Phosphorus loss from grass buffer strip species undergoing freezing and thawing

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Presentation Outline

Experimental Background and Study Location

Greenhouse Experiment
- Objectives
- Methodology
- Results and Conclusions

Field Research
- Objectives
- Methodology
- Results and Conclusions

Management Implications

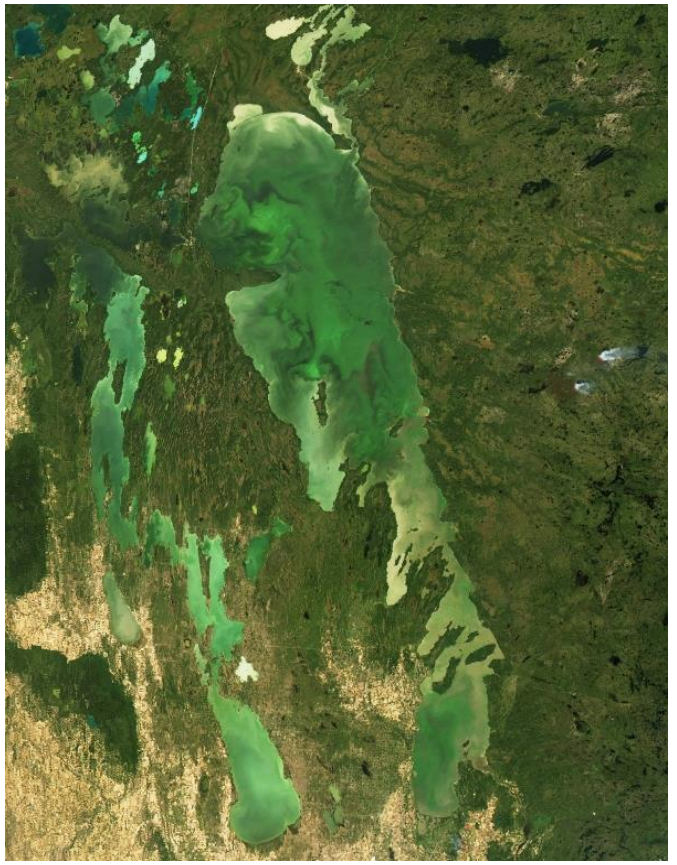
Lake Winnipeg Basin Stewardship Projects

Lake Winnipeg was named the 'World's Most Threatened Lake' in 2013 (Manitoba Water Stewardship 2011)

Annual algae blooms have emerged in both the north and south arms of the lake

Algae blooms are a product of excess phosphorus making its way into tributaries to Lake Winnipeg

Three tributaries which run through primarily agricultural landscapes are responsible for 80% of the total phosphorus load in the lake (Manitoba Water Stewardship 2011)



Aerial image of algae blooms visible in the north and south arms of Lake Winnipeg

Experimental Background

Ponded water and frozen, snow covered buffer at field site in Morden, MB

What is a buffer?

- A vegetated strip intended to reduce surface runoff, increase infiltration, and encourage nutrient uptake by vegetation

However, some research has shown that buffers can act as a source of phosphorus (Sheppard et al. 2006)

Buffer effectiveness can be greatly diminished when soils and vegetation are frozen and covered in snow and ice (Sheppard et al. 2006; Lobb et al. 2012)

Northern climates are prone to numerous freeze thaw cycles (FTCs)

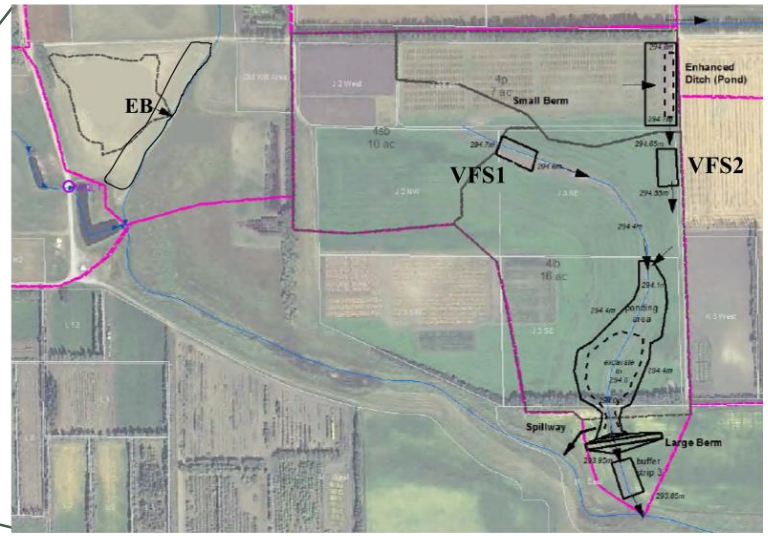
- Cells in dead vegetation lyse when frozen and release P during spring snowmelt

Concentrations of bioavailable phosphorus have been found to increase with the number of FTCs (Bechmann et al. 2005; Øgaard 2015)

Study Location

LAKE WINNIPEG BASIN

AGRICULTURE AND AGRI-FOOD CANADA RESEARCH CENTRE – MORDEN, MB



RESEARCH SITES

EB – Established Buffer (5320 m^2)
- Planted to meadow foxtail for 20 years
- Annual harvesting, no fertilizer applied

VFS1 – New buffer (229 m^2)
- Planted in May 2015
- Timothy and brome grasses, substantial weeds

VFS2 – New buffer (146 m^2)
- Planted in May 2015
- Primarily timothy grass

Objectives

Quantify P concentrations contained in the shoots of buffer vegetation in the fall and spring to determine how much P is potentially leached

Quantify and compare soil P concentrations between buffer sites

a) VFS1, a 229 m^2 new buffer
b) VFS2, a 146 m^2 new buffer
c) EB, a 5320 m^2 buffer entirely composed of meadow foxtail (*Alopecurus pratensis*) (Images from July 2015)

Methods

Triplicate samples of shoots were harvested from each buffer within a 0.50 m by 0.50 m quadrat

Shoot samples were weighed, dried at 60°C for 48 hours and weighed again

Samples were analysed for TP by ICP-OES (Farmer's Edge Laboratories, Winnipeg, MB) and reported on a dry weight basis

Samples were taken in September and October 2015 and March 2016

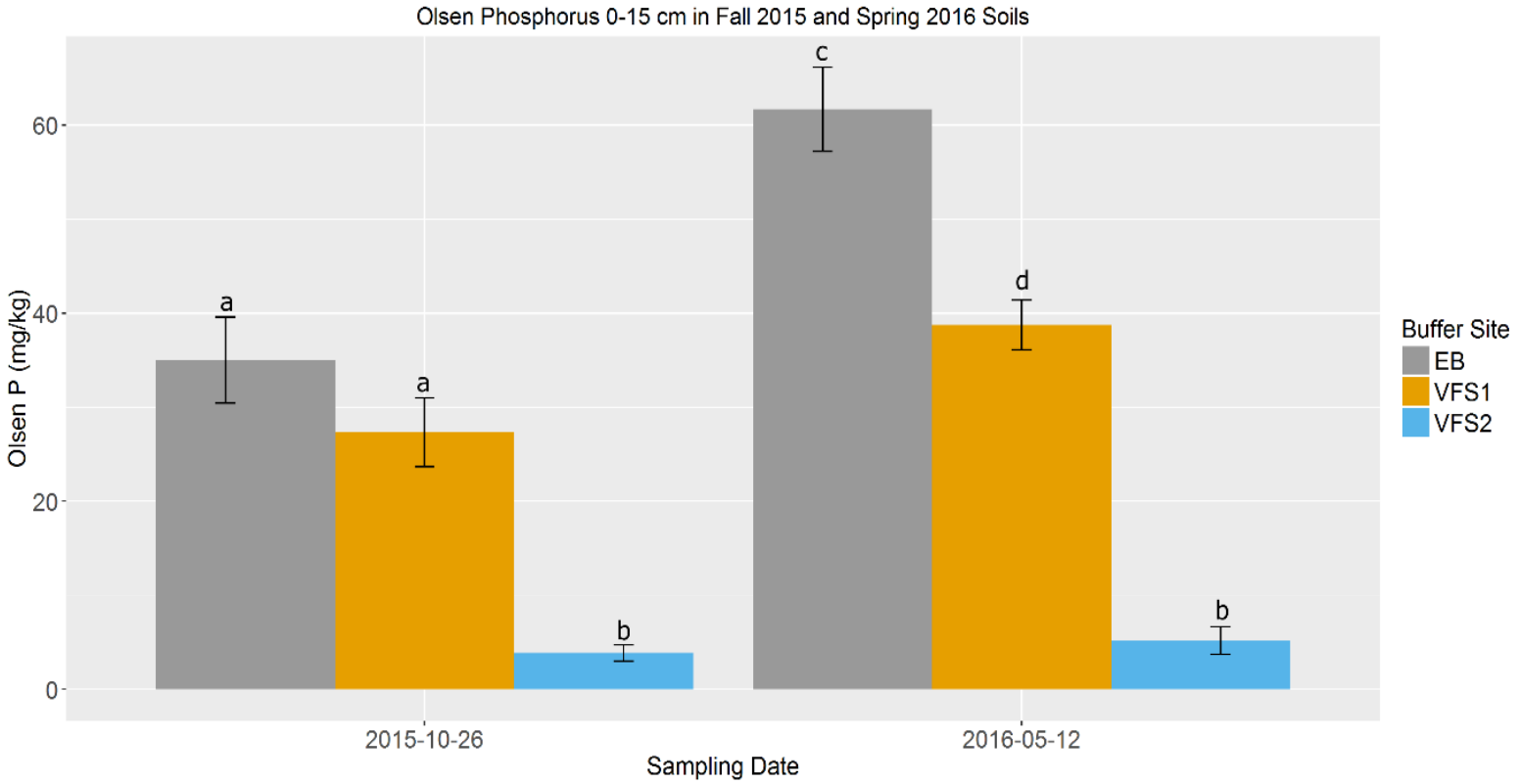
Soil samples were taken from 0-15 cm in October 2015 and May 2016 within the buffer features

Results : P loss over winter

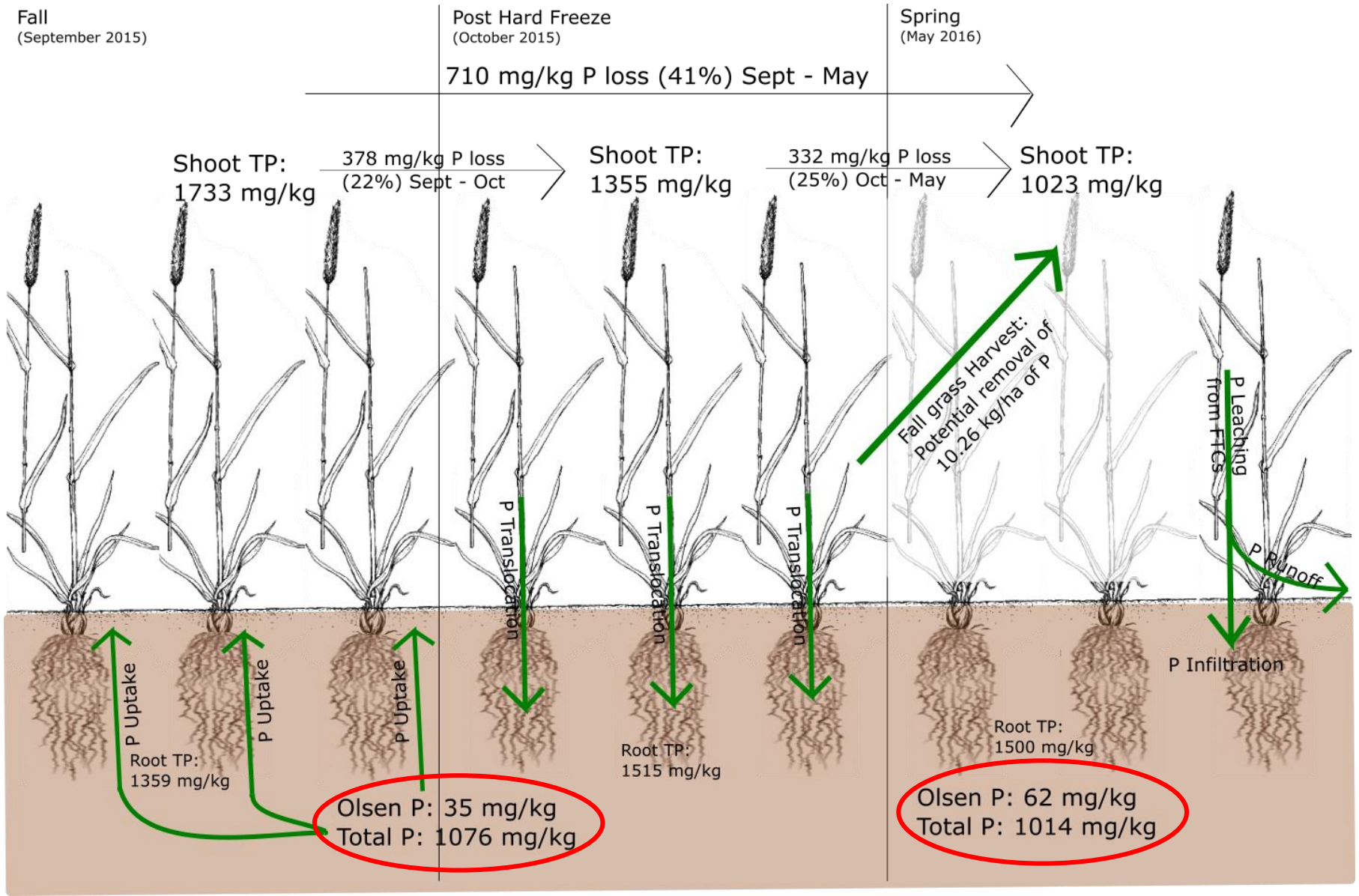
- 32%-47% of shoot biomass TP was lost from September to March
- Based on buffer area, EB showed the greatest loss (4.2 kg/ha) followed by VFS1 (4.0 kg/ha) and VFS2 (2.5 kg/ha)

	Sept-Oct	Sept-Mar	Oct-Mar
VFS1 TP Loss	341 mg/kg	**833 mg/kg**	492 mg/kg
% Loss	13%	**32%**	22%
		Total loss from buffer	4.0 kg/ha
VFS2 TP Loss	418 mg/kg	**837 mg/kg**	418 mg/kg
% Loss	24%	**47%**	31%
		Total loss from buffer	2.5 kg/ha
EB TP Loss	378.7 mg/kg	**710 mg/kg**	331 mg/kg
% Loss	22%	**41%**	25%
		Total loss from buffer	4.2 kg/ha

Results : Soil P (Olsen) over time



Management implications



Objectives

Quantify differences in the concentration of water extractable phosphorus (WEP) and total phosphorus (TP) released from timothy grass undergoing various numbers of freeze–thaw cycles (FTCs)

Determine the relative amount of WEP in extracts compared to total phosphorus (TP) contained in the plant biomass

Methods

Soils imported from field site in Morden, MB

- Primarily sandy loam

Timothy grass grown in two soil treatments:

1. No added phosphorus
2. Soil amended with MAP (12:61:0)
   - 80 kg/ha P MAP

Grown under controlled conditions:

- 16 hours of daylight
- Temperature range: 20-25°C
- Irrigated every 1-2 days as needed with tap water

Methods

Shoots harvested after 65 days and again after 37 days and subjected to 0, 3, or 6 FTCs

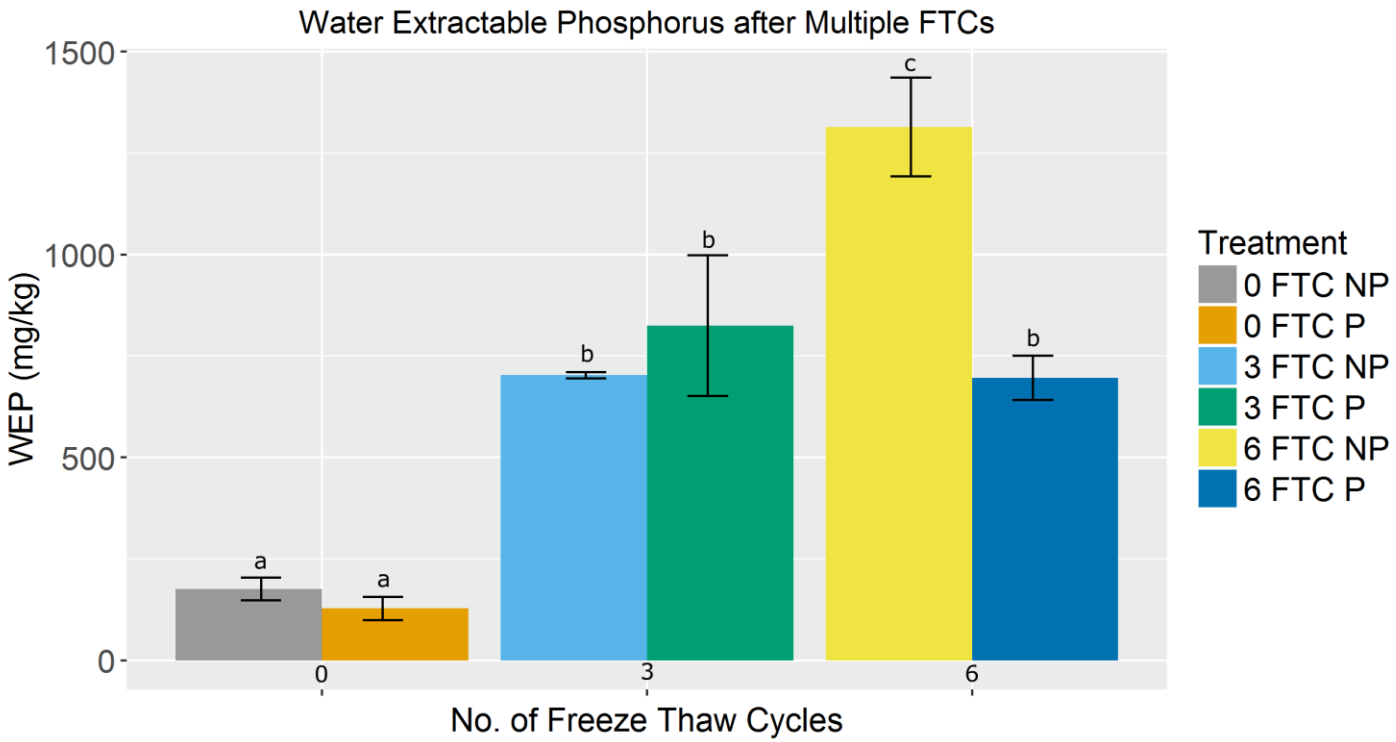
- 16 hrs at -20°C followed by 8 hrs at +4°C

Shoot samples shaken with 100 mL DI for 1 hour at 85 rpm

Extracts analysed colorimetrically for water extractable phosphorus (WEP) and total phosphorus (TP)

Shoot biomass analysed for TP by ICP-OES (Farmers Edge, Winnipeg MB)

ANOVA and Tukey HSD test performed to compare treatment means using R version 3.2.1



Results – Harvest 1

There was no significant difference in WEP concentrations between soil P treatments

After 6 FTCs, 67-100% of TP from extracts was released as WEP

After 6 FTCs 19-55% of biomass TP was released as WEP

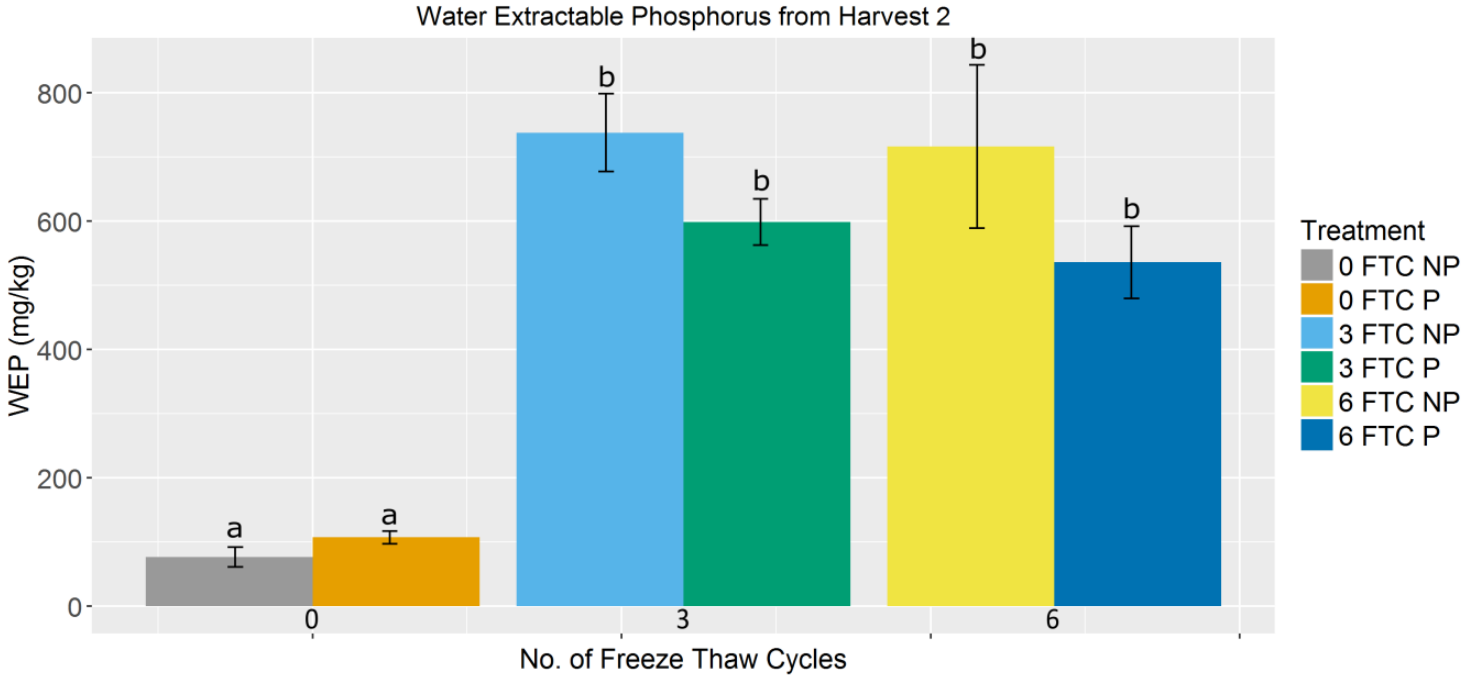
Results – Harvest 2

There was no significant difference in WEP concentrations between soil P treatments

WEP concentrations were significantly different between 0-3 and 0-6 FTCs

After 6 FTCs, 80-100% of TP from extracts was released as WEP

After 3 and 6 FTCs 19-21% of biomass TP was released as WEP



Conclusions and Implications

Significant concentrations of P are released from vegetation undergoing numerous FTCs

After 6 FTCs, nearly 100% of TP from extracts was released as WEP in both harvests

A greater number of FTCs increases the amount of P released, **and** the amount of bioavailable P released

Management Implications

Should buffers still be implemented as a BMP?

How can we make buffers more effective?

- Targeted to specific areas within a field
- Plant species, densities and **management**

In the flat landscapes of much of the Canadian prairies – harvest and remove

- Potential issues with soil erosion

Additional BMPs to hold water on the landscape:

1. Berms
2. Retention ponds

Retention pond at the Morden, MB field site

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