



Update on Churchill River MeHg flux experiments

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Muskrat Falls dam & reservoir – Oct 2017



2016/2017 Churchill River soil sampling sites



Churchill River soil sampled Nov 2016

Site type	Flux core experiment in NWR (Dec 2016/Jan 2017)
Pre-flood	Upper Brook (PF-UB), Edwards Brook (PF-EB)
Infrequently or seasonally flooded	Upper Brook (IF-UB)
Wetland	Wet bog and dry bog from 7 Km past UB
Experiment Manipulation	Leaf litter layer removed (OL-UB, OL-EB) Top 5 cm soil removed (5 cm-UB, 5 cm-EB)

Flux core experiments – Dec 2016 to Jan 2017

- Incubated at 5⁰ C in walk-in refrigerator at North West River lab - soil cores collected in Nov
- Three cores incubated for each site & manipulation
- Overlying water sampled at intervals of 3 to 12 days for 6 weeks
- Overlying water replaced with fresh Churchill River water daily
- Water quality measurements daily (T, S, DO, pH)

Mixing heads & flux cores



Daily water changes & WQ measurements

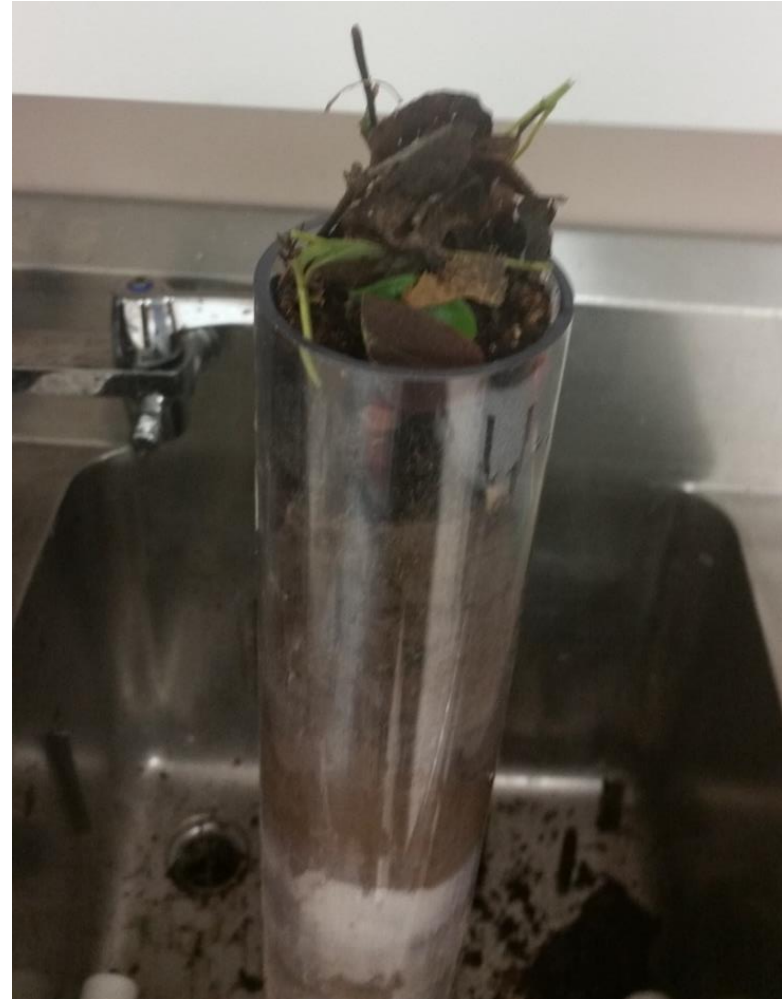


Manipulating sediment cores

Leaf litter & top 5 cm removed

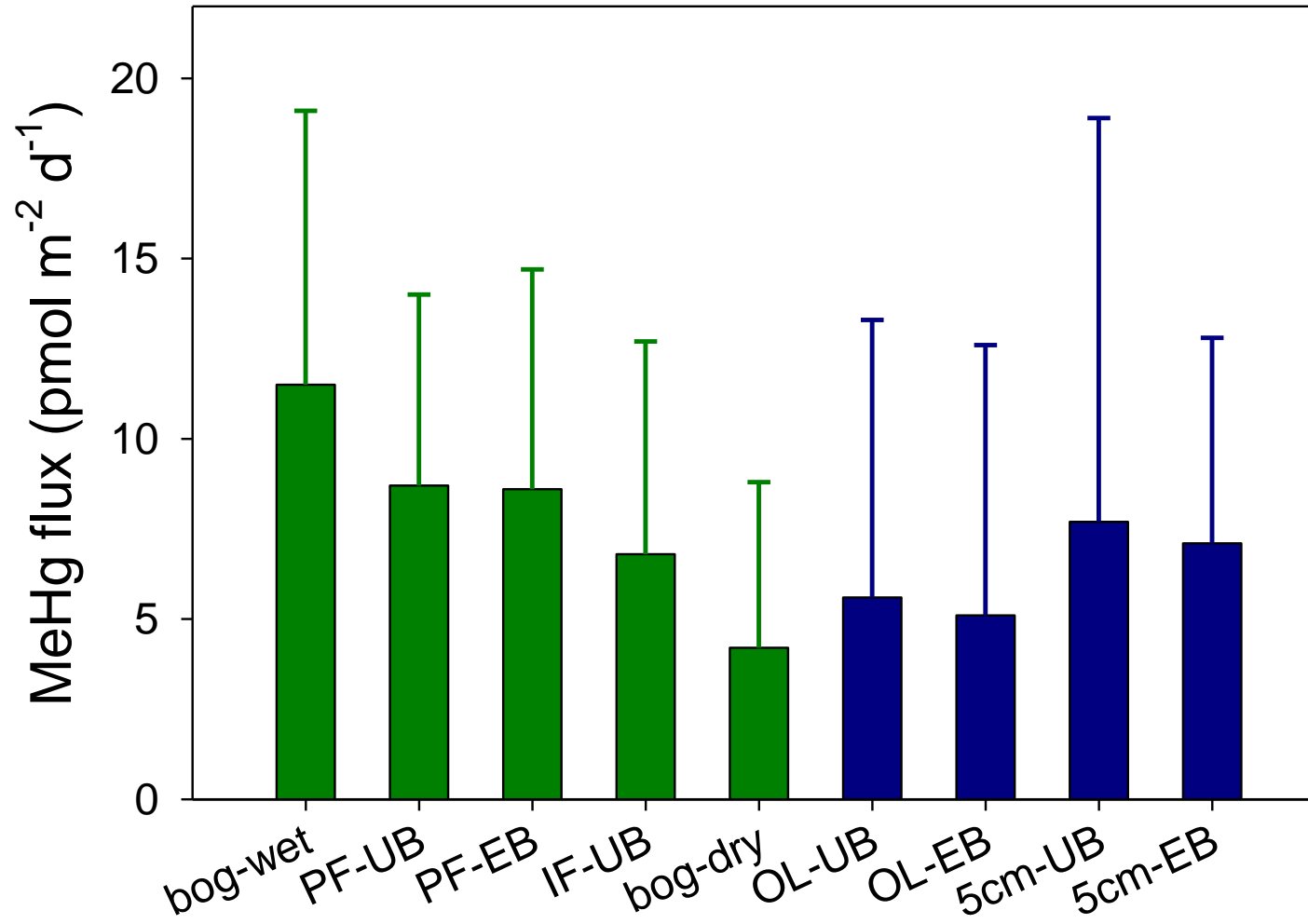


Leaf litter layer removed



Churchill River average MeHg flux - Dec 2016 to Jan 2017

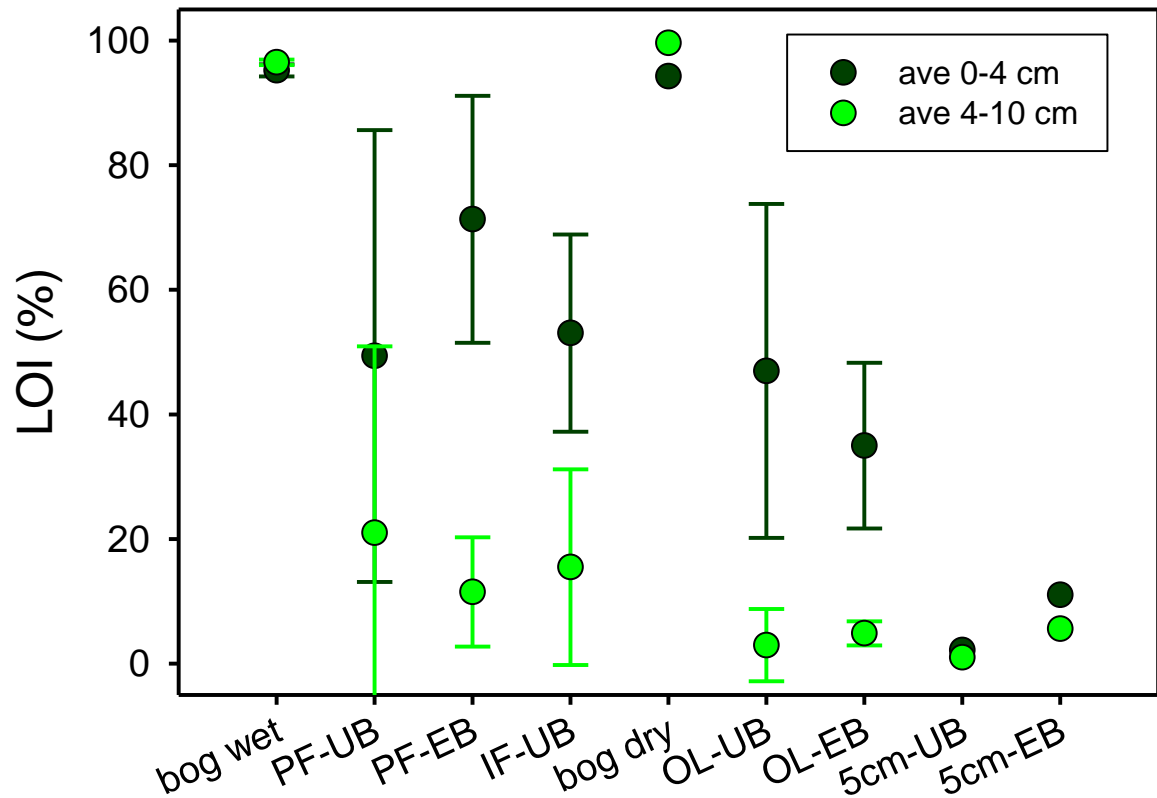
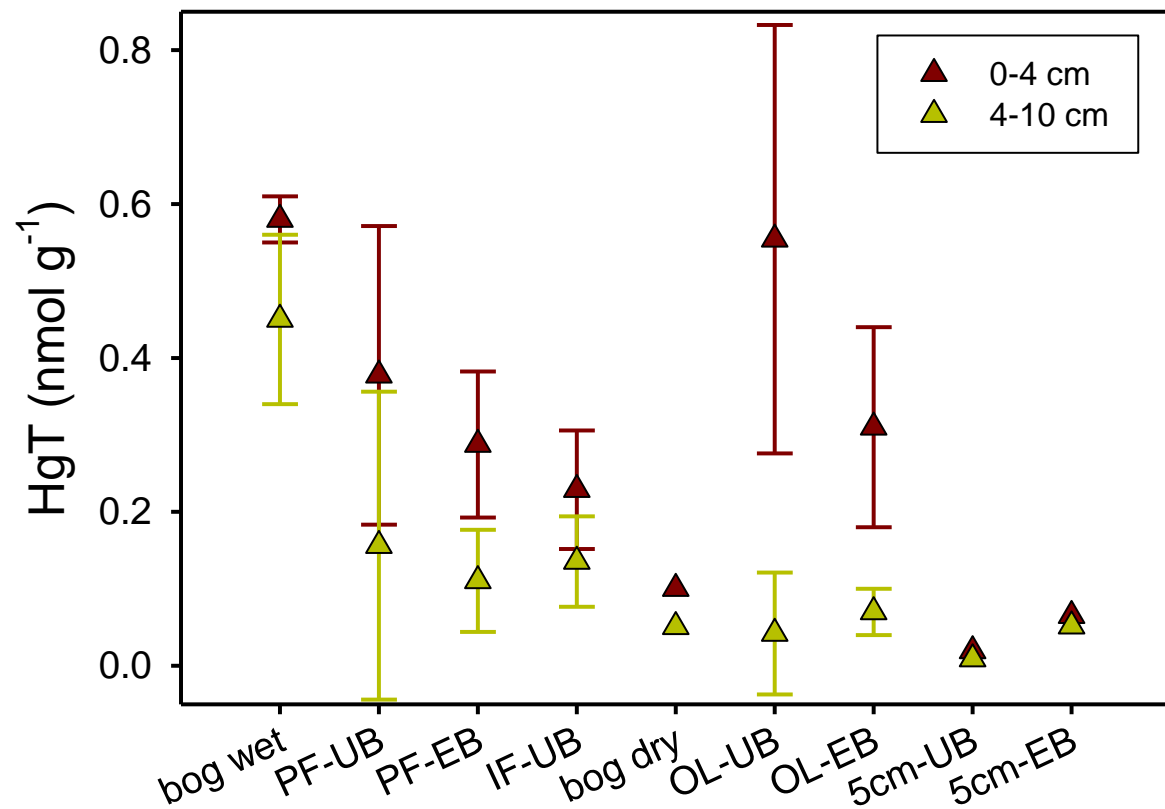
(days 2-34, 6 sampling days)



MeHg flux measurements - Dec 2016 to Jan 2017

- Winter MeHg flux was about 20 times lower than June 2013 fluxes (120 to 170 pmol m⁻² d⁻¹; Schartup et al., 2015) from pre-flood soils and there was little temporal change
- As anticipated, MeHg fluxes were consistently low for soils sampled and incubated under cold season conditions. These results suggest that the initial increase in reservoir water levels during the cold season had negligible effects on MeHg production

Soil organic matter (LOI) and total Hg Dec 2016 to Jan 2017 flux cores



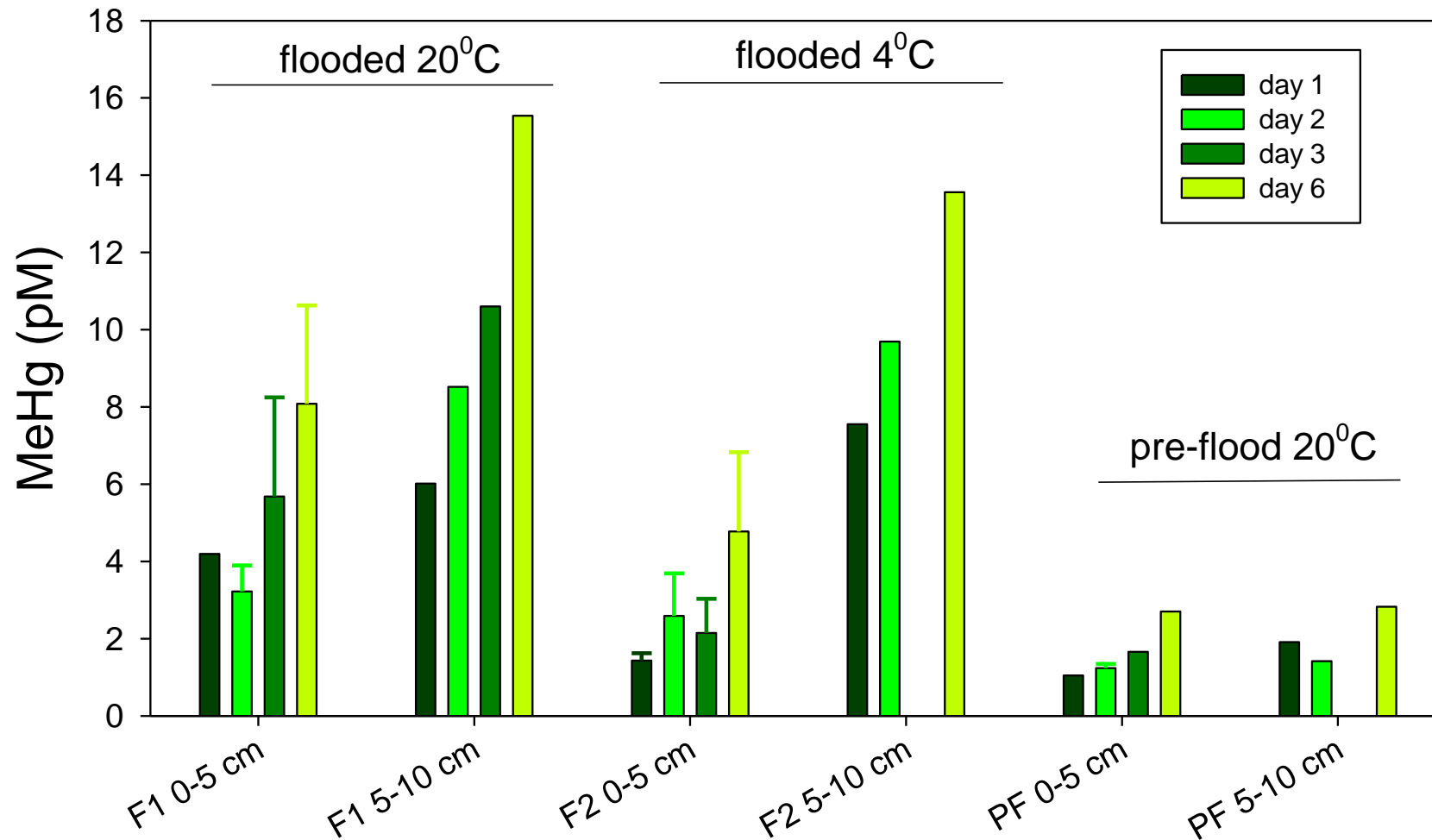
Churchill River soil sampled July 2017

Site type	Whole core experiments at Harvard (Aug 2017)
Pre-flood	Upper Brook (PF-UB)
Flooded	Upper Brook (F-UB)

Whole core experiments – Aug 2017

- Soil cores collected in July, drained of water and kept cool during holding and shipping to Harvard - 24 cores from flooded site and 12 cores from pre-flood site
- Whole cores were inundated with Churchill River water collected in July - ~3 cm overlying water in cores
- Flooded cores Incubated at in the lab at 20⁰ C and in a walk-in refrigerator at 4⁰ C - pre-flood cores incubated at 20⁰ C only
- 3 replicate cores for each experimental condition and incubation time point (day)
- soil pore water was separated from 0-5 and 5-10 cm depth intervals in each core by centrifugation and filtration (0.22μm)

Soil core pore water MeHg – Aug 2017



Pore water MeHg experiments – Aug 2017

- These experiments at Harvard included soils with the most time flooded among soils tested to date
- Flooded soils had 161 days greater than or equal to the 20.3 m (masl) water level when soil cores collected on 24 July (includes ice cover time)
- Trends in pore water concentrations indicate that MeHg was being produced in these flooded soils
- Results suggest that summer microbial community produces MeHg regardless of test temperature (4 and 20°C)

Burned & wet bog sites – Oct 2017



UB pre-flood & flooded sites – Oct 2017



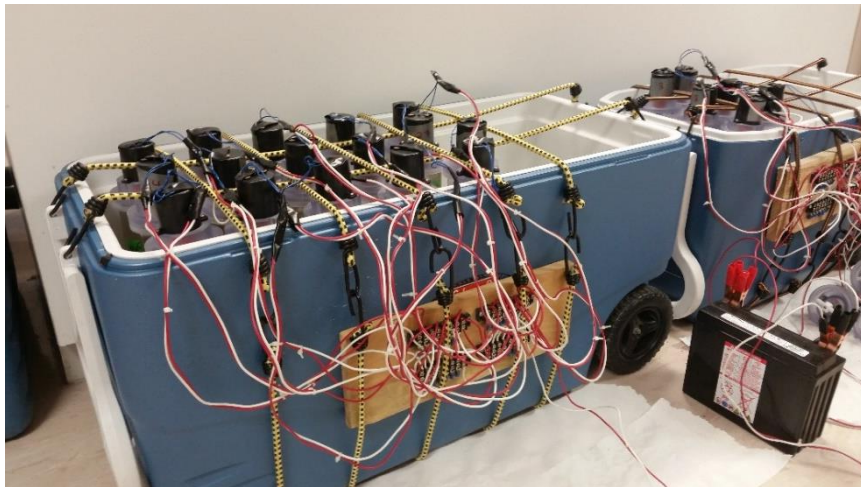
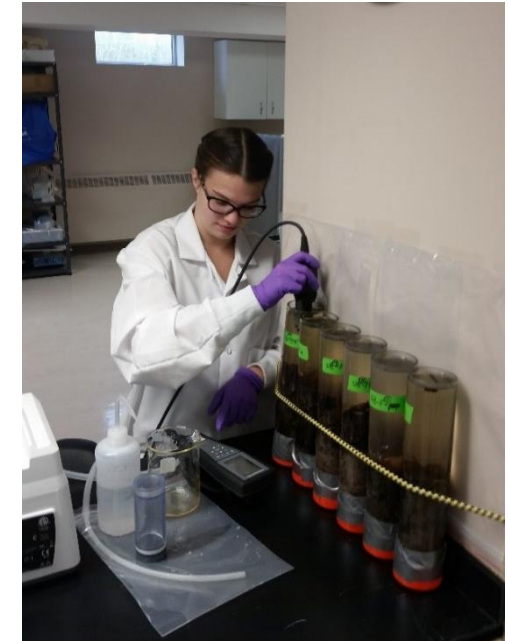
Churchill River soil sampled Oct 2017

Site type	Flux core experiment in NWR (Oct 2017)
Pre-flood	Upper Brook (PF-UB), Edwards Brook (PF-EB)
Flooded	Upper Brook (F-UB), Edwards Brook (F-EB)
Burned	South of river near Edwards Brook
Wetland	Wet bog from 7 Km past UB
Flooded core manipulations	Leaf litter layer removed (F-OL-UB, F-OL-EB) Top 5 cm soil removed (F-5cm-UB, F-5cm-EB)

Flux core experiments – Oct 2017

- Incubated at 22⁰ C in lab – soil cores collected in Oct at 6 to 7⁰C water temperature
- Three cores incubated for each site (2 cores for pre-flood sites) & manipulation
- Overlying water sampled daily for 6 days
- Overlying water replaced with fresh Churchill River water daily
- Water quality measurements daily (T, S, DO, pH)

Flux cores – North West River Lab



Processing sediment & water



Burned pre-flood soil & wet bog



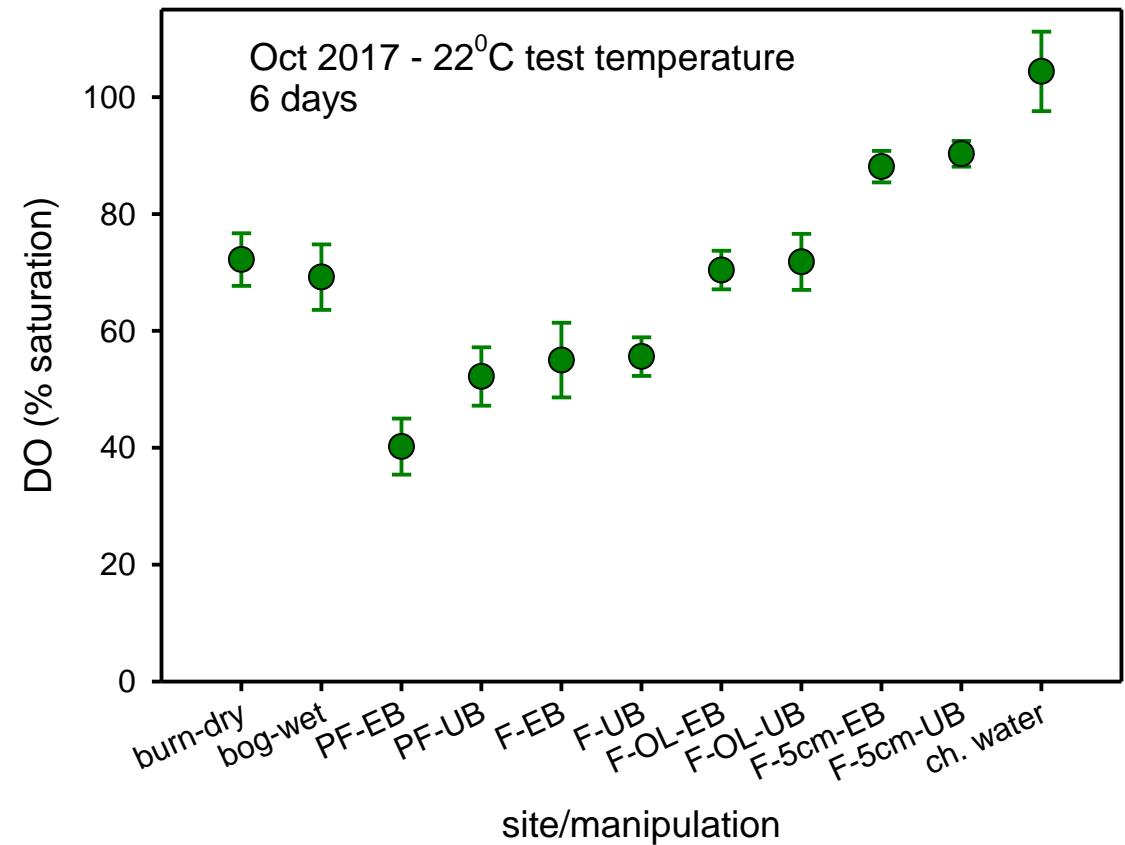
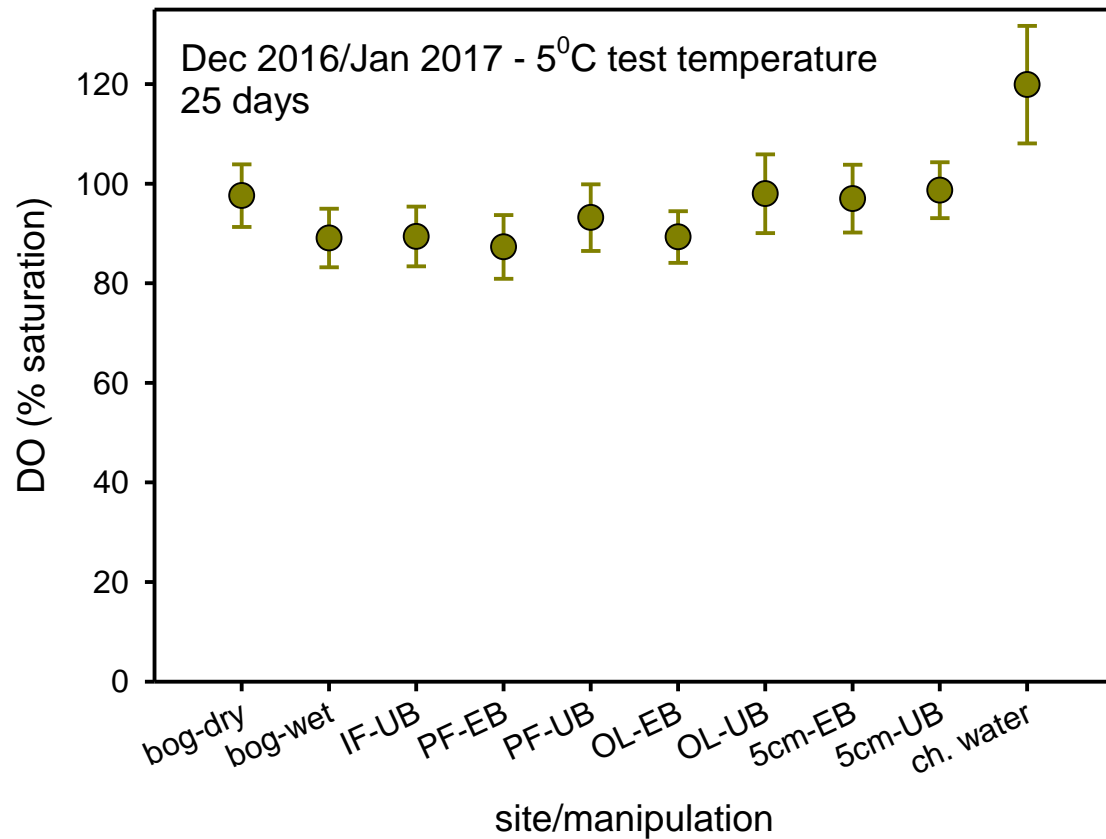
Pre-flood & flooded sites



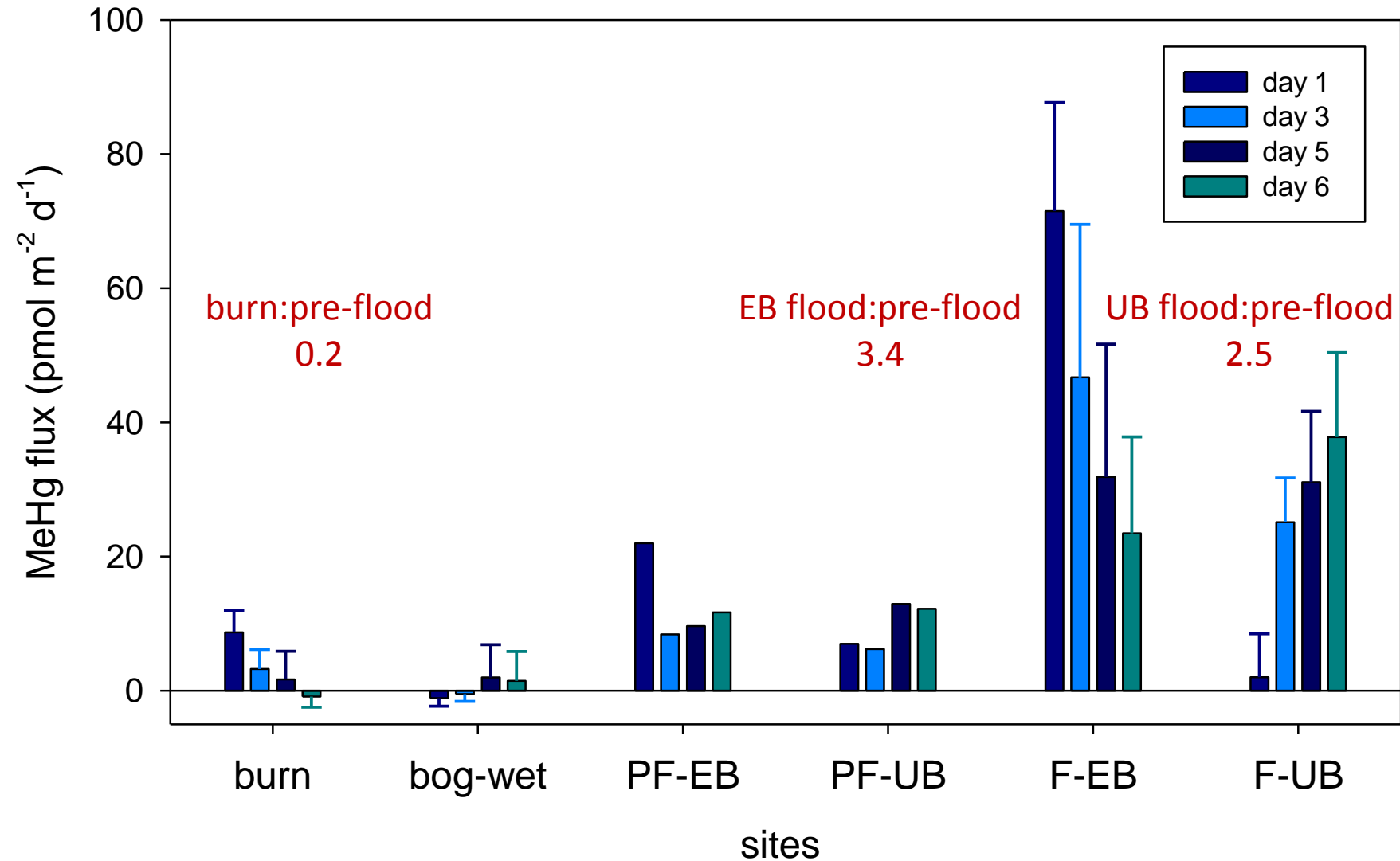
Leaf litter (OL) or top 5 cm removed –
flooded cores



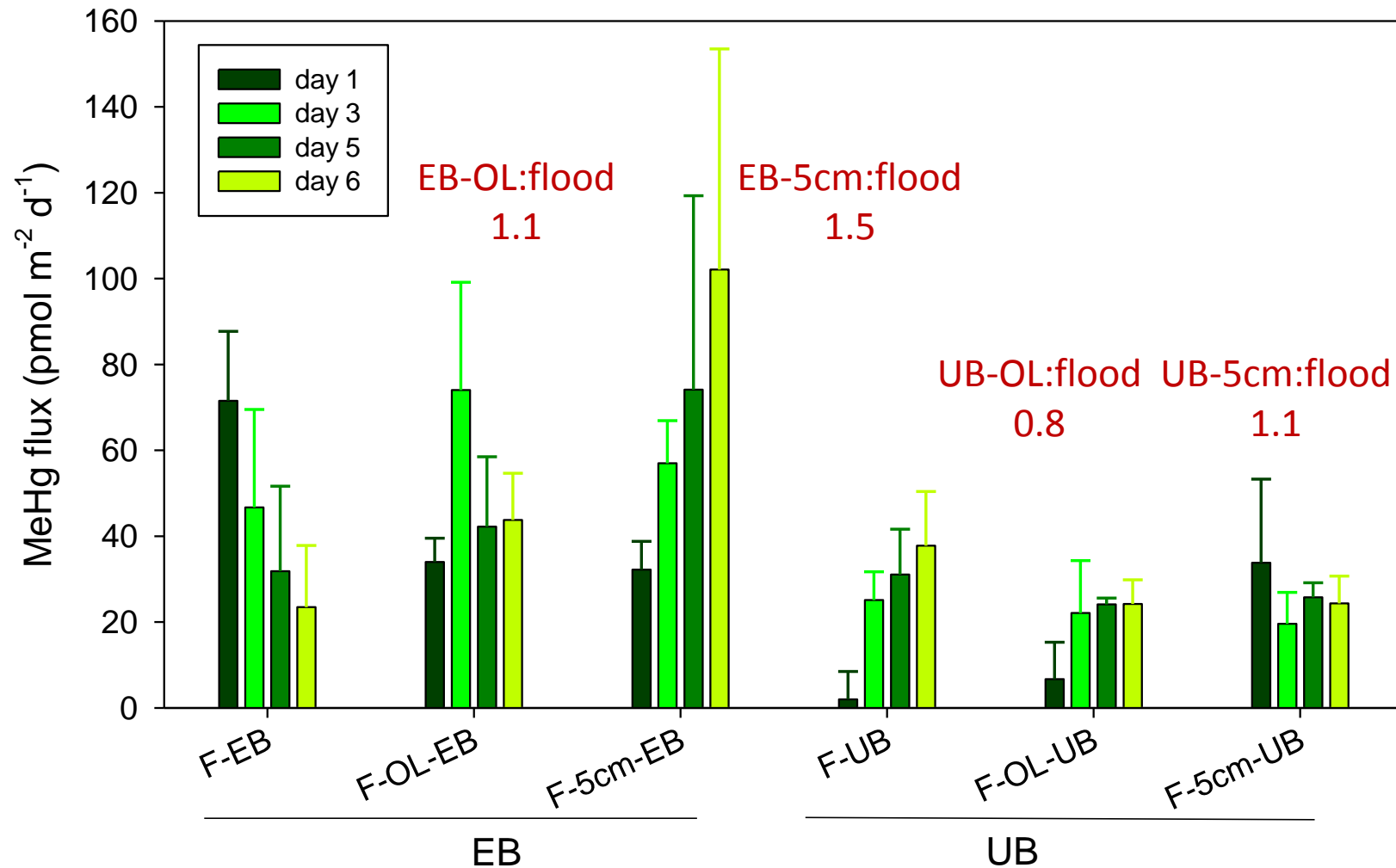
Dissolved oxygen (DO) measurements during flux core experiments



MeHg flux from each site – Oct 2017



MeHg flux from manipulated soils – Oct 2017



MeHg flux measurements - Oct 2017

- Flooded soils had 42 days greater than or equal to the 21.8 m (masl) water level when cores collected on 16 Oct
- The days at or above 21.8 m were all during Mar & Apr 2017 - probably mostly ice cover
- Water level at 21.8 m for only ~ 1 d prior to 16 Oct
- The increased flux was associated with minimal soil flooding time, and whole core pore water experiments indicated that MeHg production would be higher with more flooding time
- Mean flux for EB 5 cm removed cores increased daily to $100 \text{ pmol m}^{-2} \text{ d}^{-1}$ on day 6 and the 5cm:flooded flux ratio was elevated to 4.4
- Indicates MeHg production below 5 cm in flooded EB cores, and whole core pore water experiments also showed higher pore water MeHg concentrations below 5cm

Recommendations for additional work at Muskrat Falls

- MeHg flux core and laboratory experiments with different soil types, flooding histories, and carbon manipulations will provide information that can be used to inform recommendations for reservoir site preparation
- MeHg flux core experiments should be continued at regular intervals to monitor changes in MeHg release from flooded soil
- Water column & plankton MeHg measurements will be important once significant elevations in MeHg flux are measured

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Sediment-water flux calculation

$$F = dC/dt \times V/A$$

(e.g., Hammerschmidt & Fitzgerald, 2008)

- C is conc. of MeHg at time t (slope), V is the volume of water in each chamber (~0.6 L), A is the surface area of the sediment (0.0032 m²)
- Calculation includes a time 0 samples (initial MeHg conc. of water)