FORESTRY FUTURES TRUST ONTARIO

Knowledge Transfer and Tool Development (KTTD) Progress Report

SECTION A: PROJECT INFORMATION

Project Title: Advancing Digital Soil Mapping tools in support of forest resource inventory, planning and decision making		**Project Number:** KTTD-19B-2021
Interim Report accompanies each invoice. **Period Cover by Report:** April 2024 – October 2024	**Interim Report:**	**Final Report: X**
Project Lead (Name, Title, and Organization) Kara Webster, Research Scientist, Canadian Forest Service, Natural Resources Canada		
Mailing Address: Great Lakes Forestry Centre, 1219 Queen St. E., Sault Ste. Marie, ON, P6A 3N3		
Phone: 705-987-0596	**Email:** Kara.Webster@nrcan-rncan.gc.ca	

SECTION B: SUMMARY OF WORK COMPLETED

Project Progress:

Summarize project progress for the period covered by this *final* report.

1. Compiling legacy soil data and facilitating future soil data acquisition

Part A of this objective was to compile soil data. In terms of some summary statistics, 22 different studies that had soil data were curated. These studies covered 50 years. This reflected 94,650 soil data points. 88% of those soil data were from eFRI inventory that while extensive had only field-assessed soil values. For each study containing soil data, a fact sheet was created. Fact sheets have been compiled into a report and contain a timeline and summary of the type of soil data collected. We plan to have this report made into a CFS information report and we hope that Forestry Futures Trust can have a link to the report, or the report itself on its webpage. Efforts are ongoing to standardize, organize and quality check the datasets, and to update them as required.

Part B of this objective was to create standardized, yet flexible protocols for collecting soil information. We previously reported on an overview booklet ("Collecting, analysing and storing forest soil data and samples in the age of big data. A guide for researchers and field practitioners") and we have created two more detailed booklets on: 1. "Collecting forest soil samples", and; 2. "Soil preparation for bulk density and chemical analyses". A version of the collecting forest soil samples booklet was adapted for use by an industry partner to take opportunistic samples while doing other collections at sites.

Brandon Heung is the lead on a newly funded NSERC-SSHRC Strategic Grant entitled "The Canadian Soil Data Portal - Transforming Canada's Soil Data Infrastructure to Facilitate GHG Reductions and Climate Change Mitigation", in which Kara Webster and Dave Morris are collaborators. The data compilation from this Forestry Futures Trust funded project will provide a key piece to the national soil data portal.

2. Indicators or metrics of key soil properties based on aspatial analyses from existing plot networks.

We previously reported on a manuscript and presentation on creating soil pedotransfer functions. Given the proof of concept of this work on two test areas this work will continue, first using soil data collected across forest management units as part of the OMNR Vegetation Sampling Network (VSN) and then expanded to include the other soil data curated from the first objective.

An adjunct to this objective was to explore the potential of Spectro-radiometric technology to quickly assess critical soil property information. Dave Morris purchased a spectrometer and is testing and comparing soil samples analyzed by spectrometry to lab analytical results. Brandon Heung is also testing samples from across Canada with spectrometers. Initial results will help guide future data collections and field sampling protocols for programs such as FRI, enabling higher density of soil information measurement across our vast forested area.

3. Expanding map products.

With the help of Forsite contractors and using Romeo Malette Forest as a case study area we have: 1. Refined the DSM workflow process, 2. Created a manual of DSM best practices, 3. Developed a training tutorial of the DSM workflow, including how to run the scripts with example data, 4. Expanded our existing map products of texture and moisture regime to include: organic soil/layer depth, mineral soil depth, total carbon, total nitrogen, carbon to nitrogen ratio, organic soil (peatland) presence, pH, and soil organic carbon pools. 5. Drafted a manuscript highlighting the effect of different qualities of soil data on maps of moisture regime and texture.

We are now ready to apply these refinements to the workflow to different case study areas and at larger regional scales.

In addition, Kara Webster contributed to CFS-led review paper on connecting forest soil properties with ecosystem services and the role of DSM in mapping these services.

4. Expanding the applications of DSM

We contracted part of our work to Forsite to assist with the workflow development and map production. In addition to the technical expertise Forsite provided, this collaboration allowed us to incorporate their LiDAR-derived hexagon forest inventory information as biological (vegetation) covariates to the DSM process. We are poised to now look at making the next step to incorporate vegetation information, with soil depth, moisture regime and texture to predict ecosites and map out the spatial distribution of ecosites. This was beyond the scope of the present study, but there is considerable interest from many different partners to continue this work, should funding become available.

In addition, with the creation of new map products (see above in #3), several key applications of the DSM can start to be realized. These include carbon stock and peatland mapping (with applications to carbon accounting and nature-based climate solutions, protected area planning), soil fertility mapping (with applications to growth and yield modelling, herbicide alternatives, forest silvicultural planning and options).

In addition, Kara Webster and other CFS researchers (Charlotte Norris, David Paré and Jerôme Lagenière) were successful in receiving Canadian Forest Service ForSITE funding to support a project entitled “Indicators of Soil Degradation”. Both the indicator development in objective 2 and the development of digital soil mapping workflow in objective 3 will help in developing mapped products for different soil degradation metrics (e.g., susceptibility to erosion, nutrient loss, etc.).

Explain any deviations from the original project proposal.

Given issues with Covid restrictions earlier in the project and federal travel caps later in the project, in-person partner meetings were not possible. Updates of the work were given through a recorded presentation, a newsletter and through FFT webinars. For similar reasons, a soil sampling field workshop was not possible, but we are completing the booklets on undertaking soil sampling in the field. The DSM tools workshop for practitioners was replaced with a tutorial document.

Describe any technology and knowledge transfer activities that have taken place (publications, workshops, presentations, reports, etc.)

Yanni, S., Webster, K.L. 2024. Forest Soil Datasets in Ontario – Fact Sheets. CFS Information Report. 75pp.

Nelson, S.A., Webster, K.L. 2024. Collecting forest soil samples. CFS Information report. In preparation.

Nelson, S.A., Webster, K.L. 2024. Soil preparation for bulk density and chemical analysis. CFS Information report. In preparation

Arkin, J., McCartney, G., Webster, K.L. 2024. Digital soil mapping in forests: Understanding and implementing the workflow. CFS Information Report. In preparation

Webster, K.L, et al. 2024. Guidance and practical tips for Digital Soil Mapping in Forest Ecosystems. CFS Information Report. In preparation.

Webster, K.L. et al. 2024. Assessing the reliability of historical forest soil data for use in digital soil mapping: A case study in the Romeo Malette Forest, northern Ontario. In preparation for the Canadian Soil Science Society Journal.

Paré, D., Bognounou, F., Emilson, E.J., Laganière, J., Leach, J., Mansuy, N., Martineau, C., Norris, C., Venier, L. and Webster, K., 2024. Connecting forest soil properties with ecosystem services: Toward a better use of digital soil maps—A review. Soil Science Society of America Journal.

FORESTRY FUTURES TRUST ONTARIO

Knowledge Transfer and Tool Development (KTTD) Progress Report

Fleming, R.L., Uhlig, P.W., Morris, D.M., Kwiaton, M., Baldwin, K.A., Hazlett, P.W., Webster, K.L. and Chapman, K.A., 2023. A quantitative approach to defining soil nutrient regimes within ecosystem classifications for Northwestern Ontario. Canadian Journal of Forest Research, 53, 620-641.https://doi.org/10.1139/cjfr-2022-0296

CFS Group of Analytical Labs (edited by Paré, D., Webster, K., and Norris, C. 2023. Collecting, analysing and storing forest soil data and samples in the age of big data. A guide for researchers and field practitioners. Laurentian Forestry Centre publication. ISBN: Fo4-211/2023E-PDF 978-0-660-47983-5. https://scf.rncan.gc.ca/publications?id=40929.

Zhang,J., Heung, B., Yanni, S., Webster, K. 2023. Building pedotransfer functions for soil nutrient regime. Canadian Soil Science Society, Truro, Nova Scotia, June 26-29, 2023.

Webster, K.L. 2023. Advancing Digital Soil Mapping tools in support of forest resource inventory, planning and decision-making. Forestry Futures Trust Webinar. October 19, 2023.

Blackford, C., Heung, B. and Webster, K.L., 2022. Incorporating spatial uncertainty maps into soil sampling improves digital soil mapping classification accuracy in Ontario, Canada. Geoderma Regional, p.e00495.

Digital soil mapping Newsletter, sent to project partners in October 2022.

Webster, K. 2021. Advancing Digital Soil Mapping tools in support of forest resource inventory, planning and decision-making. Overview talk. Partner Meeting #1, September 2021.

Yanni, S. 2021. Advancing Digital Soil Mapping tools in support of forest resource inventory, planning and decision¬-making. Data compilation update. Partner Meeting #1, September 2021.

Blackford, C., Heung, B., Baldwin, K., Fleming, R., Hazlett, P., Morris, D.M., Uhlig, P., Webster, K.L. 2021. Digital Soil Mapping workflow for forest resource applications: A case study in the Hearst Forest, Ontario. Canadian Journal of Forest Research 51: 59–77. https://doi.org/10.1139/cjfr-2020-0066

Webster,K., Heung, B., Fleming, R., Morris, D., Blackford, C. 2021. Digital soil and ecosystem mapping as a potential tool for planning herbicide alternatives. HAP2.0 Webinar Series. January 28, 2021.

Webster,K., Heung, B., Fleming, R., Morris, D., Blackford, C. 2021. Digital soil mapping as a tool for Sustainable Forest Management. CIF-IFC Innovative Forest Solutions Forum -February 23, 2021.

SECTION C: SUMMARY OF EXPENDITURES

Description of eFRI Funds Spent: The Forestry Futures Trust Committee requires confirmation that funds are being spent as outlined in the project budget.

- Present the current yearly expenditures on the two spreadsheets provided in the Section E: Project Financial Tracking document.

- Provide additional description of how funds were spent, (i.e., number of people employed (person days), conferences attended, workshops and publications, etc.).

  Remaining funds were used to sub-contract work to Forsite to complete modelling, mapping and creation of tutorial.

- Provide a brief summary of any significant deviations from planned project expenditures, reasons for differences and implications for the project.

We contracted out modeling aspects of the work due to due to difficulties with hiring within Federal Government. This arrangement has worked well.

Description of In-Kind Contributions:

- Present the current applicant contributions using the provided Financial Tracking form,
- Explain any deviations from planned in-kind contributions. None
- Provide an update on new partnerships (if any). None

SECTION D: DECLARATION

I hereby certify that the above is a true and accurate report of work completed during the reporting period noted on page one of this report.

Project Lead Authorization:

Kara Webster (Research Scientist)	CFS, GLFC
Name and Title (Print)	Institution
Webster, Kara Digitally signed by Webster, Kara Date: 2024.10.29 12:06:13 -04'00'	October 29, 2024
Authorized Lead Signature	Date

Institution Authorization (university, college, company etc):

Danny Galarneau (Director General)	CFS, GLFC
Name and Title (Print)	Institution
Galarneau, Danny Digitally signed by Galarneau, Danny Date: 2024.10.31 13:10:17 -04'00'	
Authorized Institution Signature	Date