Global Water Futures 2021 Operations Team Meeting – Project Reporting Template

Instructions: All GWF projects are asked to provide a summary update on their activities and accomplishments in preparation for the upcoming Operations Team meeting. **Please submit these by email to chris.debeer@usask.ca by no later than December 2.** These will be used to help guide discussions and breakout synthesis activities and will be made generally accessible on our website in advance of the meeting.

Project Name:	Northern Water Futures

Our major accomplishments to date are:

- Trained HQP in knowledge mobilization through digital storytelling, communication and plain language report and poster writing workshops.
- Co-developed and developed knowledge sharing opportunities with GNWT and broader NWF community (i.e., hosted NWF virtual webinar series, participated in GNWT's 2019 Fire Workshop and Water Stewardship Strategy, and contributed to GNWT action plans and state of environment reports).
- Expanded capacity for research and monitoring in the NWT.
- 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).
- Predicted changes in hydrology and transboundary flows to the NWT (Thompson and Wright, 2020).
- Improved country/local food security (Packull-McCormick et al., 2020; Ratelle et al., 2020a, 2021).
- Advanced understanding of sustainability of fisheries (Laird et al., 2018).
- Assessed and predicted food and drinking water safety (Ratelle et al., 2018ab; 2020bc).
- Enhanced safety of harvesters (supported fire/permafrost vulnerability data management).
- Implemented baseline monitoring to support environmentally sustainable, non-renewable resources exploration and development.
- Improved regional mapping of thermokarst hotspots across the NWT (Gibson et al., 2020).
- Improved security of hydrologically sensitive infrastructure.

Our current activities are:

- Developing a synthetic diagram that illustrates the interconnectedness of research themes featured in NWF works (Fig. 1). It is aimed that this diagram will frame an integrative synthesis paper about NWF.
- Hosting the NWF Virtual Webinar Series throughout Fall 2021 which highlights completed and ongoing research projects, and provides an excellent opportunity for fruitful discussion and cross-project connections (Fig. 2). Turnout by NWT partners has been high and we see this as a communication success in the time of COVID related challenges in partner engagement.
- Activities supporting **main accomplishments 1 & 4** *(accomplishments outlined in final section of document)*:
    - *Cross-site comparative analysis of ecohydrological functioning in a rapidly changing landscape*

        - Ongoing NASA ABoVE and NISAR calibration/validation studies and collaborative analysis
        - Develop the conceptual framework for cross-observatory syntheses
        - Air photo analysis of landcover change at the five observatories with ecohydrological instrumentation (Baker, Scotty, Smith, Havikpak, TVC)
        - Validation of permafrost conditions where needed to support air photo analysis
        - Compilation of data supporting cross-site analysis of ecohydrological change and additional data collection as needed to complete this dataset
    - *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
        - Map active layer depth, taliks and ground subsidence
        - Use airborne and satellite RADAR to evaluate shrub - soil moisture links
        - Use UAV and airborne radar to quantify snow depth and SWE
        - Airborne infrared mapping of groundwater discharge locations
        - Application of SUTRA-Ice, Cryogrid and custom code to model interactions between permafrost and groundwater
        - In collaboration with GWF core-modelling, test legacy models (CRHM, MESH) and next-generation CHM at key observatories and carry out numerical experiments
        - Meetings with partners to communicate research results
    - *Characterizing hydrological vulnerability of shallow lakes*
        - Historic air photo analysis of the nature and rate of changes in areal extent of small lakes across the NWT coupled with targeted isotopic sampling in WBNP
        - Develop plain language materials showing the types and drivers of lake change
    - *Evaluating how warming-induced biophysical changes alter water quality and biological process*
        - Evaluation of deep and shallow groundwater inputs to surface water expressions in Bogg Creek
        - Measure shifts in instream biological structure/function across latitudes
        - Develop the conceptual framework synthesis – current status is an evaluation of the state of knowledge on modelling groundwater and surface water interactions in permafrost environments.
        - Evaluate linkages between rates of permafrost thaw and landcover change and water quality of adjacent surface water
- Activities supporting **main accomplishments 2 & 4** *(accomplishments outlined in final section of document)*:
    - *Mitigating risks associated with changing fish resources*
        - Develop the conceptual and analytical framework for linking terrestrial changes with fish mercury concentrations
        - Evaluate relationships between water quality and healthy fatty acid concentrations in fish
        - Develop public health screening tool to assess fish consumption risks

        - Develop a model linking environmental change with contaminant exposures and nutrient status using a risk benefit framework
        - Expand fish-down efforts in the Dehcho region with the goal of reducing mercury concentrations in fish populations.
        - Plain language, culturally appropriate results posters for fish mercury levels for 13 studied lakes in the Dehcho region
        - Examine impact of consumption advisories on food choices and contaminant exposure
        - Develop and pilot test a risk communication strategy based on results from the Health Messages Survey
    - *Understanding patterns of terrestrial landscape change caused by climate-induced hazards*
        - Upscale fire behavior maps to ABoVE domain in collaboration with ABoVE fire working group
        - Partnership with the Northwest Territories Geologic Survey on the NWT Thermokarst Collective – an effort to produce the first map of thermokarst features on the landscape, and evaluate patterns and drivers.
        - Integrate spatial datasets to create hazard probability maps for key climate-related land hazards (thermokarst, severe burning)
        - Synthesize data on patterns of post-fire forest regeneration across the North American boreal to evaluate patterns and drivers (Baltzer et al., 2021)
    - *Incorporating fire and permafrost thaw risk into harvester safety, caribou range planning, and food security*
        - Model validation through field measurements in areas of known subsidence
        - Connect ground-based vegetation recovery measures with scalable land cover information through high resolution hyperspectral data acquired for our sites by NASA ABoVE
        - 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
        - Apply spatial modeling framework to develop thermokarst vulnerability maps for the region and couple with harvester safety information
        - Connect permafrost data from Inuvik-Tuk highway and food security data in Tuktoyaktuk
    - *Enhancing community led monitoring of changing land and water conditions*
        - Develop smartphone Harvester Safety App to combine our risk models with on-the-land observations of change and risk
        - Ongoing development of the Ka'a'gee Tu Atlas supporting community-led monitoring
        - Development of community led monitoring in the UNESCO Tsá Tué Biosphere Reserve
- Activities supporting **main accomplishments 3 & 4** *(accomplishments outlined in final section of document)*:
    - *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

The main accomplishments expected by the end of the project are:

1. Improve understanding of the impacts of rapid biophysical change on water resources
2. Improve understanding of biophysical change to improve food security
3. Evaluate sustainability of renewable energy sources
4. Strengthen existing partnerships between Laurier, the GNWT, and communities and regional authorities, and build the capacity of partners and end users through iteration of needs identification, knowledge creation, mobilization, and application.

Here is a key visual from the project (figure, photo, table, graph, etc.) *See pages 5 and 6*

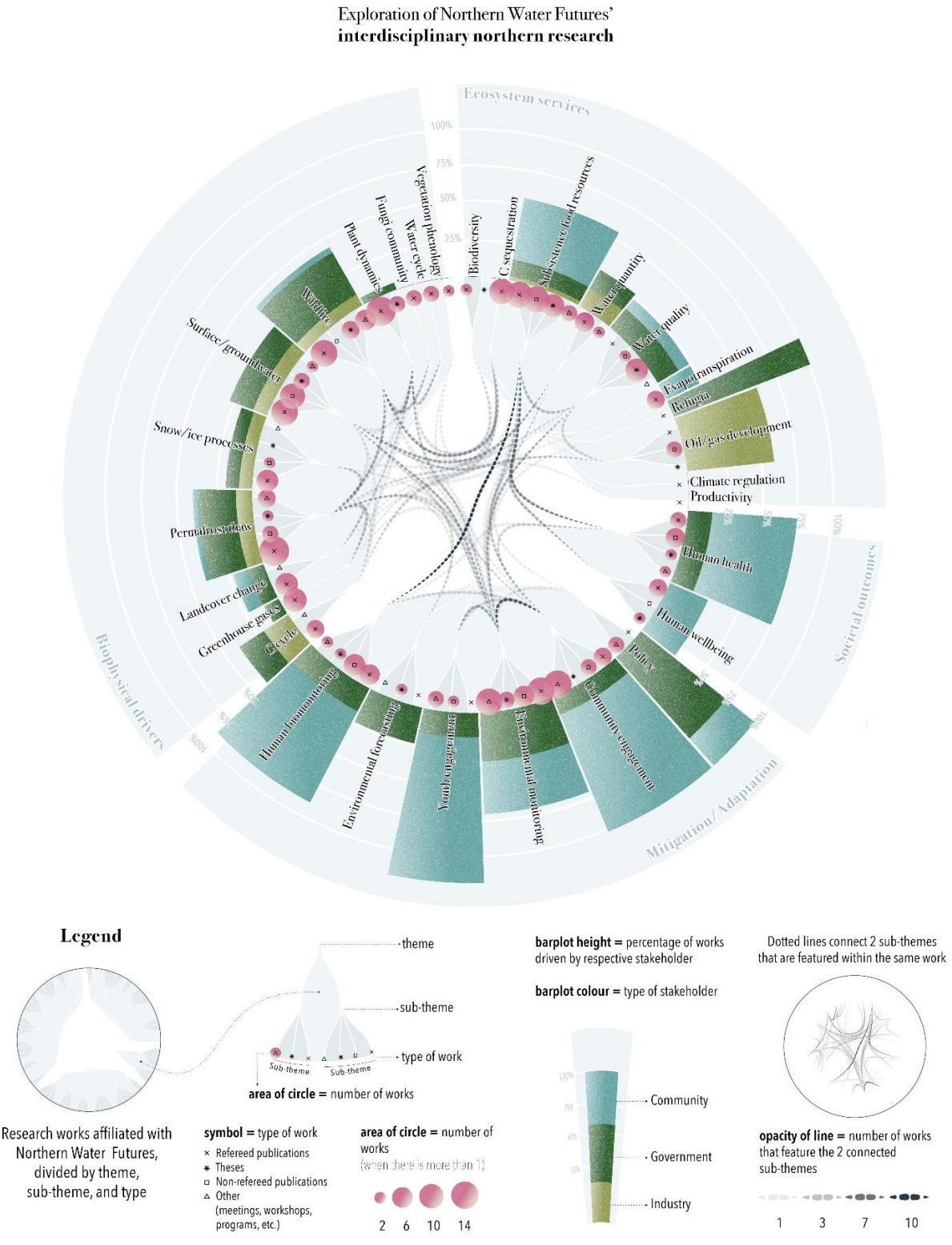

Fig. 1 Preliminary synthetic diagram showing connectedness of themes featured in NWF works, as well as stakeholders driving respective works.

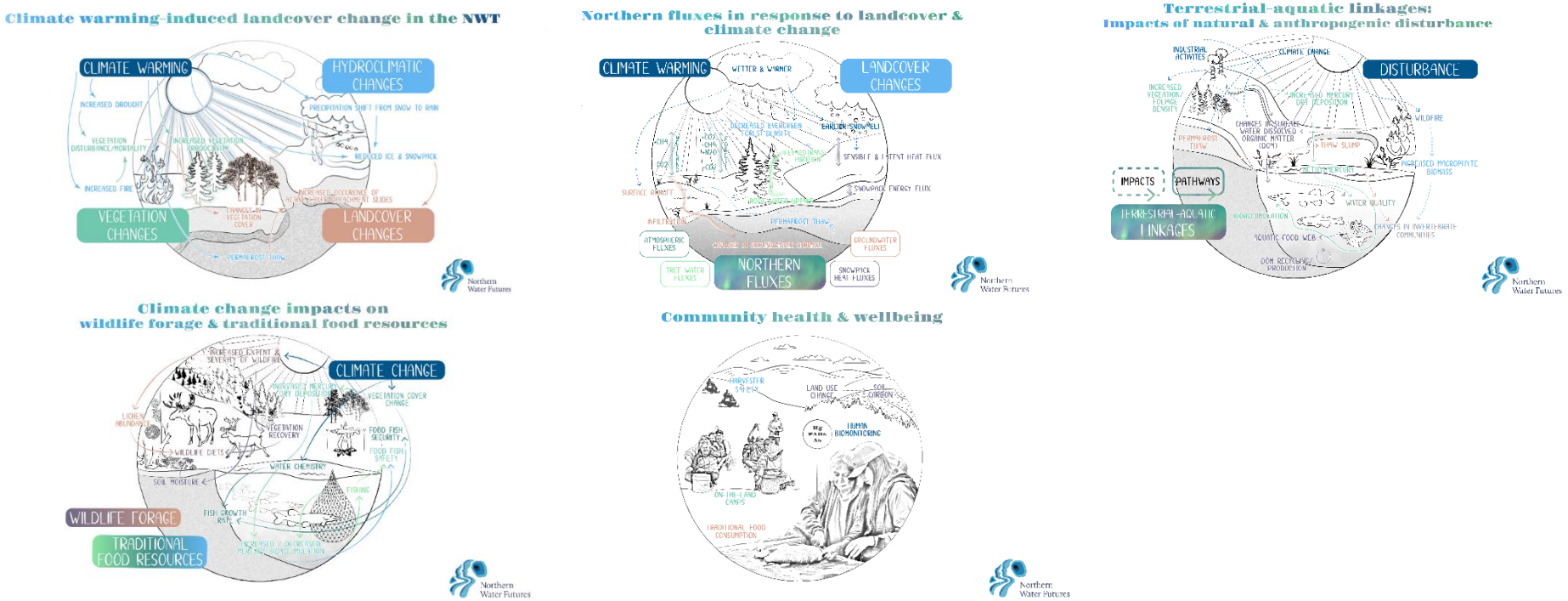

Fig. 2 Series of diagrams illustrating themes covered in NWF virtual webinar sessions which occur throughout the fall 2021 term.

References

Baltzer, J. L., Day, N. J., Xanthe, J. W., Greene, D., Mack, M. C., Alexander, H. D., Arseneault, D., Barnes, J., Bergeron, Y., Boucher, Y., Bourgeau-Chavez, L., Brown, C. D., Carrière, S., Howard, B. K., Gauthier, S., Parisien, M.-A., Reid, K. A., Rogers, B. M., Roland, C., Sirois, L., Stehn, S., Thompson, D. K., Turetsky, M. R., Veraverbeke, S., Whitman, E., Yang, J., and Johnstone, J. F.: Increasing fire and the decline of fire adapted black spruce in the boreal forest, Proceedings of the National Academy of Sciences, 118, e2024872118, https://doi.org/10.1073/pnas.2024872118, 2021

Day, N. J., Cumming, S. G., Dunfield, K. E., Johnstone, J. F., Mack, M. C., Reid, K. A., Turetsky, M. R., Walker, X. J., and Baltzer, J. L.: Identifying fungal drivers of decomposition and plant growth after wildfire in boreal forests, Frontiers in Forests and Global Change, 3, 68, https://doi.org/10.3389/ffgc.2020.00068, 2020a

Day, N. J., White, A. L., Johnstone, J. F., Degre-Timmons, G. E., Cumming, S. G., Mack, M. C., Turetsky, M., R., Walker, X. J., and Baltzer, J. L.: Fire characteristics and environmental conditions shape plant communities via regeneration strategy, Ecography, 43, 10, 1464-1474, https://doi.org//10.1111/ecog.05211, 2020b

Dearborn, K. D., and Baltzer, J. L.: Unexpected greening in a boreal permafrost peatland undergoing forest loss is partially attributable to tree species turnover, Global Change Biology, https://doi.org/10.1111/gcb.15608, 2021

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

Gibson, C., Morse, P. D., Kelly, J. M., Turetsky M. R., Baltzer, J. L., Gingras-Hill, T., Kokelj, S.V.: Thermokarst Mapping Collective: Protocol for organic permafrost terrain and preliminary inventory from the Taiga Plains test area, Northwest Territories Geological Survey, NWT Open Report 2020-010, https://tinyurl.com/nwfreport2020, 2020

Kay, M. L., Swanson, H. K., Burbank, J., Owca, T. J., Savage, C. A. M., Remmer, C. R., Neary, L. K., Wiklund, J. A., Wolfe, B. B., and Hall, R. I.: A Bayesian mixing model framework for quantifying temporal variation in source of sediment to lakes across broad hydrological gradients of floodplains, Limnology and Oceanography Methods, 19, 540-551, https://doi.org/10.1002/lom3.10443, 2021

Laird, M. J., Henao, J. J. A., Reyes, E. S., Stark, K. D., Low, G., Swanson, H. K., and Laird, B. D.: Mercury and omega-3 fatty acid profiles in freshwater fish of the Dehcho Region, Northwest Territories: Informing risk benefit assessments, The Science of the Total Environment, 637-638, 1508–1517, https://doi.org/10.1016/j.scitotenv.2018.04.381, 2018

Neary, L. K., Remmer, C. R., Krist, J., Wolfe, B. B., and Hall, R. I.: A new lake classification scheme for the Peace-Athabasca Delta (Canada) characterizes hydrological processes that cause lake-level variation, Journal of Hydrology: Regional Studies, 38, 100948, https://doi.org/10.1016/j.ejrh.2021.100948, 2021

Owca, T. J., Kay, M. L., Faber, J., Remmer, C. R., Zabel, N., Wiklund, J. A., Wolfe, B. B., and Hall, R. I.: Use of pre-industrial baselines to monitor sources and pathways of metals in recently-deposited surface sediment of floodplain lakes in the Peace-Athabasca Delta (Alberta, Canada), Environmental Monitoring and Assessment, 192, 106-128, https://doi.org/10.1007/s10661-020-8067-y, 2020

Packull-McCormick, S., Swanson, H., Skinner, K., and Laird, B.: Estimating the Impact of Freshwater Fish Harvest Location on Mercury Exposures in Dene Communities of the Northwest Territories, Report prepared for Government of the Northwest Territories, Health and Social Services, 2020

Pretty, T. J., Chanyi, C., Kuhn, C., and Gray, D. K.: Factors influencing the structure of macroinvertebrate communities in subarctic lakes affected by wildfires, Canadian Journal of Fisheries and Aquatic Sciences, 78, 218-231, https://doi.org/10.1139/cjfas-2020-0141, 2020

Ratelle, M., Skinner, K., Laird, M. J., Majowicz, S., Brandow, D., Packull-McCormick, S., Bouchard, M., Dieme, D., Stark, K. D., Henao, J. J. A., Hanning, R., and Laird, B. D: Implementation of human biomonitoring in the Dehcho region of the Northwest Territories, Canada (2016-2017), Archives of Public Health, 76, 73, https://doi.org/10.1186/s13690-018-0318-9, 2018a

Ratelle, M., Laird, M., Majowicz, S., Skinner, K., Swanson, H., and Laird, B.: Design of a human biomonitoring community-based project in the Northwest Territories Mackenzie Valley, Canada, to investigate the links between nutrition, contaminants and country foods, International Journal of Circumpolar Health, 77:1, https://doi.org/10.1080/22423982.2018.1510714, 2018b

Ratelle, M., Skinner, K., Packull-McCormick, S., and Laird, B.: Food frequency questionnaire assessing traditional food consumption in Dene/Métis communities, Northwest Territories, Canada, International Journal of Circumpolar Health, 79, 1760071, https://doi.org/10.1080/22423982.2020.1760071, 2020a

Ratelle, M., Packull-McCormick, S., Bouchard, M., Majowicz, S., and Laird, B.: Human biomonitoring of metals in sub-Arctic Dene communities of the Northwest Territories, Canada, Environmental Research, 190, 110008, https://doi.org/10.1016/j.envres.2020.110008, 2020b

Ratelle, M., Khoury, C., Adlard, B., and Laird, B. D.: Polycyclic aromatic hydrocarbons (PAHs) levels in urine samples collected in a subarctic region of the Northwest Territories, Canada, Environmental Research, 182, 109112, https://doi.org/10.1016/j.envres.2020.109112, 2020c

Ratelle, M., Haig, L., Laird, B., and Skinner, K.: Game bird consumption in Dene communities of the Northwest Territories, Canada, Public Health Nutrition, 24, 1229-1239, https://doi.org/10.1017/S1368980021000021, 2021

Remmer, C. R., Neary, L. K., Kay, M. L., Wolfe, B. B., and Hall, R. I.: Multi-year isoscapes of lake water balances across a dynamic northern freshwater delta, Environmental Research Letters, 15, 104066, https://doi.org/10.1088/1748-9326/abb267, 2020

Savage, C. A. M., Owca, T., Kay, M. L., Faber, J., Wolfe, B. B., and Hall, R. I.: Application of artificial substrate samplers to assess enrichment of metals of concern by river floodwaters to lakes across the Peace-Athabasca Delta, Journal of Hydrology: Regional Studies, 38, 100954, https://doi.org/10.1016/j.ejrh.2021.100954, 2021

Thompson, L. M., and Wright, S.: State of Knowledge on Permafrost Characterization and Impacts of Thaw on Water Quality in AB-NT Transboundary Watersheds, Report prepared for the governments of Alberta and Northwest Territories, 2020

Walker, X. J., Rogers, B. M., Veraverbeke, S., Johnstone, J. F., Baltzer, J. L., Barrett, K., Bourgeu-Chavez, L., Day, N. L., de Groot, W. J., Dieleman, C. M., Goetz, S., Hoy, E., Jenkins, L. K., Kane, E. S., Parisien, M.-A., Potter, S., Schuur, E. A. G., Turetsky, M., Whitman, E., and Mack, M. C.: Fuel availability not fire weather controls boreal wildfire severity and carbon emissions, Nature Climate Change, 10, 1130–1136, https://doi.org/10.1038/s41558-020-00920-8, 2020a

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