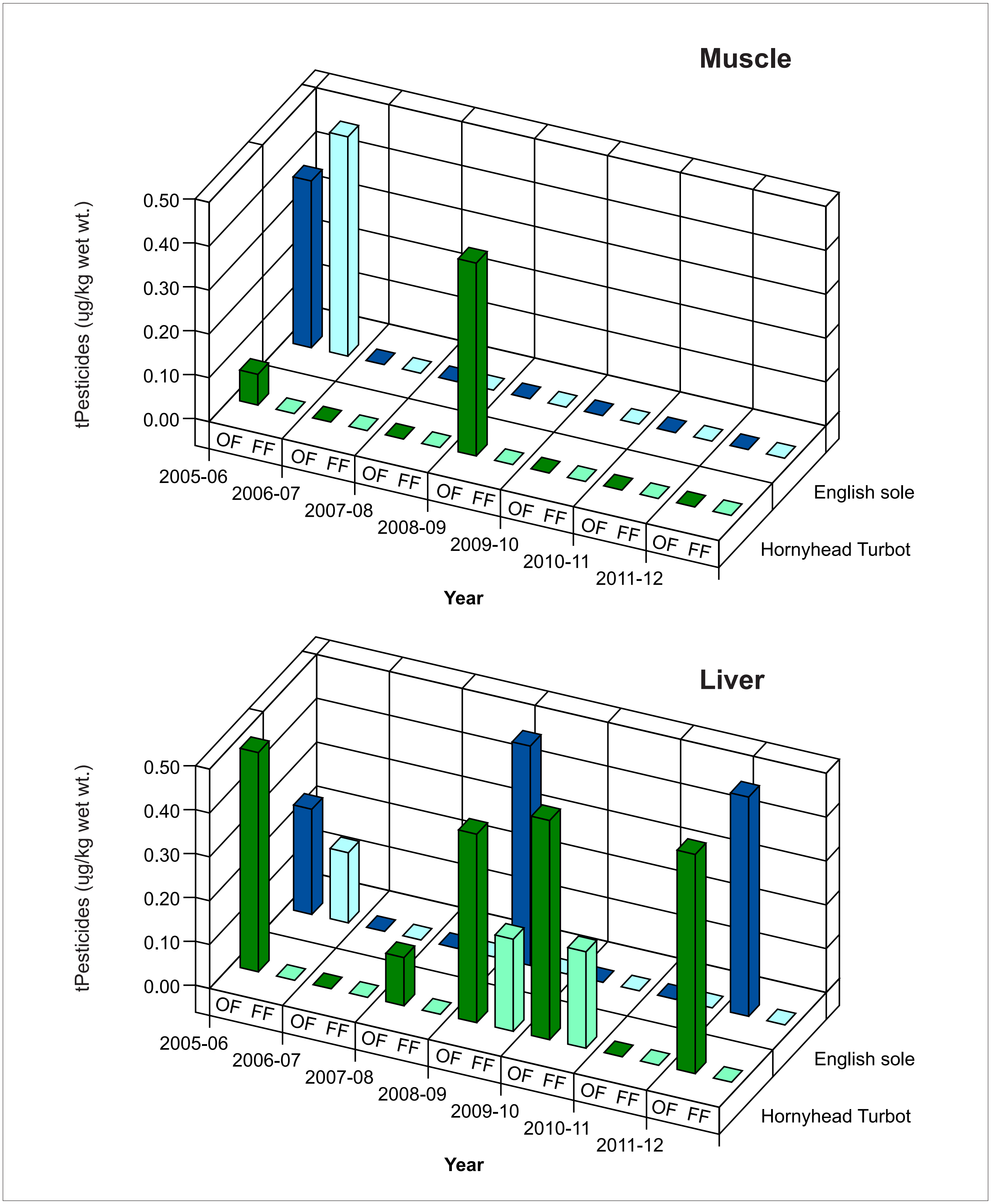

Figure 6-14. **Mean concentrations of total chlorinated pesticides (ųg/kg wet weight) in hornyhead turbot (*Pleuronichthys verticalis*) and English sole (*Parophrys vetulus*) muscle tissue and liver, in August 2011 at outfall (OF) versus farfield (FF) sites.**
Data normalized to % lipids.

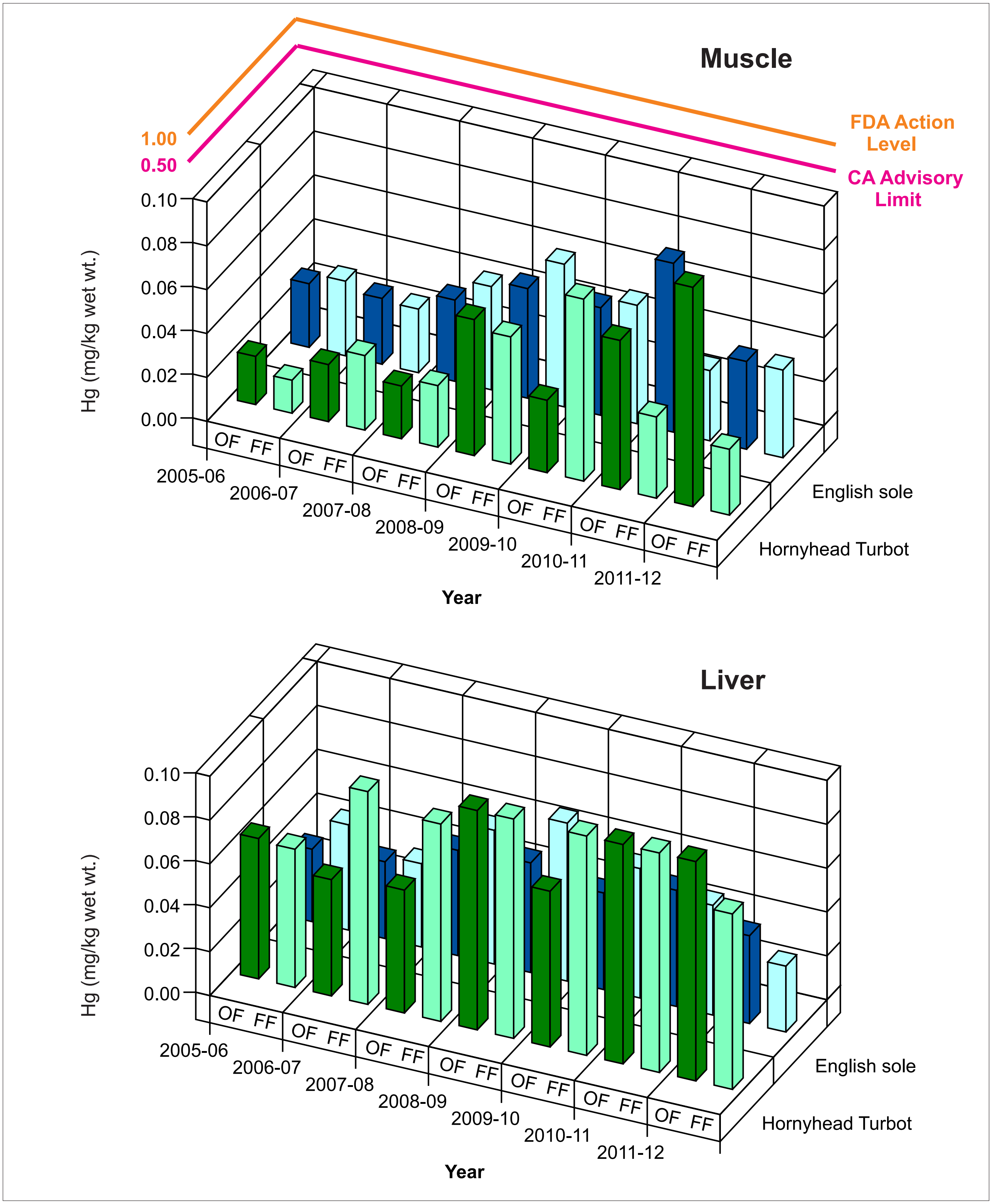

Figure 6-15. **Mean concentrations of mercury (mg/kg wet weight) in hornyhead turbot (*Pleuronichthys verticalis*) and English sole (*Parophrys vetulus*) muscle and liver tissue in August 2011 at outfall (OF) versus farfield (FF) sites.**
Data normalized to % lipids.

concentrations are usually due to high concentrations in one or two individuals with the majority of fish having low tissue levels. The highest tissue concentrations for hornyhead turbot and Pacific sanddab occurred during the 2008-09 monitoring year, while the highest tissue concentration in English sole occurred at the farfield site in 2007-08. There were no apparent reasons for the high values since there were no concomitant increases in sediment tDDT concentrations.

Total PCB
Tissue concentrations of tPCB showed a similar interannual pattern as tDDT for both species (Figure 6-13). The highest concentrations in hornyhead turbot and English sole occurred in the 2008-09 monitoring year. Like tDDT, long-term trends were unrelated to sediment tPCB concentrations, though tPCB tissue and sediment levels are consistently higher at the outfall than at farfield sites.

Chlorinated Pesticides
Fish tissue samples were analyzed for 12 chlorinated pesticides other than DDT. Detection of these compounds in fish tissue is sporadic with more than half the annual surveys yielding results below the detection limit for both species (Figure 6-14).

Mercury
Mercury tissue concentrations were comparable to previous years. Overall, mercury contamination has been fairly consistent since 2004-05 (Figure 6-15). Mercury concentrations in fish from outfall and farfield sites are generally comparable. The largest difference occurred in 2009-10 when hornyhead turbots at the farfield stations had a mean concentration (0.083 mg/kg); almost three times that of outfall fish (0.033 mg/kg; Table 6-5).

Health Advisory Assessments
Mercury concentrations in hornyhead turbot and English sole muscle tissue samples were well below the Federal Food and Drug Administration (FDA) Action Level of 1.0 mg/kg and the California State Department of Health Services (CDHS) advisory limit of 0.5 mg/kg. All concentrations of tDDT and tPCB in muscle tissue samples were below the FDA Action Levels of 5,000 and 2,000 µg/kg, respectively, and state advisory limit for PCB of 100 µg/kg.

The State of California Office of Environmental Health Hazard Assessment (OEHHA) has published safe eating guidelines on several sport fish species from Ventura to San Mateo Point in south Orange County (OEHHA 2009). Mercury is the most common contaminant in southern California sport fish. Mercury has several sources into the environment including aerial deposition from coal-burning power plants and point sources, including wastewater discharge. DDT was also very common in fish tissues, but in relatively low concentrations except in white croaker on the Palos Verdes Shelf near Los Angeles. PCBs are found in higher concentrations than DDT and are considered more of a regional human health concern due to fish consumption. DDT and PCBs are legacy contaminants that are still found in sediments from previous, now discontinued, discharges due to their long degradation times. In the region encompassing the District’s outfall, Seal Beach Pier to San Mateo Point, 19 fish species have consumption advisories. However, no advisories exist based specifically on the District’s wastewater discharge.

The Outfall as an Epicenter for Fish Tissue Contamination

The mercury, tDDT, and tPCB values for all fish composites and the station means of composite samples (Table 6-5) are within the ranges of non-POTW strata within the SCB and do not show patterns of measured concentrations near the outfall. Consequently, the outfall does not seem to be causing degradation due to the bioaccumulation of contaminants in fish.

Parasites and Abnormalities

External Parasites and Abnormalities

External parasites and abnormalities, such as skeletal deformities, tumors, lesions, and abnormal coloring occurred in less than 1% of the fish collected. The most common occurrence was the presence of the parasitic eye copepod *Phrixocephalus cincinnatus*, which occurred in 1.1% (82 occurrences) of Pacific sanddabs and in less than 1% (1 occurrence) of slender sole. This parasite was found at all of the 60 m and 137 m stations in both surveys, with the exception of T13 in summer. At the 40 m stations (T2, T6, and T18), there was only one occurrence at Station T2 in summer. No outfall trend was evident. Only 15 of the 82 *P. cincinnatus* were found at T1 and the 1.5% incidence rate is within the range found regionally in the SCB (Perkins and Gartman 1997; Allen *et al.* 1998, 2002). *P. cincinnatus* is found throughout the SCB, most often occurring on Pacific sanddabs. Perkins and Gartman (1997) found that *P. cincinnatus* occurred in 1.4% of the Pacific sanddabs collected near SCB wastewater outfalls, while the SCB regional monitoring surveys found occurrences of 1.1% in 1994 and 3.5% in 1998 (Allen *et al*. 1998, 2002).

In addition to the parasitic eye copepod, five other abnormalities were found in 2011-12. One Dover sole collected at deep Station T14 was affected with a tumor. One other Dover sole collected at T10 had a lesion. Ambicolorism occurred in one Pacific sanddab collected at Station T3. One English sole at Station T13 had a deformity and one unidentified parasite was found on a California skate collected at Station T2.

CONCLUSIONS

Community measures of the fish and EMI populations remained within historical ranges and concentrations of contaminants in fish, were comparable to regional non-POTW values, and below both state and federal human health advisory levels. However, the fish and EMI assemblages near the discharge site have changed, likely as a response to the same influences driving changes in the infaunal community (see Chapter 5). The outfall Station T1 fish community in summer clustered separately from the other middle shelf stations, but clustered with all other 60 m sites in winter suggesting the return to a normal fish community

While the cluster analysis results indicate some impacts from the wastewater discharge, other assessments do not. For example, fish diversity, fish tissue contaminants, epibenthic macroinvertebrate abundance, and regional comparison results suggest that the outfall was not an epicenter of disease. Further, the species assemblages present near the outfall were representative of those found elsewhere on the southern San Pedro shelf.

Comparisons of tissue chemistry burdens between outfall and reference sites are complicated by evidence suggesting that there are no areas of the SCB sufficiently free of contamination to be considered a reference site (Brown et al. 1986). For example, Schiff and Allen (1997) concluded that 100% of certain flatfish species in the SCB are contaminated with DDT and PCB. Similarly, Mearns *et al.* (1991) found that there are no regional patterns in fish tissue mercury concentrations within the SCB.

Comparison between sites is further complicated by the transitory nature of fishes. In making these comparisons we assume that the location of capture is also the location of exposure. Generally, concentrations of contaminants in fish tissues are highest in fish residing near the source of the contaminant (Mearns *et al.* 1991). However, demersal fish with large ranges may transport contaminants away from the source or be captured away from the primary location of exposure (Allen 2006b). Little is known about the migratory patterns of the fish species used in the District's ocean monitoring program. Immigration of fish into the monitoring area may account for the occasional high tissue concentrations of some contaminants (e.g., DDT and PCB).

Overall, the results from the 2011-12 trawl monitoring indicate that normal fish and epibenthic macroinvertebrate communities are present within the District's monitoring area and that the outfall is not an epicenter of disease and that NPDES permit compliance criteria C.5.a, C.5.b., and C.5.c were met.

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