Summary Notes – Annual General Meeting | April 9–10, 2025
Theme: Wetlands as Nature-Based Solutions

Contents

DISCLAIMER: These summary notes were automatically generated by AI based on the video transcripts from the principal investigators' presentations held online on April 9 and 10, 2025.

This was the third edition of the Annual General Meeting.

SUMMARY OBJECTIVE 1. Develop authoritative estimates of landscape-scale density of wetland coverage for agricultural landscapes

Presenter: David Lobb

Objective 1 aimed to produce landscape-scale estimates of wetland coverage density across Canadian agricultural landscapes, focusing on Prairie and Great Lakes regions. The team compiled, harmonized, and validated existing wetland databases from 1970 through 2024, negotiating data-sharing agreements for proprietary inventories. We have generated Landsat-derived subpixel water fraction (SWF) maps in August 2023 and revised inventories in May 2024 using inundation-frequency thresholds validated against Ducks Unlimited Canada data. Integration of Sentinel-2 optical imagery, Sentinel-1 radar, and LiDAR-derived geomorphometric indices via statistical learning improved classification accuracy. Detailed field studies quantified sediment, organic carbon, and nutrient transfers within wetland catchments. A holistic managed-versus-unmanaged wetland framework was developed to inform greenhouse gas inventories. Output products now support other objectives and policy briefs. Additional projects also funded by ECCC will allow advances in automation and including AI enhancements enable more scalable monitoring.

1. Database Compilation and Harmonization

The first major task was to compile and harmonize all existing wetland inventories. Federal, provincial and non-profit organizations supplied published and unpublished datasets. The team negotiated memoranda of understanding and data-sharing agreements with conservation authorities to access proprietary wetlands data. Technical staff consolidated these diverse sources into a unified database, standardizing spatial resolution and classification schemes. The resulting dataset spans from 1970—used as a reference year for residual emissions—to 2024, aligning with key reporting benchmarks (1990, 2005, 2025, 2030 and beyond).

2. Extending and Validating Time Series

To capture both historical and recent wetland dynamics, the team extended mapping efforts back to 1970 and forward through 2024. They employed Landsat imagery to produce a continuous subpixel water fraction (SWF) time series for 1984–2020. Multiple minimum inundation-frequency thresholds (from one to ten years within a ten-year window) were tested against high-resolution inventories provided by Ducks Unlimited Canada. This validation identified optimal thresholds to balance omission and commission errors. The first version of SWF-based wetland maps was published in August 2023. In May 2024, a revised inventory was released—mitigating overestimation caused by major flood years—ensuring greater accuracy for both water-covered and seasonally inundated wetlands.

3. Integration of Additional Remote-Sensing Data

To improve spatial and temporal resolution beyond Landsat's 30 m and 16-day revisit, the team integrated Sentinel-2 optical imagery, offering 10 m resolution and a 5-day revisit interval. They also incorporated radar (Sentinel-1) to detect inundation under cloud cover and to capture fine-scale surface water dynamics. LiDAR-derived geomorphometric indices, such as microtopographic curvature and depression storage, were generated to distinguish wetlands from upland water bodies. A statistical learning framework fused these multi-sensor inputs, enhancing classification accuracy, especially in complex or densely vegetated wetlands.

4. Analyzing Wetland Spatial Structure and Catchments

The team conducted field campaigns to characterize the spatial structure of representative wetlands and their catchments. They mapped hydrologic units including wetland cores, inner and outer riparian zones, and upland slope positions. Systematic transects from wetland centers to catchment edges captured gradients in soil organic carbon, sediment accumulation and vegetation communities. Analysis revealed that riparian zones at the footslope function as critical sinks for sediment and nutrients delivered by tillage, surface runoff and wind erosion. Quantifying lateral transfers of sediment-associated carbon highlighted the importance of catchment-scale management for greenhouse gas mitigation.

5. Managed vs. Unmanaged Wetland Classification

A core technical question addressed whether agricultural landscape wetlands should be classified as managed or unmanaged for national greenhouse gas inventory purposes. The team reviewed jurisdictional approaches—Canada currently treats all wetlands as unmanaged, whereas the United States largely considers them managed except in truly remote areas. Through literature review and stakeholder workshops, they identified key factors informing "managed" status: direct human alteration, catchment-scale land management, permanence of alteration, and governance responsibilities. The team proposed a holistic definition that accounts for both direct manipulation (drainage, restoration) and indirect influences (adjacent tillage, nutrient runoff), enabling more inclusive carbon accounting.

6. Developing Data Products for Policy and Science

Building on mapping and classification work, the team generated a suite of wetland data products:

- **Inundation Probability Maps:** Annual probability surfaces derived from SWF time series, showing persistent and ephemeral wetlands.
- **Recharge vs. Discharge Wetland Classification:** Using Landsat thermal bands to infer groundwater interactions for subregions like Alberta's Beaver Hills Moraine.
- **Wetland-Type Maps:** Statistical learning outputs combining optical, radar and topographic indices to classify freshwater wetland types relevant to carbon modeling.

These products are integrated with Objective 2's greenhouse gas flux measurements to scale site observations to landscape estimates, and to inform hydrological process models for Objective 3.

7. Automation and Continuous Improvement

Recognizing the cost and labor of manual updates, the team developed automated workflows for large-area wetland monitoring. They prototyped breakpoint-detection algorithms to identify abrupt changes in SWF time series—indicating drainage events or restoration activities. They are also exploring AI-driven classification methods, leveraging convolutional neural networks trained on multi-sensor imagery to improve accuracy and repeatability. Future enhancements include extending SWF methods to higher-resolution optical sources and deeper integration of ancillary land-use data for context-aware mapping.

8. Cross-Objective Integration and Publications

With Objective 1 outputs now stable, the team is feeding wetland coverage and classification data into other objectives:

- **Objective 2 (Carbon Accumulation):** Scaling up plot-level carbon stock measurements across mapped wetlands.
- **Objective 3 (Hydrological Controls):** Modeling organic carbon transport influenced by watershed connectivity.
- **Objective 4 (Synergies & Conflicts):** Assessing carbon benefits versus agricultural impacts at regional scales.
- **Objective 5 (Policy & Practice):** Developing decision-support tools and incentive mechanisms informed by wetland distribution and management status.

Results have been drafted for publication in journals such as *Agricultural Systems* and for presentations at national conferences. Preliminary policy briefs are in preparation to guide Environment and Climate Change Canada on updating wetland inventory protocols.

9. Anticipated Impacts and Next Steps

Objective 1 has delivered a robust, time-series wetland coverage database and advanced mapping methodologies that are largely complete. The team expects the following impacts:

- **Improved National Inventories:** Providing data to include wetlands in Canada's greenhouse gas reporting.
- **Policy Influence:** Informing land-management guidelines that balance carbon sequestration with agricultural productivity.
- **Automated Monitoring:** Establishing scalable workflows for routine updates and change detection.
- **Stakeholder Engagement:** Equipping farmers and conservation authorities with spatially explicit wetland information.

Ongoing work includes finalizing breakpoint-detection methods, refining AI classification models, and extending inventories to peatland and non-agricultural settings under controlled uncertainty thresholds. Continuous collaboration with technical partners will ensure that wetland coverage estimates remain authoritative, repeatable and ready to support Canada's climate action goals.

SUMMARY 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 waters

Presenter: Pascal Badiou

The research team compiled historical core and flux datasets from sites in Southern Ontario, the Prairie Pothole Region, and Atlantic Canada to determine organic carbon sequestration rates and methane emissions. We have harmonized chamber, dissolved gas, and eddy covariance protocols and explored innovative methods such as drone-based sampling. Subtask 2.3 involved deploying measurement networks, including chamber arrays and flux towers, in diverse wetland types to quantify seasonal and spatial variability in CO_2, CH_4, and N_2O exchange. Preliminary data synthesis revealed winter methane accumulation under ice, differential fluxes by hydrology and land use, and significant diffusive emissions in cropland-embedded wetlands. Some researchers have also developed machine learning and remote sensing approaches for upscaling flux estimates and began modeling carbon sequestration potential under future climate scenarios.

Summary

Objective 2 addresses the quantification of organic carbon accumulation rates, greenhouse gas exchanges, and lateral carbon transports in Canadian wetland systems over years 1–5 of the project. Building on pilot work from 2013, the effort grew into a national-scale collaboration between Ducks Unlimited Canada (DUC), the University of Toronto, the University of Lethbridge, McGill University, the University of Manitoba, and industry partner Ducks Unlimited Canada. The project team includes more than 20 principal investigators and over 60 highly qualified personnel, with graduate students, postdoctoral researchers, and field biologists conducting the bulk of field sampling and laboratory analyses.

A critical early activity was the integration of extensive historical coring and flux data. Sediment cores collected across Atlantic Canada, Southern Ontario, and the Prairie Pothole Region under previous SPG and carbon projects were reanalyzed to establish baseline organic carbon stocks. Graduate work by Purbasha Mistry combined Cs-137 and Pb-210 dating with carbon concentration profiles to derive annual sequestration rates for intact wetlands. Parallel efforts by Shizhou Ma compiled chamber-based methane flux measurements from legacy projects and ongoing studies, creating the first comprehensive greenhouse gas dataset spanning the Peripothole Region. This compilation highlighted clear spatial and temporal patterns in carbon stocks and emissions.

To ensure data comparability, the team harmonized field and analytical protocols (Subtask 2.2). They standardized chamber designs, dissolved gas sampling procedures, and eddy covariance methodologies, drawing on expertise from Sara Knox and Larry Flanagan's labs. Technique exchanges and student workshops facilitated consistent dissolved gas handling, bubble trap deployment, and covariance data processing. Innovative approaches were piloted, including equipping a Splash drone with gas-sampling modules to collect minimally disturbed water samples from wetland centers. Above- and below-ground biomass measurement protocols were also aligned across multiple sites to link vegetation dynamics with carbon fluxes.

Subtask 2.4, which focuses on lateral carbon flows into and out of wetlands, remains under review. The team recognized challenges in quantifying solute and particulate transport, particularly in Prairie pothole systems. Plans are underway to re-strategize sampling designs or explore tracer studies, building on opportunities identified during the network meeting. Meanwhile, Subtask 2.5 work on predictive modeling progressed in parallel through machine learning and remote sensing. Early models developed by Shizhou Ma employ regional predictor variables to estimate sequestration rates, while integration with GWP★ metrics by Shizhou enables assessment of wetlands' long-term radiative impacts beyond the standard 100-year horizon.

Subtask 2.3, the core measurement program, deployed chamber arrays and flux towers across more than a dozen sites to capture greenhouse gas exchanges in diverse wetland contexts. A map presented during the meeting illustrated monitoring locations from coastal freshwater impoundments in Atlantic Canada to restored prairie potholes in Manitoba and beyond. Each site network measures CO_2, CH_4, and N_2O exchanges across seasons, capturing spring thaw responses, summer peaks, and winter under-ice dynamics.

In Atlantic Canada, Gail Chmura's group at McGill conducted monthly measurements of both diffusive and ebullitive methane fluxes in freshwater impoundments. Graduate students Wendy Ampuero, Arunabha Dai, and Rachel Plant quantified biomass of emergent vegetation such as cattails, developing predictive equations for vegetation age and biomass to link plant dynamics with gas emissions. Winter sampling under ice revealed unexpectedly high methane accumulation, suggesting that a pulse of gas release may occur during melt.

At the Attica Bay site near Toronto, Christian von Sperber's team studied seasonal methane trends in a large intact wetland. They tested the hypothesis that methane concentrations would peak during low-water, high-temperature summer conditions. Field observations included dramatic bubbling events recorded on video, where algal mats detached, and methane bubbles streamed to the surface. Additional experiments assessed the impact of goose droppings and manure applications, showing that higher inputs of both substrates led to significantly increased methane emissions—an insight relevant for managing waterfowl staging areas.

In the Prairie Pothole Region, Matt Bogard's lab extended earlier flux studies to all three soil zones. Initial work in the Black Soil Zone revealed that cropland-embedded wetlands had higher phosphorus and lower sulfate concentrations, correlating with elevated methane emissions compared to perennial cover sites. Expanded sampling across Alberta's northern, central, and southern wetlands is investigating stoichiometric controls on gas fluxes and ecosystem respiration, with intriguing counter-intuitive trends in evapotranspiration and isotopic signatures. These findings will be tested against data from additional British Columbia and Ontario wetlands.

High-frequency flux towers provided continuous measurements at key sites. In Manitoba, towers at a cropland wetland, a perennial cover wetland, and Oakhammock Marsh captured diurnal cycles of net ecosystem exchange and methane flux. The marsh site exhibited the highest methane emissions, underscoring the role of wetland depth and management history on flux magnitude. Ducks Unlimited Canada's Ameriflux data portal now hosts publicly available tower data, with thousands of downloads demonstrating broad scientific interest.

Modeling activities leveraged these rich datasets. Machine learning algorithms are predicting regional carbon sequestration potentials, while remotely sensed indices—such as NDVI and NDBI moisture metrics—are calibrated against in-situ flux measurements to enable spatial upscaling. Darion Ing's work uses satellite-derived moisture indices to estimate methane emissions beyond tower footprints. Larry's team applies scaling approaches combining photon flux density and vegetation indices to project overall carbon budgets.

Looking ahead, the project will refine Subtask 2.4 strategies for lateral flux quantification, explore biological export pathways of carbon via fauna, and test soil amendments like calcium sulfate to mitigate methane in restored wetlands. Plans for an experimental wetland drainage study aim to quantify emissions and carbon stock changes upon dewatering. Anticipated impacts include generation of regionally specific emission factors for Canadian agricultural wetlands, improved wetland management guidelines, and enhanced mapping of climate-positive conservation targets. Collaboration with Objectives 1, 3, and 5 will integrate flux data into larger modeling and policy analyses, ensuring that Objective 2 outcomes inform future nature-based climate solutions at national scales.

SUMMARY OBJECTIVE 3. Develop robust estimates of hydrological process controls on organic carbon accumulation and greenhouse gas fluxes.

Presenter: George Arhonditsis

We collected GIS and satellite data across our Lake Winnipeg and Lake Erie basins to map wetland connectivity. Ameli's team used models on over 20 million observations to predict groundwater table depth at 500-meter resolution and to classify wetlands as groundwater sources or sinks. UofT employed the SPARROW regression model to estimate phosphorus export by land use, identifying greenhouse operations as the highest per-area contributors. At farm scale, we applied the HOLOS model to simulate methane and nitrous oxide emissions under varying livestock diets. We developed a nested mechanistic model representing carbon cycling, macrophyte dynamics, and sediment diagenesis, with open-source tools under development. We will integrate triad chronosequence data to predict carbon flux changes under future restoration scenarios.

Detailed Summary

We initiated Objective 3 to develop robust estimates of hydrological process controls on organic carbon accumulation and greenhouse gas fluxes in agricultural wetlands. We assembled a multidisciplinary team including modelers, technicians, postdoctoral researchers, and graduate students. We collected data across our network of wetland sites in Southern Ontario, the Prairie Pothole Region, Lake Winnipeg basin, and Lake Erie basin. We prioritized GIS, airborne, and satellite imagery to characterize spatial and temporal wetland connectivity. Our vision has expanded beyond the initial process-based mechanistic models to incorporate data-driven approaches and to address carbon, nitrogen, and phosphorus cycling.

We defined three modeling scales to connect our approaches. At the basin scale, we developed coarse resolution annual models to assess watershed-level carbon, nitrogen, and phosphorus fate and transport. At the watershed scale, we implemented mechanistic models to identify hot spots and hot moments of hydrological connectivity between wetlands and stream networks. At the farm scale, we applied the HOLOS model to simulate greenhouse gas emissions and soil carbon processes at fine spatial and temporal resolution. We maintain a library of models and foster bidirectional feedback between scales to refine predictions and guide future iterations.

We collected field observations and harmonized measurement protocols for chamber flux arrays, eddy covariance towers, and dissolved gas sampling across diverse wetland types. We integrated these in situ measurements with GIS and remote sensing products to map hydrological connectivity. Ameli's group developed an XGBoost-based machine learning framework using over 20 million real observations to predict groundwater table depth at 500-meter resolution. This model outperformed conventional Darcy-based numerical simulations and achieved high prediction fidelity. We further classified wetlands as groundwater sources or sinks and distinguished ephemeral, seasonal, and perennial surface and subsurface connections. This database underpins our connectivity analyses and informs both mechanistic and regression-based modeling efforts.

We applied the SPARROW regression model to estimate phosphorus export across sub-watersheds in the Lake Erie and Lake Winnipeg basins. We calibrated the model using land use attributes, climate, soil, and topographic predictors. Our results revealed that greenhouse operations contribute the highest per-area phosphorus loads, while cropland and urban areas present substantial cumulative exports. We accounted for potential bias by integrating literature-derived coefficients when observational coverage was limited. We visualized phosphorus export both as total annual mass per sub-watershed and as normalized yield per unit area. These insights inform nutrient management scenarios and support the development of web-based interactive tools for scenario analysis.

At the farm scale, we implemented the HOLOS model to quantify methane and nitrous oxide emissions in the Lake Erie agricultural watershed. We ran model simulations for four years (2001, 2006, 2011, and 2016) and distinguished emissions by source: enteric fermentation, manure management, direct and indirect nitrous oxide, and farm energy. We evaluated county-level contributions and linked spatial patterns to livestock diet assumptions, testing seven diet scenarios. We quantified uncertainty through ensemble outputs and identified northeastern counties as hotspots for greenhouse gas fluxes, contrasting with phosphorus export hotspots in the western basin. These results guide targeted mitigation strategies and inform linkages between nutrient and carbon management.

We developed a nested mechanistic model framework to represent organic carbon cycling within wetlands. We structured the model to include state variables for dissolved and particulate organic carbon, macrophyte biomass, phytoplankton productivity, and sediment diagenesis. We parameterized microbial processes in aerobic and anaerobic zones to capture oxygen dynamics and carbon transformations. We configured model modules to activate or suspend specific processes depending on wetland type and data availability. We designed the framework as an open-source tool to facilitate adaptive refinement and user-driven customization. We enlisted expertise in peatland wetland modeling by collaborating with Dr. Betty Ehnvall from Sweden, who will apply our process models to two drained and restored peatland triads to validate transferability and identify necessary adjustments for Canadian wetland contexts.

We developed web-based interactive computer tools to allow scenario analysis of hydrological, biogeochemical, and greenhouse gas projections under varying climatic and land management scenarios. We integrated outputs from basin, watershed, and farm scale models into a unified platform for user-driven exploration. We compiled a parameter database through literature review and Bayesian bias inference techniques to support model calibration when observational data are sparse. We published an accepted manuscript on hydrological connectivity modeling in Advances in Water Resources and we plan additional manuscripts on phosphorus export and greenhouse gas simulation in agricultural wetlands.

Our next steps involve integrating triad chrono sequence datasets from intact, drained, and restored wetlands to develop statistical relationships between soil profile changes and carbon flux dynamics under different land management scenarios. We plan to enhance model interoperability by defining common data standards and metadata protocols. We will refine user interfaces for the web tools and develop training materials for stakeholders. We will continue to coordinate with international collaborators and field teams to update process parameterization and support policy-relevant scenario planning.

SUMMARY OBJECTIVE 4. Develop robust estimates of the synergies (and conflicts) of wetlands as nature-based solutions for carbon storage versus other benefits.

Presenter: Irena Creed

We initiated Objective 4 to integrate data from Objectives 1–3 and develop a planning tool quantifying synergies and trade-offs among wetland functions. We formed a cross-cutting cluster of researchers and consultants and assigned a theme lead to develop an uncertainty calculator. We defined guiding principles: relevance to climate and water security, transparency, observability via geospatial datasets, transferability across jurisdictions, and interoperability with policy systems. We mapped conceptual linkages among wetland structure, functions, supply, and socioeconomic benefits. We piloted quantitative methods for carbon sequestration and economic valuation, revealing higher benefit-cost ratios for intact wetland protection than for restoration based on carbon alone. We have a prototype web app supporting real-time scoring, with Bow River as our western case study and plans to select an eastern watershed. We invite collaborators to refine indicators, finalize consensus terms for deployment.

Summary

We launched Objective 4 to build scalable planning tools that quantify synergies and trade-offs among wetland ecosystem functions, with a focus on carbon storage and complementary co-benefits. We structured our workflow around knowledge synthesis from the first three objectives to generate actionable outputs for policy and management. To support this integration, we formed a cross-cutting cluster of researchers and consultants and assigned a theme lead to develop an uncertainty calculator.

We defined five guiding principles to steer tool development. First, we prioritized relevance to climate and water security targets, recognizing the intensifying need for municipal and regional planners to anticipate hydrologic risks. Second, we committed to transparency and open, reproducible methods, enabling peer review and continuous improvement. Third, we emphasized observability by ground-truthing with geospatial indicators derived from airborne and satellite imagery, reducing reliance on labor-intensive field sampling. Fourth, we ensured transferability by designing tools applicable across agricultural and urban landscapes. Fifth, we established interoperability to integrate with carbon accounting frameworks, biodiversity tracking systems, and land-use planning platforms.

At the conceptual core, we articulated clear definitions for key terms: wetland function, ecosystem service supply, and social or economic benefit. We refined our terminology through iterative discussions, guided by a matrix linking ecological processes, benefit-relevant indicators, and realized benefits. For wetland function, we described hydrological, biochemical, and ecological processes such as photosynthesis, respiration, and redox dynamics. For service supply, we specified capacity metrics, for example, carbon sequestration potential quantified by belowground biomass accumulation and greenhouse gas flux measurements. For human benefit, we linked ecosystem service supply to socioeconomic outcomes, such as carbon credit valuation or water quality improvements, shaped by access, demand, and policy context.

We designed a dual planning approach to address both conservation and restoration pathways. Under the avoidance branch, we assess existing wetlands to prevent further degradation and maximize retention of high-functioning sites. Under the enhancement branch, we simulate restoration or rehabilitation scenarios to elevate ecosystem service supply, incorporating the lift function that quantifies incremental gains from management interventions. This dual focus supports natural climate solution implementation and aligns with funding mechanisms under Canada's Climate Action Fund and the Nature-smart Climate Solutions program.

Our step-by-step workflow for carbon highlights integration of within-wetland processes, exchange with contributing catchments, and lift effects. We catalogued potential indicators for internal sequestration, including species composition, plant productivity, soil mineral interactions, and hydrologic regime metrics. We identified exchange indicators such as groundwater depth, perimeter-area ratio, and dissolved organic carbon leaching. We specified lift indicators related to restoration activities, including drainage reversal, buffer strip installation, and adaptive land use practices. We plan to apply statistical learning techniques, such as random forests or deep neural networks, to model benefit-relevant indicators based on remotely sensed and field data inputs.

We piloted our economic valuation framework using the Prairie Pothole Region extension project. We assessed restoration costs from Ducks Unlimited Canada's financial records, including site preparation, labor, and opportunity costs. We applied a 30-year time horizon for sequestration and adopted a carbon price trajectory of CAD 50 per tonne incrementing by CAD 15 annually. Our benefit-cost analysis revealed that intact wetlands produce benefit-cost ratios above one, indicating positive net returns solely from carbon storage benefits. By contrast, restored wetlands exhibited ratios below one on average, underscoring the need to stack multiple co-benefits for financial justification.

To facilitate stakeholder engagement, we developed a prototype web application that automates calculation of functional scores and benefit indices at multiple scales. Users can select planning units, ranging from sub-watersheds to municipal boundaries, and visualize color-coded wetland scores. The app supports real-time recalculation as site conditions or policy parameters change. We demonstrated this functionality using the Bow

River watershed in southwestern Alberta as our inaugural pilot. We are now evaluating candidate watersheds in eastern Canada, with input from provincial Ducks Unlimited offices to leverage high-resolution wetland inventories.

We are assembling socio-economic datasets to underpin benefit translation modules. We recently acquired longitudinal agricultural census data spanning 1961 to the present. We catalogued over 600 variables, including farm area, livestock counts, irrigation metrics, fertilizer use, and market indicators. This data repository will enable us to calibrate economic models of wetland co-benefits such as flood mitigation, drought resilience, nutrient retention, and biodiversity enhancement. We encourage team members to identify additional metrics necessary for monetary valuation of non-carbon services.

Looking ahead, we invite ongoing collaboration to finalize consensus on terminology, indicator selection, and algorithmic weightings. We seek partnerships with Ducks Unlimited Canada, municipal planners, Indigenous communities, and federal agencies to test tool outputs in real-world decision contexts. We plan to present our conceptual backbone at the upcoming international wetland assessment symposium in Washington, DC to harmonize local, regional, and national tool architecture. We anticipate that additional resources, including personnel, computational infrastructure, and funding, will accelerate prototype refinement and pave the way for full deployment by year five.

SUMMARY OBJECTIVE 5. Use the authoritative and robust estimates of organic carbon accumulation and greenhouse gas fluxes to inform policy and practice tools to incentivize the use of wetlands as nature-based solutions for multiple benefits in agricultural landscapes.

Presenters: Guillaume Peterson St. Laurent, & John Pattison-Williams

We have engaged with ECCC's Nature Smart Climate Solutions Fund to generate authoritative estimates of organic carbon accumulation and greenhouse gas fluxes in wetlands, aiming to inform federal and provincial policy and practice tools that incentivize wetland conservation and restoration as nature-based solutions in agricultural landscapes. We developed geospatial baselines by mapping wetland conversion rates across Prairie Pothole and Great Lakes-St. Lawrence regions and conducted systematic reviews of conversion drivers. Our multi-provincial farm survey (n≈1,000) employed a choice experiment to derive farmers' willingness-to-accept for wetland retention and restoration, with preliminary results indicating higher participation willingness for retention, sensitivity to termination costs, and limited size effects. We will start working on integrating economic valuation and cost-effectiveness to develop a model to assess leakage.

Summary

In alignment with Objective 5, we have engaged with the Nature Smart Climate Solutions Fund to generate authoritative estimates of organic carbon accumulation and greenhouse gas fluxes in wetlands, aiming to inform federal and provincial policy and practice tools that incentivize wetland conservation and restoration as nature-based solutions in agricultural landscapes. We positioned our work within the Fund's science and delivery accountability stream, which supports improving baseline knowledge, informing short-term implementation needs, and establishing long-term learning and knowledge hubs. Our research activities span targeted ecosystems including freshwater mineral wetlands, coastal wetlands, cropland-embedded wetlands, forests, grasslands and peatlands, reflecting the Fund's multi-system focus.

We developed geospatial baselines by harmonizing historical wetland inventories and mapping land use change across two key regions: the Prairie Pothole Region and the Great Lakes-St. Lawrence Basin. We compiled polygon-level wetland area and density data from multiple inventories up to August 2023 and overlaid these with surface water and drainage networks. We generated annualized conversion rate maps and quantified spatial patterns of intact, partially drained, and fully drained wetlands. This spatial analysis provides precise estimates of historical wetland loss and informs projections of future change, serving as the foundation for ecosystem service quantification and policy scenario evaluation.

To understand the socio-ecological drivers of wetland conversion and retention, we conducted a systematic literature review of published studies on wetland loss drivers. We extracted themes related to agricultural expansion, urban development, hydrological modifications, policy instruments, economic incentives and cultural values. Our review identified gaps in consistent reporting of organic carbon fluxes, methane emissions under ice in winter, and the role of land use transitions. We synthesized these findings to inform survey design, model parameterization and policy tool development, ensuring that our subsequent empirical work addresses key knowledge needs without extrapolating beyond reported activities.

We designed and deployed a multi-provincial farm survey in partnership with a national agricultural panel, collecting responses from approximately 200 producers in each of Alberta, Saskatchewan, Manitoba, Ontario and Quebec. The survey comprised sections on farm characteristics, wetland context, a choice experiment to elicit farmers' willingness to accept voluntary wetland retention and restoration options, knowledge and perceptions of existing wetland policies, environmental attitudes, and demographic information. We mapped respondent locations by postal code to ensure regional representativeness. We also gathered self-reported data on past drainage, retention and restoration participation to calibrate model inputs for cost and leakage analyses.

Our preliminary choice experiment results reveal that farmers exhibit higher willingness to accept compensation for wetland retention compared to restoration, and they display limited sensitivity to the size of the wetland area under contract. We found that contract termination costs significantly decrease participation likelihood, while variation in contract duration (25 versus 40 years) has no statistically significant impact. Engagement increases with policies that permit compensation within catchment areas, and past spending on drainage activities negatively influences program uptake. These insights guide payment design by emphasizing retention incentives, structuring termination clauses and aligning contract terms with farmers' operational preferences.

We integrated economic valuation and cost-effectiveness analyses with precision agriculture data to estimate carbon and productivity impacts of wetland conservation. By analyzing yield differences adjacent to drained, intact and partially drained wetlands, we quantified the opportunity cost of retaining wetlands in crop rotations. We further synthesized cost data from recent restoration and retention projects, producing meta-analyses for phosphorus retention, greenhouse gas mitigation and biodiversity co-benefits. We published our Prairie data in *Agricultural Systems* and are collaborating with the Great Lakes team to develop unified cost frameworks that compare restoration versus preservation under varying agro-ecological conditions.

To account for policy-induced leakage, we developed a conceptual and computational framework that links spatial patterns of retention and conversion with regional policy strength, urban expansion metrics, environmental attitudes derived from survey data and incentive structures. We are calibrating this model using empirically derived parameters from the choice experiment and geospatial layers of land use change. This framework will predict indirect conversion outcomes and quantify net mitigation benefits, supporting scenario-based decision support. We are designing an integrated decision-support tool that allows policymakers to evaluate trade-offs between program costs, carbon benefits, biodiversity outcomes and economic impacts under alternative policy options.

Throughout these activities, we have fostered cross-objective collaboration within five funded learning and knowledge hubs, including Indigenous-led initiatives and thematic hubs on forest, coastal wetlands, grassland and peatland systems. We continue to refine our methodologies, automate data processing pipelines and adapt our approach to reflect feedback from funders and Indigenous communities. Over the next phase, we will finalize manuscripts, disseminate key findings through policy briefs and producer outreach, and explore carbon market integration and AI-based analytics. These ongoing efforts will solidify robust evidence to guide nature-based wetland solutions, supporting the Fund's goals to achieve multi-million-ton annual emission reductions.

UPDATE ON DATA REPOSITORY, AND MAIN IDEAS FROM DAY 1

Presenter: Irena Creed

We attempted to establish a centralized data repository, encountering challenges with government, non-profit and consulting hosts. We pivoted by commissioning a custom web platform hosted outside university IT frameworks. We developed and tested a cost-effective solution, $15,000 versus a budgeted $350,000, and completed development with Build Great under Todd Fraser's guidance. (https://www.wetlandsolutions.org) We populated the platform structure with network data assembled by Diego, including presentations, publications and project metadata. We finalized a modernized logo and prepared for launch next month. We designed the platform to be sustainable, scalable and informative, enabling ongoing contributions from network members and integration of extension projects. We incorporated impact metrics to track downloads and engagement. We reallocated budget savings to fund additional network initiatives. We will publish the repository link and encourage active participation to enrich our collective knowledge base via our website and communication channels.

Detailed Summary

We launched Objective 5.1 with the goal of creating a sustainable, centralized data repository to consolidate all project outputs and ensure long-term accessibility across our network. Over a two-year period, we explored multiple hosting options to find a durable solution. We first approached federal agencies to house the repository, only to face a lack of institutional interest and restrictive IT policies that precluded reliable storage. We then engaged not-for-profit providers, but their proposals carried high upfront fees, far beyond our funding capacity, and relied on unstable revenue models. In parallel, we consulted strategic data management firms for custom solutions, but their cost projections vastly exceeded our budget and introduced unacceptable financial risk. Finally, we pursued collaboration with related ECCC Climate Action Fund extension projects, yet bureaucratic hurdles and incompatible university IT systems prevented integration.

Following these setbacks, we recalibrated our approach, abandoning the pursuit of centralized institutional hosting and pivoting to build a custom web platform hosted outside university infrastructure. We selected the startup Build Great to develop this solution, with Todd Fraser leading the technical implementation. Guided by our specifications for metadata standards, thematic organization and user contributions, the team delivered a functioning prototype on schedule. We incorporated a flexible architecture that reflects our project's five objectives and supports multiple extension projects concurrently.

Our bespoke platform demonstrated remarkable cost efficiency. We had budgeted CAD 350,000 for repository development and maintenance, but the custom web solution required only CAD 15,000 in expenditure. This produced CAD 335,000 in savings, which we promptly reallocated to underfunded network initiatives and emerging research ideas. By maximizing our purchasing power, we amplified the project's reach without compromising quality.

To seed the repository, we consolidated existing datasets, presentations and publications. Diego curated and structured the network's outputs into a cohesive directory that appears in the platform's left-hand navigation menu, organized by resource type and project objective. We established clear guidelines for content submission, metadata formatting and version control, ensuring consistency and discoverability. Early testing confirmed that users can rapidly locate key documents, filter by wetland type, geographic region or temporal phase, and download full datasets with minimal effort.

Recognizing the importance of a strong visual identity, we refreshed our branding by commissioning a new network logo. Build Great advised that our original emblem lacked long-term resonance, so we developed a modern symbol that conveys wetlands as dynamic, interconnected ecosystems. This logo can extend to future ecosystem domains, such as rivers or forests, enabling the platform to evolve beyond the scope of our current project.

We engineered the repository to be highly sustainable and scalable. By hosting on an external cloud environment, we circumvented university IT constraints while retaining full administrative control over updates, security and data backups. The platform's modular design allows new modules, such as an API or specialized analysis tools, to be integrated seamlessly in future phases. We also implemented a secure upload portal that validates incoming data against metadata standards, reducing manual oversight.

Impact measurement formed a core component of our development. We integrated analytics to track repository usage, capturing metrics on downloads, page views, contributor activities and session durations. These indicators will inform our reporting to ECCC and guide iterative improvements. Initial user feedback has highlighted the intuitive layout and comprehensive coverage of resources as strengths.

As we prepare for full launch, anticipated next month, we are finalizing user documentation and training materials. We will disseminate the repository link through network mailing lists, collaborative platforms and project newsletters, accompanied by tutorial webinars. We will encourage all network members to contribute their forthcoming publications, datasets and presentations, fostering a “tsunami” of information flow. Contributors will retain control over licensing and can update their submissions as new results emerge.

The repository also hosts our two existing CAAF extension projects, and its architecture enables us to onboard other funding streams, such as the NSERC Alliance grants, ensuring that all related climate and wetland initiatives can converge in a single platform. This extensibility reinforces our network goal of enhanced collaboration across objectives and disciplines.

Objective 5.1’s repository represents a pivotal achievement for our project. By navigating institutional barriers, adopting an agile startup partnership and rigorously controlling costs, we delivered a resilient, user-friendly knowledge base that will outlast the funding period. This infrastructure underpins our ability to mobilize knowledge into climate action by making our collective outputs accessible to policymakers, practitioners and fellow researchers. We look forward to leveraging this repository to drive synthesis papers, policy perspectives and data-driven decision support tools that advance wetland natural climate solutions.

WETLANDS ON NATIONAL INVENTORY REPORT

Presenter: Doug McDonald (ECCC AFOLU)

We integrated estimates of wetland drainage and carbon fluxes into our national greenhouse gas inventory framework under Objective 5.2. We compiled activity data on Prairie pothole drainage using remote sensing analyses over decadal windows (1990–2000, 2000–2010, 2010–2020), refined by an inundation-occurrence method and validated against the Prairie Habitat Monitoring Program’s surface ditching index. We incorporated land-use change rates into the Soil Landscapes of Canada database to ensure confidence. We reviewed literature on soil carbon pools and found Canadian data sparse, so we adopted the IPCC Tier 1 default carbon loss rate of 29 percent over 20 years and plan to transition post-20-year emissions into our Tier 3 cropland model. We evaluated methane emissions using USGS data, recognizing uncertainty, and we are developing spatially differentiated emission factors. We aim to integrate these results into the 2027 national inventory report.

Summary

Under Objective 5.2, we are integrating wetlands into Canada’s national greenhouse gas inventory by quantifying agricultural drainage impacts and associated carbon and methane fluxes in the Prairie pothole region. We collaborated with Environment and Climate Change

Canada's Science Policy interface, led by Douglas MacDonald, to align our approach with IPCC land-use change guidelines. We initiated a state of knowledge study in early 2024, led by Dr. Irena Creed, to compile all available data on wetland characteristics, drainage mechanisms, and greenhouse gas measurements for our inventory modeling framework.

Activity Data Acquisition:

We recognized that obtaining accurate activity data on wetland drainage is our greatest challenge. To address this, we:

- Applied remote sensing change-detection analyses over three decadal windows (1990–2000, 2000–2010 and 2010–2020) to identify persistent surface-water patterns indicative of drainage or consolidation rather than temporary flood events.
- Refined these observations using an inundation occurrence method under development by Doug McDonald's team and validated outputs against the Prairie Habitat Monitoring Program's surface ditching index.
- Filtered out confounding flood-year data—such as the extensive inundation in 2011—by comparing year-specific layers to long-term averages, ensuring that extreme weather events do not bias drainage estimates.
- Coordinated with ECCC's Landscape Science and Technology Division to access high-resolution imagery products and to support change-detection workflows developed by Daniel Idele.

We are integrating this activity data into the Soil Landscapes of Canada database. We aggregate fine-scale wetland loss rates to the soil landscape unit level when confidence thresholds are unmet, balancing spatial precision against data reliability.

Carbon Pool Analysis:

We structured our carbon accounting around three principal pools—live biomass, dead organic matter and soil carbon—following IPCC guidelines. Our literature review of Canadian wetland soil carbon studies revealed that:

- Available datasets are sparse, geographically uneven and lack standardized post-drainage sampling protocols.
- Many studies fail to apply equivalent soil mass methods, which impedes accurate cross-site comparisons.
- Mineral-soil isotope analyses often rely on short timeframes and inconsistent sampling depths, limiting their quantitative utility.

To address these gaps, we adopted a Tier 1 approach, using the IPCC default parameter of 29 percent carbon loss over 20 years for mineral soil wetland conversions. We defined disturbance matrices that describe carbon transfers from live biomass and dead organic matter to the atmosphere and to soil pools. We then coordinated with the U.S. Environmental Protection Agency's greenhouse gas program during a joint workshop to validate the simplicity and transferability of our mineral soil wetland methodology. We plan to transition all converted wetland areas into our Tier 3 cropland model after the initial 20-

year period, which will allow us to continue tracking carbon dynamics under ongoing agricultural management.

Methane Emission Assessment:

We found that Canadian measurements of methane emissions from prairie wetlands are limited to short-term field campaigns, resulting in high uncertainty. To strengthen our estimates, we:

- Leveraged spatially differentiated methane emission factors developed by USGS and curated by Sheel Bansal, acknowledging potential biases due to climatic and management differences across the Canada–U.S. border.
- Designed a validation strategy to compare these U.S.-derived factors against emerging Canadian field measurements generated by Pascal Badiou's team, enabling future refinement of emission factors.
- Established a reporting framework that classifies methane emissions from wetlands within intensively managed cropland as "cropland remaining cropland," while emissions from expanded or consolidated wetland areas are reported under "flooded land," in line with national inventory conventions.

Woody Biomass Integration:

Recognizing that woody biomass represents a significant carbon pool in many pothole regions, we integrated parallel research on biomass inventories to parameterize aboveground woody biomass. We combined these parameters with our soil and methane estimates to develop comprehensive, end-to-end greenhouse gas budgets for both managed and unmanaged wetland areas, strictly isolating direct land use change impacts and excluding indirect drivers such as ammonia deposition and broader climate trends.

Methodological Challenges and Communication:

Key challenges include data management, spatial scaling and harmonizing methodologies across pools and emission pathways. To address these issues, we:

- Established a tiered aggregation strategy that scales data to soil landscape units when fine-scale confidence is insufficient.
- Assembled a country-specific carbon pool library to ensure consistent parameter application across provinces.
- Developed a stakeholder communication plan to explain why wetland emissions are reported under receiving land-use categories—anticipating and addressing confusion that arises from people's expectation that wetland impacts should be labeled under "wetlands."
- Incorporated provincial policy nuances, such as Manitoba's requirement for equivalent wetland area replacement versus provinces without formal drainage regulations, into our interpretation of land use change scenarios.

Next Steps and Outlook:

We are on track to integrate our comprehensive wetland drainage and greenhouse gas estimates into the 2027 national inventory report, subject to resource availability, final data validations and enhancements to our data management infrastructure. We will perform periodic reanalyses as Landsat time series data extend beyond 2020 and as new field datasets and isotope studies emerge. We remain committed to refining our methodology in partnership with stakeholders, particularly regarding soil pool representativity, methane factor validation and activity data accuracy. Through this collaborative, iterative process, we will deliver transparent, policy-relevant greenhouse gas estimates that support Canada's commitments under the UNFCCC.

HOLOS MODEL

Presenter: Roland Kroebel (AAFC)

Under Objective 5.3, we advanced integration of wetland management within the Holos whole-farm greenhouse gas and soil carbon model. We aligned core calculations with IPCC Tier 2 emission factors and expanded nitrous oxide, methane and CO_2 flux modules. We supported eleven living labs in using and troubleshooting Holos for reporting, collaborated with universities to incorporate Holos in curricula, and advised students and government and producer groups. We finalized version 4 development, wrote an open-source interface for Mac OS, refined the water budget and manure handling modules, and initiated biodiversity and shelter-belt components. Through ECCC funding secured by Dr. Creed, we specified wetland zone definitions and user inputs for wetland size, permanence and management options. We published algorithms on GitHub to enable farmers to evaluate wetland impacts on emission balances and inform national inventory improvements with precision.

Summary

Under Objective 5.3, our team has focused on incorporating wetland management into the Holos whole-farm greenhouse gas and soil carbon model to support Canadian agricultural climate solutions. Building on the national inventory framework, Holos employs IPCC Tier 2 emission factors to quantify direct nitrous oxide and methane emissions and represents biogenic CO_2 fluxes through solar carbon modeling. We maintain reliable alignment with national inventory calculations while leveraging peer-reviewed science and user-provided farm data for enhanced accuracy and applicability.

Our multidisciplinary team comprises software developer, a data technician, and the model developer Dr. Sarah Pogue, and collaborative leadership by Roland Kroebel. We operate at the Lethbridge Research and Development Centre and coordinate algorithm development, quality control, and open-source interface design. Our data technician ensures algorithm integrity through rigorous quality checks and ongoing validation. The model developer advances new modules and documents computational algorithms for transparent publication. The software developer manages code implementation and user interface refinements.

Currently, we support eleven living labs under the Agricultural Climate Solutions project. We collaborate closely with these demonstration sites to tailor Holos to diverse farm systems, troubleshoot data inputs, and guide reporting protocols. We also conduct model training workshops at Canadian universities, integrate Holos into graduate-level curricula, and mentor students using the model in their theses. These educational initiatives foster a broader understanding of whole-farm greenhouse gas analyses and encourage adoption of Holos as a decision-support tool.

We engage with government programs, including algorithm consultations with the carbon credit group at Environment and Climate Change Canada. We contribute to protocol development by sharing our algorithm documentation, which has informed the design of carbon credit methodologies. Producer groups, Farm Credit Canada, and the Royal Bank of Canada rely on our technical support to address specific modeling inquiries. Recent international collaborations with Irish agricultural researchers extend Holos applicability beyond Canadian borders.

Milestones in version 4 development include completing the open-source core, refining the water budget model for integrated water flux analyses, and improving representation of manure handling systems. We authored a Mac-compatible graphical interface to expand accessibility on diverse computing platforms. The water budget module now supports preliminary water footprint estimates, adding a hydrological dimension to carbon assessments. We continue to refine manure management algorithms to reflect best practices and real-world variability.

A critical advancement has been the incorporation of the shelter-belt component, developed in partnership with researchers at the University of Saskatchewan. This module quantifies greenhouse gas impacts and carbon sequestration potential of tree belts bordering crop fields. Shelter belts represent one of the first practices beyond crop and grazing systems to be included in Holos and exemplify our modular expansion approach.

With funding secured by Dr. Irena Creed, we initiated the Holos wetland module under Objective 5.3. We defined wetland zones within field boundaries, specifying user inputs for wetland size, permanence and management regime. We designed the interface to allow farmers to delineate wetland areas, estimate vegetation cover options and simulate their effects on soil carbon change and greenhouse gas fluxes. This modular framework sets the stage for managed versus unmanaged wetland analysis and enables scenario testing for conservation practices.

We are onboarding a postdoctoral researcher supported by Dr. Creed. The postdoc will conduct a meta-analysis of existing publications and our internal database to identify best management practices for wetlands. This analysis will generate a comprehensive dataset for publication and will inform enhancements to our zone-specific algorithms and uncertainty frameworks.

Our approach maintains a balance between interface simplicity and computational complexity. We adhere to IPCC 2019 guidelines for process model calibration and validation to ensure credibility of model outputs. By running mechanistic model scenarios across multiple farms, we derive refined emission factors that can inform national inventory enhancements. We are exploring Monte Carlo methods for uncertainty quantification to provide users with probabilistic emission estimates.

All Holos algorithms and documentation are published on our open-source GitHub repository. We supply a QR-linked download portal and encourage user feedback via email. Transparency in algorithm design supports regulatory adoption and provides a foundation for stakeholder review. Algorithm documents are slated for publication as AAFC technical reports, ensuring permanent access for researchers and policymakers.

Looking ahead, we plan to integrate lateral hydrological flows and riparian zone processes into the wetland module to capture both vertical and horizontal exchanges. We will collaborate with hydrologists and wetland ecologists to parameterize zone-specific flux values. Further development will address biodiversity indicators and economic valuation metrics to inform multifunctional land management decisions. We aim to support policy evolution by translating Holos outputs into methodologies compatible with the national inventory process.

In summary, under Objective 5.3, we have systematically expanded Holos to encompass diverse agricultural practices, culminating in a robust wetland-management module. We have delivered model enhancements, educational outreach, stakeholder engagement and open-source dissemination. These efforts position Holos as a leading whole-farm greenhouse gas analysis tool for Canadian agriculture and set the foundation for ongoing contributions to national inventory refinement and sustainable farm management.

SUMMARY DISCUSSION SESSION

1. Meeting structure

The session had two parts.

- **Topic-setting plenary (≈ 40 min).** Participants reviewed seven candidate themes raised earlier, merged overlapping items, and agreed on four priority topics for breakout work.
- **Breakout discussions (30 min) and plenary reports.** Four self-selected groups met in parallel, chose rapporteurs, and then returned to present their findings to the full assembly.

2. Topics selected for breakout work

After deliberation the following four themes were retained:

Topic No.	Working title	Rationale noted in plenary
1	Long-term differences in carbon and nutrient signals under *retention* versus *restoration*, and implications for setting conservation priorities	Needed to link soil-core evidence with policy choices that often favour restoration over protecting intact sites.
2	Closing the carbon budget and building a multifunctional wetland assessment tool	Emphasis on integrating vertical and lateral fluxes (water, solutes, biota) and on packaging results for farm-scale decision tools such as HOLOS.
3	Benefits “beyond carbon” – reconciling cooling effects with carbon storage across wetland types	Aimed to frame wetlands as climate-adaptation assets, not only carbon stores, and to explore trade-offs or synergies in homogeneous versus heterogeneous systems.
4	Regionally specific emission factors for mineral wetlands in agricultural landscapes, linked to a managed versus unmanaged classification	Intended to supply simplified factors for the National Greenhouse Gas Inventory while resolving definitional issues that affect inventory reporting.

3. Breakout-room conclusions and comments

Topic 1 – Retention versus restoration

Rapporteur: Dr G. Chmura

- It was stated that intact prairie pothole wetlands may have been accumulating carbon since Lake Agassiz (?) drained; however, management decisions need time horizons closer to two decades.
- Restoration rarely replaces the original carbon stock; lag times and sampling depth (below 30 cm was recommended) must be considered.
- Socio-economic modelling should run in parallel with biogeochemical studies because farmer incentives remain insufficient to favour large-scale restoration.
- The group proposed compiling deep-core datasets to quantify climate-driven variability and to refine mitigation ratios used in offset schemes.

Topic 2 – Closing the carbon budget and assessment tool

Rapporteur: Dr C. von Sperber

- High uncertainty around lateral carbon, nitrogen and phosphorus flows was identified; acquiring empirical data was prioritised before constructing indicators.
- Potential proxies discussed included soil moisture, texture and organic carbon, but current spatial resolution is inadequate.
- Clear differentiation between overland and subsurface flow paths was recommended; prairie pothole sites and rain-fed clay-basin wetlands were highlighted as contrasting end-members for comparative campaigns.
- Joint design of measurement networks by modellers and empiricists was urged to balance the number of sampled wetlands against within-site replication.

Topic 3 – Beyond carbon: cooling and other services

Rapporteur: Prof. S. Knox (reported by Prof. I. Creed)

- The group will draft a perspective that integrates biogeochemical (carbon stocks, GHG fluxes) and biophysical (latent and sensible heat, albedo) functions of freshwater mineral wetlands.
- It was suggested that “trade-off” language be replaced, since wetlands can deliver both cooling and carbon storage or neither, depending on vegetation cover.

- Two case-study sites were chosen: Frank Lake (Alberta) and a three-wetland complex in Manitoba. Remote-sensing indices, flux-tower data and methane measurements will supply comparative metrics.

Topic 4 – Emission factors and managed versus unmanaged wetlands

Rapporteur: Dr P. Badiou

- Existing national datasets are considered sufficient to derive regionally specific default emission factors for mineral wetlands, but integration into the inventory depends on a clear managed/unmanaged schema.
- Cropped wetlands (Class II) and water-level-controlled wetlands were cited as obvious managed categories, yet both lack robust emission measurements.
- Environment and Climate Change Canada (ECCC) was asked to supply a schematic that shows exactly how land-use transitions should be flagged in inventory reporting; scientists will then align data products with this framework.
- Coordination with HOLOS development was recommended to keep farm-level modelling consistent with national accounting methods.

Breakout Room Outcomes

No.	Theme	Key Findings	Data Gaps	Agreed Actions	Leads / Early Contributors
1	**Retention vs. Restoration: Long-term carbon, nutrient, and policy trade-offs**	• Intact prairie pothole wetlands likely accumulate C over millennia, but farm decisions pivot on the next 20 years. • Restoration seldom replaces pre-drainage C stocks; lag time before a wetland becomes a net C sink is uncertain. • Mitigation ratios in most provinces ignore carbon, focusing on habitat area. • Deep cores (>30 cm) are needed to capture drainage impacts across climate and landscape gradients. • Economic incentives remain inadequate; nuisance costs	• Quantitative relation between climate variability and C sequestration. • Empirical lag curves for restored sites. • Valuation methods that add C to mitigation ratios.	1. Compile regional deep-core datasets (Hudson Bay Lowlands, Prairie Potholes, Atlantic impoundments). 2. Integrate lag functions into policy guidance on wetland banking. 3. Draft a briefing on incentive structures for provincial agencies.	G. Chmura (rapporteur), D. Lobb, DUC team, economists

		for landholders are high.			
2	**Closing the Carbon Budget: Toward a Multifunctional Wetland Assessment Tool**	• Lateral C, N, P fluxes (surface and subsurface) remain the largest unknown in budget closure. • Soil moisture, texture and SOC are candidate indicators, but current national data (250 m grid) are too coarse. • Surface outlets likely dominate over groundwater at most sites. • Indicator design must precede model inclusion; premature inclusion risks false precision. • End-users identified: municipalities, ECCC program managers, and HOLOS developers.	• Empirical measurements of lateral fluxes in two contrasting test watersheds (Prairies, Québec clay basins). • High-resolution surficial geology and soil texture layers. • Economic weighting metrics for multifunctional valuation.	1. Modellers and empiricists will co-design a sampling campaign (Q3 2025 start). 2. Remote-sensing team will trial outlet detection and wetland density layers. 3. Economic sub-team will propose valuation weights for Objective 4 tool.	C. von Sperber (rapporteur), P. Mistry, D. Aldred, J. He, R. Brouwer
3	**Beyond Carbon: Cooling and Other Climate Services of Freshwater**	• Cooling via latent heat and albedo can equal or exceed carbon	• Comparative datasets linking energy flux towers, albedo, and vegetation	1. Draft Perspective paper, target Nature Climate Change.	S. Knox (lead), L. Flanagan, B. Baxter, I.

	Mineral Wetlands	benefits, yet is missing from most assessments. • Open-water, low-LAI wetlands may deliver stronger evaporative cooling than high-carbon emergent systems. • Conceptual synthesis will integrate radiative forcing (NEE, CH_4) with surface energy metrics.	indices across wetland types. • Crop-yield responses to nearby wetland cooling.	2. Case-study analysis: Frank Lake (AB) and three Manitoba flux sites, using RS indices and tower data. 3. Establish OneDrive workspace; first writing workshop in May 2025.	Creed, P. Badiou
4	**Regionally Specific Emission Factors and Managed vs. Unmanaged Wetlands**	• National datasets now support region-specific default factors, but inventory uptake needs a simple rule set. • Managed wetlands include hydrologically controlled sites and cropped Class I-II basins, yet emission data are sparse. • Inventory reporting must avoid double counting between wetland and	• Flux measurements for water-level-managed and actively farmed wetlands. • Clear, visual decision tree for class transitions in the NIR and HOLOS.	1. ECCC to draft graphical reporting framework by July 2025. 2. Science team to test framework in watershed datasets (Manitoba, Ontario, Québec). 3. Researchers to share underlying data from ~30 new papers via secure repository for inventory review.	P. Badiou (rapporteur), D. MacDonald (ECCC), R. Kroebel (AAFC), D. Lobb

		cropland categories.			