



DRM LiDAR Model Calibration Results

Presentation to Staff of Resolute Forest Products

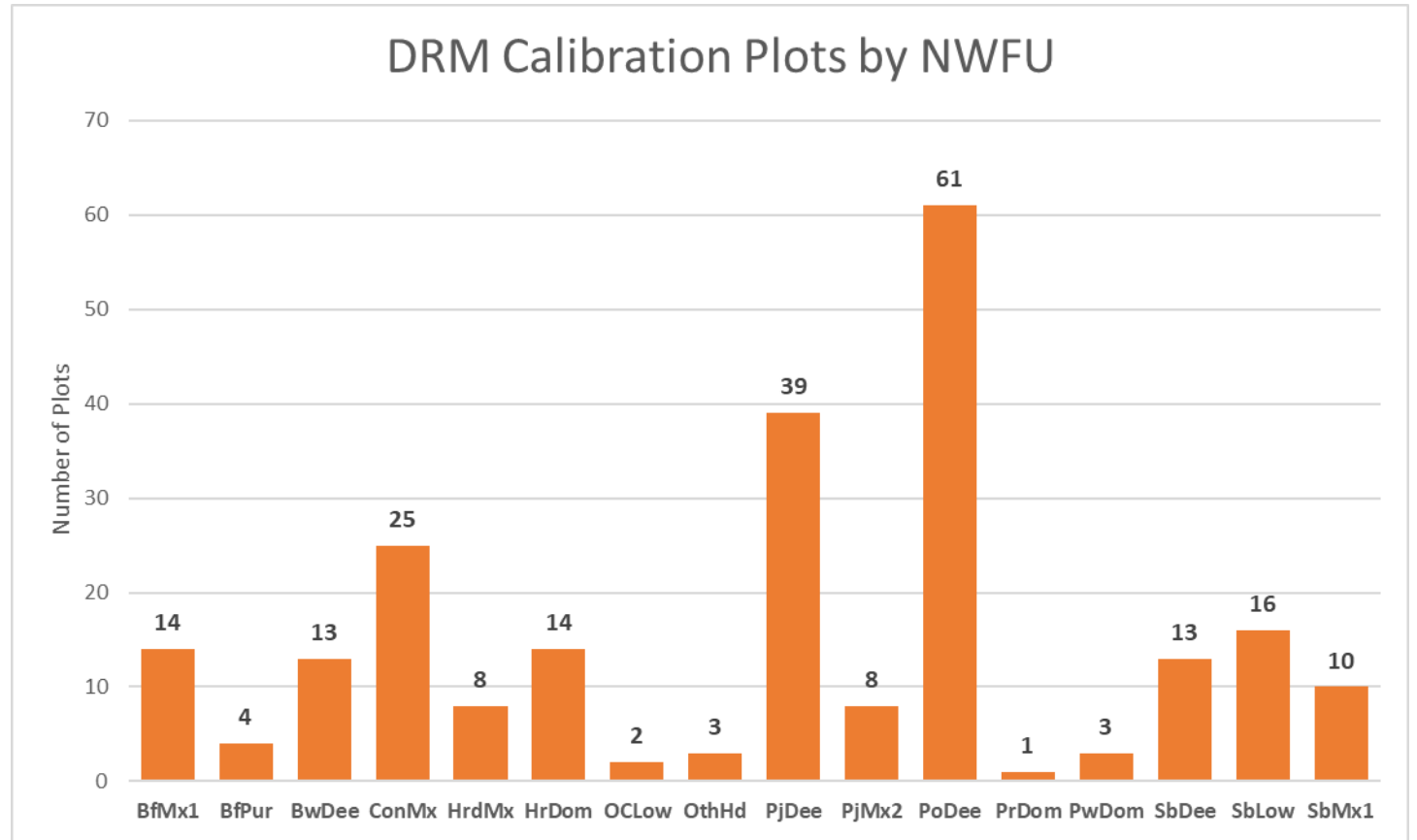
Margaret Penner & Murray Woods

February 2, 2022

DRM Calibration Data Summary

FU	N	BH_AGE	CDHT	BasalArea	GTV
BfMx1	14	52 (37-79)	15.7 (11.5-20.3)	30.3 (18.4-49.1)	200.4 (111.6-314.9)
BfPur	4	38 (18-67)	12.6 (7.3-18.6)	13.0 (1.4-19.6)	75.2 (6.2-124.7)
BwDee	13	62 (16-114)	18.5 (6.8-26.7)	24.1 (0.5-34.8)	203.8 (1.4-379.7)
ConMx	25	63 (15-111)	16.8 (6.4-27)	27.3 (2.4-39.1)	204.8 (10.5-451.3)
HrdMx	8	65 (47-84)	18.8 (5.9-24.9)	26.7 (0.5-41.5)	229.3 (1.4-399.7)
HrDom	14	66 (41-107)	19.6 (15.3-26.2)	27.7 (6.9-38.2)	243.3 (63.4-426.8)
OCLow	2	54 (54-54)	7.7 (5.6-9.8)	21.6 (0.1-43.2)	99.6 (0.2-198.9)
OthHd	3	71 (68-75)	15.7 (14.4-18.1)	27.4 (17.0-43.9)	181.4 (119.3-271.3)
PjDee	39	46 (9-113)	14.8 (4.7-24.7)	25.8 (0.8-43.2)	188 (1.5-420.1)
PjMx2	8	33 (17-49)	16.4 (4.1-21.3)	29.5 (1.0-41.7)	233.5 (1.8-377.2)
PoDee	61	73 (30-110)	23.9 (14.9-31.5)	32.7 (5.7-67.8)	351.7 (61.9-780.6)
PrDom	1	NA	19 (19-19)	47.9 (47.9-47.9)	426.3 (426.3-426.3)
PwDom	3	98 (91-106)	27.3 (27-27.5)	47.2 (47.2-47.4)	516.8 (505.3-531.4)
SbDee	13	40 (11-83)	12 (6-24)	22.1 (3.9-35.6)	127.9 (11.6-236.9)
SbLow	16	65 (13-130)	10.2 (5.6-19.1)	9.6 (0.2-28.1)	56.3 (0.5-222.6)
SbMx1	10	52 (34-81)	15.7 (9.7-20.5)	26.8 (1.1-43.1)	182.4 (4.5-303.6)
Total	234	61 (9-130)	17.8 (4.1-31.5)	27.1 (0.1-67.8)	230.2 (0.2-780.6)

DRM Calibration Data Summary



Model Calibration Dataset

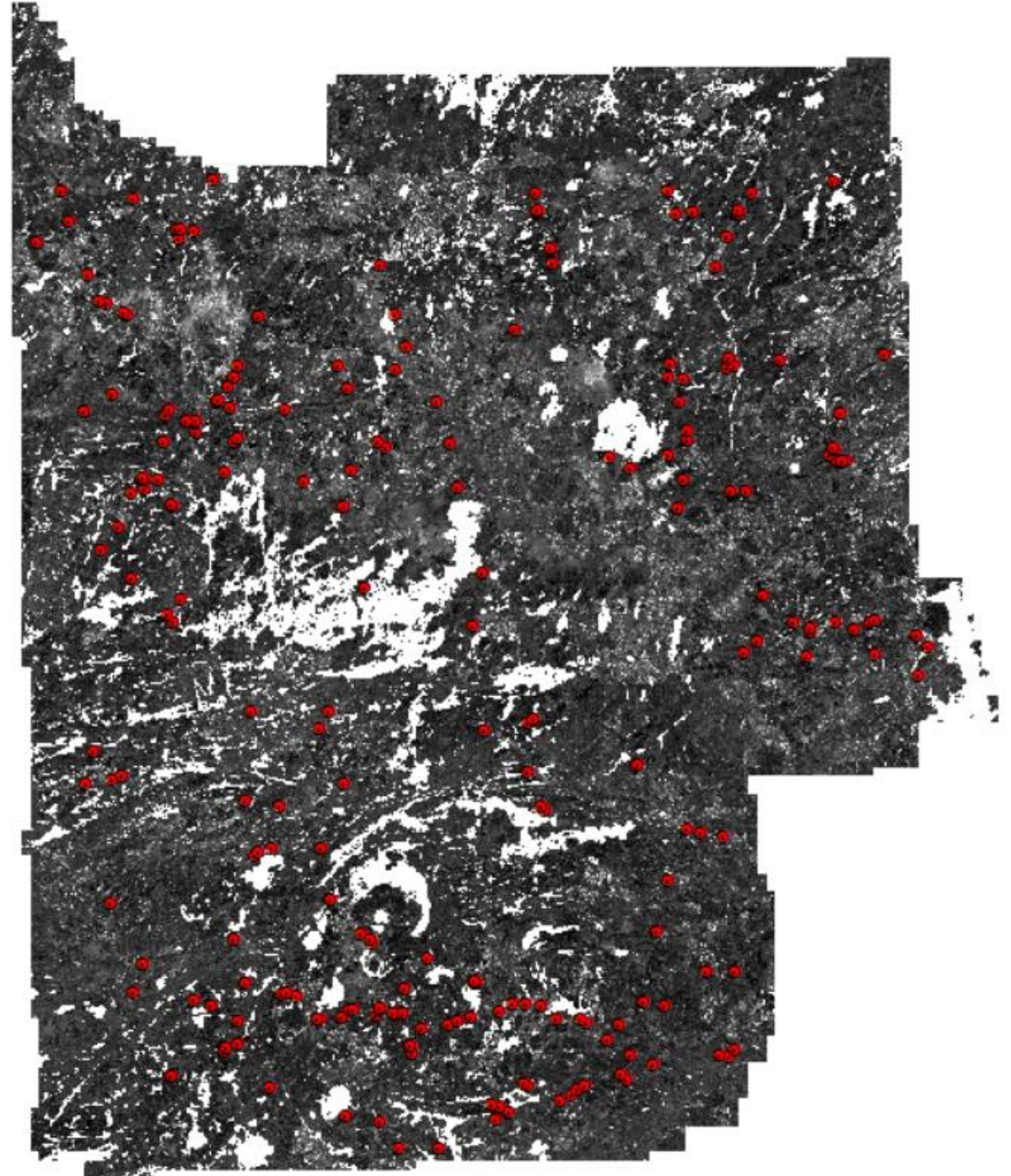
238 Calibration plots established



The following plots are being removed during Data Cleaning
7 - Dead trees only
9 - Dead trees only
10 - Dead trees only
17 - no live trees > 5m
24 - no live trees > 5m
198 -- no live trees > 5m



232 Calibration plots for Modeling

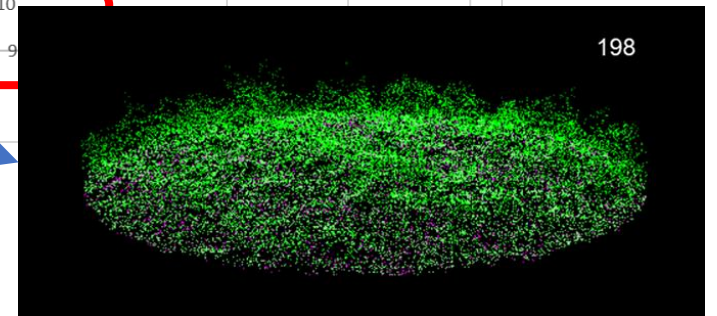
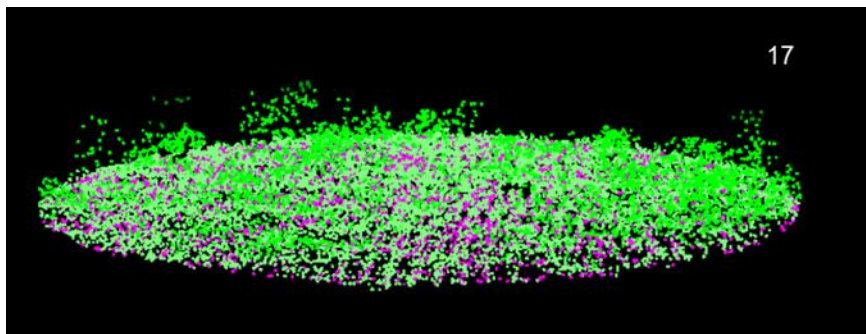
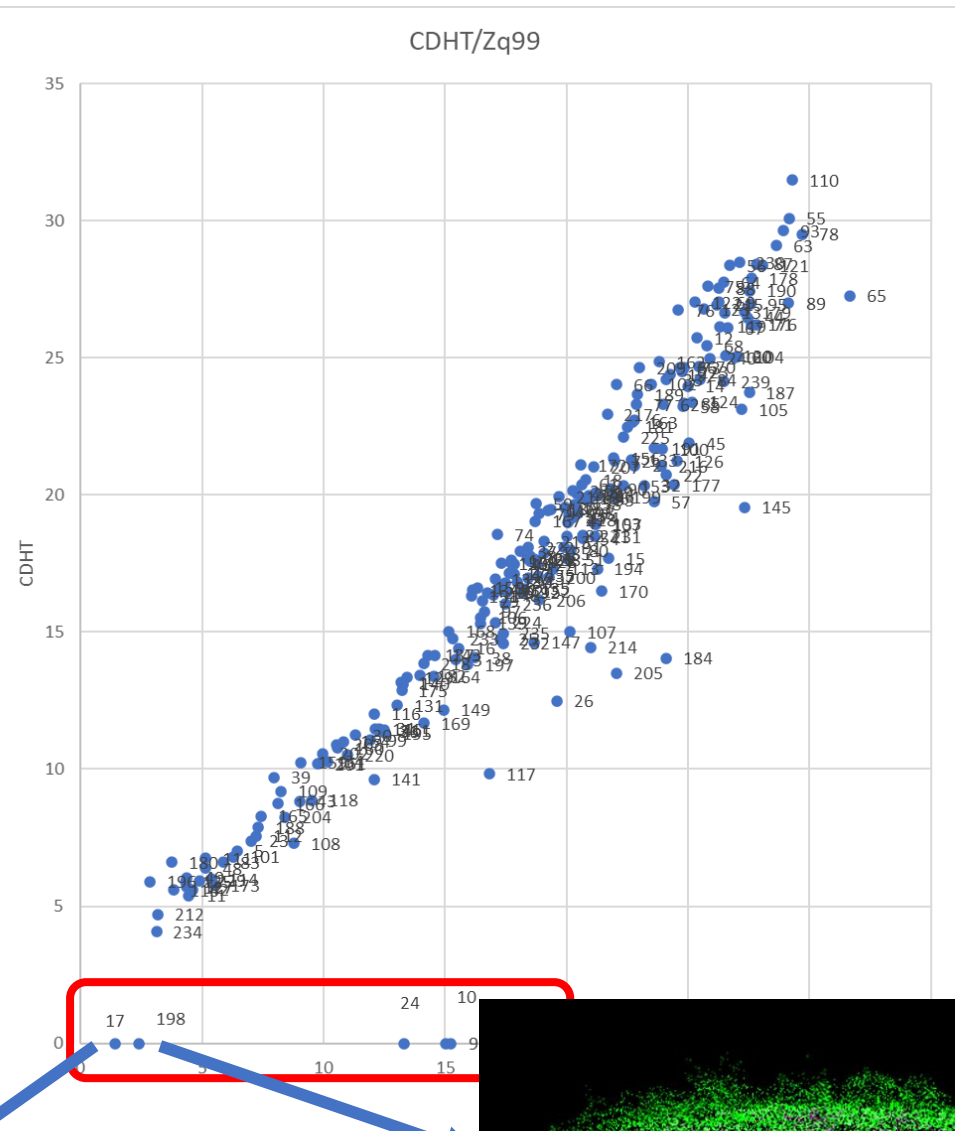


Model Calibration Dataset

238 Calibration plots established

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232 Calibration plots for Modeling

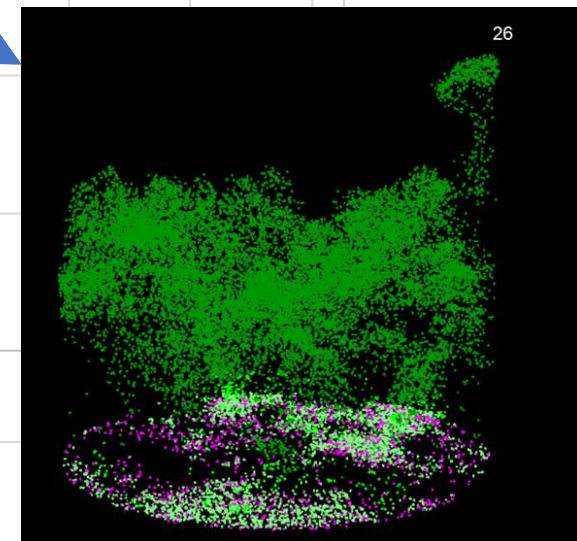
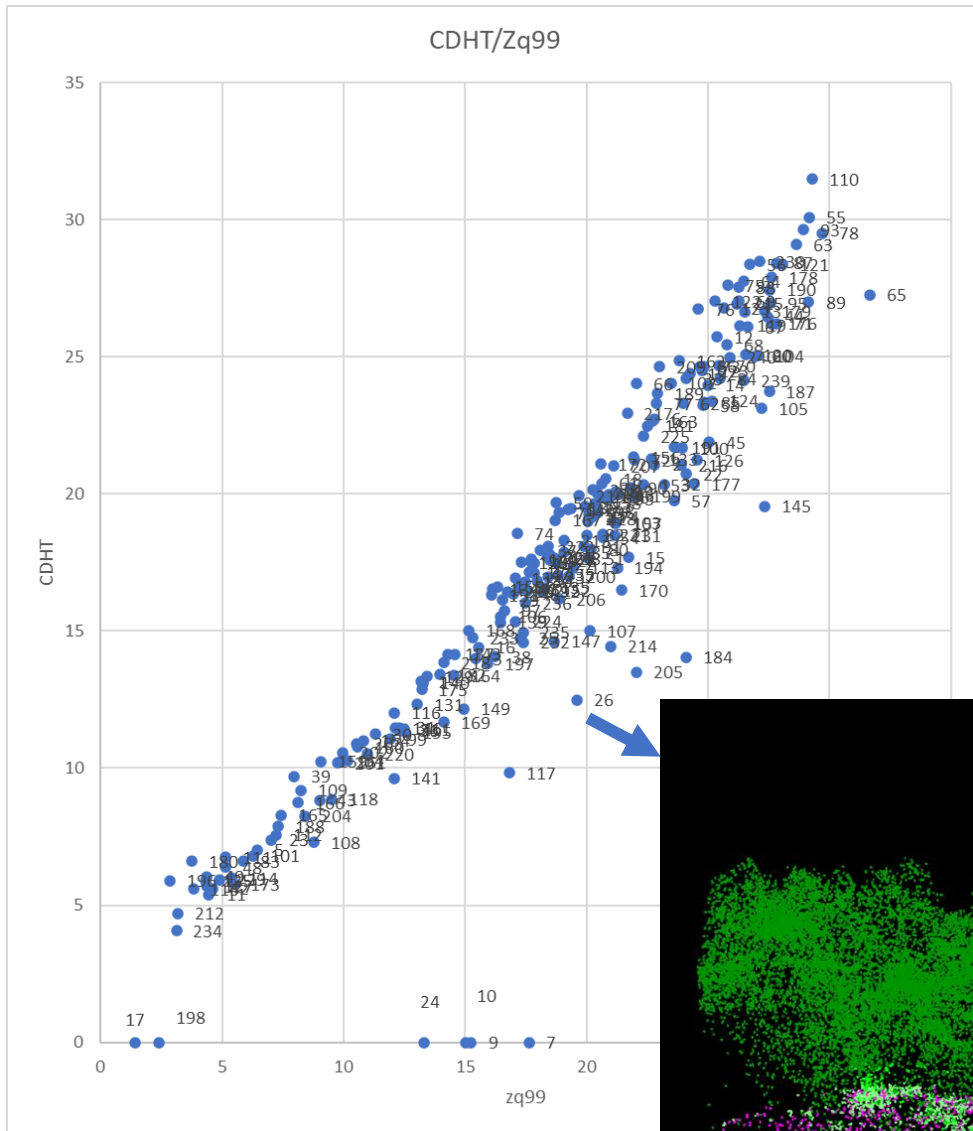


Model Calibration Dataset

238 Calibration plots established

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232 Calibration plots for Modeling

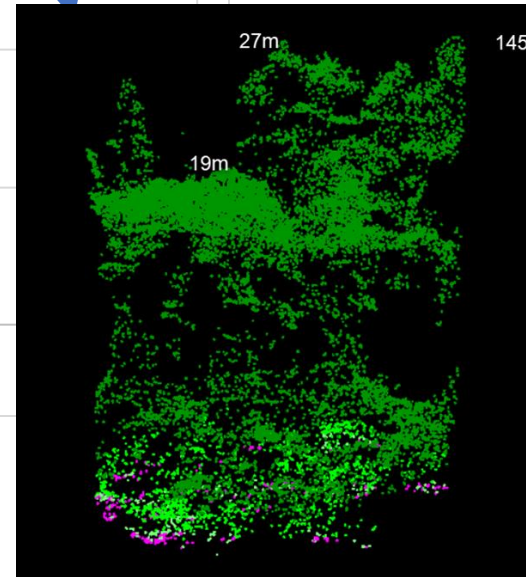
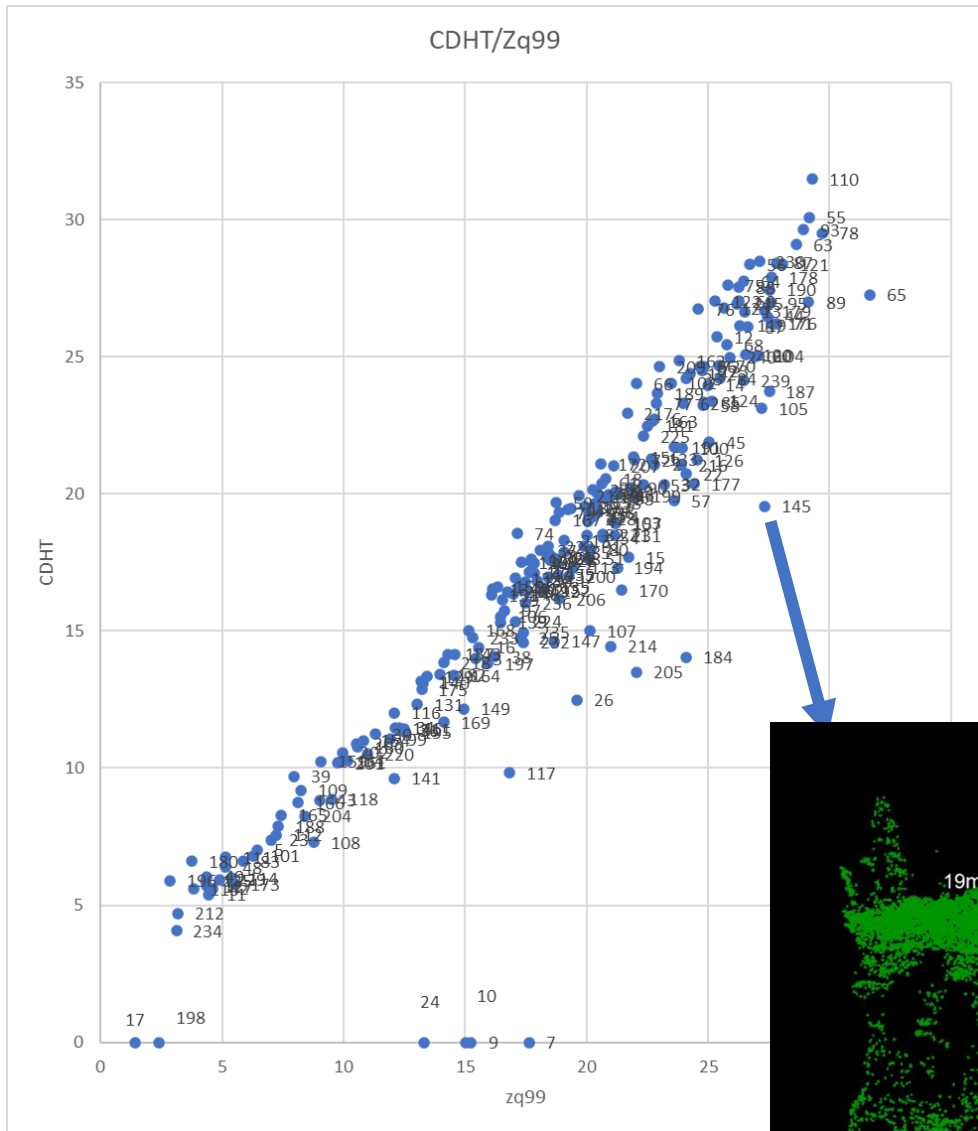


Model Calibration Dataset

238 Calibration plots established

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198 -- no live trees > 5m

232 Calibration plots for Modeling



Plot Compilation – pixel/plot attributes

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

Tree level

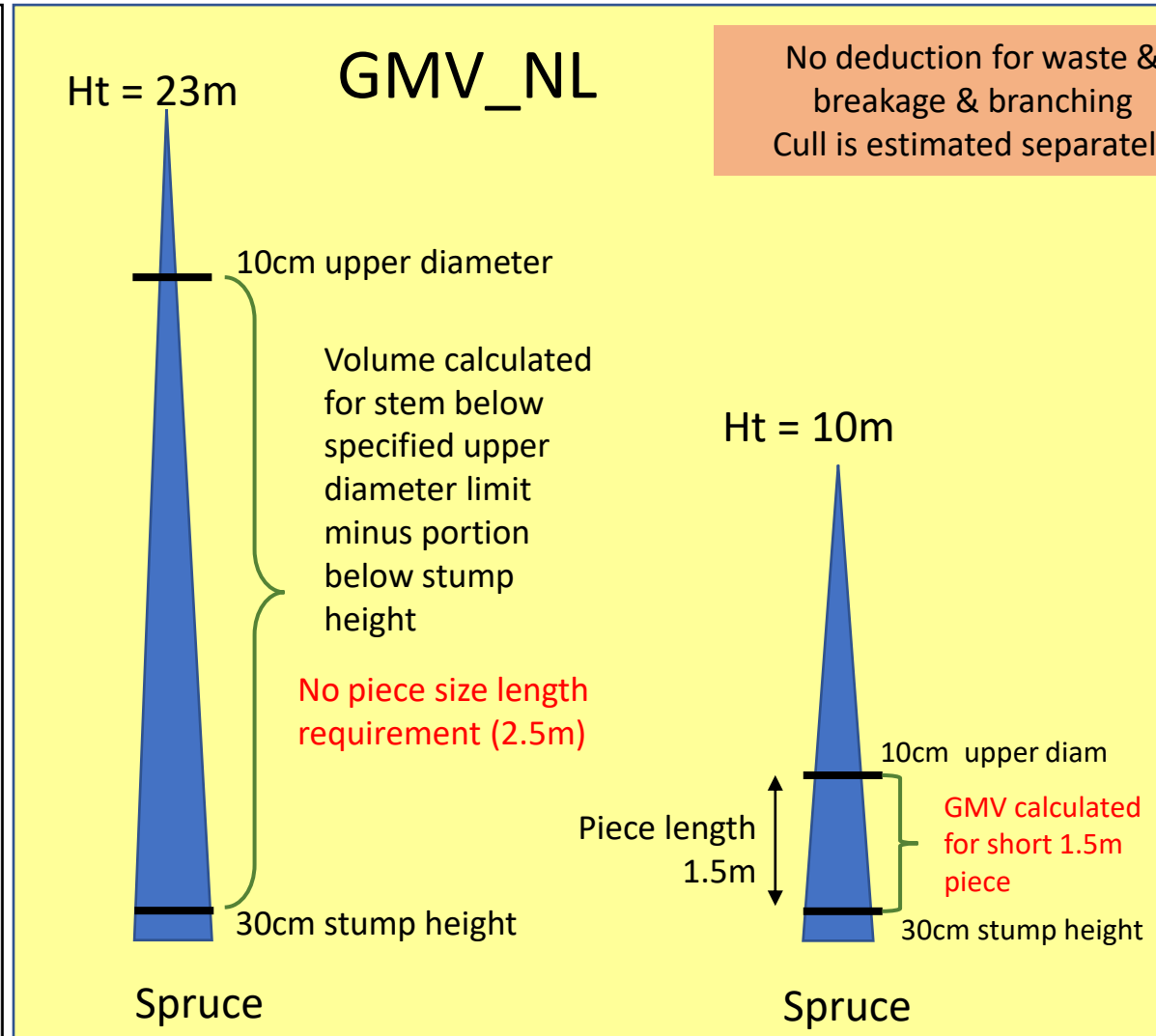
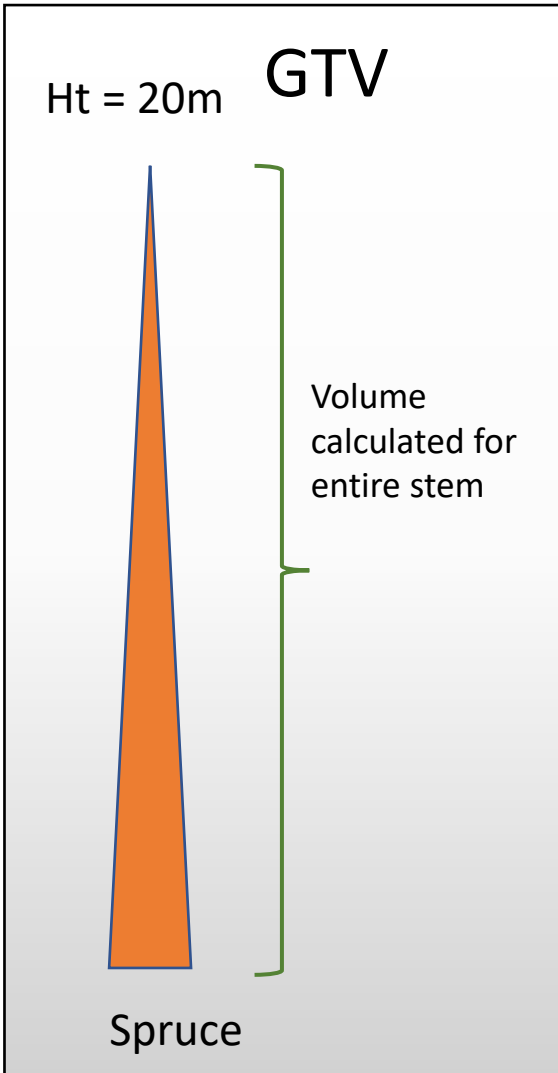
- Height – top height, dom/codom height, Lorey's height
- Quadratic mean Dbh

Area level

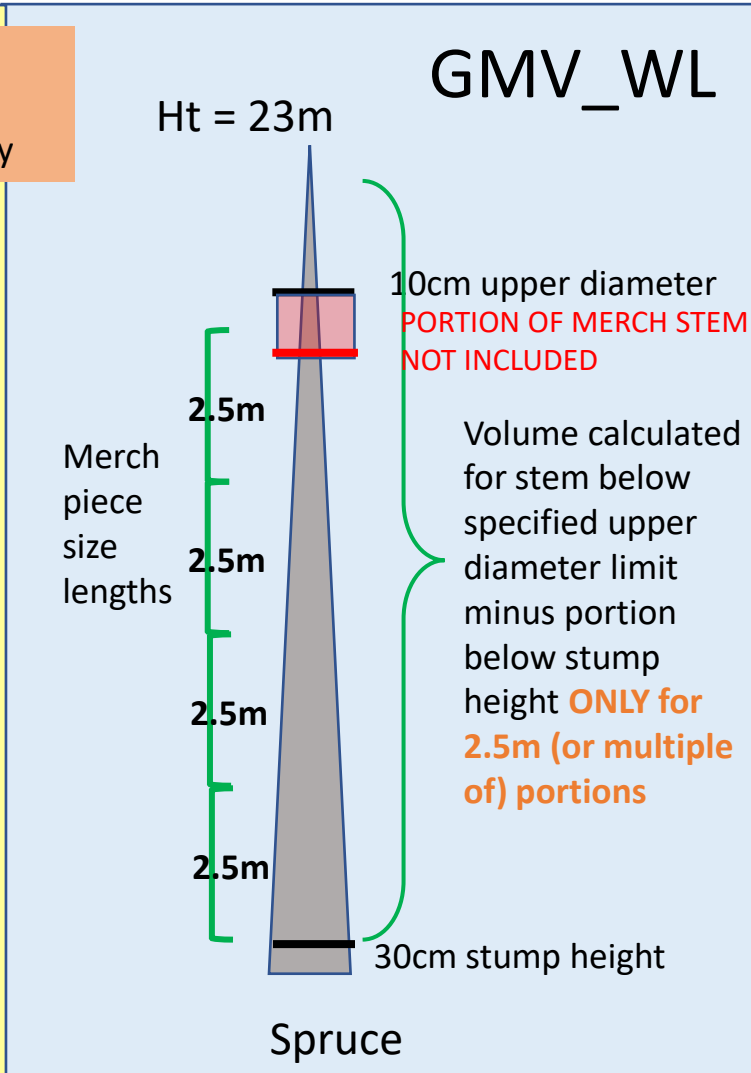
- Basal area
- Volume - GTV, GMV_NL, GMV_WL
- Biomass

Plot compilation - volumes

Species	Minimum Diameter Outside Bark (DOB)
Hardwoods (not poplar/white birch)	18cm class, 17.1 cm
Conifers (not White & Red Pine, Hemlock)	10cm class, 9.1 cm
White & Red Pine, Hemlock	14cm class, 13.1 cm
Poplar, White Birch	14cm class, 13.1 cm



No deduction for waste & breakage & branching
Cull is estimated separately



Plot compilation – SFL specific volumes

Volume	Stump height	Maximum butt diameter (inside bark)	Minimum top diameter (inside bark)	Minimum length	Maximum length	Species
GMV_NL	30 cm	NA	Table 1	None	None	All
GMV_WL	30 cm	NA	Table 1	8' 4" (2.54 m)	8' 4" (2.54 m)	All
GMV_DRM_TL_ATK	30 cm	23" (58.5 cm)	12.7 cm (Sw & Sb) 14 cm (Pj & Bf)	12' (3.6 m)	64' (19.5 m)	Applied to SPF
GMV_DRM_TL_IGN_TBY	30 cm	23" (58.5 cm)	7 cm (Sw & Sb) 9 cm (Pj & Bf)	12' (3.6 m)	64' (19.5 m)	Applied to SPF
GMV_DRM_CTL_ATK	30 cm	NA (ignoring oversize)	12.7 cm (Sw & Sb) 14 cm (Pj & Bf)	98" (2.49 m)	27' (8.23 m)	Applied to SPF
GMV_DRM_CTL_IGN_TBY	30 cm	NA (ignoring oversize)	7 cm (Sw & Sb) 9 cm (Pj & Bf)	98" (2.49 m)	27' (8.23 m)	Applied to SPF
GMV_DRM_Norbord_Hwd	30 cm	24"	4" (10cm)	102" (259 cm)	106" (2.69m)	Applied to Po/Bw
GMV_DRM_Kenora_Hwd	30 cm	30"	4" (10cm) poplar 6" (15cm) birch	80" (2.03m)	115" (2.92m)	Applied to Po/Bw

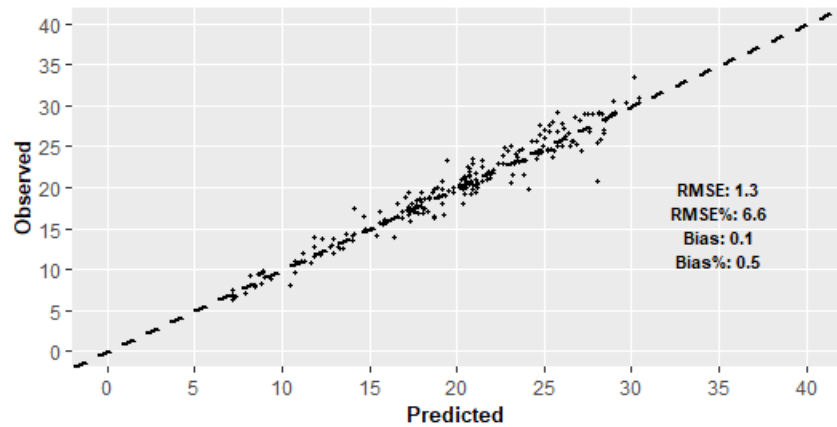
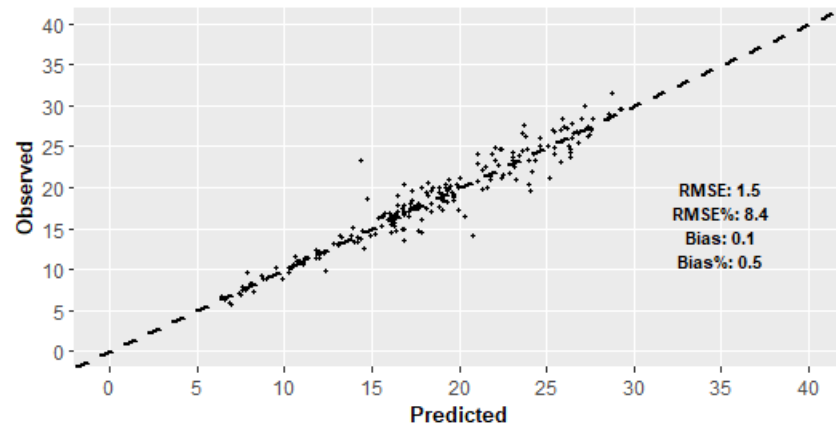
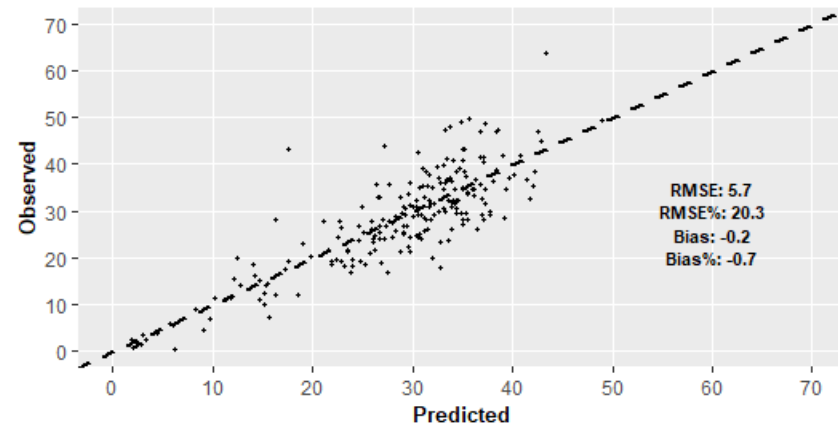
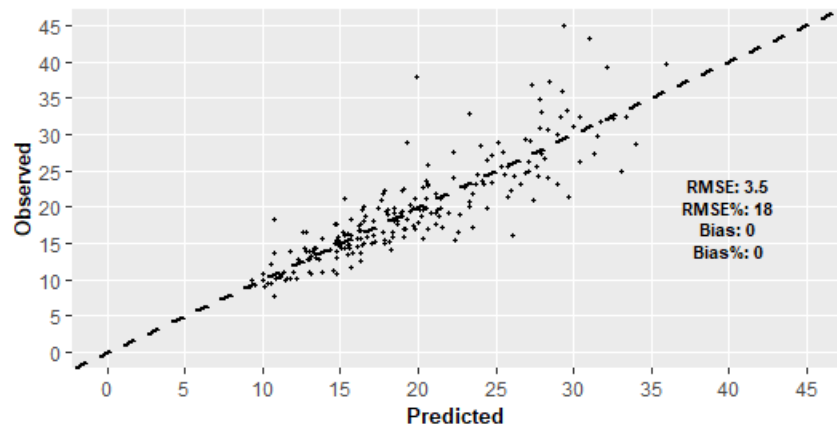
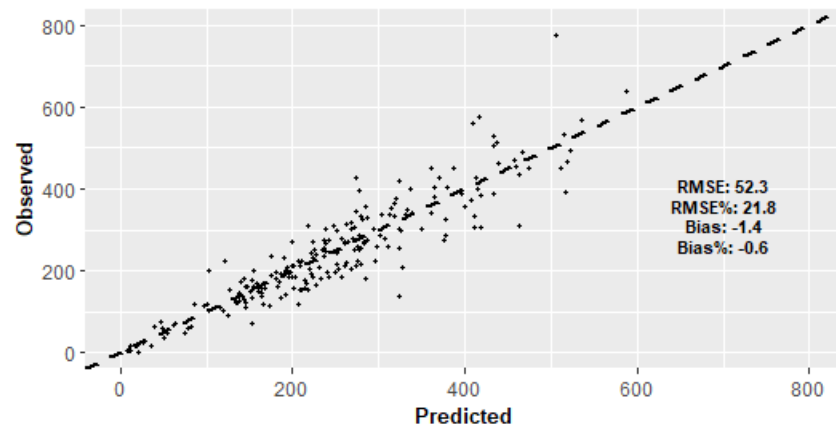
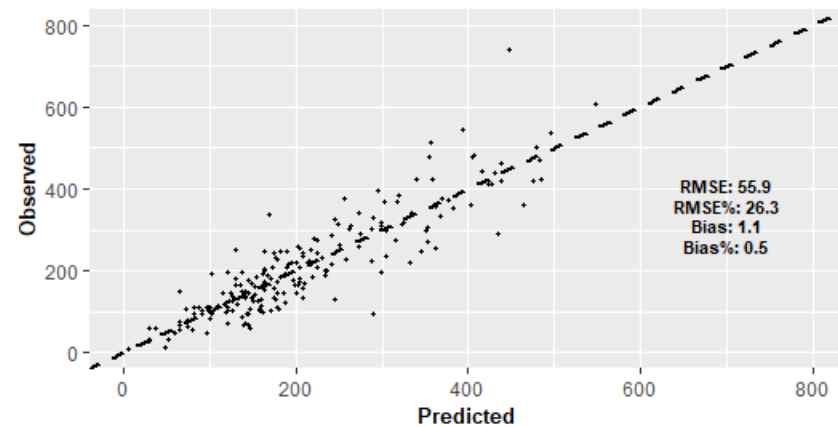
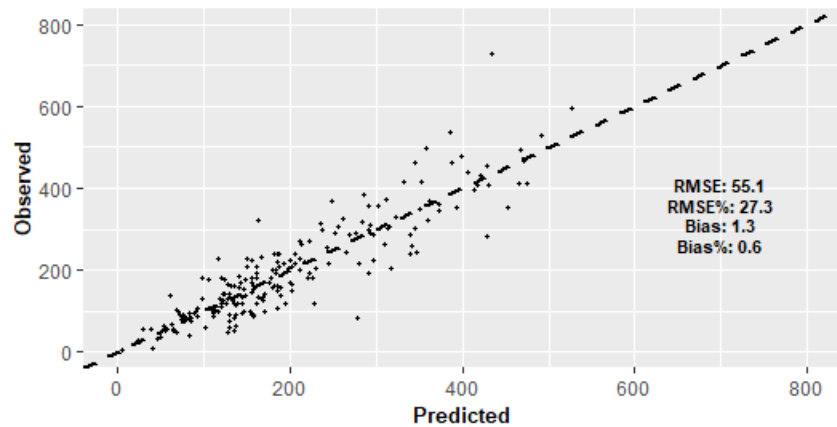
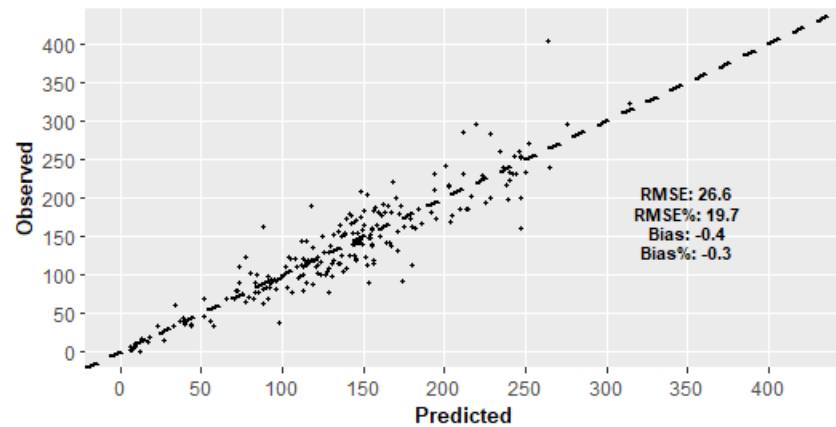
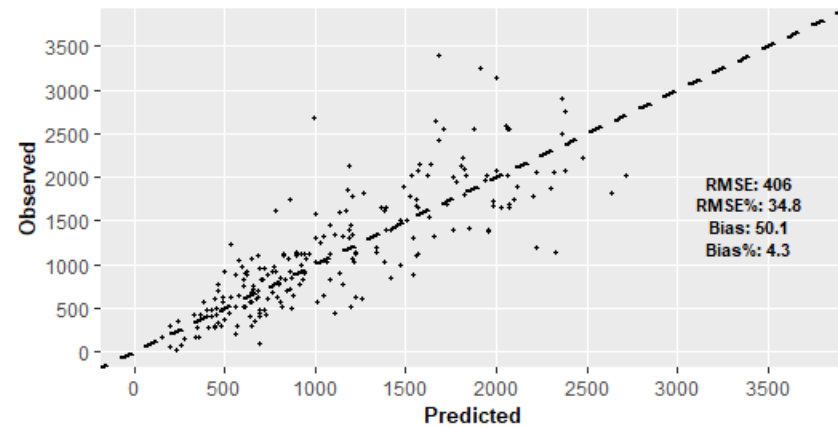
SPF = white & black spruce, jack pine and balsam fir

Tamarack, white and red pine are ignored are not included in SPF

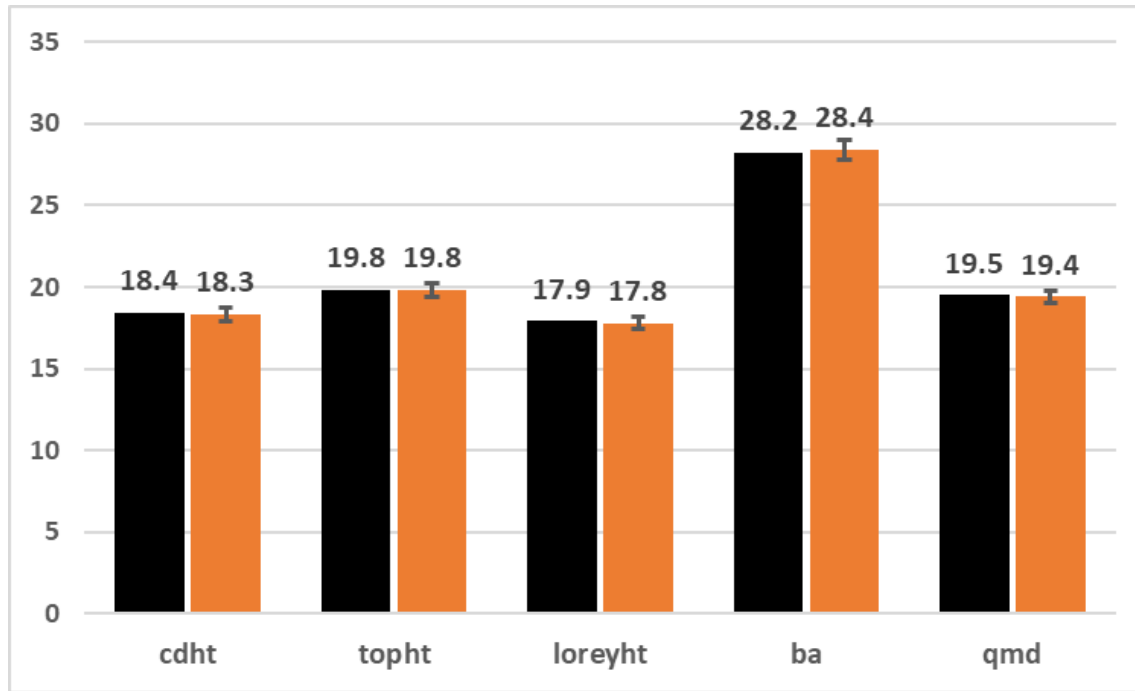
Plot Compilation – BA/volume by size class

Standard Deliverable

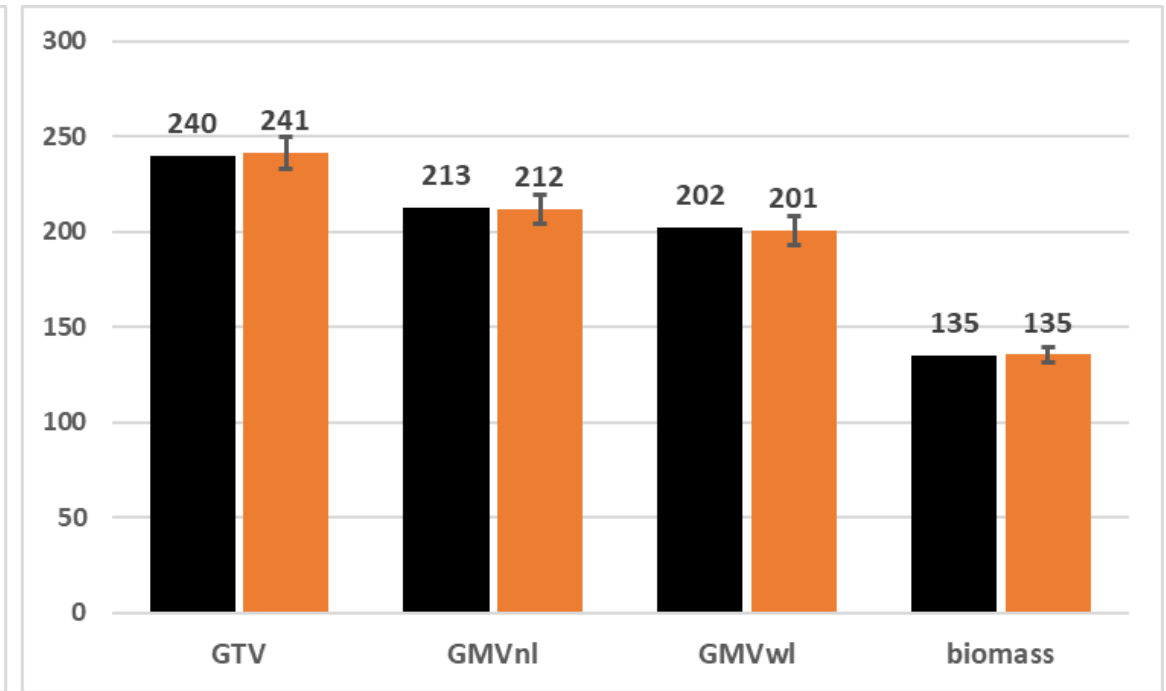
- Only one GMV being modeled (GMV_nI)
- 4 Size classes
 - SmPoles [9 < Dbh ≤ 16 cm]**
 - LargePoles [16 < Dbh ≤ 25]**
 - Small Sawlogs [25 < Dbh ≤ 37]**
 - Large Sawlogs [37cm+]**
- 9m threshold for GMV and size class predictions

Top Height (m)**Average Dom-CoDom Height (m)****Basal Area (m2 ha)****Dbhq (cm)****Gross Total Volume (m3 ha)****Gross Merchantable Volume_NL (m3 ha)****Gross Merchantable Volume_NL (m3 ha)****Total Above Ground Biomass (tonnes ha)****Calculated Stems (ha)**

LiDAR Modelling – Plot Level Cross Validation



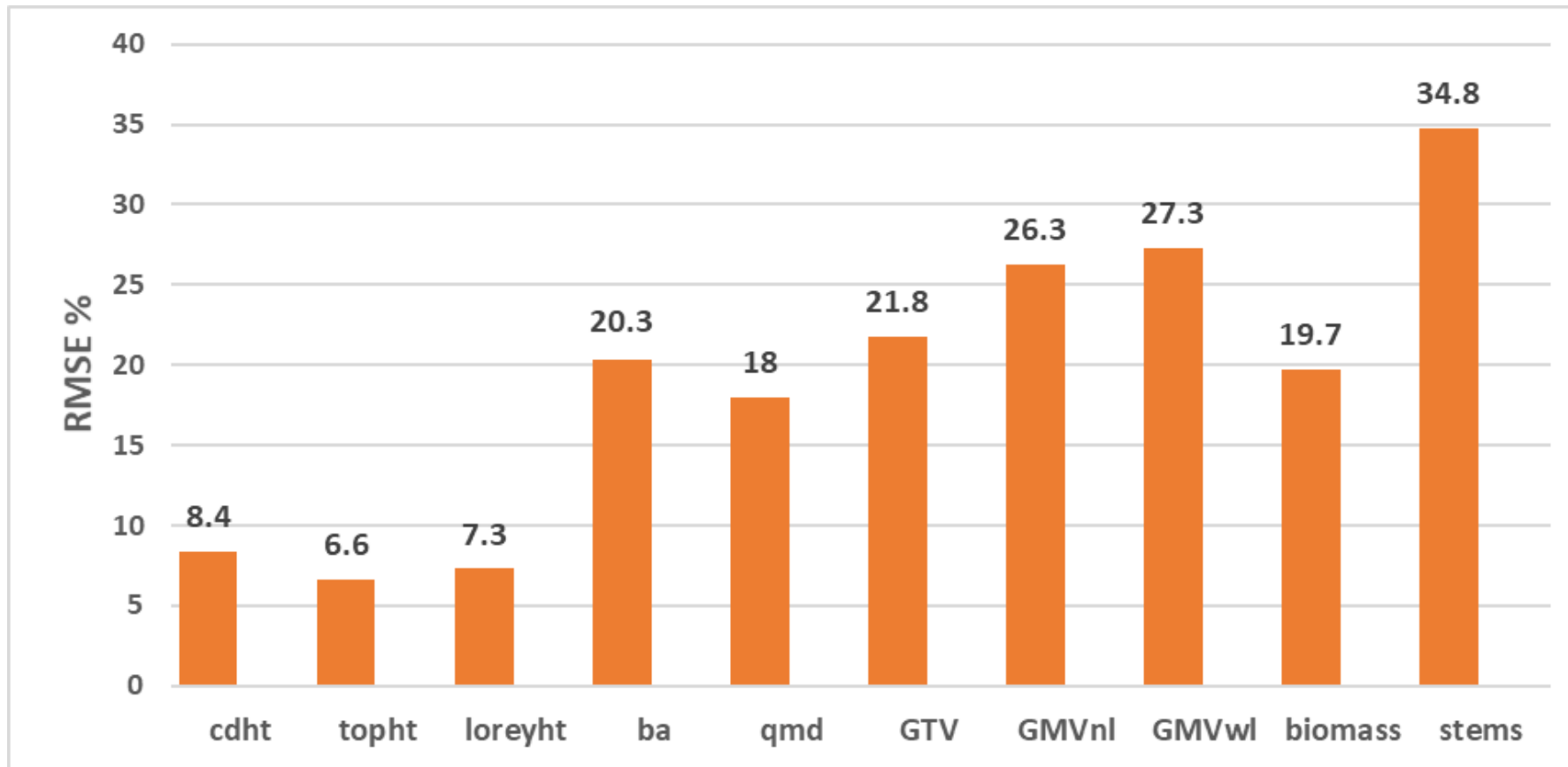
Observed Predicted



Observed Predicted

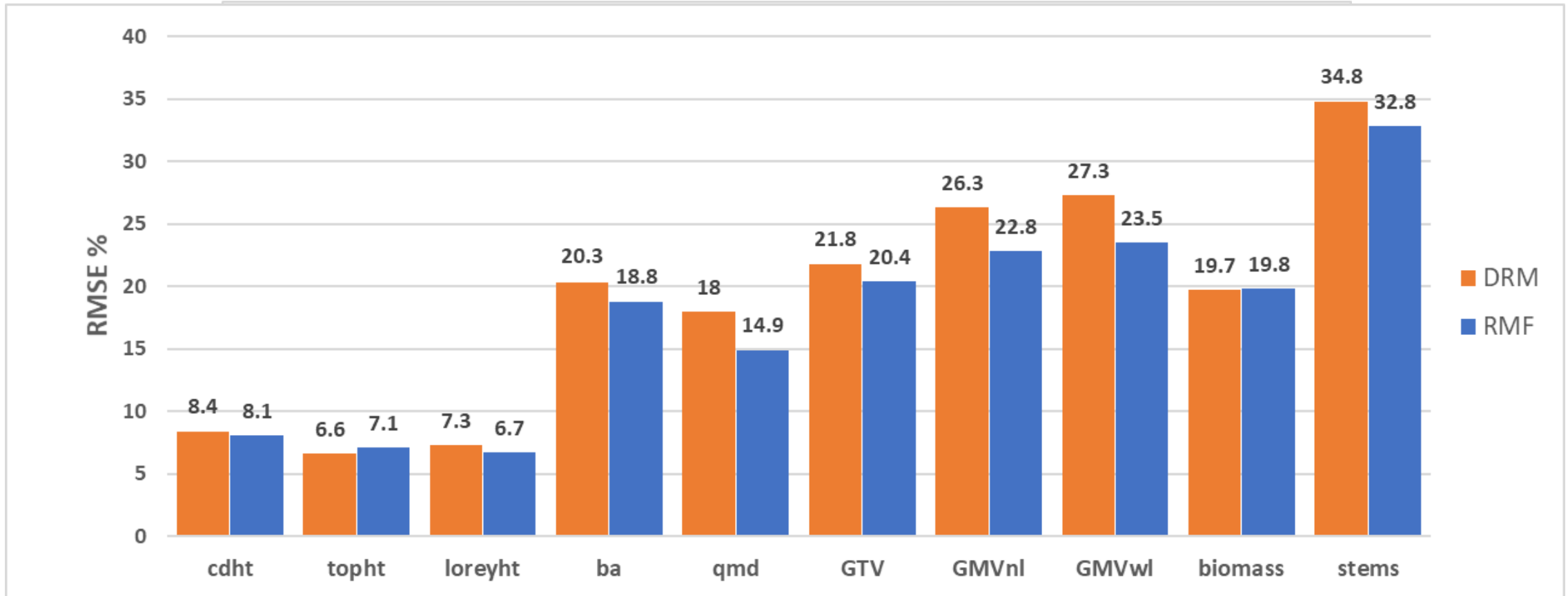
LiDAR Modelling – Plot Level CV RMSE%

Dog River Matawin

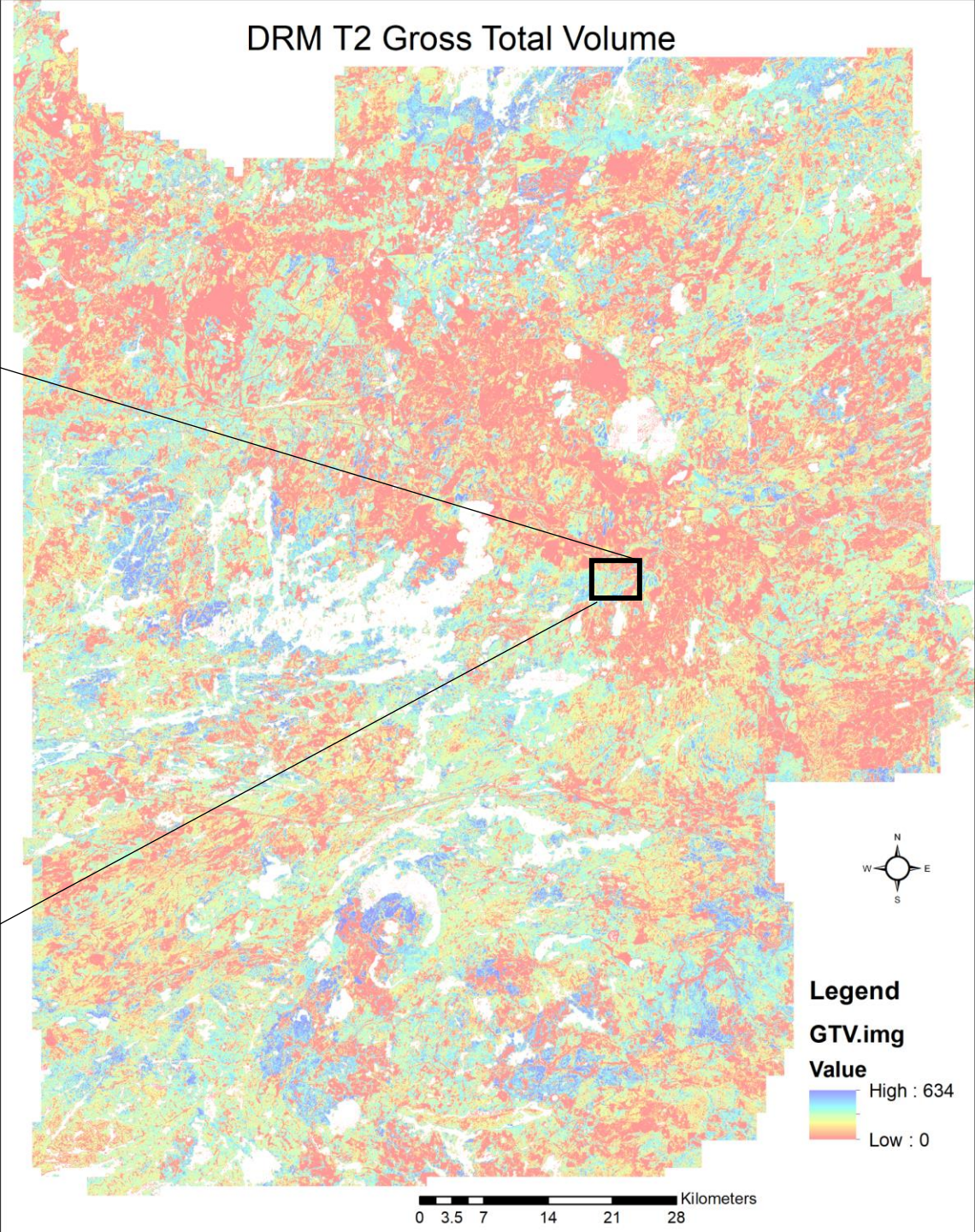
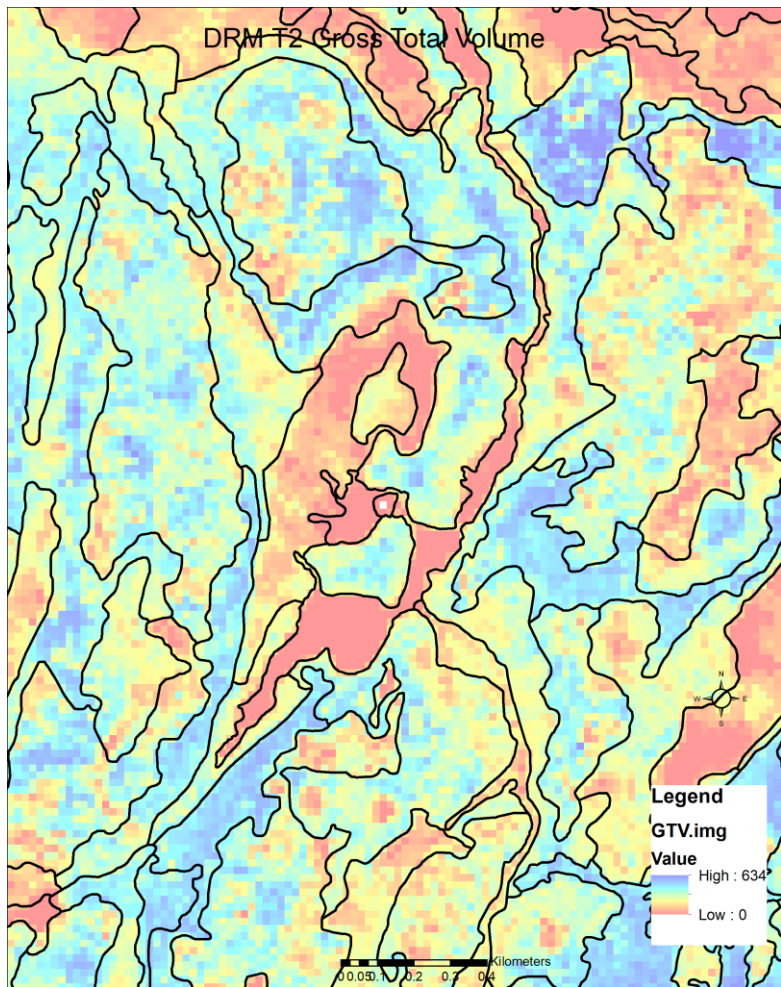


LiDAR Modelling – Plot Level CV RMSE%

Dog River Matawin & RMF Comparison



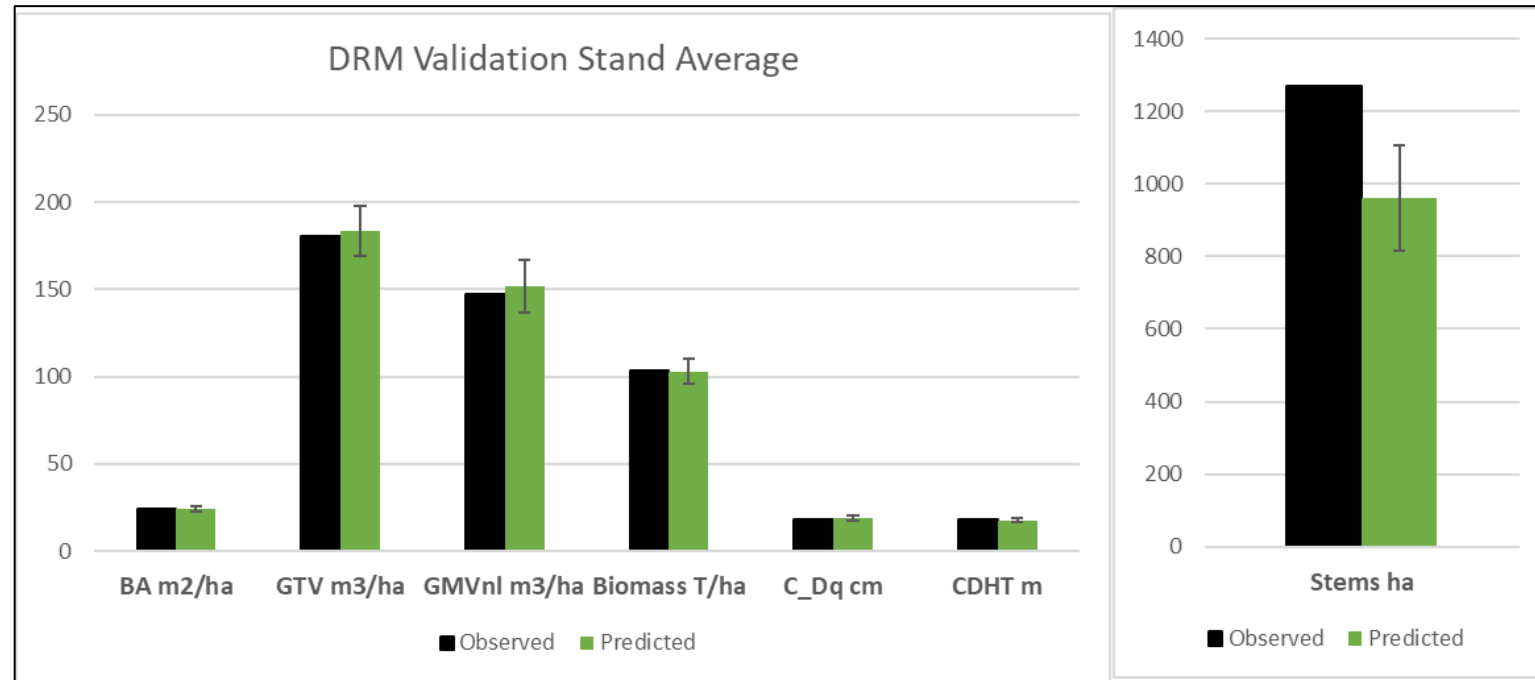
DRM LiDAR Inventory Raster



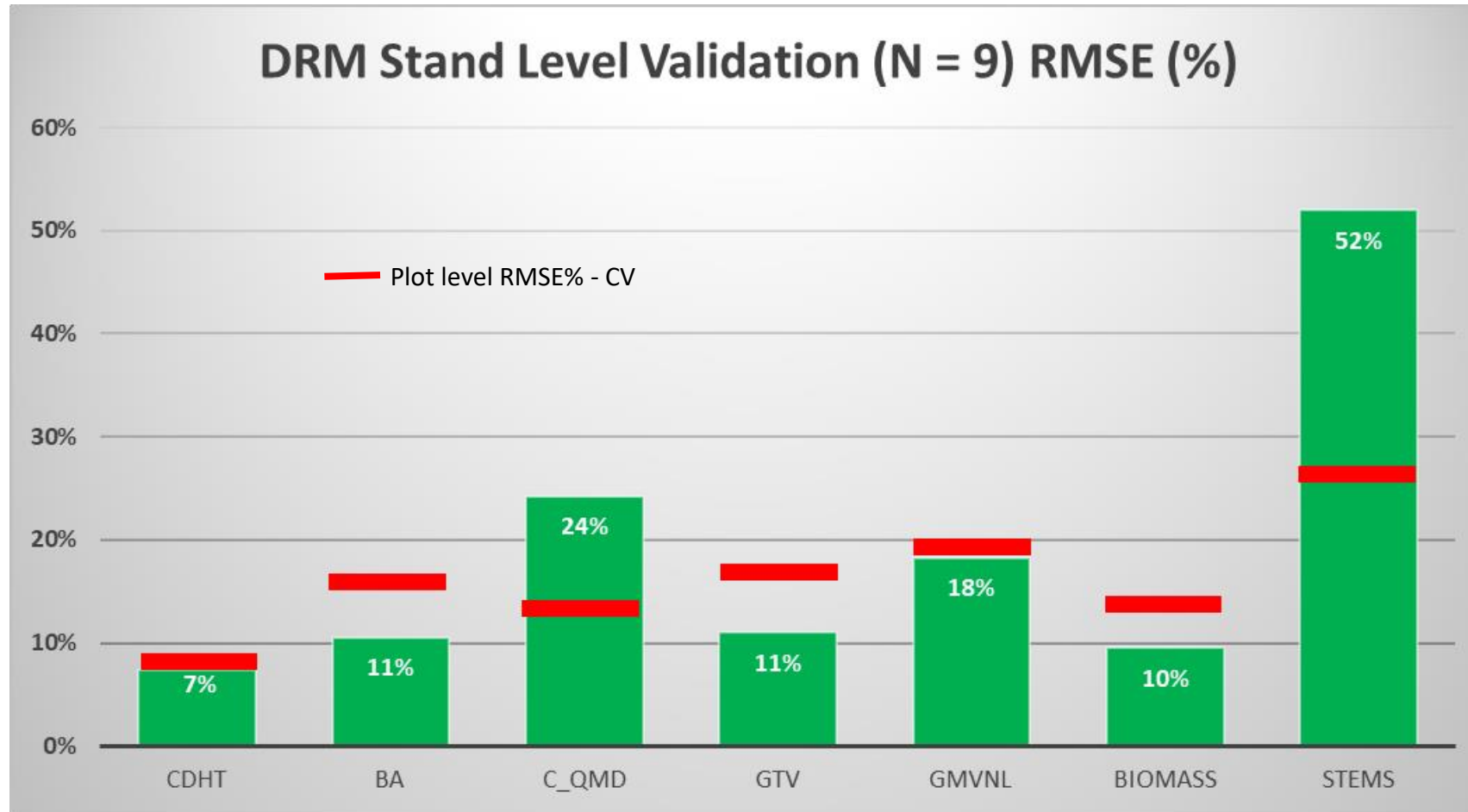
Stand Level Validation

- 9 DRM Polygons sampled
- Range of Structures/Forest Units
- BAF 2 Prism Cruise
- Mixed Species Compositions

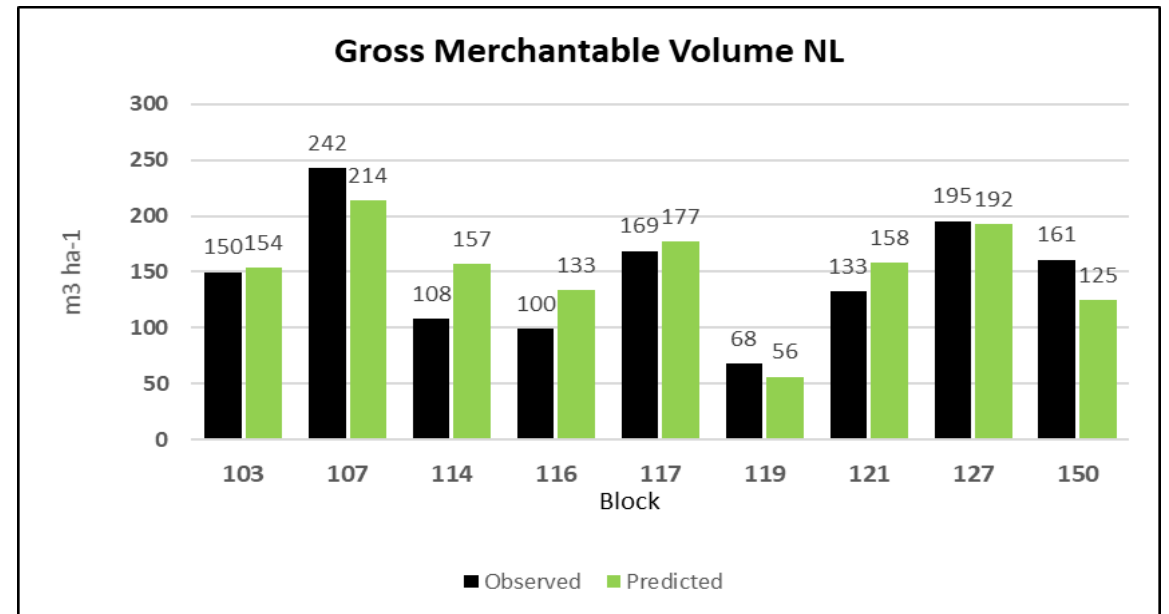
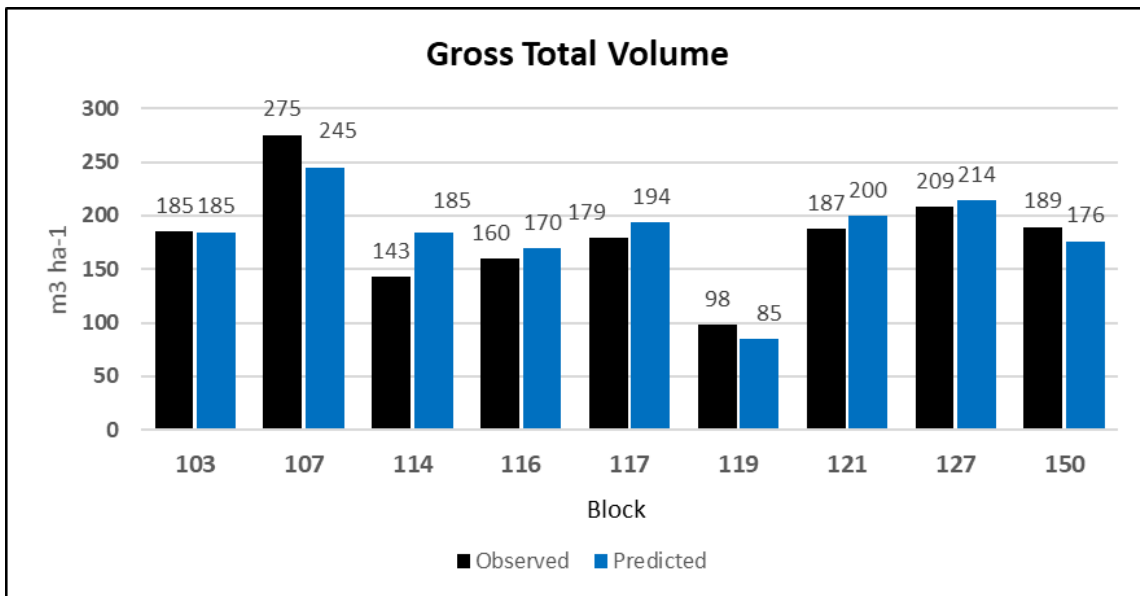
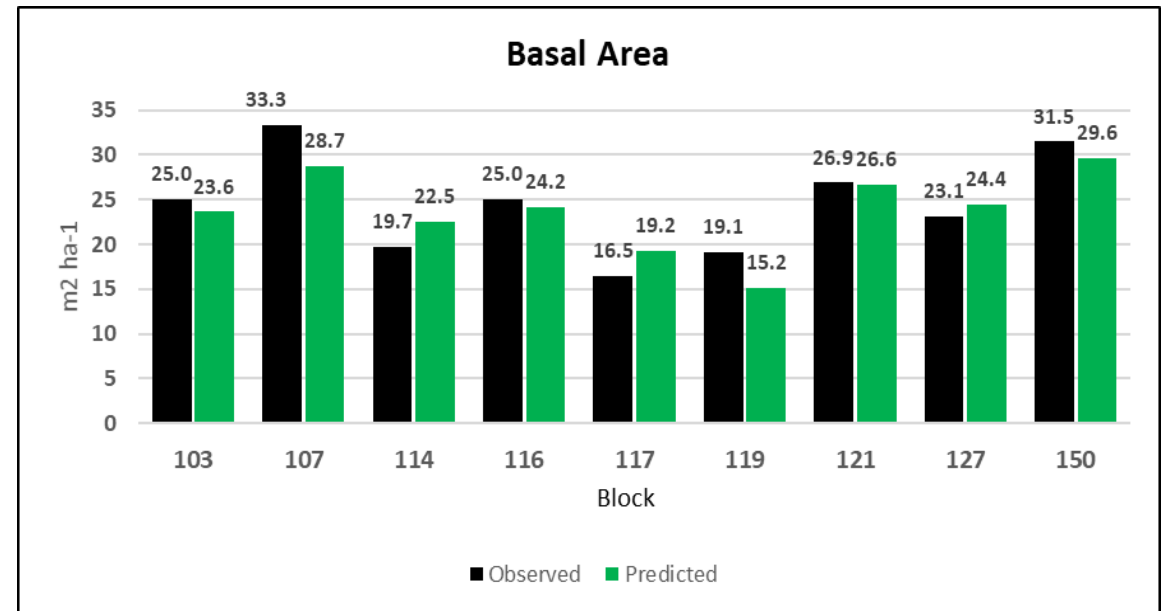
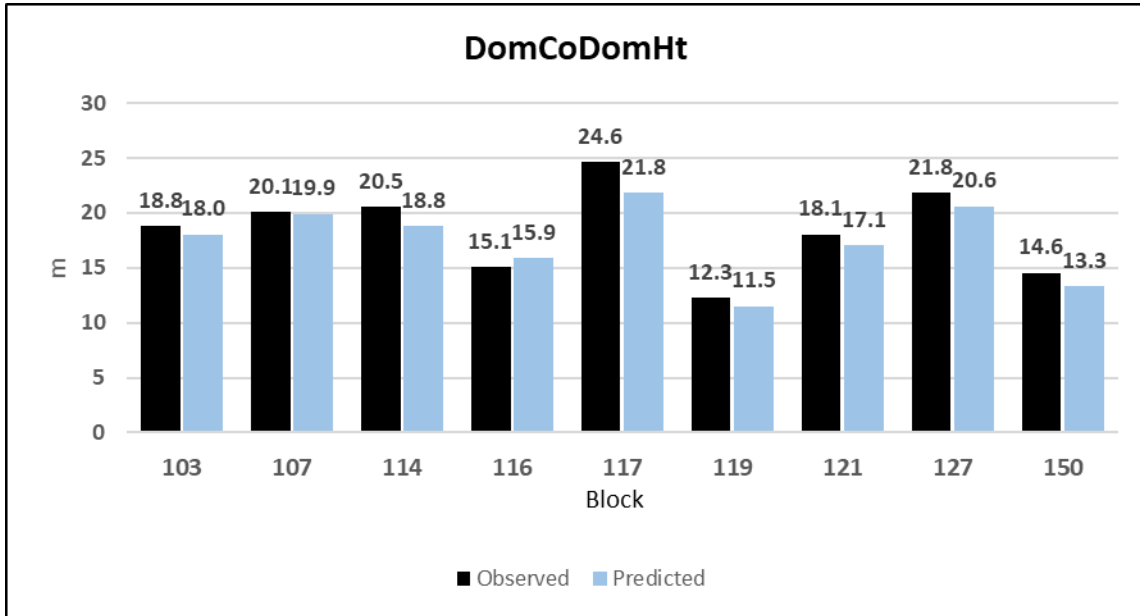
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103	20	Pt 29 Bf28 Bw21 Mr9 Pw4 Sw3 Sb3 Pb2 Ab1
107	20	Sb 46 Pj41 Bf8 Pt4 La1 Sw0
114	20	Pt 40 Bf31 Sb23 Bw3 121 Pj1 Sw1
116	20	Bf 58 Pt29 Sb8 Bw3 Sw2 Pb0
117	20	Pt 92 Sw5 Bw2 Cp1
119	20	Sb 67 La18 Cw14 121
121	20	Bf 33 Pw32 Pt16 Bw12 Sb4 Cw2 Sw1 Am0
127	20	Pj 75 Pt11 Sb6 Bf4 Sw3 Bw1 120
150	20	Sw 53 Sb31 Bf15 Pt1 Bw0 Pj0



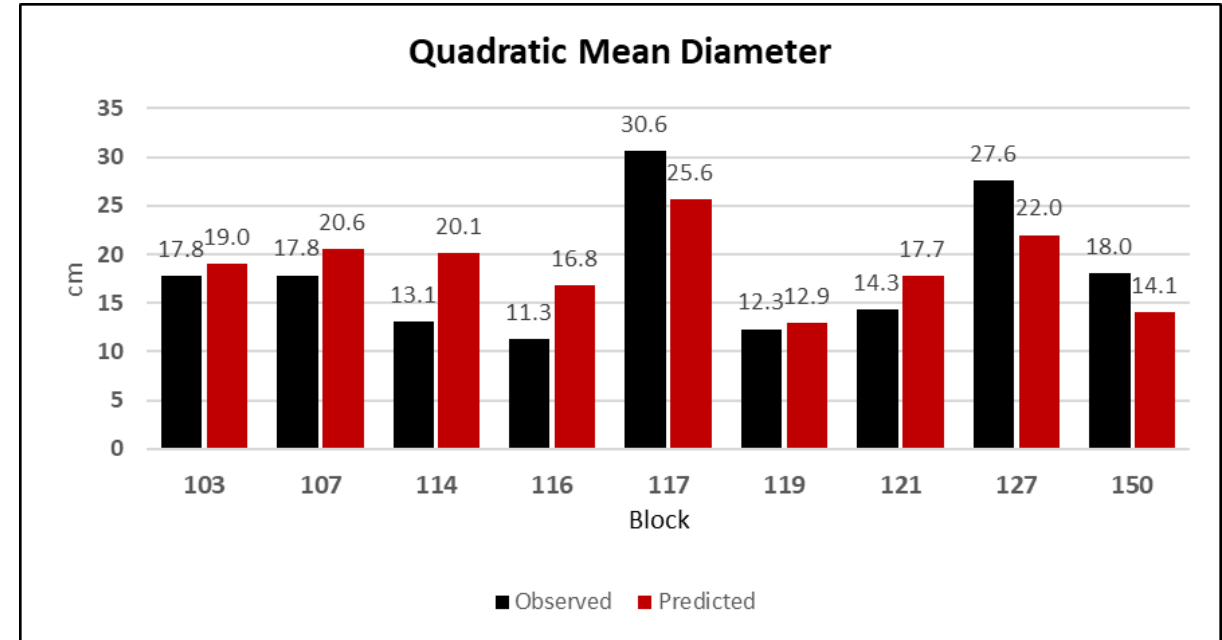
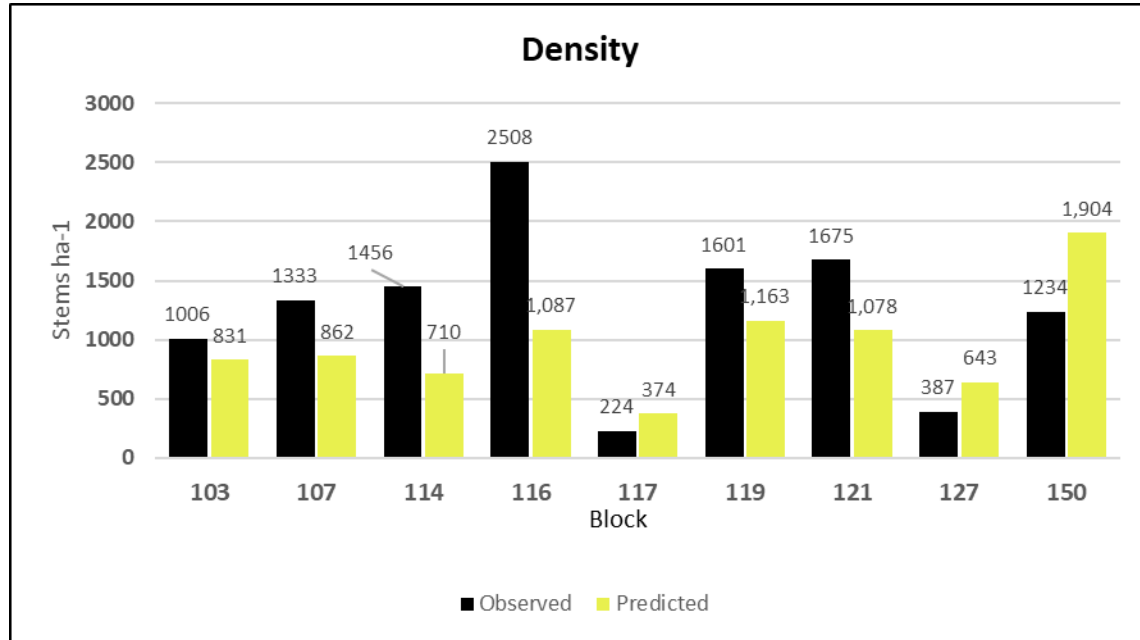
Stand Level Validation RMSE



DRM Stand Level Validation

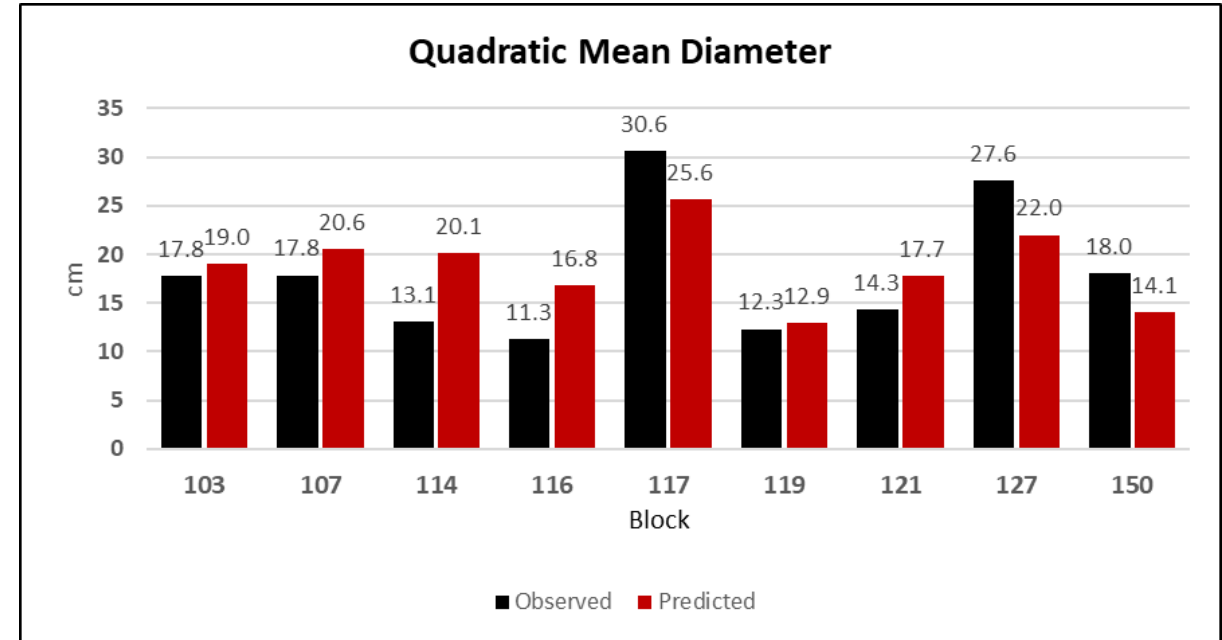
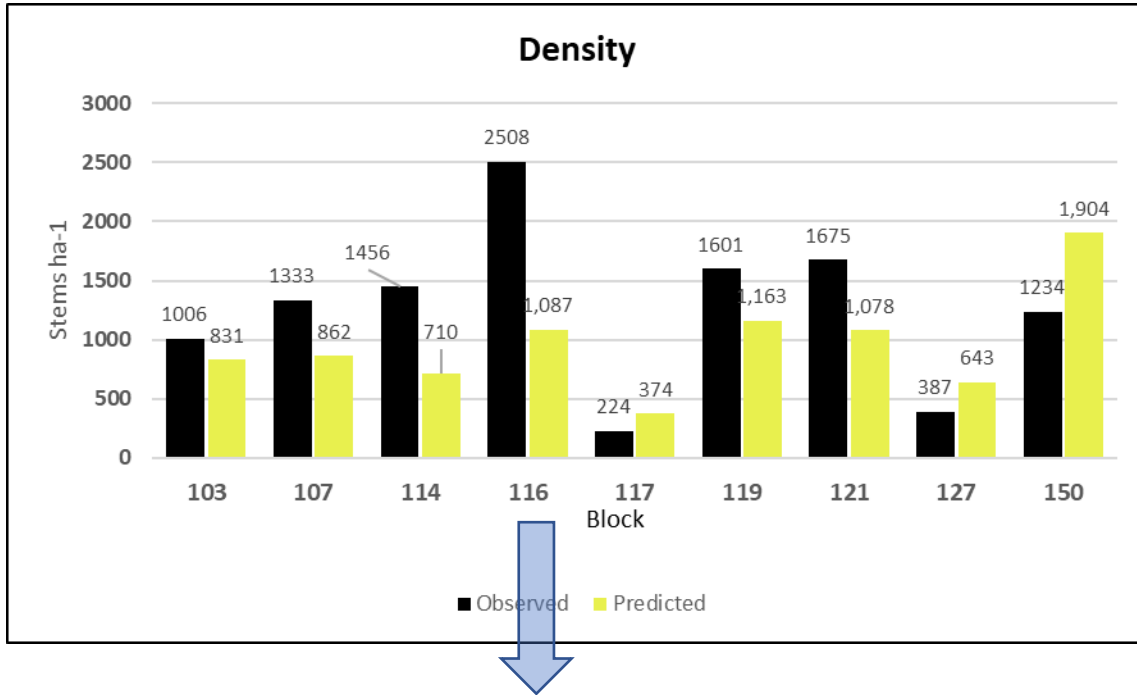


DRM Stand Level Validation

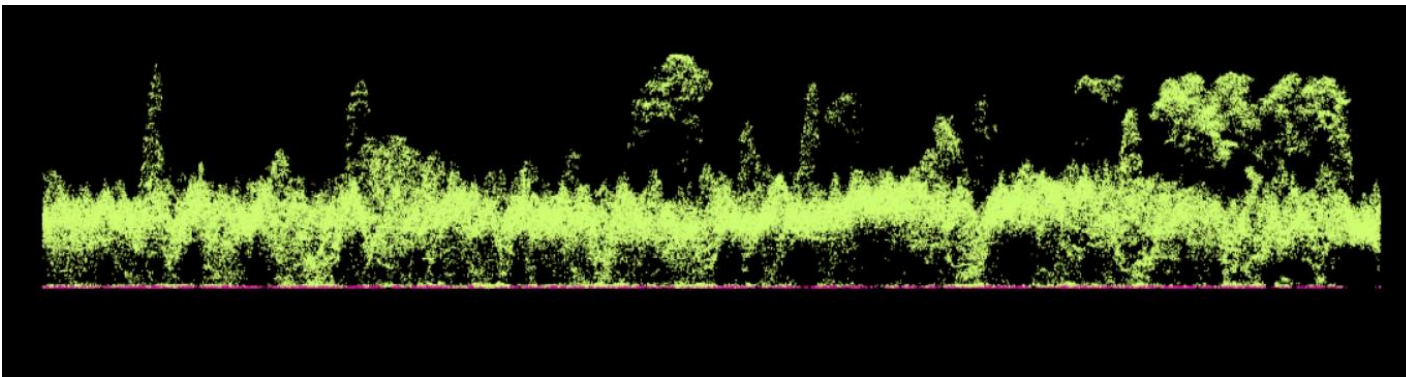


Updated Feb 6 22 for null plots

DRM Stand Level Validation



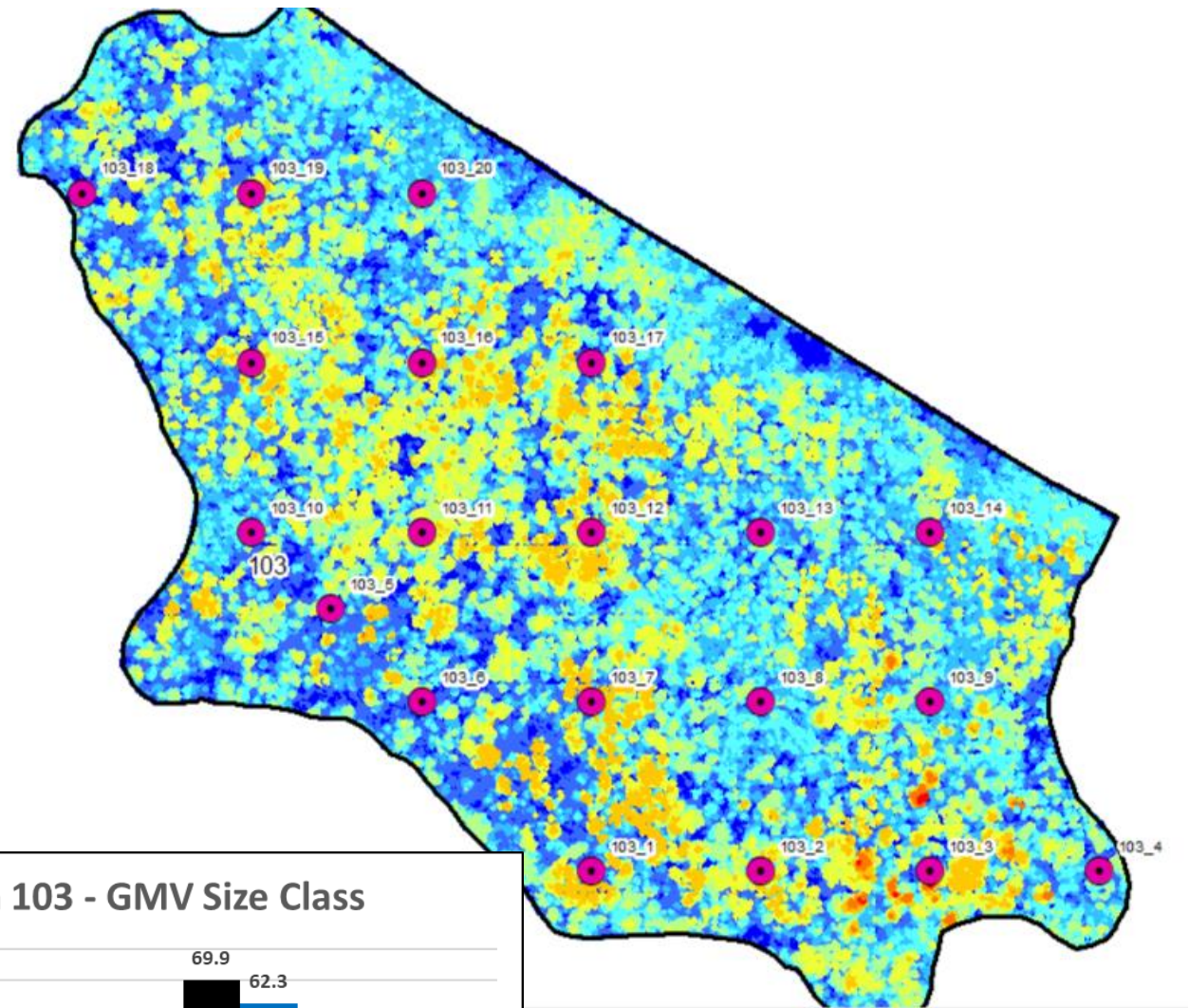
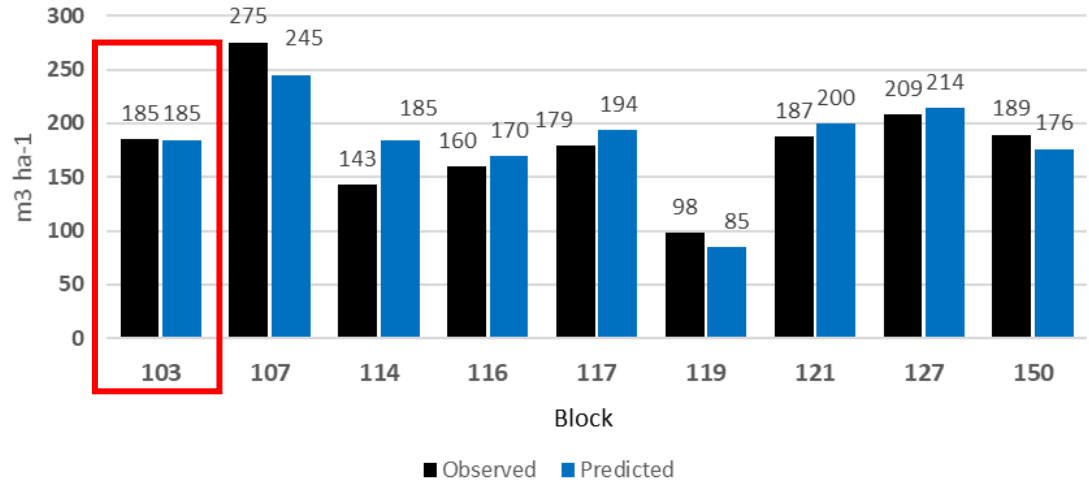
116 Bf 58 Pt29 Sb8 Bw3 Sw2 Pb0



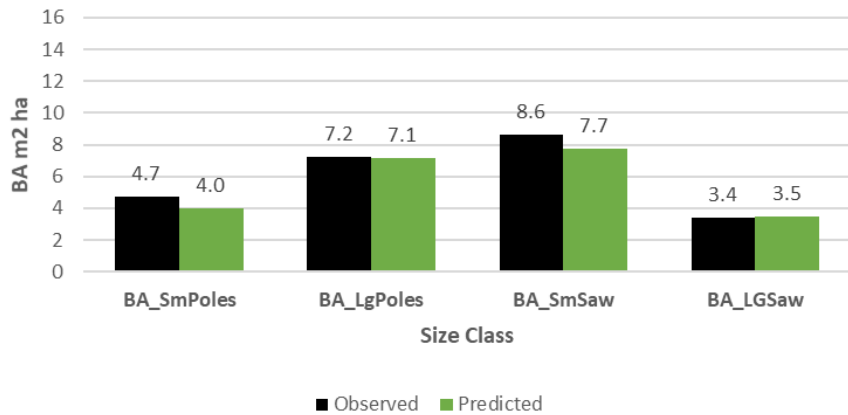
Polygon 103 STRATA: HwDom_CX

Pt 29 Bf28 Bw21 Mr9 Pw4 Sw3 Sb3 Pb2 Ab1

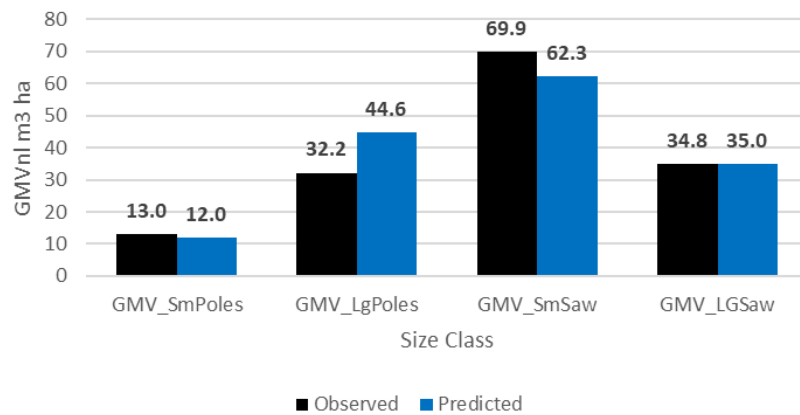
Gross Total Volume



Polygon 103 - BA Size Class

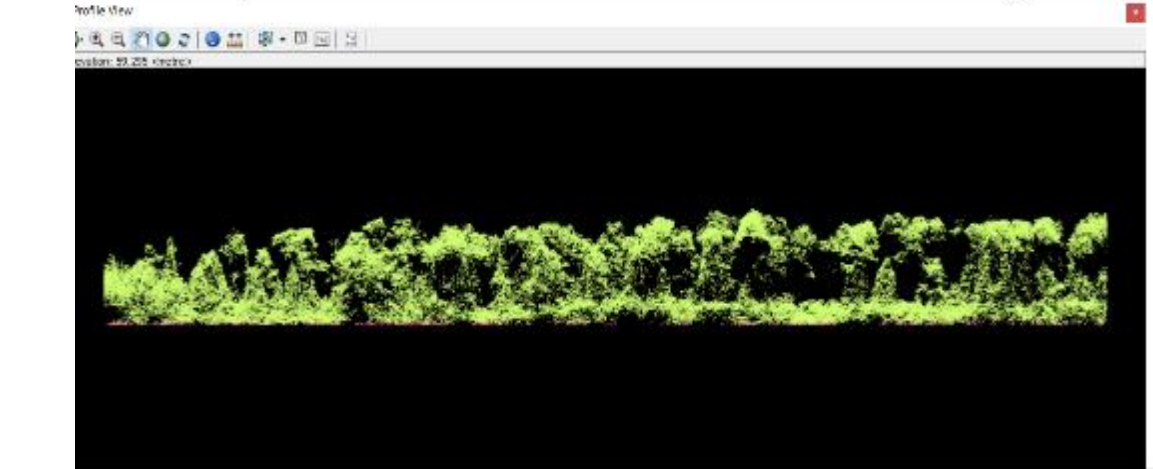
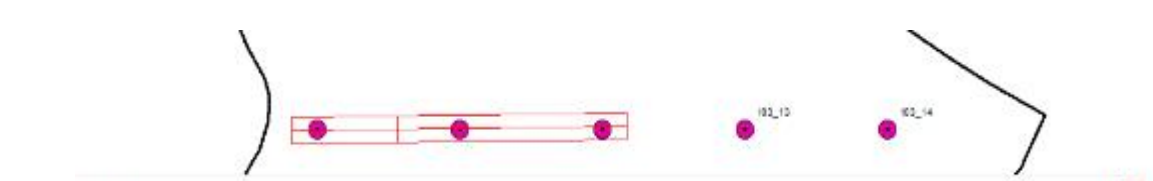
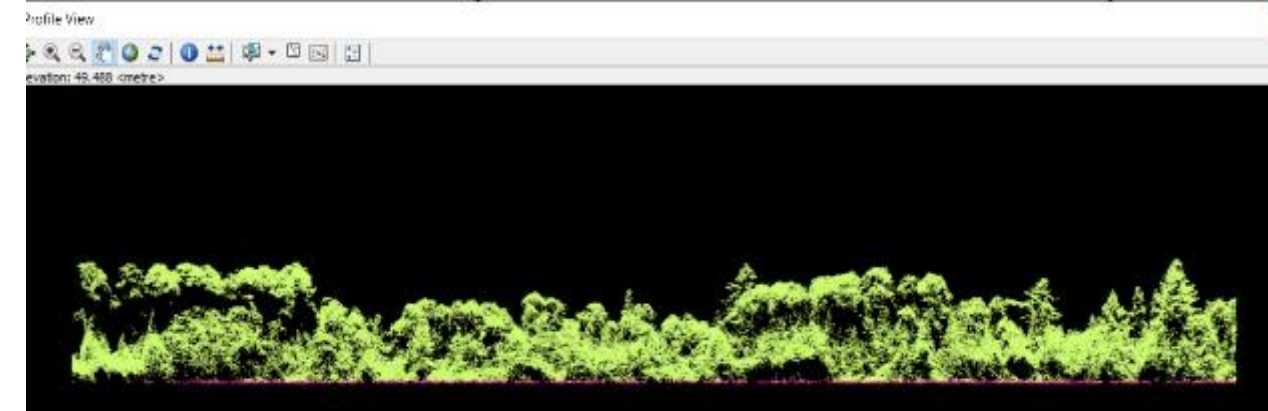
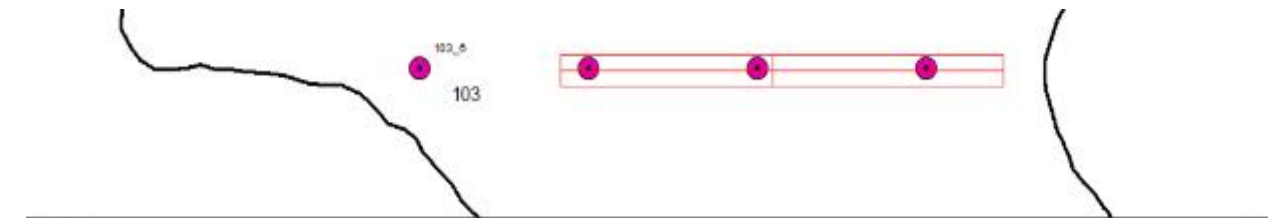
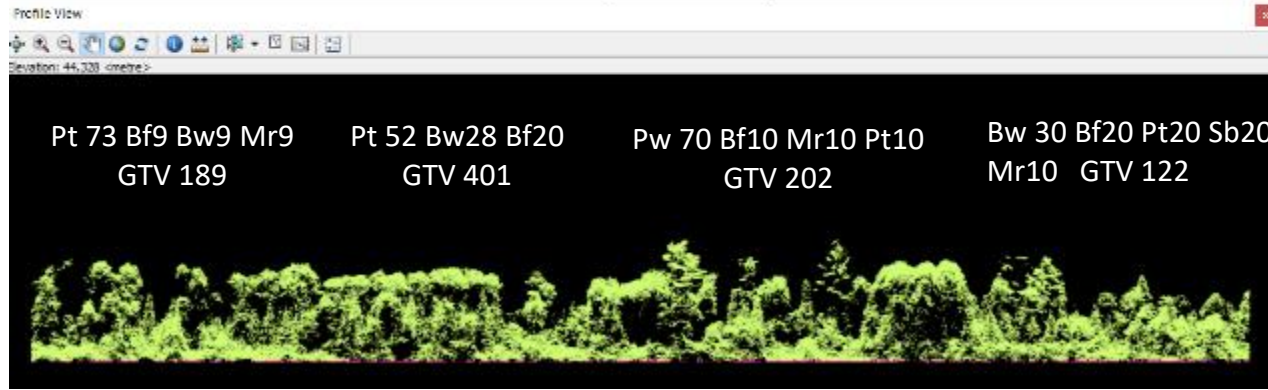
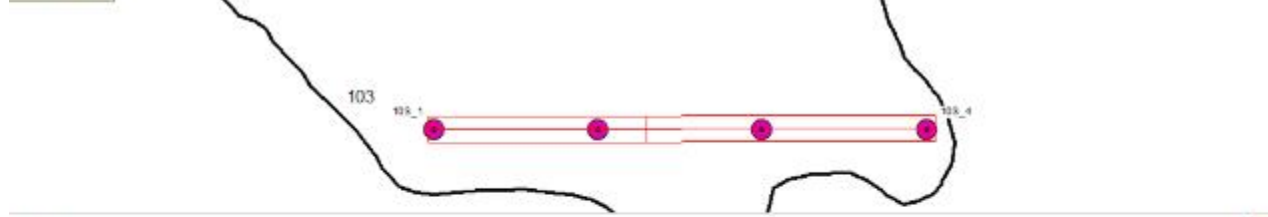


Polygon 103 - GMV Size Class

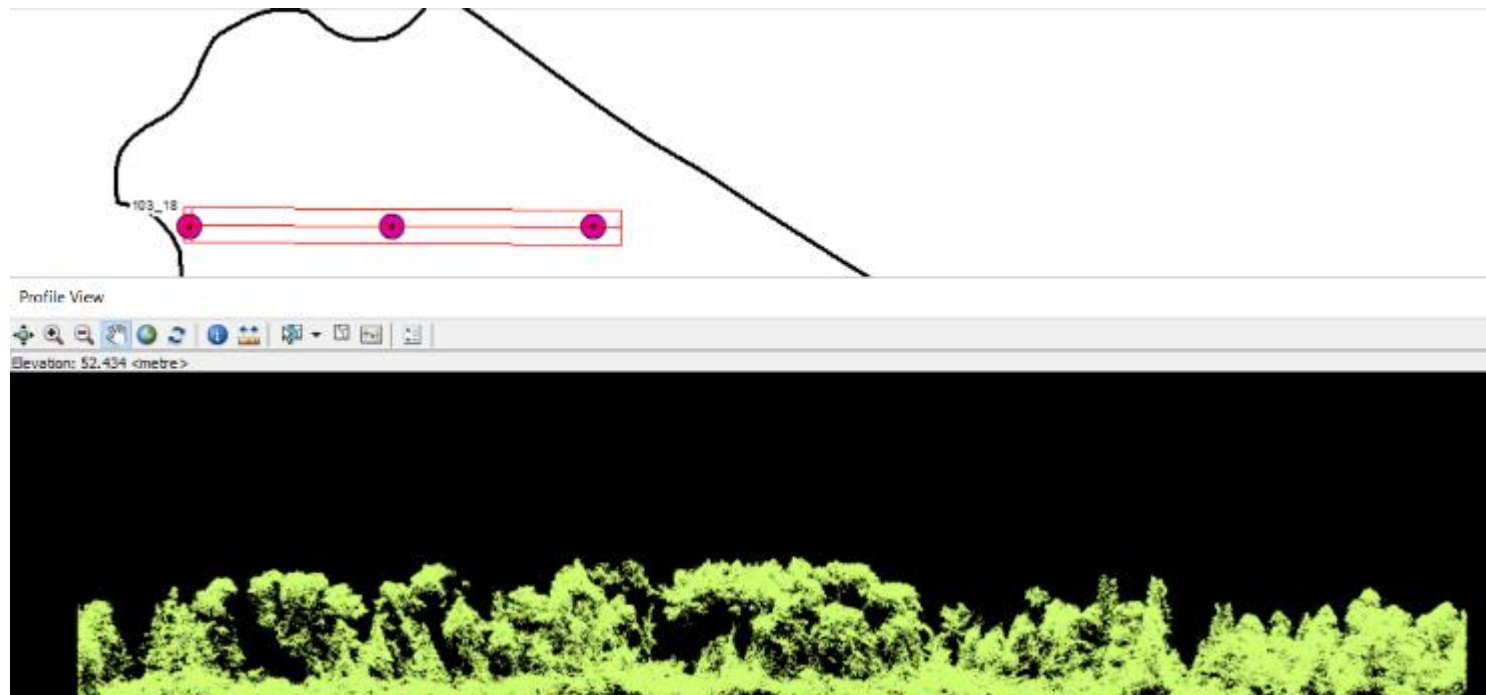
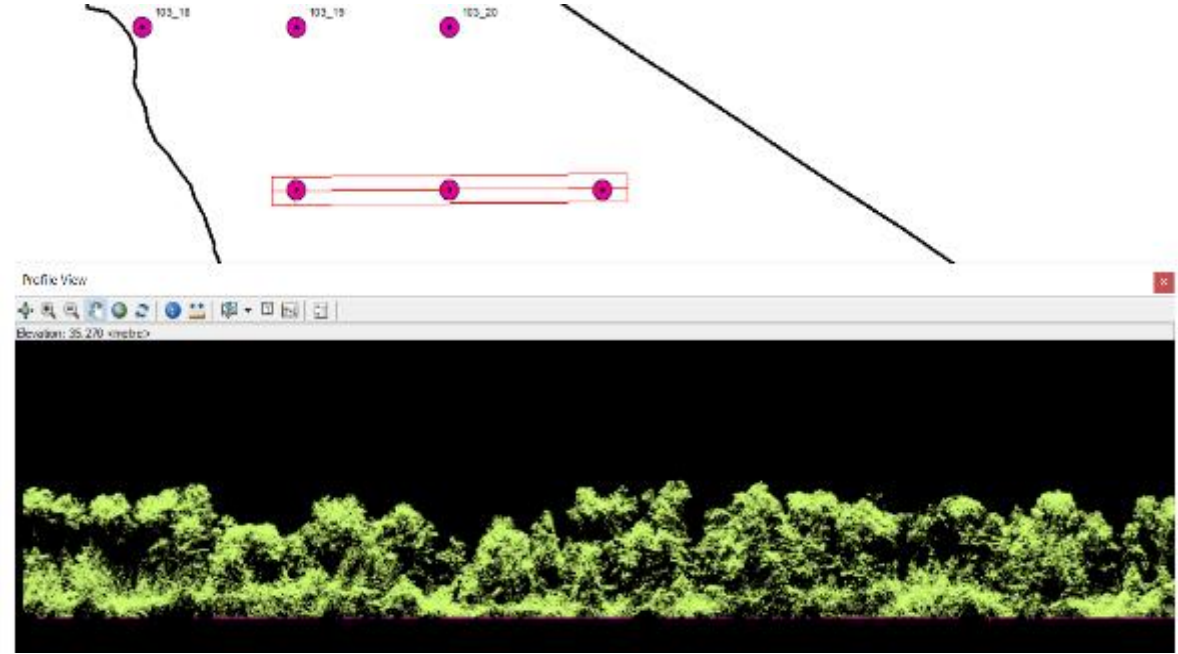
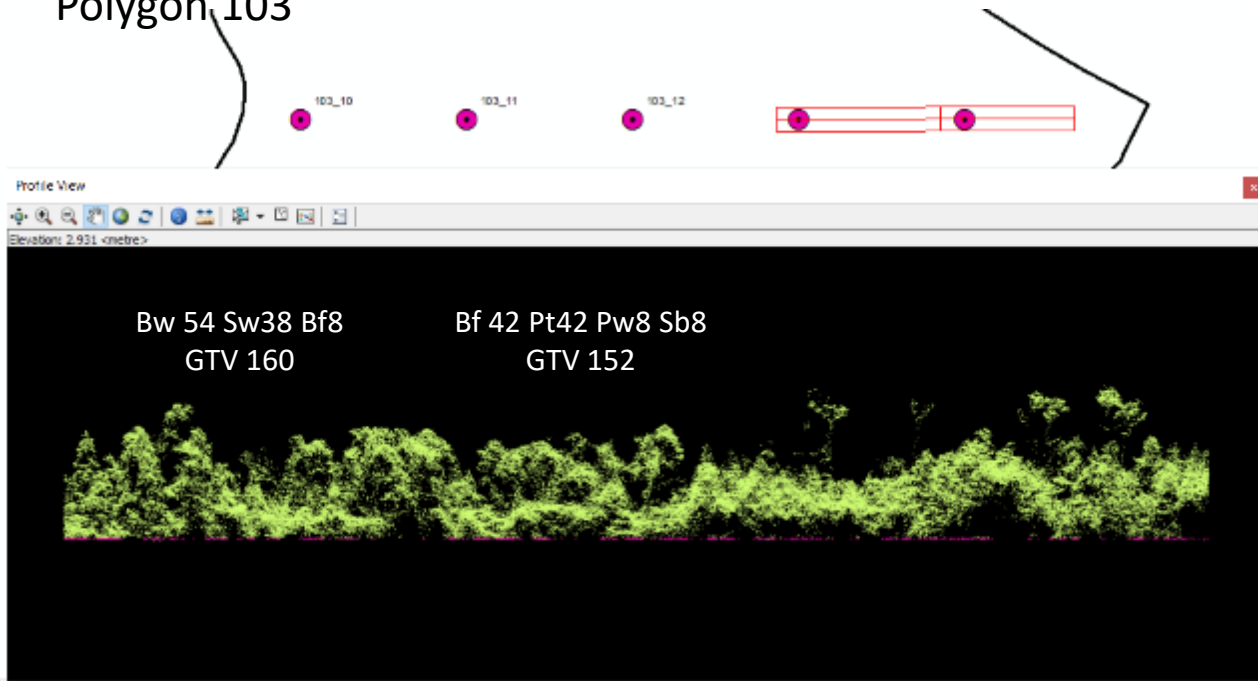


Updated Feb 6 22 for null plots

Polygon 103



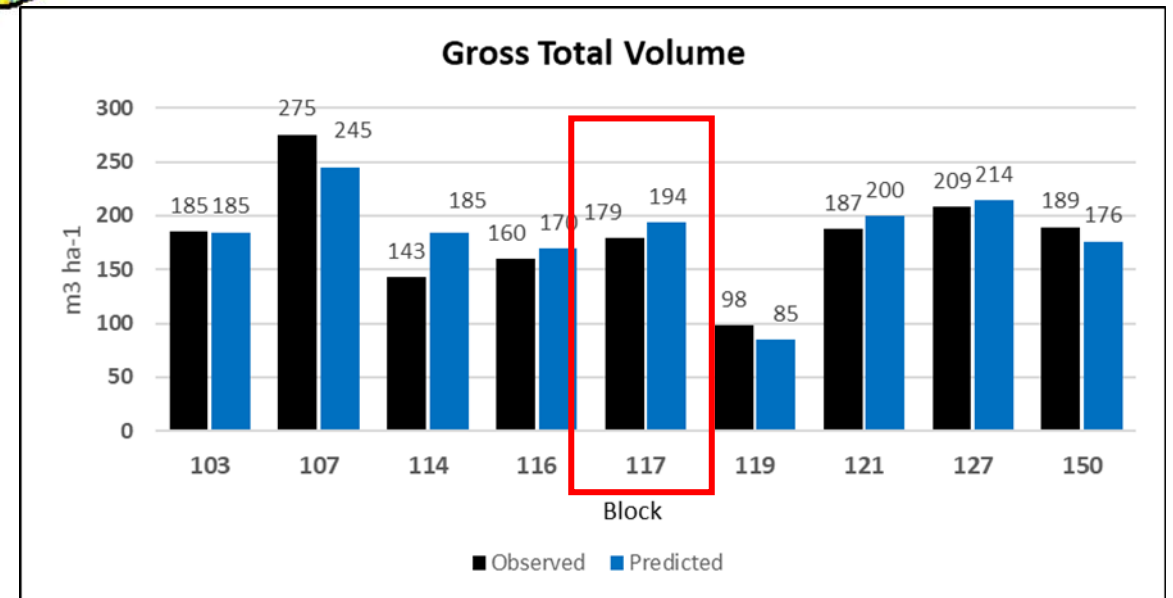
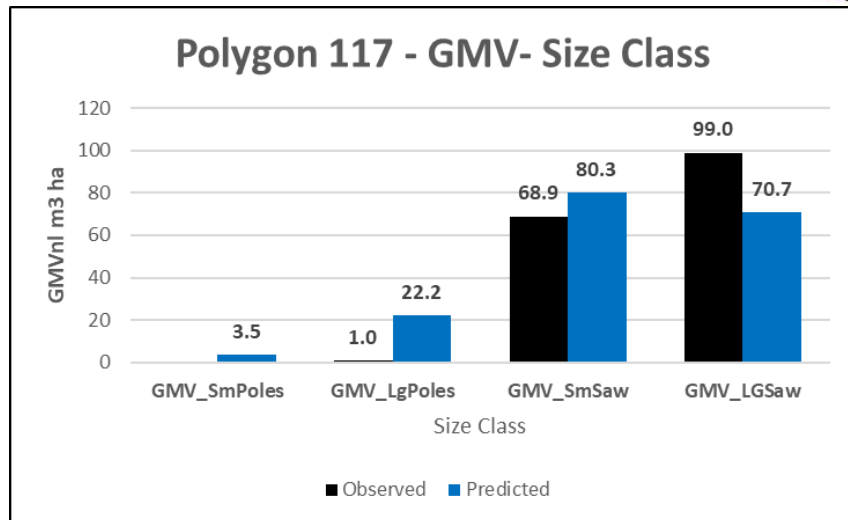
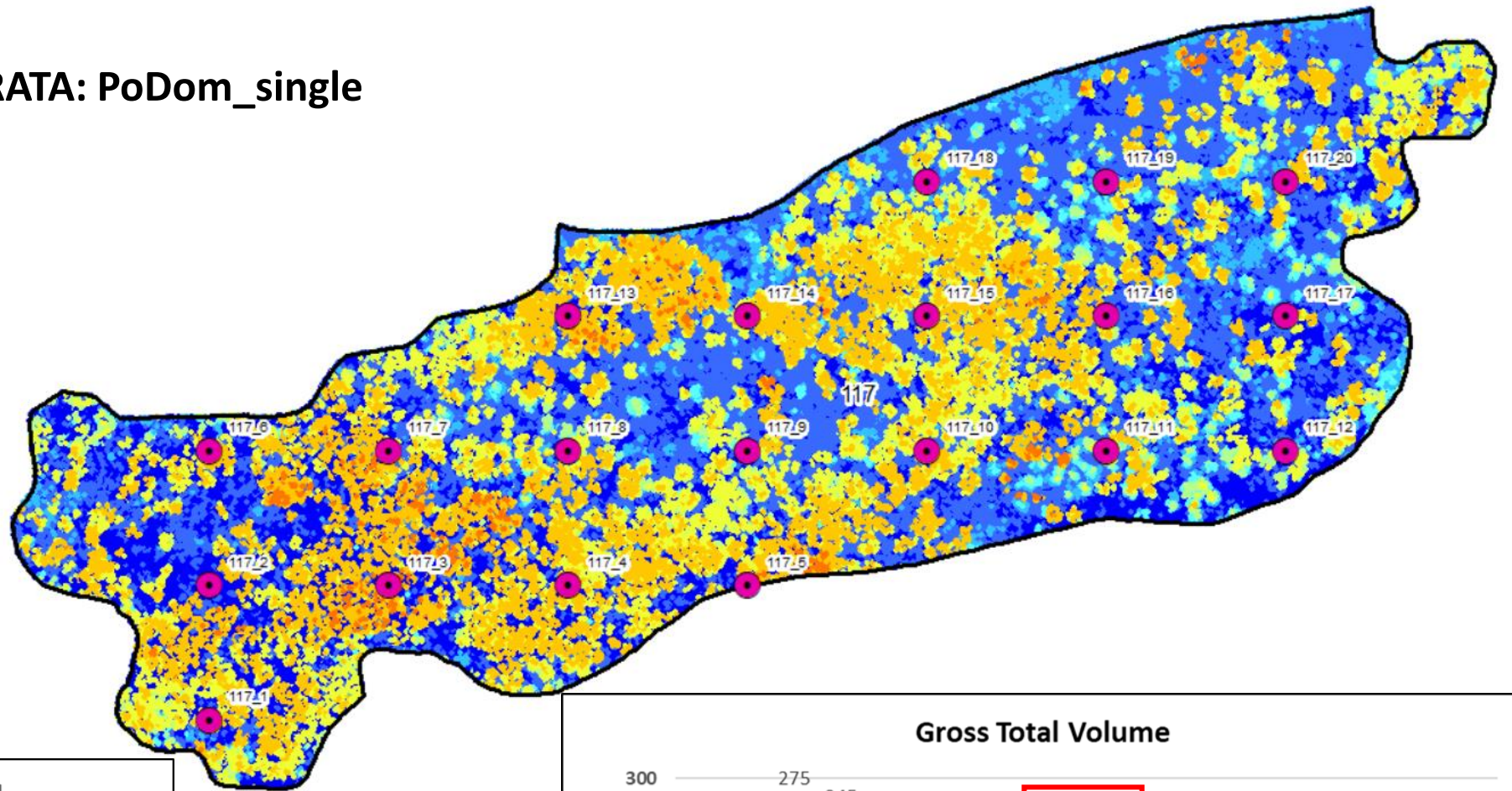
Polygon 103



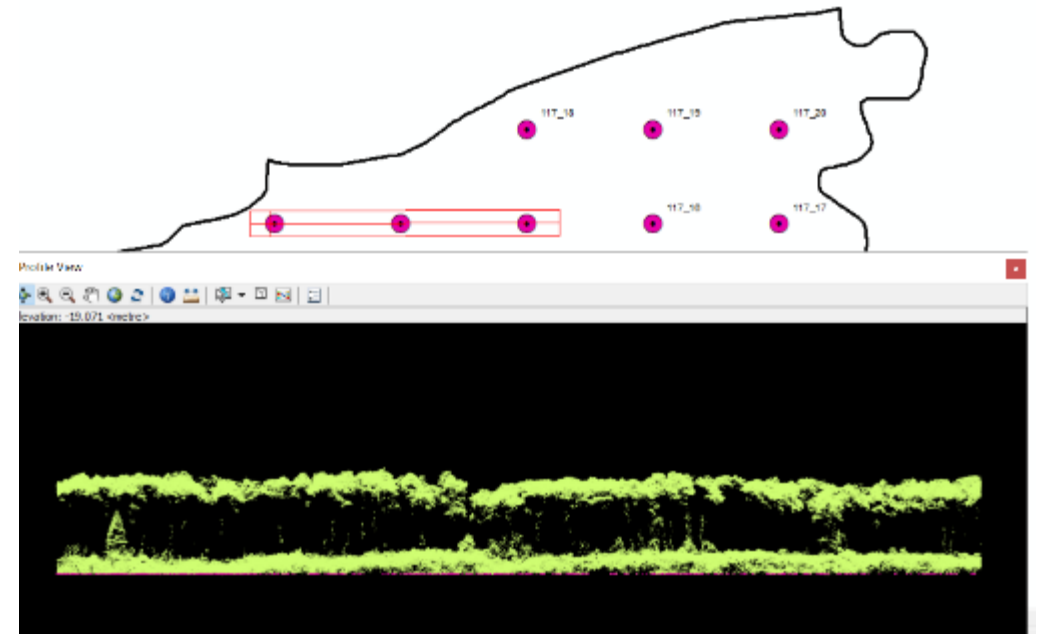
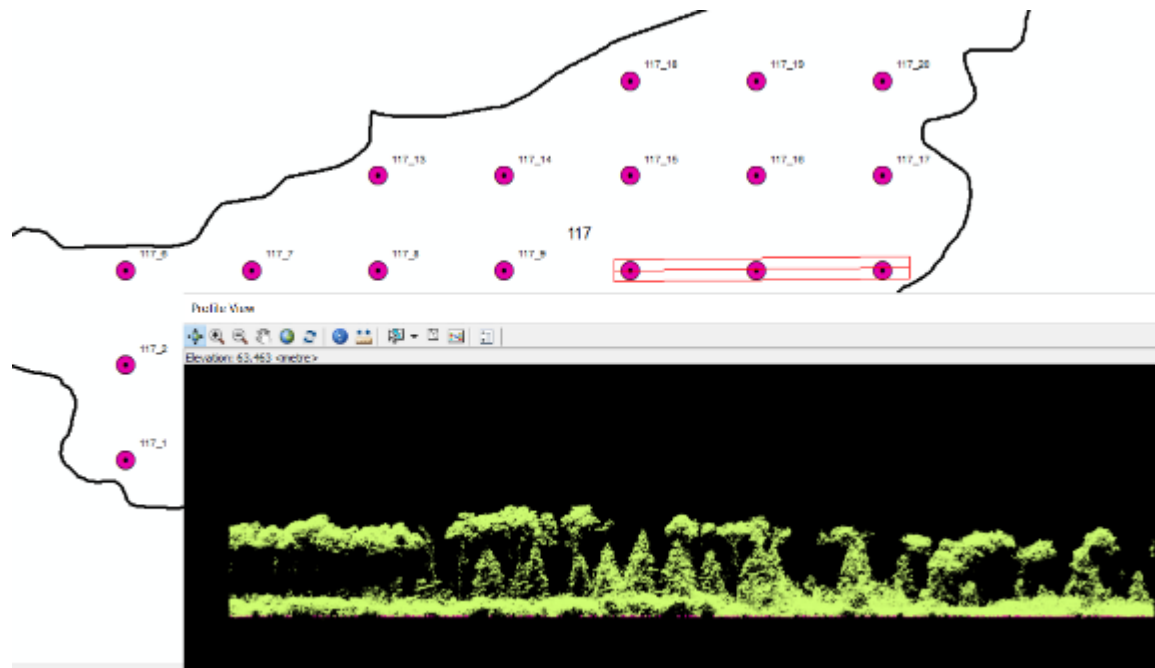
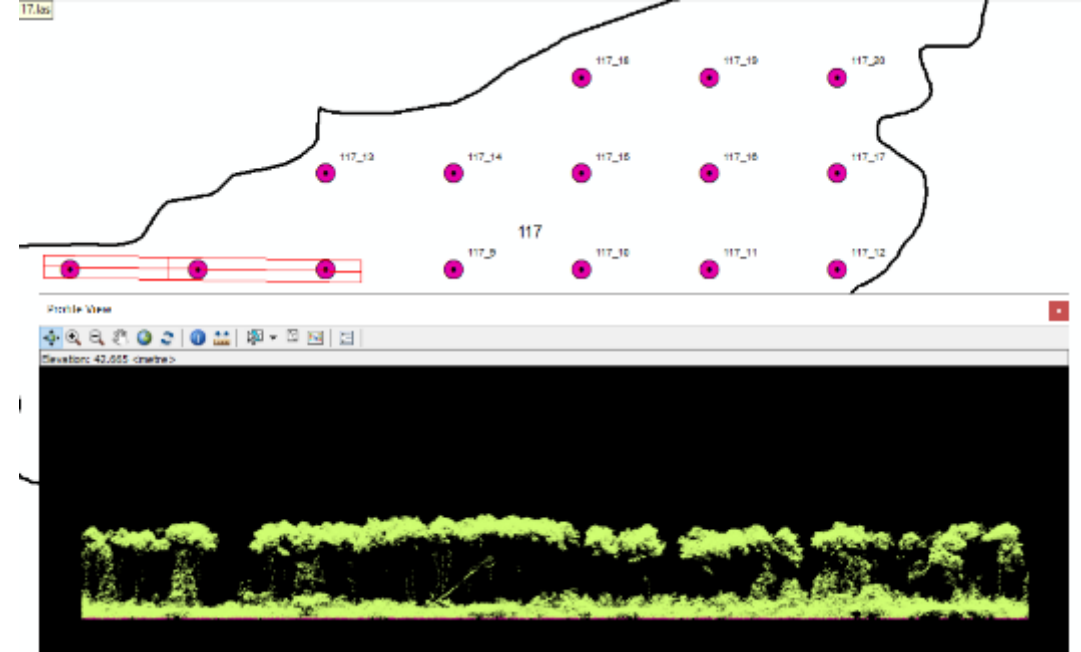
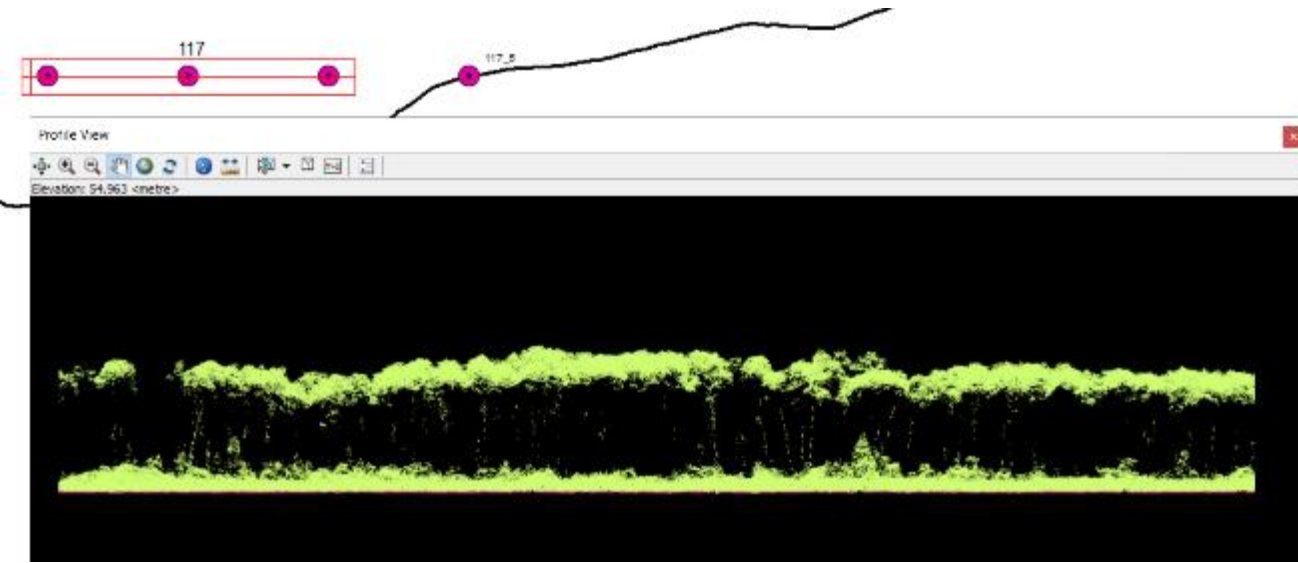
Polygon 117

STRATA: PoDom_single

Pt 92 Sw5 Bw2 Cp1

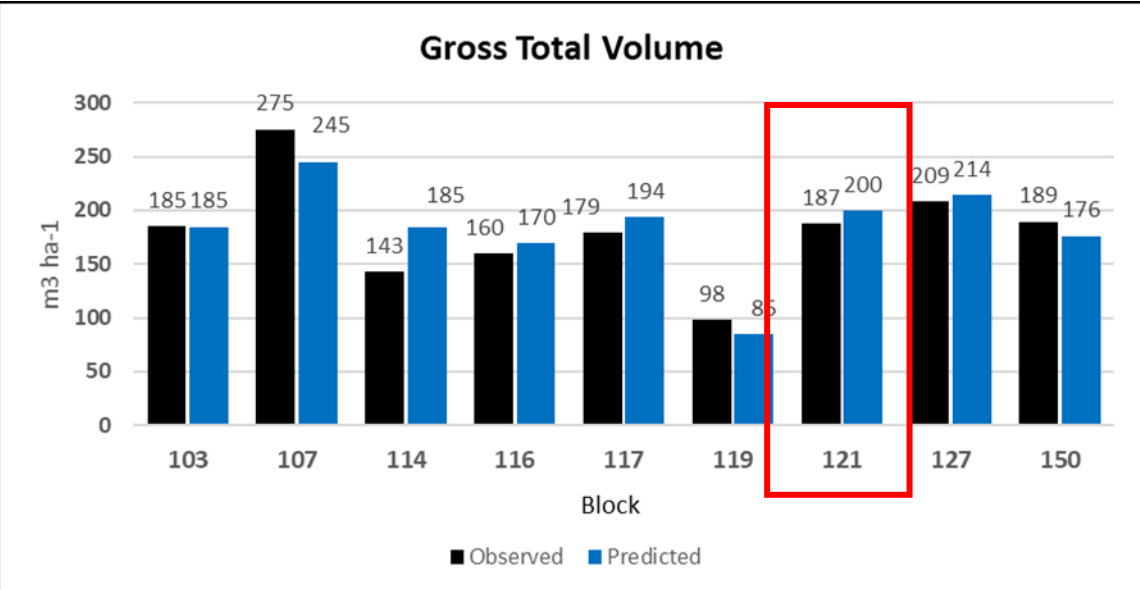
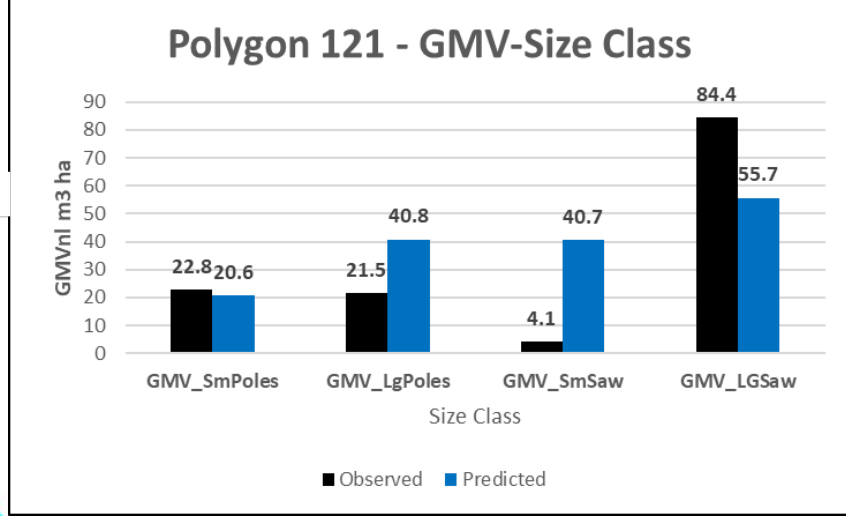
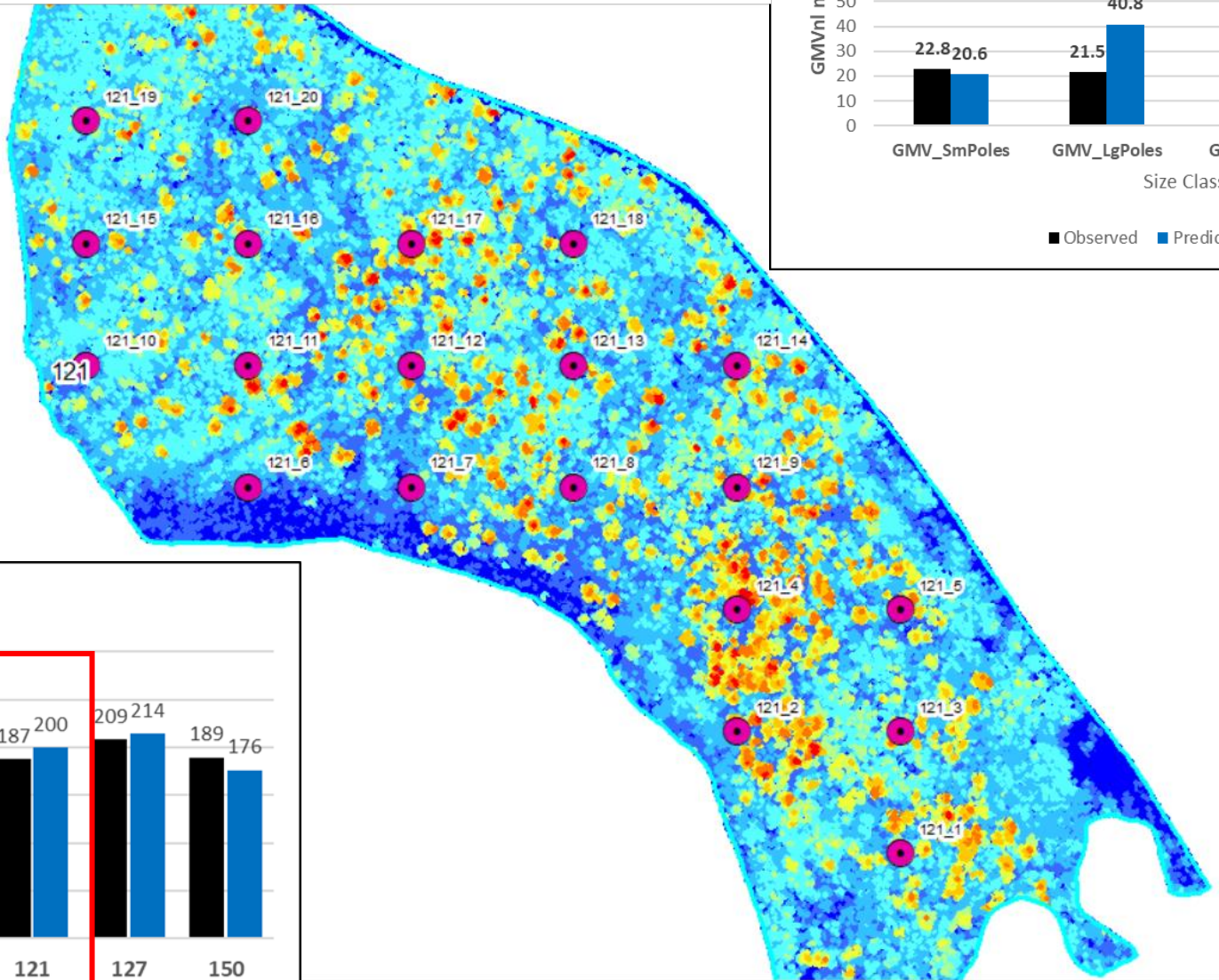


Polygon 117



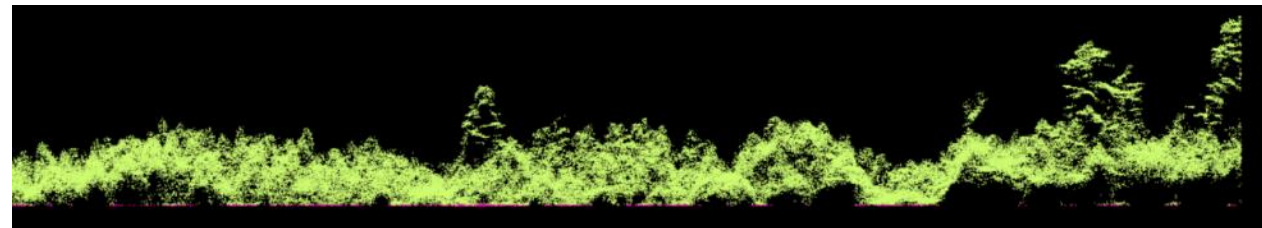
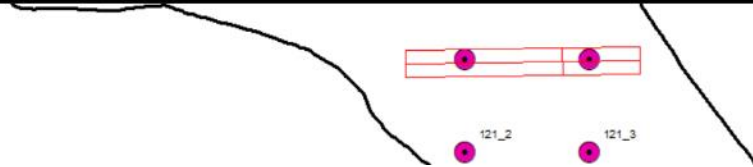
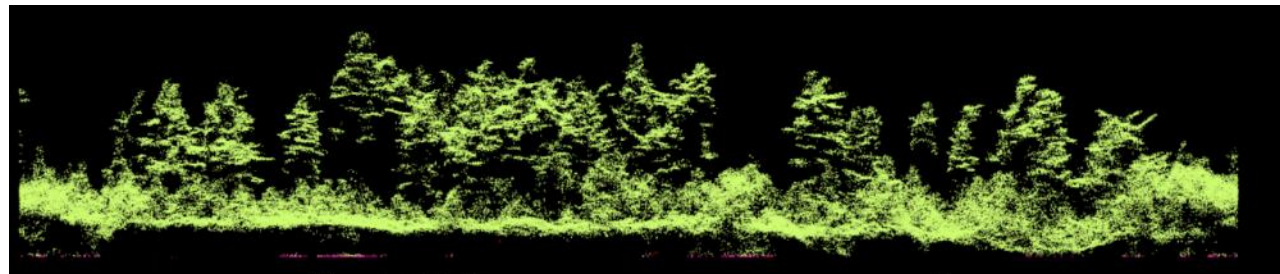
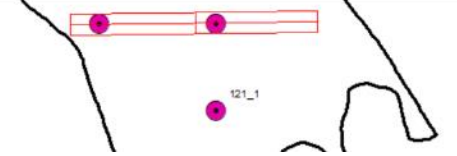
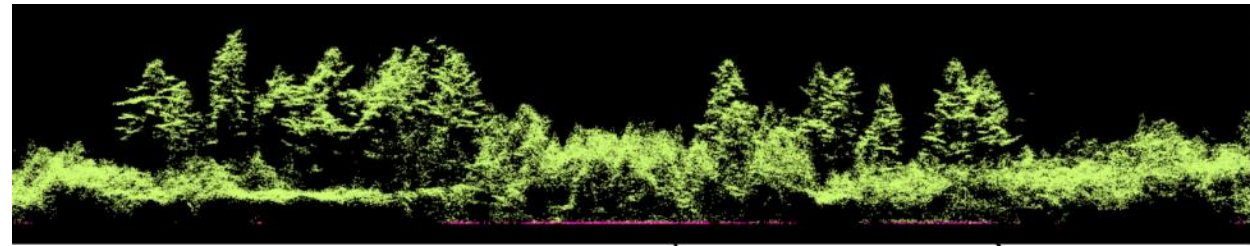
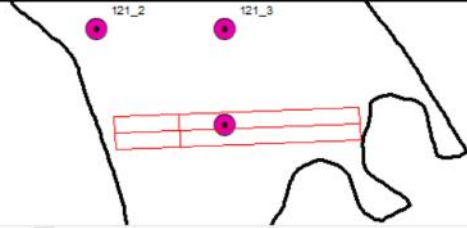
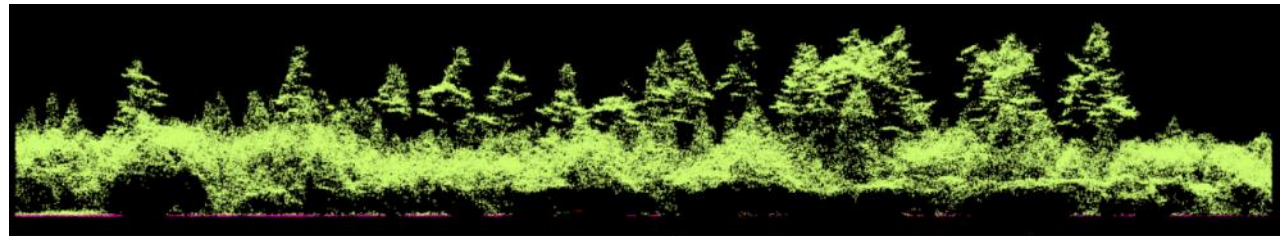
Polygon 121 ConMx_managed_CX

Bf 33 Pw32 Pt16 Bw12 Sb4 Cw2 Sw1 Am0

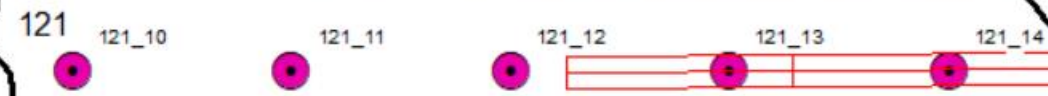
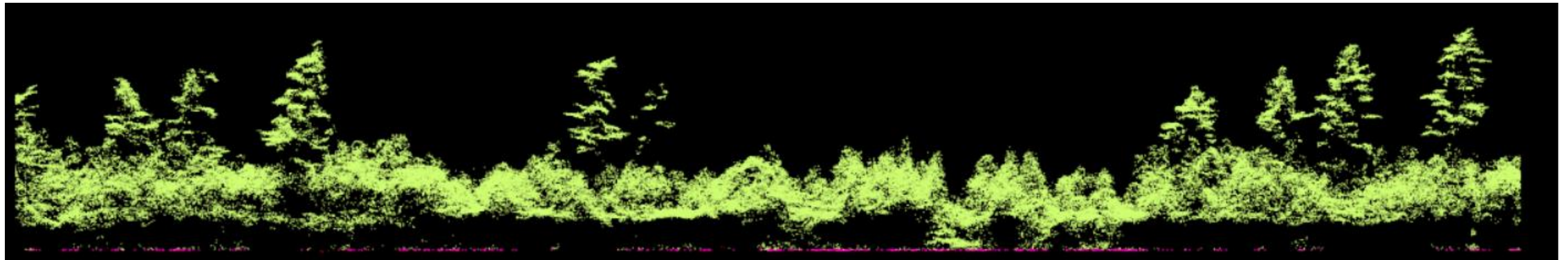
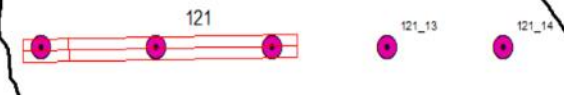
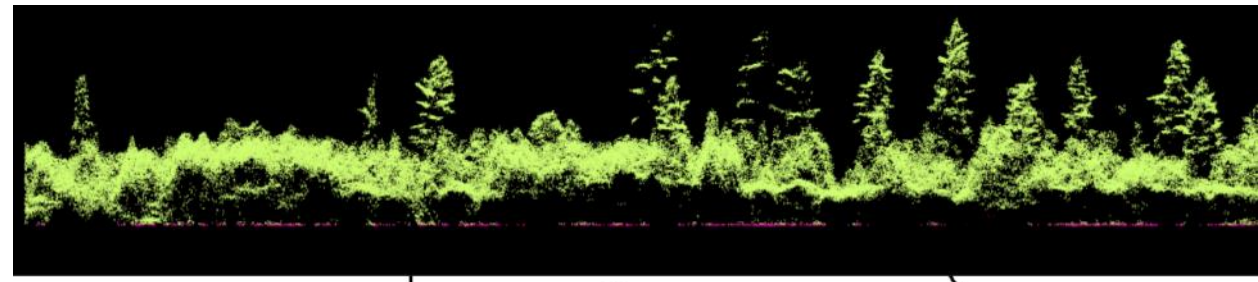
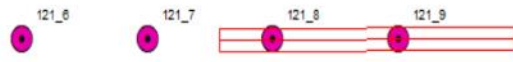
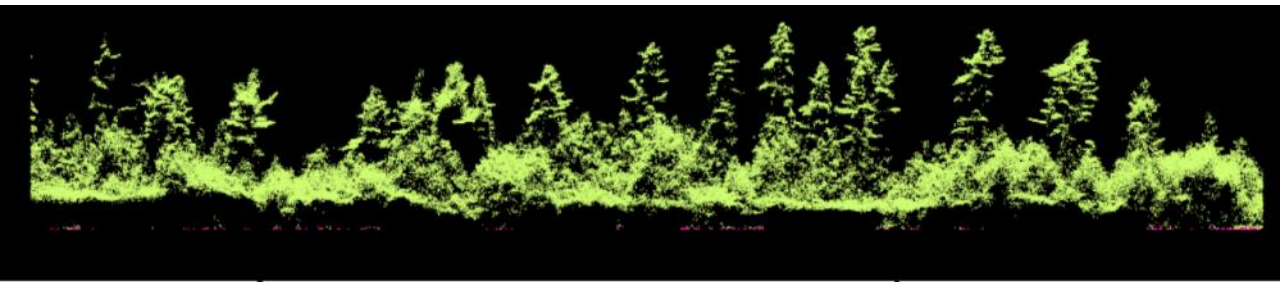


Updated Feb 6 22 for null plots

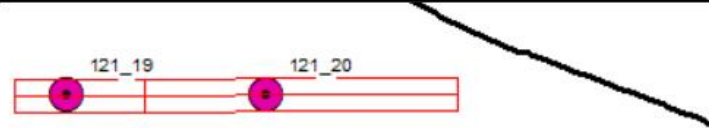
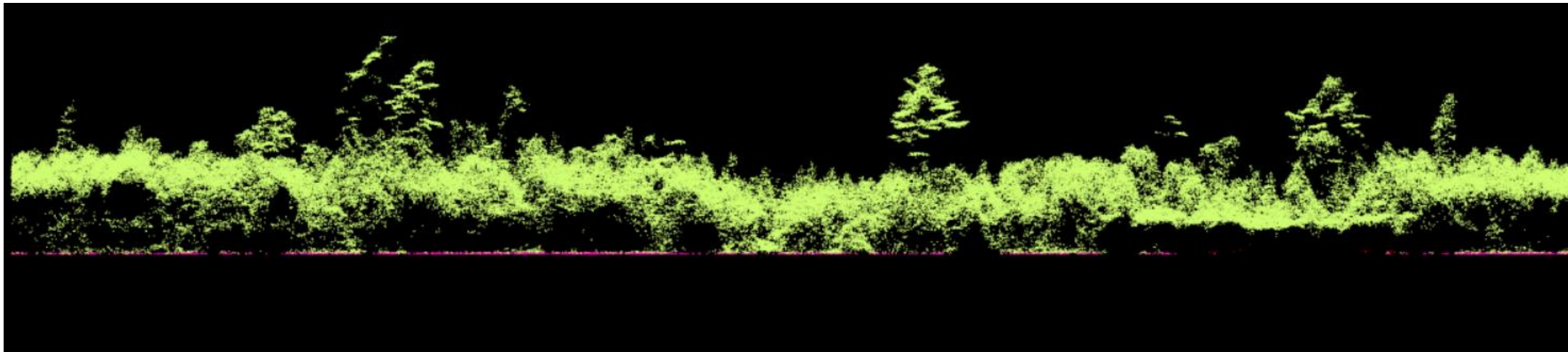
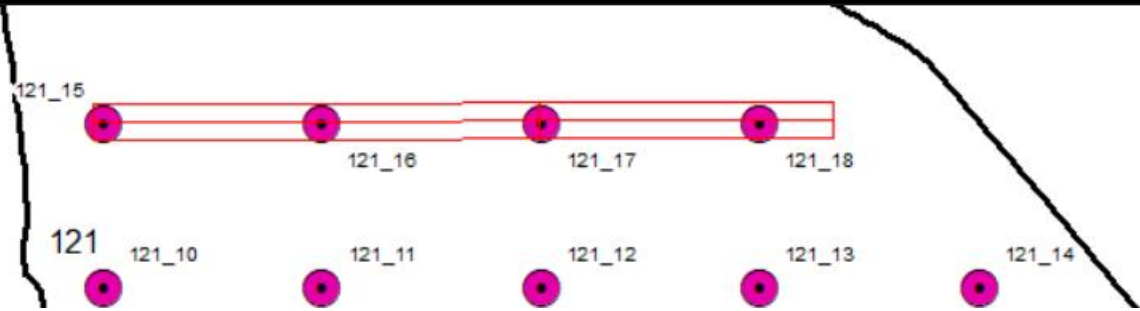
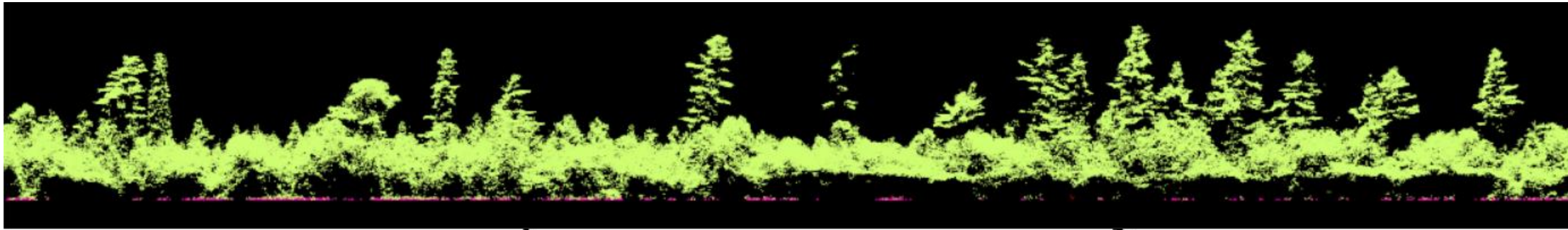
Polygon 121



Polygon 121

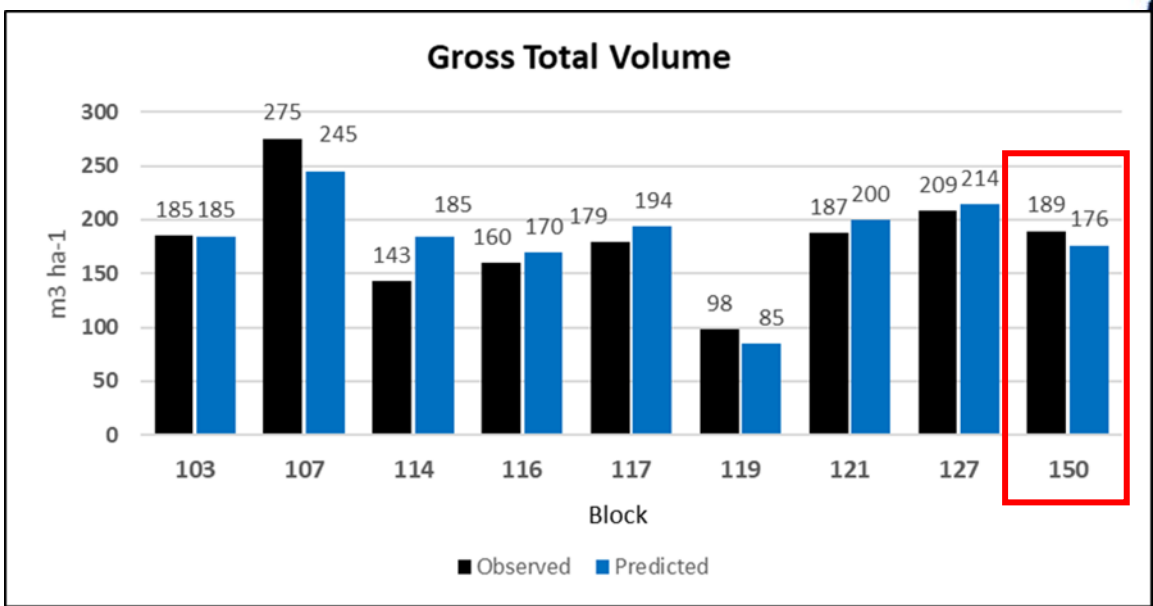
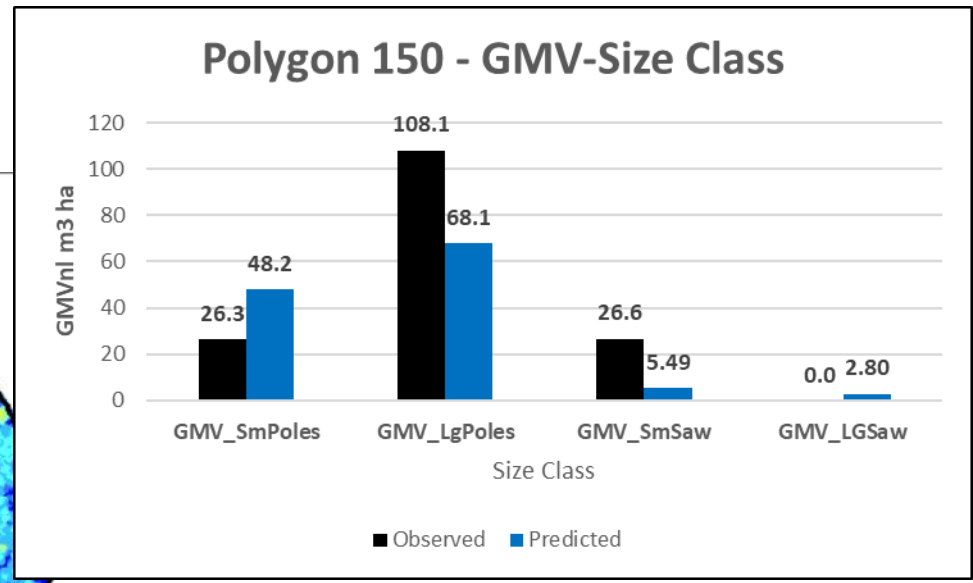
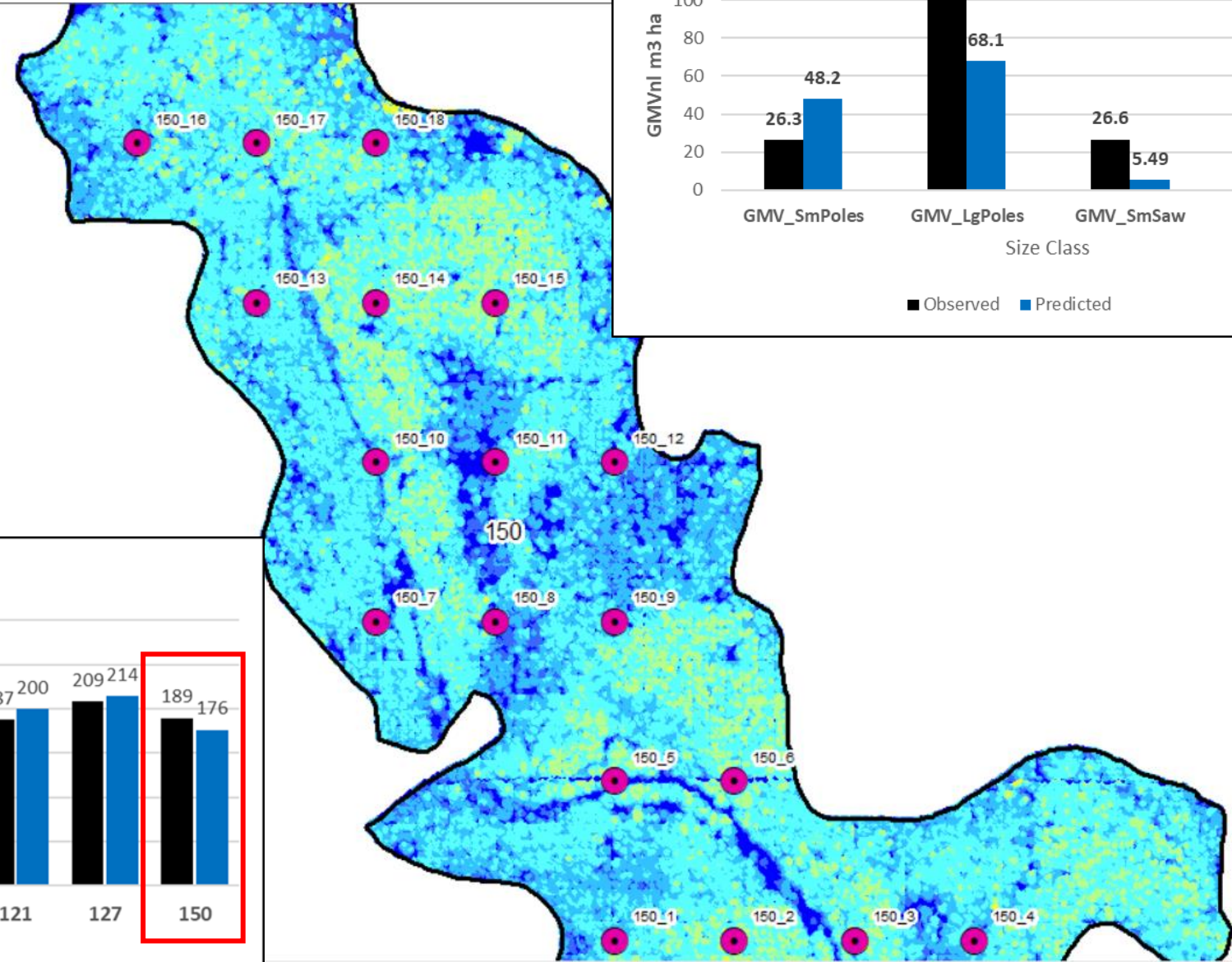


Polygon 121



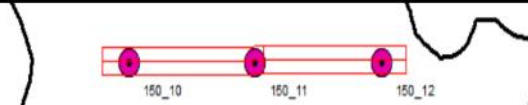
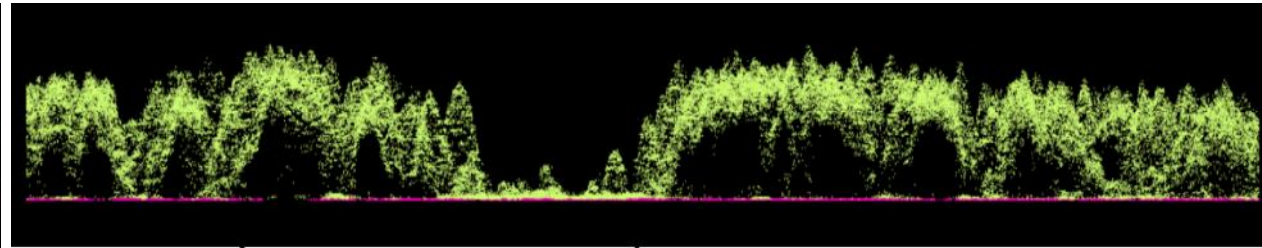
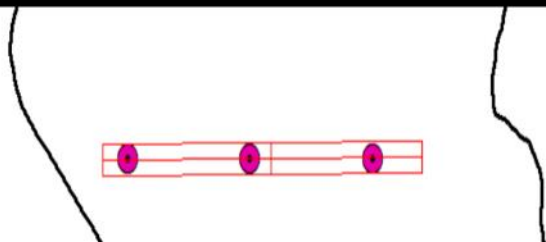
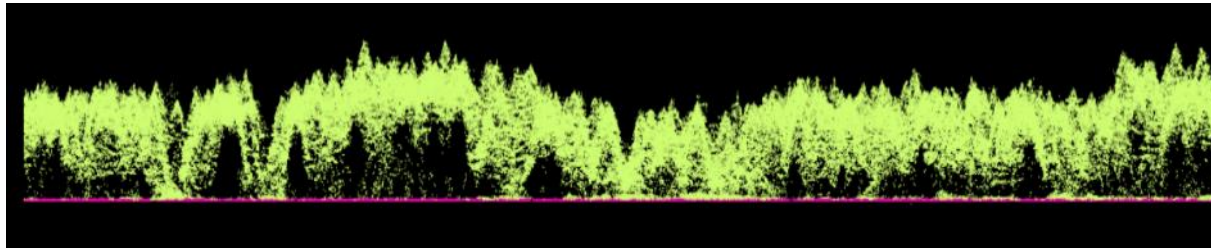
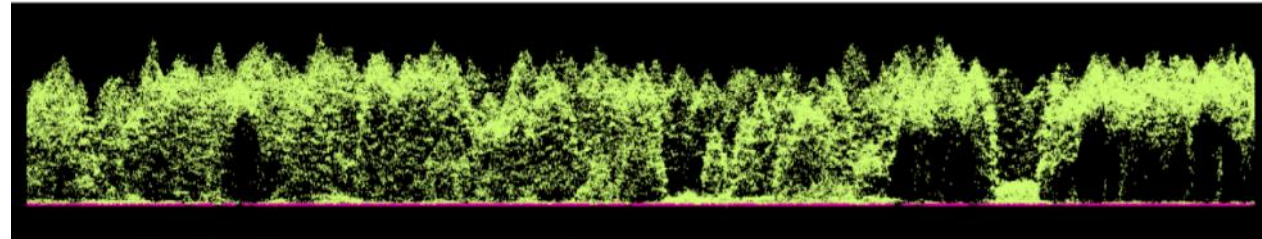
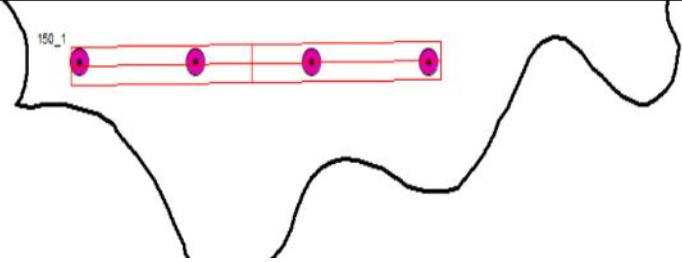
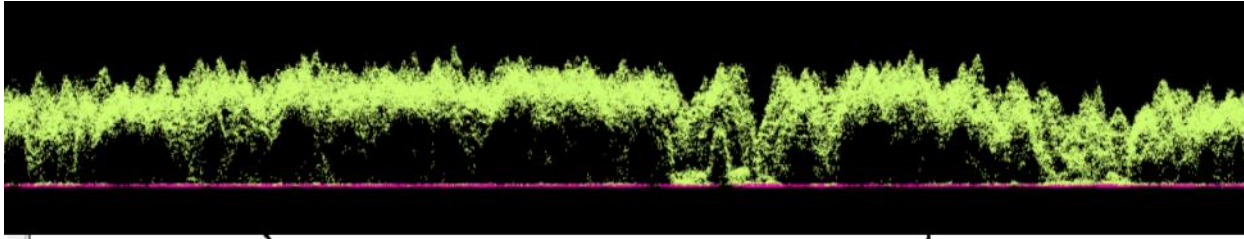
Polygon 150 STRATA: Old_plant_single

Sw 53 Sb31 Bf15 Pt1 Bw0 Pj0

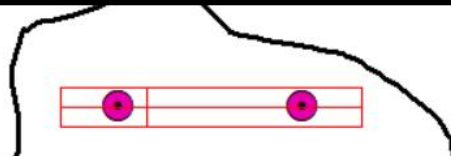
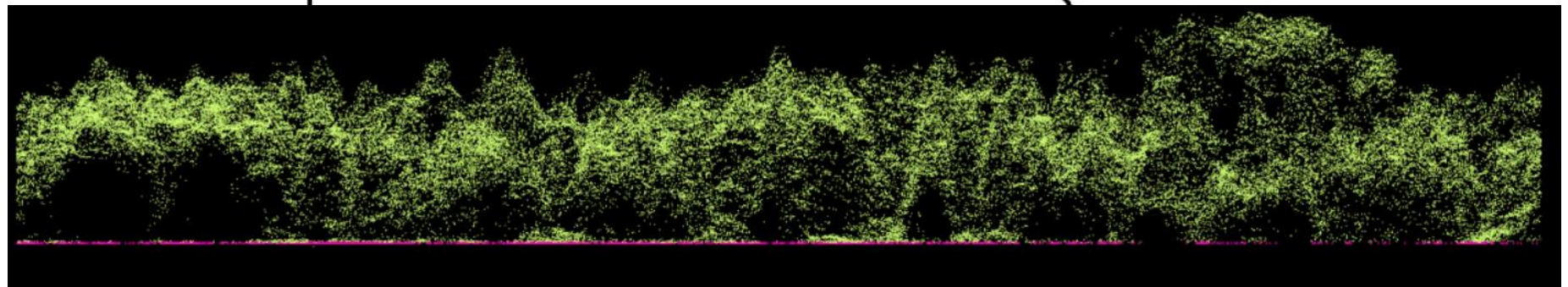
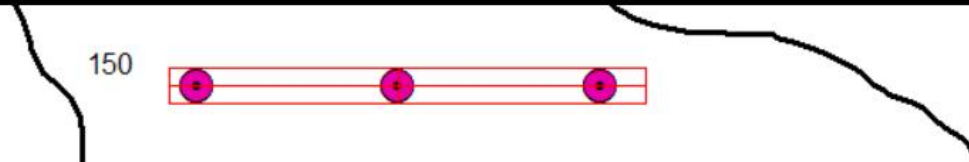
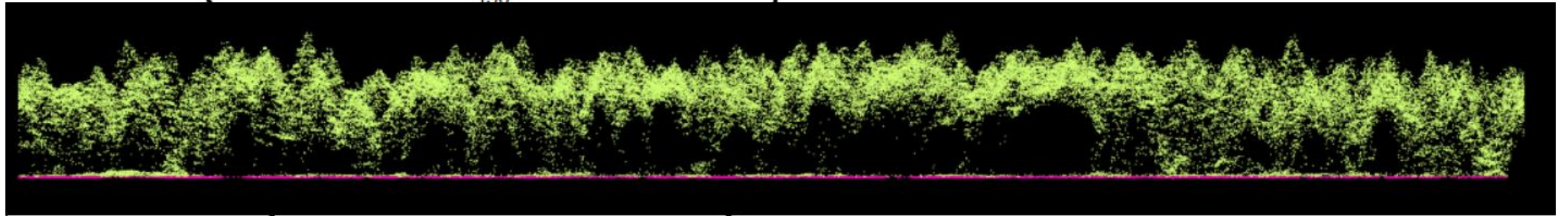
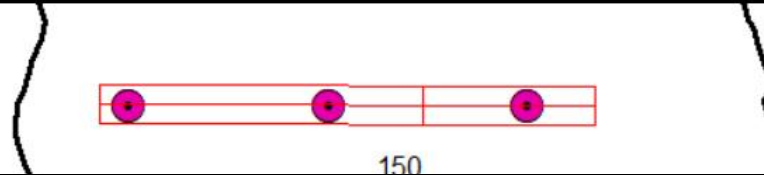
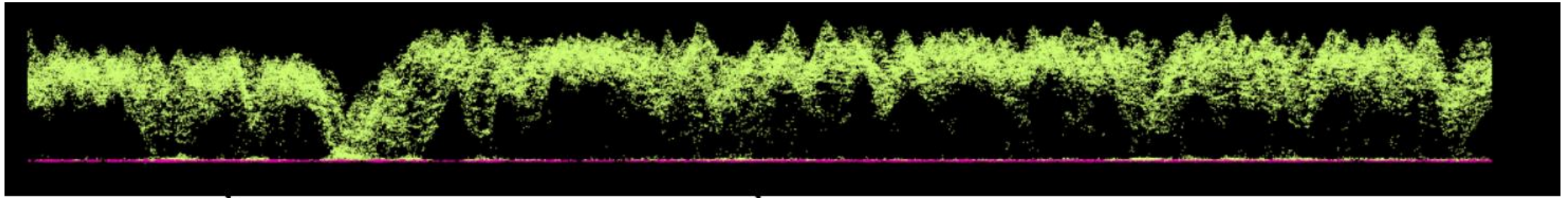


Updated Feb 6 22 for null plots

Polygon 150

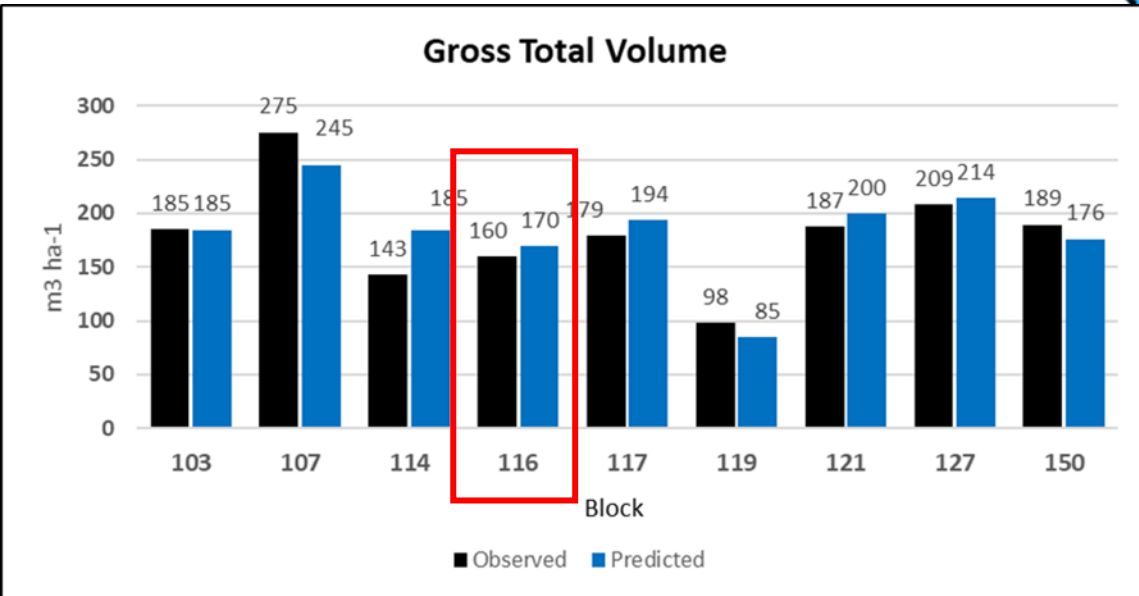
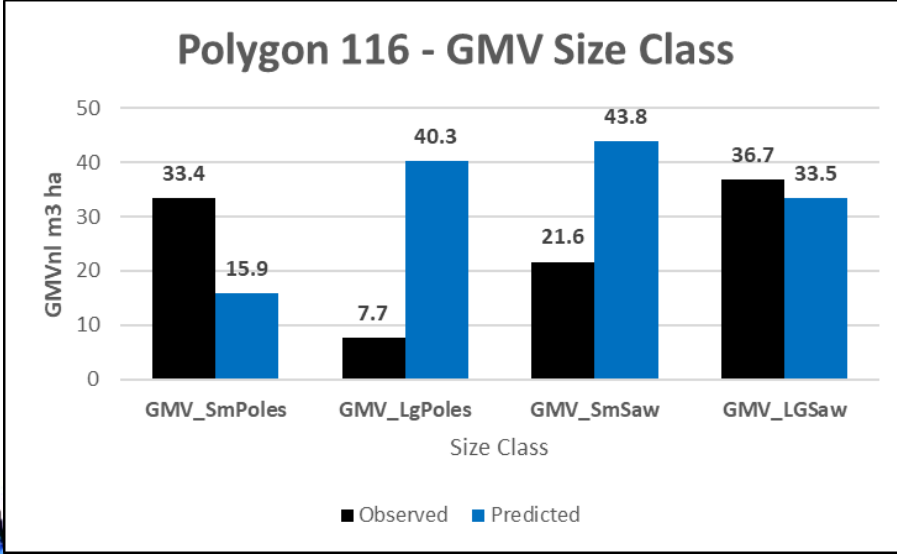
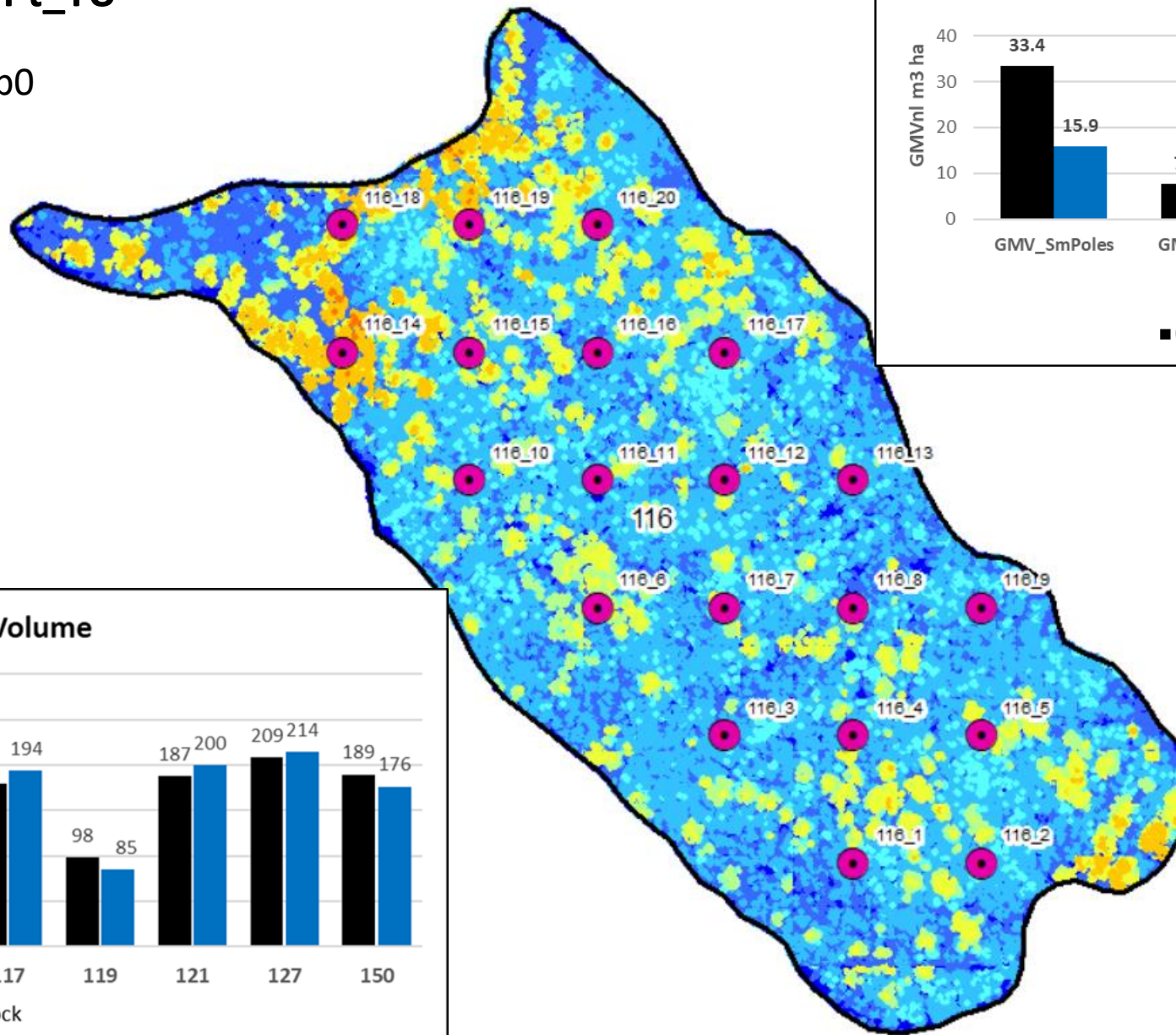


Polygon 150

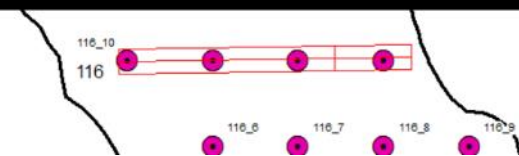
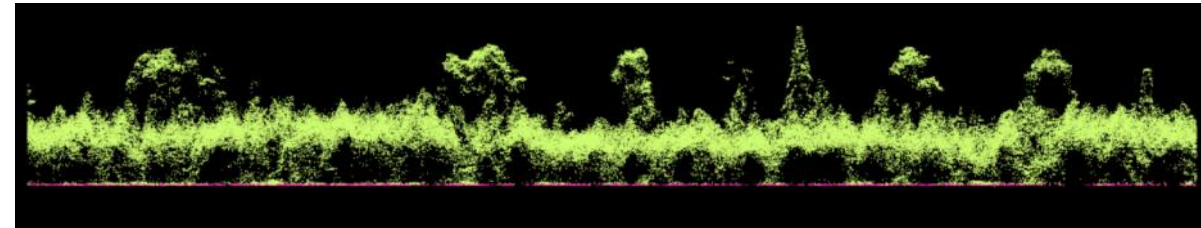
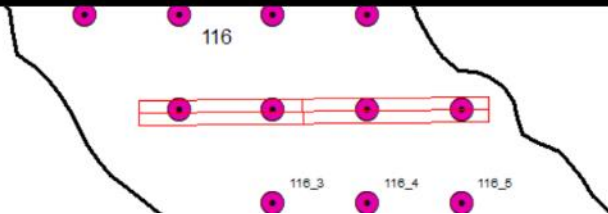
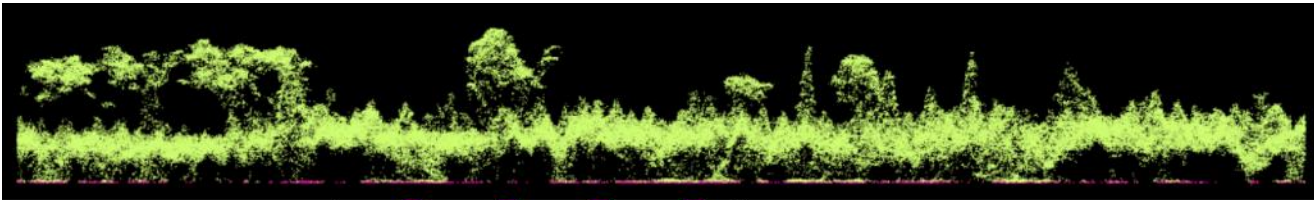
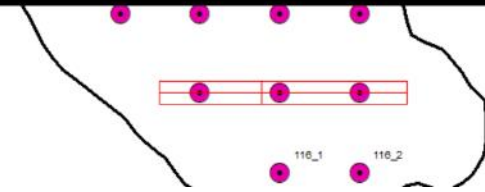
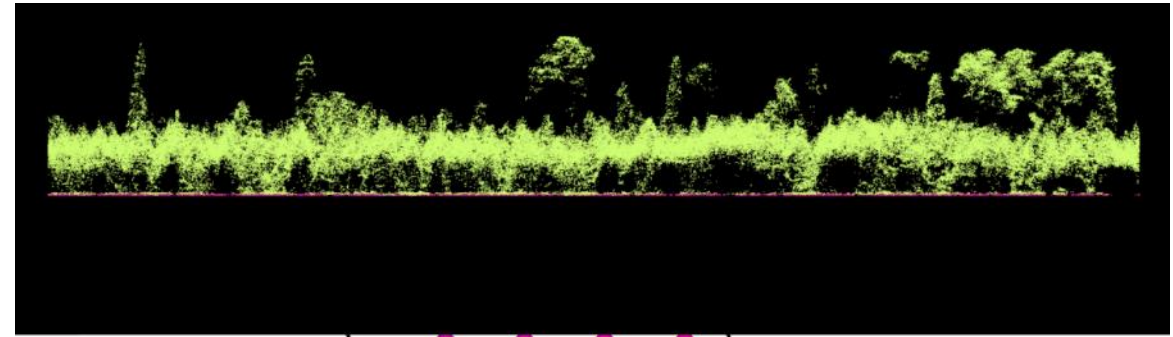
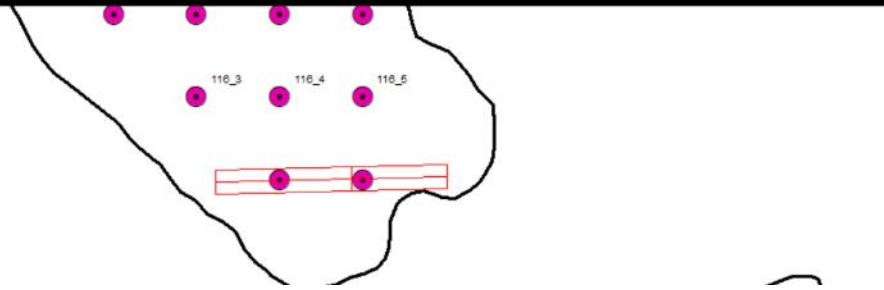
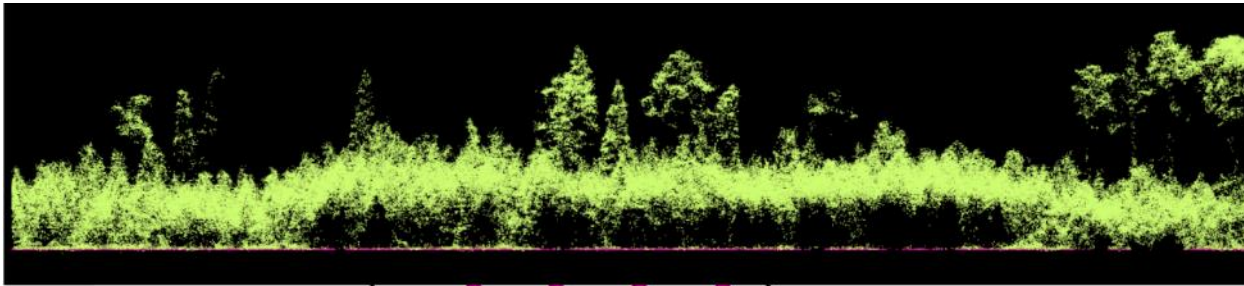


Polygon 116 STRATA: Pt_TU

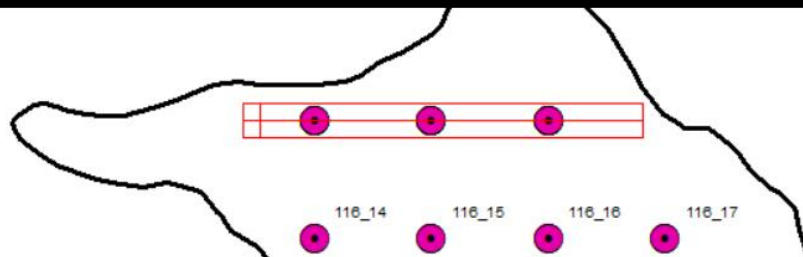
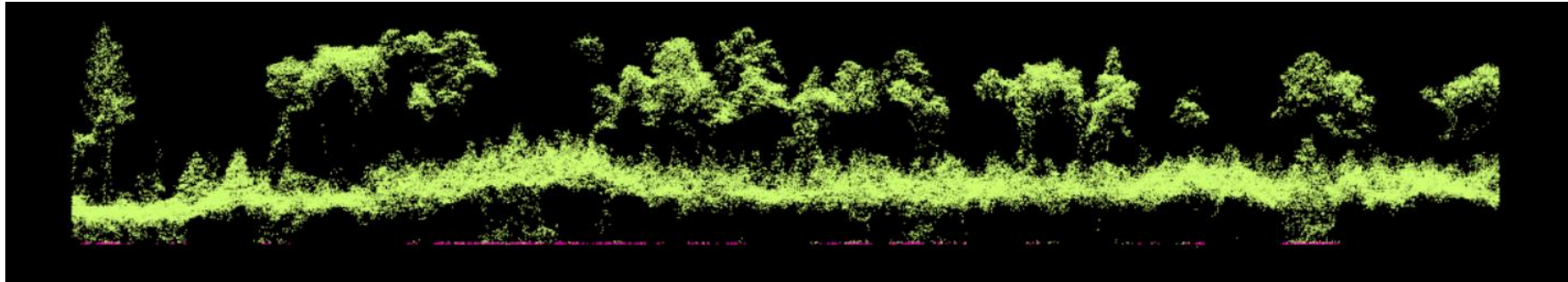
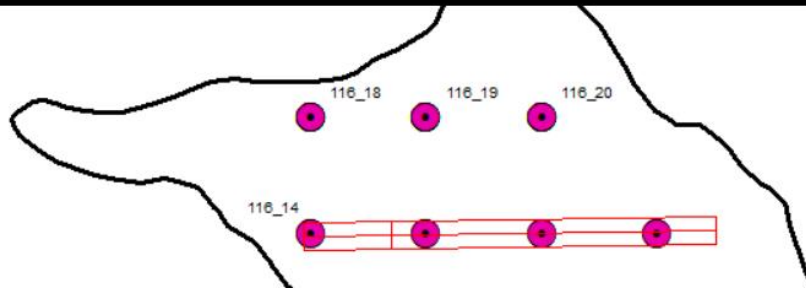
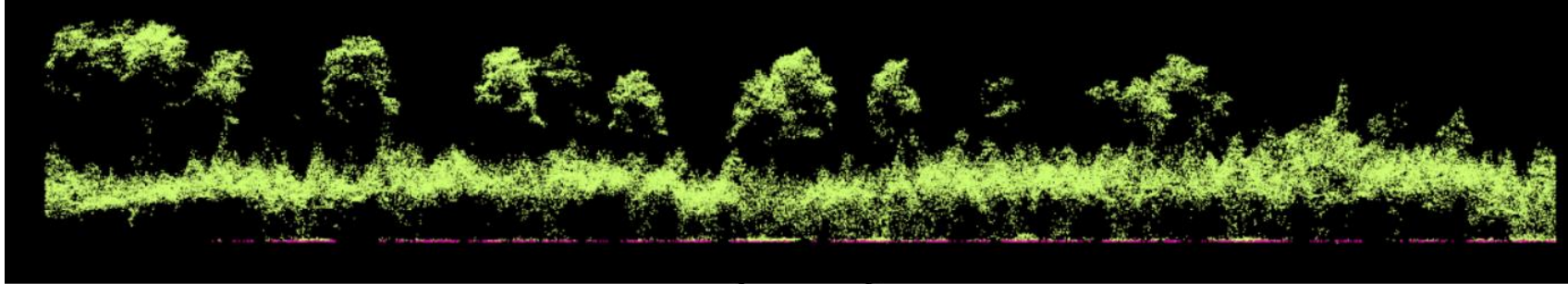
Bf 58 Pt29 Sb8 Bw3 Sw2 Pb0



Polygon 116



Polygon 116



Producing T2 – Raster summarized to Polygon Mean

From T1 Inventory

$$\text{Site Index} = f(\text{Lead Spec, Age, Topht})$$

POLYID	SPCOMP	AGE	CC2m	SI	stocking	TOPHT	CDHT	LoreyHT	BA	Stems	GTV	GMV_NL	NMV_NL	GMV_WL	NMV_WL	Biomass
4	SB 90BF 10	134	60.8	7.1	0.48	14.1	11.8	11.9	17.0	1197	91.1	64.1	59.9	56.1	52.5	58.9
6	SB 80SW 10BW 10	94	63.4	15.5	0.23	20.1	18.6	17.9	11.5	231	87.6	76.4	74.0	74.4	72.2	46.9
50	BW 50SB 20PT 10SW 10PB 10	84	79.2	18.5	1.22	23.6	21.2	20.4	32.8	953	295.1	260.0	233.3	250.5	224.7	160.1
114	PT 40SB 30PJ 15PB 10SW 5	114	77.4	16.7	1.03	24.0	22.1	21.1	29.5	828	282.9	252.0	204.5	242.9	197.1	153.6
337	SX 61PJ 39	6	13.3	<Null>	<Null>	11.5	7.1	10.2	3.3	211	17.0	<Null>	<Null>	<Null>	<Null>	13.0



$$\text{Stocking} = f(\text{Lead Spec, Age, BA, SI})$$

Size Class Predictions

POLYID	SPCOMP	BA_SmP	BA_LgP	BA_SmS	BA_LgS	GMV_SmP	GMV_LgP	GMV_SmS	GMV_LgS
4	SB 90BF 10	9.8	4.1	0.7	2.3	29.5	26.8	3.1	4.6
6	SB 80SW 10BW 10	1.8	1.3	3.3	5.1	6.0	12.6	23.0	34.8
50	BW 50SB 20PT 10SW 10PB 10	4.8	11.7	10.3	6.0	18.2	85.3	99.6	56.8
114	PT 40SB 30PJ 15PB 10SW 5	3.6	9.7	10.8	5.4	14.5	76.3	109.3	52.0
337	SX 61PJ 39	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>	<Null>

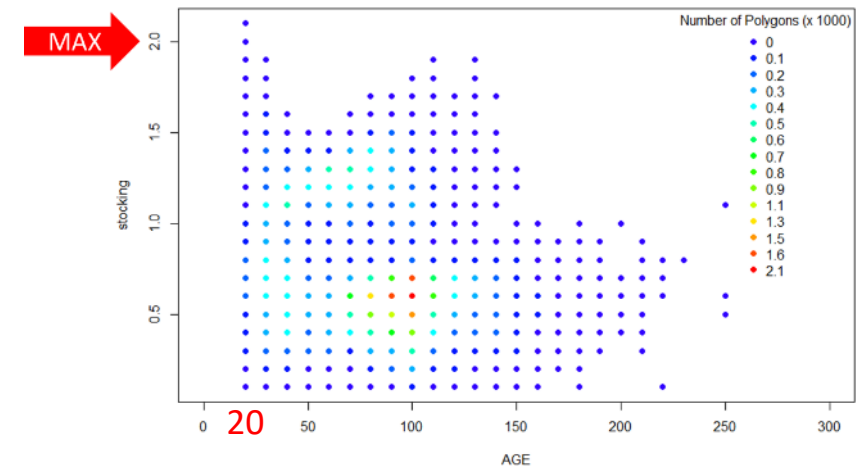
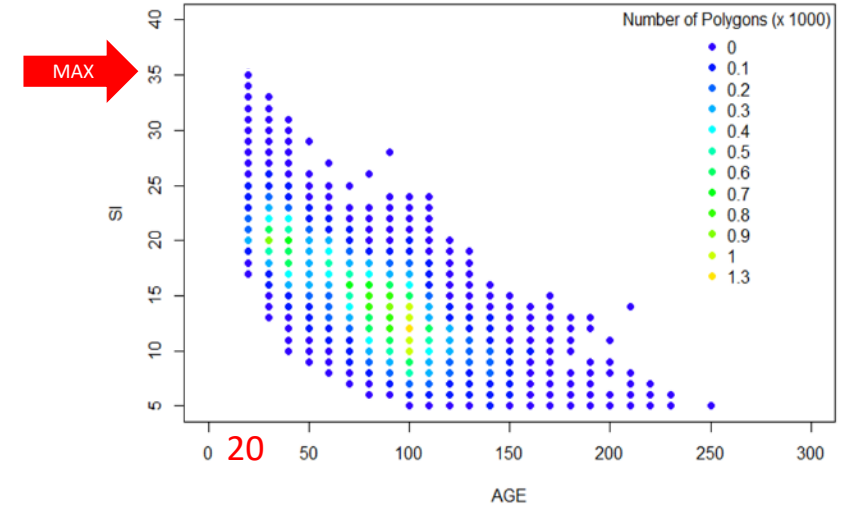
Producing T2 – Challenges

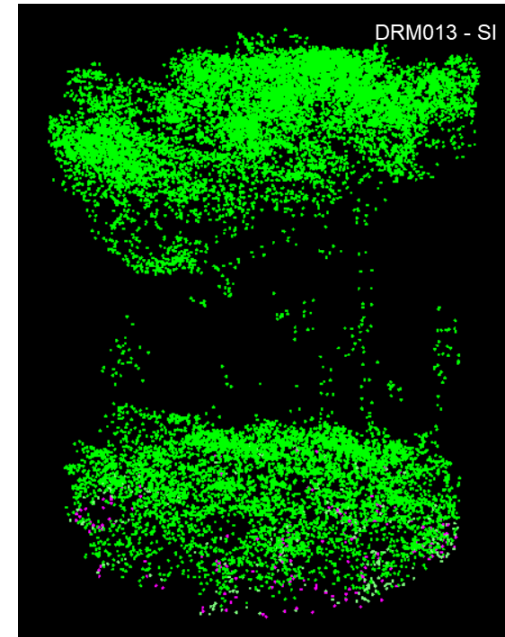
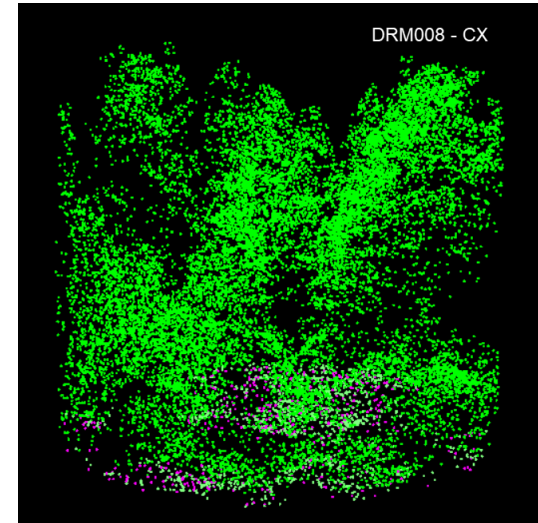
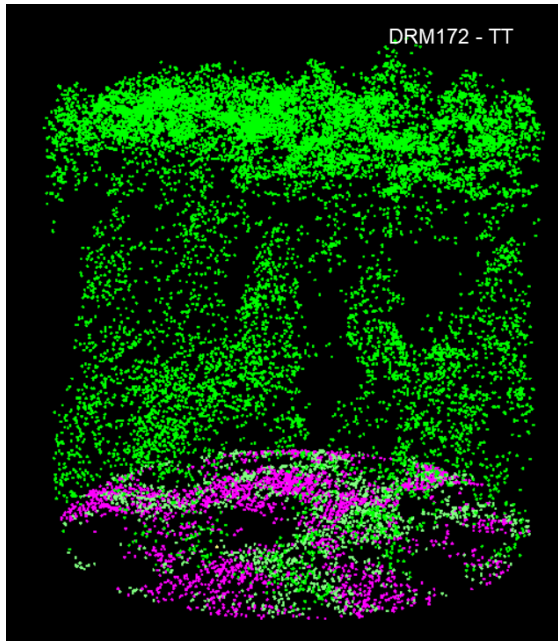
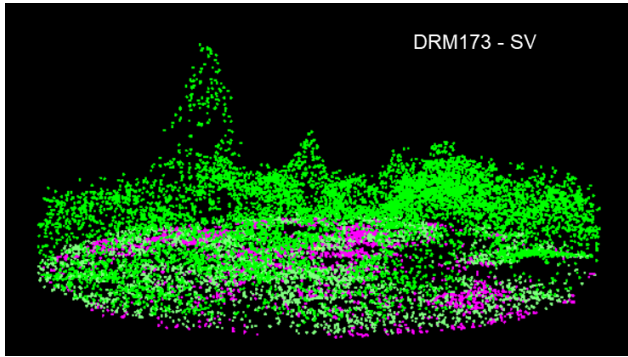
- **SI calculation**

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

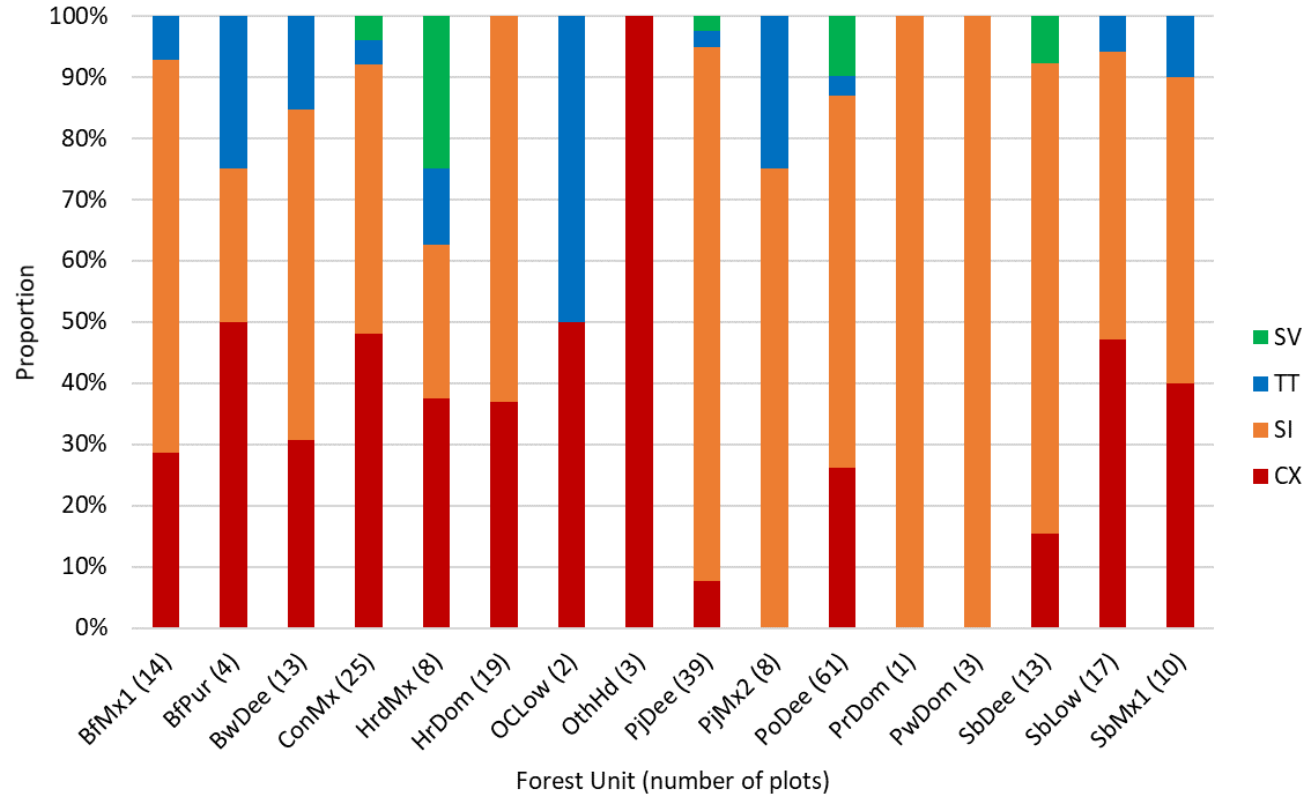
- **Stocking calculation**

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





DRM Calibration Plot Vertical Structure



Thank you!



Comments? Questions?