

# ENHANCED FOREST INVENTORY IN NEWFOUNDLAND AND LABRADOR

Project Status and Core Site description  
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*Joan Luther (Canadian Forest Service)*

*Richard Fournier (Université de Sherbrooke)*

*et al. ...*



# ENHANCED FOREST INVENTORY PROJECT IN NEWFOUNDLAND AND LABRADOR: *USING REMOTE SENSING TO ENHANCE FOREST INVENTORIES*

GOAL: To develop remote sensing technologies for cost-effective and spatial quantification of forest resources in order to support enhanced forest management decision making and increased competitive advantage.

## Objectives:

1. Develop methods for value-based inventory using enhanced inventory tools
2. Develop methods to map forest ecosystem services and the effects of forest management practices on ecosystem services
3. Develop larger scale mapping and monitoring methods for key forest attributes

# ENHANCED FOREST INVENTORY PROJECT

## CORE RESEARCH TEAM & PARTNER AGENCIES



**Joan Luther**  
(CFS/CWFC)



**Richard Fournier**  
(U. Sherbrooke)



**Olivier van Lier**  
(CWFC)



**Jean Francois Côté**  
(CWFC)



**Darrell Harris**  
(CFS)



**Barry Elkins**  
(CBPPL)



**Boyd Pittman**  
(NLFAA)



**Scott Payne**  
(NLFAA)



**Aurelie Schmidt**  
(M.Sc. Student)



**Melodie Bujold**  
(M.Sc. Student)

... and others (Vandendaele, Coops, Dech, Marshall ...)



Natural Resources Canada  
Ressources naturelles Canada



Natural Sciences and Engineering Research Council of Canada  
Conseil de recherches en sciences naturelles et en génie du Canada



## Research studies precluding the EFI project:

### MAPPING WOOD FIBRE ATTRIBUTES (SUMMARY OF 4 STUDIES): RESULTING R<sup>2</sup> OF PREDICTING MODELS

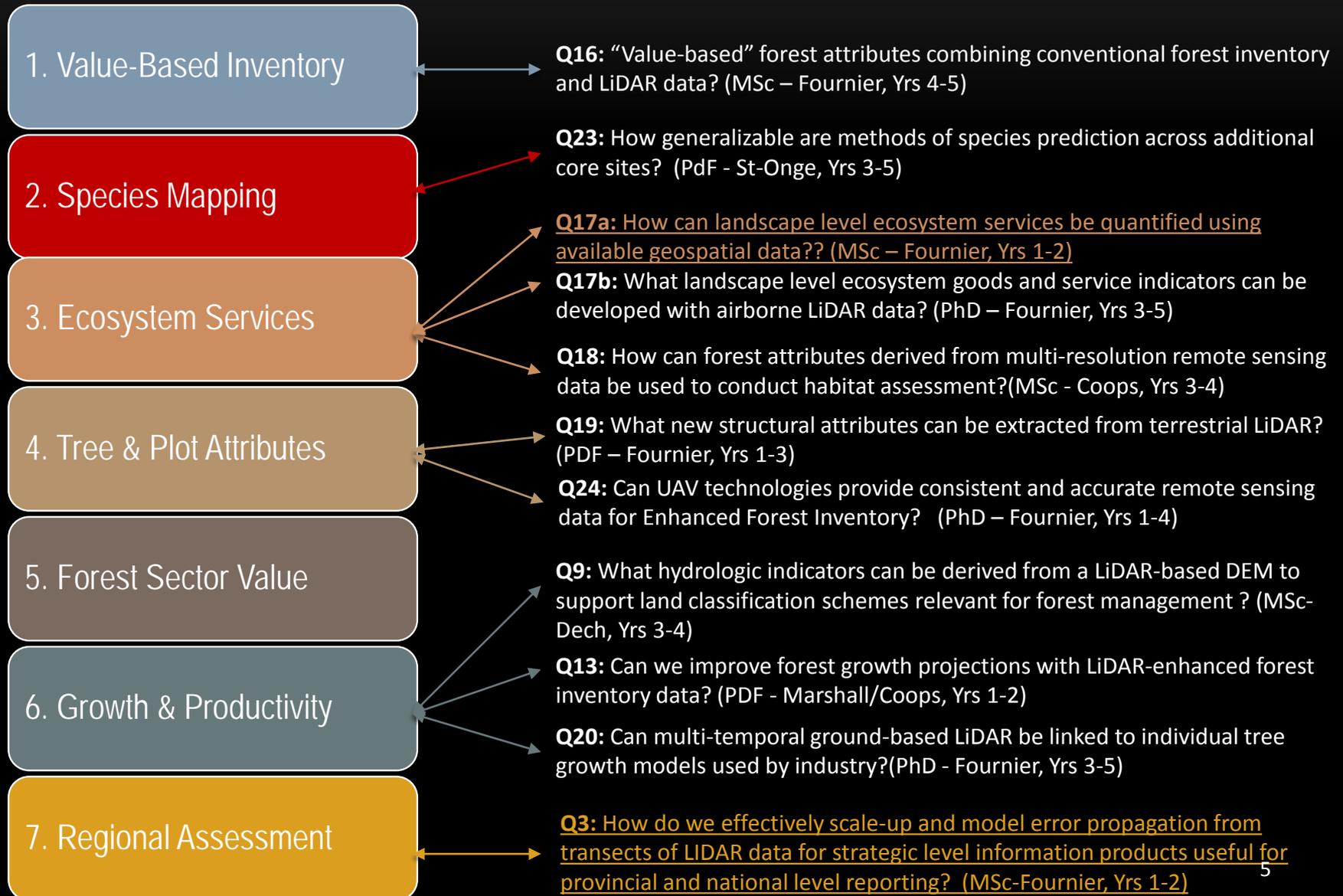
Scale	Species	Lessard et al. (Inventory + Environment)	Luther et al. (Airborne LiDAR)	Blanchette et al. (Terrestrial LiDAR)	Côté et al. (L-Architect)
Landscape 	Black Spruce	0.51-0.59	0.51-0.62		
	Balsam Fir	0.33-0.48	0.28-0.61		
Plot 	Black Spruce	0.52-0.61	0.51-0.62	0.63-0.72	0.79-0.89
	Balsam Fir	0.35-0.48	0.28-0.61	0.37-0.63	
Tree 	Black Spruce				0.78-0.90
	Balsam Fir				

➤ *Improving the characterization of forest structure generally improved our ability to predict fibre attributes*

# ENHANCED FOREST INVENTORY ROADMAP

## CWFC Major Activities

## AWARE Questions





# ACTIVE STUDIES

1. Species Mapping
2. Tree & Plot Attributes
3. Ecosystem Services
4. Regional Assessment

## 1. Species Mapping

# AREA-BASED PREDICTION OF FOREST SPECIES USING RANDOM FORESTS AND AIRBORNE LASER SCANNER DATA IN WESTERN NEWFOUNDLAND



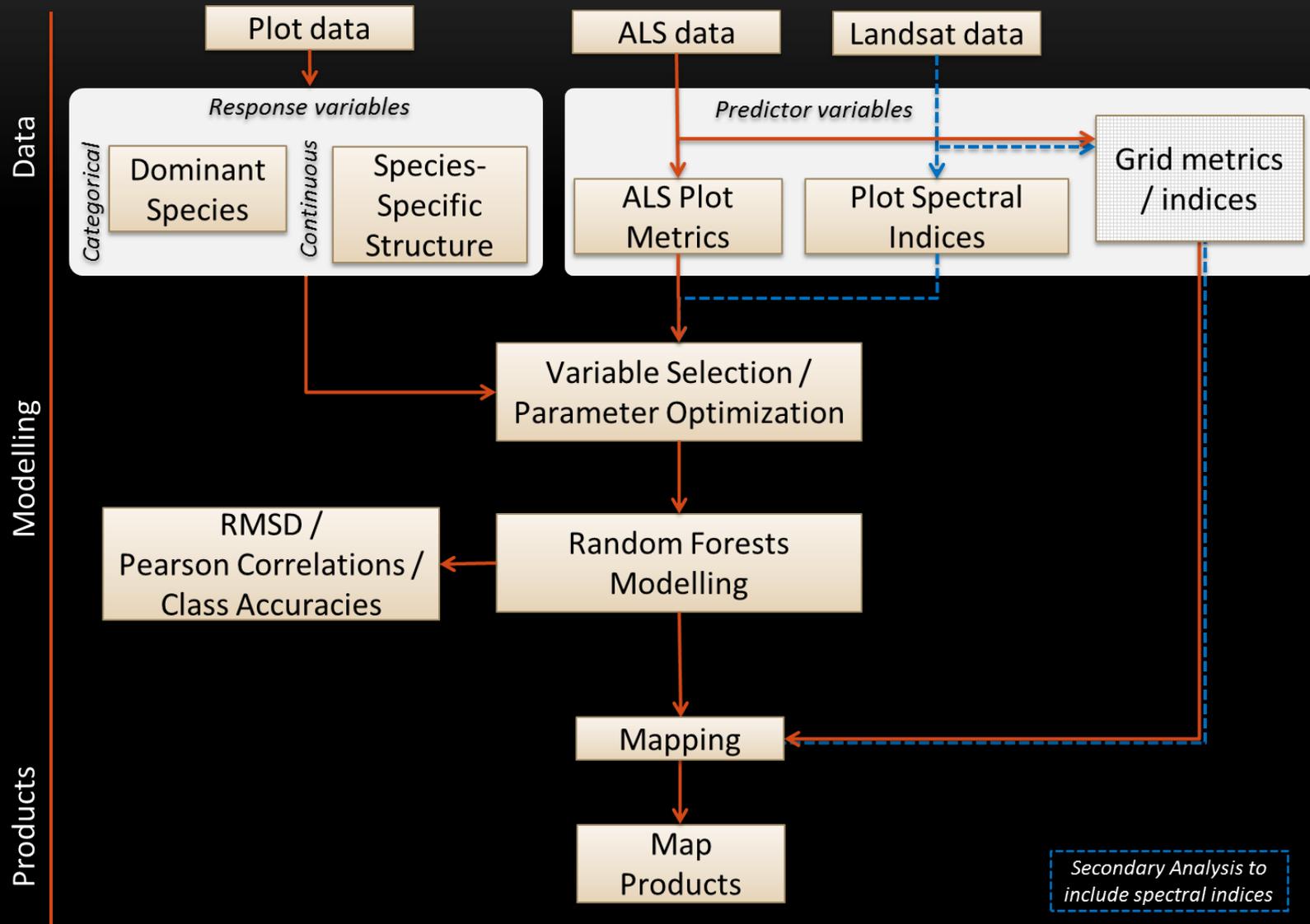
Olivier van Lier  
(CWFC)

*O.R. van Lier and J.E. Luther*

### Key Research Questions

- Can ALS data be used to predict species-specific basal areas and/or volumes in Western Newfoundland's Boreal forests?
- Can these predictions be improved with the addition of spectral indices from other optical data?

# 1. Species Mapping



## 2. Tree and Plot Attributes

# FINE-SCALE 3D RECONSTRUCTION OF BOREAL FOREST PLOTS TO IMPROVE FOREST CHARACTERIZATION WITH REMOTE SENSING



Jean Francois (CWFC)

*J.-F. Côté, R.A. Fournier, J.E. Luther  
and O.R. van Lier*

### Key Research Question

- How can we best use the *L-architect* model for producing surrogate ground plots to enhance forest structural characterization with above-canopy remote sensing tools?



### 3. Ecosystem Services

# MAPPING THE IMPACTS OF FOREST MANAGEMENT PRACTICES ON WATER-RELATED ECOSYSTEM SERVICES

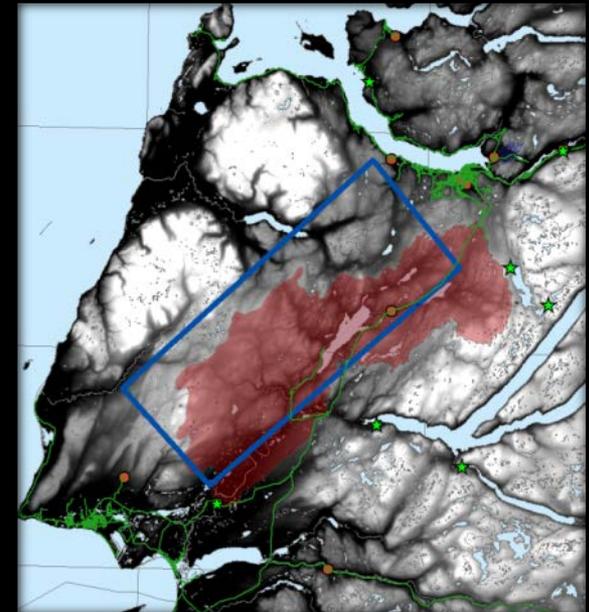


Aurelie Schmidt  
(M.Sc. Student)

*A. Schmidt, R.A. Fournier and J.E. Luther*

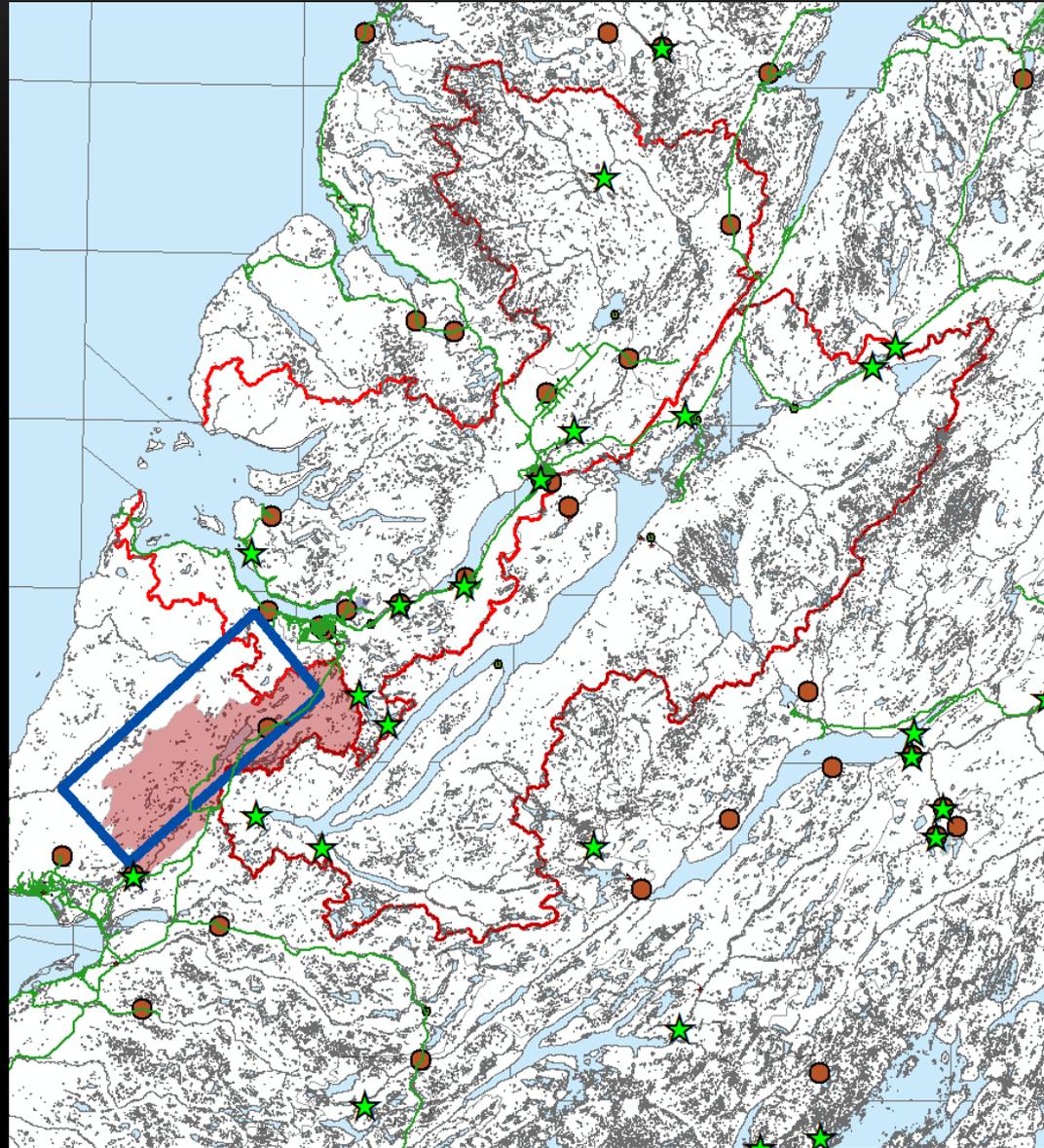
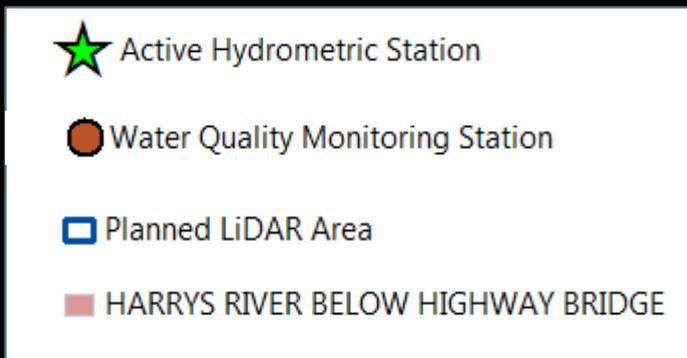
Key Research Question

- AWARE Q17a: How can landscape level ecosystem services be quantified using available geospatial data?



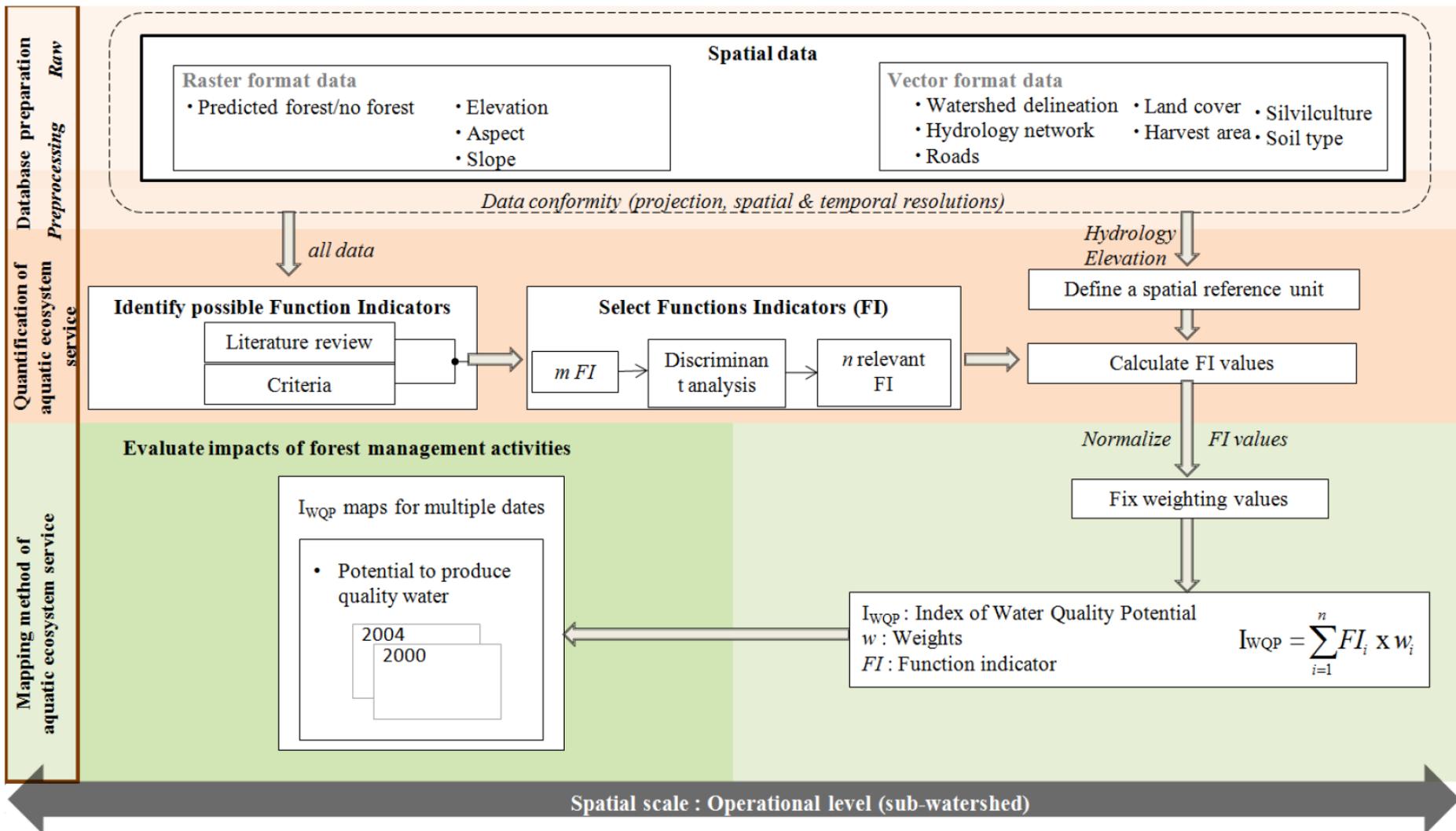
### 3. Ecosystem Services

## PROPOSED WATERSHED (HARRY'S RIVER)



# 3. Ecosystem Services

## METHODS OVERVIEW



## 4. Regional Assessment

# STRATEGIES FOR MAPPING FOREST ATTRIBUTES OVER A LARGE AREA OF BOREAL FOREST OF NEWFOUNDLAND USING AIRBORNE LIDAR TRANSECTS

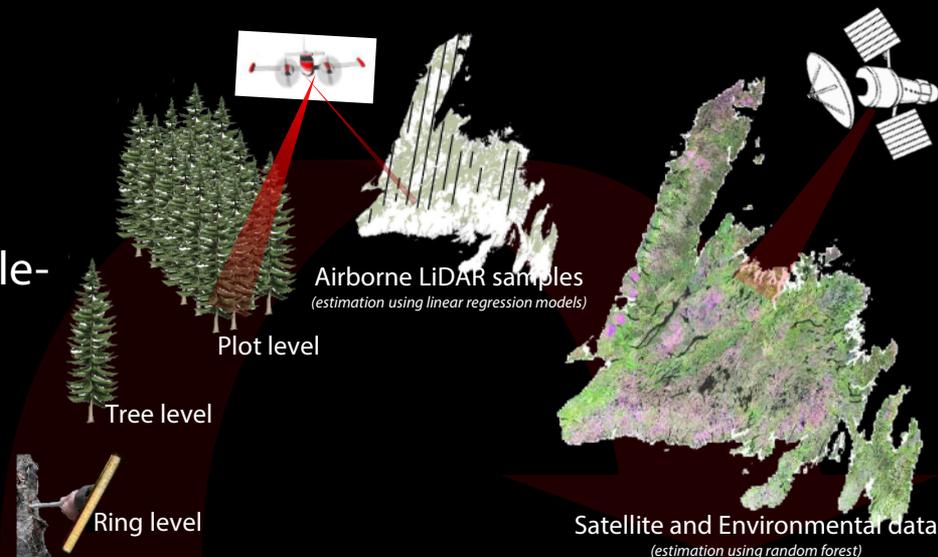


Melodie Bujold  
(M.Sc. Student)

*M. Bujold, R.A. Fournier, J.E. Luther and O. van Lier*

### Key Research Question

- AWARE Q3: How do we effectively scale-up from transects of LiDAR data to produce strategic level information products useful for provincial and national level reporting?



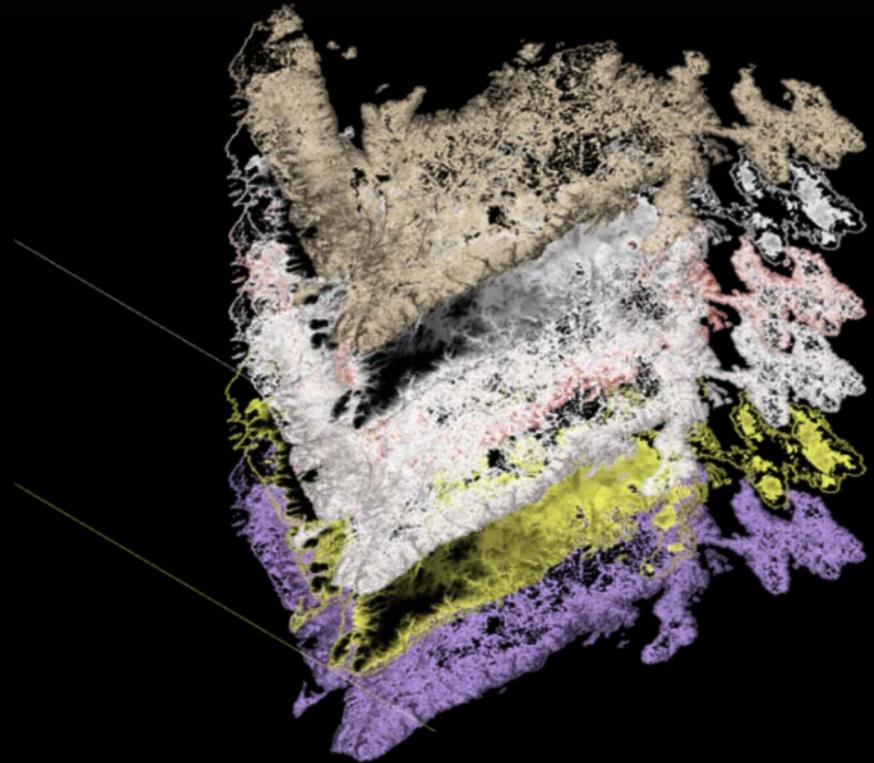
## 4. Regional Assessment

# SPATIALLY COMPREHENSIVE LAYERS

### Factors Affecting Tree Growth

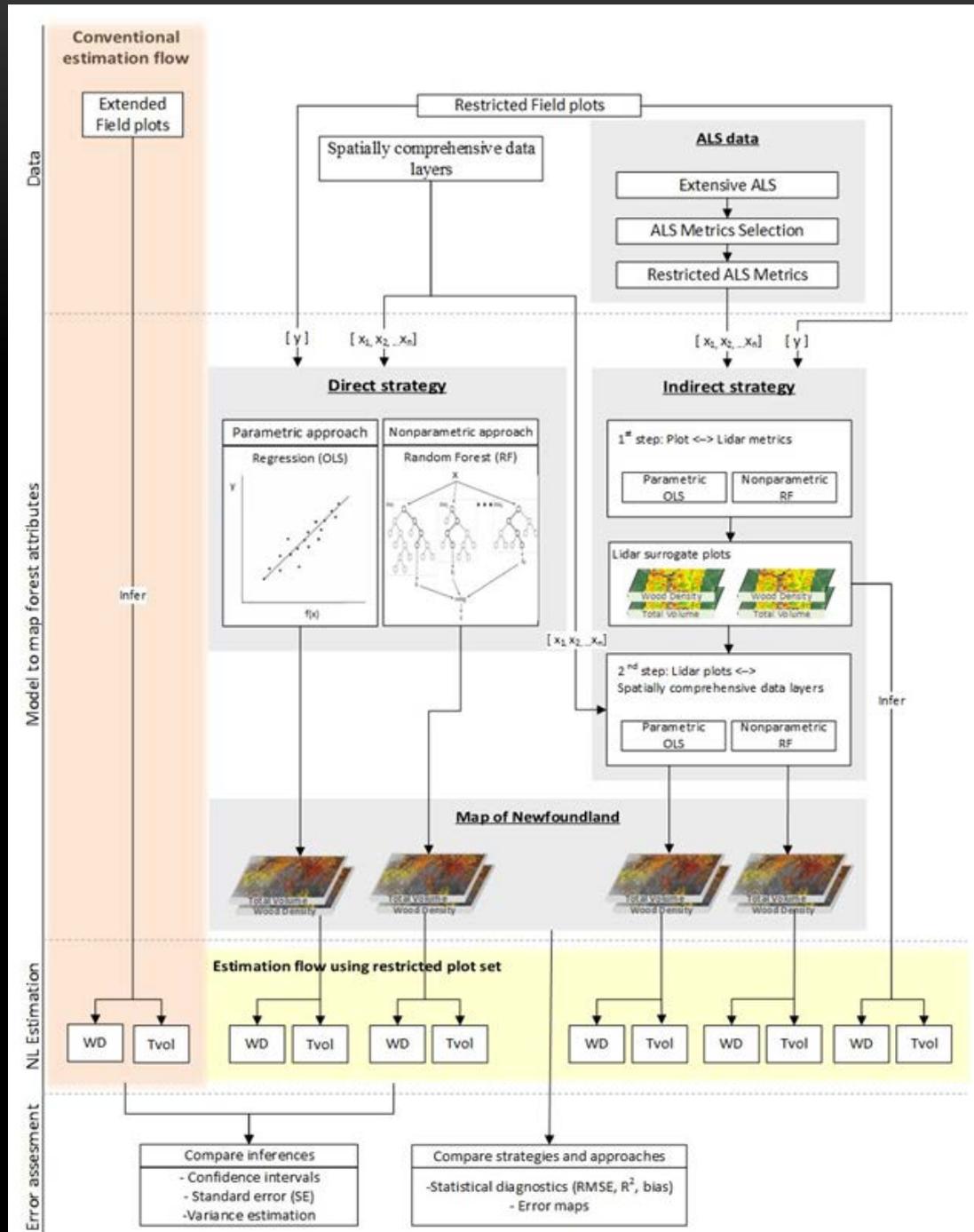
*(candidate predictor variables)*

- Vegetation Composition and Structure
  - spectral bands and indices
- Climate
  - temperature and precipitation
- Topography / Solar Radiation
  - elevation, slope and aspect



# 4. Regional Assessment

## METHODS OVERVIEW

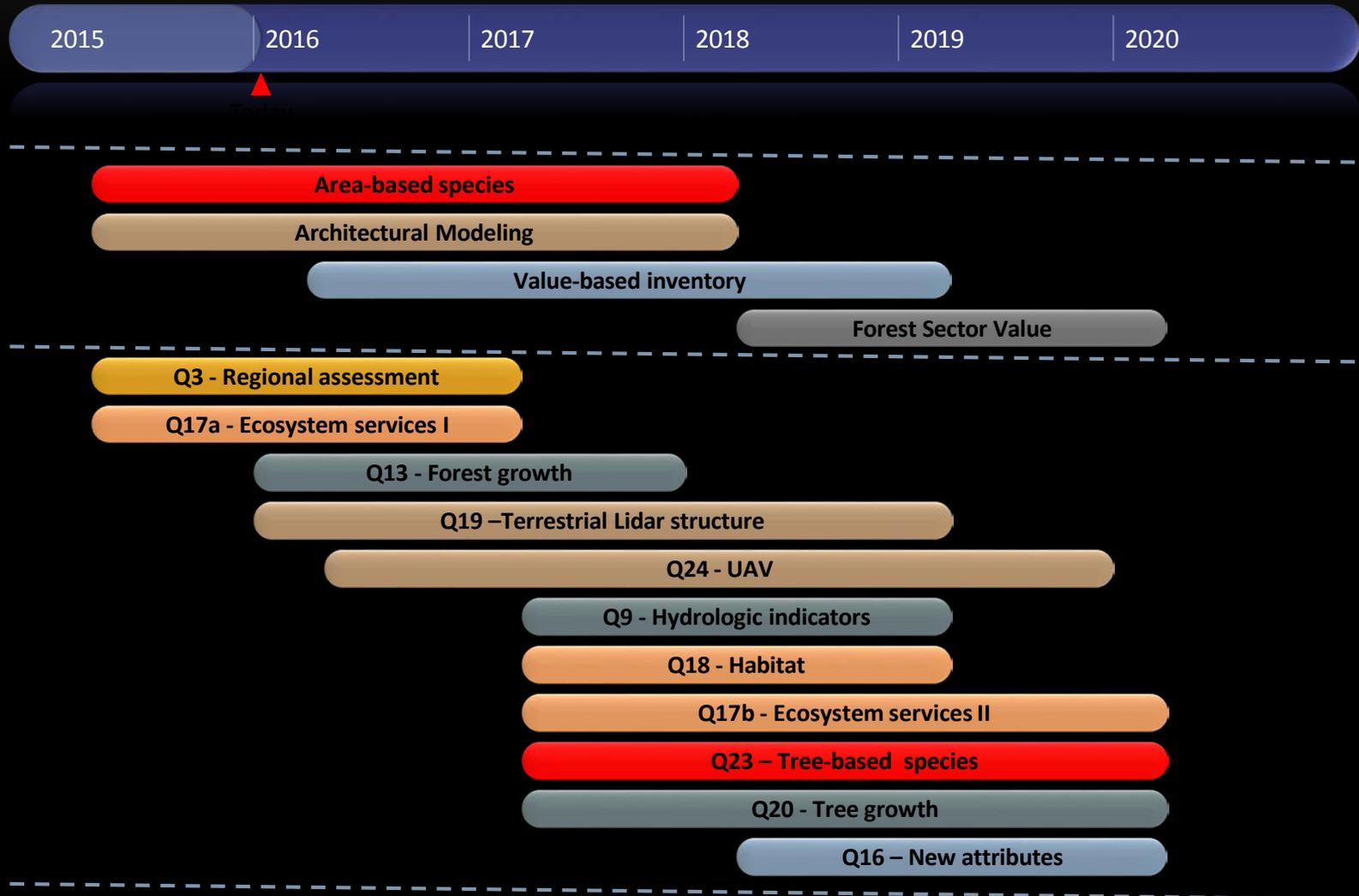


# NEXT STEPS

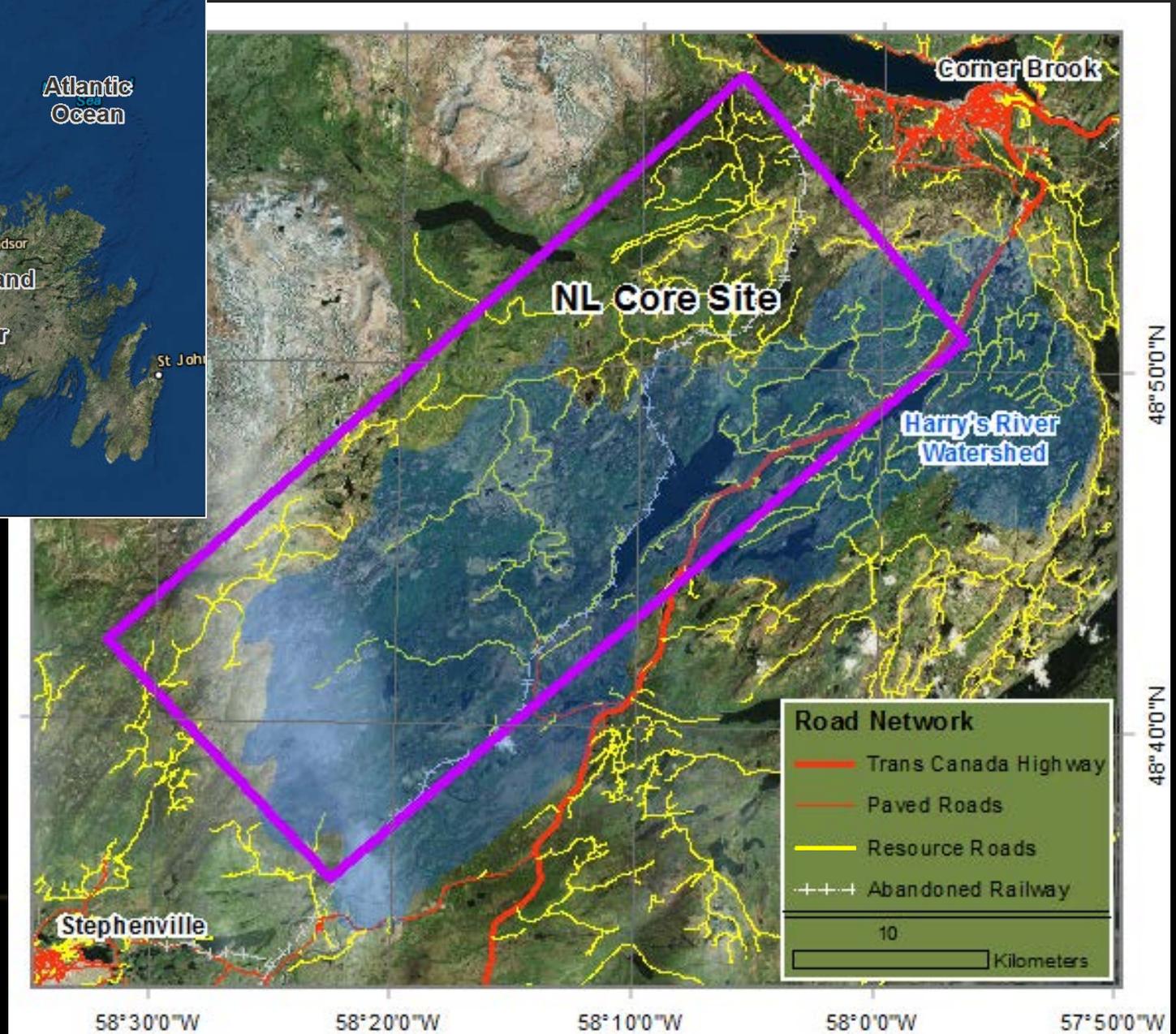
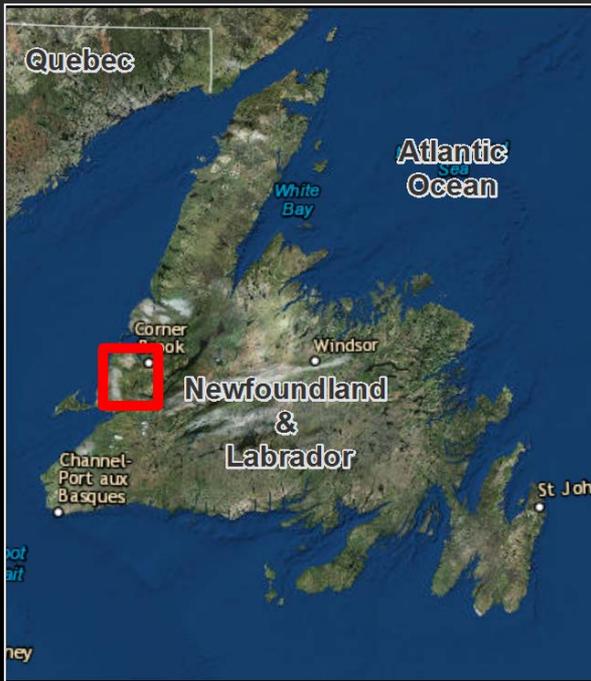
1. Data Acquisition Summer 2016
  - Completion of LiDAR acquisition
  - Remeasurement of established PSPs
  - Supplementary plots (structure, species, tLiDAR, UAV)
2. Processing ALS data of Newfoundland Core Site
  - Quality assessment
  - ALS metrics
3. Modeling (species, structure)
  - Parametric and non-parametric methods
4. Mapping
  - Production of enhanced forest inventory rasters



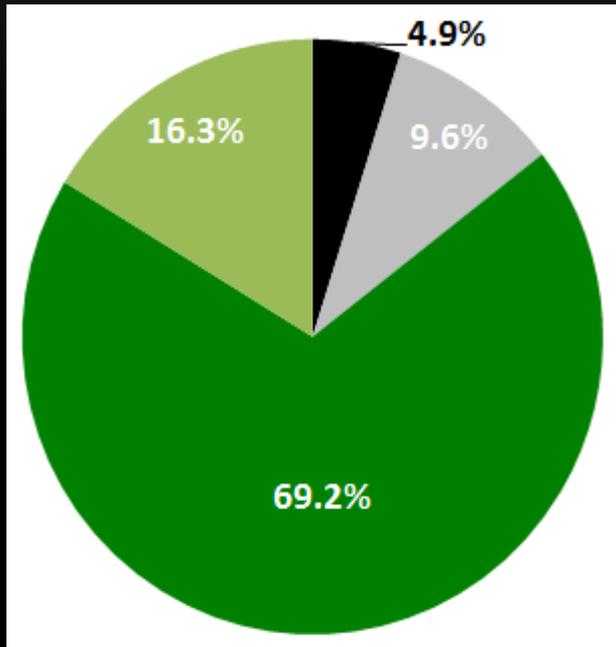
# NL ENHANCED FOREST INVENTORY PROJECT TIMELINE



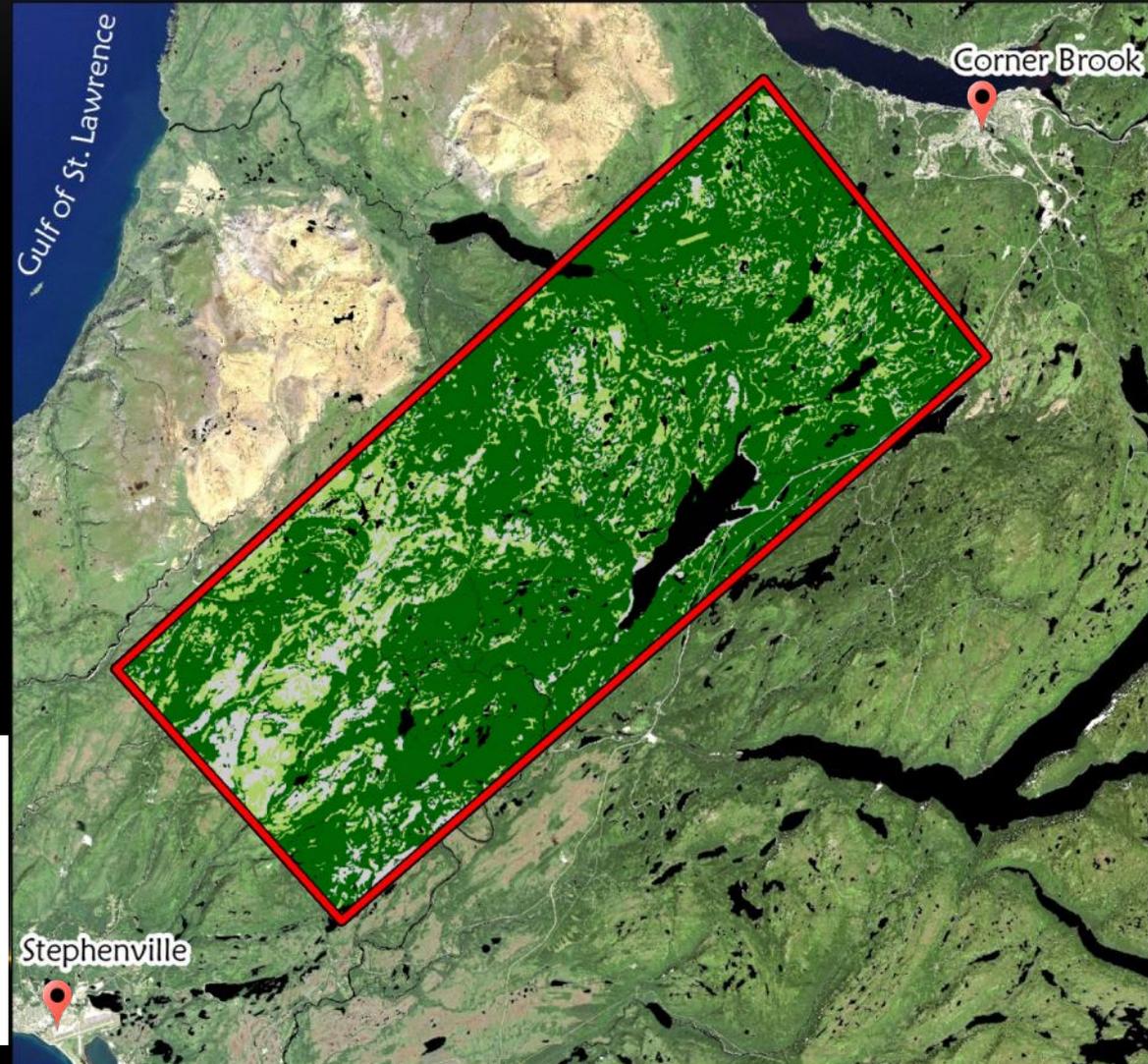
# CORE SITE LOCATION



# LAND COVER DISTRIBUTION

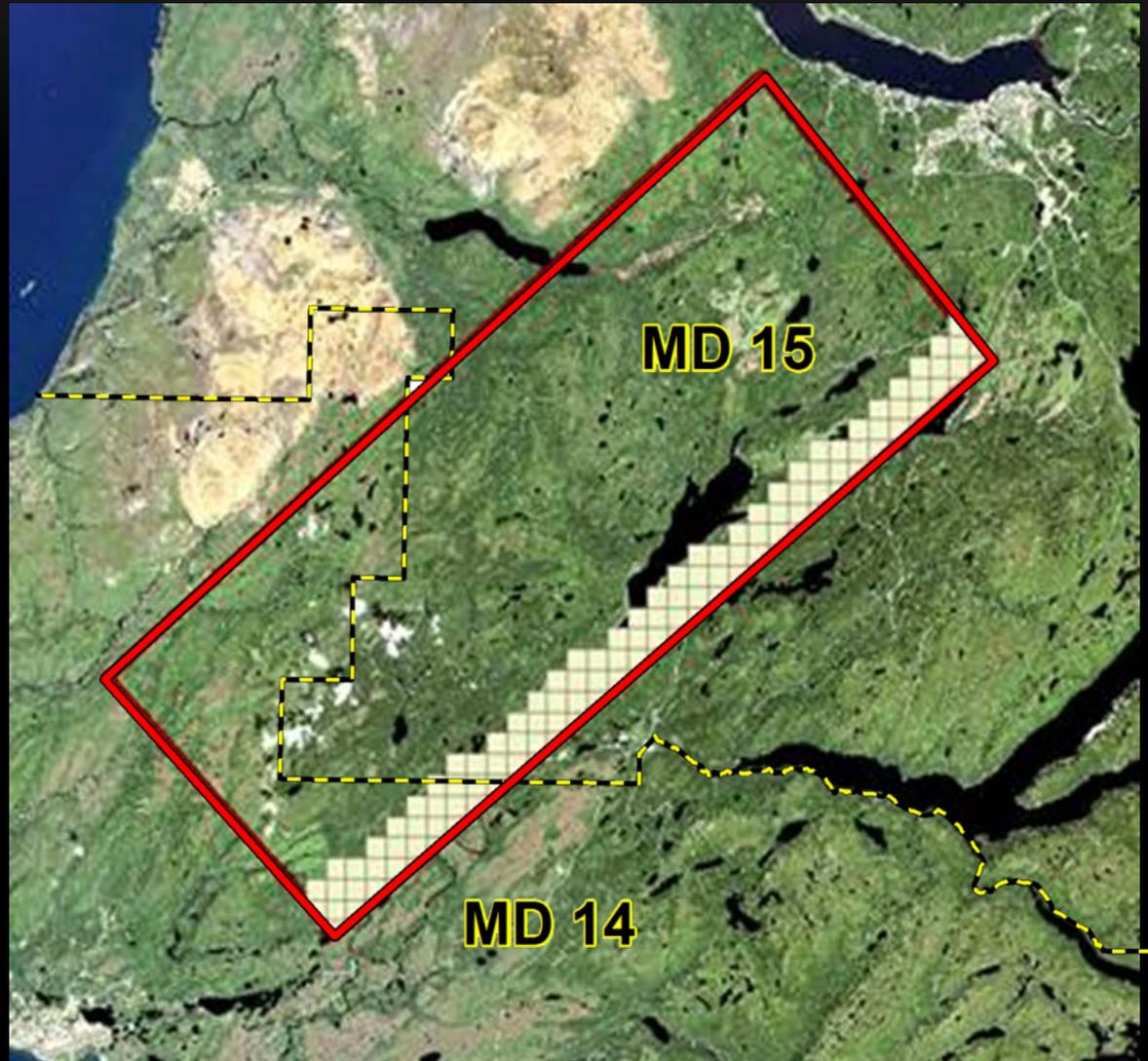


- Waterbodies - 3,631 ha
- Non-Forest - 7,062 ha
- Commercial Forest - 51,109 ha
- Non-Comemrcial Forest - 12,050 ha

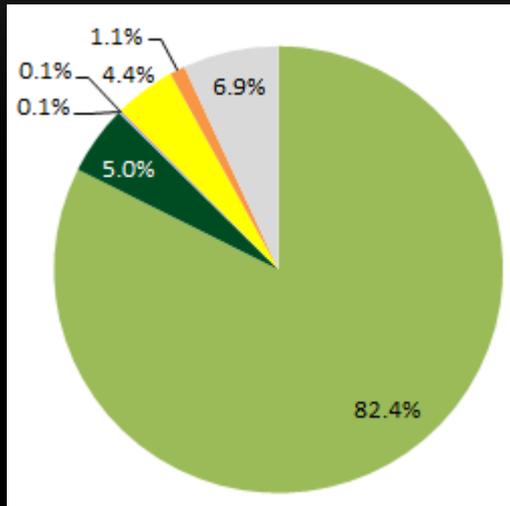


# ALS DATA ACQUIRED IN SUMMER 2015 BY LEADING EDGE GEOMATICS

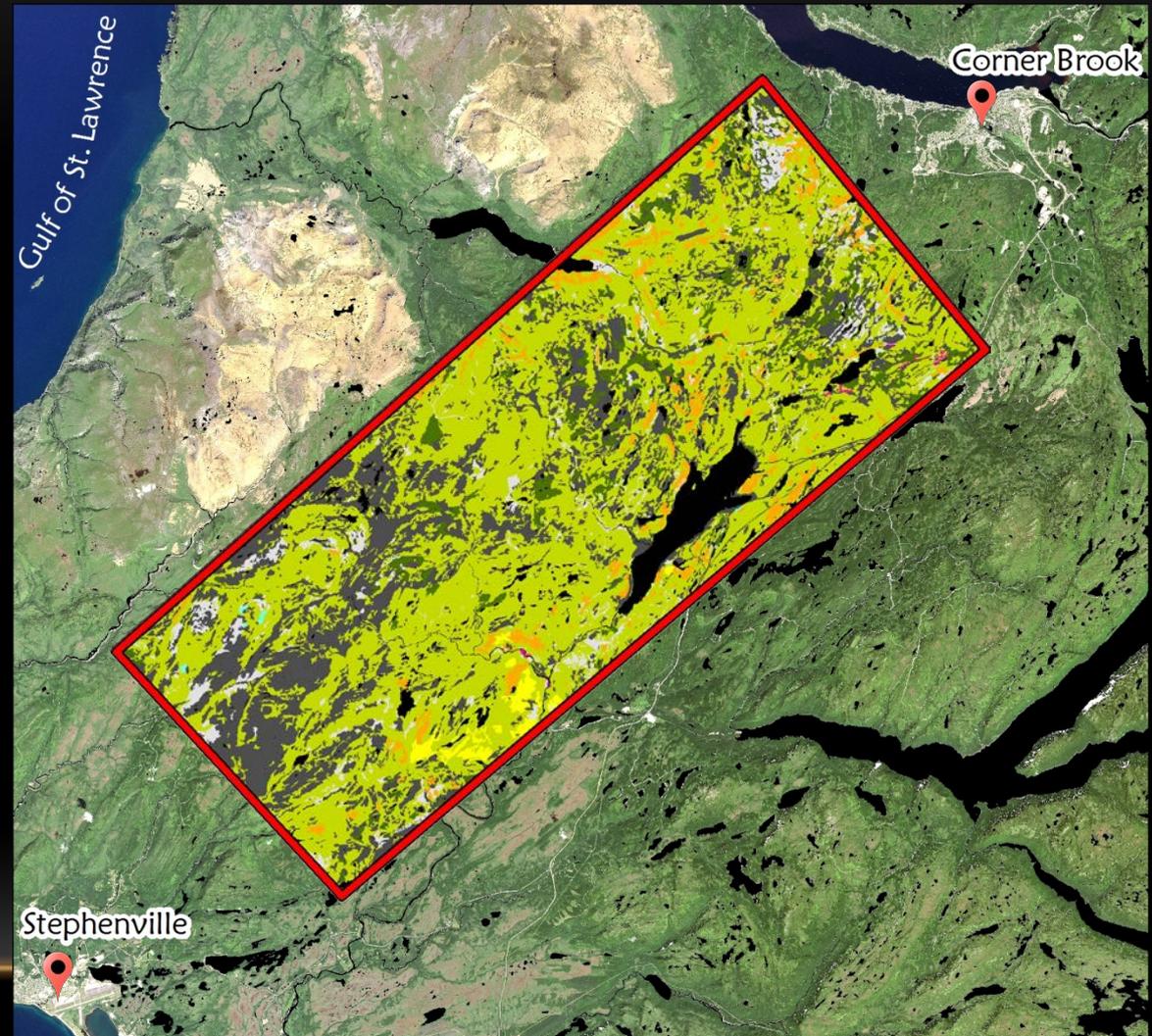
- ~74,000 ha
- Forest Management Districts 14 and 15
- The remainder of the test site will be collected by LED in summer 2016
- ALS data has multiple returns, 6 pts/m<sup>2</sup>, view angle +/- 30 deg., 50% line overlap



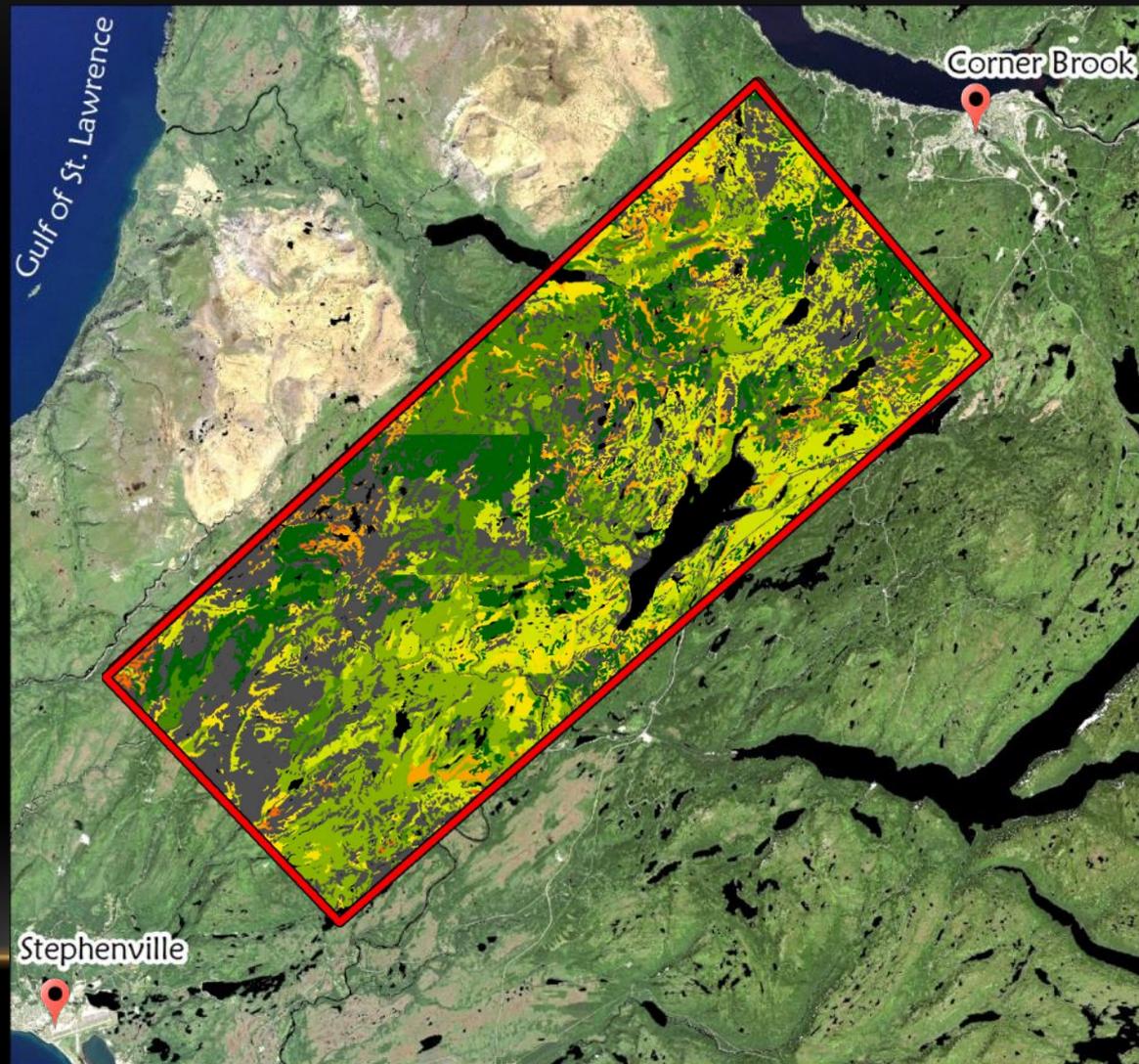
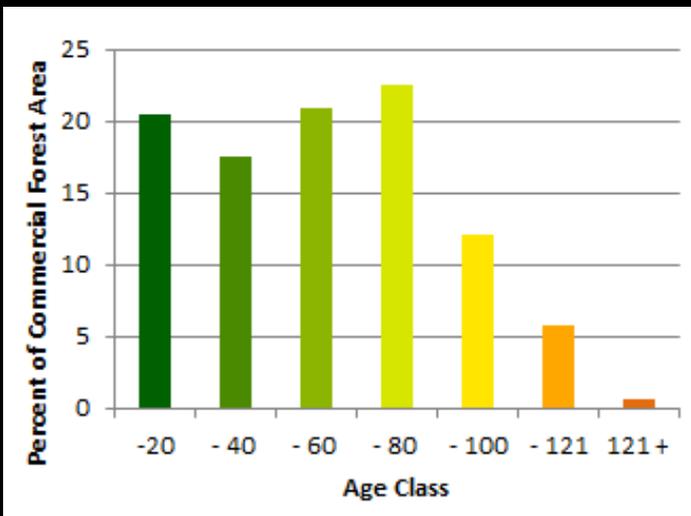
# DOMINANT SPECIES DISTRIBUTION



- Balsam Fir
- Black Spruce
- White Spruce <1%
- Eastern Larch <1%
- White Birch
- Yellow Birch
- Not Stocked or Disturbed

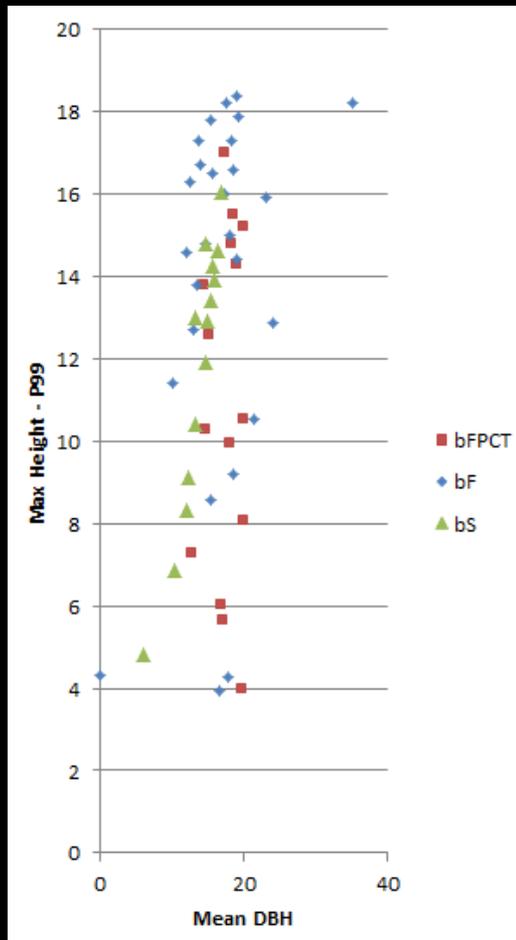


# AGE CLASS DISTRIBUTION



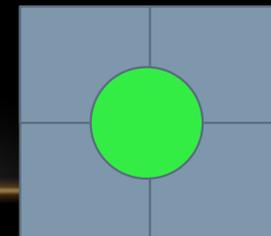
# SAMPLE PLOT LOCATIONS

- ~ 22 Permanent Sample Plots ●
- ~ 40 Supplementary ●
- Balsam Fir; Black Spruce; bF PCT



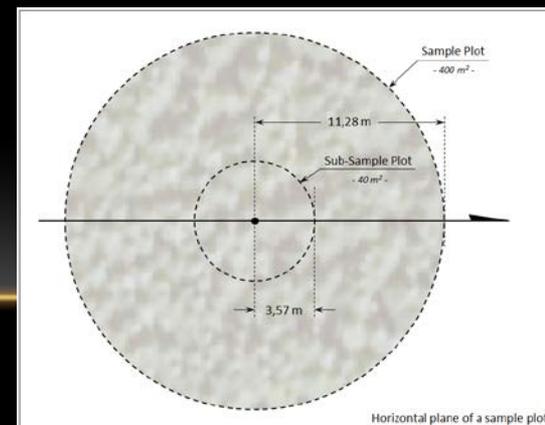
# SAMPLING DESIGN

- Stratification of PCA of available lidar flown in 2010
  - 8 PC1 + 8 PC2 = 64 PCA classes
  - Input metrics *T2\_IQR, T2\_LCV, T2\_Lskew, T2\_P50, T2\_P75, T2\_P95, T2\_P99, T2\_PA, T2\_PF, TGnd\_PA, TGnd\_PF, Tmean\_Pa, Tmean\_PF*
- Populate the PCA strata with existing PSPs
- Establish supplementary plots for PCA strata not represented
  - Random selection with logistical limitations
  - Selection within homogenous area
    - min of 40m x 40m



# WHAT'S MEASURED AT EACH PLOT?

- PSPs
  - Site, Soils
  - Forest mensuration (species, status, dbh, blc, hgt, etc)
  - Every 4 years
- Supplementary
  - Main plot dbh > 9cm; subplot dbh > 4cm
  - Forest mensuration (species, status, dbh, blc, hgt)
  - Tree locations
  - TLS



# FIELD TOUR



-  NL Core Site Boundary
-  Balsam Fir Dominated
-  Black Spruce Dominated
-  Hardwood Dominated

