Fate of polycyclic aromatic compounds (PACs) from diluted bitumen spilled into freshwater limnocorrals

Stoyanovich, S[a*]., Yang, Z[b]., Hanson, M[d]., Hollebone, B.P[b]., Orihel, D. M[c]., Palace, V[e]., Rodriguez-Gil, JR[a,e]., Shah, K[b]., Blais, J.M[a]

[a] Department of Biology, University of Ottawa, Ottawa, Ontario, K1N 6N5, Canada

[b] Emergencies Science and Technology Section, Environment and Climate Change Canada, Ottawa, Ontario, Canada

[c] Department of Biology and School of Environmental Studies, Queen's University, Kingston, ON K7L 3N6

[d] Department of Environment and Geography, University of Manitoba, Winnipeg, MB, R3T 2N2, Canada.

[e] International Institute for Sustainable Development, Experimental Lakes Area, 111 Lombard Avenue, Suite 325, Winnipeg, Manitoba R3N 0T4, Canada

*Corresponding Author:

Sawyer S. Stoyanovich
University of Ottawa
75 Laurier Ave E
K1N 6N5, Ottawa, ON, Canada
Tel: +1 (613) 323-3279
Email: sstoy012@uottawa.ca

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Table S1. Identified targets and abbreviations. Abbreviations s,w,a represent sediment, water, and air samples.

Biomarker compounds		Alkylated PACs	
[s,w]C21 tricyclic terpane	C_{21}T	[s,w,a]C_0-Naphthalene	C_0-NAP
[s,w]C22 tricyclic terpane	C_{22}T	[s,w,a]C_1-Naphthalenes	C_1-NAP
[s,w]C23 tricyclic terpane	C_{23}T	[s,w,a]C_2-Naphthalenes	C_2-NAP
[s,w]C24 tricyclic terpane	C_{24}T	[s,w,a]C_3-Naphthalenes	C_3-NAP
[s,w]18α(H),21β(H)-22,29,30-trinorhopane	C_{27}Ts	[s,w,a]C_4-Naphthalenes	C_4-NAP
[s,w]17α(H),21β(H)-22,29,30-trinorhopane	C_{27}Tm	[s,w,a]C_0-Phenanthrene/anthracene	C_0-PHEN
[s,w]17α(H),21β(H)-30-norhopane	C_{29}αβ H	[s,w,a]C_1-Phenanthrenes/anthracenes	C_1-PHEN
[s,w]17α(H),21β(H)-hopane	C_{30}αβ H	[s,w,a]C_2-Phenanthrenes/anthracenes	C_2-PHEN
[s,w]22*S*-17α(H),21β(H)-30-homohopane	C_{31}(S) H	[s,w,a]C_3-Phenanthrenes/anthracenes	C_3-PHEN
[s,w]22*R*-17α(H),21β(H)-30-homohopane	C_{31}(R) H	[s,w,a]C_4-Phenanthrenes/anthracenes	C_4-PHEN
[s,w]22*S*-17α(H),21β(H)-30,31-bishomohopane	C_{32}(S) H	[s,w,a]C_0-Dibenzothiophene	C_0-DBT
[s,w]22*R*-17α(H),21β(H)-30,31-bishomohopane	C_{32}(R) H	[s,w,a]C_1-Dibenzothiophenes	C_1-DBT
[s,w]22*S*-17α(H),21β(H)-30,31,32-trishomohopane	C_{33}(S) H	[s,w,a]C_2-Dibenzothiophenes	C_2-DBT
[s,w]22*R*-17α(H),21β(H)-30,31,32-trishomohopane	C_{33}(R) H	[s,w,a]C_3-Dibenzothiophenes	C_3-DBT
[s,w]22*S*-17α(H),21β(H)-30,31,32,33-tetrakishomohopane	C_{34}(S) H	[s,w,a]C_0-Fluorene	C_0-FLU
[s,w]22*R*-17α(H),21β(H)-30,31,32,33-tetrakishomohopane	C_{34}(R) H	[s,w,a]C_1-Fluorenes	C_1-FLU
[s,w]22S-17α(H),21β(H)-30,31,32,33,34-pentakishomohopane	C_{35}(S) H	[s,w,a]C_2-Fluorenes	C_2-FLU
[s,w]22*R*-17α(H),21β(H)-30,31,32,33,34-pentakishomohopane	C_{35}(R) H	[s,w,a]C_3-Fluorenes	C_3-FLU
[s,w]C_{27} 20-5α(H),14β(H),17β(H)-cholestane	C_{27}αββ H	[s,w,a]C_0-Fluroanthene/pyrene	C_0-FLA
[s,w]C_{28} 20-5α(H),14β(H),17β(H)-ergostane	C_{28}αββ H	[s,w,a]C_1-Fluroanthenes/pyrenes	C_1-FLA
[s,w]C_{29} 20-5α(H),14β(H),17β(H)-stigmastane	C_{29}αββ H	[s,w,a]C_2-Fluroanthenes/pyrenes	C_2-FLA
		[s,w,a]C_3-Fluroanthenes/pyrenes	C_3-FLA
		[s,w,a]C_4-Fluroanthenes/pyrenes	C_4-FLA
		[s,w]C_0-Benzonaphthothiophenes	C_0-BNT
		[s,w]C_1-Benzonaphthothiophenes	C_1-BNT
		[s,w]C_2-Benzonaphthothiophenes	C_2-BNT
		[s,w]C_3-Benzonaphthothiophenes	C_3-BNT
		[s,w]C_4-Benzonaphthothiophenes	C_4-BNT
		[s,w,a]C_0-Chrysene	C_0-CHR
		[s,w,a]C_1-Chrysenes	C_1-CHR
		[s,w,a]C_2-Chrysenes	C_2-CHR
		[s,w,a]C_3-Chrysenes	C_3-CHR
		[s,w]Biphenyl	Bph
		[s,w,a]Acenaphthylene	Acl
		[s,w,a]Acenaphthene	Ace
		[s,w,a]Anthracene	An
		[s,w,a]Pyrene	Py
		[s,w,a]Benz(a)anthracene	BaA
		[s,w,a]Benzo(b)fluoranthene	BbF
		[s,w,a]Benzo(k)fluoranthene	BkF
		[s,w]Benzo(e)pyrene	BeP
		[s,w,a]Benzo(a)pyrene	BaP
		[s,w]Perylene	Pe
		[s,w,a]Indeno(1,2,3-cd)pyrene	IP
		[s,w,a]Dibenzo(a,h)anthracene	DA
		[s,w,a]Benzo(g,h,i)perylene	BgP

Table S2. Mean percent recoveries (± standard deviation) for deuterated compounds in water, sediment, and air samples

	% Recovery (±sd)		
Compound	**Water Samples**	**Sediment Samples**	**Air Samples**
d_8-naphthalene	71.4 ± 16.7	74.2 ± 13.8	97.4 ± 16.6
d_{10}-Acenaphthene	80.1 ± 16.5	89.2 ± 12.9	83.0 ± 8.0
d_{10}-Phenanthrene	91.8 ± 18.0	97.2 ± 11.8	69.7 ± 3.0
d_{12}-Benz(a)anthracene	92.4 ± 18.7	100.0 ± 14.0	53.1 ± 4.0
d_{12}-Perylene	81.6 ± 16.4	103.7 ± 9.5	52.3 ± 5.7

Table S3. Maximum concentrations of 7 different PAC groups measured in our study compared to other studies using diluted bitumen at similar oil:water ratios. The maximum concentration observed for each PAC group is presented as well as the day in which this concentration was reached during the study (T_{max}).

	Our Study				Ortmann et al. (2020)[a]						Stoyanovich et al. (2019)[b]	
	CLB 1:10000 (18 L)		CLB 1:4600 (42 L)		AWB 1:6400		Synbit 1:6400		WCS 1:6400		CLB 1:8000	
PAC Group	**Max Conc (ng/L)**	**T_{max} (d)**	**Max Conc (ng/L)**	**T_{max} (d)**	**Max Conc (ng/L)**	**T_{max} (d)**	**Max Conc (ng/L)**	**T_{max} (d)**	**Max Conc (ng/L)**	**T_{max} (d)**	**Max Conc (ng/L)**	**T_{max} (d)**
$\Sigma NAP_{C0\text{-}C4}$	299	8	619	15	1466	2	2125	2	3196	2	1005	4
$\Sigma PHEN_{C0\text{-}C4}$	197	8	284	28	26.76	4	2719	10	1974	10	362	4
$\Sigma DBT_{C0\text{-}C3}$	182	8	293	2	0	0	1550	10	1431	10	89	7
$\Sigma FLU_{C0\text{-}C3}$	280	15	466	15	130.5	4	1508	10	1021	10	251	4
$\Sigma FLA_{C0\text{-}C4}$	27.5	8	34.5	8	-	-	-	-	-	-	12	4
$\Sigma BNT_{C0\text{-}C4}$	45.9	8	61.1	8	12.14	14	1190	10	1058	10	n.d.[c]	n.d.
$\Sigma CHR_{C0\text{-}C3}$	17.3	8	21.2	8	0	0	766	10	444	10	5	4

[a]Ortmann et al. (2020) spilled 3 different types of diluted bitumen (Access Wester Blend; AWB, Synbit, and Western Canadian Select; WCS) into enclosures containing seawater during the summer and sampled the water column for 14 days following the spill.

[b]Stoyanovich et al. (2019) spilled Cold Lake Blend (CLB) into tanks containing freshwater during the summer and samples the water column for 11 days following the spill.

[c]n.d. represents concentration below method detection limits

Table S4. Comparison between sediment jar and oiled sediment core data with fold change presented in brackets.

PAC Group	Jar Sample Max Jar[a]	Oiled Core Sample TB-18-1	TB-18-2	TB-18-3	TB-82-1	TB-82-2	TB-82-3
ΣPAC_{46}	189	14646 (77X)	1696.2 (9X)	587.2 (3X)	379.2 (2X)	4708.6 (25X)	532.3 (3X)
$\Sigma NAP_{C0\text{-}C4}$	22.8	263 (12X)	78.9 (3X)	84.1 (4X)	25.8 (1X)	343.6 (15X)	63.5 (3X)
$\Sigma PHEN_{C0\text{-}C4}$	50.7	4144 (82X)	581.2 (11X)	136.1 (3X)	150.8 (3X)	1240.5 (24X)	145.0 (3X)
$\Sigma DBT_{C0\text{-}C3}$	31.9	3684 (115X)	343.6 (11X)	127.9 (4X)	62.8 (2X)	1016.6 (32X)	115.4 (4X)
$\Sigma FLU_{C0\text{-}C3}$	19.6	929 (47X)	88.7 (5X)	50.8 (3X)	22.5 (1X)	254.1 (13X)	44.8 (2X)
$\Sigma FLA_{C0\text{-}C4}$	9.65	859 (89X)	76.2 (8X)	22.6 (2X)	16.1 (2X)	222.4 (23X)	23.4 (2X)
$\Sigma BNT_{C0\text{-}C4}$	45.8	3760 (82X)	410.9 (9X)	127.4 (3X)	75.7 (2X)	1301.0 (28X)	104.9 (2X)
$\Sigma CHR_{C0\text{-}C3}$	10.5	788 (75X)	87.9 (8X)	25.3 (2X)	15.5 (1X)	249.1 (24X)	25.3 (2X)

[a]The maximum jar values were observed in the 18 L treatment for each PAC group except for $\Sigma FLU_{C0\text{-}C3}$ and $\Sigma NAP_{C0\text{-}C4}$ which were observed in the 180 L treatment, all on day 70.

Table S5. Water column regression coefficients obtained by regressing the log_{10} transformed concentration of each respective PAC group against the log_{10} transformed oil:water ratio (alpha = 0.05). Certain compounds remained below detection limit during the earlier timepoints of the study and therefore did not yield sufficient regression coefficients, denoted by "*NA*".

Compound group	Pre-Spill to 8 days $Log_{10}[PAC]_i = m * Log_{10}[oil:water] + b$						15 to 70 days $Log_{10}[PAC]_i = m * Log_{10}[oil:water] + b$					
	Time	**m**	**b**	**R^2**	***p***	**Sig**	**Time**	**m**	**b**	**R^2**	***p***	**Sig**
ΣPAC_{46}	-3 days	-0.10	0.78	0.07	0.553	no	15 days	0.23	3.94	0.75	0.012	*
NAP (C0-C4)		-0.11	0.36	0.03	0.722	No		0.38	3.98	0.95	0.0002	***
PHEN (C0-C4)		-0.09	-0.13	0.05	0.619	No		0.09	2.69	0.34	0.168	No
DBT (C0-C3)		0.00	0.00	*NA*	*NA*	No		0.10	2.68	0.19	0.322	No
FLU (C0-C3)		-0.04	-0.12	0.17	0.357	No		0.28	3.54	0.79	0.008	*
FLA (C0-C4)		0.00	0.00	*NA*	*NA*	No		0.05	1.19	0.01	0.795	No
BNT (C0-C4)		0.00	0.00	*NA*	*NA*	No		0.51	3.04	0.59	0.045	*
CHR (C0-C3)		0.07	0.35	0.05	0.634	No		0.12	1.33	0.78	0.009	*
ΣPAC_{46}	0.25 days	0.64	3.75	0.50	0.076	No	22 days	0.35	4.26	0.65	0.029	*
NAP (C0-C4)		0.65	3.53	0.62	0.034	*		0.48	4.24	0.84	0.004	**
PHEN (C0-C4)		0.35	1.99	0.18	0.339	No		0.23	3.03	0.53	0.062	No
DBT (C0-C3)		0.64	2.81	0.66	0.027	*		0.19	2.85	0.25	0.256	No
FLU (C0-C3)		0.40	2.16	0.25	0.254	No		0.40	3.84	0.63	0.033	*
FLA (C0-C4)		0.00	0.00	*NA*	*NA*	No		0.40	2.15	0.94	0.0003	***
BNT (C0-C4)		0.00	0.00	*NA*	*NA*	No		0.47	2.62	0.77	0.010	*
CHR (C0-C3)		0.00	0.00	*NA*	*NA*	No		0.13	1.19	0.72	0.015	*
ΣPAC_{46}	1 day	0.27	3.67	*NA*	0.006	*	28 days	0.44	4.50	0.66	0.027	*
NAP (C0-C4)		0.38	3.85	0.89	0.002	**		0.50	4.28	0.79	0.007	*
PHEN (C0-C4)		0.07	2.02	0.24	0.269	No		0.34	3.36	0.56	0.052	No
DBT (C0-C3)		0.10	2.14	0.21	0.304	No		0.31	3.26	0.41	0.123	No
FLU (C0-C3)		0.15	2.22	0.76	0.011	*		0.50	4.14	0.63	0.033	*
FLA (C0-C4)		-0.03	-0.04	0.21	0.303	No		0.45	2.24	0.89	0.001	**
BNT (C0-C4)		-0.01	-0.03	0.35	0.160	No		0.52	2.46	0.70	0.018	*

CHR (C0-C3)		-0.07	-0.21	0.53	0.062	No			0.22	1.42	0.93	0.0004	***
ΣPAC_{46}	2 days	0.21	3.25	0.12	0.442	No		42 days	0.35	4.02	0.67	0.025	*
NAP (C0-C4)		0.14	2.66	0.04	0.661	No			0.39	3.75	0.88	0.002	**
PHEN (C0-C4)		0.27	2.49	0.09	0.509	No			0.22	2.76	0.43	0.107	No
DBT (C0-C3)		0.44	3.33	0.20	0.313	No			0.30	3.03	0.56	0.054	No
FLU (C0-C3)		0.42	3.10	0.23	0.277	No			0.42	3.69	0.50	0.074	No
FLA (C0-C4)		-0.14	-0.36	0.21	0.298	No			0.47	2.37	0.64	0.030	*
BNT (C0-C4)		-0.02	-0.07	0.35	0.160	No			0.70	3.20	0.80	0.007	*
CHR (C0-C3)		-0.02	0.01	0.03	0.720	No			0.34	1.86	0.76	0.011	*
ΣPAC_{46}	4 days	-0.03	2.44	0.02	0.769	No		56 days	0.60	4.77	0.97	0.0001	***
NAP (C0-C4)		0.08	2.40	0.20	0.309	No			0.64	4.57	0.95	0.0002	***
PHEN (C0-C4)		-0.11	1.38	0.19	0.322	No			0.43	3.44	0.94	0.0003	***
DBT (C0-C3)		-0.19	1.05	0.27	0.228	No			0.56	3.73	0.98	0.00002	****
FLU (C0-C3)		0.06	2.20	0.14	0.415	No			0.66	4.31	0.87	0.002	**
FLA (C0-C4)		0.18	1.03	0.72	0.016	No			0.47	2.10	0.79	0.008	*
BNT (C0-C4)		-0.25	-0.06	0.21	0.305	No			0.57	2.54	0.88	0.002	**
CHR (C0-C3)		-0.20	-0.33	0.36	0.157	No			0.32	1.58	0.97	0.00004	****
ΣPAC_{46}	8 days	0.14	3.58	0.63	0.033	*		70 days	0.51	4.50	0.78	0.008	*
NAP (C0-C4)		0.26	3.47	0.92	0.001	**			0.61	4.39	0.90	0.001	**
PHEN (C0-C4)		0.08	2.66	0.50	0.075	No			0.47	3.58	0.80	0.006	*
DBT (C0-C3)		0.03	2.46	0.02	0.736	No			0.42	3.31	0.63	0.033	*
FLU (C0-C3)		0.15	2.96	0.69	0.021	*			0.54	4.00	0.57	0.048	*
FLA (C0-C4)		0.22	2.26	0.87	0.002	**			0.67	2.96	0.77	0.010	*
BNT (C0-C4)		0.13	2.19	0.41	0.122	No			0.87	3.87	0.77	0.009	*
CHR (C0-C3)		0.24	2.20	0.68	0.023	*			0.54	2.53	0.88	0.002	**

Table S6. Sediment regression coefficients obtained by regressing the log_{10} transformed concentration of each respective PAC group against the log_{10} transformed oil:water ratio (alpha = 0.05). Certain compounds remained below detection limit during the earlier timepoints of the study and therefore did not yield sufficient regression coefficients, denoted by "*NA*".

	Pre-Spill to 15 days							**22 to 70 days**						
	$Log_{10}[PAC]_i = m * Log_{10}[oil:water] + b$							$Log_{10}[PAC]_i = m * Log_{10}[oil:water] + b$						
Compound group	**Time**	**m**	**b**	**R^2**	***p***	**Sig**		**Time**	**m**	**b**	**R^2**	***p***	***Sig***
ΣPAC_{46}	-3 days	0.01	1.44	0.01	0.831	No		22 days	0.16	2.31	0.18	0.404	No
NAP (C0-C4)		0.00	0.96	0.0001	0.985	No			0.08	1.25	0.18	0.407	No
PHEN (C0-C4)		0.02	1.10	0.04	0.676	No			0.09	1.49	0.09	0.555	No
DBT (C0-C3)		0.01	0.12	0.12	0.439	No			0.19	1.73	0.31	0.253	No
FLU (C0-C3)		0.00	0.19	0.002	0.918	No			0.20	1.41	0.20	0.368	No
FLA (C0-C4)		0.02	0.48	0.09	0.517	No			0.18	1.28	0.33	0.230	No
BNT (C0-C4)		0.00	0.00	*NA*	*NA*	No			0.29	2.03	0.18	0.406	No
CHR (C0-C3)		0.01	0.16	0.25	0.252	No			0.11	0.90	0.11	0.524	No
ΣPAC_{46}	1 day	0.02	1.60	0.03	0.698	No		28 days	0.07	1.95	0.08	0.541	No
NAP (C0-C4)		0.01	1.18	0.01	0.876	No			0.13	1.44	0.56	0.052	No
PHEN (C0-C4)		0.03	1.26	0.15	0.389	No			0.00	1.17	0.00002	0.993	No
DBT (C0-C3)		0.01	0.13	0.05	0.619	No			0.16	1.50	0.13	0.419	No
FLU (C0-C3)		0.00	0.25	0.001	0.943	No			0.15	1.12	0.32	0.187	No
FLA (C0-C4)		0.01	0.46	0.04	0.651	No			0.09	0.81	0.31	0.195	No
BNT (C0-C4)		0.00	0.00	*NA*	*NA*	No			0.09	1.16	0.02	0.736	No
CHR (C0-C3)		0.00	0.11	0.05	0.621	No			-0.06	0.26	0.06	0.610	No
ΣPAC_{46}	2 days	-0.11	0.78	0.09	0.520	No		42 days	0.12	2.28	0.12	0.448	No
NAP (C0-C4)		-0.12	0.36	0.12	0.449	No			0.13	1.47	0.70	0.020	*
PHEN (C0-C4)		-0.11	0.30	0.09	0.508	No			0.07	1.54	0.06	0.593	No
DBT (C0-C3)		0.00	0.00	*NA*	*NA*	No			0.17	1.69	0.20	0.308	No
FLU (C0-C3)		-0.03	0.16	0.01	0.843	No			0.21	1.52	0.41	0.124	No
FLA (C0-C4)		-0.06	0.07	0.12	0.451	No			0.16	1.23	0.31	0.193	No
BNT (C0-C4)		0.00	0.00	*NA*	*NA*	No			0.09	1.39	0.01	0.795	No

CHR (C0-C3)		-0.01	0.03	0.07	0.566	No			0.11	1.07	0.10	0.484	No
ΣPAC_{46}	8 days	0.00	1.17	0.00003	0.991	No	70 days		0.21	2.76	0.53	0.063	No
NAP (C0-C4)		-0.02	0.67	0.01	0.874	No			0.09	1.59	0.83	0.004	**
PHEN (C0-C4)		0.01	0.77	0.001	0.958	No			0.17	2.05	0.42	0.114	No
DBT (C0-C3)		0.00	0.00	*NA*	*NA*	No			0.29	2.18	0.55	0.058	No
FLU (C0-C3)		0.00	0.09	0.0002	0.977	No			0.17	1.71	0.54	0.061	No
FLA (C0-C4)		0.01	0.33	0.01	0.822	No			0.20	1.50	0.52	0.068	No
BNT (C0-C4)		0.00	0.00	*NA*	*NA*	No			0.42	2.67	0.56	0.053	No
CHR (C0-C3)		0.00	0.09	0.01	0.847	No			0.19	1.43	0.34	0.171	No
ΣPAC_{46}	15 days	-0.04	1.41	0.24	0.267	No							
NAP (C0-C4)		0.01	1.01	0.002	0.928	No							
PHEN (C0-C4)		-0.04	0.88	0.27	0.237	No							
DBT (C0-C3)		-0.04	0.58	0.16	0.374	No							
FLU (C0-C3)		0.00	0.47	0.001	0.954	No							
FLA (C0-C4)		0.00	0.39	0.003	0.903	No							
BNT (C0-C4)		-0.11	0.16	0.46	0.096	No							
CHR (C0-C3)		-0.04	0.04	0.19	0.335	No							

Table S7. CCME guidelines for protection of aquatic life in water. Only PACs with available data are presented. Max concentrations presented across range of dilbit treatments.

Compound	Conc (ng/L)	Maximum concentrations observed in timeseries samples of present study (ng/L)
Acenaphthene	5800	3.22 – 10.8
Anthracene	12	2.10 – 9.69
Benz(a)anthracene	18	0.72 – 2.14
Benzo(a)pyrene	15	0.40 – 3.41
Fluoranthene	40	1.74 – 5.40
Fluorene	3000	5.98 – 20.0
Naphthalene	1100	8.10 – 98.2
Phenanthrene	400	10.9 – 35.2
Pyrene	25	1.56 – 13.3

Table S8. CCME guidelines for protection of aquatic life in sediments. Only PACs with available data are presented. Max concentrations presented across range of dilbit treatments.

Compound	ISQG[a] (ng/g d.w.)	PEL[a] (ng/g d.w.)	Maximum concentrations observed in timeseries samples of present study (ng/g d.w.)
2-Methylnaphthalene	20.2	201	2.54 – 4.63
Acenaphthene	6.71	88.9	0.15 – 0.26
Acenaphthylene	5.87	128	0.097 – 0.18
Anthracene	46.9	245	0.26 – 0.38
Benz(a)anthracene	31.7	385	0.18 – 0.31
Benzo(a)pyrene	31.9	782	0.064 – 0.15
Chrysene	57.1	862	0.51 – 1.43
Dibenz(a,h)anthracene	6.22	135	0.025 – 0.10
Fluoranthene	111	2355	1.39 – 2.02
Fluorene	21.2	144	0.69 – 1.20
Naphthalene	34.6	391	1.54 – 3.23
Phenanthrene	41.9	515	3.86 – 5.67
Pyrene	53	875	1.09 – 1.89

[a]ISQC: Interim Sediment Quality Guideline
[b]PEL: Probable Effect Level

Figures

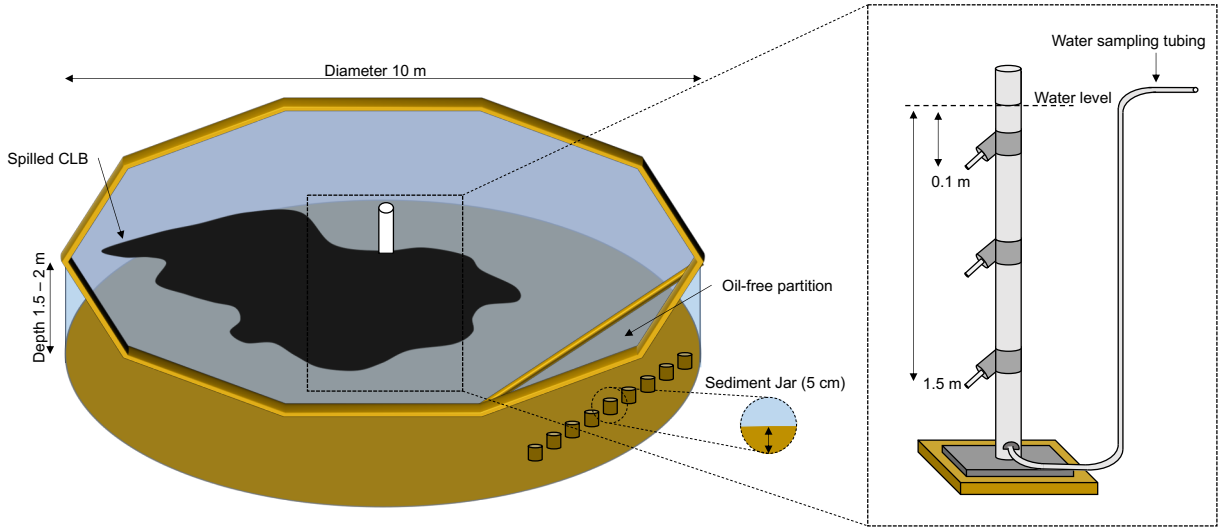

Figure S1. Schematic of limnocorral set up showing water and sediment sampling methods.

Figure S2. The addition of 180 L of CLWB (1:500 oil:water, v/v) onto the water surface of the limnocorral. (A) Overview of addition method and visible sandbags used to seal the membrane to the sediments, (B) View of telescopic arm and pumping system being held at approximately 5 – 10 cm from the water's surface. The oil exited the hose parallel to the water's surface to avoid forcing oil below the water surface and allowing it to spread out during the addition.

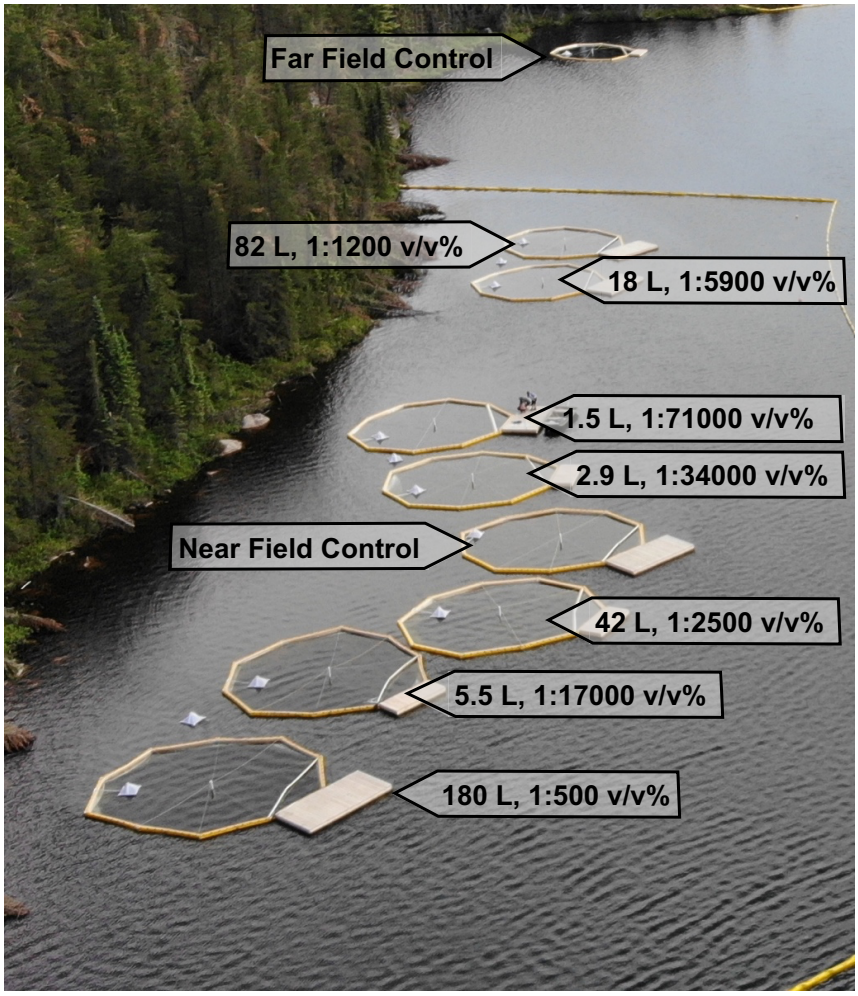

Figure S3. Distribution of spill volumes and resulting oil:water ratios

Figure S4. Example of a tarball sitting on top of the sediment in a coring tube. The tarball was removed and then the top 1cm of the core was processed for PAC analysis.

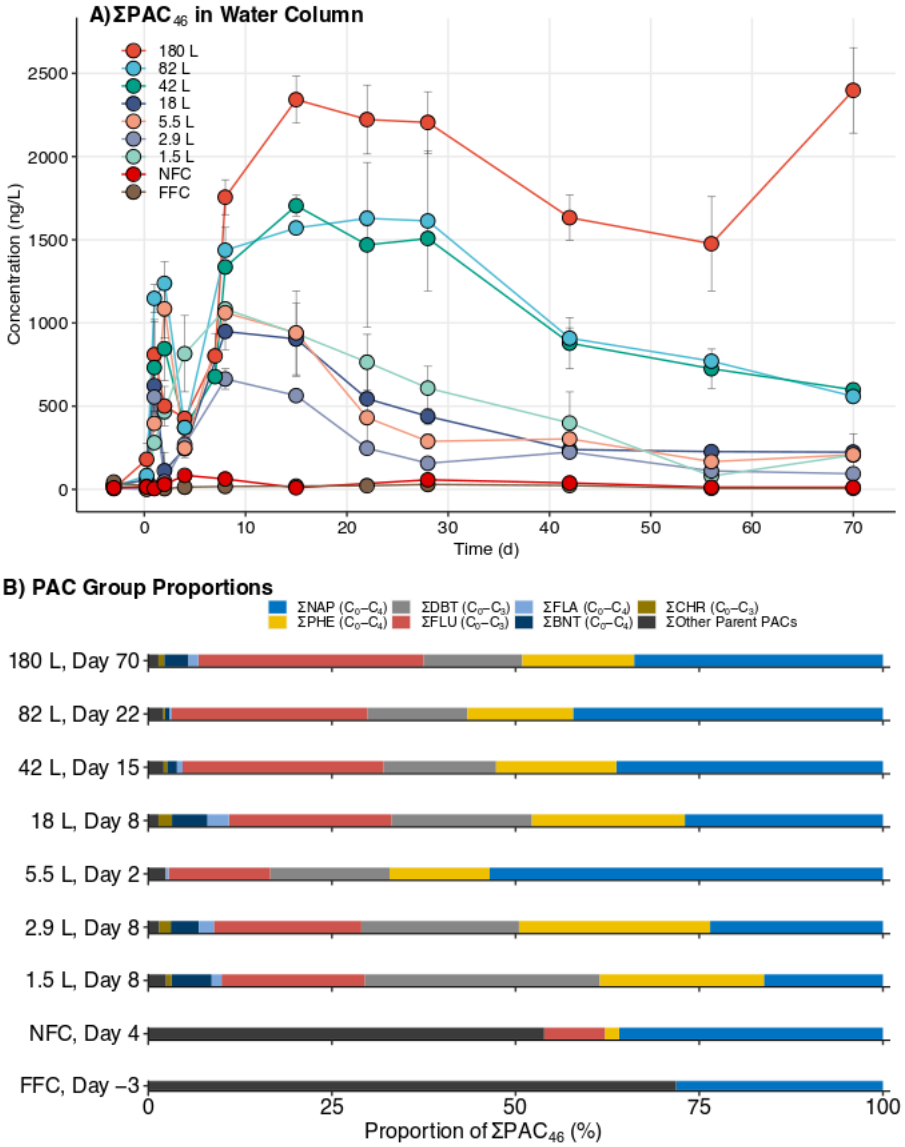

Figure S5. Temporal progression of mean ΣPAC_{46} concentrations in the water column, error bars represent standard deviation (A) and the resulting proportions of each PAC group during the period of maximum ΣPAC_{46} concentration in each treatment (B). ΣPAC_{46} concentrations have been previously reported by Rodriguez-Gil et al. (2021). "Σ Other Parent PACs" represents the sum of Biphenyl, Acenaphthylene, Acenaphthene, Anthracene, Pyrene, Benz(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(e)pyrene, Benzo(a)pyrene, Perylene, Ideno(1,2,3-cd)pyrene, Dibenzo(a,h)anthracene, and Benzo(g,h,i)perylene.

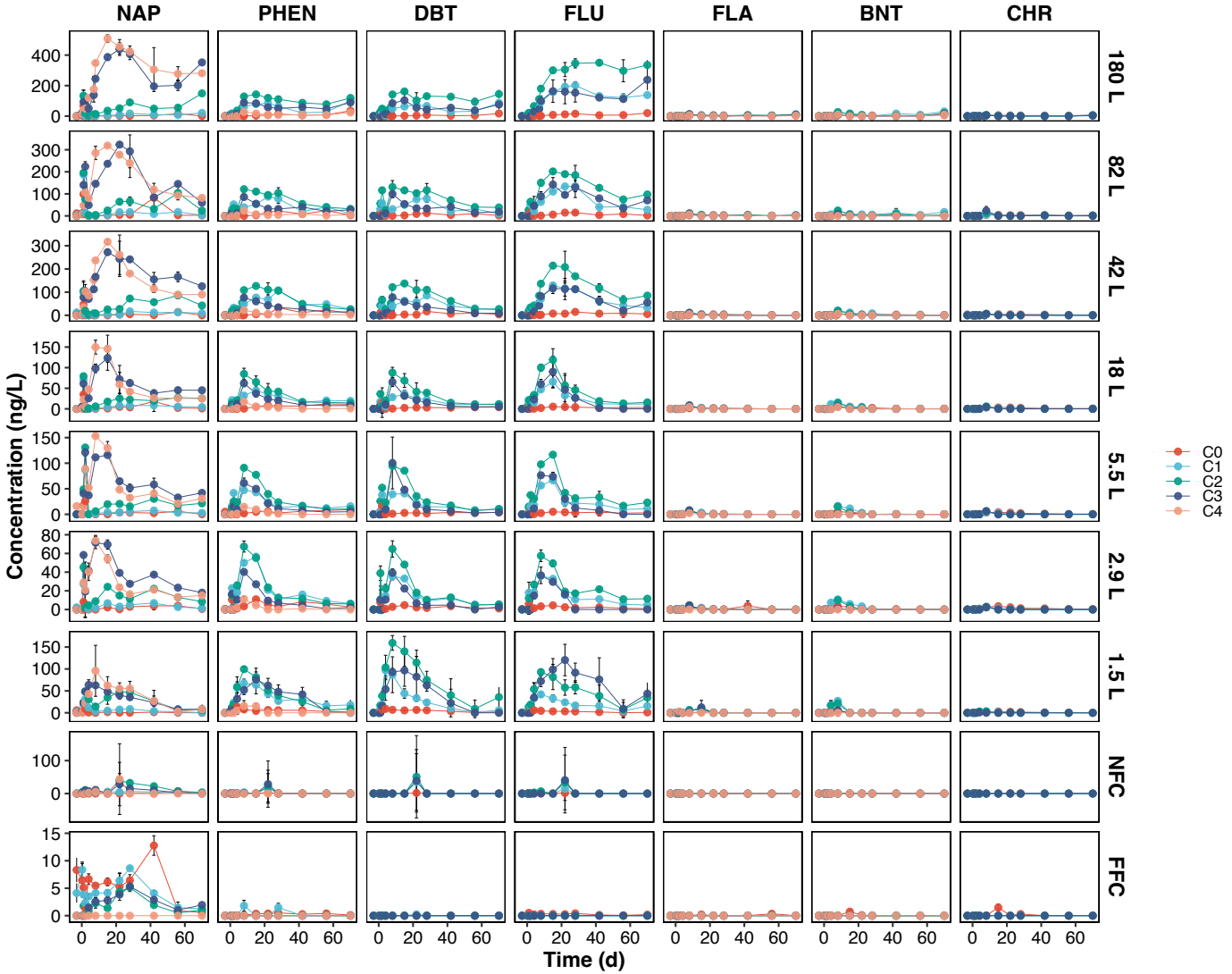

Figure S6. Temporal progression of alkylated PAC concentrations in the water columns of each treatment and control, across each parent PAC group. The error bars represent standard deviation about the mean.

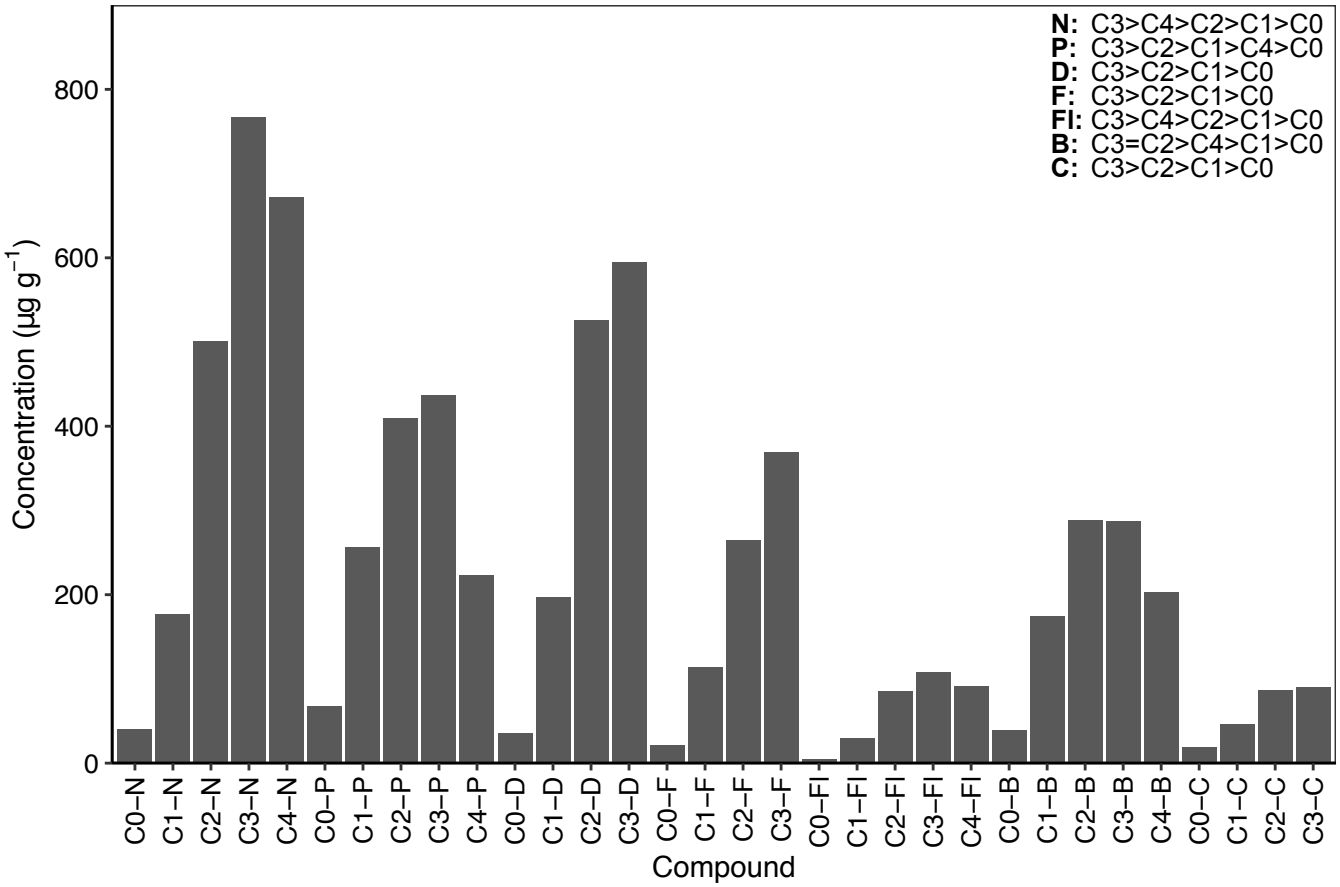

Figure S7. Distribution of parent and alkylated PACs in the source CLWB dilbit. The upper right quadrat of the plot shows the within group abundance distributions of each alkylated compound. N: naphthalene, P: phenanthrene, D: dibenzothiophene, F: fluorene, Fl: fluoranthene, B: benzonaphthothiophene, and C: chrysene.

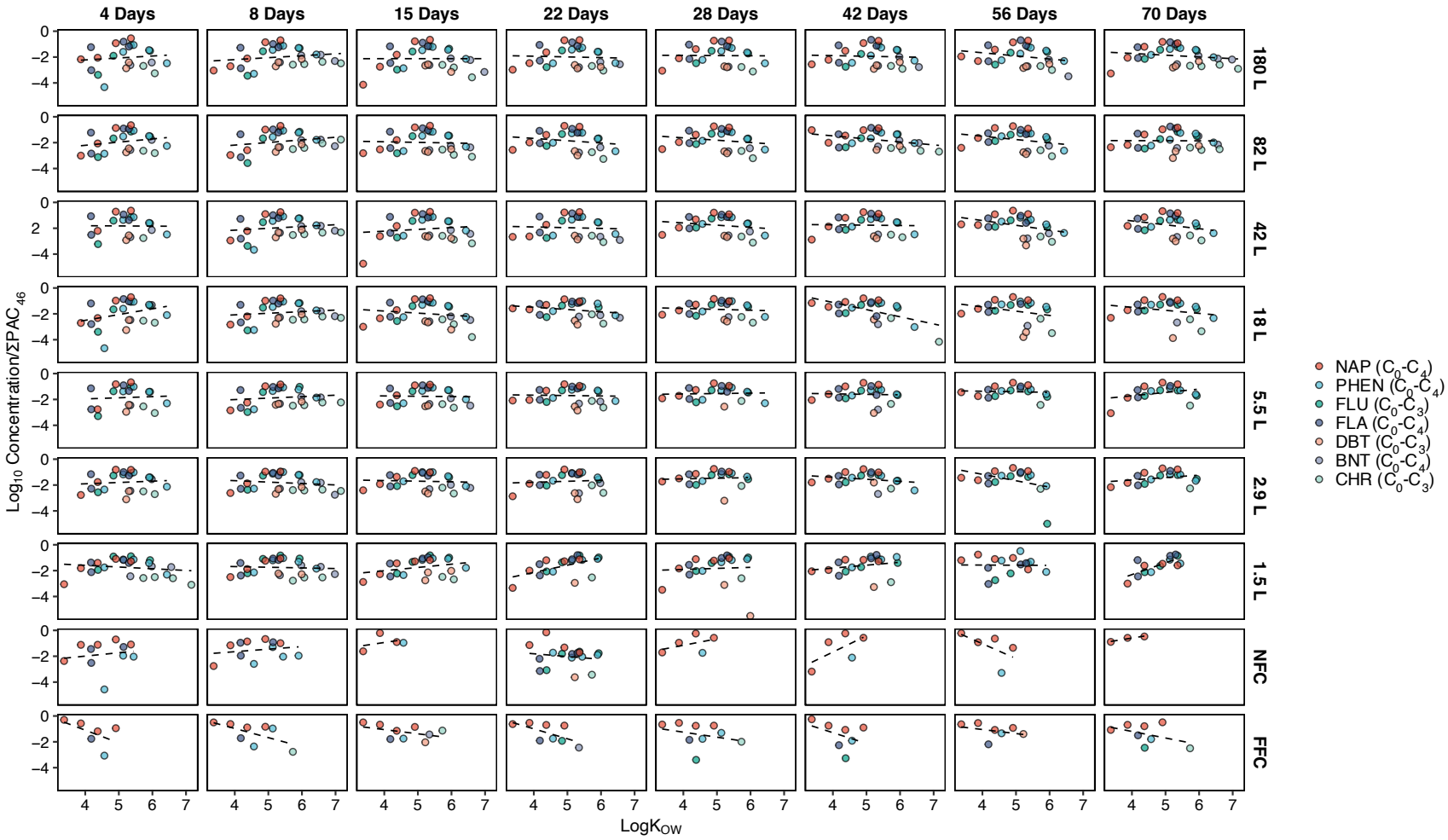

Figure S8. The relationship between water column concentration of individual PACs and logK_{OW}. The dashed lines represent linear regression outputs. Individual compound concentrations were normalized to the ΣPAC_{46} concentration of each respective sample. Compounds whose concentrations were below MDL were omitted from this analysis.

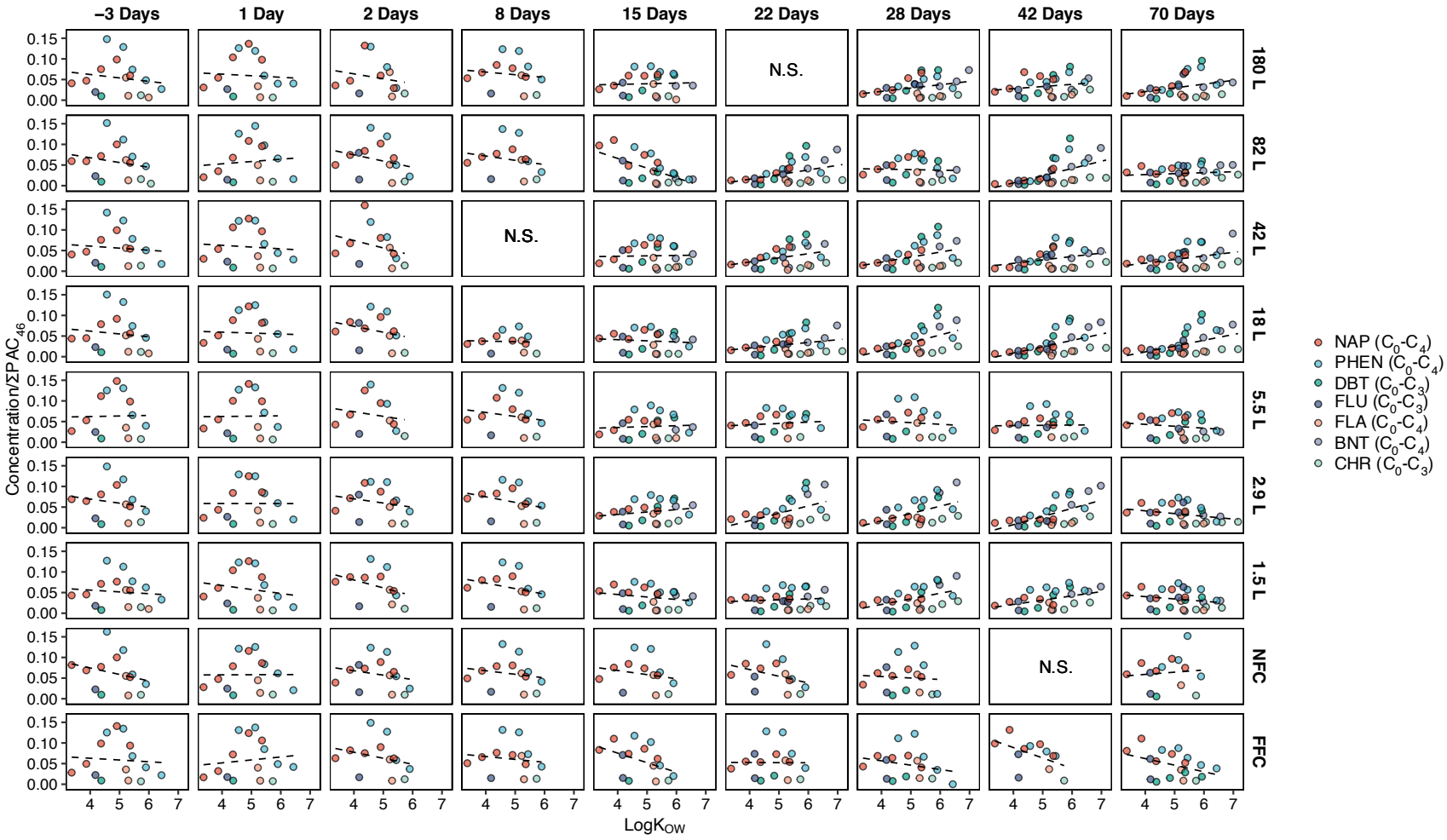

Figure S9. The relationship between sediment concentration of individual PACs and $\log K_{OW}$. The dashed lines represent linear regression outputs. Individual compound concentrations were normalized to the ΣPAC_{46} concentration of each respective sample. Compounds whose concentrations were below MDL were omitted from this analysis.

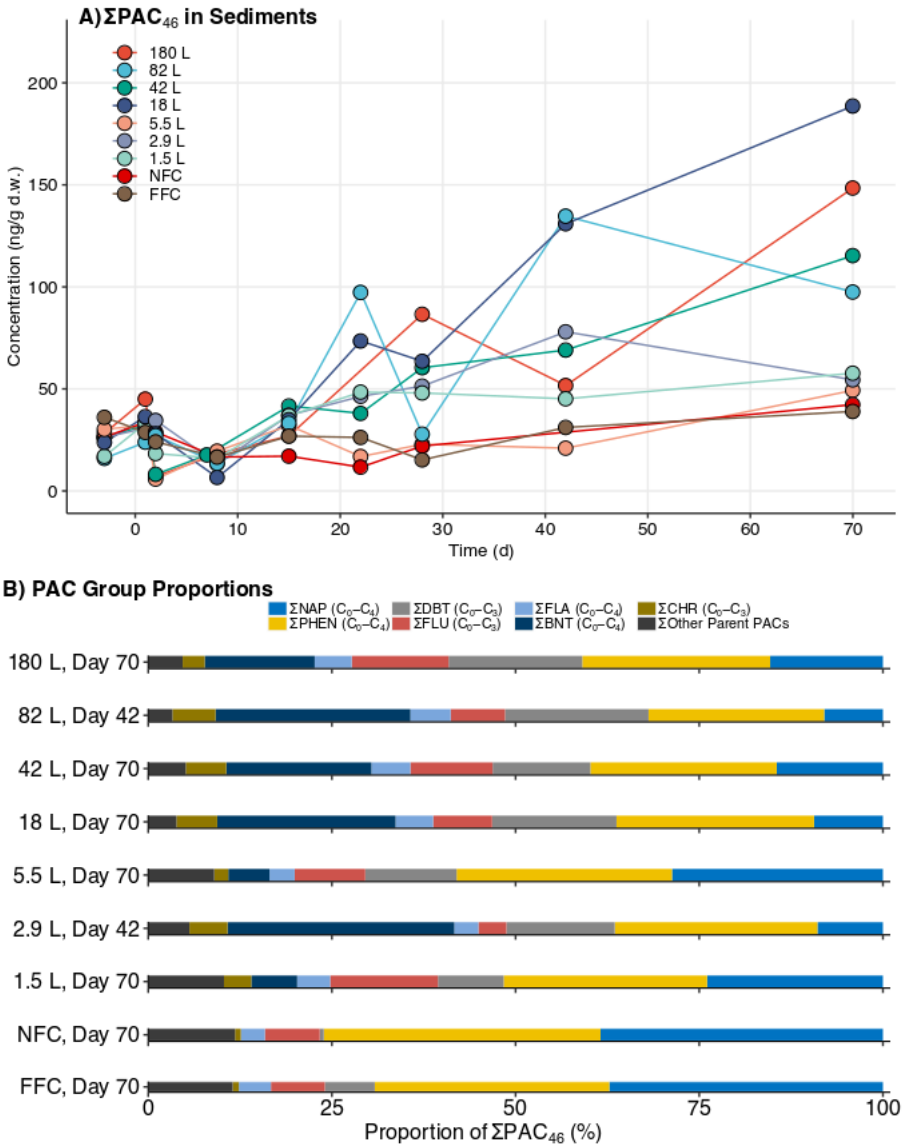

Figure S10. Temporal progression of mean ΣPAC$_{46}$ concentrations in the sediments (A) and the resulting proportions of each PAC group during the period of maximum ΣPAC$_{46}$ concentration in each treatment (B).ΣPAC$_{46}$ concentrations have been previously reported by Rodriguez-Gil et al. (2021). "Σ Other Parent PACs" represents the sum of Biphenyl, Acenaphthylene, Acenaphthene, Anthracene, Pyrene, Benz(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(e)pyrene, Benzo(a)pyrene, Perylene, Ideno(1,2,3-cd)pyrene, Dibenzo(a,h)anthracene, and Benzo(g,h,i)perylene.

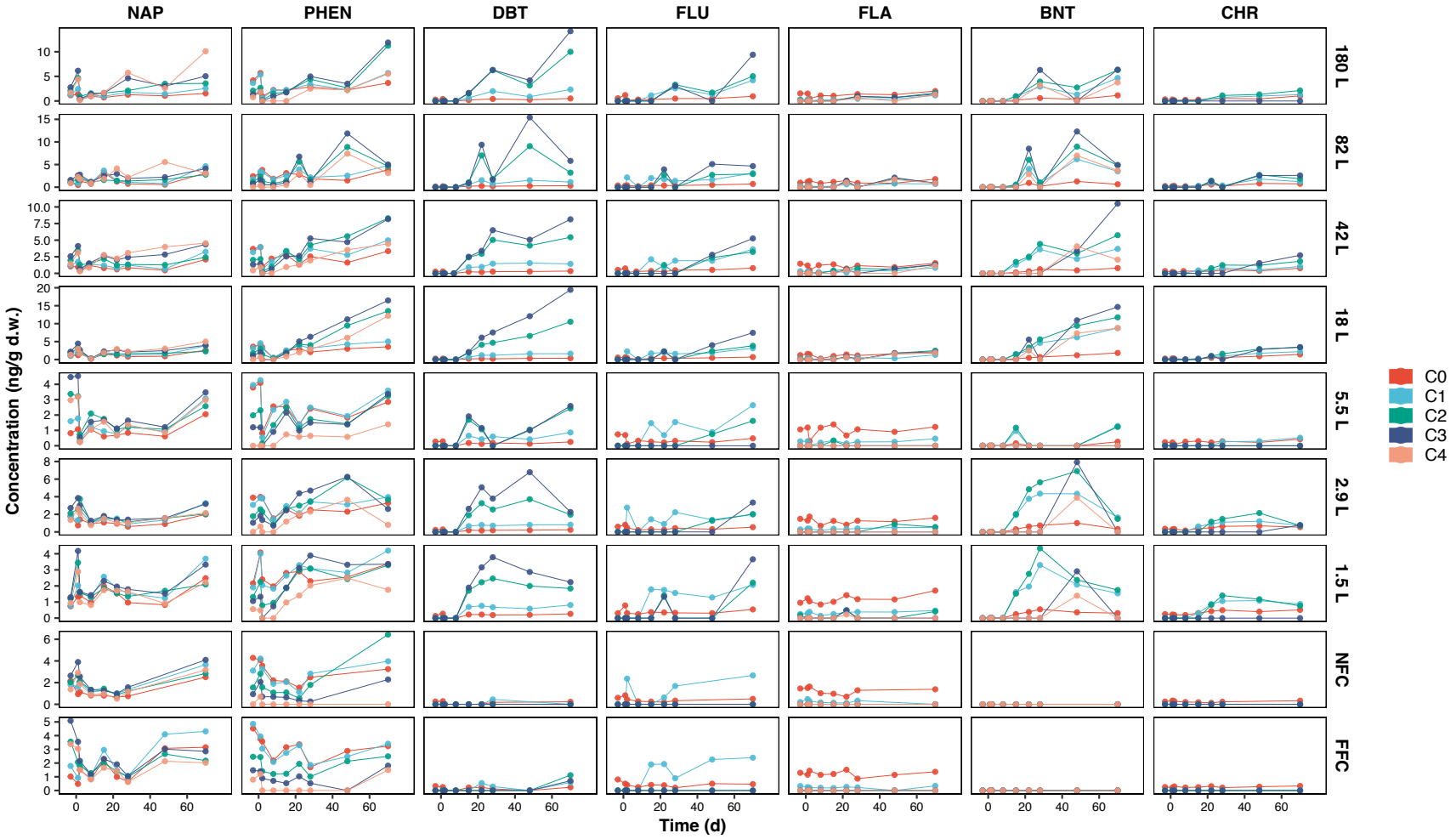

Figure S11. Temporal progression of alkylated PAC concentrations in sediment samples collected from each treatment and control, across each parent PAC group.

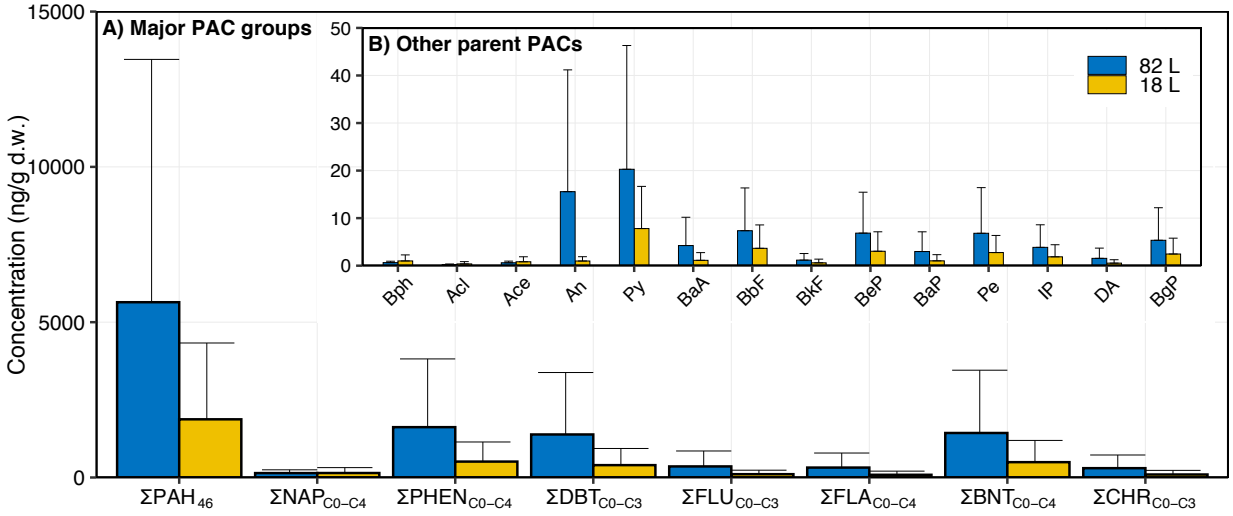

Figure S12. Mean concentrations of polycyclic aromatic compound (PAC) groups in sediment samples in direct contact with sunken dilbit. The sum of the parent and each alkylated homolog in each group is in (A). Other parent PACs are in panel (B). Error bars are standard deviations (N= 3)

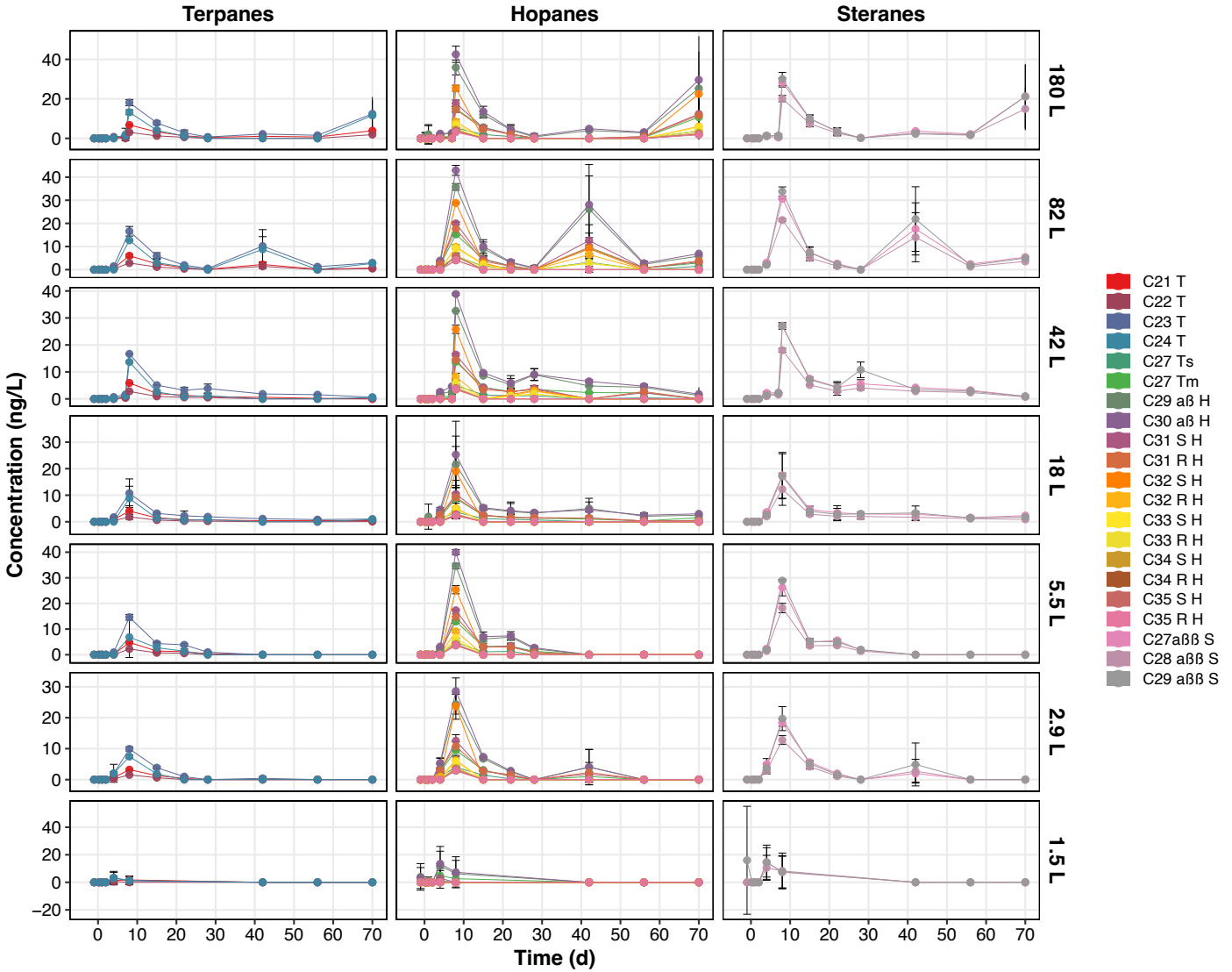

Figure S13. Temporal progression of petroleum biomarker compound concentrations (mean ± standard deviation) in the water column.

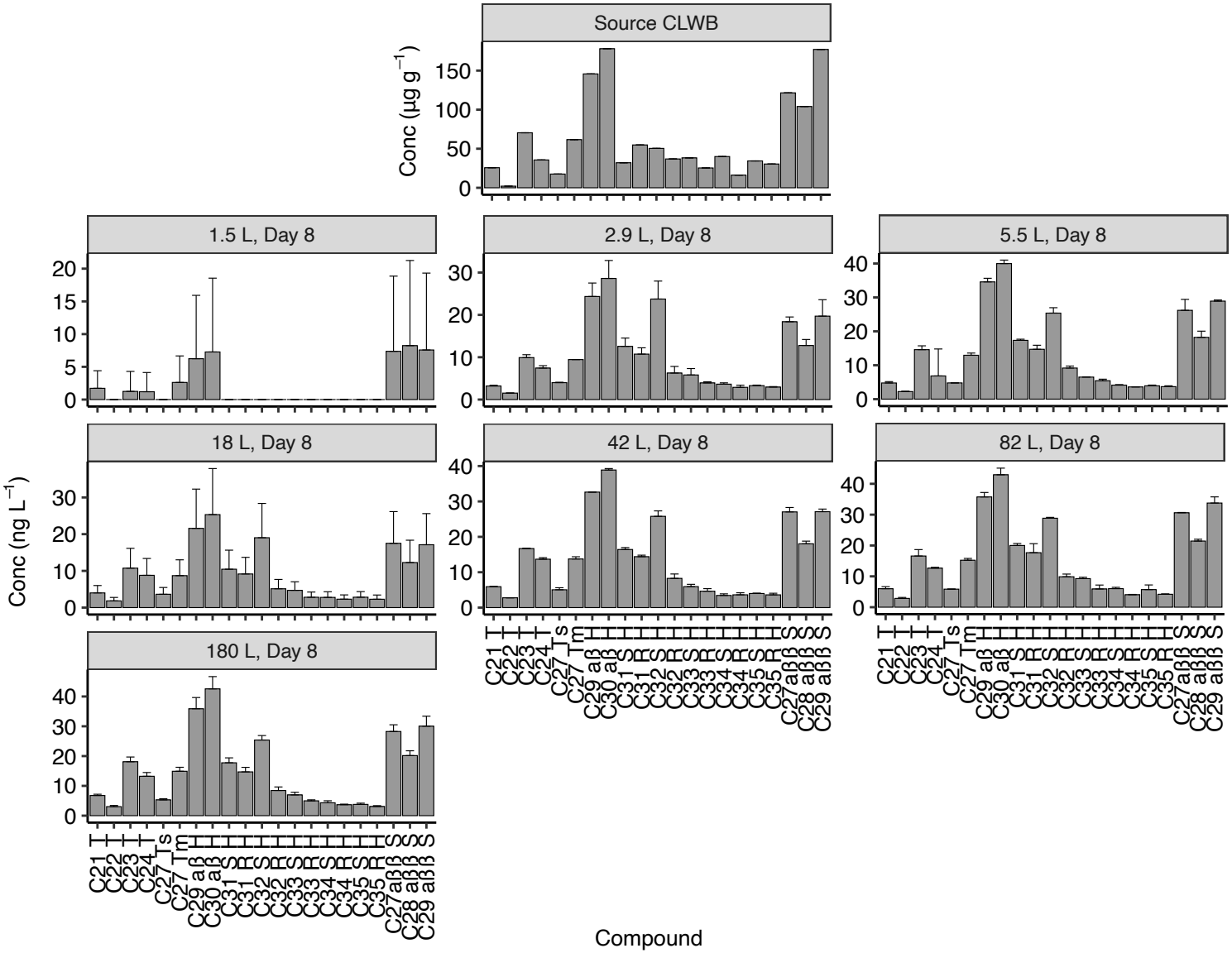

Figure S14. Concentration profiles of petroleum biomarkers in the source CLWB and water samples collected on day 8 from each dilbit amended treatment. Error bars represent standard deviation about the mean.

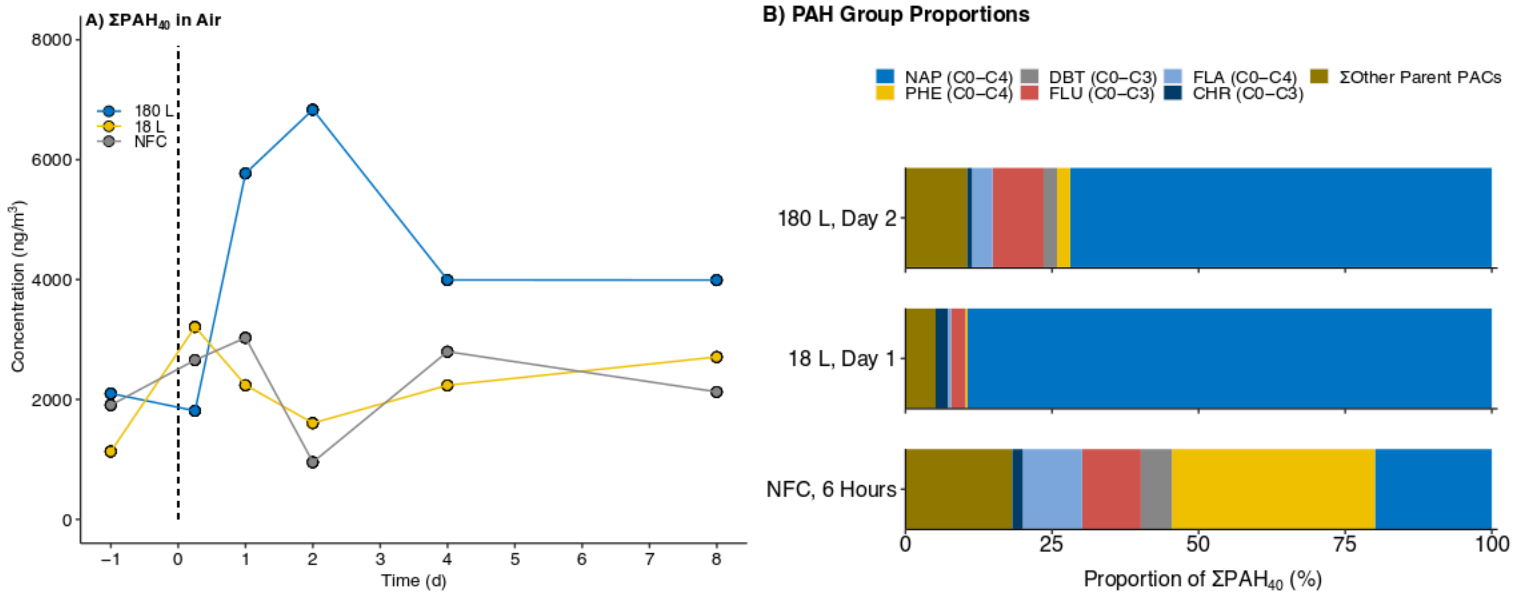

Figure S15. Temporal progression of ΣPAC_{40} concentrations in the sediments (A) and the resulting proportions of each PAC group during the period of maximum ΣPAC_{40} concentration in each treatment (B). "Σ Other Parent PACs" represents the sum of Biphenyl, Acenaphthylene, Acenaphthene, Anthracene, Pyrene, Benz(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(e)pyrene, Benzo(a)pyrene, Perylene, Ideno(1,2,3-cd)pyrene, Dibenzo(a,h)anthracene, and Benzo(g,h,i)perylene.

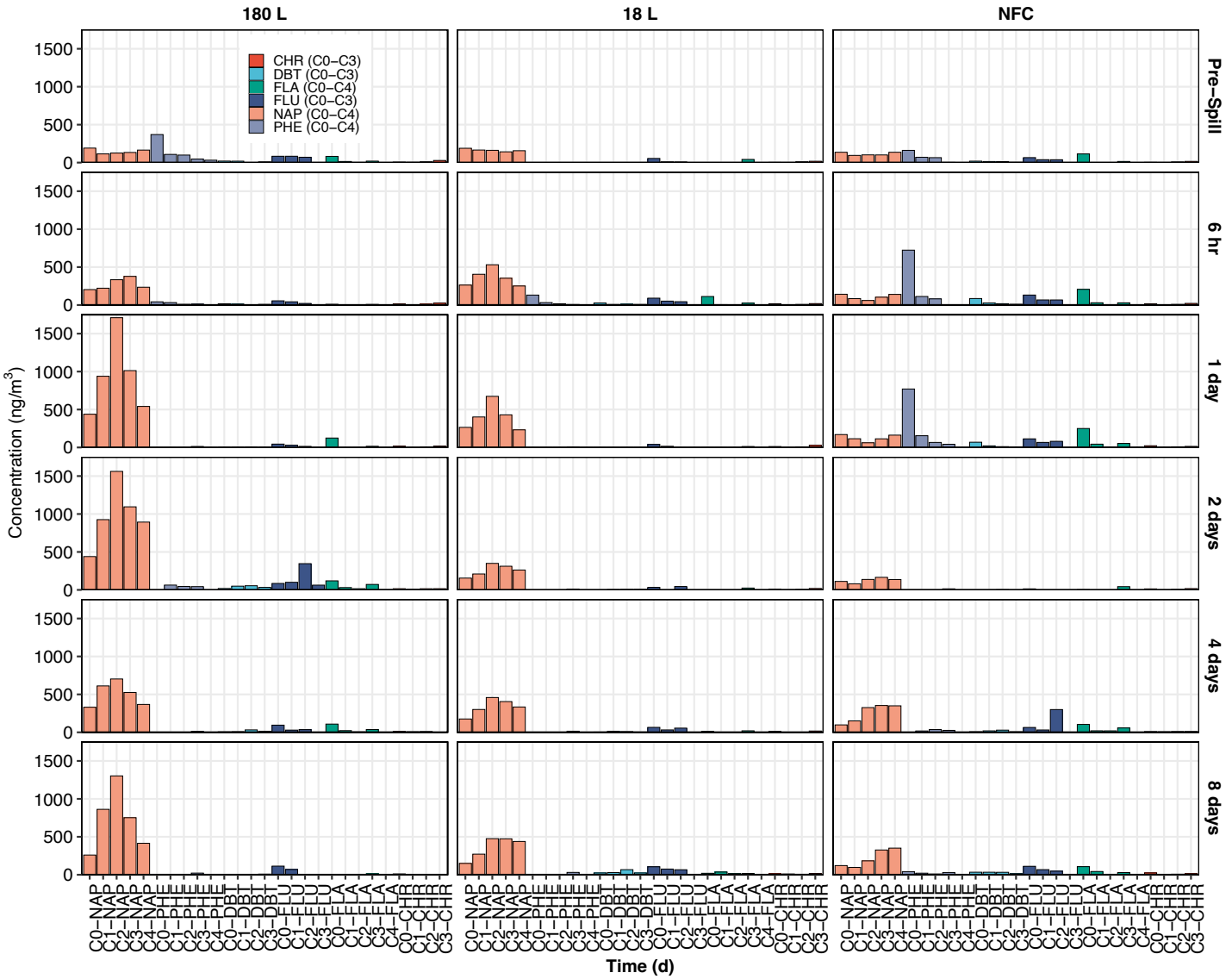

Figure S16. Alkylated PAC profiles of each air sample collected over time during the first 8 days of the study.

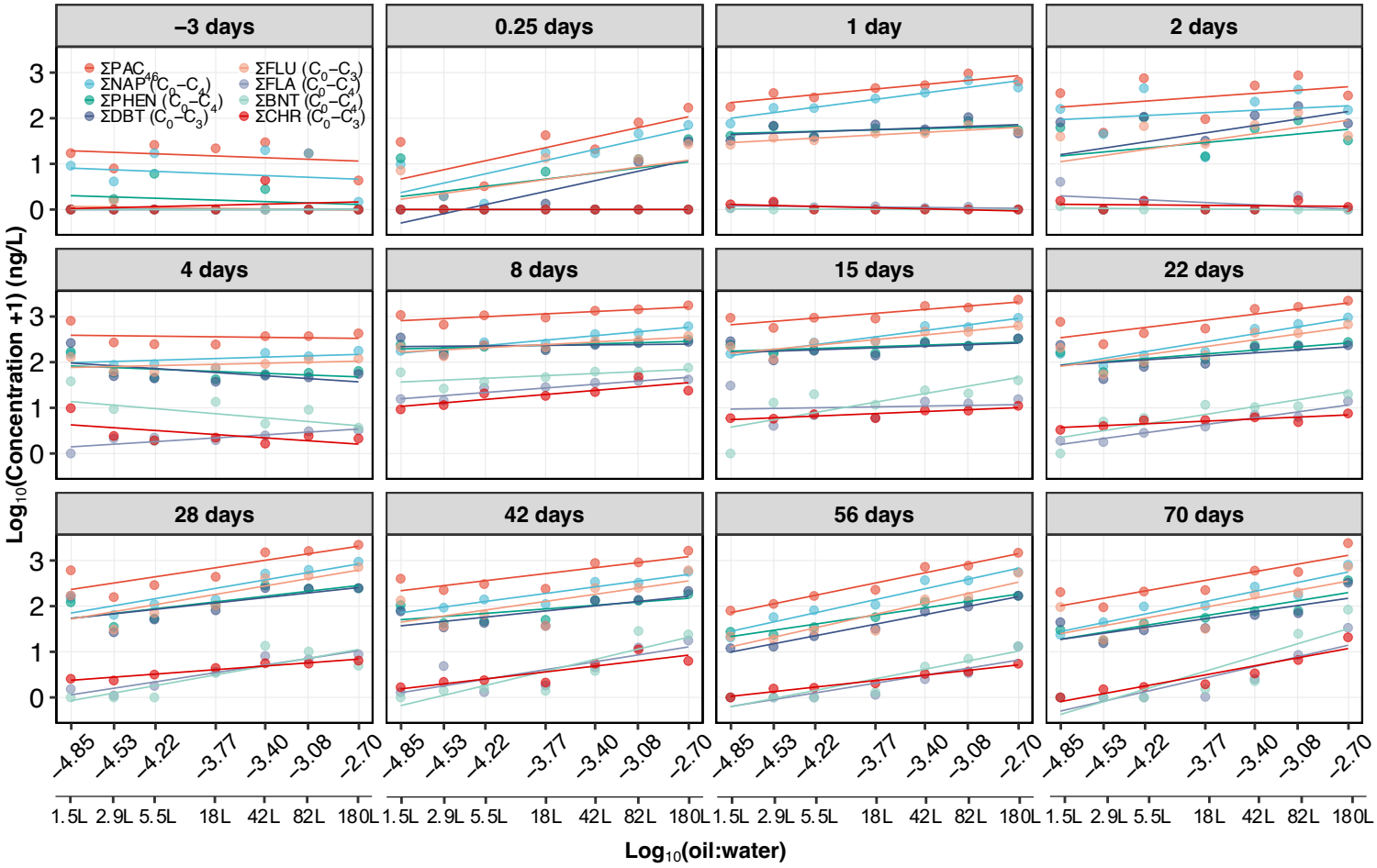

Figure S17. Individual linear regressions comparing concentration in the water column and spill volume at each timepoint for each PAC group. Both axes were logarithmically transformed. To account for cases where concentrations were 0, a constant of 1 was added to each measurement prior to transformation. The controls were excluded from the regressions.

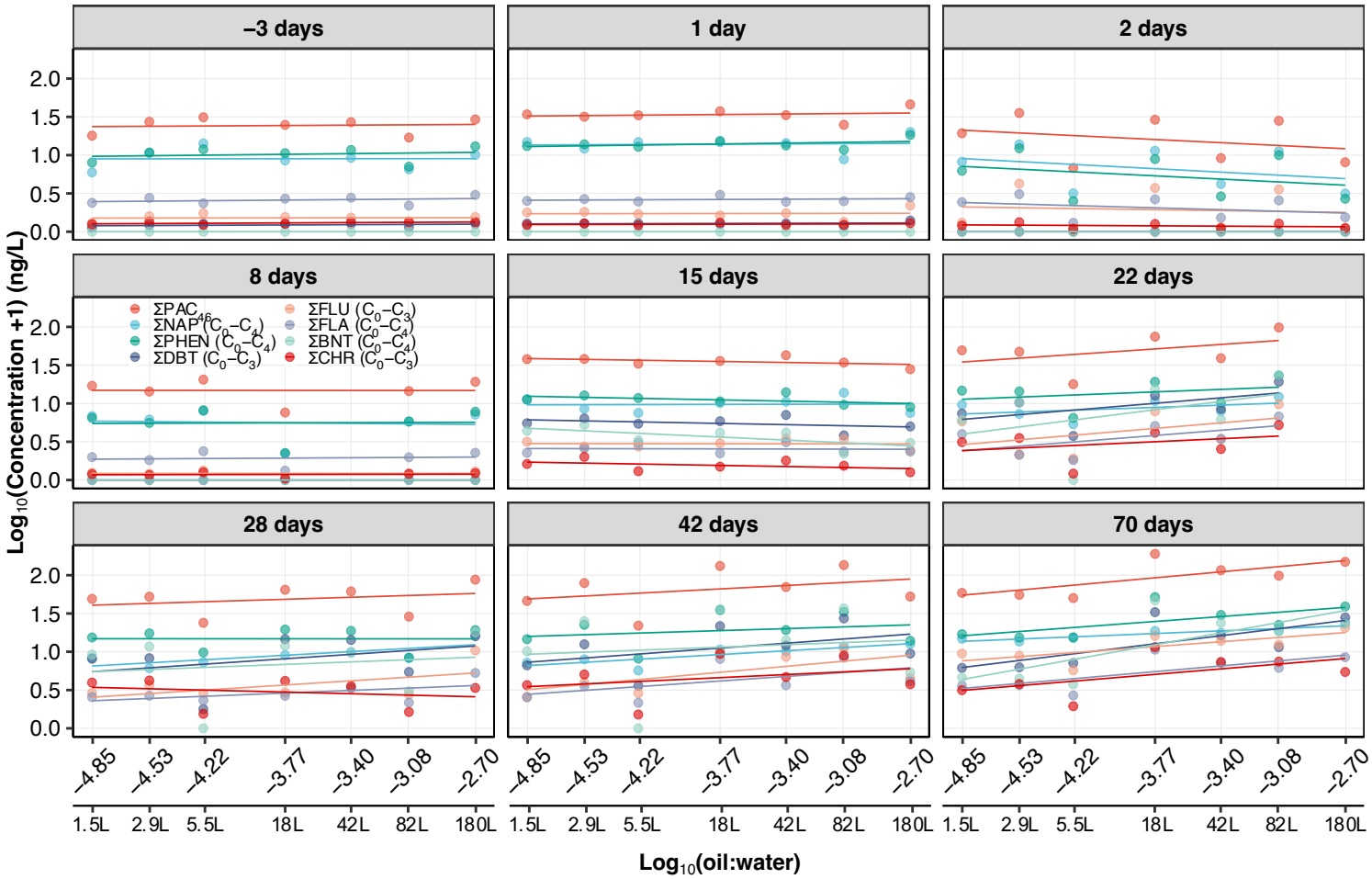

Figure S17. Individual linear regressions comparing concentration in the sediments and spill volume at each timepoint for each PAC group. Both axes were logarithmically transformed. To account for cases where concentrations were 0, a constant of 1 was added to each measurement prior to transformation. The controls were excluded from the regressions.

References

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Rodriguez-Gil, J.L., Stoyanovich, S., Hanson, M.L., Hollebone, B., Orihel, D.M., Palace, V., Faragher, R., Mirnaghi, F.S., Shah, K., Yang, Z., 2021. Simulating diluted bitumen spills in boreal lake limnocorrals-Part 1: Experimental design and responses of hydrocarbons, metals, and water quality parameters. Sci. Total Environ. 148537.

Stoyanovich, S., Yang, Z., Hanson, M., Hollebone, B., Orihel, D., Palace, V., Rodriguez-Gil, J., Faragher, R., Mirnaghi, F., Shah, K., Blais, J., 2019. Simulating a spill of diluted bitumen: Environmental weathering and submergence in a model freshwater system. ET&C. https://doi.org/10.1002/etc.4600