Landsat research status report: 1. recent research activities 2. product development through data integration

Mike Wulder

Joanne White, Meg Andrew, Gordon Frazer, Geordie Hobart, Brice Mora
Canadian Forest Service

Key collaborators

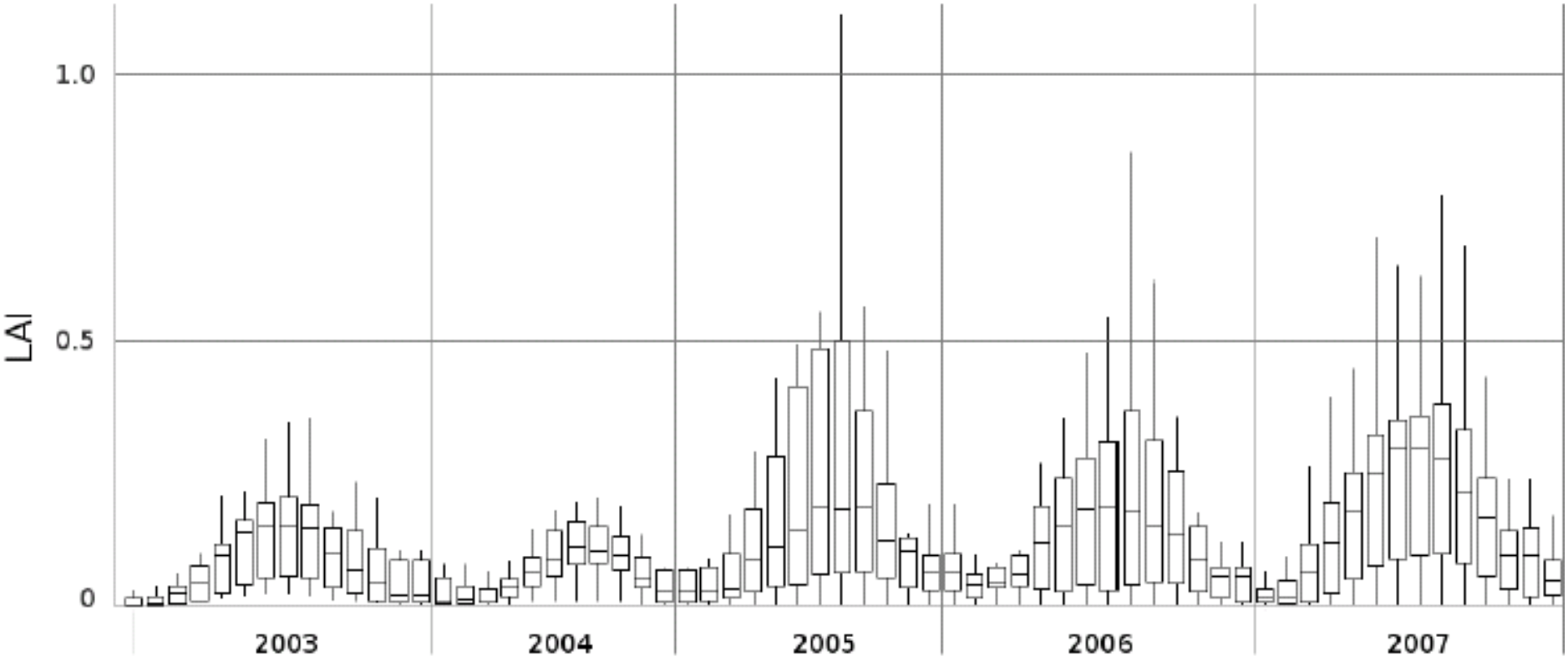
UBC: Prof. Nicholas Coops, Thomas Hilker, Chris Bater

UVic: Prof. Trisalyn Nelson, Ben Stewart, Nick Gralewicz

Recent Landsat work

- Feature-based change attribution
  - Multi-scale
- Edge development, habitat modeling
- Fragmentation for national park context
- Fragmentation – as record of forest management
- Long time series analysis over grizzly bear habitat
- Synthetic imaging (synthetic data and change)
  - Change, dating change, and accuracy
- LAI from synthetic data

Monthly LAI post year 2002 harvest



May to October; 7 2-week periods — Growing opportunity (Snow free)

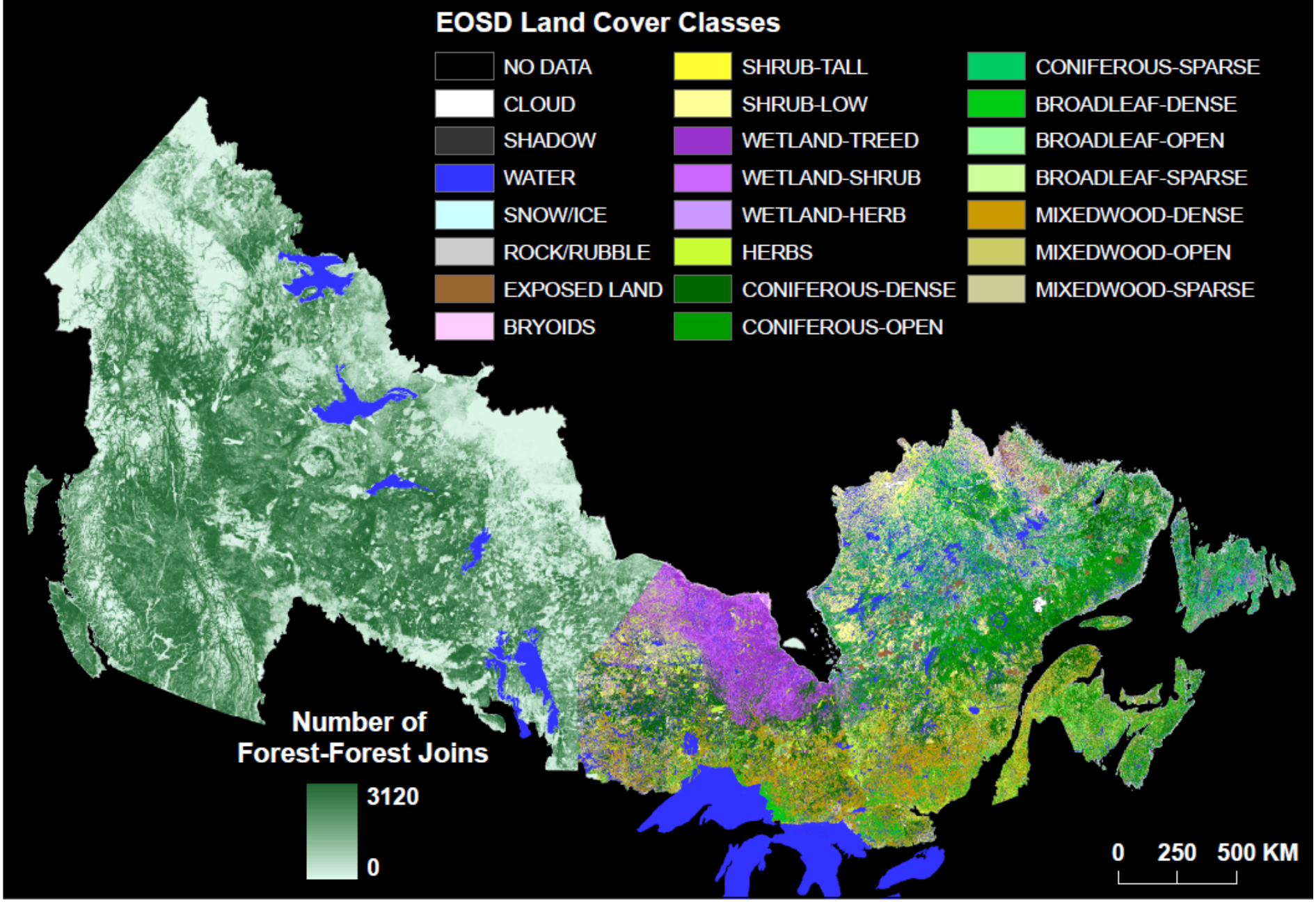
Context

- Wide area monitoring
  - National and regional programs
  - FRA RSS 2010
  - Global Forest Carbon Tracking
  - GEO Forest Monitoring Network
  - REDD+
  - * Country level responsibilities persist
  - Wall-to-wall coverage

  - Landsat is the common thread across these programs

- Linking *in situ* and remotely sensed data
  - Biomass as example

THE FORESTED AREA OF CANADA



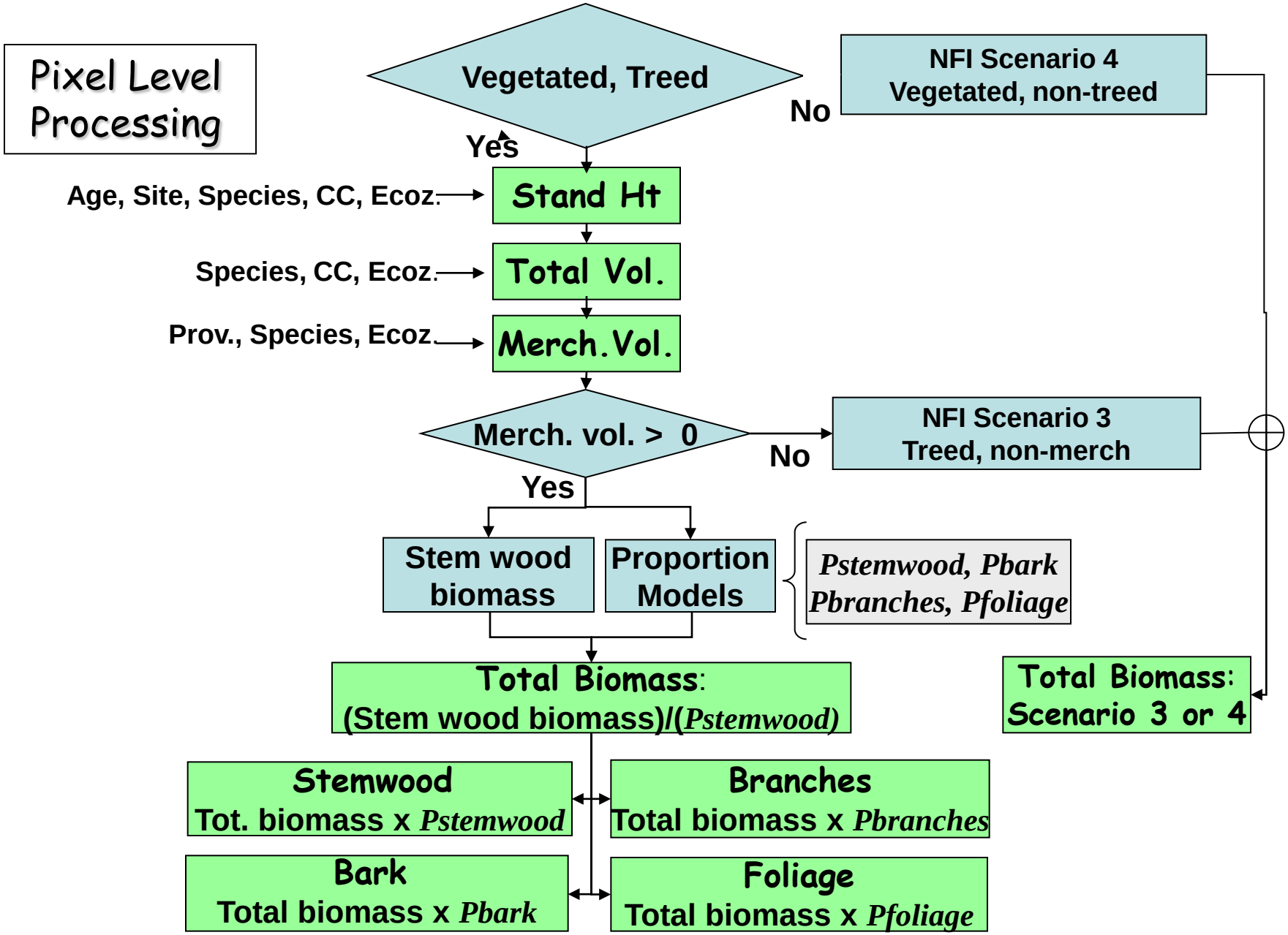
Integrating multi-scale remote sensing and modeling

- Establish high spatial resolution, fine scale grid
  - Deal with detail – incorporate samples (lidar, VHSR imagery, plots)
- Populate grid through remote sensing and spatial data (e.g., Landsat use / cover) and modeling
  - WELD base, STARFM,
- Update the grid through satellite change detection
  - Find change, attribute change (as possible)
  - STAARCH for frequent change
- Confirm / adjust modeled outcomes through sample based, higher spatial resolution remote sensing
- Repeat

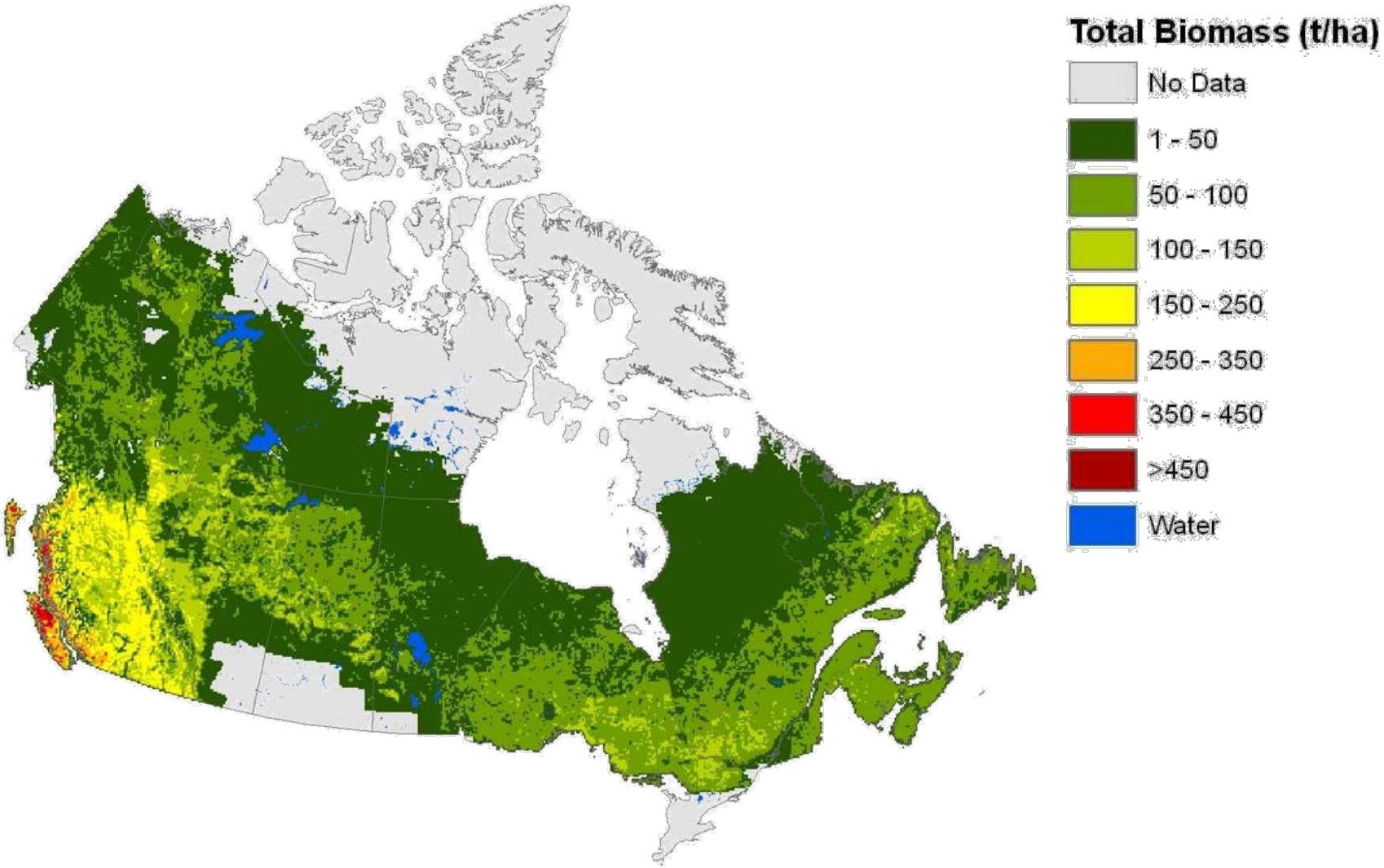
National Landsat-based biomass baseline

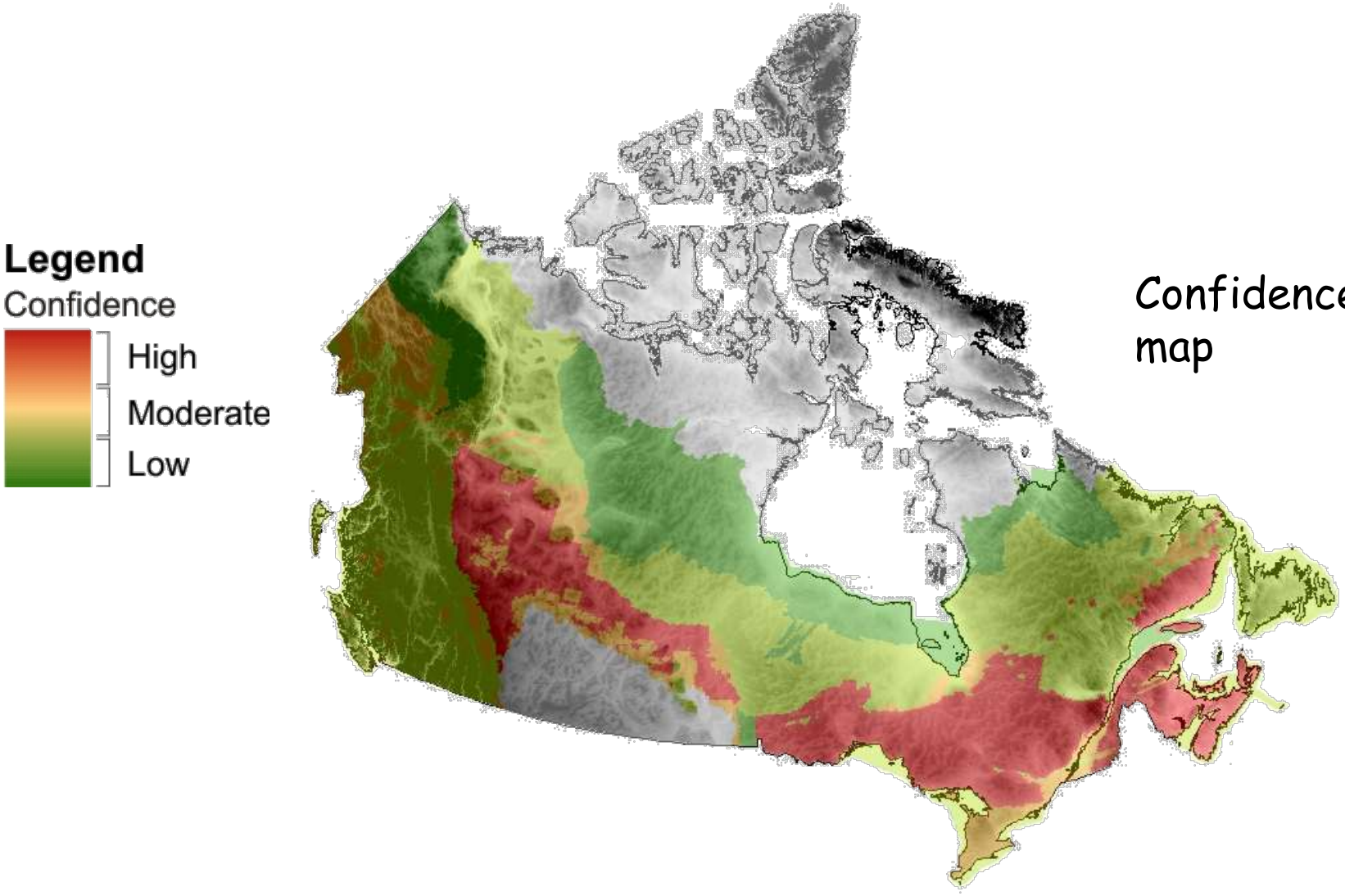
1. Objective: Produce first spatially contiguous forest biomass map of Canada at EOSD LC product tile level (circa 2000).
2. Approach: Integrate CanFI 2001 Age, climate grids to estimate site, Ecozones, NFI models, and EOSD land cover to estimate volume and biomass.

Biomass project lead: Dr. Ron Hall, NoFC, CFS


Pixel Level Processing
Vegetated, Treed
No
NFI Scenario 4
Vegetated, non-treed
Yes
Age, Site, Species, CC, Ecoz.
Stand Ht
Species, CC, Ecoz.
Total Vol.
Prov., Species, Ecoz.
Merch.Vol.
Merch. vol. > 0
No
NFI Scenario 3
Treed, non-merch
Yes
Stem wood biomass
Proportion Models
Pstemwood, Pbark
Pbranches, Pfoliage
Total Biomass:
(Stem wood biomass)/(Pstemwood)
Total Biomass:
Scenario 3 or 4
Stemwood
Tot. biomass x Pstemwood
Branches
Total biomass x Pbranches
Bark
Total biomass x Pbark
Foliage
Total biomass x Pfoliage

Aboveground Biomass (tonnes/ha)





Confidence map

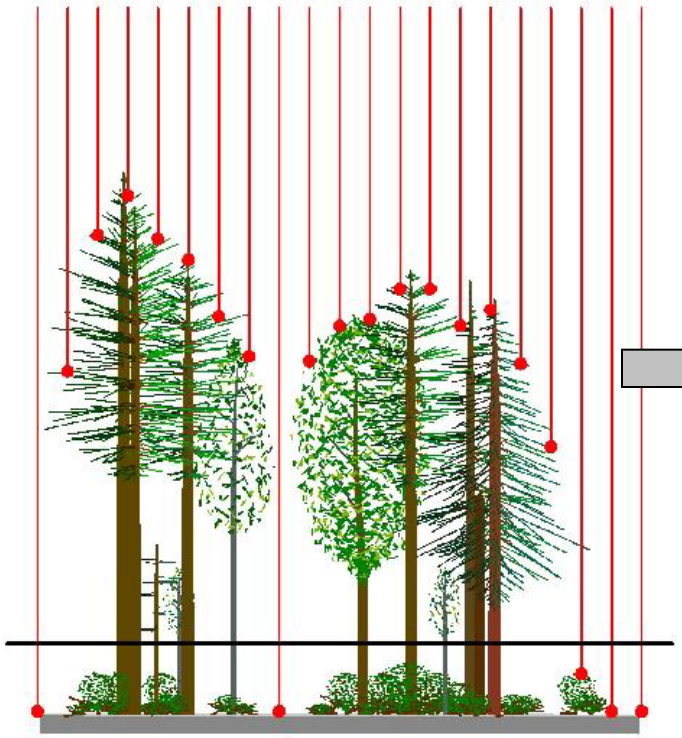
Info need: inventory attributes and biomass

- Lidar plots
- Lidar sample (scanning lidar transects)
- Sample of population (including revisit capacity)
- Capture vertical structural attributes of interest

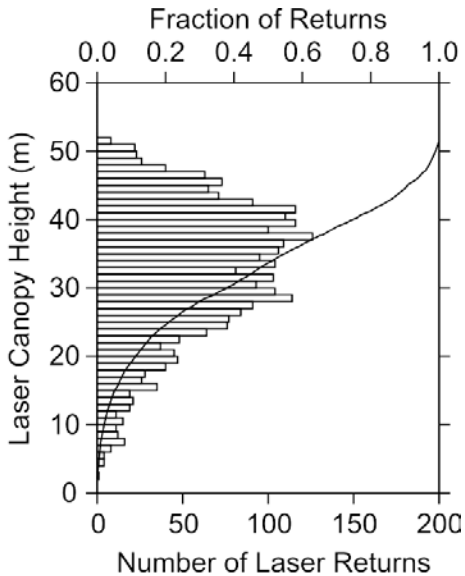
- Enables integration of data across scales
- Enables calibration and validation of products
- Enables cross-program and science utility
  - Example, National Forest Inventory and Carbon Accounting, national biomass map (Landsat)
  - Integrate with VHSR boreal NFI project (EcoMonitor)

Individual tree measures from the lidar are summarized to produce *critical* plot-level attributes at thousands of plot locations.

Tree-level measures



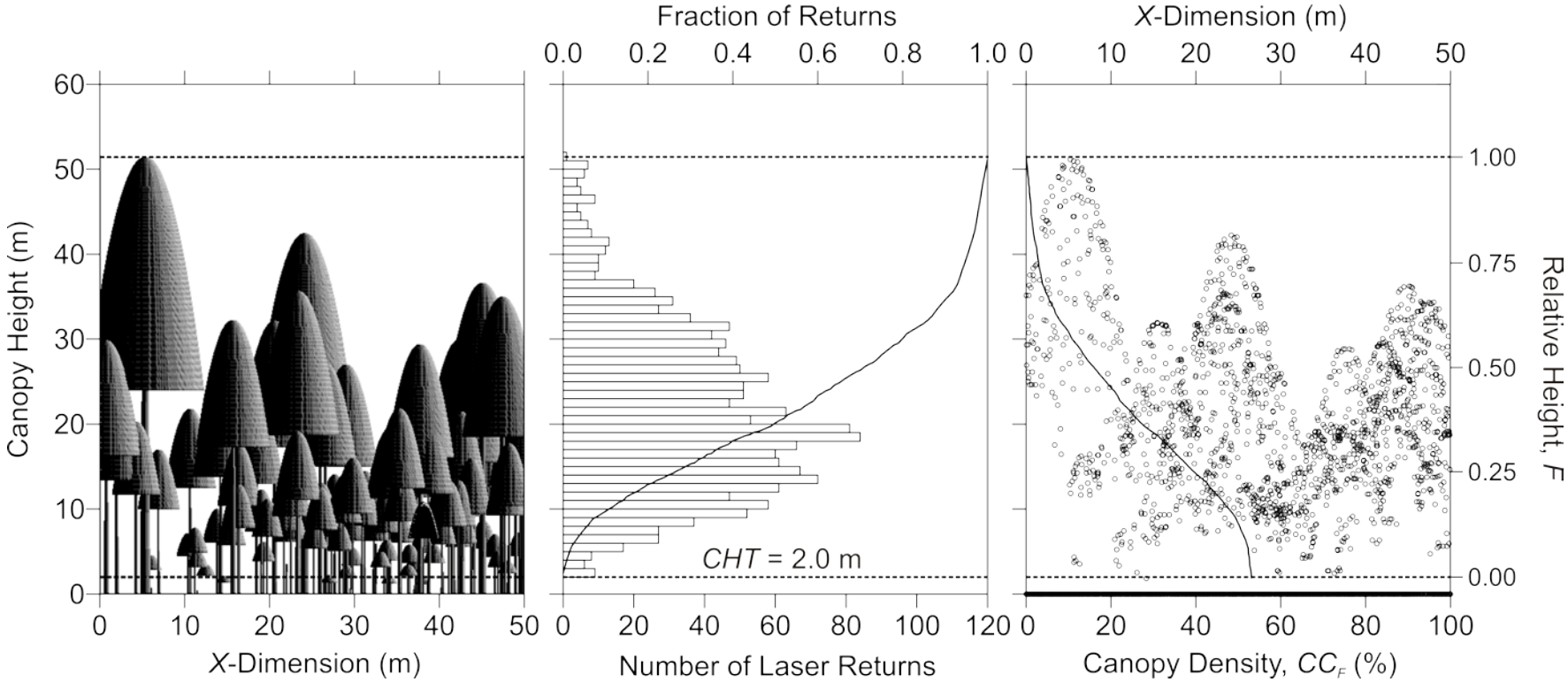
Plot



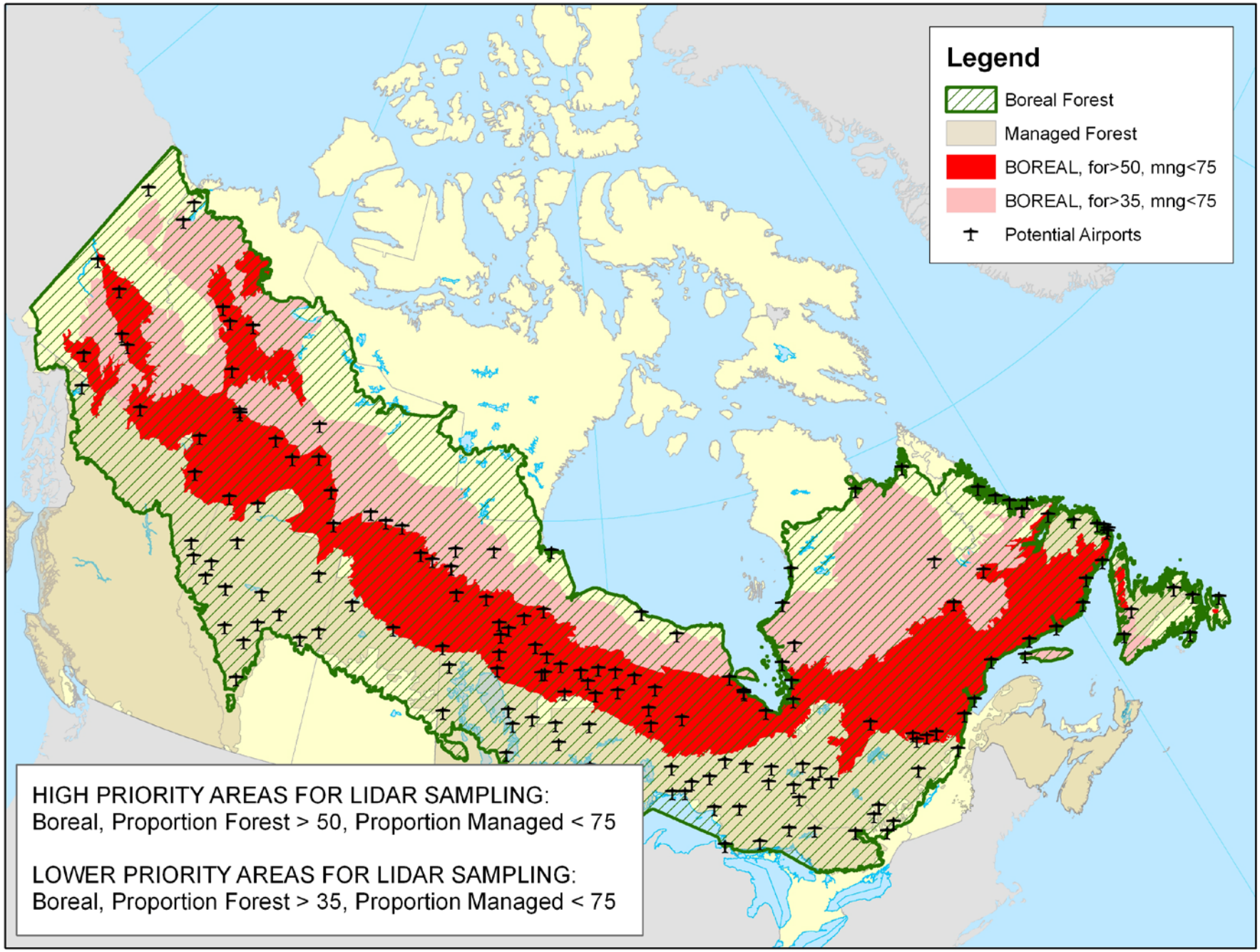
Plot-level attributes

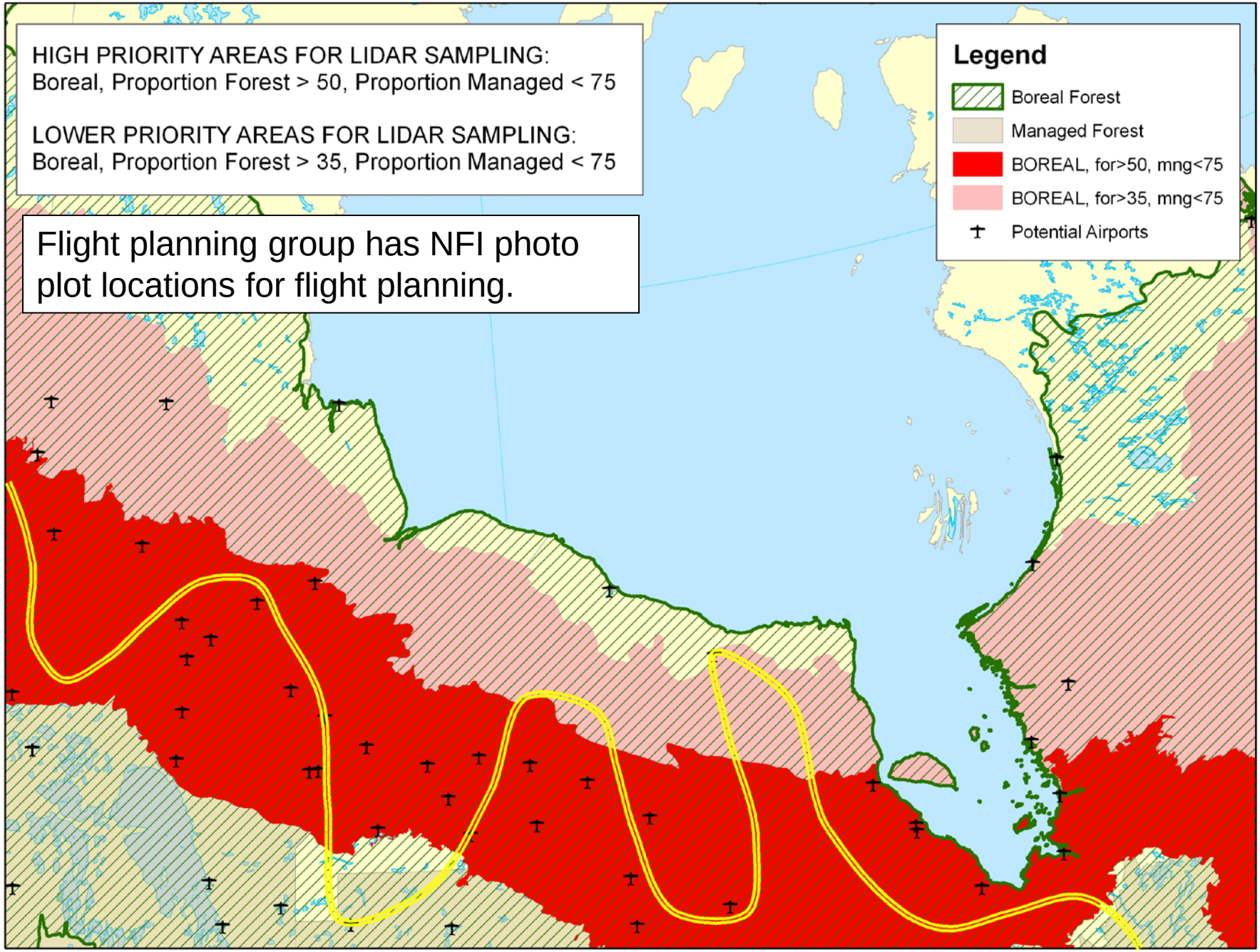
stand structure
height (max, mean…)
crown closure
volume
biomass
gap fraction
stem density

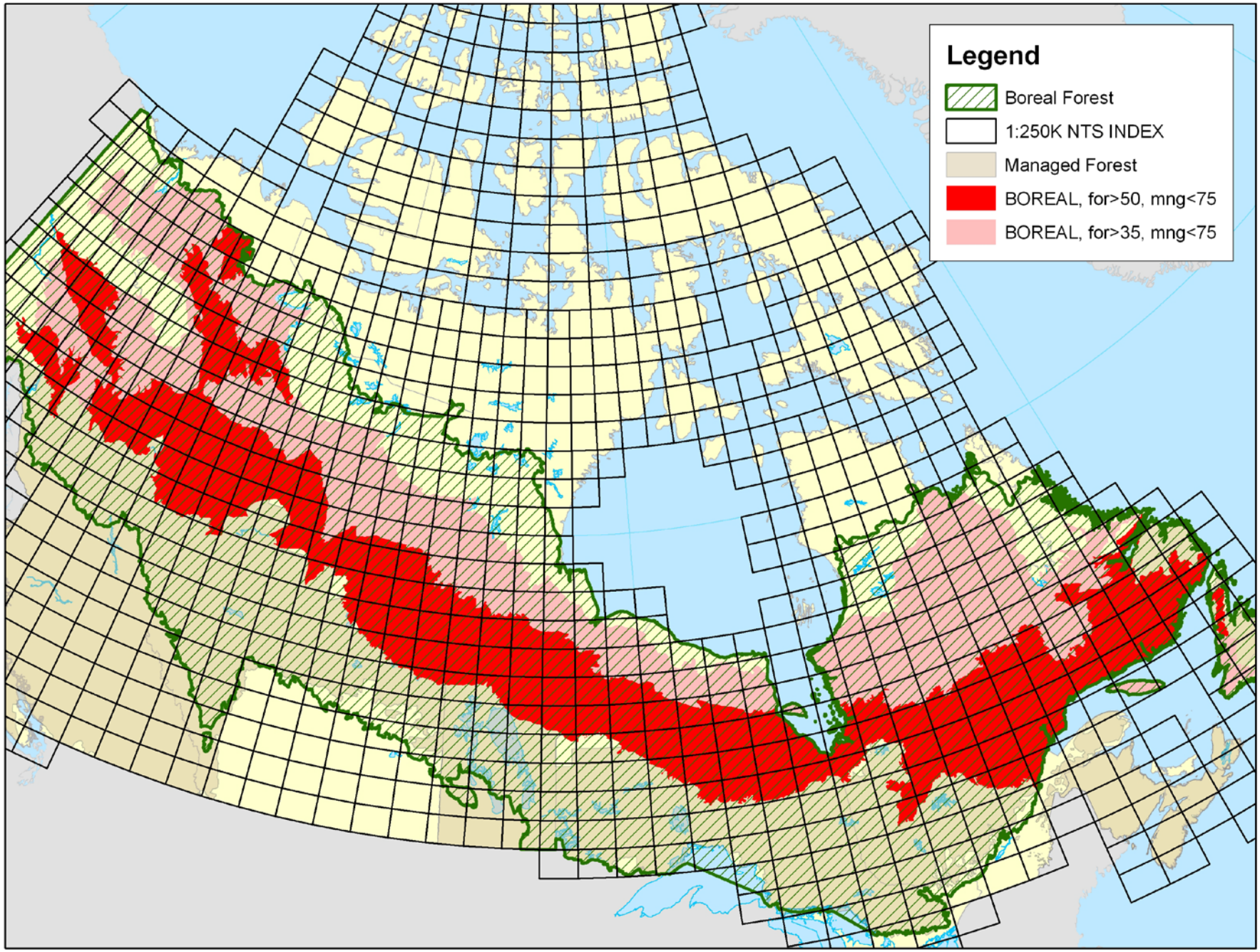
Spatially generalizing the lidar data

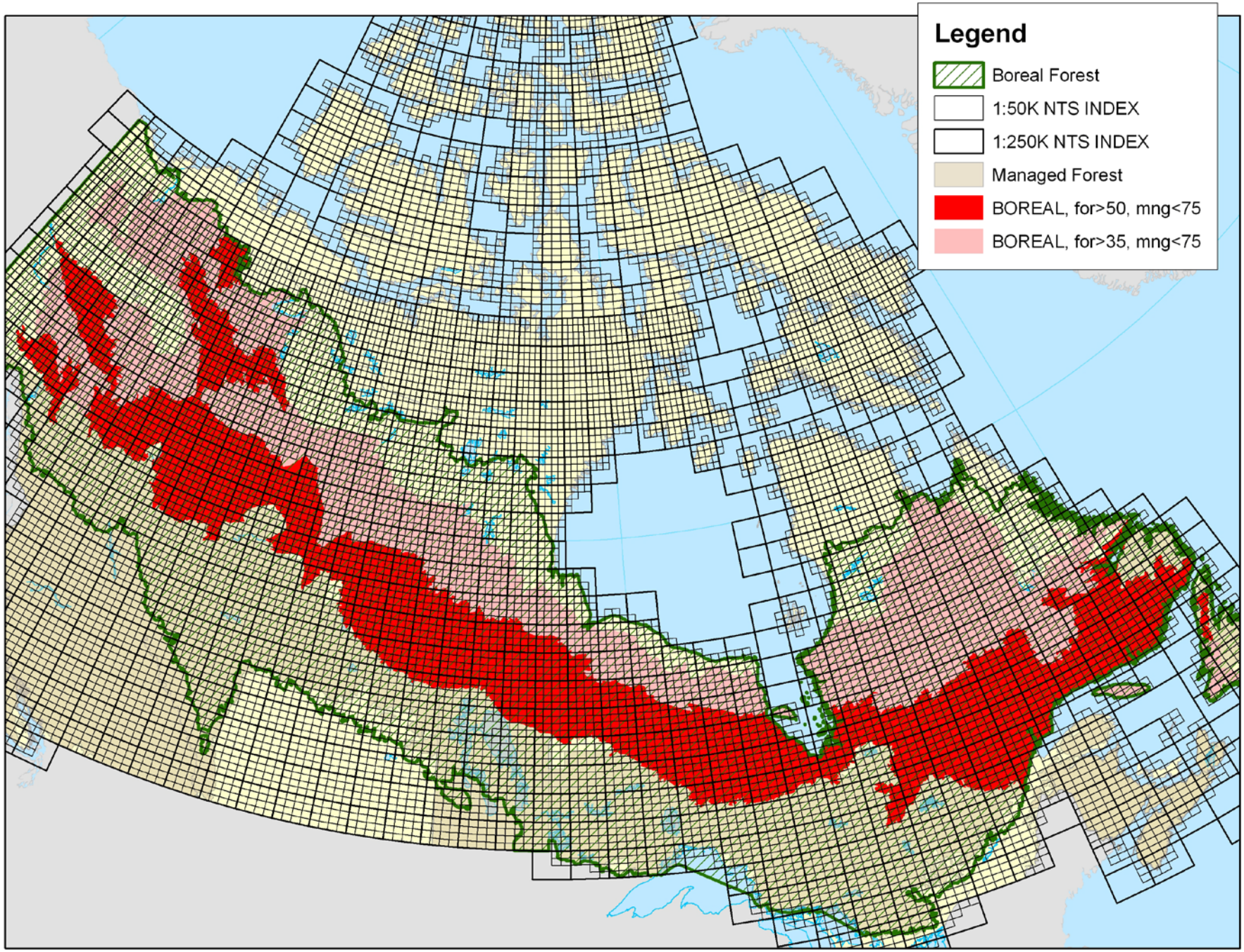


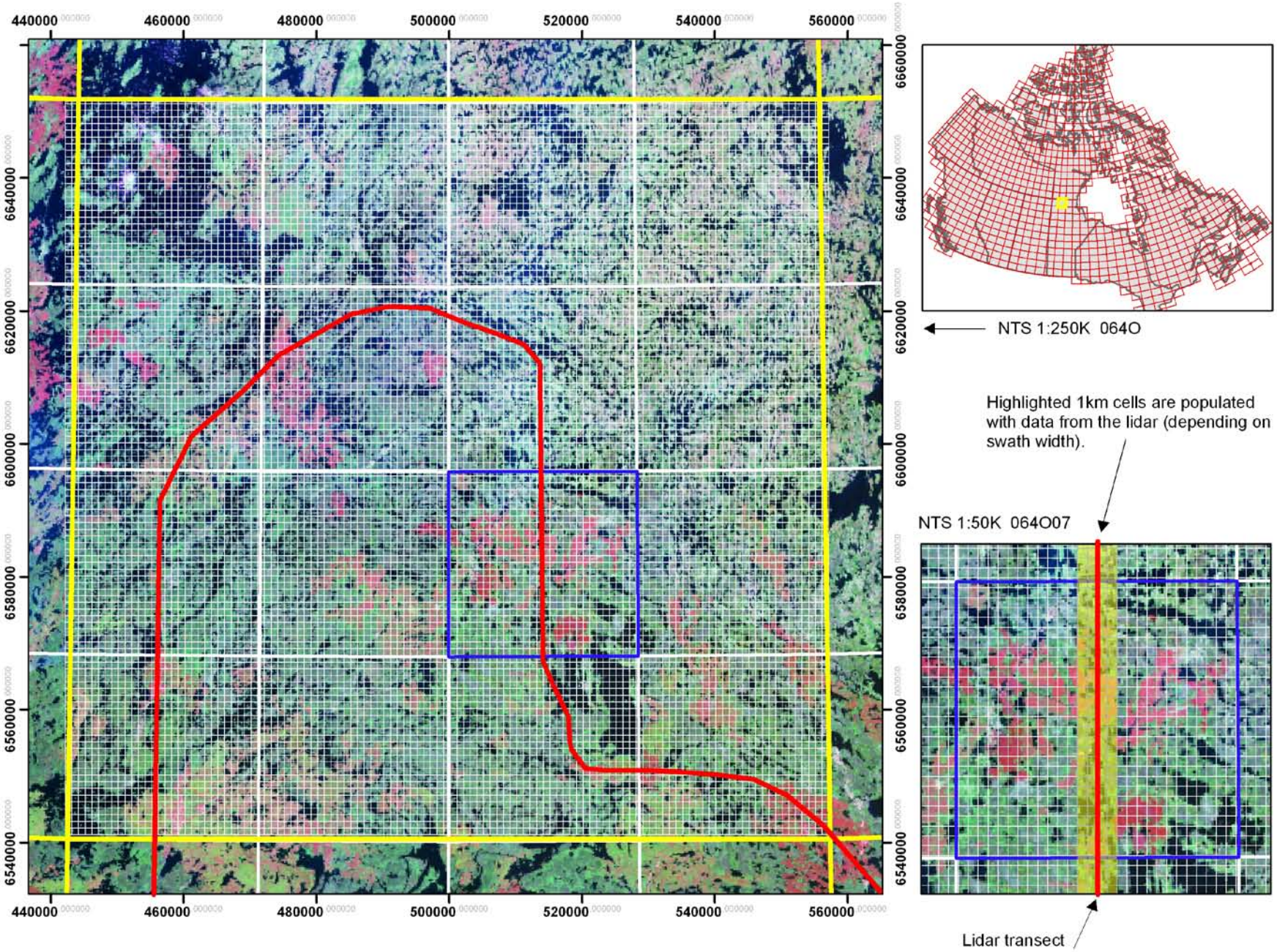
Cross-sectional view of simulated canopy (left), histogram and sample quantiles of the vertical distribution of canopy heights (middle), and canopy density (ratio of heights above threshold *F* to total number of LiDAR returns in plot) for each relative canopy height *F* (right).

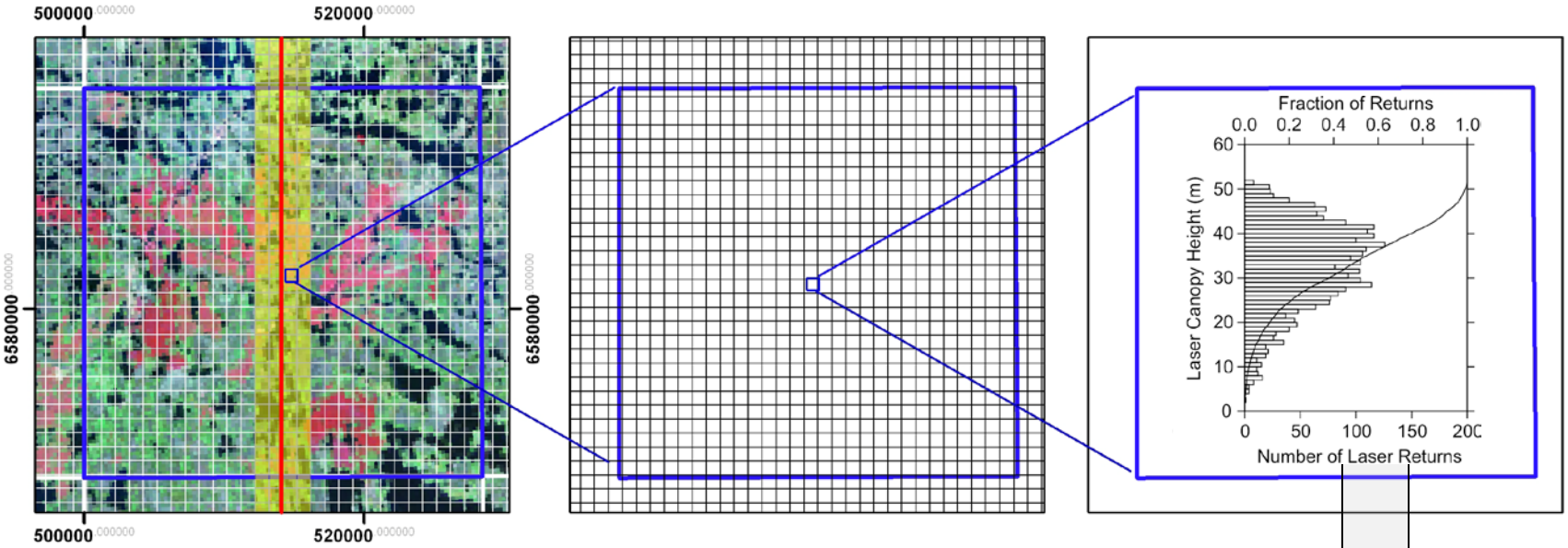

Legend
Boreal Forest
Managed Forest
BOREAL, for>50, mng<75
BOREAL, for>35, mng<75
Potential Airports
HIGH PRIORITY AREAS FOR LIDAR SAMPLING:
Boreal, Proportion Forest > 50, Proportion Managed < 75
LOWER PRIORITY AREAS FOR LIDAR SAMPLING:
Boreal, Proportion Forest > 35, Proportion Managed < 75


HIGH PRIORITY AREAS FOR LIDAR SAMPLING:
Boreal, Proportion Forest > 50, Proportion Managed < 75
LOWER PRIORITY AREAS FOR LIDAR SAMPLING:
Boreal, Proportion Forest > 35, Proportion Managed < 75
Flight planning group has NFI photo plot locations for flight planning.
Legend
Boreal Forest
Managed Forest
BOREAL, for>50, mng<75
BOREAL, for>35, mng<75
Potential Airports


Legend
Boreal Forest
1:250K NTS INDEX
Managed Forest
BOREAL, for>50, mng<75
BOREAL, for>35, mng<75


Legend
Boreal Forest
1:50K NTS INDEX
1:250K NTS INDEX
Managed Forest
BOREAL, for>50, mng<75
BOREAL, for>35, mng<75


440000
460000
480000
500000
520000
540000
560000
6660000
6640000
6620000
6600000
6580000
6560000
6540000
NTS 1:250K 064O
Highlighted 1km cells are populated with data from the lidar (depending on swath width).
NTS 1:50K 064O07
Lidar transect



NTS 1:50K 064O07

A single 1 km cell with 25 m tessellation

A single 25 m cell

ATTRIBUTES for each 25 m cell

Flight date	**Stand structure**
Number of returns	**Height**
Elev minimum	**Crown closure**
Elev maximum	**Volume**
Elev mean	**Biomass**
Elev mode	**Volume**
Elev stddev	**Gap fraction**
Elev variance	**Stem density**
…	

Closing musing

- Communications – Landsat status and directions (special issue / collection)

- Looking forward, future products
  - Applying compositing and synthetic data logic
  - More iterations of products ~ gold-standard products
  - Consider user needs

- Keeping eye on community and policy needs
  - Science underpinning products and operations

Thank you

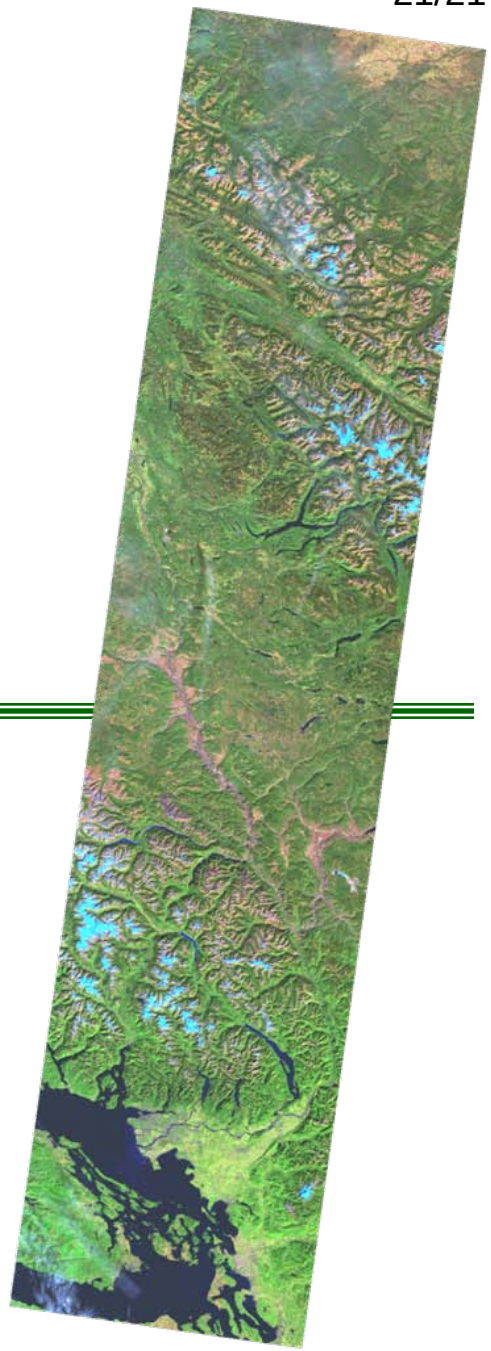
Contact Information:

Mike Wulder

mwulder@nrcan.gc.ca

http://cfs.nrcan.gc.ca/subsite/wulder/

Canada

Natural Resources Canada | Ressources naturelles Canada

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