NAWM's Wetland Mapping Consortium

Government of Alberta Inventory Pilot Project

Next Generation Wetland Mapping in Alberta using AI

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Alberta Government

Ducks Unlimited Canada

ABMI

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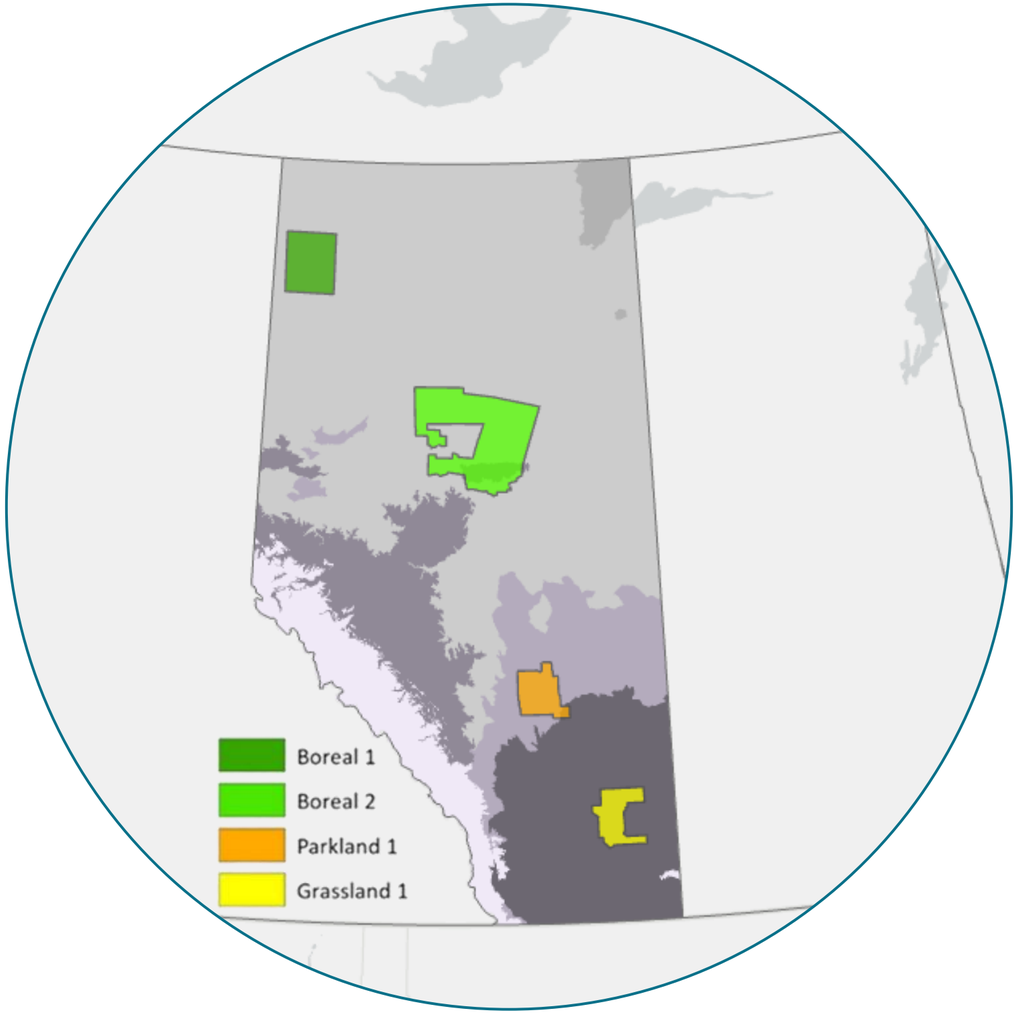
Thank you!

Project Background

Pilot study areas

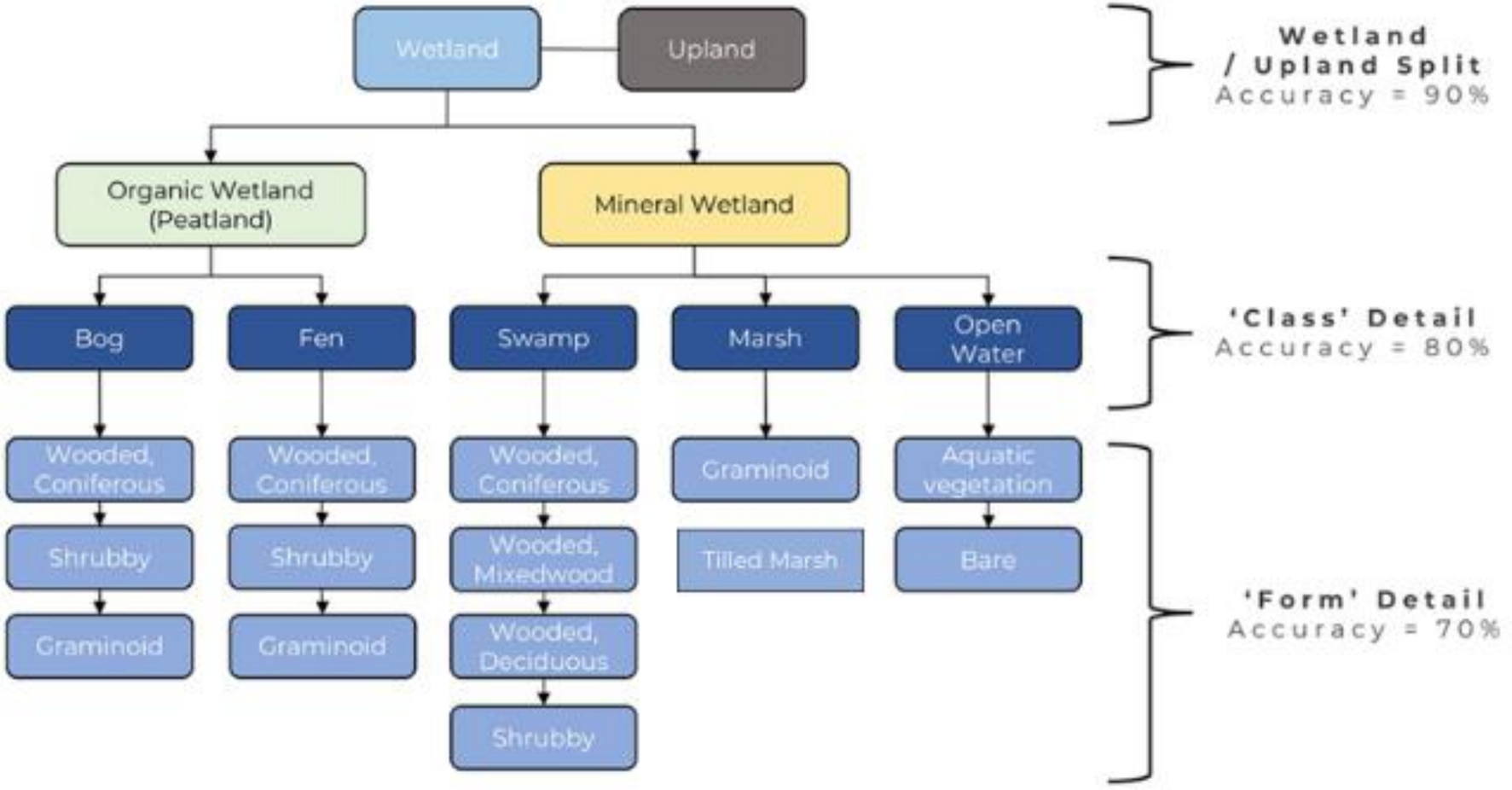


Four pilot areas within the Boreal, Parkland and Grassland Natural Regions.

These areas represent the broad diversity of wetland and land uses in the province

Project Background

Alberta Wetland Classification System



Methods

Methodology

Inputs

Satellite Data

- Optical
- Radar
- Terrain

Aerial Data

- LiDAR
- High-res optical

Training Data

- Photoplots
- Existing data

Modeling

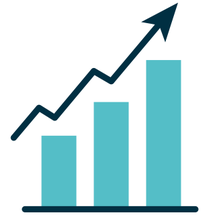
AI Models

- Machine learning
- Deep learning

Outputs

Wetland Maps

- Class
- Form

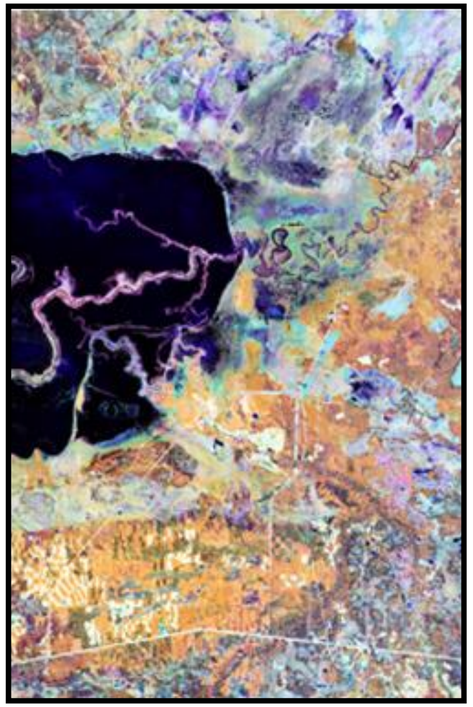


Accuracy Assessment

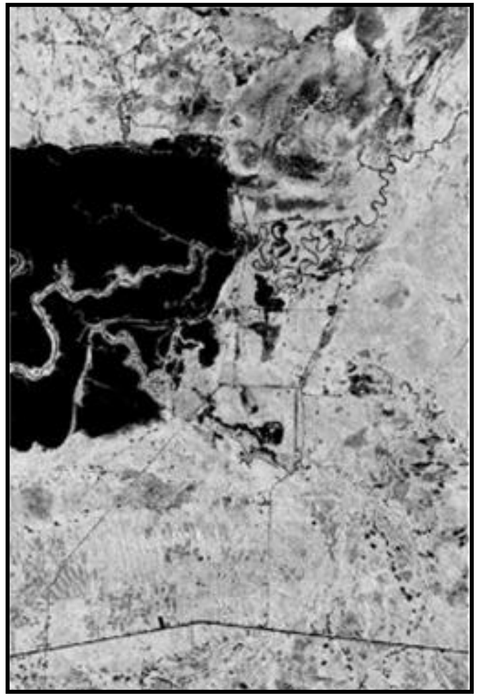
- Field data

Satellite Data

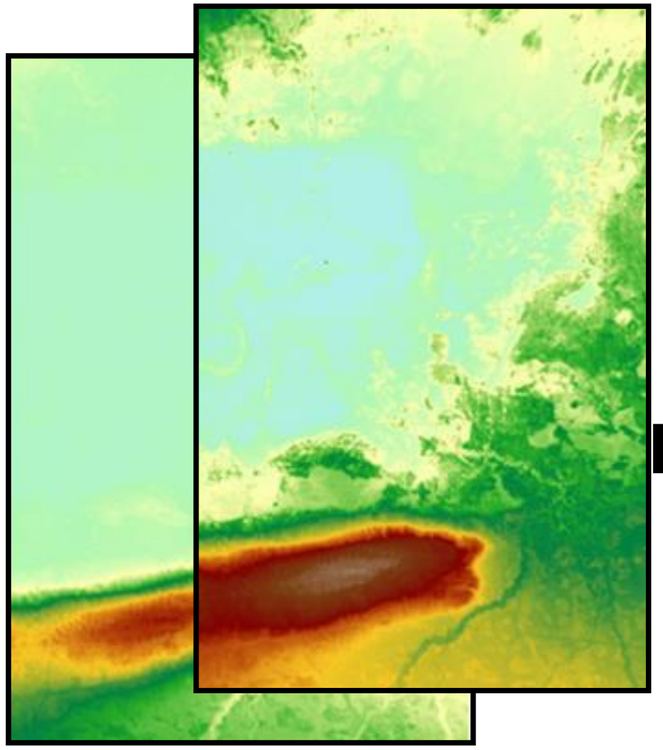
Boreal Metrics



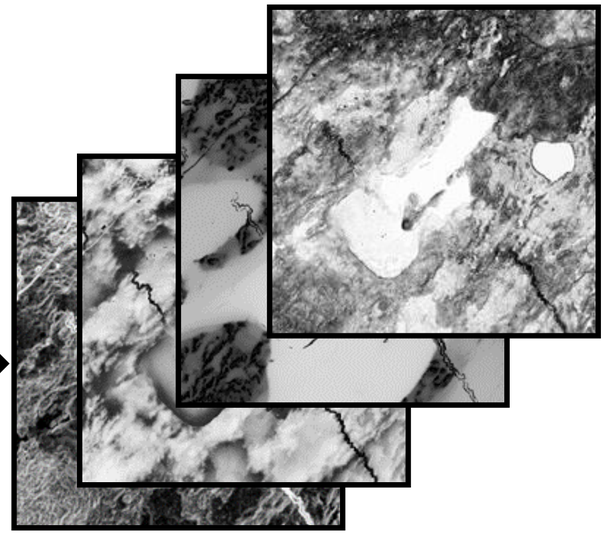
Multispectral
Sentinel-2
(10m)



Radar
Sentinel-1
(10m)



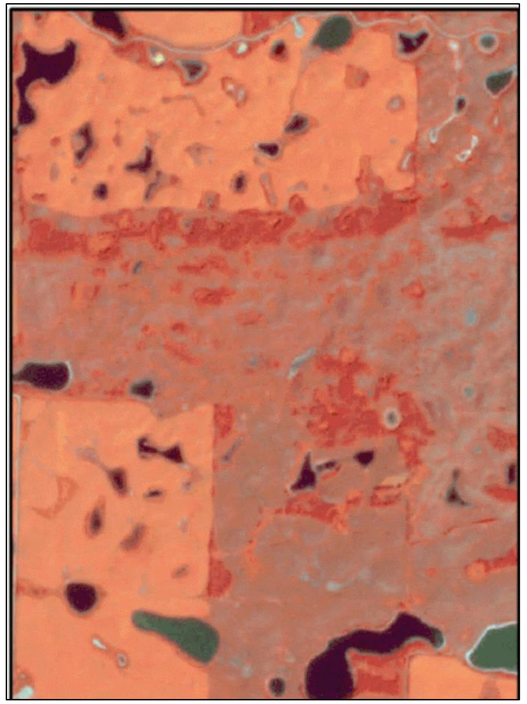
Topography
DEM/LiDAR
(1m)



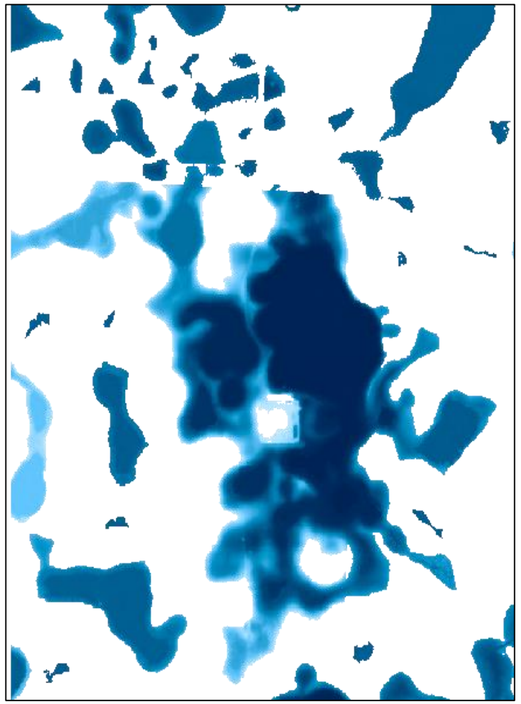
Topographic
Derivatives

Satellite Data

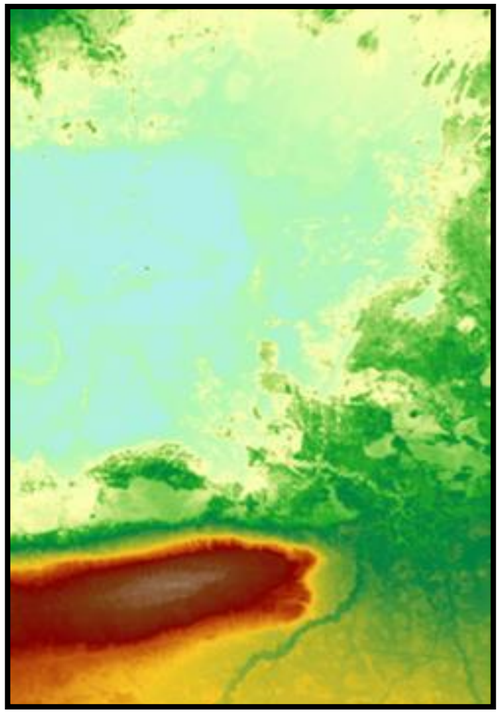
Prairie Metrics



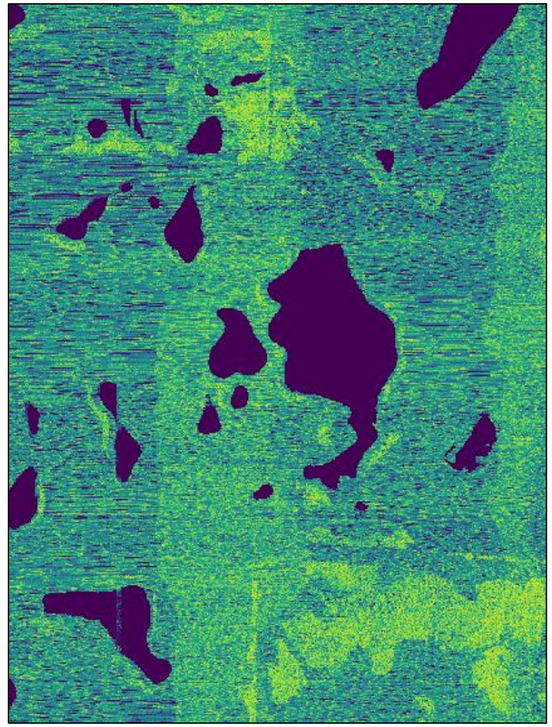
Multispectral Planet (3m)



Terrain High Res. DEM

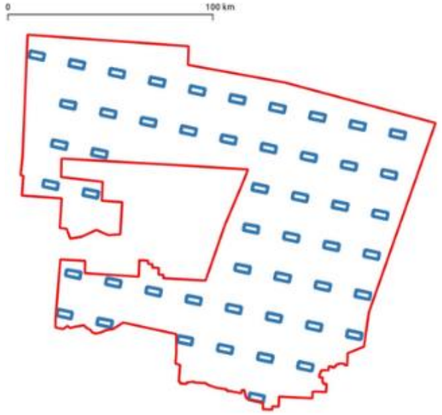


Topography LiDAR



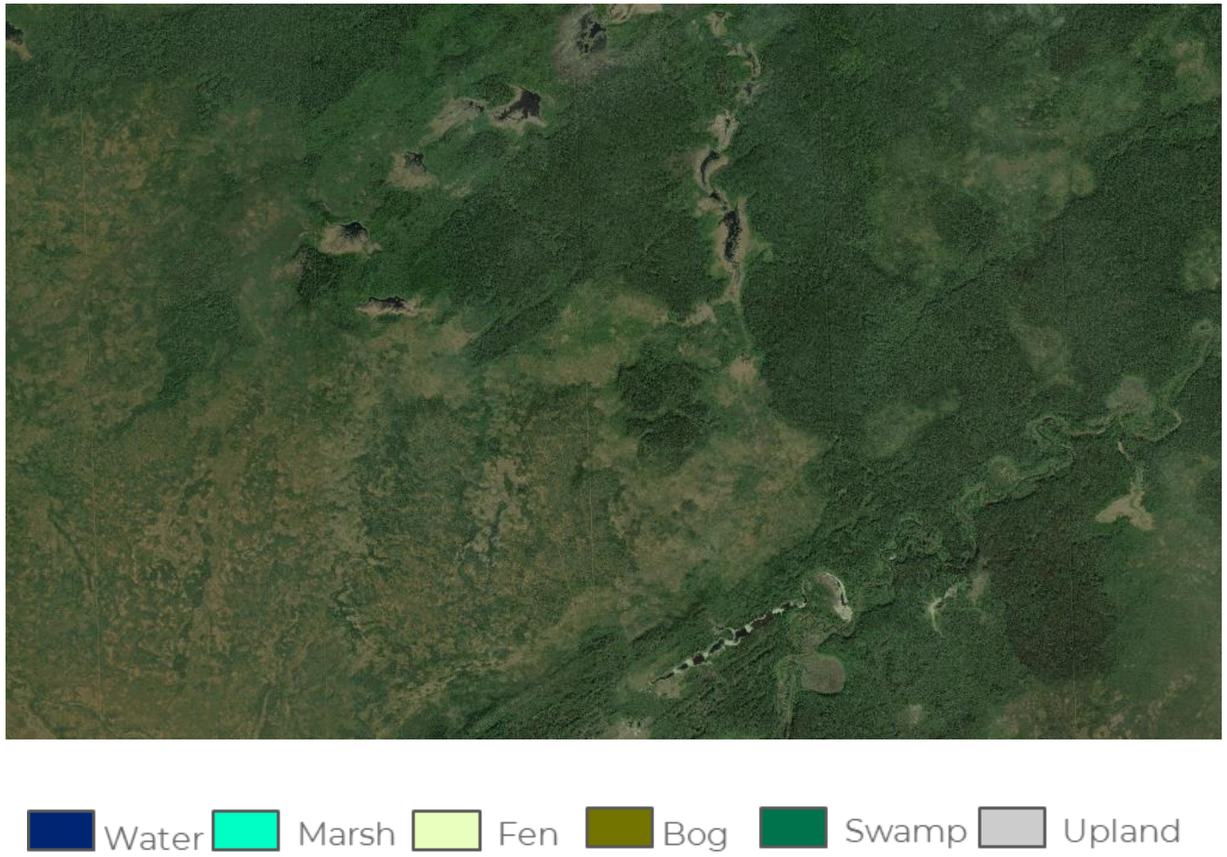
Metrics derived from Point Cloud

Training Data



Boreal 3x7 plots

- ABMI 3x7 km photoplots were used for training AI models.
- Photoplots were created in 2016 and needed to be updated following standards.
- They were enhanced by DUC using the vegetation attributes, hydrological cues, canopy and tree species code etc.



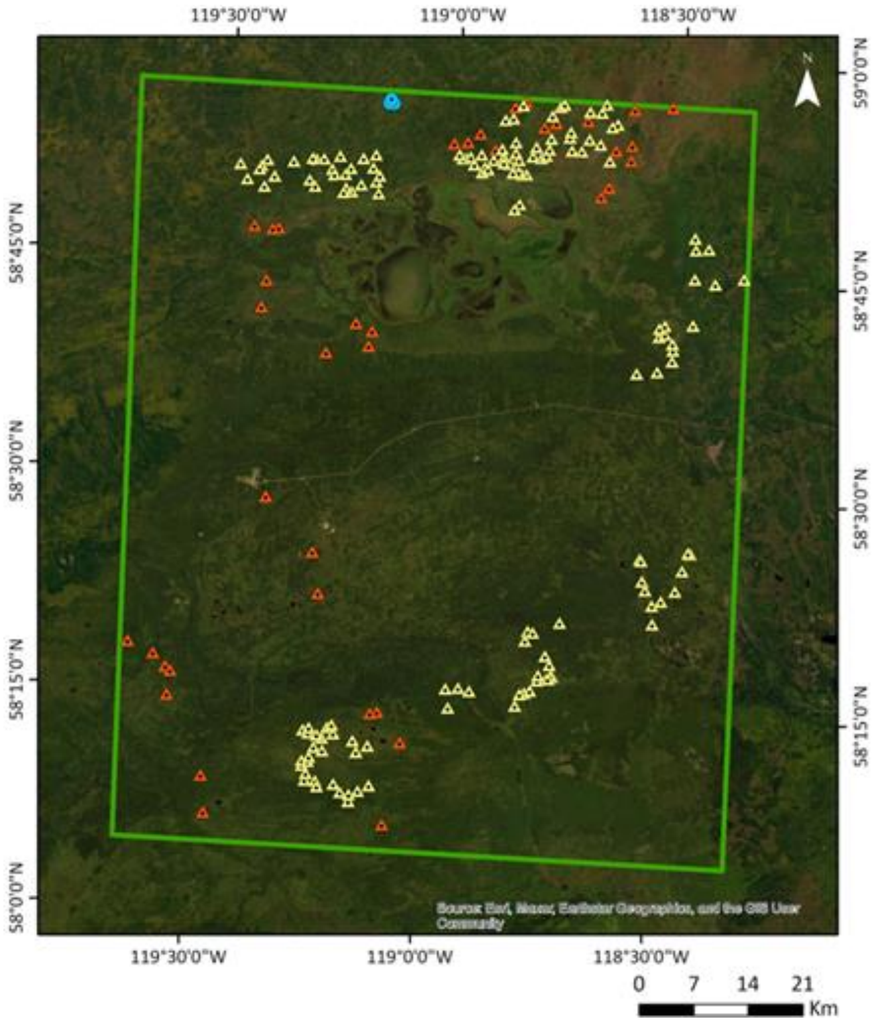
Training Data

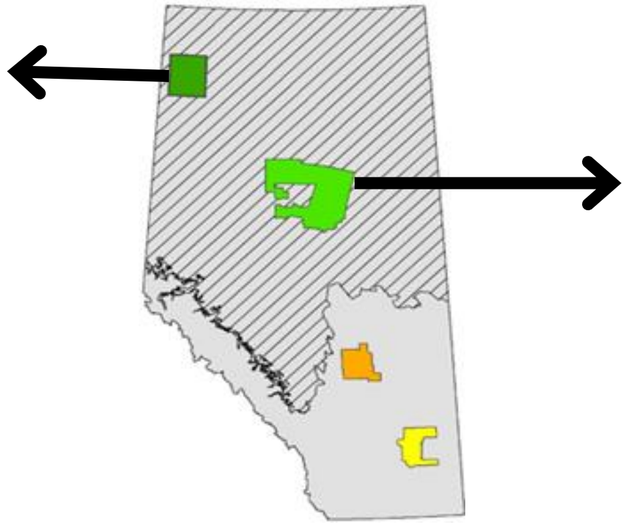
Prairie 5x5 plots

- DUC 5x5 km photoplots were used for training AI models.
- Photoplots were created using a combination of 2018, 2021, and 2023 stereo imagery.
- They were collected with existing CWI mapping protocols which were adapted to include open water and swamp forms.

Validation Data

Boreal Field Data Collection

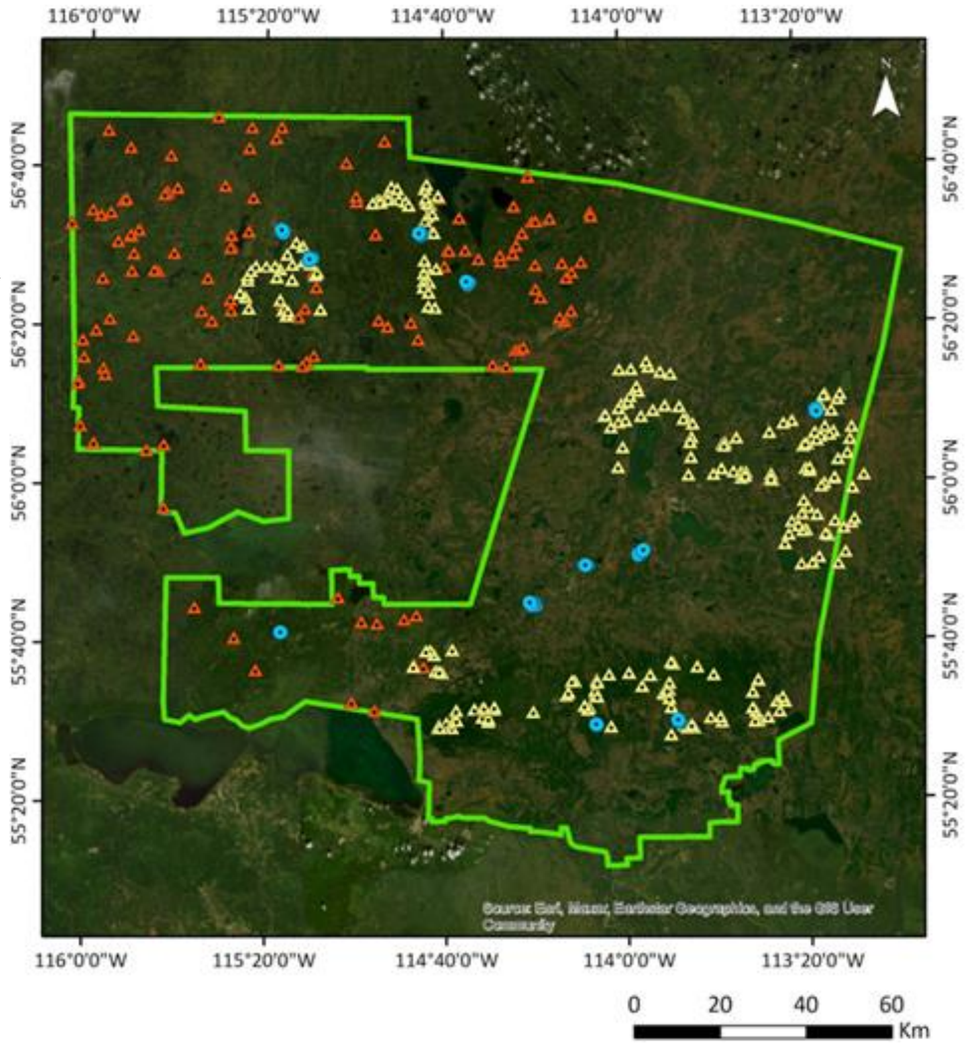




ABMI Ground

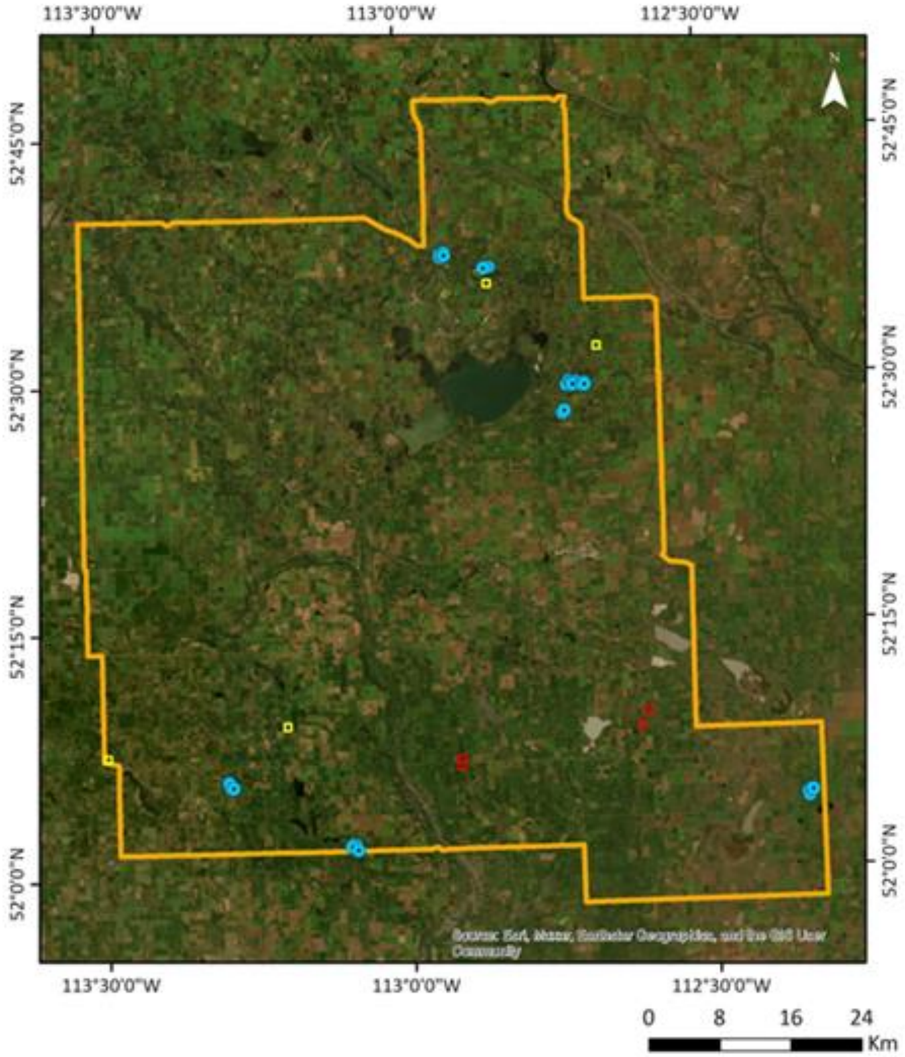
DUC Helicopter

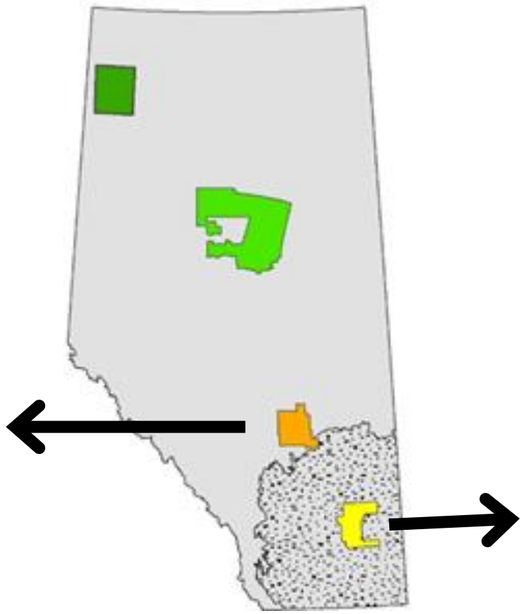
DUC Historical Helicopter



Validation Data

Prairie Field Data Collection

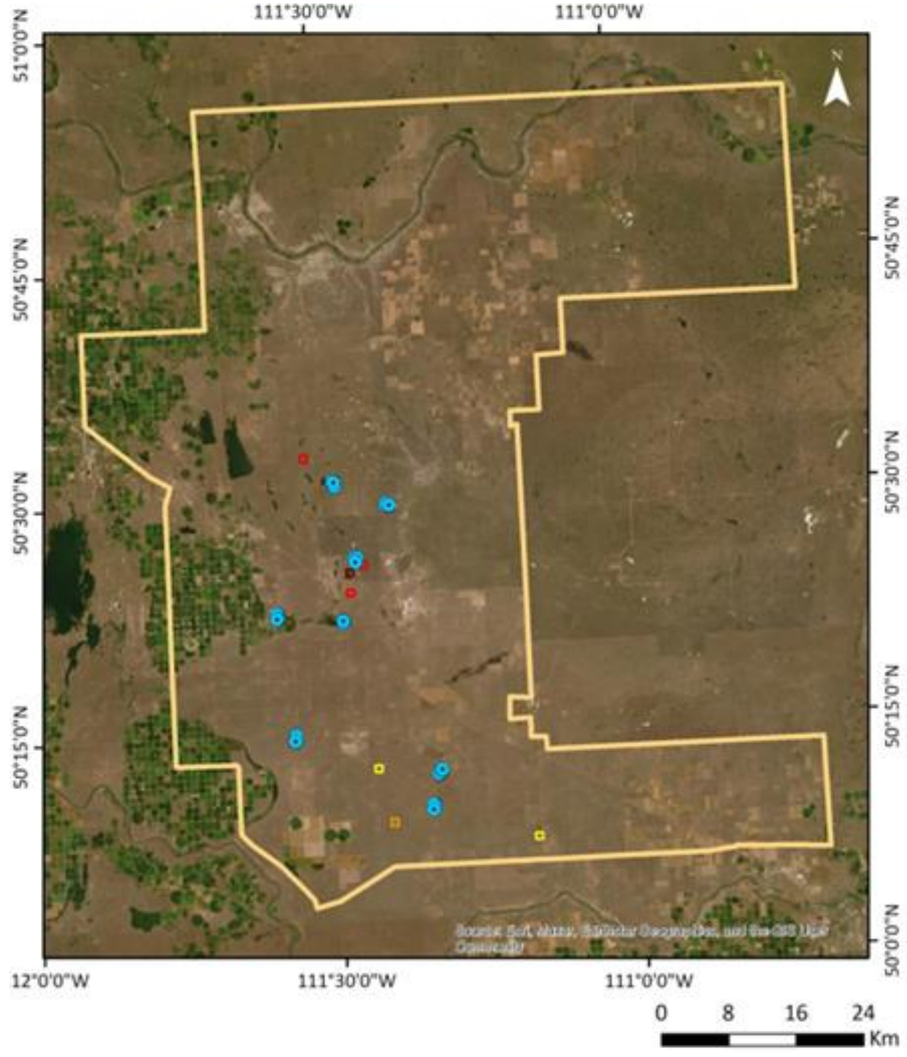




ABMI 2023 Sites

DUC 2023 Sites

DUC 2022 Sites

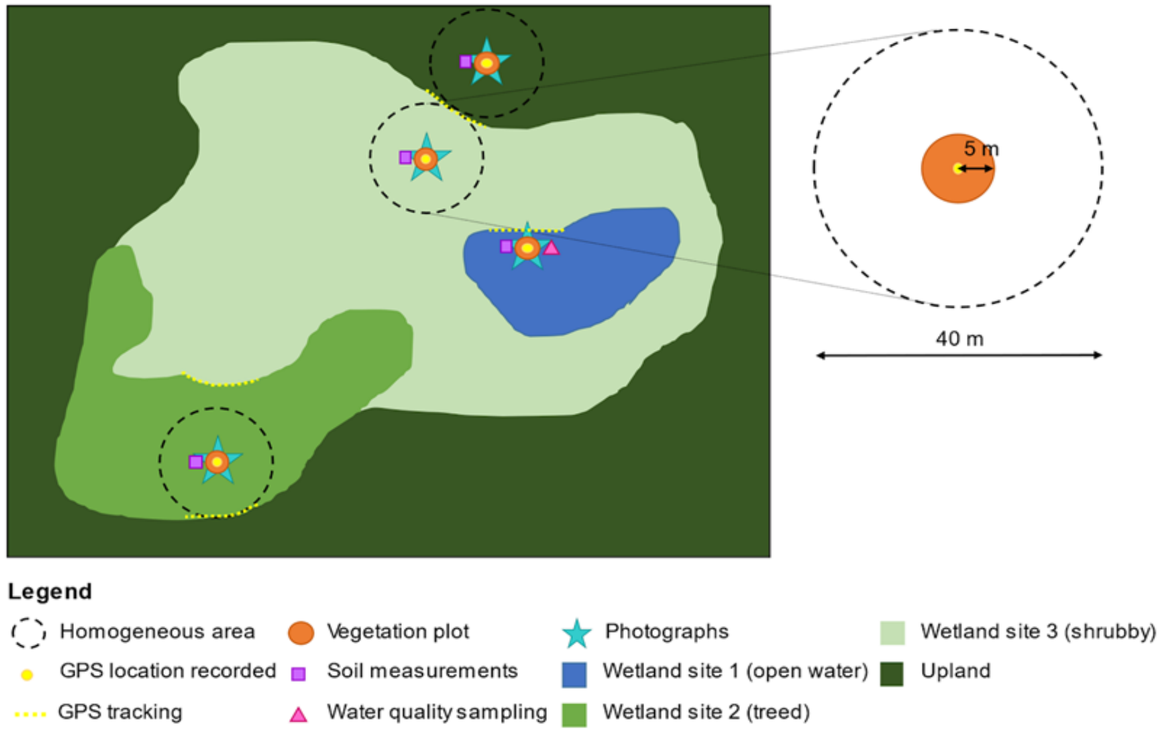


Validation Data

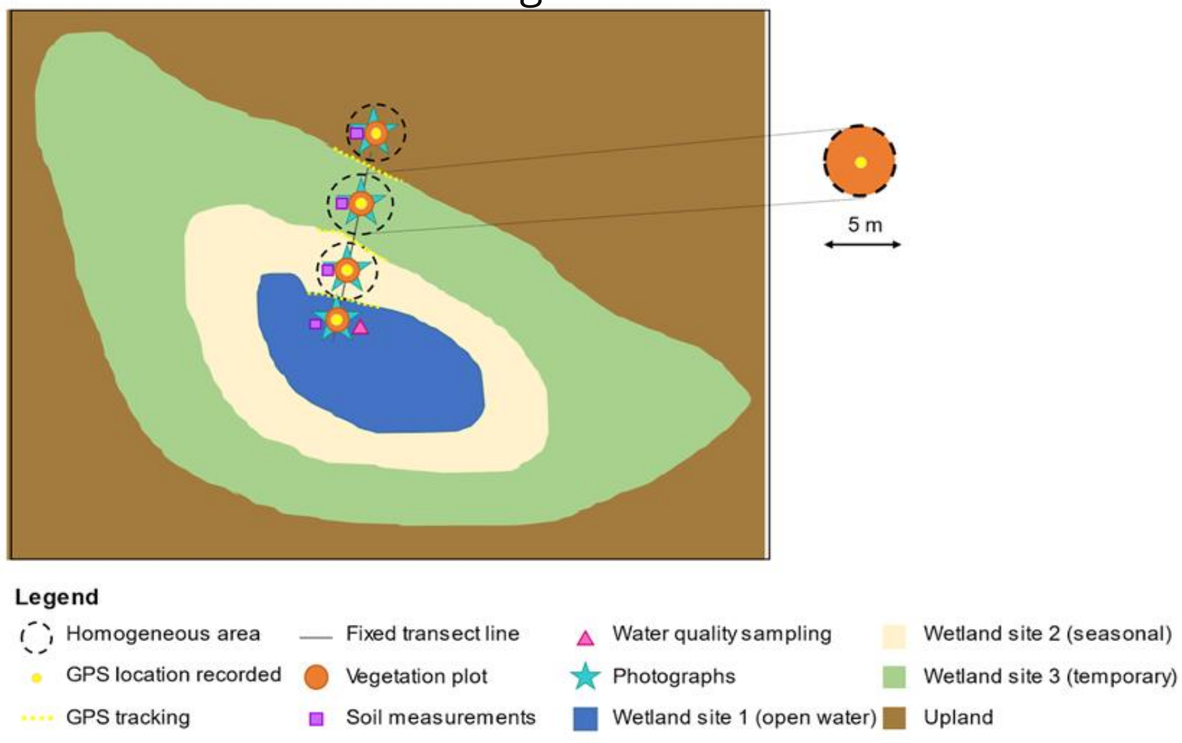
Field Protocols

Developed new protocols for field collection and classification of AWCS wetlands

Boreal Protocol Diagram



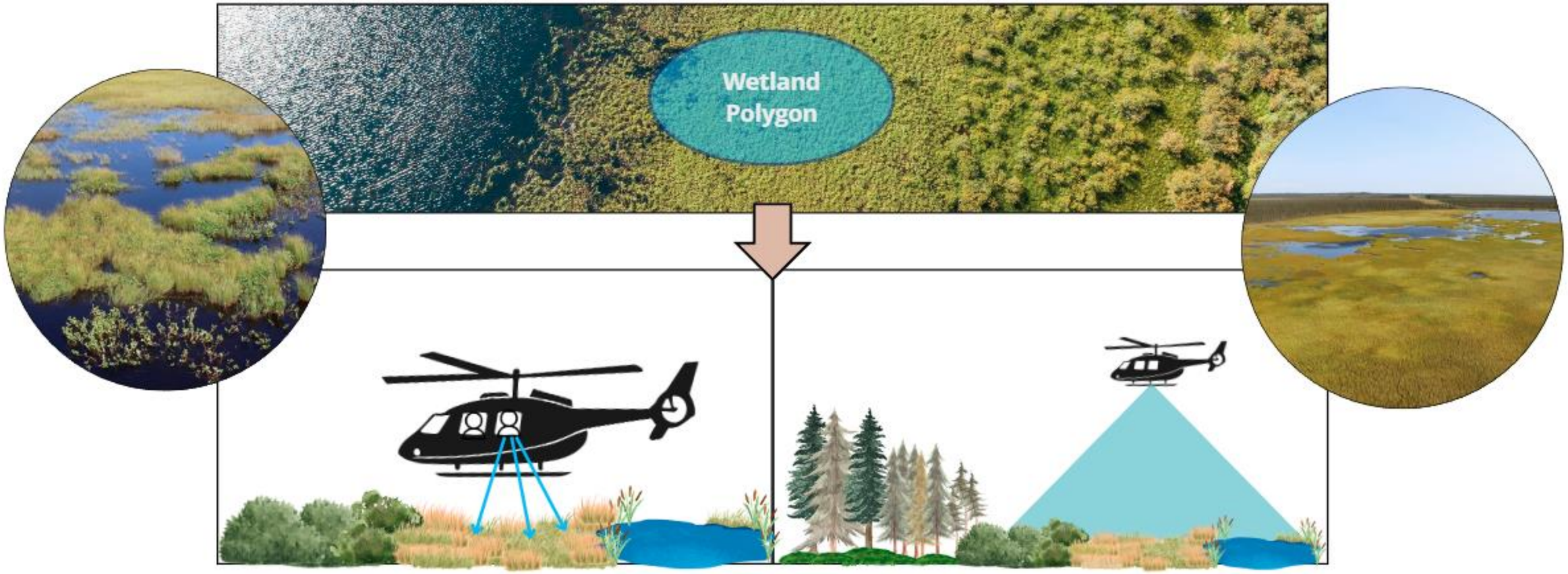
Prairie Protocol Diagram



Validation Data

Helicopter-based Protocols

Species type| Percent coverage (%) | Species heights (m) | Class/Form |Site photographs



Validation Data

Prairie Field Protocols

Field Survey

- Targeted sampling of individual wetlands (points/edge) to collect wetland representative features and minority classes.
- Full parcel sampling conjunction with UAV acquisition and photo interpretation to compile validation polygons.

- Information collected:
  - Vegetation species types
  - Vegetation species heights (m)
  - Vegetation percent cover (%)
  - Class/Form/Type
  - Wetland edge / Soil observation
  - Hydrological indicators
  - Disturbance
  - Site photographs

AI Modeling

Machine Learning for Boreal and Prairie

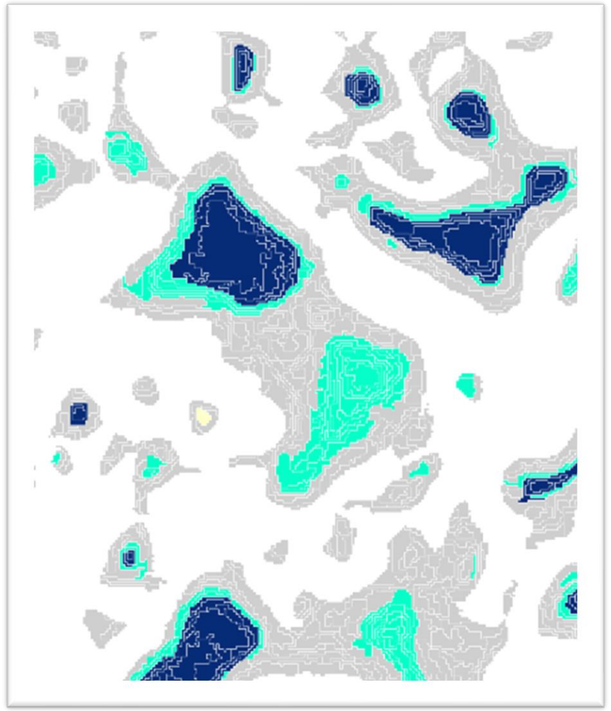
Machine Learning relies on the algorithm to identify patterns and make predictions based on structure data

Point samples

Boreal

Point Based

- Balanced Sampling
- Pixels are independent
- Ensemble learning methods XGBoost



Prairie

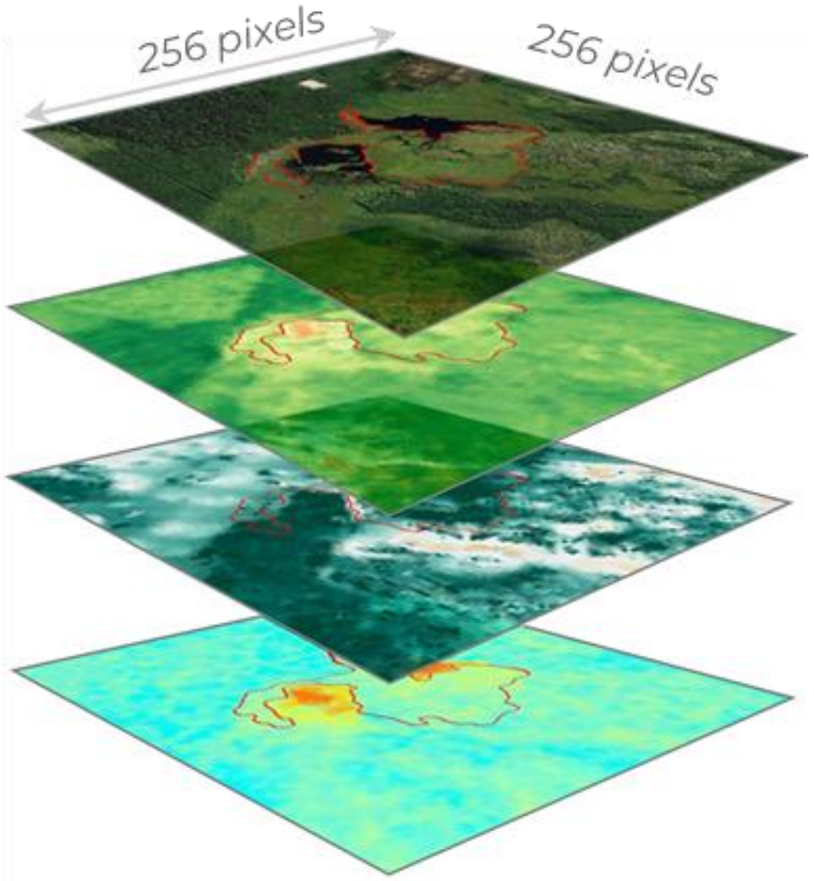
Segment based

- Balanced Sampling
- XGBoost and Random Forest evaluated

AI Modeling

Deep Learning for Boreal and Prairie

Deep Learning uses neural networks to automatically extract features and learn from large volumes of unstructured data



Deep Learning

- Convolutional Neural Network
- U-Net Architecture
- Segmentation model that trains using image patches

Results

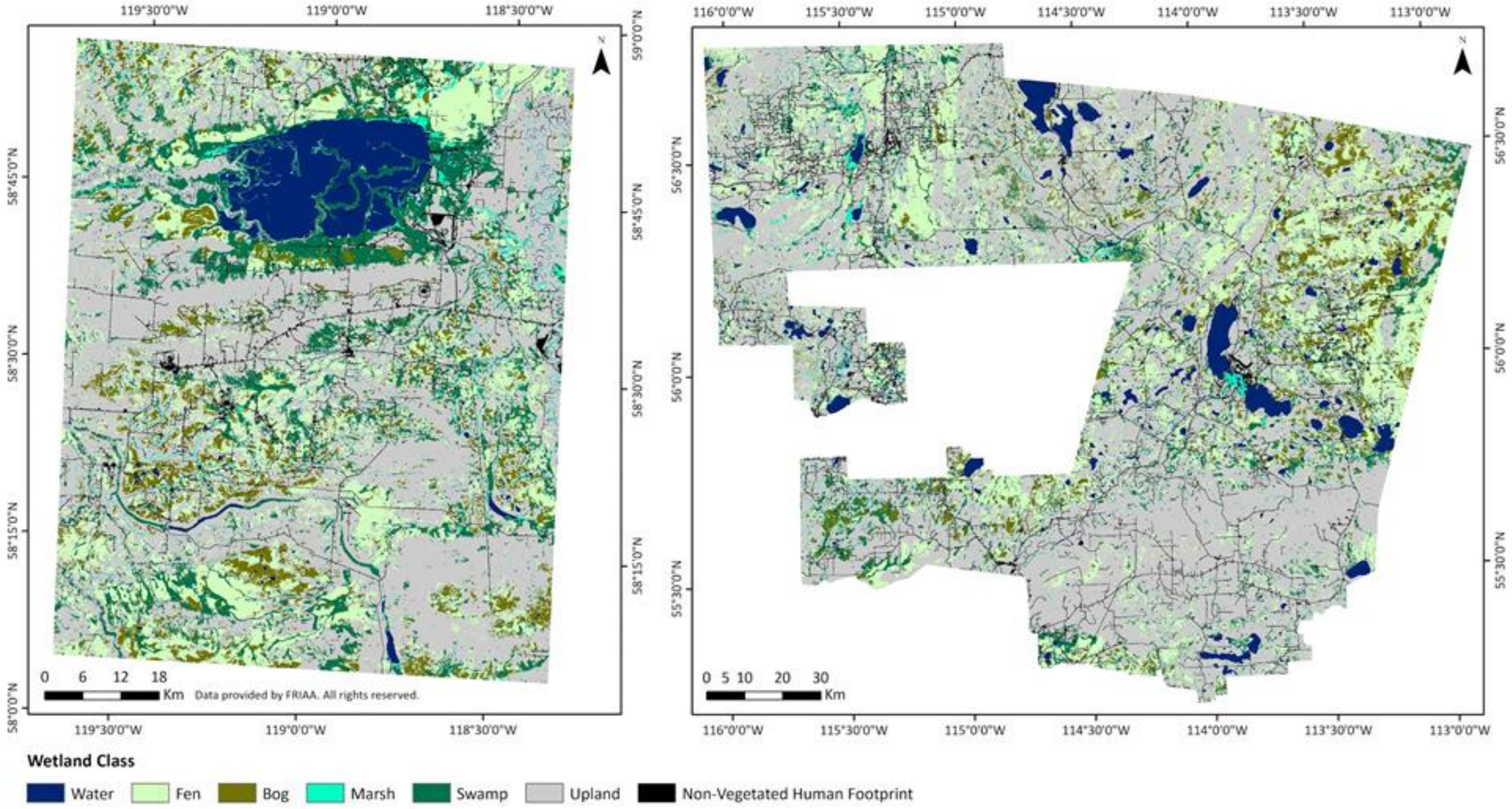
Results

Boreal Validation

			Overall Accuracy (%)		
Pilot	**AI Model**	**Inputs**	**Wetland vs. Upland** (Standard 90%)	**Class** (Standard 80%)	**Form** (Standard 70%)
Boreal-1	Deep Learning	Important features	**98**	**82**	58
		Important features + lidar	96	68	71
	Machine Learning	Important features	95	72	-
		Important features + lidar	97	78	**74**
		Accuracy Benchmark	✓	✓	✓
Boreal-2	Deep Learning	Important features	95	81	63
		Important features + lidar	95	81	65
	Machine Learning	Important features	96	84	-
		Important features + lidar	**98**	**87**	**70**
		Accuracy Benchmark	✓	✓	✓

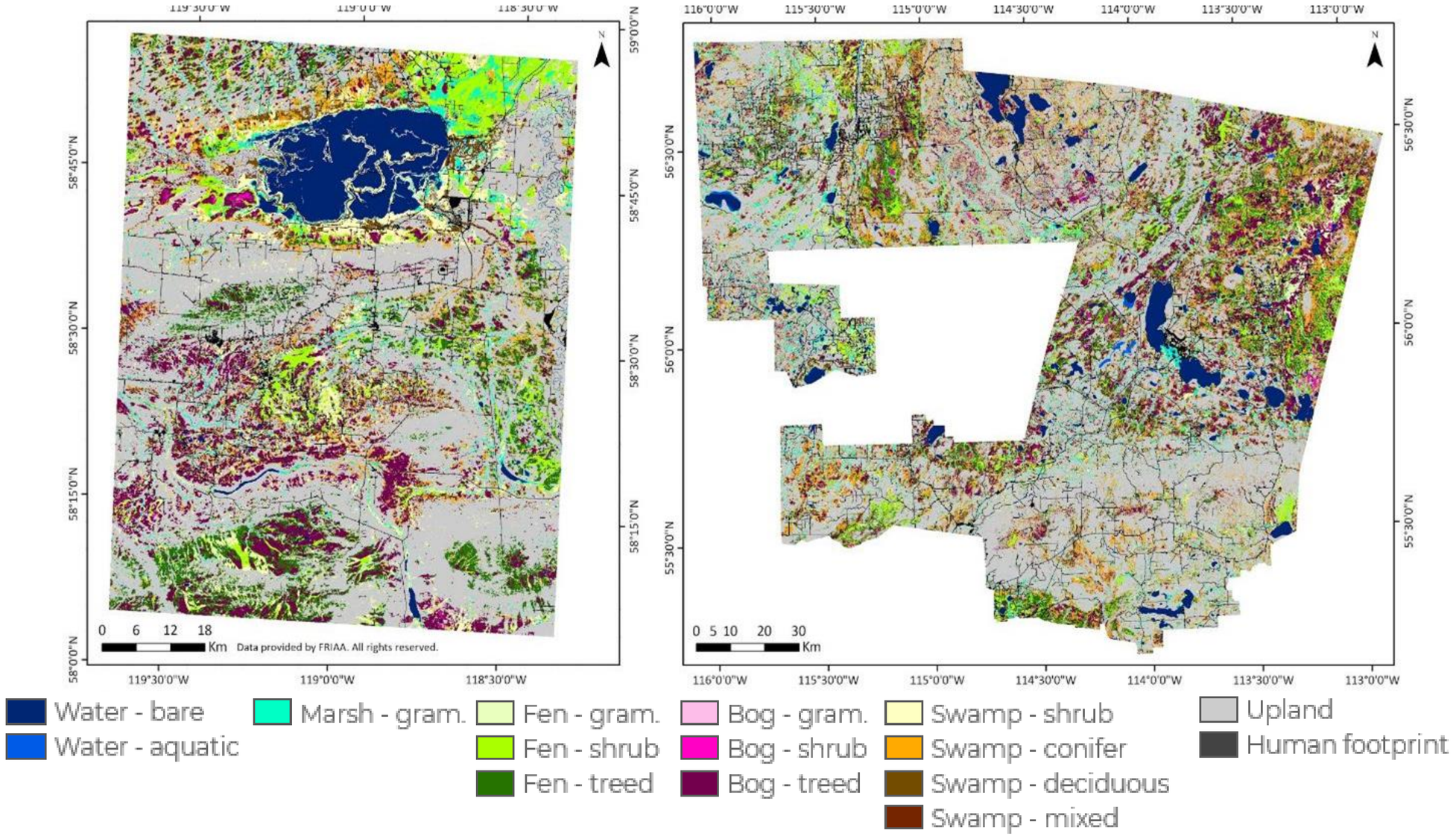
Results

Boreal Class Deep Learning



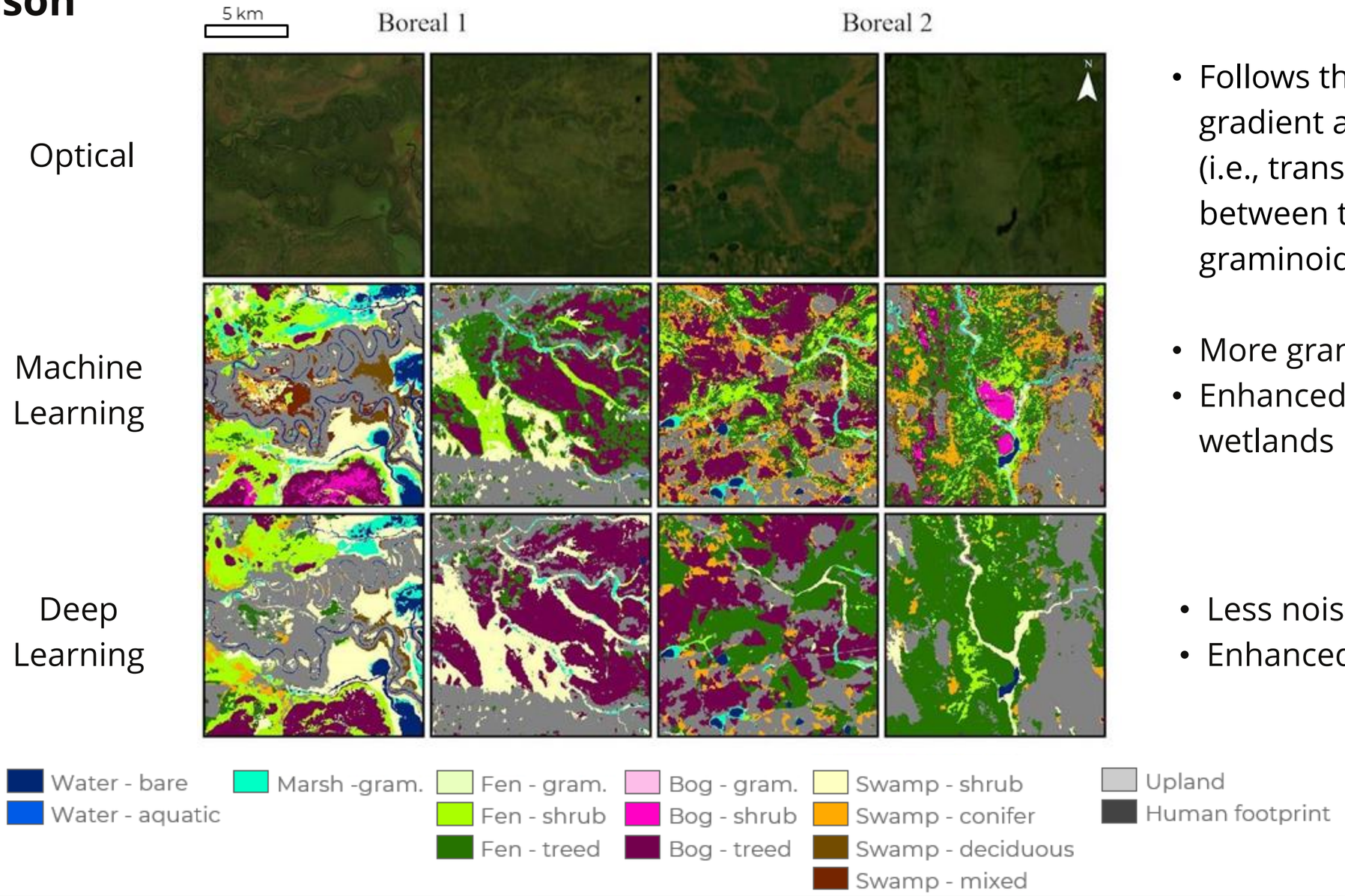
Results

Boreal Form Machine Learning



Results

Comparison



- Follows the ecological gradient at the form level (i.e., transitional boundaries between treed, shrub and graminoid)

- More granular
- Enhanced detection of rare wetlands

- Less noise
- Enhanced boundaries

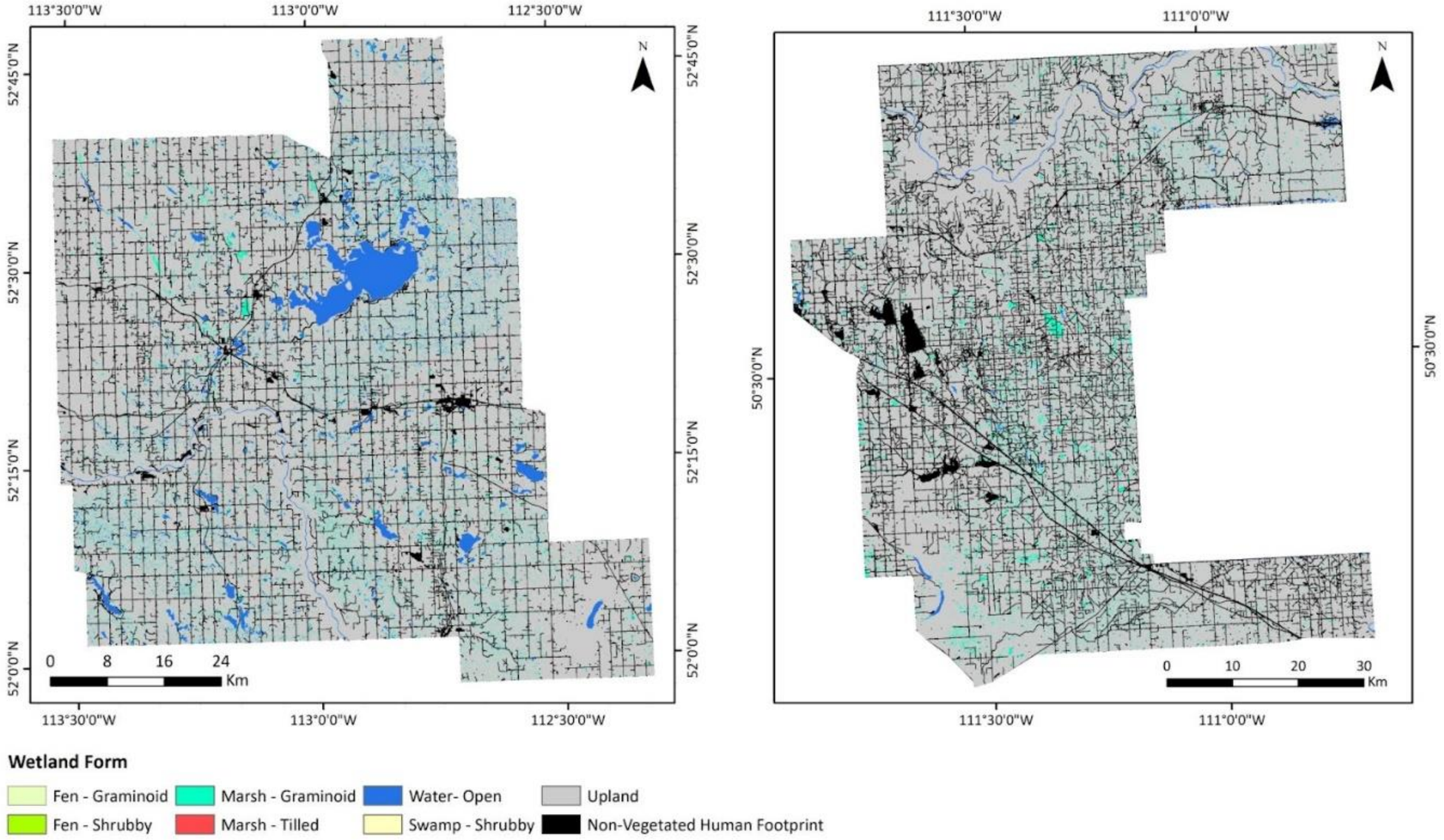
Results

Prairie Validation

			Overall Accuracy (%)		
Pilot	**AI Model**	**Inputs**	**Wetland vs. Upland** (Standard 90%)	**Class** (Standard 80%)	**Form**
Parkland-1	Deep Learning	Important features + LiDAR	85	64	64
	Machine Learning	Important features + LiDAR	**87**	**66**	**66**
Accuracy Benchmark			✗	✗	
Grassland-1	Deep Learning	Important features + LiDAR	**93**	**95**	**95**
	Machine Learning	Important features + LiDAR	83	82	82
Accuracy Benchmark			✓	✓	

Results

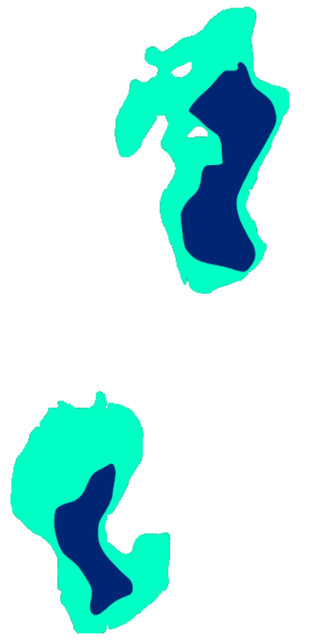
Prairie Validation

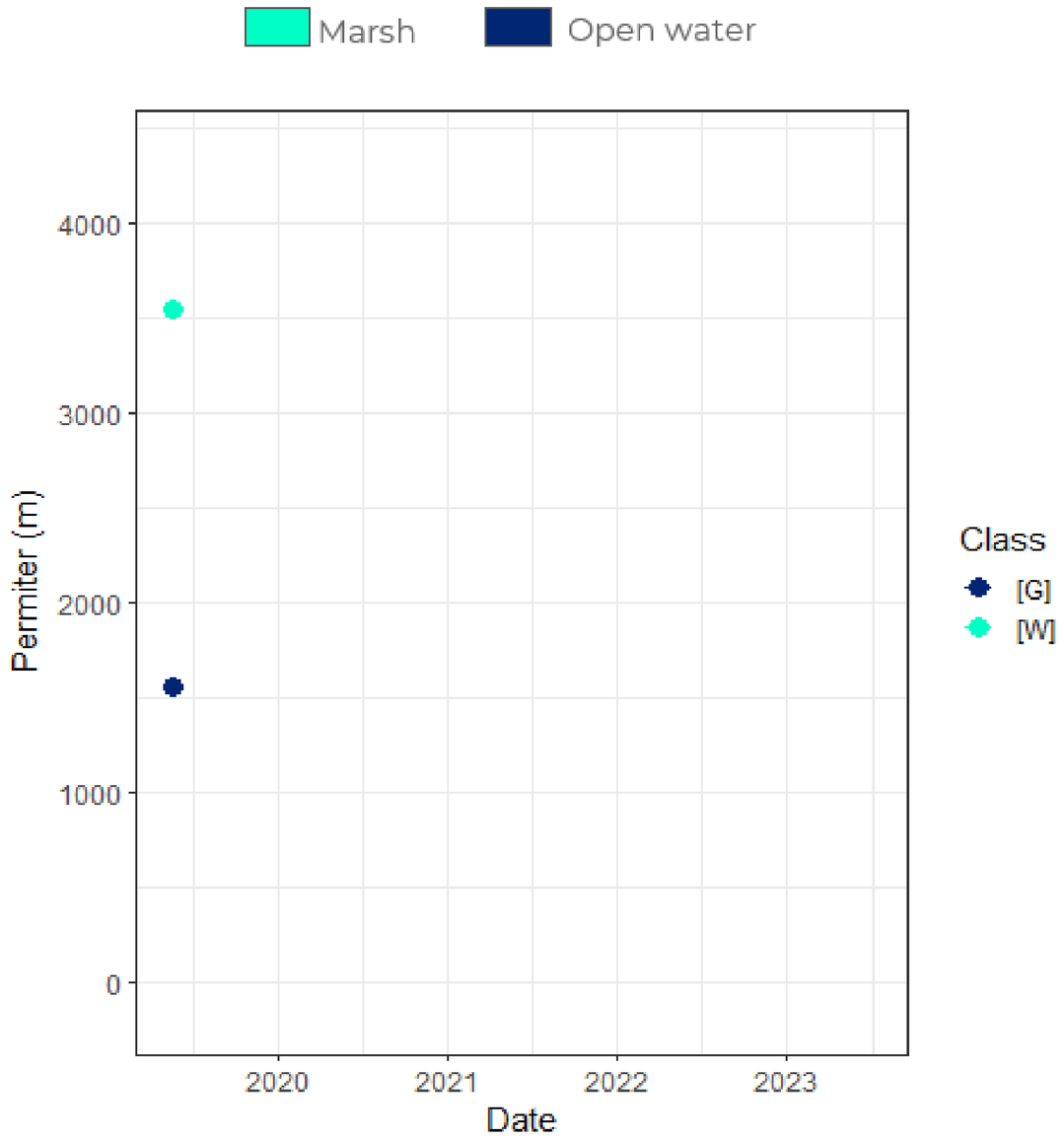


Results

Parkland vs Grassland

- Parkland
  - More complex veg.
  - High seasonal variability
  - Most wetlands <1ha
  - Challenging to align satellite imagery with ground validation

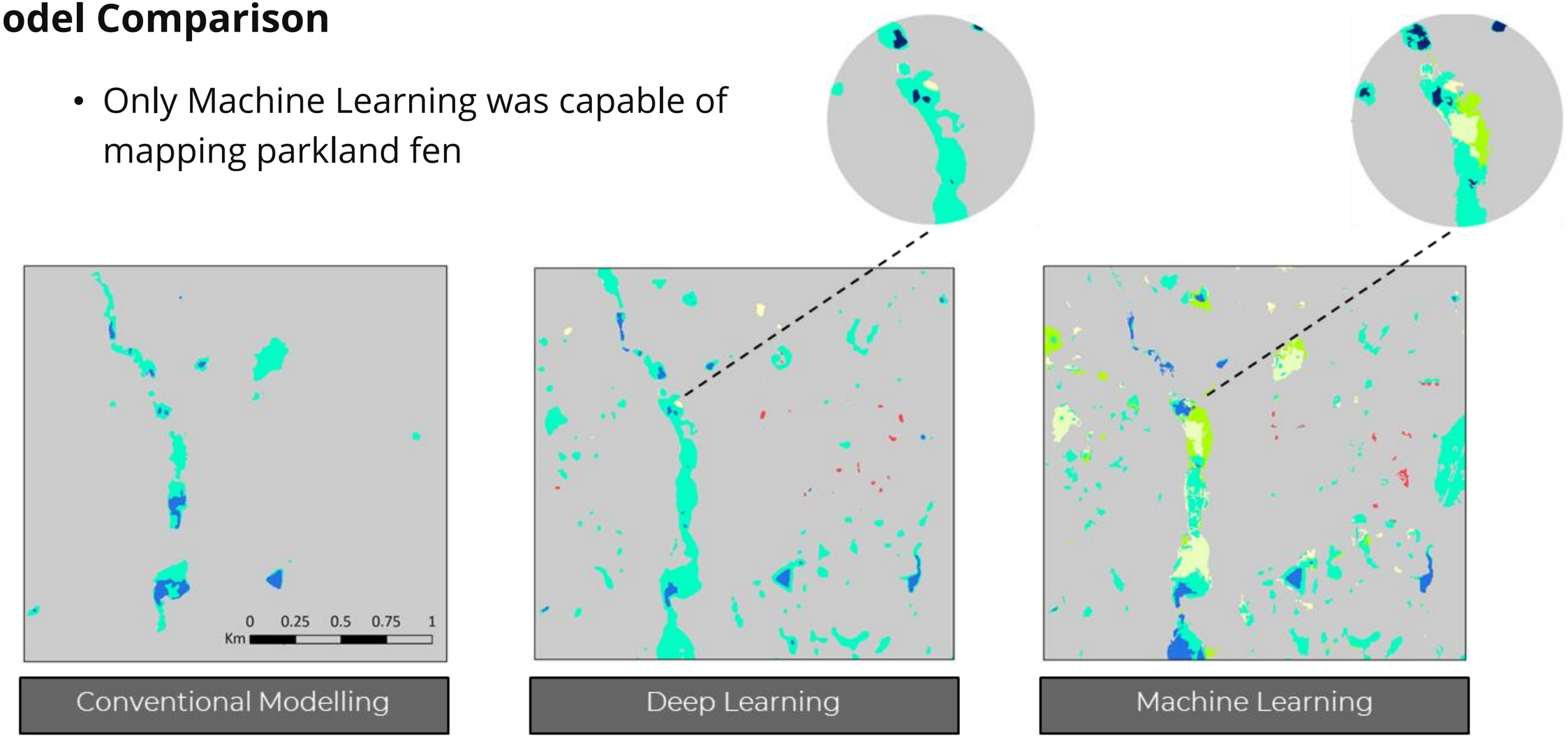




Results

Model Comparison

- Only Machine Learning was capable of mapping parkland fen



Take away Message

Key takeaways

1

Successfully Met Standards

Pilot project successfully tested and advanced AI methods. The top DL or ML methods in 3 pilot areas met the GOA's wetland mapping standards for accuracies >70%.

Resolution matters

2

DL vs ML

Machine learning based methods require higher accuracy in the training data, whereas DL methods require more training data.
We recommend a hybrid ML/DL approach for the model pipeline.

3

LiDAR

In the Boreal, LiDAR had a significant impact on the form level. In the Prairie, bare earth is critical for defining isolated depressions, but point cloud derivatives (i.e., CHM) were negligible.

4

Field Data

Dedicate appropriate resources to collecting a large, detailed, and representative field reference dataset.
Focus on rare or unique forms.

NAWM's Wetland Mapping Consortium

Thank you!

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