Linking Policy Needs and Water Quality Science Knowledge and Expertise

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CONCEPTS

- Key factors that determine wetland water quality
  - Hydrologic influences
  - Landscape influences
  - Internal influences
  - Temporal influences

NONPOINT SOURCE POLLUTION

- In North America nonpoint sources are now the dominant supply of pollutants, including nutrients, to surface waters.
- Agricultural runoff now contributes significant amounts of nutrients and other contaminants to rivers, lakes, streams, and wetlands.
- Generally well accepted that wetlands (natural, restored and constructed) are effective at mitigating non-point source nutrient pollution

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INCREASING EVIDENCE FOR THE LINKAGE BETWEEN WETLAND DRAINAGE AND FLOODING

- Schottler et al (2013): Watersheds with large land-use changes had increases in seasonal and annual water yields of >50% since 1940 that were highly correlated with artificial drainage and loss of depressional areas.

- Pomeroy et al (2014): Using the PHM showed that wetland drainage increases the contributing area of wetland-dominated prairie basins, and can increase annual and peak daily flows substantially, with notable increases in the flood of record.

LINK BETWEEN HIGH FLOW EVENTS AND NUTRIENT EXPORT

- McCullough et al., (2012), flood years roughly double TP concentration in the Red-Assiniboine River watershed, and increases in discharge explains most of the increase in nutrient loading to Lake Winnipeg (32%), relative to increases in anthropogenic loading (14%)

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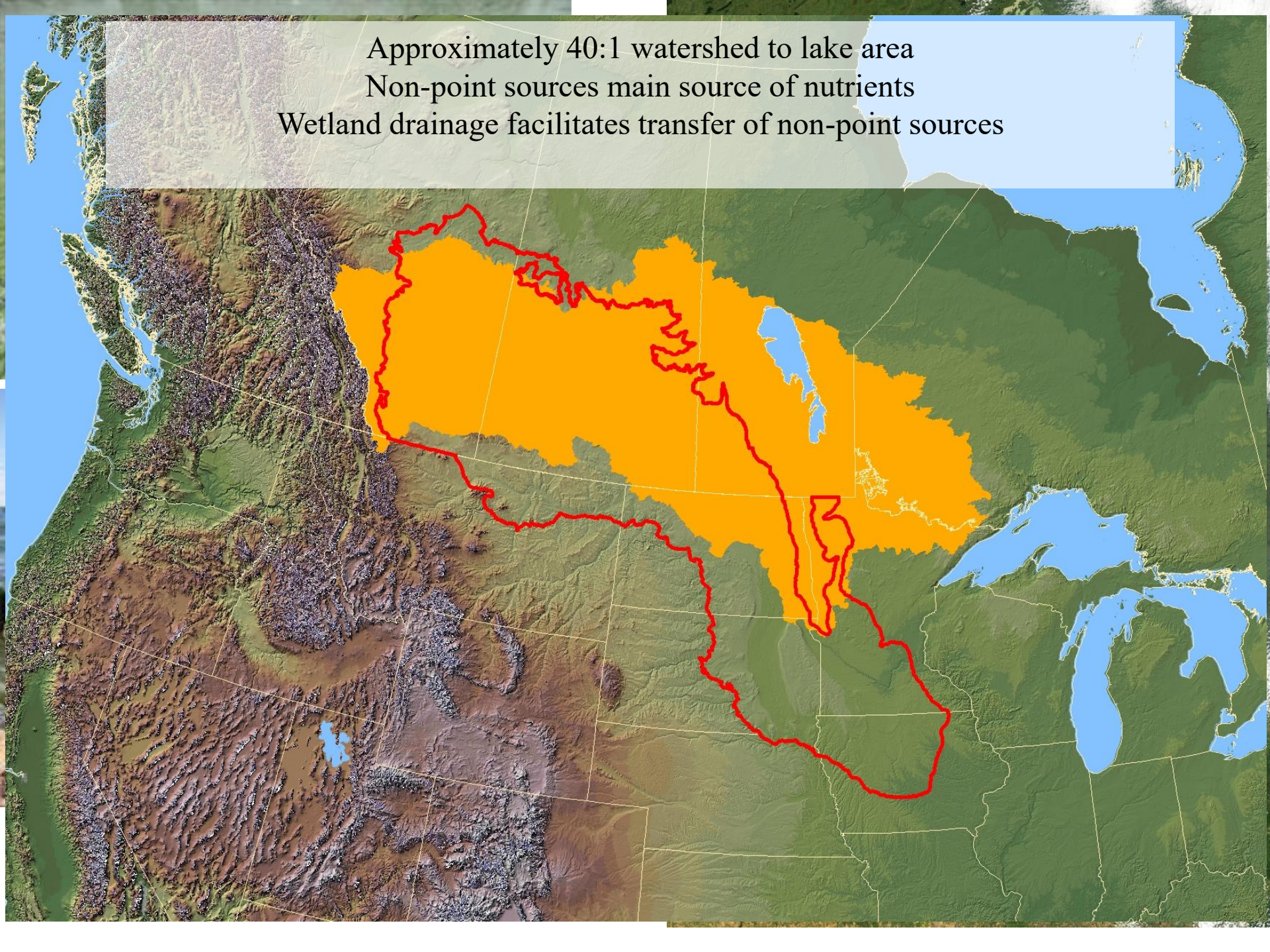
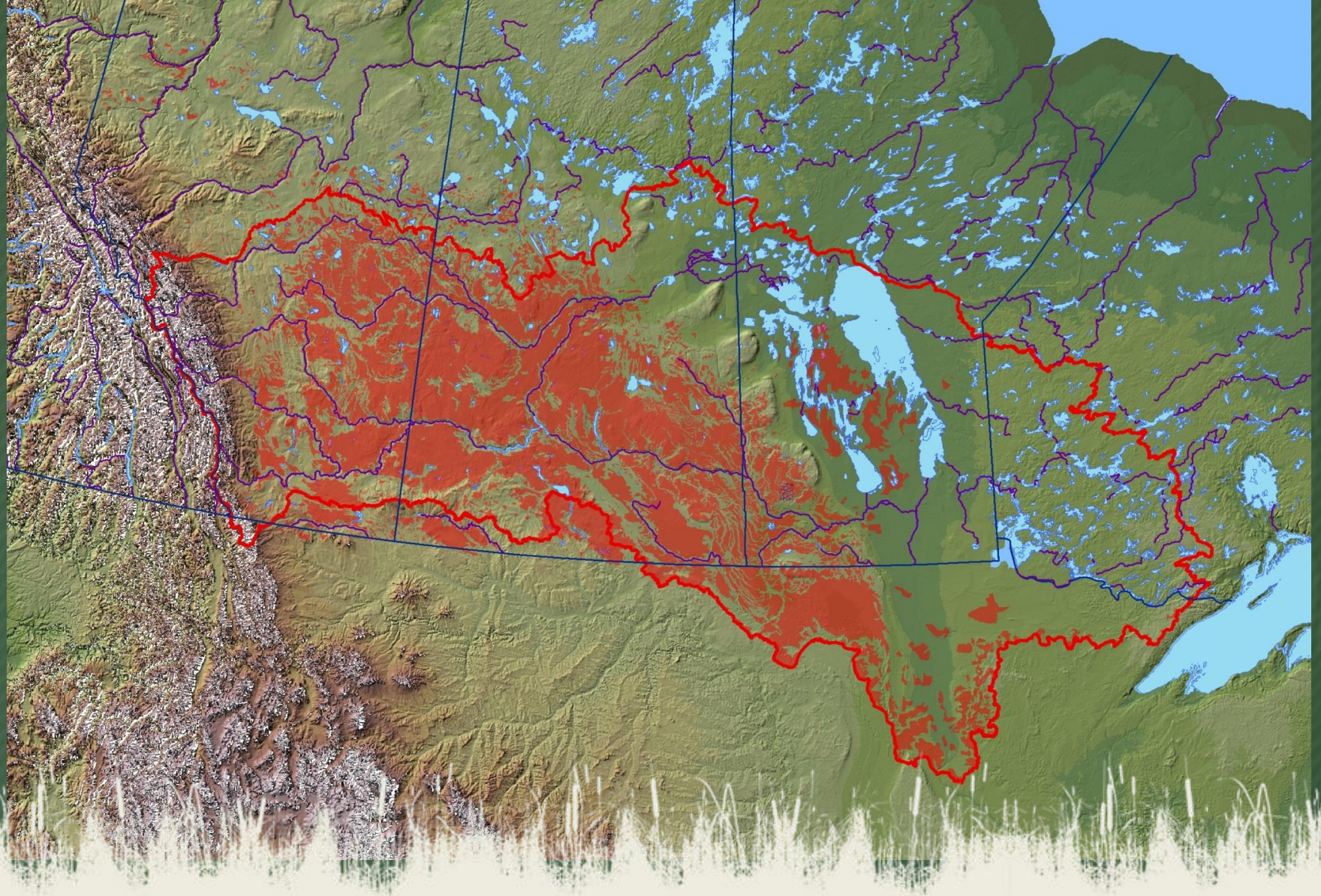

Approximately 40:1 watershed to lake area
Non-point sources main source of nutrients
Wetland drainage facilitates transfer of non-point sources



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Strong relationship between runoff ratio (amount of ppt that leaves as runoff) and amount of watershed that is considered to effectively contribute

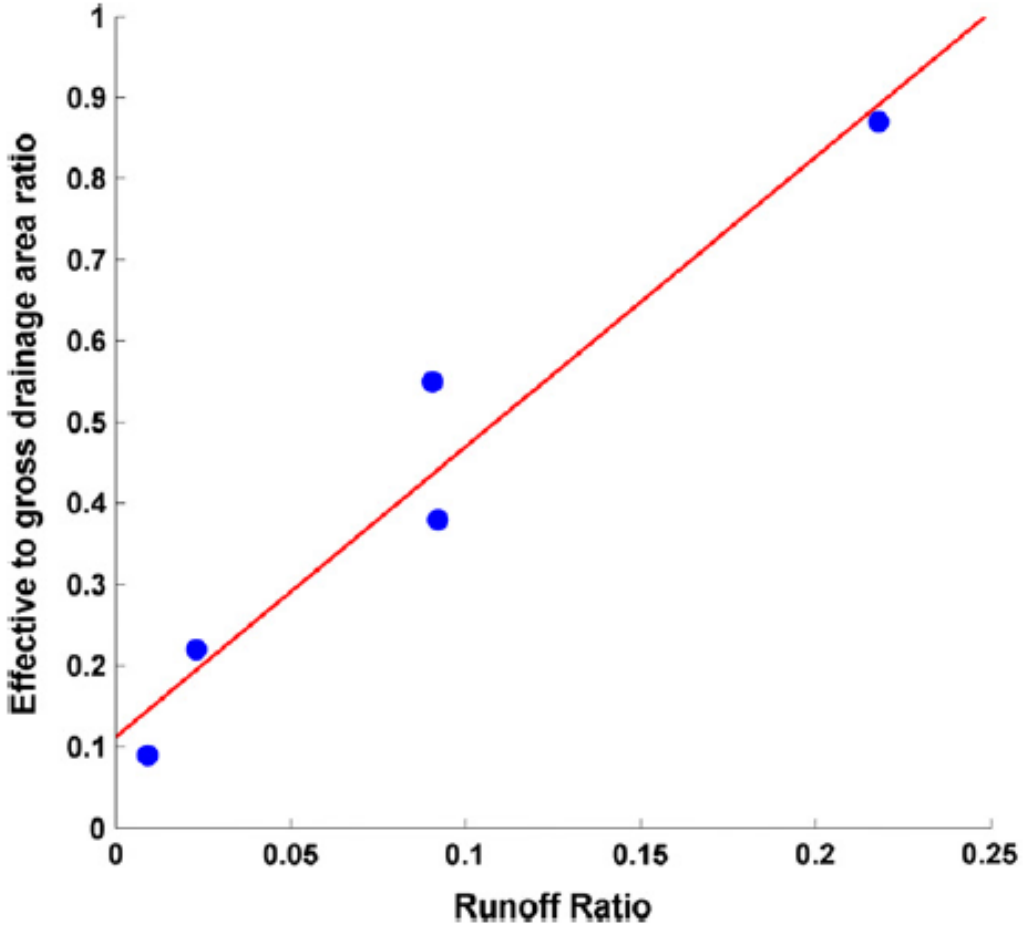


Fig. 9. The relationship between runoff ratio and effective to gross drainage area ratio for the Central Saskatchewan WSC gauged watersheds used in the study.

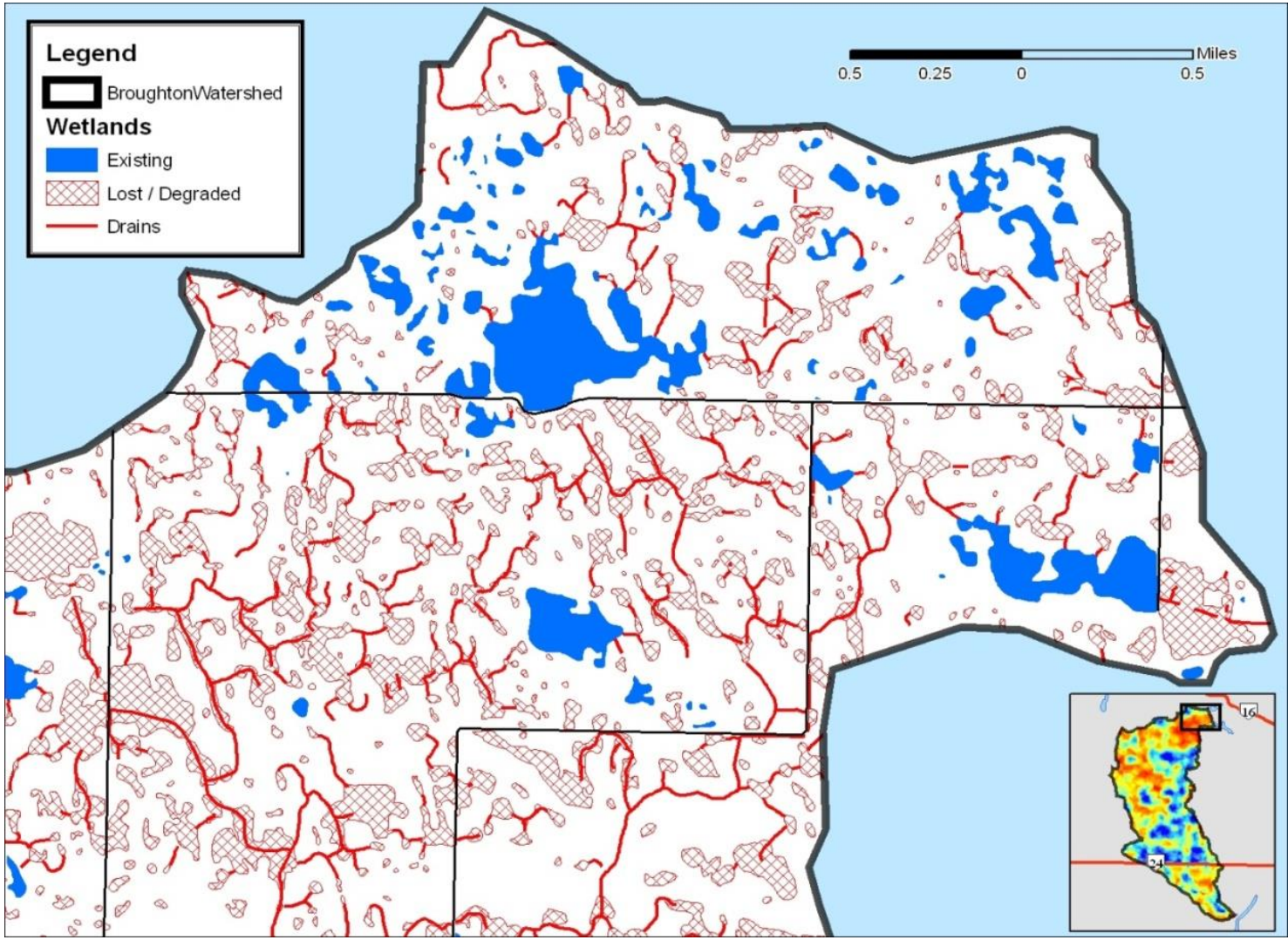
Wetland Loss in Manitoba

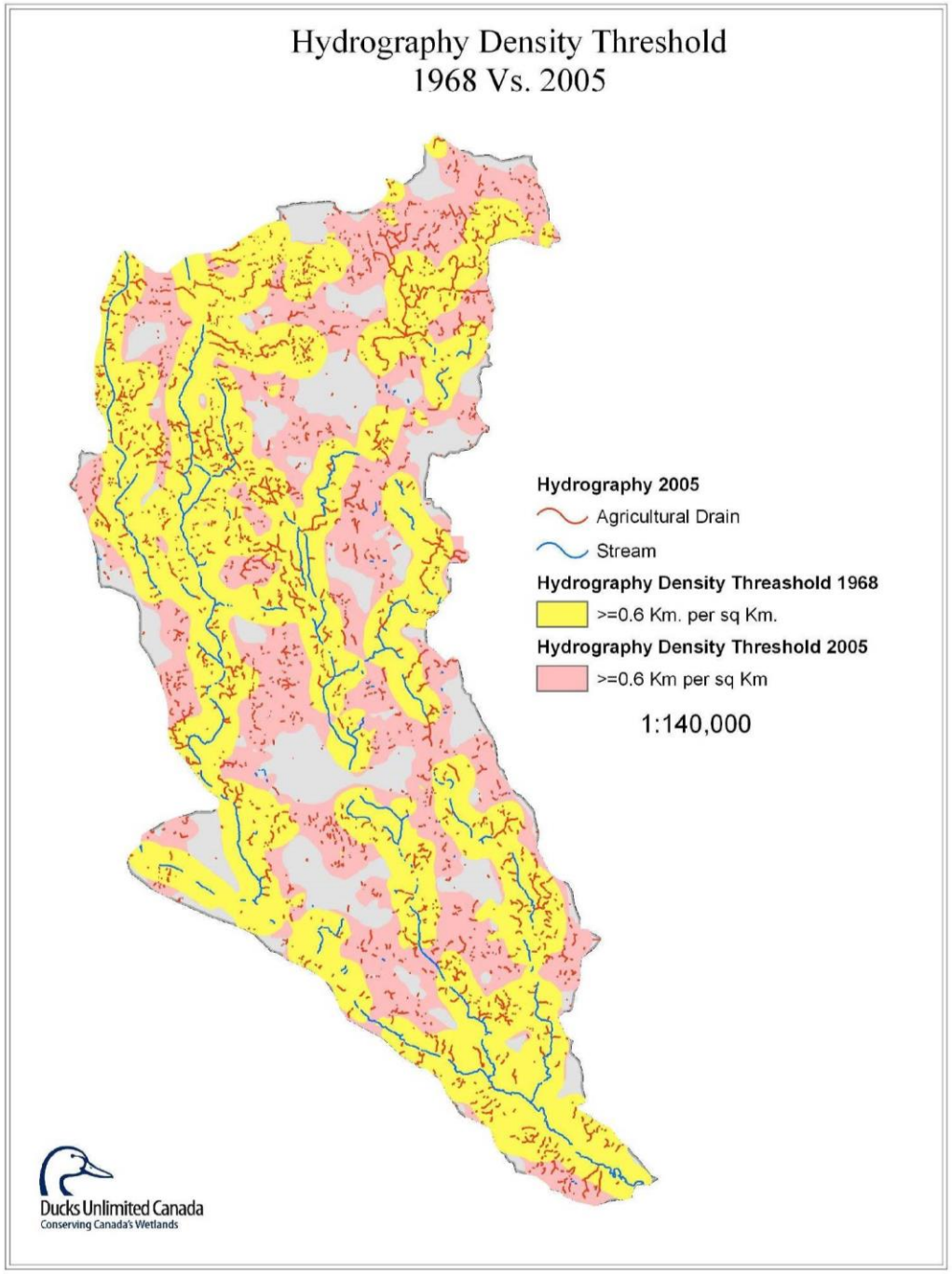
1903

2005

21% reduction in wetland area

69% of wetland basins have been lost or degraded





Contributing area increased from 14,668ha (1968) to 22,507ha (2005), an increase of over 53.4%

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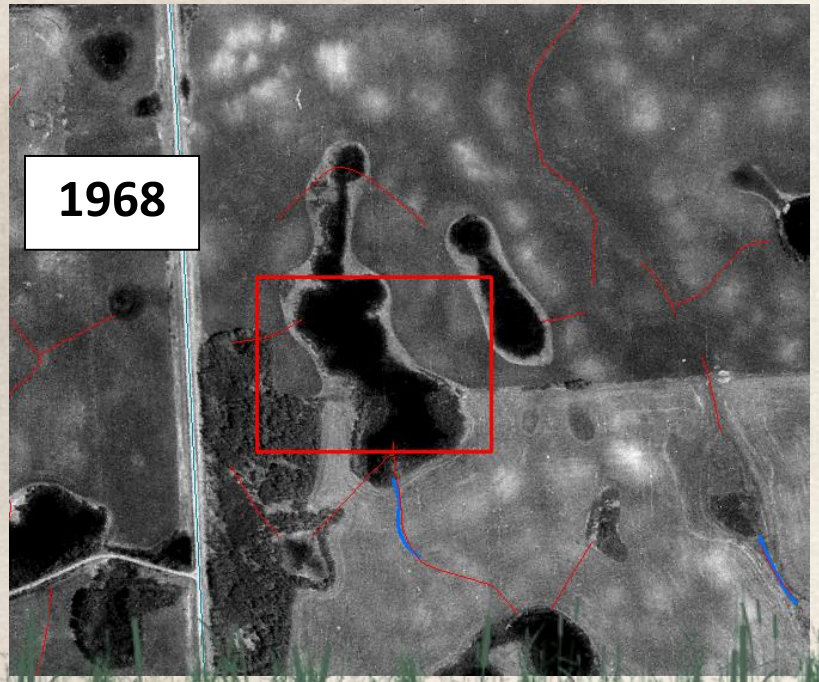
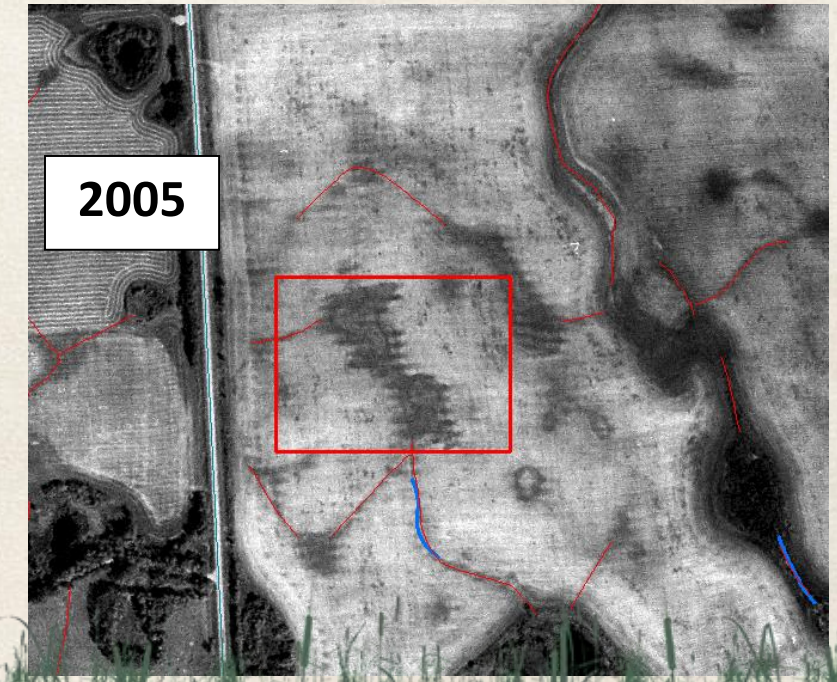
Broughton's Creek Research:

Nutrient Export From Drained Wetlands





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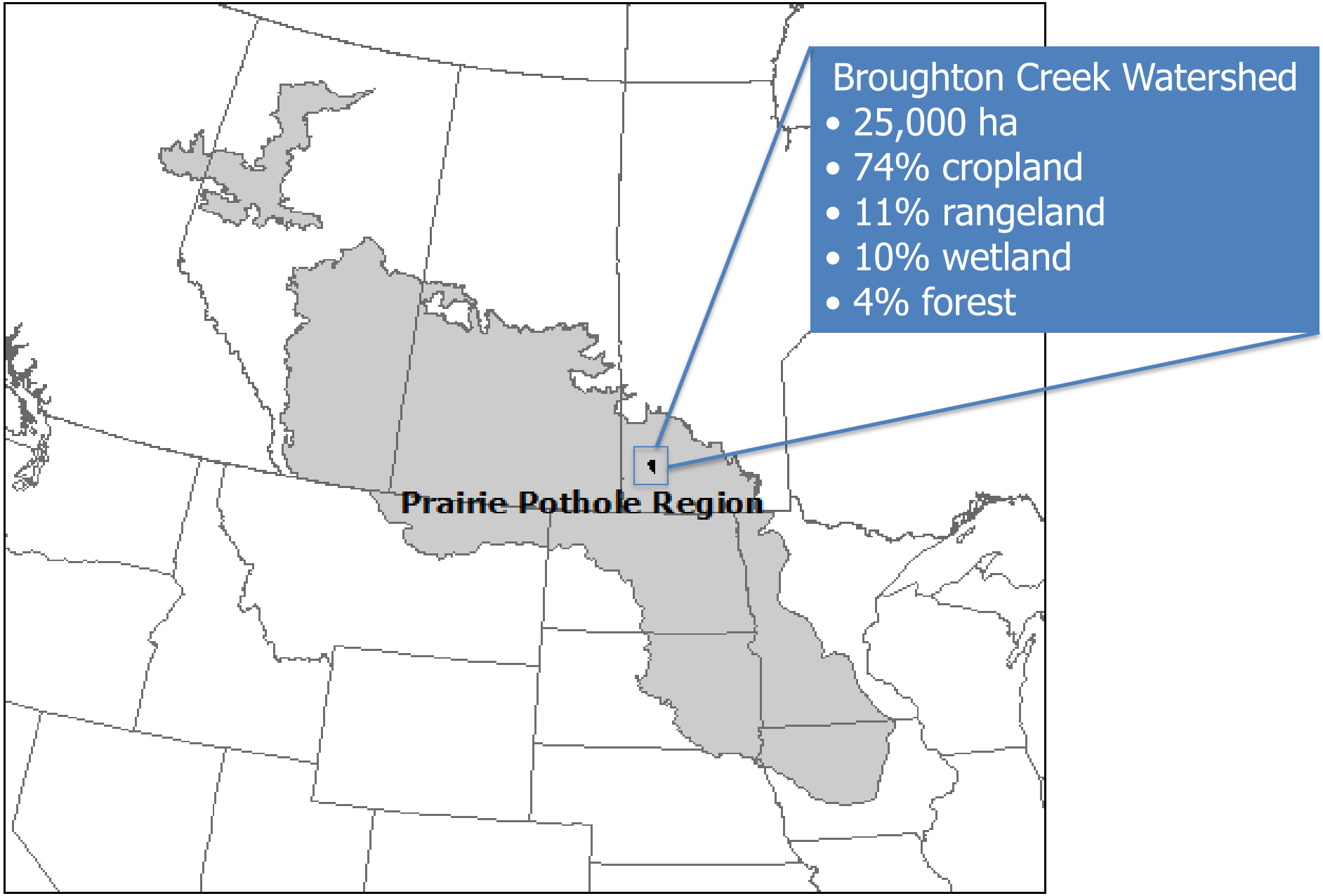
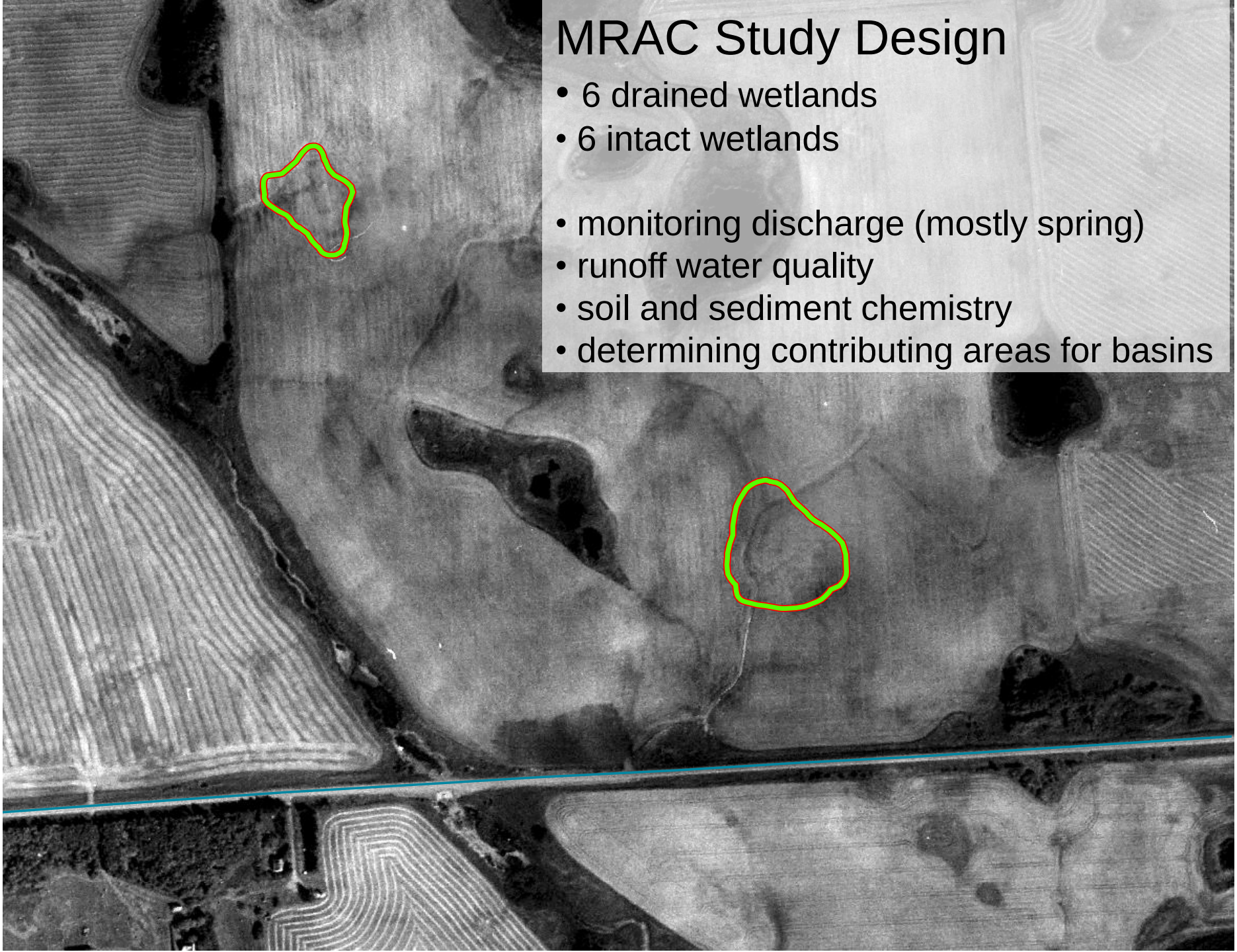

Broughton Creek Watershed
• 25,000 ha
• 74% cropland
• 11% rangeland
• 10% wetland
• 4% forest
1
Prairie Pothole Region

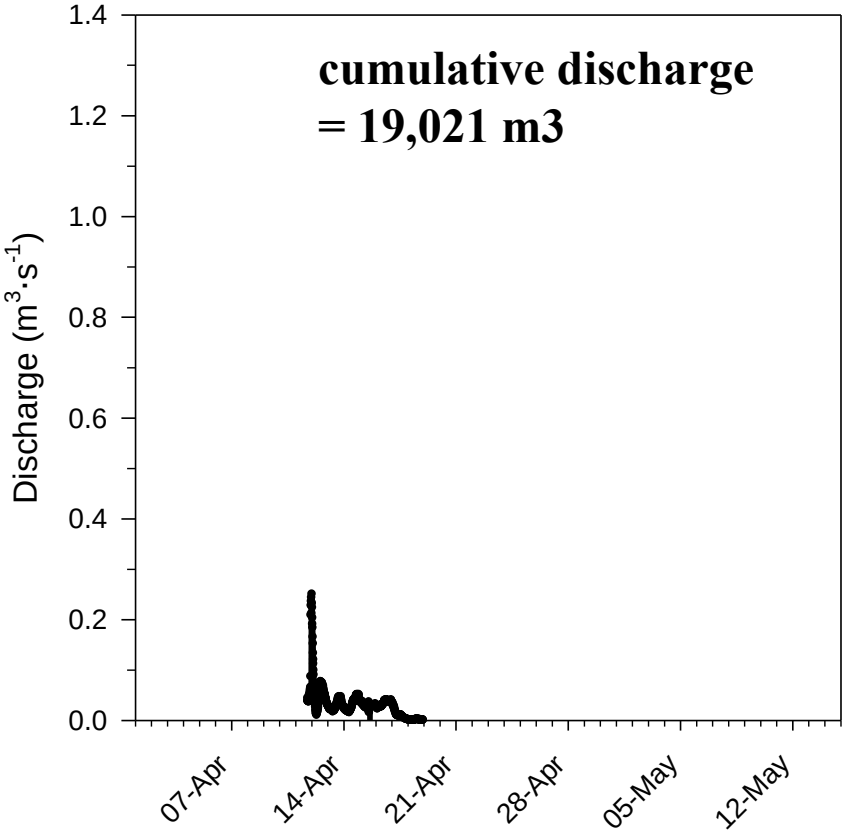


MRAC Study Design

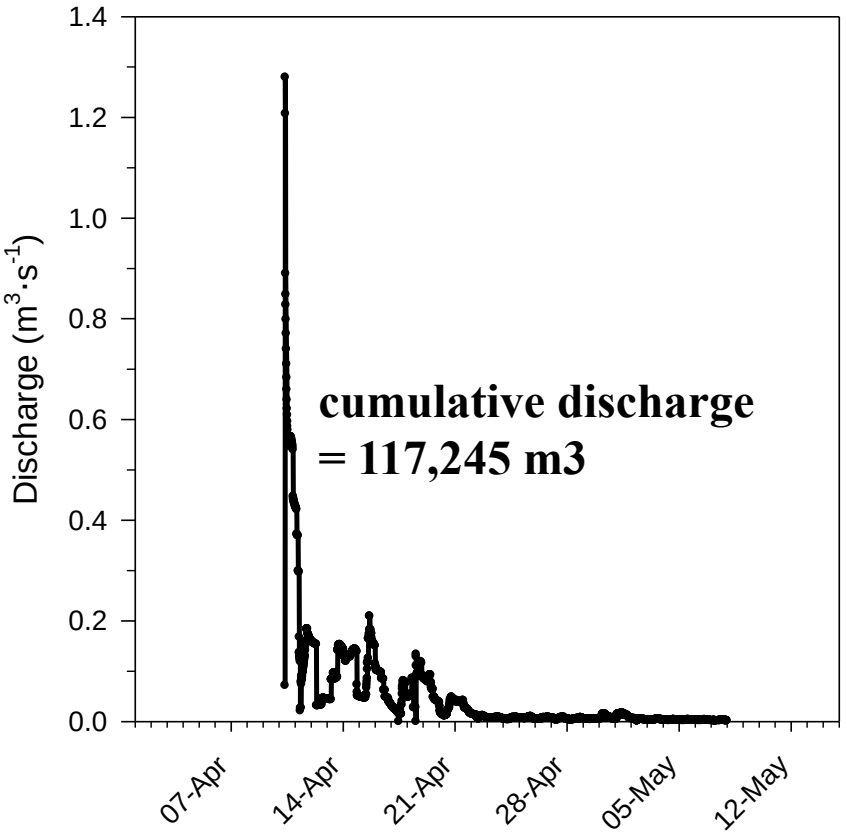
- 6 drained wetlands
- 6 intact wetlands

- monitoring discharge (mostly spring)
- runoff water quality
- soil and sediment chemistry
- determining contributing areas for basins

S6 - 2008



S6 - 2009



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Water quality of discharge from drained wetlands

- P concentrations at the outlets of drained wetlands were always very high (5 to 30x guideline for hypereutrophic systems)
- Most P present in dissolved form
- More bioavailable P in drained wetland soils relative to intact wetland soils

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Phosphorus export from drained wetlands relative to other landuse

- Average P export from drained wetland basins:
  - 2008 = 2.2 kg P/ha/yr
  - 2009 = 1.2 kg P/ha/yr
  - 2008/2009 ave. = 1.7 kg P/ha/yr
- Average P export from the Lake Winnipeg watershed (1994-2007): 0.07 kg P/ha/yr
- MB cropland P export (Tiessen et al., 2010):
  - 0.65 kg P/ha/yr (Cons. T)
  - 0.39 kg P/ha/yr (Conv. T)

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Illegally drained

- Forecasted reduction in water level of 0.5m
- Discharge of over 12M m3
- Export of over 2 tonnes of P

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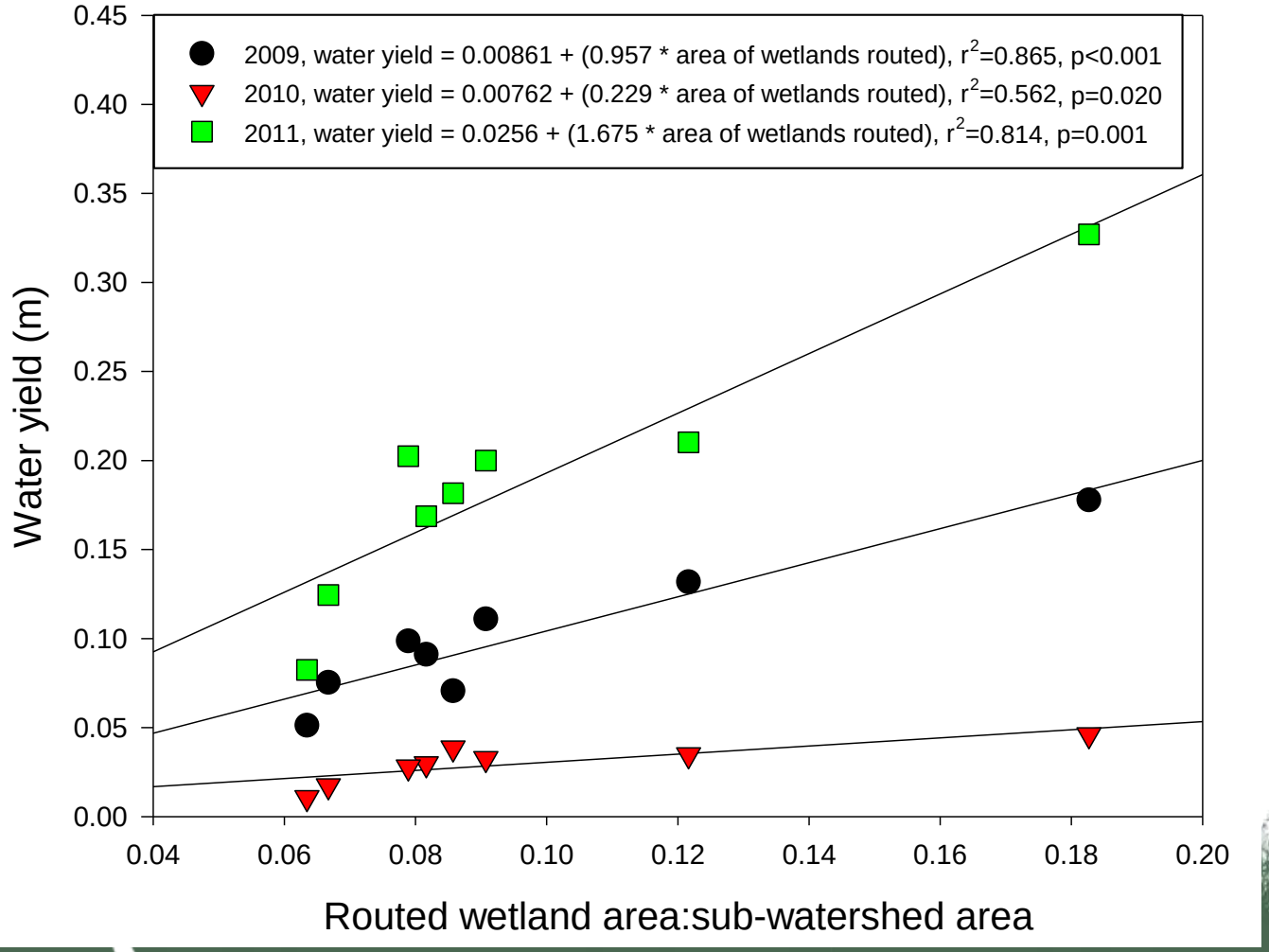
Combining Wetland and Drainage Metrics with Flow and Water Quality

- As wetland drainage increases, runoff increases regardless of event size
- This demonstrates the need to account for wetland drainage, storage, as well as changes to contributing area



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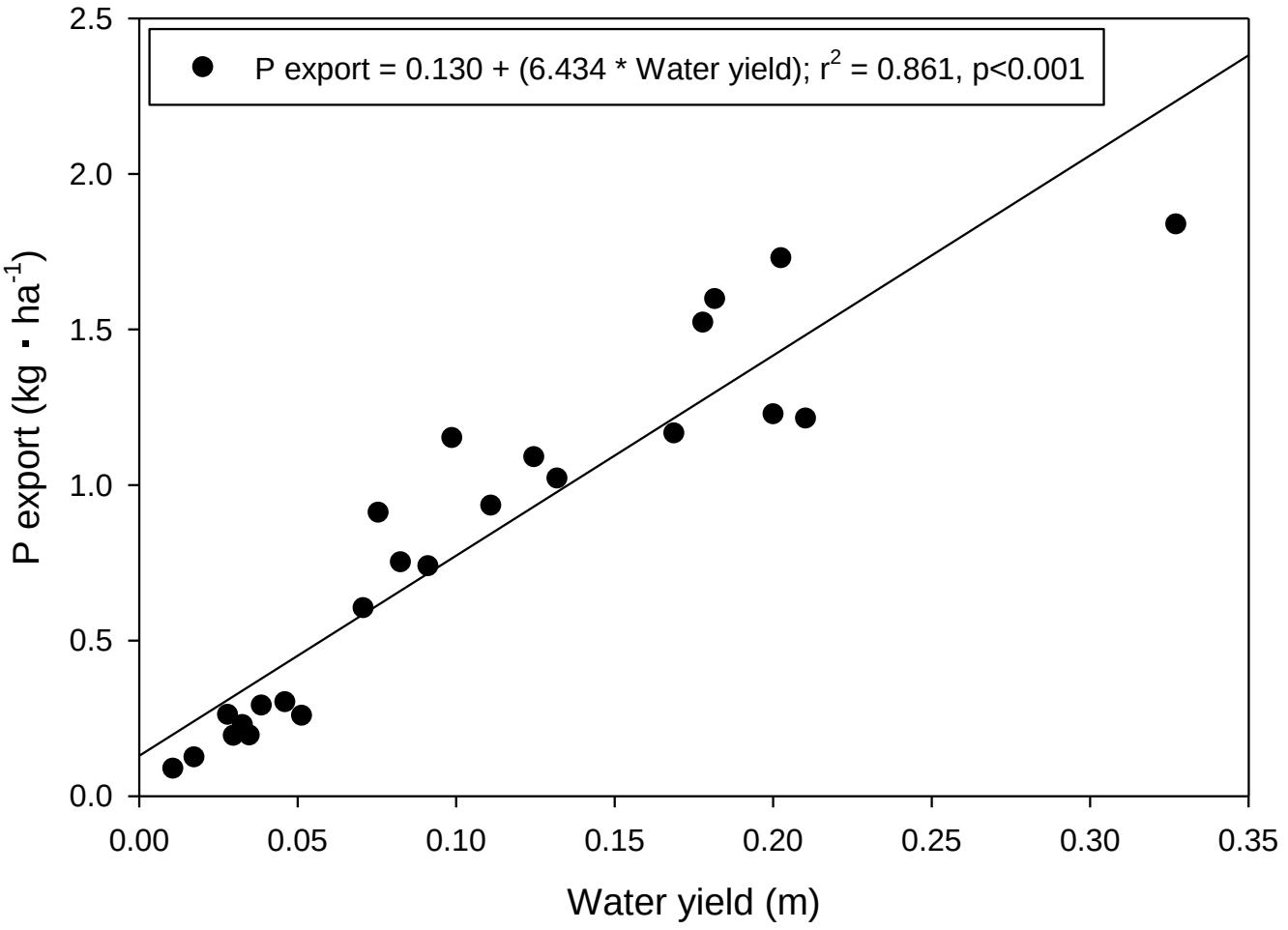
Combining Wetland and Drainage Metrics with Flow and Water Quality

- More drained wetland greater water yield.
- Greater water yield, greater P export
- Therefore wetland drainage increases P export at the watershed scale



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Water Quality of Intact and Restored Wetlands

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Geographically Isolated Wetlands and Water Quality

- Because of their productive nature and the fact they contain high densities of aquatic vegetation GIWs are often thought of as having poor water quality
  - Not the case under natural conditions
  - Where water quality is poor this is usually linked to adjacent land uses

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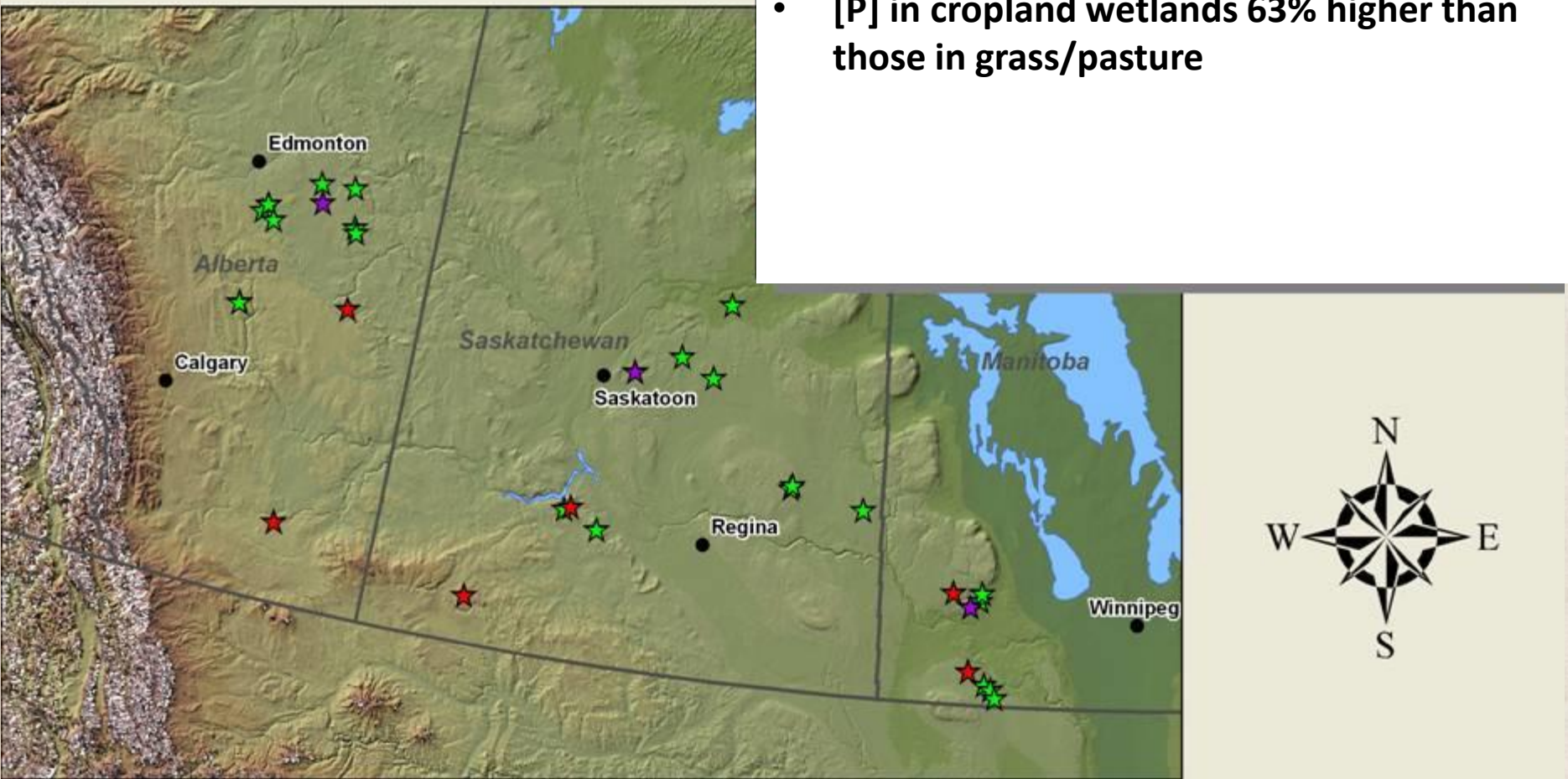
Legend

- ACAAF sites
- Research Farms
- Environment Canada Sites

Water Quality in intact wetlands in grassland/pasture or embedded in cropland

- **Mean [P] cropland wetlands = 1.07 mg L^{-1}**
- **Mean [P] grass/pasture wetlands = 0.65 mg L^{-1}**
- **[P] in cropland wetlands 63% higher than those in grass/pasture**



Water quality of intact wetlands vs. cropland runoff

- Mean [P] for intact wetlands = 0.36 $mg \cdot L^{-1}$
- Mean [P] from cropland runoff = 1.16 $mg \cdot L^{-1}$
- [P] in runoff from cropland was 3x greater

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Survey (summer 2013) of wetlands embedded in cropland vs pasture/grassland

- 31 wetlands sampled, cropland (n=17), pasture/grassland (n=14)
- Mean [P] in cropland wetlands (0.98 mg L^{-1}), more than 3x those in grass/pasture wetlands (0.28 mg L^{-1})
- Median [P] in cropland wetlands (0.78 mg L^{-1}), more than 40x higher than those in grass/pasture wetlands (0.02 mg L^{-1})

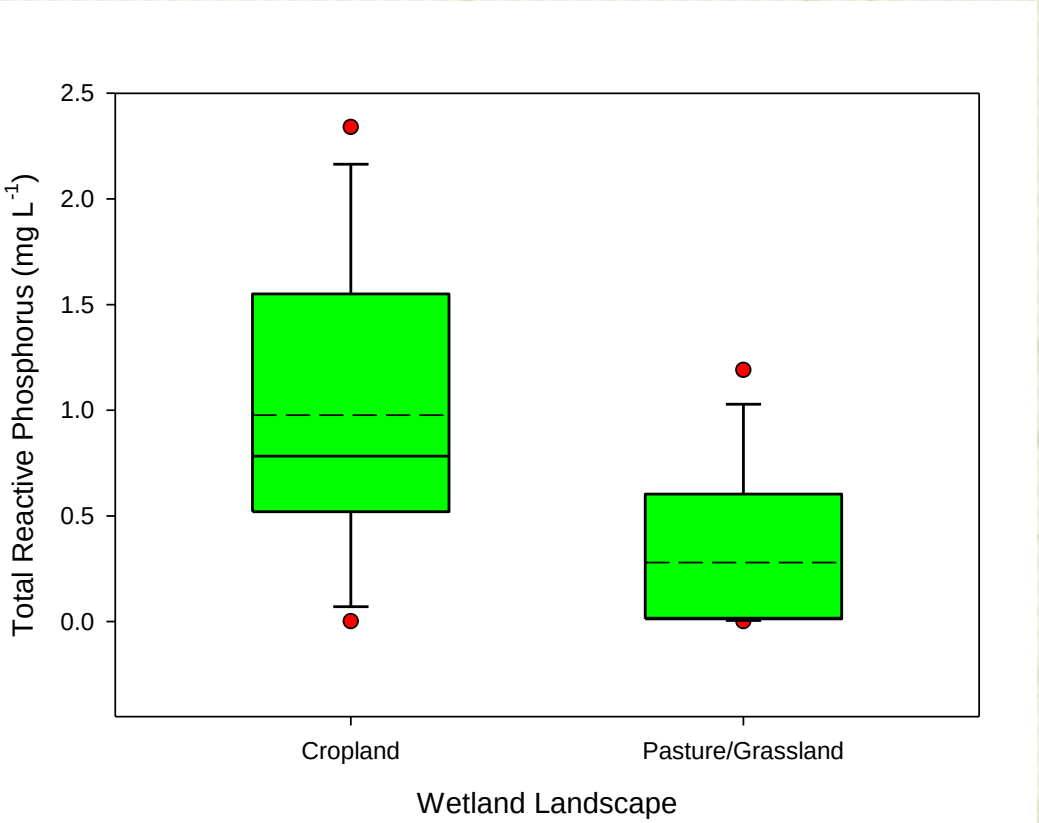

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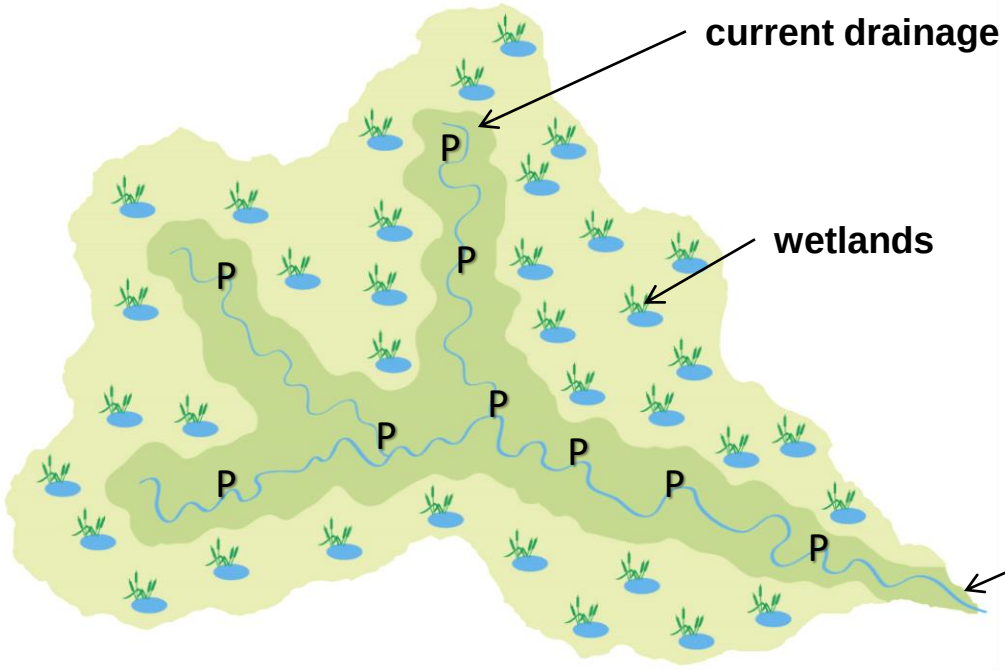
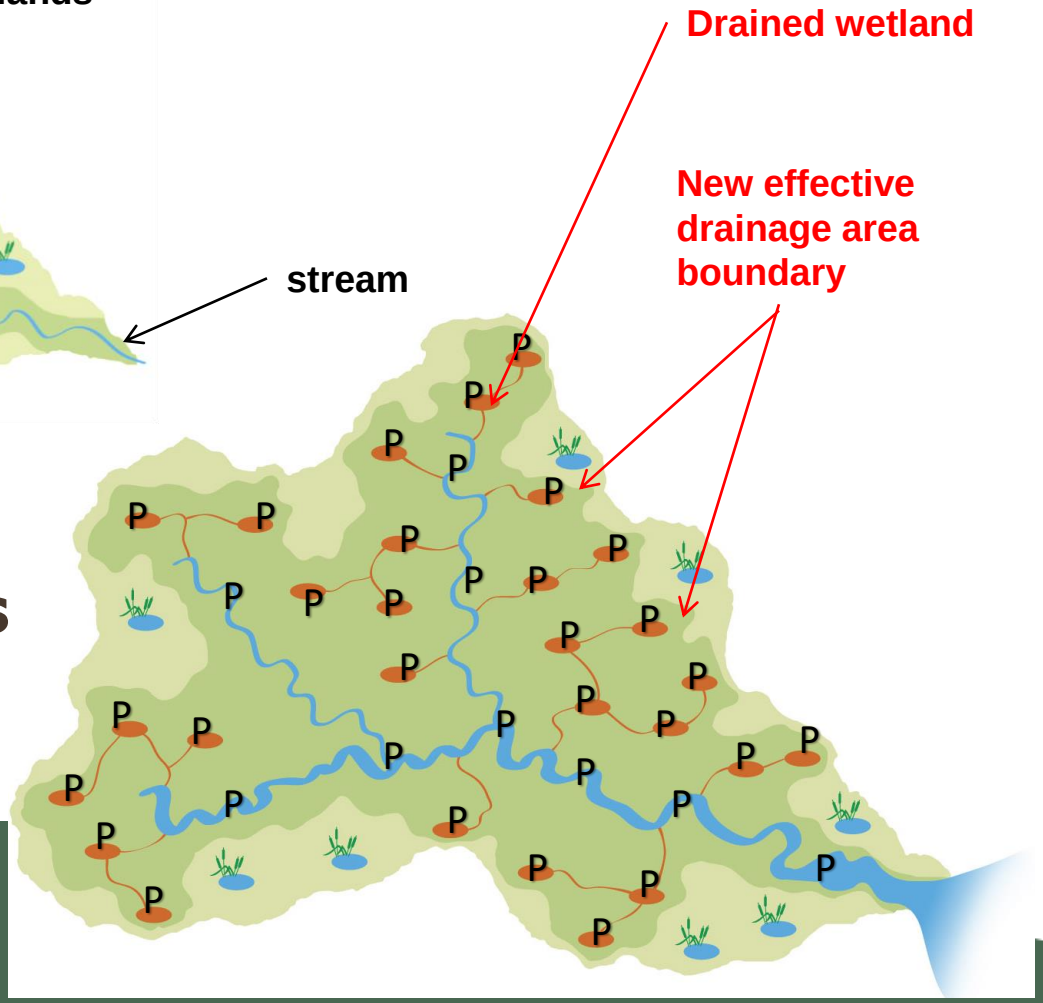
Table 30. Median concentrations for selected nutrient and pesticide constituents for wetlands embedded in cropland or grassland/pasture land in the Broughton's Creek and Smith Creek watersheds.

Water quality parameter	Median concentration found in wetlands embedded in cropland	Median concentration found in wetlands embedded in grassland/pasture land
Total dissolved phosphorus (mg L^{-1})	0.959	0.037
Total reactive phosphorus (mg L^{-1})	0.783	0.016
Total phosphorus (mg L^{-1})	1.210	0.056
Total Kjeldahl nitrogen (mg L^{-1})	2.93	2.13
2,4-D (µg L^{-1})	0.033	0.014
Bromoxynil (µg L^{-1})	0.0054	0.0013
Clopyralid (µg L^{-1})	0.056	0.004
Fluroxypyr (µg L^{-1})	0.015	0.004
Glyphosate (µg L^{-1})	0.060	0.022
MCPA (µg L^{-1})	0.427	0.026





Wetland drainage converts areas that were acting as P sinks to critical source areas for P export

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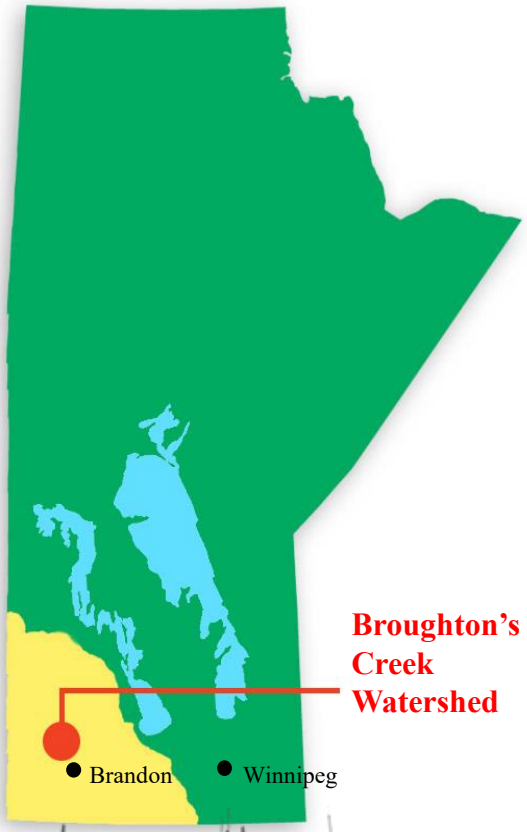
Impacts of GIW loss on P export

- Based on conservative estimates of drainage based on routed basins in Broughton's Creek
- Assuming similar P export across PPR in southwestern MB
- An additional 1,800 tonnes of P reaching surface waters in the Lake Winnipeg watershed



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Final thoughts

- No consistent long-term monitoring of prairie wetlands even though they are a valuable water resource
- Very little information regarding the immediate impacts of wetland drainage on WQ
- Little information regarding the impact of various land uses and wetland management practices on water quality in wetlands

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Thank you

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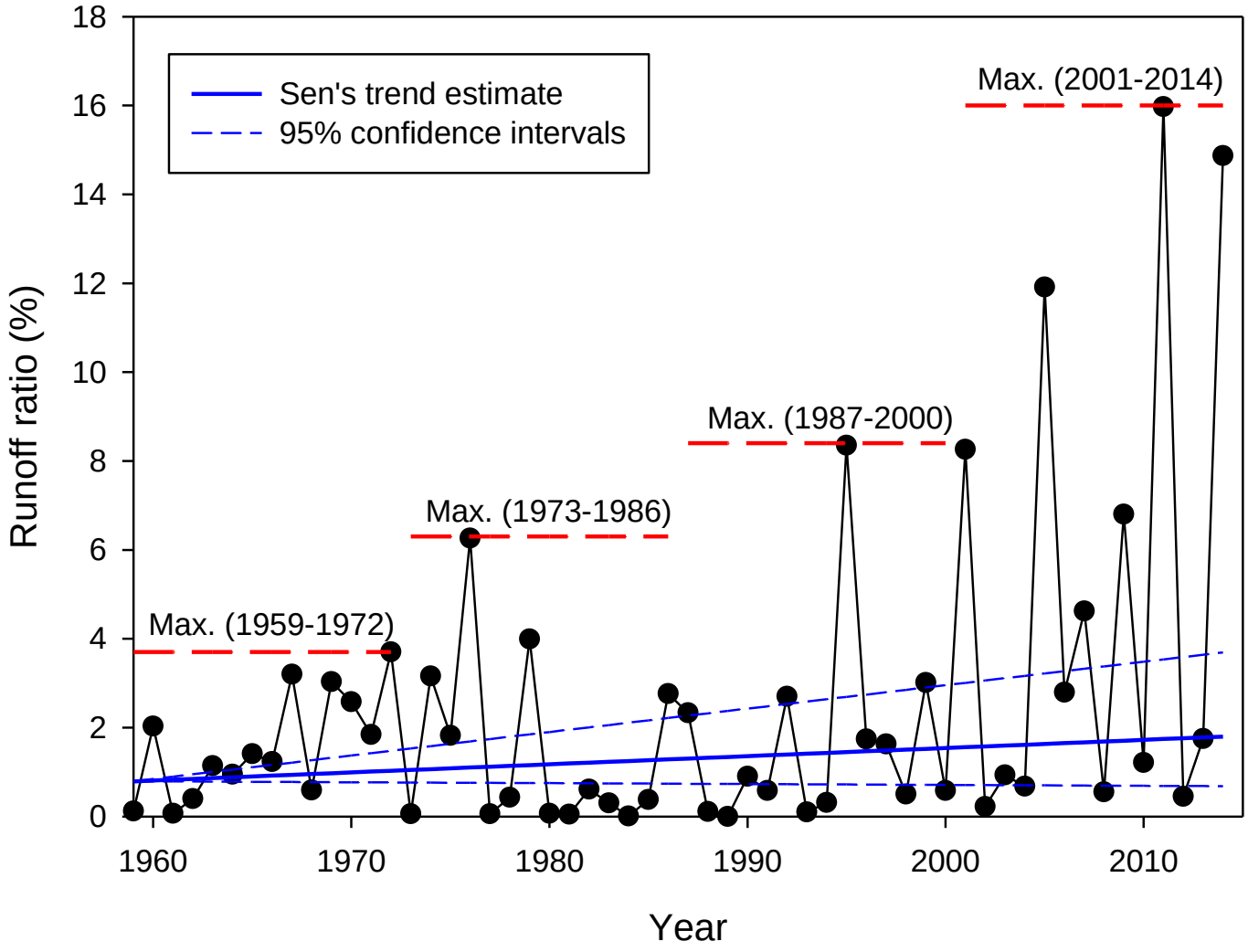

Oak River (1959-2014),
1,166 km2

- *Significant increase in runoff ratio (more than double).*
- *Dramatic increase in maximum runoff ratio over time.*
- *Similar trends and significance for total Q Assiniboine River (Kamsack and Headingley, Stony Creek, Medora Creek)*