



Wetlands

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Questions and Challenges

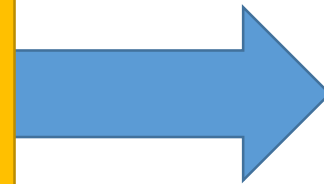
Questions

How do climate, land use, and socio-economics interact to affect wetland function and management?

Objectives

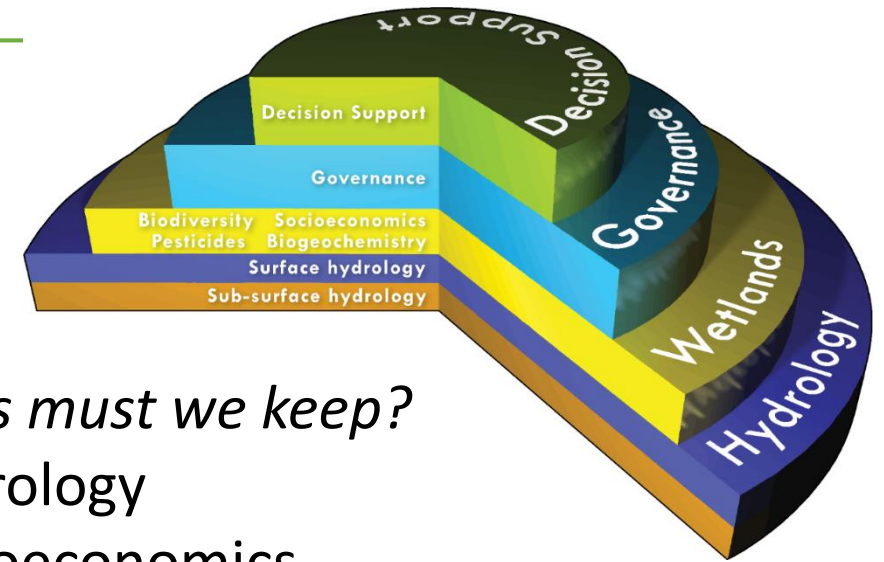
Improve understanding of

- Wetland ecosystem services
- Vulnerability
- & factors affecting conservation & decision making



What wetlands must we keep?

- Hydrology
- Socioeconomics
- Biogeochemistry (nutrients)
- Biodiversity
 - pesticides, habitat

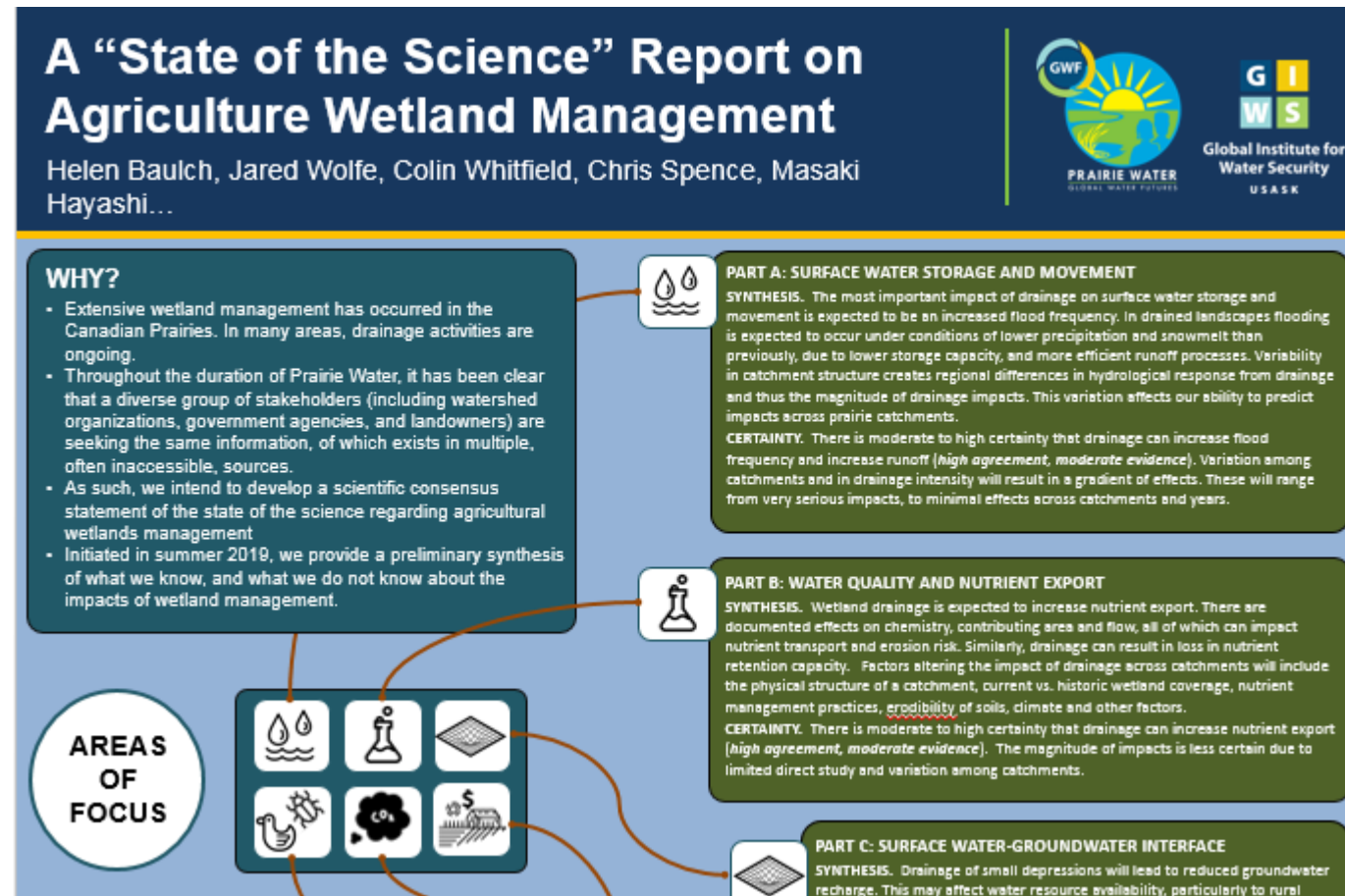


Objectives & Progress

- What wetlands must we keep?

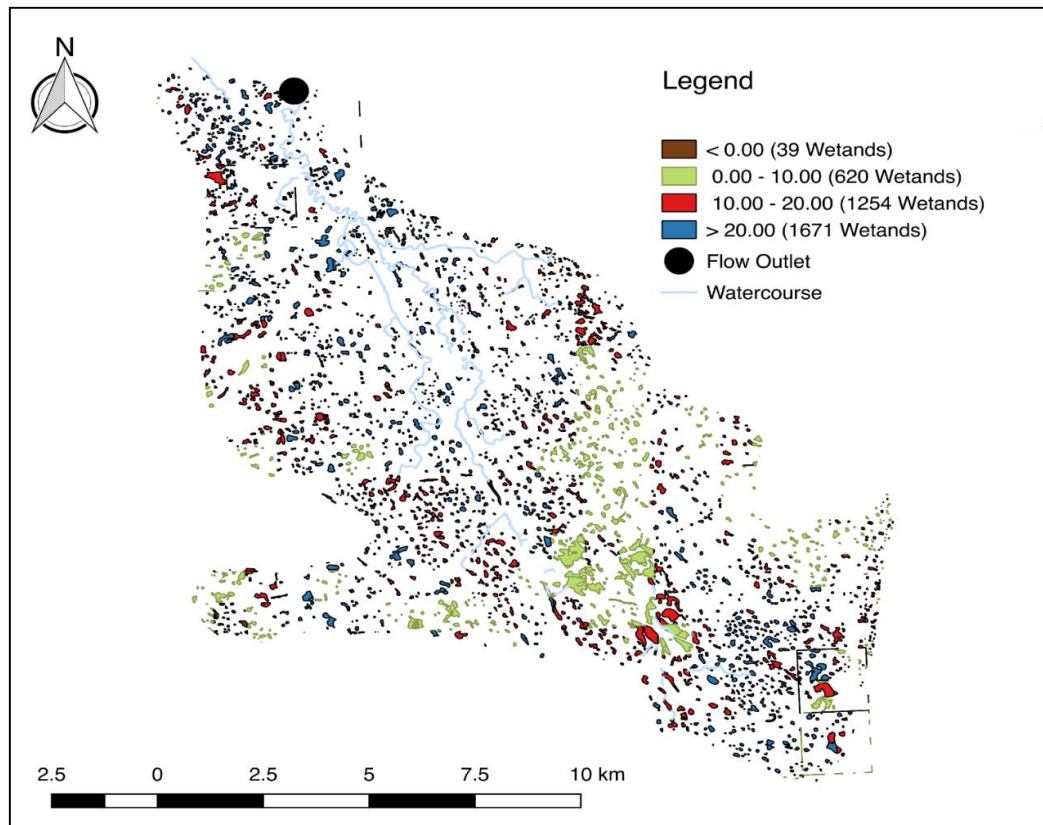
Throughout the project, the theme has been emerging that we (all of us) need to be on the same page about what we know regarding wetland ecosystem services, costs, and management.

2019, we initiated a consensus statement.



Progress - socioeconomics

Understanding how the variability in land value can be used to understand drainage-related decisions

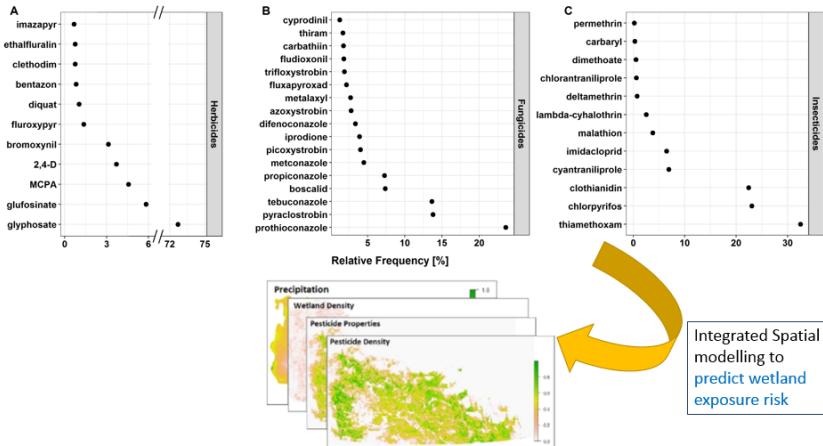


There is high spatial variability in the revenues that might be gained by producers from wetland drainage

Figure 1. Spatial Heterogeneity in Present Value Net Revenues from Annual Crop Production from Drained Wetlands -- \$/Acre

Progress - pesticide exposure risk

Pesticide Use in the Prairie region



Model development

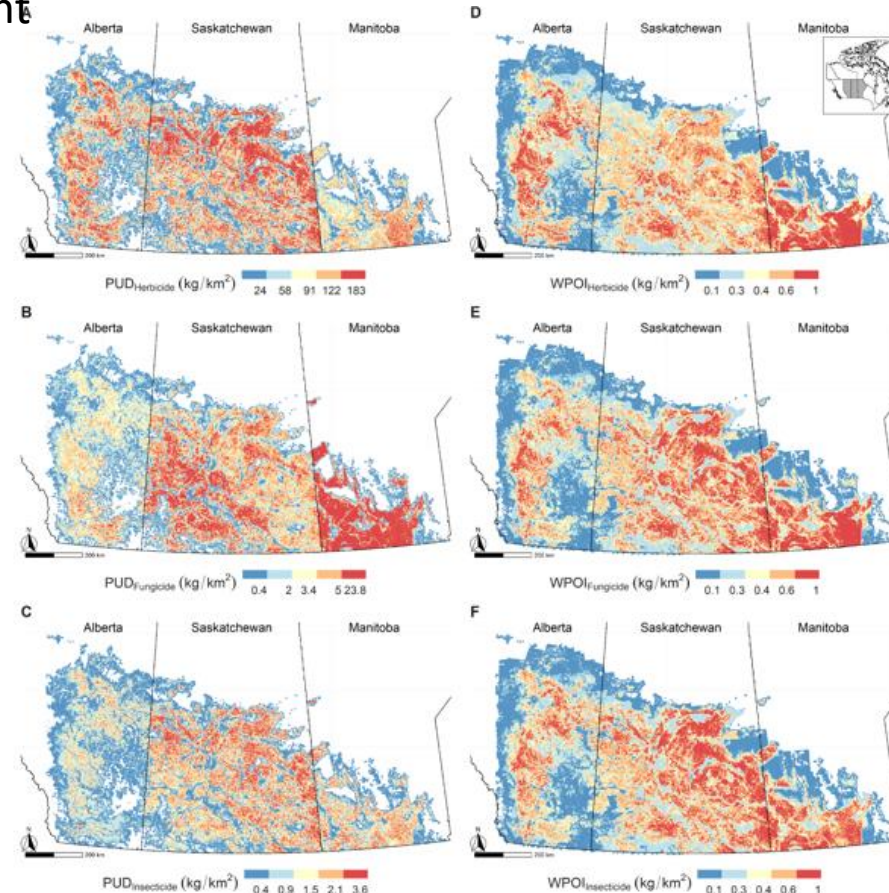


Spatial Pesticide Use Density (kg/km²)

Herbicides

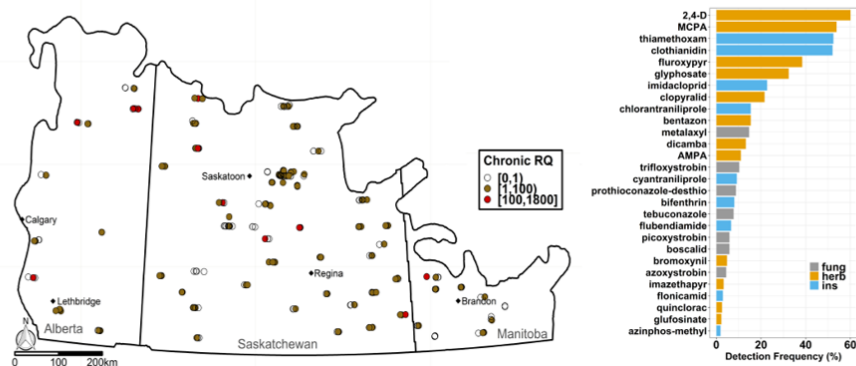
Fungicides

Insecticides



Predicted Wetland Pesticide Occurrence Index (kg/km²)

Pesticide Monitoring in the Prairies (2018-19)



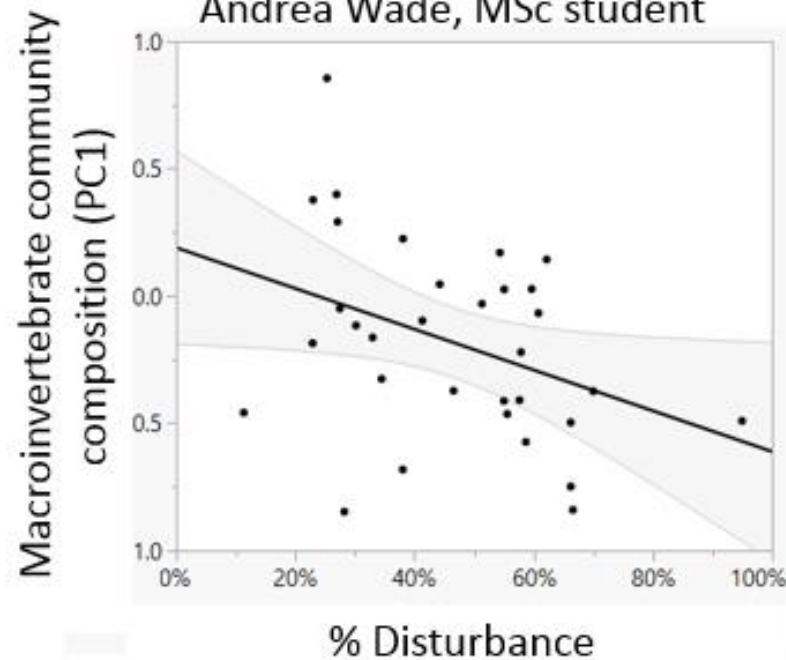
Model validation

Malaj et al. 2019
STOTEN

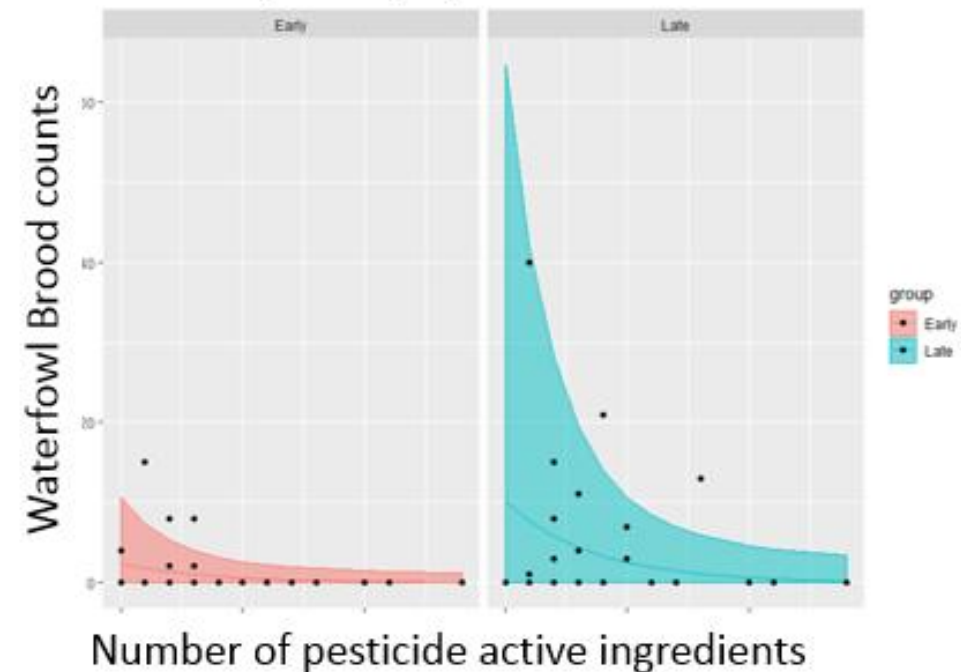
Progress – pesticide vulnerability



Andrea Wade, MSc student



Tyler Bryan, MSc student

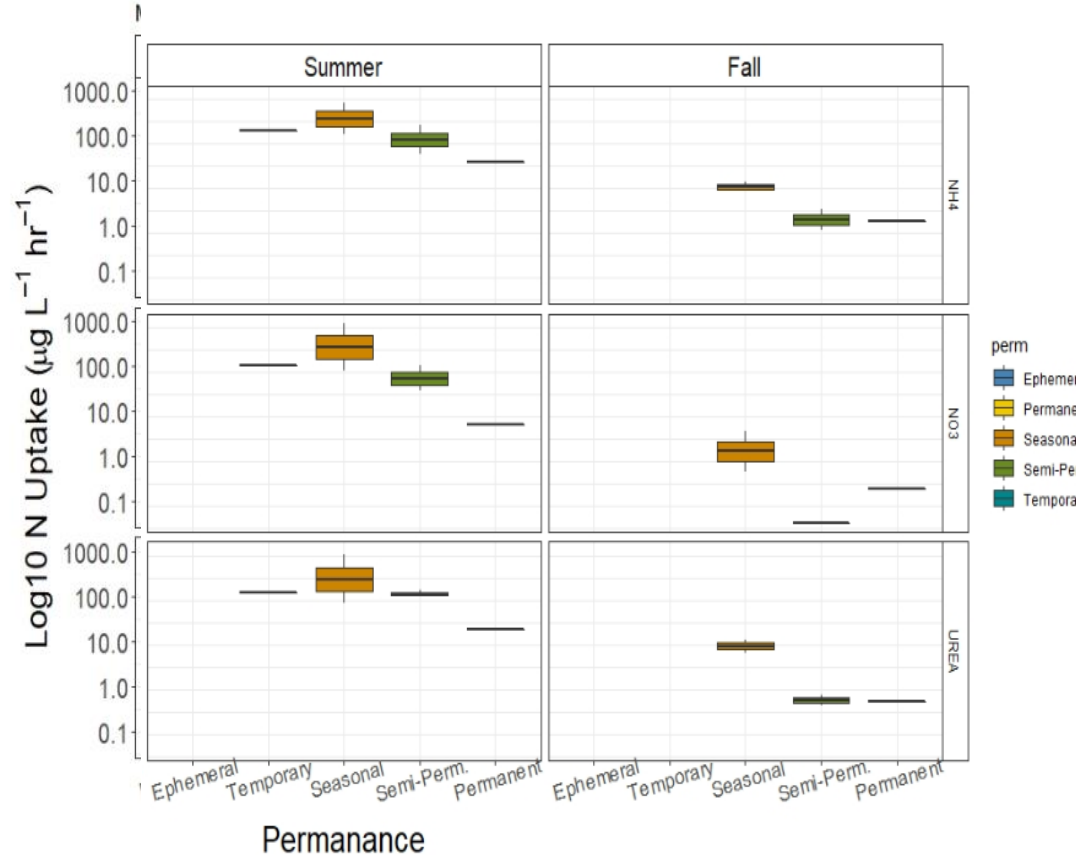


Invertebrate (left) and duck (right) communities respond negatively to water quality issues and wetland disturbance

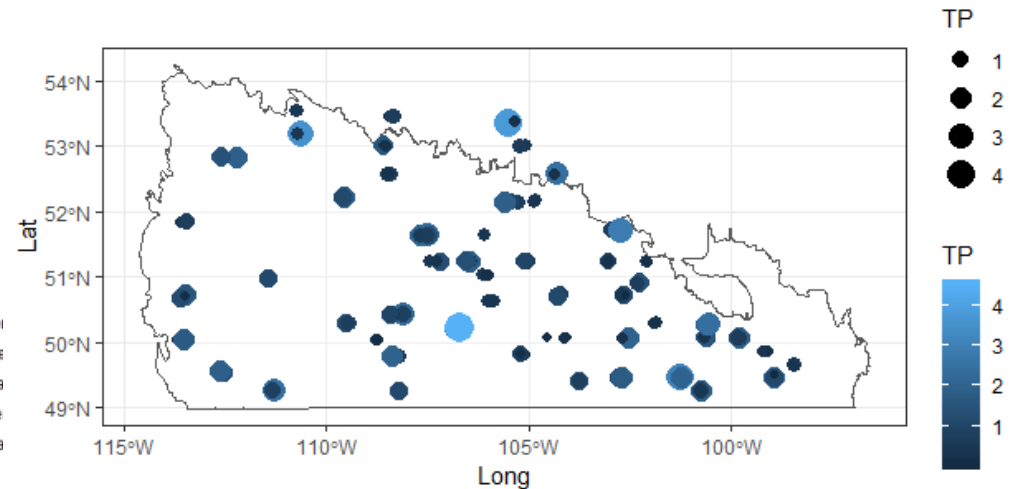
Progress – nutrient retention behaviour

What wetlands must we keep...?

Process measurements



Spatial surveys (breadth of conditions)

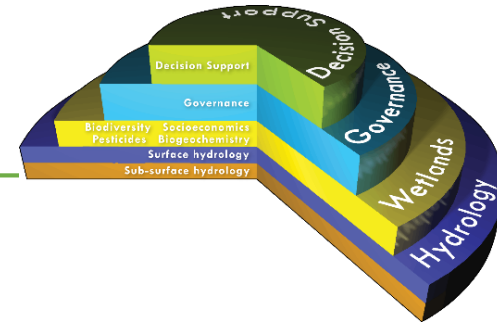


There is high variability among wetlands
Wetlands are extremely important hotspots of
nutrient cycling, and they can be important to
nutrient retention

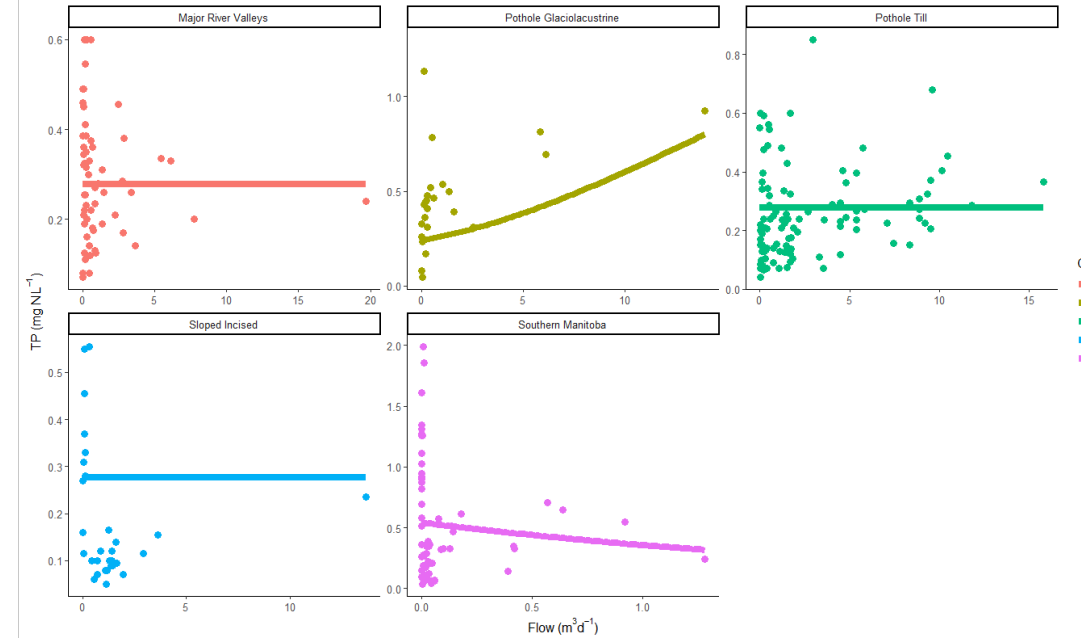
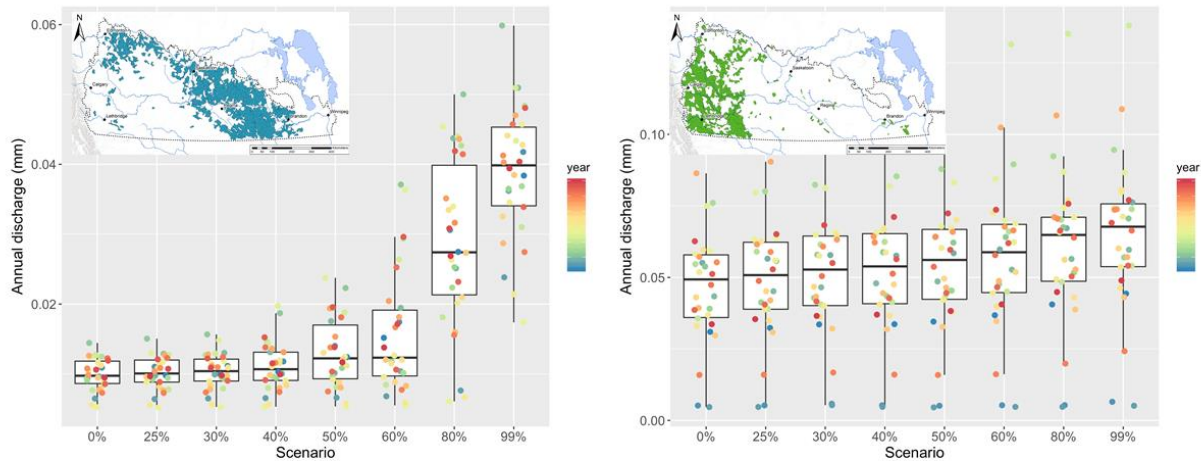
Using process understanding at different scales
in development of wetland (pond) model

Very fast transformations
Higher nitrogen uptake in less permanent
wetlands

Moving on to integration....



- What wetlands must we keep?
- What are the consequences of drainage (on nutrient load)?



Flow changes will be key factor governing changes in nutrient loads
Changes in nutrients will be \sim proportional to flows
In some cases nutrient export may be amplified under higher flow

A "State of the Science" Report on Agriculture Wetland Management

Helen Baulch, Jared Wolfe, Colin Whitfield, Chris Spence, Masaki Hayashi...



WHY?

- Extensive wetland management has occurred in the Canadian Prairies. In many areas, drainage activities are ongoing.
- Throughout the duration of Prairie Water, it has been clear that a diverse group of stakeholders (including watershed organizations, government agencies, and landowners) are seeking the same information, of which exists in multiple, often inaccessible, sources.
- As such, we intend to develop a scientific consensus statement of the state of the science regarding agricultural wetlands management.
- Initiated in summer 2010, we provide a preliminary synthesis of what we know, and what we do not know about the impacts of wetland management.



PART A: SURFACE WATER STORAGE AND MOVEMENT

SYNTHESIS. The most important impact of drainage on surface water storage and movement is expected to be an increased flood frequency. In drained landscapes flooding is expected to occur under conditions of lower precipitation and snowmelt than previously, due to lower storage capacity, and more efficient runoff processes. Variability in catchment structure creates regional differences in hydrological response from drainage and thus the magnitude of drainage impacts. This variation affects our ability to predict impacts across prairie catchments.

CERTAINTY. There is moderate to high certainty that drainage can increase flood frequency and increase runoff (high agreement, moderate evidence). Variation among catchments and in drainage intensity will result in a gradient of effects. These will range from very serious impacts, to minimal effects across catchments and years.



PART B: WATER QUALITY AND NUTRIENT EXPORT

SYNTHESIS. Wetland drainage is expected to increase nutrient export. There are documented effects on chemistry, contributing area and flow, all of which can impact nutrient transport and erosion risk. Similarly, drainage can result in loss in nutrient retention capacity. Factors altering the impact of drainage across catchments will include the physical structure of a catchment, current vs. historic wetland coverage, nutrient management practices, gradability of soils, climate and other factors.

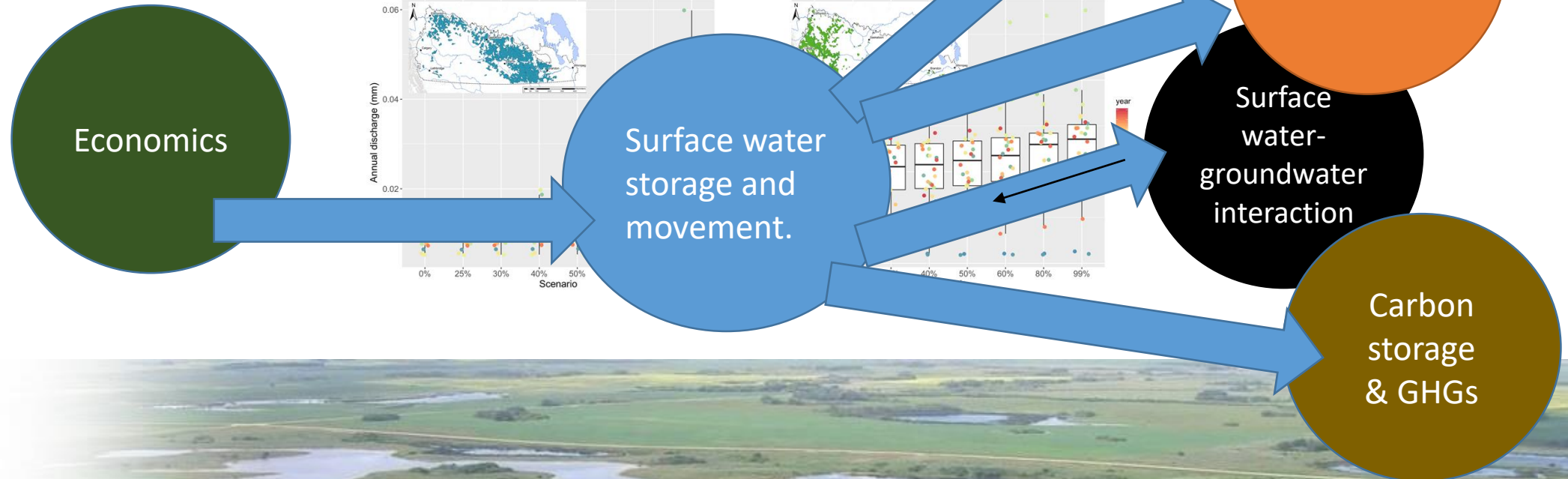
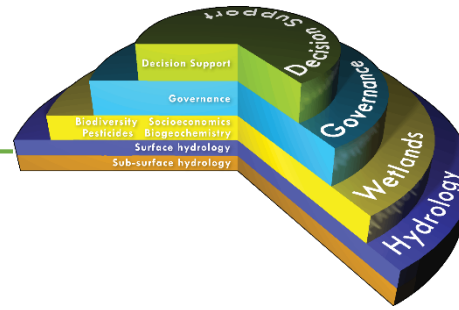
CERTAINTY. There is moderate to high certainty that drainage can increase nutrient export (high agreement, moderate evidence). The magnitude of impacts is less certain due to limited direct study and variation among catchments.



PART C: SURFACE WATER-GROUNDWATER INTERFACE

SYNTHESIS. Drainage of small depressions will lead to reduced groundwater recharge. This may affect water resource availability, particularly to rural

AREAS OF FOCUS



Wetland / Waste land

- Prairie drainage governance...
- <https://www.youtube.com/watch?v=-ut3x-wGyuQ>



A FILM BY PHILIP LORING AND DONALD SELBY

Wetlands Crystallization

Data & methods

- Field data from pan-prairie wetland survey
- Proprietary dataset, including pesticide sales and land values, GIS & modelling
- Rate measurements of key processes, spatial modelling & mapping
- Synthesis of water quality monitoring stations
- Model integration to evaluate land use and climate impacts (hydrology to chemistry, economics and biodiversity)

Result

- Herbicide and neonic concentrations found in surveyed wetlands, with observed impact to wetland bugs and birds
- Nutrient concentrations in wetlands are heterogeneous, differing widely across the prairies. Experiments reiterate that wetlands serve important biogeochemical function.
- Established a process to identify the net-present value of a wetland to a producer & support conservation policy informed by landscape heterogeneity.

Uncertainty

- Pesticide and nutrient modelling in the process of calibration
- Difficult to capture space and time variability, and watershed-specific findings would require more detailed analysis
- Social costs of wetland removal to be determined in coming phase.