**Continuous update of Enhanced Forest Inventory attributes with optical time series data**

**Introduction/Aim:**

Detailed and up-to-date forest inventories are critical in informing sustainable forest management decisions. One method of deriving spatially explicit maps of forest attributes is to combine airborne laser scanning data with field measurements to generate an Enhanced Forest Inventory (EFI), which can provide wall-to-wall characterizations of key forest attributes. Although providing a high level of spatial and structural detail, EFIs represent a single point in time and thus are not capable of characterizing changes in forest attributes, a need that is becoming more important given uncertain future conditions and increasing disturbance frequencies and intensities. To address this challenge, we investigated how a time series of optical satellite data could be used to update an EFI generated for a large (~690,000 ha) forest management unit in Ontario, Canada, at an update interval of every 2 weeks.

**Methods:**

The approach involved two distinct phases. In the first phase, a time series of Harmonized Landsat Sentinel-2 data were downloaded and variables characterizing the intra-annual amplitude, slope, and trend of 14 spectral bands and indices were calculated. Next, models were developed to impute 7 commonly derived EFI attributes: aboveground biomass, basal area, stem density, Lorey’s height, quadratic mean diameter, and stem volume using a k-Nearest Neighbour (kNN) model with the spectral metrics as the response variables. The study area was split into 20 strata representing all combinations of species groups and site productivity classes, and a kNN model per stratum was created. In Phase 2, the same spectral variables were derived at 2-week intervals for the 3-year period following the EFI acquisition. The models developed in the first phase were applied to key stands of interest and imputed attributes were observed through time to investigate the application of the models to stands experiencing both disturbances and growth (i.e., no disturbance).

**Results:**

Across all strata, models were generally accurate, with relative RMSE ranging from 11.47% (canopy cover) to 31.82% (stem volume). While there were generally no patterns of how accuracy varied across species groups, attributes for more productive site classes were typically predicted with greater accuracy than attributes for low-productivity sites. In the application to future periods (Phase 2), models were able to capture the stand dynamics of the focal sites in the study area. Outputs from this second phase demonstrated the potential of the approach for characterizing changes in EFI values in areas experiencing no change or non-stand replacing disturbances.

**Conclusion:**

A timely and detailed forest inventory is critical to sustainable forest management. In order to keep up with highly dynamic future conditions, new tools and techniques need to be tested in order to understand how they can be integrated into managing the forests of the future. This study demonstrated an approach to update EFI attributes at any temporal interval, thereby promoting near-real time integration into forest management and enabling more informed decision-making to prescribe treatments or understand the state of forest resources under uncertain future conditions.