SEARCH TERM: Ecological or Ecosystem (and synonyms) – 9 projects

Southern Forest Water Futures

- Evaluation of heat and drought impact on carbon exchanges in different age southern temperate managed forest ecosystems. Results indicate that the timing, frequency and concurrent or consecutive occurrence of extreme weather events may have significant implications for growth and carbon sequestration in these forests. Study results will help in developing climate resilient and sustainable forestry practices to offset atmospheric greenhouse gas emissions and converse water resources.

- Publication of peer-reviewed papers on water and carbon exchanges in the southern managed forest ecosystems that have advanced our understand of processes.

- Collaboration with the GWF Co-creation of indigenous water quality tools and ecosystem health group to conduct modelling studies at McKenzie Creek to explore the impacts of climate change on hydrological processes and water resources in the Six Nations Community.

- Climate adopted forest management strategies for southern forest ecosystems to provide sustainable and clean water resources and enhanced carbon sink capabilities.

- Annual total (a) gross ecosystem productivity (GEP), (b) ecosystem respiration (RE), and (c) net ecosystem productivity (NEP) in the 80-, 45-, and 17-year-old forests. Dry years are shaded as yellow (2007, 2017), hot year is shaded as orange (2018), and concurrent hot and dry years are shaded as red (2005, 2010, 2012 and 2016). Arain M.A., Xu B., Brodeur J.J., Khomik M., Peichl M., Beamesderfer E., Restrepo-Couple N., Thorne R.., 2021. Heat and drought impact on carbon exchange in an age-sequence of temperate pine forests. Ecological Processes (in press). [Image]

Boreal Water Futures 2

- Analysis of field carbon flux data from Parkland County study sites and combination with literature data to build post-fire ecosystem trajectory and evapotranspiration partitioning

eDNA

- Development of eDNA/eRNA platform for biomonitoring of aquatic ecosystems
- Collection of eDNA data for genomic baseline of boreal ecosystems (North Saskatchewan River and ELA lakes)
- Development and application of normalized activity of microbial community and normalized vitality of zooplankton communities for assessment the ecological impact of artificial stressors
- Implement of zooplankton metabarcoding for assessment of ecological impacts of cleaning practices after oil spill
- Collection of eDNA data for genomic baseline of boreal ecosystems (North Saskatchewan River and ELA lakes)

- Data-analyses and paper writing: impact of selenium exposure and diluted bitumen spill on whole lake ecosystems

FORMBLOOM

Biophysical work to understand factors influencing bloom severity, factors influencing bloom duration, and key interventions. This includes setting the stage for a whole ecosystem experiment, now in progress.

- Enhanced understanding of adaptation needs, with case study of partnership with Buffalo Pound Water Treatment Plant to help foster municipal water treatment adaptation. This has already led to adapted water treatment processes to account for cyanobacterial ecology and risk.
- Case study analysis of willingness to pay for interventions, and priorities for change resulting from management interventions (preferred ecosystem service changes).
- **Five journal manuscripts/publications** – 1 on inter-tidal spring temperature dynamics (already published in *HP*), 1 on coastal groundwater warming and impacts to groundwater-dependent coastal ecosystems (in prep, led by MASc student J. KarisAllen – to be submitted to *HESS*), one on groundwater temperature patterns in coastal regions as measured in provincial observation well networks (in prep, led by PhD student K. Smith – to be submitted to *HESS*), 1 on estuary temperature modeling under climate change scenarios (in prep, led by PhD student A. Zeighami – to be submitted to *WRR*), 1 on drone vs. fiber-optic DTS vs. loggers ("what do we miss from the air", led by PhD student K. Smith – to be submitted to a hydrology like *HP* or environmental technology journal like *ES&T*). We are also considering a sixth paper on coastal storms and the impacts to thermally stratified lagoons.

Integrated Modelling Program for Canada

- **Integrated Water Management modelling** (Drs. Razavi & Brouwers' teams): Model integration efforts successfully completed so far combine the MODSIM Water Resource Management framework with the Inter-Regional Supply-side Input-Output (ISIO) economic model to evaluate relative economic impacts in the SRB under changing climate conditions, socioeconomic development, and policy interventions, to identify opportunities for building resilience into the SRB water system. Several python scripts have been developed to link ecological metrics to the modelling framework as described below.
- **Ecological modelling** (Drs. Jardine & Strickerts' teams): naturalized daily and future flows from MESH (15 climate scenarios, 3 time periods) were used to produce naturalized flow presumptive standards (sustainable boundaries) for 28 sites in Alberta, five sites in Saskatchewan, and two sites in Manitoba. Ecological performance indicators were developed, including percent deviation from natural flow and Indicators of Hydrologic Alteration (IHA) variables.
- **User engagement** (Carlson, Balkhi & IMPC integration team): IMPC recorded a growth from 45 collaborators to more than a 100 in 60 partner organizations involved in various capacities with project activities. The project has also conducted two user engagement surveys so far to track user perceptions over the lifetime of the project (year 1 and year 3) to design partner-specific outreach and engagement strategies and understand changing partner needs. IMPC researchers have had a long-lasting relationship with the Cumberland House's majority Indigenous community that has allowed the IMPC team at large to try and better understand the community's concerns and respond where possible. Although this is an ongoing process, over the past four years of the project, IMPC has been working to enhance its collaborative efforts between the delta stewards, community ambassadors and researchers, including a computer science lead, water modelers, social scientist, and an ecological expert, as well as delta stakeholders including SaskPower and WSA. IMPC has been hosting the meeting series, Delta Dialogues – Finding a Way Forward, (in collaboration with Cumberland House Delta Stewardship Committee) since August 2020 to provide and

facilitate two-way dialogue between stakeholders and rightsholders in the Saskatchewan River Delta region and provide knowledge support to the community where needed.

Integration of water quality metrics, ecological metrics, and climate change scenarios into the water management modelling framework:

- Couple flows and fluxes between MODSIM and WASP; calibrate/validate MODSIM-WASP modelling system; complete development of MESH-WASP modelling system. Run water-management and climate-change scenarios with MESH-WASP and MODSIM-WASP modelling systems.
- Deriving a target range of river flows for people and wildlife to thrive in the Saskatchewan River Delta (based on 'presumptive standard method' that estimates sustainable boundaries for flow) and using integrated models to understand how these targets may be met or not.
- Including future climate change scenarios (possible collaboration with Core modelling on use of climate change scenarios) in combination with policy scenarios as described in section above.
- Definition and testing flow-ecology relationships and coupling validated flow-ecology metrics with the MODSIM model.

Warming Estuaries, Closing Gates

- **Five journal manuscripts/publications** – 1 on inter-tidal spring temperature dynamics (already published in *HP*), 1 on coastal groundwater warming and impacts to groundwater-dependent coastal ecosystems (in prep, led by MASc student J. KarisAllen – to be submitted to *HESS*), one on groundwater temperature patterns in coastal regions as measured in provincial observation well networks (in prep, led by PhD student K. Smith – to be submitted to *HESS*), 1 on estuary temperature modeling under climate change scenarios (in prep, led by PhD student A. Zeighami – to be submitted to *WRR*), 1 on drone vs. fiber-optic DTS vs. loggers ("what do we miss from the air", led by PhD student K. Smith – to be submitted to a hydrology like *HP* or environmental technology journal like *ES&T*). We are also considering a sixth paper on coastal storms and the impacts to thermally stratified lagoons.

Managing Urban Eutrophication Risks

WP3: ecosystem valuation (*Main objective:* Valuate ecosystem services impacted by nearshore eutrophication with the focus on determining how nearshore recreational use intensity and lakefront property differentials varies in WLO as a function of nearshore eutrophication)

- Collected data on response (i.e., price of lakefront properties) and predictor variables (i.e., population and dwelling density as proxies for urban input to aquatic systems) in the study area to be used in regression models.
- Used a mixed-effects model to capture fixed and random effects of covariates to compute the price differentials and premiums for lakefront properties in WLO.
- Mapped water-related cultural ecosystem services based on geo-tagged photos uploaded in social media websites.

WP3: ecosystem valuation

- Collect and archive data on historical (i) chlorophyll (*chl-a*) concentrations from publicly available Moderate Resolution Imaging Spectroradiometer (MODIS) daily data (and other remote sensing sources), and (ii) additional open access water quality (P concentrations, temperature, meteorological data) and demographic plus socio-economic (census) data.

WP3: ecosystem valuation

- Quantify the influence of water quality changes in the WLO nearshore zone (i.e., eutrophication) on lakefront properties' price premium.
- Valuate the recreational value of the WLO nearshore zone and include these in cost-benefit analyses of P abatement investments (in particular, green infrastructure and LID).

Northern Water Futures

- Improved understanding of ecosystem stability in response to severe wildfire and permafrost thaw using NWT-wide network of hundreds of sites (Baltzer et al., 2021; Day et al., 2018, 2020ab; Dearborn and Baltzer, 2021; Dearborn et al., 2021; Pretty et al., 2020; Walker et al., 2018ab, 2019, 2020ab).

- Developed tools for aquatic ecosystem hydrological and contaminant monitoring in the Peace-Athabasca Delta, Alberta (Kay et al., 2021; Neary et al., 2021; Owca et al., 2021; Remmer et al., 2020; Savage et al., 2021).

- *Improved understanding and prediction of changes in water across the boreal-taiga-tundra zone*
  - Develop framework for integrating process studies and modelling
  - Process studies at key Observatories to enhance understanding of surface and subsurface processes, and links to aquatic ecosystems

- *Incorporating fire and permafrost thaw risk into harvester safety, caribou range planning, and food security*
  - Couple spatial and statistical outputs of thermokarst vulnerability and landcover change associated with fire and thermokarst with SpaDES ecological forecasting tools with collaborators McIntire and Cumming

- *Impacts of biofuel production on terrestrial and aquatic ecosystems in permafrost landscapes*
  - Site instrumentation and measurement of pre-harvest conditions at forest management sites and post-harvest remeasurement

- Dearborn, K. D., Wallace, C. A., Patankar, R., and Baltzer, J. L.: Permafrost thaw in boreal peatlands is rapidly altering forest community composition, Journal of Ecology, 109, 1452-1467, https://doi.org/10.1111/1365-2745.13569, 2021

- Walker, X. J. Baltzer, J. L., Bourgeau-Chavez, L., Day, N. J., Dieleman, C. M., Johnstone, J. F., Kane, E. S., Rogers, B. M., Turetsky, M. R., Veraverbeke, S., and Mack, M. C.: Patterns of Ecosystem Structure and Wildfire Carbon Combustion Across Six Ecoregions of the North American Boreal Forest, Frontiers in Forests and Global Change, 3, 87, https://doi.org/10.3389/ffgc.2020.00087, 2020b

Sub-Arctic Metal Mobility Study

DOM Quantity and Quality, Metal Binding, and Toxicology

- Sharma S. 2021. Modeling Impact of Changing Hydroclimatic Regime on Dissolved Organic Carbon Export from Baker Creek Catchment. MES thesis. University of Saskatchewan.
  Terrestrial Stores of Historical Metal Deposition and Transport to Aquatic Ecosystems

Winter Soil Processes

- We used climate-related parameters to define the start and end dates of the NGS and our results supported defining NGS based on readily available climatic parameters that account for the interannual variability of regional climate and ecosystem response.

What is Water Worth?

- Connect the economic valuation of aquatic ecosystem services to available water quality monitoring data and policy-relevant biophysical indicators for the water quality challenge in question. Where possible, use will be made of available environmental models to assess changes in baseline water quality conditions due to water quality policy intervention scenarios. In particular, we aim to employ and update the current prototype of the Water Quality Valuation Model developed by ECCC as an integrated environmental-economic water quality modeling framework.

- Set up a geo-referenced national data and information system for the economic values of relevant aquatic ecosystem services across Canada

- Derive and test a generic Canadian water quality valuation function for aquatic ecosystem services that can be used by policy-makers to assess the benefits of improving water resources. We will explore potential collaboration with the Environmental Valuation Reference Inventory (EVRI), initiated in the 1990's by ECCC.