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US Army Corps of Engineers
New England District

New Bedford Harbor Operable Unit #3 Sediment and Biological Data Summary Report

New Bedford, Massachusetts

Contract No. W912WJ-09-D-0001-0005-05

Prepared For:
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New England District
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1.0 EXECUTIVE SUMMARY

This report presents and discusses the data from the analysis of sediment and biological samples collected in 2009 in support of a Remedial Investigation for Operable Unit #3, New Bedford Harbor Superfund Site. These data were obtained within OU#3 and at a reference area in Sippican Harbor, Marion, MA (Figure 1).

The sampling program obtained data on PCB concentrations in sediment and biota, sediment TOC, biota lipids, grain size, benthic community analysis, and toxicity in intertidal, nearshore and offshore habitats throughout the Site and at corresponding habitats in the reference area, and two surface water samples. However, this report discuses only the PCB concentrations in biota and sediment and certain ancillary data (the sediment TOC and grain size, and biota lipids).

The data presentations include summaries of the PCB concentrations and ancillary data that:

- Describe the PCB concentrations in sediment and biota at various stations throughout the Site;
- Compare the Site and Reference Area PCB concentrations in sediment and tissue;
- Compare PCB concentrations in sediment and biota by habitat (intertidal, marsh, nearshore and offshore environments, and areas of concern near the Cap and hurricane barrier);
- Describe the spatial distribution of PCB concentrations;
- Describe patterns of homologue contribution to total PCBs in sediment and tissue;
- Compare sediment and tissue data with concentrations from the literature that indicate a potential for adverse ecological effects.

This report includes the following sections:

- **Section 2. Background:** provides background on sampling conducted as part of the Remedial Investigation (RI) for OU#3, focusing on sediment and biological sampling;
- **Section 3. Data Analyses**: describes methods used to analyze the data and the specific questions addressed by the analyses;
- **Section 4. Data Summary**: presents the data and describes major findings;
- **Section 5. General Observations:** summarizes trends observed in data.

2.0 SEDIMENT AND BIOLOGICAL SAMPLING

The Field Sampling Plan (Woods Hole Group, 2009a), Field Reconnaissance Plan (Woods Hole Group, 2009b), Quality Assurance Project Plan (QAPP, Woods Hole Group, 2009c), and Field Sampling Report (Woods Hole Group, 2010) describe in detail the types and numbers of samples collected, as well as sampling methods.

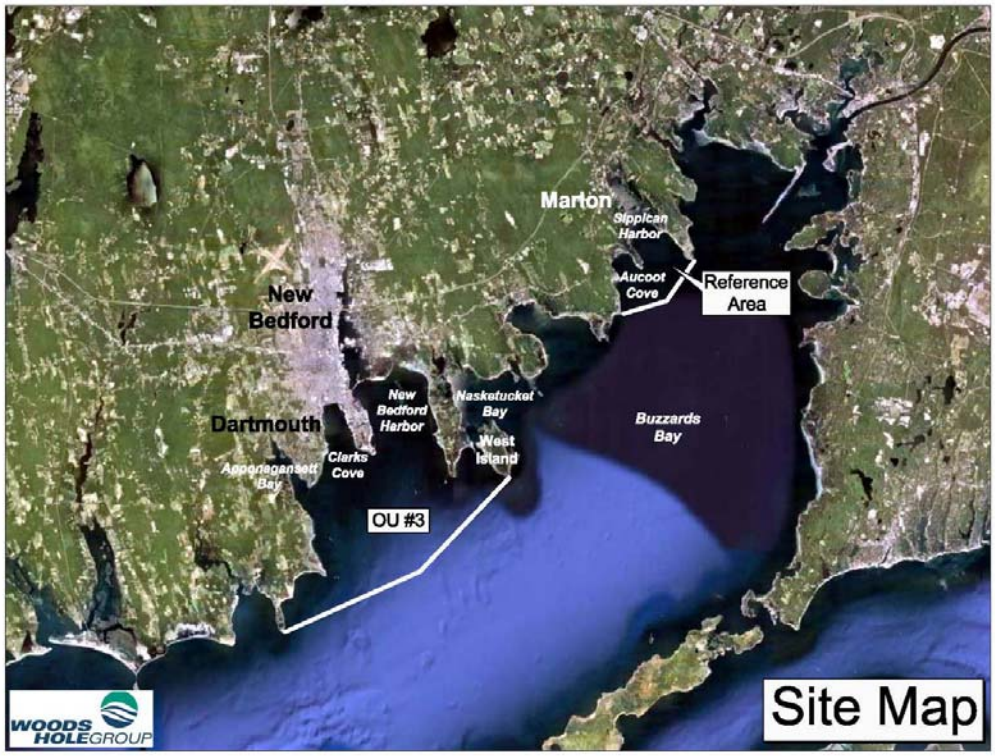


Figure 1. Site Map - New Bedford Harbor OU#3 and Reference Area

2.1 SAMPLE LOCATIONS

Figures 2 and 3 show the locations of sediment samples collected at various locations within OU#3 and in the Reference Area (Figure 3). Figures 4 and 5 show the locations of biota samples obtained at OU#3 and reference locations. Table 1 summarizes the number of samples originally planned and finally collected.

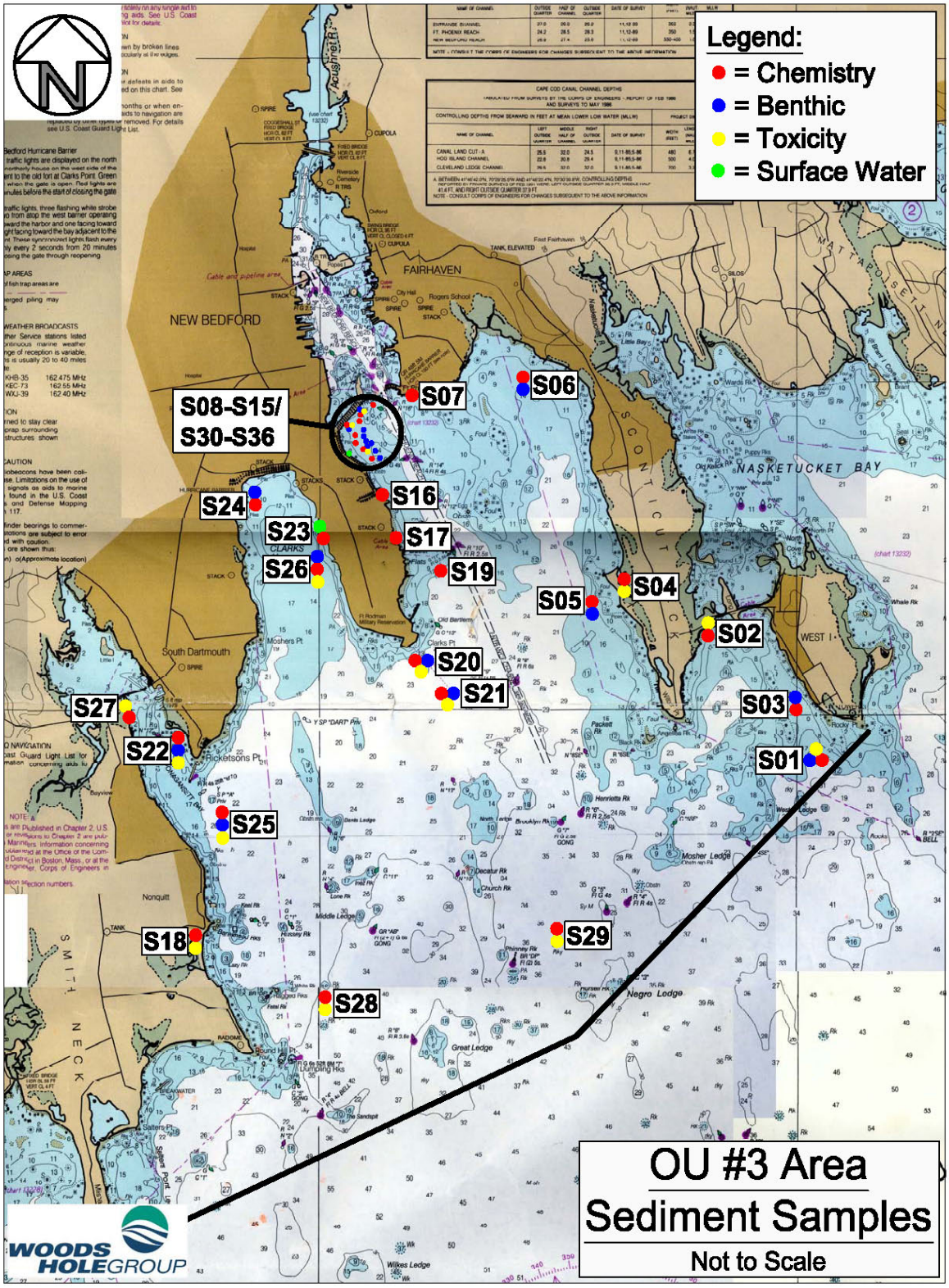


Figure 2. Sediment and Surface Water Samples in OU#3

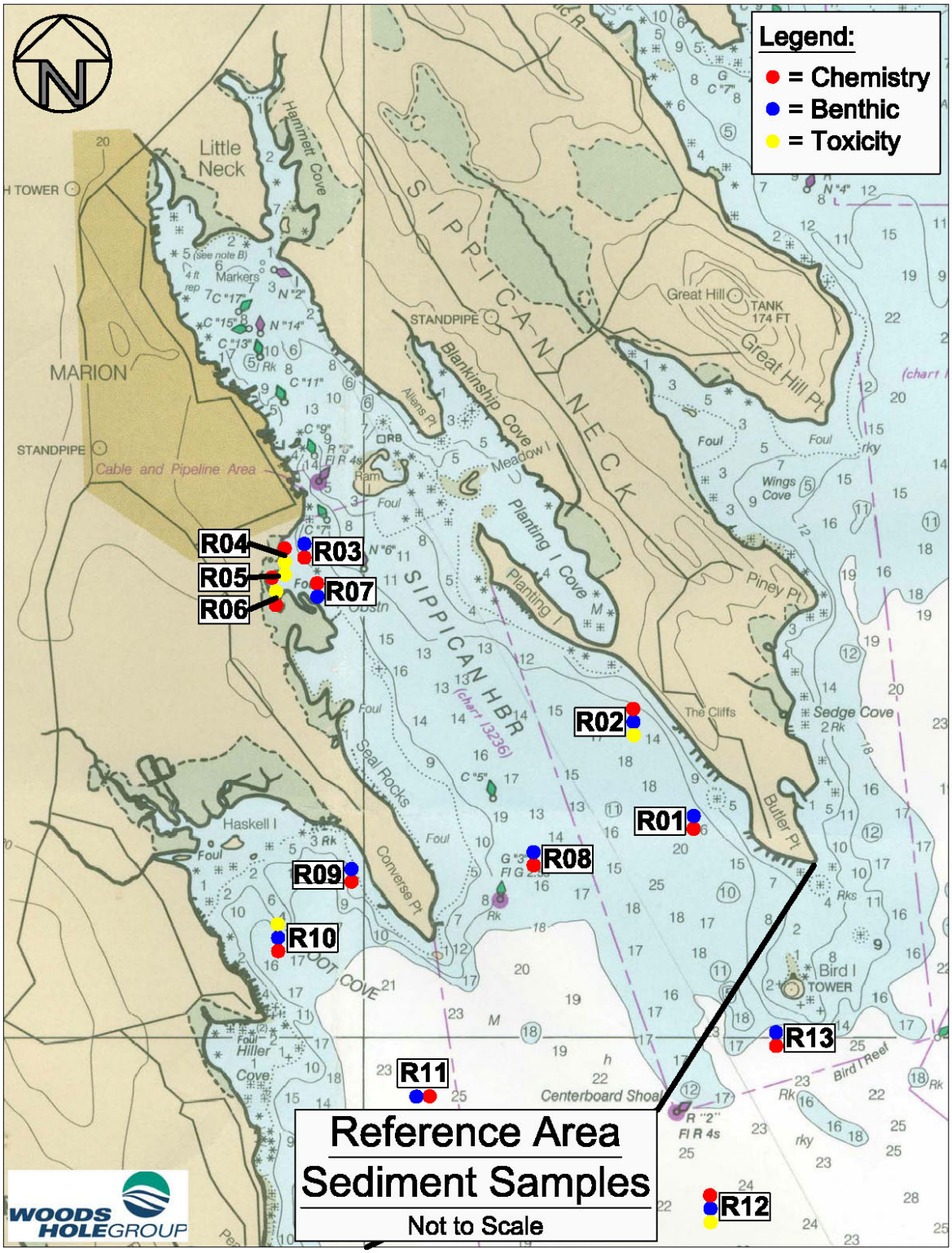


Figure 3. Sediment Samples in the Reference Area

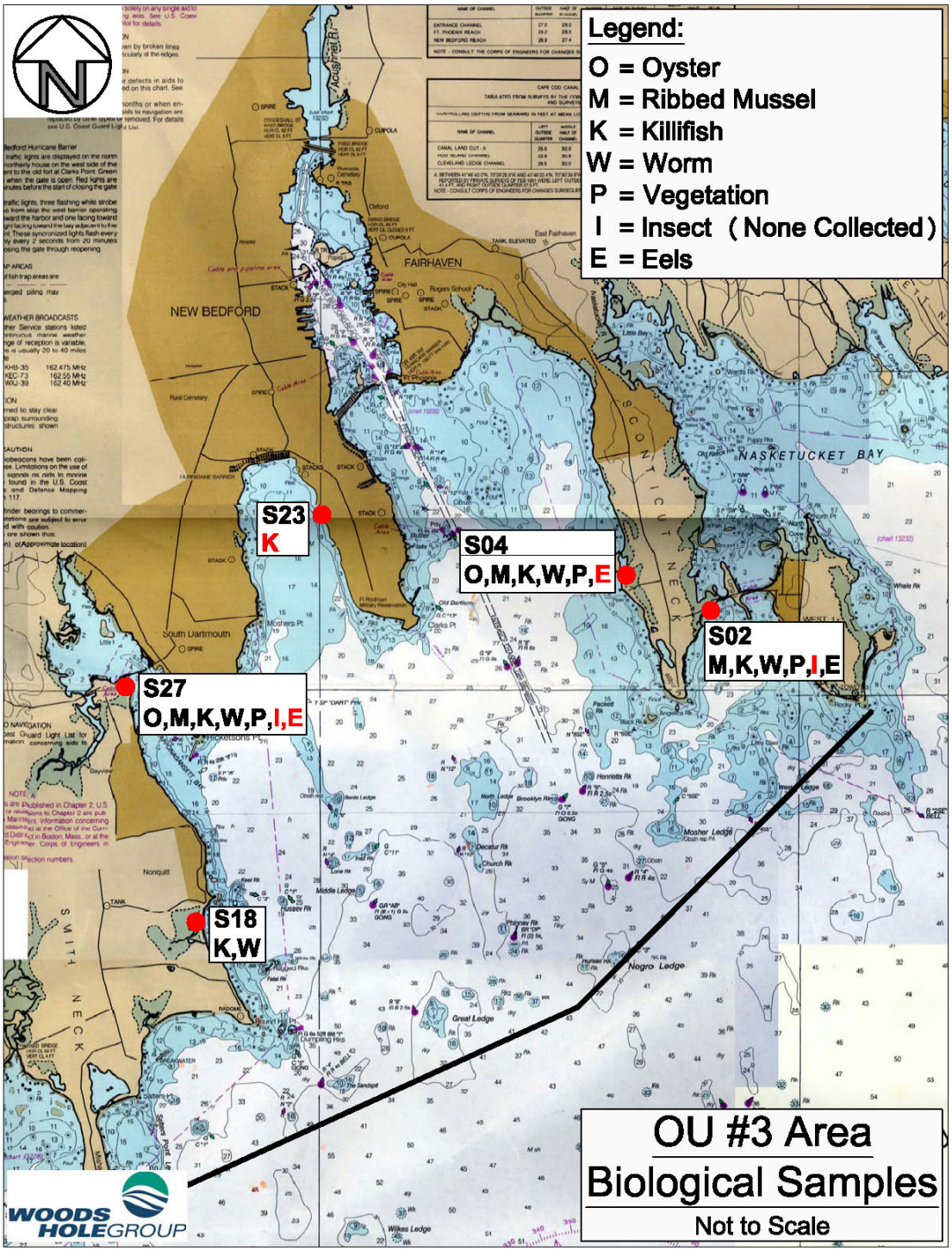


Figure 4. **Biological Samples in OU#3** (red letter on legend indicates samples not obtained).

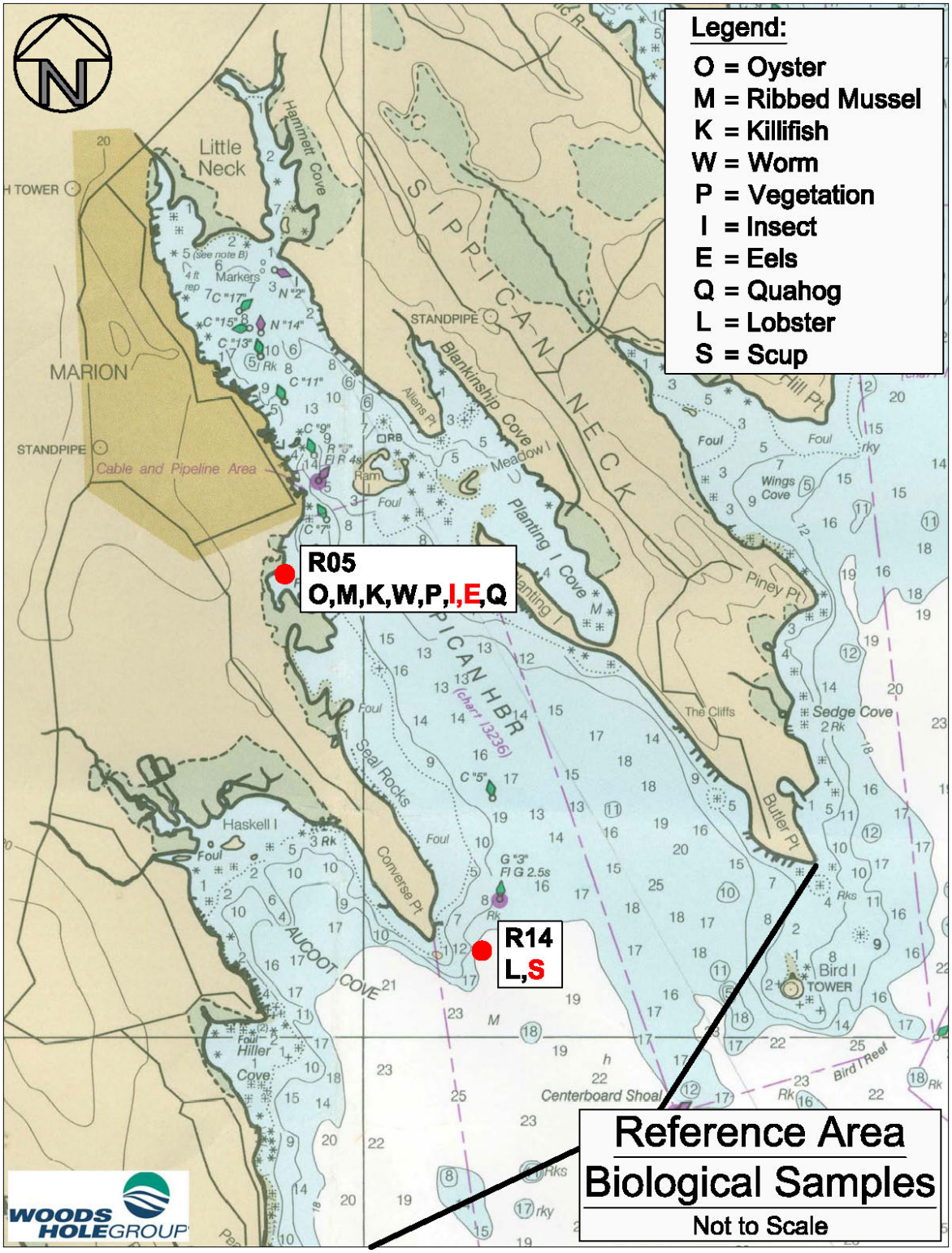


Figure 5. **Biological Samples in the Reference Area** (red letter indicates samples not obtained)

Table 1. Planned and Collected Samples

Sample Type	# Planned	# Collected
Chemistry	42	42
Toxicity	21	21
Benthic	29	29
Oyster	3	2
Ribbed mussel	4	4
Quahog	3	3
Infaunal worms	5	5
Plants	4	4
Lobster meat	1	1
Lobster tomalley	1	1
Scup	1	0
Insects	3	0
Killifish	6	5
Eels	4	1

3.0 DATA ANALYSIS METHODS

This subsection describes the methods used to reduce and summarize the sediment and biota tissue PCB concentrations. It describes the methods used for:

- Initial data reduction to calculate total PCBs;
- Data summaries for each station by habitat in tables and histograms;
- Comparing the site data to reference area data and developing preliminary maps of spatial distribution;
- Providing some perspective on the data by comparing the magnitude of sediment and tissue total PCB concentrations, normalized PCB concentrations, or avian and mammalian TEQs in tissue or sediment to some corresponding values from the literature that suggest a potential for ecological effects.

3.1 DATA REDUCTION

The PCB data are generally presented as total PCBs, total organic carbon (TOC) or lipid normalized PCBs, or homologues in tabular or graphical format.

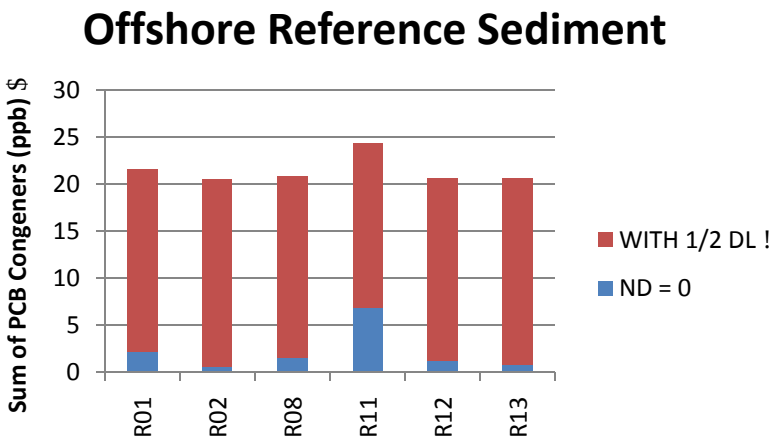
3.1.1 Initial Data Exploration

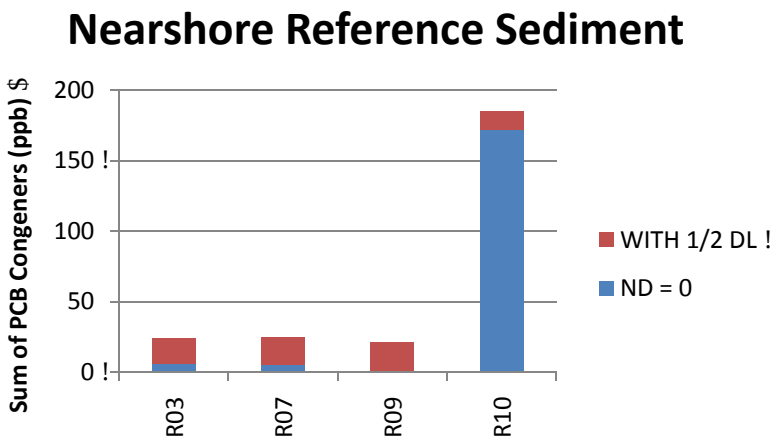
The initial selection of congeners of concern in sediment proceeded by including any congener detected in any sediment sample at OU#3 or the reference area as a congener of concern. Similarly, congeners of concern in tissue were selected as any congener detected in any tissue sample from OU#3 or the reference area. We then assigned a value of one-half the detection limit to any congener of concern not detected in a given sediment or tissue sample. The total PCBs were then expressed as the sum of detected concentrations and one-half the detection limit for non-detected congeners of concern in a given sample.

Our initial data exploration revealed that this process resulted in total PCB concentrations in sediment that were overly influenced by the non-detected congeners. This was particularly the case in the reference areas where as much 100% of the total PCB concentration in a given sample was the result of adding half detection limits for congeners never detected in the reference area samples.

Figure 6 demonstrates the low signal (contribution of detected congeners to total PCBs) to noise (contribution of non-detected congeners to total PCBs) in the various reference samples.

Table 2 demonstrates that the site stations exhibited many more detected congeners than the reference stations.





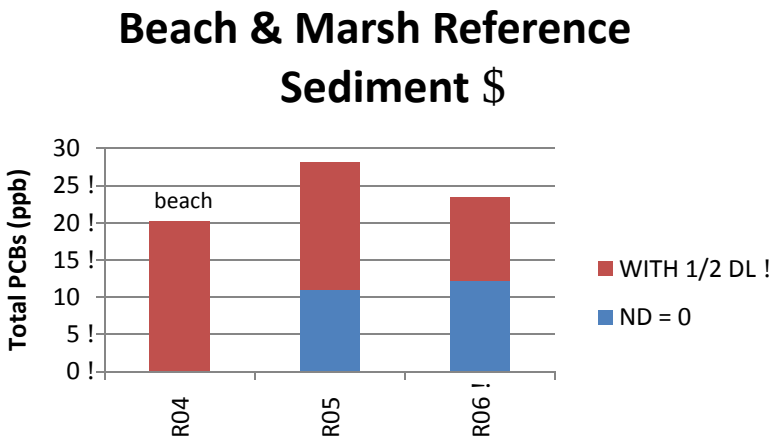


Figure 6. Large contribution of non-detects in reference sediment samples

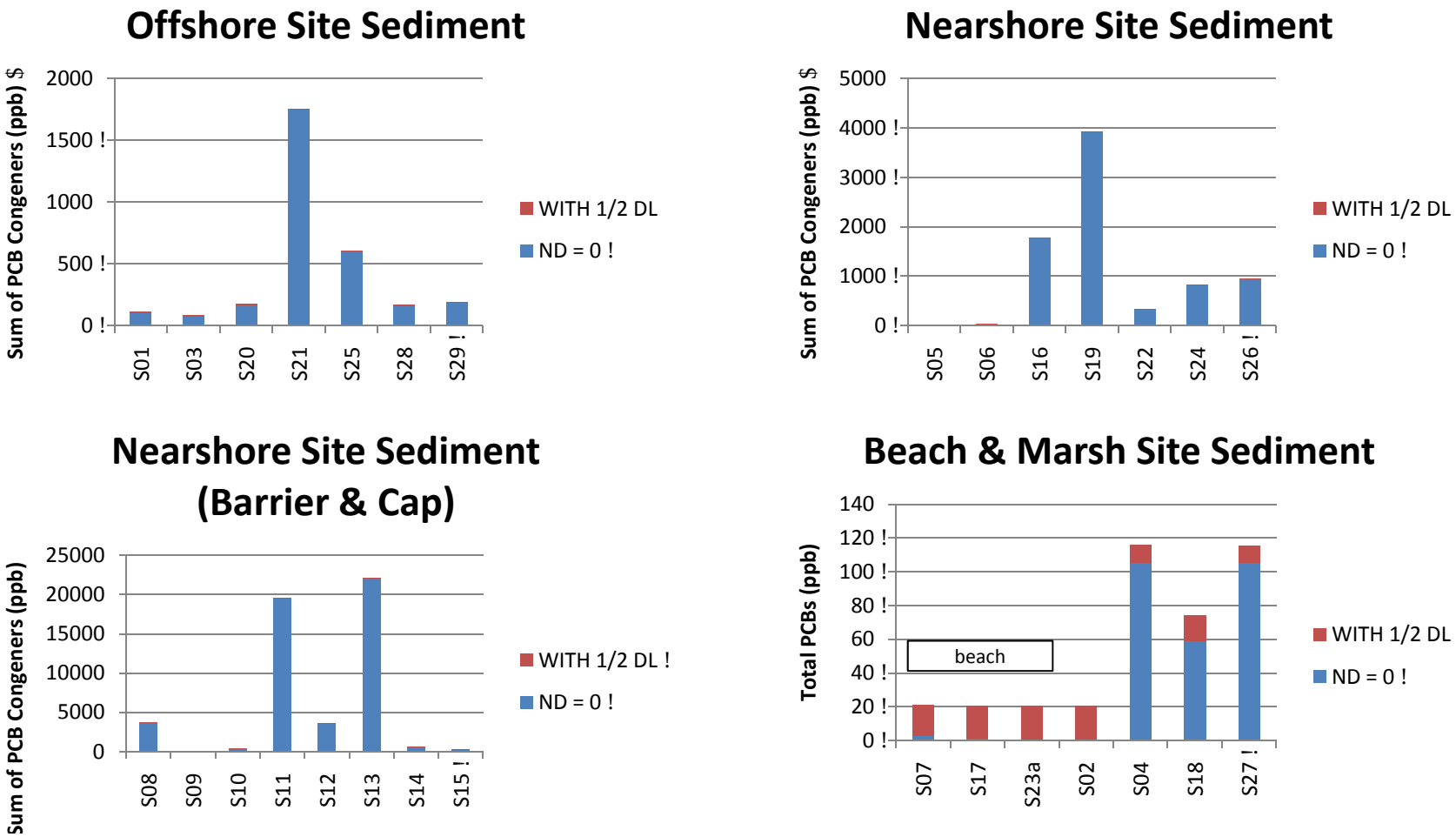


Figure 7. Small contribution of non-detects in site sediment samples

Table 2. Comparison of Range in number of Detected Congeners in sediment at Site and Reference Stations

	Reference	Site	Site (Barrier)	Site (Cap)
Offshore	5 - 32	86 - 148		
Nearshore	6 - 91	35 - 157	77 - 158	115 - 166
Marsh	37 - 41	2 - 84		
Beach	0	6 - 16		

Figure 7 demonstrates that the strong influence of non-detected congeners on reference area sediment samples was not observed in most of the site sediment samples. This dichotomy in the influence of the non-detected congeners introduced artificiality into comparisons of site and reference area sediment samples. Specifically, this process inflated the concentrations of total PCBs in sediment in the reference areas, but had a relatively minor effect on the calculation of total PCBs in site samples.

We therefore modified the procedure for selecting congeners of concern and calculating the total PCB concentrations in sediments from OU#3 and the reference areas.

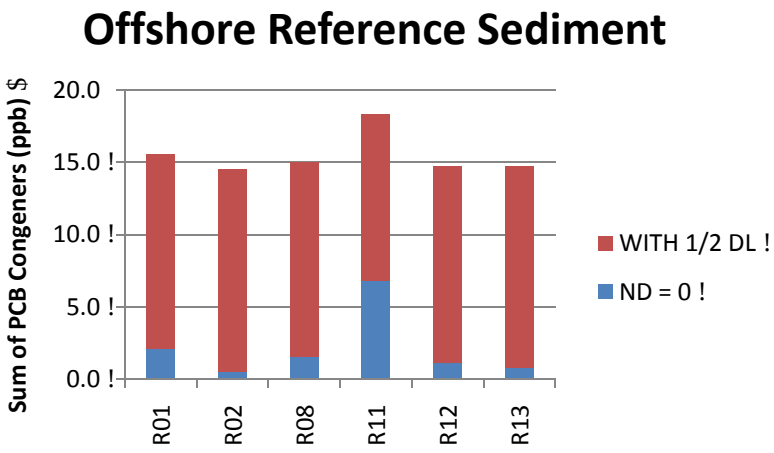
The initial modification was to separately select congeners of concern for OU#3 sediment samples and reference area sediment samples. In this case a congener of concern in OU#3 was any congener detected in any OU#3 sediment sample. Total PCBs in OU#3 samples were represented as the sum of detected congeners plus one-half the detection limit for any congener not detected in a given sample (no change from the initial data exploration). However, reference area congeners of concern were now selected as any congener detected in any reference area sediment sample (modification of initial data exploration). Total PCBs in reference area samples were represented as the sum of detected congeners plus one-half the detection limit for any congener not detected in a given sample.

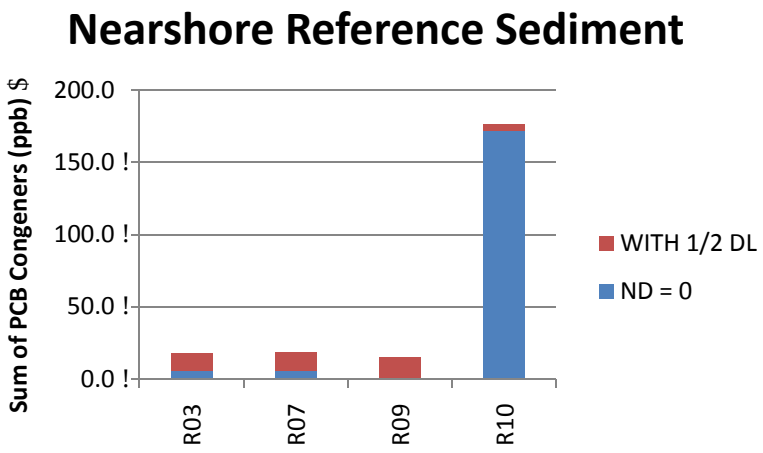
The results of this modification did not substantially increase the signal to noise ratio as described above. Although fewer congeners were selected as congeners of concern in the reference areas using this method, the non-detected congeners still contributed significantly to the total PCB calculation (Figure 8) in reference areas. This observation was driven by the relatively large number of detected congeners in one reference area sample, R-10.

We therefore made a final modification which simply uses only detected concentrations of congeners in the calculation of total PCBs in sediment samples. That is for any given sample, total PCBs were calculated as the sum of detected congeners with non-detected congener concentrations set to zero.

We observed a similar pattern of the effect of non-detected congeners in *Spartina* and oyster tissue, and to a lesser extent in other tissue types. Therefore, we applied the same process for calculating total PCBs in tissue as used for sediment samples. Table 3

demonstrates that the site stations exhibited many more detected congeners in various tissue samples than the reference stations.





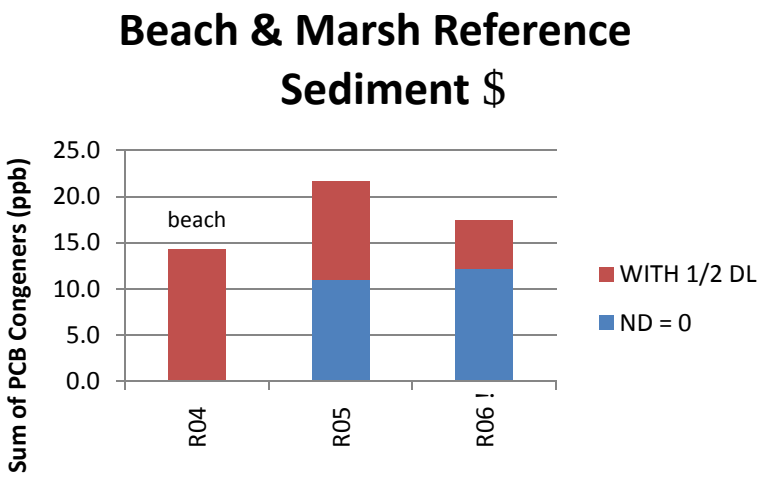


Figure 8. Large contribution of non-detects in reference sediment samples (initial modification of method)

Table 3. Comparison of Range in number of Detected Congeners in Tissue at Site and Reference Stations

	Reference	Site
Spartina	10	24 – 46
Worm	37	56 – 85
Oyster	22	89 – 100
Quahog	3 – 11	Not Obtained
Mussel	14	53 – 68
Lobster	16 – 84	Not Obtained
Killifish	60	50 – 128
Eel	Not Obtained	98

3.2 COMPARISON BETWEEN SITE STATIONS AND REFERENCE AREA STATIONS

The data from four habitats (salt marsh, nearshore stations, Cap/Barrier stations, and offshore stations) were compared to their respective reference stations. Table 4 shows the site station locations and their respective reference stations. Note that the reference area has neither a cap nor a hurricane barrier environment. Therefore we used the nearshore reference stations as the basis of comparison for these site samples.

Table 4. Designation of Site and Reference Stations

	Offshore	Nearshore	Cap/Barrier	Marsh	Beach
Reference Stations	R01	R03	R03	R05	R04
	R02	R07	R07	R06	
	R08	R09	R09		
	R11	R10	R10		
	R12				
	R13				
Site Stations	S01	S05	S08	S02	S07
	S03	S06	S09	S04	S17
	S20	S16	S10	S18	S23
	S21	S19	S11	S27	
	S25	S22	S12		
	S28	S24	S13		
	S29	S26	S14		
		S08	S15		

The reference areas were selected on the basis of similarity of habitat to site stations, and general similarity in grain size and TOC.

The data comparisons included:

- Tables and histograms comparing the sediment total PCB concentrations at each site station within a specific habitat to their respective reference area total PCB concentrations;
- Tables and histograms comparing the biota (species by species) total PCB concentrations at each site station to their respective reference area biota total PCB concentrations;
- Maps depicting the spatial distribution of total PCBs in OU#3;
- Histograms comparing the homologue concentrations in each site station to the homologue concentrations in each appropriate reference area station by habitat;
- Histograms comparing total PCBs, individual congeners, or TEQs in biota to concentrations from the literature that indicate potentially adverse ecological effects.

3.3 METHODS FOR PROVIDING PERSPECTIVE ON PCB DATA IN SEDIMENT AND TISSUE

We provided some perspective on the data by comparing the magnitude of sediment and tissue total PCB concentrations to some corresponding values from the literature that suggest a potential for ecological effects. These values are not regulatory endpoints nor are they the product of a site specific toxicity assessment (which would be part of a site specific ecological risk assessment). They are offered to provide some basis for discussing the data.

3.3.1 Suggested potential effect levels for total PCBs in sediment

- NOAA ER-L = 23 ppb dry weight;
- NOAA ER-M = 180 ppb;
- Gobas and Arnot (2010) provided some total sediment PCB targets for protection of various species, developed for San Francisco Bay. These values range from 1.6 ppb dry weight (d.w.) for protection of marine mammals to 24 ppb d.w. for protection of cormorants.

3.3.2 Suggested potential effect levels for sediment TEQs

Toxic Equivalents (TEQs) are generally are calculated in prey or food and the corresponding endpoint is the dose. However, some investigators from Michigan and USEPA have offered an avian TEQ (TOC normalized) in sediment that they feel may conservatively be interpreted as protective of higher order predator birds. This endpoint is:

- Froese et al (1998): threshold concentration of TEQ in sediments for protection of birds at top of a sediment based food chain = 0.15 ng TEQ/g TOC.

3.3.3 Suggested potential effect levels for individual sediment PCB congeners

Investigators in the Netherlands offered some TOC normalized PCB congener concentrations that they associated with potential effects. These are:

- van Wezel et al. (1999) offer TOC normalized concentrations of several congeners that they identify as environmental risk limits based on all toxicity data reviewed (congener 77), the most sensitive toxicity value among those reviewed (congener 105), or toxicity to mammals and birds (congeners 118, 126, 153, 156, 157, 169).

3.3.4 Suggested potential effect levels for tissue from EPA/SETAC Data Base

Jarvinen and Ankley (1999) offer a range of toxicity residue values for various Aroclors and unspecified PCB mixtures. We recognize that there have been subsequent contributions to this literature. However, as a first cut at providing some perspective on the body burden data, we used no effect levels for those species with measured body burdens at OU#3 (or closely related species). These data include tissue concentrations of Aroclors or PCB mixtures in adult whole body tissue at no effect levels of:

- Sandworm = 0.63 ppm;
- Sheepshead minnow = 49 ppm to 110 ppm;
- Grass shrimp = 0.10 ppm to 18 ppm;
- Hard Clam = 0.12 ppm;
- Oyster = 33 ppm.

3.3.5 Suggested potential effect levels from Hudson River Revised Baseline Ecological Risk Assessment

EPA's Hudson River provides no effect total PCB and TEQ endpoints for body burdens in some fish species that are protective of fish, birds, and mammals (in section 4 tables http://www.epa.gov/hudson/revisedbera-tables.pdf). We used these to provide perspective on the tissue data. These are among the lower values offered by EPA in their review of data. They include:

- Fish endpoint for protection of higher-trophic level fish species (striped bass) = 0.19 ppm total PCBs;

- Mammal endpoint protection from ingestion of food (fish) = 0.0003 ppb dioxin TEQ;
- Mammal endpoint protection from ingestion of food = 0.66 ppm total PCBs;
- Bird endpoint protection from ingestion of food = 0.091 ppb to 5.41 ppb TEQ;
- Bird endpoint protection from ingestion of food = 0.61 ppm to 17.9 ppm total PCBs.

4.0 DATA SUMMARY

4.1 TOTAL PCBS IN SEDIMENT AND BIOTA

Table 5 and Figure 9 summarize the bulk and TOC-normalized PCB concentrations in sediment. Figures 11 and 12 show the spatial distribution of bulk total PCB concentrations in sediment and TOC normalized concentrations of PCBs in sediment, respectively. Tables 7 to 11 provide station specific breakdowns of these data from the marsh habitats (where most of the tissue samples were obtained). The PCB concentrations are generally higher at OU#3 Site stations than at the reference stations. Specifically:

- Offshore samples indicate total PCBs are 140 to 3,500 times higher than reference stations;
- Nearshore samples indicate total PCBs are 15 to 24,600 times higher than reference stations (one of the nearshore reference samples (R10) is elevated relative to other reference stations);
- Total PCBs in site marsh samples are up to 10 times greater than reference marsh samples. However total PCBs at one site station (S02) are lower than reference marsh stations. Sediment from S02 is predominantly sandy and the PCB concentration better reflects a beach sample. Excluding S02, total PCB concentrations in sediment are consistent across the marshes sampled in OU#3.
- PCBs were not detected at the reference beach station, and are relatively low at site beach stations.

Table 5. Total PCBs in Sediment

	Total PCBs (ppb)		**TOC-Normalized Total PCBs (ppb)**	
	Reference	**Site**	**Reference**	**Site**
Offshore	0.5 - 6.8	73.2 - 1752.9	571 - 2743	14126 - 172104
Nearshore[1]	0.9 - 171.6	13.1 - 22139.6	610 - 11712	8910 - 2021880
Marsh	11 - 12.2	0.3 - 105.8	485 - 603	114 - 20271
Beach	0 - 0	0.7 - 2.9	0 - 0	1983 - 5503

1. Includes Cap/Barrier stations

Table 6 and Figure 10 summarize the bulk and lipid-normalized PCB concentrations in tissue. Figures 13 and 14 show the spatial distribution of total PCB concentrations in tissue samples and lipid normalized concentrations of PCBs in tissue, respectively. Tables 7 to 11 provide station specific breakdowns of these data from the marsh habitats (where most of the tissue samples were obtained). Bulk and lipid-normalized PCB concentrations in tissue are generally higher in OU#3 than the reference area. Specifically:

- Total PCBs in *Spartina* in OU#3 are 4 to 13 times higher than the reference area;
- Total PCBs in worms from OU#3 are 2 to 6 times higher than the reference area;
- Total PCBs in oyster from OU#3 are 25 to 39 times higher than the reference area;
- The sum of 136 PCB congeners as recently reported by the Massachusetts Division of Marine Fisheries (MADMF, 2010), in quahogs from OU#3 are up to 367 times higher than the sum of these same congeners in reference area samples. One of the ten OU#3 quahog samples from the MADMF survey has lower levels of PCBs than those collected by Woods Hole Group from the reference area;
- Total PCBs in Mussel from OU#3 are 7 to 13 times higher than the reference area.
- The sum of 136 PCB congeners as recently reported MADMF (MADMF, 2009) in lobster muscle from OU#3 are 2 to 18 times higher than the Reference area. The sum of 136 PCBs, as measured by MADMF, in lobster tomalley from OU#3 are 3 to 18 times higher than the Reference area.
- Total PCBs in killifish and eel from OU#3 are up to 16 times higher than in similar tissue from the reference area. One of the killifish samples from OU#3 (S18) has a total PCB body burden less than the reference killifish sample.
- At the reference area marsh, the number of detected congeners in sediment were generally higher than the number of detected congeners in tissue (with the exception of killifish).
- At site stations (with one exception), the number of detected congeners in oysters and killifish exceeded the number of detected congeners in sediment.
- The spatial distribution of PCBs (expressed on a TOC normalized basis) indicate that the highest concentrations of PCBs in outer New Bedford Harbor occur near the cap and hurricane barrier, along the shore of Clarks Point, at the treatment plant outfalls, in Clarks Cove and offshore of Apponagansett Bay.

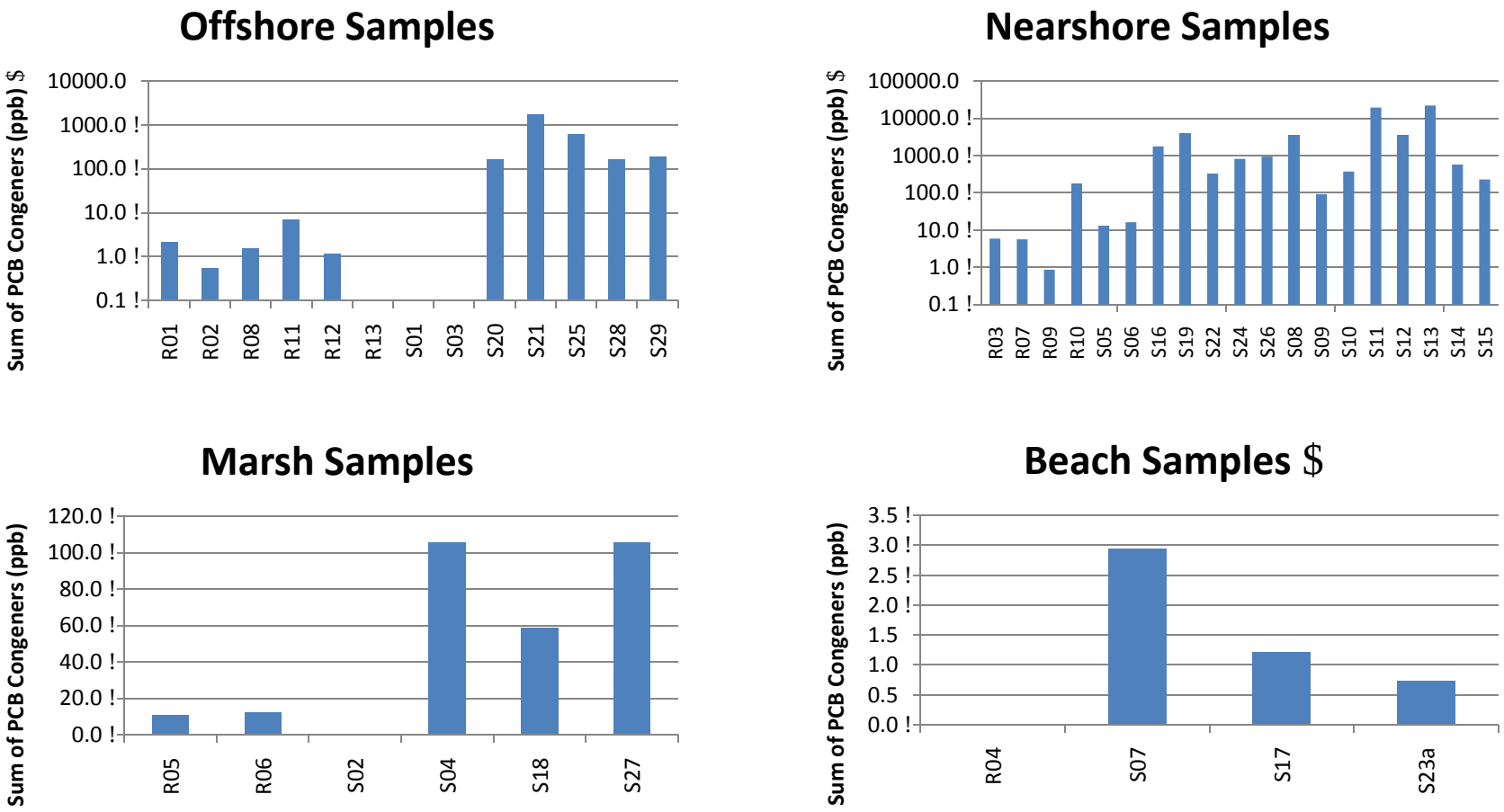


Figure 9. Total PCBs in Sediment

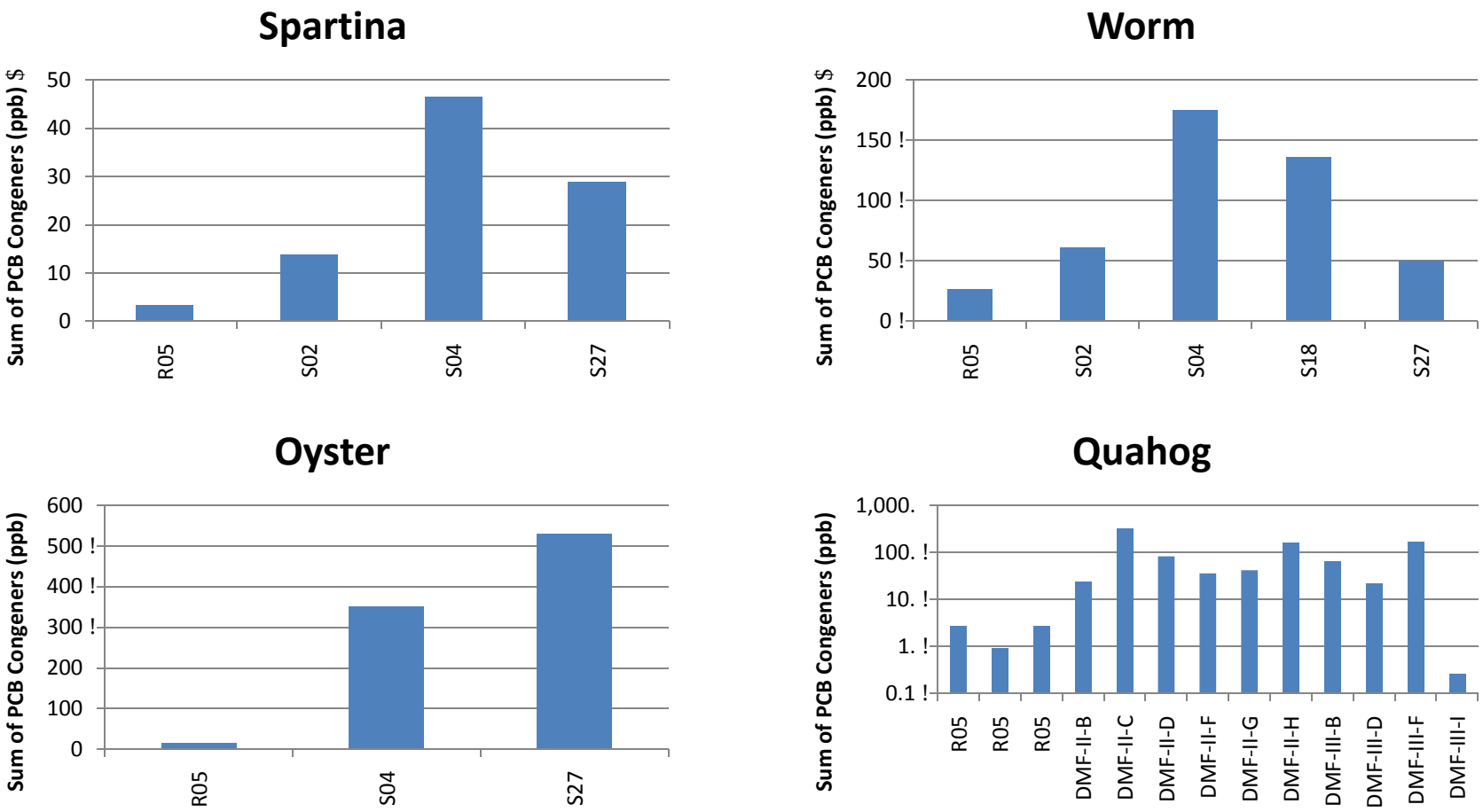


Figure 10. Total PCBs in Tissue

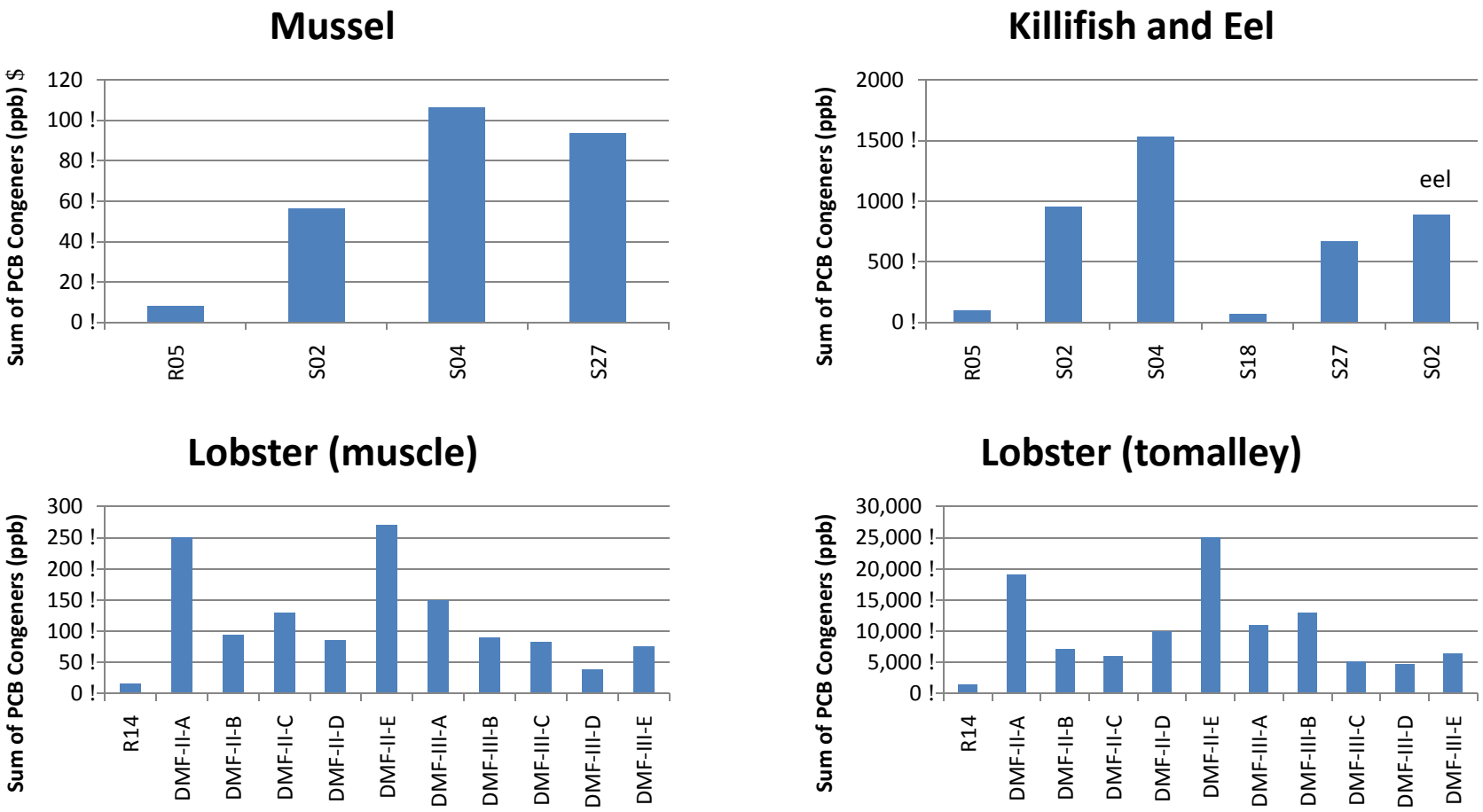


Figure 10 (cont). Total PCBs in Tissue

Table 6. Total PCBs in Tissue

	Total PCBs (ppb)		Lipid-Normalized Total PCBs (ppb)	
	Reference[1]	**Site[2,3]**	**Reference[1]**	**Site[2,3]**
Spartina	3.5	13.8-46.5	N/A	N/A
Oyster	26.9	50-175	3476	16802-34185
Worm	13.7	351.4-529.7	2425	53903-58987
Quahog	0.9-2.8 / [0.9-2.8]	[0.27-330]	305-1228 / [305-1228]	[75-150000]
Mussel	7.9	56.4-106.4	1814	13420-31567
Lobster (Muscle)	15.4 / [15.4]	[38-270]	3019 / [3019]	[633-29348]
Lobster (Tomalley)	1416.7 / [1394.6]	[4700-25000]	10341 / [10180]	[7833-38462]
Killifish/Eel	97.8	69.3-1532.6	3621	4441-41310

1. Bracketed concentrations represent recalculated Total PCBs to match MA DMF 136 Congeners
2. 2008 Post-Spawn (October) Quahog Collection, MA DMF Seafood Monitoring Program - Total PCBs from 136 Congeners
3. 2007 Lobster Collection, MA DMF Seafood Monitoring Program - Total PCBs from 136 Congeners

Table 7. Marsh Station Summary R05

Marion Marsh Interior - R05						
	Grain size (F%/S%/G%)	**TOC %**	**Lipid %**	**# Congeners Detected**	**Total PCB (ppb)**	**TOC/Lipid Normal Total PCBs (ppb)**
Sediment	13.7%/61.2%/7.5%	2.28	-	41	11	485
Worms		-	0.774	37	26.9	3476
Mussels		-	0.435	14	7.9	1814
Oysters		-	0.565	22	13.7	2425
Quahogs		-	0.221-0.304	3-11	0.9-2.8	305-1228
Killifish		-	2.7	60	97.8	3621
Spartina		-	-	10	3.5	-

Table 8. Marsh Station Summary S02

Hoppys Landing Marsh - S02						
	Grain size (F%/S%/G%)	**TOC %**	**Lipid %**	**# Congeners Detected**	**Total PCB (ppb)**	**TOC/Lipid Normal Total PCBs (ppb)**
Sediment	6.5%/86%/3%	0.290	-	2	0.3	114
Worms		-	0.327	57	61.4	18768
Mussels		-	0.42	53	56.4	13420
Oysters		-	-	-	-	-
Killifish		-	3.12	120	953.1	30548
Spartina		-	-	24	13.8	-

Table 9. Marsh Station Summary S04

Winsegansett Marsh - S04						
	Grain size (F%/S%/G%)	**TOC %**	**Lipid %**	**# Congeners Detected**	**Total PCB (ppb)**	**TOC/Lipid Normal Total PCBs (ppb)**
Sediment	6.9%/90.2%/1%	0.52	-	84	105.4	20271
Worms		-	0.512	85	175	34185
Mussels		-	0.337	68	106.4	31567
Oysters		-	0.652	89	351.4	53903
Killifish		-	3.71	128	1532.6	41310
Spartina		-	-	46	46.5	-

Table 10. Marsh Station Summary S18

Nonquitt Marsh - S18						
	Grain size (F%/S%/G%)	**TOC %**	**Lipid %**	**# Congeners Detected**	**Total PCB (ppb)**	**TOC/Lipid Normal Total PCBs (ppb)**
Sediment	44.8%/55.2%/0.1%	3.655	-	71	58.6	1605
Worms		-	0.809	84	135.9	16802
Mussels		-	-	-	-	-
Oysters		-	-	-	-	-
Killifish		-	1.56	50	69.3	4441
Spartina		-	-	-	-	-

Table 11. Marsh Station Summary S27

Apponogansett Marsh - S27						
	Grain size (F%/S%/G%)	**TOC %**	**Lipid %**	**# Congeners Detected**	**Total PCB (ppb)**	**TOC/Lipid Normal Total PCBs (ppb)**
Sediment	13.4%/77.6%/4.4%	1.225	-	83	105.8	8635
Worms		-	0.218	56	50	22938
Mussels		-	0.356	68	93.8	26337
Oysters		-	0.898	100	529.7	58987
Killifish		-	3.15	109	666.1	21146
Spartina		-	-	37	28.9	-

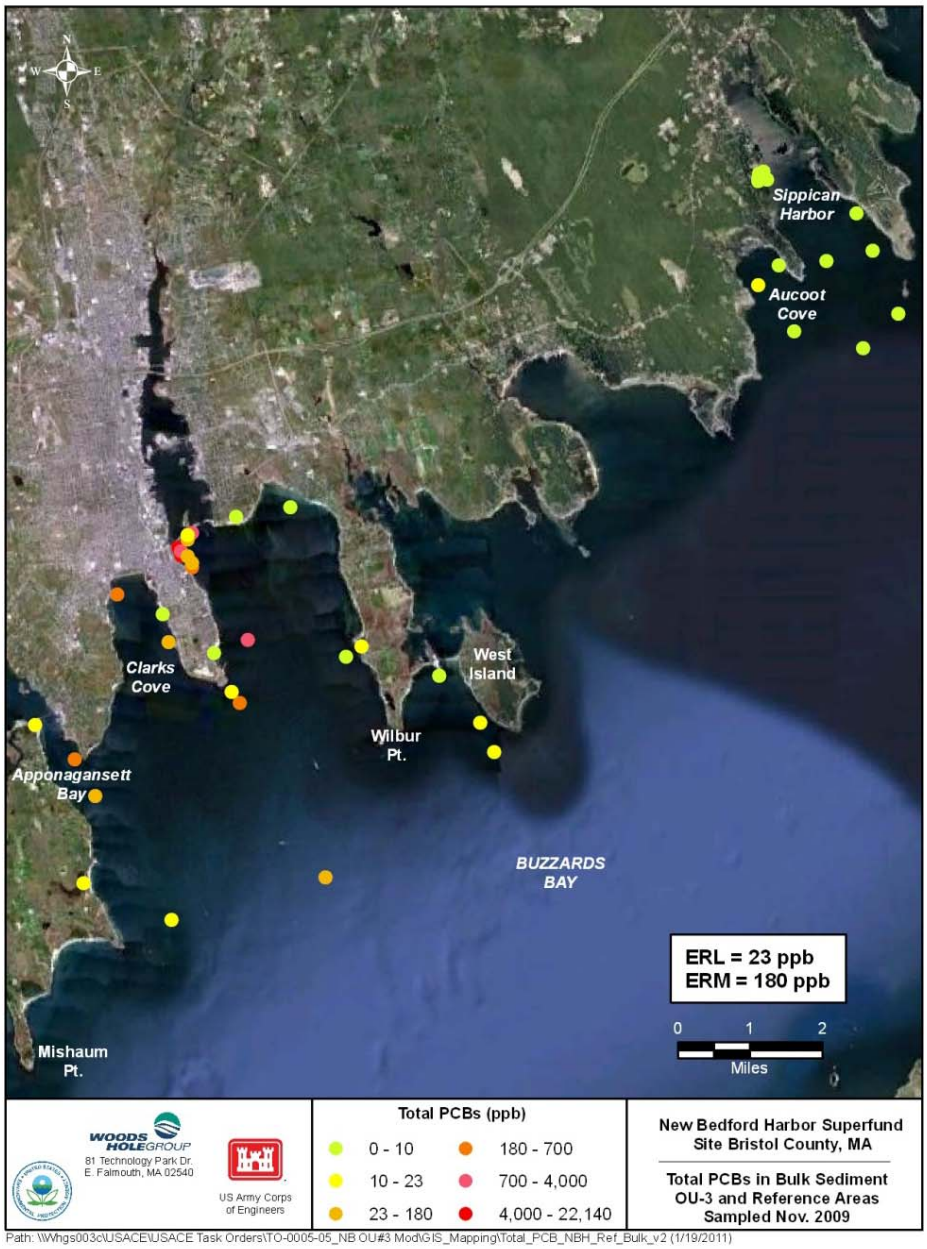


Figure 11. Total PCBs in Sediment

Figure 12. TOC-normalized PCBs in Sediment

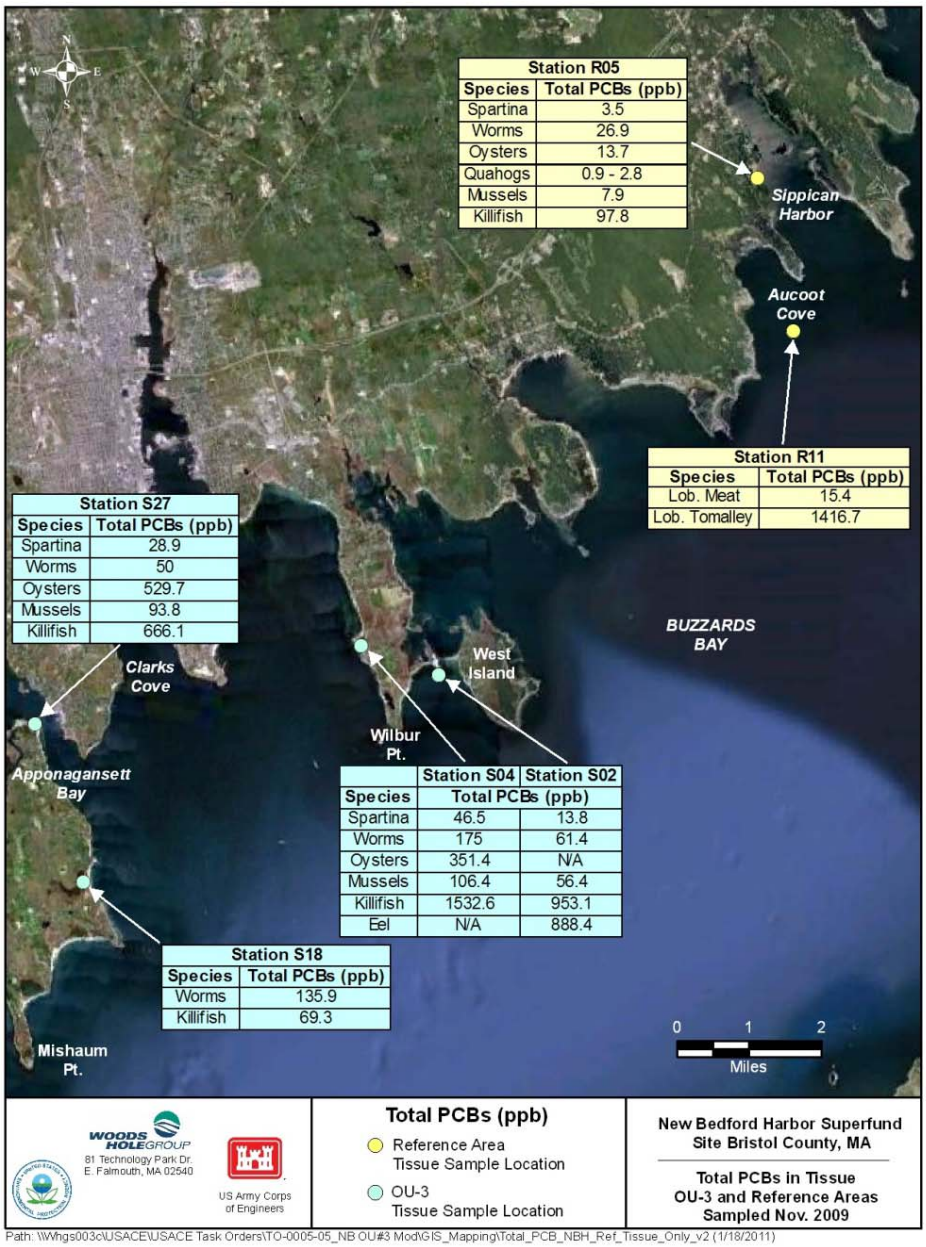


Figure 13. Total PCBs in Tissue

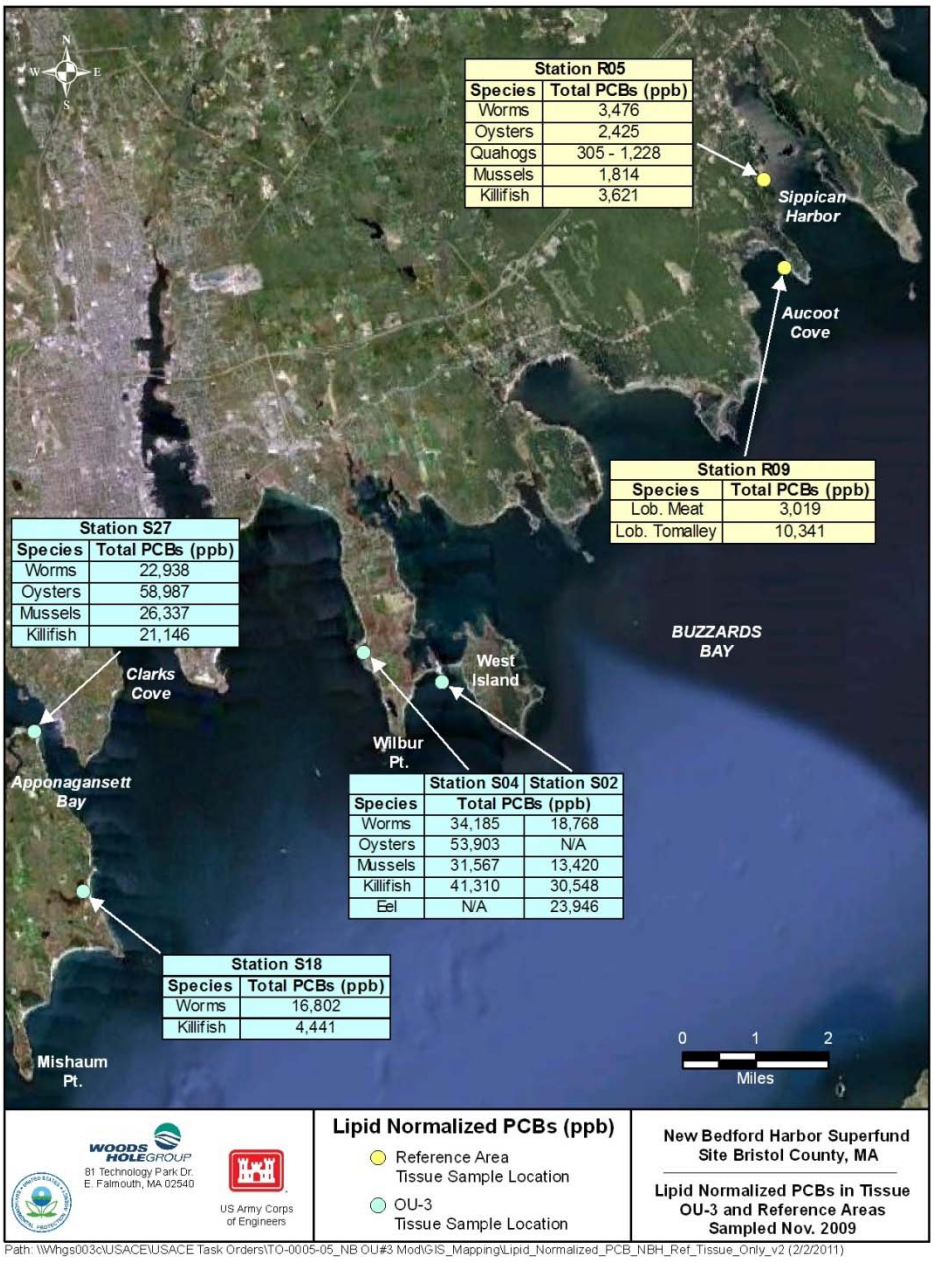


Figure 14. Lipid-normalized PCBs in Tissue

4.2 HOMOLOGUE ANALYSIS

We performed an analysis of the distribution of homologues to determine if there were any qualitative patterns in PCBs among the habitat areas (Figure 15). The figures show that:

- Offshore samples are predominantly mid-range homologues (Tri-, Tetra-, Penta-, and Hexachlorobiphenyls);
- Homologue patterns in Nearshore samples are similar to those of Offshore samples, with the exception of S16. Nearshore Site sample S16 is proportionally higher in Di- and Trichlorobiphenyl than other Nearshore or Offshore samples;
- Sediments from the Nearshore cap/barrier area similarly show proportionally higher fractions of Di- and Trichlorobiphenyl;
- Marsh samples, with the exception of S02, are like Offshore and Nearshore samples in composition (predominantly Tri-, Tetra-, Penta-, and Hexachlorobiphenyls). Marsh sample S02 is predominantly composed of the lighter homologues (Di- and Trichlorobiphenyl), displaying a pattern similar to the Beach samples. There were very few congeners detected in the Beach samples, so small differences in the detected values among these samples can significantly influence the homologue distribution.

In general homologue distributions are similar within habitats and fairly consistent between habitats.

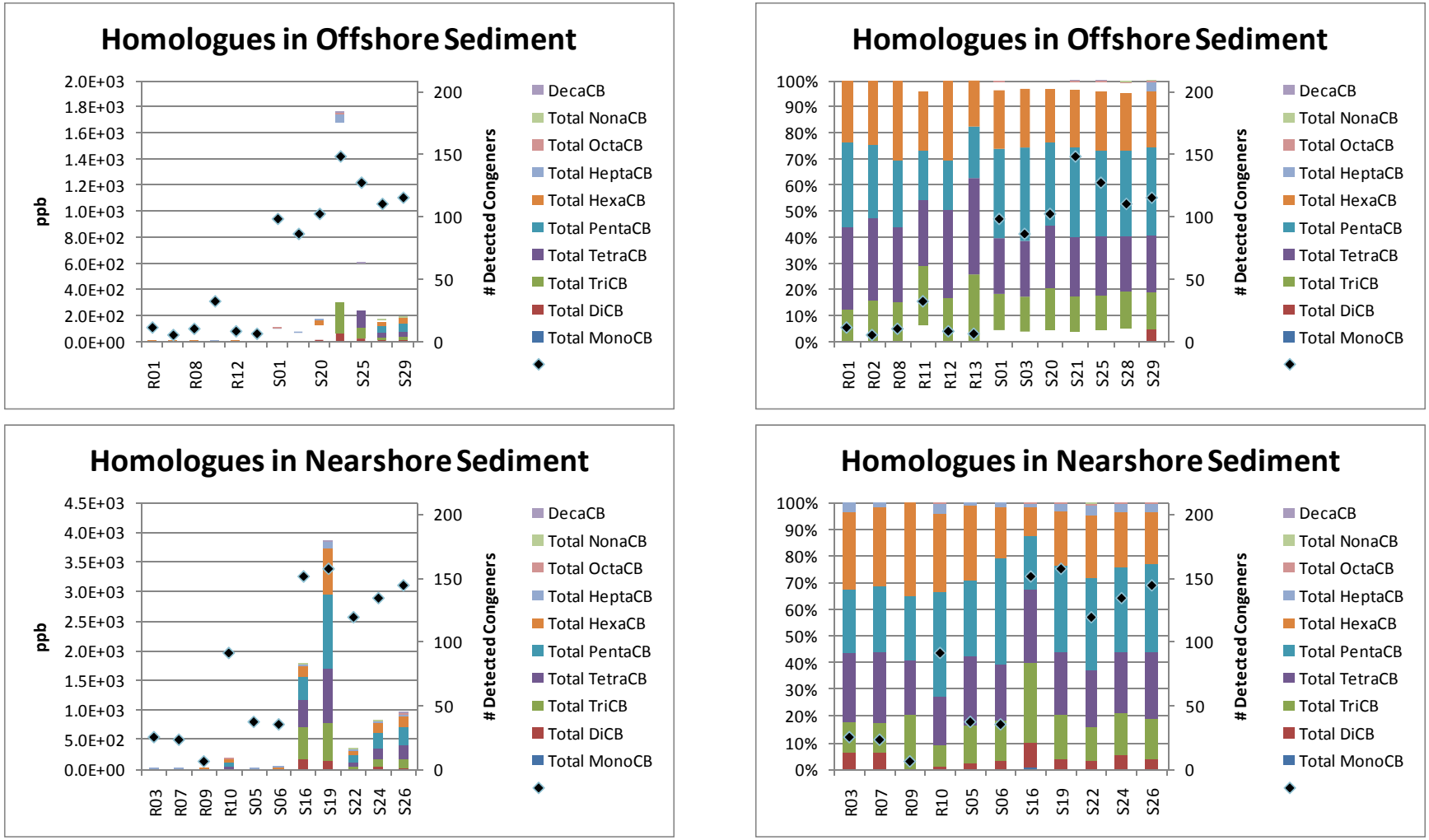
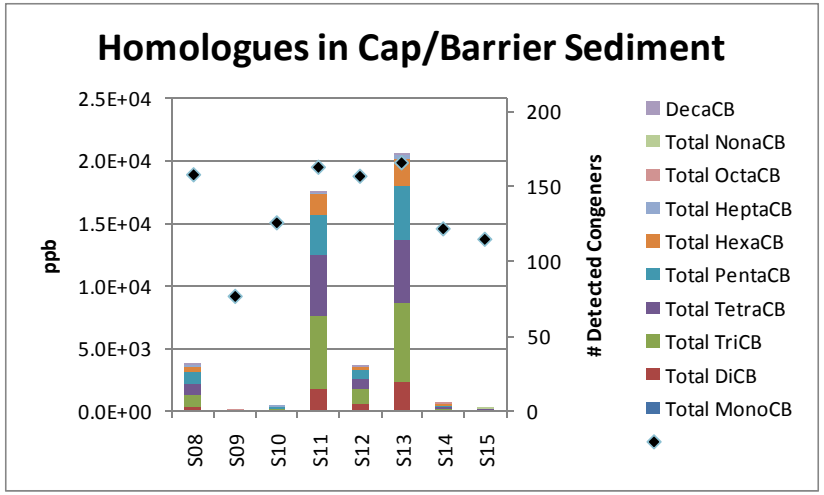
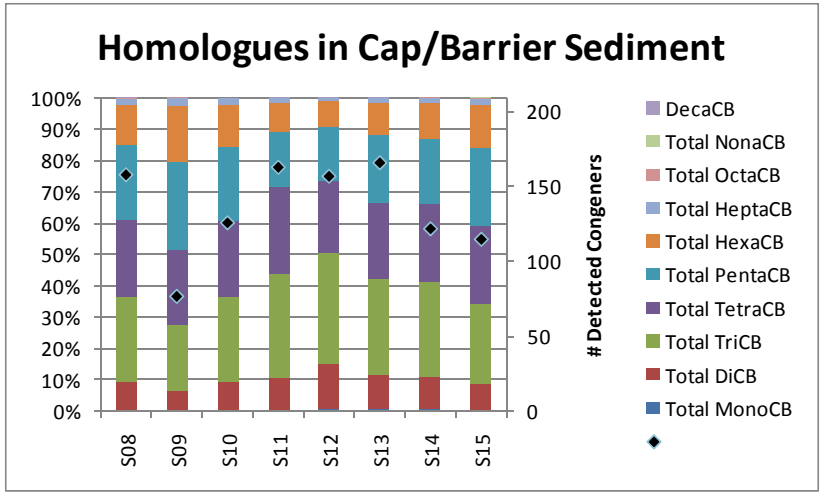
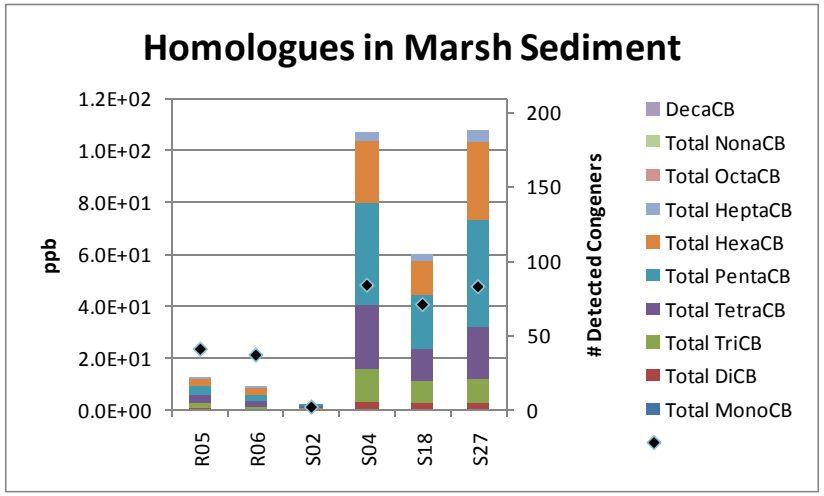


Figure 15. Homologue Patterns in Sediment







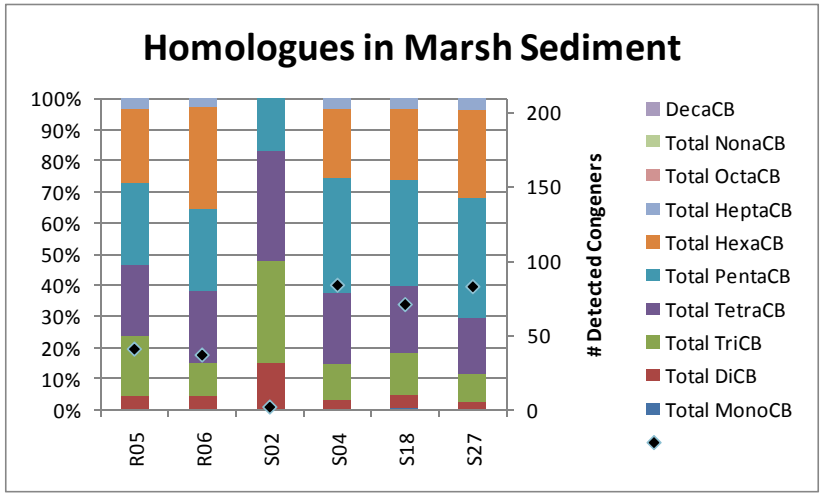
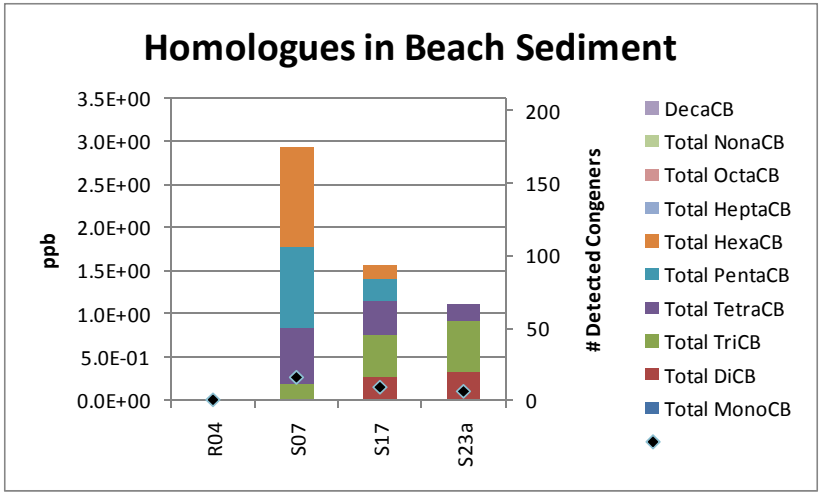


Figure 15 (cont.) Homologue Patterns in Sediment



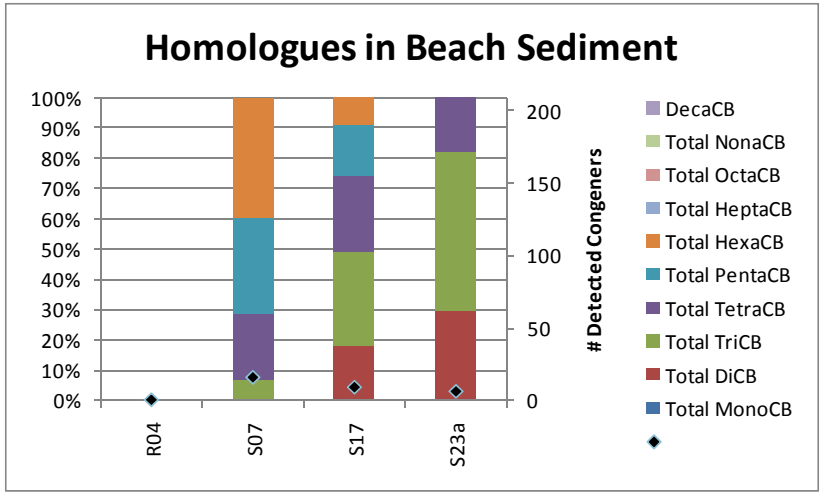


Figure 15 (cont). Homologue Patterns in Sediment

4.3 POTENTIAL EFFECT LEVELS IN SEDIMENT AND TISSUE

Figures 16 to 25 provide histograms that compare total PCBs, individual congeners, or TEQs in biota to concentrations from the literature that indicate potentially adverse ecological effects. These values are not regulatory endpoints nor are they the product of a site specific toxicity assessment (which would be part of a site specific ecological risk assessment). They are offered to provide a basis for discussing the data.

These comparisons show that:

- The bulk sediment total PCB concentrations throughout OU#3 (Figure 16) exceed several of the sediment concentrations that suggest a potential ecological effect (ER-L, ER-M, and two of the Gobas and Arnot potential effect concentrations derived for San Francisco Bay (note that these were developed for a list of 40 congeners, but are applied to the totals at OU#3 based on all detected congeners).

- The avian TEQ concentrations (TOC normalized) at various stations across all habitats exceed a potentially adverse effect level on birds (Figure 17).

- The TOC normalized concentrations of various congeners exceed TOC normalized potential effect levels (from literature) for these congeners (Figure 18).

- Total PCB concentrations in intertidal worms do not exceed a no effect level for sand worms from the literature (Figure 19).

- Total PCB concentrations in quahogs at some stations in OU#3 exceed a no effect level for this species from the literature (Figure 20).

- Total PCB concentrations in killifish and eels do not exceed a no effect level for forage fish from the literature (Figure 22).

- Ingestion of killifish or eels from site stations may have a potentially adverse effect on higher trophic level organisms (Figure 23).

- Ingestion of oysters, lobster, killifish, or eels by predators may have a potentially adverse ecological effect on mammals consuming that prey (Figure 24).

- Ingestion of oysters, lobster, killifish, or eels by predators does not have a potentially adverse ecological effect on birds consuming that prey (Figure 25).

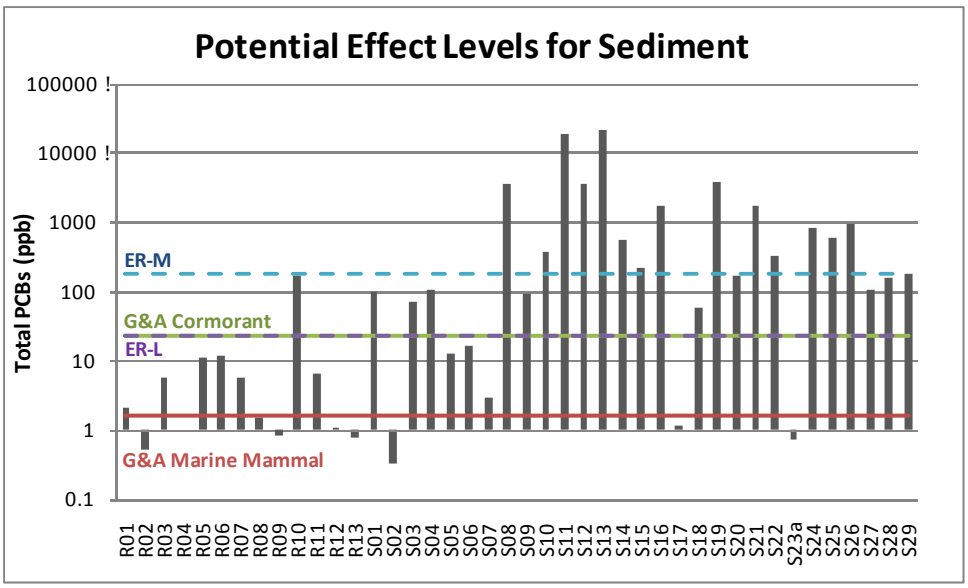


Figure 16. Comparison of total PCB in bulk sediment to concentrations associated with potentially adverse ecological effects in the literature.

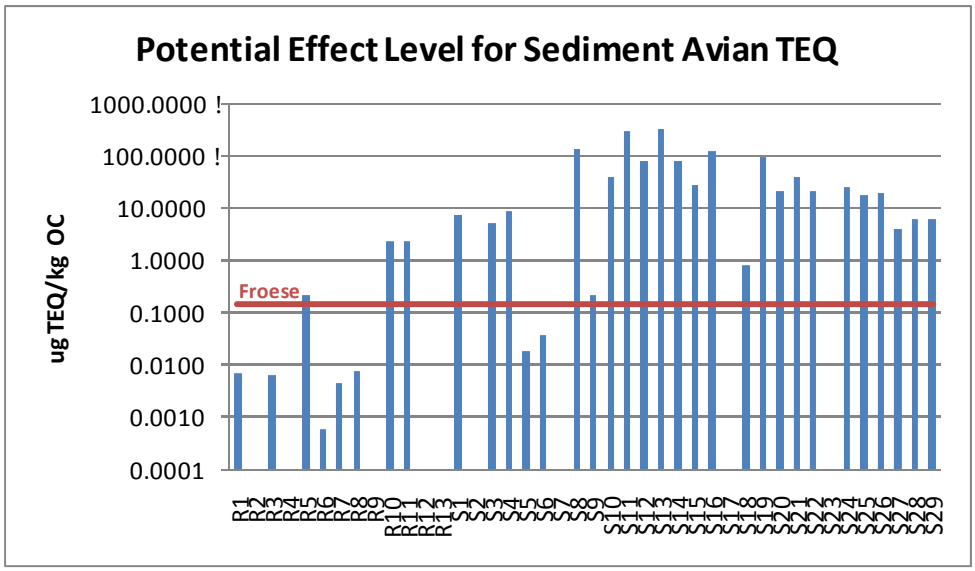


Figure 17. Comparison of sediment avain TEQs expressed on a TOC normalized basis to a potentially adverse effect level.

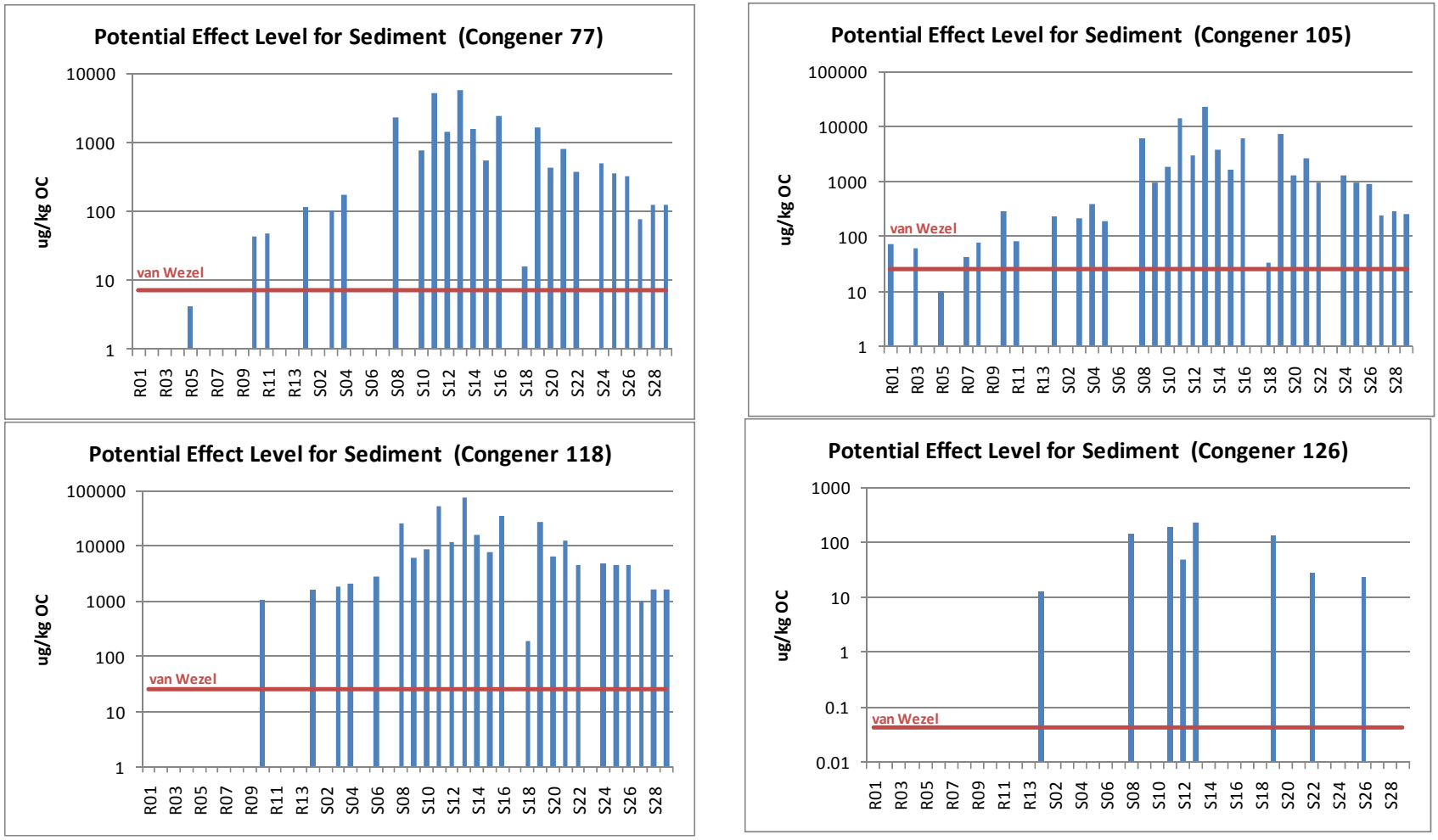


Figure 18. Comparison of TOC normalized concentrations of specific congeners to potentially adverse effect levels from the literature.

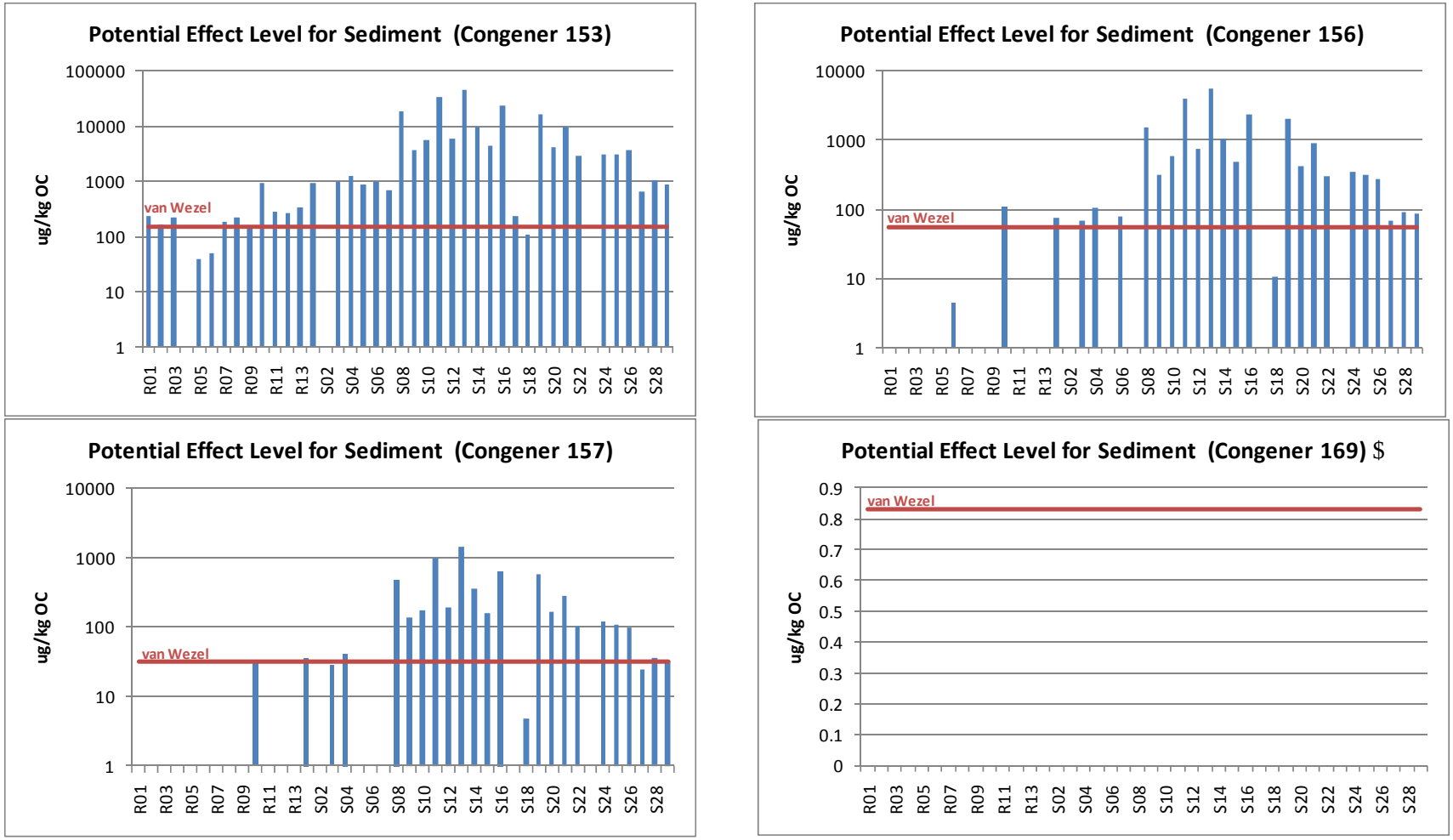


Figure 18 (cont). Comparison of TOC normalized concentrations of specific congeners to potentially adverse effect levels from the literature.

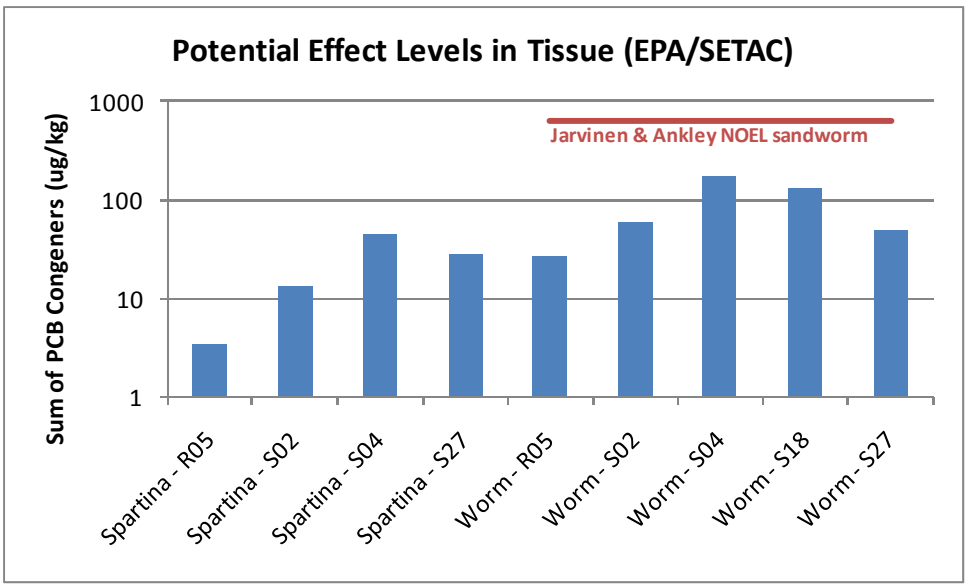


Figure 19. Comparison of total PCBs in tissue of intertidal worms to a no effect level.

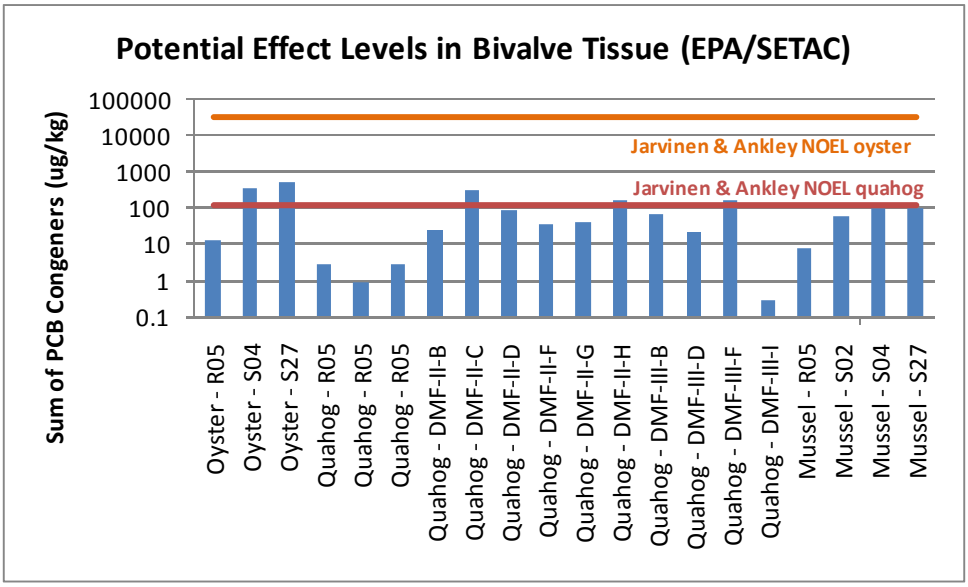


Figure 20. Comparison of total PCBs in tissue of several bivalves to no effect levels to the same or related species.

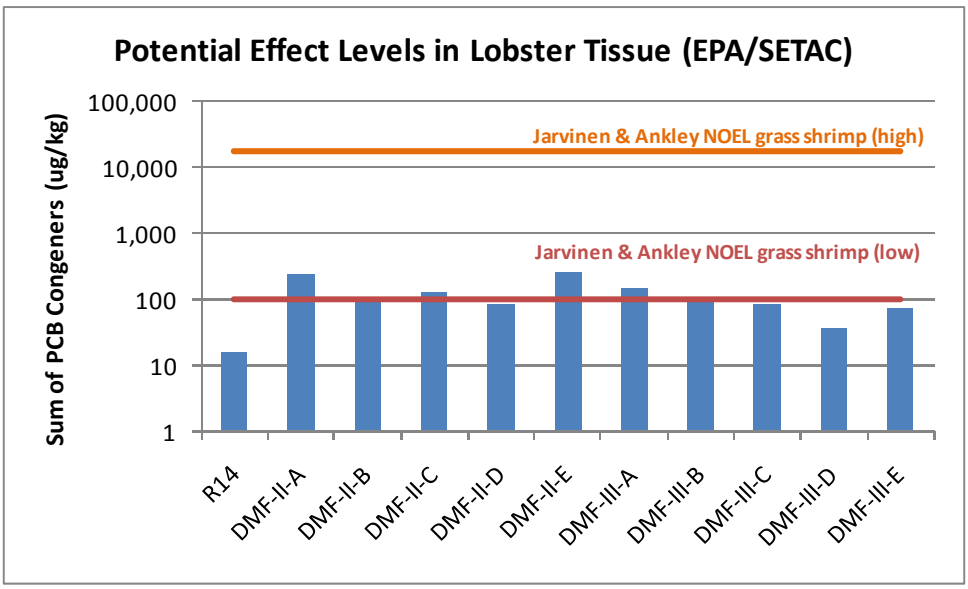


Figure 21. Comparison of total PCBs in tissue of lobster to no effect levels in a related species.

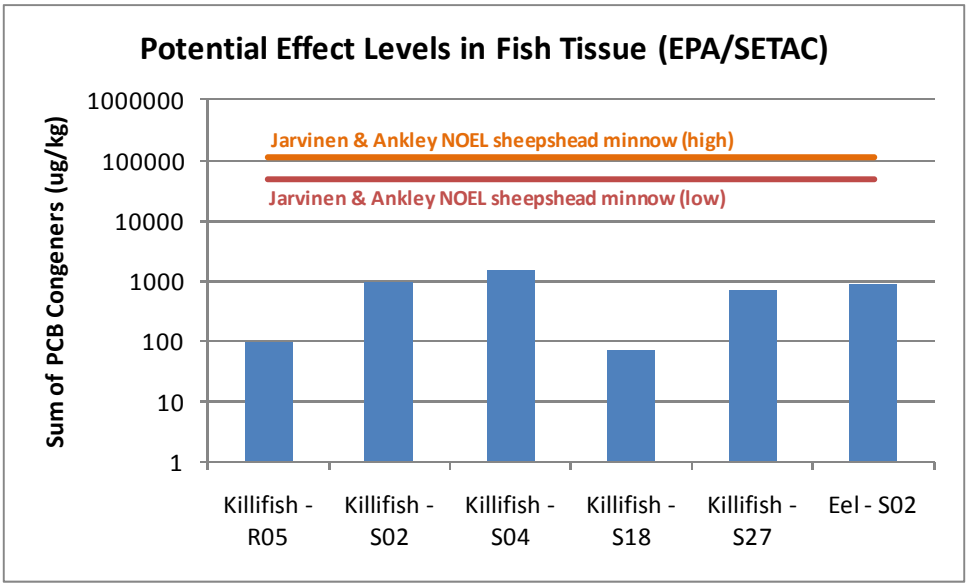


Figure 22. Comparison of total PCBs in tissue of killifish or eels to no effect levels in a forage fish.

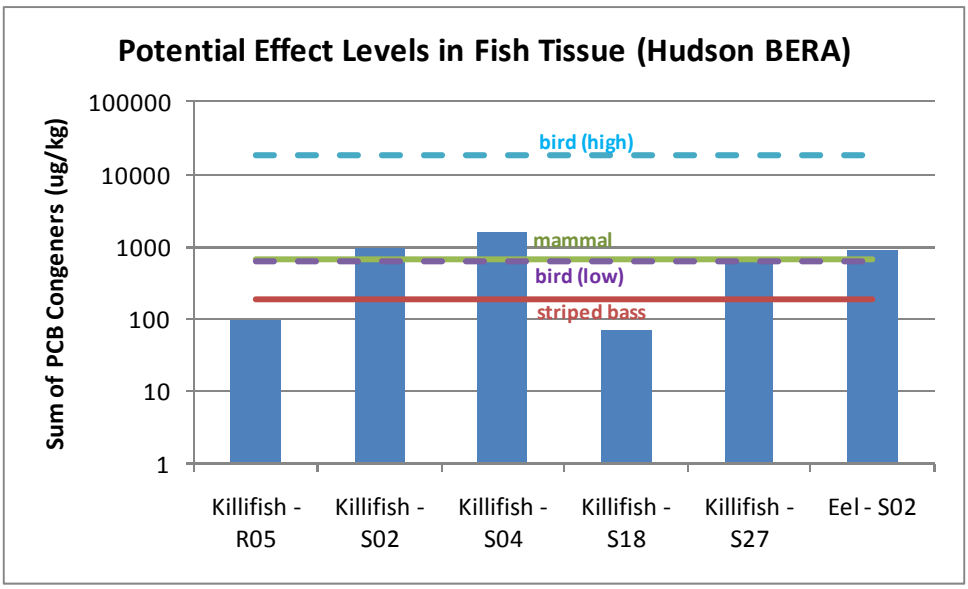


Figure 23. **Comparison of total PCBs in tissue of killifish or eels to concentrations in prey animals associated with potentially adverse ecological effects on higher trophic level animals.**

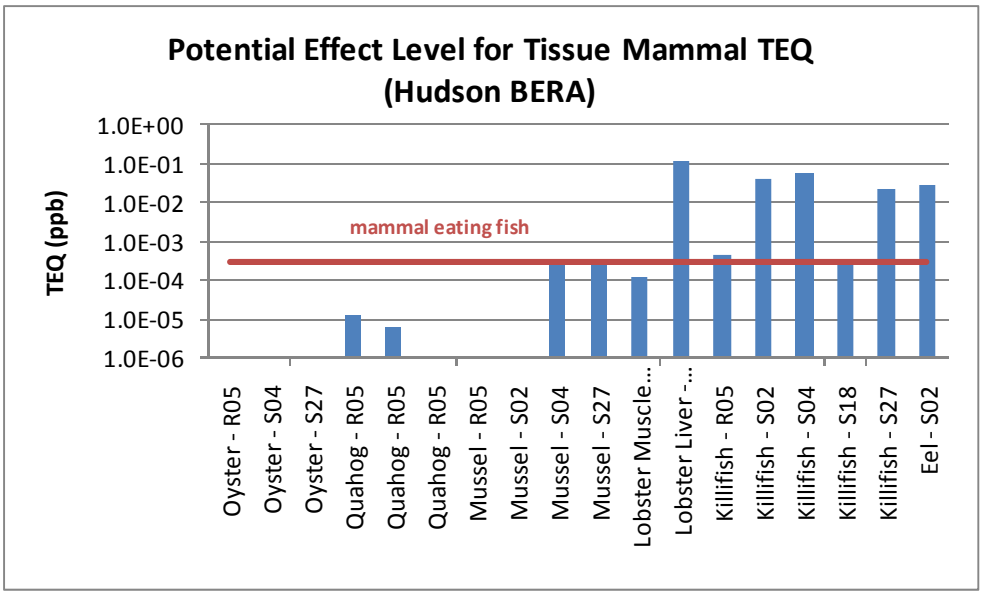


Figure 24. **Comparison of mammalian TEQs in tissue of various prey to concentrations in fish associated with potentially adverse ecological effects on mammals consuming those fish.**

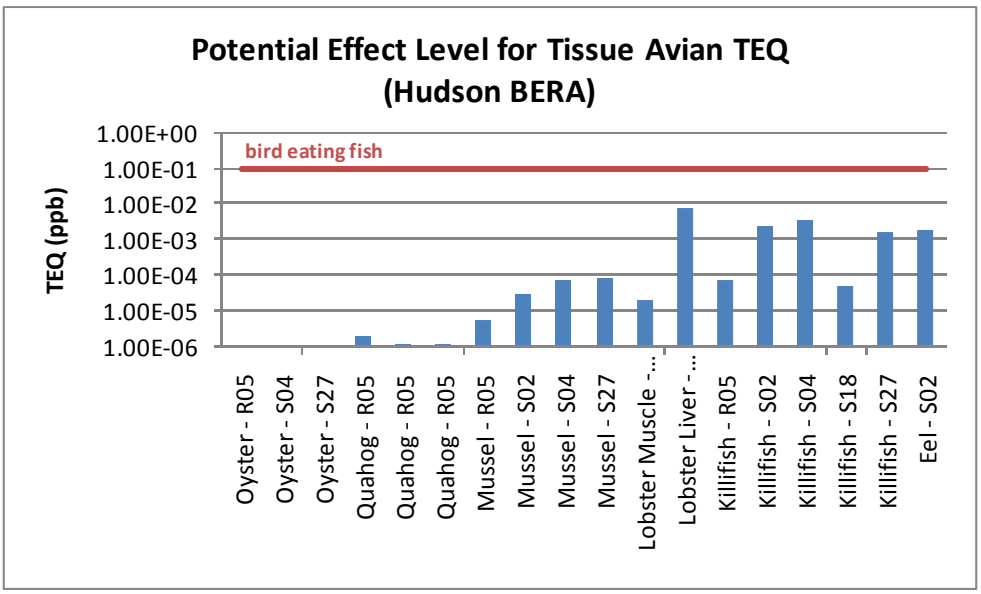


Figure 25. Comparison of avian TEQs in tissue of various prey to TEQ concentrations in fish associated with potentially adverse ecological effects on birds consuming those fish.

5.0 GENERAL OBSERVATIONS

The review of data from OU#3 and reference stations indicate that:

- Bulk sediment total PCB concentrations in OU#3 exceed concentrations in the reference area for all habitats.
- TOC normalized PCB concentrations in OU#3 exceed concentrations in the reference area for all habitats.
- Total PCB concentrations in tissue samples from OU#3 exceed concentrations in the reference area for all similar tissues.
- Lipid normalized PCB concentrations in tissue in OU#3 exceed concentrations in the reference area for all similar tissues.
- Sediment concentrations of PCBs and tissue concentrations of PCBs in OU#3 exceed various potential effect or no effect levels derived from the literature.
- The spatial distribution of PCBs (expressed on a TOC normalized basis) indicate that the highest concentrations of PCBs in outer New Bedford Harbor occur near the cap and hurricane barrier, along the shore of Clarks Point, at the treatment plant outfalls, in Clarks Cove and offshore of Apponagansett Bay.

6.0 REFERENCES

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