water

MDPI

Supplementary Materials

An Assessment of Vegetation in the Kearl Treatment Wetland following Exposure to Oil Sands Process-Affected Water

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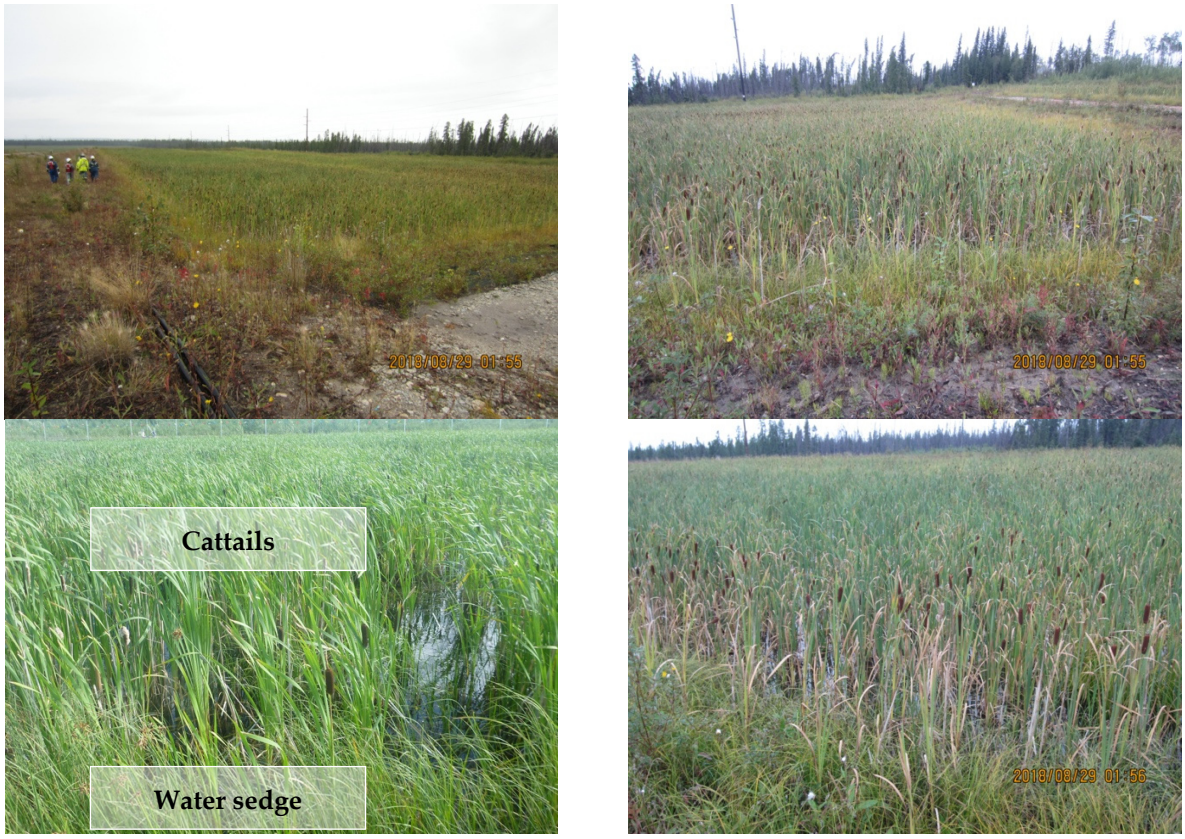

Figure S1. Photos of the shallow areas at the Kearl Treatment Wetland.

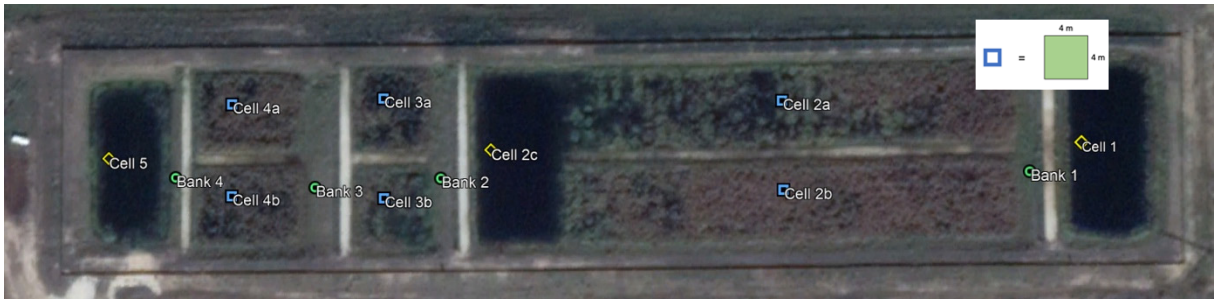

Figure S2. Overview of (4 x 4 m) vegetation plot locations. Plot locations in deep cells are show as yellow diamonds (Cell 1, 2c, and 5), shallow cells are show as blue squares (Cell 2a, 2b, 3a, 3b, 4a, and 4b). Source water is pumped into Cell 1 (forebay) and exits from Cell 5 (final deep cell) (Imagery date: September 9, 2019). For statistical analysis discussion, Location 2 = cell 2, Location 3 = cell 3, and Location 4 = cell 4.

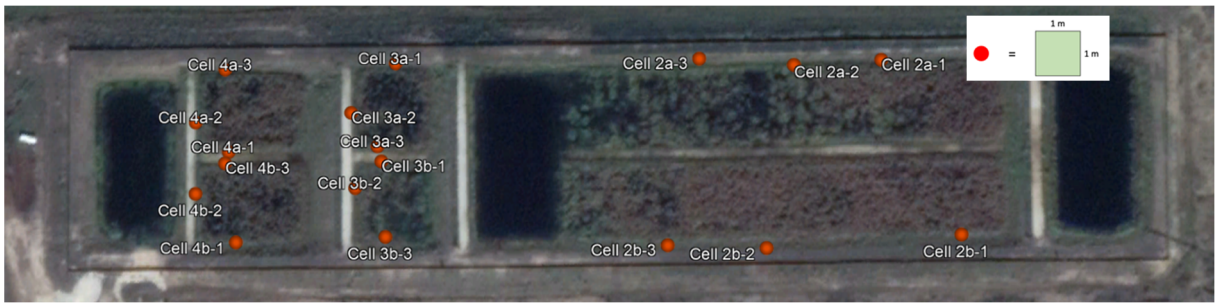

Figure S3. Overview of emergent plant growth (1 x 1 m) plot locations shown as red circles. Three emergent plant growth plots are located in each shallow cell (Cell 2a, 2b, 3a, 3b, 4a, and 4b), for a total of 18. For statistical analysis discussion, Location 2 = cell 2, Location 3 = cell 3, and Location 4 = cell 4.

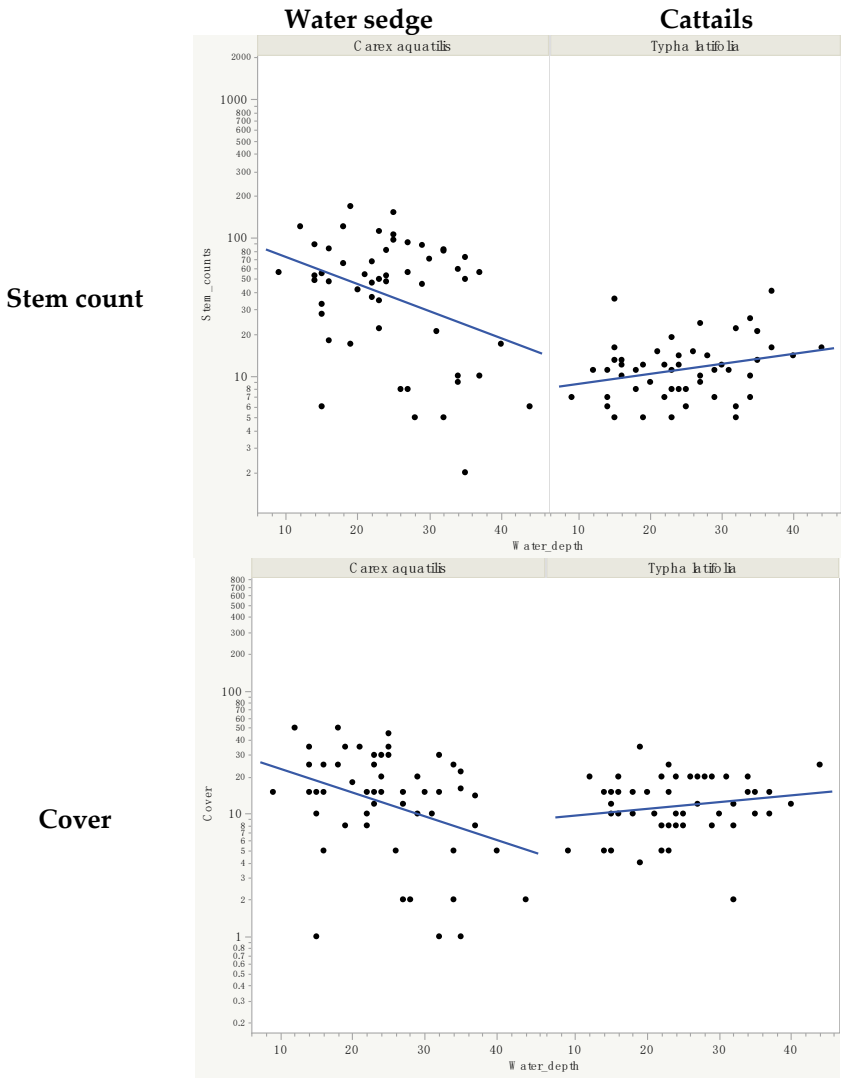

Figure S4. Effects of water depth on species characteristics at the Kearl Treatment Wetland, 2019-2021.

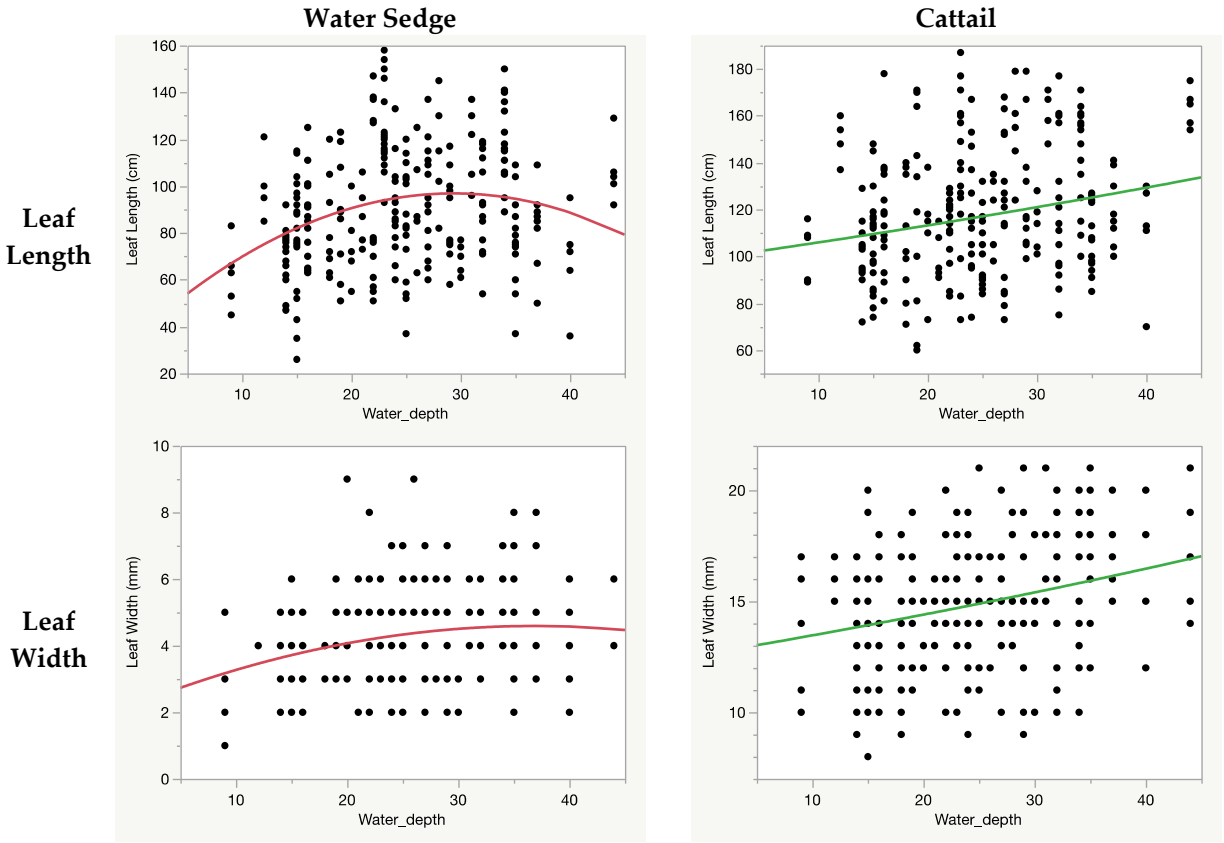

Figure S5. Leaf length and leaf width of water sedge and cattail vs. water depth in the Kearl Treatment Wetland, 2019-2021.

Table S1. Definition of plant vigor ratings used in vegetation assessments at the KTW (ESRD, 2003).

Rating	Description
0	*Dead* – most or all plant parts are yellowed (chlorotic) or brown (necrotic) (rating '0');
1	*Poor* – plant size is stunted (small plant size) and plant parts may be up to half discoloured (chlorotic) or dead (necrotic) (rating '1');
2	*Fair* (average) – plant species considered average for size and colour, some chlorosis, necrosis, or yellowing (up to 25%) may be present (rating '2');
3	*Good* – plant species size and colour slightly above average; minor chlorosis, necrosis, or yellowing (5 to 10%) may be present depending on season (rating '3'); and
4	*Excellent* – plant species above average size and colour, very minor, or no chlorosis, necrosis, or yellowing (<5%) may be present (rating '4').

Table S2. Water budget estimates from the KTW in each year of wetland operation. Total precipitation (P) and evapotranspiration (ET) was determined for the wetland based on calculations in [9]. $\Delta V = P\text{-}ET$.

Year	P	ET	ΔV^*
	m^3	m^3	m^3
2016	1933.9	2256.6	-322.7
2017	685.4	3691.2	-3005.9
2018	1424.7	2451.4	-1026.7
2019	1456.2	2978.0	-1521.9
2020	2720.0	2899.0	-179.0
2021	1943.1	3691.6	-1748.4

*ΔV does not account for water removed from the wetland or OSPW added to the wetland prior to the vegetation assessments.

Table S3. Plant vigor ratings in the KTW, 2016 – 2021.

Year	Bank	Deep Cell	Shallow Cell	Average (std)
2016	2.9 (0.2)	2.8 (0.4)	2.8 (0.3)	**2.8** (0.3)
2017	2.8 (0.4)	2.9 (0.5)	3.0 (0.2)	**2.9** (0.3)
2018	2.9 (0.4)	3.0 (0.5)	2.9 (0.3)	**2.9** (0.4)
2019	2.6 (1.1)	2.9 (1)	3.0 (0.2)	**2.8** (0.7)
2020	3.2 (0.8)	3.4 (0.5)	3.5 (0.7)	**3.4** (0.7)
2021	3.2 (0.5)	3.1 (0.7)	3.4 (0.6)	**3.3** (0.6)
Average (std)	**2.9** (0.5)	**3.0** (0.6)	**3.1** (0.4)	**3.0** (0.5)

Table S4. Stem density, leaf length and leaf width of water sedge and cattails in the shallow cells of the KTW, 2019 – 2021.

Plot Averages	Stem density (stems/m²)			Leaf Length (cm)			Leaf Width (mm)		
(n = 3)	2019	2020	2021	2019	2020	2021	2019	2020	2021
Water Sedge									
Cell 2a	50 (35.9)	96 (80)	80 (9.2)	114.7 (10.4)	88.9 (21.1)	72.9 (7.6)	4.5 (0.9)	4.5 (1.5)	3.1 (0.7)
Cell 2b	24 (20.2)	46 (32.7)	89 (21.0)	109.4 (14.2)	99.7 (27.1)	83.1 (21.8)	4.9 (1.2)	5.7 (1.1)	3.5 (1.0)
Cell 3a	6 (1.5)	4 (2.1)	46 (11.7)	114.7 (19.4)	78.1 (18.1)	68.5 (20.8)	4.4 (1.3)	3.9 (1.1)	3.7 (1.2)
Cell 3b	27 (8.5)	50 (38.2)	64 (22.0)	105.9 (13.6)	75.9 (19.3)	69.5 (12.2)	4.0 (0.9)	4.6 (2.0)	3.4 (0.8)
Cell 4a	35 (16.6)	44 (19.1)	68 (15.0)	129.8 (18.1)	97.4 (25.0)	72.9 (13.2)	4.9 (1.2)	4.4 (1.1)	3.2 (1.0)
Cell 4b	96 (41.6)	70 (74.1)	61 (17.8)	105.3 (12.5)	78.6 (25.8)	74.9 (17.2)	4.1 (1.0)	5.4 (1.8)	3.4 (1.0)
Average (std)	**40** (20.7)	**52** (41.0)	**68** (16.1)	**113.2** (14.7)	**86.4** (22.7)	**73.6** (15.5)	**4.5** (1.1)	**4.8** (1.4)	**3.4** (1.0)
Cattail									
Cell 2a	7 (2.5)	18 (20)	8 (3.2)	152.1 (17)	116.3 (35.3)	107.9 (11.1)	15.8 (3.7)	14.9 (3.1)	12.6 (2.8)
Cell 2b	13 (2.9)	21 (7.0)	8 (2.5)	157.5 (17.2)	120.1 (22.1)	91.7 (10.2)	18.0 (2.5)	14.3 (2.2)	12.9 (2.3)
Cell 3a	11 (2.6)	26 (8.4)	11 (3.2)	150.4 (18.8)	102.6 (17.1)	103.3 (15.5)	16.7 (2.2)	18.1 (2.0)	12.7 (2.7)
Cell 3b	8 (4.6)	11 (2.6)	8 (2.6)	134.3 (16.5)	101.1 (22.9)	100.3 (15.2)	16.5 (1.4)	15.3 (2.7)	13.4 (2.4)
Cell 4a	12 (0.6)	17 (2.1)	12 (2.0)	148.2 (24.5)	112.4 (22.5)	102.0 (13.0)	15.7 (1.8)	15.8 (2.2)	14.4 (2.8)
Cell 4b	9 (1.7)	9 (8.1)	12 (4.5)	142.5 (12.9)	118.3 (14.2)	106.8 (15.3)	16.4 (1.8)	16.4 (3.0)	13.4 (2.2)
Average (std)	**10** (2.5)	**17** (8.0)	**10** (8.0)	**147.5** (17.8)	**111.8** (22.3)	**102.0** (13.4)	**16.5** (2.2)	**15.8** (2.5)	**13.2** (2.5)

Table S5. Water level (cm) in the shallow cells of the KTW, 2019 – 2021.

Plot Averages	Water Level (cm)			
(n = 3)	2019	2020	2021	Average
Cell 2a	33 (1.2)	26 (9.5)	30 (1.5)	30 (4.0)
Cell 2b	35 (8.1)	32 (4.4)	23 (4.0)	30 (5.5)
Cell 3a	24 (5.5)	27 (10.8)	13 (3.8)	22 (6.7)
Cell 3b	18 (4.4)	29 (10.1)	14 (0.0)	20 (4.8)
Cell 4a	21 (2.1)	27 (8.7)	21 (4.2)	23 (5.0)
Cell 4b	18 (6.0)	29 (5.5)	20 (4.7)	22 (5.4)
Average (std)	**25** (4.5)	**28** (8.2)	**20** (3)	**25** (5.2)