Comparison of Hydrocarbon-Degrading Consortia from Surface and Deep Waters of the Eastern Mediterranean Sea: Characterization and Degradation Potential

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Supplementary Material

Figures

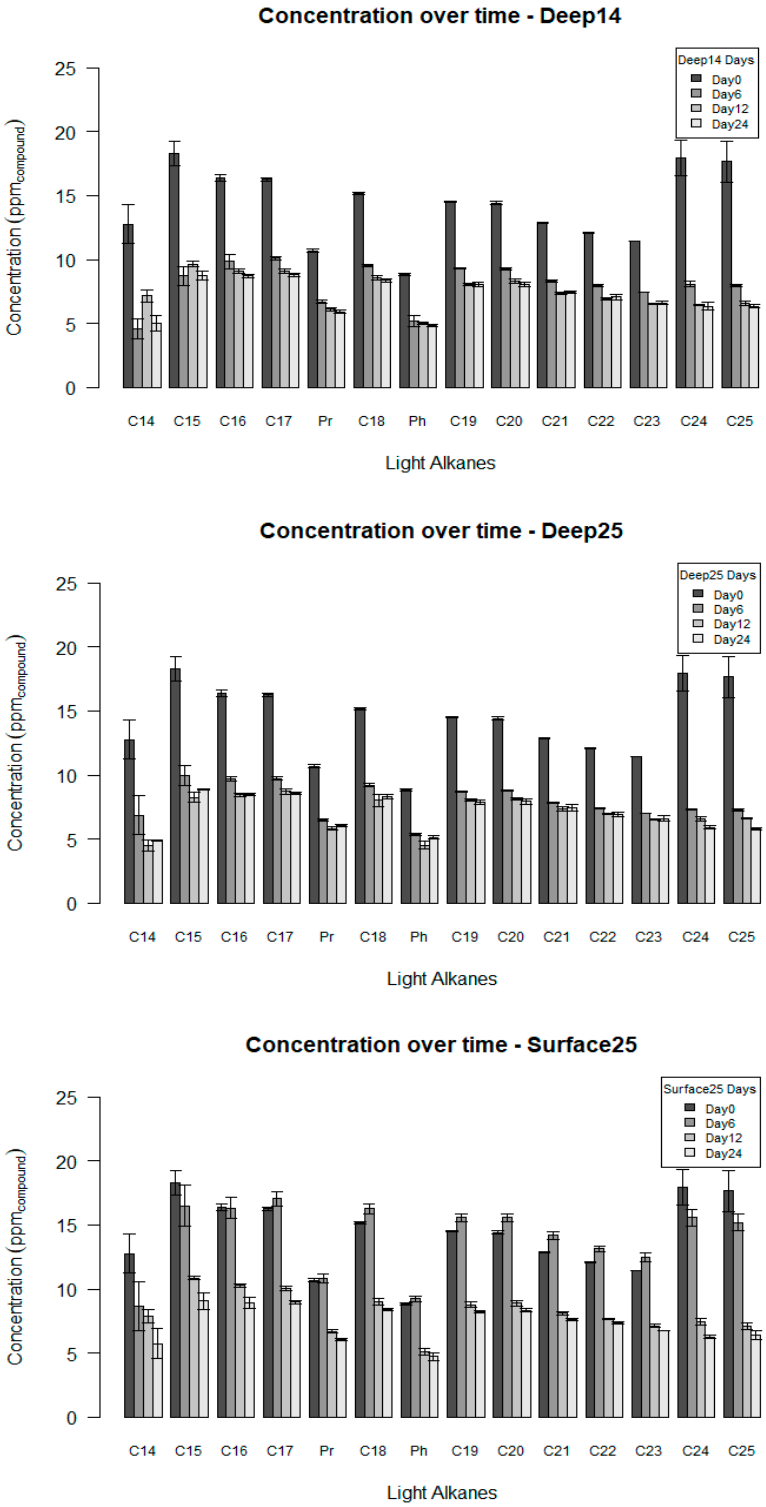


Figure S1. Concentration changes of the light alkanes over time in treatments Deep14, Deep25, and Surface25. Error bars represent standard deviation (n=3).

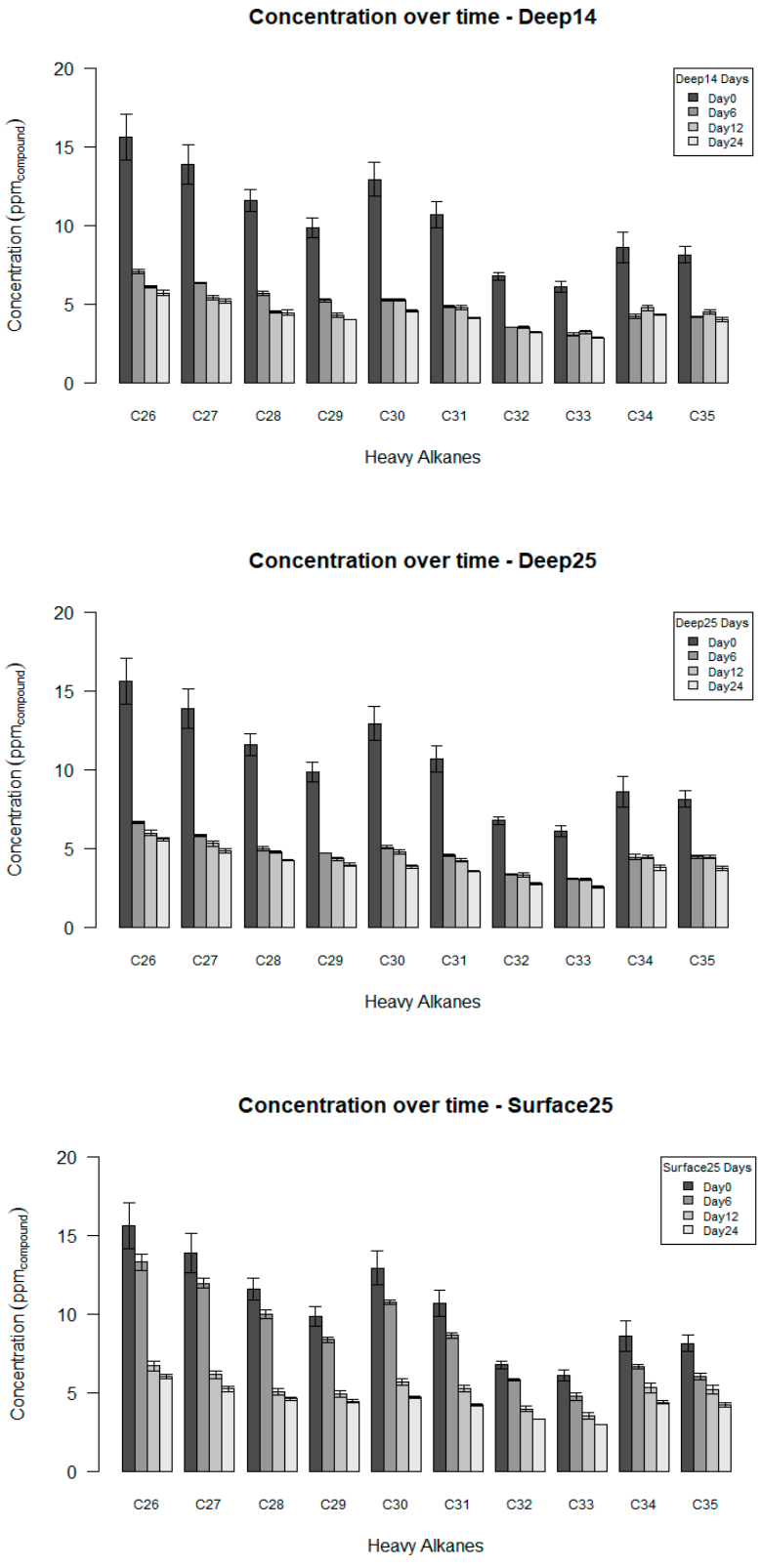


Figure S2. Concentration changes of the heavy alkanes over time in treatments Deep14, Deep25, and Surface25. Error bars represent standard deviation (n=3).

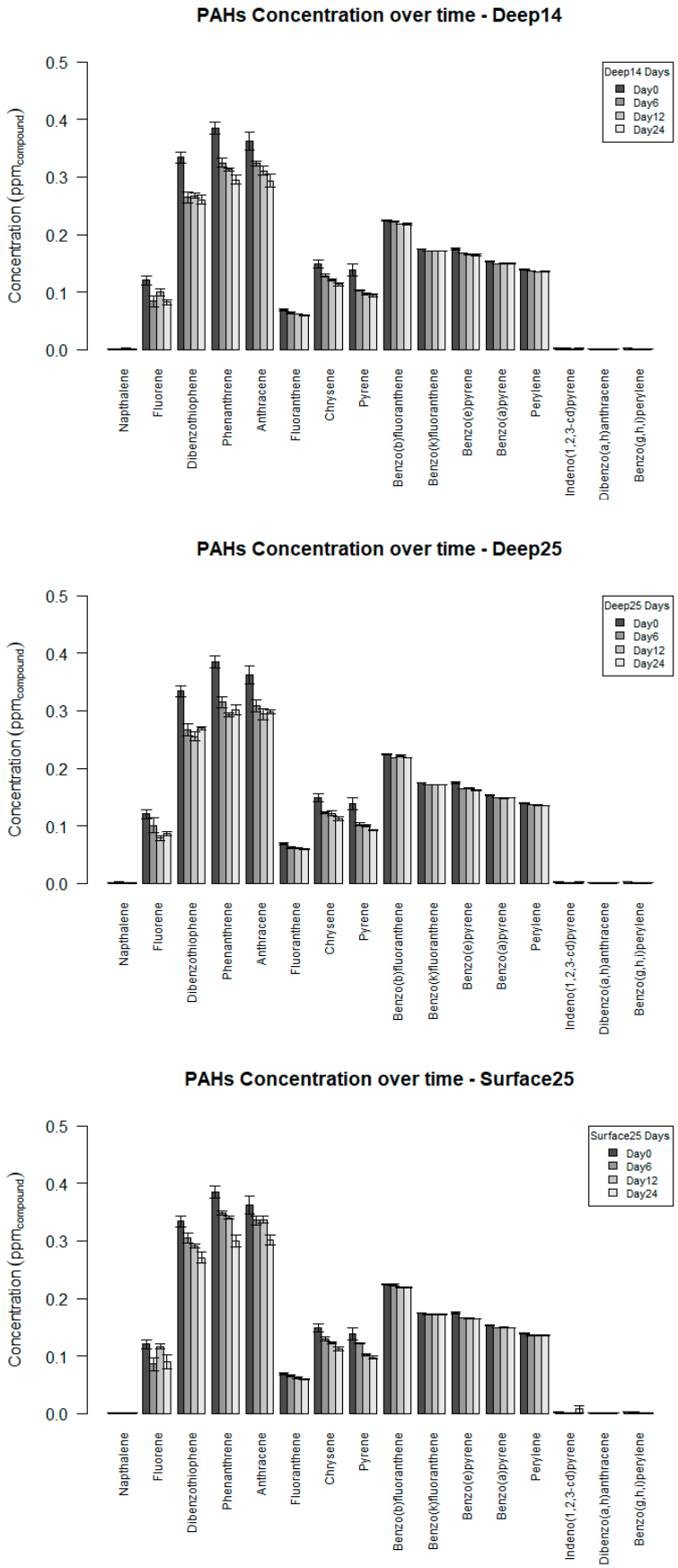


Figure S3. Concentration changes of the PAHs over time in treatments Deep14, Deep25, and Surface25. Error bars represent standard deviation (n=3).

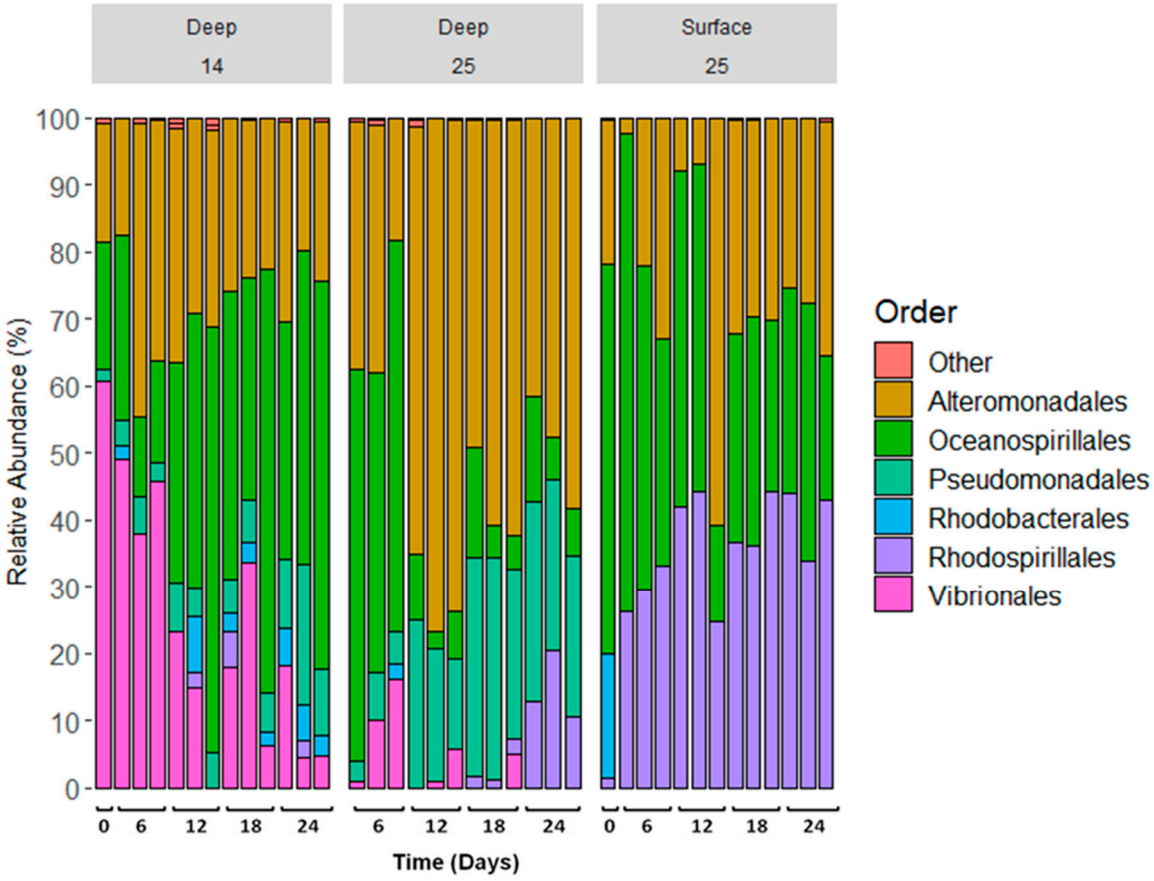


Figure S4. Relative abundance of bacterial taxa at the Order level plotted against time (days) and grouped by treatment (Deep14, Deep25, Surface25). Brackets on the x-axis correspond to the triplicate samples for the given timepoint.

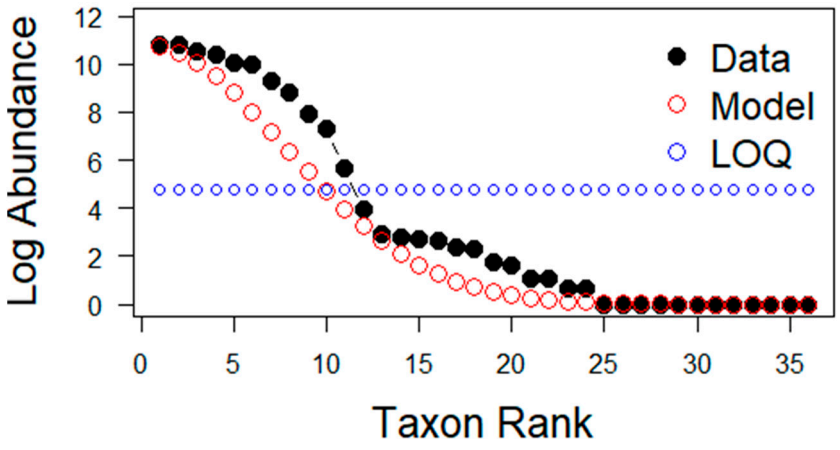


Figure S5. Rank distribution of Genus taxa. The limit of quantification (LOQ), shown in blue circles, is 1.3 standard deviation from zero in order to address false positive results. Taxa are displayed in black while the lognormal rank distribution model is given in red circles.

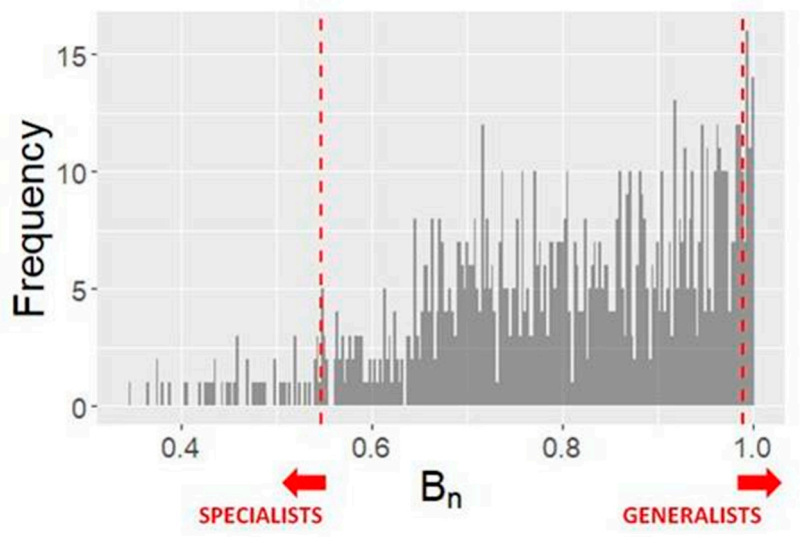


Figure S6. Null model distribution of Levin's BN niche. On the x-axis, the Levin's BN distribution across the three different treatments (Deep14, Deep25, Surface25) versus the frequency of random BN values on the y-axis. The red dotted lines indicate the 0.05 and 0.95 quantiles. Samples below the 5th quantile are considered specialists while those above the 95th are generalists.

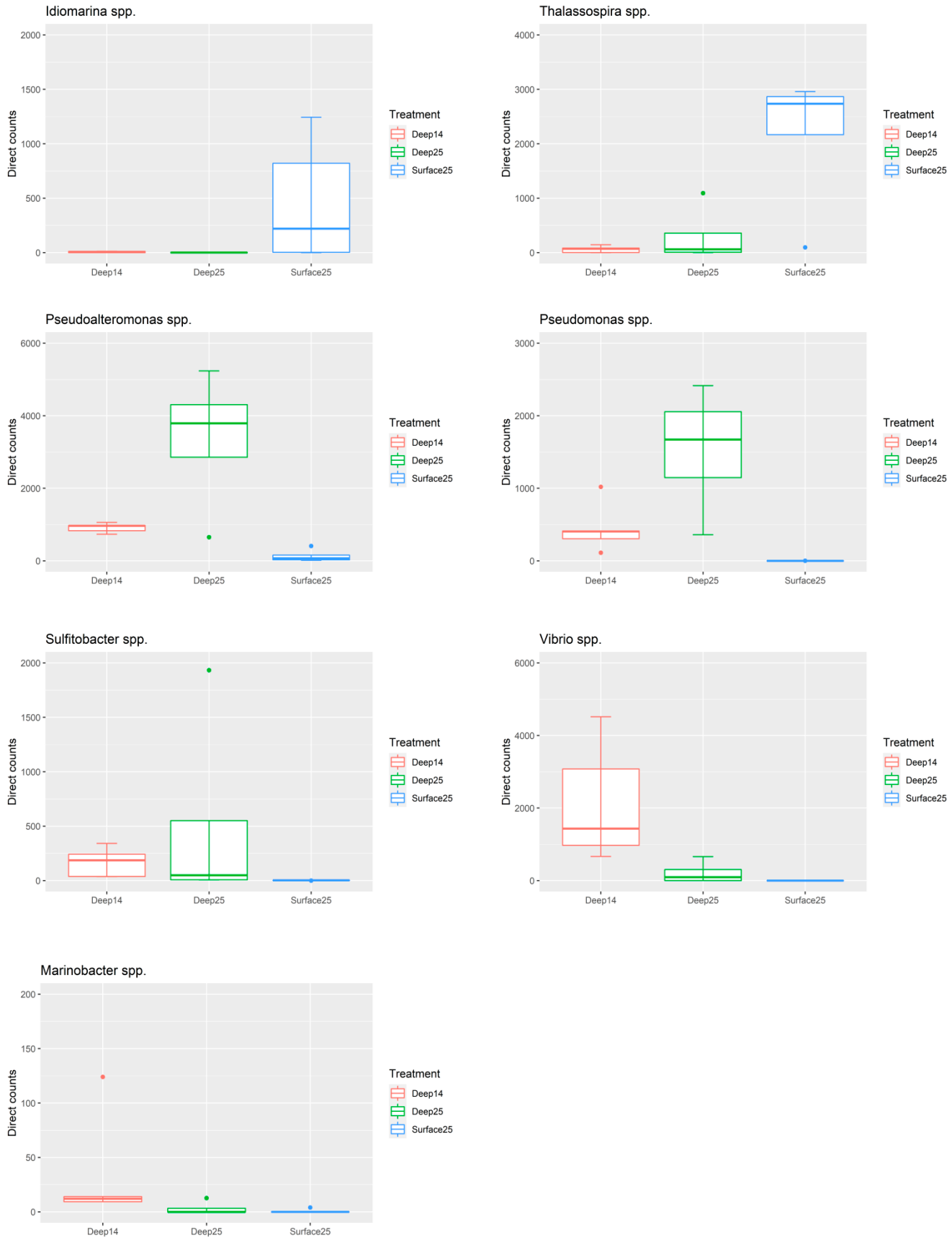


Figure S7. Direct counts from rarefied data of specialist taxa, identified by Levin's BN niche, by Treatment.

Tables

Table S1. % Degradation by Day24 for each of the 16 EPA priority PAHs examined in this study in treatments Deep14, Deep25, and Surface25. Empty values correspond to non-detectable peaks.

PAH	**Surface25**	**Deep14**	**Deep25**
Naphthalene	45.48	46.26	41.24
Fluorene	25.27	31.39	28.39
Dibenzothiophene	18.81	21.89	19.21
Phenanthrene	22.24	23.37	21.75
Anthracene	16.69	18.93	17.47
Fluoranthene	13.91	13.53	14.18
Chrysene	24.72	23.47	24.88
Pyrene	29.52	31.50	33.10
Benzo(b)fluoranthene	2.39	2.40	2.98
Benzo(k)fluoranthene	1.55	2.09	1.84
Benzo(e)pyrene	5.82	6.07	7.50
Benzo(a)pyrene	2.22	2.17	2.35
Perylene	2.67	2.90	2.98
Indeno(1,2,3-cd)pyrene	—	—	—
Dibenzo(a,h)anthracene	0.76	—	3.87
Benzo(g,h,i)perylene	64.23	59.06	51.22

Table S2. Alpha diversity indices of microbial communities in treatments Deep14, Deep25, and Surface25 at each time-point.

	ASV Richness			**Shannon diversity**		
	Deep14	Deep25	Surface25	Deep14	Deep25	Surface25
Background	364	—	248	4.54	—	4.44
Aged	159	—	179	2.98	—	2.97
0	50	—	72	2.36	—	1.68
6	94.33 ± 14.01	70.67 ± 21.78	39.33 ± 3.06	2.62 ± 0.05	2.3 ± 0.32	1.5 ± 0.25
12	87.33 ± 24.66	70.67 ± 29.02	49.33 ± 8.08	2.45 ± 0.57	1.9 ± 0.24	1.44 ± 0.15
18	85.33 ± 19.86	63.67 ± 17.01	48.33 ± 6.03	2.55 ± 0.42	2.09 ± 0.18	1.74 ± 0.09
24	80.33 ± 10.02	64 ± 6.24	51 ± 9.54	2.63 ± 0.27	2.1 ± 0.13	1.66 ± 0.14
	Chao1 index			**InvSimpson diversity**		
	Deep14	Deep25	Surface25	Deep14	Deep25	Surface25
Background	522.91	—	262.44	27.28	—	50.73
Aged	199.62	—	219.07	10.41	—	8.69
0	59.75	—	157	7.01	—	4.65
6	387.06 ± 77.19	180.9 ± 192.74	54.06 ± 11.5	8.9 ± 0.65	5.75 ± 1.99	3.6 ± 0.97
12	220.42 ± 112.77	126.97 ± 108.88	91.39 ± 15.56	7.47 ± 4.02	3.54 ± 0.74	3.21 ± 0.6
18	147.23 ± 36.41	169.03 ± 139.99	62.17 ± 4.38	7.87 ± 3.77	4.79 ± 1.08	4.17 ± 0.41
24	177.37 ± 30.86	193.83 ± 83.99	80.44 ± 36.57	9.4 ± 3.87	5.33 ± 0.8	3.85 ± 0.3

Table S3. DESeq2 analysis results.

DESeq2 by Depth. Most influential ASVs in enriched in Surface samples (positive log2FC)

	log2FoldChange	**padj**	**Order**	**Family**	**Genus**
ASV80	7.240484	3.42E-21	Oceanospirillales	Halomonadaceae	Halomonas
ASV4	5.972842	6.05E-21	Oceanospirillales	Halomonadaceae	Halomonas
ASV82	6.643629	4.94E-19	Oceanospirillales	Halomonadaceae	Halomonas
ASV19	6.962857	5E-19	Alteromonadales	Alteromonadaceae	Alteromonas
ASV16	5.889541	8.55E-19	Oceanospirillales	Halomonadaceae	Halomonas
ASV48	5.700159	1.32E-17	Oceanospirillales	Halomonadaceae	Halomonas
ASV30	8.462	3.42E-14	Alteromonadales	Idiomarinaceae	Idiomarina
ASV87	4.304216	4.82E-14	Oceanospirillales	Halomonadaceae	Halomonas
ASV15	7.97939	7.5E-14	Alteromonadales	Idiomarinaceae	Idiomarina
ASV111	5.159446	6.27E-13	Oceanospirillales	Halomonadaceae	Halomonas
ASV125	4.543738	1.2E-11	Oceanospirillales	Halomonadaceae	Halomonas
ASV247	4.750055	3E-09	Oceanospirillales	Halomonadaceae	Halomonas
ASV24	4.570913	1.86E-05	Caulobacterales	Hyphomonadaceae	Hyphomonas
ASV83	3.473179	3.35E-05	Rhodospirillales	Thalassospiraceae	Thalassospira
ASV23	2.511715	4.96E-05	Rhodobacterales	Rhodobacteraceae	Sulfitobacter
ASV299	3.780624	0.000166	Rhodospirillales	Thalassospiraceae	Thalassospira
ASV1	3.56691	0.00021	Rhodospirillales	Thalassospiraceae	Thalassospira
ASV77	3.340557	0.000389	Rhodospirillales	Thalassospiraceae	Thalassospira
ASV289	4.250027	0.000631	Alteromonadales	Alteromonadaceae	Alteromonas
ASV320	3.399414	0.001117	Oceanospirillales	Halomonadaceae	Halomonas

DESeq2 by Temperature. Most influential ASVs enriched at 14^{o}C (Deep14 treatment) (negative log2FC).

	log2FoldChange	**padj**	**Order**	**Family**	**Genus**
ASV25	-4.19424	3.13E-06	Rhodobacterales	Rhodobacteraceae	Sulfitobacter
ASV44	-4.80003	9.14E-05	Alteromonadales	Marinobacteraceae	Marinobacter
ASV257	-4.15966	0.000319	Oceanospirillales	Alcanivoracaceae1	Alcanivorax
ASV240	-3.99691	0.000649	Oceanospirillales	Alcanivoracaceae1	Alcanivorax
ASV7	-2.16424	0.004031	Oceanospirillales	Alcanivoracaceae1	Alcanivorax
ASV41	-4.07133	0.005807	Vibrionales	Vibrionaceae	Vibrio
ASV21	-4.06944	0.006391	Vibrionales	Vibrionaceae	Vibrio
ASV27	-4.02641	0.007581	Vibrionales	Vibrionaceae	Vibrio

Table S4. Successional patterns in the microbial community structure as shown in DESeq2 analysis by Time and Treatment.

		Enriched ASVs					Depleted ASVs				
			log2FoldChange	padj	Order	Genus		log2FoldChange	padj	Order	Genus
Deep14	Day 0-6	No ASVs enriched					No ASVs depleted				
	Day 6-12	ASV1	6.866	<0.001	Rhodospirillales	Thalassospira	No ASVs depleted				
		ASV4	4.823	0.001	Oceanospirillales	Halomonas					
	Day 12-18	No ASVs enriched					No ASVs depleted				
	Day 18-24	ASV22	1.858529319	<0.001	Pseudomonadales	Pseudomonas	No ASVs depleted				
		ASV25	1.165912144	<0.001	Rhodobacterales	Sulfitobacter					
		ASV9	1.559843895	<0.001	Pseudomonadales	Pseudomonas					
		ASV12	1.367002217	0.004	Oceanospirillales	Alcanivorax					
		ASV18	1.515809692	0.006	Pseudomonadales	Pseudomonas					
		ASV14	1.279769589	0.008	Oceanospirillales	Alcanivorax					
Deep25	Day 0-6	No ASVs enriched					No ASVs depleted				
	Day 6-12	ASV2	3.681	<0.001	Alteromonadales	Pseudoalteromonas	ASV26	-10.423	<0.001	Alteromonadales	Alteromonas
		ASV10	3.864	<0.001	Alteromonadales	Pseudoalteromonas	ASV5	-5.964	<0.001	Alteromonadales	Alteromonas
		ASV53	4.751	<0.001	Alteromonadales	Pseudoalteromonas	ASV3	-3.896	<0.001	Oceanospirillales	Alcanivorax
		ASV8	4.596	<0.001	Oceanospirillales	Alcanivorax	ASV44	-7.297	<0.001	Alteromonadales	Marinobacter
		ASV79	3.392	0.001	Alteromonadales	Pseudoalteromonas	ASV34	-4.670	0.001	Alteromonadales	Alteromonas
		ASV213	5.962	0.002	Alteromonadales	Pseudoalteromonas	ASV97	-4.616	0.001	Oceanospirillales	Alcanivorax
		ASV91	3.442	0.002	Alteromonadales	Pseudoalteromonas	ASV121	-4.838	0.002	Oceanospirillales	Alcanivorax
		ASV94	3.215	0.004	Alteromonadales	Pseudoalteromonas	ASV25	-3.263	0.004	Rhodobacterales	Sulfitobacter
		ASV98	3.332	0.004	Alteromonadales	Pseudoalteromonas	ASV7	-2.945	0.004	Oceanospirillales	Alcanivorax
							ASV19	-5.443	0.006	Alteromonadales	Alteromonas
	Day 12-18	ASV1	7.678	<0.001	Rhodospirillales	Thalassospira	ASV8	-8.540	<0.001	Oceanospirillales	Alcanivorax
		ASV178	6.524	<0.001	Rhizobiales	Aurantimonas	ASV23	-5.824	0.006	Rhodobacterales	Sulfitobacter
	Day 18-24	ASV1	3.824	<0.001	Rhodospirillales	Thalassospira	No ASVs depleted				
Surface25	Day 0-6	ASV4	5.786	<0.001	Oceanospirillales	Halomonas	ASV7	-10.529	<0.001	Oceanospirillales	Alcanivorax
		ASV1	3.371	<0.001	Rhodospirillales	Thalassospira	ASV8	-14.463	<0.001	Oceanospirillales	Alcanivorax
		ASV16	5.659	<0.001	Oceanospirillales	Halomonas	ASV23	-10.258	<0.001	Rhodobacterales	Sulfitobacter
		ASV20	5.694	<0.001	Oceanospirillales	Halomonas	ASV6	-10.613	<0.001	Oceanospirillales	Alcanivorax
		ASV48	5.035	<0.001	Oceanospirillales	Halomonas	ASV24	-8.262	0.001	Caulobacterales	Hyphomonas
	Day 6-12	ASV15	6.453	<0.001	Alteromonadales	Idiomarina					
		ASV30	8.988	<0.001	Alteromonadales	Idiomarina					
	Day 12-18	No ASVs enriched					No ASVs depleted				
	Day 18-24	No ASVs enriched					No ASVs depleted				