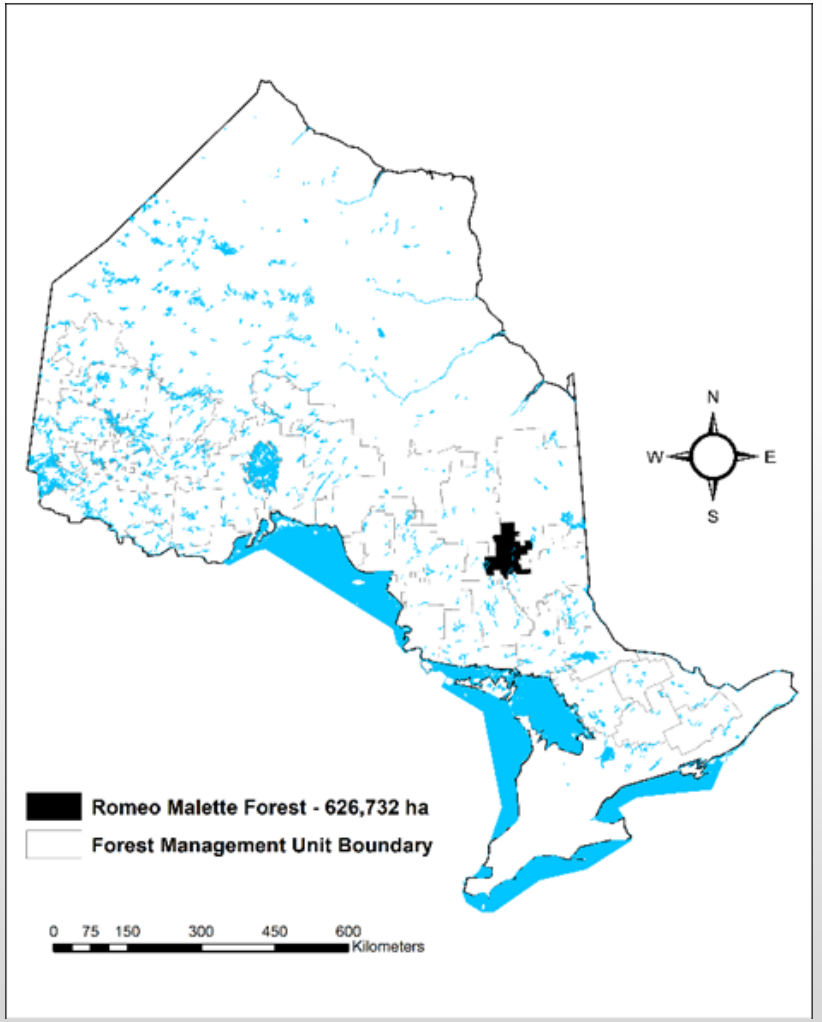
KTTD Project Results
Acceleration of LiDAR Enhanced Inventories – Romeo Malette Forest

Results – Phase I

Partner Meeting November 5, 2021

Outline

- Team
- Objectives
- Plot compilation
  - Project deliverables
- LiDAR Processing
- LiDAR results
  - Plot level
  - Stand level validation
- Creating the T2 inventory
  - Challenges/Opportunities
- Next steps



Project Team

- Joanne White – CFS
- Chris McDonell - GreenFirst
- Tom Ratz – Resolute
- Gord Cumming – AFA
- Barry Davidson – Westwind
- Rob Keron/Glen Watt – MNRF S Planning
- Daniel Kim/Lindsey Russell – MNRF NE Planning
- Robert Fournier – MNRF NE GIS Specialist
- Garnet Beemer – MNRF NW Planning
- Ian Sinclair/Geordie Robere-McGugan – MNRF FRI
- Chris McDonell
- Lino Morandin
- Kevin Delguidice
- Stephane Girard

Objectives

Accelerating the implementation of enhanced forest inventories in Ontario (KTTD 20B-2021)

For the **Romeo Malette Forest (RMF)**, **Dog River Matawin Forest (DRM)** and **Algonquin Park Forest (APF)**, [Option for French-Severn Forest]:

- summarize calibration plots
- generate prediction rasters
- Integrate predictions with T1 inventory

Using open source software and sharing developed code.

Using a cloud-based solution.

Communicate with clients (SFLs and Crown) through entire project

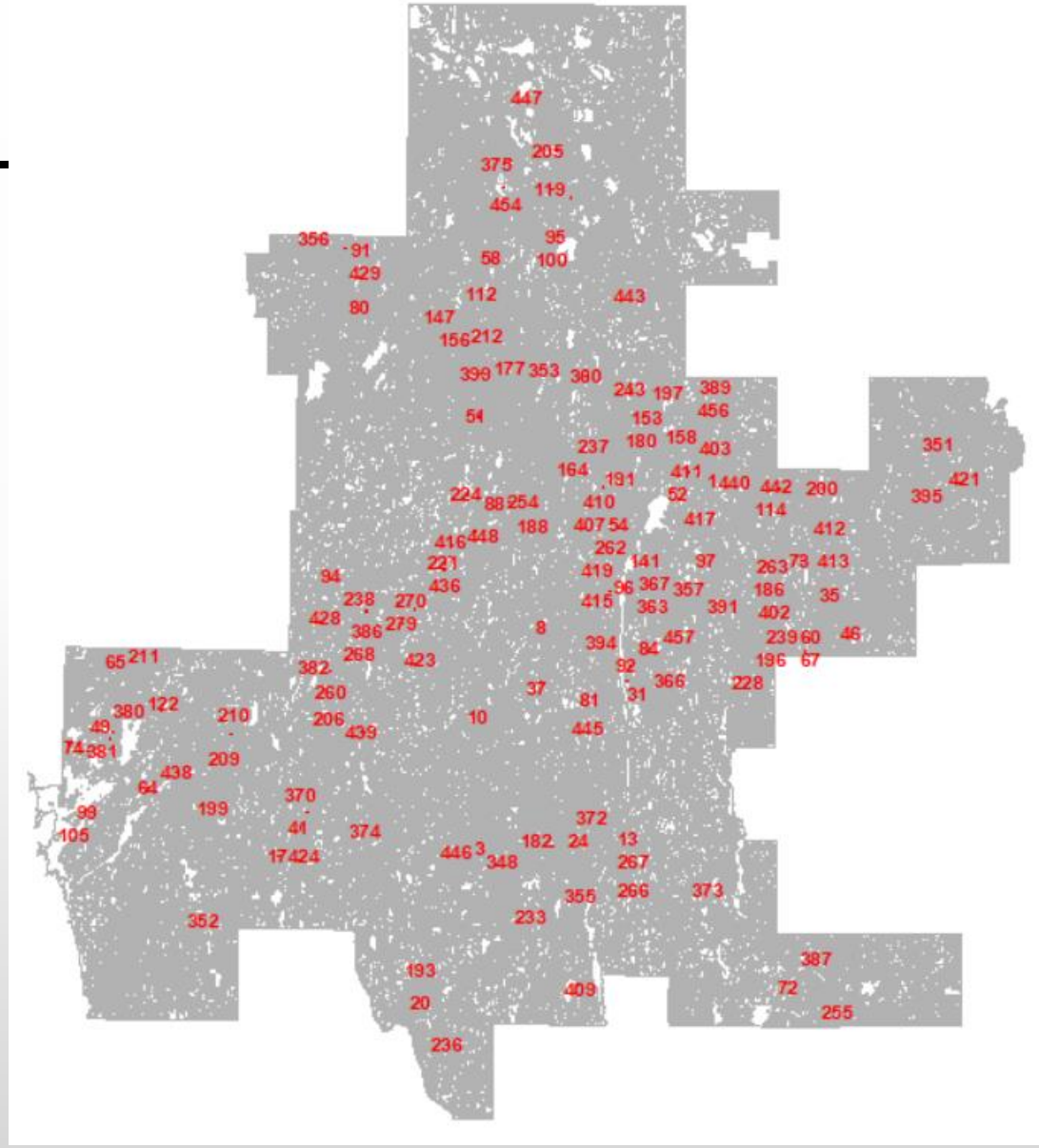
Plot Compilation

- Compilation software written in R – Open Source
- Will be posted on Github
- Accesses Provincial VSN Database structure
- Utilizes Ontario/Canada published sources
  - Height diameter equations (Sharma & Parton 2007)
  - Volume – (Zakrzewski & Penner 2013)
  - Biomass – (Lambert et al. 2005)
- Using a Dbh ≥ 7.1 cm threshold

```
•       #
•#  Callibration plot compiler
•#
•#  Read in Plot file and tree file
•#
•#  For live trees
•#    do basic data cleaning
•#    estimate missing heights
•#    estimate tree volume
•#
•# Produce plot level estimates of
•#    basal area, QDBH, volume, heights, stems/ha
•#
•# by Margaret Penner (mpenner@forestanalysis.ca)
•#
•# clean slate - assign working directory and delete all objects currently in memory
•rm(list=ls(all.names=TRUE))


•# Set working directory
•rdir <- "c:/ForestAnalysis/on/2021/FRI_Acceleration/Rscripts"
•setwd(rdir)

•# Load the height estimation function
•source(paste(rdir,"/Functions/Ht_Est_FUN.R",sep=""))
•# Load the function that converts numeric species codes to alpha species codes
•source(paste(rdir,"/Functions/Spp_Alpha_FUN.R",sep=""))
•# Load the function that converts numeric species codes to alpha species codes
•source(paste(rdir,"/Functions/NE_FU_FUN.R",sep=""))

•# Set error directory & file
•# Output will be directed to thie error file as well as the screen
•ErrDir <- "./Error"
•error_file <- paste(ErrDir,"/Error_File.txt",sep="")
•sink(error_file,append=FALSE,split=TRUE)
•sink()
•sink(error_file,append=TRUE,split=TRUE)
•cat("This file contains the results of error checking \n",file=error_file,  append=TRUE)

•Forest <- "RMF"
•MU <- 930
•InputDir <- paste("c:/forestanalysis/on/2021/FRI_Acceleration/Sascode/RMF_DR/",sep="")


•# get the plot data
•Plot_Data <- read.table(paste(InputDir,"/Plot.csv",sep=""),sep  = ',',header=TRUE)

•# get plot data for RMF
•Plot_Data <- Plot_Data[Plot_Data[,"MU"]==MU, ]
```

Plot Compilation

- 258 VSN LiDAR calibration plots established in 2019 – 14 excluded because of fire or harvesting



Plot Compilation

NE- Forest Unit	No Plots	Breast Height Age (yrs)*	CDHT (m)	Basal Area (m^2 ha^{-1})	GTV (m^3 ha^{-1})
BW1	**13**	55 (16 - 80)	18.3 (9.9 - 23.1)	24.1(2.6 - 41.6)	198 (12 - 401)
LC1	**33**	81 (18 - 135)	15.0 (7.9 - 22.2)	24.9 (2.5 - 56.3)	169 (23 - 344)
MC2	**7**	71 (18 - 92)	21.0 (8.9 - 25.3)	32.1 (11.3 - 42.9)	295 (52 - 455)
MH1	**11**	61 (29 - 89)	16.8 (6 - 21.1)	30.2 (2.9 - 43.6)	216 (8 - 329)
MH2	**23**	84 (44 - 115)	23.5 (15.7 - 35.5)	41.3 (27.1 - 59.2)	406.3 (213 - 723)
PJ1	**33**	54 (9 - 96)	17.2 (4.4 - 26)	26.3 (0.2 - 43.4)	216 (0.4 - 453)
PJ2	**12**	70 (30 - 111)	19.5 (13.5 - 25.3)	31.8 (14.9 - 42.3)	250 (126 - 352)
PO1	**85**	78 (21 - 125)	26.2 (8.2 - 36)	42.3 (9.3 - 86.3)	488 (289 - 1045)
PW1	**1**	113 (113 - 113)	26.8 (26.8 - 26.8)	26.7 (26.7 - 26.7)	313 (313 - 313)
SB1	**8**	85 (70 - 111)	12.8(7.6 - 17.1)	20.9 (3.1 - 37)	131 (13 - 221)
SF1	**13**	49 (25 - 97)	12.9 (6.9 - 21.5)	19.6 (0.5 - 37.9)	129 (2 - 298)
SP1	**5**	66 (26 - 106)	17.4 (9.1 - 25.8)	23.7 (3.4 - 36.1)	193 (17 - 336)
All	**244**	**72 (9 - 135)**	**20.6 (4.4 - 36)**	**33.0 (0.2 - 86.3)**	**318 (0.4 - 1045)**

Plot Compilation – pixel/plot attributes

Unless otherwise noted, the following summaries are for live trees with Dbh ≥ 7.1 cm

Tree level

- Height – top height, dom/codom height, Lorey's height
- Quadratic mean Dbh

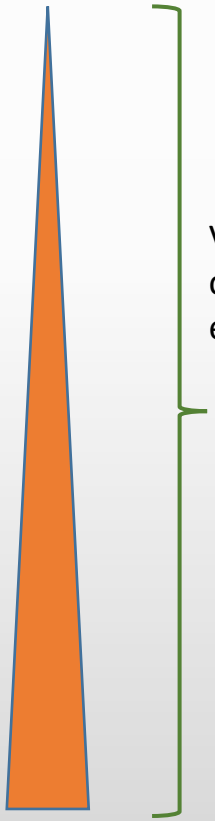
Area level

- Basal area
- Volume - GTV, GMV_NL, GMV_WL
- Biomass

Plot compilation - volumes

GTV

Ht = 20m



Volume calculated for entire stem

Spruce

GMV_NL

Ht = 23m

10cm upper diameter

Volume calculated for stem below specified upper diameter limit minus portion below stump height

No piece size length requirement (2.5m)

30cm stump height

Spruce

No deduction for cull & Branching

Ht = 10m

Piece length 1.5m

10cm upper diam

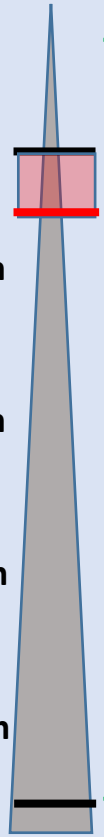
GMV calculated for short 1.5m piece

30cm stump height

Spruce

GMV_WL

Ht = 23m



10cm upper diameter

PORTION OF MERCH STEM NOT INCLUDED

Merch piece size lengths

2.5m

2.5m

2.5m

2.5m

Volume calculated for stem below specified upper diameter limit minus portion below stump height **ONLY for 2.5m (or multiple of) portions**

30cm stump height

Spruce

Plot Compilation – BA/volume by size class

Standard Deliverable	RMF Deliverable
• Only one GMV being modeled (GMV_nl) • 4 Size classes **SmPoles [9 < Dbh ≤ 16 cm]** **LargePoles [16 < Dbh ≤ 25]** **Small Sawlogs [25 < Dbh ≤ 37]** **Large Sawlogs [37cm+]** • 9m threshold for GMV and size class predictions	• Only one GMV being modeled (GMV_nl) • 4 Size classes **SmPoles [9 < Dbh ≤ 14.9 cm]** **LargePoles [14.9 < Dbh ≤ 25]** **Small Sawlogs [25 < Dbh ≤ 37]** **Large Sawlogs [37cm+]** • 9m threshold for GMV and size class predictions

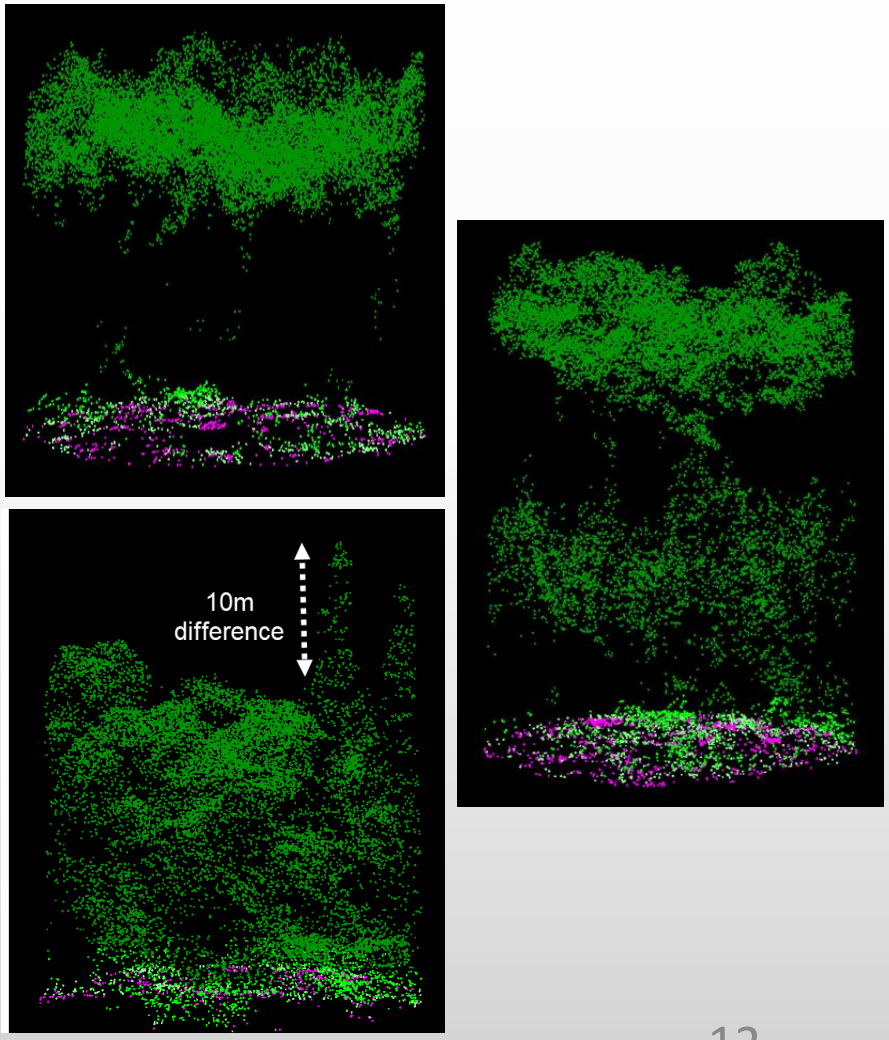
Plot Compilation – SFL volumes

GREENFIRST FOREST PRODUCTS

Volume	Stump height	Minimum top diameter (inside bark) (cm)	Minimum length	Maximum length	Species
GMV_NL	30 cm	9.1 for SPF, 13.1 for hardwoods	None	None	All
GMV_WL	30 cm	9.1 for SPF, 13.1 for hardwoods	8’ 4” (2.54 m)	8’ 4” (2.54 m)	All
GMV_GF_Cochrane	30 cm	9.1	10‘ 4” (3.15 m)	52’ (15.85 m)	Applied to SPF
GMV_Eacom_Timmins 8’	30 cm	9.1	8’ 4” (2.54 m)	8’ 4” (2.54 m)	Applied to SPF
GMV_Eacom_Timmins 16’	30 cm	11.1	16’ 5” (5.00 m)	16’ 5” (5.00 m)	Applied to SPF
GMV_Georgia_Pacific	30 cm	12.1	8’ 4” (2.54 m)	14‘ 6” (4.42 m)	Applied to Po/Bw
GMV_Rockshield	30 cm	21.1	8’ 10” (2.70 m)	8’ 10” (2.70 m)	Applied to Po/Bw

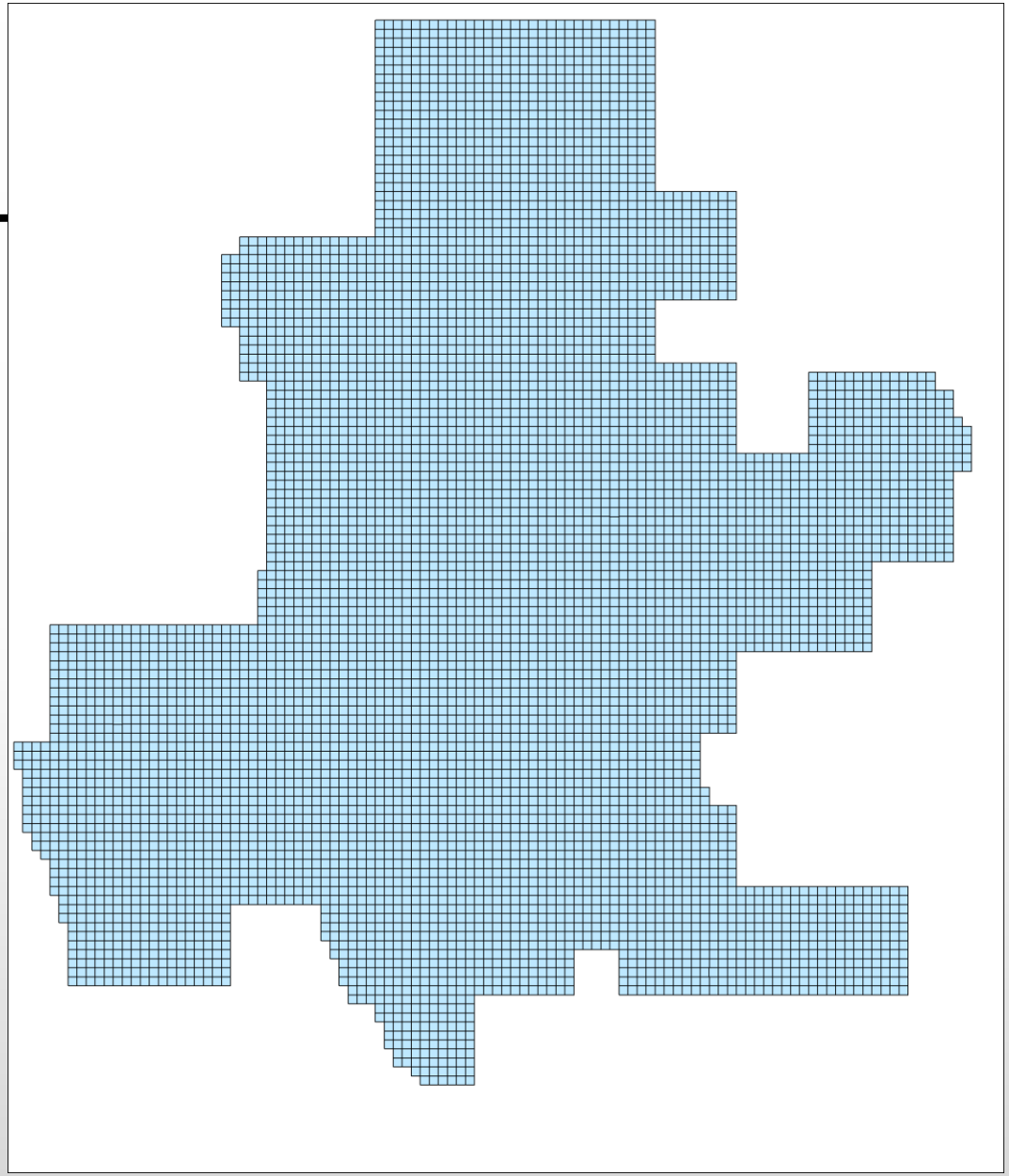
LiDAR Derived ABA Inventory – Phase 1

- Area-Based-Approach (ABA)-20m raster inventory product
- All raster cell vertical structures are treated the same way
- Calibration plot summary considers ALL live trees and sums their contribution to total per ha values
- This has been the default prediction method for Ontario (and other jurisdictions)
- Ongoing research to predict structure classes & inventory attributes by layer (FFT – KTTD project) – Phase 2

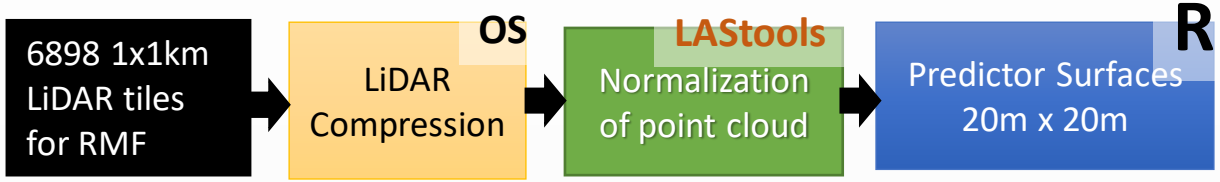


LiDAR Processing Flow

6898 1x1km LiDAR tiles for RMF → LiDAR Compression (OS) → Normalization of point cloud (LAStools)



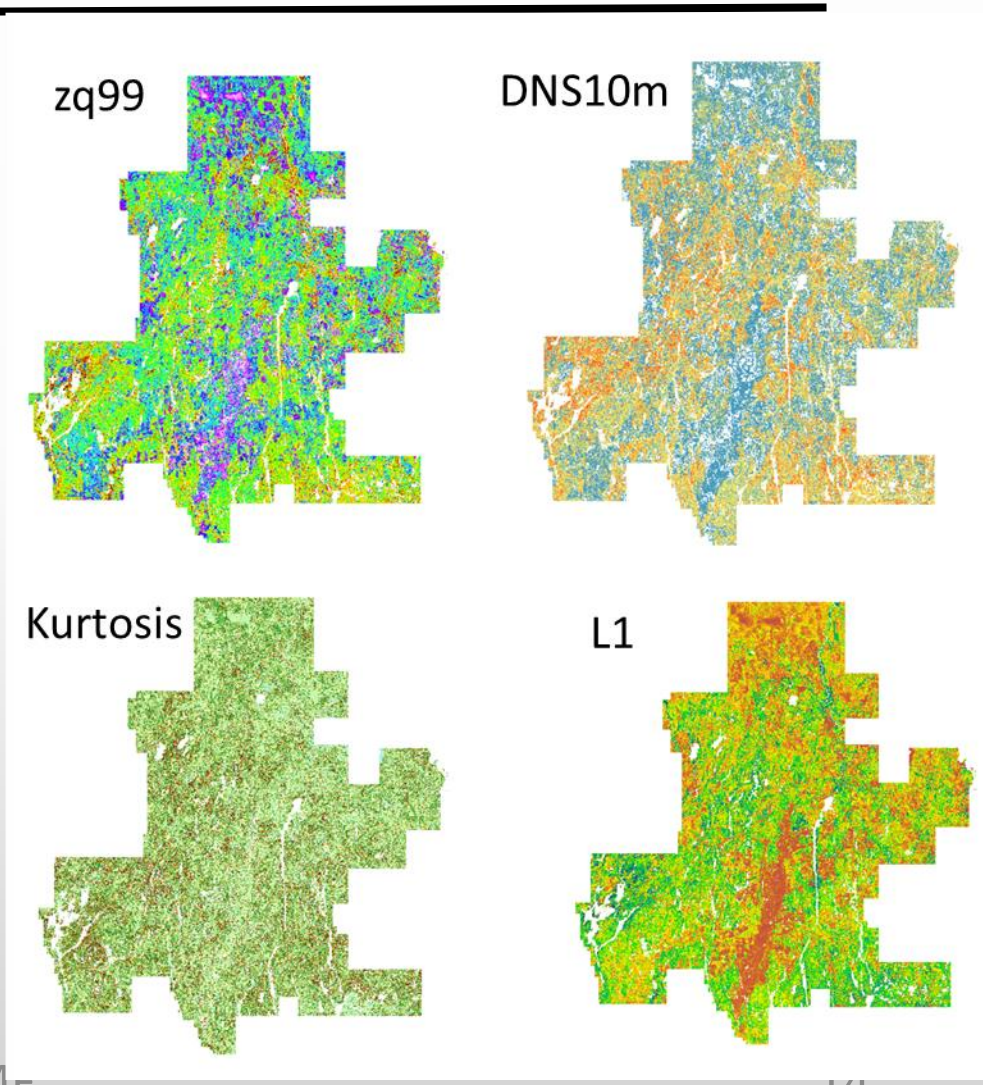
LiDAR Processing Flow



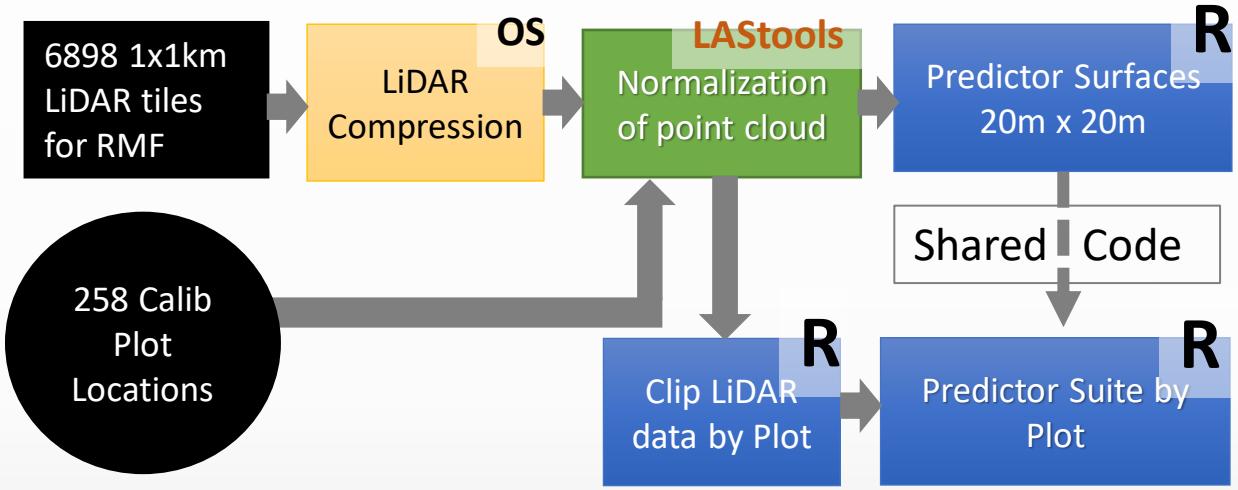
- LiDAR percentiles zq5, zq10, zq20,….zq90, zq95, zq99
- Canopy Cover measures (COV/DNS -> 2m, 4m,… 30m)
- % Vegetation returns (0-2m, 2-4m, 4-6m….28-30m)
- % of returns by decile
- Stdev, Skewness, kurtosis (Trimmed)
- L Moments (L1 - L4)
- Z Mean, Z Entropy, LPI, Veg Complexity Index
- Veg Coefficient of Variation
- Rumple Index
- …

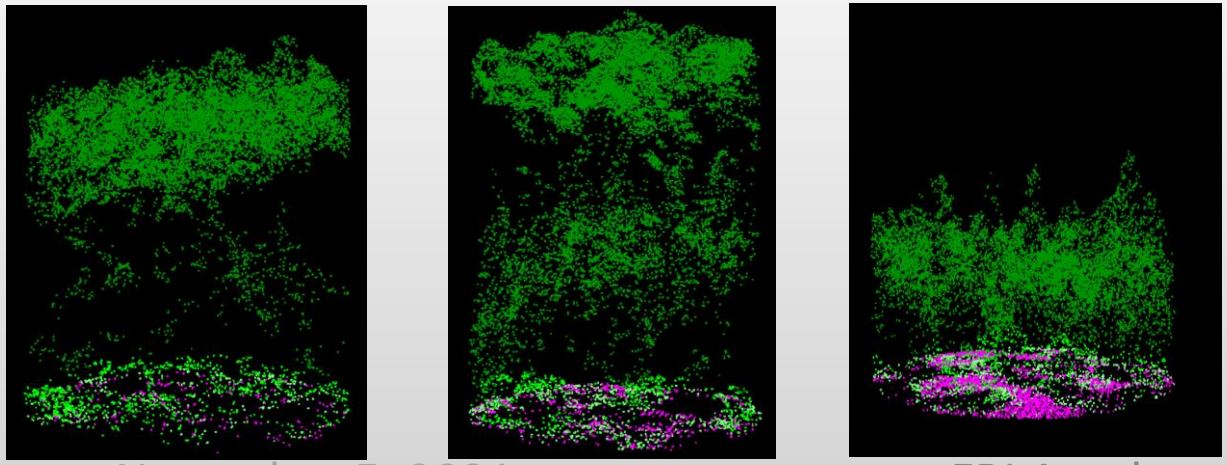
➢ **77 Predictors used for modeling of 111 generated**

Examples of Derived Predictors



LiDAR Processing Flow

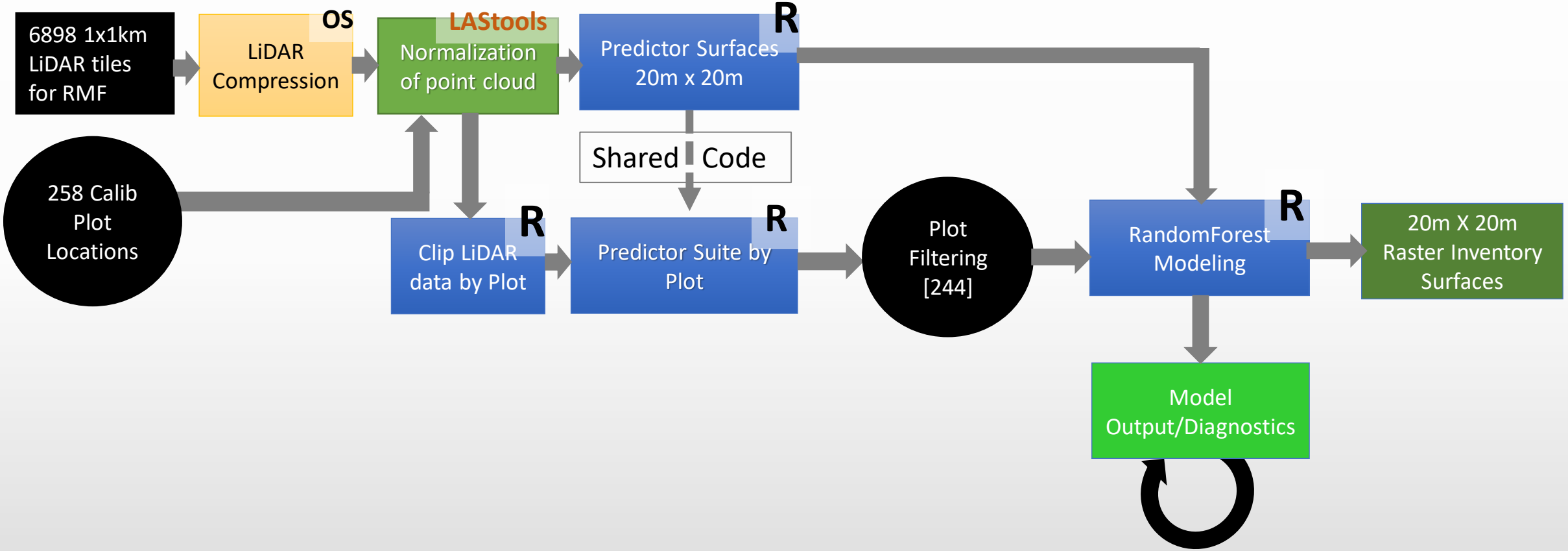




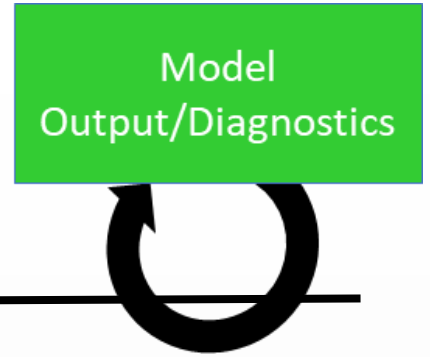
Plot Level LiDAR Predictors

PlotID	zmax	zmean	zsd	zskew	zkurt	zentropy	^zmean	zq5	zq10	zq15	zq20	zq25	zq30	zq35	zq40	zq45	zq50	zq55	zq60	zq6
RMF1	3.42	1.09	0.74	0.28	2.08	0.72	49.43	0.09	0.13	0.18	0.25	0.39	0.54	0.68	0.80	0.93	1.07	1.20	1.31	1.4
RMF10	11.68	6.91	1.05	-2.87	21.36	0.50	52.92	5.75	6.03	6.20	6.35	6.48	6.59	6.70	6.79	6.88	6.97	7.05	7.13	7.2
RMF100	31.45	14.59	10.00	0.15	1.49	0.93	48.79	2.02	2.82	3.43	3.86	4.41	5.00	5.61	9.88	12.19	14.12	15.71	17.47	20
RMF105	27.91	14.02	10.17	-0.04	1.37	0.87	47.18	0.29	0.74	1.16	1.88	2.65	5.63	8.21	9.65	11.02	12.82	14.99	21.67	2
RMF108	31.75	15.23	12.91	0.10	1.11	0.74	46.72	1.26	1.60	1.85	2.09	2.33	2.64	2.95	3.48	5.46	9.72	23.66	27.47	2
RMF109	31.39	12.74	11.94	0.45	1.40	0.83	40.46	0.65	1.02	1.40	1.83	2.24	2.63	3.07	3.48	4.25	5.95	9.25	13.13	1
RMF112	23.72	16.35	7.48	-1.46	3.44	0.71	77.85	0.19	0.48	1.31	15.31	17.15	17.89	18.42	18.82	19.18	19.58	19.91	20.19	20.
RMF114	25.20	17.24	6.22	-1.75	5.09	0.80	70.49	0.62	5.93	13.80	15.76	16.62	17.29	17.85	18.33	18.73	19.15	19.49	19.90	20.2
RMF115	23.78	17.89	5.60	-2.34	7.10	0.67	79.81	1.61	9.96	16.87	17.86	18.45	18.81	19.09	19.32	19.55	19.73	19.91	20.08	20.2
RMF118	25.91	16.27	7.71	-1.04	2.85	0.87	65.28	0.23	0.55	6.19	10.44	12.65	14.24	16.35	17.34	18.25	18.93	19.75	20.34	20
RMF119	29.02	18.75	8.77	-0.98	2.63	0.85	63.21	0.16	0.82	8.35	10.73	12.64	14.50	17.34	20.85	22.52	23.35	23.89	24.30	2
RMF120	26.18	17.45	6.91	-1.41	3.81	0.83	71.89	0.70	2.81	10.17	12.43	15.89	18.02	18.77	19.28	19.70	20.11	20.47	20.77	2
RMF122	27.18	18.24	7.06	-1.21	3.45	0.89	66.81	1.73	6.69	10.16	12.77	15.05	16.75	18.75	19.64	20.25	20.83	21.31	21.76	2
RMF128	28.09	18.04	8.06	-0.96	2.60	0.90	63.86	1.09	3.10	6.93	10.89	12.87	14.49	17.58	19.77	21.00	21.64	22.19	22.67	23
RMF13	15.91	4.73	2.91	0.57	3.34	0.84	46.67	0.28	0.57	1.44	2.35	2.89	3.30	3.61	3.89	4.16	4.49	4.85	5.22	5.5
RMF131	29.64	14.96	10.83	-0.21	1.27	0.87	53.97	0.32	0.93	1.63	2.08	2.46	3.05	4.98	9.87	14.08	18.82	22.01	23.21	24.0
RMF132	31.68	15.72	12.34	-0.16	1.16	0.79	53.37	0.62	1.00	1.26	1.49	1.69	1.97	2.48	6.39	12.80	22.81	24.83	25.86	26.
RMF133	32.16	16.90	11.96	-0.16	1.31	0.85	49.31	0.17	0.42	1.27	2.67	4.63	7.02	9.02	10.66	12.67	16.10	25.82	27.05	27
RMF135	29.55	17.33	11.27	-0.42	1.28	0.78	59.08	1.47	2.09	2.55	3.09	3.75	5.04	6.93	13.08	24.24	25.10	25.65	26.07	2
RMF136	33.15	16.17	13.24	0.06	1.11	0.78	47.61	0.69	1.23	1.91	2.60	3.07	3.57	4.07	5.03	7.30	10.18	26.13	28.55	2
RMF137	35.76	16.87	13.80	0.08	1.20	0.84	45.83	0.37	0.87	1.37	1.86	2.54	3.40	4.82	7.61	9.99	12.56	19.24	29.28	3
RMF138	32.70	15.30	13.24	0.13	1.23	0.79	45.09	0.17	0.30	0.56	1.08	1.66	2.21	2.89	5.94	9.31	12.35	15.41	26.28	29.
RMF141	28.71	20.00	9.17	-1.42	3.37	0.74	75.76	0.19	0.47	1.78	12.53	20.39	21.93	22.71	23.30	23.77	24.23	24.57	24.87	25.1
RMF146	29.40	20.90	9.03	-1.32	3.24	0.80	72.39	0.54	2.04	9.27	12.70	16.47	22.09	23.23	23.96	24.77	25.39	25.79	26.10	26.3
RMF147	26.88	18.54	8.54	-1.38	3.35	0.76	72.21	0.15	0.29	2.84	13.14	16.95	19.51	20.71	21.53	22.11	22.54	22.89	23.18	23
RMF149	29.03	18.85	10.58	-0.91	2.13	0.74	65.06	0.12	0.22	0.40	3.00	11.61	14.07	19.08	23.71	24.44	24.96	25.38	25.77	2
RMF152	30.42	18.97	10.80	-0.69	1.75	0.83	61.42	0.58	1.57	2.33	3.98	8.03	11.68	15.42	22.68	25.07	25.75	26.21	26.58	2
RM	31	20.71	9.57	-0.90	83	61.59	0.31	3.77	13.34	14.93	16.85	22.7	27	26.77	27.20	2				

LiDAR Processing Flow - Modeling



LiDAR Processing Flow - Modeling



Predicted Directly

Inventory Metric
TopHt
CDHT
LoreyHeight
BA
QMD
Biomass

Logical Calculation of Attributes

- **GTV >= GMV_NL >= GMV_WL**

- **BA_smallpoles + BA_largepoles + … + BA_largesawlogs = Predicted BA**
- **GMV_smallpoles + GMV_largepoles + … + GMV_largesawlogs = Predicted GMV**

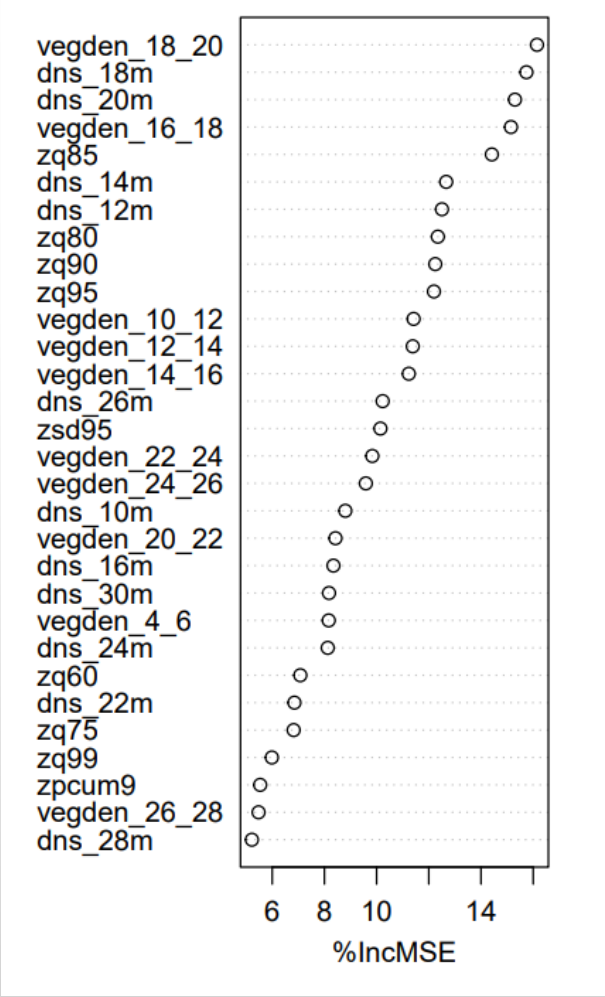
- **Stems = (BA/ QMD^2) / 0.00007854**

Additional T2 Attributes Not Directly Predicted from LiDAR

- **Site Index is calculated from Topht & T1 Age & T1 Leading Species)**
- **Stocking is calculated from Site Index, BA ,T1 Age & T1 Leading Species)**

LiDAR Modelling – RMF Dom/CoDom Ht

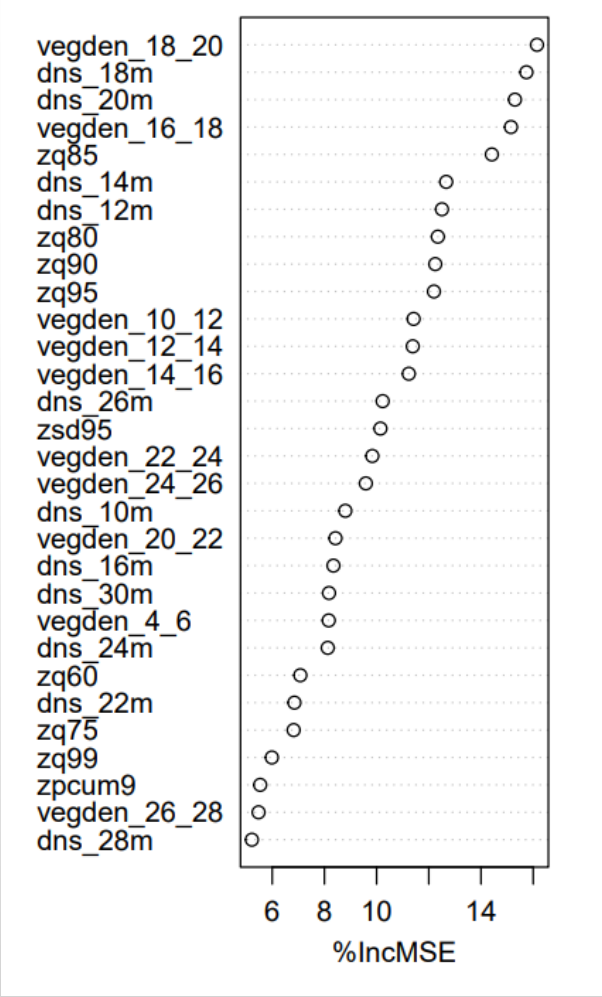
Variable Importance CDHT

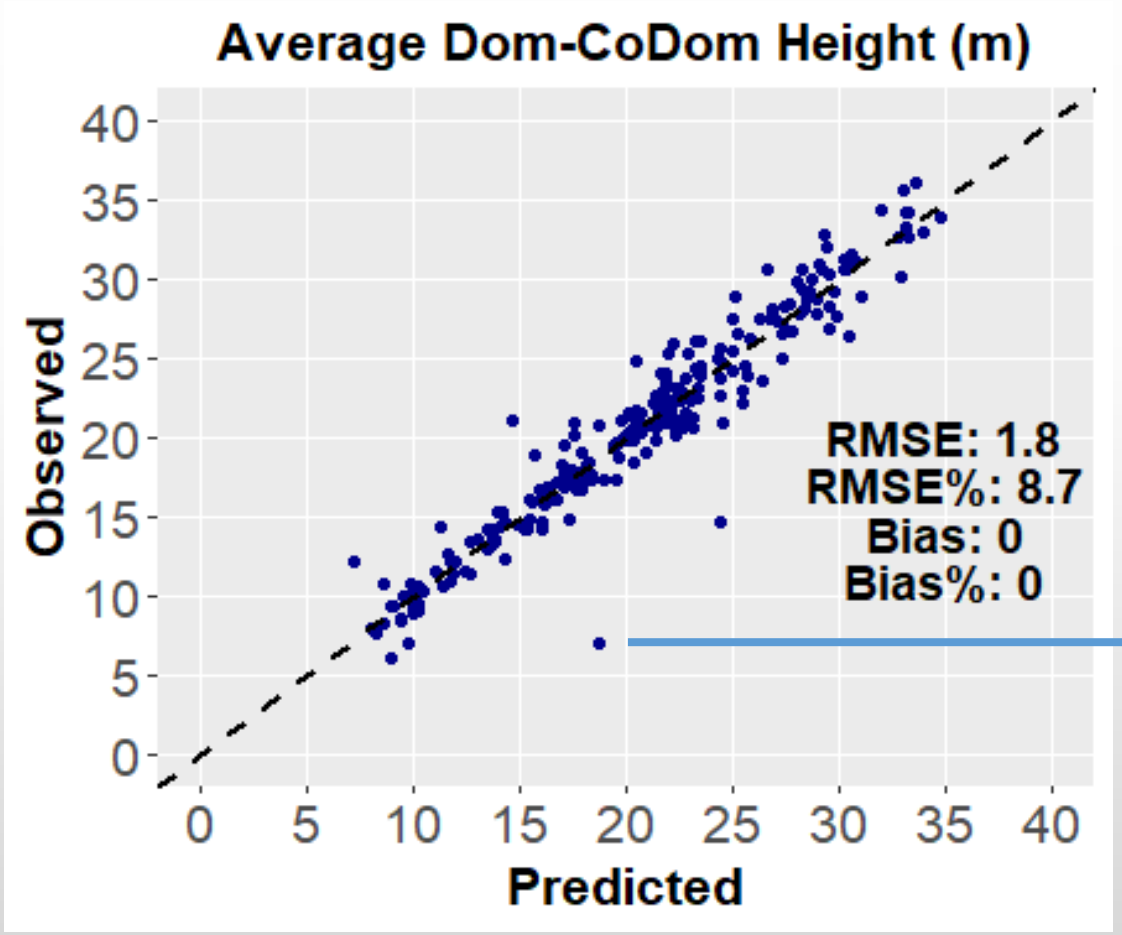


RMF276

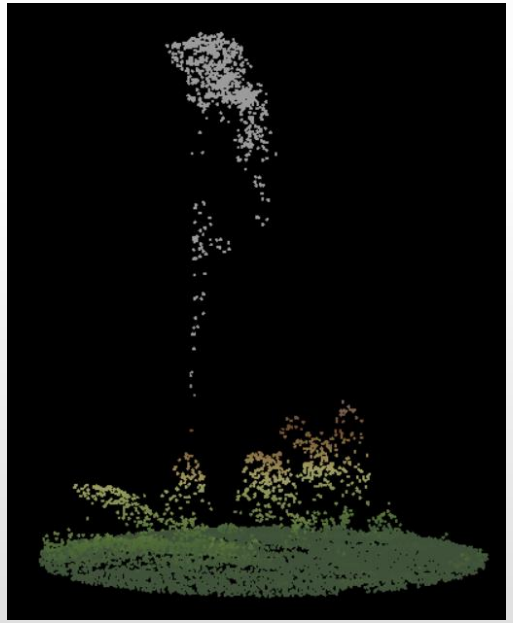
LiDAR Modelling – RMF Dom/CoDom Ht

Variable Importance CDHT



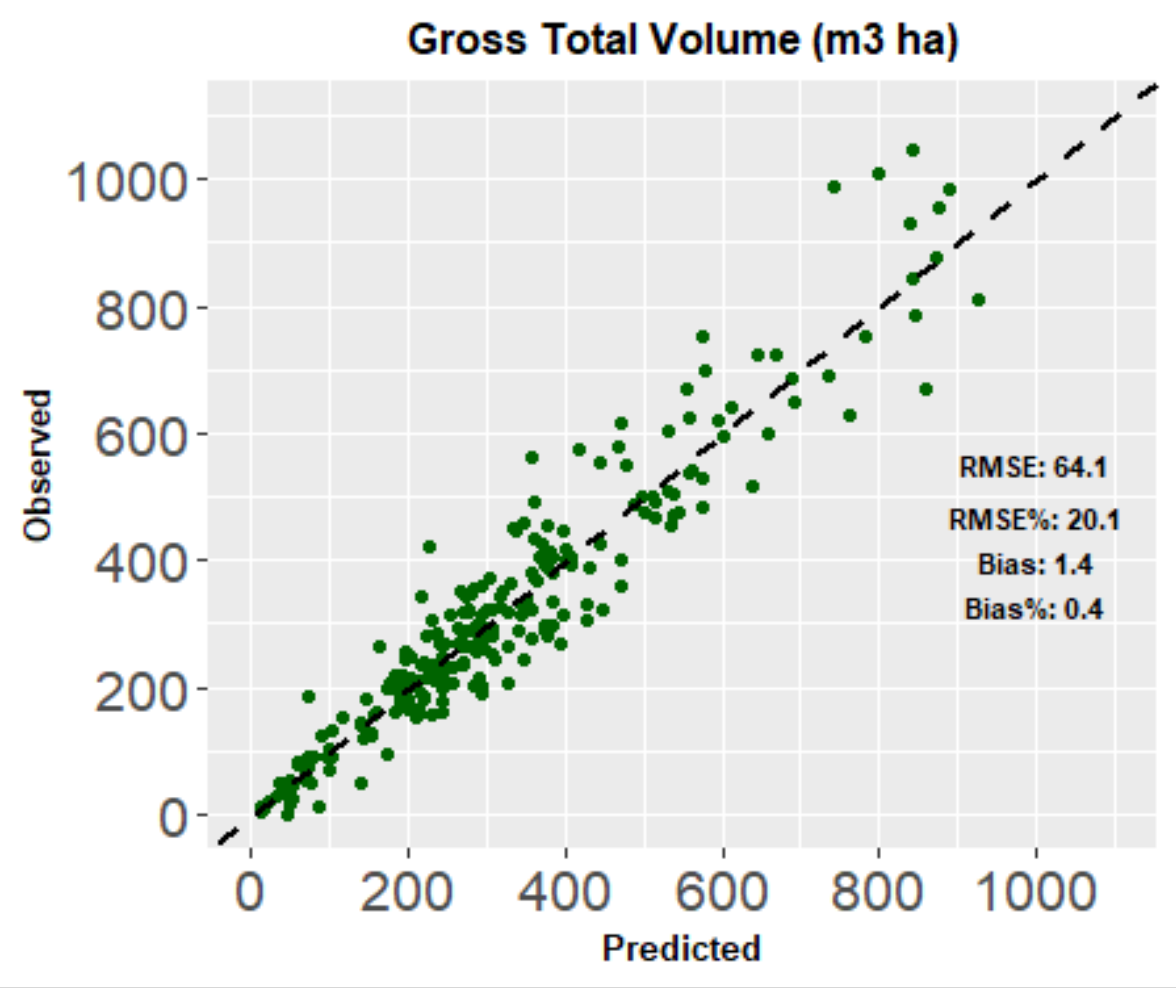


RMF375

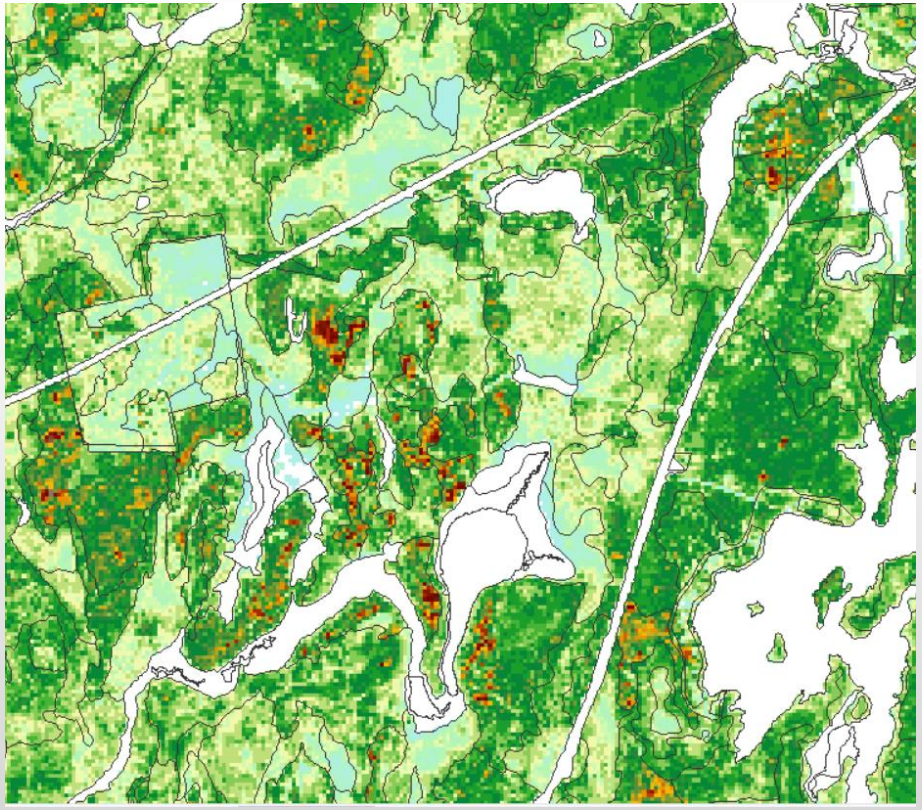


Pt is outside field measured plot

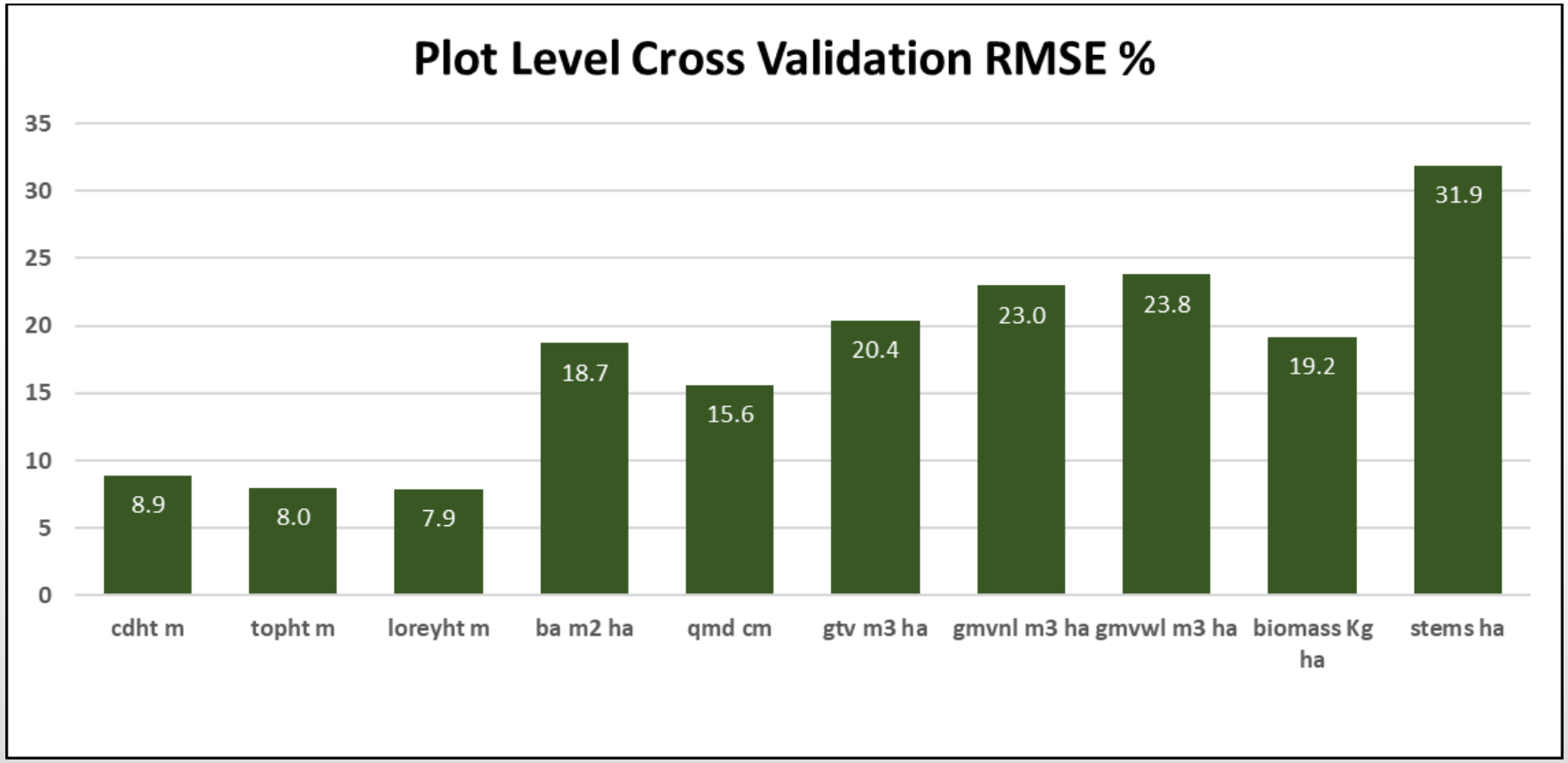
LiDAR Modelling – RMF Gross Total Volume



- Calculated from:
  - predicted Basal Area &
  - predicted VBAR [GTV/BA ratio]

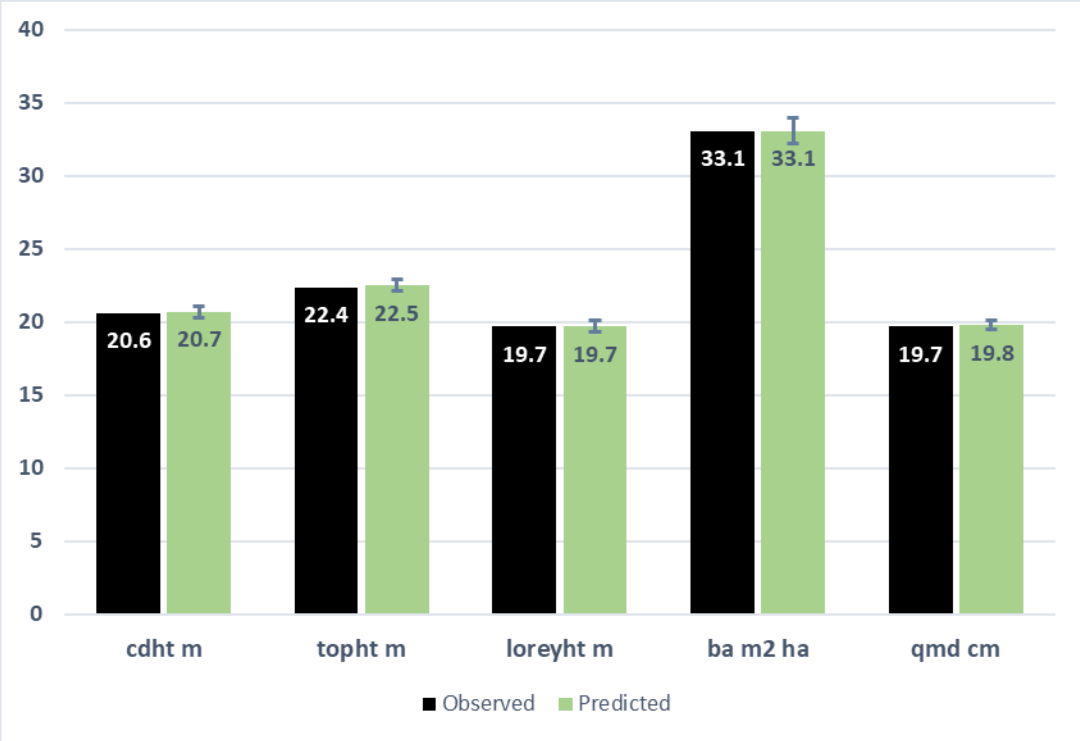


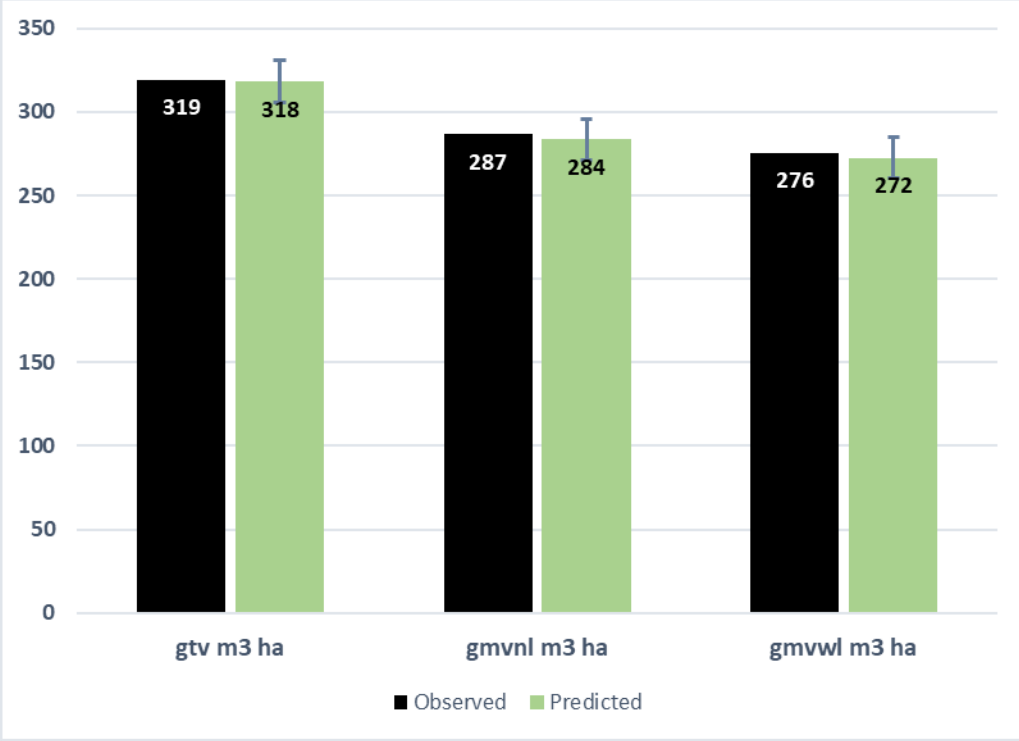
LiDAR Modelling – Plot Level Cross Validation

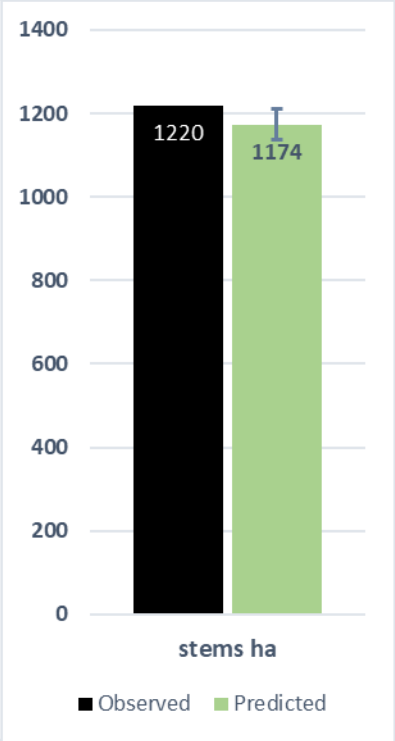


RMF 32% Harvested – one Bf left and Bf understory

LiDAR Modelling – Plot Level Cross Validation

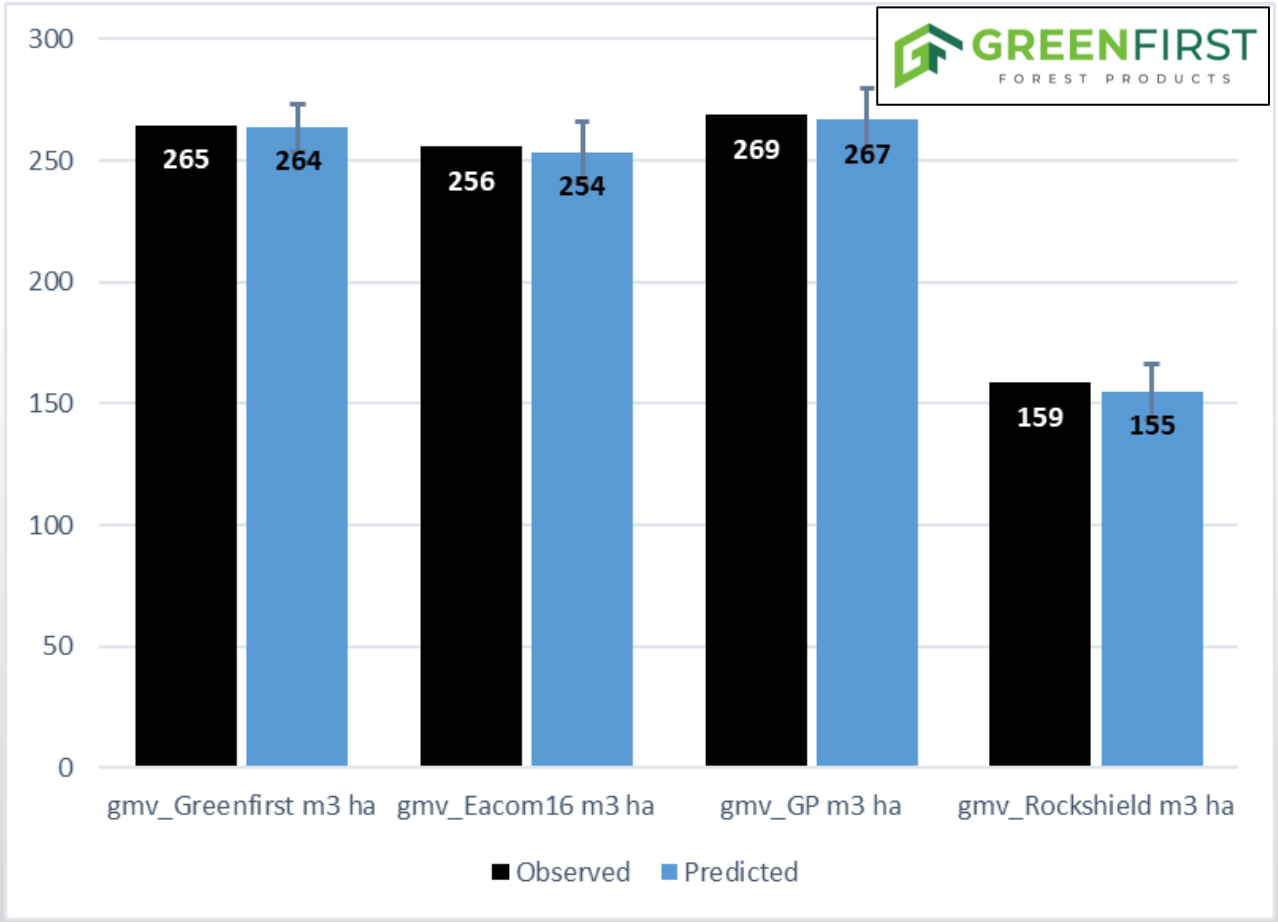






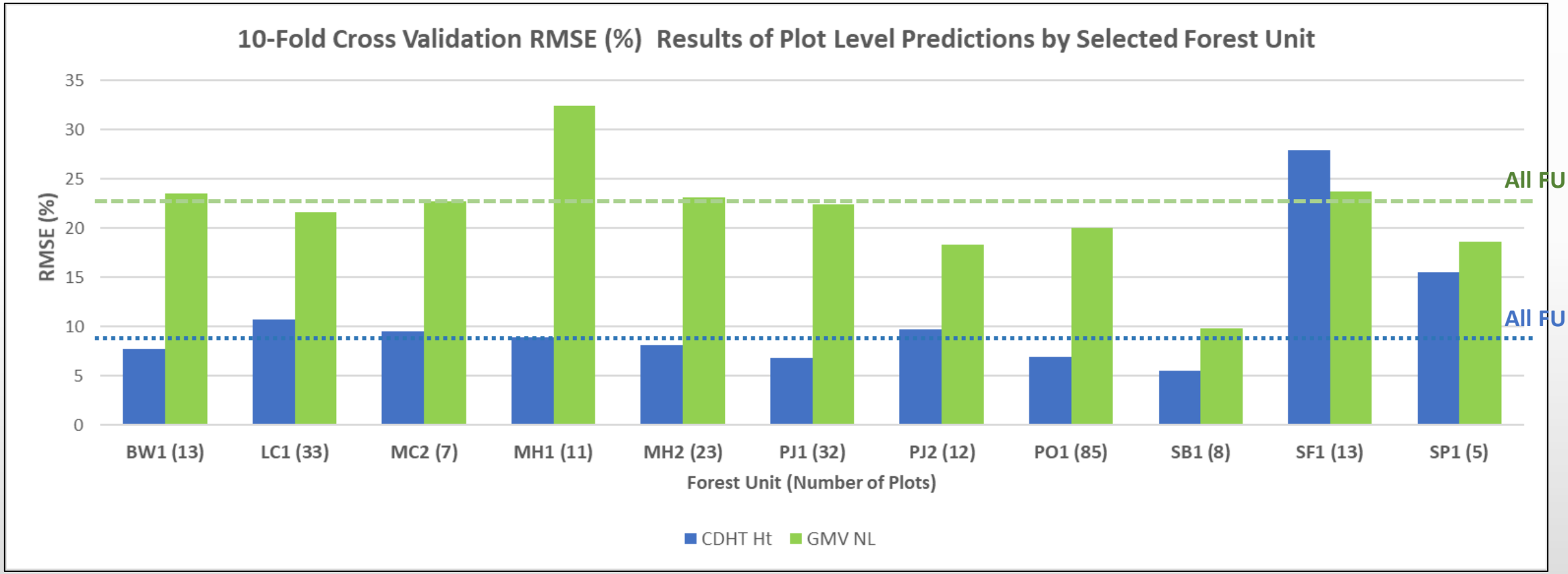
LiDAR Modelling – Plot Level Cross Validation

GreenFirst Forest Products RMF Requested Volume Outputs

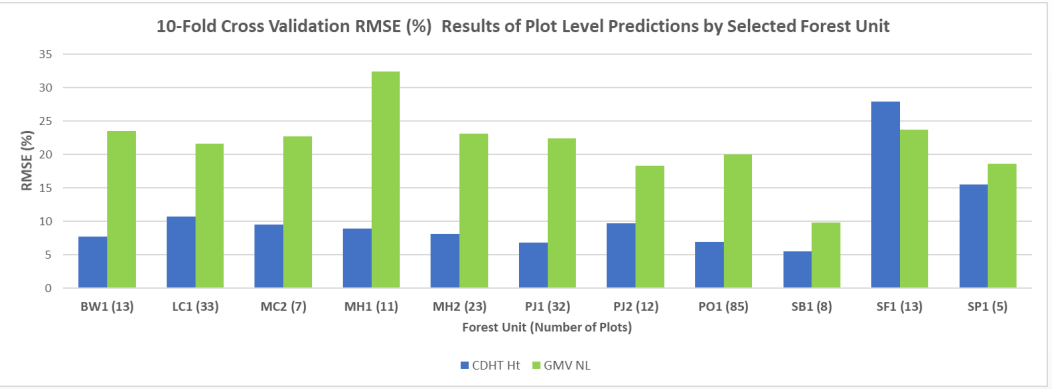


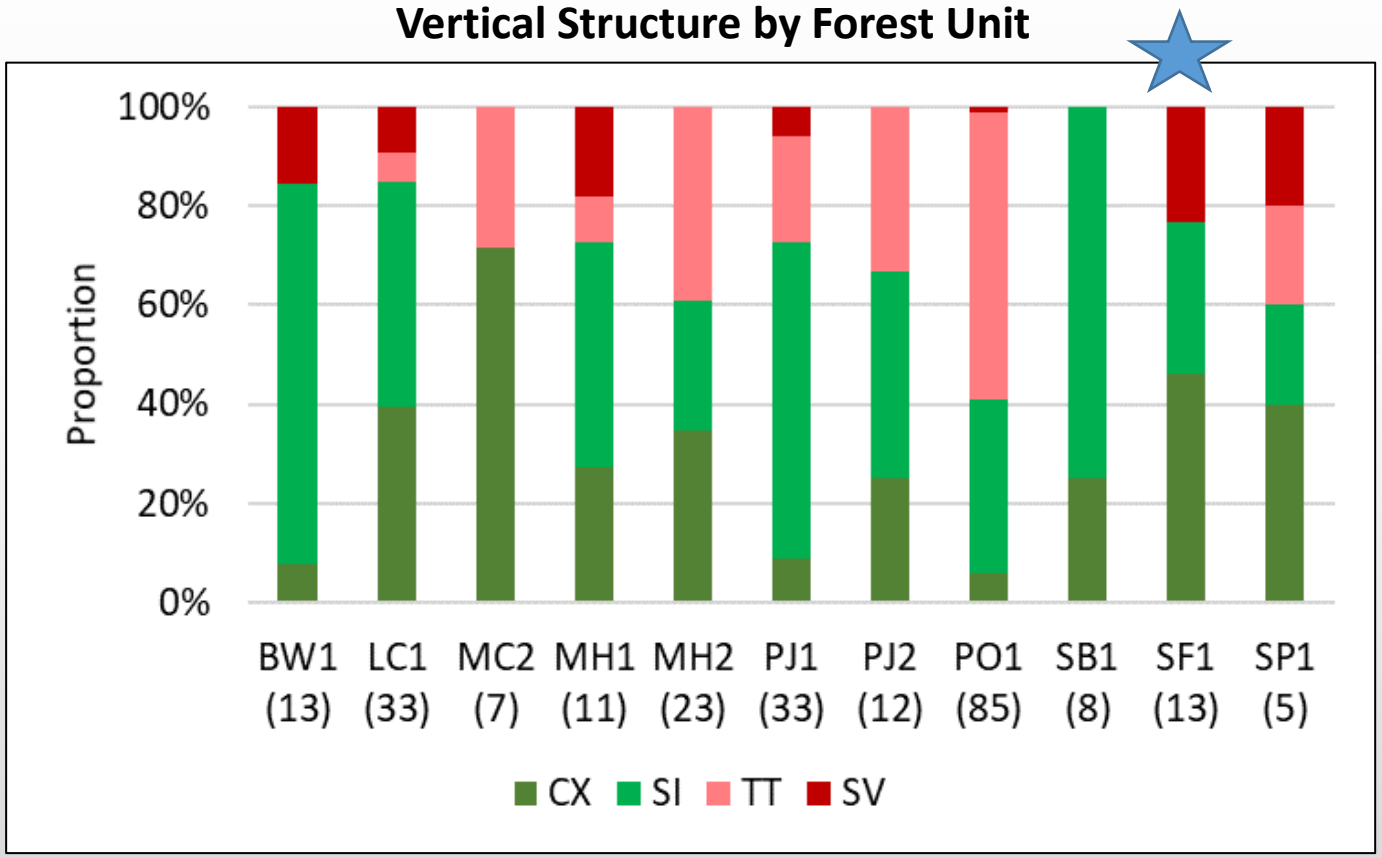
- Mill specific GMV Specifications

LiDAR Modelling – Plot Level Cross Validation by FU



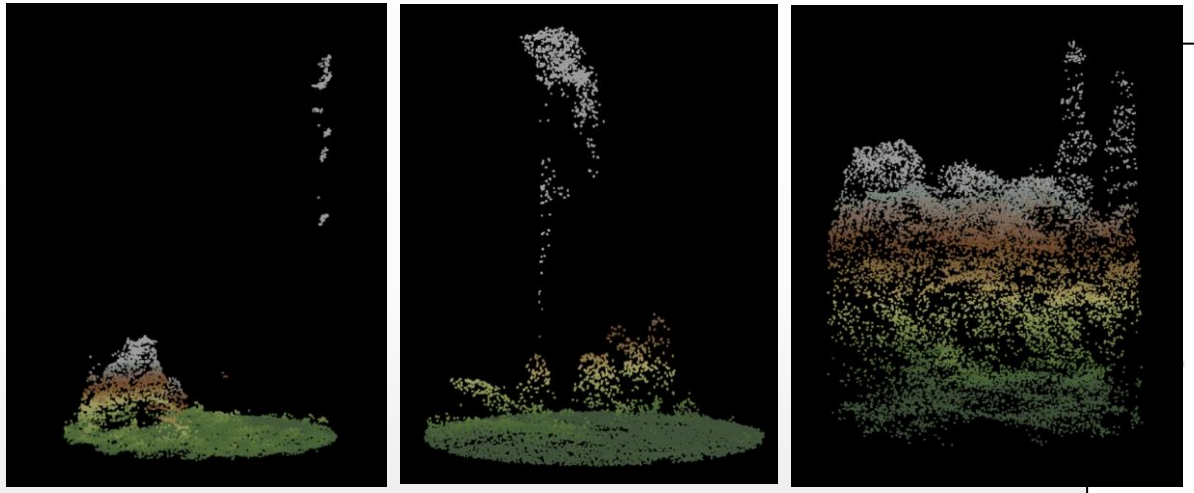
LiDAR Modelling – Plot Level Cross Validation





LiDAR Modelling – Plot Level Cross Validation

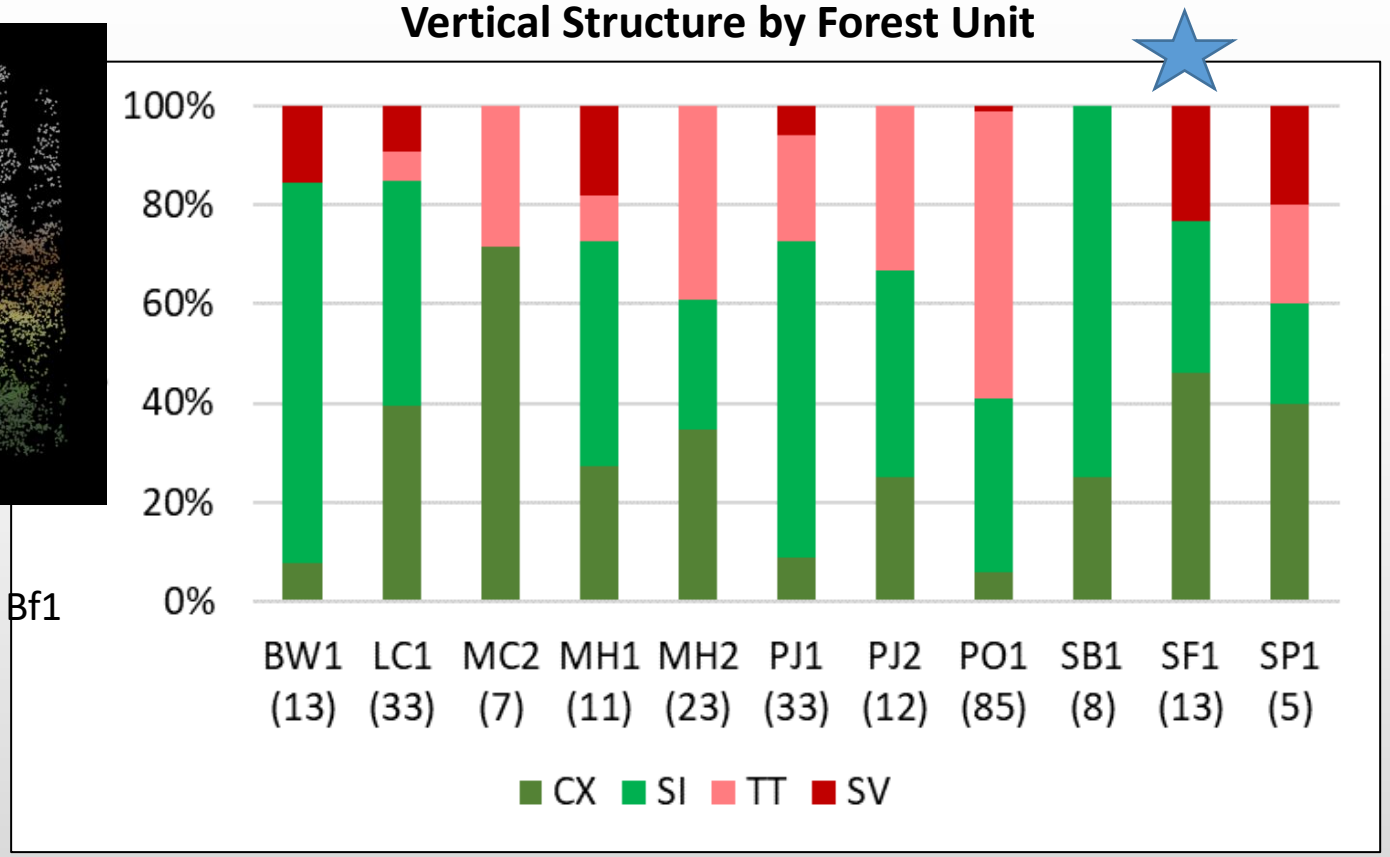
SV Examples from SF1 FU



RMF374
Bf100
6.9m

RMF375
Bf100
7m

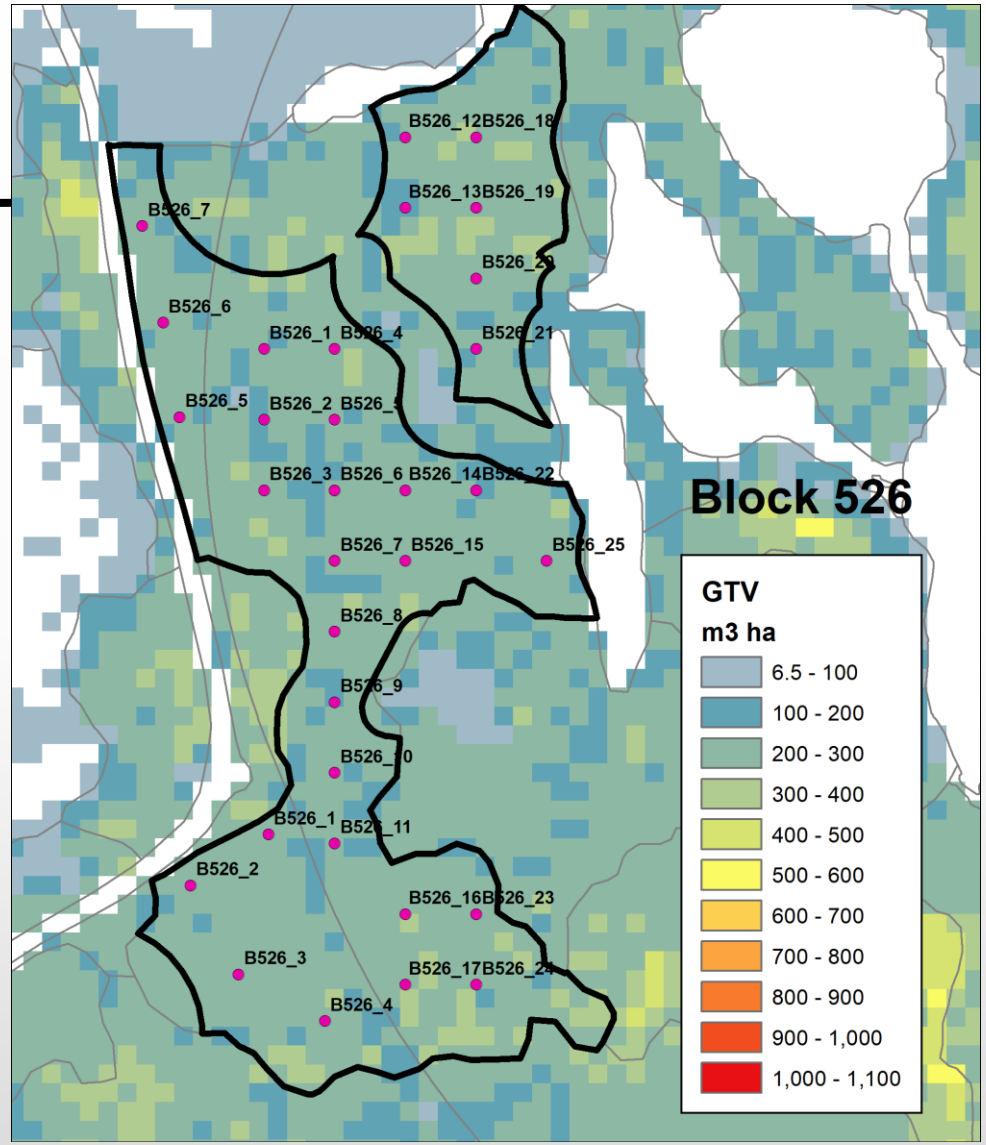
RMF432
Ce4 Bw3 Sb2 Bf1
17.2m



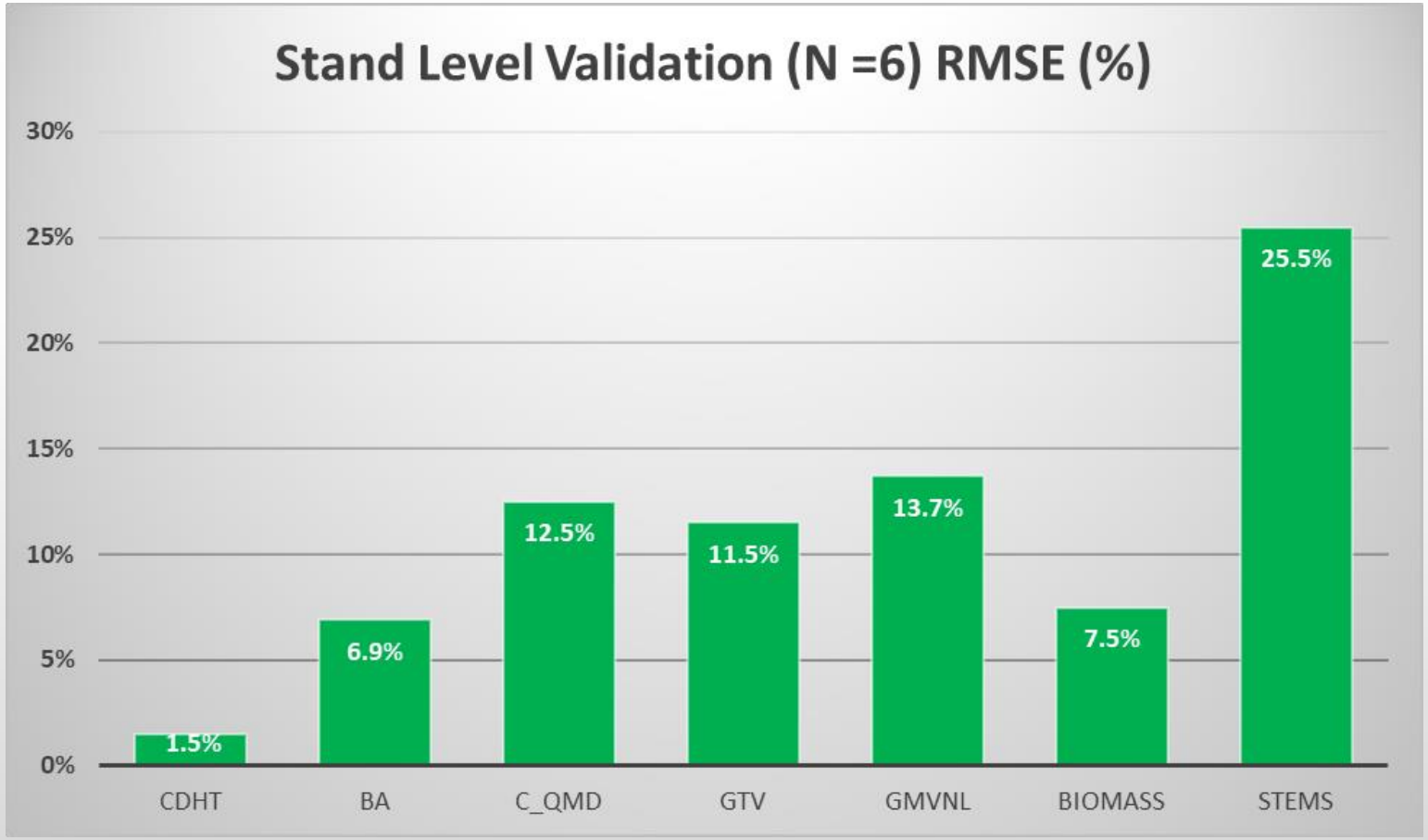
Stand Level Validation

- 6 RMF Harvest Blocks sampled
- Range of Forest Units
- BAF 2 Prism Cruise
- Mixed Species Compositions

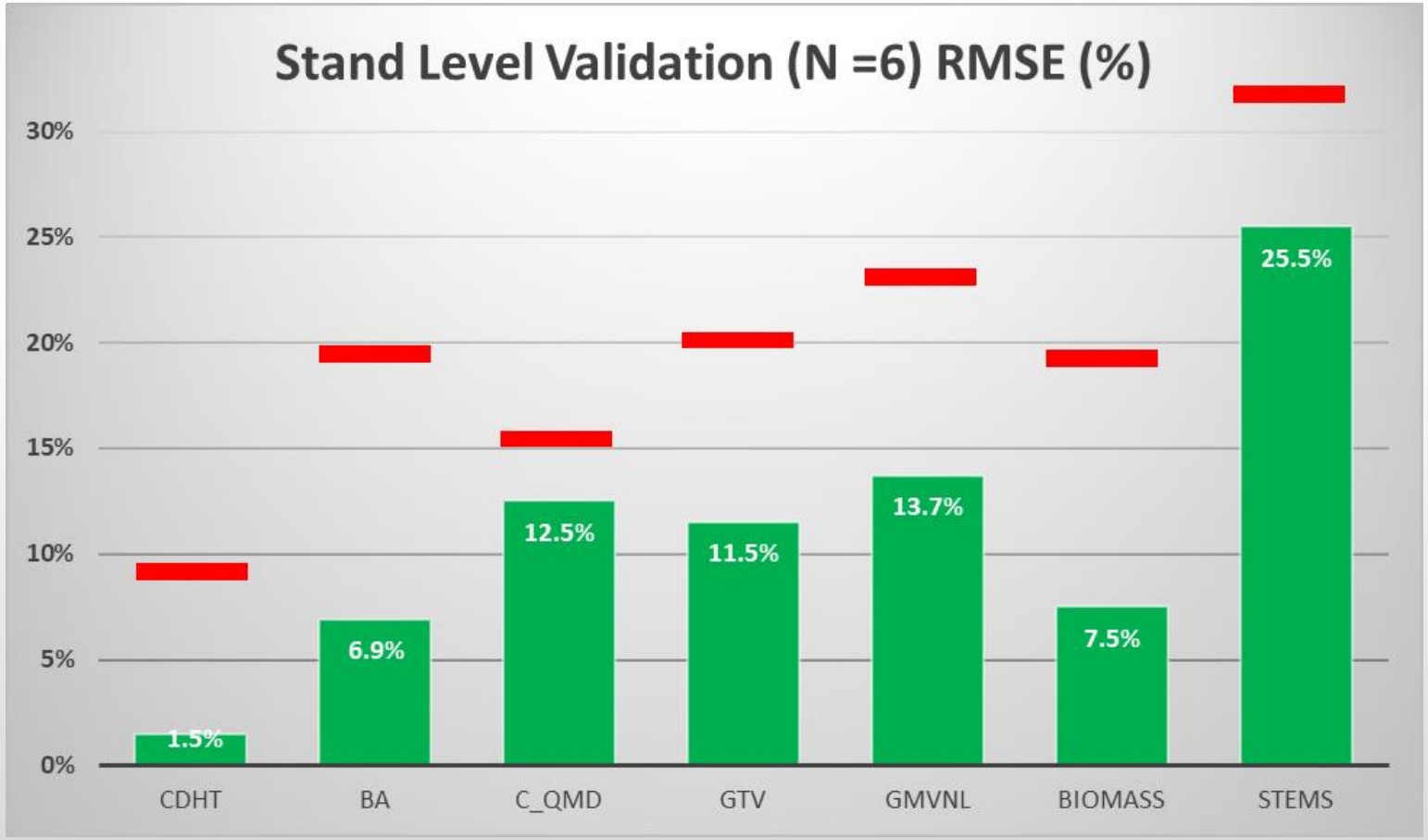
Block	Cruised Spec Comp	Stations
436	Sb 47 Bf33 Pt8 Pb4 Bf8	19
446	Sb 67 Bf17 Bw10 La6	11
499	Pj 52 Pt29 Bf7 Bw5 Sb7	20
500	Sb 40 Bf26 Bw17 Ce7	17
526	Pj 51 Sb19 Pt10 Sw8	26
527	Bw 37 Sw30 Bf14 Pt6	20



Stand Level Validation – RMSE % for all 6 Stands



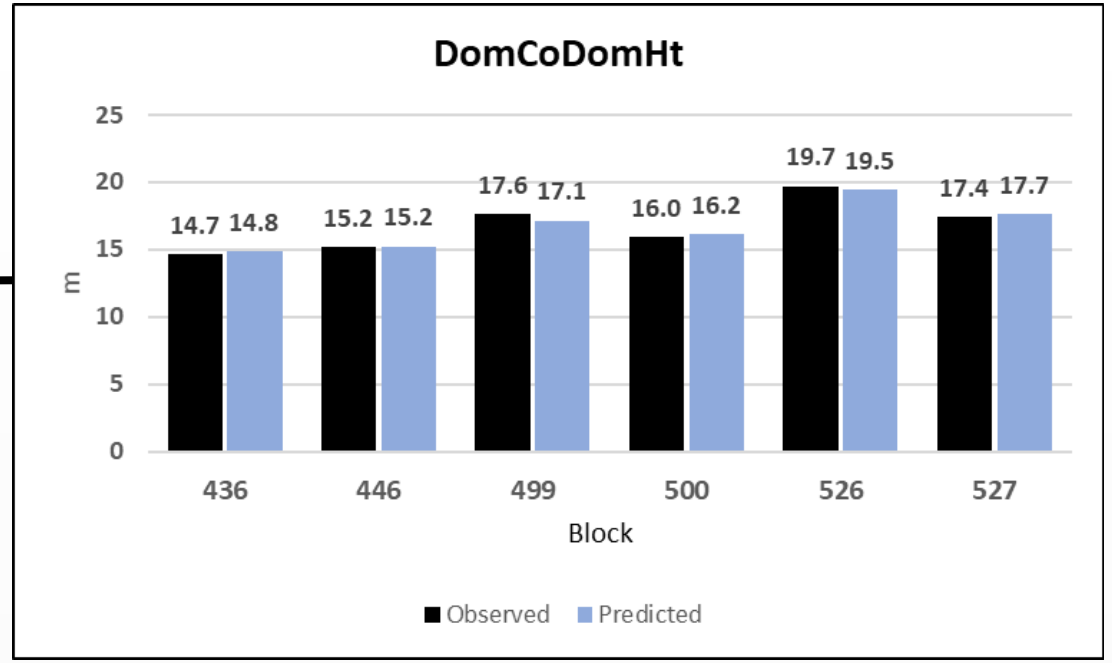
Stand Level Validation – RMSE % for all 6 Stands

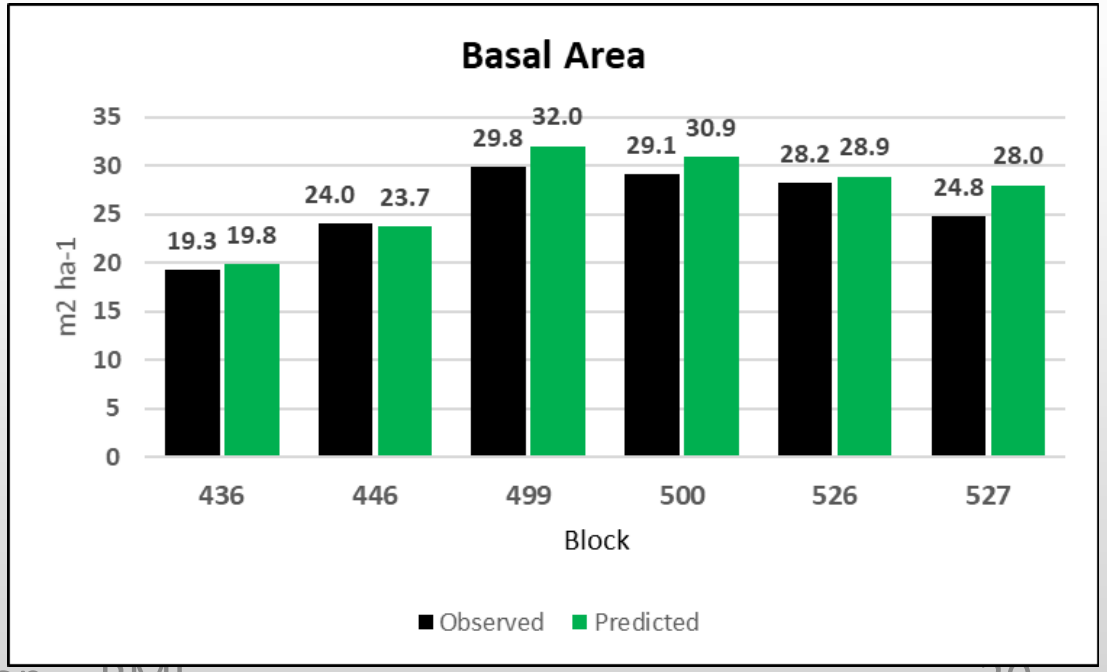


Plot/Pixel RMSE % based on Cross Validation

Stand Level Validation

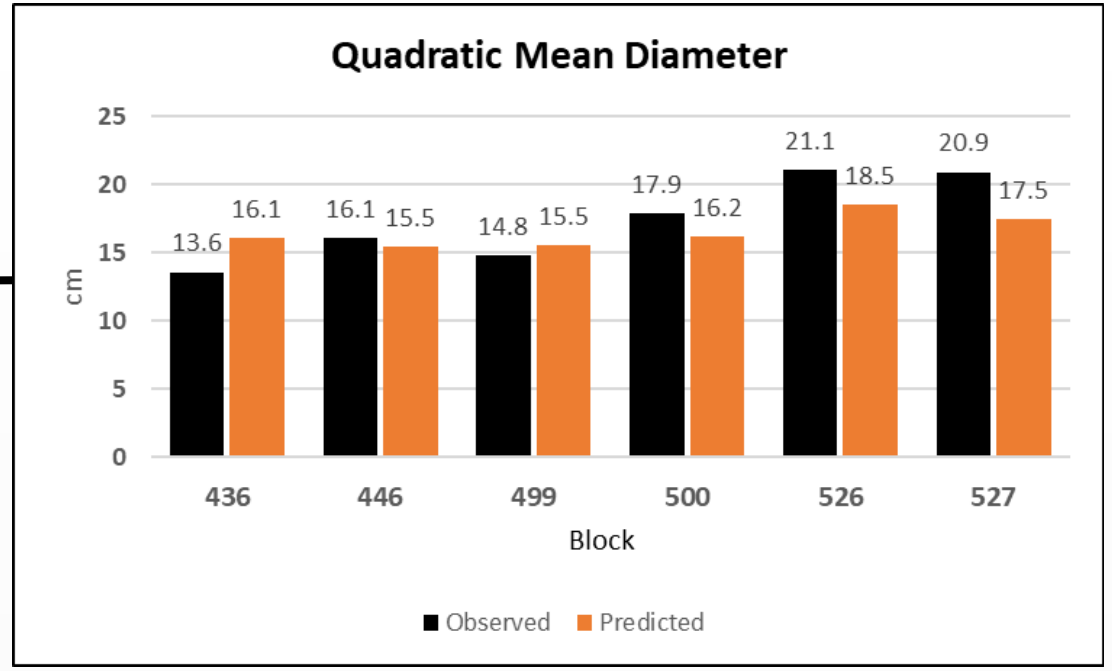
	Species Composition
436	Sb 47 Bf33 Pt8 Pb4 Bf8
446	Sb 67 Bf17 Bw10 La6
499	Pj 52 Pt29 Bf7 Bw5 Sb7
500	Sb 40 Bf26 Bw17 Ce7
526	Pj 51 Sb19 Pt10 Sw8
527	Bw 37 Sw30 Bf14 Pt6

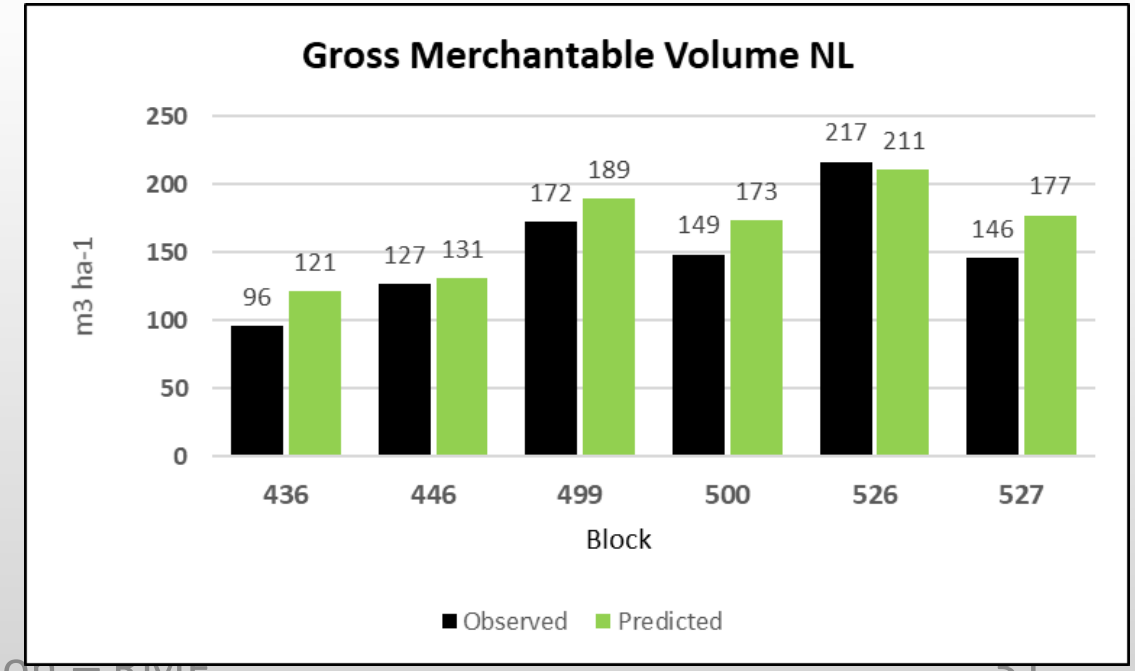




Stand Level Validation

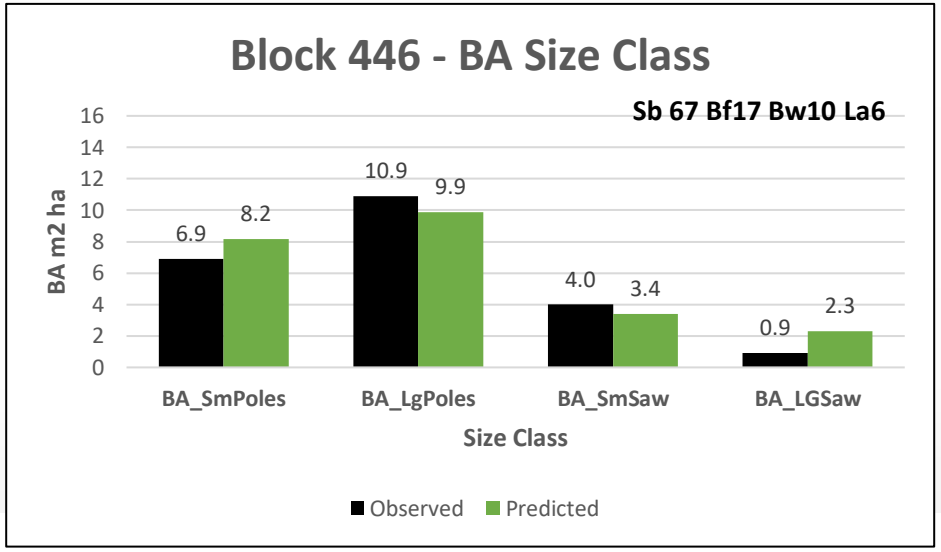
	Species Composition
436	Sb 47 Bf33 Pt8 Pb4 Bf8
446	Sb 67 Bf17 Bw10 La6
499	Pj 52 Pt29 Bf7 Bw5 Sb7
500	Sb 40 Bf26 Bw17 Ce7
526	Pj 51 Sb19 Pt10 Sw8
527	Bw 37 Sw30 Bf14 Pt6

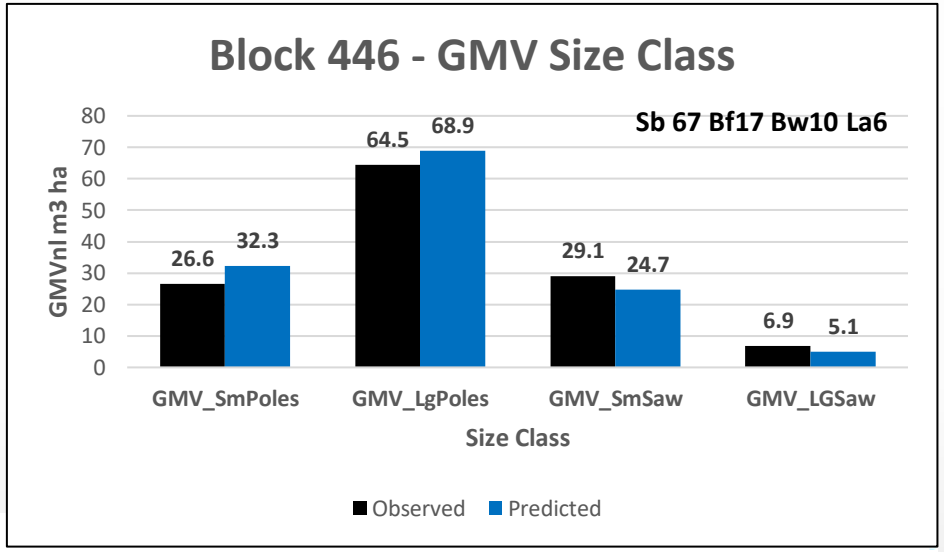


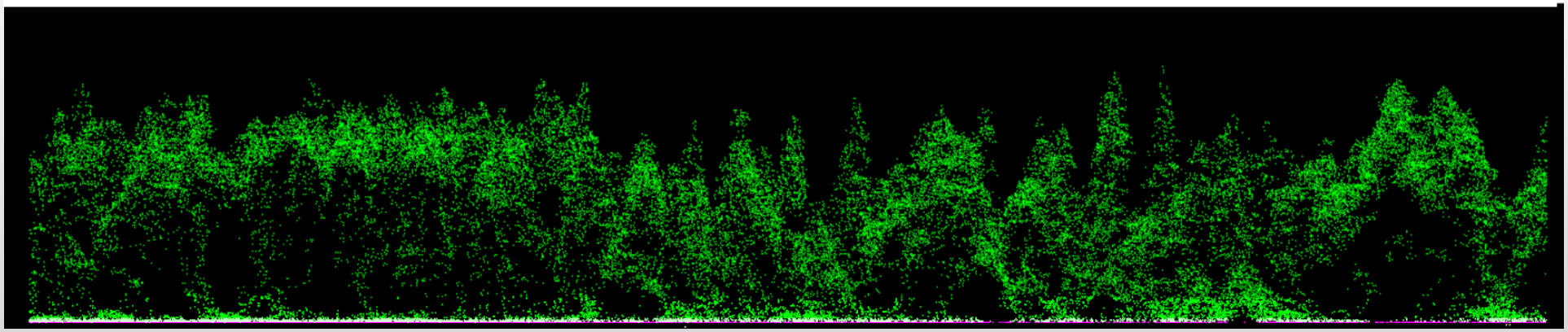


Stand Level Validation – BA/volume Size Class Predictions

- 4 Size classes
  - SmPoles [9 < Dbh ≤ 16 cm]
  - LargePoles [16 < Dbh ≤ 25]
  - Small Sawlogs [25 < Dbh ≤ 37]
  - Large Sawlogs [37cm+]







Stand Level Validation – BA/volume Size Class Predictions

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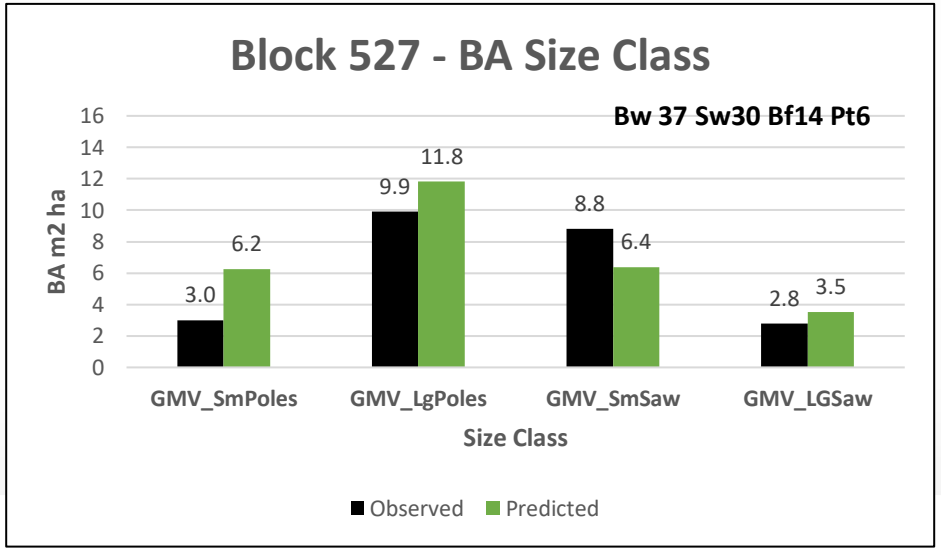
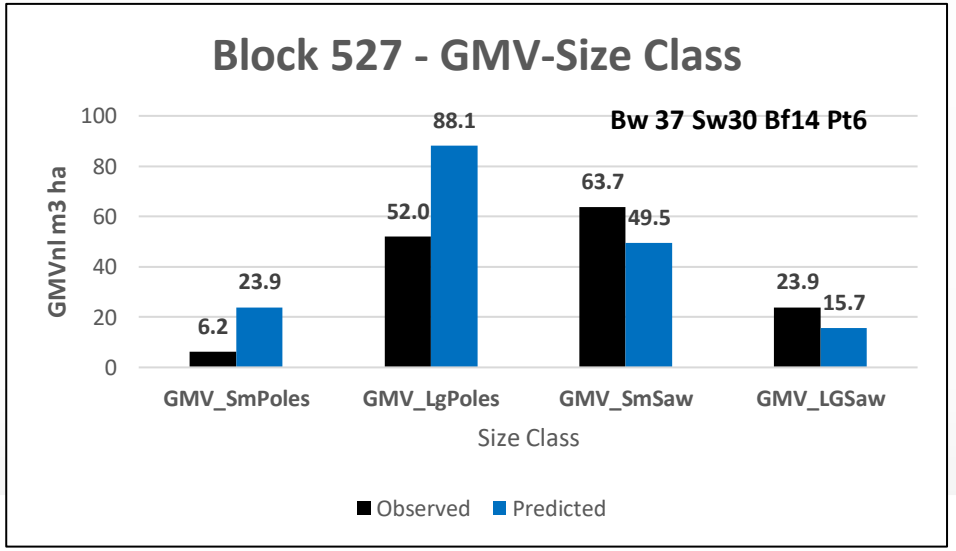
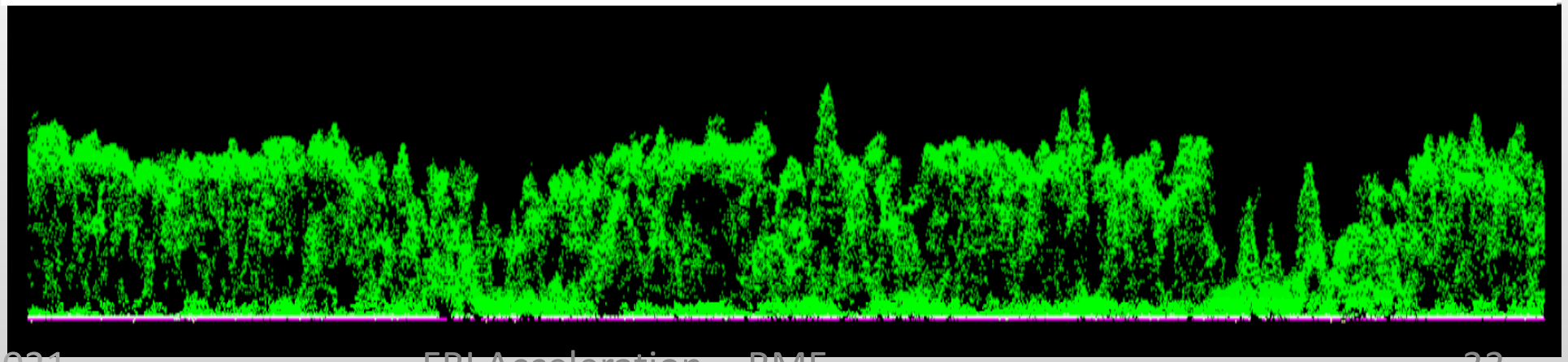






Producing T2 – Methods

- Calculating inventory attributes for existing T1 polygons using the means of the LiDAR-predicted rasters and weighted zonal statistics
  - Crown Closure 2m^{+}
  - TopHt, CDHT, LoreyHt
  - Basal Area
  - GTV, GMV_NL, GMV_WL
  - Biomass
- Assigning T1 Species composition and updated age to T2 update
  - Site index
  - Merch Stocking

Producing T2 – Challenges

- Which polygon inventory should we use to summarize LiDAR T2 Statistics
  - PCI? /OPI?
  - Who is the source for this inventory
    - Gov't
    - Industry
- Raster → Polygon
- SI/stocking

Producing T2 – Raster summarized to OPI Polygon Mean

Site Index = ∫(Lead Spec, Age, Topht)

From T1 Inventory

POLYID	SPCOMP	AGE	CC2m	SI	Stocking	TOPHT	CDHT	LoreyHT	QMD	BA	Stems	GTV	GMV_NL	GMV_WL	Biomass	BA_SmP	BA_LgP	BA_SmS	BA_LgS	GMV_SmP	GMV_LgP	GMV_SmS	GMV_LgS
10	SB 100	114	55	9.6	0.41	15.8	12.4	12.9	14.0	15.2	995	79.7	55.2	48.9	56.4	6.5	4.5	1.8	2.4	20.4	21.6	7.7	5.6
11	SB 85SW 5BF 5BW 5	114	20	6.7	0.14	12.0	9.7	10.7	14.1	4.6	296	27.2	24.7	22.8	17.6	1.8	1.3	0.5	0.9	7.3	9.6	5.1	2.7
12	SB 80LA 10BW 10	94	68	11.6	0.46	16.1	13.7	13.0	14.7	17.3	1026	100.9	74.9	67.2	62.1	7.1	5.0	2.8	2.5	25.3	30.1	14.3	5.2
13	SB 100	114	28	7.1	0.24	12.6	10.9	10.9	13.6	8.4	578	46.4	33.9	30.3	31.7	4.1	2.4	0.5	1.3	16.4	12.6	3.3	1.7
14	SB 30CE 30BW 20LA 20	94	49	8.8	0.34	13.0	11.1	11.1	13.4	11.6	827	65.3	53.2	47.8	42.0	5.2	3.2	1.2	2.0	19.7	23.0	7.4	3.1
15	SB 80BF 15BW 5	144	16	5.0	0.13	10.6	7.9	9.5	12.7	4.3	340	20.7	17.9	15.9	15.2	2.1	0.9	0.3	1.0	9.6	5.6	1.7	1.0
16	SB 95LA 5	114	30	6.3	0.24	11.5	8.7	9.9	11.9	8.1	729	39.4	28.6	24.4	27.0	4.7	1.5	0.3	1.6	17.6	8.5	1.2	1.3
17	SB 85LA 15	114	30	6.6	0.21	11.9	10.3	10.4	12.4	7.2	601	36.7	24.4	21.3	25.2	4.1	1.5	0.3	1.3	14.9	7.1	1.4	1.2
18	SB 75SW 10BF 10BW 5	124	69	9.2	0.42	16.1	13.7	13.0	15.4	15.9	860	102.5	79.3	72.7	58.0	5.8	4.8	2.7	2.5	23.0	31.0	16.6	8.7
20	SB 80BF 10BW 10	94	34	7.9	0.22	11.8	10.1	10.2	13.6	7.2	491	38.4	39.8	36.0	25.0	3.1	1.8	0.9	1.4	13.8	15.3	7.1	3.7
21	SB 85BF 10BW 5	134	5	5.0	0.07	10.3	6.9	9.4	12.3	2.4	203	10.7	5.9	4.9	8.4	1.2	0.5	0.1	0.6	4.8	0.7	0.2	0.2
22	SB 80LA 10BW 10	94	70	12.4	0.46	17.0	14.5	14.2	15.9	18.0	906	119.3	94.3	87.4	69.4	5.7	6.0	3.5	2.8	22.2	39.1	23.7	9.2
23	SB 85BF 10BW 5	144	10	5.0	0.08	9.6	7.2	8.8	12.2	2.6	221	11.0	7.4	6.2	8.6	1.2	0.5	0.2	0.7	4.9	1.6	0.5	0.4
24	SB 80SW 10BW 5BF 5	124	73	11.9	0.55	19.2	16.9	16.2	17.6	22.2	915	160.1	134.4	126.8	93.3	5.2	8.8	5.4	2.8	21.4	60.2	41.8	11.1
50	BW 50SB 20PT 10SW 10PB 10	84	79	18.5	1.22	23.6	21.2	20.3	20.9	33.0	962	296.6	261.1	251.1	160.6	4.8	11.9	10.3	6.0	18.4	85.8	99.6	57.3

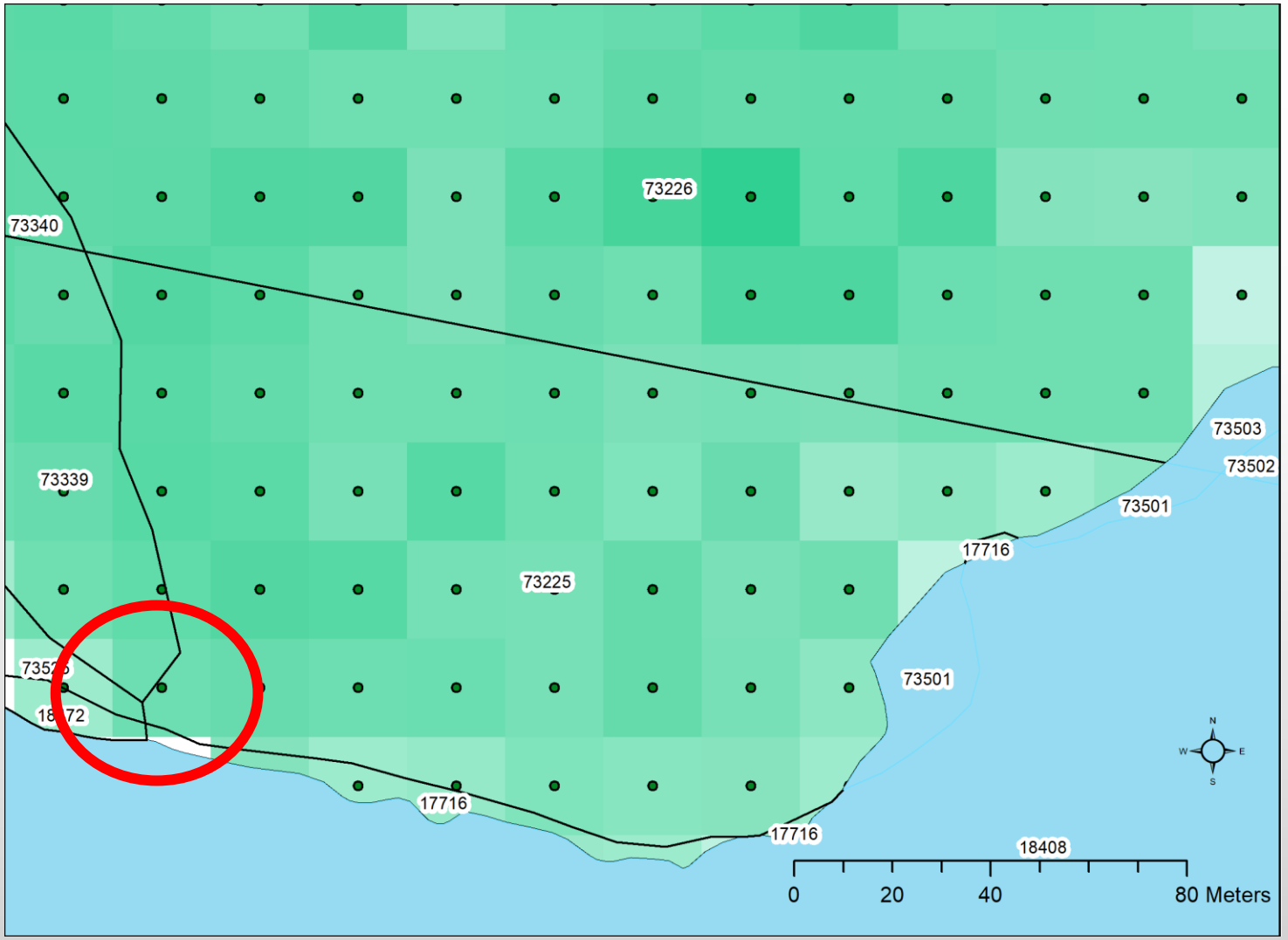
Stocking = ∫(Lead Spec, Age, BA, SI)

Producing T2 – Challenges

- **Raster → Polygon populating**
  - Slivers & linear features
  - Polygons dissecting raster cells into 2 or more parts

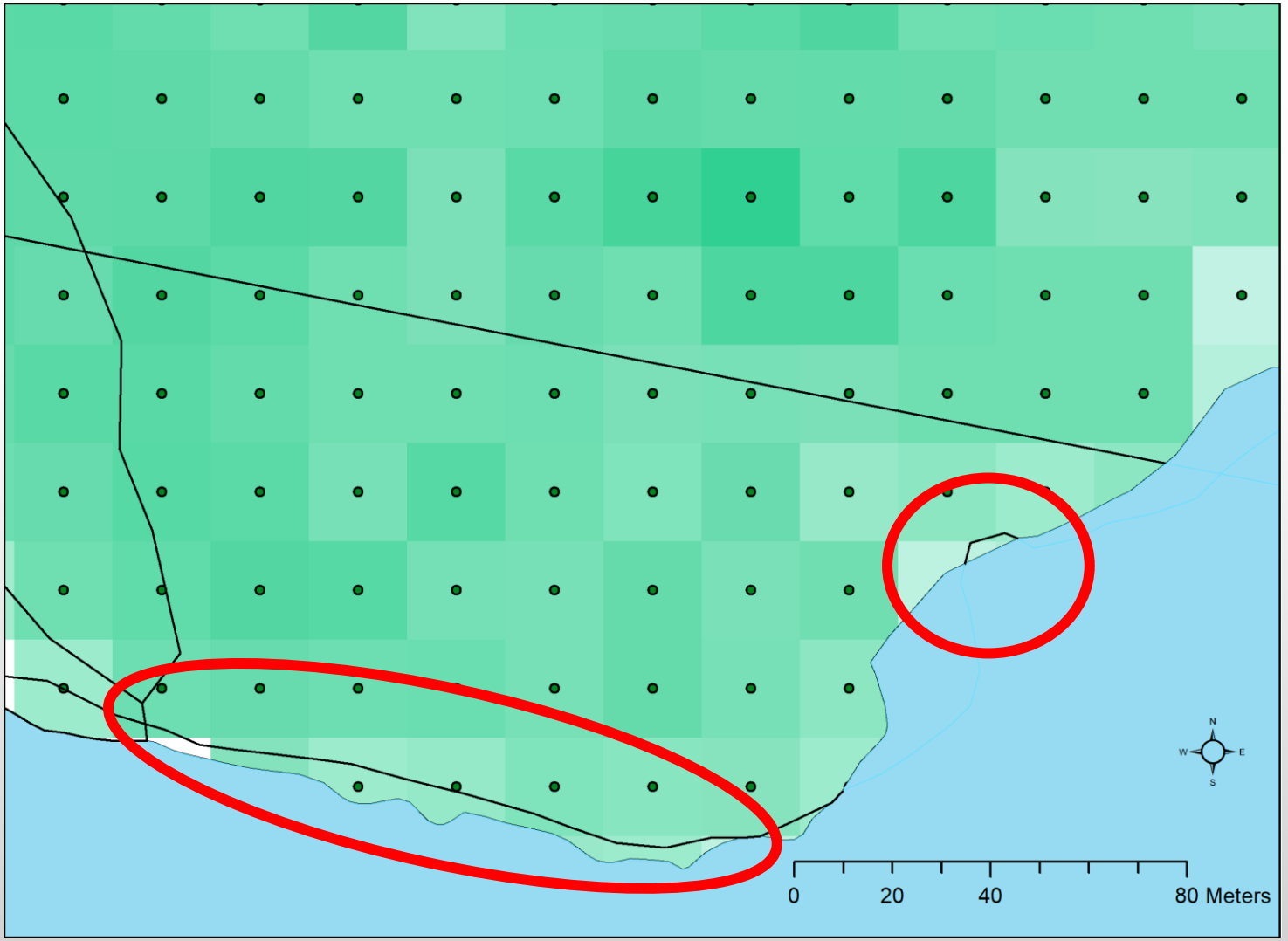
Producing T2 – Challenges

Some pixels straddle polygon boundaries



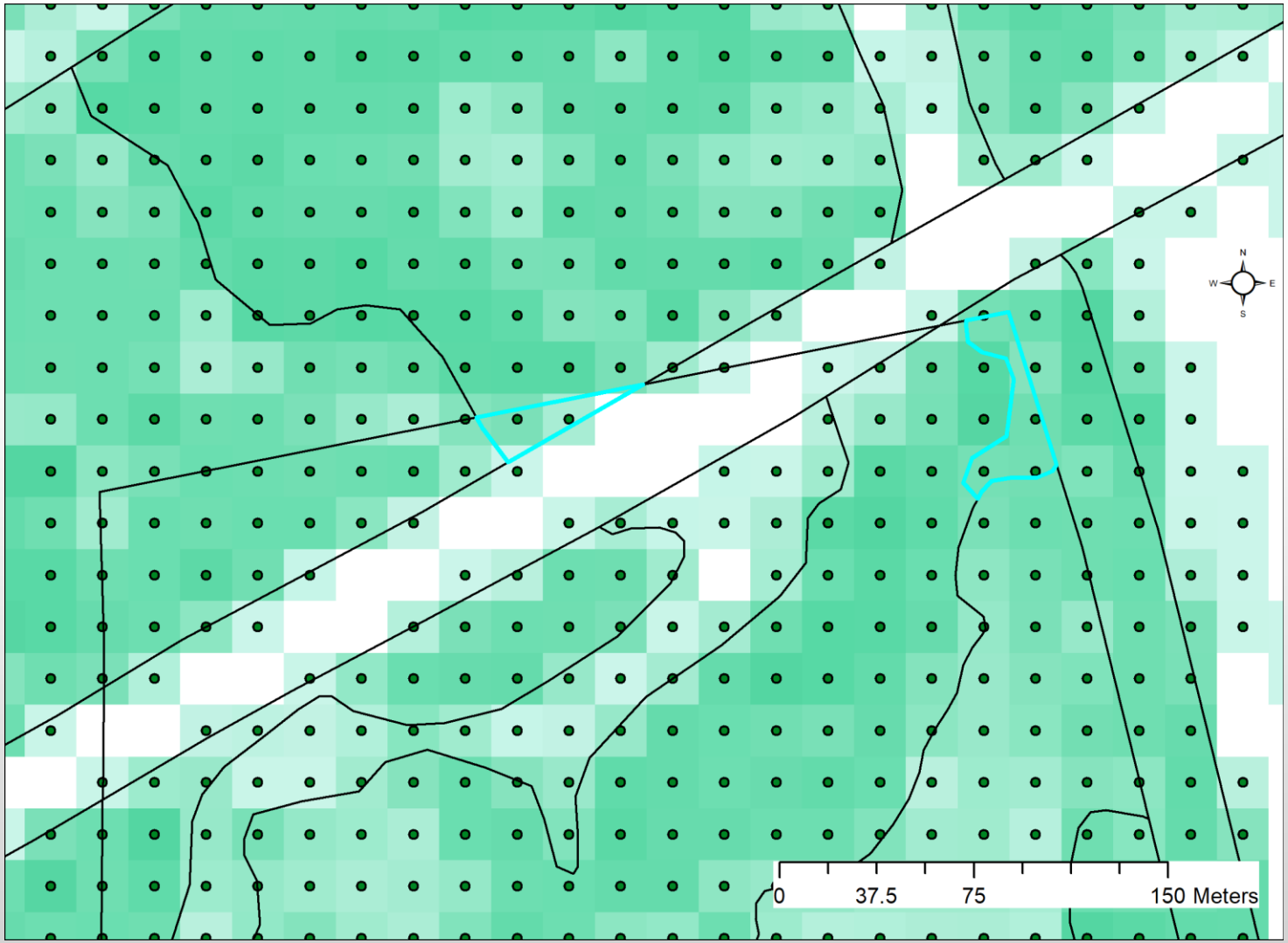
Producing T2 – Challenges

Some polygons are tiny



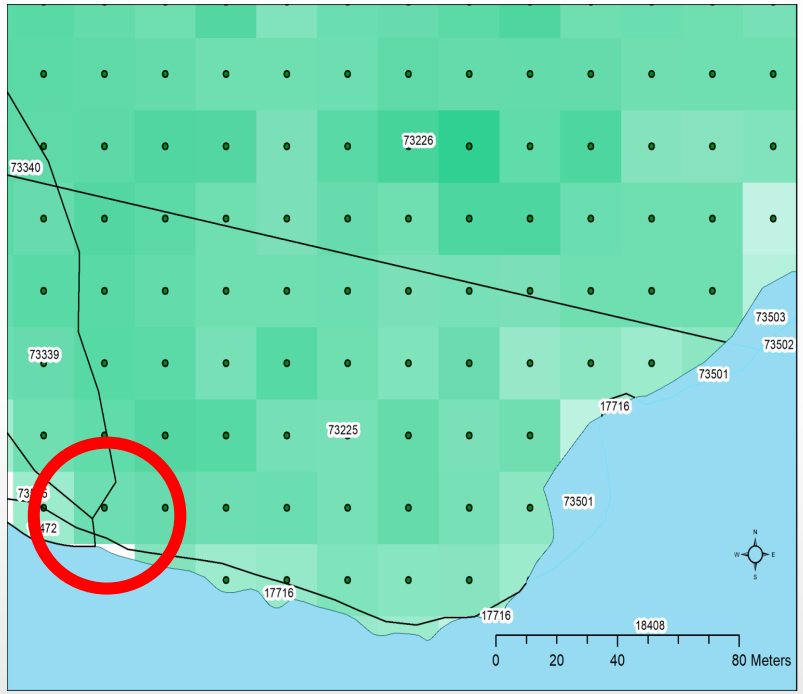
Producing T2 – Challenges

Some features are linear



Producing T2 – Challenges

Polygon attributes are computed by pixel attributes, weighted by the proportion of the pixel in the polygon

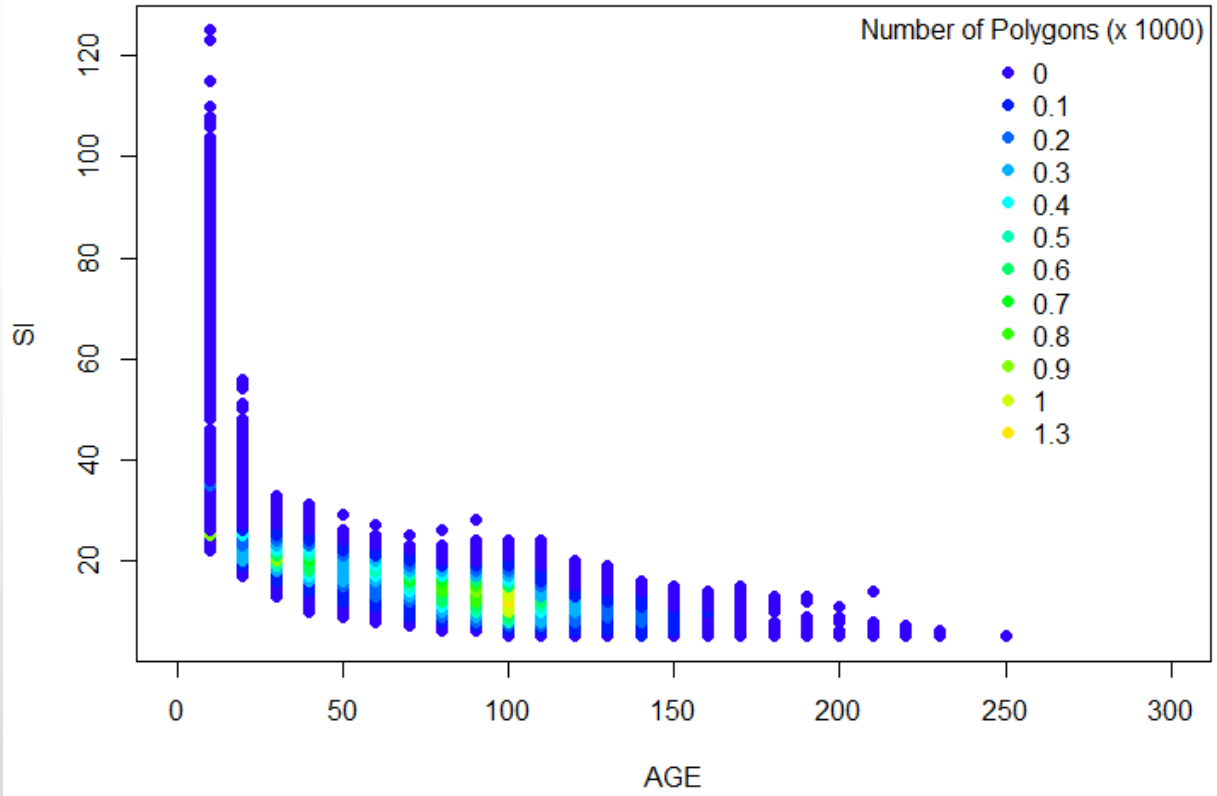


Producing T2 – Challenges

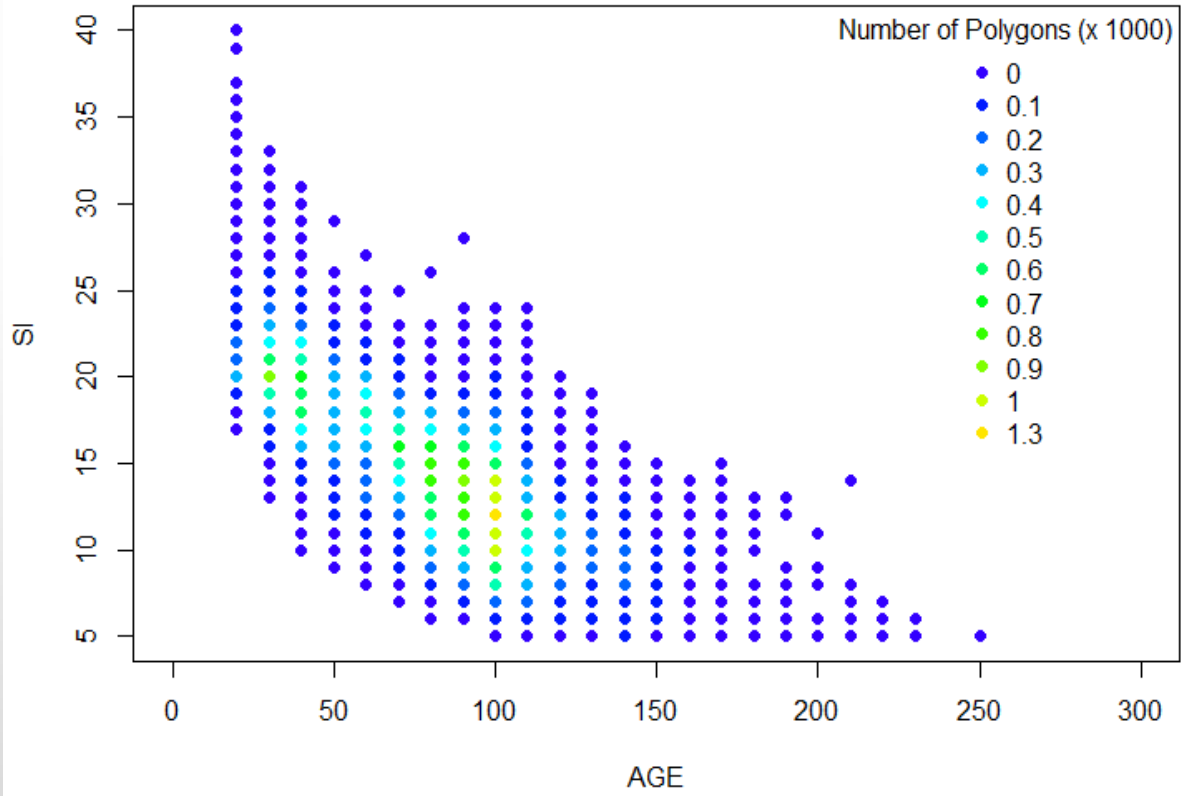
- **SI calculation**
  - challenging with young stands
  - issue when interpreted age is low and LiDAR height is high

Producing T2 – Challenges – Site Index

Polygon Age ≥ 10 years

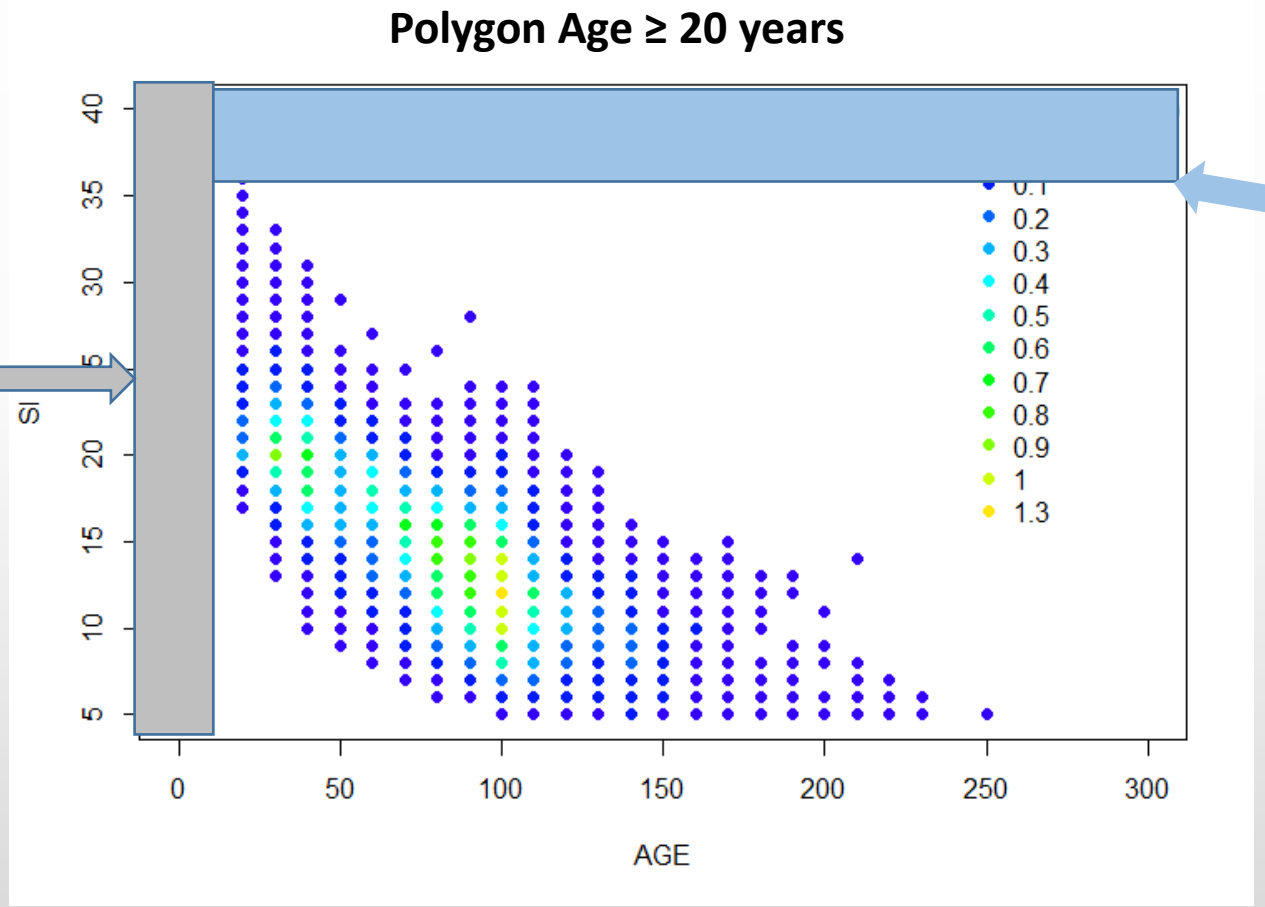


Polygon Age ≥ 20 years



Producing T2 – Challenges – Site Index

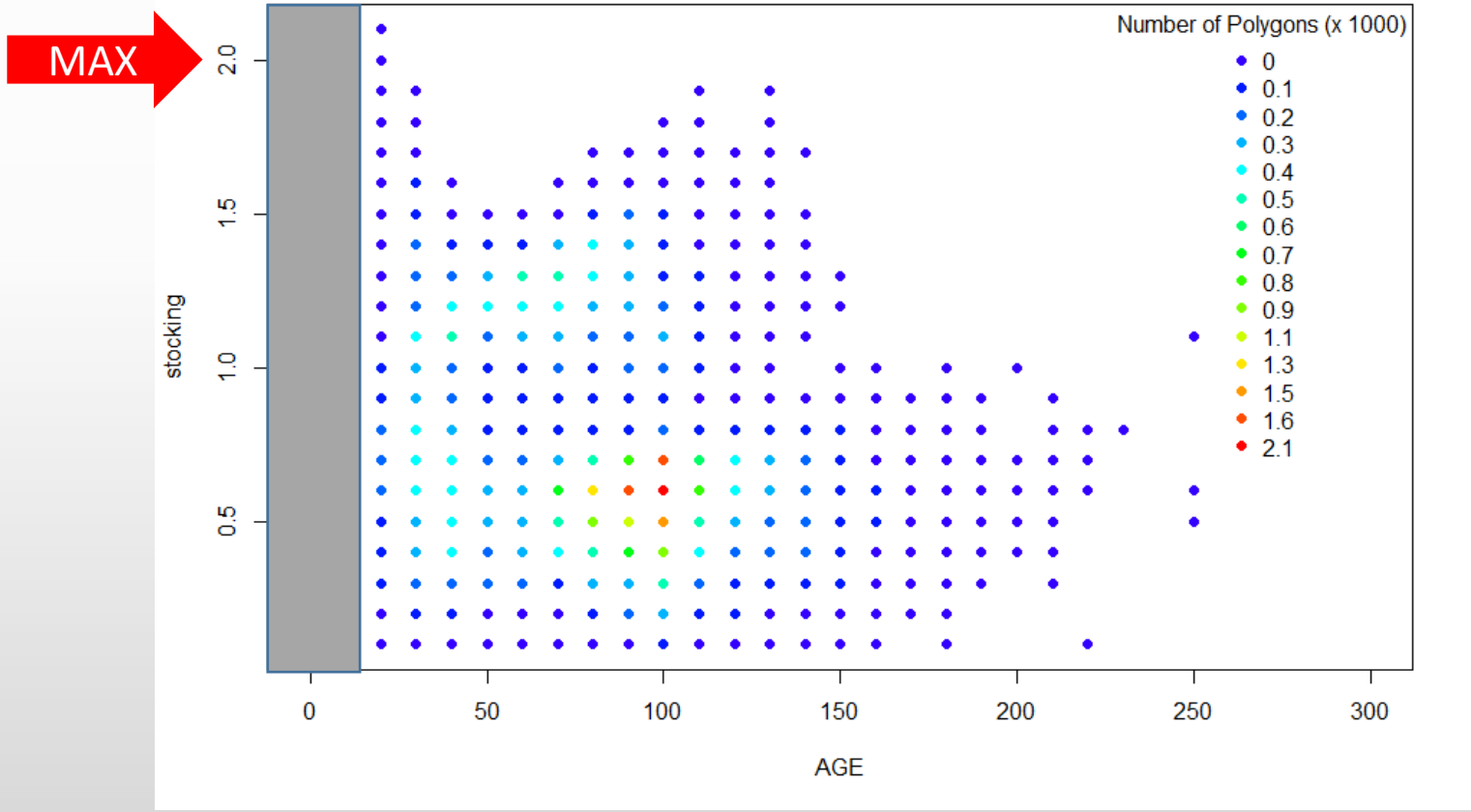
Set SI = missing when age < 20 years



Cap SI at 35m

Producing T2 – Challenges

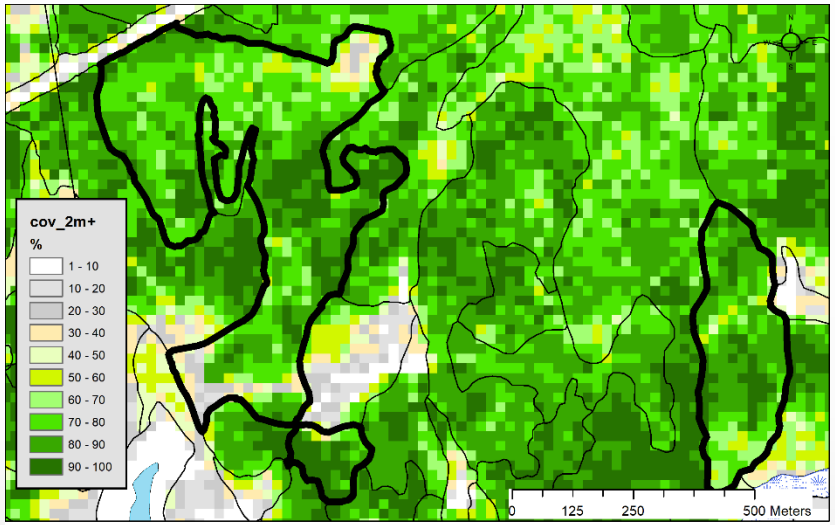
- **Stocking calculation**
  - Issue for young stands – requires BA – we have a 7.1cm min threshold

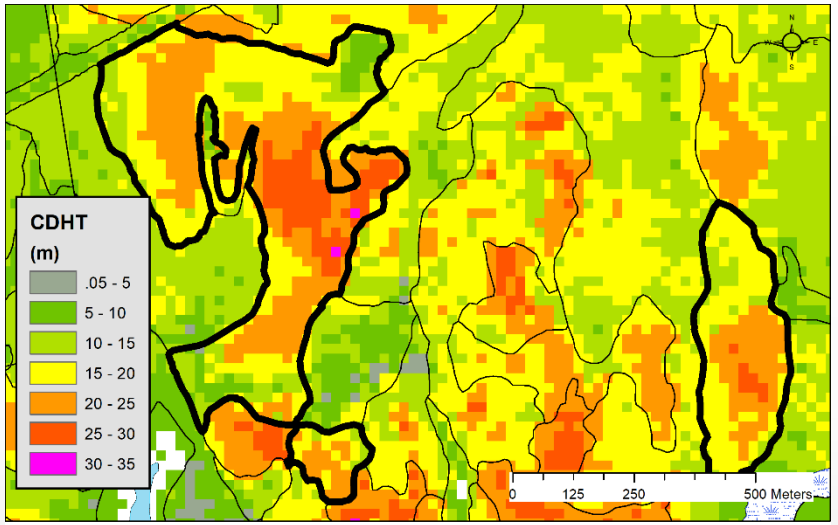


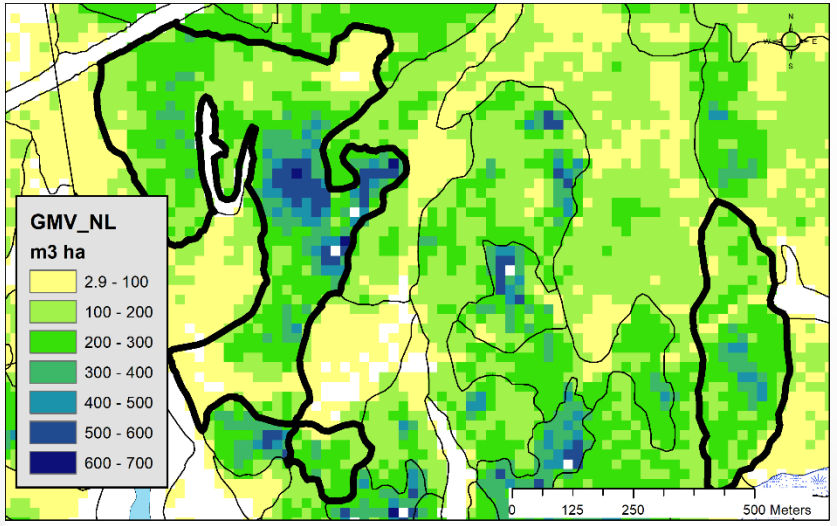
Producing T2 – Opportunities

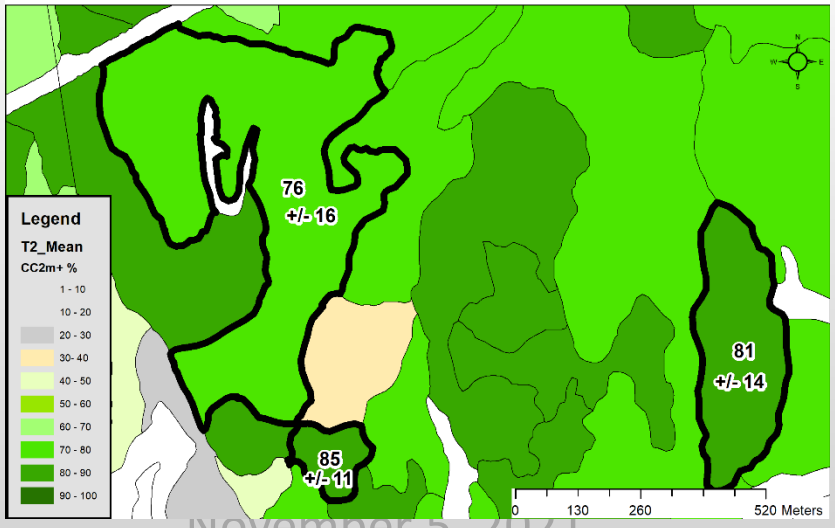
- Would additional measures of pixel stand variation be useful for operational planning?

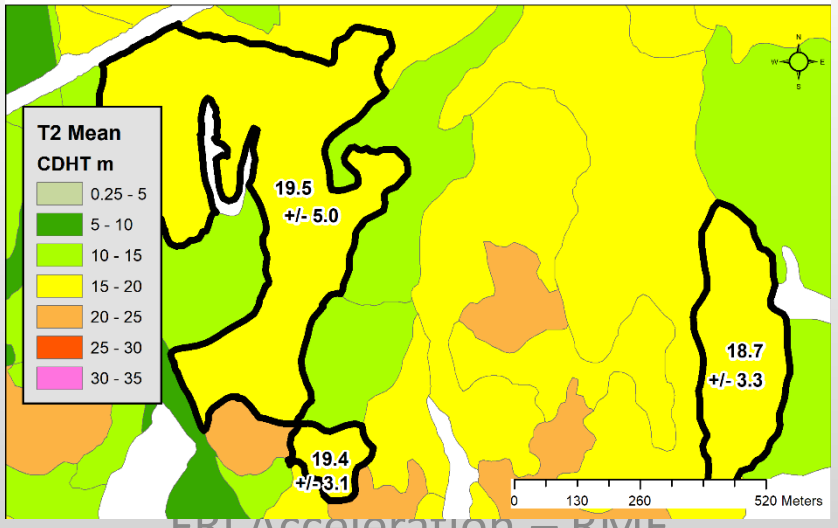
Producing T2 – Opportunities - Measures of variation?

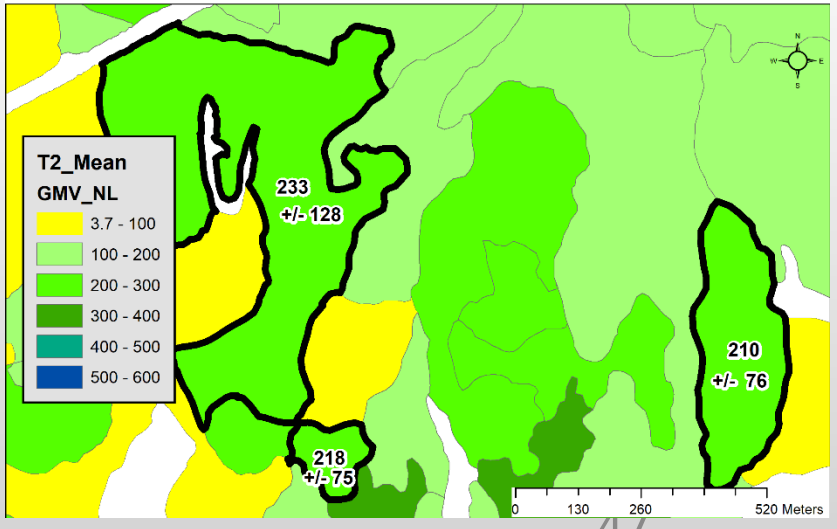








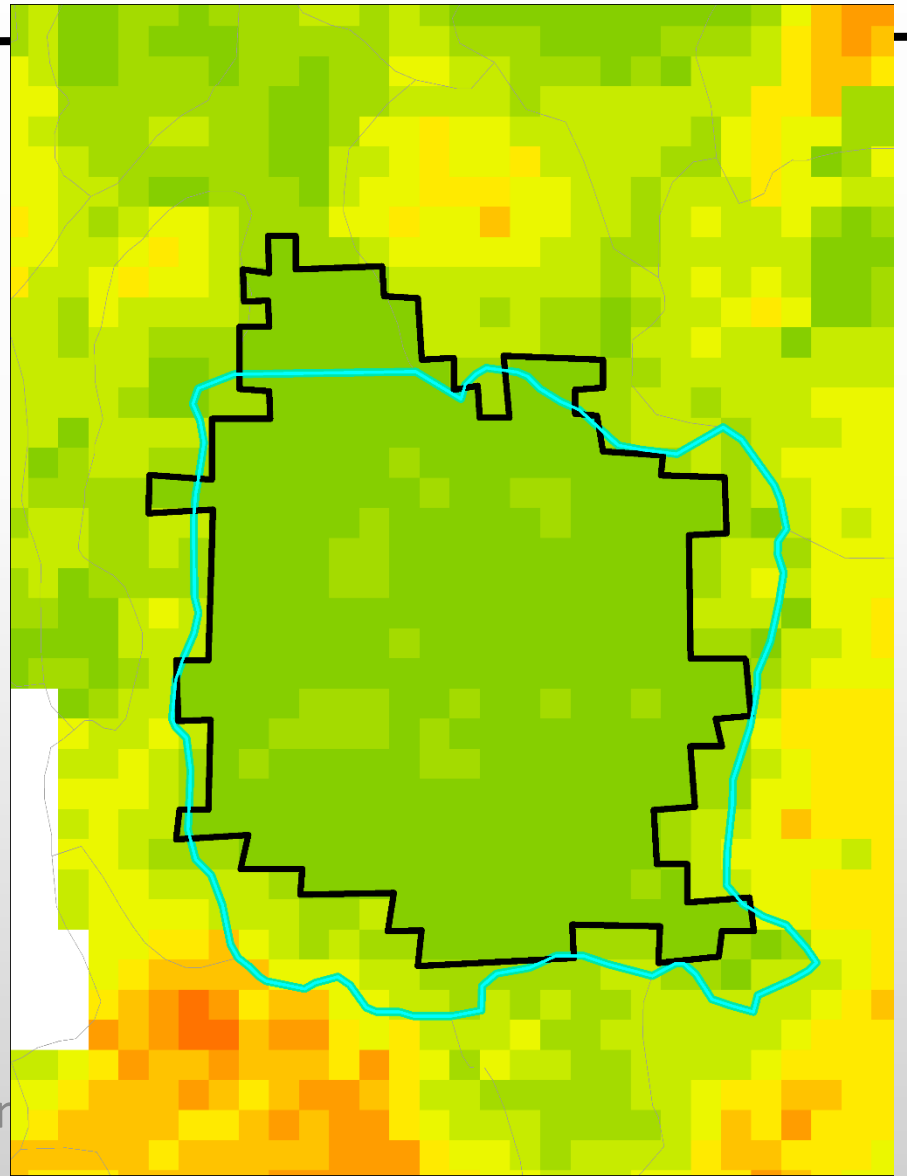




Producing T2 – Opportunities

Additional automation

- Automate polygon delineation using raster layer(s)
- Extract roads



Pushing the Pause Button

Next Steps

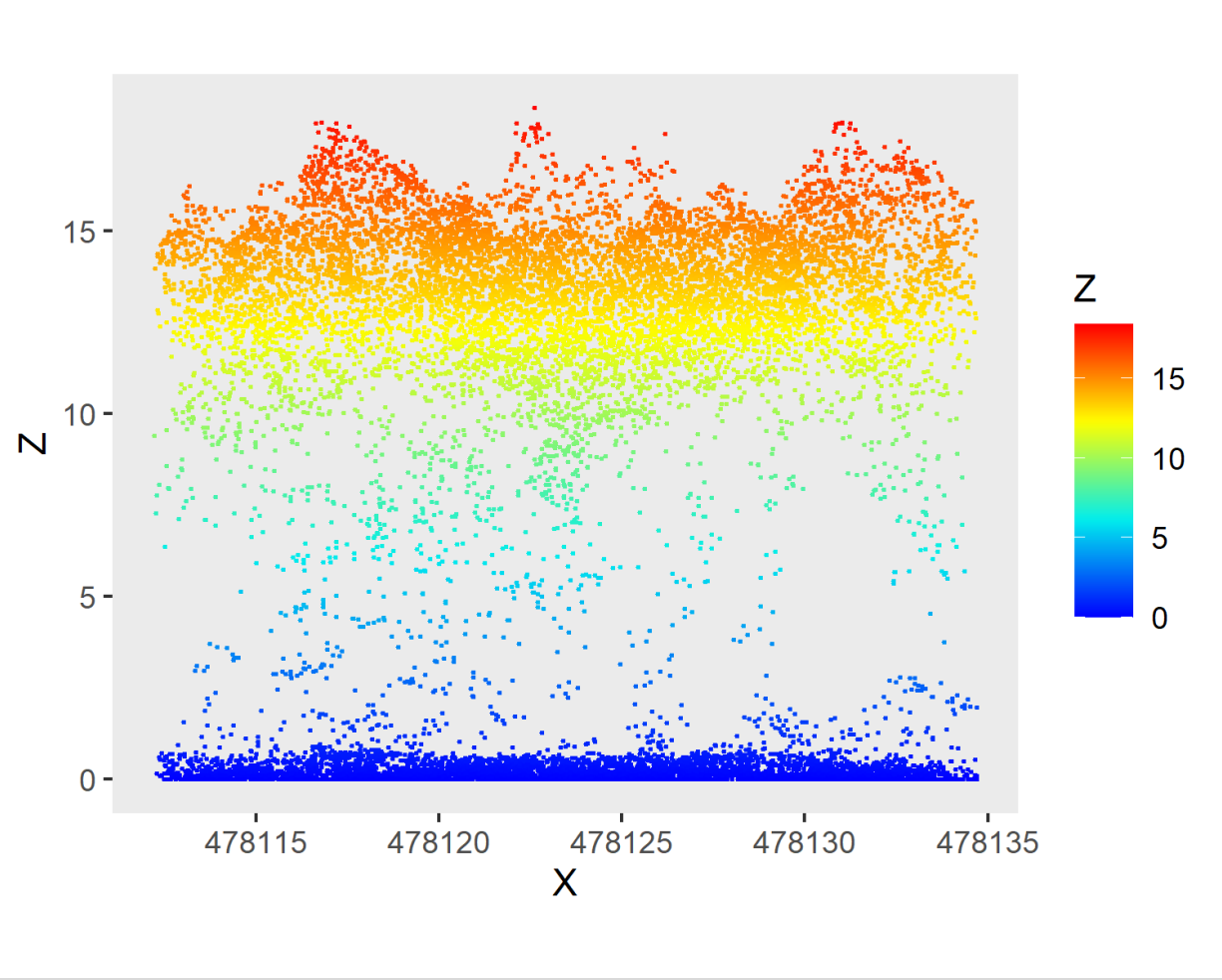
Accelerating the implementation of enhanced forest inventories in Ontario

- Dog River – Matawin
- Algonquin Park Forest

Vertical structure

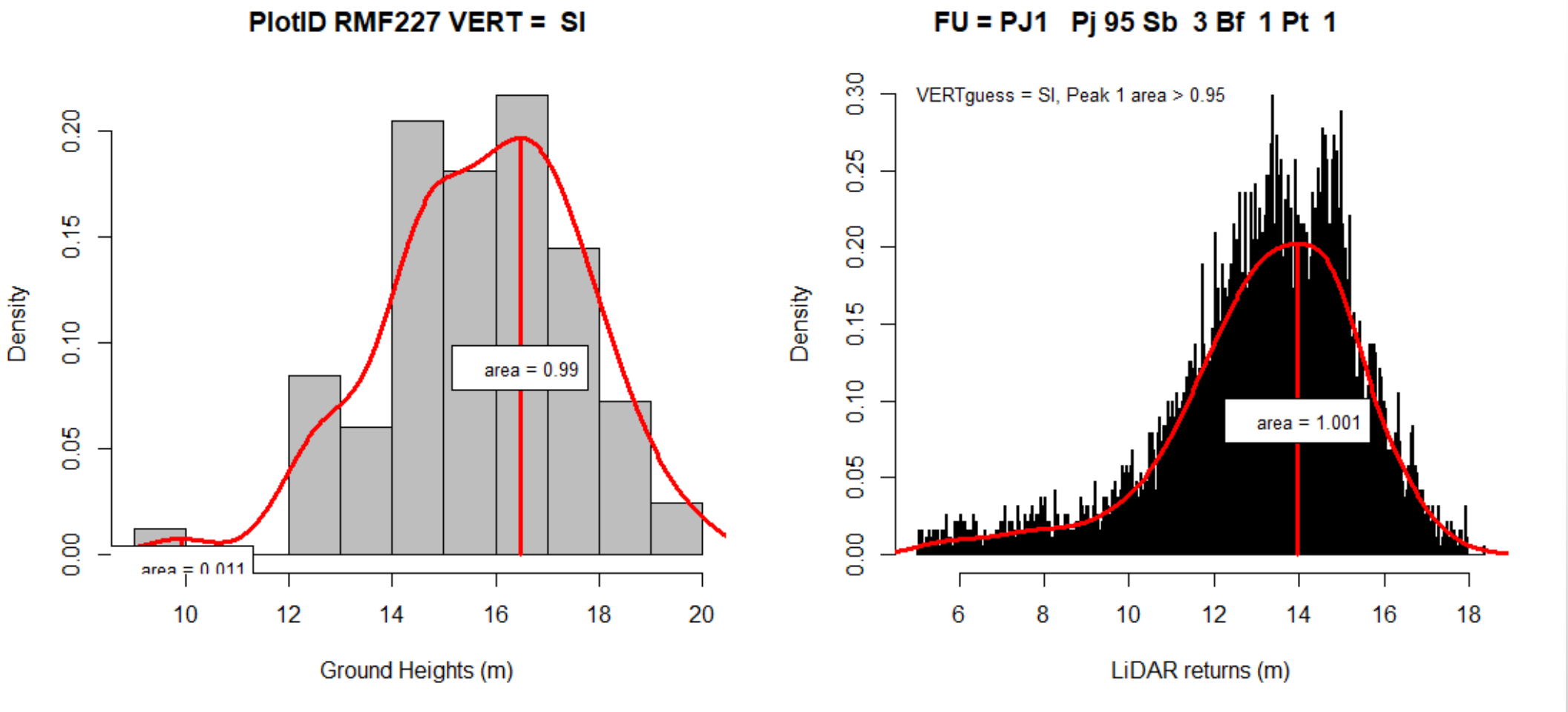
- Starting with RMF then PRF and APF

Next Steps - Vertical Structure

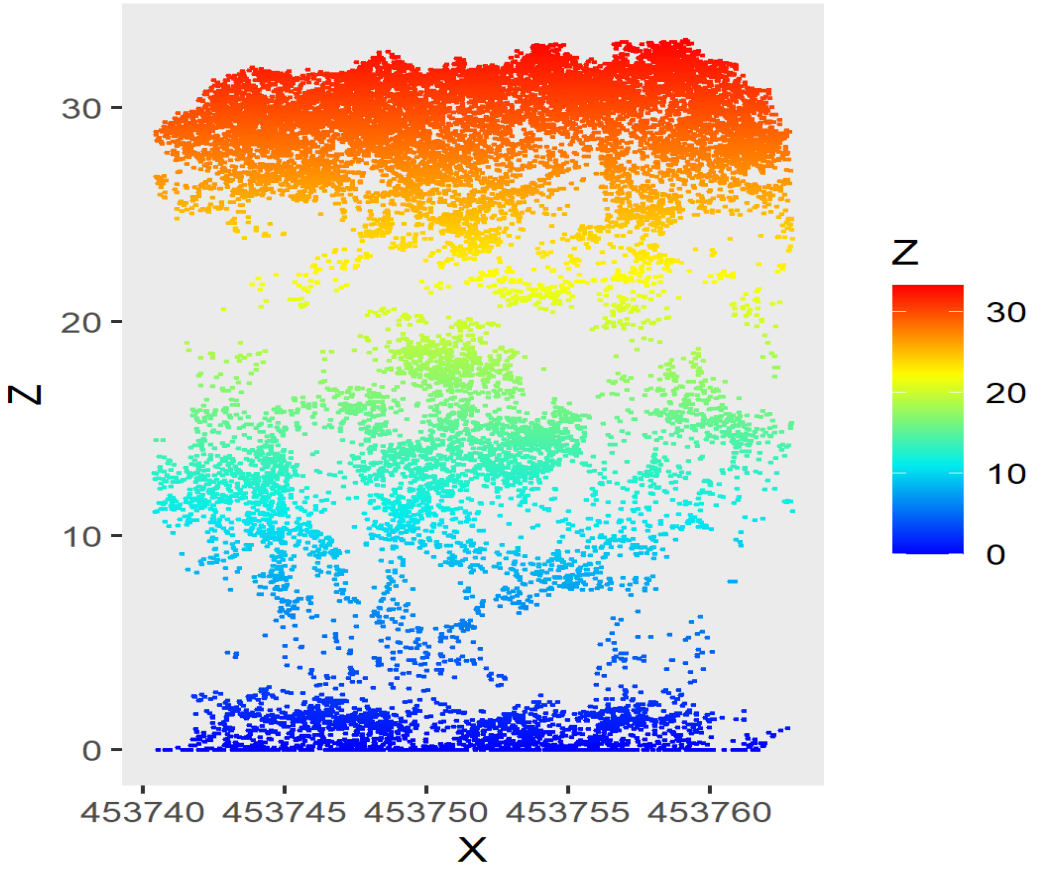


RMF 227
Pj 95 Sb 3 Bf 1 Pt 1

Next Steps - Vertical Structure

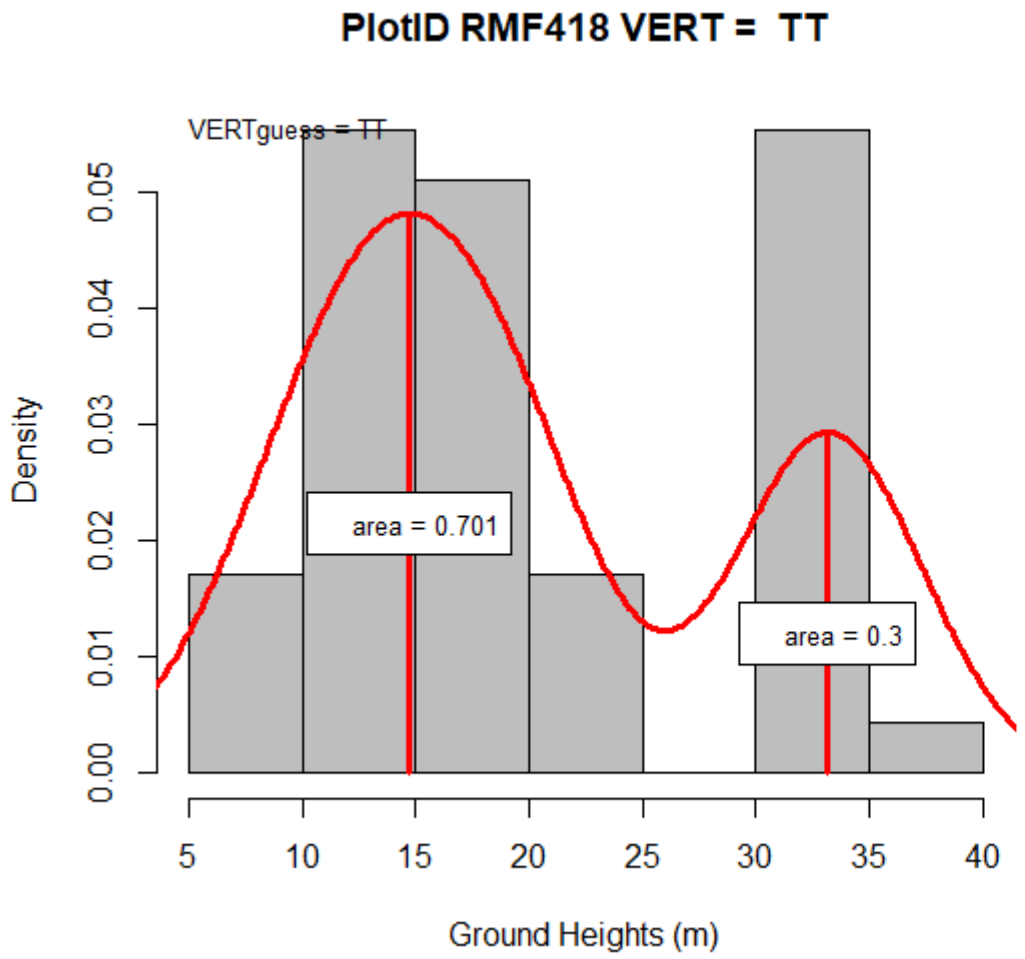


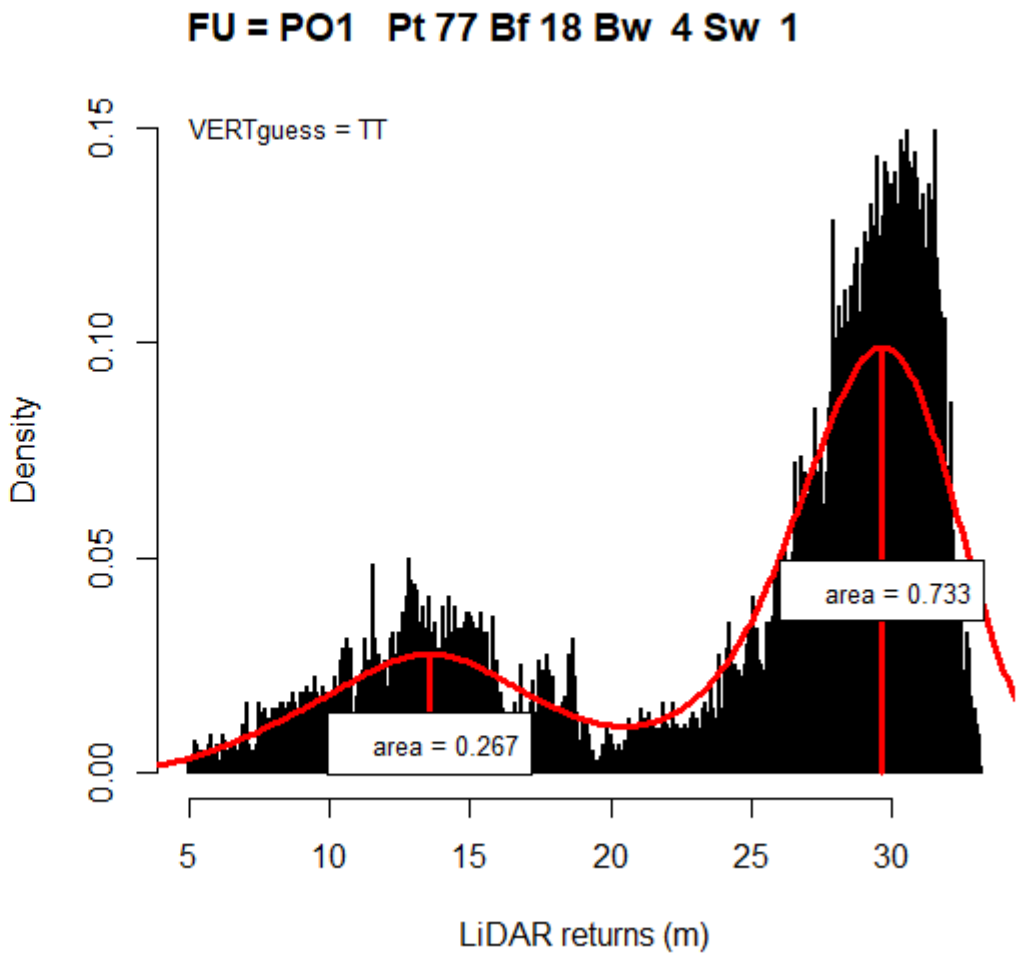
Next Steps - Vertical Structure



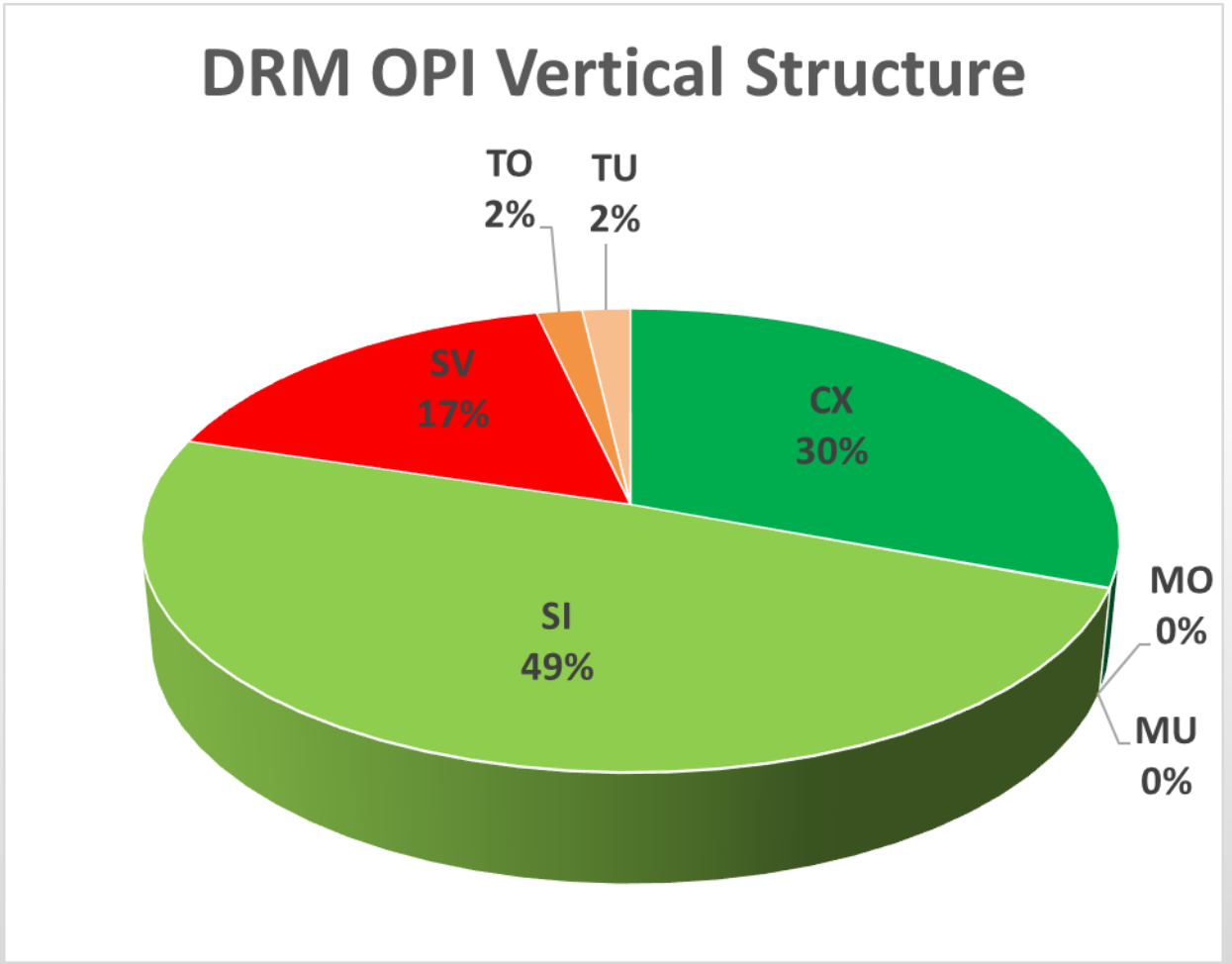
RMF 418
Pt 77 Bf 18 Bw 4 Sw 1

Next Steps - Vertical Structure

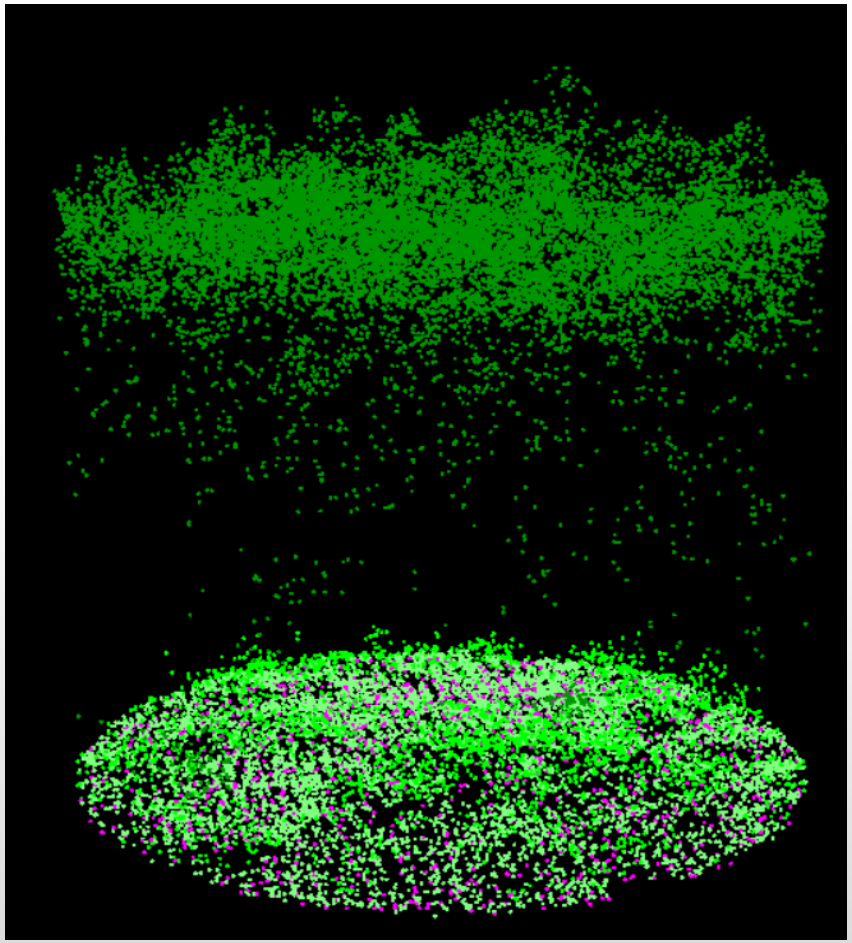




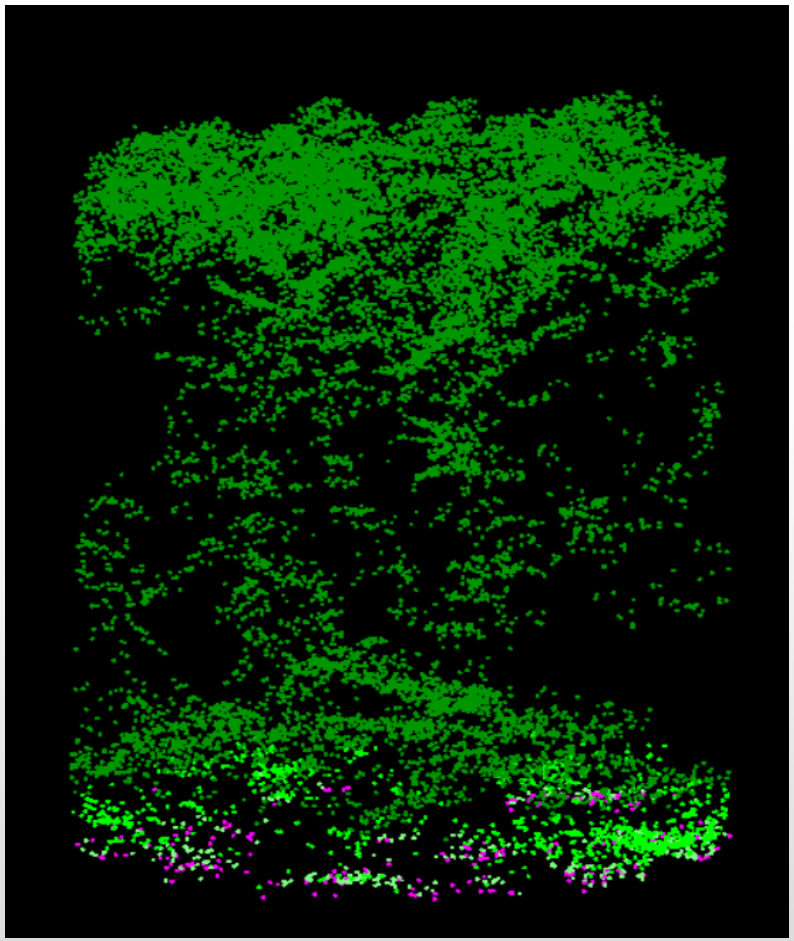
Next Steps - T1 OPI Vertical Structure for DRM



Next Steps - DRM Vertical Structure

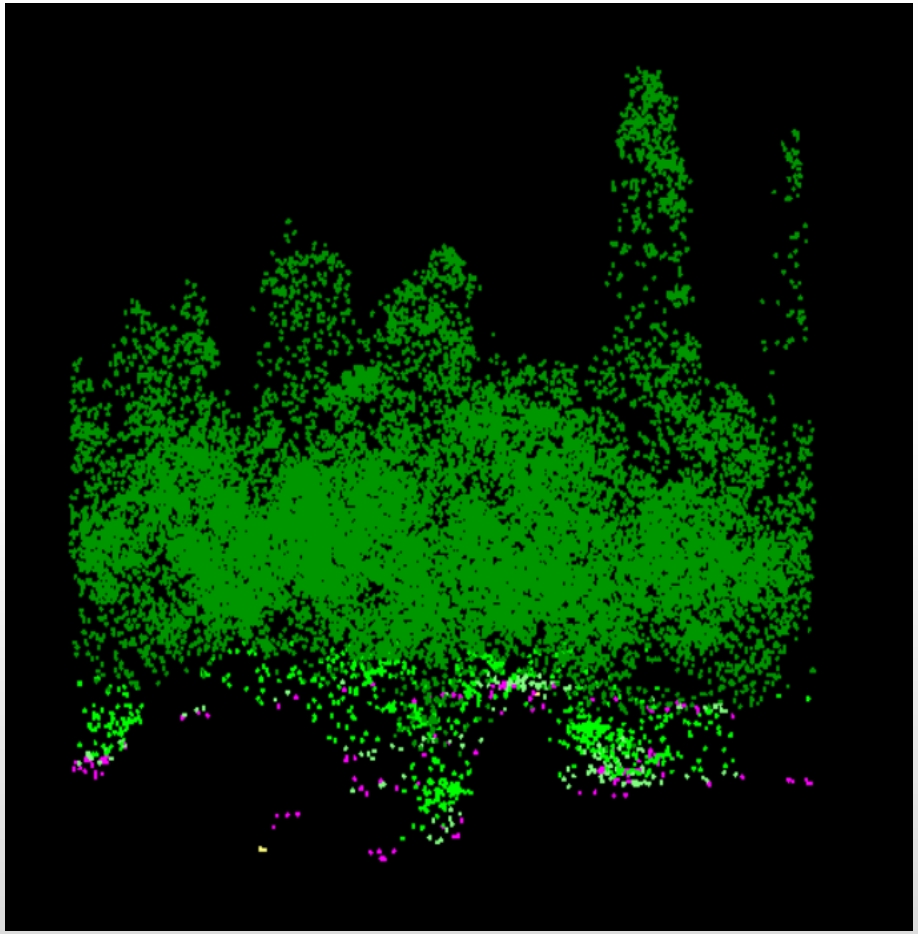


DRM041– Pj - SI

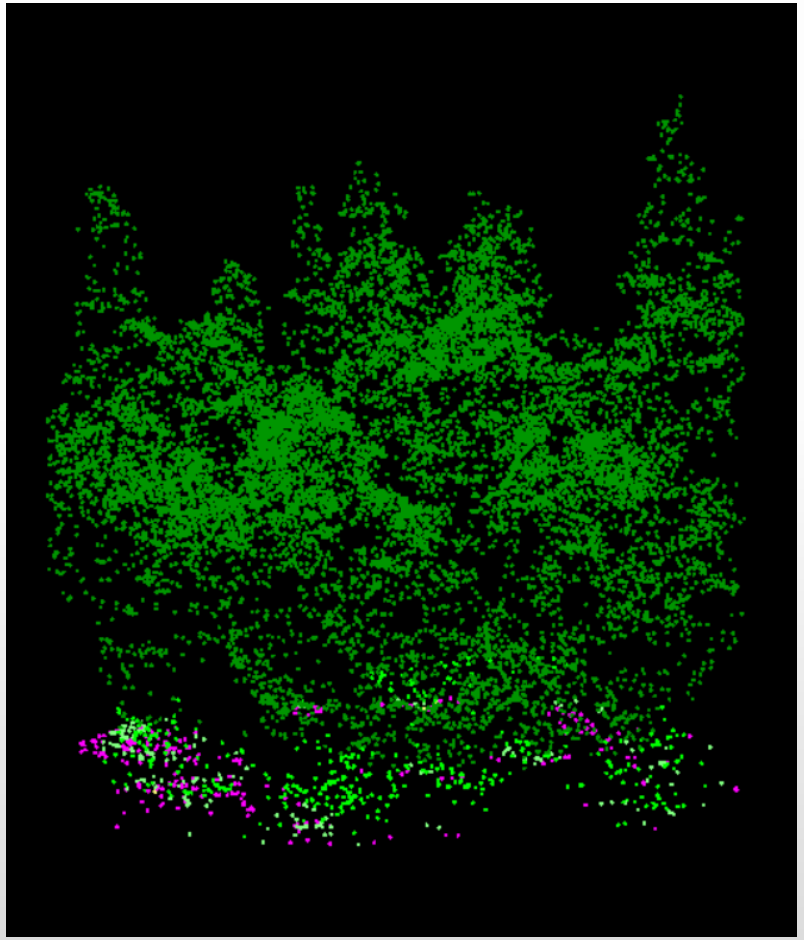


DRM089– Pw/Po - SI

Next Steps - DRM Vertical Structure

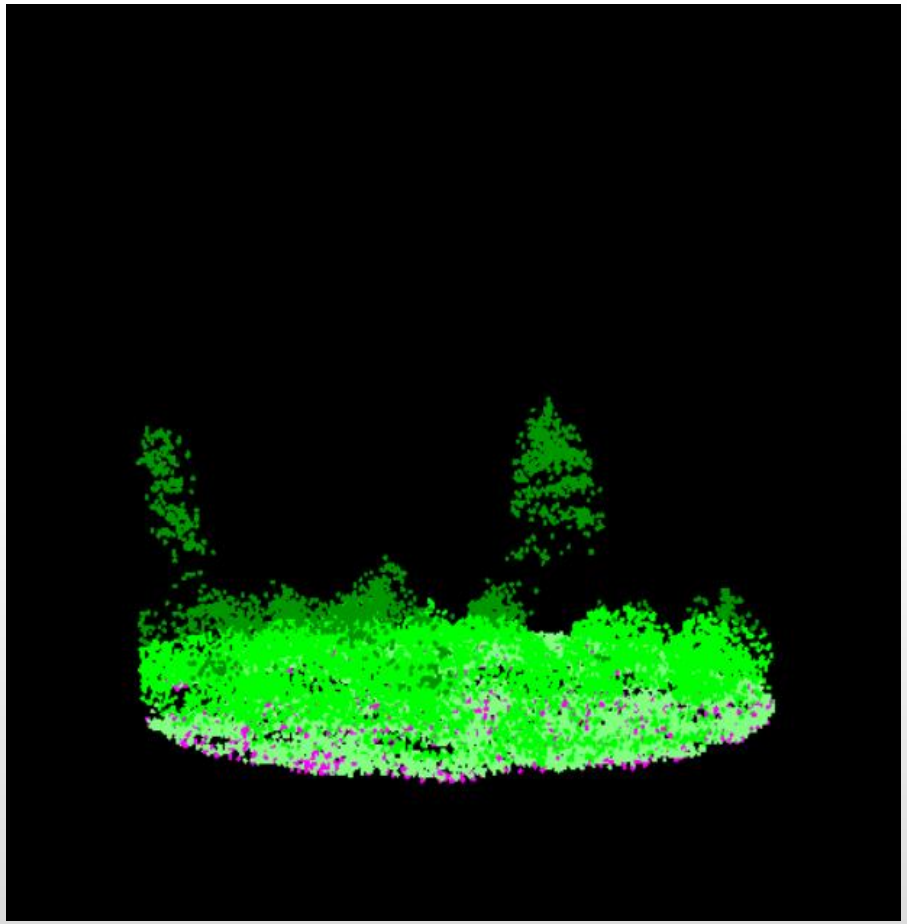


DRM117 – Ce - CX

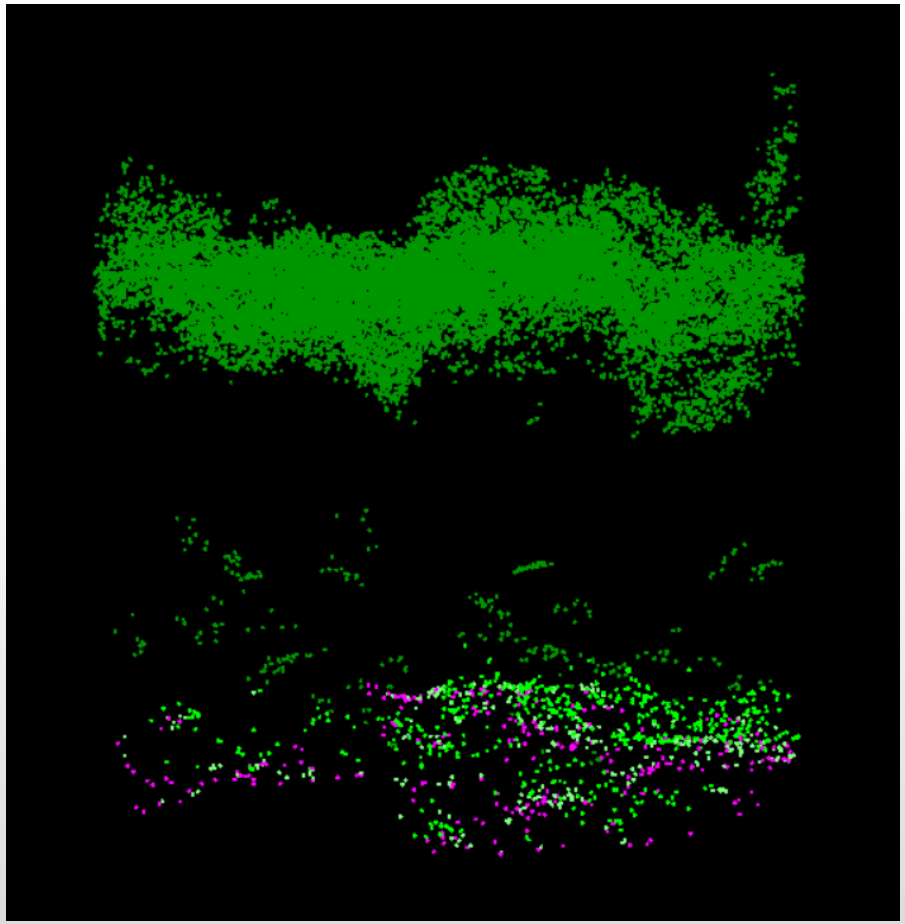


DRM135 – Spruce - CX

Next Steps - DRM Vertical Structure

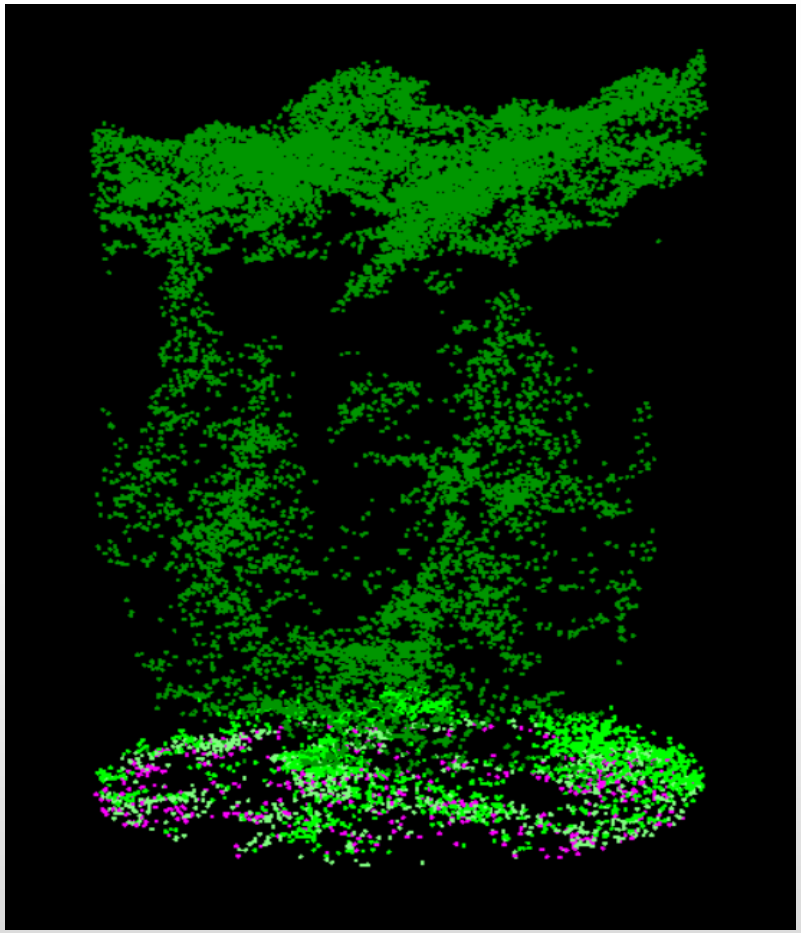


DRM039 – Po - SV

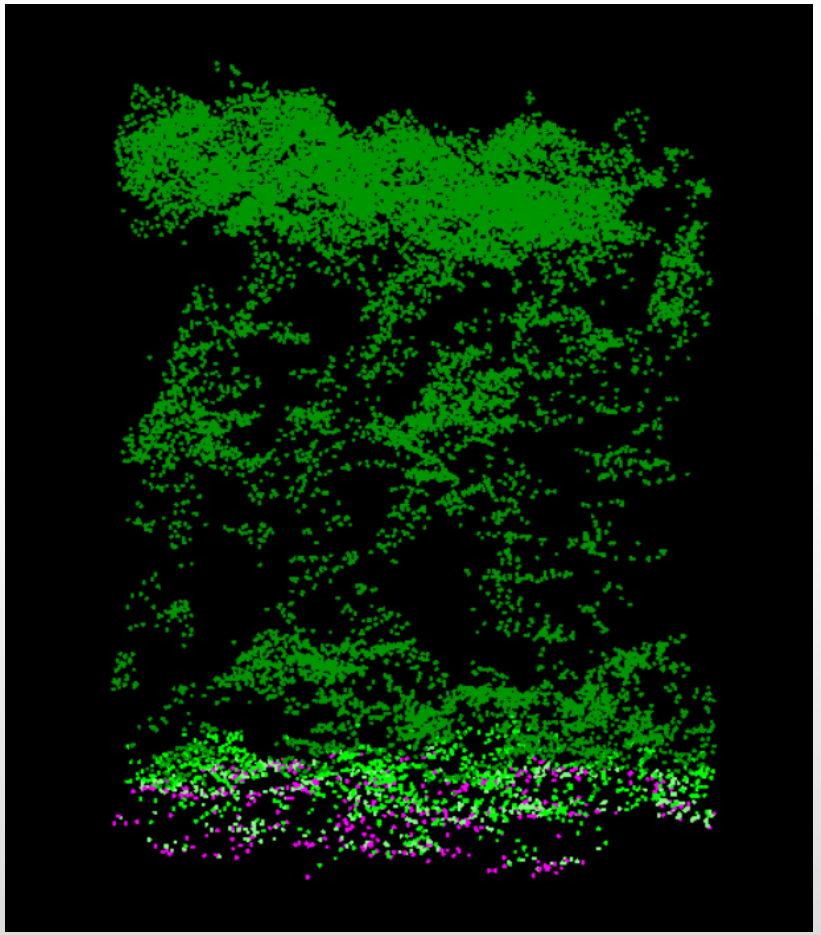


DRM020 – Bw - SV

Next Steps - DRM Vertical Structure



DRM110 – Po - TT



DRM088 – Po/Pw - TT

Thank you!

Comments? Questions?