List of Approved Projects for KTTD Round 3, 2021

Small-Scale KTTD Projects: Funding <$25,000 (+ HST) and One-Year Duration

Project Number	KTTD 1A-2021
Project Name	Enhancements for eFRI Next Generation Handhelds - for VSN Plots
Company	Forsite Consultants Ltd
Contact	Craig Robinson
Maximum Project Funding	$19,250
Project Description	In Round 2 of the KTTD, we completed a handheld application for Ontario VSN plot ground data collection. Since completion of that, the province completed their specifications and data model for the Vegetation Sampling Network, and updates need to be made to the handheld app to align it with these final plot specifications, and changes to the data model. This project is to do these final changes to the app, test it, and prepare it for use for the 2021 VSN field season which gets underway in June.
Deliverables	Full code and documentation, added to the public git repository on Github at this link: (https://github.com/csrobins/eFRI_LiDAR_Handheld)
	Final Date: June 30, 2021

Project Number	KTTD 5A-2021
Project Name	Linking FRI data to FVS-Ontario
Company	ESSA Technologies Ltd.
Contact	Donald Robinson
Maximum Project Funding	$24,904
Project Description	The project will create approaches, templates and example code and scripts that will help to refine the development of a linkage between external data sources held by the Ministry, academic and commercial forestry agencies, and identify any priority gaps in the existing FRI data. Because the implementation of enhanced FRI methods is still under development, our approach will work with existing sources and focus on developing flexible methods that will be suitable as the methods and data mature.
	Deliverable 1. Document summarizing:
	a. Existing potential data sources and subject matter experts.
	b. Rationale for the selection of up to three types for the development of the prototype tools.
	c. Description of the process required to translate the data into FVS requirements.
	d. Options for the different prototype tools and the rationale for selecting one of them.
	Target date: August 15th, 2021 or two months after the start of the project.
	Deliverable 2. Results and Next Steps
Deliverables	a. Code/script examples with information flow diagramming and in-code comments describing operations. Note that this code/script will be a prototype, possibly without comprehensive error-handling. While others will be able to use the prototypes, we assume that they will have a good understanding of the chosen design environment.

	b. Database examples containing results of prototype FVS-ready input data.
	c. Examples of FVS outputs.
	d. Document describing the key data gaps encountered, and interim steps taken to fill those gaps.
	Target date: December 15th, 2021 or six months after the start of the project.
	Deliverable 3. Hands-on Training session
	a. 3-hour web-meeting to review the script examples and run them in a group setting, to encourage discussion of the prototypes and promote new ideas about their improvement.
	Target date: early December, 2021.

Project Number	KTTD 6A-2021
Project Name	eFRI Wetland Crosswalk and Applied Products
Company	Ducks Unlimited Canada
Contact	Alain Richard
Maximum Project Funding	$25,000
Project Description	This project will involve the development of several LiDAR-based geospatial tools, designed to enhance forest operational planning processes in the Kenogami Forest in Northern Ontario. This will include the refinement of the seasonal operability tool created during Round 2 of the KTTD program, and the development of a Road Location Optimization Tool - using LiDAR data, eFRI data and other geospatial datasets. These tools will be designed and created in collaboration with industry, to ensure they enhance operational planning processes for forest managers, and provide accurate information using up to date information. Once completed, the tools will be available to industrial forest tenure holders across Ontario. The need for these tools was identified by forest managers at AV Terrace Bay (the industrial partner in the project) due to the lack of such tools for operational planning at their disposal. Resource Innovations Inc. will collaborate with AV Terrace Bay and Nedaak Inc., Forest Manager in the Kenogami Forest, in the development of these tools.
Deliverables	(1) Geodatabases housing EWC habitat types and inferred information; January
	(2) Final written report; February 2022
	(3) Knowledge and Technology Transfer; March 2022

Project Number	KTTD 7A-2021
Project Name	Development of LiDAR-based Geospatial Tools to Aid in Operational Planning in Ontario
Company	Resource Innovations Inc.
Contact	Adam Anderson, R.P.F.
Maximum Project Funding	$23,507
Project Description	This project will involve the development of several LiDAR-based geospatial tools, designed to enhance forest operational planning processes in the Kenogami Forest in Northern Ontario. This will include the refinement of the seasonal operability tool created during Round 2 of the KTTD program, and the development of a Road Location Optimization Tool - using LiDAR data, eFRI data and other geospatial datasets. These tools will be designed and created in collaboration with industry, to ensure they enhance operational planning processes for forest managers, and provide accurate information using up to date information. Once completed, the tools will be available to industrial forest tenure holders across Ontario. The need for these tools was identified by forest managers at AV Terrace Bay (the industrial partner in the project) due to the lack of such tools for operational planning at their disposal. Resource Innovations Inc. will collaborate with AV Terrace Bay and Nedaak Inc., Forest Manager in the Kenogami Forest, in the development of these tools.
Deliverables	Throughout the implementation of the project, RI will deliver two automated geospatial tools to AV Terrace Bay for evaluation. Each tool will have several iterations, each building on the last as it moves towards completion. The delivery of each tool will include a GIS-based toolset for the ArcGIS environment
	First, RI is planning to amend/update the Seasonal Operability Tool which was designed in Round 2 of the KTTD program. This will be done early on in the project, to ensure it accurately executes using newly acquired LiDAR datasets in ON. The updated tool will be delivered as per Milestone #1 above - August 2, 2021. The Road Location Optimization Tool will be developed throughout the third quarter of 2021. Several iterations of this tool will be delivered to AV Terrace Bay for evaluation (on computer and in the field) during that time. The goal is to have the final draft of the Road Location Optimization Tool completed by the end of 2021 (Milestone #3), and have all field evaluations of the tool completed by the end of 2021 (Milestone #4). All deliverables will be completed and delivered prior to the project end date of March 31, 2022.

Project Number	KTTD 8A-2021
Project Name	Developing an inventory of eastern hemlock for Ontario
Company	University of Guelph (UG) and Natural Resources Canada (NRCan)
Contact	Dr. Ben DeVries (UG) and Dr. Chris MacQuarrie (NRCan)
Maximum Project Funding	$20,900
Project Description	This project will use free and open data from the ongoing Sentinel-2 satellite mission to generate an inventory of Eastern hemlock for the Province of Ontario. Plot data from representative forest stands will be used to train a machine learning classifier based on Sentinel-2 image composites. The hemlock inventory generated through this classification process will allow the Province of Ontario to respond to infestations of Hemlock Woolly Adelgid (HWA).
Deliverables	1. Dataset: Hemlock and conifer measurements for sample sites - May 2023
	2. Tool: Hemlock classifier for Ontario hemlock - May 2023
	3. Dataset: Inventory of hemlock for Ontario - May 2023
	4. Publication: Peer reviewed-publication(s) describing project, methods and results - submission in May 2023
	5. Presentations: Scientific and workshop presentations on project, methods and tools - December 2022, July 2023

Project Number	KTTD 10A-2021
Project Name	Private Land Inventory and Economics Study
Company	Ontario Woodlot Association (OWA)
Contact	John Pineau
Maximum Project Funding	$25,000
Project Description	The project will use existing 2015 LiDAR data to render a forest inventory for the United Counties of Prescott-Russell in Eastern Ontario. This Inventory will be used in six individual case studies with existing FSC certified woodlot data, to analyze and model the economic implications of applying best management practices including sustainable harvest, to better inform the landowners. A comprehensive paper will be produced, and along with an array of knowledge transfer and communications initiatives, private land forest owners across Ontario will have an opportunity to adapt and apply the results. The project will also inform a planned large-scale project to produce forest inventory for all private land in southern and central Ontario, currently in development.

Deliverables	LiDAR processing and forest inventory production complete: June 30th, 2021
	Field data collection complete: August 30th, 2021
	Inventory data adjusted and validated: September 30th, 2021
	Analysis and modeling of private land wood fibre availability and value: October 30th, 2021
	Final Project Paper and Knowledge Exchange/Outreach: December 31st, 2021

Project Number	KTTD 11A-2021
Project Name	Assisting Ottawa Valley Forest transition to T2 FRI
Company	JWRL Geomatics Inc.
Contact	Andy Welch
Maximum Project Funding	$24,980
Project Description	The primary project objective is to assist Ottawa Valley Forest (OVF) in the transition from FRI T1 to T2. It provides a process with which OVF can create and maintain a reliable T1 FRI base, which does not currently exist and which is necessary for both ongoing revisions and to facilitate eventual T2 calibration/validation. Related components include initial explorations into Sentinel-2 satellite imagery products for both revision and automated species classification and volume sampling using existing aerial imagery.
Deliverables	*WP1 Start-up and Project Management*
	Deliverables: WP1 Progress Report and Invoice #1: May 31, 2021.
	WP2 FRI Revision (3.5 months): addressing major project objectives 1 & 2
	Deliverables: WP2 Progress Report (includes draft revision procedures document) and Invoice #2, Sept. 17, 2021
	WP3 Sentinel Test (5 months): addressing minor project objective 3
	Deliverables: WP3 Progress Report and Invoice #3, Oct 31, 2021
	WP4 Volume Sampling (1 month): addressing minor project objective 4
	Deliverables: WP4 Progress Report, no invoice; Sep 30, 2021
	WP5 Technology Transfer (2 months)
	Deliverables: Final Project Report and Presentation Material; Invoice #4; Dec 31, 2021

Large-Scale KTTD Projects: Funding >$25,000 (+ HST) and >Two-Year Duration

Project Number	KTTD 1B-2021
Project Name	Assessing Site Productivity from Remote Sensing and historic information
Company	Overstory Consultants
Contact	Alexander Bilyk
Maximum Project Funding	$120,000
Project Description	This project aims to mine successive forest inventories to determine site productivity across a variety of forest conditions and with a variety of input datasets across Ontario. Conditions with one pass, two passes and three passes of LiDAR will be compared along with photogrammetric point clouds derived from stereo photography and historic plot information. The outcomes will include a methodology for mining successive digital inventories to estimate site productivity and provide a blueprint for utilizing future forest inventories if they include either LiDAR or photography.
Deliverables	1) Project Commencement - May 3, 2021
	2) Project Charter and RACI Matrix for roles and responsibilities developed and signed - May 17, 2021
	3) Data compilation and processing for Dog River Matawin Complete - September 1, 2021
	4) Data analysis and model creation Complete - January 31, 2022
	5) Interim Report completed and preliminary results submitted - March 31, 2022
	6) Data compilation and processing of Romeo Malette and Petawawa forests complete - September 1, 2022
	7) Data analysis and model creation - January 31, 2023
	8) Final Report completed and submitted - March 31, 2023
	9) Webinar of results - March 2023 - date TBD

Project Number	KTTD 2B-2021
Project Name	Automated Road and Attribute Extraction from SPL Data
Company	University of British Columbia
Contact	Dr. Nicholas Coops
Maximum Project Funding	$272,800
Project Description	Forest roads are an essential prerequisite for forestry and their activation and de-activation are critical decision points for management and biodiversity conservation. The aims of this project are first to develop and validate new automatized approaches to accurately locate forest roads across Ontario from SPL data, and second to predict the condition (or attributes) of both active and decommissioned forest roads from SPL. The methodologies will be open-access, through the R scripting language and python, to enable users to gain direct access to the approaches, and apply them to update, classify and attribute road layers across Ontario.

Deliverables	15th September 2021: Compiled SPL and road datasets over study area. Metadata statements (WORD) and vector road coverages of existing road networks at key forest focus sites. Initial SPL data processing (raster files).
	15th March 2021. Initial Algorithm designed and applied to SPL data in Ontario at small sections of focus sites. Code made available to project team for initial testing. Road segments predictions provided to MSc student for verification. Vector and initial road database developed.
	15th September 2022. Accuracy assessment complete (Draft paper produced on accuracies). New road layers developed and provided to project partners for accuracy assessment (vector files). Attributes predicted using new model development (draft paper).
	15th May 2023. Code publicly released for download. Draft paper on toolkit. Workshops developed and run for Ministry and Forest Company staff on the toolkit and its effective use.

Project Number	KTTD 3B-2021
Project Name	Integration of Photo Interpreted and LIDAR Attributes Into a Polygonal Forest Inventory Framework Attributes
Company	University of British Columbia
Contact	Dr. Nicholas Coops
Maximum Project Funding	$214,500
Project Description	The acquisition of SPL over the forested area of Ontario is redefining how forest attributes are predicted and monitored throughout the Province. A key question remains however, of how to aggregate these area-based (raster) estimates of forest attributes into traditional strategic or tactical-level inventory polygons. This project is designed to address this need. Outcomes of the project will be open source segmentation and attribute prediction tools to develop a polygon based eFRI inclusive of both SPL and interpreted forest stand attributes as well as knowledge transfer activities and demonstration at a number of forest management units.
Deliverables	Deliverable 1: 15th December 2021 Digital Layers Compiled SPL and EFI datasets over study areas – provided to Ministry and Industry staff.
	Deliverable 2: 15th May 2022. Object based segmentation approach with validation. Code available for broader scale testing and applications
	Deliverable 3: 15th December 2022. Imputation draft paper developed. Imputation code developed ready for testing.
	Deliverable 4: 15th May 2023 Jan 2023 Open source code release. Workshop for industry and Government participants. Peer reviewed papers on approach.

Project Number	KTTD 10B-2021
Project Name	Automated characterization of forest vertical structure using single photon LIDAR
Company	Forest Analysis Ltd.
Contact	Dr. Margaret Penner
Maximum Project Funding	$66,250
Project Description	Vertical stand structure is an important information need for forest management planning. Vertical stand structure affects classification, management, yield, and stand development. Vertical stand structure is also relevant for other applications including habitat modelling and fuels management. The objective of this project is to use Single Photon LiDAR (SPL) to predict vertical forest structure at the pixel level and predict forest attributes by layer. The approach developed will be validated using a combination of field reference data and expert knowledge. We will also explore methods to meaningfully summarize grid cell-level predictions of vertical structure to the stand level to support forest management planning. This proposal covers the Petawawa Research Forest because of the extensive experience of the project team with the LIDAR-based inventory of this forest and the importance and prevalence of vertical structure in the forest. This proposal also covers two provincial Forest Licenses (FLs) – one in the boreal (Romeo Malette) and one in the Great Lakes/St. Lawrence (GLSL) forest type (Algonquin Park).
Deliverables	Deliverable #1: Completion of the PRF. The methodology for predicting attributes by layer will be documented and results for the PRF summarized. Results will be presented to project partners (March 2022)
	Deliverable #2: Completion of the Romeo Malette Forest. Results will be documented and presented to project partners (June 2022)
	Deliverable #3: Completion of the Algonquin Park Forest. Results will be documented and presented to project partners (December 2022)
	Deliverable #4: Presentation of results to larger target audience (via eLectures) (November 2022–March 2023)
	Deliverable #5: Completion of technical report and a draft manuscript for publication (March 2023)
	Deliverable #6: Sharing of spatial data layers for all sites with final grid-cell estimates of vertical structure and derived stand-level summaries (March 2023)

Project Number	KTTD 14B-2021
Project Name	Developing G&Y models for white pine and white spruce plantations
Company	Ontario Forest Research Institute, Ministry of Natural Resources and Forestry
Contact	Dr. Mahadev Sharma
Maximum Project Funding	$85,000
Project Description	New taper, volume, and diameter growth models will be developed by sampling 200 white pine and white spruce trees each from across Ontario. Stand density information and climate variables will be incorporated in deriving these models. Tree and stand characteristics (e.g., diameter at breast height (DBH), height, stand density, tree species) data obtained from intensive ground based and airborne lidar or extensive forest resource inventory (FRI) type data can be used as inputs to these models to estimate wood product recoveries. As a result, once these models are incorporated into FRI products directly or via the Modelling Inventory Support Tool (MIST) by updating benchmark yield curves, the wood supply can be estimated more accurately.
Deliverables	May 1, 2022: Technical report/draft journal paper on taper and volume equations for white spruce
	June 1, 2023: Draft journal papers on taper and volume equations for white pine plantations
	July 1, 2023: Draft journal paper on diameter growth of white spruce and white pine plantations
	July 31, 2023: Final report to Forestry Futures Committee
	Dec 31, 2023: Implementation and transfer of final model products in MIST

Project Number	KTTD 16B-2021
Project Name	FIM Compliant LiDAR Inventory of Selected Areas in the Romeo Malette Forest
Company	Forsite Consultants Ltd.
Contact	Craig Robinson, R.P.F.
Maximum Project Funding	$142,863
Project Description	The objective of this project is to build a strategic level FIM compliant inventory using single photon LiDAR data and other ancillary data. The process will identify individual trees with attributes (height, species, DBH, etc) and then use this data in a hybrid ITC/ABA inventory approach to attribute tiles and provide statistical measures of accuracy. These tiles are then further aggregated into polygons appropriate for strategic modeling. The final product will leverage this and other data to provide the full suite of current FIM attributes, including ages and ecosites, and non-forested areas, in addition to a rich set of stand attributes that describe forest products and sizes for use in operational planning.
Deliverables	Individual Tree Inventory – Date: December 2021
	Tile Inventory (ABA- EFI) – Date: January 2022
	Polygon FIM compliant inventory – Date: March 31 2022

Project Number	KTTD 19B-2021
Project Name	Advancing Digital Soil Mapping tools in support of forest resource inventory, planning and decision making
Company	Canadian Forest Service, Natural Resources Canada
Contact	Dr. Kara Webster
Maximum Project Funding	$180,000
Project Description	The aim of this project is to continue to advance tools and create products to map soils at high spatial resolutions that will provide a foundational layer to enhance Ontario's forest resource inventory, assist in forest management planning, and improve operational decision making. This project builds on a previous FFT funded project that developed a workflow using openly available GIS software (SAGA) and R scripts to map soil moisture regime and texture using a suite of machine learning algorithms and applied it to case study areas (Blackford et al. 2021. Canadian Journal of Forest Research. 51: 59–77). This project also expands on the data curation activities, mapping products and applications initiated in previous research.
Deliverables	Partner meeting #1 (September 2021; Lead(s) - Webster/Morris)
	Partner meeting #1 (September 2021; Lead(s) - Webster/Morris)
	Database summary report and map (March 2022; Lead(s) - Yanni/Blackford)
	Soil sampling protocol compilation (February 2022; Lead(s) – Yanni/Chapman)
	Upload of shareable data, not currently open access to FGP (June 2022; Lead(s) - Yanni)
	Soil sampling approaches field workshop (August 2022; Lead(s) - Webster/Morris/Fleming)
	Partner meeting #2 (September 2022; Lead(s) - Webster/Morris)
	Continuous soil properties maps and manuscript from case study area (May 2022; Lead(s) - Blackford/Heung)
	Summary of soil metrics for use in forest management report (September 2022; Lead(s) – Fleming/Yanni/Webster)
	Survey to planners, managers and policy makers on priorities for applications of DSM (Feb 2023, Lead(s) - Webster/Morris/Fleming)
	Soil metrics maps and manuscript from case study area (March 2023; Lead(s) - Backford/Heung)
	Partner meeting #3 (May 2023; Lead(s) - Webster/Morris)

Project Number	KTTD 20B-2021
Project Name	Accelerating the implementation of enhanced forest inventories in Ontario
Company	TreeDimensions
Contact	Murray Woods
Maximum Project Funding	$135,141
Project Description	The objectives of this project are to: 1. Accelerate the implementation of enhanced forest inventories in Ontario by developing standardized, open-source code (R) for summarizing calibration plot data for use in the area-based-approach (ABA); 2. Use Ontario's AZURE cloud platform to test and refine the code output to operationally model and derive lidar enhanced forest inventories in the boreal forest and Great Lakes forest regions to update and augment existing forest inventory information; and, 3. Provide opportunities for increased technology transfer between government and industry staff on methodological approaches and linkage to inventory and planning. Three forest management units are proposed to be completed in a 2-year project: Romeo Malette Forest, Dog River Matawin Forest, and Algonquin Park. Adding a fourth forest management unit (French Severn Forest) to the project is an option that could be added to the project scope if funding was available.
Deliverables	*Year 1*
	#1 – August 30, 2021 – Calibration plot compilation program prototype created and tested
	#2 – October 31, 2021 – Romeo Malette Forest inventory raster products completed
	#3 – November 15 – Technology Transfer sessions for Romeo Malette Forest via web-based platform
	#4 – February 28, 2022- Dog River Matawin inventory raster products completed
	#5 – March 25, 2022 – Technology Transfer sessions for Dog River Matawin via web-based platform
	#6 – March 31, 2022 - Report documenting boreal inventory raster development and calibration plot summary software.
	Year 2
	#7 – August 31, 2022 – Algonquin Park inventory raster products completed
	#8 – Sept 15, 2022 – Technology Transfer sessions for Algonquin Park inventory
	#9 – September 30, 2022 – Report documenting Algonquin Park inventory raster development
	#10 – October 31, 2022 – Ontario calibration plot compilation code documentation completed
	#11 – December 15, 2022 – Plot compilation code and documentation posted to GITHUB
	[December 15 – March 31, 2023 – OPTIONAL French Severn Forest addition] – refer to budget request