

**ENHANCED FOREST RESOURCE INVENTORY (eFRI)
KNOWLEDGE TRANSFER AND TECHNOLOGY DEVELOPMENT (KTTD) PROGRAM
LIST OF APPROVED PROJECTS AND DELIVERABLES FOR ROUND 2, 2018**

Small-Scale KTTD Projects: Funding < \$25,000 and one-year duration

Project Number: KTTD 1A-2018 – Cancelled by applicant	
Project Name	Using the eFRI to predict hardwood selection stands in the Bancroft Minden Forest
Company	Bancroft-Minden Forest Company
Contact	Svetlana Zeran
Maximum Project Funding	\$25,000 (HST not included)
Project Description	To test assumptions used to delineate hardwood sites suitable for selection management in the Bancroft-Minden forest and re-measure areas previously harvested under this system to determine which variables in the newly delivered FRI will help predict the best sites for selection management. This study will help inform better use of our FRI for our upcoming Forest management plan and will help add to the limited body of knowledge on GLSL hardwood management.
Deliverables	<ol style="list-style-type: none"> 1. Assessment and organization of current FRI data and subsequent planning for field data collection (Late winter – early Spring) 2. Data collection in the field processed and uploaded into an electronic database (Spring – Fall) 3. Analysis of all data and reporting of results (Fall – Winter) 4. Communication of results by the intern via CIF platforms e.g. through an electronic lecture, Chronicle Journal article, success stories publication etc. (early Spring of 2019) 5. Presentations to neighboring SFLs and to MNRF (early Spring 2019)

Project Number: KTTD 2A-2018 (Completed)	
Project Name	Seasonal Operability Predictor Tool for Forest Operations
Company	Resource Innovations Inc.
Contact	Adam Anderson
Maximum Project Funding	\$23,870 (HST not included)
Project Description	The project will aim to utilize existing eFRI information and supplemental data to produce an automated stand-level seasonal operability predictor tool to support annual scheduling of forest operations, and will compare the predicted (stand-level) results with interpreted results in the provincial inventory. The tool will enable the project partner (AV Terrace Bay) and other tenure holders to get a better indication of the best potential season for harvesting a stand and will contribute to a balanced supply of wood fiber across all seasons.
Deliverables	<ol style="list-style-type: none"> 1. Throughout the implementation of the project, RI will deliver various iterations of the seasonal operability prediction tool to AV Terrace Bay for review and input. 2. At the completion of the project, RI will deliver the stand-level, seasonal operability prediction tool to AV Terrace Bay for use in

	future planning operations. The tool will be delivered in ArcGIS format such that it can be integrated into the company's planning system moving forward. RI will also provide brief documentation outlining the steps necessary to operate the tool to predict seasonal operability.
--	---

Project Number: KTTD 3A-2018	
Project Name	Modeling post-fire residual shoreline forest pattern
Company	Ontario Ministry of Natural Resources and Forestry
Contact	Robert Mackereth
Maximum Project Funding	\$25,000 (HST not included)
Project Description	Forest management policy in Ontario has adopted the principle of emulation of natural disturbance pattern; however, riparian forest management that relies on fixed-width buffers to mitigate negative impacts to aquatic ecosystems may result in unnatural residual forest patterns. The objective of this project is to quantify post-fire residual forest patterns using eFRI imagery and develop a model that will assist forest management planners to design shoreline forest management to better emulate natural disturbance patterns and protect ecologically sensitive riparian areas.
Deliverables	<ol style="list-style-type: none"> 1. Report summarizing literature review and imagery and methodology selected for project - Sept 2018 2. Report on results of spatial analysis and model development and testing - Jan 2019 3. Presentation(s) on project to partner groups (e.g. CCSIC, Forestry Futures workshop) - ongoing from Sept 2018 4. Final project report and peer-reviewed manuscript - Mar 2019

Project Number: KTTD 4A-2018 (Completed, Workshop Pending)	
Project Name	FRIHub: A Discovery Portal for FRI Data and Products
Company	Lim Geomatics Inc
Contact	Dr. Kevin Lim
Maximum Project Funding	\$25,000 (HST not included)
Project Description	To develop a cloud-based web GIS portal called the FRIHub to host FRI source data and products, and provide users the ability to discover, visualize and download them. The FRIHub will be engineered as a highly scalable system to support Ontario's digital imagery and lidar information management needs of today and tomorrow, and provide the public a user-friendly self-serve portal for accessing those data. The status, availability, and quality of FRI data can also be communicated via the FRIHub, thereby ensuring all stakeholders are always in the know.
Deliverables	<ol style="list-style-type: none"> 1. Product Backlog / Requirements Document - April 30, 2018 2. User Interfaces and Use Cases - May 31, 2018 3. FRIHub Discovery Portal (Beta Version) - December 31, 2018 4. FRIHub Discovery Portal (Final Version) - February 15, 2019 5. Training Materials (User Guide and Help Videos) - March 1, 2019

	6. Technical Workshop (Hands-On Training) - March 20, 2019 7. Webinar Workshop - March 27, 2019
--	--

Project Number: KTTD 5A-2018 (Completed, Workshop Pending)	
Project Name	ITESTA - Individual Tree Extraction and Species Typing Analysis
Company	Lim Geomatics Inc
Contact	Dr. Kevin Lim
Maximum Project Funding	\$25,000 (HST not included)
Project Description	To apply Lim Geomatics' newly developed proprietary individual tree extraction and species classification technology to a subset of the Petawawa Research Forest. Available algorithms today for individual tree extraction rely on canopy height models as input, which has shown to yield inaccurate predictions. Lim Geomatics' technology uses the entire LiDAR point cloud for individual tree extraction and species classification, which represents a significant innovation. This project will allow Lim Geomatics to test its new technology in a well-studied forest.
Deliverables	<ol style="list-style-type: none"> 1. Generate the required input LiDAR predictors for the Petawawa Research Forest - April 30, 2018 2. Process the airborne LiDAR data to extract individual trees - July 31, 2018 3. Collect plot data for independent validation (i.e., stem maps with species) - August 31, 2018 4. Develop unique signatures for individual tree species models - October 31, 2018 5. Use developed species classifier to type each individual tree extracted with species - December 31, 2018 6. Review preliminary research with forestry subject matter experts - January 31, 2019 7. Run final models and baseline results - February 28, 2019 8. Deliver knowledge and technology transfer workshop - March 2019

Project Number: KTTD 6A-2018	
Project Name	Next Generation eFRI Ground Data Collection App
Company	ArborData Consulting Ltd
Contact	Craig Robinson
Maximum Project Funding	\$23,880 (HST not included)
Project Description	This project will be the development of a mobile field application for eFRI Ground Calibration Plots data collection. The proposed application will be created to adhere to the principles of a modern application for tablets or smartphones that can be easily deployed to commonly used platforms of iOS and Android. The application will be GPS capable and have full plot quality control checks on the device, available in the field. Plot data will be collected disconnected in the field, and then synchronized with a centrally managed cloud service once the device has connectivity.
Deliverables	<ol style="list-style-type: none"> 1. Technology design complete - Mar 28, 2018 2. Alpha Version available for testing - May 18, 2018

	3. Beta Version available for testing - June 8, 2018 4. Final Version available - June 29, 2018 5. Technology Transfer documentation - July 20, 2018
--	--

Project Number: KTTD 7A-2018	
Project Name	Development of an enhanced operational forest inventory based on multispectral imagery and 3D point data.
Company	KBM Resources Group
Contact	Laird Van Damme
Maximum Project Funding	\$24,000 (HST not included)
Project Description	The objective of this project is to develop an enhanced operational forest inventory tool and associated mobile application to enable operators to harvest blocks with greater efficiencies through the provision of detailed information on the distribution of groups of trees of similar composition and structure within a stand or harvest block. A low cost mobile field mapping application that integrates these new operational forest inventory layers will be developed.
Deliverables	Operational FRI mobile app solution (January 2019): <ul style="list-style-type: none"> Whitesand harvest allocation layers with FRI sub-compartments and attributes Mobile mapping application with easy access to viewing and querying of operational FRI sub-compartments

Large-Scale KTTD Projects: Funding >\$25,000 and up to two-year duration

Project Number: KTTD 1B-2018 Ver. 2	
Project Name	Development of a forest inventory using 2018 Single Photon LiDAR and assessing decadal forest change.
Company	University of British Columbia
Contact	Dr. Nicholas Coops
Maximum Project Funding	\$518,650 (HST not included)
Project Description	<p>With the provision of 2018 Single Photon LiDAR data at the Romeo Malette forest in Ontario an opportunity exists to demonstrate how an Enhanced Forest Inventory (EFI) can be developed using this new type of LIDAR data, as well as assess forest growth and change using the previous collected LIDAR data in the mid 2000's.</p> <p>This project has three aims: (i) propose a sampling design for collecting FRI calibration plots for model development for the 2018 SPL, (ii) Coordinate procurement and delivery of field data collection services using the draft Integrated Monitoring Framework (IMF) design specifications, (iii) develop an EFI and examine the utility of both Area Based Approach (ABA) and Individual Tree Detection (ITD) approaches using SPL data and (iv) assess growth and change using previous acquired LIDAR data.</p>
Deliverables	1. Digital Layers: Initial location and number of plots required for field season (Feb 15, 2019)

	<ol style="list-style-type: none"> 2. Digital Data: Field plot data will be delivered to support long-term forest resource inventory production and broader monitoring objectives. (Aug 15, 2019) 3. Short Report and Digital Layers- EFI Modeled Forest Attributes using the ABA approach over the estate – (Sept. 15, 2019) 4. Report - Draft Peer Reviewed Publication - Accuracy Assessment of EFI and comparison between mid-2000 and SPL EFI. (Dec. 15, 2019) 5. Report - Change assessment and ITD based analysis. (March 15, 2020) 6. Final Report - March 15, 2020
--	--

Project Number: KTTD 2B-2018 (Completed)	
Project Name	Scoping an enhanced Growth and Yield program to complement the eFRI
Company	Forest Analysis Ltd.
Contact	Margaret Penner
Maximum Project Funding	\$96,092 (HST not included)
Project Description	A growth and yield master (G&Y) plan for Ontario was developed in collaboration with forest industry and published in 1993 and continues to guide the G&Y program. It is now 25 years old. While the need for reliable data and models remains, much has changed since 1993. The objective of this project is to meet with forest industry and government to identify strengths and weaknesses of the growth and yield program including linkages to other programs and to identify needs and opportunities for improvement. The results of the meetings will be summarized and presented to the MNR&F for setting priorities and program planning. The results will also be shared with forest industry and the FFTC.
Deliverables	<ol style="list-style-type: none"> 1. Final Report – April 17, 2019 2. Final Presentation to MNRF – June 11, 2019

Project Number: KTTD 3B-2018	
Project Name	An analysis of machine learning methodologies for determining stand level attributes.
Company	KBM Resources Group
Contact	Arnold Rudy
Maximum Project Funding	\$97,000 (HST not included)
Project Description	The project will investigate the use of machine learning techniques for the estimation of basal area, stocking and volume for various forest cover types using existing FRI calibration plot data, ADS40 multispectral imagery and photo-derived 3D point clouds. Use of existing data provides a cost-effective approach at a scale appropriate to Ontario's forest management requirements. The prediction accuracy of various machine learning techniques with emphasis on convolutional neural networks (CNN) and 3D CNNs architectures will be tested. Based on the best performing model, forest management unit level maps of basal area, stocking and volume will be generated.

Deliverables	<ol style="list-style-type: none"> 1. Development of labelled training set - August 2018 2. Machine learning architecture development - December 2018 3. Machine learning configuration, training, testing - March 2019 4. Deployment and landscape map production - May 2019 5. Analysis, Compilation - August 2019 6. Final report produced - July 2019 7. Public workshop and or presentations - February 2020
--------------	--

Project Number: KTTD 4B-2018 (Completed)	
Project Name	Enhancing Forest Inventory with Terrestrial LiDAR
Company	Overstory Consultants
Contact	Alexander Bilyk
Maximum Project Funding	\$130,822 (HST not included)
Project Description	The purpose of this project is to use the existing growth and yield plot network to explore the use of terrestrial LiDAR (tLiDAR) to both collect growth and yield information more efficiently and use this as calibration data for an aerial LiDAR inventory. The project would identify what parts of the current growth and yield program could transition to tLiDAR collection to increase efficiency of the current ground-based data collection process. It would also explore the use of these same plots as calibration data for the aerial LiDAR being flown in the next round of the Enhanced Forest Resource Inventory (eFRI).
Deliverables	<ol style="list-style-type: none"> 1. Acquisition of the tLiDAR unit and initial calibration complete - June 15, 2018 2. All selected growth and yield plots scanned (number will be based on results of step 1 calibration and is expected to be a minimum of 75 plots) - October 1, 2018 3. Data compilation complete and all scans converted to aligned .xyz format - November 1, 2018 4. tLiDAR plot processing and metric summary - February 01, 2019 5. Statistical comparison to field data - March 29, 2019 6. Final project summary report complete - March 29, 2019

Project Number: KTTD 5B-2018	
Project Name	Exploring the innovation potential of single photon LiDAR for Ontario's eFRI
Company	Canadian Institute of Forestry
Contact	Dana Collins
Maximum Project Funding	\$136,555 (HST not included)
Project Description	This project will benchmark and document the potential of single-photon LiDAR (SPL) for forest and terrain characterization. The outcomes of this project will be both operationally and scientifically relevant to forestry professionals in Ontario and nationally. Specific objectives are to: (i) quantify the performance of SPL in an area-based approach to estimate forest inventory attributes; (ii) quantify the performance of SPL in characterizing terrain under varying forest types and canopy densities; (iii) identify and explore any incremental

	advantages or innovations for the eFRI program resulting from unique SPL data characteristics.
Deliverables	<ol style="list-style-type: none"> 1. Area-based inventory complete and validated - October 2019 2. DTM completed and validated - October 2019 3. Technical report summarizing project outcomes - March 2020 4. National e-Lecture hosted by CIF reporting on project outcomes - February 2020

Project Number: KTTD 6B-2018	
Project Name	A Review, Enhancement, and Accuracy Assessment of Wetland Features within the eFRI
Company	Confederation College
Contact	Keith Hautala
Maximum Project Funding	\$66,000 (HST not included)
Project Description	This project will develop a comprehensive wetland inventory and wetland ecosite field accuracy assessment for Quetico Provincial Park. We will use eFRI imagery to supplement existing ecosite data to include marshes and other wetlands presently misclassified as waterbody or island polygons. These data will provide a better understanding of the location, value and role of wetlands in the landscape. We will assess the potential of methods developed in this project to be applied elsewhere so that wetland features may be more accurately identified during the forest inventory or wetland inventory process.
Deliverables	<ol style="list-style-type: none"> 1. Digitized wetland polygons from waterbodies and islands - December 2018 2. Classification of new wetland polygons - December 2018 3. Completed wetland field surveys - September 2019 4. DUC EWC crosswalk report - February 2019 5. Final Report - December 2019 6. Recommendations report to eFRI Branch - December 2019

Project Number: KTTD 8B-2018	
Project Name	Validation of eFRI and SkyForest™
Company	First Resource Management Group Inc.
Contact	Philip Green
Maximum Project Funding	\$52,787 (HST not included)
Project Description	The objective is to find new ways to validate interpreted inventory attributes of the eFRI and to demonstrate the potential of satellites for producing forest inventory. We will validate stand level predictions for SkyForest™ and selected attributes of the new photo interpreted Temagami eFRI with stand level field data. It is envisioned that SkyForest™ may provide the means to validate and supplement the eFRI program on a broader provincial scale.
Deliverables	<ol style="list-style-type: none"> 1. A report on validation and the potential of SkyForest™ to aid in eFRI updating/validation, written in collaboration with Mr. Murray Radford, Mr. Murray Woods and Mr. Frank Kenny of MNRF.

	<ol style="list-style-type: none"> 2. FRMG will provide volume, basal area and hardwood/softwood data, and a high resolution digital terrain model (DTM) to incorporate into operational planning. 3. FRMG will make all Temagami SkyForest™ data and interpretative reports available to the MNRF. 4. Measures of utilization 5. Electronic operational maps from SkyForest™ data for logging operators, local mills, local municipalities, Temagami FN (can be read with a GPS enabled tablet), board of directors of the Local Forest management Company.
--	--

Project Number: KTTD 9B-2018	
Project Name	Post-Harvest Surveys from Satellite Capture and Machine Learning
Company	Global Surface Intelligence Ltd. (GSI)
Contact	Maurice LeBlanc
Maximum Project Funding	\$ 59,966 (HST Exempt)
Project Description	This project is to use the GSI Platform to develop a solution that will use the power of high performance computing and machine learning to combine actual observations and satellite data to provide objective determination of post-harvest conditions in line with the timing of Establishment and Performance surveys. The intention is to develop and calibrate a model using the most objective data available that would provide attributes such as height, species composition, stocking, density, and growth rates to inform forest management decisions by the OMNRF and the forest industry.
Deliverables	<p>10/28/2018 Milestone 1: Density, Height, Site Occupancy, Species Composition at harvest blocks required 2018 as geotiffs (10m x 10m pixel size) in the Ministry's preferred spatial projection; with relevant descriptions on accuracy of validation, and any raw sampled data used for comparisons in cross-validation.</p> <p>11/30/2018 Milestone 2: Density, Height, Site Occupancy, Species Composition at harvest blocks required 2015, 2016, and 2017 as geotiffs (10m x 10m pixel size) in the Ministry's preferred spatial projection; with relevant descriptions on accuracy of validation, and any raw sampled data used for comparisons in cross-validation.</p>

Project Number: KTTD 10B-2018	
Project Name	Forest Health Monitoring from Satellite Capture and Machine Learning
Company	Global Surface Intelligence Ltd. (GSI)
Contact	Maurice LeBlanc
Maximum Project Funding	\$150,083 (HST Exempt)
Project Description	<p>This project is to use the GSI Platform to develop a solution that will use the power of high performance computing and machine learning to combine actual observations and satellite data to objectively identify forest areas having experienced significant change in health from a variety of natural disturbance events whether through a gradual change over time or from a specific event in time. The results/process of this trial are intended to become integrated as part of OMNRF's Integrated Monitoring Framework. The intention would be to develop and calibrate a model on past survey results or confirmed ground observations of specific disturbances and incorporate new observations from 2018.</p>
Deliverables	<p>Disturbance layers will be presented as a likeliness heatmap in geo-tiffs format (10m pixel size) which will be posted in GSI's online viewing application named Ethos for review by the partners. Once satisfied, the outputs will be made available for download in an ESRI compatible format in the preferred spatial projection. All outputs will include relevant descriptions on accuracy of validation, and any raw sampled data used for comparisons in cross-validation.</p> <p>The time frames and proposed schedule of deliverables is shown in the table on Page 10 of the proposal.</p>

Project Number: KTTD 11B-2018	
Project Name	Species Composition Determined from Satellite Images and Machine Learning
Company	Global Surface Intelligence Ltd. (GSI)
Contact	Maurice LeBlanc
Maximum Project Funding	\$59,966 (HST Exempt)
Project Description	This project is to use the GSI Platform to develop a solution that will use the power of high performance computing and machine learning to combine actual observations and satellite data to provide objective determination of tree species identification. The intention would be to develop and calibrate a model on past/future survey results using the most objective data available to help quantify species composition based on tree metric attributes such as height, basal area, volume, and canopy closure, with by species (group).
Deliverables	<p>Forest species composition layers will be presented as likeliness (percentage) maps by each species or species group in raster format (10m pixel size) which will be posted in GSI's online viewing application named Ethos for review by the partners. Once satisfied, the individual layers will be amalgamated into one thereby giving a species composition output (i.e. the sum of all species/groups will equal 100%) will also be posted to Ethos.</p> <p>All spatial outputs will be made available in downloadable ESRI compatible format in the preferred spatial projection. All outputs will also include relevant descriptions on accuracy of validation, and any raw sampled data used for comparisons in cross-validation. The time frames and proposed schedule of deliverables is shown in the table found on page 9 of the proposal.</p>