Welcome

Today, April 2024

Start
April 1, 2022

|2023 |2024 |2025 |2026 |2027

Finish
March 31, 2027

CAAF Project:
Wetlands as nature-based climate-change solutions: Quantifying carbon-capture potential while building a stronger green economy.

Five years: April 1, 2022 - March 31, 2027 (Possibly one year extension without additional funding)

Prairies Project:
Wetland as Natural Solutions: Baselines and projections for Wetlands on Agricultural Land

Three years: Jan 1, 2023 - March 31, 2025

Great Lakes Project:
Wetlands as Nature-Based Climate Solutions: A Socioeconomic Analysis of the Great Lakes-St. Lawrence River Basin

Four years: Jan 1, 2024 – March 31, 2027

CAAF, All Objectives

|2023 |2024 ▼ |2025 |2026 |2027

Start
April 1, 2022

Finish
March 31, 2027

Core Activities
April 1, 2022 - March 31, 2027

Objective 1. Develop Authoritative Estimates Of Landscape-Scale Density Of Wetland Coverage For Agricultural Landscapes
April 1, 2022 - March 31, 2025

Objective 2. Develop Authoritative Estimates For Rates Of OC Accumulation, GHG Fluxes To The Atmosphere, And Carbon Transports Into (And Out Of) Wetlands
April 1, 2022 - October 15, 2026

Objective 3. Develop Robust Estimates Of Hydrological Process Controls On OC Accumulation And GHG Fluxes From Wetlands
April 1, 2022 - March 31, 2027

Objective 4. Develop Robust Estimates Of The Synergies (And Conflicts) Of Wetlands As NBS For Carbon Storage Versus Other Benefits
April 1, 2022 - March 31, 2027

Objective 5. Use The Authoritative And Robust Estimates Of OC Accumulation And GHG Fluxes To Inform Policy And Practice Tools To Incentivize The Use Of Wetlands As NBS For Multiple Benefits In Agricultural Landscapes
April 1, 2023 - March 31, 2027

Prairies Project:

Wetland as Natural Solutions: Baselines and projections for Wetlands on Agricultural Land

Prairies

Start
April 1, 2022

2023

2024

2025

Finish
March 31, 2025

Objective 1. Identify the main drivers of wetland conversion and projecting how these drivers might change the rates of wetland conversion, and the resulting GHG emissions, over time.

Objective 2. Analysis of how activities might shift to a different location or ecosystem (leakage) if activities are undertaken to reduce the draining of wetlands on agricultural lands in each region.

Task 1. Conceptual socioeconomic model planning approach for Lake Winnipeg watershed

Task 2. Engagement with science teams in the development of wetland inventory

Task 3. Analysis of primary drivers of wetland conversion

Task 4. Development of survey instrument on socioeconomic perspectives

Task 5. Development of socioeconomic model for wetland conversion

Task 6. Evaluation and assessment of policy instruments

Task 7. Development of model to assess leakage of wetlands

Task 8. Research Team

Great Lakes Project

Wetlands as Nature-Based Climate Solutions: A Socioeconomic Analysis of the Great Lakes-St. Lawrence River Basin
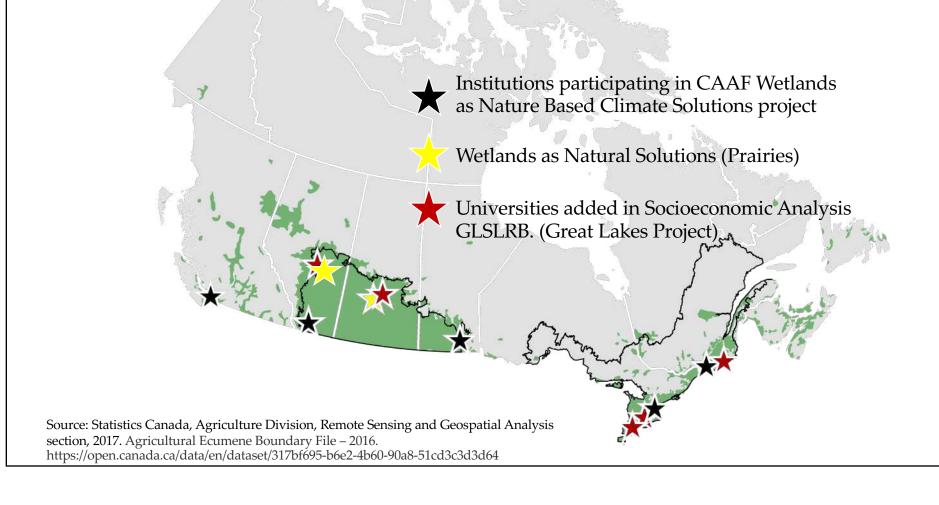

WETLANDS
NATURE BASED SOLUTIONS

Great Lakes, all objectives

|Jan '24 |Apr '24 |Jul '24 |Oct '24 |Jan '25 |Apr '25 |Jul '25 |Oct '25 |Jan '26 |Apr '26 |Jul '26 |Oct '26 |Jan '27

Start
January 1, 2024

Finish
January 4, 2027

Wetlands as Nature-Based Climate Solutions: A Socioeconomic Analysis of the Great Lakes-St. Lawrence River Basin
January 1, 2024 - January 4, 2027

Objective 1. Evaluate methods of mapping wetlands and estimating historical rates of land use change and conversion of wetlands in the GLSLRB
January 1, 2024 - December 31, 2024

Objective 2. Create an inventory of wetlands and identify historical rates of land use change and conversion of wetlands in the GLSLRB
January 1, 2025 - January 1, 2027

Objective 3. Identify the main socio-economic drivers of wetland conversion and projecting how these drivers might change the rates of wetland conversion, and the resulting GHG emissions, over time in the GLSLRB
January 1, 2024 - January 4, 2027

Objective 4. Cost-effectiveness and cost-benefit analysis of restoration and/or conservation of wetlands on agricultural lands as NbCS in the GLSLRB
January 1, 2024 - January 4, 2027

National Wetland Information Network

★ Institutions participating in CAAF Wetlands as Nature Based Climate Solutions project

★ Wetlands as Natural Solutions (Prairies)

★ Universities added in Socioeconomic Analysis GLSLRB. (Great Lakes Project)

Investigators (CAAF Project)

Investigators (Prairies Project)

Dr. Irena Creed

Dr. Patrick Lloyd-Smith

Dr. John Pattison-Williams

Investigators (Great Lakes Project)

Dr. Irena Creed

Dr. Georgios Arhonditsis

Dr. Roy Brouwer

Dr. Jie He

Dr. Ben DeVries

Dr. Geneviève Ali

Dr. Lota Tamini

Wetland Assessments

Area covered by:
CAAF Wetlands as Nature Based Climate Solutions (green)

Lake Winnipeg Watershed Area
covered by the first extension to the
CAAF Wetlands as Nature Based Climate Solutions Project
led by Patrick Lloyd-Smith,
and John Pattison-Williams.

Great Lakes-St. Lawrence River Basin area*
covered by the proposed second extension
to the CAAF Wetlands as
Nature Based Climate Solutions Project
led by
Roy Brouwer
Jie He
Ben DeVries
Genèvieve Ali
George Arthonditsis
Lota Tamini

Wetland Assessments

Cross fertilization of theories, methods, approaches

Area covered by:
CAAF Wetlands as Nature Based Climate Solutions (green)

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led by
Roy Brouwer
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Ben DeVries
Genèvieve Ali
George Arthonditsis

Agenda, May 1

- 8:30 – 9:00, Welcome
- 9:00 – 9:30, Introductions
- 9:30 – 10:30, Breakout room (A, B)
- 10:30 – 10:45, Morning Break
- 10:45 – 12:00, Breakout rooms (A, B)
- 12:00 – 1:00, Lunch break
- 1:00 – 2:30, Breakout rooms (C, D)
- 2:30 – 2:45, Afternoon Break
- 2:45 – 3:30, Breakout rooms (C, D)
- 3:30 – 4:00, From Science to Impact
- 4:00 – 4:30, Final remarks

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Rose Fuchsia Room, Topic A

Topics:

GIS, remote sensing, mapping, and modeling

Objectives:

CAAF, Objectives 1, 3, 5.3.

Great Lakes, Objectives 1, 2, 4.5.

Room leaders:

David Aldred, Ben DeVries

Purple Room, Topic B

Topics:

Flux towers, measurements, and carbon cycling

Objectives:

CAAF, Objective 2

Room leaders:

Pascal Badiou, Matthew Bogard

Rose Fuchsia Room, Topic A

Topics:

GIS, remote sensing, mapping, and modeling

CAAF:

Ali Ameli

George Arhonditsis (Ratnajit Saha, Yoji Uno, Xin Wey Wen)

Irena Creed (David Aldred, Forough Fendereski, Eric Enanga, Shizhou Ma, Nayyer Mirnasl, Michael Dallosch, Pengfei Ren, Adan Auyeung)

Great Lakes:

Ben DeVries (Maciej Lizak, Alejandro Nieto, Kathleen B.)

Genevieve Ali

Purple Room, Topic B

Topics:

Flux towers, measurements, and carbon cycling

CAAF:

Pascal Badiou

Christian von Sperber (Calder Jones, Shir Gruber)

Matthew Bogard (Chin Ngai Chan)

Larry Flanagan* (Oshini Fernando)

David Lobb

Gail Chmura (Wendy Ampuero, Rachel Plant)

Sara Knox

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- 4:00 – 4:30, Final remarks

Room A. Rose Fuchsia

Topics:

GIS, remote sensing, mapping, and modeling

Room B. Purple

Topics:

Flux towers, measurements, and carbon cycling

Questions:

How do we link our measurements and modelling approaches across scales? (i.e. results from soil/water incubations - Kayak sampling - Eddy co-variance measurements on site and across country - large scale modelling approaches).

What information/knowledge do we gain and/or lose during the upscaling? What gaps of knowledge need to be filled to link the different scales?

Discussions on sampling GHG concentrations in water.

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- 12:00 – 1:00, Lunch break – Checkout for some travelers
- 1:00 – 2:30, Breakout rooms (C, D)
- 2:30 – 2:45, Afternoon Break
- 2:45 – 3:30, Breakout rooms (C, D)
- 3:30 – 4:00, From Science to Impact
- 4:00 – 4:30, Final remarks

12:00 – 1:00, Lunch break

Foyer 2

Checkout for some travelers

Welcome to the Second Annual General Meeting Wetlands as Nature-Based Climate Solutions

May 1, 2024

ROOM A: Purple Room

GIS, remote sensing, mapping, and modeling

ROOM A: GIS, remote sensing, mapping, and modeling

- Sheel Bansal
- David Aldred
- Forough Fendereski
- Eric Enanga
- Shizhou Ma
- Nayyer Mirnasl
- Ratnajit Saha
- Ben DeVries
- Genevieve Ali
- David Lobb

ROOM A: GIS, remote sensing, mapping, and modeling

- Sheel Bansal

Wetland Biogeochemistry:
Mechanisms, Models, Management, Methods (Web4M)

U.S. Geological Survey, Climate Research & Development Program
Northern Prairie Wildlife Research Center
Jamestown, North Dakota, USA
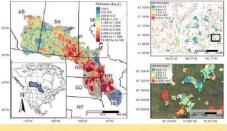
Sheel Bansal, Senior scientist
Brian Tangen, Junior scientist
Jacob Meier, Lead technician
Max Post van der Burg, Modeler

1. Mechanisms
Vegetation, hydrology, and soils

2. Models
Spatially explicit methane model

3. Management
Conservation Reserve Program

4. Methods
Automation, Patents, Student led
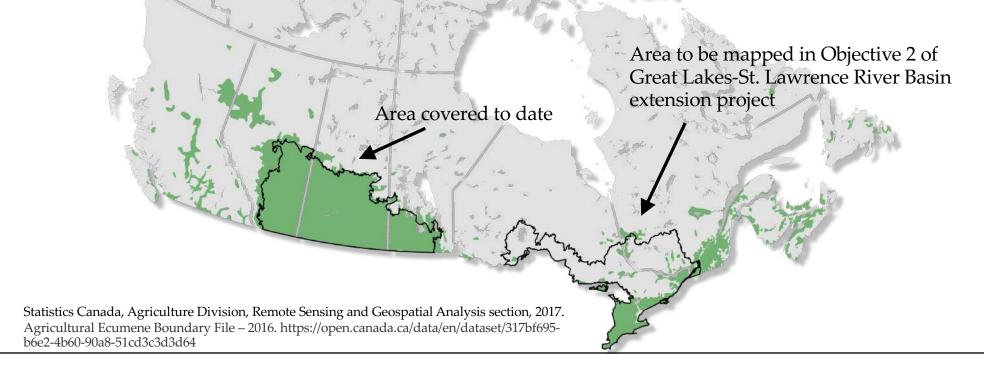
ROOM A: GIS, remote sensing, mapping, and modeling

- David Aldred

Objective 1, Task 2: Develop authoritative estimates of landscape-scale density of wetland coverage for agricultural landscapes
Irena Creed, David Aldred
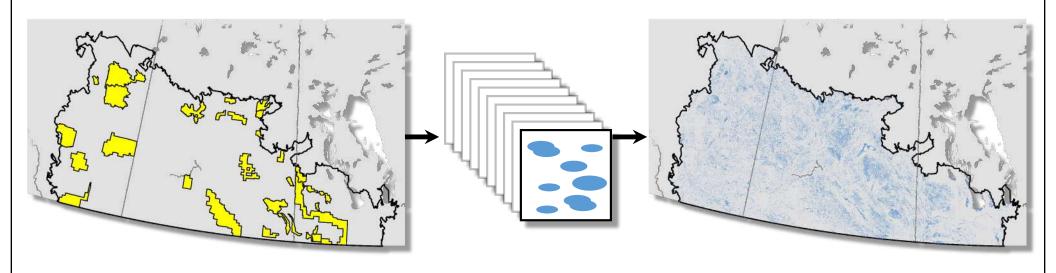
In Task 1 we compiled existing inventories in the Prairies and identified limitations of having non-standardized approaches (different source data, different dates, different specifications)
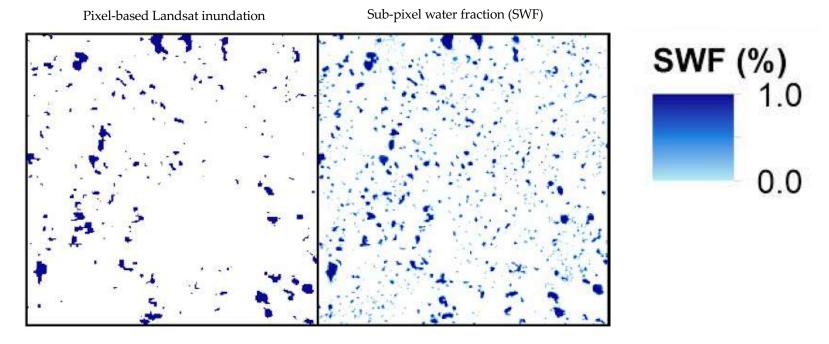
In Task 2 we are creating standardized inventories that span multiple years

Area to be mapped in Objective 2 of Great Lakes-St. Lawrence River Basin extension project

Area covered to date

Statistics Canada, Agriculture Division, Remote Sensing and Geospatial Analysis section, 2017.
Agricultural Ecumene Boundary File – 2016. https://open.canada.ca/data/en/dataset/317bf695-b6e2-4b60-90a8-51cd3c3d3d64

We tested multi-year (1 to 10 year) overlays of Landsat-based Dynamic Surface Water of Canada*
annual inundation maps with lakes and rivers removed for spatial accuracy and drainage loss
estimates in 30 areas where high resolution DUC inventories were available for comparison

Our testing resulted in 28-year (1993-2020) time series of annual wetland inventories based on 10-year
overlays
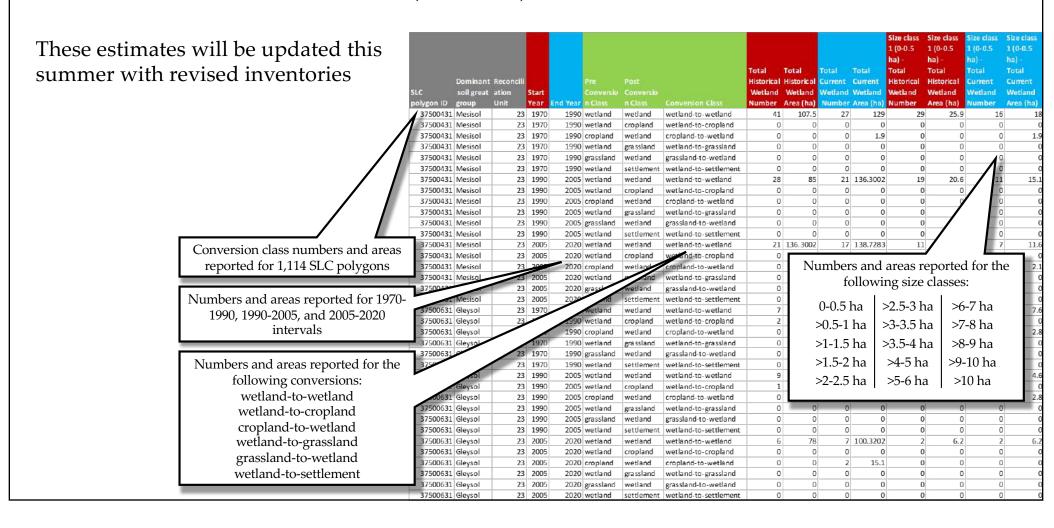
*Olthof I, Rainville T. 2022. Dynamic surface water maps of Canada from 1984 to 2019 Landsat satellite imagery. Remote Sensing of Environment 279: 113121.
https://doi.org/10.1016/j.rse.2022.113121

We are continuing to test different multi-year overlays using frequency of inundation thresholds

Together with Objective 2 of the Great Lakes-St. Lawrence River Basin extension project, we will also test sub-pixel water fraction (SWF) methods* to improve wetland mapping

Pixel-based Landsat inundation

Sub-pixel water fraction (SWF)

SWF (%)
1.0
0.0
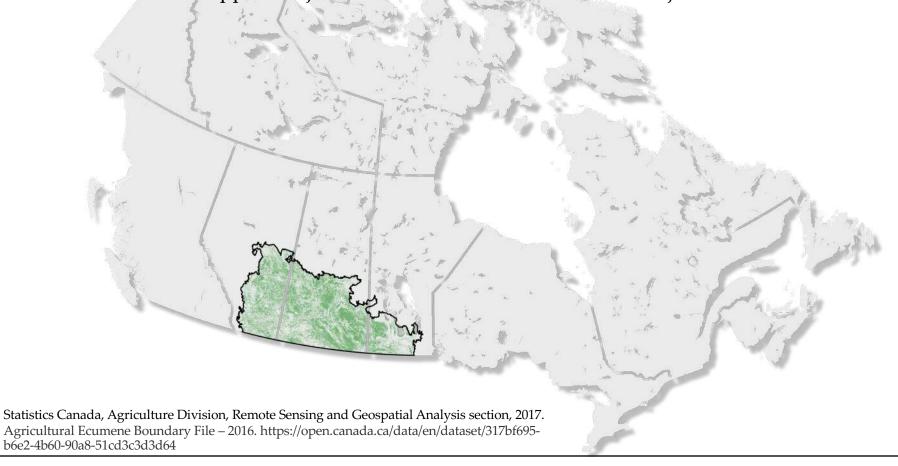
*DeVries B, Huang C, Lang MW, Jones JW, Huang W, Creed IF, Carroll ML. 2017. Automated quantification of surface water inundation in wetlands using optical satellite imagery. Remote Sensing 9(8): 807. https://doi.org/10.3390/rs9080807
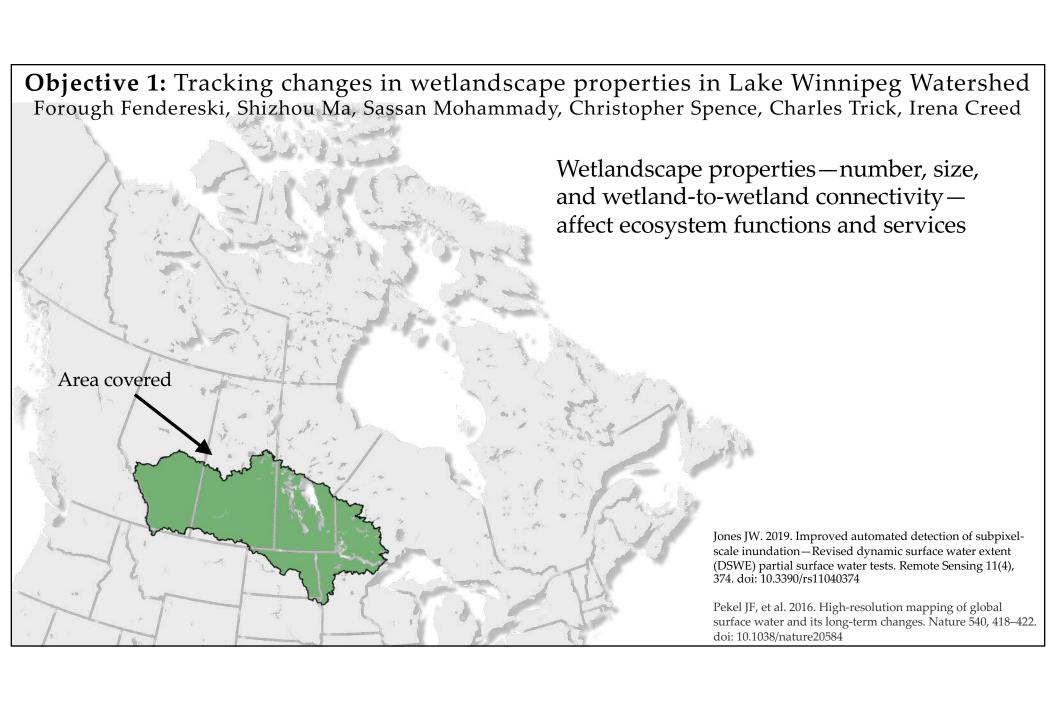
Using these inventories and AAFC land cover maps, we generated estimates of number and area of wetland conversions between 1970-1990, 1990-2005, and 2005-2020

These estimates will be updated this summer with revised inventories

Conversion class numbers and areas reported for 1,114 SLC polygons

Numbers and areas reported for 1970-1990, 1990-2005, and 2005-2020 intervals

Numbers and areas reported for the following conversions:
wetland-to-wetland
wetland-to-cropland
cropland-to-wetland
wetland-to-grassland
grassland-to-wetland
wetland-to-settlement

Numbers and areas reported for the following size classes:

0-0.5 ha	>2.5-3 ha	>6-7 ha
>0.5-1 ha	>3-3.5 ha	>7-8 ha
>1-1.5 ha	>3.5-4 ha	>8-9 ha
>1.5-2 ha	>4-5 ha	>9-10 ha
>2-2.5 ha	>5-6 ha	>10 ha

Standardized wetland inventories will be available to all project investigators and will directly support Tasks 1.3, 1.4, 3.2, 3.3, 4.2, and 4.4 of the CAAF project and Objectives 1 and 2 of the Prairies Project, and the methods will support Objectives 1 and 2 in the Great Lakes Project

ROOM A: GIS, remote sensing, mapping, and modeling

- Forough Fendereski

Objective 1: Tracking changes in wetlandscape properties in Lake Winnipeg Watershed
Forough Fendereski, Shizhou Ma, Sassan Mohammady, Christopher Spence, Charles Trick, Irena Creed

Wetlandscape properties—number, size, and wetland-to-wetland connectivity— affect ecosystem functions and services

Area covered

Jones JW. 2019. Improved automated detection of subpixel-scale inundation—Revised dynamic surface water extent (DSWE) partial surface water tests. Remote Sensing 11(4), 374. doi: 10.3390/rs11040374

Pekel JF, et al. 2016. High-resolution mapping of global surface water and its long-term changes. Nature 540, 418–422. doi: 10.1038/nature20584

We identified wetland "objects" from Landsat inundated areas and extracted
wetlandscape properties —number, size, and wetland-to-wetland connectivity— to
track their changes from 1984-2020

Wetlandscape properties increased 1984-2020 in response to increases in precipitation

Spearman's rank correlation showed precipitation alone could explain **more than 70%** of the variations in wetlandscape properties (p < 0.01).

ROOM A: GIS, remote sensing, mapping, and modeling

- Eric Enanga

OBJECTIVE 2. Develop Authoritative Estimates For Rates Of _OC Accumulation_, GHG Fluxes To The Atmosphere, And Carbon Transports Into (And Out Of) Wetlands.

2.2 Develop Standards And Protocols To Measure Wetland _OC Accumulation_ And GHG Flux Rates.

OC stock estimation: Does the method matter?

CAAF Annual General Meeting, May 1st 2024

Eric Enanga
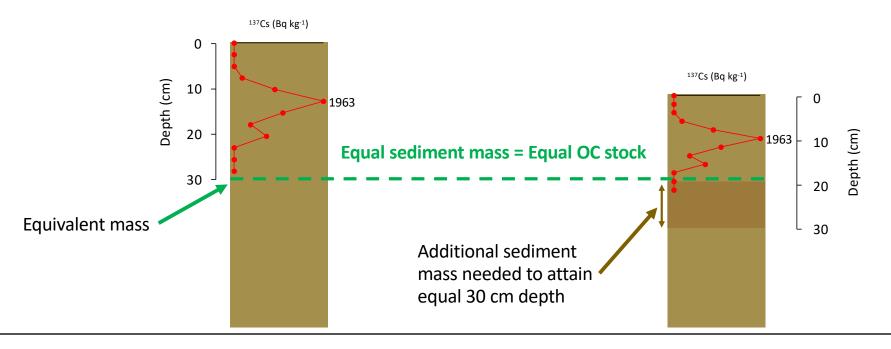
Supervisor – Dr. Irena Creed

Equivalent mass vs Depth and ^{137}Cs 1963 peak OC stock
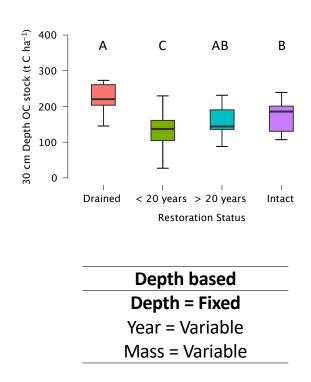
Method	Depth	Year	Mass
Depth based	*Fixed*	Variable	Variable
^{137}Cs 1963 peak based	Variable	*Fixed*	Variable
Equivalent Mass based	Variable	Variable	*Fixed*
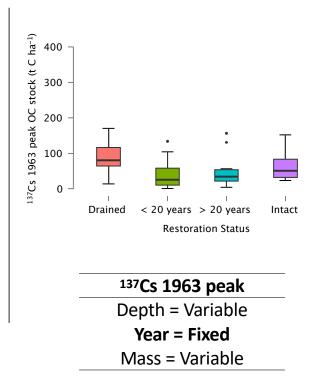
Before compaction
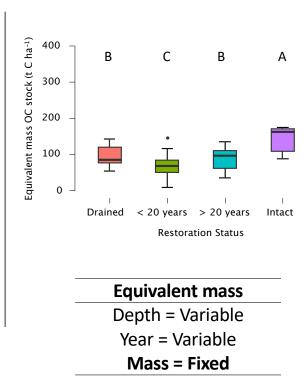
After compaction "e.g., tractor tire"

^{137}Cs (Bq kg^{-1})

Depth (cm)

1963

^{137}Cs (Bq kg^{-1})

Depth (cm)

1963

Equal sediment mass = Equal OC stock

Equivalent mass

Additional sediment mass needed to attain equal 30 cm depth

Depth, ^{137}Cs 1963 peak & Equivalent mass OC stock estimates

Depth based

Depth = Fixed

Year = Variable

Mass = Variable

^{137}Cs 1963 peak

Depth = Variable

Year = Fixed

Mass = Variable

Equivalent mass

Depth = Variable

Year = Variable

Mass = Fixed

Take home message

All three methods have a role to play in OC stock estimates:

❖ Depth based method is fast and efficient where the sampling sites are homogenous with minimal compaction, excellent for screening large sample sets.

❖ ^{137}Cs 1963 peak method is useful where, in addition, OC sequestration rates are important (i.e., time marker).

❖ Equivalent mass is much more reliable where substantial compaction is anticipated, e.g., drained sites, although requires more time investment.

Contributions to Objective 2

2.2 Develop Standards And Protocols To Measure Wetland ***OC Accumulation*** And GHG Flux Rates (April 3, 2023 - April 1, 2024).
We have demonstrated that the Equivalent Mass method is more reliable for consideration as a potential protocol for OC accumulation estimation.

2.3 Using Standards And Methodologies Developed In Task 2.2, Measure Wetland ***OC Accumulation*** And GHG Flux Rates (April 1, 2022 - October 15, 2026).
Where substantial compaction is anticipated, equivalent mass should, in future, be the preferred protocol for calculating OC accumulation based on the conclusions arrived at in 2.2 above.
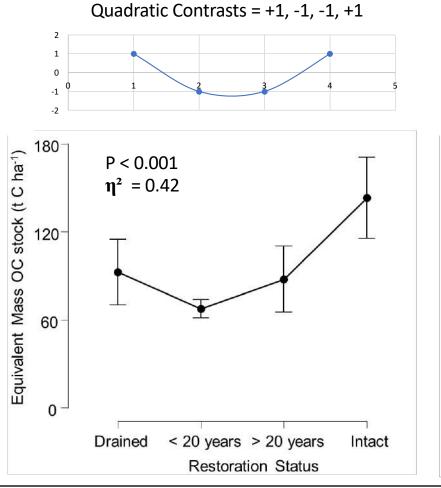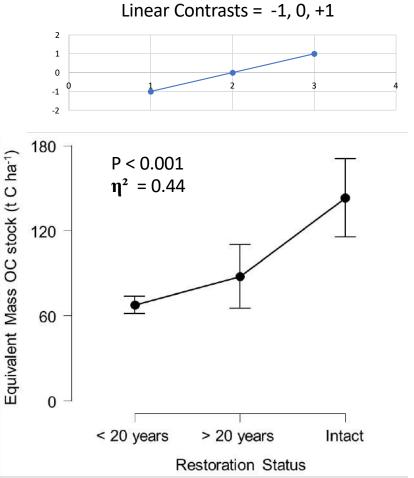
1. Creed, I.F., Badiou, P., Enanga, E., Lobb, D.A., Pattison-Williams, J.K., Lloyd-Smith, P., Gloutney, M. (2022). Can restoration of freshwater mineral soil wetlands deliver nature-based climate solutions to agricultural landscapes? *Frontiers in Ecology and Evolution,* 10, 932415, doi:10.3389/fevo.2022.932415, 2022.
2. Purbasha, M., Creed, I.F., Trick, C.G., Enanga, E., Lobb, D.A., Submitted. Technical Note: Comparison of radiometric techniques for estimating recent organic carbon sequestration rates in freshwater mineral soil wetlands
3. Ellert B.H., and Bettany J.R. (1995). Calculation of organic matter and nutrients stored in soil under contrasting management regimes. *Canadian Journal of Soil Science* 75: 529-538, doi:10.4141/cjss95-075

END

THANK YOU

Trends in OC stock – Polynomial Orthogonal Contrasts
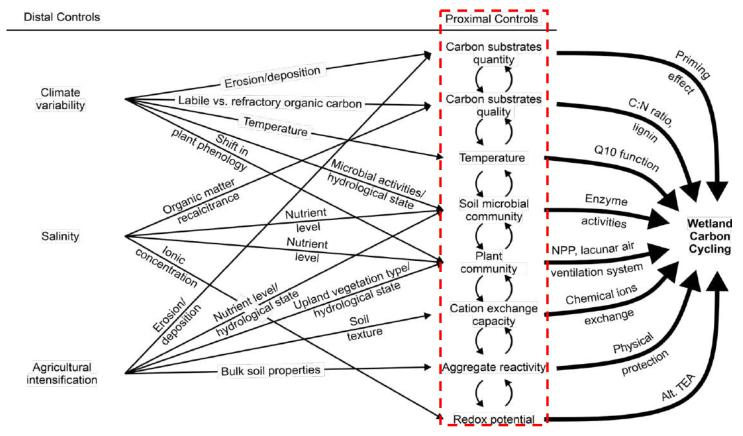
ROOM A: GIS, remote sensing, mapping, and modeling

- Shizhou Ma

Objective 2: Develop authoritative estimates for rates of organic carbon accumulation, greenhouse gas fluxes to the atmosphere, and carbon transports into (and out of) wetlands

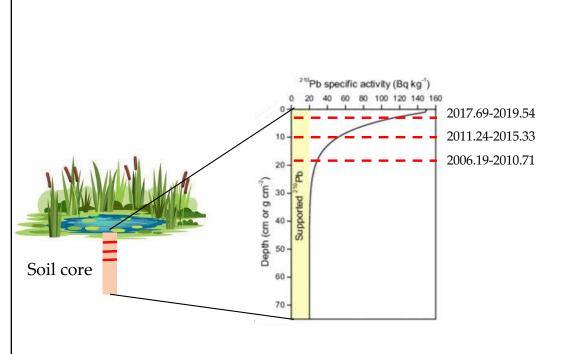Task 2.5: Develop models to predict the potential for wetlands for OC sequestration and GHG reduction

Ma, S., Mistry, P., Badiou, P., Bansal, S., Creed, I.F. Factors regulating the potential for freshwater mineral soil wetlands to function as natural climate solutions. Wetlands. (submitted)
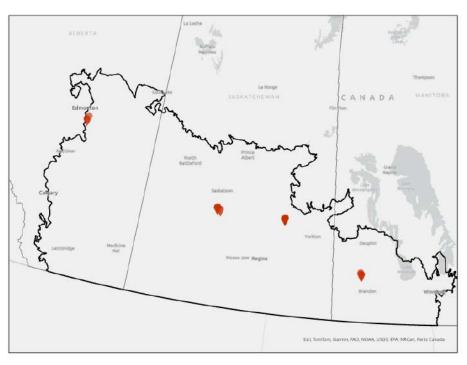
GIS/remote sensing proxies for proximal controls (inspired from the conceptual diagram)
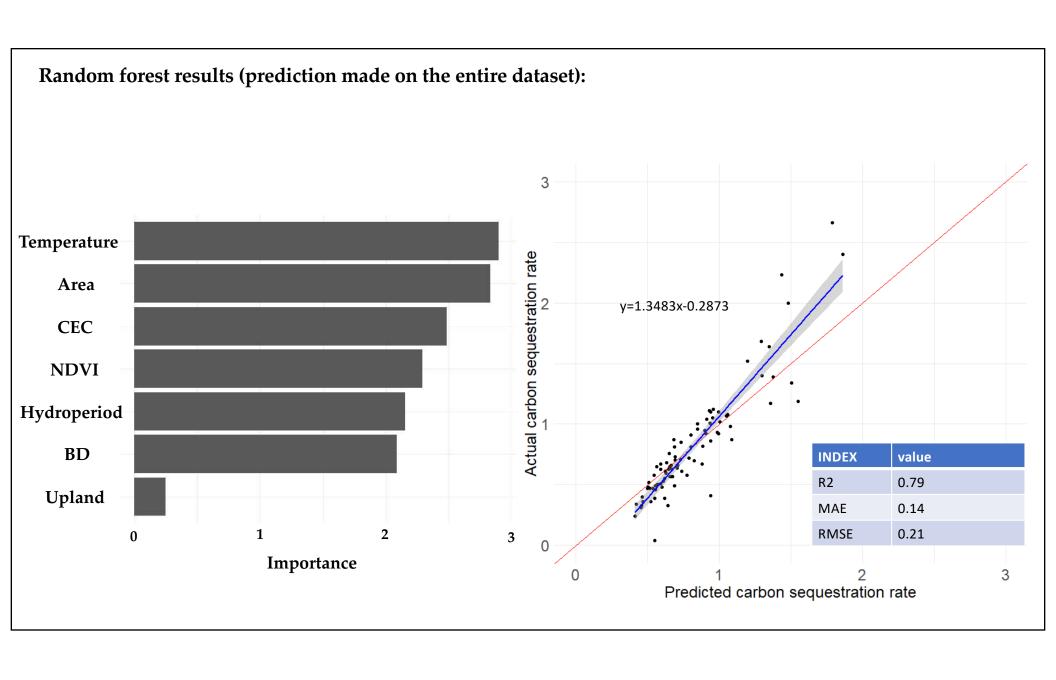
Proximal controls	GIS/remote sensing proxies
Carbon substrate quantity →	Normalized Difference Vegetation Index (NDVI) and Wetland area
Carbon substrate quality →	Normalized Difference Vegetation Index (NDVI)
Temperature →	Temperature - Landsat Thermal Bands
Soil microbial community →	Agricultural intensity – Upland Type (cropland vs grassland)
Plant community →	Normalized Difference Vegetation Index (NDVI)
Cation exchange capacity →	Cation Exchange Capacity (CEC)
Aggregate reactivity →	Bulk Density (BD)
Redox potential →	Hydroperiod

Response variable for the random forest model - wetland carbon sequestration rate:

- 210 Pb Constant Flux (CF) model derived C sequestration rate

- Varying C sequestration rate available for single wetland at different time intervals

- Total 89 observations across Alberta, Saskatchewan and Manitoba

Random forest results (prediction made on the entire dataset):

$y=1.3483x-0.2873$

INDEX	value
R2	0.79
MAE	0.14
RMSE	0.21
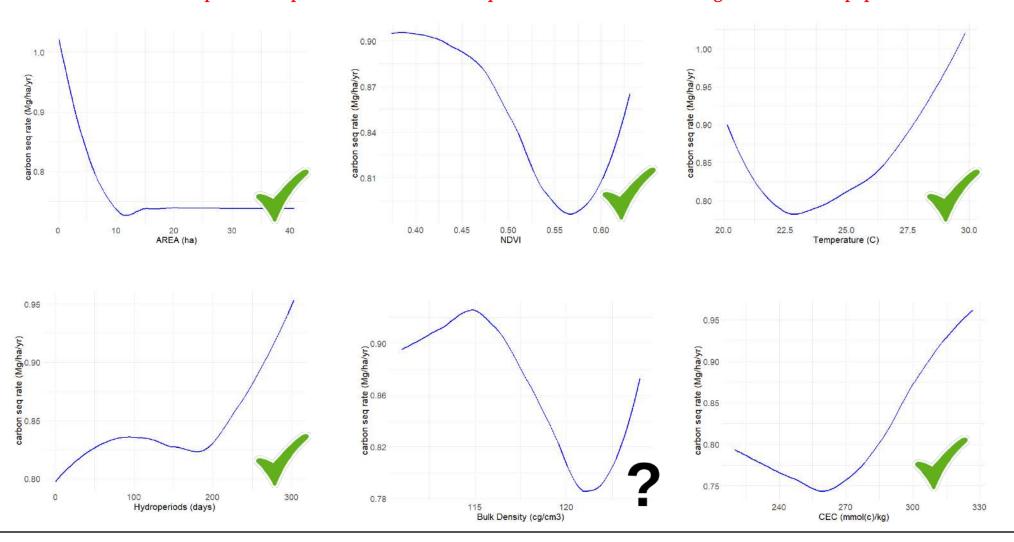
Random forest partial dependence plot for predictors:
- Functional relationship between predictors and carbon sequestration rate match findings in our review paper
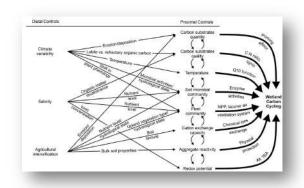
Next steps

- Find better land use data for North America to upgrade "upland" predictors

- Apply the process informed RF model to understand how different environmental factors affect wetland GHG fluxes

- Predict and upscale carbon sequestration rate and GHG fluxes to the entire PPR

Random forest

ROOM A: GIS, remote sensing, mapping, and modeling

- Nayyer Mirnasl
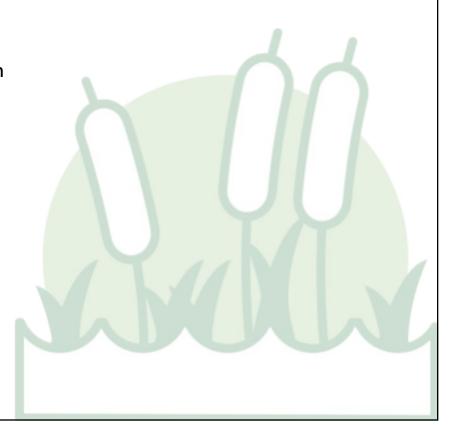
CAAF
Objectives

- Obj2, Task 2.4: Estimate Lateral Flows of Carbon into (and out of) Wetlands

- Obj3, Task 3.1: Develop Mechanistic Models of Carbon Cycling

Objective

Estimating the rates of dissolved organic and inorganic carbon accumulation and transport to and from wetlands
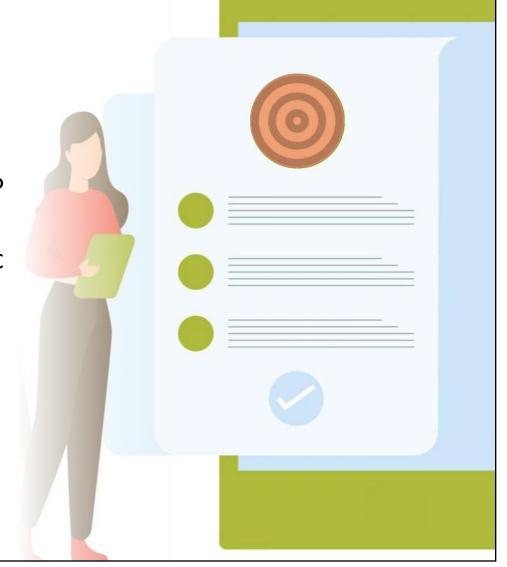
- Document spatial and temporal variations in DOC and DIC concentrations in the stream network

- Identify causes of such variability

- Gain insights into the relationship between wetlands and DOC/DIC export from the basin

58

Study area
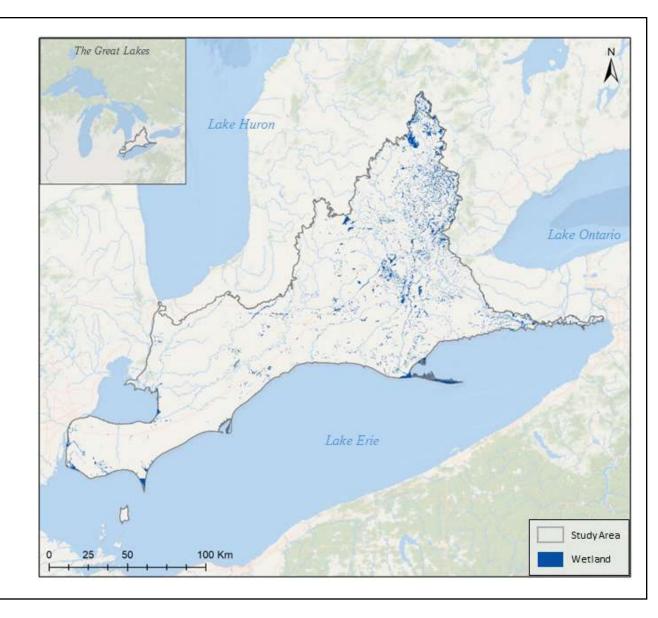
🌾 Canadian side of the Lake Erie Basin

🌾 10.5% increase in downstream DOC export relative to terrestrial inputs

🌾 DIC export shows 0.5% increase relative to terrestrial inputs

(Xenopoulos, 2017)

SPARROW (SPAtially Referenced Regressions On Watershed attributes)

- A parsimonious hybrid empirical/process-based model

- Developed by the United States Geological Survey (USGS)
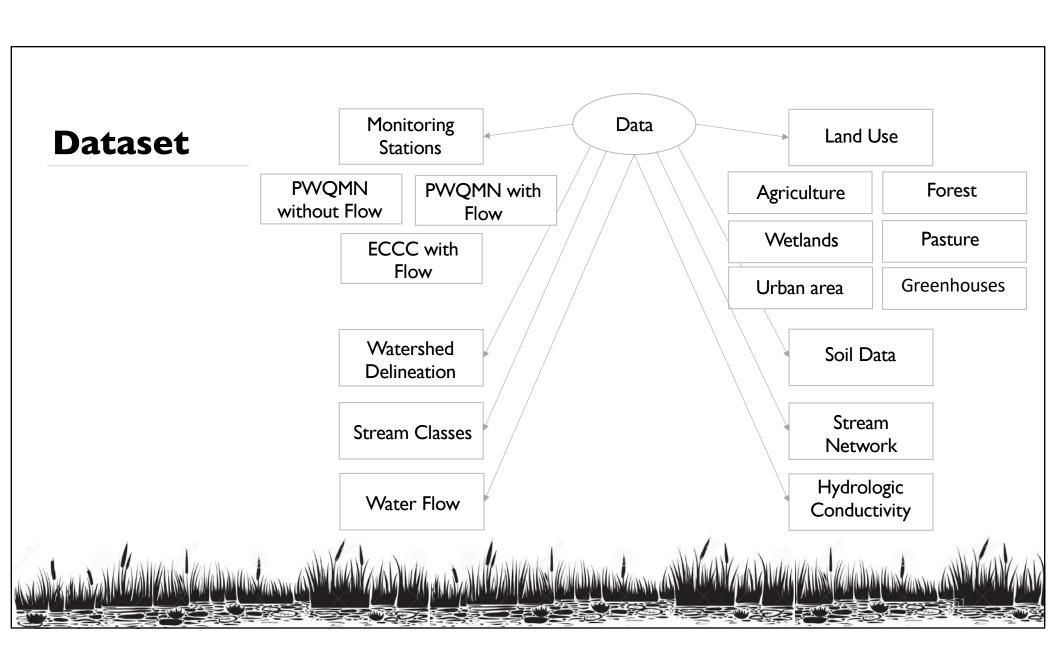
- Suitable for large spatial scales

- Rank contributing catchments based on the loads and yields

(Smith et al., 1997)

Dataset

Next Steps

- Estimating the hydrological connectivity of wetlands and assessing its influence on DIC/DOC fate

- Modeling the carbon cycle in wetlands to comprehend the behavior of various wetland classes

- Determining wetlands as either sinks or sources of carbon

ROOM A: GIS, remote sensing, mapping, and modeling

- Ratnajit Saha

Quantify agricultural impact on GHG emissions at major cash-crop farms in a changing climate in Ontario, Canada

Supervisor: Prof. George B. Arhonditsis

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agriculture.canada.ca

Objective
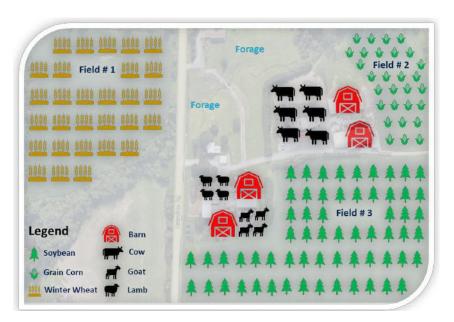
Aims to investigate the impact of farming activities on GHG emissions in a changing climate in Ontario over the past two decades

Methodology-Data sources

- ❖ Crop rotation practices from Statistics Canada and OMAFRA databases
- ❖ Identifying agriculture-intensive counties across Ontario
- ❖ Novel concept of virtual farm is used (for a first time) to quantify GHG emissions

Significance

- ➢ Provincial and national agricultural strategy to achieve "net zero-carbon emission".
- ➢ Develop nature-based solutions to support carbon-smart food production systems and be a part of the national strategy on agri-food sustainability.

An example of a virtual farm
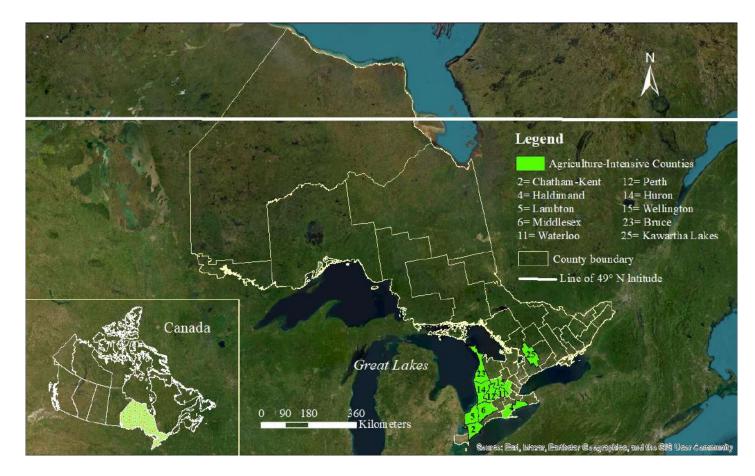
Agriculture-Intensive Counties

Crop intensive

1. Huron
2. Chatham-Kent
3. Middlesex
4. Lambton
5. Perth

Livestock intensive

1. Wellington
2. Perth
3. Waterloo
4. Bruce
5. Kawartha Lake

Holos model

To estimate GHG emissions from farms and test best management practices to reduce emissions
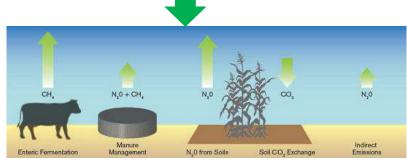
❑ Model based on empirical flux estimates

❑ Primarily based on IPCC Tier 2 (2006) methodology: modified to reflect Canadian conditions

❑ Yearly and seasonal time step

❑ Farm-level scale

❑ Boundaries of the system are the farm gate

Uses of Holos model

➢ Understand, predict and control a food-production system

➢ Identify areas of deficient knowledge

➢ Answer various "what if?" scenarios

➢ Adding value to experiments

https://agriculture.canada.ca/en/agricultural-production/holos-software-program

agriculture.canada.ca
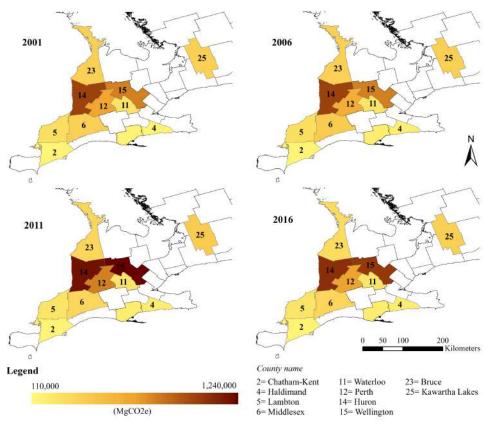
County-wise total GHG emissions

- ❖ GHG fluxes from agricultural virtual farms

- ❖ Years: 2001, 2006, 2011 and 2016
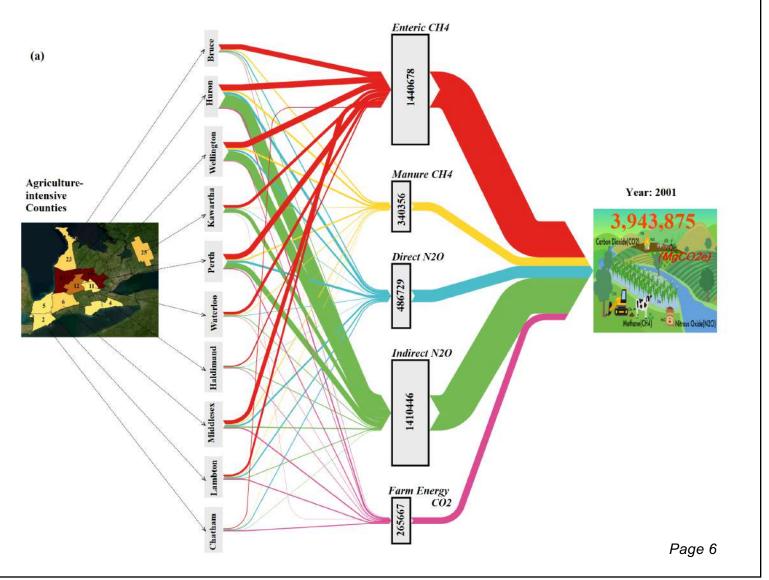
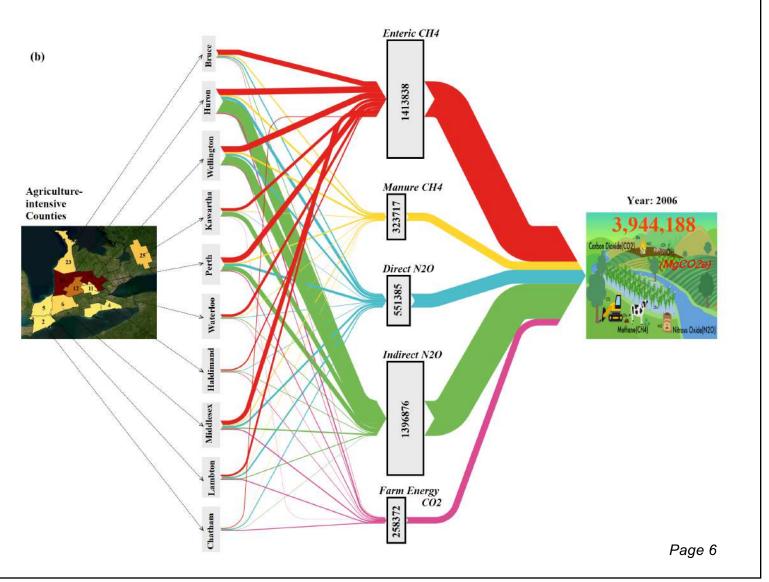- ❖ Total-farm emission: Crops versus livestock

GHG Flux from agricultural farms

Year: 2001

(Indirect N_2O > Enteric CH_4 > Direct N_2O > Manure CH_4 > Farm energy CO_2)

GHG Flux from agricultural farms
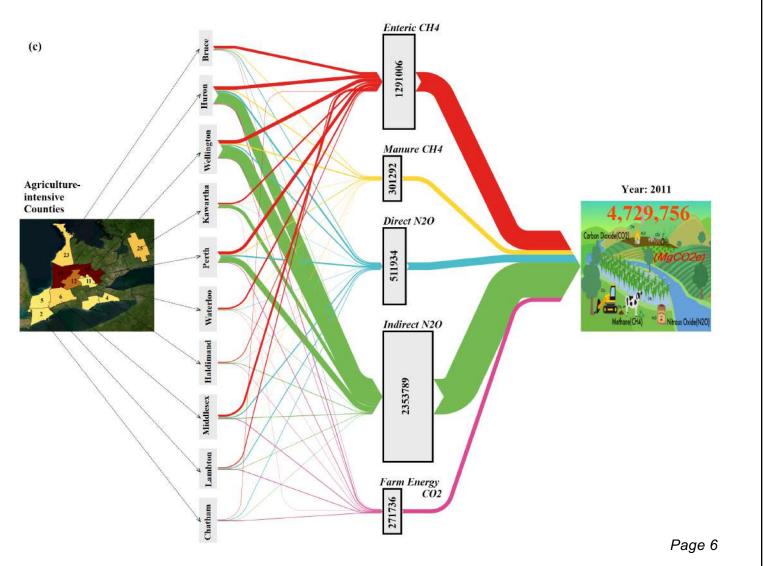
Year: 2006

*(Indirect N$_2$O> Enteric CH$_4$ >
Direct N$_2$O > Manure CH$_4$ >
Farm energy CO$_2$)*

GHG Flux from agricultural farms
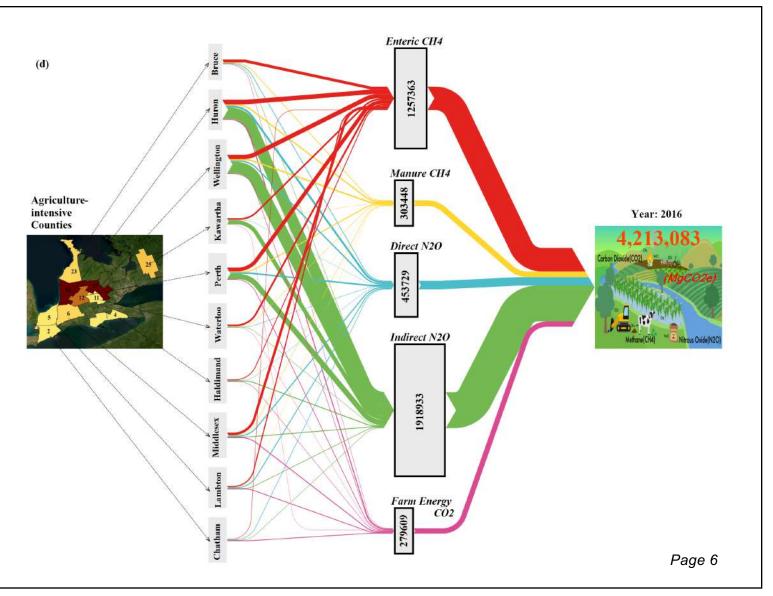
Year: 2011

(Indirect N_2O > Enteric CH_4 > Direct N_2O > Manure CH_4 > Farm energy CO_2)
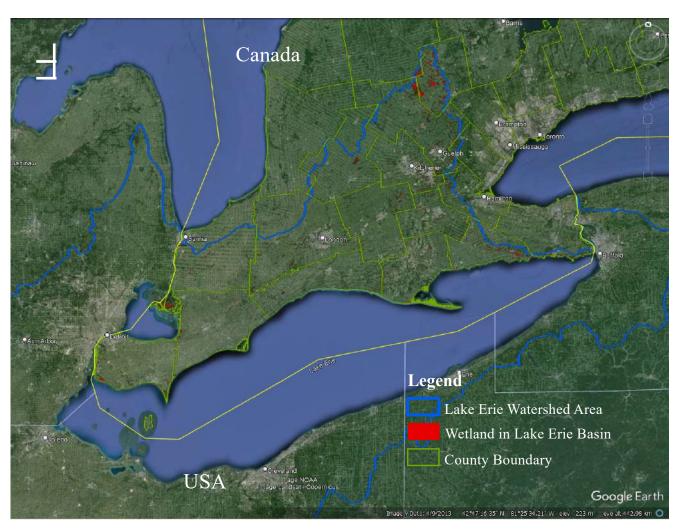
GHG Flux from agricultural farms

Year: 2016

(Indirect N$_2$O> Enteric CH$_4$ > Direct N$_2$O > Manure CH$_4$ > Farm energy CO$_2$)
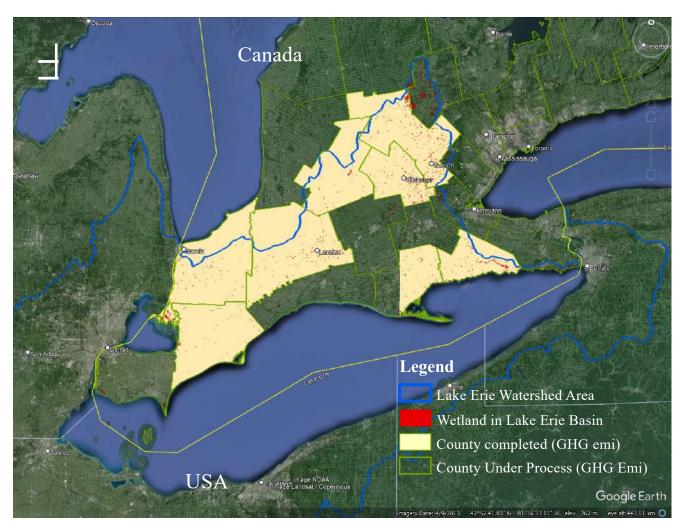
Next Steps

(Lake Erie Basin)

❑ Quantify GHG emissions
in the rest of the counties.

❑ Explore the role of
wetlands for carbon
sequestration.

❑ Validate GHG fluxes
derived from the HOLOS
model.

Next Steps

(Lake Erie watershed area)

❑ Quantify GHG emissions in the rest of the counties.

❑ Explore the role of wetlands for carbon sequestration.
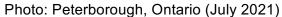
❑ Validate GHG fluxes derived from the HOLOS model.

Thank You

Get in touch!

Email:
ratnajit.saha@mail.utoronto.ca

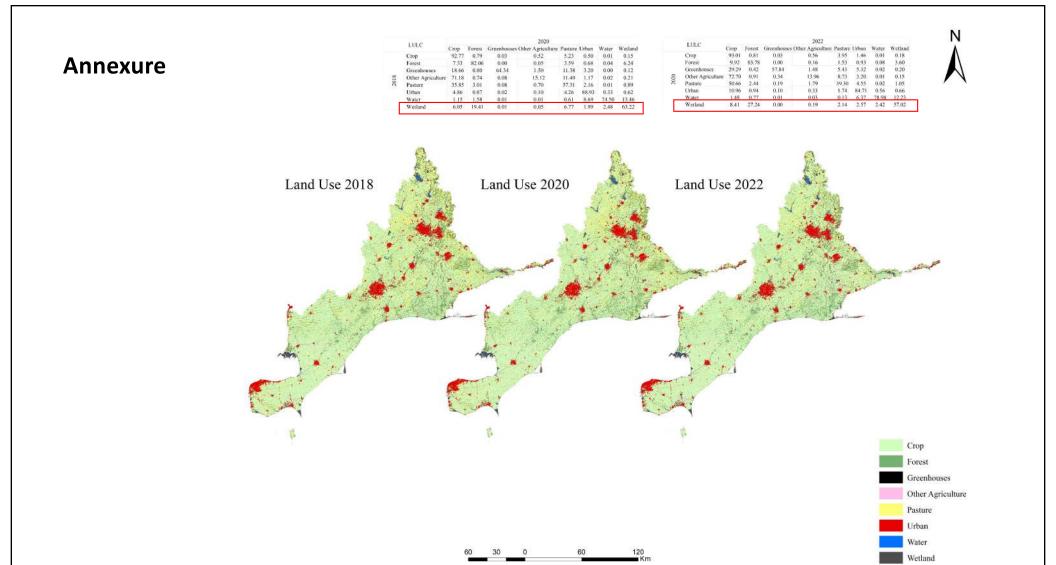Photo: Peterborough, Ontario (July 2021)

Linked-in: www.linkedin.com/in/ratnajit-saha-069922a0

Google Scholar:
https://scholar.google.ca/citations?hl=en&tzom=300&user=kQEPsAEAAAAJ&view_op=list_works&sortby=pubdate

Annexure

2020

LULC		Crop	Forest	Greenhouses	Other Agriculture	Pasture	Urban	Water	Wetland
2018	Crop	92.77	0.79	0.03	0.52	5.23	0.50	0.01	0.15
	Forest	7.33	82.06	0.00	0.05	3.59	0.68	0.04	6.24
	Greenhouses	18.66	0.80	64.34	1.50	11.38	3.20	0.00	0.12
	Other Agriculture	71.18	0.74	0.08	15.12	11.49	1.17	0.02	0.21
	Pasture	35.85	3.01	0.08	0.70	57.31	2.16	0.01	0.89
	Urban	4.86	0.87	0.02	0.10	4.26	88.93	0.33	0.62
	Water	1.15	1.58	0.01	0.01	0.61	8.69	74.50	13.46
	Wetland	6.05	19.41	0.01	0.05	6.77	1.99	2.48	63.22

2022

LULC		Crop	Forest	Greenhouses	Other Agriculture	Pasture	Urban	Water	Wetland
2020	Crop	93.01	0.81	0.03	0.56	3.95	1.46	0.01	0.18
	Forest	9.92	83.78	0.00	0.16	1.53	0.93	0.08	3.60
	Greenhouses	29.29	0.42	57.84	1.48	5.43	5.32	0.02	0.20
	Other Agriculture	72.70	0.91	0.34	13.96	8.73	3.20	0.01	0.15
	Pasture	50.66	2.44	0.19	1.79	39.30	4.55	0.02	1.05
	Urban	10.96	0.94	0.10	0.33	1.74	84.71	0.56	0.66
	Water	1.48	0.77	0.01	0.03	0.13	6.37	78.98	12.23
	Wetland	8.41	27.24	0.00	0.19	2.14	2.57	2.42	57.02

Land Use 2018   Land Use 2020   Land Use 2022

N

Legend:
- Crop
- Forest
- Greenhouses
- Other Agriculture
- Pasture
- Urban
- Water
- Wetland

60 30 0 60 120
Km

ROOM A: GIS, remote sensing, mapping, and modeling

- Ben DeVries

Quantifying and Characterizing wetland change in the Great Lakes St. Lawrence Basin

Ben DeVries, Maciej Lizak, Alejandro Nieto Rodriguez, Kathleen Reid

Department of Geography, Environment and Geomatics

University of Guelph

ECCC-NbS Annual General Meeting

May 1, 2024, Toronto, ON

UNIVERSITY of GUELPH

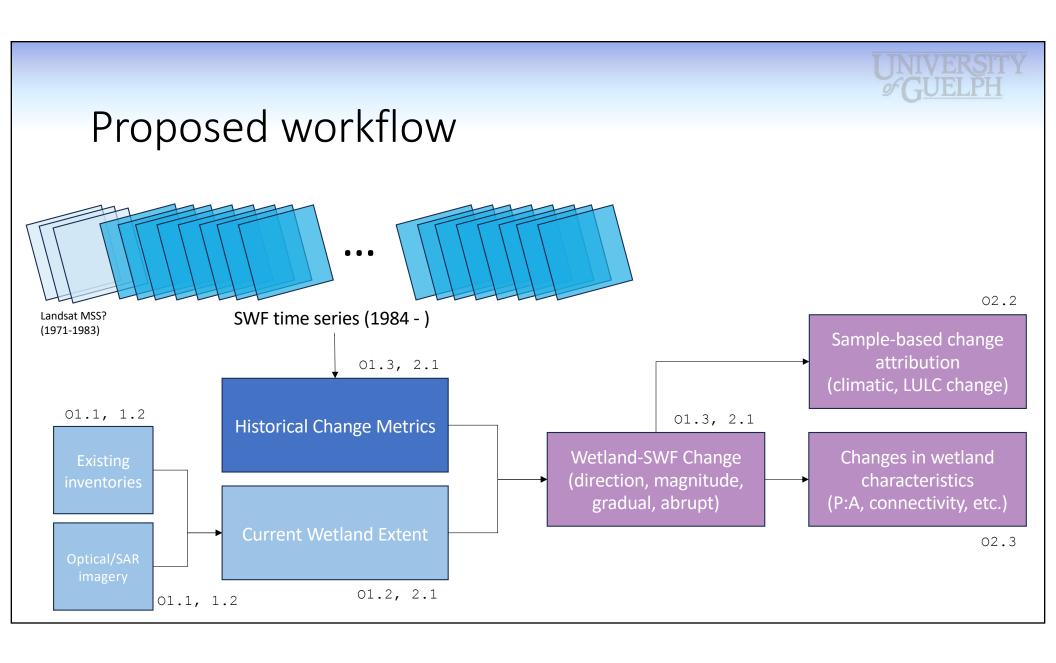# Project Objectives

1	Evaluate satellite-based methods of mapping wetlands and estimating historical rates (1970 to present) of land use change and conversion of wetlands in the Great Lakes-St. Lawrence River Basin.	Lead: University of Toronto, in collaboration with UGuelph & McGill U	1. Compile ground-based wetland inventories from governmental or non-governmental sources (e.g., DUC SOLRIS inventory) and reported estimates of uncertainty for these wetland inventories (i.e., minimum mapping size, spatial accuracy, omission/commission errors associated with wetland coverage methodology, unaccounted wetlands (i.e., those too small to be captured)) are identified. 2. Compare ground-based with satellite-based wetland inventories to determine the best available wetland mapping methods and to produce a report (see adjacent column) providing the limitations and uncertainties associated with both methods. 3. Estimate wetland and landcover change from 1970 to present.
2	Create an inventory of wetlands and identify historical rates (1970 to present) of land use change and conversion of wetlands in the Great Lakes-St. Lawrence River Basin.	Lead: University of Toronto, in collaboration with UGuelph & McGill U	1. Wetlands are mapped using methods tested in Strategy 1. Estimates are provided of historical rates of conversion of wetlands in the Great Lakes-St. Lawrence River Basin. Wetland loss (or gain) is mapped by applying a number of statistical analyses, including non-parametric Theil-Sen/Mann-Kendall trend tests, to each pixel in the SWF image stack. These maps and rates will provide inputs into the next objectives (strategies). 2. Where wetlands are lost, its follow-on land use and land cover will be classified using pixels drawn from a stratified random sample of change types (including strata of no significant change) using very high-resolution reference imagery. By performing this analysis on a stratified random sample, unbiased areal estimate of follow-on land uses will be produced, which will inform further analysis of socio-economic drivers of wetland change. 3. Estimate changes from 1970 to present in wetland number, size, permanence, perimeter:area ratio, and perimeter width and distinctness (factors known to influence carbon cycling) are provided at several assessment unit levels in the Great Lakes-St. Lawrence River Basin, including the Soil Landscapes of Canada (SLC) soil polygon database, which is currently being used to support the national greenhouse gas (GHG) inventory. Uncertainties associated with land cover change/wetland conversion rate are estimated.

Proposed workflow

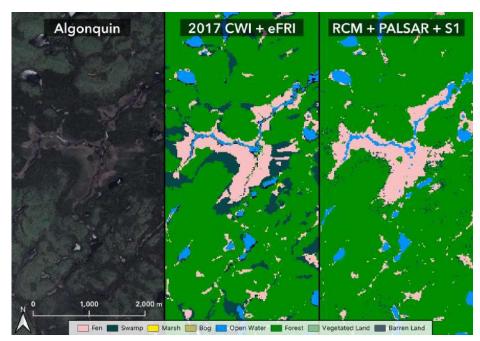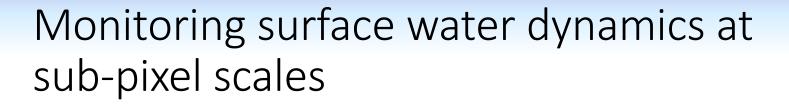# Wetlands mapping and inventories

Figure: Maciej Lizak

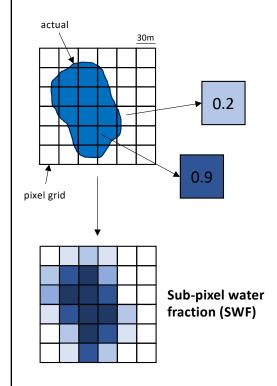Identify and evaluate existing datasets:
- DUC inventories
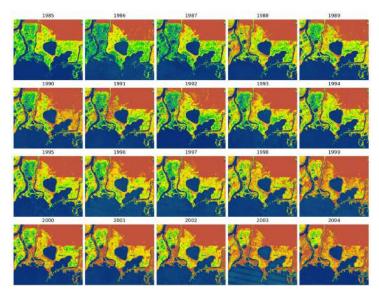- ECCC-CWI
- Other LULC products

Derive high-confidence cal-val data for wetland (type) classification

Develop automated classification models using combinations of optical and (multi-frequency) SAR data:
- Landsat + Sentinel-2
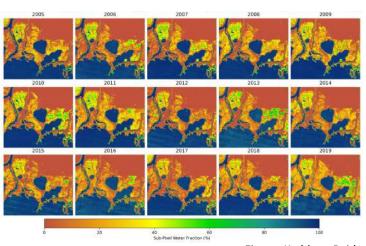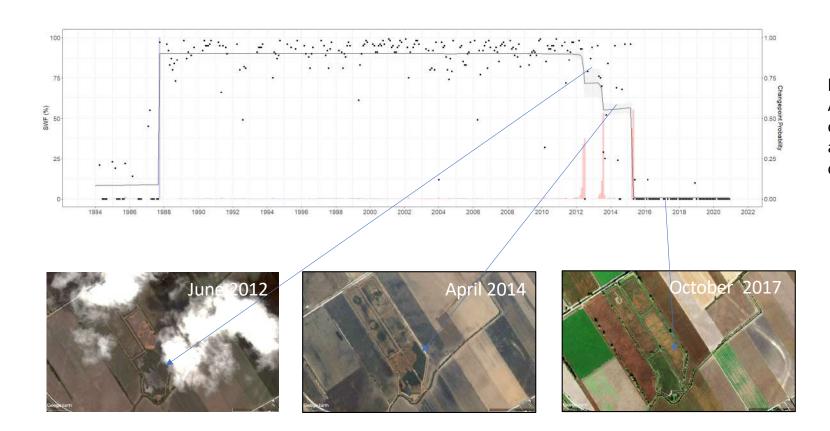- Sentinel-1 + ALOS-PALSAR (+ RCM + NISAR)
- Terrain indices

Monitoring surface water dynamics at sub-pixel scales

actual

30m

0.2

0.9

pixel grid

Sub-pixel water fraction (SWF)

Figure: Kathleen Reid

DeVries et al. (2017)

Genevieve Ali, Ben DeVries, Wanhong Yang (OMAFRA)

Time Series decomposition

Hypothesis:
Abrupt, semi-permanent changes in wetland SWF are likely due to LULC changes

ROOM A: GIS, remote sensing, mapping, and modeling

- Genevieve Ali

Refining the definition and classification of mineral wetlands

Genevieve Ali
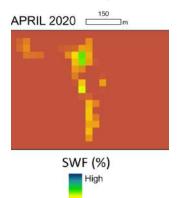
Department of Earth & Planetary Sciences | Department of Geography
McGill University

CAAF project focused on the Great Lakes-St. Lawrence River Basin
Research objectives related to our work

Objective	Activities / Tasks
Objective 1. Evaluate satellite-based methods of mapping wetlands and estimating historical rates (1970 to present) of land use change and conversion of wetlands in the Great Lakes-St. Lawrence River Basin.	**Task 1.1.** Compile ground-based wetland inventories from governmental or non-governmental sources (e.g., DUC SOLRIS inventory) and reported estimates of uncertainty for these wetland inventories (i.e., minimum mapping size, spatial accuracy, omission/commission errors associated with wetland coverage methodology, unaccounted wetlands (i.e., those too small to be captured)
	Task 1.2. Compare ground-based with satellite-based wetland inventories to determine the best available wetland mapping methods
	Task 1.3. Estimate wetland and landcover change from 1970 to present.
Objective 2. Create an inventory of wetlands and identify historical rates (1970 to present) of land use change and conversion of wetlands in the Great Lakes-St. Lawrence River Basin	**Task 2.1.** Provide estimates are provided of historical rates of conversion of wetlands in the Great Lakes-St. Lawrence River Basin; quantify wetland loss (or gain) by applying a number of statistical analyses, including non-parametric Theil-Sen/Mann-Kendall trend tests, to each pixel in the SWF image stack
	Task 2.2. Where wetlands are lost, identify follow-on land use and land cover using pixels drawn from a stratified random sample of change types (including strata of no significant change) using very high-resolution reference imagery.
	Task 2.3. Estimate changes from 1970 to present in wetland number, size, permanence, perimeter:area ratio, and perimeter width and distinctness (factors known to influence carbon cycling) at several assessment unit levels in the Great Lakes-St. Lawrence River Basin, including the Soil Landscapes of Canada (SLC) soil polygon database, which is currently being used to support the national greenhouse gas (GHG) inventory.

Satellite-based wetland inventories & best mapping methods
Considering additional ancillary data in support of SWF data

**U. Of Guelph team
(Devries *et al.*)**

Google Earth
(April 2020)

Our planned contribution
- Consider hydric/drainage status of underlying soil
  - Goal(s):
    - ✓ Assess the likelihood of wetland presence based on location-specific soil characteristics

- Match SWF map dates with gridded daily climate data (precipitation, antecedent precipitation, potential evapotranspiration, surface soil moisture)
  - Goal(s):
    - ✓ Differentiate wetlands from swales and non-wetland inundated areas
    - ✓ Differentiate surface-water-dominated from groundwater-dominated wetlands

Data sources
- Stack of Landsat images
- Ancillary data (Digital Elevation Model, Land use and Land cover map)

Changes from 1970 to present in wetland characteristics
Adding to the list of wetland characteristics

"Traditional" wetland characteristics used to monitor historical change: wetland number, size, permanence, perimeter:area ratio

Potential, additional wetland characteristics:
- Wetland permanence standardized by climate characteristics
  - o Goal(s): differentiating permanent (or quasi-permanent) open water in dry versus wet years
- Wetland-to-wetland and wetland-to-stream connectivity
  - o Goal(s): quantifying historical changes in the frequency with which surface water flow paths may have facilitate connectivity between a wetland and nearby water bodies
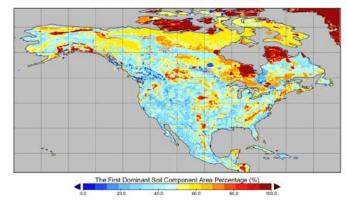
Work done to date

January 2024 to now (Postdoc Sarah Ariano, Genevieve Ali)

Unified North American Soil Map (Liu et al., 2013)

Variables: topsoil and subsoil data from STATSGO/SSURGO and SLC

The First Dominant Soil Component Area Percentage
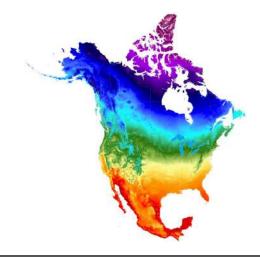
Computations underway for soil hydraulic parameters using pedotransfer functions (Saxton & Rawls, 2006)
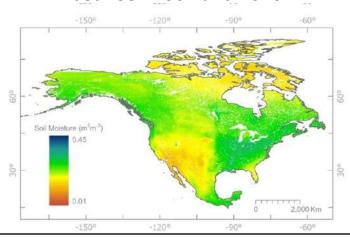
Gridded climate dataset Daymet Daily climate data, 1-km resolution, since 1980

Variables: day length, precipitation, shortwave radiation, SWE, max and max air temperature, water vapor pressure

North America Soil Moisture Dataset Derived from Time-Specific Adaptable Machine Learning Models

Variable: near-surface soil moisture (0-5 cm), 250-m resolution de 250 m, biweekly between 2002 and 2020

ROOM A: GIS, remote sensing, mapping, and modeling

- David Lobb

Lateral Transfers of soil and sediment into wetlands
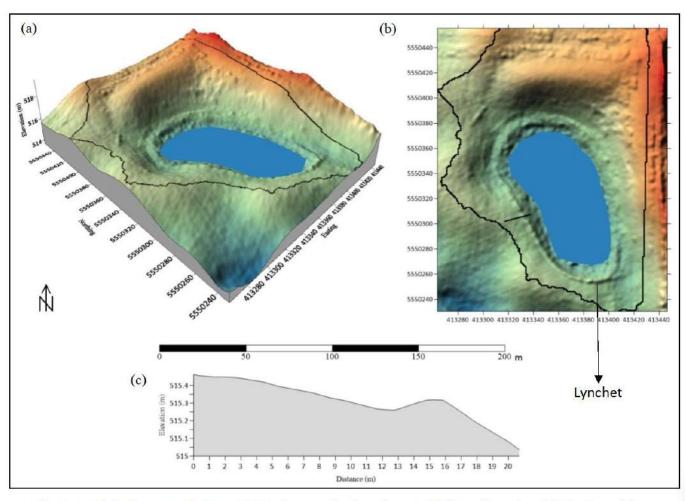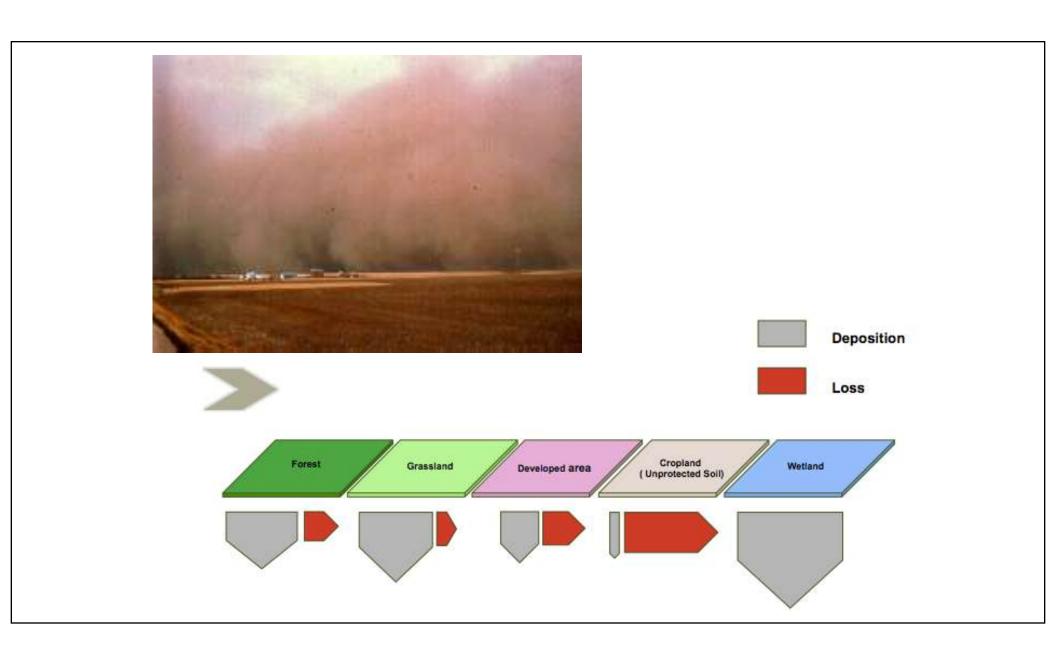
Fig. 3. 9. Original unsmoothed 1-m DEM of one wetland catchment: (a) three-dimensional (3D) view of the catchment, (b) colour relief view of the catchment and (c) geometrical characteristics of the sedimentary features for the shown transect in the colour relief view.

Deposition

Loss

| Forest | Grassland | Developed area | Cropland (Unprotected Soil) | Wetland |

ROOM B: Flux Towers, measurements, and carbon cycling

- Pascal Badiou
- Larry Flanagan (Matthew Bogard)
- Matthew Bogard
- Sara Knox
- Christian Von Sperber
- Gail Chmura

ROOM B: Flux Towers, measurements, and carbon cycling

- Pascal Badiou

OBJECTIVE 2

Develop authoritative estimates for rates of *organic carbon* accumulation, *greenhouse gas fluxes* to the atmosphere, and *carbon transports* to (and out of) wetlands to downstream water

Monitoring GHG emission from freshwater mineral wetland in agricultural landscapes
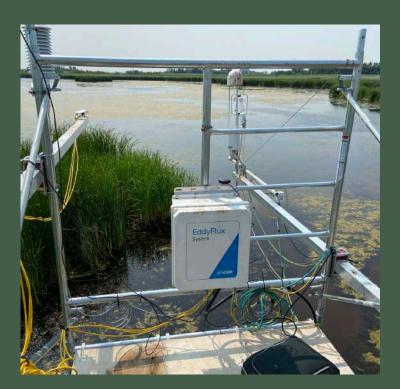
Prior to CAAF – 48 sites monitored across PPR (black soil zone / Parklands region) including first two freshwater mineral wetland Eddy Covariance flux tower sites in the PPR

Through the CAAF we have expanded monitoring to more than 100 wetland sites including:
- Brown and Dark Brown soil zone in the PPR (both in AB and SK), expanding to additional sites in southern AB (2024)
- Small restored wetlands in southern Ontario (n = 16)
- DUC project wetlands in the BC interior (n = 16)
- Deployed 3rd flux tower at Oak Hammock Marsh
- Collected cores from 2 MB flux tower sites
- Continuing cattail chamber measurements in 2024
- Adding ebullition measurements at flux tower sites in 2024

Ducks Unlimited Canada

MB Wetland Flux Tower Sites
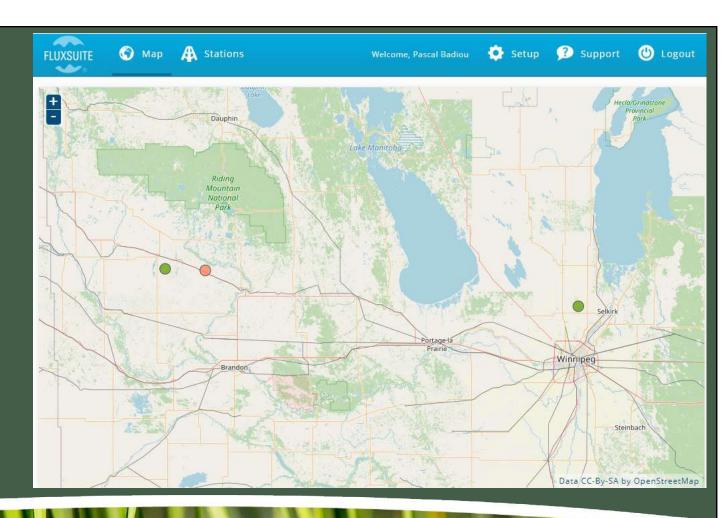
Manitoba Wetland Flux Tower Sites
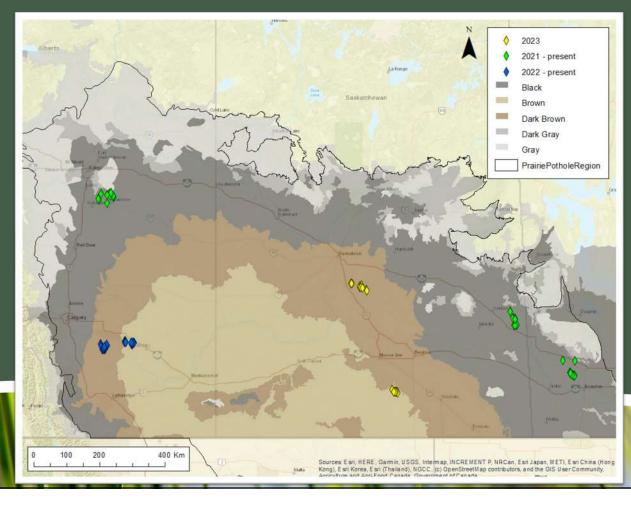
Cattail Chambers & Floating Chambers

Extensive dissolved gas sampling - Prairies

- Surface water dissolved gas
- Ambient air
- In situ water quality
  (pH, SpCond, temp, DO%)
- Surface water area
- Wind speed and atmospheric
  pressure
- Water chemistry
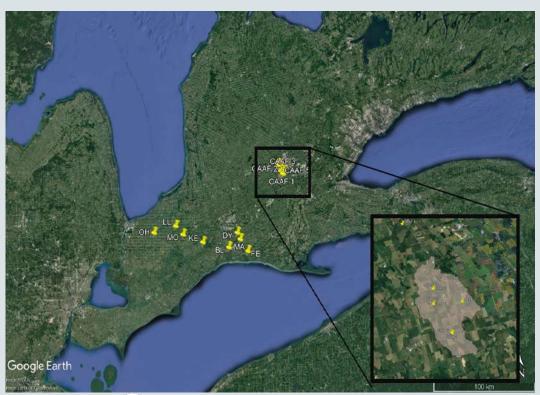 (sulfate, alkalinity, nutrients)

Ducks Unlimited
Canada

Biodiversity Monitoring - Prairies

• We collected data with ARUs at all black soil zone wetland sites (n = 48) in 2022 and a subsample of sites (n = 16) in brown and dark brown soil zones of AB/SK in 2023.

• We can estimate biodiversity indices (species richness/alpha diversity, evenness, similar) of birds and amphibians at each site to compare to other ecosystem service metrics.

• Expanding to additional sites spanning a gradient of production where ARUs are deployed and invertebrate sampling and eDNA monitoring is occurring

Ducks Unlimited
Canada

CAAF – Southwestern Ontario (I)

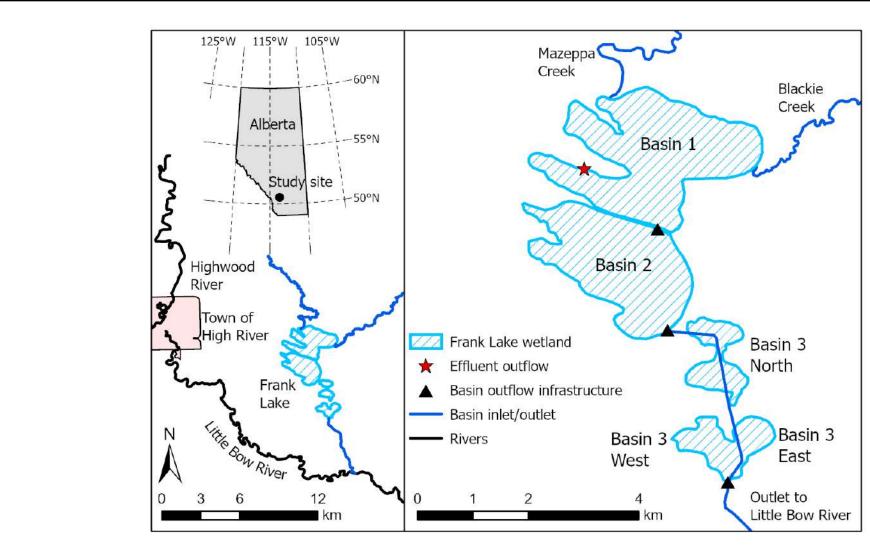| Ontario Small Wetland - Water Quality Study (ha)	Nature Force - Water Quantity Study (ha)
n = 8	n = 8
0.34 ± 0.06	0.19 ± 0.04
0.27 ± 0.04	

ON 16
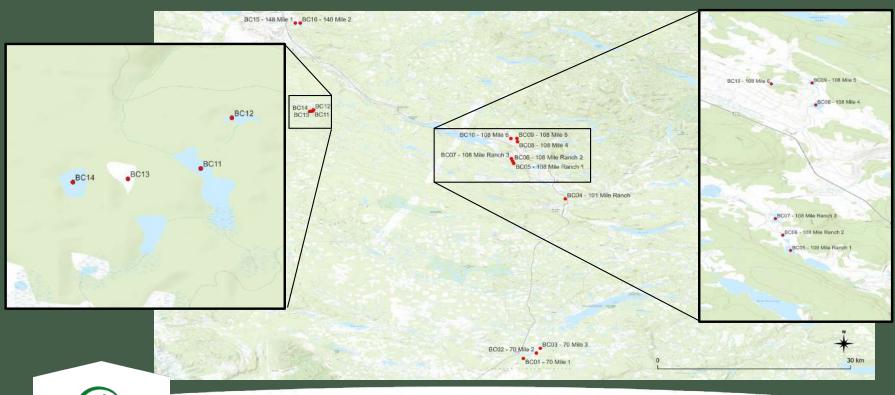
CAAF – British Columbia

ROOM B: Flux Towers, measurements, and carbon cycling
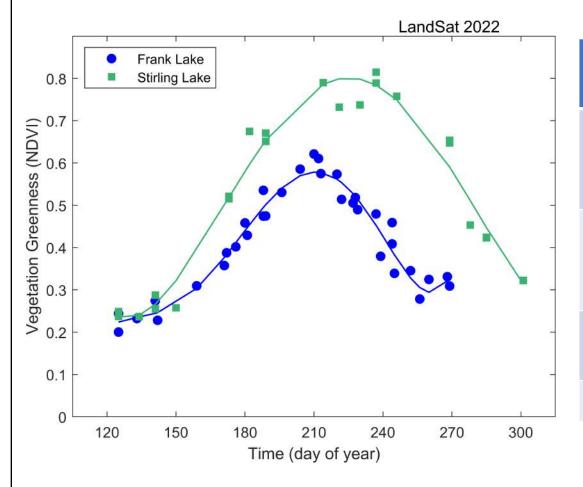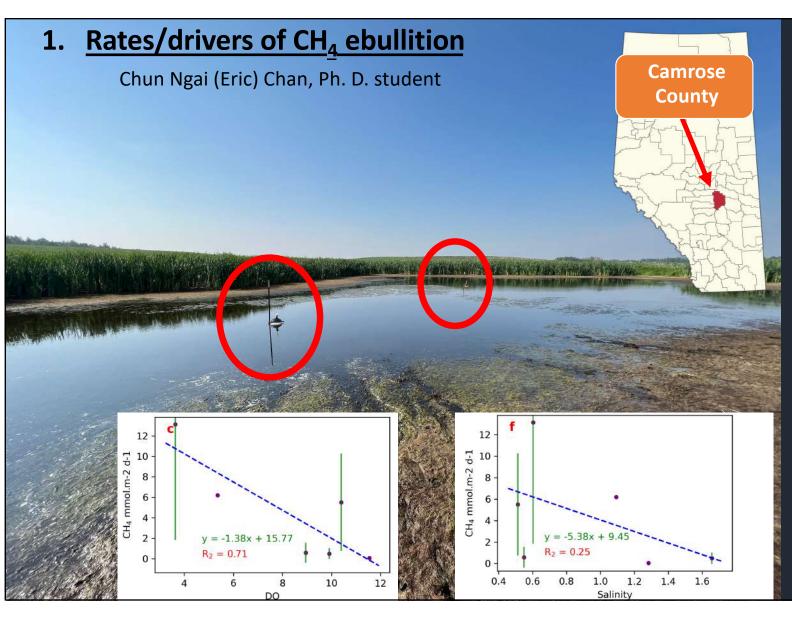
- Larry Flanagan (Matthew Bogard)

University of Lethbridge - Flanagan Lab - Project Goals:

Establish an eddy flux tower in a new prairie pothole wetland ecosystem – Stirling Lake (near Lethbridge)

Conduct comparative ecosystem analyses of CO_2 and CH_4 fluxes within the ECCC project and other projects in Alberta - Frank Lake

Flanagan et al. (2022) Wetlands

Eddy Covariance and Chamber Flux Measurements

Frank Lake

Apply Remote Sensing Measurements for Scaling and Historical Perspectives of Fluxes

	Stirling Lake	Frank Lake
Dominant Emergent Macrophyte	Cattail	Bulrush
Aboveground Biomass $(g\ m^{-2})$	1560 ± 517	352 ± 55
Leaf Area Index $(m^2\ m^{-2})$	5.3 ± 1.6	2.2 ± 0.9

ROOM B: Flux Towers, measurements, and carbon cycling

- Matthew Bogard

Bogard Lab Updates

ECCC-CAAF Project Meeting 2024-01-01

Summarizing work led by:

Chun Ngai Chan, Sam Woodman, Laura Logozzo
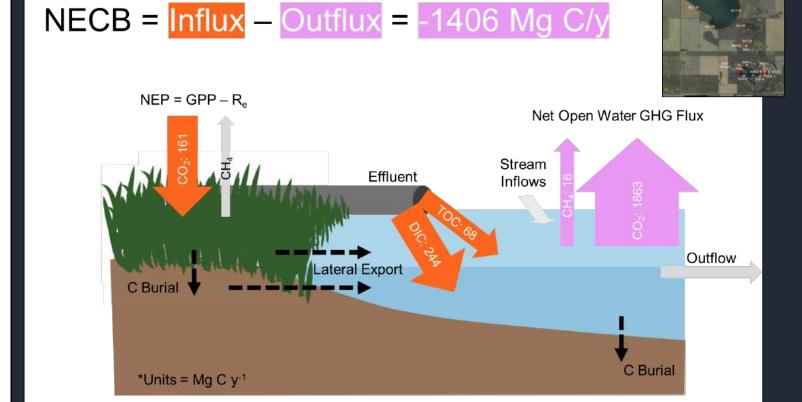
3. In kind project: NECB at Frank Lake, AB: Laura Logozzo, PDF

$$NECB = \text{Influx} - \text{Outflux} = -1406 \text{ Mg C/y}$$

NEP = GPP – R_e

CO_2: 161 CH_4

Effluent

Net Open Water GHG Flux

Stream Inflows

CH_4: 16 CO_2: 1863

TOC: 68

DIC: 244

Lateral Export

Outflow

C Burial

C Burial

*Units = Mg C y^{-1}

- Scaling C fluxes to entire wetland complex using aquatic emissions/lat. Flux data + biomass sampling + EC + remote sensing

Sustained aquatic emissions dominate NECB due to effluent processing… A tradeoff in services!

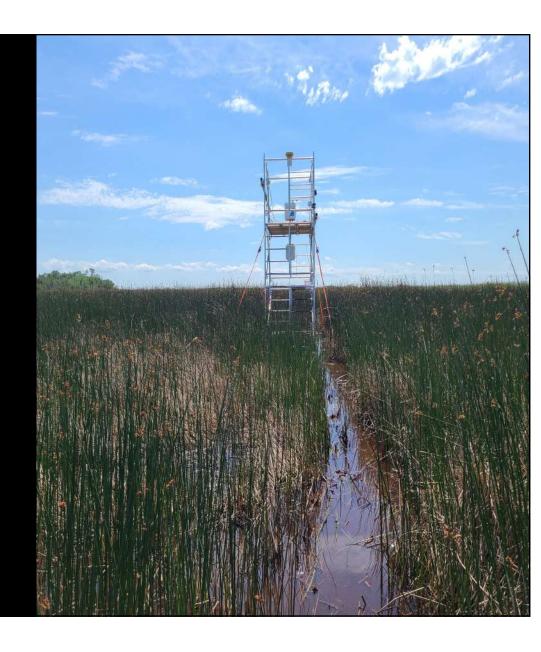# ROOM B: Flux Towers, measurements, and carbon cycling

- Sara Knox

PROJECT UPDATE

2024 AGM

Sara Knox*, Pascal Badiou, Lauren Bortolotti, Nick Lee, Darian Ng, Joyson Ahongshangbam, Zoran Nesic

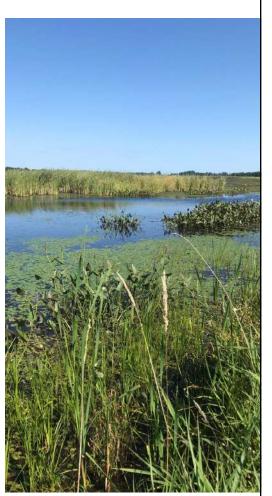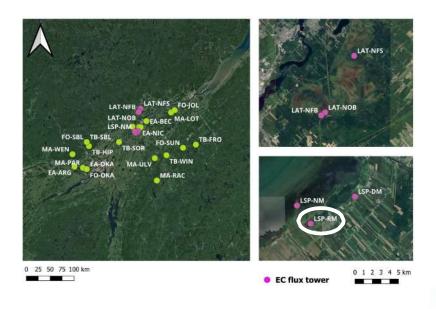*Assistant Professor, Department of Geography, McGill University

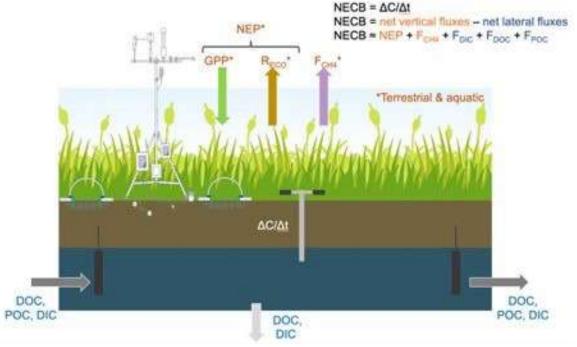NEW WETLAND SITE IN QUEBEC
(FALL 2024 OR SPRING 2025)

NEW SITE COMING SOON & POTENTIAL SYNERGIES

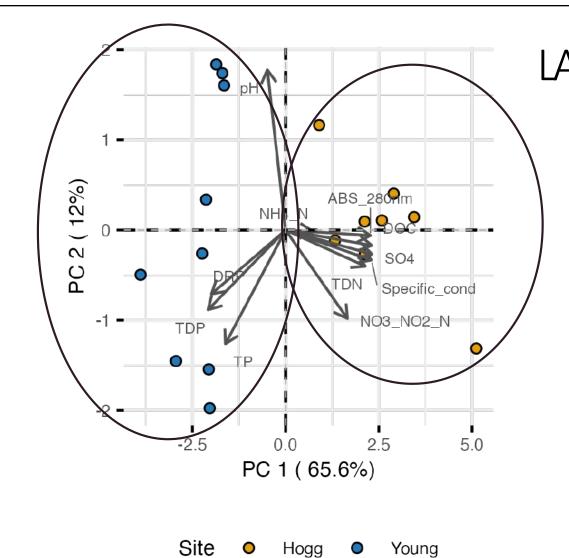# COLLABORATIONS WITH DUC

Hogg

Young

- Isolated grassland marsh

- Dominated by emergent vegetation (Tule)
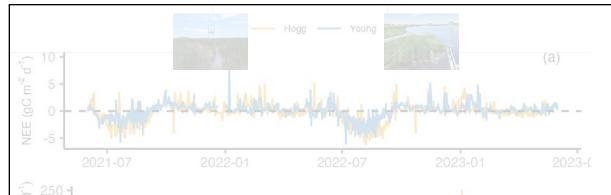
- Characterized by high sulfate concentrations

- Isolated cropland marsh

- Mix of open water & vegetation (Typha)

- Characterized by lower sulfate concentrations

LARGE DIFFERENCES IN WATER QUALITY

- **Hogg** – higher sulfate, conductivity, DOC, TDN, and ABS 280

- **Young** – higher P & pH

6

DIFFERENCES IN GHG FLUXES
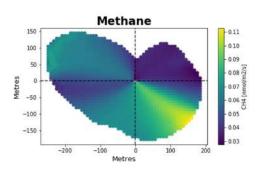
Site	Year	NEE (gC m^{-2} yr^{-1})	FCH4 (gC m^{-2} yr^{-1})	GHG (gCO$_2$eq m^{-2} yr^{-1})
Hogg	2021	-34	1.8	-7
	2022	-139	2.5	-349
Young	2021	47	7.9	674
	2022	-6	4.7	276

7

FCH4 SPATIAL HETEROGENEITY WITHIN AND BEYOND A FLUX TOWER FOOTPRINT

Pairing Flux Maps with Landsat 8

Flux Maps

Landsat 8

Darian Ng

Greenery: 26.4%   Open Water: 70.9%
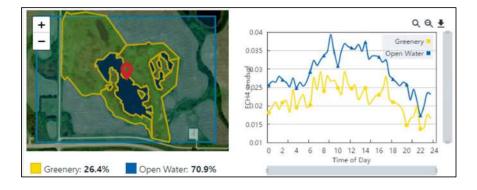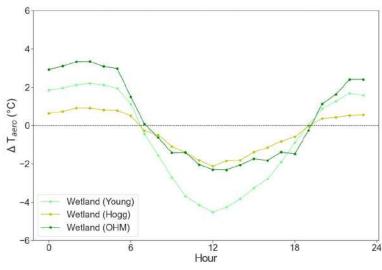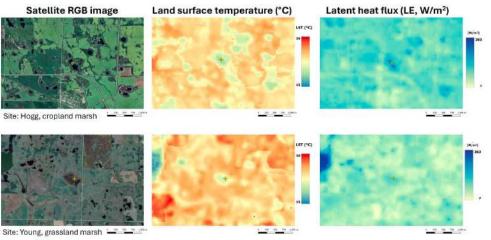
COOLING POTENTIAL OF WETLANDS

Difference in Diurnal T$_{aero}$

- ΔT_{aero} vary with wetland type
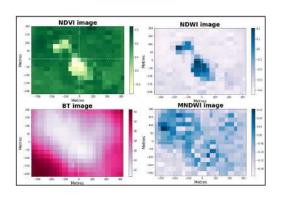- Cooler T_{aero} during daytime and warmer in wetlands
- Cooling upto 4.5 °C (at noon) and warming upto 2.2 °C at Young site

Legend:
- Wetland (Young)
- Wetland (Hogg)
- Wetland (OHM)

Spatial Pattern of LST

Satellite RGB image | Land surface temperature (°C) | Latent heat flux (LE, W/m²)

Site: Hogg, cropland marsh

Site: Young, grassland marsh

Joyson Ahongshangbam

PLANS FOR UPCOMING YEAR

- Install new flux tower in QC

- Continue collaboration with DUC

- Publication of papers on the biogeochemical and biophysical benefits of wetlands

POINTS FOR DISCUSSION

- Guidance on lateral flux sampling & water quality data

- Potential collaboration with the QC project

- Integration of data across sites

- Protocols?
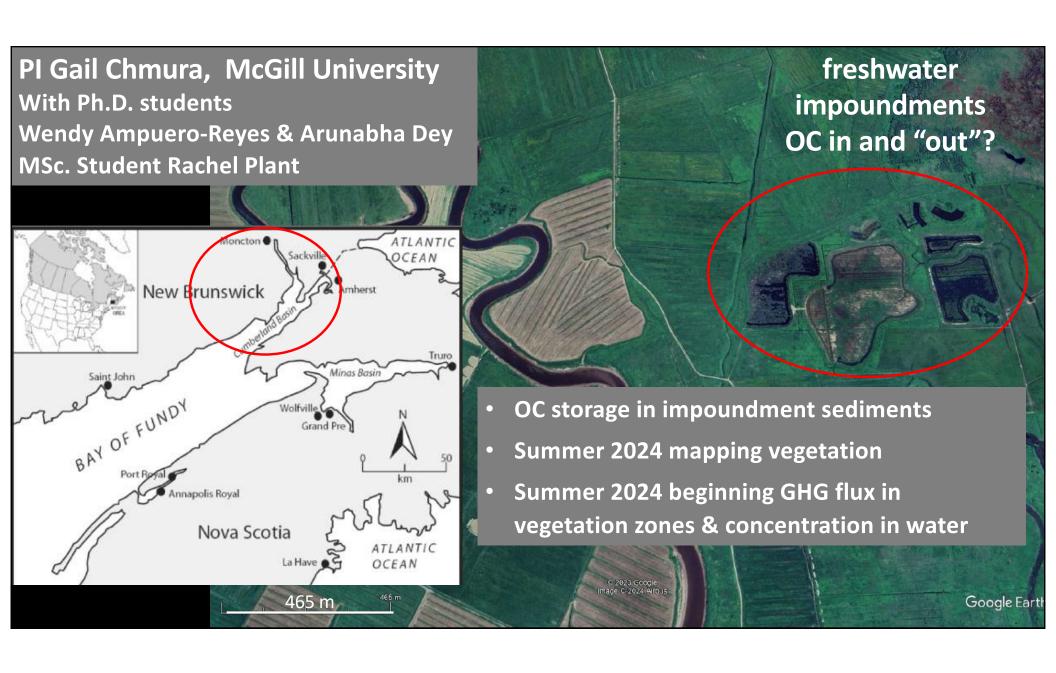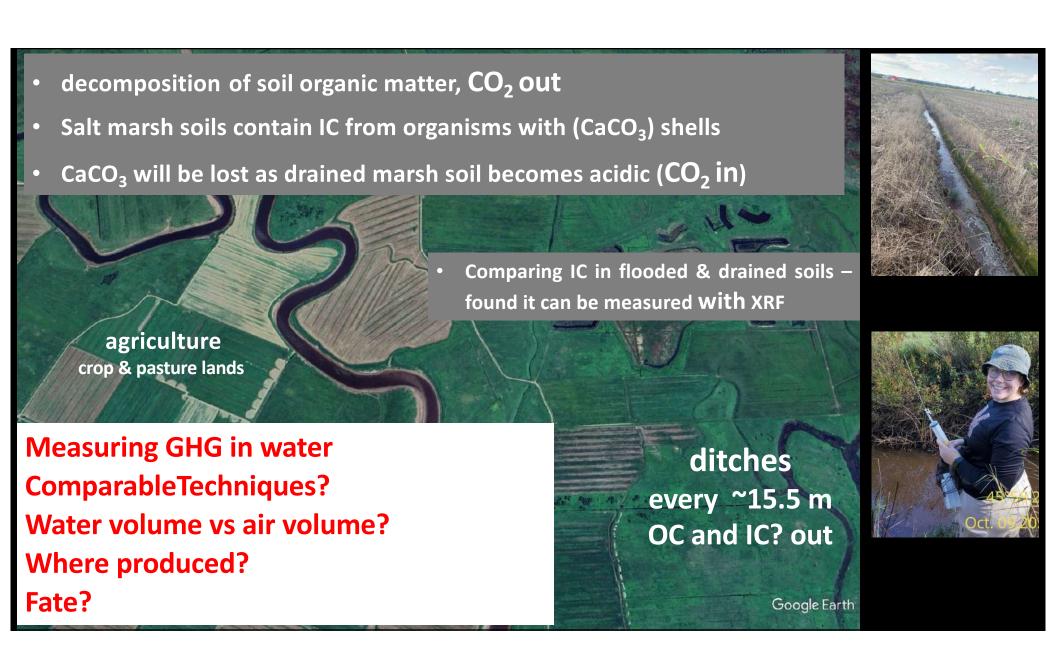
THANK YOU

Sara Knox| sara.knox@mcgill.ca | https://ubc-micromet.github.io/

ROOM B: Flux Towers, measurements, and carbon cycling

- Christian Von Sperber

ROOM B: Flux Towers, measurements, and carbon cycling

- Gail Chmura

PI Gail Chmura, McGill University
With Ph.D. students
Wendy Ampuero-Reyes & Arunabha Dey
MSc. Student Rachel Plant

freshwater impoundments OC in and "out"?

- OC storage in impoundment sediments
- Summer 2024 mapping vegetation
- Summer 2024 beginning GHG flux in vegetation zones & concentration in water

- decomposition of soil organic matter, CO_2 out
- Salt marsh soils contain IC from organisms with ($CaCO_3$) shells
- $CaCO_3$ will be lost as drained marsh soil becomes acidic (CO_2 in)
- Comparing IC in flooded & drained soils – found it can be measured with XRF

agriculture
crop & pasture lands

Measuring GHG in water
ComparableTechniques?
Water volume vs air volume?
Where produced?
Fate?

ditches
every ~15.5 m
OC and IC? out

Google Earth

Related study with Dr. Florin Pendea Lakehead U (Orillia) Lake Simcoe watershed, ON

winter fluxes critical
CH4 emissions when water is frozen over seds not

ROOM C:

Ecosystem service indicators

ROOM C: Ecosystem service indicators

- David Aldred
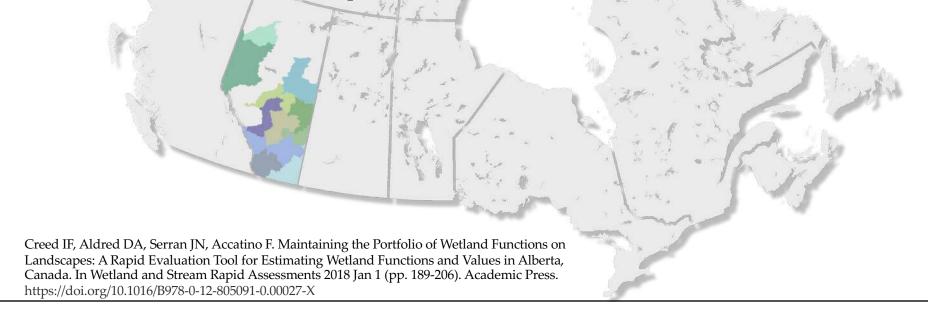- Kevin Erratt
- Owen Salmon
- Sassan Mohammady
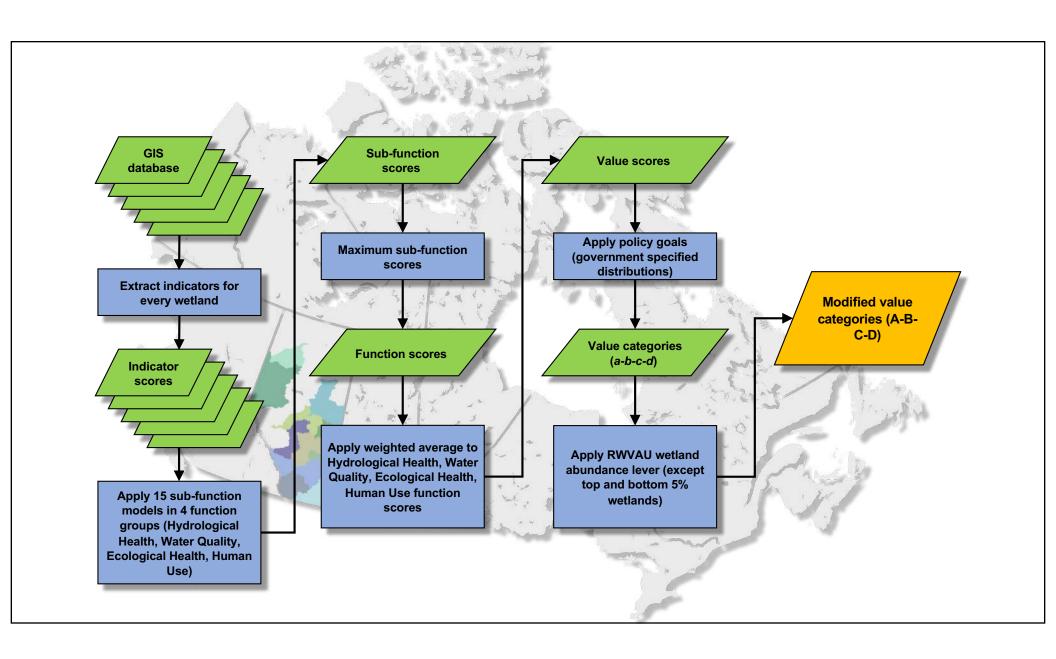- Shabnam Majnooni

ROOM C: Ecosystem service indicators

- David Aldred

Objective 4, Task 2: Develop a desktop- and indicator-based tool for rapid assessment of wetland ecosystem services
Irena Creed, David Aldred

In 2013, the Government of Alberta commissioned us to develop a desktop- and indicator-based tool to implement their no-net-loss of wetland function policy → Alberta Wetland Relative Value Evaluation Tool (ABWRET)

Relative wetland values were calculated for over 1 million wetlands in 11 relative wetland value assessment units (RWVAUs) in the province's White Area

Creed IF, Aldred DA, Serran JN, Accatino F. Maintaining the Portfolio of Wetland Functions on Landscapes: A Rapid Evaluation Tool for Estimating Wetland Functions and Values in Alberta, Canada. In Wetland and Stream Rapid Assessments 2018 Jan 1 (pp. 189-206). Academic Press. https://doi.org/10.1016/B978-0-12-805091-0.00027-X
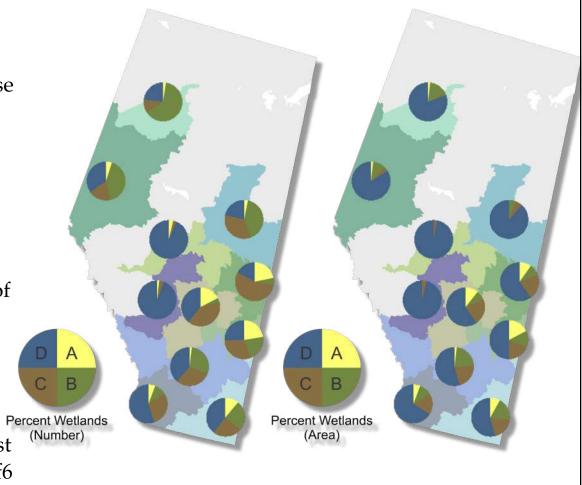
Main limitations

(1) variable quality of the wetland database (a mosaic of different inventories captured using different data acquired at different dates and using different specifications)
(2) varying quality of geospatial indicator data

Due to these limitations, the Government of Alberta reports wetland value categories aggregated to the township level

These are available at:

https://geodiscover.alberta.ca/geoportal/rest/metadata/item/6074617f4be24fcf95a2de56f6f7d28f/html
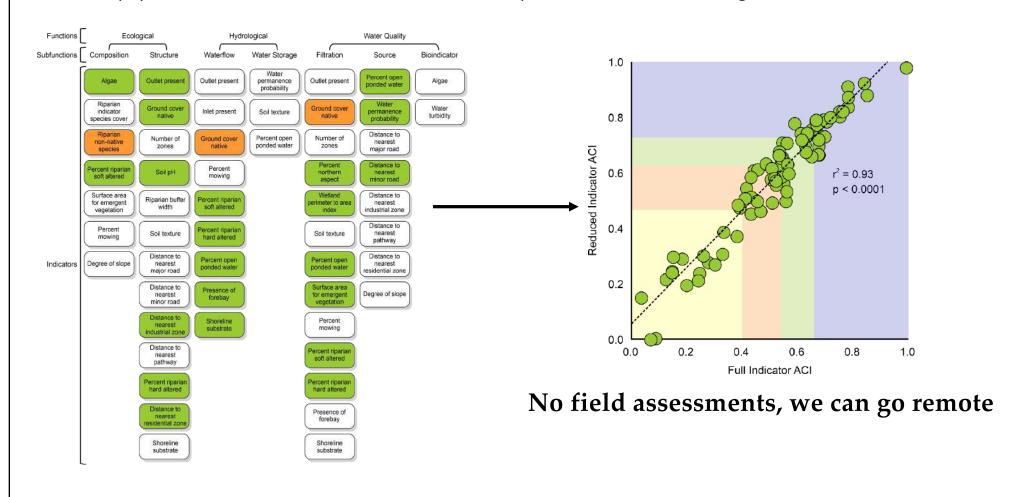

Percent Wetlands (Number)

Percent Wetlands (Area)

ROOM C: Ecosystem service indicators

- Kevin Erratt

Objective 4. Develop Robust Estimates Of The Synergies (And Conflicts) Of Wetlands As NBS For Carbon Storage Versus Other Benefits

Task 4.2. Develop A Desktop- And Indicator-Based Tool For Rapid Assessment Of Wetland Ecosystem Services Related To Hydrological Regulation, Water Purification, And Biodiversity Enhancement.
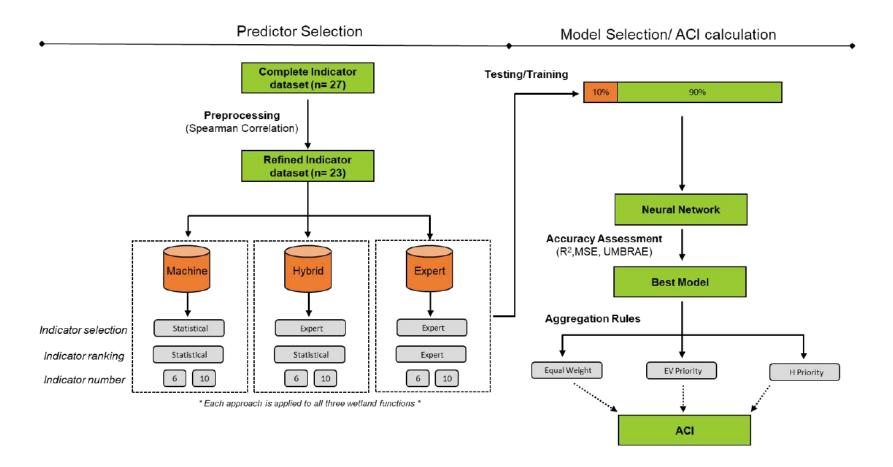
Evaluating urban wetland health: adjusting management strategies

Shift from physical to visual-based assessments, to create a rapid and cost-effective management tool

No field assessments, we can go remote

Scaling up: Applying different modelling approaches

Test human vs. machine knowledge to assess to test whether human assistance can enhance machine learning outcomes

Modelling Approaches : Hybrid wins (in most instances)

	6 Indicators			10 Indicators		
	Machine	Hybrid	Expert	Machine	Hybrid	Expert
EV	0.53	**0.78**	0.31	**0.71**	0.6	0.63
WQ	0.25	**0.43**	0.4	0.38	**0.48**	0.44
H	0.29	**0.41**	0.28	0.42	**0.54**	0.5

Modelling Approaches: **We need human knowledge!**

"Human contributions to scientific progress were once deemed to be non-essential and replaceable" in the realm of artificial intelligence Hansen & Quinon (2023) Synthese 201.1-21.

However, we show **hybrid approaches**, which use expert knowledge to "feed" artificial intelligence enhance outcomes.

ROOM C: Ecosystem service indicators

- Owen Salmon

CAAF Objective 4: "Develop robust estimates of the synergies (and conflicts) of wetlands as NBS for carbon storage vs. other benefits"
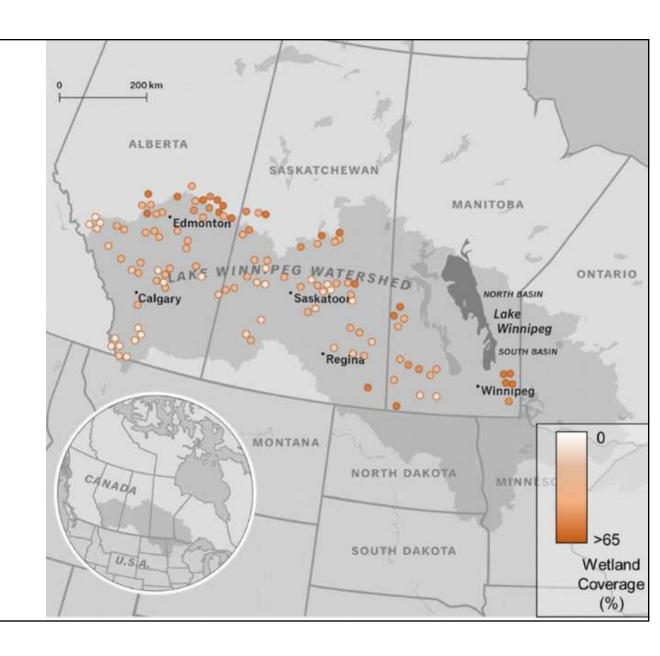
HYPOTHESIS:

Rising cyanobacteria dominance is related to % wetland cover in contributing catchments and the associated rise in DOM-Fe supplied to lakes.
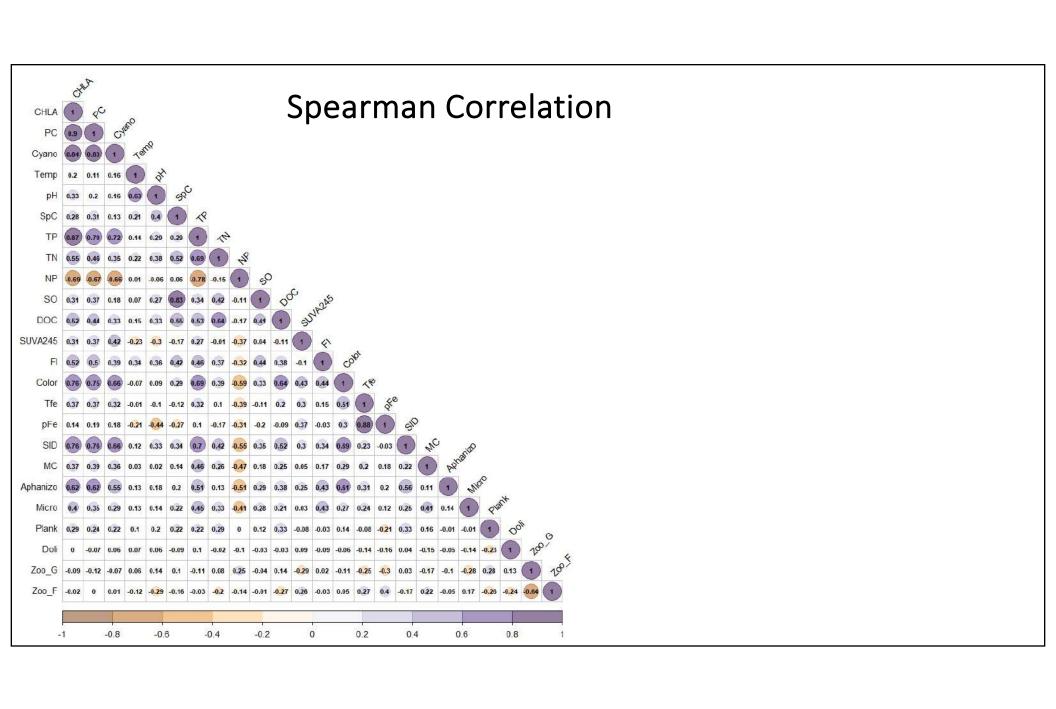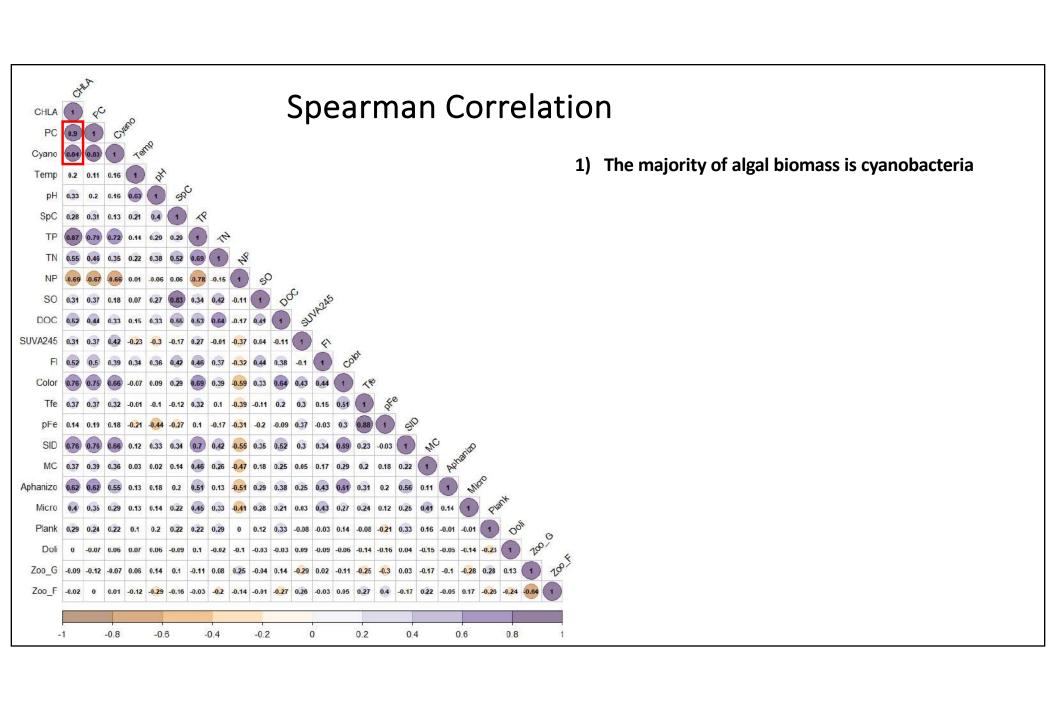
MAJOR FINDING:

Rising cyanobacteria dominance is related to low % wetland cover and high Fe phosphate delivery to lakes, causing an increase in cyanobacteria blooms.
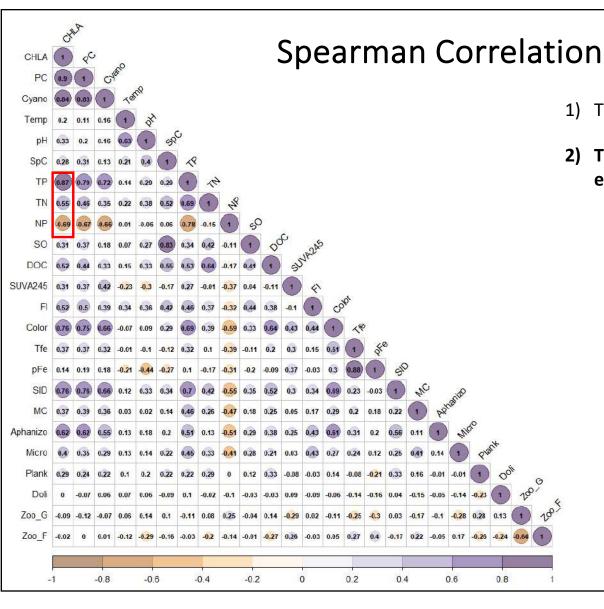
Field based study – Summer 2023

- Lakes (n=108) within Alberta, Saskatchewan, and Manitoba
- Selected based on % wetland coverage

Spearman Correlation

Spearman Correlation

1) **The majority of algal biomass is cyanobacteria**

Spearman Correlation

1) The majority of algal biomass is cyanobacteria

2) **TP drives cyanobacteria, with low N:P ratios (low N environments) regulating cyanobacteria production**

Spearman Correlation

1) The majority of algal biomass is cyanobacteria

2) TP drives cyanobacteria, with low N:P ratios (low N environments) regulating cyanobacteria production

3) **Aphanizomenon, a N-fixing genera, is dominant. This likely reflects low N conditions**
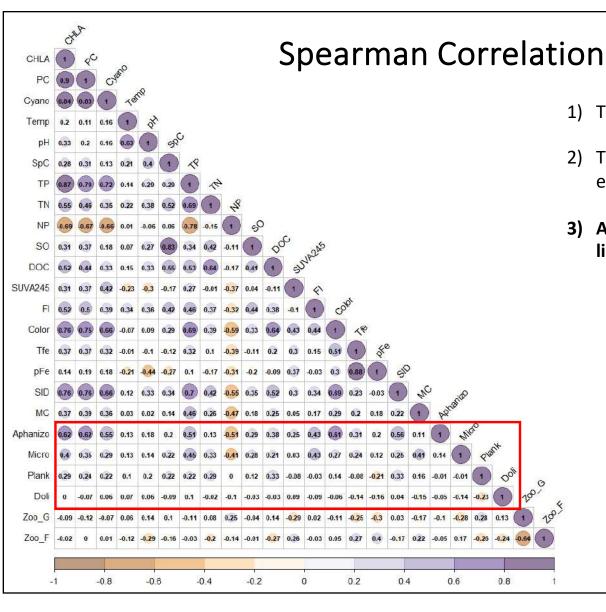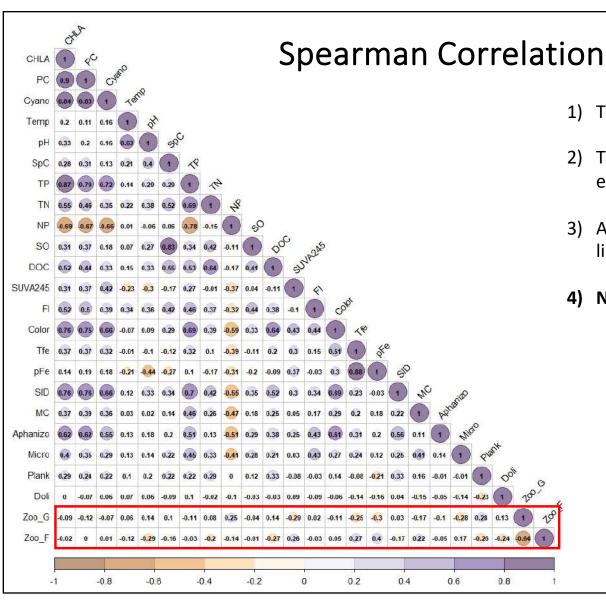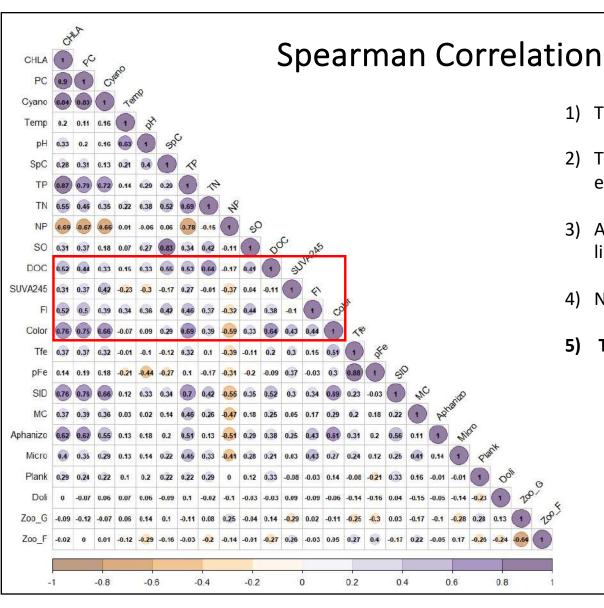
Spearman Correlation

1) The majority of algal biomass is cyanobacteria

2) TP drives cyanobacteria, with low N:P ratios (low N environments) regulating cyanobacteria production

3) Aphanizomenon, a N-fixing genera, is dominant. This likely reflects low N conditions

4) **No grazing effect**

Spearman Correlation

1) The majority of algal biomass is cyanobacteria

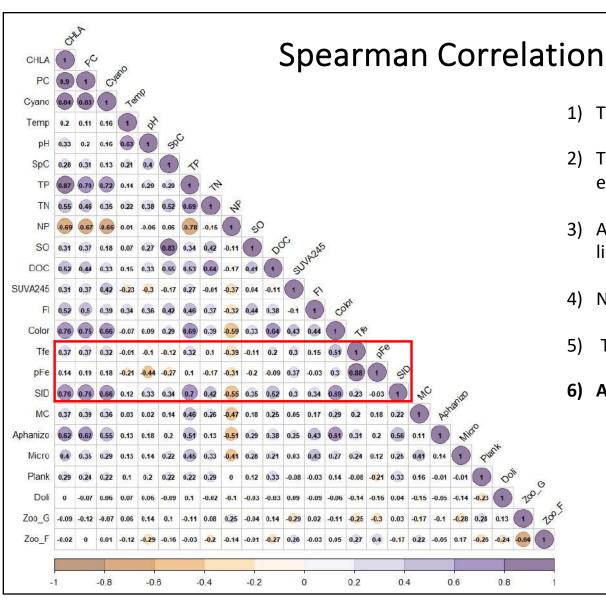2) TP drives cyanobacteria, with low N:P ratios (low N environments) regulating cyanobacteria production

3) Aphanizomenon, a N-fixing genera, is dominant. This likely reflects low N conditions

4) No grazing effect

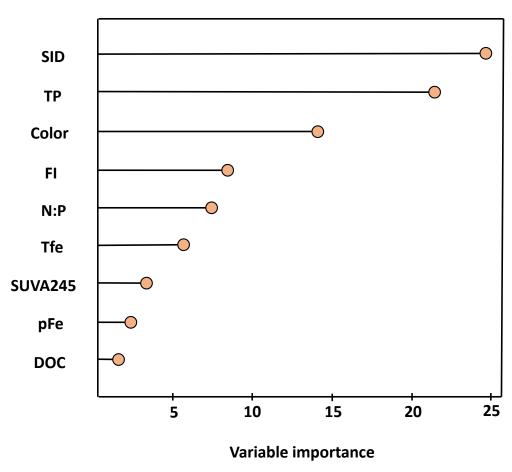5) **Terrestrial DOM is fueling cyanobacteria production**

Spearman Correlation

1) The majority of algal biomass is cyanobacteria

2) TP drives cyanobacteria, with low N:P ratios (low N environments) regulating cyanobacteria production

3) Aphanizomenon, a N-fixing genera, is dominant. This likely reflects low N conditions

4) No grazing effect

5) Terrestrial DOM is fueling cyanobacteria production

6) **Anemic lakes result in high siderophore production**

RANDOM FOREST
(Chl-a)

ROOM C: Ecosystem service indicators

- Sassan Mohammady

CAAF Objective 3, Task: 3.2. Estimate The Hydrological Connectivity Of Wetlands To The Watersheds In Which They Are Embedded.

Identifying the role of wetland to river connectivity and wetland loss (or gain) on the headwater lake's phytoplankton biomass (i.e., as an index of water quality)
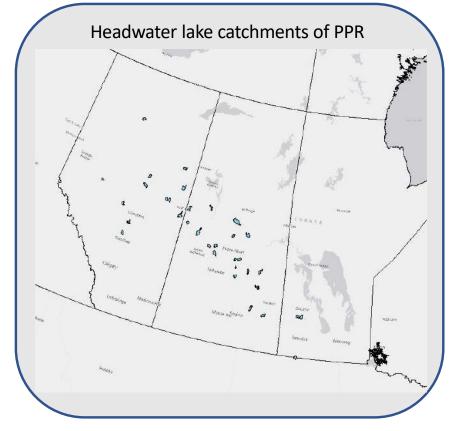
PhD Candidate : Sassan Mohammady
Supervisor: Dr. Irena Creed
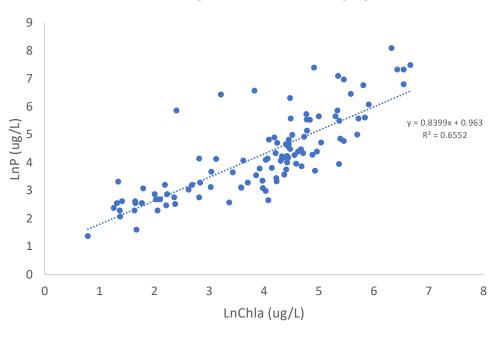
Hypothesis

Wetland loss within lake catchment will increase phytoplankton biomass in the receiving lake water

Study area

Headwater lake catchments of PPR

Total Phosphorous vs Chlorophyll-a

$y = 0.8399x + 0.963$
$R^2 = 0.6552$

LnP (ug/L)

LnChla (ug/L)
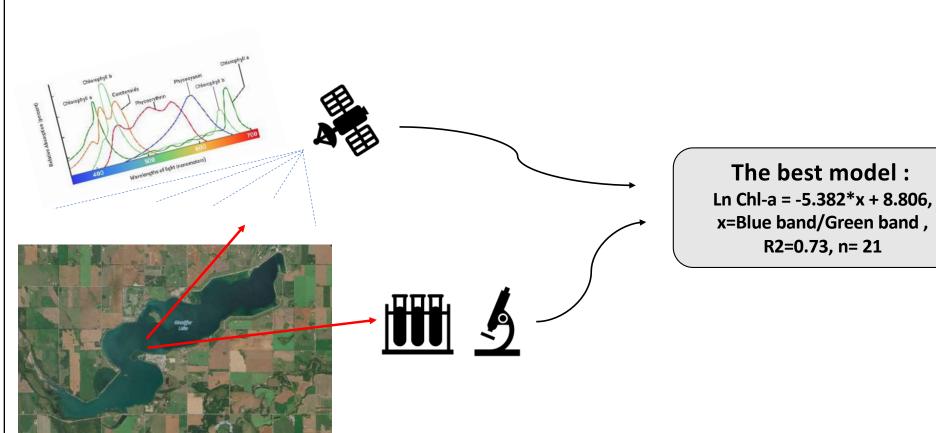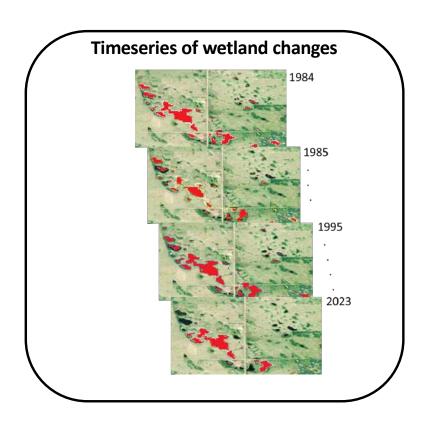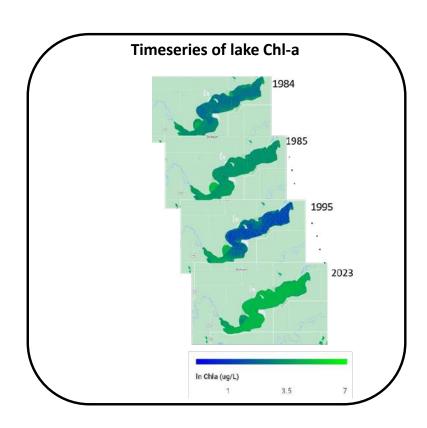
Remote sensing of Chlorophyll-a to create the timeseries of headwater lake's phytoplankton biomass (1984-2023)

The best model :
Ln Chl-a = -5.382*x + 8.806,
x=Blue band/Green band ,
R2=0.73, n= 21
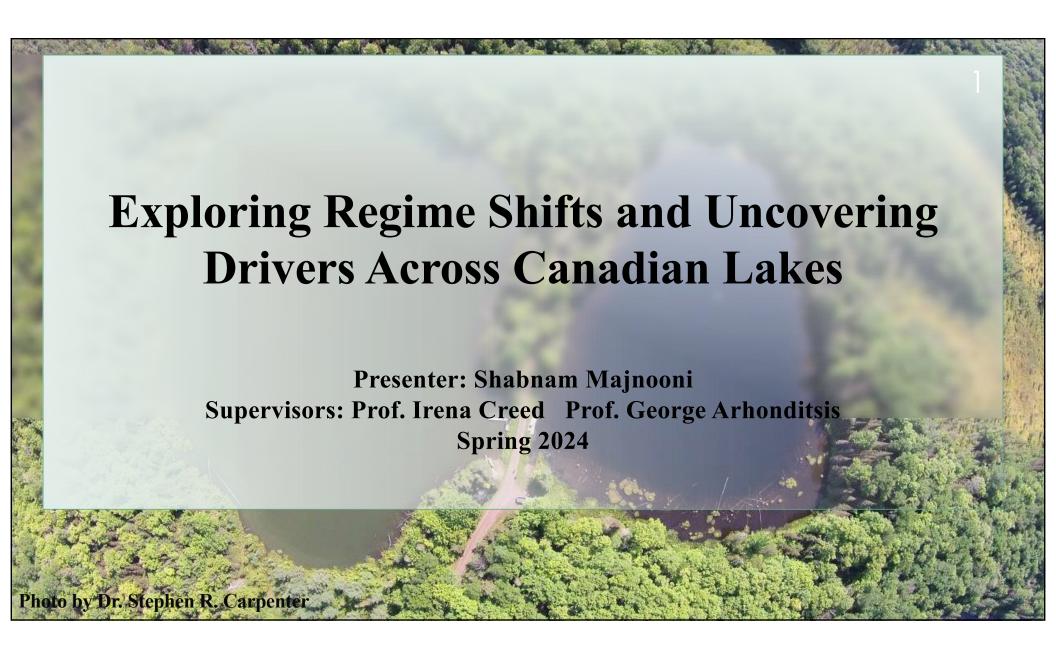
Analyzing the correlation between the timeseries of wetland changes with the timeseries of phytoplankton biomass (i.e., Chl-a)
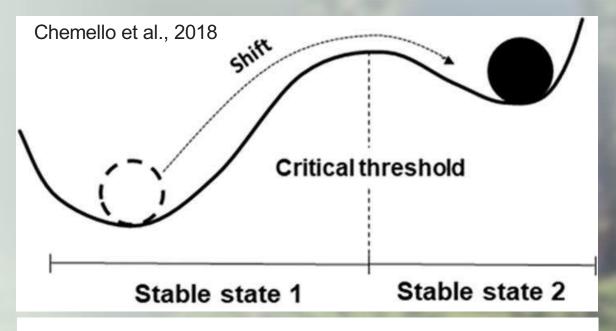
ROOM C: Ecosystem service indicators

- Shabnam Majnooni

Exploring Regime Shifts and Uncovering Drivers Across Canadian Lakes

Presenter: Shabnam Majnooni
Supervisors: Prof. Irena Creed   Prof. George Arhonditsis
Spring 2024

Photo by Dr. Stephen R. Carpenter

➢ **Objective:**
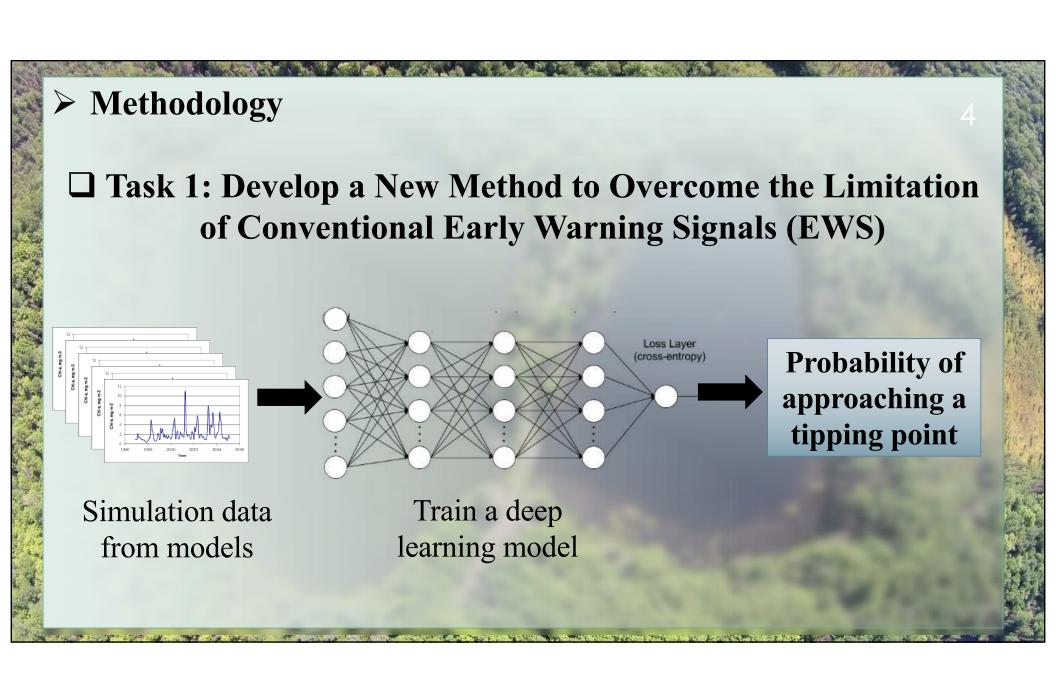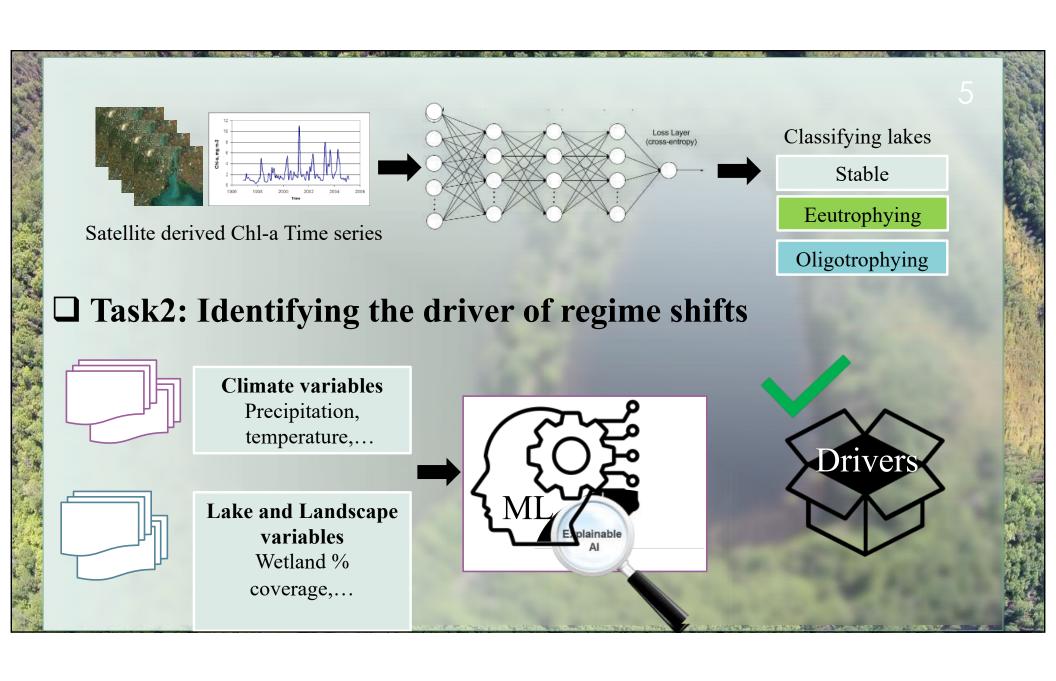
Determine if lakes are losing resilience and transitioning to new stable states, and identify the driving factors.

Chemello et al., 2018

Alternative stable states within a system

Satellite derived Chl-a Time series

Loss Layer (cross-entropy)

Classifying lakes

Stable

Eeutrophying

Oligotrophying

Task2: Identifying the driver of regime shifts

Climate variables
Precipitation, temperature,…

Lake and Landscape variables
Wetland % coverage,…

ML

Explainable AI

Drivers

ROOM D:

Socioeconomic analyses

ROOM D: Socioeconomic analyses

- John Pattison Williams & Patrick Lloyd Smith & Roy Brouwer
- Purbasha Mistry

Wetland as Natural Solutions:
Baselines and projections for Wetlands on Agricultural Land

Patrick Lloyd-Smith and John K. Pattison-Williams

Ashley Klotz, Liam Boldt and .....

Overview

Current Status

Plans for Upcoming Season

Challenges

Objectives

Watershed Analysis
- *Initial analysis of the Lake Winnipeg watershed, engaging with Ontario/Quebec and the rest of Canada*

Wetland Extent Data
Collect data on historical, current, and future wetland extent from natural science teams

Drivers of Conversion
Identify and describe the main drivers of wetland conversion (e.g. literature review and/or quantitative assessment)

Survey Design
- *Design and implement a survey instrument to explore the economic behavioural perspectives of stakeholders towards wetland management and drainage (e.g. wetlands as natural, perceived drivers of loss, risk of leakage).*

Economic Model Development
- *develop a model that incorporates behaviour to project wetland conversation rates under different scenarios based on economic conditions (e.g. input costs, commodity prices), technology changes (e.g. drainage costs, yields) and policy instruments (e.g. regulations, payment for ecosystem service schemes).*

Policy Evaluation
- *Use the developed model and projections to assess the efficiency of various policy instruments*

Leakage Assessment
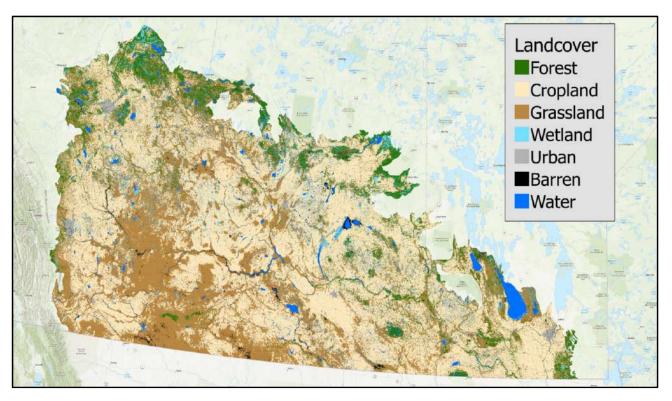*Assess the potential role of 'leakage' of wetland associated emissions (i.e., displacement of emissions from avoiding an activity to another location) in the analysis at the sub-provincial level*

Administration
- *recruitment and initial data collection*

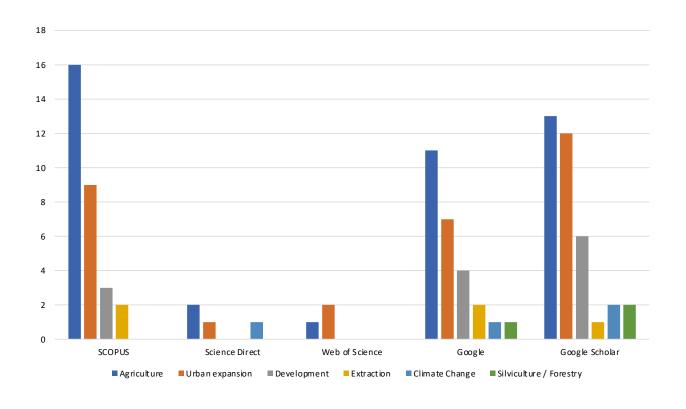# Current Status |
Watershed Analysis & Wetland Extent

Relying on David Aldred and team from U of T

Current Status |
Drivers of Conversion: Systematic Review

Stage	Description	Action
1	Google Scholar Google SCOPUS Science Direct Web of Science	Wetlands + Conversion + Agriculture Wetlands + Conversion + Drivers Wetlands + Conversion + Urban Expansion Wetlands + Conversion + Development Wetlands + Conversion + Causes Wetlands + Conversion + Forestry Wetlands + Conversion + Canada
2	Title and Abstract Review	Document titles and abstracts were reviewed for retention / exclusion Criteria: includes explicit wetland loss and discussion of conversion
3	Document Review	Documents were read to explore key themes and relevance.
4	Thematic Analysis	Key messages, lessons and limitations were identified and synthesized for: i) context: geographic, grassland type and governance structure (private/public) ii) driver of conversion iii) ecosystem service explored iv) wetland policy structure identified

UNIVERSITY OF
ALBERTA
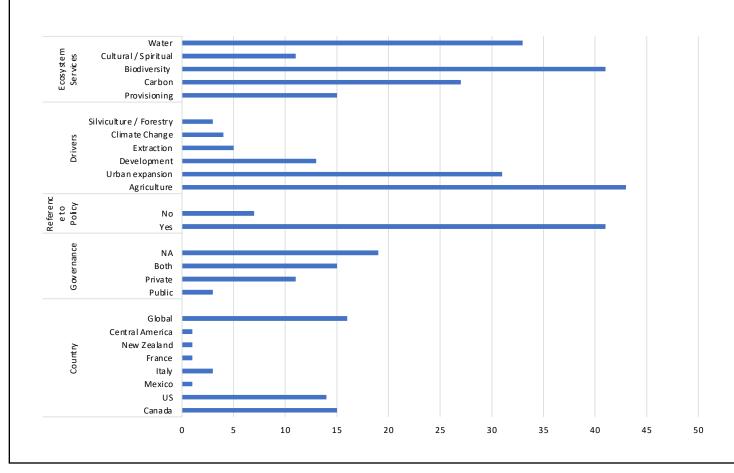
Current Status |
Preliminary Search Results

Current Status |
Systematic Review Thematic Analysis
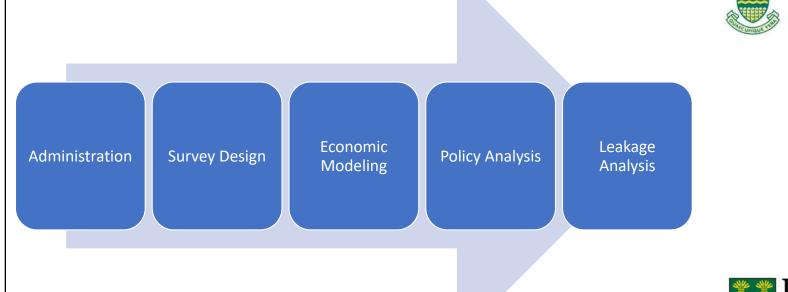
Current Status |
Economic Model Development

- Improve economic modelling of wetland conservation costs to incorporate uncertainty

- Using precision agriculture data to estimate the effects of wetlands on crop yields within the basin itself as well as in the adjacent buffer areas. Focus is on yield effect differences across soil zones, wet/dry years, wetland sizes, and crop types.

UNIVERSITY OF SASKATCHEWAN

Plans for Upcoming Season | Survey Design

- Reviewing approaches

- Design summer 2023

- Pre-test Fall 2023

- Implement January 2024

- In-person meeting May 2, 2023 in Toronto

Challenges / Opportunities

- Confirming funding and subgrant agreements

- Hiring / building team

ROOM D: Socioeconomic analyses

- Purbasha Mistry
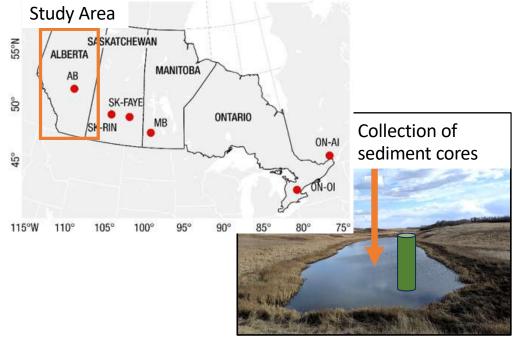
CAAF Objective 5.4. Support Other National Initiatives For Nature Climate Solutions.

Wetlands as economically viable nature-based solutions for climate change mitigation
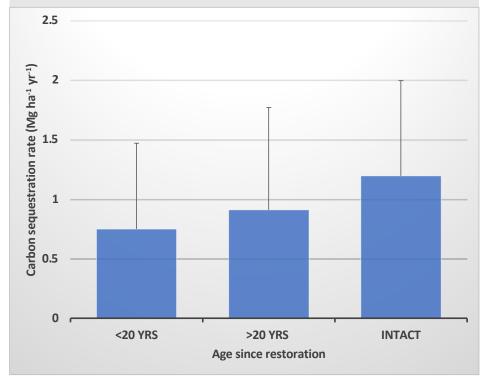
Purbasha Mistry

Supervisors: Drs. Irena Creed and Charles Trick
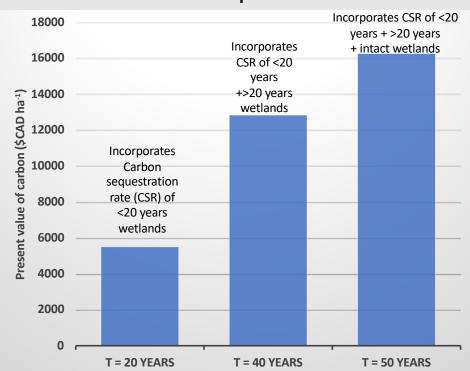
- Evaluated the value of carbon sequestration in wetlands by calculating the benefit-cost ratio of conserving vs. restoring the wetlands

Study Area

Collection of sediment cores

Carbon Sequestration Rate of restored and intact wetlands
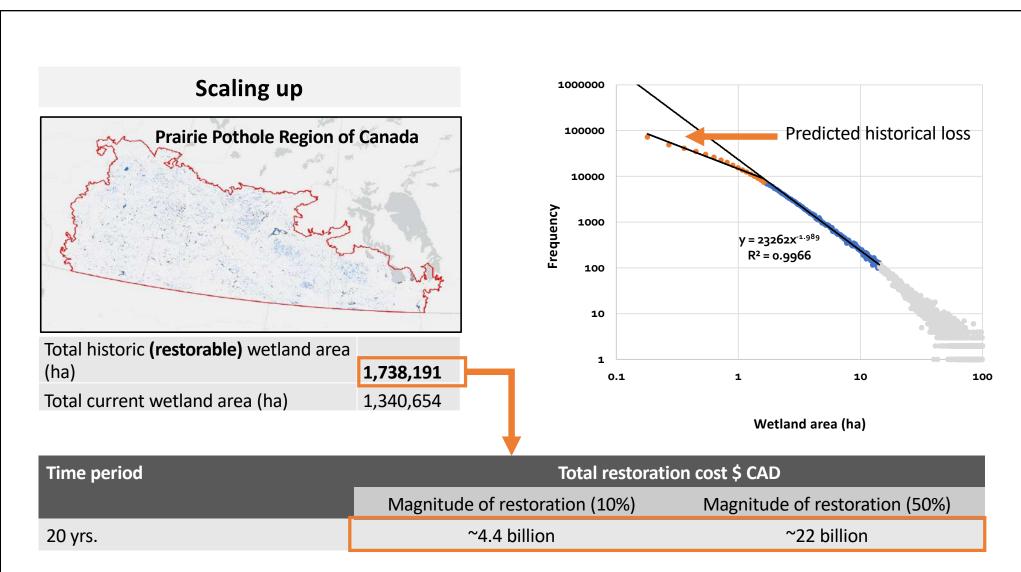
Value of carbon incorporates carbon sequestration rate and carbon price of Canada

Here T refers to time frame, used 3% discount rate, and 2% inflation

185

Comparison of costs and benefits to sequester CO_2 in wetlands in Alberta in 2021 $ CAD

Time periods	Present value of costs $ CAD/ha		Benefit-cost ratio		Breakeven cost (= present value of carbon) $ CAD/ha
	Conservation	Restoration	Conservation	Restoration	
20 yrs.	$2,127	$25,127	**2.59**	**0.22**	$5, 504
40 yrs.	$3,305	$26,305	3.89	0.49	12, 853
50 yrs.	$3,679	$26,679	4.42	0.61	$16,278

The cost of restoring the wetland incorporates restoration cost plus the opportunity cost
Used 3% discount rate and 2% inflation

Scaling up

Prairie Pothole Region of Canada

Total historic **(restorable)** wetland area (ha)	**1,738,191**
Total current wetland area (ha)	1,340,654

$y = 23262x^{-1.989}$
$R^2 = 0.9966$

Predicted historical loss

Frequency

Wetland area (ha)

Time period	Total restoration cost $ CAD	
	Magnitude of restoration (10%)	Magnitude of restoration (50%)
20 yrs.	~4.4 billion	~22 billion

Key Messages:

- Conservation is more cost-effective than restoration of wetlands

- Incorporating multiple benefits of restored wetlands can help justify the cost

Your feedback to improve this economic analysis approach is much appreciated.

Agenda, May 1

- 8:30 – 9:00, Welcome
- 9:00 – 9:30, Introductions
- 9:30 – 10:30, Breakout room (A, B)
- 10:30 – 10:45, Morning Break
- 10:45 – 12:00, Breakout rooms (A, B)
- 12:00 – 1:00, Lunch break
- 1:00 – 2:30, Breakout rooms (C, D)
- 2:30 – 2:45, Afternoon Break
- 2:45 – 3:30, Breakout rooms (C, D)
- 3:30 – 4:00, From Science to Impact
- 4:00 – 4:30, Final remarks

Rose Fuchsia Room, Topic C

Topic:

Ecosystem service indicators

Objectives:

CAAF, Objective 4

Great Lakes, Objectives 1, 2, 4.5.

Room leaders:

David Aldred, James Paterson

Purple Room, Topic D

Topic:

Socioeconomic Analyses

Objectives:

CAAF, Objective 5.4.

Prairies: Objective 1 and 2.

Great Lakes: Objectives 3 and 4.

Room leaders:

John Pattison-Williams, Patrick Lloyd-Smith, Roy Brouwer

Rose Fuchsia Room, Topic C

Topic:

Ecosystem service indicators

CAAF:

Irena Creed (David Aldred, Kevin Erratt, Sassan Mohammady, Shabnam Majnooni, Owen Salmon, Kelechi Nwokeocha)

James Paterson

Lauren Bortolotti

Purple Room, Topic D

Topic:

Socioeconomic Analyses

CAAF:

Irena Creed (Purbasha Mistry*)

Prairies:

John Pattison-Williams (Ashley Klotz)

Patrick Lloyd-Smith

Great Lakes:

Roy Brouwer (Jullian Sone)

Lota Tamini*

Jie He*

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- 4:00 – 4:30, Final remarks

- How can we better coordinate activities across projects, objectives, and teams?

- What opportunities can we create for students?

- What synergies within and between projects objectives can we explore?

- Are we on track to achieve our objectives? What needs to be done to address the delays? Are you missing data or information? How can these be provided to you?

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- 4:00 – 4:30, Final remarks

Task 5.1. CANWIN

Establish an open science Canadian Wetland Information repository to support scientists and decision makers interested in wetlands as nature-based solutions.

Late Start to be mitigated:

- **STEP 1.** Hiring a Business Analyst (May/Jun 2024)
    Will interview AAFC, ECCC, Co-PIs to identify requirements for CANWIN (Databases, datasets, normalization, user stories, technical and technological requirements)

- **STEP 2.** Hiring of Full-Stack application Developer (Expected Nov/Dec 2024)

Challenges: Intellectual property, technological, project afterlife, ...

Task 5.2. Wetlands in NIR

Integrate wetlands and their role in OC accumulation and GHG reduction into the national GHG inventory.

- Workshops and collaboration with ECCC AFOLU (Doug MacDonald)
- Wetland mapping for PPR from 1993-2020
- Estimates of wetland conversion rates 1970 to 2020 delivered to ECCC
- Proposal of criteria to classify wetlands as managed/unmanaged according to land-proxy approach

Criteria for classifying wetlands as managed or unmanaged in agricultural landscapes

To report emissions or removals of GHG from lands into the National Inventory Report, they need to be considered MANAGED or caused by DIRECT HUMAN ACTIVITY.

Currently, all wetlands in Canada are considered unmanaged. This impedes the counting of wetlands as nature-based climate change solutions.

Establishing scientific criteria, thresholds, and indicators to distinguish when a wetland has been managed or nor is required to track emissions/removals into NIR.

Task 5.3. Wetlands in Holos Model

Develop Approaches To Quantify Agricultural Impacts On Wetland Carbon Storage And Ghg Emissions To Enable Farmers To Calculate Estimates At The Farm Scale So That They Can Make Land Decisions That Are Consistent And Quantifiable At The National Scale (Holos).

- FY 3 Collaboration with AAFC (Roland Kroebel, Sarah Pogue, Shathi Akhter)

    Hire postdoctoral fellow to complete literature review, and to develop question structure for wetland inclusion

- Timeline: Start mid-2024, target 2-year duration
- Aim for inclusion in Holos V6 release (2026/2027)

Task 5.4. Socioeconomic (Prairies and Great Lakes)

Support Other National Initiatives For Nature Climate Solutions.

Summary of the conclusions from Room D.

Agenda, May 1

- 8:30 – 9:00, Welcome
- 9:00 – 9:30, Introductions
- 9:30 – 10:30, Breakout room (A, B)
- 10:30 – 10:45, Morning Break
- 10:45 – 12:00, Breakout rooms (A, B)
- 12:00 – 1:00, Lunch break
- 1:00 – 2:30, Breakout rooms (C, D)
- 2:30 – 2:45, Afternoon Break
- 2:45 – 3:30, Breakout rooms (C, D)
- 3:30 – 4:00, From Science to Impact
- 4:00 – 4:30, Final remarks

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