What's the Difference Between EFI and NFI?

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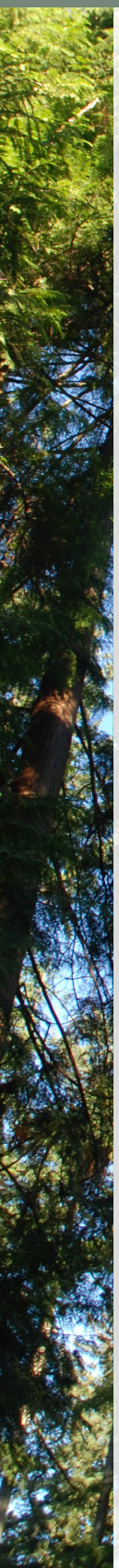


Demystifying Current Acronyms in Forest Inventory in Canada

Forest inventories in Canada are evolving as new technologies are incorporated into the inventory process. Governments and industry are under increasing pressure to reduce inventory costs, while simultaneously producing improved information to support the increasingly complex demands associated with forest management. For forest professionals, keeping up-to-date on technological innovations and understanding the different sources of forest inventory information available (and the associated terminology) can be challenging.

Amidst all this change in forest inventories in Canada, there are two acronyms in particular that seem to invite confusion: NFI and EFI. NFI stands for National Forest Inventory and represents a type of inventory with a very specific purpose: an NFI is typically designed to provide high-level information to support national-level forest policy and reporting information needs. Enhanced Forest Inventory (EFI) represents an approach to forest inventory that makes use of advanced remote sensing technologies such as Airborne Laser Scanning, also known as LiDAR (light detection and ranging) — in combination with ground plot data — to generate inventory attribute information.

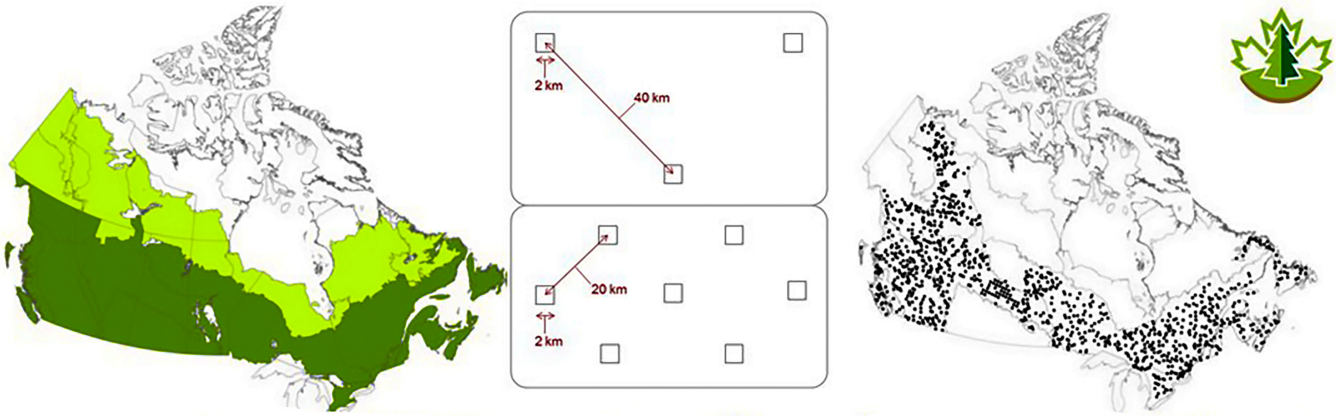
NFI and EFI differ in their spatial and temporal characteristics. Canada's NFI is sample-based, meaning only a small portion of the total forest area is actually measured to characterize Canada's entire 347 million hectare forested area. The NFI uses representative samples of different forests from across Canada. In contrast, EFIs are spatially explicit and provide complete spatial coverage of a management area of interest. These "wall-to-wall" forest inventories are very detailed and are generated over forest management areas in Canada, in excess of one million hectares.

Temporally, NFI and EFI also differ. Canada's NFI measures changes in forest attributes through time, so consistency in measurement is important, with the same sample areas remeasured approximately every 10 years using comparable techniques. EFIs on the other hand provide precise characterization of current forest conditions to support present-day operations and management, as well as mid to long-term planning exercises, such as timber supply forecasting.

National Forest Inventory

Provincial, territorial, and federal governments have been collaborating since 2000 to collect NFI data consistently across Canada detecting and analyzing forest changes over time at regional and national scales. A national network of permanent sample plots ensures all forest types are surveyed in a representative manner. The NFI maintains a network of 1,114 permanent ground plots and 13,158 remote sensing plots across Canada. Statistical techniques are used to get from what's known (forest conditions in the sample plots) to what's of interest (forest conditions in the overall forest, or population).

NFI plots were first established and measured across the country between 2000 and 2006, and again between 2008 and 2017. The first statistical estimates of forest change in Canada will be published when processing of all second measurement data has been completed. Meanwhile, a third round of measurements will begin. As time passes and repeat measurement data are collected, scientists will have more information to use for analyzing forest changes, studying relationships between changing variables and figuring out what's driving forest change over the long term. The data are used to produce reports for Canadians, such as The State of Canada's Forests Annual Report 20173, and for international reporting. The NFI data in combination with data, collected by provinces, territories, and the federal government into Canada's National Forestry Database, tracks progress toward sustainable forest management.



NFI uses aerial and satellite data to monitor Canada's forests, with higher sampling density across the south (dark green area; 20km grid) and lower density across the north (light green; 40km grid).

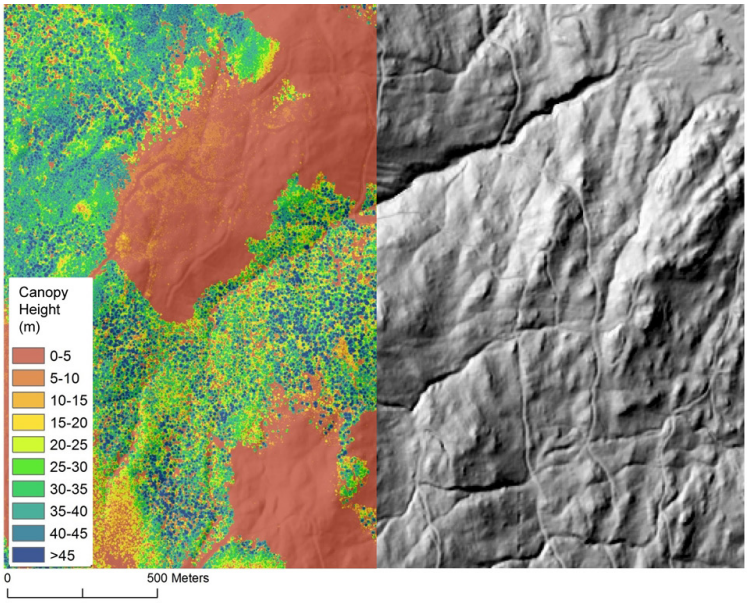
NFI takes measurements at a network of 1,115 permanent ground plots to support its aerial and satellite-based monitoring.

Enhanced Forest Inventory

Airborne LiDAR instruments acquire data by emitting laser pulses from an aircraft flying above the forest and measuring the time it takes for those laser pulses to be intercepted by an object (e.g. foliage, branches, ground) and returned to the instrument. The resulting data is a three-dimensional (3D) point cloud representing the vertical distribution of vegetation through the forest canopy, providing precise measurements of tree heights and detailed characterizations of forest vertical structure.

These 3D data are combined with spatially precise ground plot measurements to model forest inventory attributes such as height, basal area, and volume. LiDAR data also provide precise characterization of the ground under forest canopy, generating detailed digital elevation models (DEMs), which are an important information source for planning forest operations.

A new tool, digital aerial photogrammetry (DAP) is emerging as another source of 3D data to support EFIs. Airborne imaging technologies and image processing software have advanced to the extent that it is now possible to generate canopy height models (CHMs) and 3D point clouds from digital airborne imagery that are similar, but not the same, as CHMs and point clouds generated from airborne LiDAR data. DAP data are less expensive than LiDAR data and may be useful for updating EFIs cost-effectively.



Lidar data improves characterization of canopy height (left) as well as the terrain surface underneath the canopy (right).

Forest managers use LiDAR and EFIs to reduce operational costs and increase profitability through improved planning and efficient fibre utilization. The cost savings can be substantial, as many current inventories in Canada are old (>20 years) and lack the spatial detail for operational and tactical decision-making. LiDAR-derived DEMs provide useful information for operational planning and improve the efficiency of block and road layout. EFIs also provide more information to support the management of other ecosystem goods and services, such as wildlife habitat and riparian areas. In the longer-term, enhanced inventories can improve projections of future timber supply and can reduce uncertainty that is currently associated with ageing, less-detailed forest inventory data.

The Intersection of EFI and NFI

Forests are inventoried for multiple purposes. Forest information is gathered to support strategic, tactical, and operational forest planning and management. Whereas EFI is an approach used for operational- and management-level forest inventory and NFI is a strategic-level forest inventory program, the two are not mutually exclusive. Many countries are exploring the use of LiDAR-derived forest attribute information in their NFIs. Canada's NFI aligns with provincial and territorial forest inventory programs and when these inventory programs start using EFI, the data will find their way into the NFI's remote sensing survey as a new way of measuring stand attributes such as height and volume.

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Resources

1. A model development and application guide for generating an enhanced forest inventory using airborne laser scanning data and an area-based approach. Download the guide from the Canadian Forest Service bookstore.

   English: http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/38945.pdf

   French: http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/38983.pdf

2. National Forest Inventory: https://nfi.nfis.org/en
3. Enhanced Forest Inventory: http://www.nrcan.gc.ca/forests/measuring-reporting/inventory/13421
4. 2017 State of Canada's Forests Report: http://www.nrcan.gc.ca/forests/report/18934