

KTTD Temagami SkyForest™ Project

Satellite-based forest inventory

Philip Green, M.Sc.
CEO, First Resource Management Group Inc.

www.skyforest.ca



FIRST RESOURCE MANAGEMENT GROUP

February 25, 2021

Goals

- Objective 1: Find new ways to validate interpreted inventory attributes of the eFRI
- Objective 2: Demonstrate the SkyForest™ approach to forest inventory, including:
 - **Tree species**
 - **Timber attributes**
 - **Terrain**
 - **Automated stand delineation**
- Objective 3: Improve Utilization of Timber on the Temagami Management Unit.

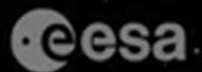


SkyForest: Satellite-based forest inventory

Satellites have several advantages for producing forest inventory:

- High refresh rate of satellite imagery means that the inventory is current, not years old
- Inventory can be produced at scale, tens of millions of hectares
- Many sources of satellite data are open source, drastically reducing costs over airborne methods of remote sensing
- Producing and updating inventory is very quick—weeks or months, not years

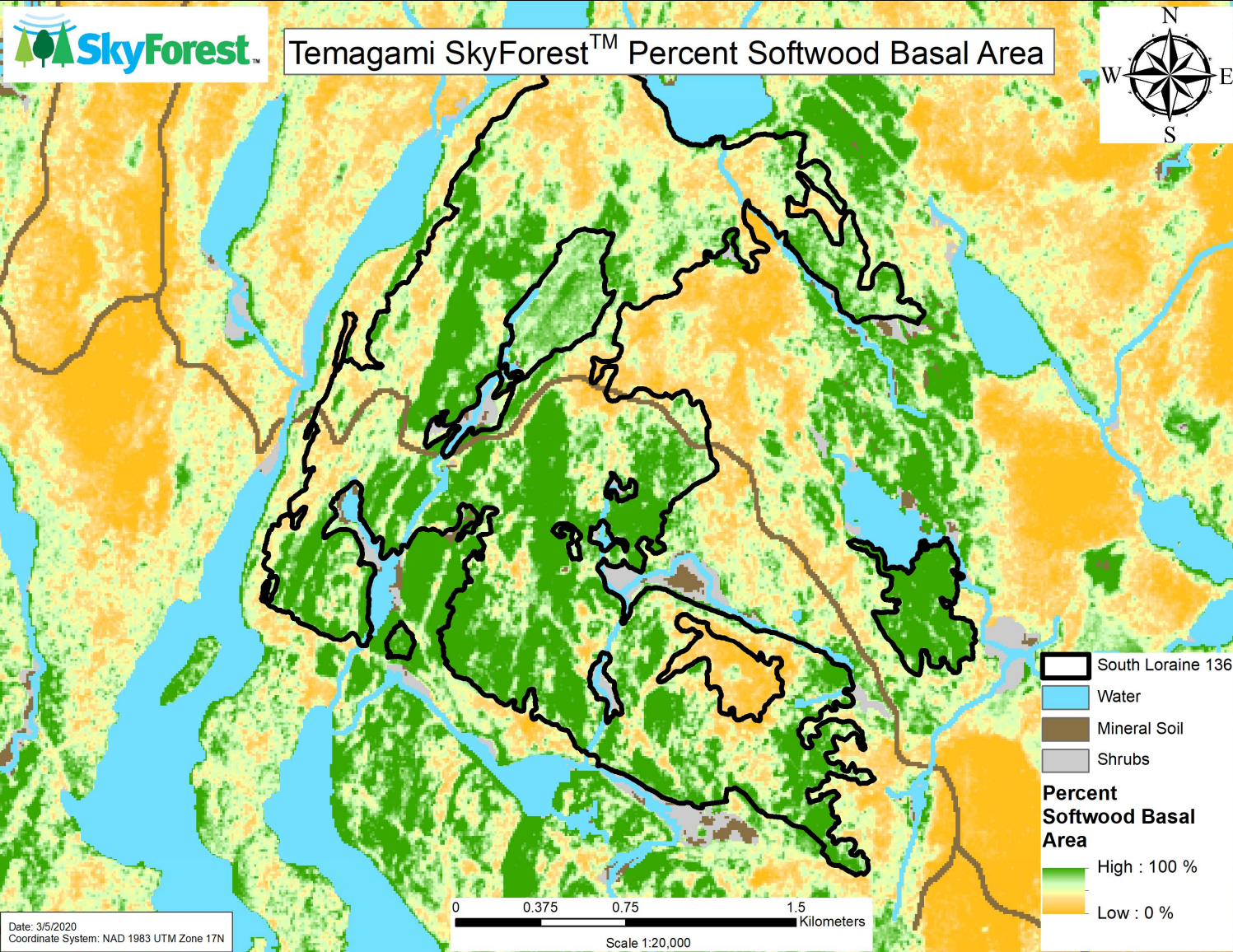




0 days 00 hours 00 minutes
Sentinel-2 constellation:
summer solstice

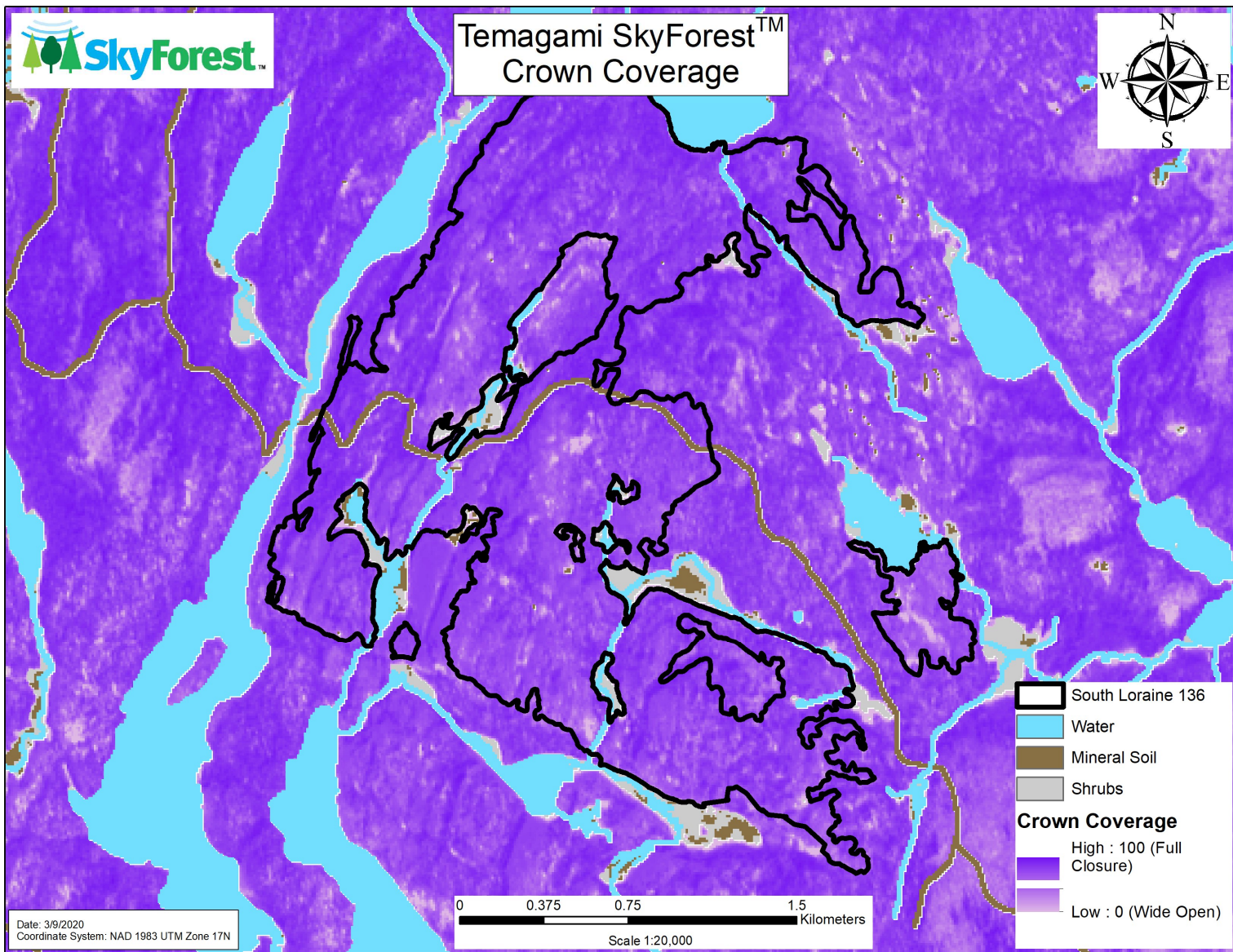


Temagami SkyForest™ Percent Softwood Basal Area

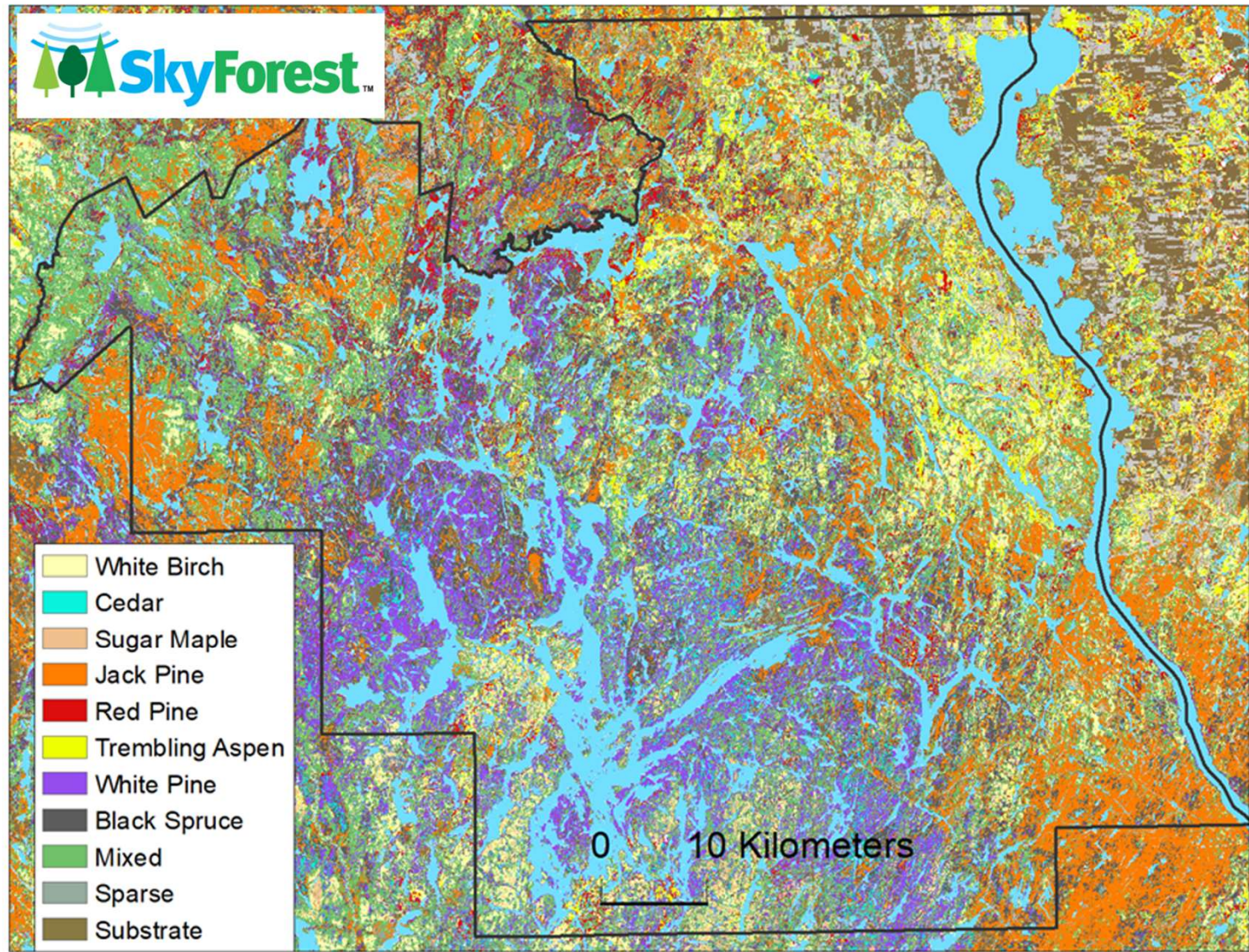


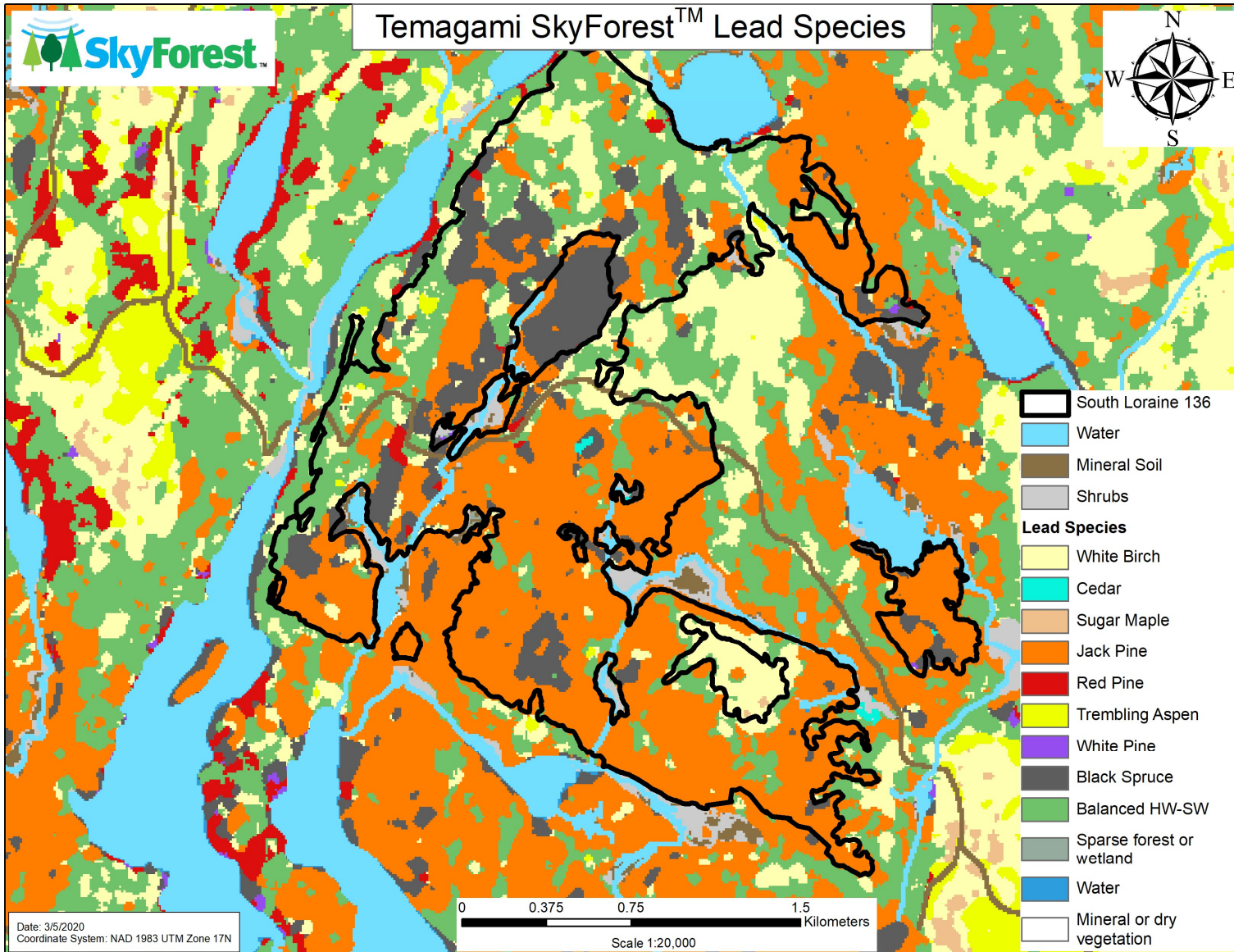
Percent softwood basal area is an accurate measure of hardwood and softwood composition.

Crown coverage provides a practical measure of site occupancy.

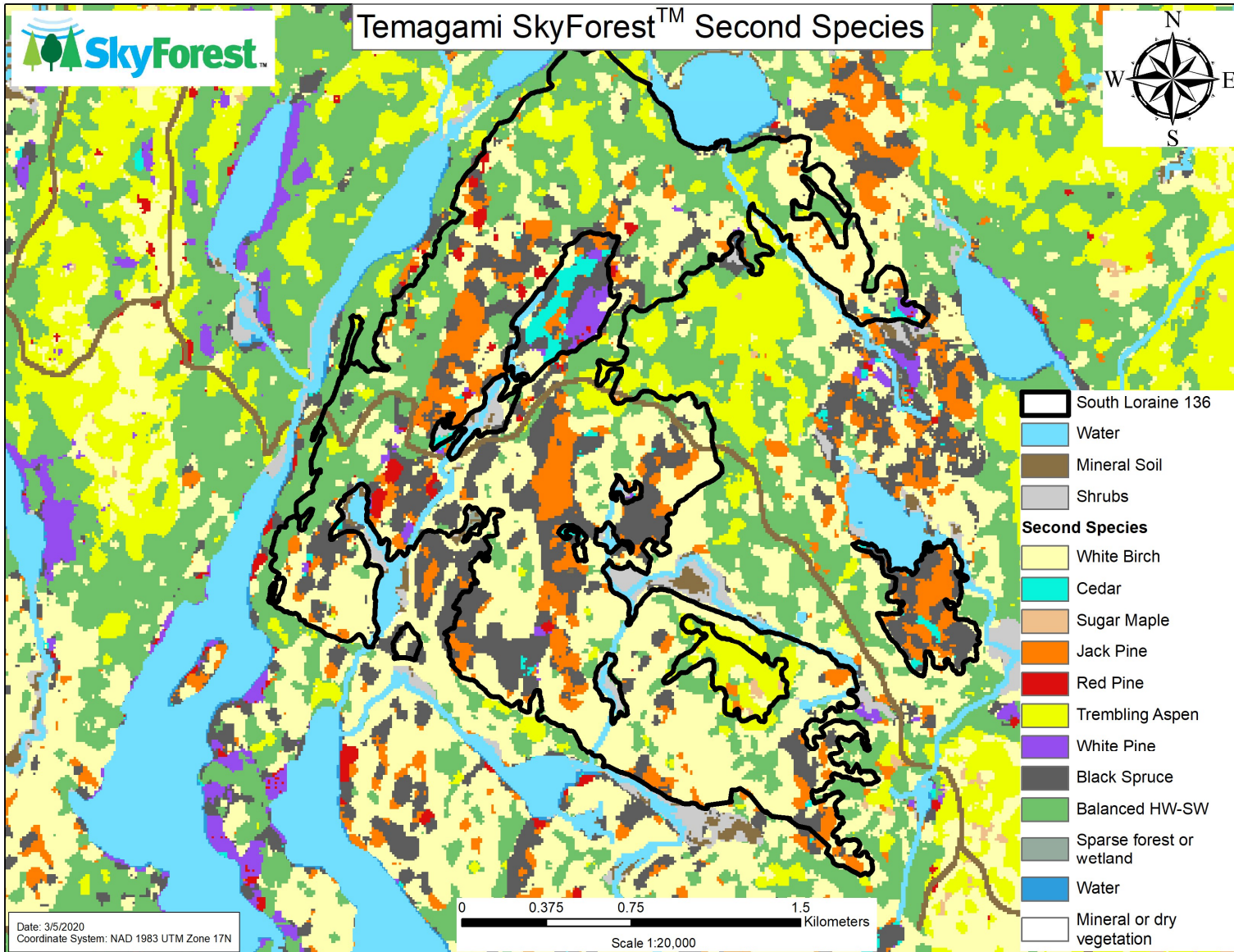


SkyForest map
of tree species
across the
Temagami
Forest and
surrounding
areas.

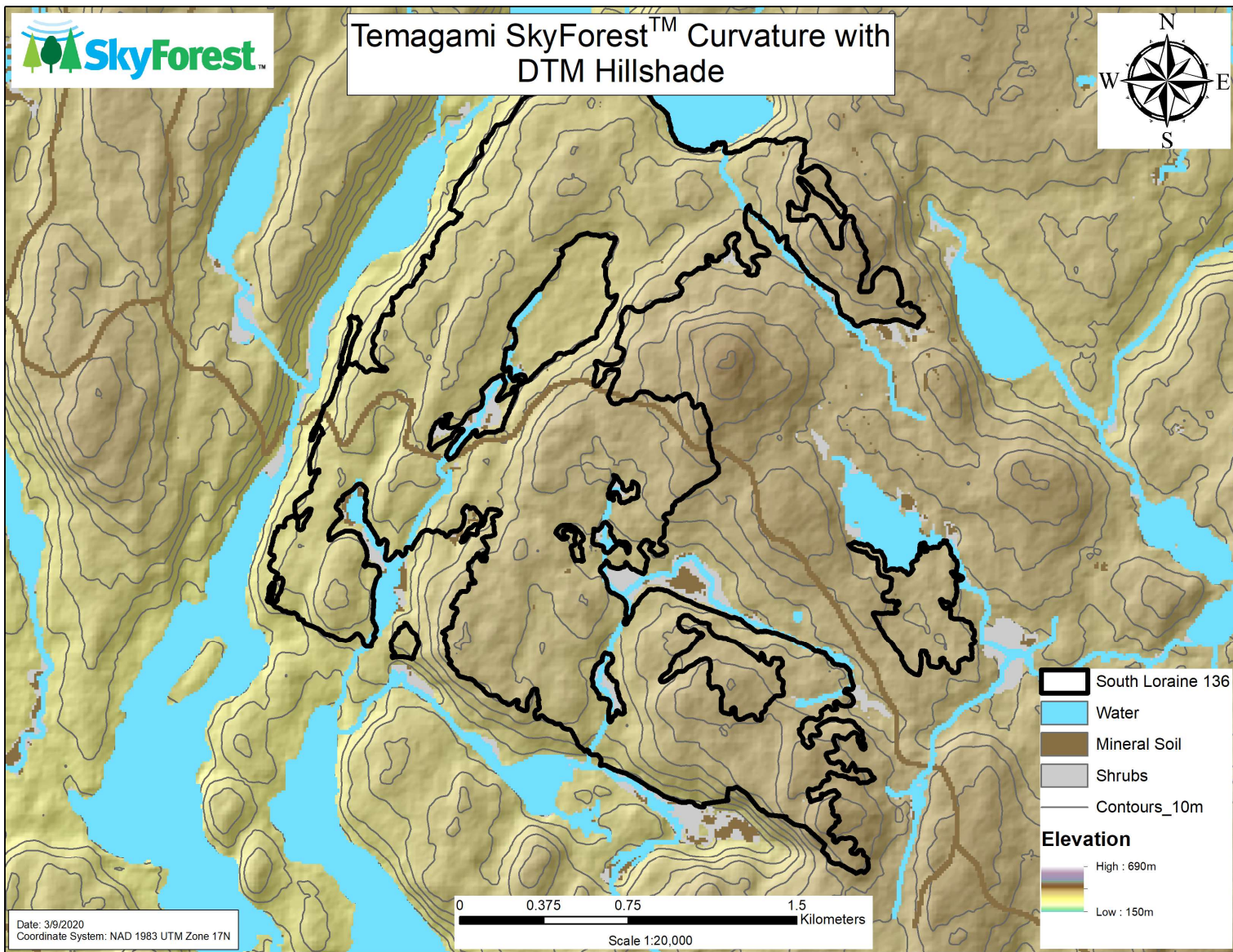




Each 10m pixel shows the lead species (by % BA). Results are smoothed for easier interpretation by forest operators.

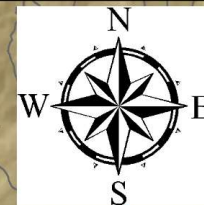


The SkyForest Digital Terrain Model was built entirely with satellite data, including stereo SPOT-7 data. It is a fast, low cost alternative to a lidar DTM. It “sees” under the forest canopy and provides sufficient accuracy and resolution for operations.

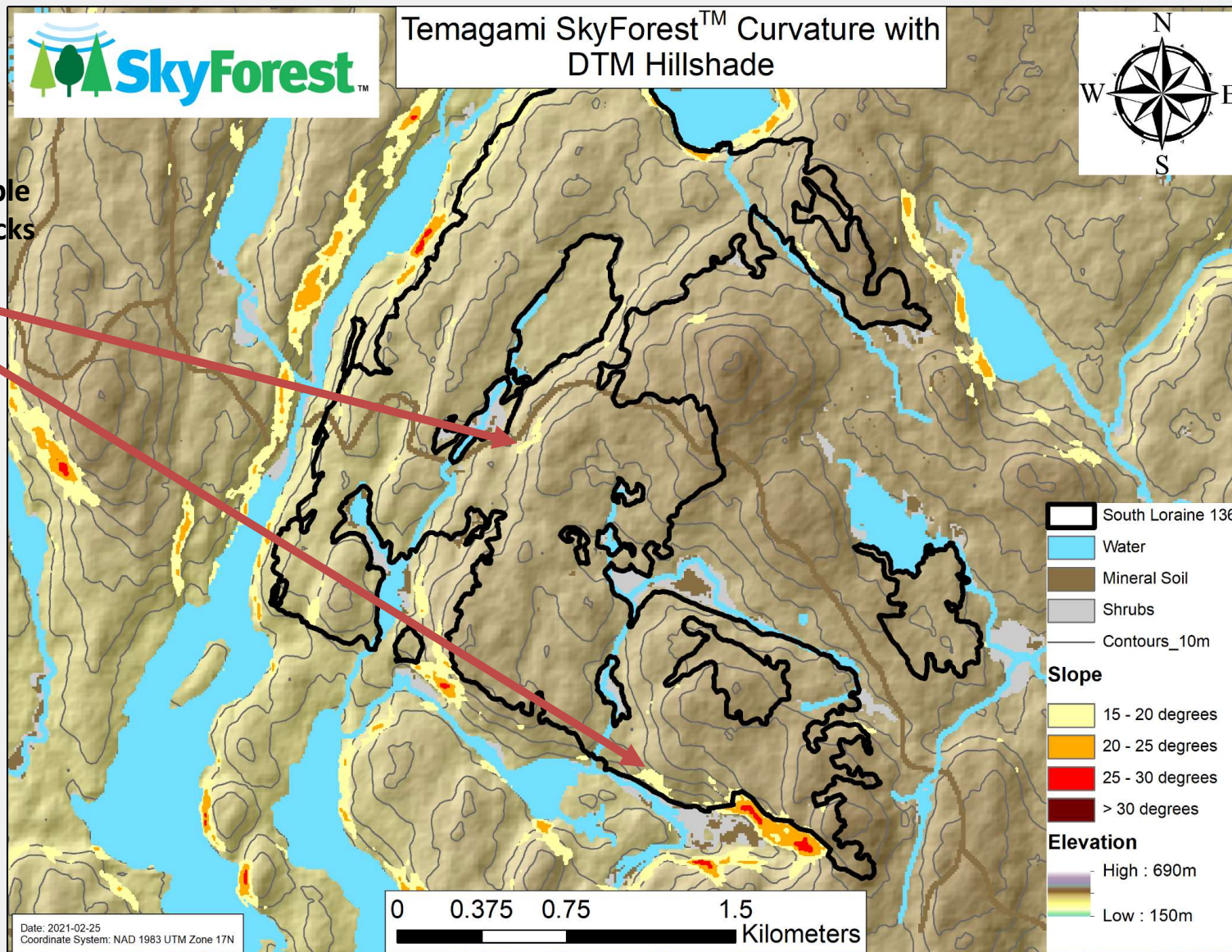




Temagami SkyForest™ Curvature with DTM Hillshade



Identify inoperable Areas within blocks

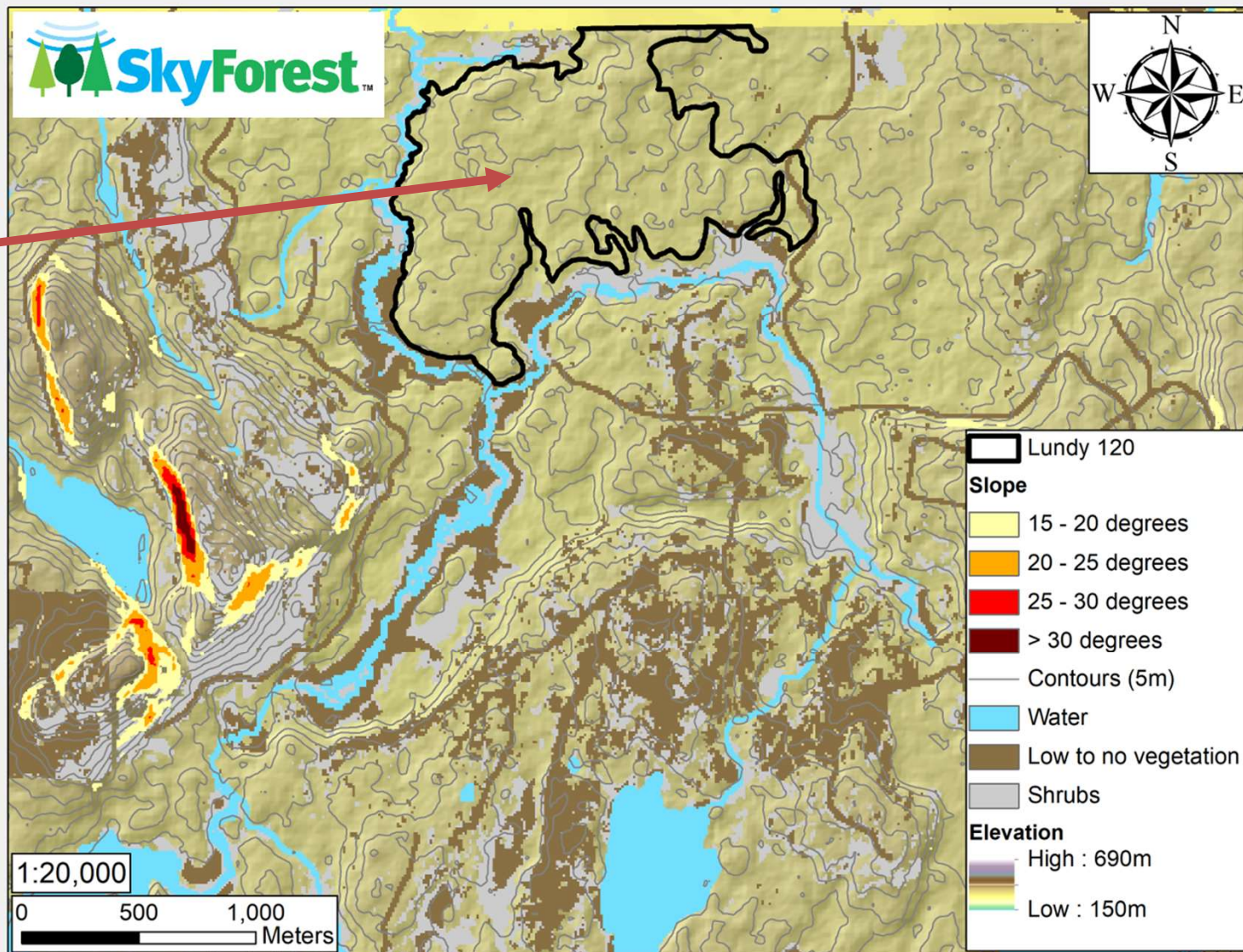


Date: 2021-02-25
Coordinate System: NAD 1983 UTM Zone 17N

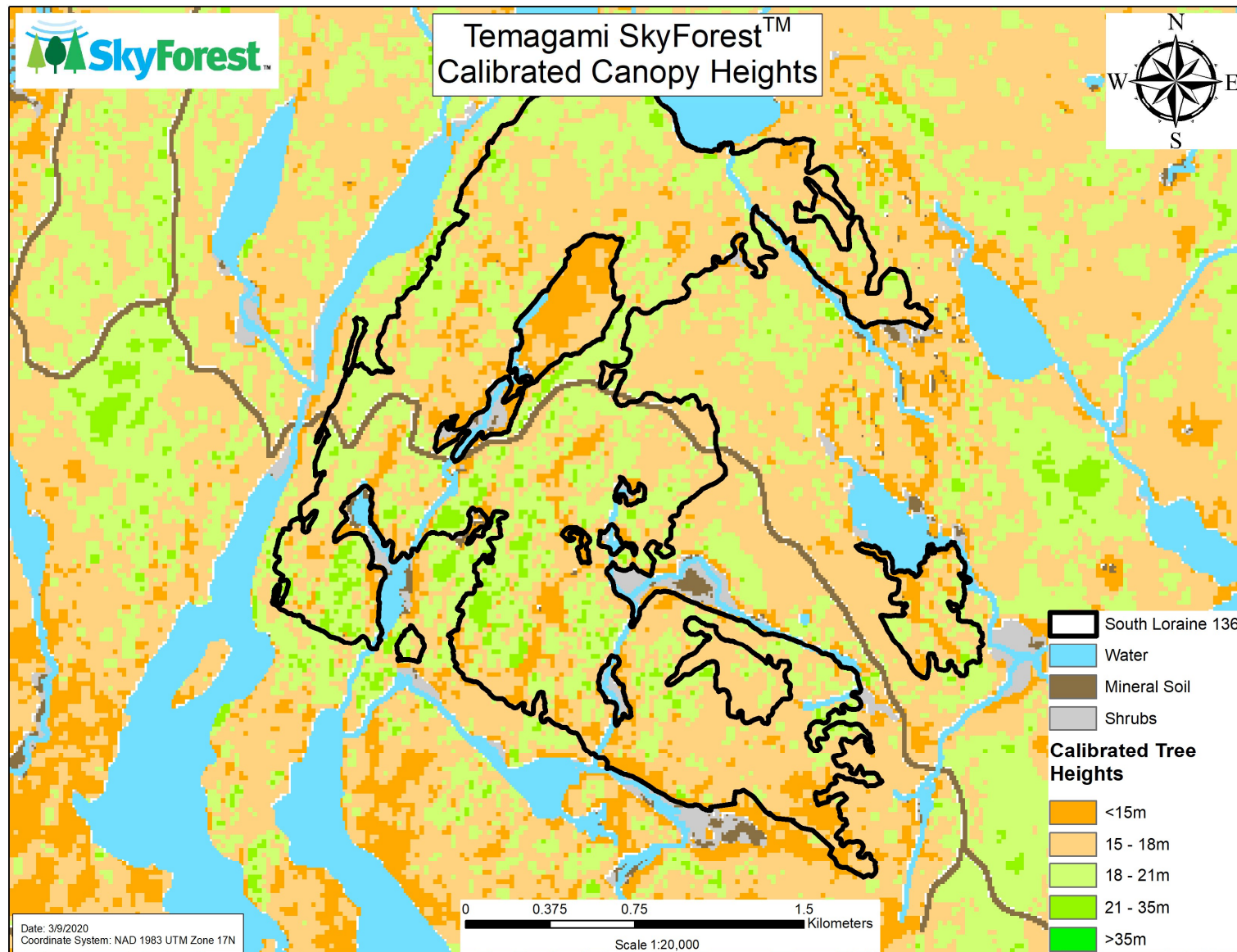
0 0.375 0.75 1.5
Kilometers

- South Lorraine 136
- Water
- Mineral Soil
- Shrubs
- Contours_10m
- Slope**
 - 15 - 20 degrees
 - 20 - 25 degrees
 - 25 - 30 degrees
 - > 30 degrees
- Elevation**
 - High : 690m
 - Low : 150m

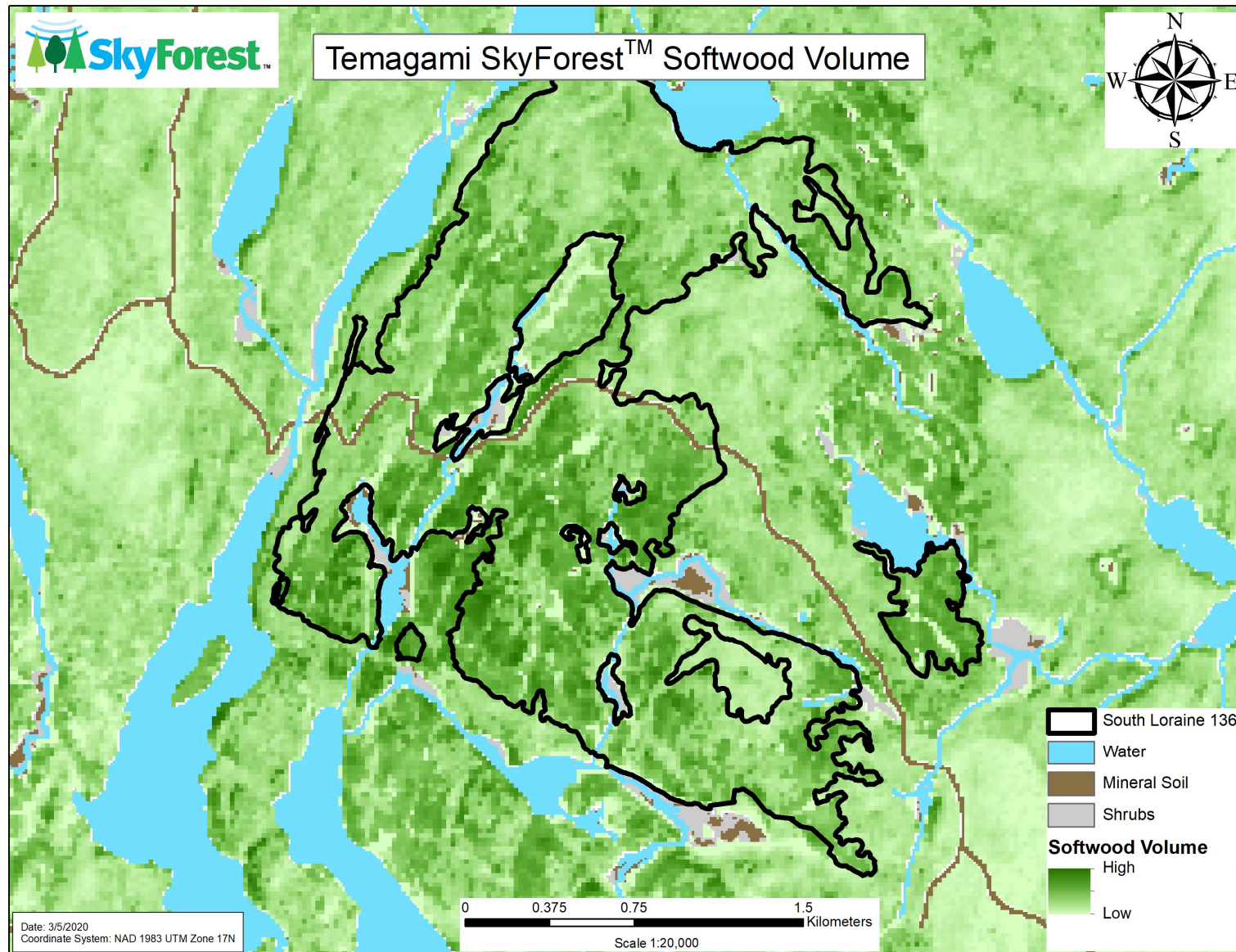
Identify
operable
blocks with flat
terrain



With the satellite based digital surface model and SkyForest digital terrain model we accurately estimate canopy height.

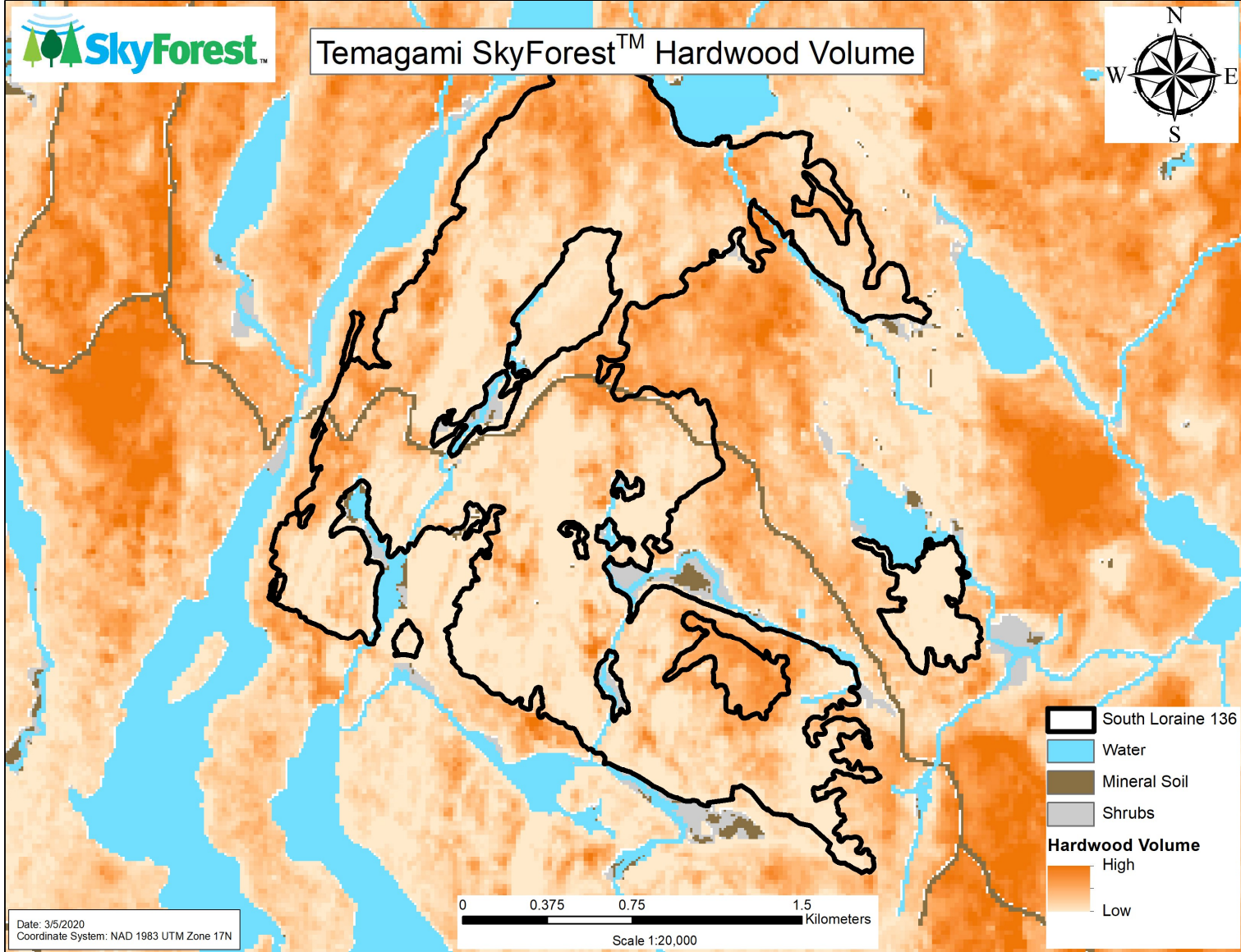
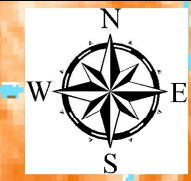


With the canopy heights we can predict hardwood and softwood timber volume. This can also be done for individual species.





Temagami SkyForest™ Hardwood Volume



Date: 3/5/2020
Coordinate System: NAD 1983 UTM Zone 17N

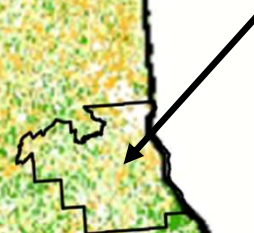
0 0.375 0.75 1.5 Kilometers
Scale 1:20,000

- South Loraine 136
- Water
- Mineral Soil
- Shrubs
- Hardwood Volume**
 - High
 - Low

Using the methods described in this project, SkyForest percent softwood basal area has been produced for all of Ontario. This map shows that SkyForest can produce large-scale forest inventory information—here hundreds of millions of hectares.



Temagami Forest

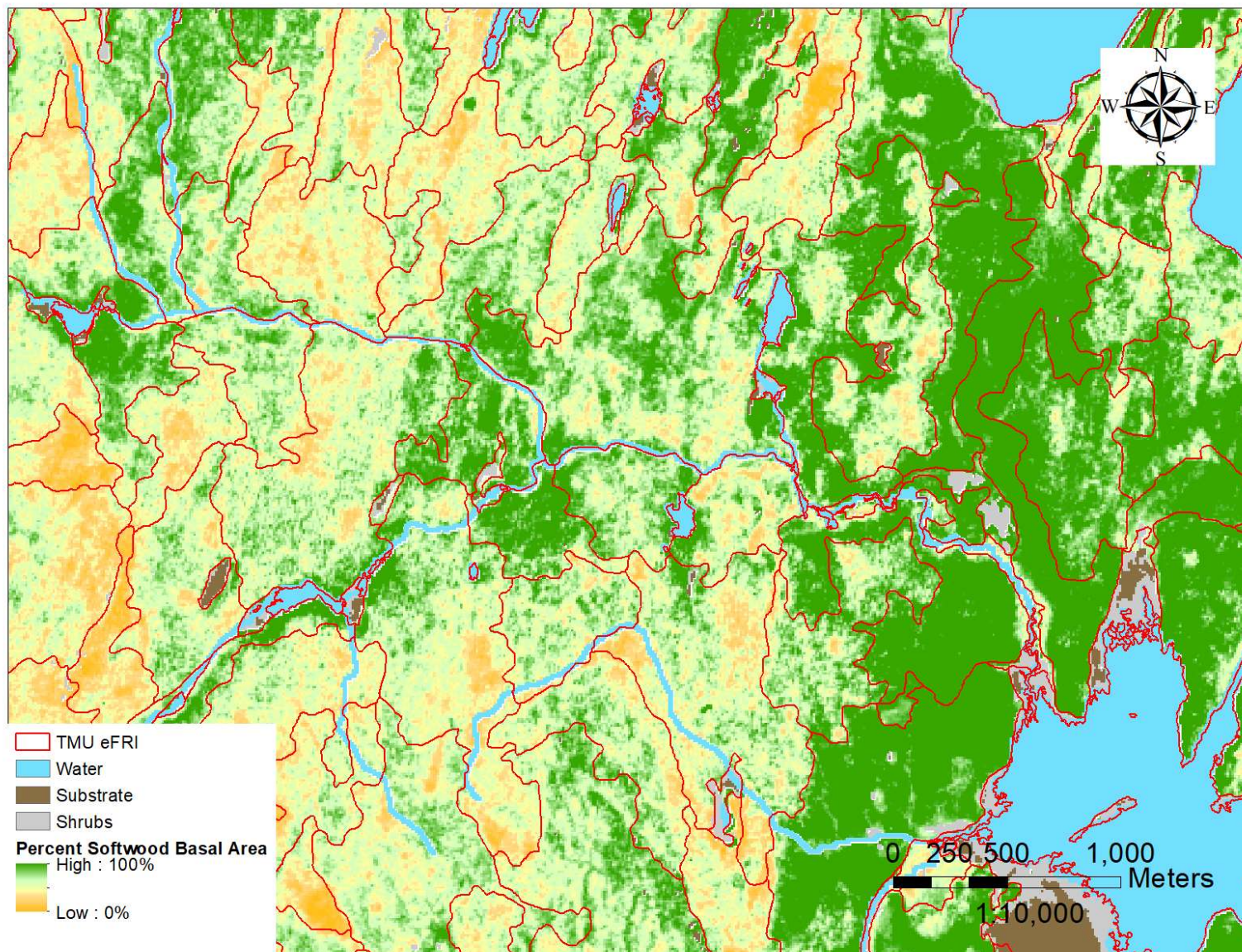


SkyStands

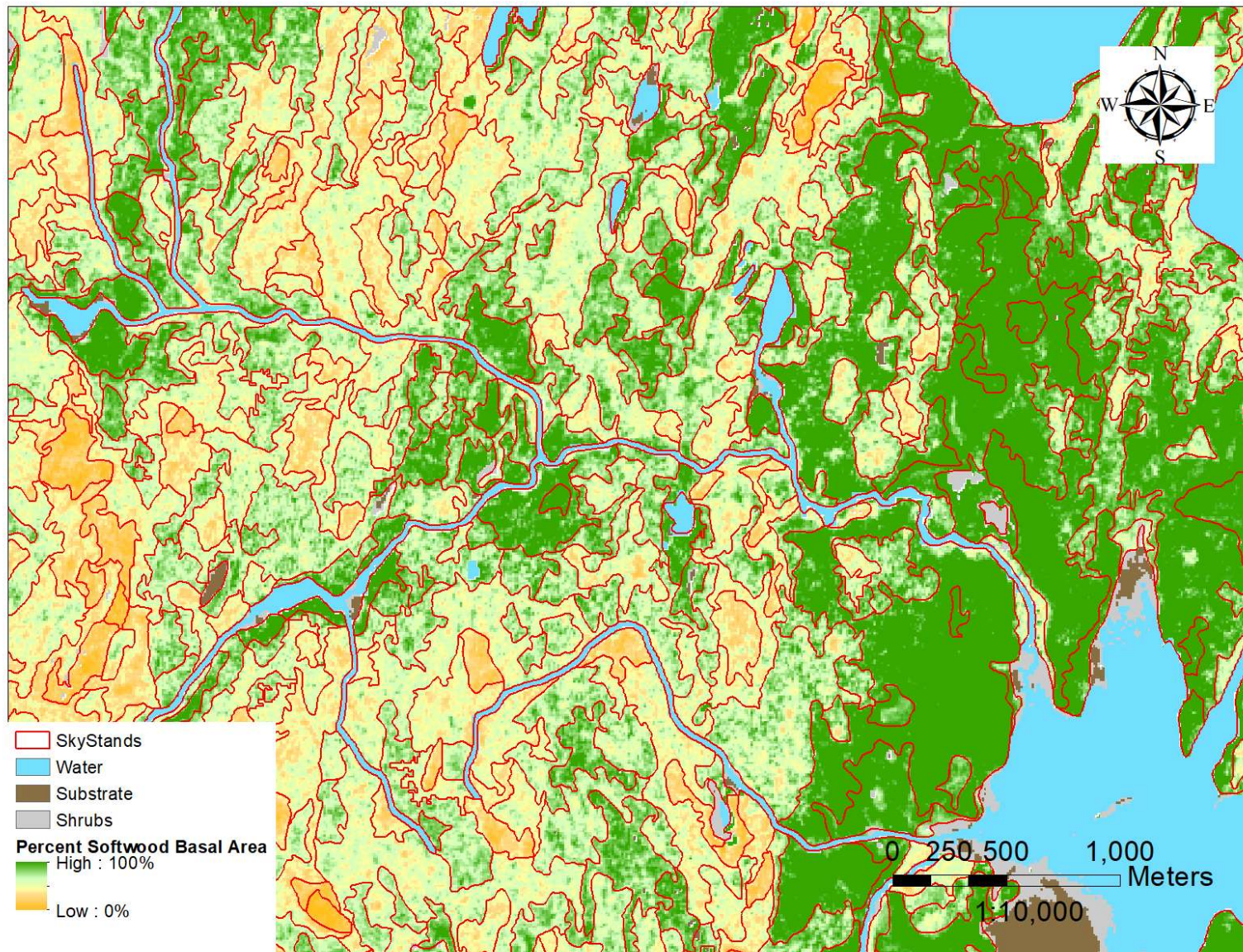
- The SkyForest automated SkyStands algorithm can rapidly and accurately delineate forest stands across an entire forest
- Each stand can be classified based on ecological or operational criteria using the SkyForest data and client input
- This saves considerable time over photo interpretation



Map showing
photo-
interpreted
stand
boundaries.



Map showing the SkyForest *SkyStands* using an automated algorithm to map stands across the entire Temagami Forest. They more accurately capture stand boundaries.



Sampling

- To produce the SkyForest data, an independent contractor collected calibration field data from the forest
- To validate the SkyForest data and the eFRI, validation field data was collected from the forest by the contractor
- The validation data and calibration data were independent
- The sampling intensity is significantly less than traditional inventory methods and machine learning methods—which is a significant cost and time savings

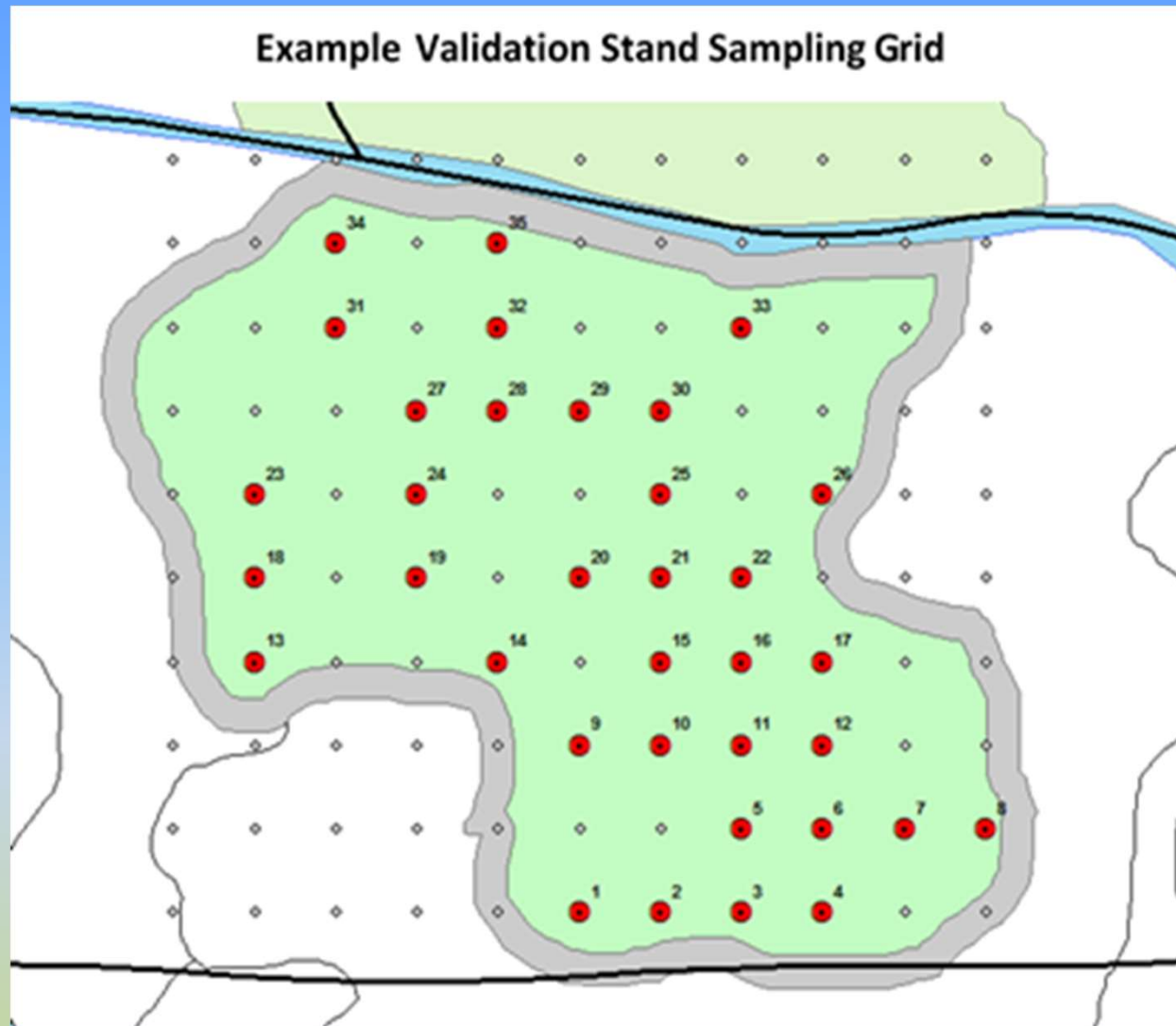


Sampling

- Calibration:
 - 200 fixed radius plots
 - 80 plots used for species calibration
- Validation
 - 30 eFRI stands
 - 30 variable radius plots per stands (total 900 prism sweeps)
- This was a research project. On commercial projects fewer samples are needed



Each validation stand had a 50m grid layout of stations for enhanced prism sweeps (black dots). In each stand, 30 stations were randomly selected for samples (red dots in diagram). This gave a total of 900 prism sweeps for validation.

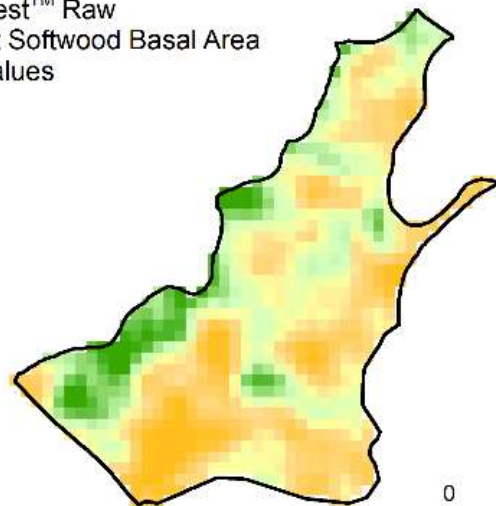


Percent softwood basal area validation

- We compared SkyForest estimates of percent softwood basal area with the data collected from the 30 validation stands.
- We also compared the eFRI species string estimates with the 30 validation stands
- We compared them statistically and graphically
- This was repeated for the SkyForest species estimates



SkyForest™ Raw
Percent Softwood Basal Area
Pixel Values

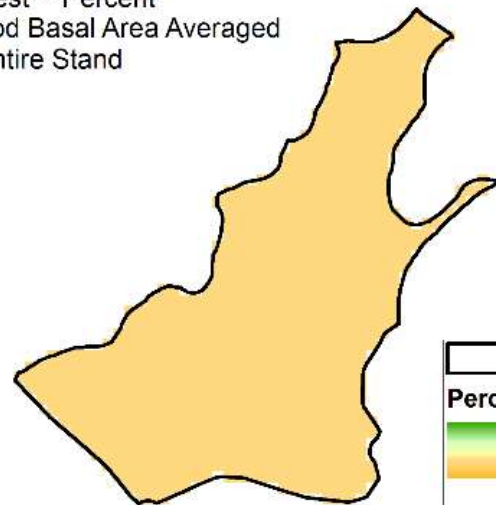


Validation Stand (cruise)
Percent Softwood Basal Area

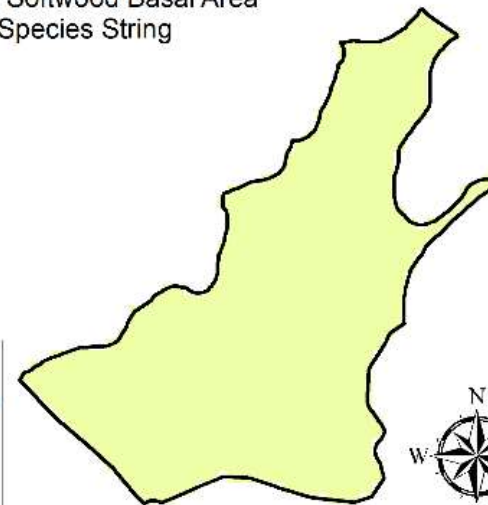


1:10,000
0 125 250 500 Meters

SkyForest™ Percent
Softwood Basal Area Averaged
Over Entire Stand



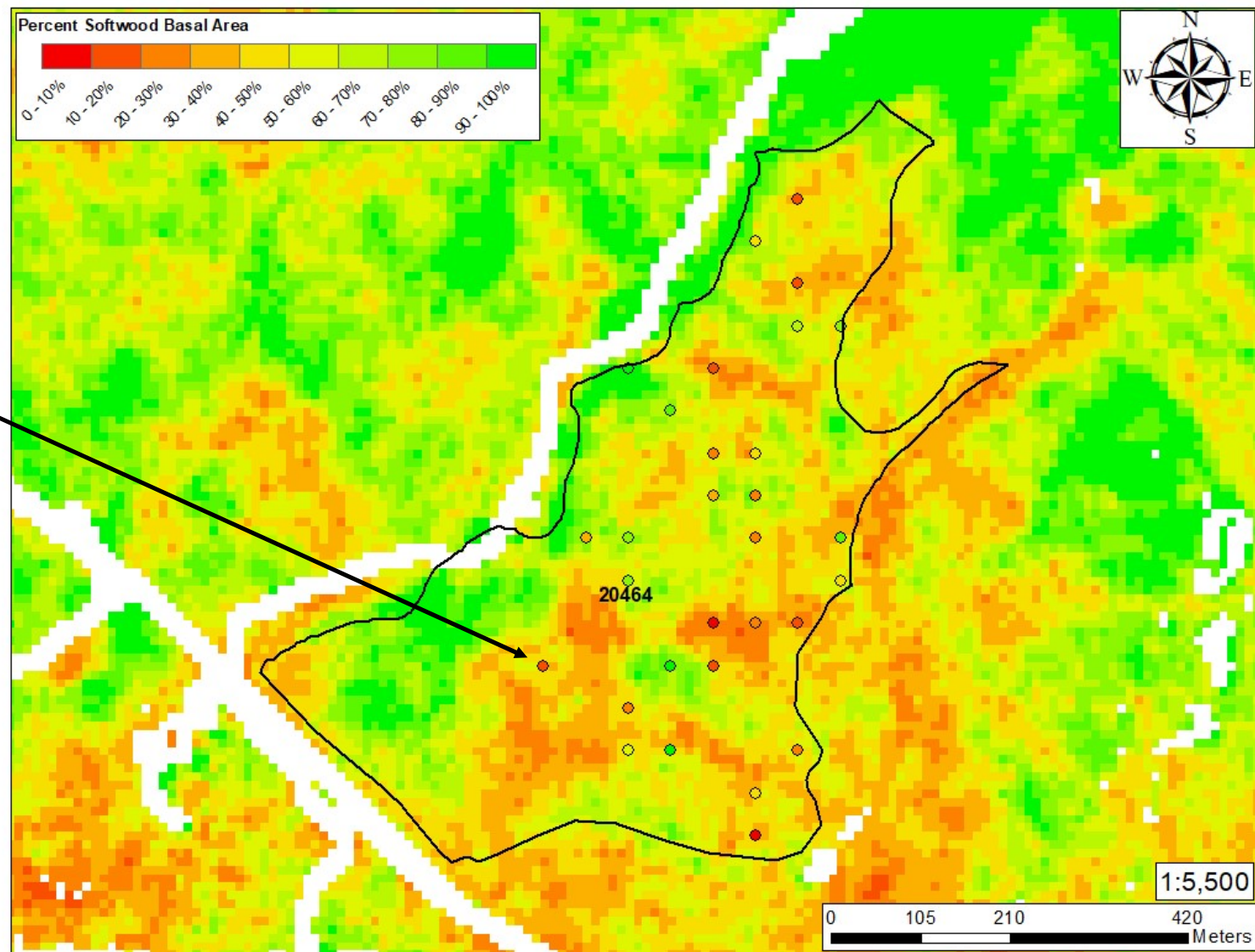
eFRI Percent Softwood Basal Area
derived from Species String



Stand 20464
Percent Softwood Basal Area
High : 100%
Low : 0%



Coloured dots represent prism sweep data and the corresponding percent softwood basal area. Base map shows SkyForest percent softwood basal area for each 10m pixel with same colour scheme.



Percent Softwood Basal Area/Species

Comparison with validation stands			
	R2	Bias	RMSE
eFRI	67%	-10.9	20%
SkyForest	67%	-2.5	13%
SkyForest Species	69%	11.3	19%

The results clearly shows that SkyForest had lower bias and higher accuracy than the eFRI. It is also faster and less costly.

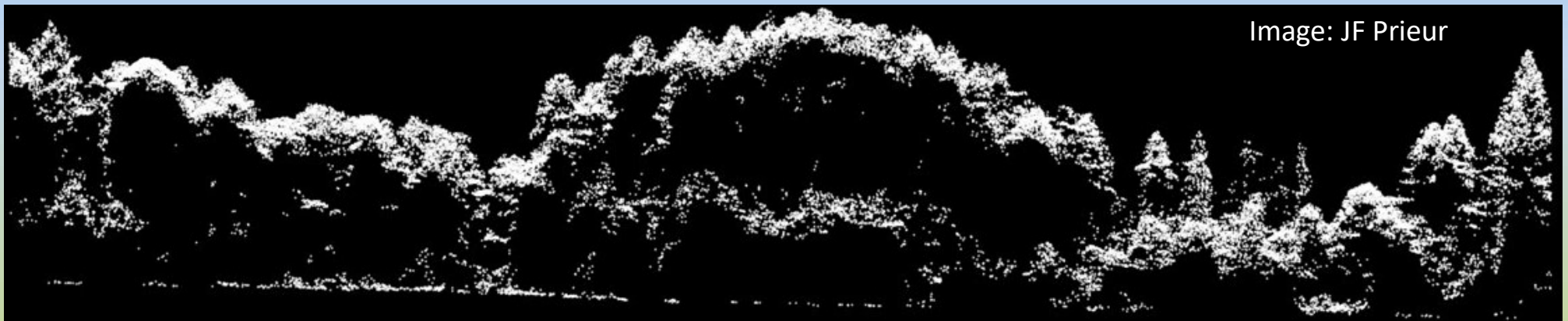


Applications



Applications to provincial inventory

- SkyForest is a cost-effective, accurate, way to provide inventory information in the era of constrained budgets
- **SkyForest** can easily incorporate **Single Photo Lidar** data to create SPL-based volumes, DBH etc. by species or by hardwood/softwood
- SkyForest can complement inventory products built with SPL

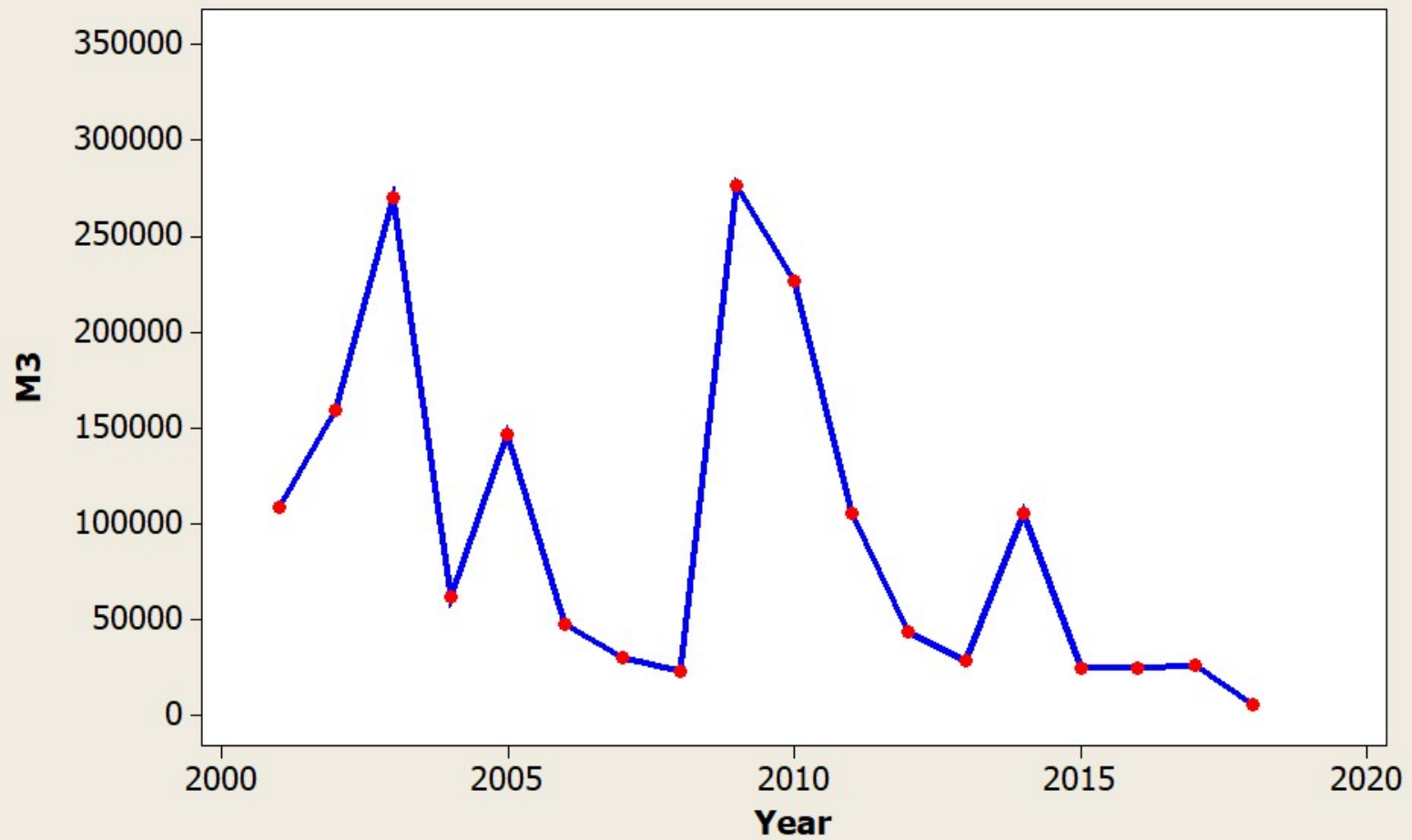


Improved utilization

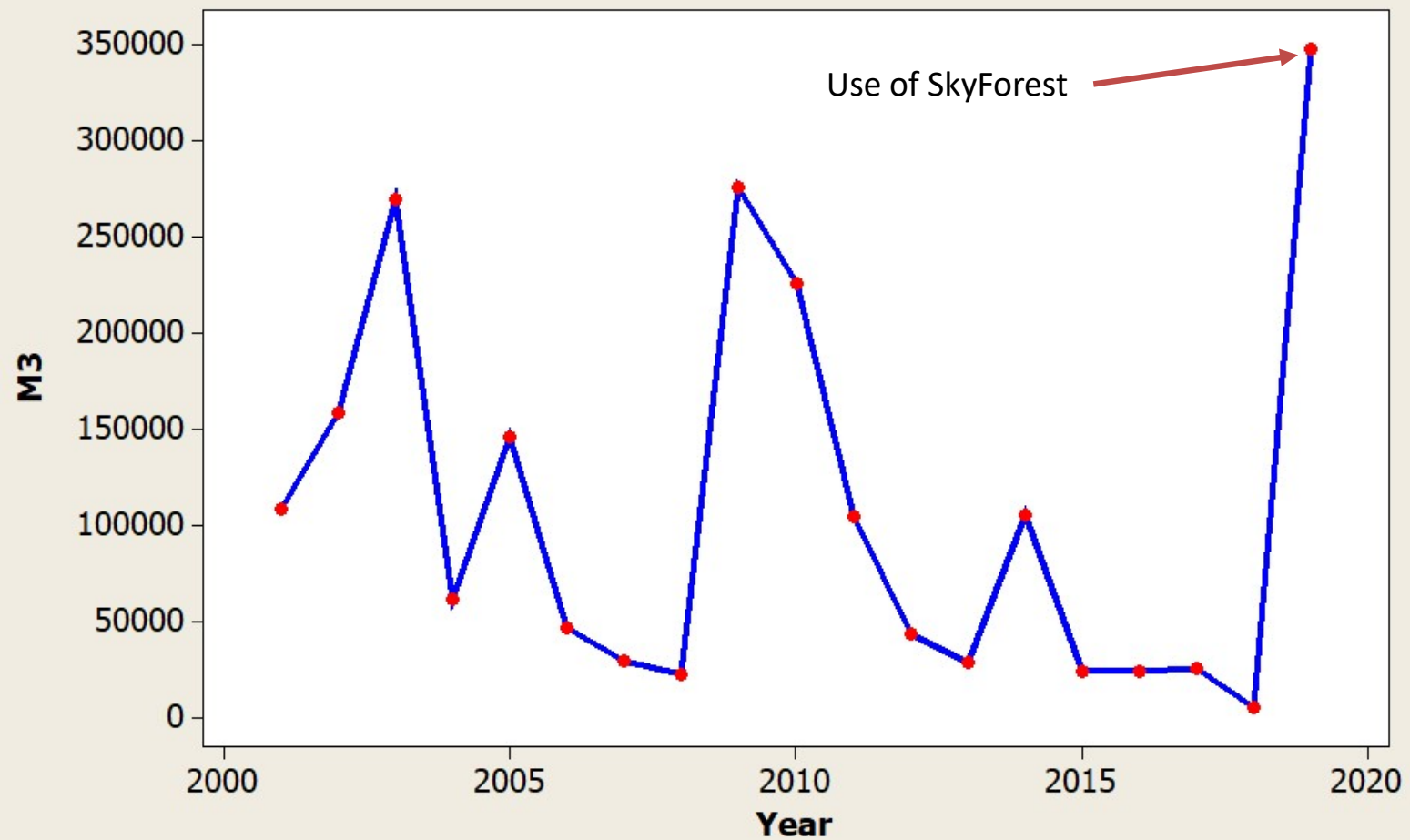
- FRMG used the SkyForest data to prepare the Temagami Forest Management Plan.
- Operators are using it on an ongoing basis
- The results show that SkyForest can significantly increase utilization of planned harvest volumes
- This will help increase the provincial wood supply, create jobs and support local industry and communities



Volume harvested per year on Temagami MU



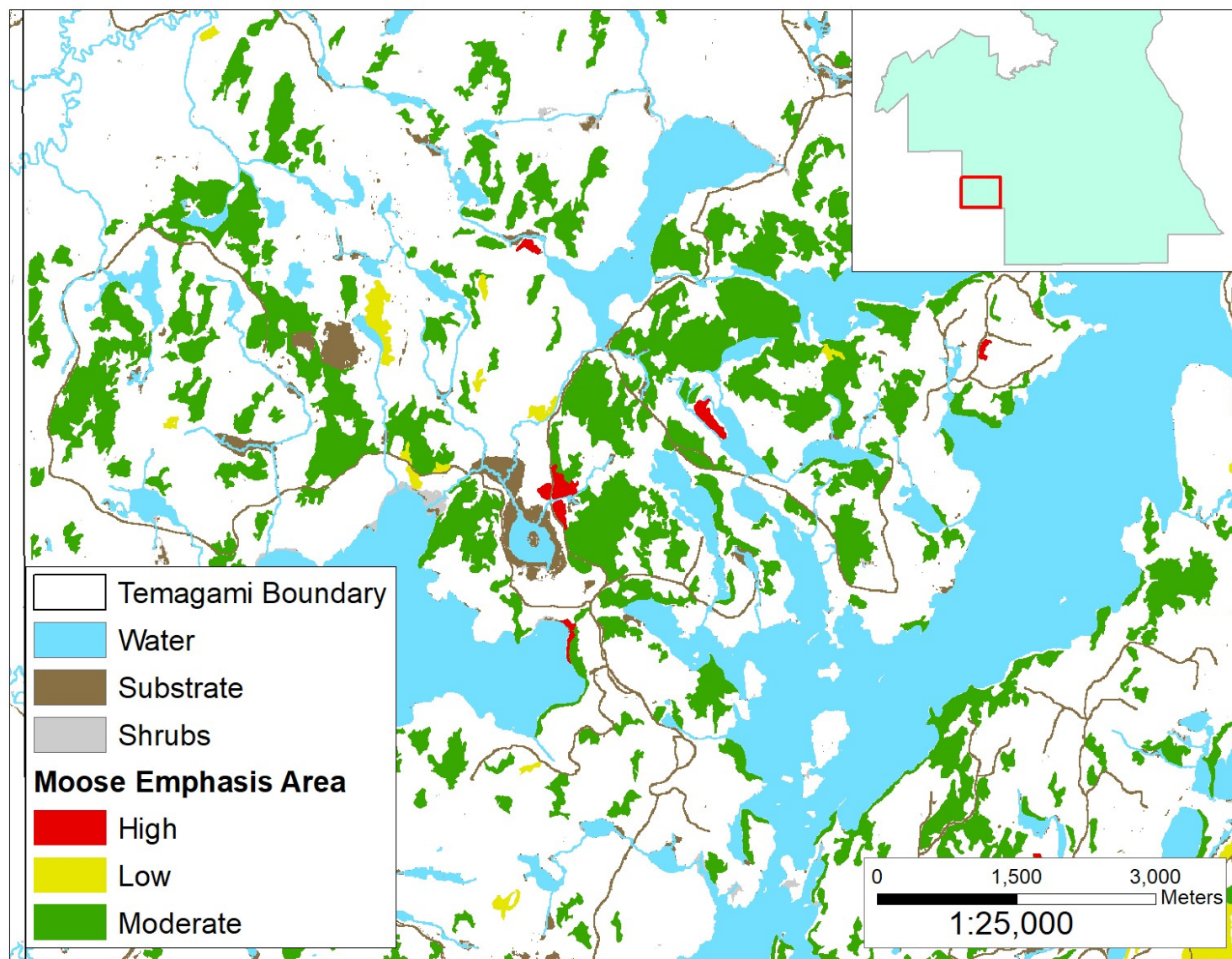
Volume harvested per year on Temagami MU



Other applications

- Wildlife species habitat, e.g. moose or caribou
- SQL queries on SkyForest data can be used to identify wildlife species habitat
- A similar method was used to identify feller buncher “habitat”
- SkyForest crosses management unit boundaries so it enables landscape level sustainability assessments
- It is not limited to the Area of the Undertaking





Acknowledgements

We gratefully acknowledge funding by

- MNRF
- FFT
- FRMG provided significant in-kind funding.





Please contact me for any questions. phil.green@frmg.ca

THANK YOU

WWW.SKYFOREST.CA