



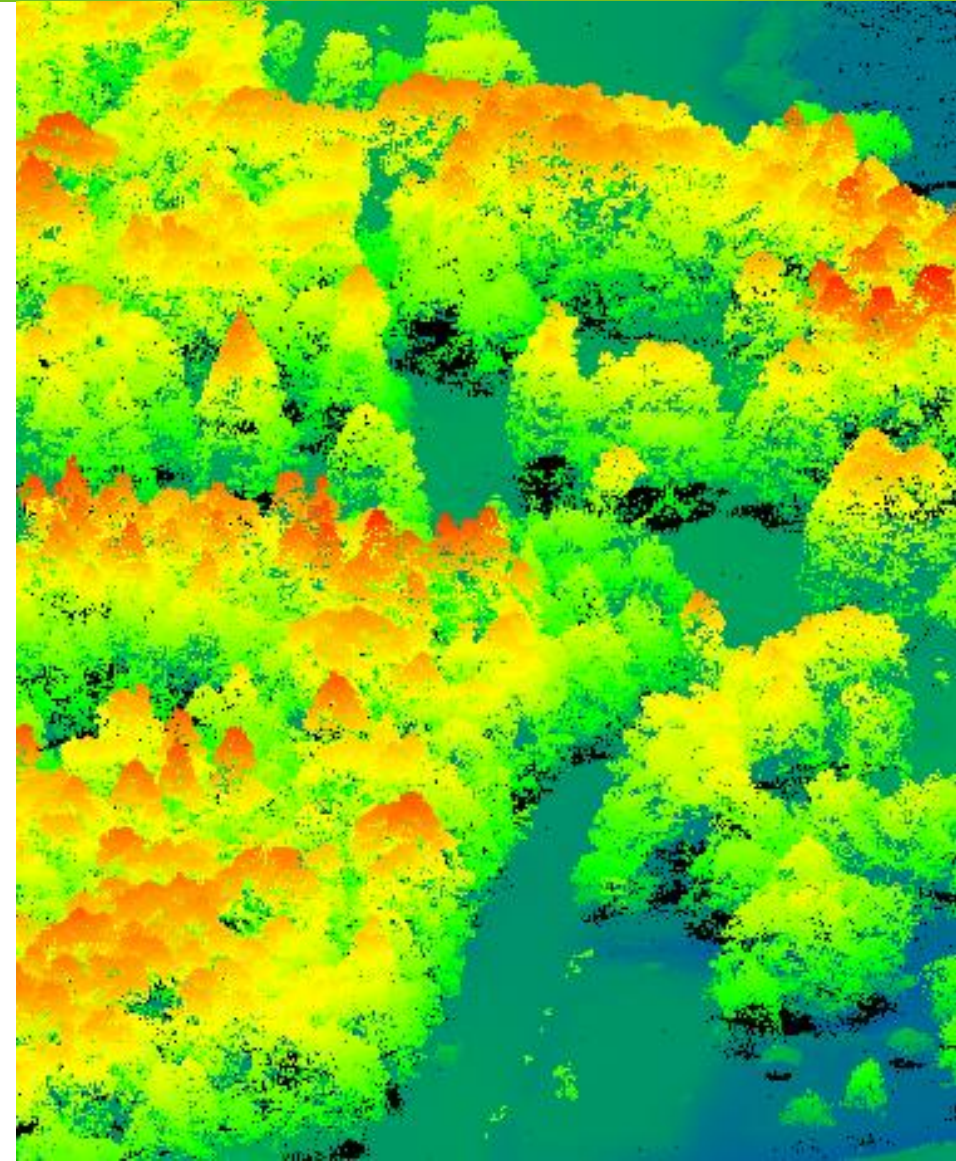
Plot Based Inventory in MN: Forest Inventory for Stewardship

Operational Lidar Inventory (OLI) Workshop – April 15, 2025, Vancouver, WA

Presented by: Keb Guralski
Jennifer Corcoran

Goals for today

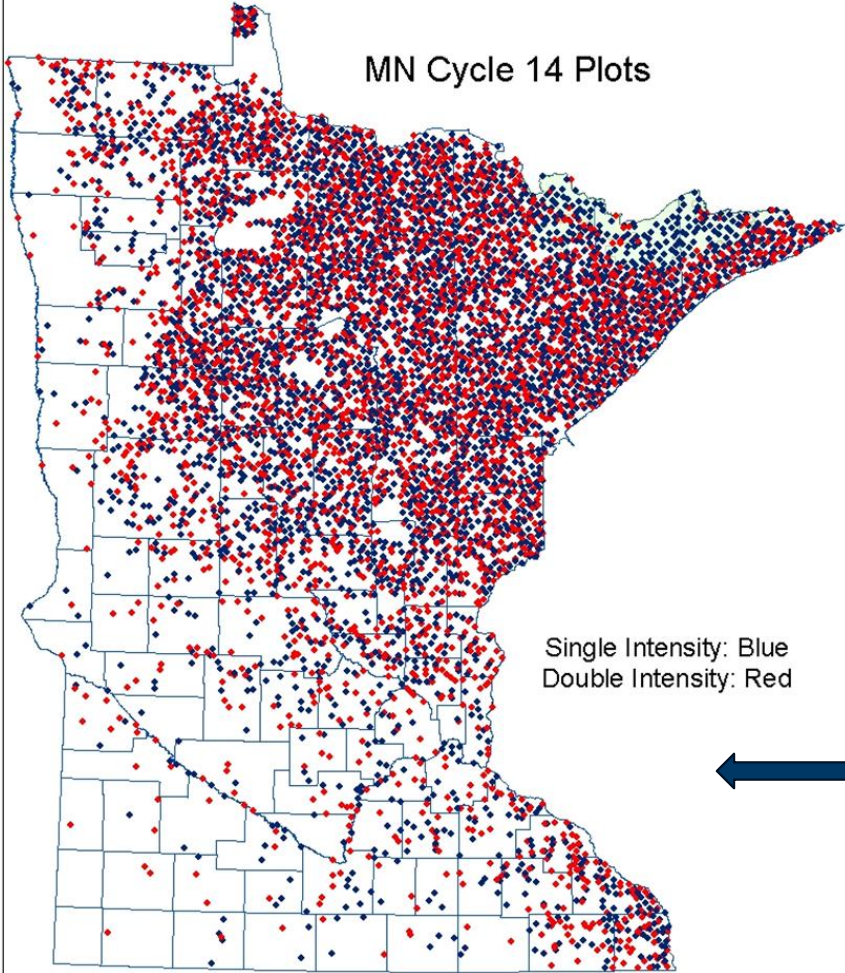
- Provide overview:
 - MN DNR Lidar Derived Forest Inventory
 - Lidar data used, processing and modeling, and field methods
 - Expansion of field data collection on private land
- Demonstrate:
 - Examples of lidar derived results
 - How to use this info in Forest Stewardship Plans
- Answer your questions



Forest Inventory and Distribution

Forest Inventory & Analysis

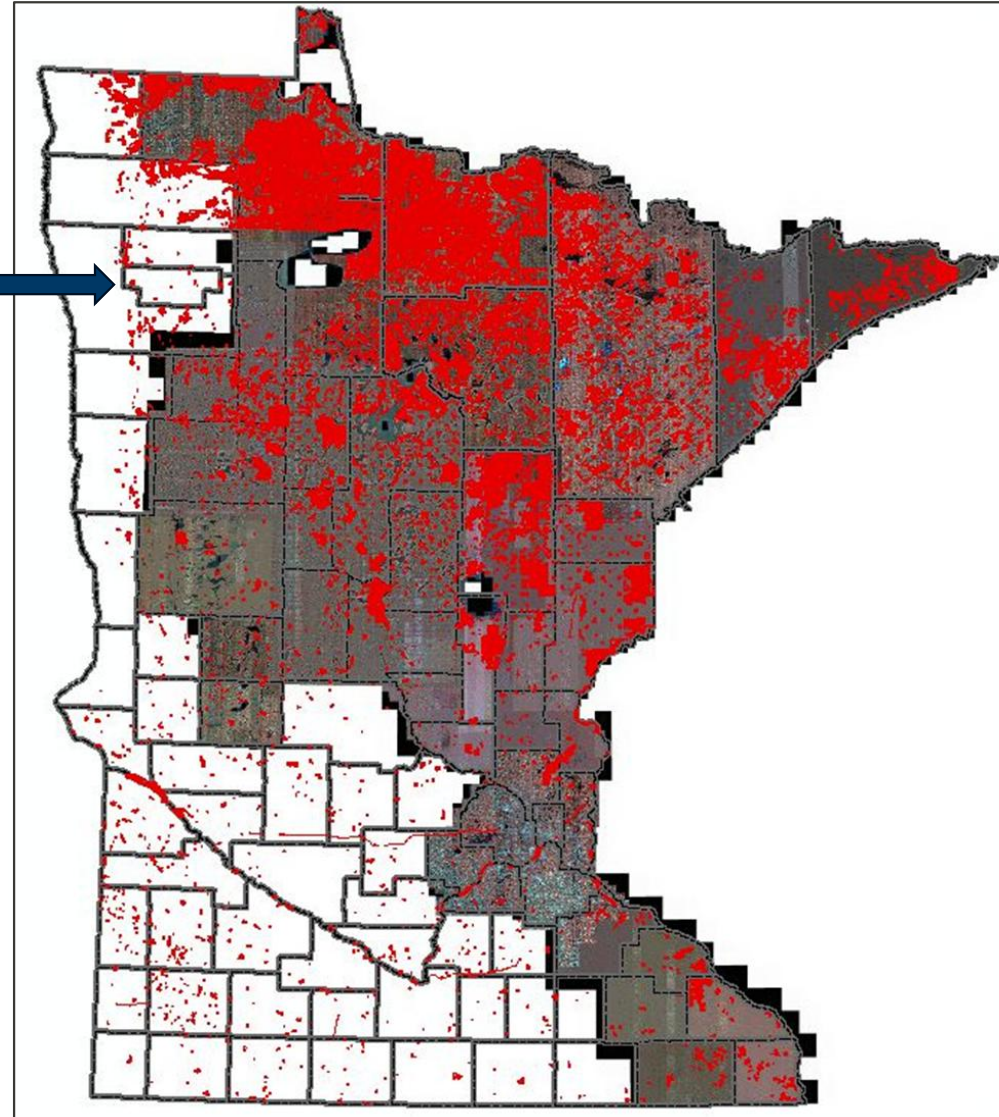
MN Cycle 14 Plots



Single Intensity: Blue
Double Intensity: Red

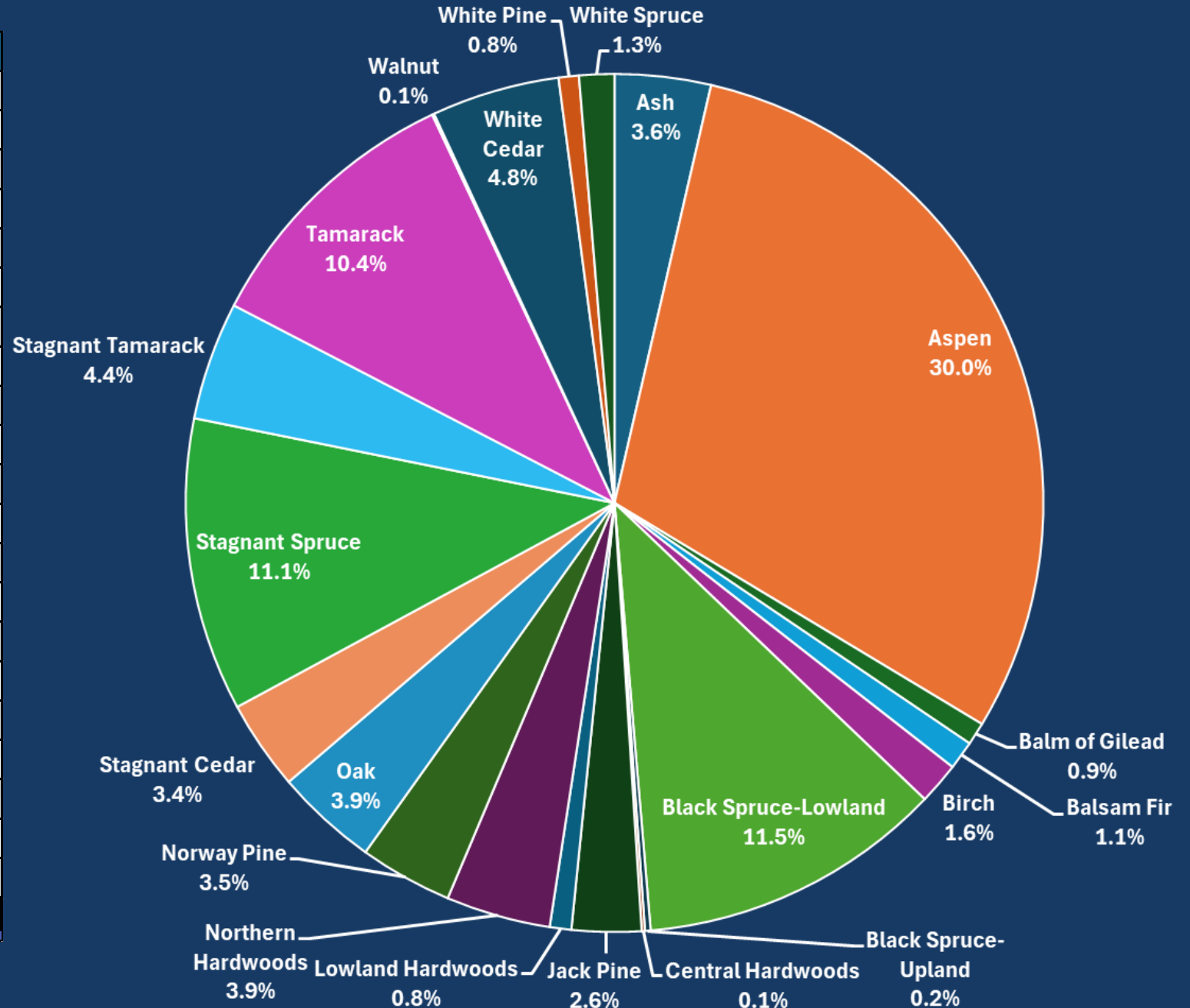
**MN DNR Manages
4.5 million Acres
of Forest Land**

**FIA Inventories:
~6500 Forested
Plots on a 5 year cycle;
~1300 Plots/year
(not including Urban FIA)**



Minnesota State Administered Land - Forest Cover Types

Forest Cover Type	Forested Acres
Ash	135,489
Aspen	1,123,365
Balm of Gilead	31,969
Balsam Fir	40,548
Birch	59,045
Black Spruce-Lowland	431,590
Black Spruce-Upland	8,126
Central Hardwoods	4,493
Jack Pine	98,024
Lowland Hardwoods	30,359
Northern Hardwoods	147,597
Norway Pine	131,339
Oak	144,827
Stagnant Cedar	126,639
Stagnant Spruce	413,854
Stagnant Tamarack	166,545
Tamarack	389,255
Walnut	2,782
White Cedar	180,754
White Pine	28,553
White Spruce	49,637
Grand Total	3,744,791



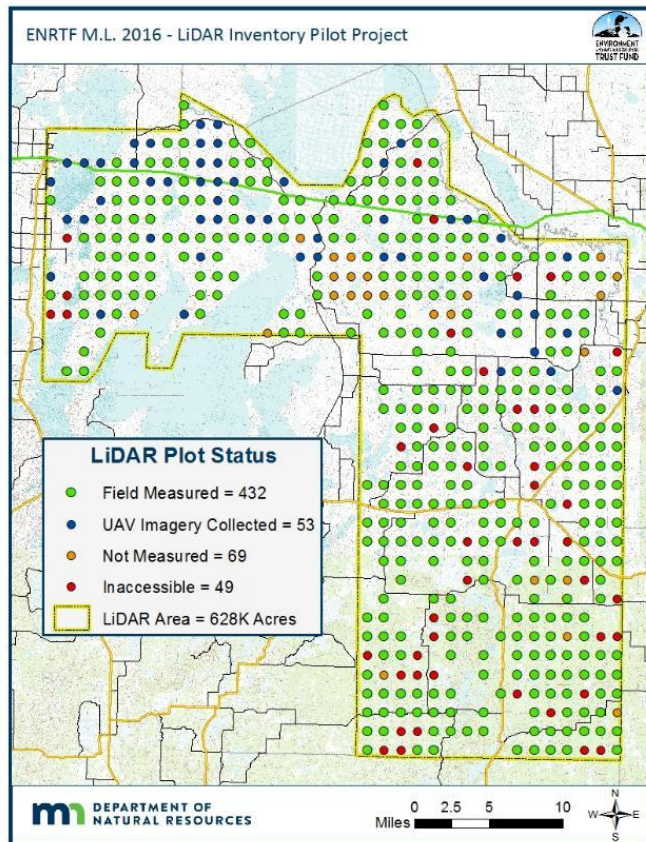
An aerial photograph of a forest, where the trees are rendered in a light, almost white color, likely due to a specific data processing or visualization technique. The forest is dense and covers most of the ground. In the background, there are patches of green, suggesting other types of vegetation or open fields. A prominent blue circular overlay is positioned on the right side of the image, containing the text 'Lidar Derived Forest Inventory' in white, sans-serif font.

Lidar Derived Forest Inventory

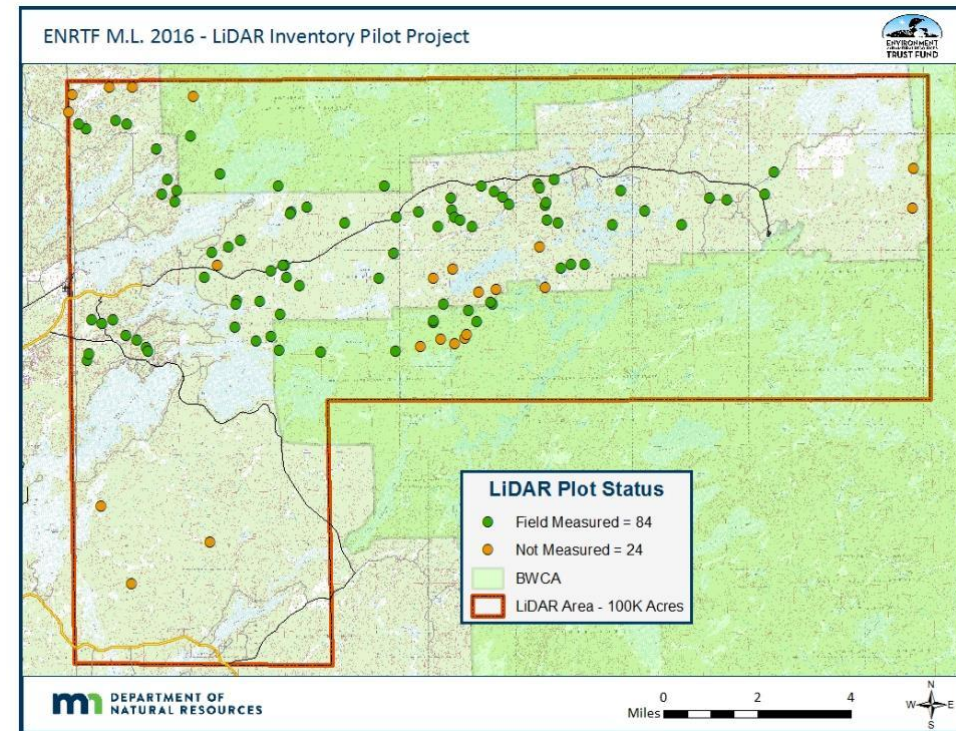
Pilot Study

➤ 1/10 acre fixed radius plots, full stem map, measured >5 in DBH:

Cass County, 432 gridded plots



Lake County, 108 Stratified Random plots



Plot Area Considerations (Pilot Data)

DNR 1/10 ac plots, sub-meter (x, y); n=150	DNR 1/24 ac plots, sub-meter (x, y); n=151	DNR BAF10 plots, sub-meter (x, y); n=146
GrossVol/ac ~ ElevMax + Cover3m + Stratum5 % Var explained: 65.18 RMSE: 629.1 cu.ft./ac	GrossVol/ac ~ ElevMean + Cover3m + Stratum5 % Var explained: 61.36 RMSE= 692.5 cu.ft./ac	GrossVol/ac ~ Stratum4+ ElevMode + ElevIQ + ElevL3 + ElevMADmedian % Var explained: 51.05 RMSE= 1474.8 cu.ft./ac

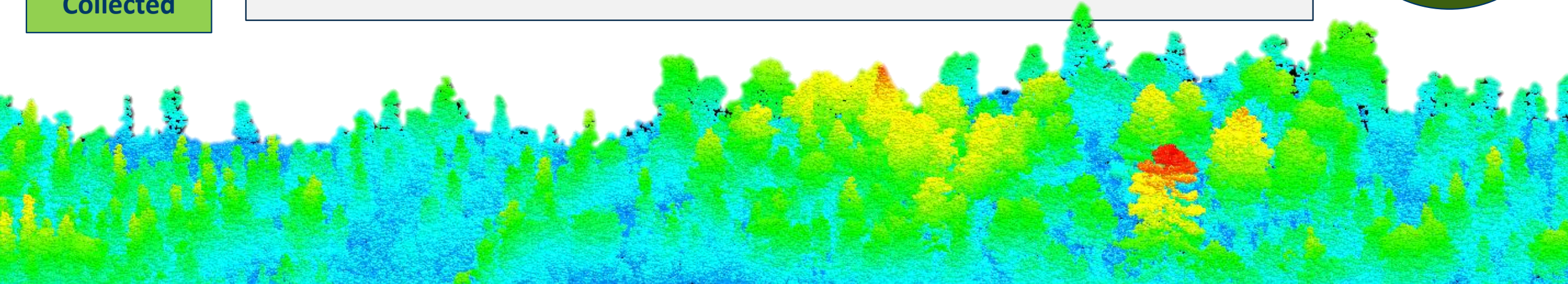
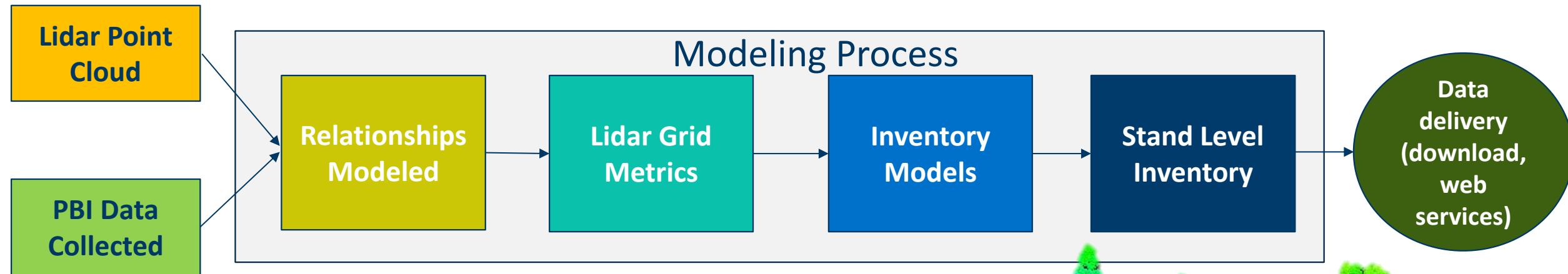
Sub-meter plot coordinates are essential

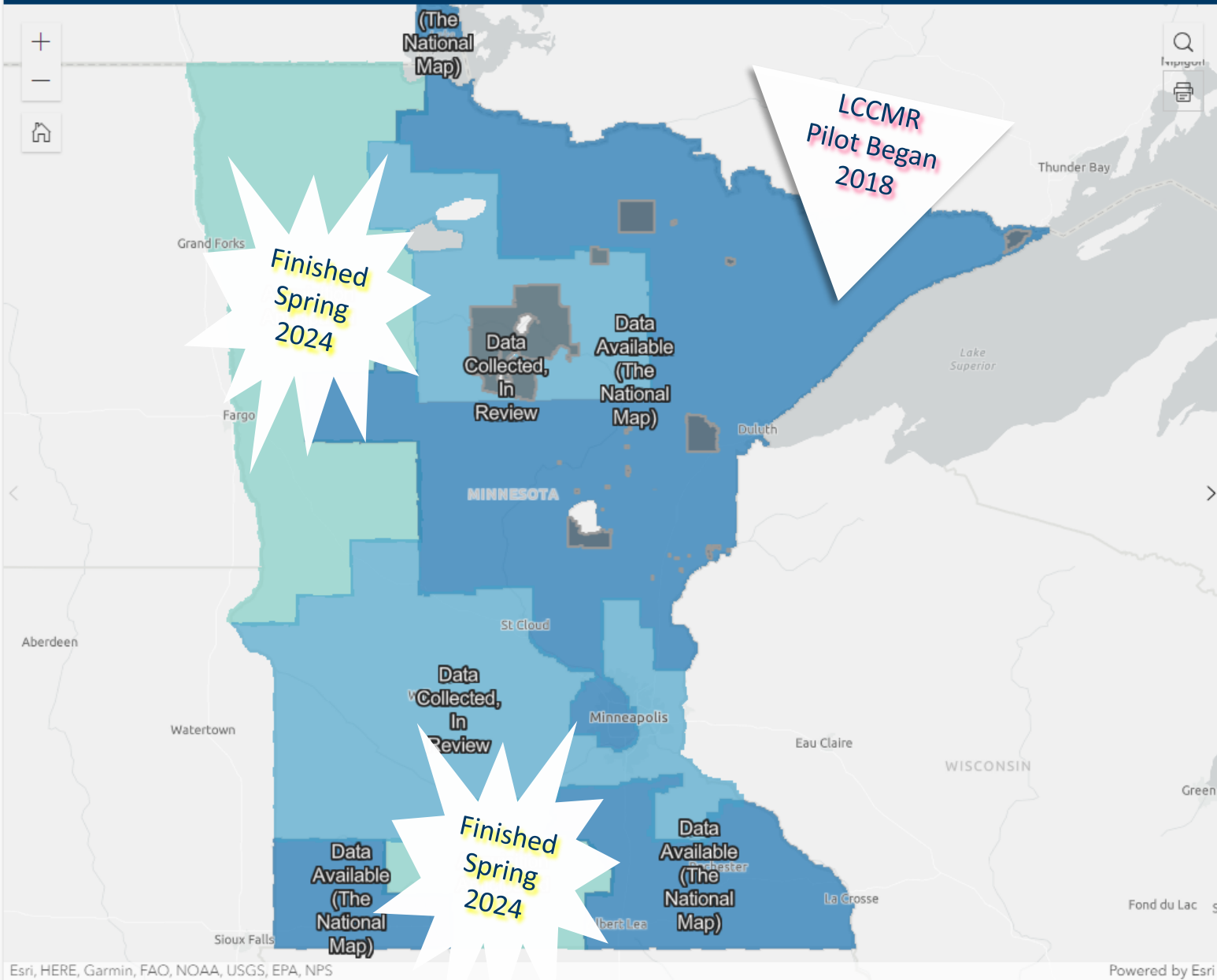
Sub-meter x,y of FIA plots (from MNDNR revisit)	Traditional GPS x,y of FIA plots (from 2013-2017 cycle)
<p>VOLCFGRS/ac ~ ElevMean + ElevP10 + Stratum2 + Stratum5</p> <p>% Var explained: 76.2</p> <p>RMSE = 618.3 cu.ft./ac</p>	<p>VOLCFGRS/ac ~ ElevMean+ ElevCV+ ElevP05+ Cover3m+ Stratum5</p> <p>% Var explained: 56.67</p> <p>RMSE= 834.2 cu.ft./ac</p>

(Results from 2018 linear LiDAR AOI) N=56

Forestry Inventory - putting elements together

Lidar and Plot Based Inventory (PBI) are Foundational Data





MN's Lidar

USGS 3D Elevation Program is ongoing, and **requires** a matching partnership

Contributions to Minnesota Lidar (\$millions)

- Minnesota Partners (59): \$ 7.55
- USGS 3DEP: \$14.72
- USFS: \$ 0.45

Total: ~\$22.71M

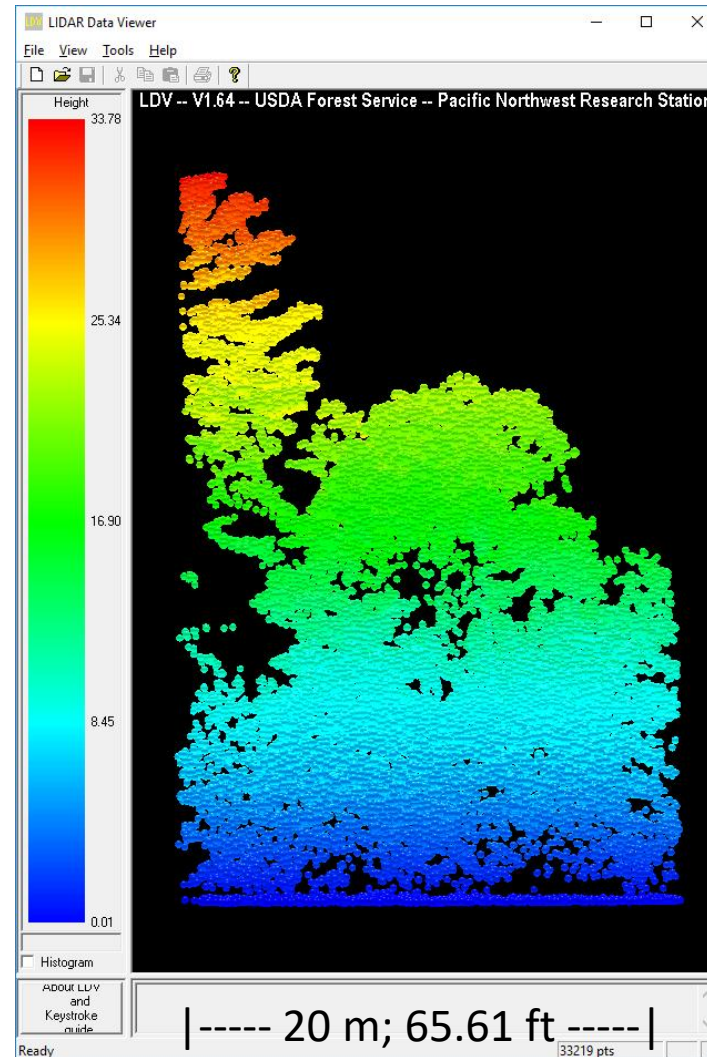
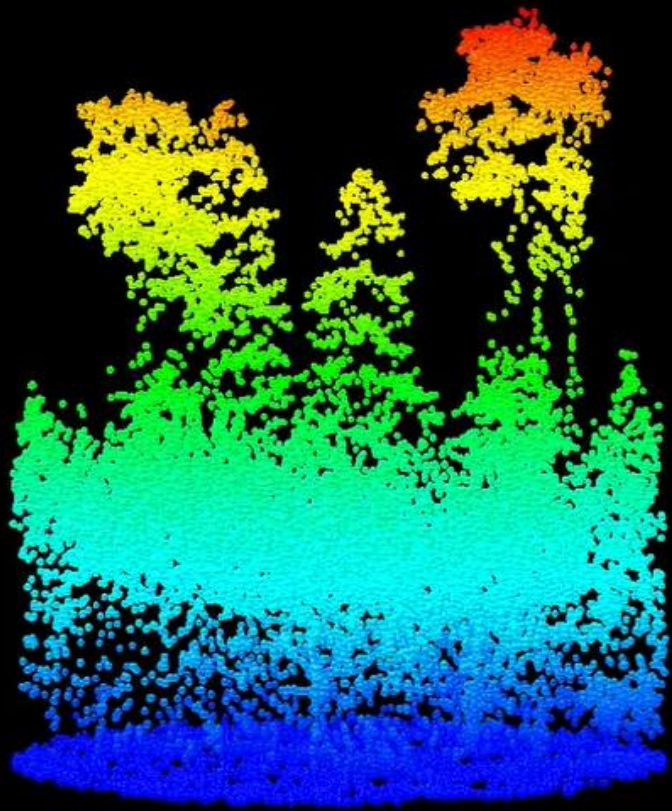
MN Partners had **major** contribution from the State NRCS and 5 SWCDs; also includes: 42 Counties, 8 State programs, 1 regional government, 1 private company, and 1 Tribal Nation.

DNR Contribution: \$1.195M

- Forestry (includes RAP, PFM, Fire): \$1,010,000
- School Trust: \$100,000
- Fish and Wildlife: \$50,000
- Eco Waters: \$35,000

Grid Metrics from Lidar Point Cloud

1/10 ac Plot

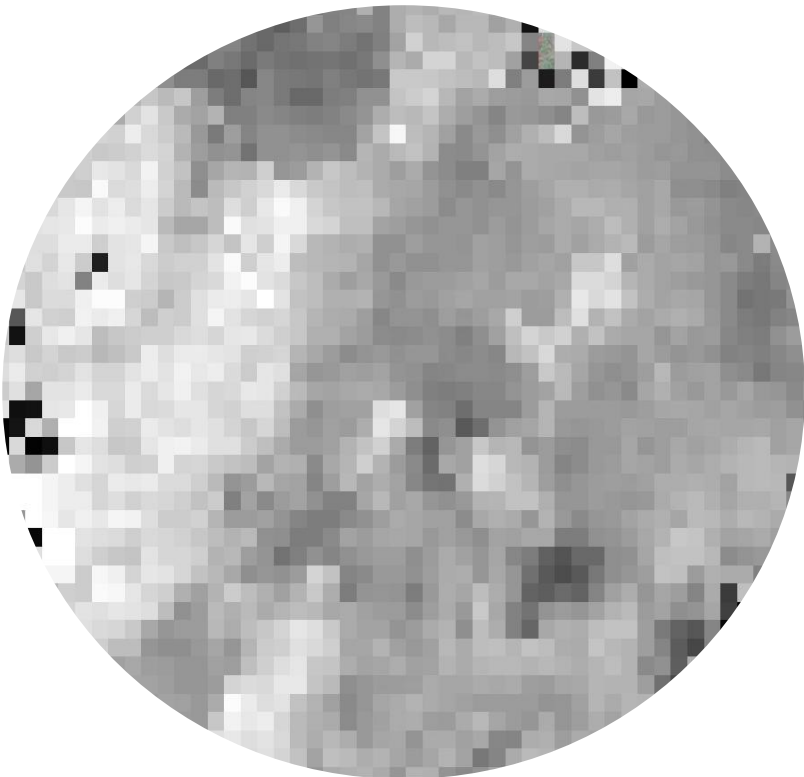


ElevMax	33.78 m
ElevP99	31.92 m
ElevP95	26.09 m
ElevMean	13.27 m
ElevMode	20.44 m
ElevSQRT	15.19 m
ElevCURT	16.74 m
Cover	89.70 %

Plot-level Lidar Point Cloud Metrics

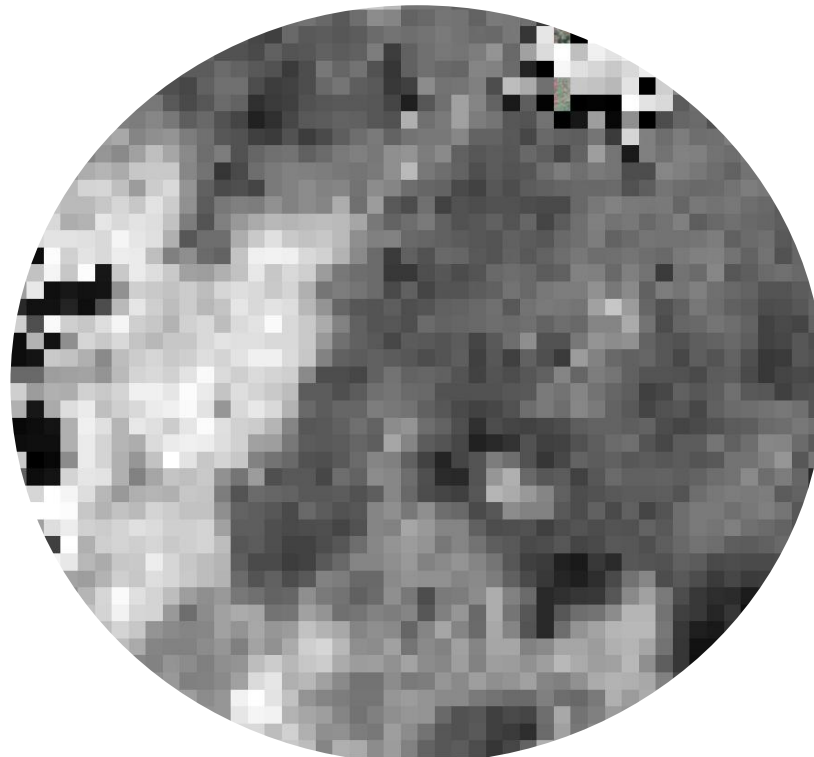
95th Percentile of Height

95 Percentile
High : 26.7274
Low : 0.1926



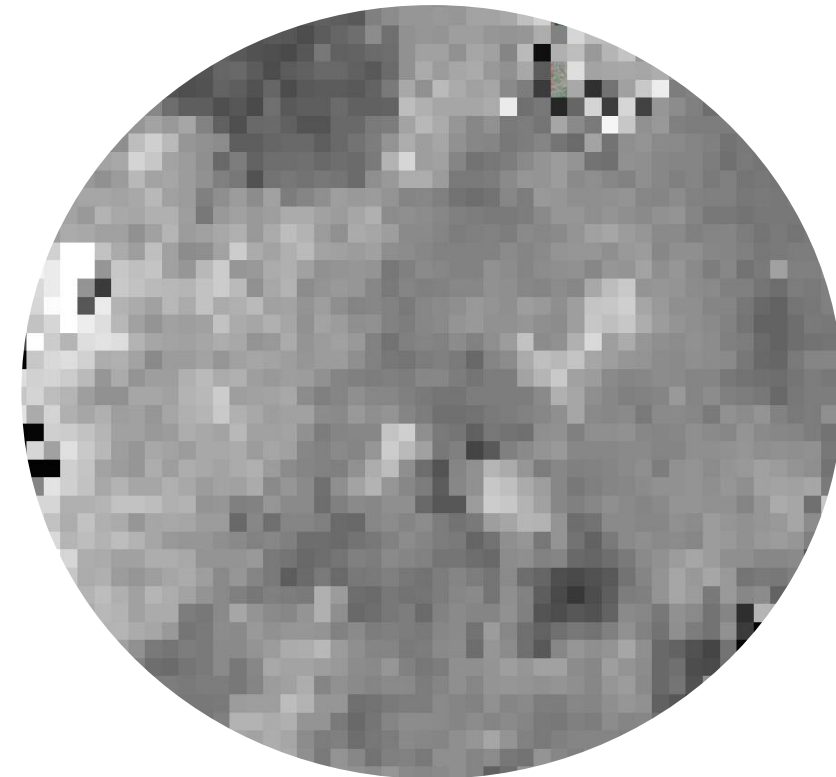
50th Percentile of Height

50 Percentile
High : 20.9781
Low : 0.162




Standard Deviation of Height

Elev Stand Div
High : 9.5365
Low : 0.0151

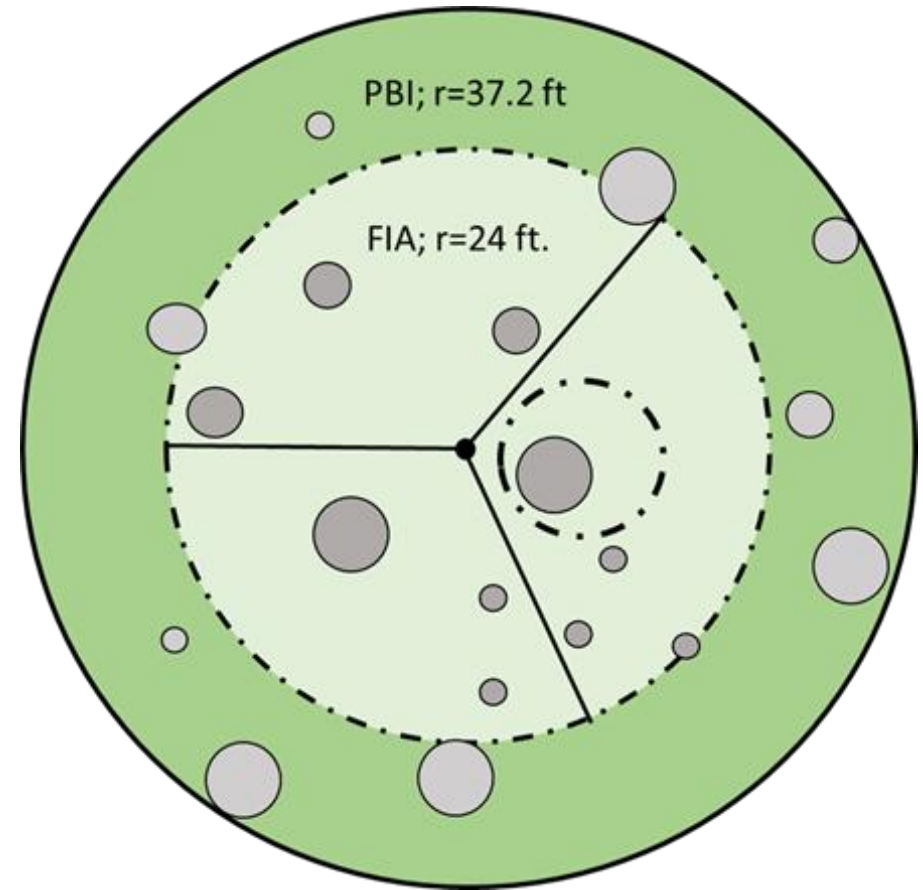
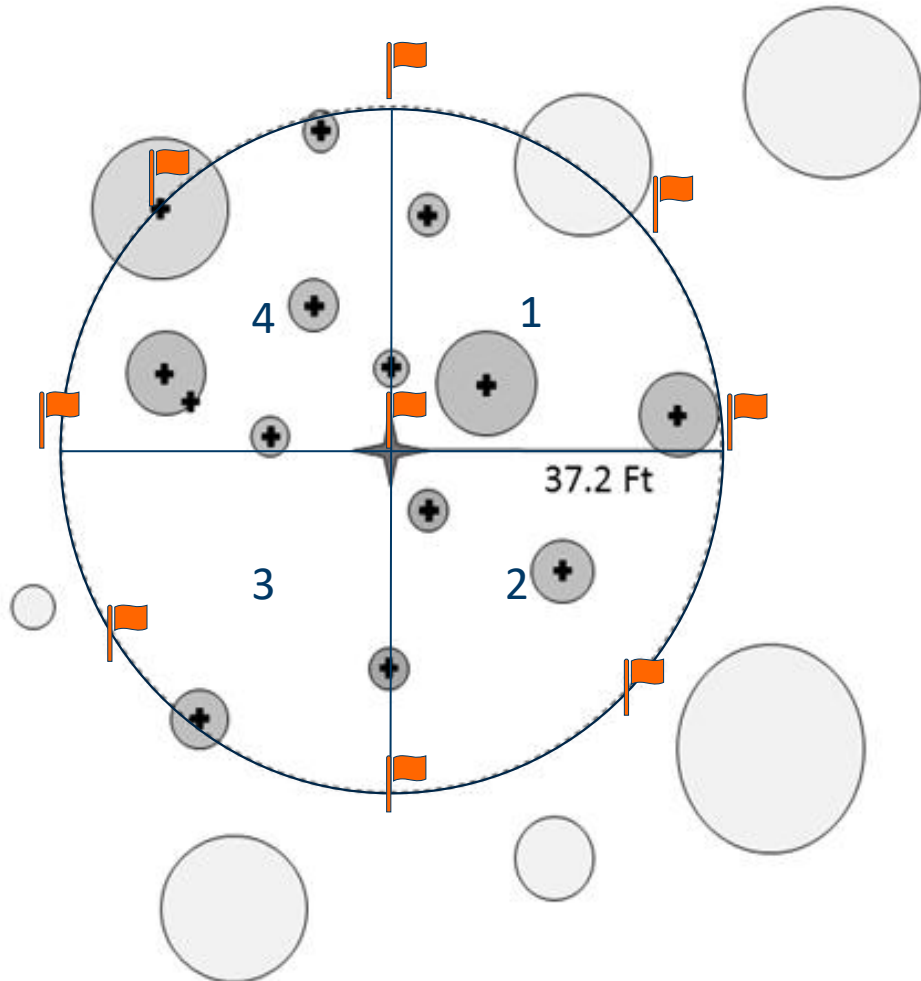


|----- 20 m; 65.61 ft -----|



Plot Based Forest Inventory (PBI)

How is PBI collected?



Our Goal is to collect one plot per 3,000 forested acres statewide across all forested land ownership types and Regional Landscapes!

PBI Planned and Complete

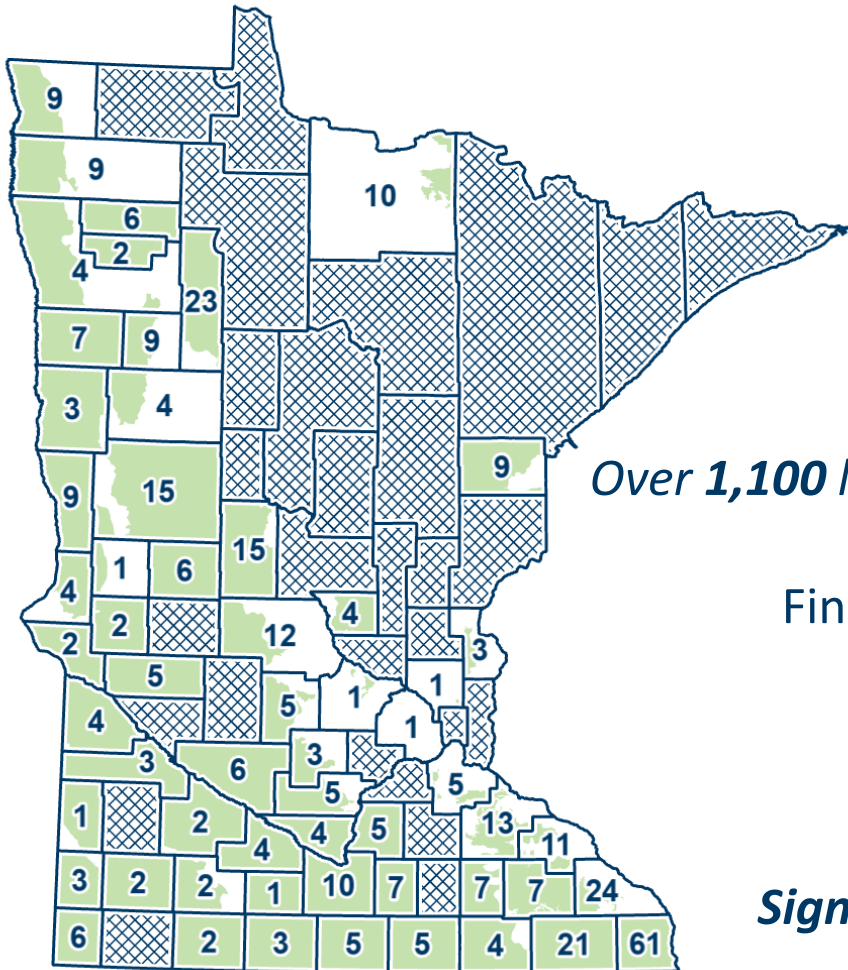
Ownership	Plots Completed	Plots Under Contract	Remaining Targets	**Total Plot Target
State	2,562	*301		2,863
County	926	*104		1,030
USFS	664	*123		787
Tribal Lands	14			14
Municipal	12			12
Private Industrial	96			96
Private	*356	*1,205	680	2,241
Total	4,630	1,733	680	7,043

* Includes PBI plots expanded from FIA collected in FY24 and FY25 (FY24 – 256 plots, FY25 – 508 plots)

** All plot completions and targets are estimated. Plot status, condition, and review determine final plot count

Private Land PBI

Private land PBI expansion target: 1,500 – 2,000 plots



Over **1,100** landowners have signed up!

Final Parcel Selection based on...

- Spatial location of plot
- Target Needs
- Ownership of >2 acres

Sign up today! (Link on last slide)

THE PRIVATE LANDOWNER PBI SIGN UP PROCESS

SIGN UP

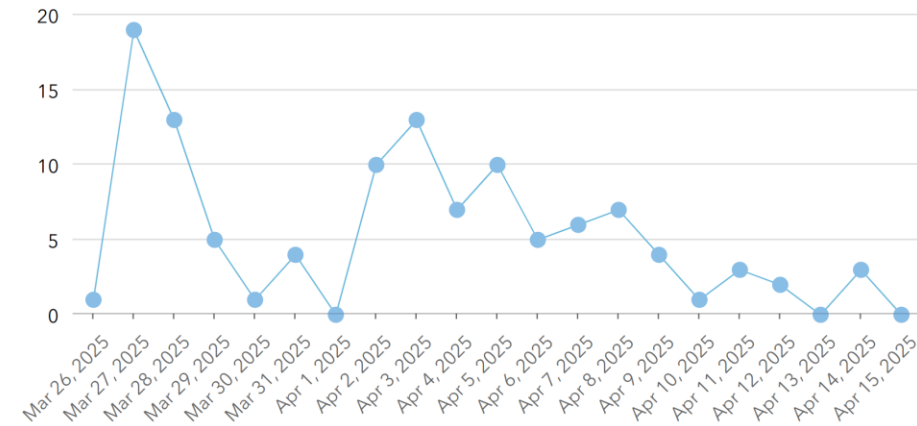
Go to www.mdnr.gov/resource-assessment to sign up or learn more

CONNECT

A coordinator will contact you, get more details about the property, and discuss the project

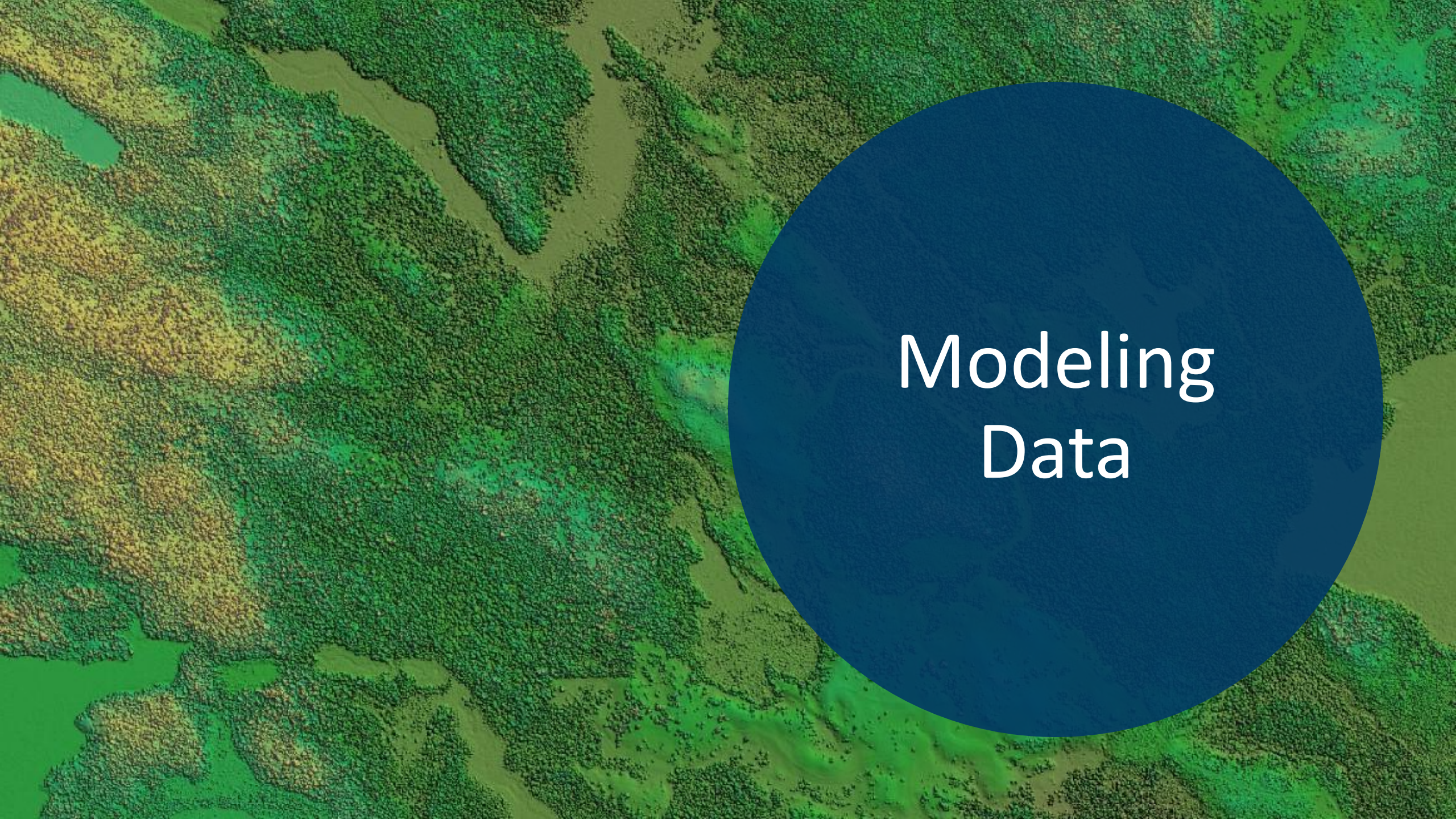
Surveys count: 114 (total: 1,107)

3/26/25 - 4/15/25



PBI Data Characteristics

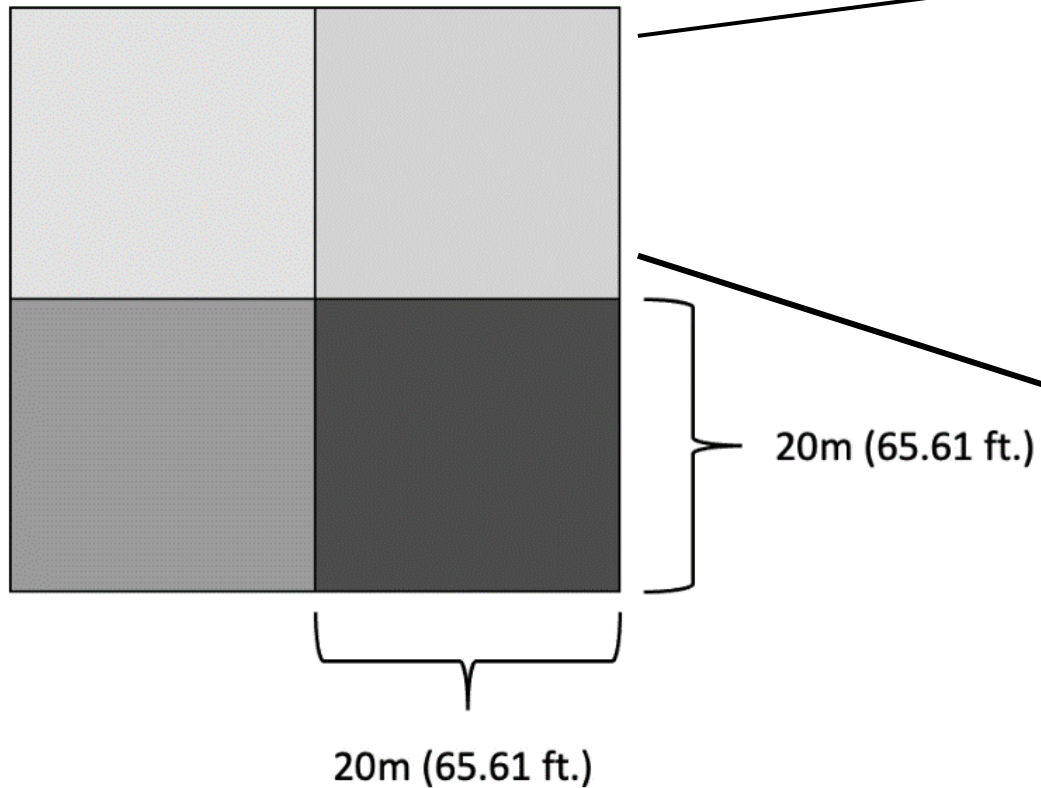
Lidar Block	Block size (Sq. miles)	No. of PBI plots	Top five cover types in PBI data	Mean to Max range of Volume (cu.ft./ac) and BA (sq.ft./ac) in PBI
RLB	11,620	1,328	Black spruce, Aspen, Tamarack, White Cedar, Ash	Vol: 1144.5 - 5242.9 BA: 59.9 - 272.5
LSB	4,975	426	Aspen, Black spruce, Tamarack, Ash, Birch	Vol: 978.5 - 4612.6 BA: 49.4 - 248.7
Pine	1,433	125	Aspen, Northern Hardwoods, Oak, Tamarack, Black spruce	Vol: 1309.8 - 4590.3 BA: 67.3 - 245.6

An aerial photograph of a wetland or marsh area, showing a complex network of water channels and vegetated land. The colors range from bright green to dark brown. A large, dark blue circular overlay is positioned on the right side of the image, containing the text "Modeling Data" in white.

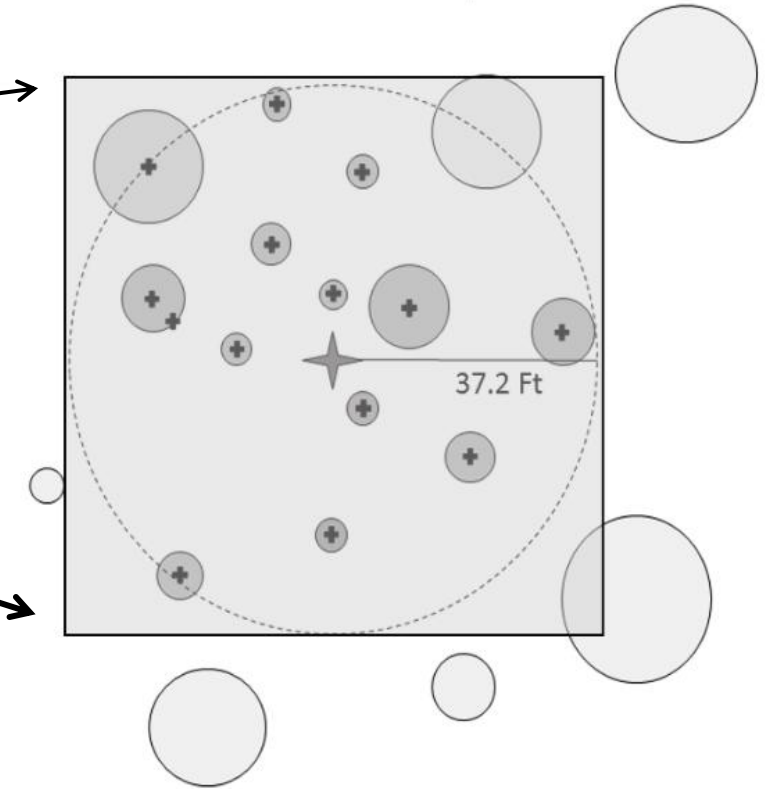
Modeling Data

Plot Based Inventory – Grid Metrics

Grid Metrics at 20 m resolution



Fixed Radius PBI Plot, 37.2 Ft



Training Data Frame

- Lidar point cloud was extracted for each plot location and numerous predictor (cloud) metrics were produced. The plot-level response variables were regressed against the predictor cloud metrics in RF and MLR frameworks.
- The spatial inventory models were extended over the AOI using grid metrics (20-m) representing canopy height distribution, vertical strata density and cover

The screenshot shows a Microsoft Excel spreadsheet titled "FramePBlix [Read-Only] - Microsoft Office". The active cell is A1, containing the text "ElevMax". The spreadsheet displays a data frame with 14 rows and 28 columns. The columns are labeled as follows: A (plot_id), H (tree_pres), J (COVER_TP), P (sba), Q (maxht), R (tree_count), S (TPA), T (QMD), U (BAWHT), Z (SIplot), AA (age_plot), AC (VOLCFGRS), AH (AGB_lbs), AL (ElevMax), AM (ElevAv), AN (ElevMode), AO (ElevSD), AP (ElevVar), AQ (ElevCV), AR (ElevIQ), AS (ElevSkew), AT (ElevKurt), AU (ElevAAD), AV (ElevMADr), AW (ElevMADr), AX (ElevL1), AY (ElevL2), AZ (ElevL3), and BA (ElevL4). The data rows contain numerical values for the predictor variables and categorical values for the response variables.

	A	H	J	P	Q	R	S	T	U	Z	AA	AC	AH	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA
1	plot_id	tree_pres	COVER_TP	sba	maxht	tree_count	TPA	QMD	BAWHT	SIplot	age_plot	VOLCFGRS	AGB_lbs	ElevMax	ElevAv	ElevMode	ElevSD	ElevVar	ElevCV	ElevIQ	ElevSkew	ElevKurt	ElevAAD	ElevMADr	ElevMADr	ElevL1	ElevL2	ElevL3	ElevL4
2	1_551	no	85	0	NA	0	0	0	0	NA	NA	0	0	15.597	2.957637	0.1	2.820448	7.954926	0.953615	2.44075	1.953505	7.159427	1.96135	1.077	2.0595	2.957637	1.379228	0.467246	0.3299
3	1_554	yes	73	105.1084	60	22	220	9.359306	43.54802	22.36971	159	1864.3322	57023.692	19.478	8.509807	0.1	4.159857	17.30441	0.488831	5.954	-0.54095	2.395649	3.438642	2.688001	9.344999	8.509807	2.339936	-0.3367	0.1733
4	1_569	yes	20	130.7313	82	23	230	10.20851	67.56046	58.40725	77	2576.0781	134742.55	24.653	13.62476	16.8584	6.354687	40.38204	0.466407	9.64175	-0.60223	2.178062	5.337454	4.0145	3.576	13.62476	3.56426	-0.60291	0.1593
5	1_570	yes	30	97.78313	89	11	110	12.7665	74.42255	69.57559	86	1827.773	112607.13	25.492	13.95992	1.715937	7.227822	52.24141	0.517755	12.715	-0.47548	1.821339	6.323532	5.377	14.18206	13.95992	4.081974	-0.61787	-0.094
6	1_571	yes	40	127.3754	88	13	130	13.40317	71.74694	62.80286	85	2551.7056	153541.98	25.04	13.95901	22.66486	6.804417	46.30009	0.487457	12.75175	-0.24966	1.776807	5.916857	5.831	7.785358	13.95901	3.905994	-0.28996	-0.043
7	115_107	yes	12	151.8301	68.5	33	330	9.184558	54.53065	47.09118	57	3250.1163	142270.54	25.034	14.33025	0.1	6.430736	41.35437	0.448752	9.672998	-0.57479	2.37946	5.294276	4.743999	15.14	14.33025	3.631235	-0.53129	0.2092
8	115_108	yes	12	126.6015	76.5	29	290	8.946574	61.46838	58.10433	62	2844.2717	114461.4	23.23	14.61252	19.92571	5.520889	30.48021	0.377819	8.9175	-0.61987	2.277602	4.778491	3.948	3.696714	14.61252	3.098385	-0.5518	0.0580
9	115_110	yes	12	14.13731	78	1	10	16.09977	78	62.77519	78	457.19441	16975.767	25.584	14.91725	1.315429	7.306241	53.38115	0.489785	12.1745	-0.55847	2.001112	6.311931	4.959	15.78957	14.91725	4.112587	-0.69253	0.0262
10	115_113	yes	9	245.6373	80	15	150	17.32758	62.2663	48.0111	78	4590.3253	243621.09	24.445	14.25543	17.50214	5.20895	27.13316	0.365401	7.733	-0.4511	2.440133	4.315266	3.814001	3.7275	14.25543	2.959956	-0.31045	0.209
11	115_132	yes	12	2.52193	36	1	10	6.799904	36	40.89402	42	34.147088	1906.5391	10.905	3.232432	1.129048	1.924585	3.704029	0.595399	2.303	1.370704	5.472682	1.414516	1.1475	1.934952	3.232432	1.013483	0.213936	0.1708
12	115_133	yes	12	98.38743	72	25	250	8.494467	56.41859	67.07745	58	2032.3673	90082.328	22.225	11.72663	17.65952	5.361114	28.74155	0.457174	8.788001	-0.25107	2.071113	4.537285	4.397999	5.632524	11.72663	3.078466	-0.19851	0.107
13	115_138	yes	12	6.978938	30.5	4	40	5.65589	28.18201	44.28711	27	98.54261	2606.4057	12.187	4.667434	1.256571	2.60543	6.788266	0.558215	4.42925	0.362362	2.122877	2.22963	2.2205	3.241928	4.667434	1.489584	0.14071	0.0218
14	115_147	yes	12	97.66751	69	24	240	8.637851	54.06942	64.81818	57	2106.7879	84346.31	20.956	11.57828	17.31517	5.414344	29.31512	0.467629	8.98075	-0.29249	1.941503	4.683164	4.508	5.340674	11.57828	3.106004	-0.25665	0.0353

Fit statistics for inventory models

Attribute	Lidar Block	Model selected lidar variables	Linear model, adj. R ²	RF model, % var explained	RF model, RMSE
AGB	RLB	ElevCV, covMeanIst, strata1, strata2, strata3, strata4, ElevIQ	0.7268	72.8	20,864.8
	LSB	ElevAv, ElevVar, cov3mlst, strata4, strata5, strata6	0.7422	74.6	18,299.0
	Pine	ElevMADmed, strata4, strata5, ElevIQ, strata6	0.788	79.7	23,548.8
Vol	RLB	Strata3, ElevLskew, strata4, covMeanIst, strata1, ElevP05, strata2, ElevAv	0.712	71.4	561.2
	LSB	ElevAv, strata4, ElevIQ, strata5, cov3mlst, strata6	0.7388	74.3	428.1
	Pine	ElevMax, strata1, ElevIQ, strata2, strata3, ElevLkurt, strata4	0.7502	76.5	489.1
BA	RLB	ElevLskew, cov3mlst, strata4, covMeanIst, strata5, ElevSD, ElevVar, ElevP05, strata1, strata2	0.6107	61.4	31.8
	LSB	ElevAv, strata4, strata1, ElevIQ, strata2, strata3, strata5	0.6368	64.3	23.5
	Pine	cov3mlst, strata5, strata6, strata4	0.694	70.5	25.7

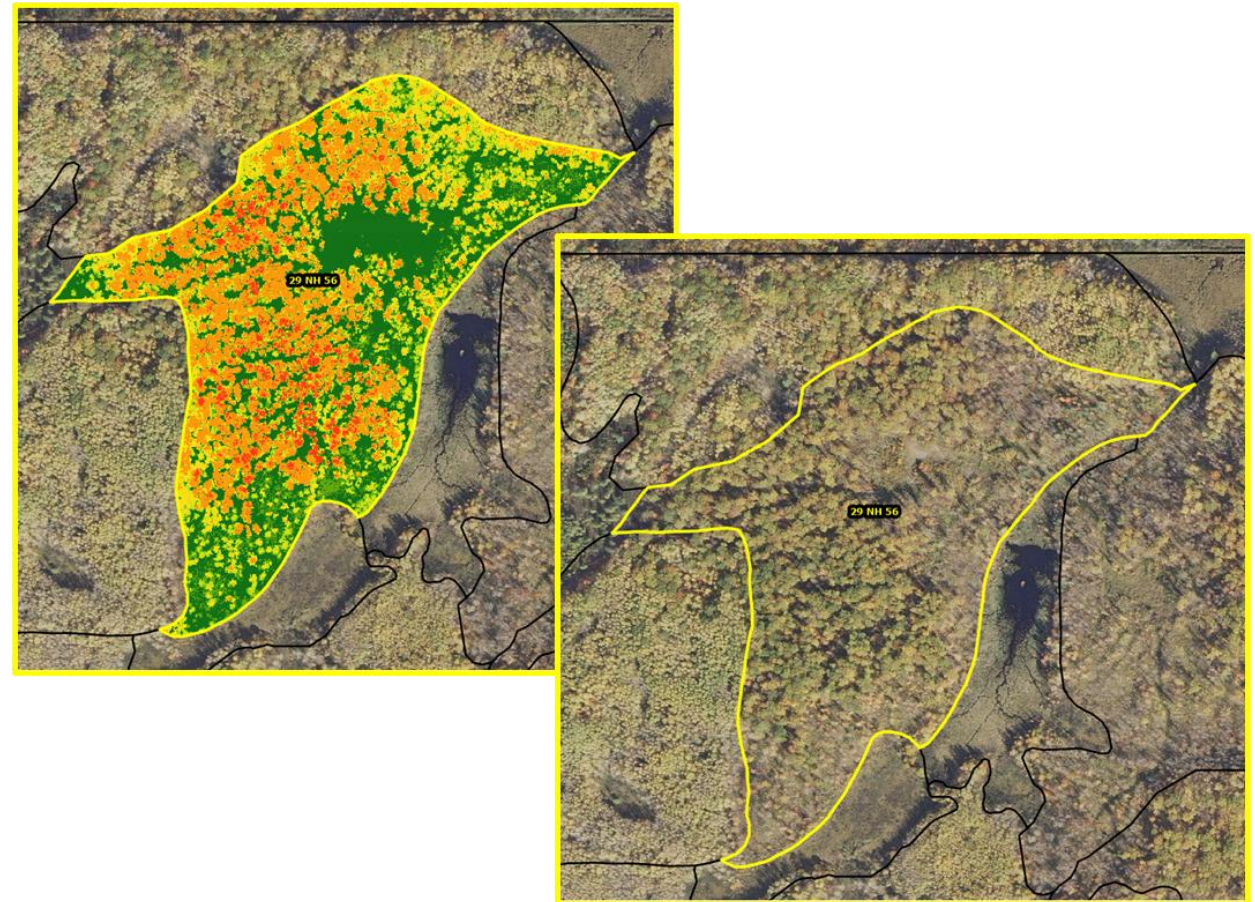


Lidar Derived Products

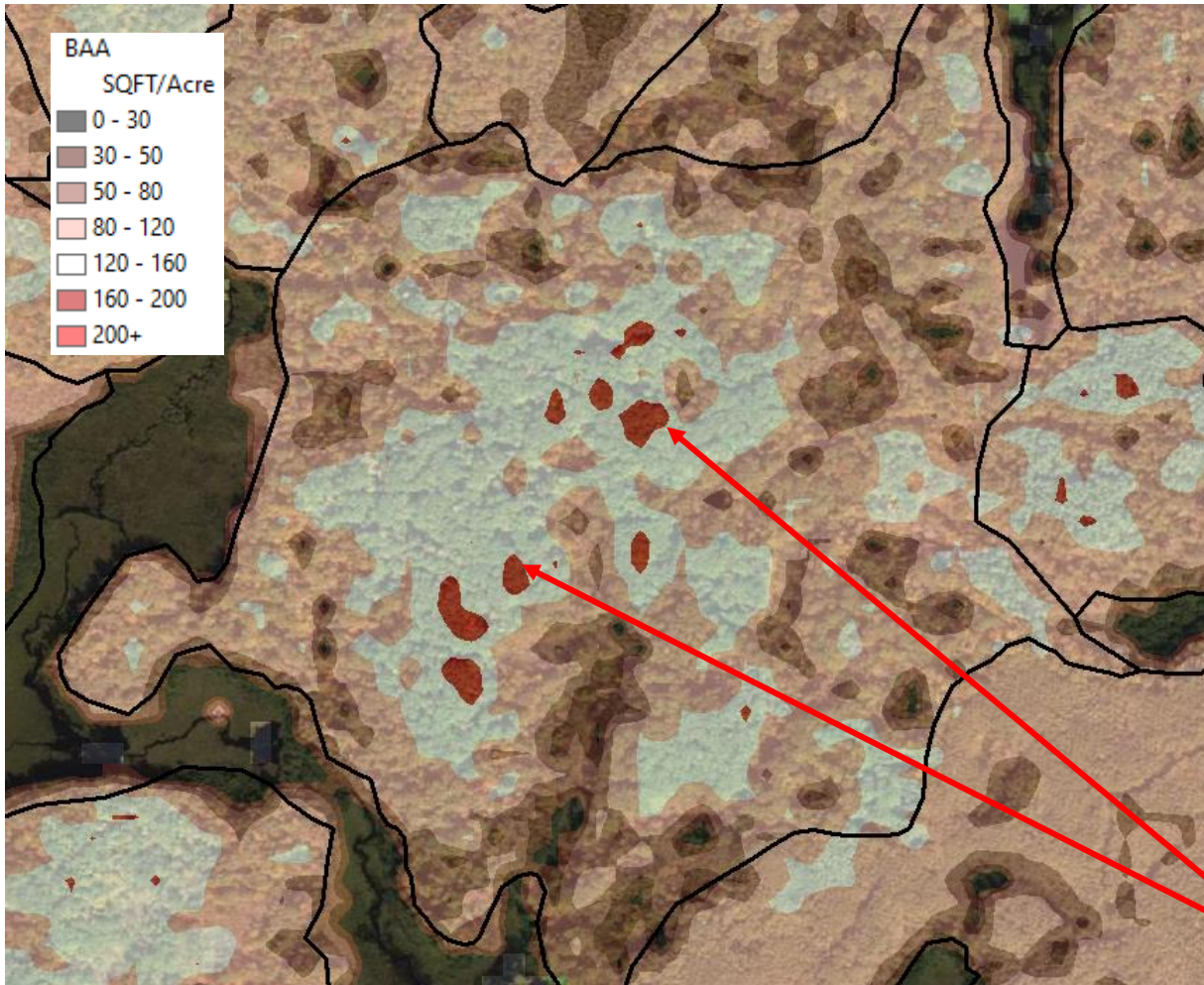
Forest Inventory Model Raster Data

Model representation at 20m resolution

- Above Ground Biomass (AGB and Carbon equivalent)
- Basal Area weighted height (BAWHT)
- Volume (Gross/ Net Cubic Feet and Cords)
- Max Height
- Quadratic Mean Diameter (QMD)
- Stand Basal Area (SBA)
- Trees Per Acre (TPA)
- Cover Type (not lidar derived)
- Age (Cover Type Dependent)
- Site Index (Cover Type Dependent)



Sub-Stand Level Analysis- Stand *Basal Area per Acre*



Raster data can help forest managers visualize and quantify change within the AOI

Basal Area provides a measure of forest density

- Forest density is a critical piece of information for any forest manager

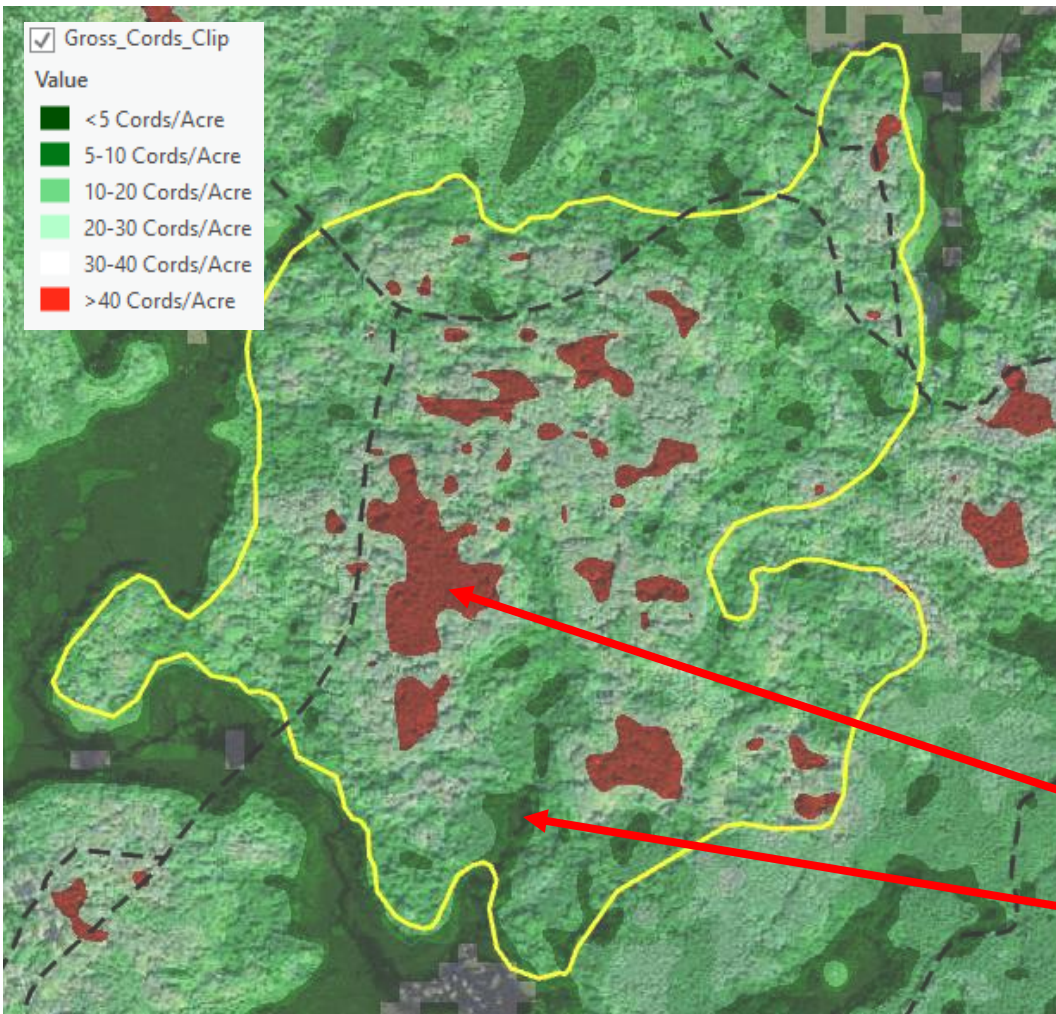
Basal Area contributes to...

- *Volume and Growth Estimation*
- *Prescription Guidance*
- *Field Planning*
- *Retention Planning*

Modeled variation within the stand provides land managers with distribution information of the stand

Areas of 170 ft² BA/Acre

Sub-Stand Level Analysis- *Volume per Acre*



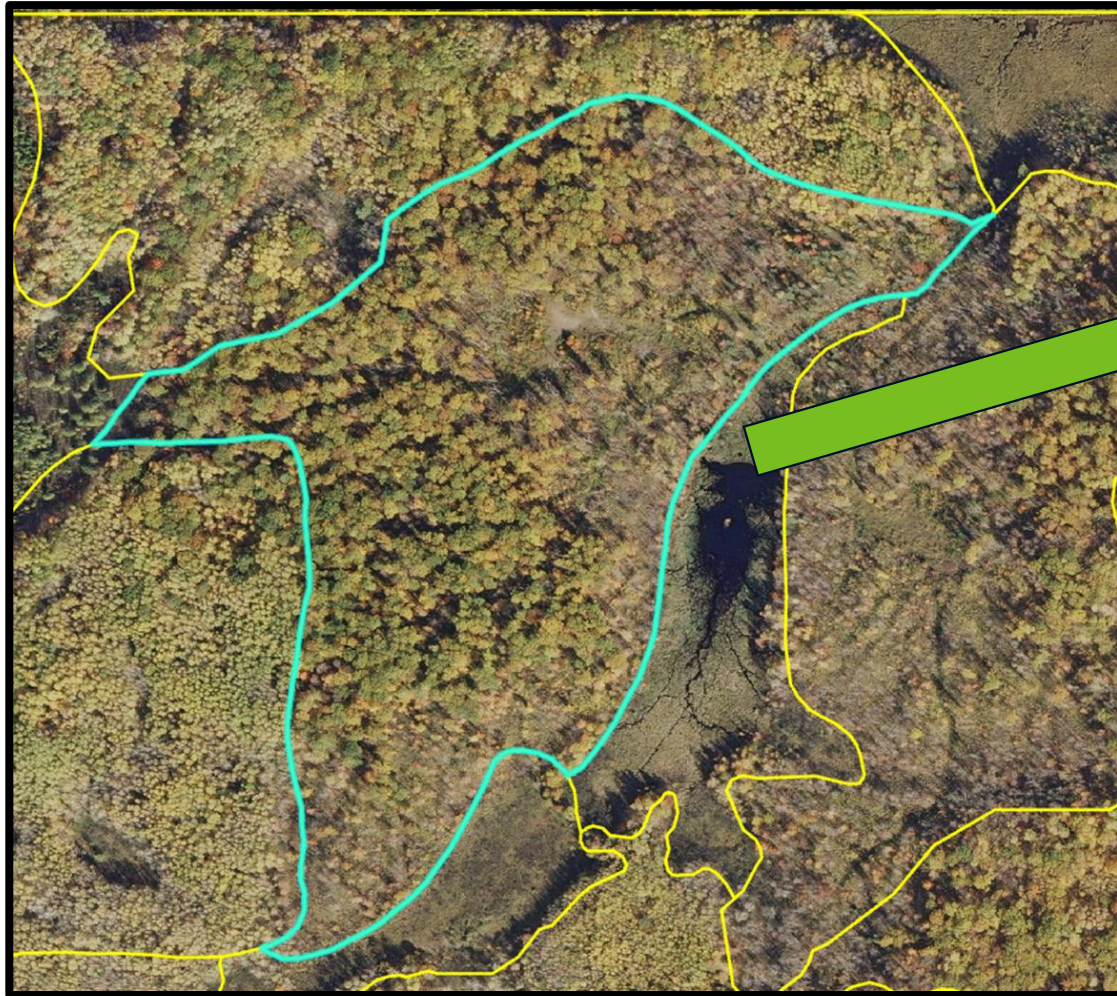
Modeled Volume data facilitates:

- *Accurate Forest Resource Planning*
 - Understanding volume distribution assists managers plan and meet harvest objectives more sustainably
- *Prescription Development*
- *Growth Estimation*
- *Site Productivity*
- *Pre-sale Forest Operations Planning*
- *Landscape level resource distribution and trends*
 - *With repeated collection*

Area depicting >40/cords per Acre

Area showing low volume – consider operability/marketability

The End Goal = Stand Level Forest Inventory



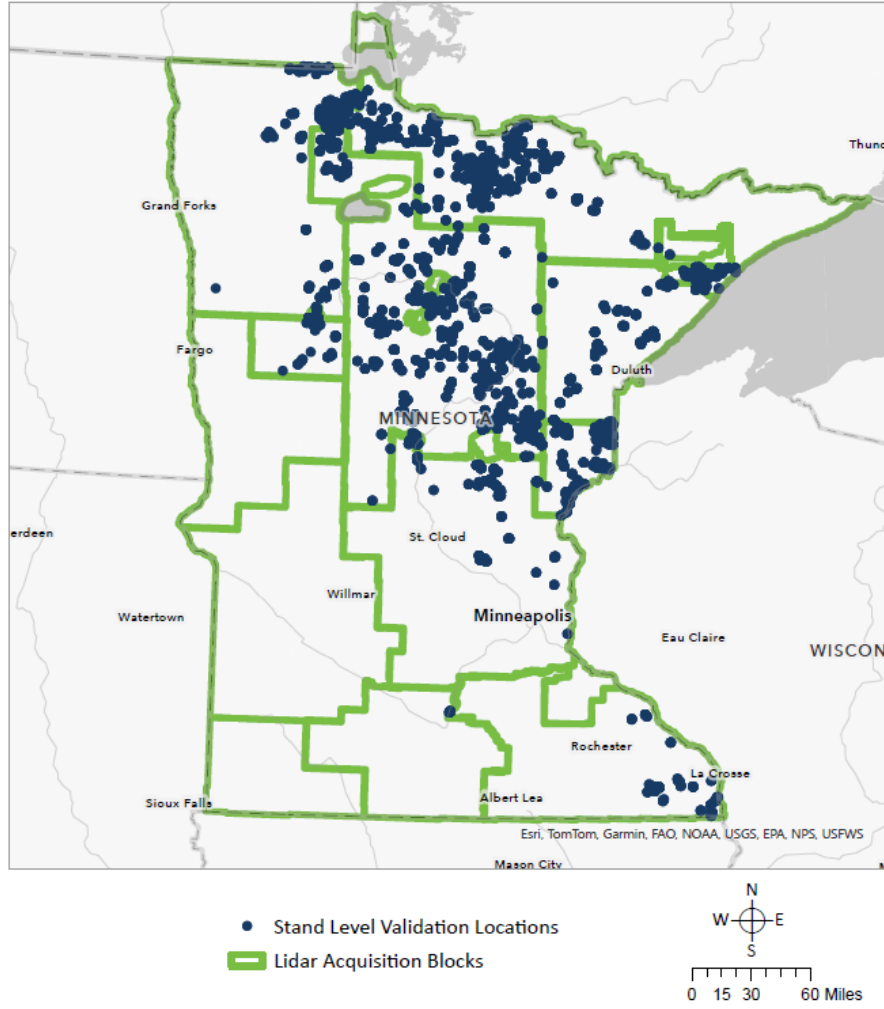
Field	Value
STAND_KEY	22574
SURVEY_YR	1991
Age	88
AG_Biomass	95023.3
AGB_SE_Per	4.7
AGB_CI_Hal	8832.1
BAA	103
BAA_SE_Per	3.6
BAA_CI_Hal	7.3
BAWHT	64.4
BAWHT_SE_P	1.8
BAWHT_CI_H	2.3
GRS_vol_pr	1953.7
Gross_Cord	24.7
GRS_Vol_SE	4.8
GrsVol_CI_	183.8
Max_HT	105.9
QMD	10.7
QMD_SE_Per	2.2
QMD_CI_Hal	0.5
SI	56
SI_SE_Perc	3.2
SI_CI_Half	4
TPA	180
TPA_SE_Per	4.6
TPA_CI_Hal	16
Stand_Acre	41.4
Covertime	20

An aerial photograph of a forest with a road and a lake. A large blue circle is overlaid on the left side of the image, containing the text "Data Validation" in white. The forest shows a mix of green, yellow, and orange trees, suggesting autumn. A road runs through the forest, and a lake is visible in the upper right corner.

Data Validation

MINNESOTA LIDAR VALIDATION NETWORK COMPLETED STAND LEVEL VALIDATION (MARCH 2025)

Data Validation Process

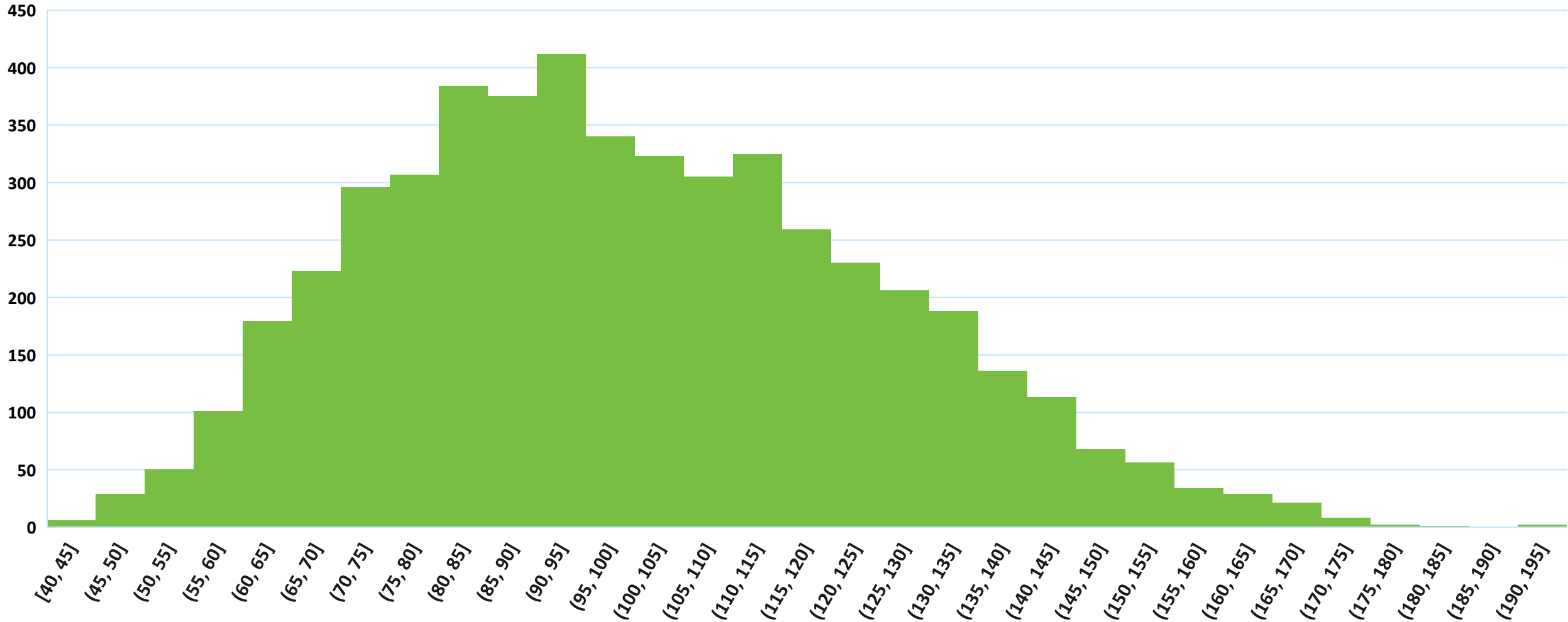


- Validation Data
 - **Stand Level Comparison**
 - MN DNR Forester Collected
 - Fall 2023 – Summer 2025
 - Stratified Sample Areas
 - Lidar Acquisition Block
 - Ecological Section
 - Cover Type
 - Sample size determined at 95% CI
 - Basal Area comparison (Cohen's D)
 - PBI Plot Data
 - MN DNR Forest Inventory Data
 - Power t test in R (sig: .05; power : .8)
 - AOI's Filtered to meet operational feasibility
 - Cohen's D $\geq .3$
 - Sample Need $\leq 75\%$ of available pool
 - Random Stand Selection

Goal is roughly 1,500 stands statewide

Model Histograms - Stand Basal Area

RLB Modeled Stand Basal Area Distribution



Stand Basal Area

Metric	Observed	Modeled
Mean	76.9	71.5
Variance	803.8	646.4
Observations	150	150
Pearson Correlation	0.69	

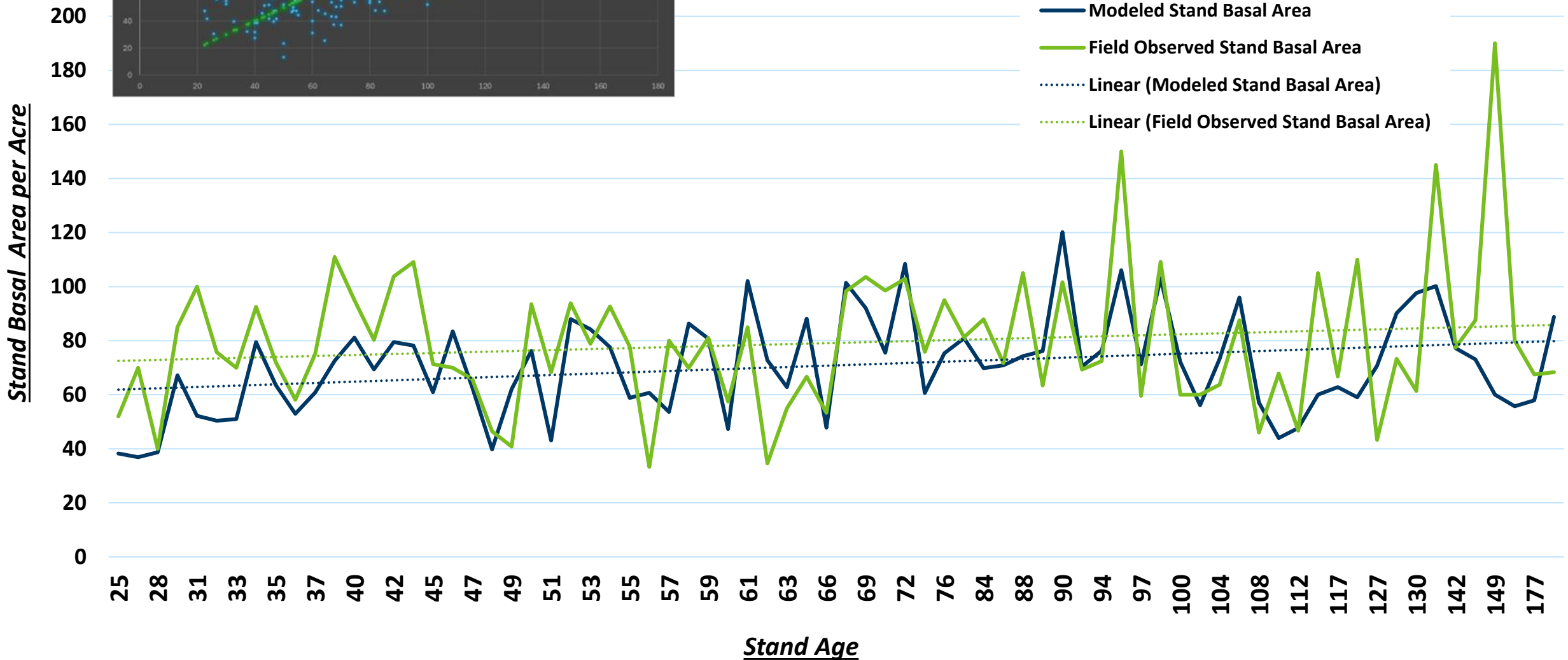
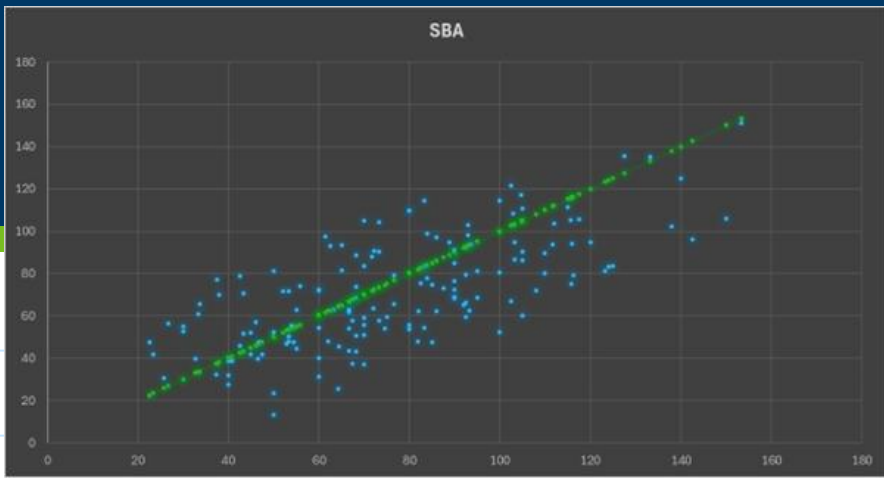
Mean Comparison	
Root Mean Square Error (RMSE)	18.3
RMSE% (percent of mean)	24.6%
nRMSE (Normalized by Range)	10.9%
Mean Differenct (MD%)	7.3%
Standard Error % (SE%)	24.8%


Validation dataset collection and analysis (2/2025)

- **150** Total Stands Observed
- Filtered by condition and outliers
 - Forested Cover Types
 - Cover Size ≥ 5 " Diameter)
 - Stand Age ≥ 20
 - Data Collected during 2023, 2024, 2025 stand collection
 - ≥ 10 sqft./acre
 - < 300 sqft./acre

More field collected validation data is needed to fully understand model tendencies and identify improvement and revision opportunities

Stand Basal Area by Age ($n=150$)



An aerial photograph of a forest with a dark blue circular overlay on the right side. The forest is a mix of green and yellowish-brown, suggesting a transition or a specific type of vegetation. The circular overlay contains the text "Working with Modeled Inventory Data" in white, sans-serif font.

Working with Modeled Inventory Data

Working with Modeled Inventory Data- *Clipping*

The screenshot shows the ArcGIS Desktop interface with the 'Clip Raster' tool active. The main map area displays a grayscale raster with a yellow polygon clipping it. The 'Clip Raster' tool parameters are visible on the right, including input raster 'TPA_xx.tif', output extent 'Pine_FIM_Stands_GIS_LIS_Sample_St...', and a rectangle with X and Y extent values. The 'Contents' pane on the left shows a list of layers, with 'TPA_xx.tif' selected.

Geoprocessing
Clip Raster

Parameters Environments

Input Raster
TPA_xx.tif

Output Extent
Pine_FIM_Stands_GIS_LIS_Sample_St...

Rectangle

X and Y Extent

Top	5127656.607
Left	528759.266
Right	529430.626
Bottom	5127011.92

Output Raster Dataset
TPA_xx_Clip2

Use Input Features for Clipping Geometry

NoData Value
-3.402823e+38

Maintain Clipping Extent

Run

Contents

Map

Map X

1:3,384

529,664.09E 5,127,690.87N m

Selected Features: 0

Geoprocessing Symbology

Working with Modeled Inventory Data- *Classification*

The screenshot displays the ArcGIS Desktop interface. The main map area shows a grayscale raster layer overlaid on a color aerial photograph. A yellow boundary outlines a specific area on the map, and a label '29 NH 56' is placed within this area. The 'Contents' pane on the left lists several layers, with 'TPA_xx_Clip2' selected. The 'Symbology - TPA_xx_Clip2' pane on the right shows the 'Classify' symbolization method selected. Below the symbolization options, a 'Statistics' table is visible.

Statistics	
Dataset	
Options	
Min	0
Max	296.48603048
Mean	179.52151531
Std. dev.	73.80958866

Working with Modeled Inventory Data - *Extract by Attributes*

The screenshot shows the ArcGIS Desktop interface with the 'Extract by Attributes' tool active. The map displays a raster of modeled inventory data with a yellow boundary. A pop-up window shows the attribute table for the selected feature, and the tool's parameters are visible on the right.

Pop-up Window:

OBJECTID	1
STAND_KEY	22574
RAN_CD	344
LOCATION	t04418w1160029
SLABEL	29 NH 56
SURVEY_YR	1991
STAND_AGE	57
Age_2022	88
AG_Biomass	95023.3
AGB_SE_Per	4.7
AGB_Cl_Hai	8832.1
BAA	103
BAA_SE_Per	3.6
BAA_Cl_Hai	7.3
BAWHT	64.4
BAWHT_SE_P	1.8
BAWHT_Cl_H	2.3
GRS_vol_Lpt	1953.7
GRS_Vol_SE	4.8
GryVol_Cl_	183.8
Max_HT	105.9
QMD	10.7
QMD_SE_Per	2.2

Geoprocessing Tool Parameters:

- Input raster: TPA_xr_Clip2
- Where clause: VALUE is gr 150
- Output raster: Extract_TPA_1

Working with Modeled Inventory Data- *Resampling*

The screenshot displays the ArcGIS Desktop interface with the following components:

- Contents Pane (Left):** Lists layers including 'Pine_FIM_Stands_GIS_LIS_Sample_Stand_Export', 'Forest Inventory', 'Pine_FIM_Stands', 'mn_county_boundaries', 'state_of_minnesota', 'Extract_TPA_1', 'TPA_xx_Clip2', 'CHM_Example', 'Pine_V1', 'SBA_xx.tif', 'QMD_xx.tif', 'GRS_vol_prAc_Cordox.tif', 'TPA_xx.tif', 'SI_ft_xx.tif', 'Merch_vol_prAc_xx.tif', 'Max_ht_xx.tif', 'BWWHT_xx.tif', and 'AGB_lbs_prAc_xx.tif'. The 'Extract_TPA_1' and 'TPA_xx_Clip2' layers are selected.
- Map Window (Center):** Shows a satellite-style map with a blue and dark blue raster overlay. A yellow line outlines a specific area. A label '29 NH 56' is visible on the map.
- Geoprocessing Pane (Right):** Shows the 'Apply Symbology From Layer' tool. The 'Input Layer' is 'Extract_TPA_1' and the 'Symbology Layer' is 'TPA_xx_Clip2'. The 'Symbology Fields' section is empty, and the 'Update Symbology Ranges by Data' dropdown is set to 'Maintain ranges'. A 'Run' button is at the bottom right.
- Status Bar (Bottom):** Shows coordinates (528,553.80E 5,127,483.13N m) and 'Selected Features: 0'.

Working with Modeled Inventory Data- *Zonal Statistics*

The screenshot displays the ArcGIS Desktop interface with the **Zonal Statistics as Table** tool configured. The map shows a forest stand with a value raster overlay, where the highest values (darkest blue) are concentrated in the central and southern parts of the stand. Three labels '29 NH 56' are placed on the map to identify specific zones.

Contents Panel:

- Map
- ✓ Pine_FIM_Stands_GIS_LIS_Sample_Stand_Export
- Forest Inventory
- ✓ Pine_FIM_Stands
- ✓ mn_county_boundaries
- ✓ state_of_minnesota
- Extract_TPA_1
- Value
- 0.001 - 50
- 50.001 - 100
- 100.001 - 150
- 150.001 - 200
- 200.001 - 300
- ✓ TPA_xx_Clip2
- Value
- 0.001 - 50
- 50.001 - 100
- 100.001 - 150
- 150.001 - 200
- 200.001 - 300
- CHM_Example
- ✓ Pine_V1
- SBA_xx.tif
- QMD_xx.tif
- GRS_vol_prAc_Cordxx.tif
- TPA_xx.tif
- SI_ft_xx.tif
- Merch_vol_prAc_xx.tif
- Max_ht_xx.tif
- BAWHT_xx.tif
- AGB_lbs_prAc_xx.tif

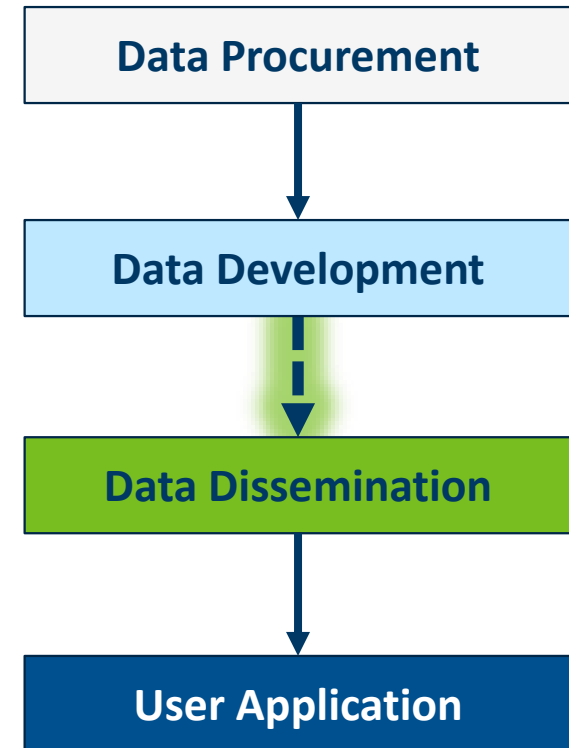
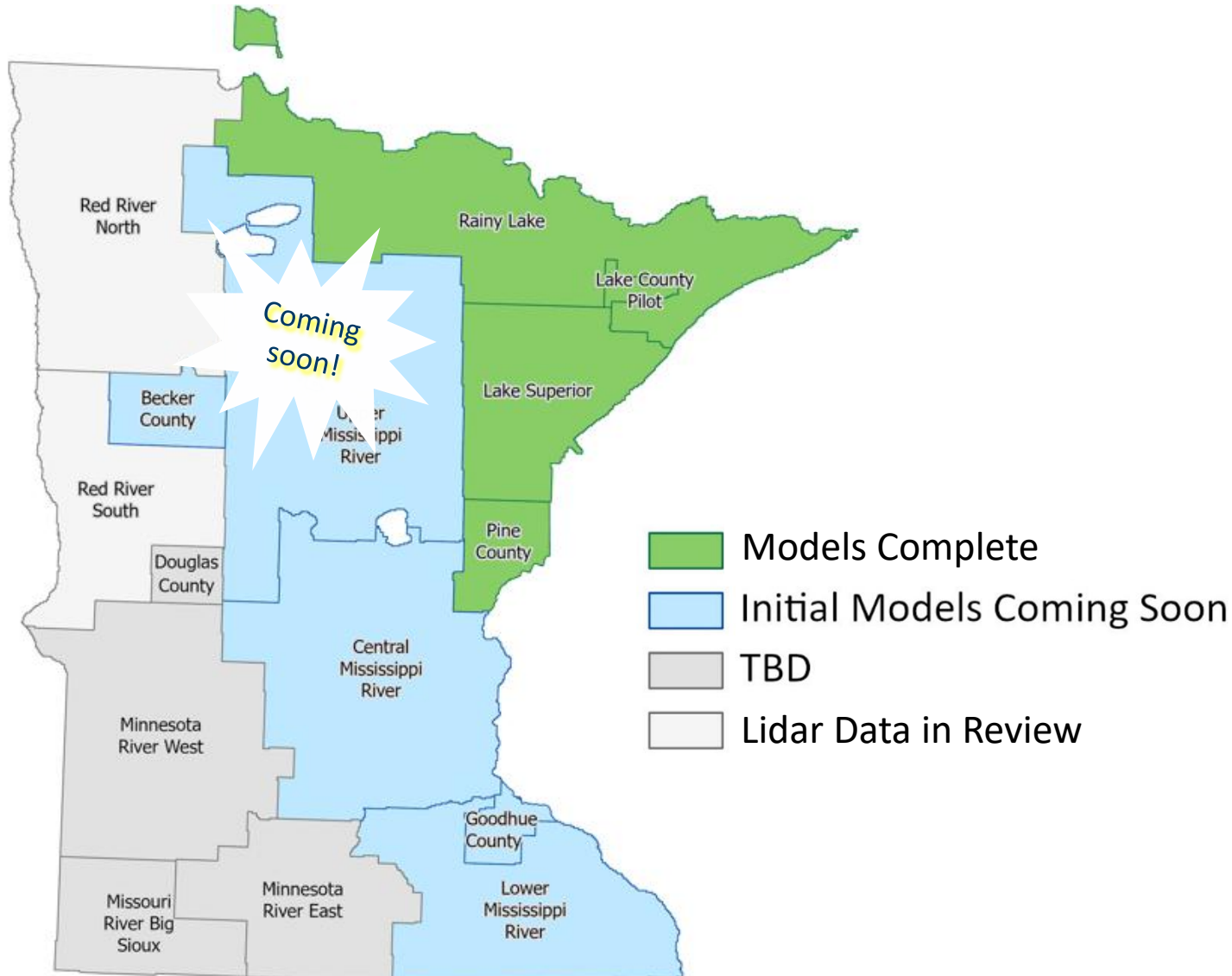
Geoprocessing Panel:

- Tool: Zonal Statistics as Table
- Pending edits: [Refresh]
- Parameters: Environments
- Input Raster or Feature Zone Data: lands_GIS_LIS_Sample_Stand_Export
- Use the selected records: 1
- Zone Field: STAND_KEY
- Input Value Raster: TPA_xx_Clip2
- Output Table: 4_Demo.gdb\ZonalSt_Pine_TPA_Clippedg150
- Ignore NoData in Calculations:
- Statistics Type: All
- Percentile Values: 90
- Percentile Interpolation Type: Auto-detect
- Calculate Circular Statistics:
- Process as Multidimensional:
- Output Join Layer: [Empty]
- Run

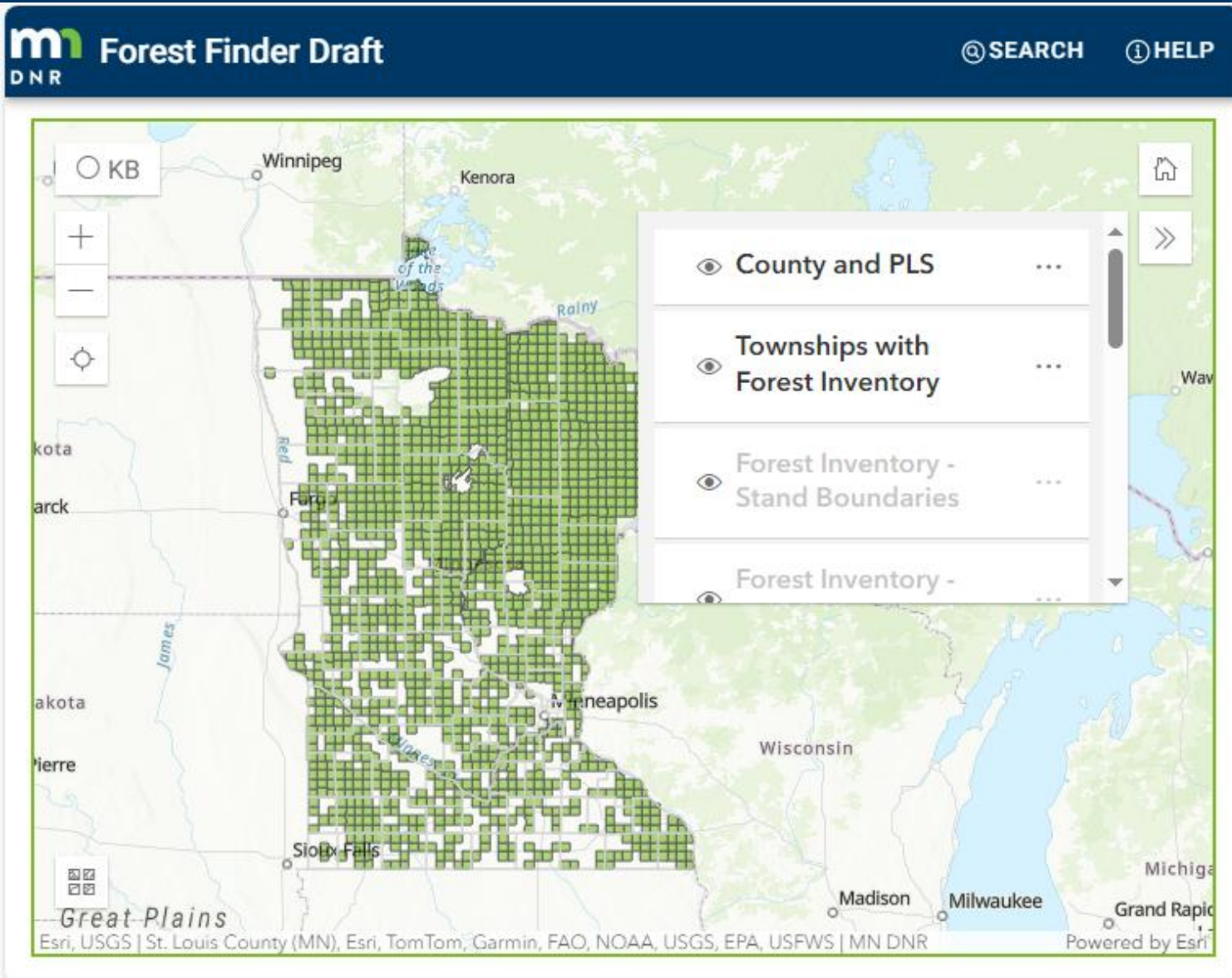
An aerial photograph of a vast river delta, likely the Ganges-Brahmaputra delta, showing a complex network of waterways and islands. The image is partially obscured by a large, semi-transparent blue circle on the right side. Inside this circle, the text "Data Availability & Planning" is written in white, bold, sans-serif font.

Data Availability & Planning

Lidar Derived Forest Inventory Status



NEW Forest Finder



<https://forest-finder.dnr.state.mn.us/>

Includes 4Trees stand level and lidar derived summaries

Replaces Landview and the Forest Inventory Viewer

MN Natural Resource Atlas

NATURAL RESOURCES RESEARCH INSTITUTE

Minnesota Natural Resource Atlas

Home

Using the Atlas

Mapping Tool

Data Catalog

About the Atlas

Options menu

Map layers | Base map | Tools | Updates | ?

Active layers:

- Forest Inventory Module - Basal Area
- Forest Inventory Module - 2019 LidarAttributes
- Forest Inventory - Pine County
- Counties

Show the opacity adjustment controls.

Drag and drop these boxes to rearrange the order that the layers appear on the map (top to bottom).

Click the map to show feature information from the active layers at that location.

Add layers

Available Layers

Category: Show all categories | Search: inventory

Only list layers that are: analyzable filterable

Category	Layer Name
Biota	Forest Cover Type - Pine County - 2021
Biota	Forest Inventory - Pine County
Biota	Forest Inventory Module - 2019 LidarAttributes
Biota	Forest Inventory Module - Basal Area
Biota	Forest Inventory Module - Boundaries
Biota	Forest Inventory Module - Cover Type
Biota	Forest Inventory Module - Last Inventory Date
Biota	Forest Inventory Module - Main Species
Biota	Forest Inventory Module - Main Species Average Diameter
Biota	Forest Inventory Module - Site Index
Biota	Forest Inventory Module - Stand Acres
Biota	Forest Inventory Module - Stand Age

Showing 29 qualifying layers (out of 537 total).

Legend:

Forest Inventory Module - Basal Area

Square Feet / Acre

- Less than 25
- 25 - 75
- 75 - 125
- 125 - 500
- 500 or higher

Forest Inventory Module - 2019 LidarAttributes

Forest Inventory - Pine County

Counties

2 km
1 mi

Finlayson
Askov

<https://mnatlas.org/gis-tool/>

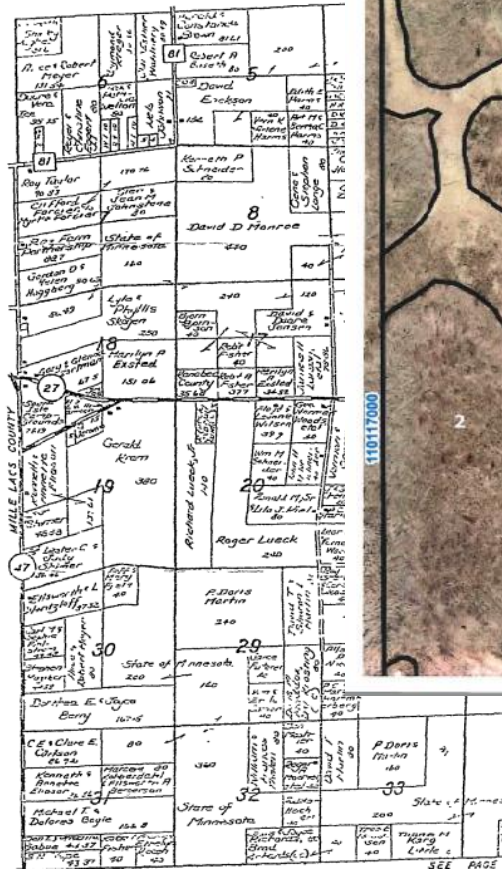
NRRI, © OpenStreetMap contributors, © CartoDB

An aerial photograph of a rural landscape. The foreground shows a winding road and a stream flowing through a green, grassy area. The middle ground is dominated by a large, dense forest with trees in various shades of green and brown. In the background, there are rolling hills and fields, some of which appear to be agricultural. The overall scene is a mix of natural and managed land.

Application: Forest Stewardship Plan Maps

Example Stewardship Plan Maps

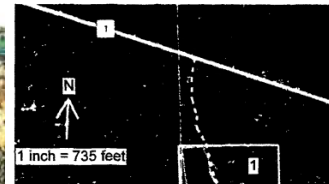
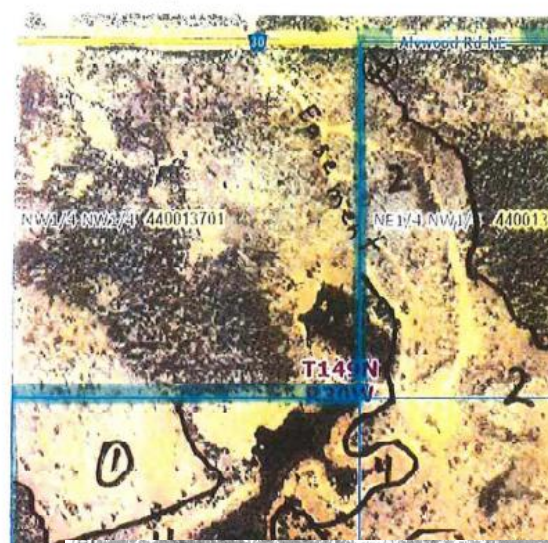
HAY BROOK



SANVIG ROBERT LSR



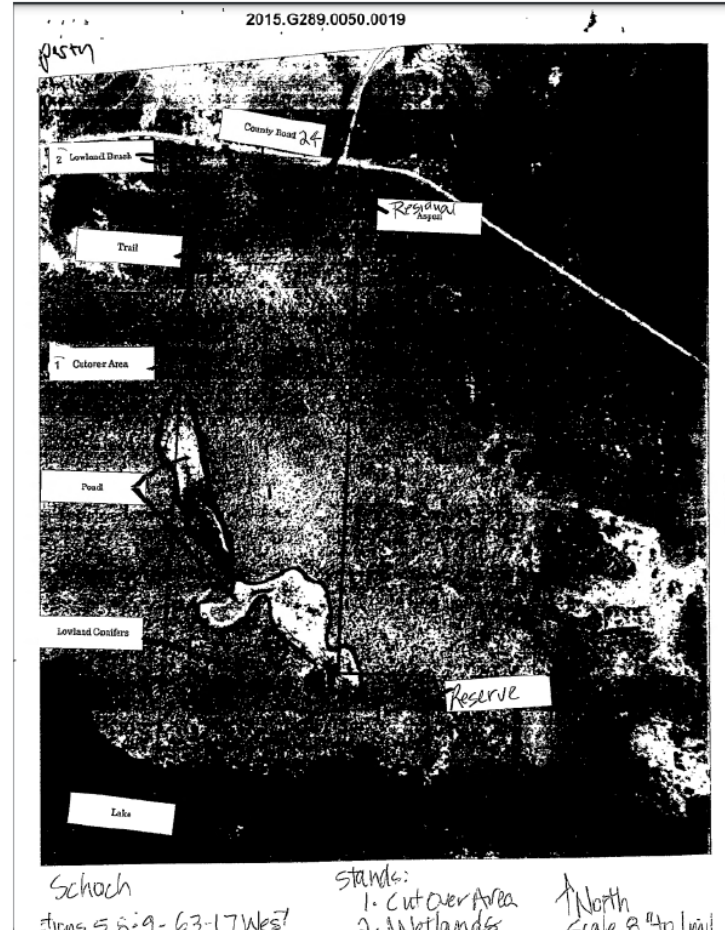
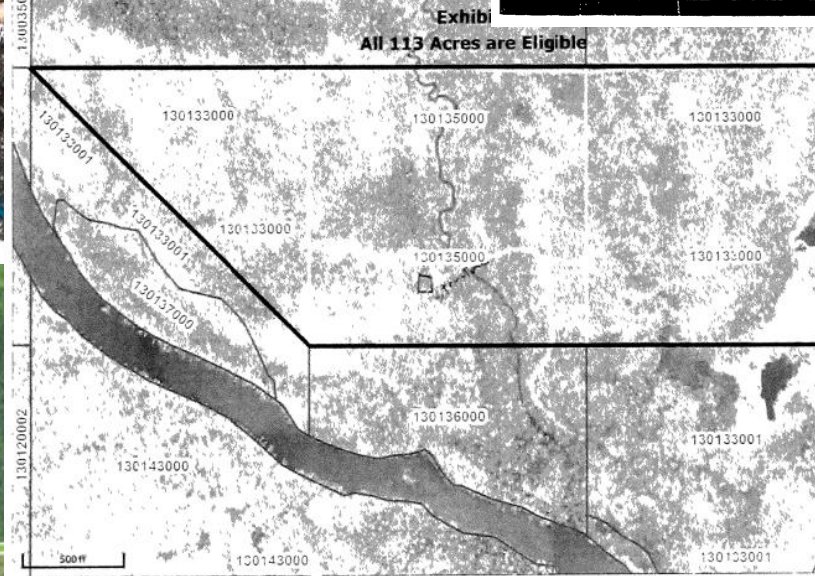
Map



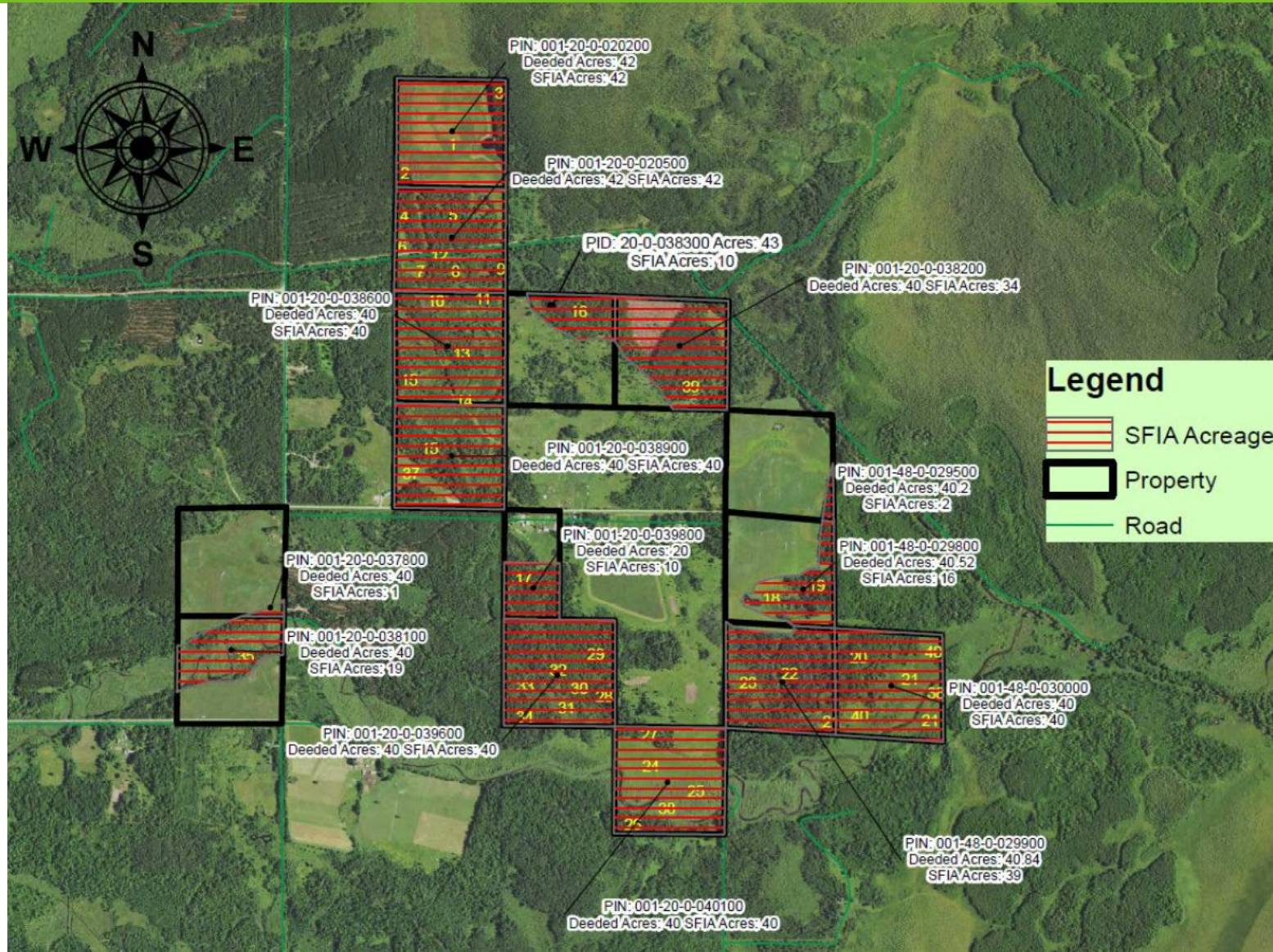
Cover #	Description	non-stewardship acres	stewardship acres
1	aspen regeneration	0	140
2	aspen poletimber	0	20
3	pine sawtimber	0	13
4	mixed birch/aspen	0	20
5	aspen/fir poletimber	0	10
6	burned area	0	33
7	spruce/fir/birch	0	7
8	spruce regeneration	0	6
9	lowland conifers	0	6
10	homestead/cabin sites	5	0

Allen Forestry - Stewardship Plan Map
 Most of NWSW, NESW, Most of NWSE, NESE,
 SESW, N1/2SWSE, S1/2SWSE SESE Sec. 32
 T60N R9W Lake County, Minnesota
 Estimated 250 Stewardship & 227 SFIA Acres
 255 Total Deeded Acres
 Owner: Charles Gould

Exhibit All 113 Acres are Eligible



Example Stewardship Plan Map



An aerial photograph of a large, winding lake with numerous forested islands. The sky is a clear blue with a large, bright white cloud formation in the upper right. The foreground shows a dense green forest. A large, semi-transparent blue circle is overlaid on the left side of the image, containing the text "Looking Forward".

Looking
Forward

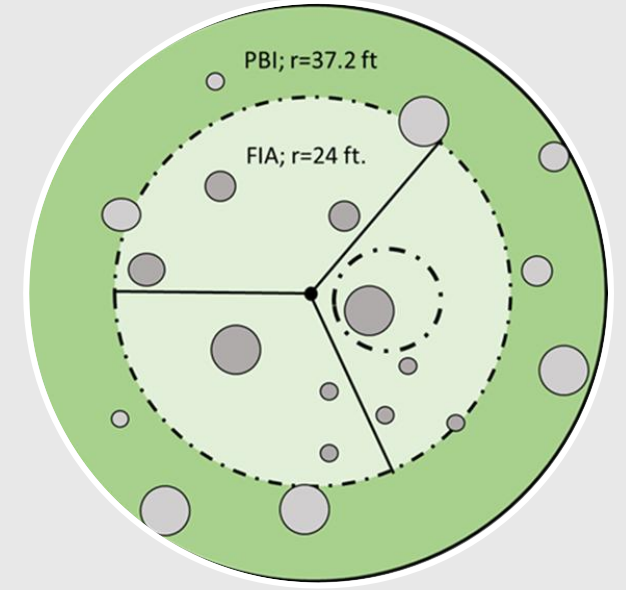
Field data collection, expansion, integration



Trimble Ranger



Javad Triumph 2 GPS



FIA Plot Size

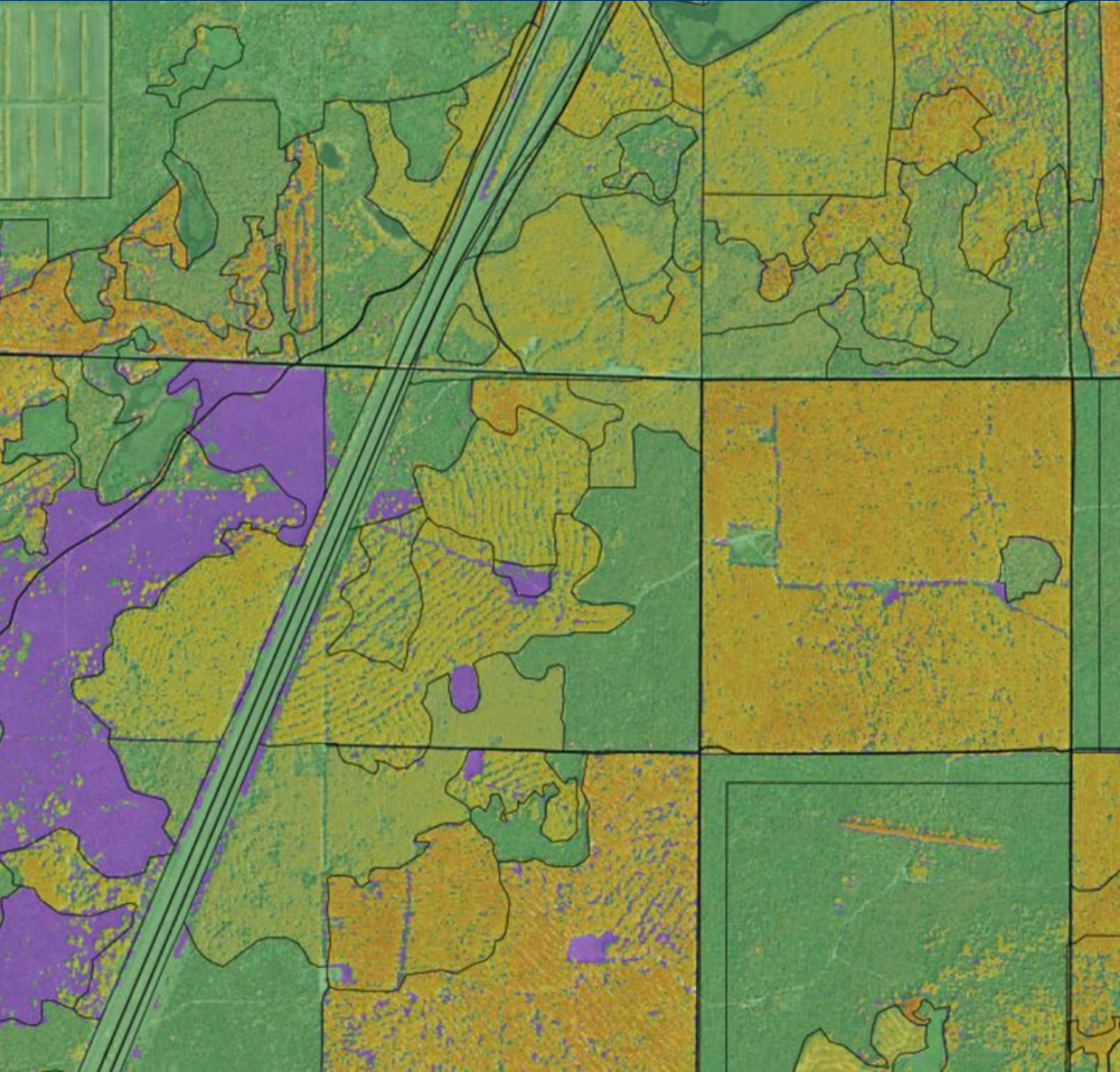
The Forest Inventory Analysis Program (FIA) offers a potential long-term field data solution. Feasibility testing and integration process are currently under consideration.

Field data collection, expansion, integration

	Traditional Inventory	Lidar Derived Inventory
<i>Interval</i>	20+ years	~ 10 years (TBD)
<i>Coverage</i>	Prioritized stands	All forested stands (Statewide)
<i>Data Collection Cost/acre</i>	~\$10-12/acre (2010-2019)	~ \$4-5/acre (2019-2025)(Full Cost Estimate)
<i>Production</i>	~200,000 acres/year (2010 – 2019)	~700,000 acres/year (2019-2025)



Looking Forward - Forest Inventory



What might the future look like?

Resources

Forest Inventory email: ForestInventory.dnr@state.mn.us

Resource Assessment website: mndnr.gov/resource-assessment

Forest Inventory website: <https://www.mndnr.gov/forest-inventory>

How-To video about PBI data collection: <https://www.youtube.com/watch?v=zcSPPY8XniU>

Lidar Processing Video: <https://www.youtube.com/watch?v=-oisFShM6Nw>

MN Lidar Hub website: <https://lidarhub-minnesota.hub.arcgis.com/>

MN Natural Resources Atlas: <https://mnatlas.org/gis-tool/>

Acknowledgements

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Aitkin, Beltrami, Carlton, Cass, Crow Wing, Hubbard, Itasca, Koochiching, Lake, Pine, and St. Louis Counties; Leech Lake Band of Ojibwe; USFS Chippewa and Superior National Forest; City of Duluth, City of Tower; Blandin Paper; Minnesota Forestry Association

MN DNR Funding Sources:

USFS Landscape Scale Restoration grant; Infrastructure Investment and Jobs Act (Public Law 117 - 58); Environment and Natural Resources Trust Fund (ENRTF), as recommended by the Legislative and Citizen Commission on Minnesota's Resources (LCCMR)



Natural Resources
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Questions & Discussion

