

Overview of the Minnesota Lidar Plan and an Update to Forest Inventory

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March 16, 2021

Goals for today

- Share Minnesota Lidar Plan
- Introduce lidar derived forest inventory
- Provide time for questions and discussion



Governor's Budget – Advancing DNR Forest Inventory

THIS INVESTMENT IS FOR DNR'S FOREST INVENTORY WORK ON STATE MANAGED LANDS

- The Governor has recommended a one time \$1 Million investment from the Forest Management Investment Account (FMIA) in the Natural Resources Fund
 - \$500,000 annually in FY2022 and FY2023
 - Increases the Minnesota annual FMIA budget for two years by three percent
- This investment is for:
 - **Partnering** to purchase high density lidar
 - Conducting field forest inventory data collection **on state land**
 - Producing and analyzing technical information **on state land**
 - Evaluating stand level forest inventory **on state land**
- This investment results in:
 - Increased forest inventory data accuracy
 - Improved efficiencies over space and time
 - Strengthened collaborations across public agencies

An aerial photograph of a vast, green forested landscape. In the center, a large, irregularly shaped lake or reservoir is visible, surrounded by dense trees. The sky is filled with large, white, fluffy clouds, and the overall scene is captured from a high vantage point. A large, solid blue circle is overlaid on the right side of the image, containing the text "High-density Lidar" in white, sans-serif font.

High-density Lidar

Need for High-density Lidar

- Dramatically **improves** our ability to analyze the landscape in Minnesota, map assets, and assess resources
- Provides the foundation for development of authoritative **derived products** used for planning and making informed decisions
- Enables practitioners, managers, and researchers to be more **proactive** than reactive



High Density Lidar Point Cloud Colorized by Photo During Peak Fall Color

What is lidar?

- **Lidar** stands for **light detection and ranging**
- It is a **mapping technology** that uses a pulsed laser to measure the time it takes for emitted light to travel from a sensor to the ground or other objects and back.
- The sensor can **pulse** a laser beam hundreds of thousands of times per second, millions of returns ("**points**") are captured, resulting in a "point cloud" of three dimensional measurements.

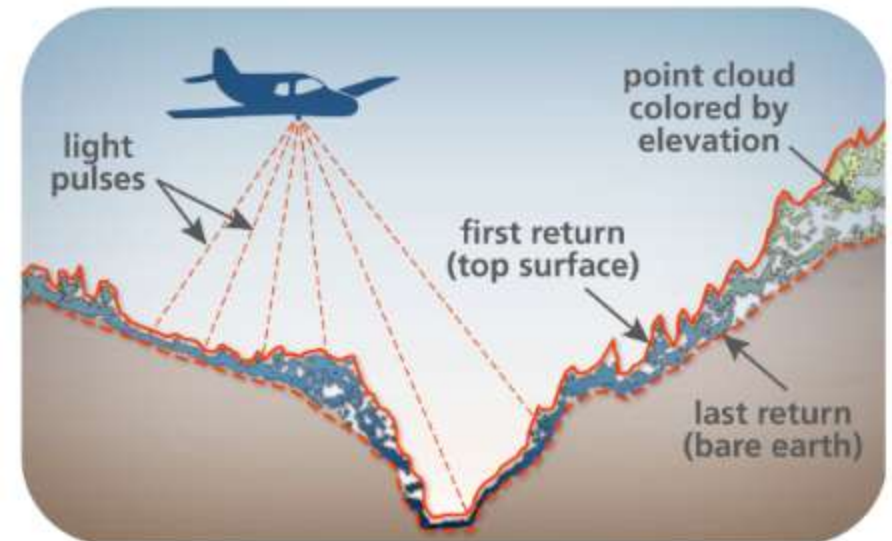
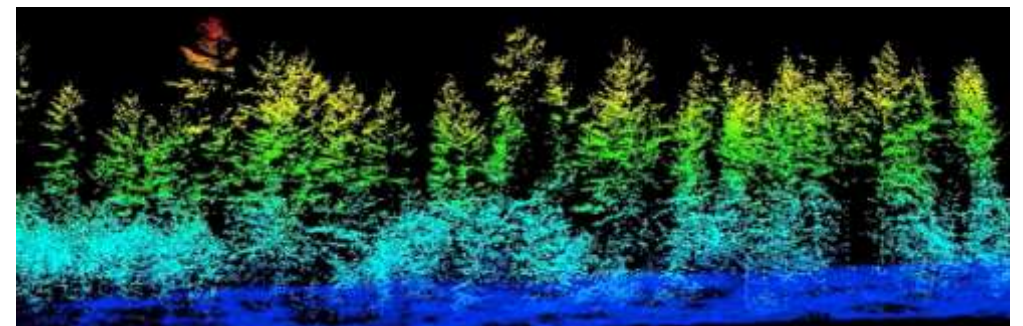
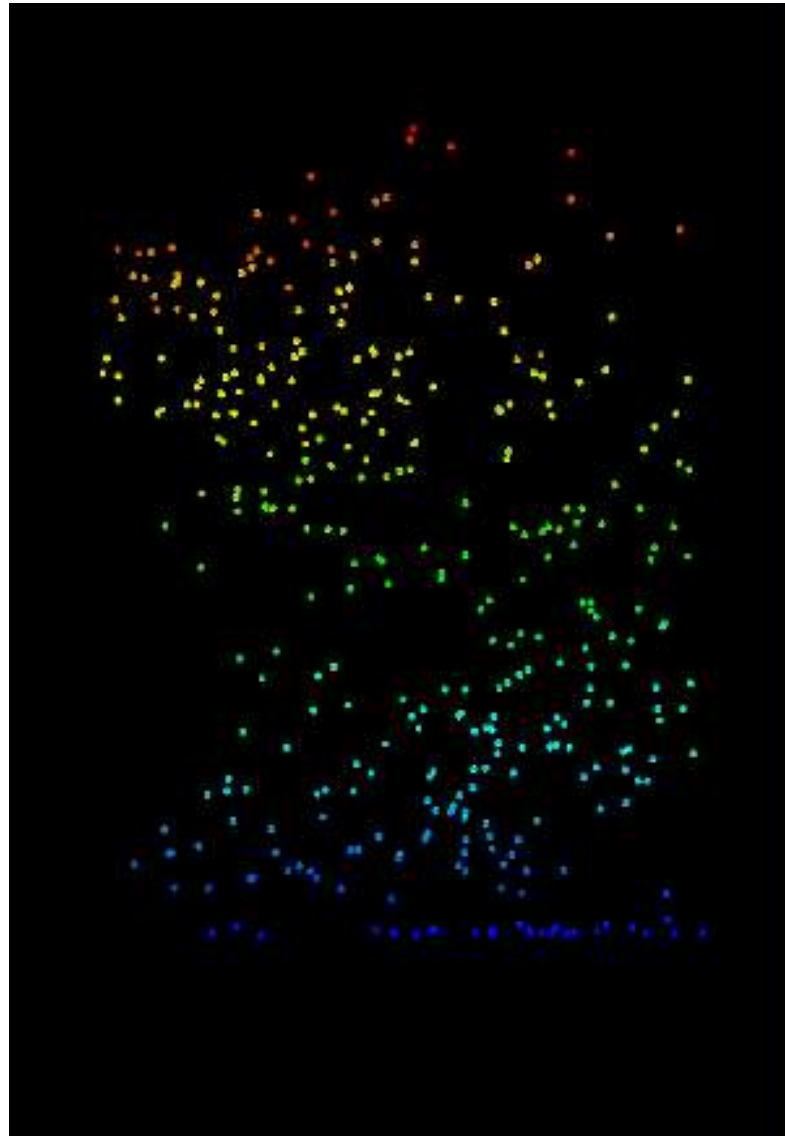


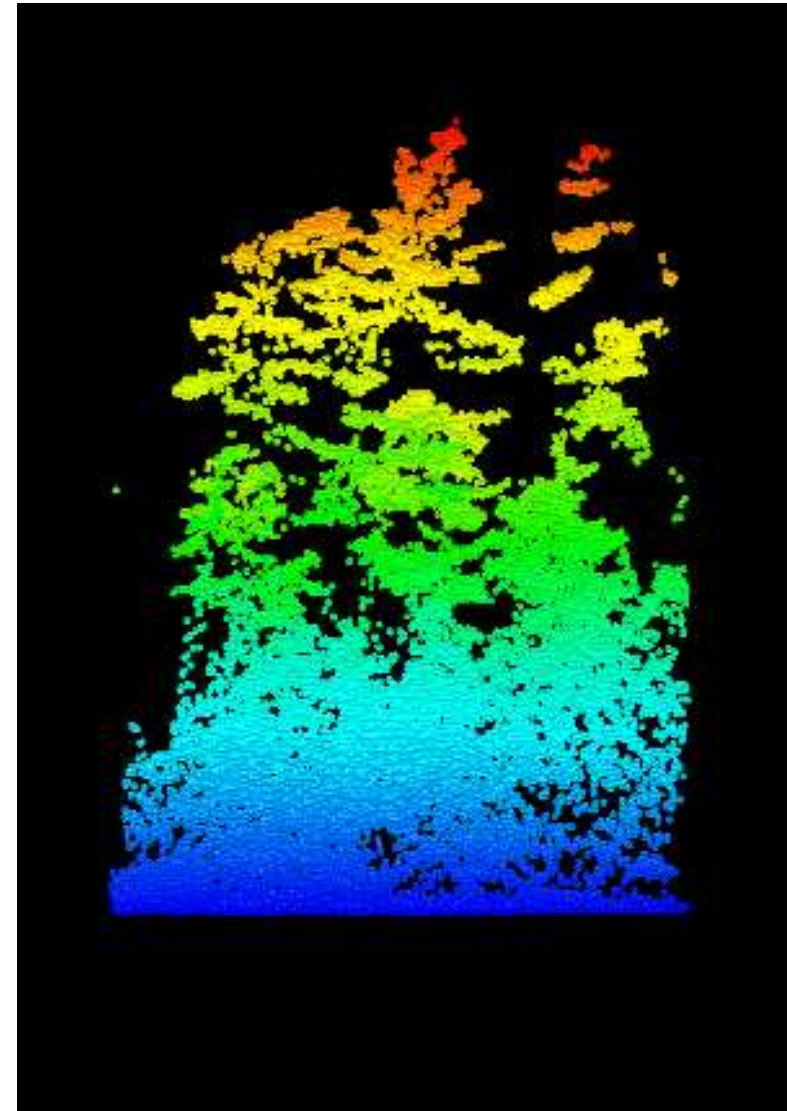
Image from the Washington Geological Survey



QL3, Low Density Lidar 2011

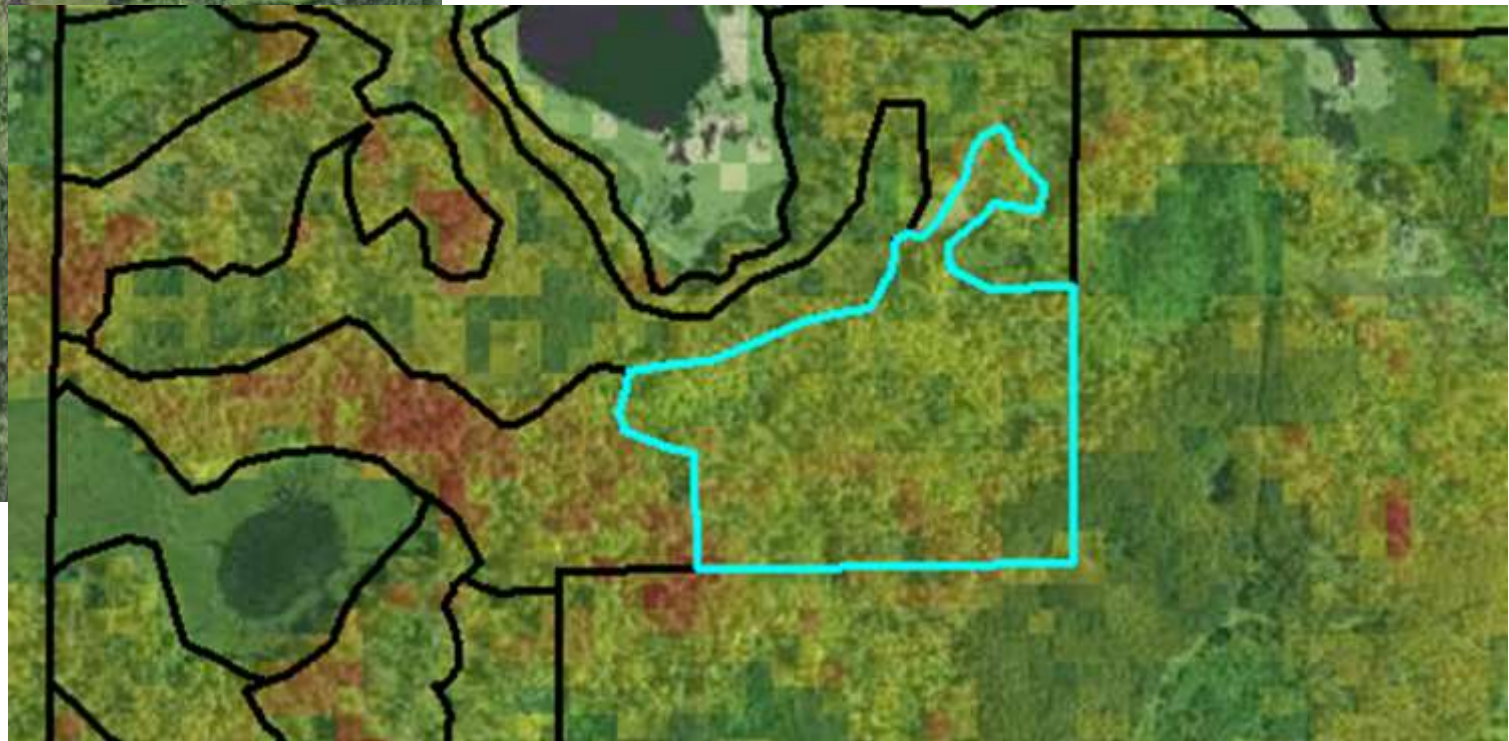
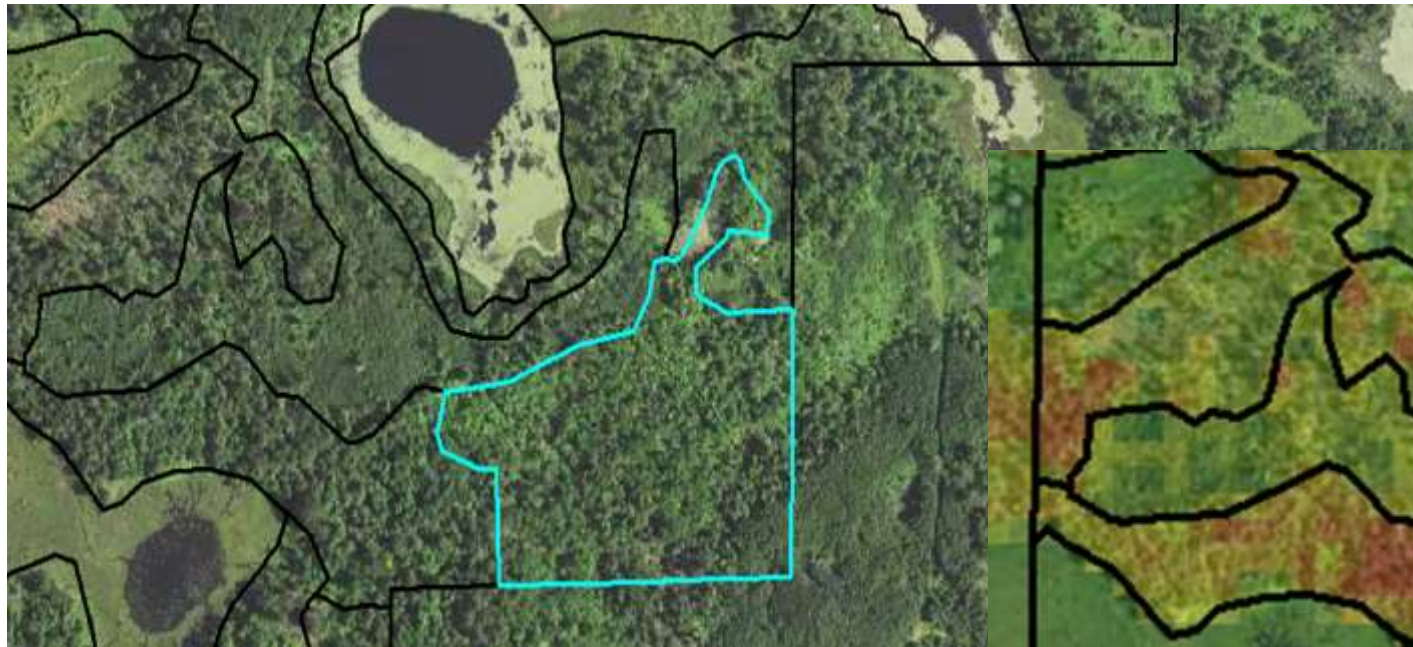


QL1, Linear Lidar 2018



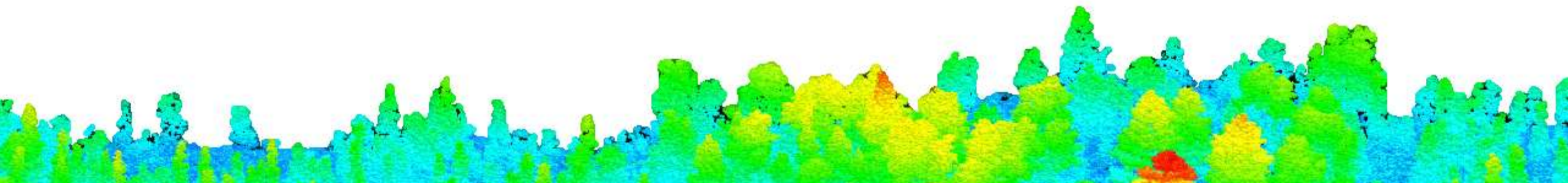
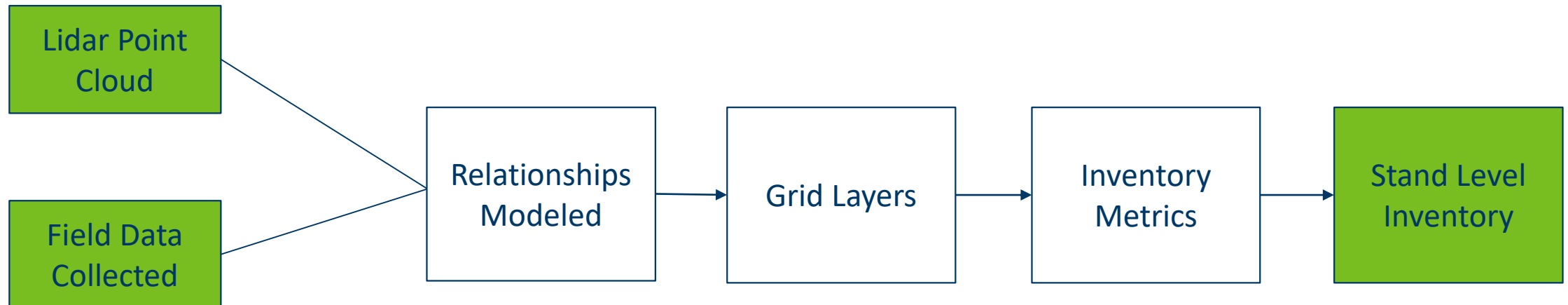
Forest Inventory - The End Goal

FID	Shape *	STAND_KEY	MN_CTYPE	SURVEY_YR	STAND_AGE	Field1	STAND_KE_1	Grid_Cell_	AGB_Lbs	BAWHT_Max	BA_Vt_weig	QMD_Inches	BA_SqFT_Pe	Site_Index	TPA	Volume_CuF	Age_2019	Volume_Cor	Stand_Acre
2908	Polygon	5374	1	1992	99	255	5374	164	91711.17	85.33	56.97	11.3	93.36	56.86	152	2230.88	126	28.24	16



Forestry Inventory - Pulling Elements Together

Lidar is Foundational Data for DNR



A topographic map of Duluth, Minnesota, showing terrain contours, streets, and water bodies. A large blue circle is overlaid on the right side of the map, containing the text "Lidar Collection Planning". The map includes labels for various locations such as Proctor, West Duluth, Riverside, and Clough Island. A red line and a purple line are drawn across the map, likely indicating planned collection paths or boundaries. The map also shows the St. Louis Bay and the Minnesota River.

Lidar Collection Planning

Geospatial Advisory Council - 3D Geomatics Committee



What is the GAC?

- The Minnesota ***Geospatial Advisory Council*** is the coordinating body for the Minnesota geospatial community.
- **Cross-section of organizations** that include counties, cities, universities, business, nonprofit organizations, federal and state agencies, tribal government, and other stakeholder groups.

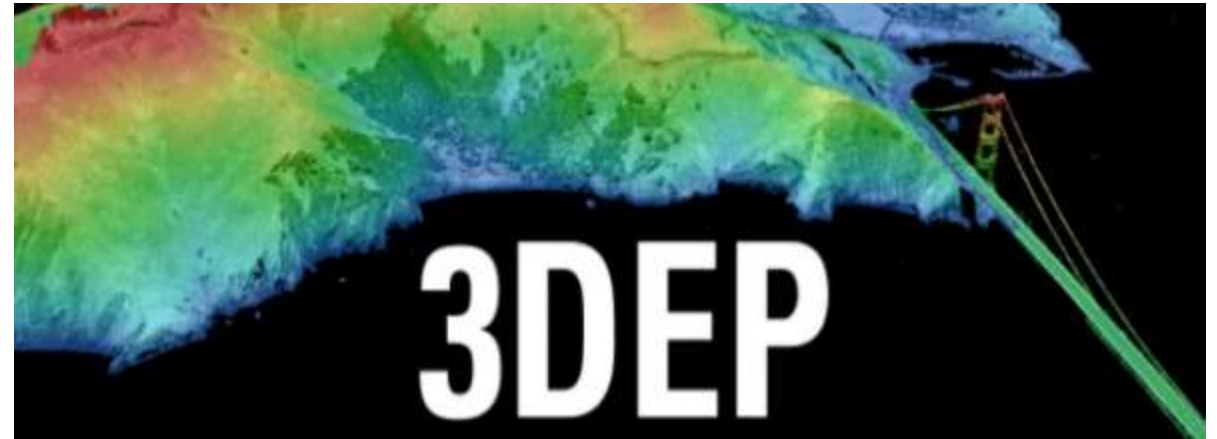
What is the 3D Geomatics Committee?

- The ***3D Geomatics Committee*** (3DGeo) is a committee under GAC that works to identify and promote the need for planning, funding, acquisition, and management of three-dimensional geomatic data and derived products.

USGS 3D Elevation Program (3DEP)

3D Elevation Program (3DEP)

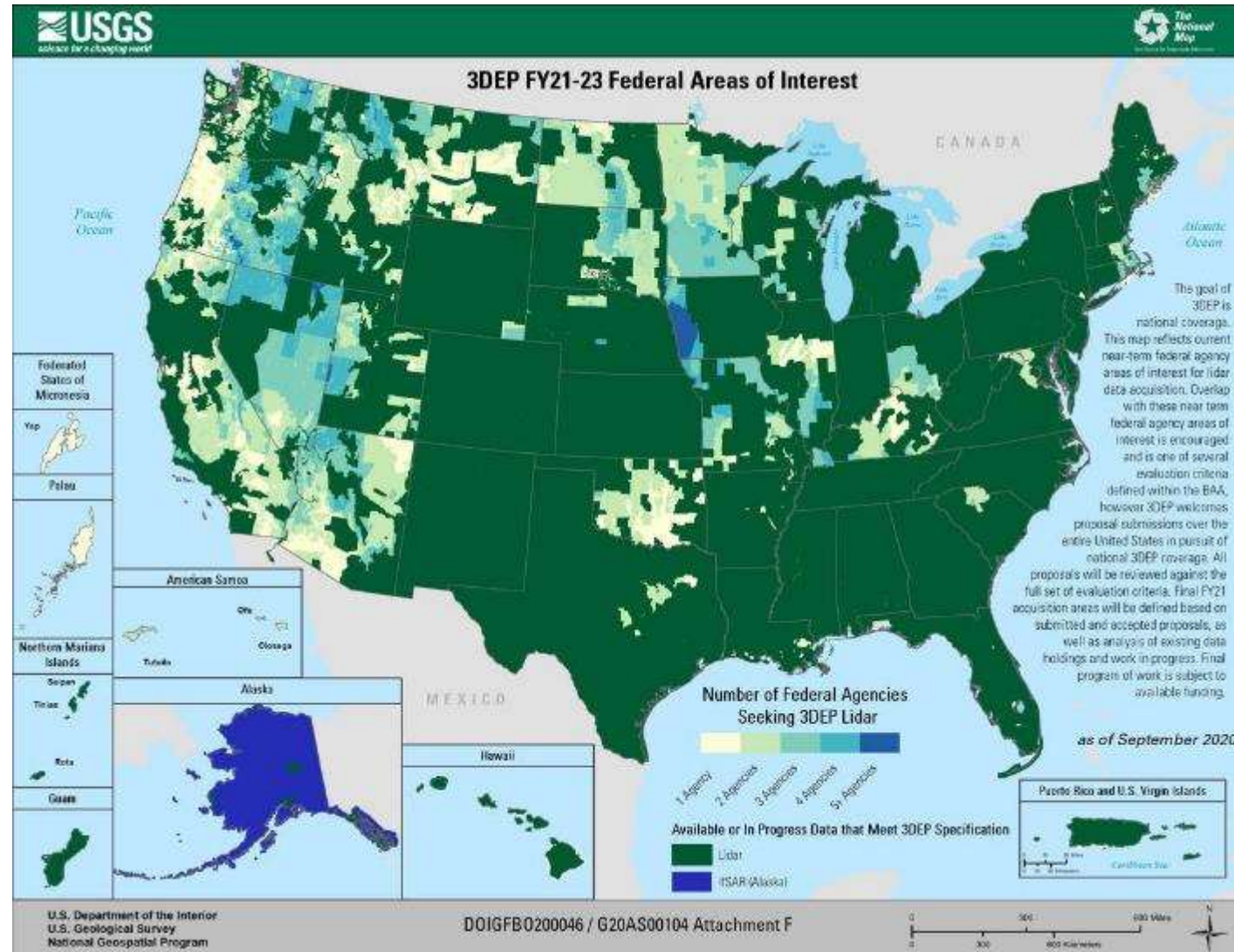
- **Systematically** guiding the collection of 3D elevation data in the form lidar data for the United States, and the U.S. territories
- Goal: elevation dataset for the nation **by 2023**
- Acquisition contracts are under two managerial mechanisms
 - GPSC
 - COOP



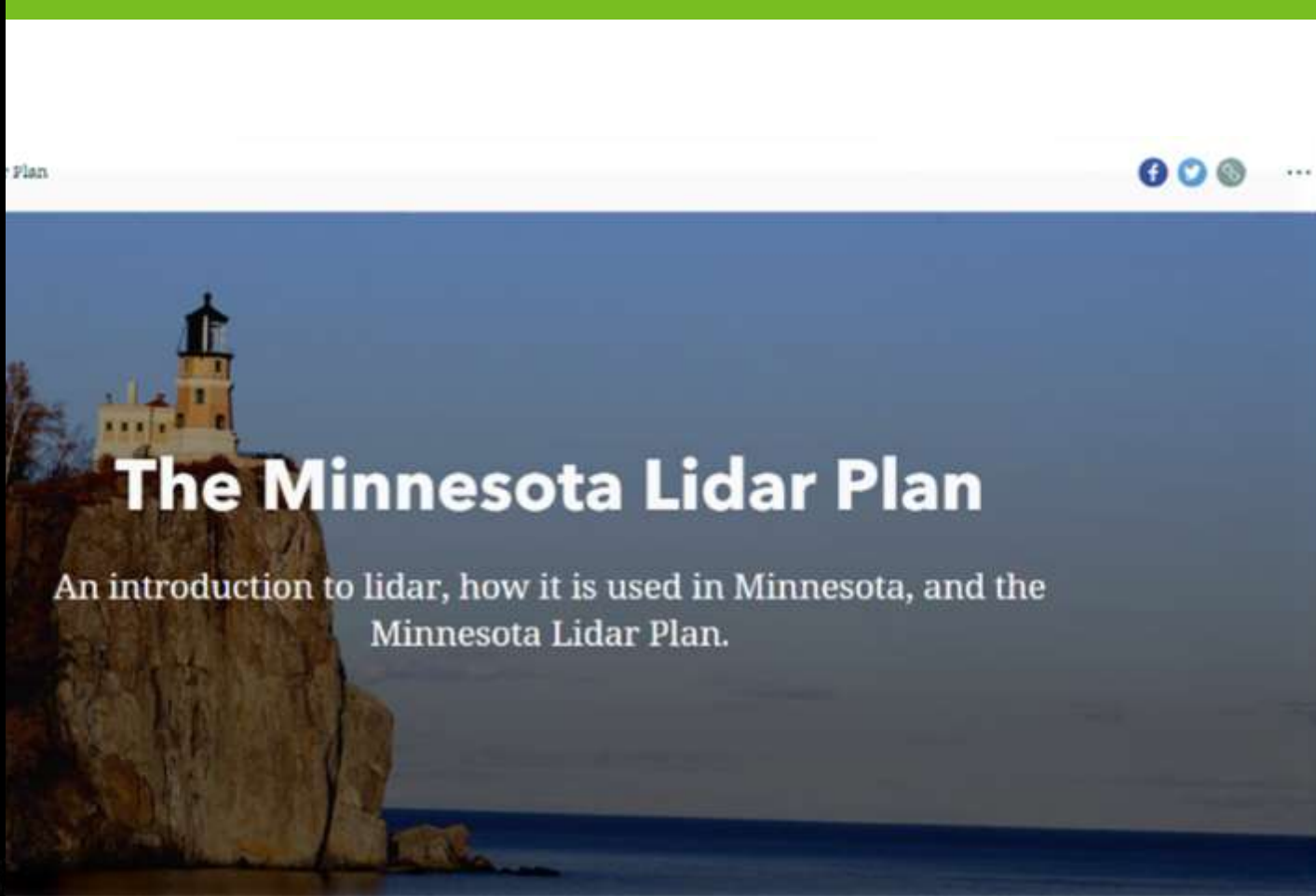
USGS 3D Elevation Program (3DEP)

Broad Agency Announcement (BAA)

- **Grant coordinating mechanism 3DEP**
- Guides **partnerships** between the USGS and other Federal agencies with other public and private entities seeking high-quality 3D lidar elevation data acquisition.
- USGS is **cost-sharing** via grant funds for QL2 or greater
- Grants through “BAA” process – **deadlines** are every fall (Oct/Nov)

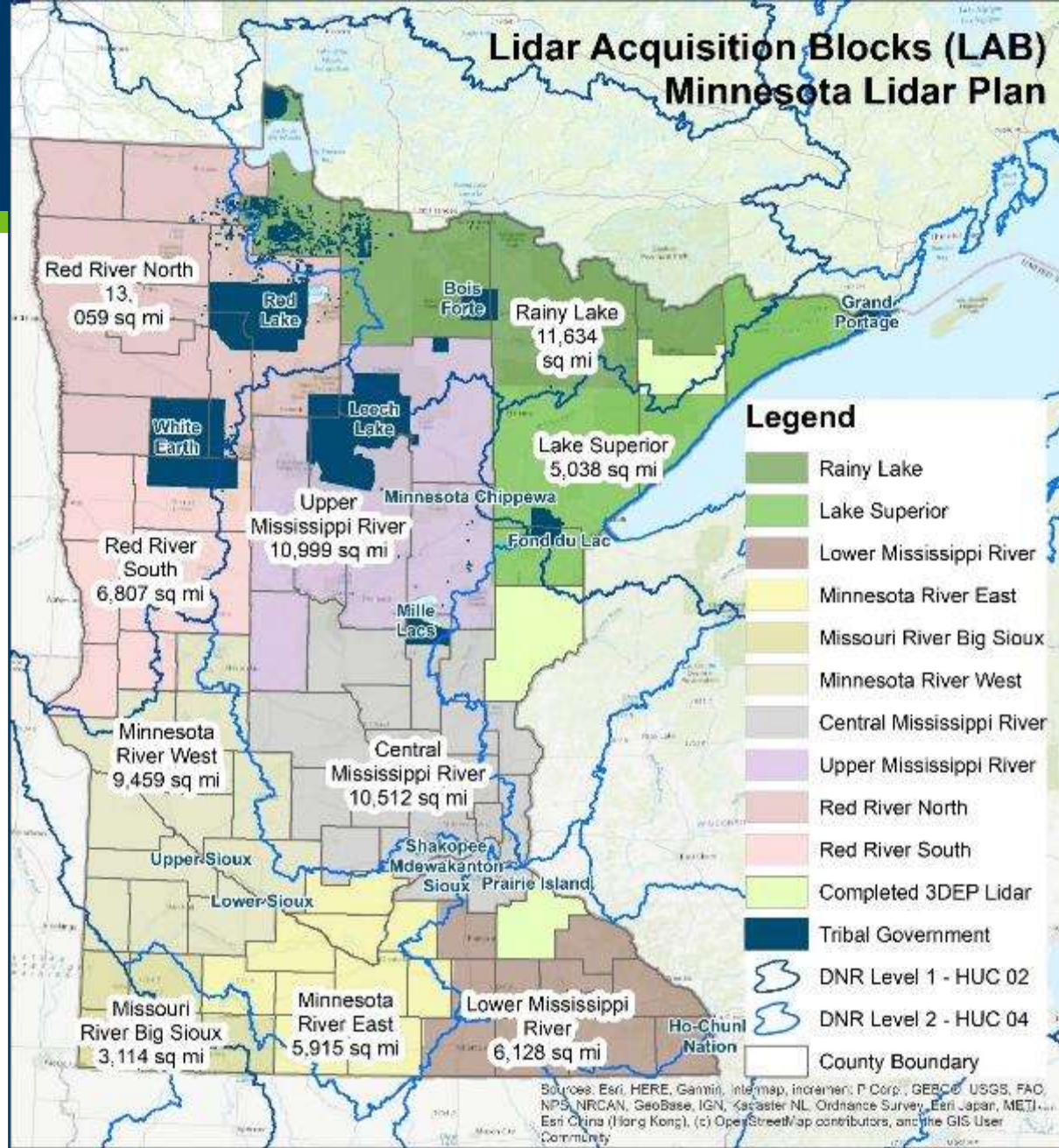


Minnesota Lidar Plan & Story Map

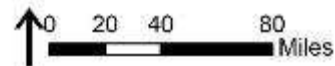


<http://bit.ly/MnLidarPlanStoryMap>

Lidar Acquisition Blocks (LAB) Minnesota Lidar Plan

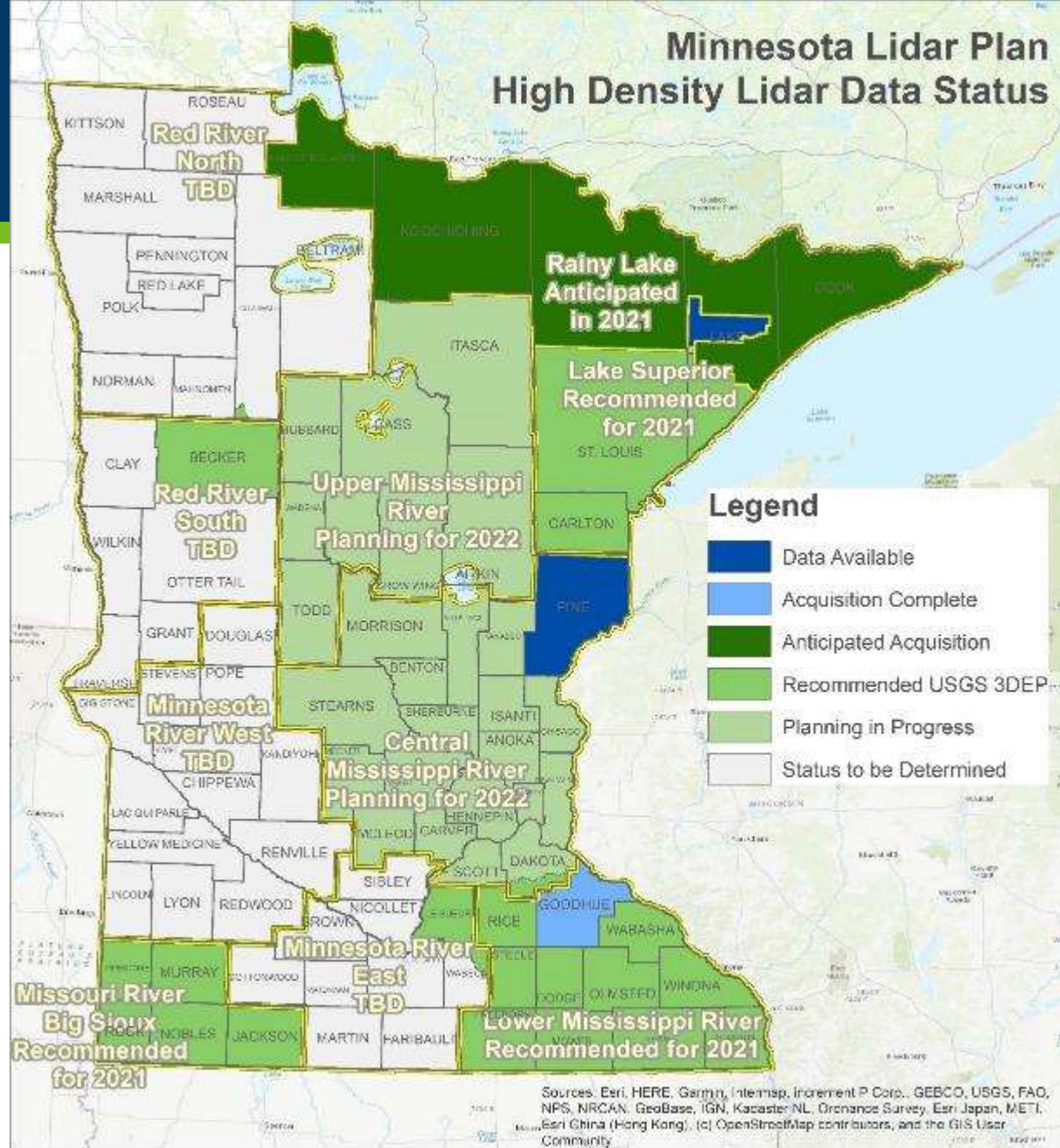


Tribal boundaries data source:
MnDOT, US Census Data Sept 2019



Map Date: Nov 16, 2020

Minnesota Lidar Plan High Density Lidar Data Status



2021 anticipated and recommended contracts are underway. All other areas are pending partnerships and funding.



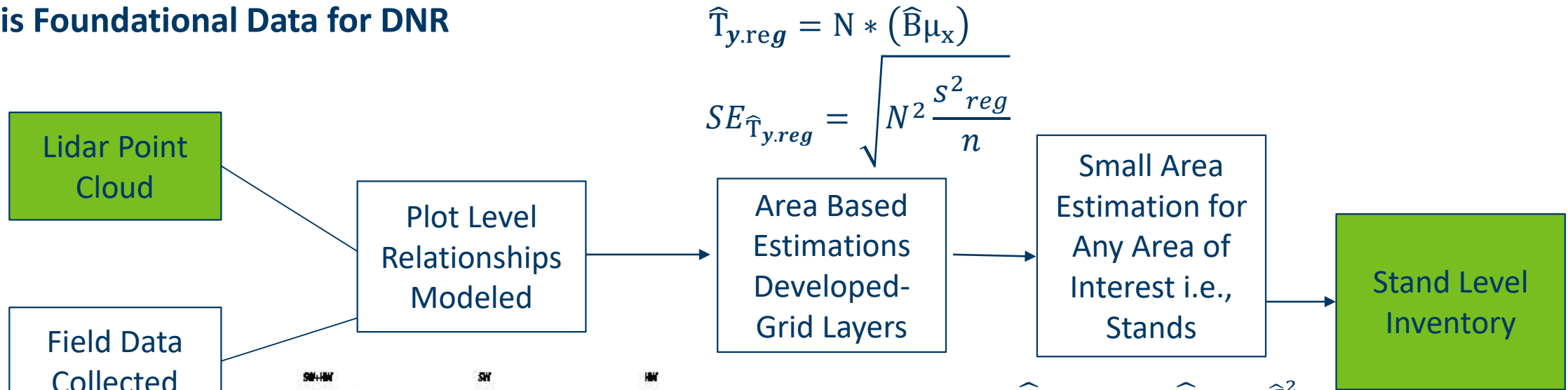
Map Date: Feb 26, 2021



Lidar
Derived
Forest
Inventory

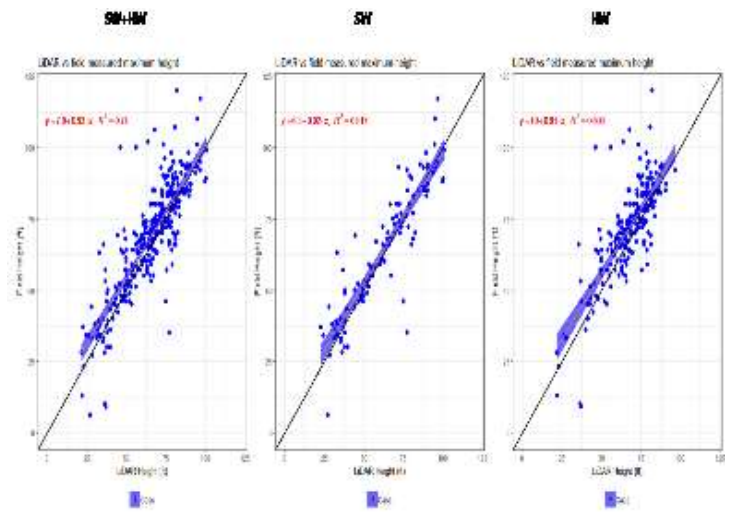
Forestry Inventory - pulling elements together

Lidar is Foundational Data for DNR



$$\hat{T}_{y.reg} = N * (\hat{B}\mu_x)$$

$$SE_{\hat{T}_{y.reg}} = \sqrt{N^2 \frac{s^2_{reg}}{n}}$$

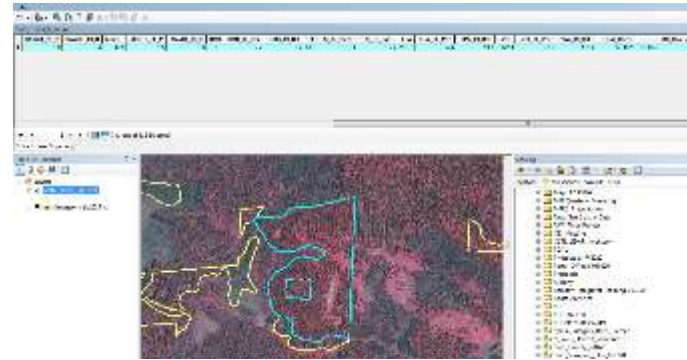


$$\widehat{Var}_{pr}(\hat{Y}_m) = \widehat{Var}_p(\hat{Y}_m) + \frac{\hat{\sigma}_\epsilon^2}{N_m}$$

$$\widehat{Var}_{prh}(\hat{Y}_m) = \widehat{Var}_p(\hat{Y}_m) + \frac{1}{N_m^2} \sum_{i=1}^{N_m} \hat{\sigma}_i^2$$

$$\widehat{Var}_{pr}(\hat{Y}_m) = 2 * (\widehat{Var}_p(\hat{Y}_m) + \frac{\hat{\sigma}_\epsilon^2}{N_m})$$

Streamlining Data Collection



The screenshot shows a GIS software interface with a catalog tree on the left and a data table at the bottom. Blue arrows point from the field photos to the catalog and table.

Catalog Tree:

- Project Portal Favorites
- Search
- Class
- Toolboxes
- Databases
- Styles
- Follows
- My Project
- SDC_Connection_File
- sd_scripts
- Inventory
- SyncSurveyModifield
- ab20_pg_pbiade
- pbipbiPlot_Based_Forest_Inventory
- pbipbiPlot_Based_Forest_Inventory_ATTACH
- pbipbiPlot_Based_Forest_Inventory_ATTACH_WLL
- pbipbiPlot_Based_Forest_Inventory_trees
- pbipbi.trees
- sync_bill.tbl
- Locators

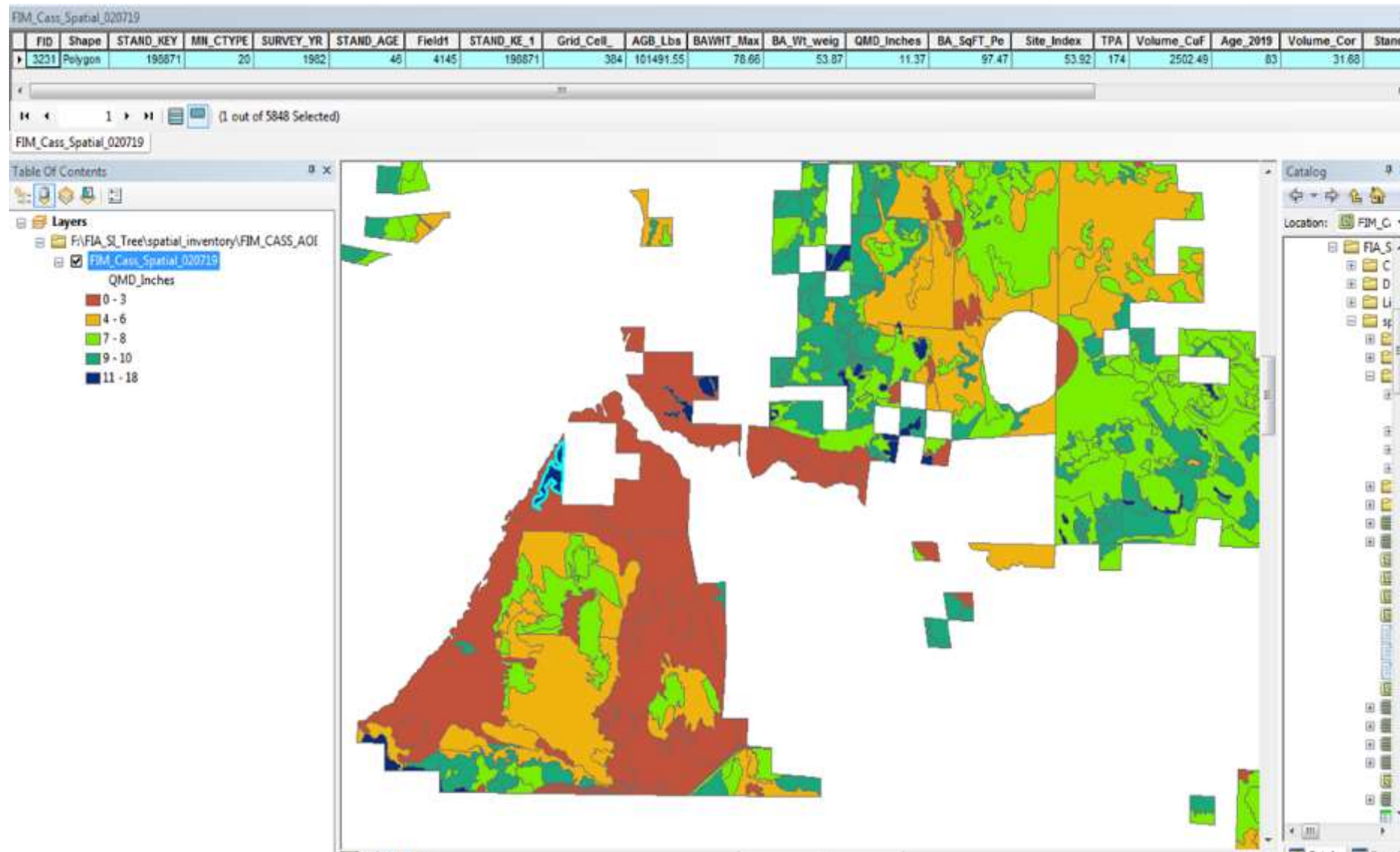
Data Table:

objectid	GlobalID	Lidar Block Name	County Code	Plot ID Number	Plot ID Sequence	Date	Time	Organization	Status of person c		
1	{CD1E5081-1618-42C4-BC7D-47BC0A02D4}	Missouri Big Sioux Block	100	9859	1019859	7/8/2020	5:00:00 PM	14:42	Minnesota DNR	Forester	
2	{DC78FF47-15A4-4DA5-8F53-11D866B1087D}	Lower Mississippi Block	19	1	191	7/8/2020	5:05:00 PM	<Null>	Minnesota DNR	Contractor	
3	{406A474-5DB6-4DB4-8DE5-D8C35E091103}	Lake Superior Block	137	9010	1370010	7/9/2020	5:05:00 PM	<Null>	Minnesota DNR	Forester	
		Lake Superior Block	137		3	1373	7/9/2020	5:05:00 PM	05:22	Minnesota DNR	Forester

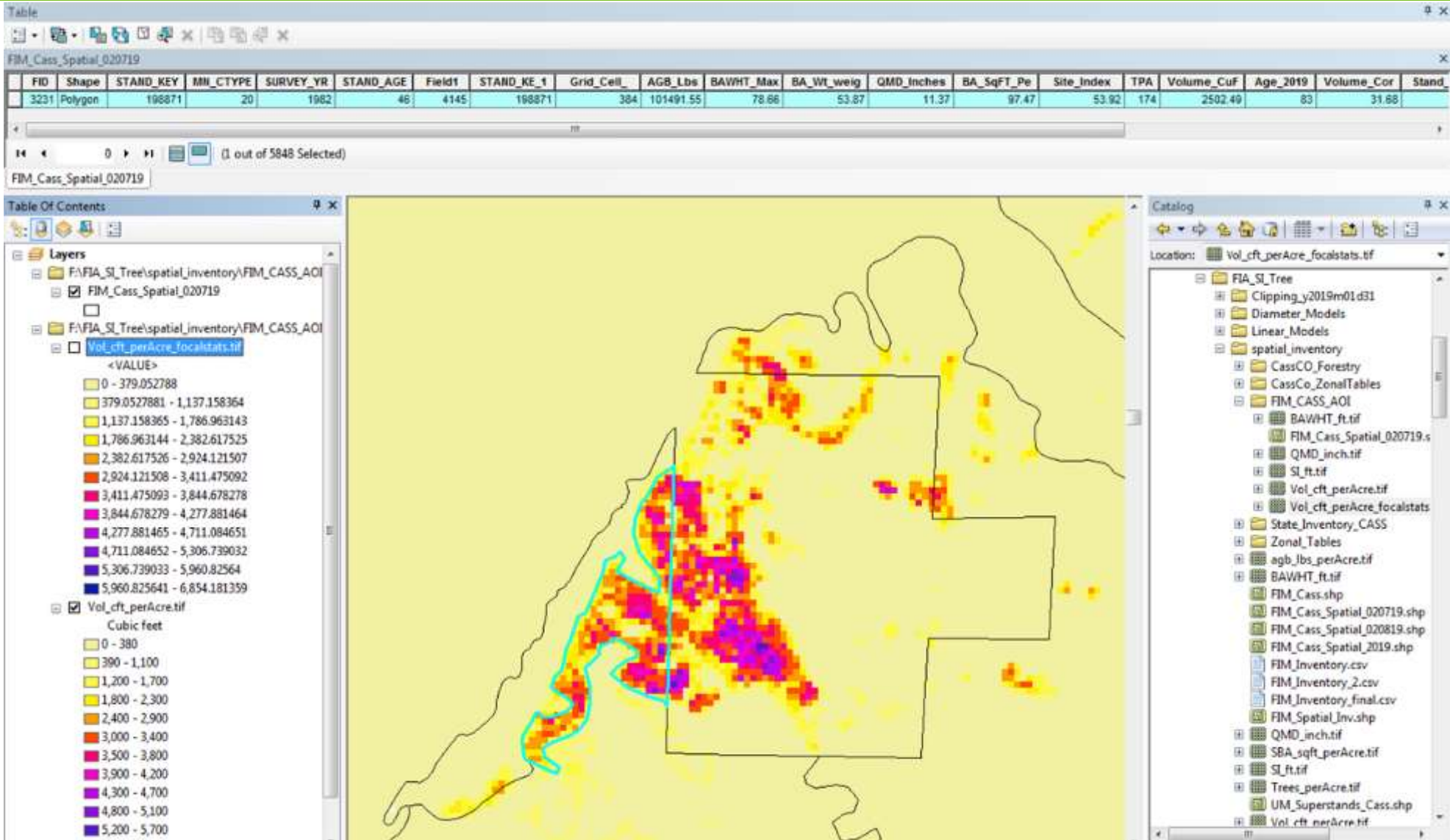
Table Info:

pbipbiPlot_Based_Forest_Inventory_trees
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Modified: 8/1/2020 10:42:22 AM
Location: D:\arcgis\lib\desktop\SDC_Connection_File\ab20_pg_pbiade\pbipbiPlot_Based_Forest_Inventory_trees

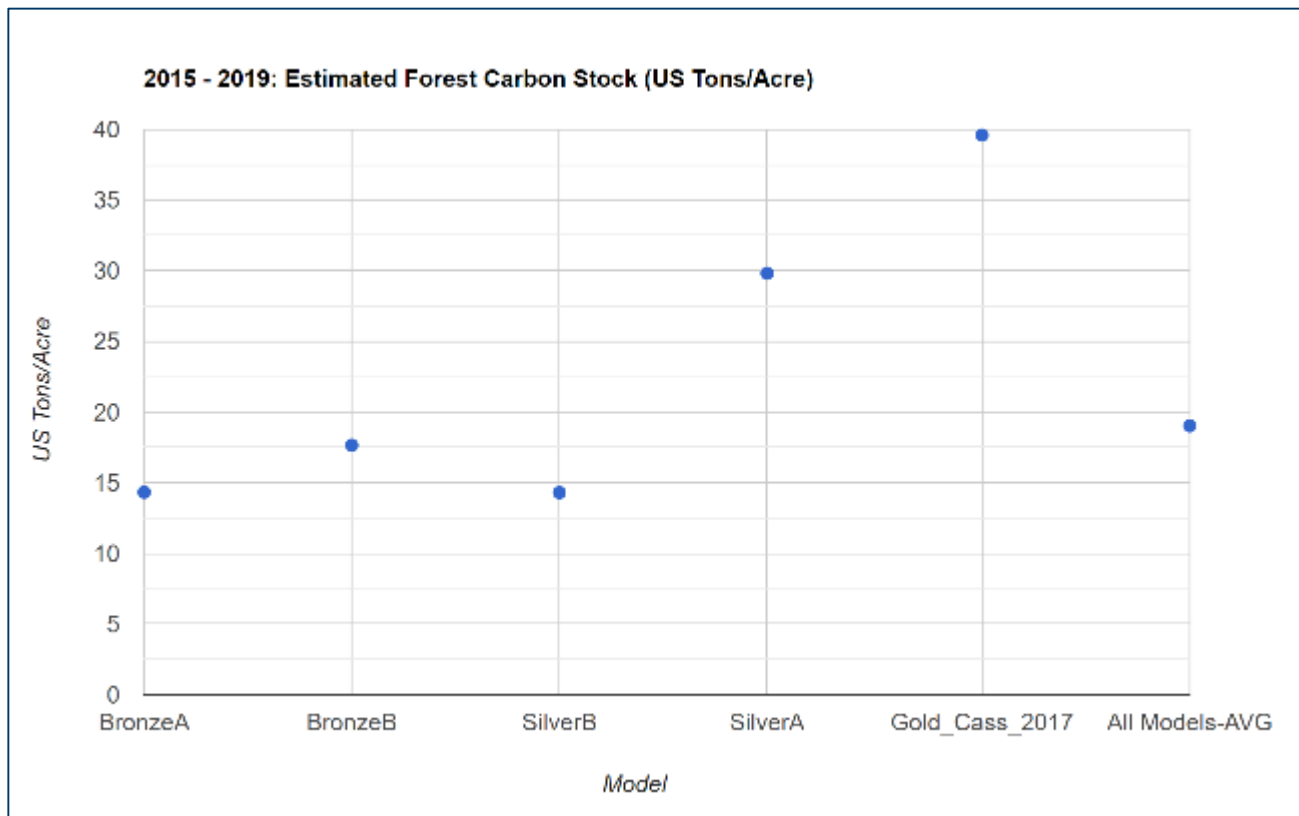
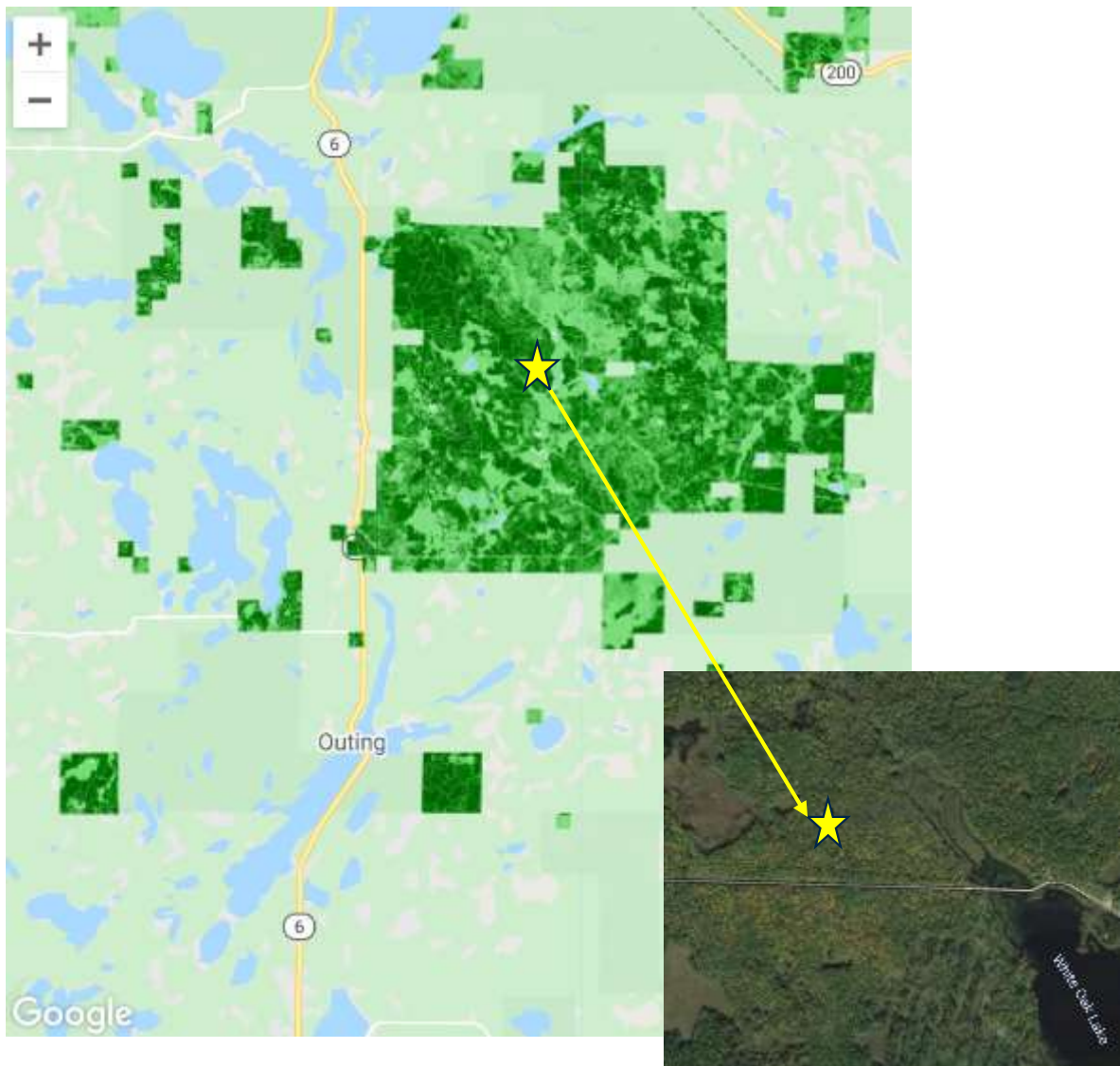
Small Area Estimation - Any Area of Interest



Sub-Stand Information and Landscape Scale



Carbon Stock Model – Testing Methods



Carbon Stock Model – Testing Methods



Summer 2010 Image (NAIP)

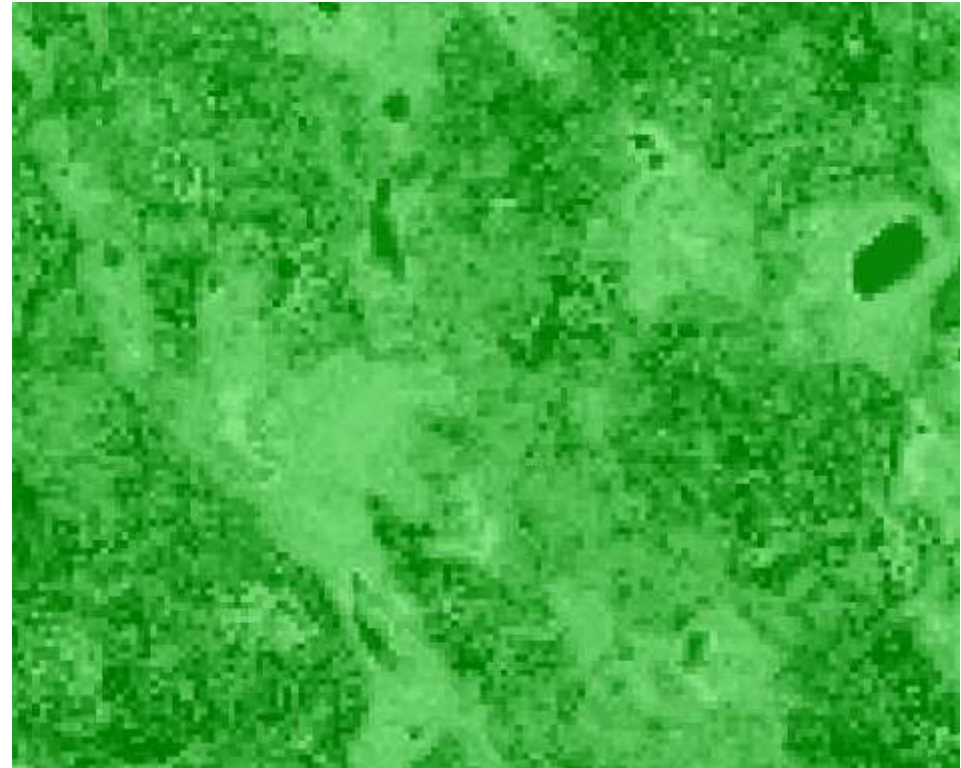


Bronze Model (Imagery Only, Fuzzed FIA Locations)

Carbon Stock Model – Testing Methods



Summer 2010 Image (NAIP)

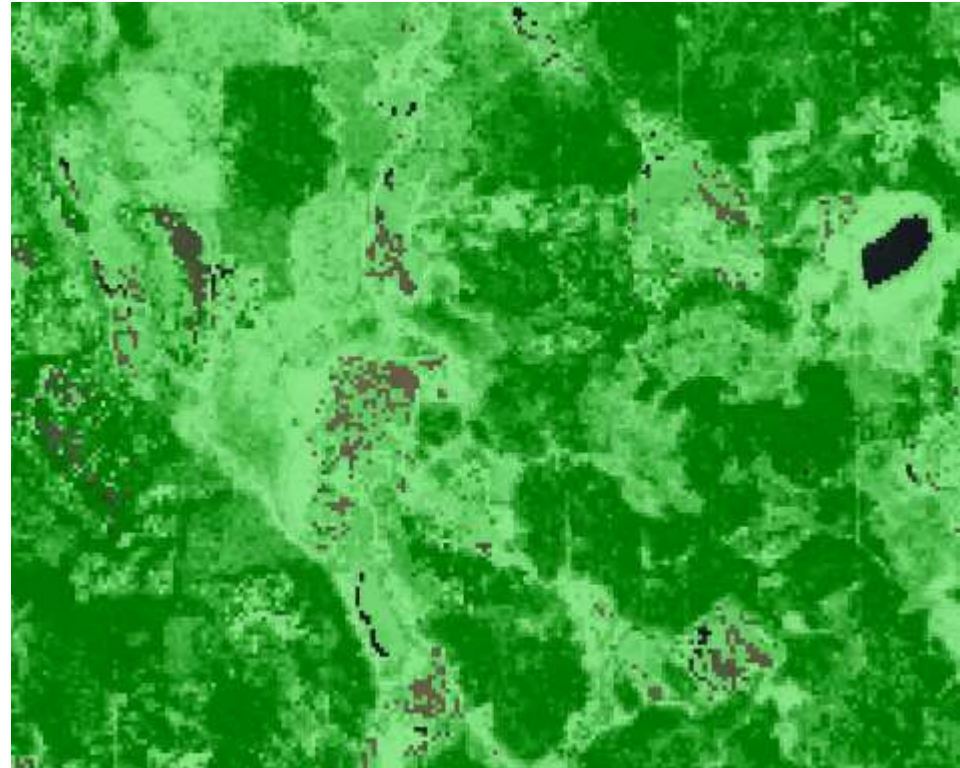


Silver B Model (Imagery Only, True FIA Locations)

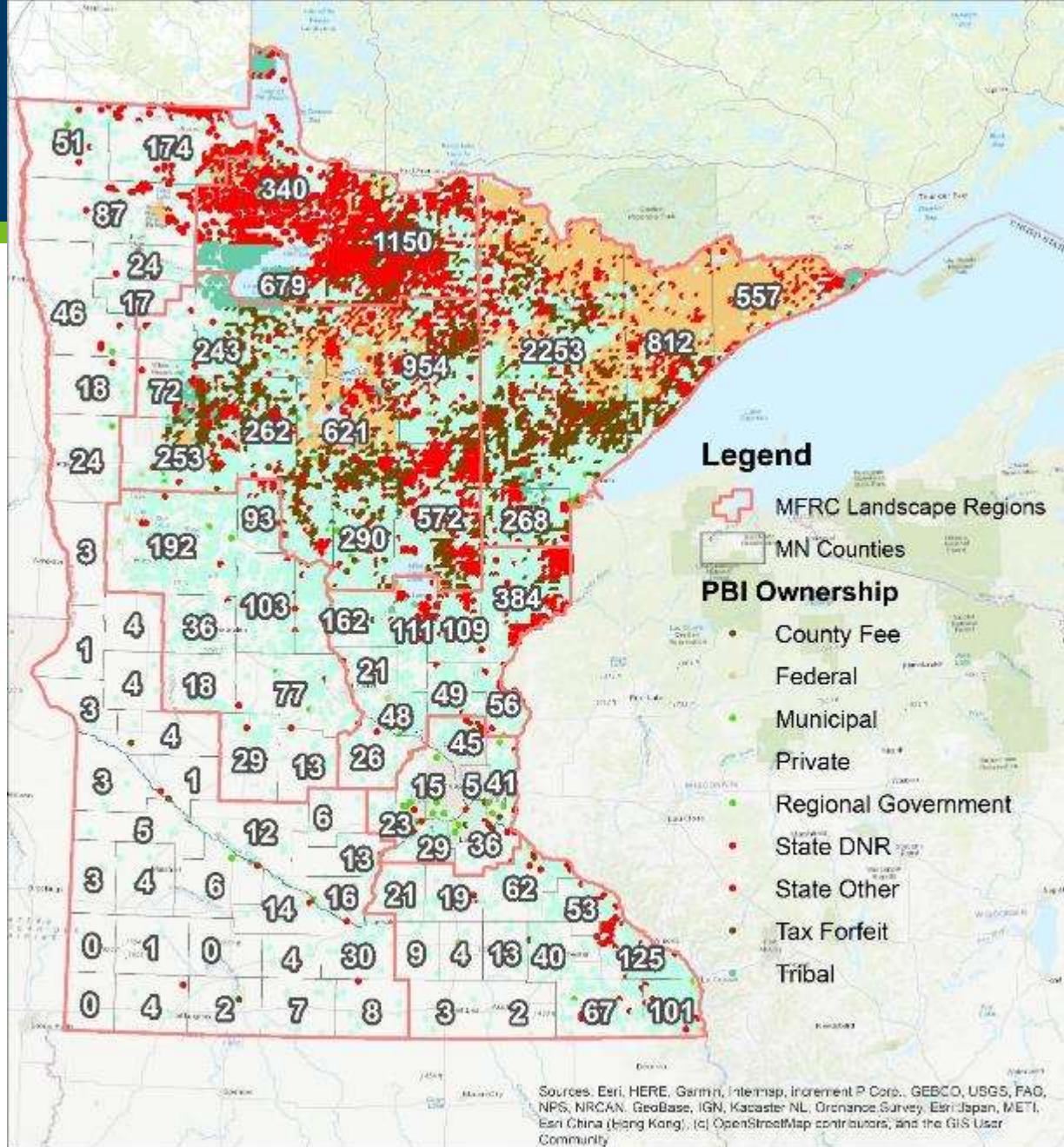
Carbon Stock Model – Testing Methods



Summer 2010 Image (NAIP)



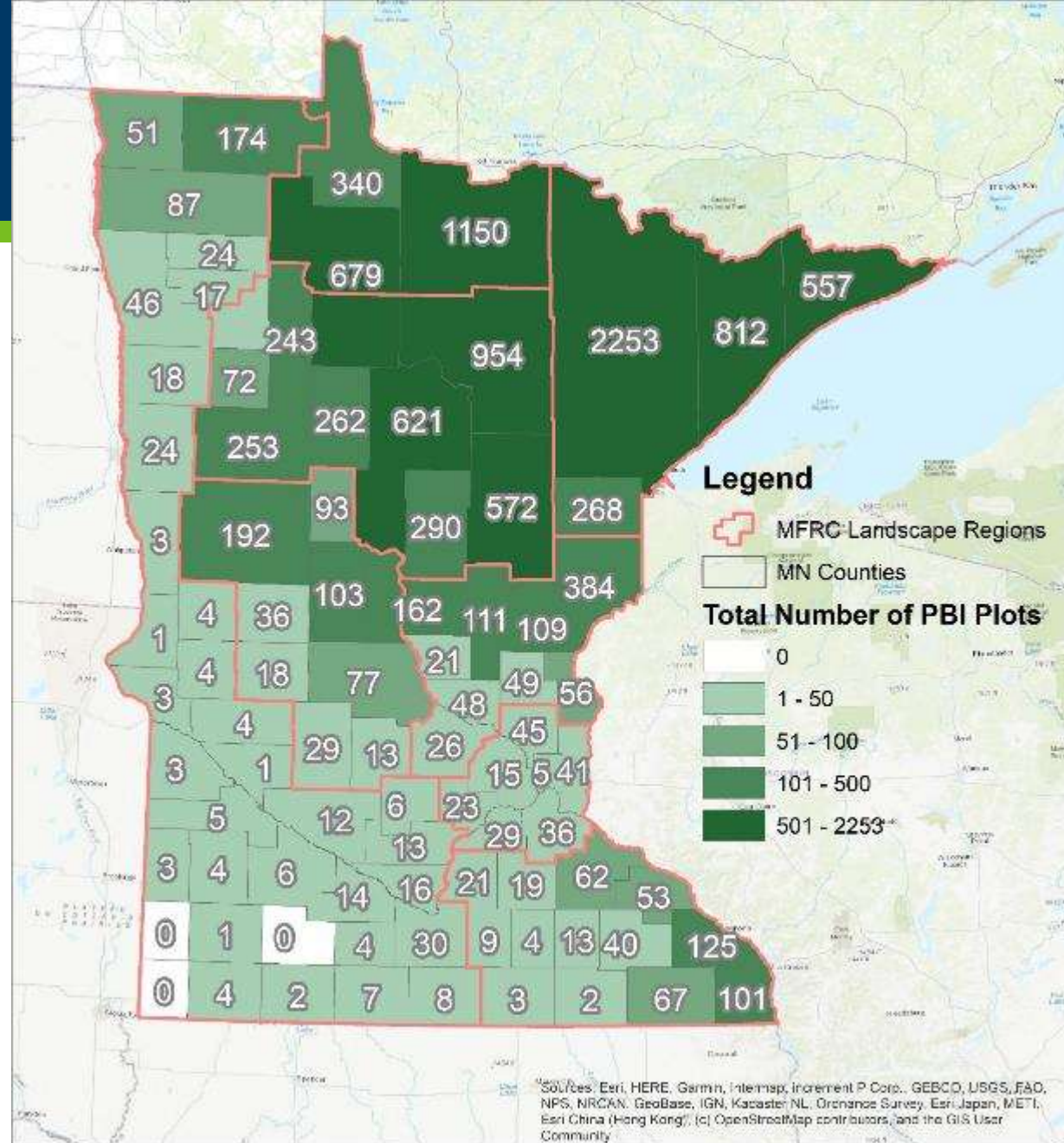
Silver A Model (Imagery, Lidar Height Metrics, and True FIA Locations)



Labels show the total number of PBI Plots across All Ownerships



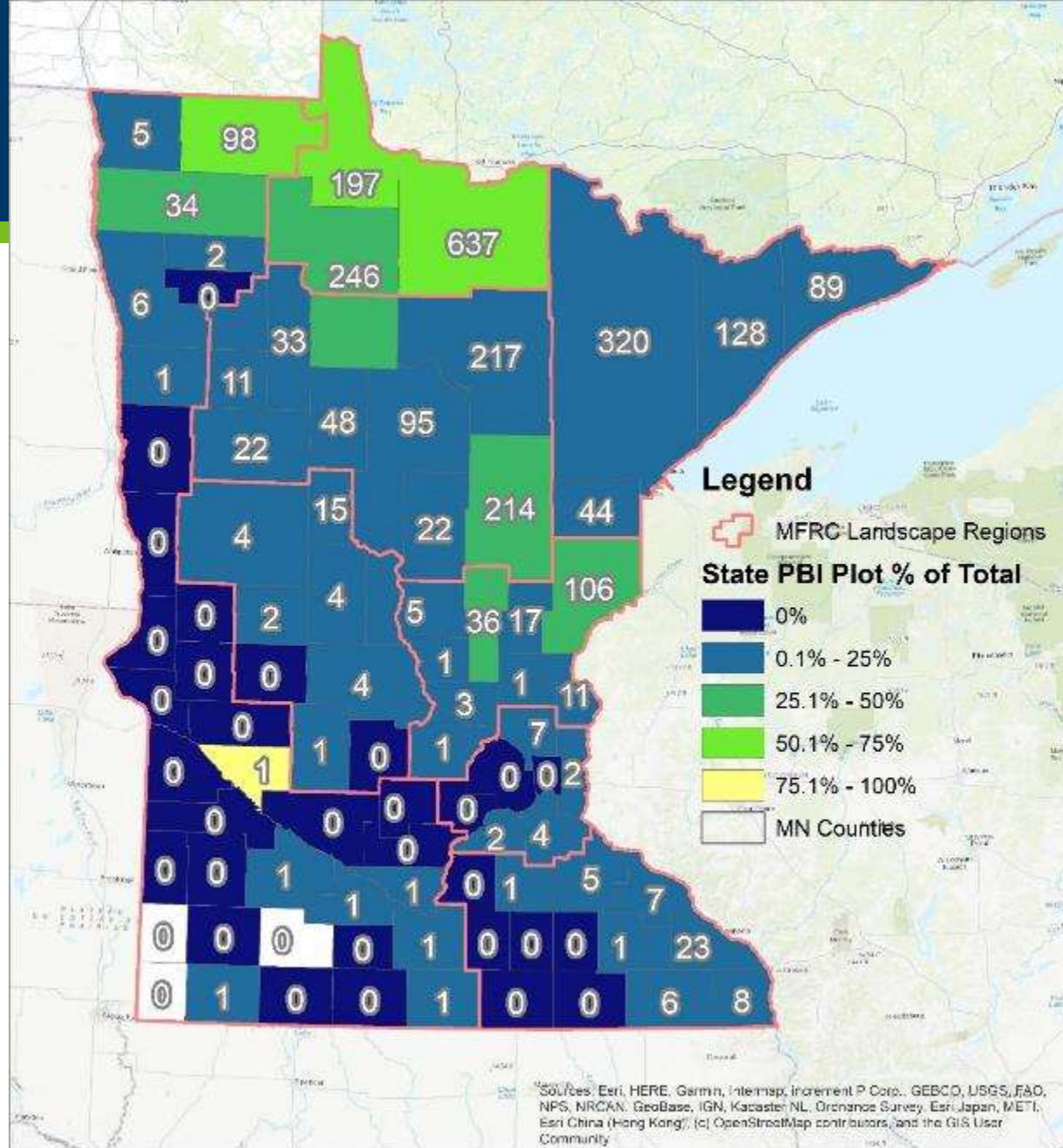
Map Date: February 2, 2021



Labels show the total number of PBI Plots across All Ownerships

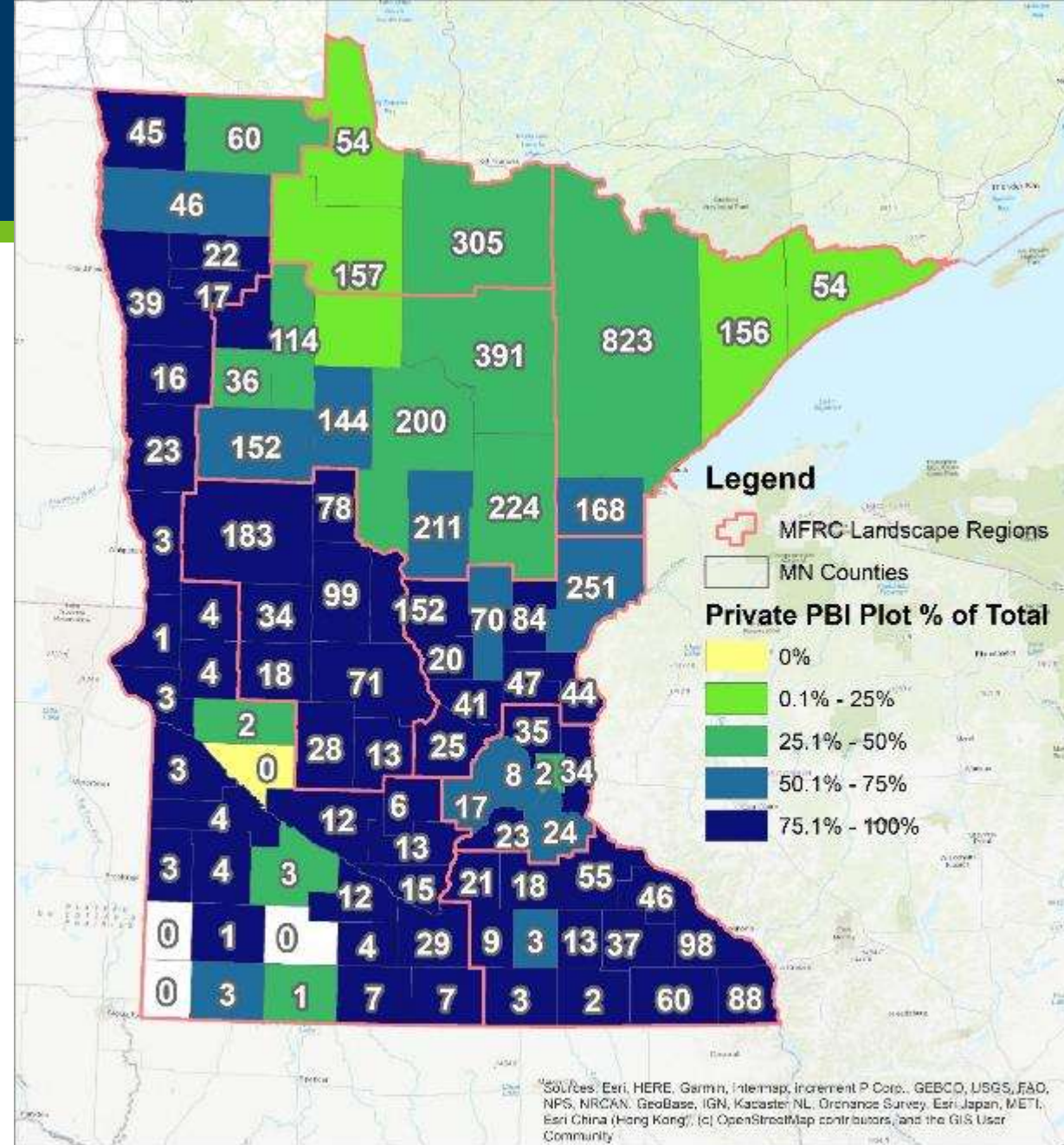


Map Date: February 2, 2021



Labels show number of State PBI Plots

Map Date: February 2, 2021



Labels show number of Private PBI Plots

Map Date: February 2, 2021

Next Steps - Pulling Elements Together

Forest inventory engagement on other land ownerships

- Private forest land – collaboration for funding requests to develop a private forest inventory program with MFRC, MFA, UMN Extension, and DNR
- County and City/Municipal forest land – partnerships developing

Collect high density lidar to operationalize PBI model building far and wide

- High density lidar expected to come online within about a year from now: Rainy Lake Block, Lake Superior Block, Pine County (already in hand), Becker County, and Goodhue County (already in hand)
- Partnerships needed in Upper Mississippi and Central Mississippi Blocks

Information sharing and data hosting

- Needed: platform to share results – different tools for different business needs



*Questions &
Discussion*

Thank You!

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