



# Plot Based Inventory (PBI) – Area Based Estimation for Updating Minnesota's Stand Level Inventory

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Operational Lidar Inventory Meeting  
April 7, 2021

# Goals for today

- Share info about Minnesota Lidar Planning efforts
- Update on MNDNR progress in lidar derived forest inventory
- Provide time for questions and discussion

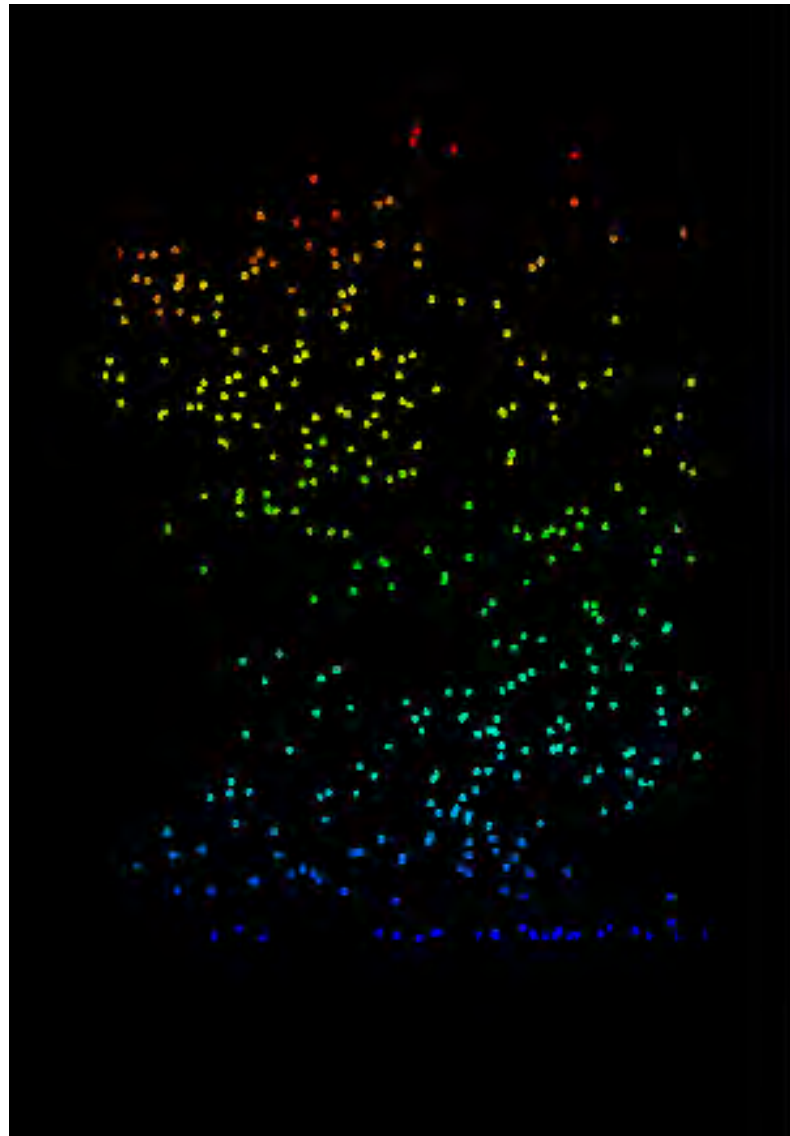




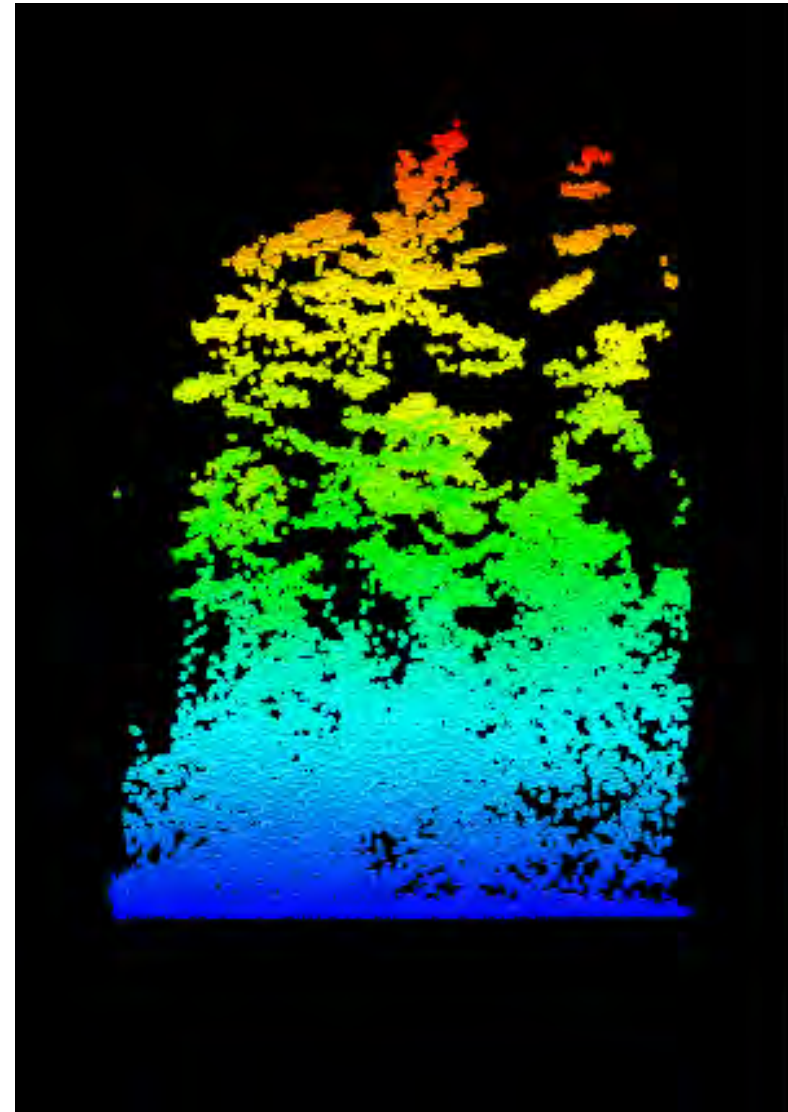
An aerial photograph of a vast, green forested landscape. In the center, a large, irregularly shaped lake or reservoir is visible, surrounded by dense trees. The sky is filled with large, white, fluffy clouds, and the overall scene is captured from a high vantage point. A large, dark blue circular overlay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

# High-density Lidar

QL3, Low Density Lidar 2011



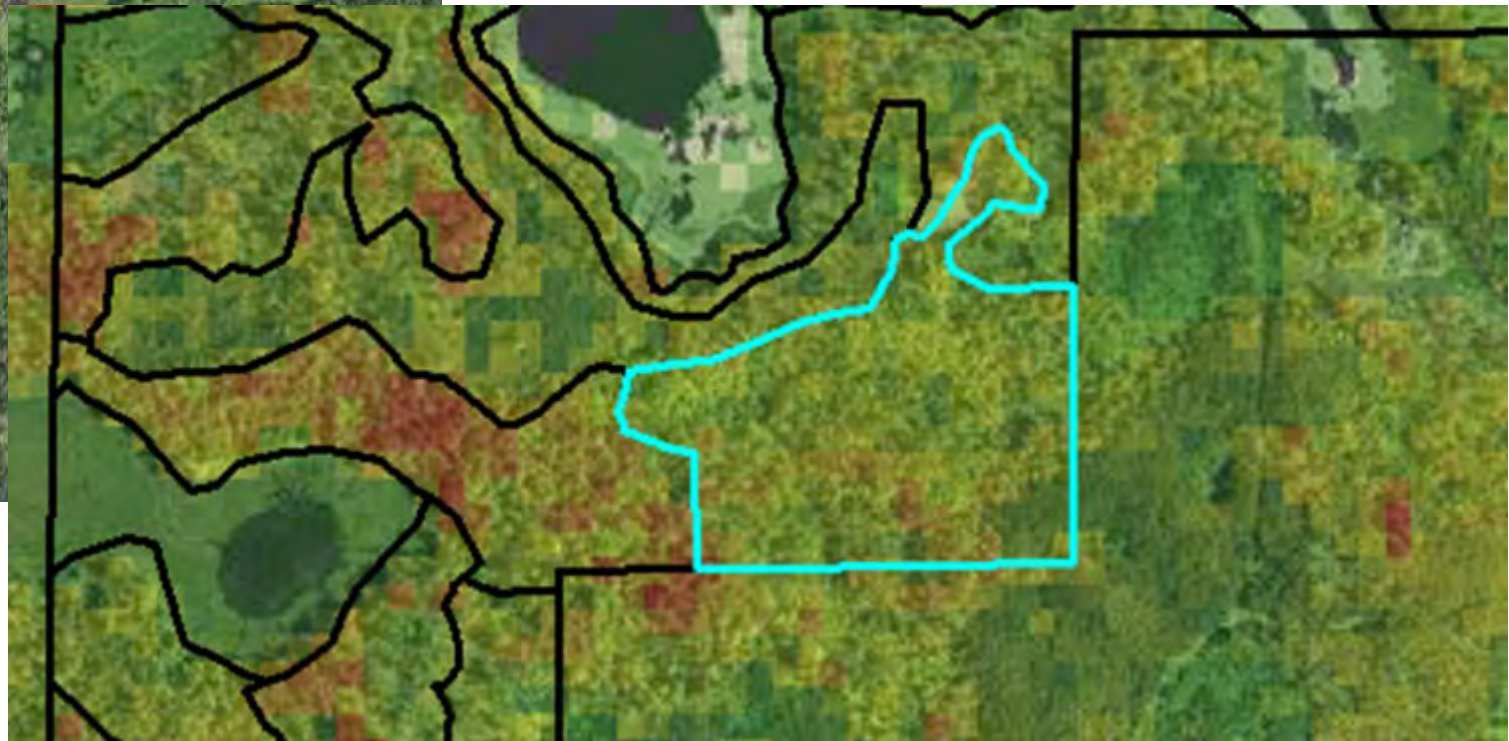
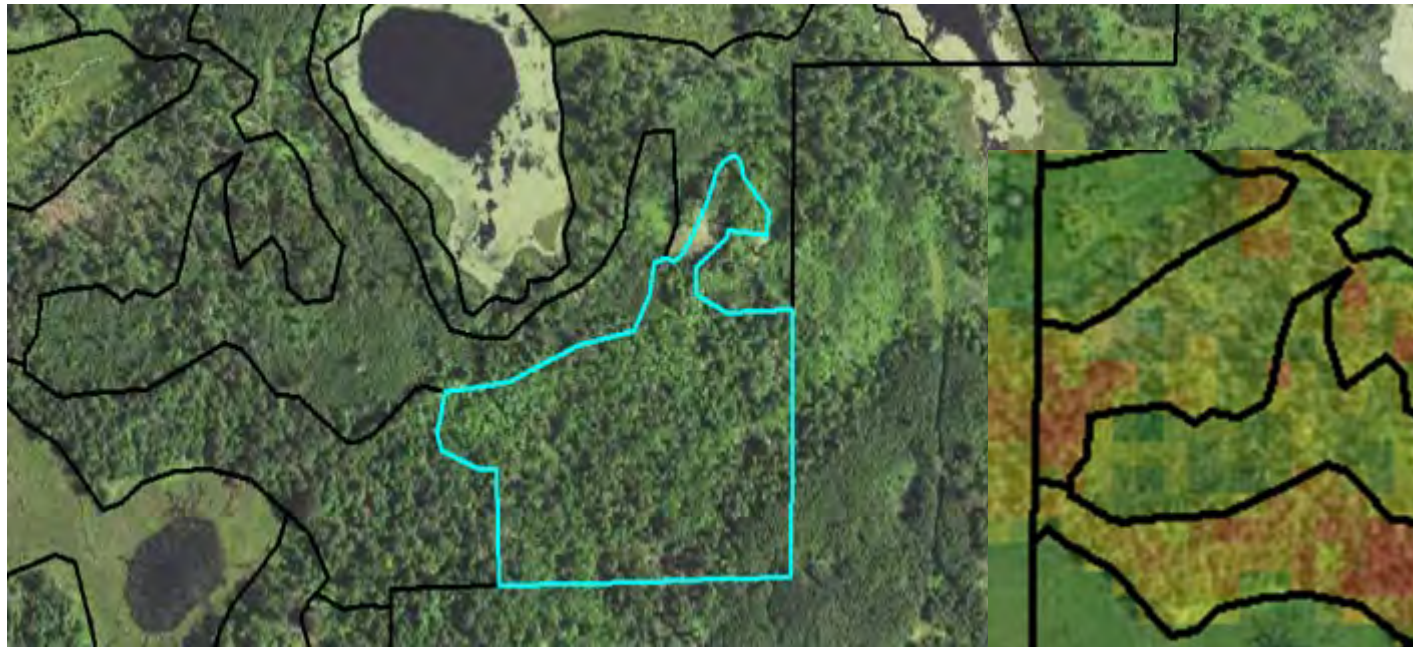
QL1, Linear Lidar 2018





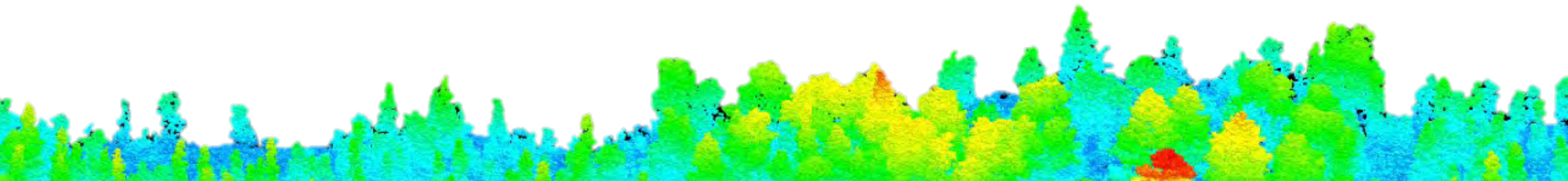
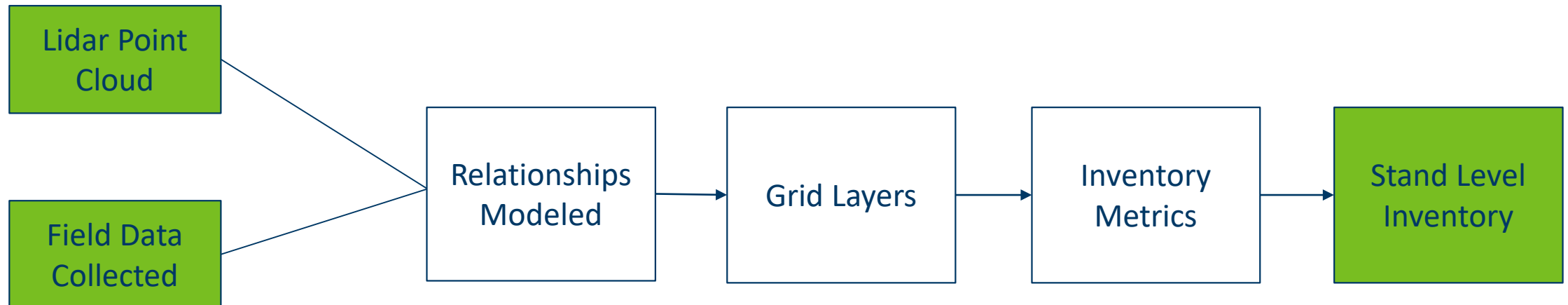
# Forest Inventory - The End Goal

FID	Shape *	STAND_KEY	MN_CTYPE	SURVEY_YR	STAND_AGE	Field1	STAND_KE_1	Grid_Cell_	AGB_Lbs	BAWHT_Max	BA_Wt_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" in white. The map includes labels for various locations such as Proctor, West Duluth, Riverside, Clough Island, and Duluth. It also shows geographical features like Kingfisher Creek, Tullas Island, and the St. Louis Channel. The map is color-coded with greens for land and blues for water, with brown contour lines indicating elevation.

# 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?

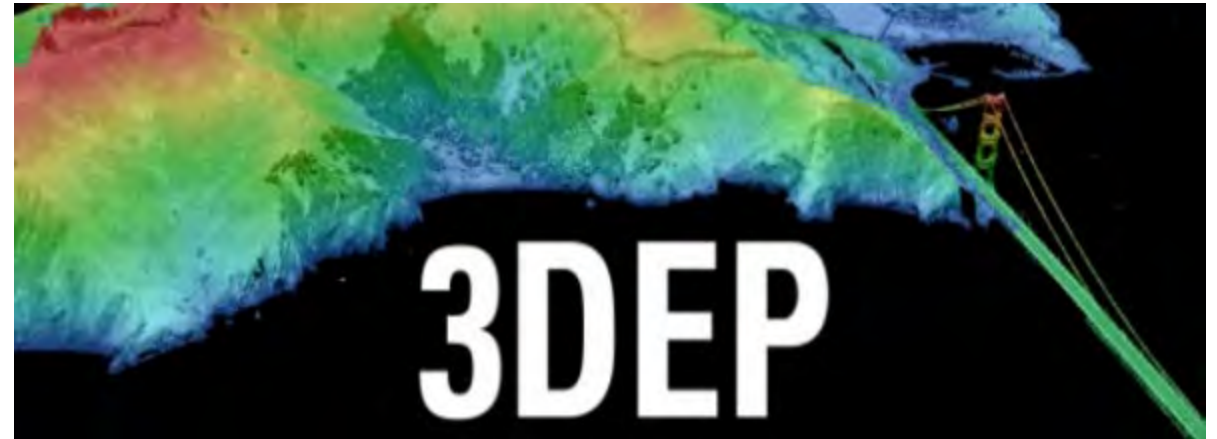
- The ***3D Geomatics Committee*** (3DGeo) is a committee under GAC that works to identify and promote the need for planning, funding, acquisition, and management of three-dimensional geomatic data and derived products.



# USGS 3D Elevation Program (3DEP)

## 3D Elevation Program (3DEP)

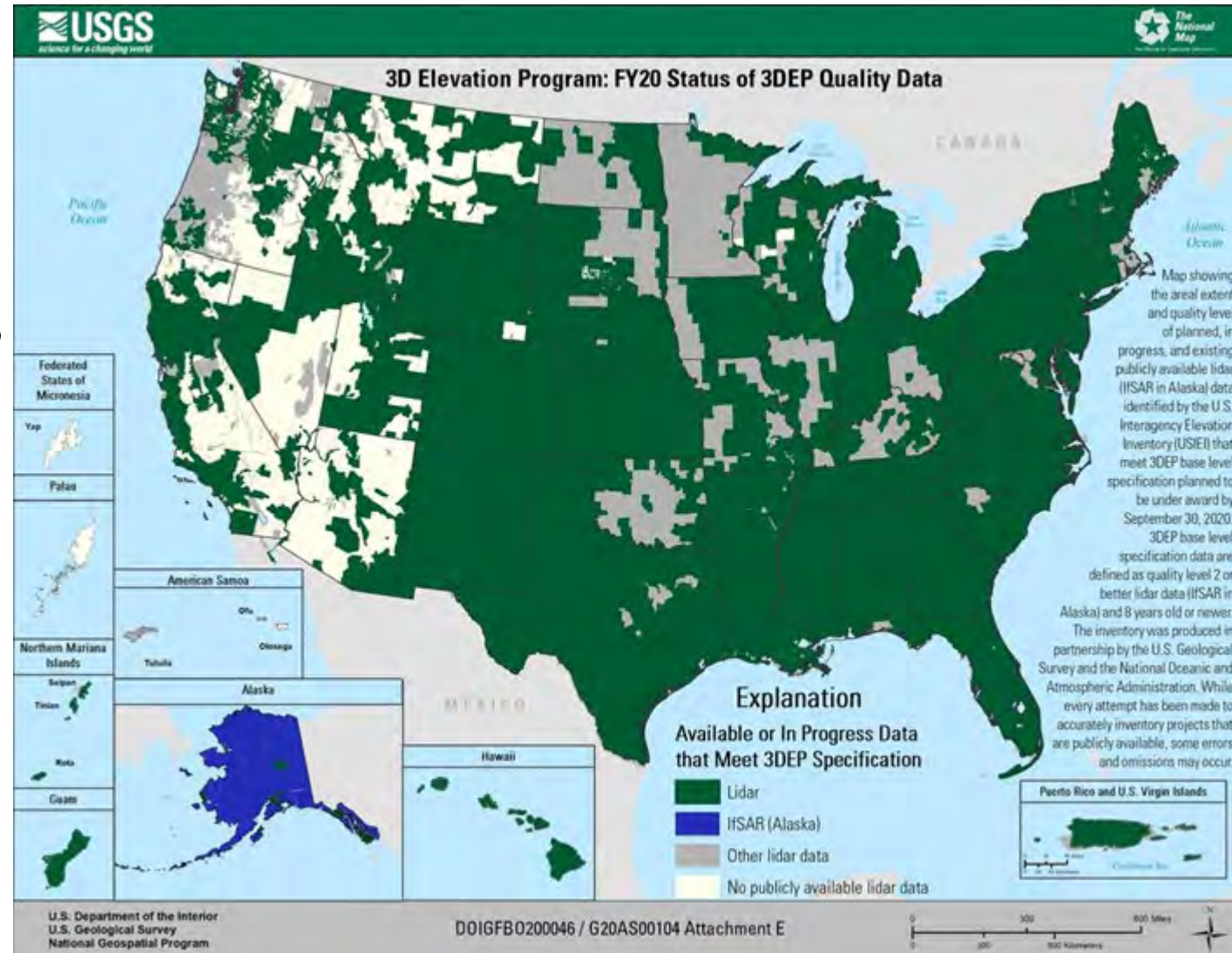
- **Systematically** guiding the collection of 3D elevation data in the form lidar data for the United States, and the U.S. territories
- Goal: elevation dataset for the nation **by 2023**
- Acquisition contracts are under two managerial mechanisms
  - GPSC
  - COOP



# USGS 3D Elevation Program (3DEP)

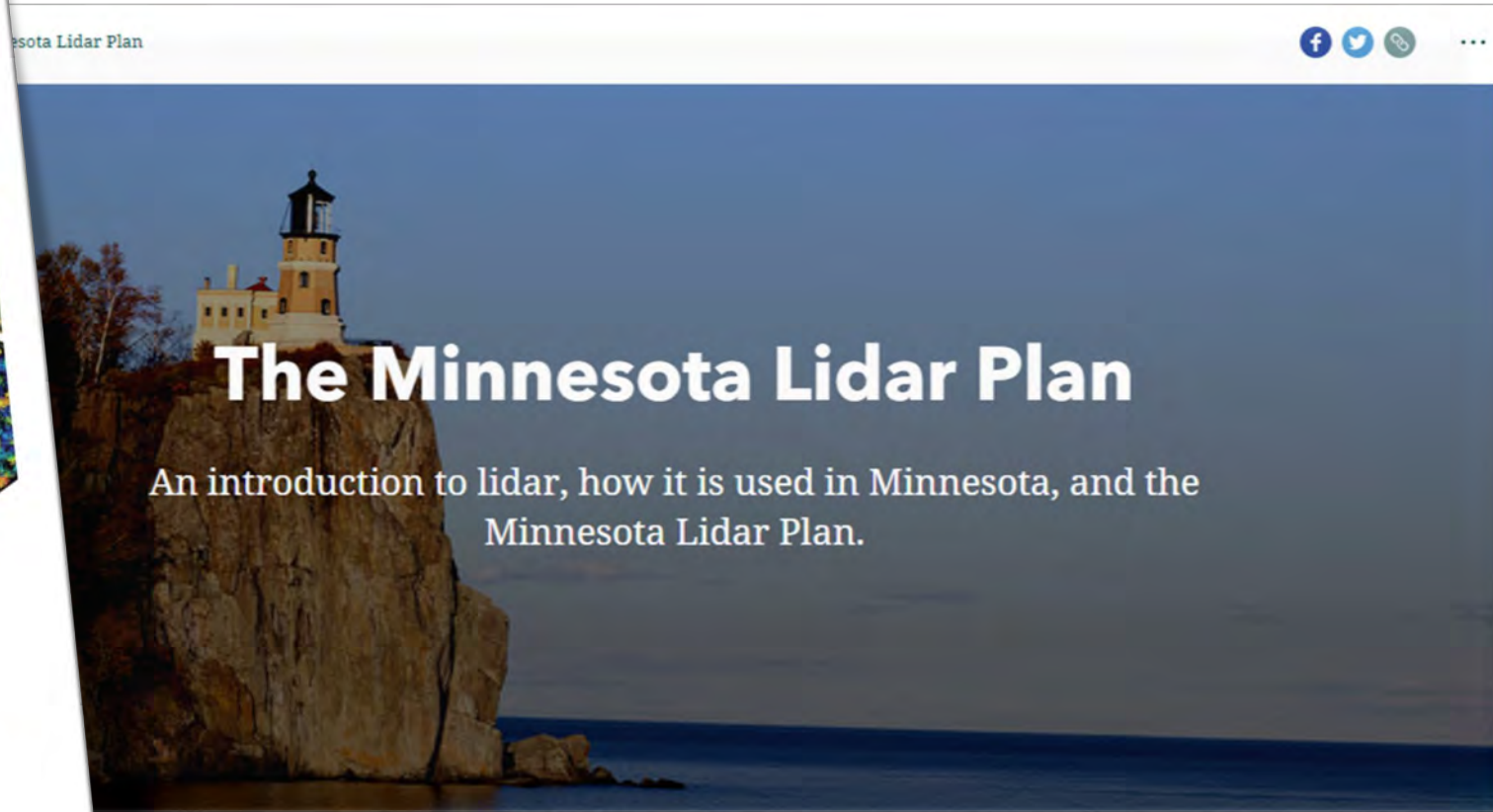
## Broad Agency Announcement (BAA)

- 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)



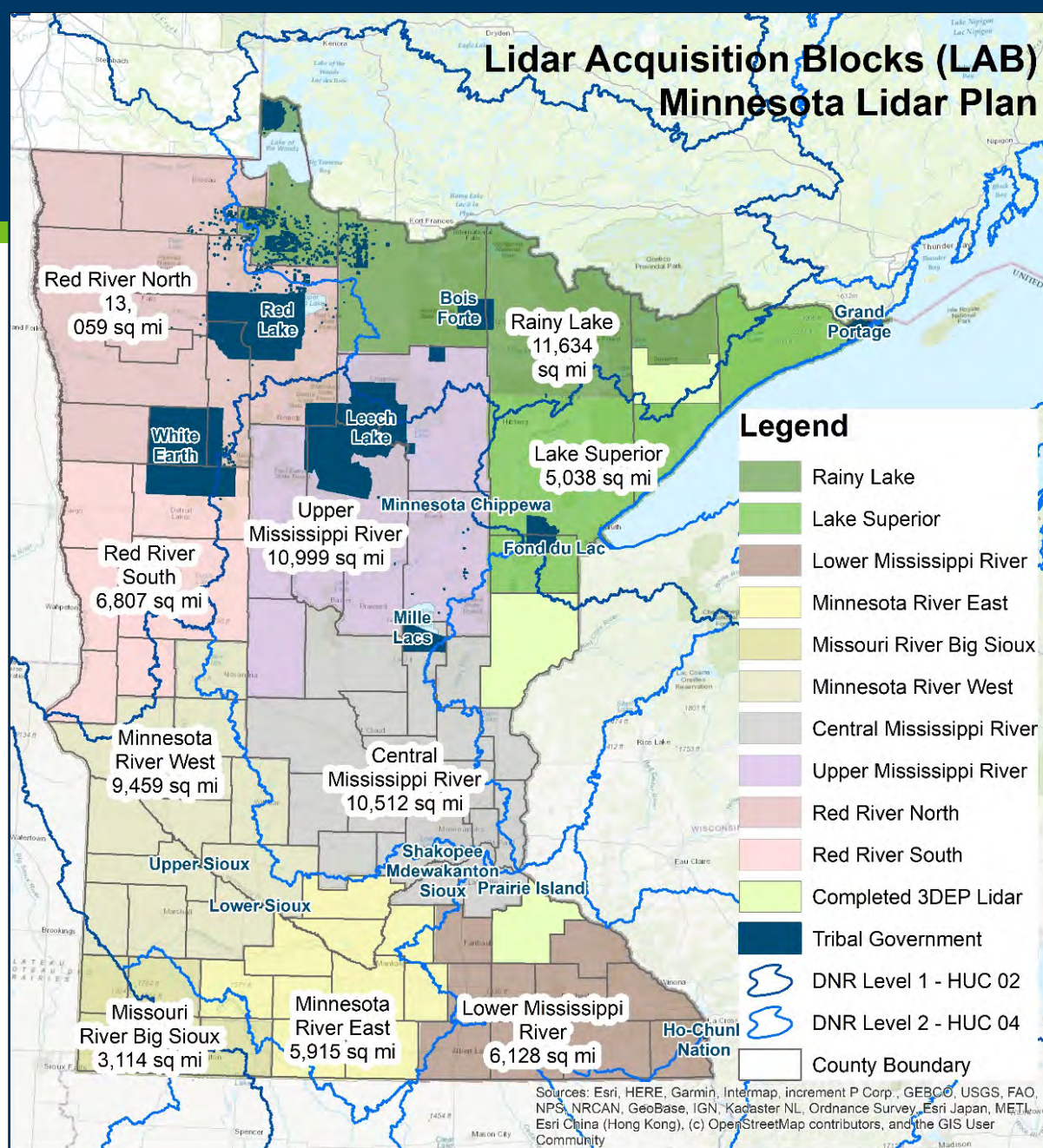


# Minnesota Lidar Plan & Story Map

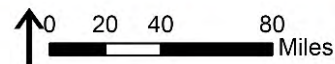


<http://bit.ly/MnLidarPlanStoryMap>

# Lidar Acquisition Blocks (LAB) Minnesota Lidar Plan



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



Map Date: Nov 16, 2020



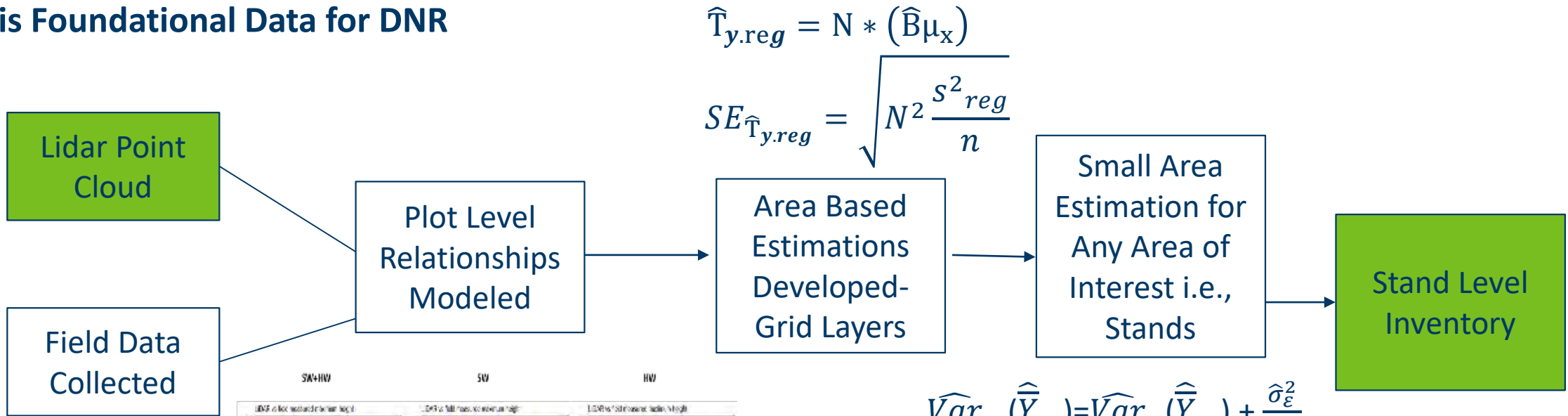


# Lidar Derived Forest Inventory



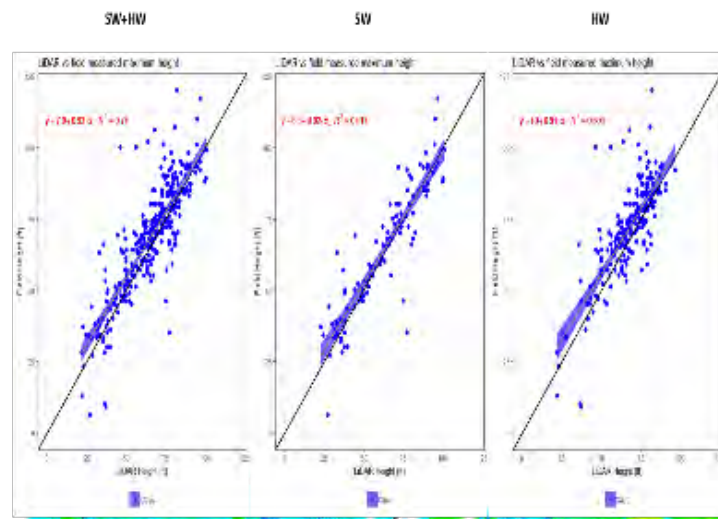
# Forestry Inventory - pulling elements together

Lidar is Foundational Data for DNR



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

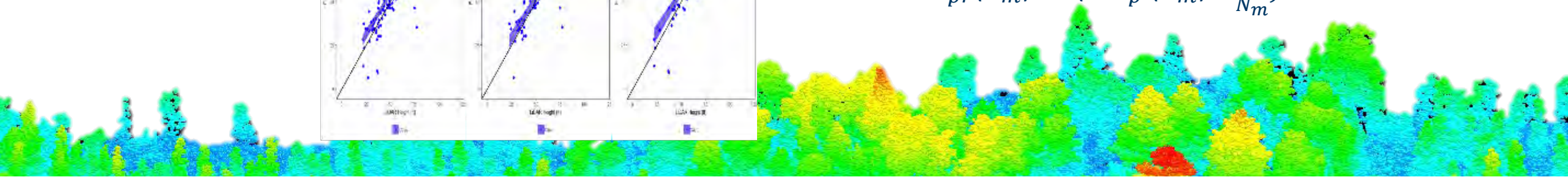
$$SE_{\hat{T}_{y.reg}} = \sqrt{N^2 \frac{s^2_{reg}}{n}}$$



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

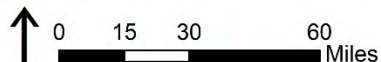
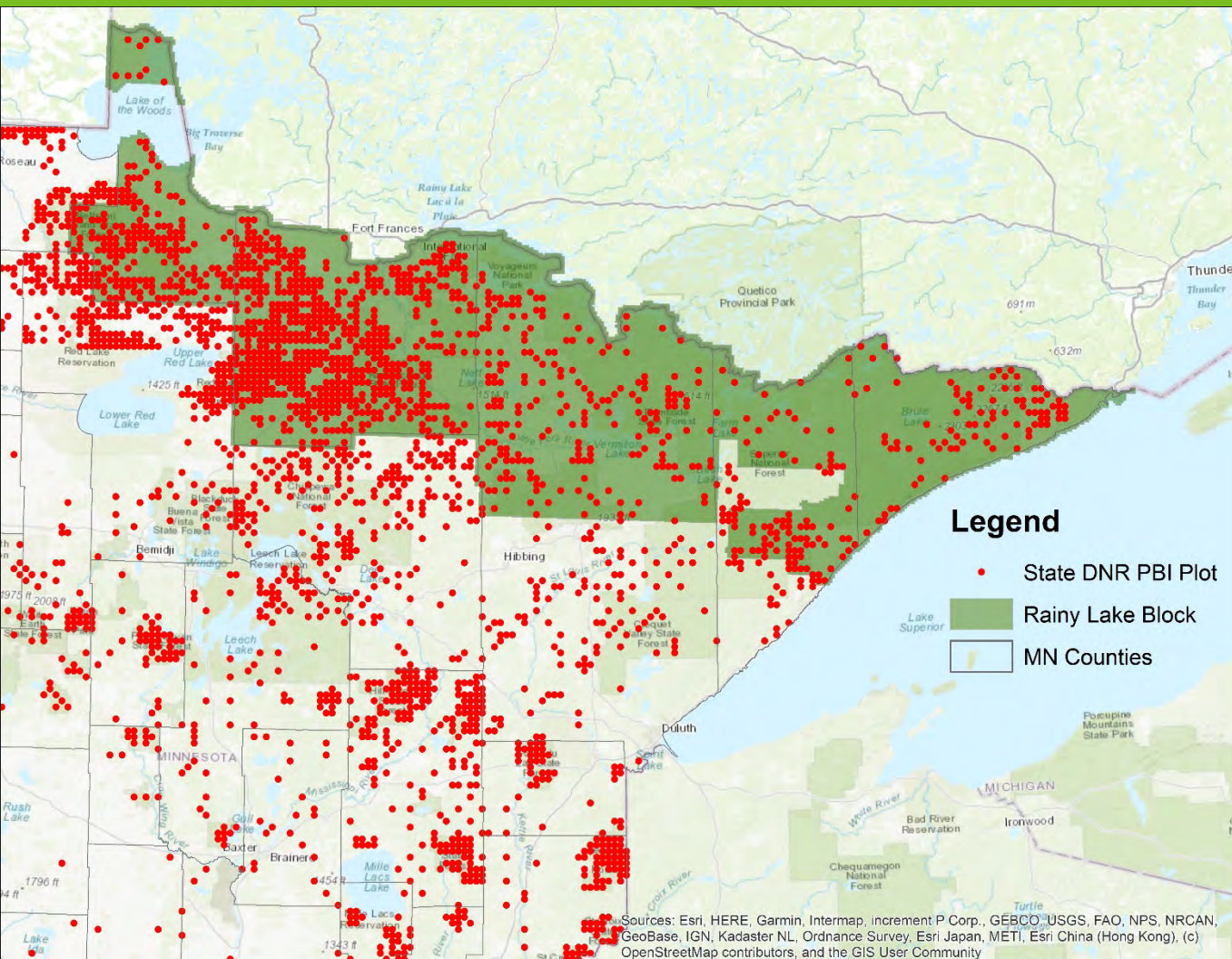
$$\widehat{Var}_{prh}(\hat{Y}_m) = \widehat{Var}_p(\hat{Y}_m) + \frac{1}{N_m^2} \sum_{i=1}^{N_m} \hat{\sigma}_i^2$$

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





# New Plot Based Inventory (PBI): Transition Plan



Map Date: February 2, 2021

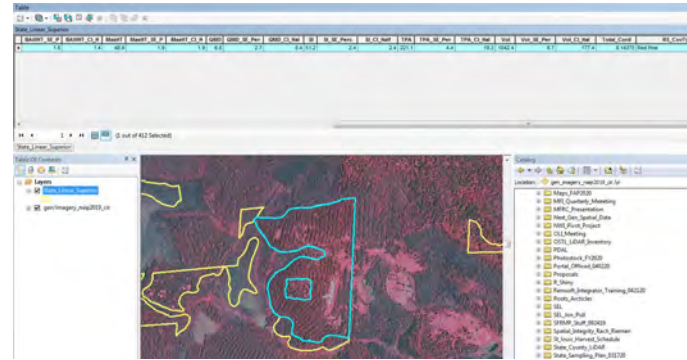
- RA research supports the recommended plot density = 1 plot : 1500 acres forest land
- Cost per Plot = ~\$300-\$500 (that's only \$0.17-\$0.29 per acre for field work)

## Example: Rainy Lake Block

Owner Type	Count	Total Acres
County	9	12,846
NPS	68	120,554
State	1086	1,954,396
Tribal	63	129,679
USFS	606	1,010,723
Other	5	4,923



# Streamlining Data Collection



The screenshot displays a GIS software interface with a catalog on the left and a data table on the right. The catalog shows a folder structure under 'Folders' with a sub-folder 'db20-pg-pbi.sde' containing several data layers. The data table shows a list of records with columns for objectid, GlobalID, Lidar Block Name, County Code, Plot ID Number, Plot ID Sequence, Date, Time, Organization, and Status of person c.

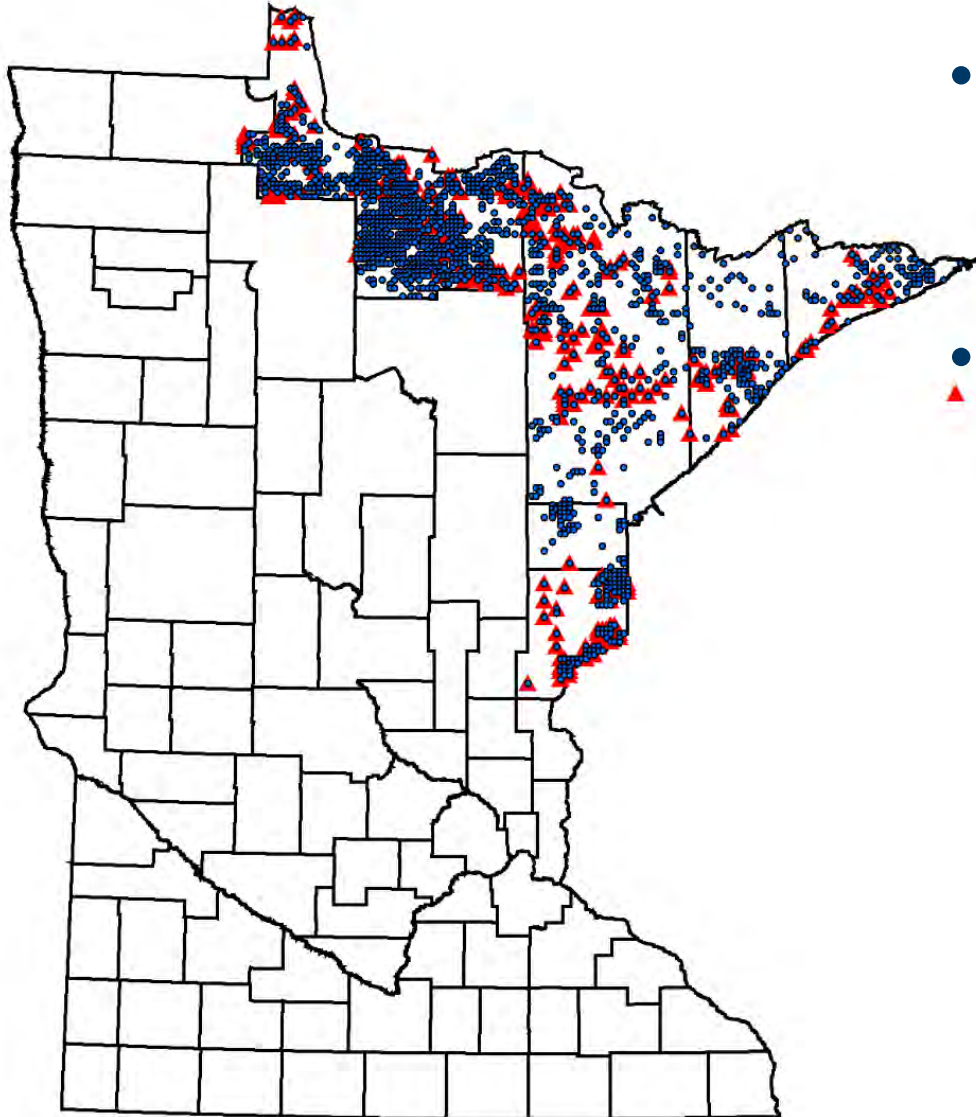
objectid	GlobalID	Lidar Block Name	County Code	Plot ID Number	Plot ID Sequence	Date	Time	Organization	Status of person c
1	{CDEE908F-F6B6-42C4-BC7D-F376C0A02D4}	Missouri Big Sioux Block	101	9999	1019999	7/8/2020 5:00:00 PM	14:42	Minnesota DNR	Forester
2	{DC76FF4F-15A4-4DA1-8853-11D646B1097D}	Lower Mississippi Block	39	1	391	7/8/2020 5:00:00 PM	<Null>	Minnesota DNR	Contractor
3	{4906A474-5DB6-4DB4-BDE5-D3C356D91193}	Lake Superior Block	137	9999	1379999	7/9/2020 5:00:00 PM	<Null>	Minnesota DNR	Forester
		Lake Superior Block	137		3 1373	7/9/2020 5:00:00 PM	05:22	Minnesota DNR	Forester

Additional information for the selected record:

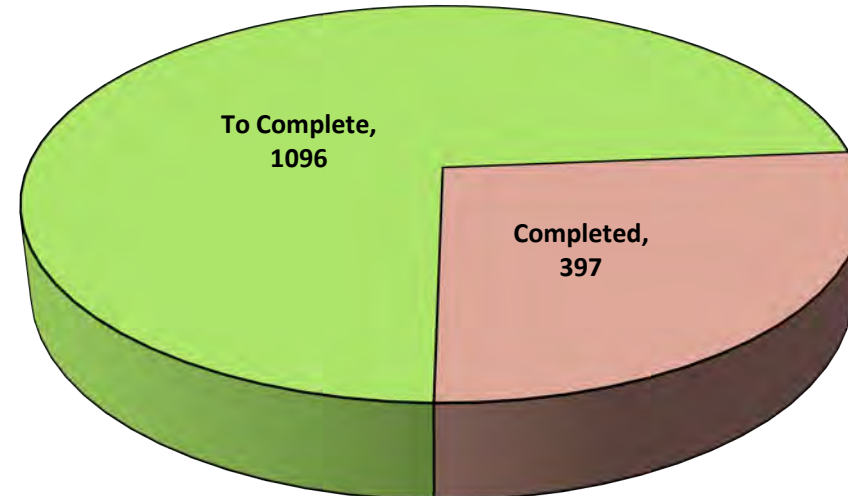
pbi.pbi.Plot\_Based\_Forest\_Inventory\_trees  
Type: Enterprise Geodatabase Relationship Class  
Modified: D:\Users\schillar\Desktop\SDE\_Connection\_File\ldb20-pg-pbi.sde  
Location: D:\Users\schillar\Desktop\SDE\_Connection\_File\ldb20-pg-pbi.sde\pbi.pbi.Plot\_Based\_Forest\_Inventory\_trees



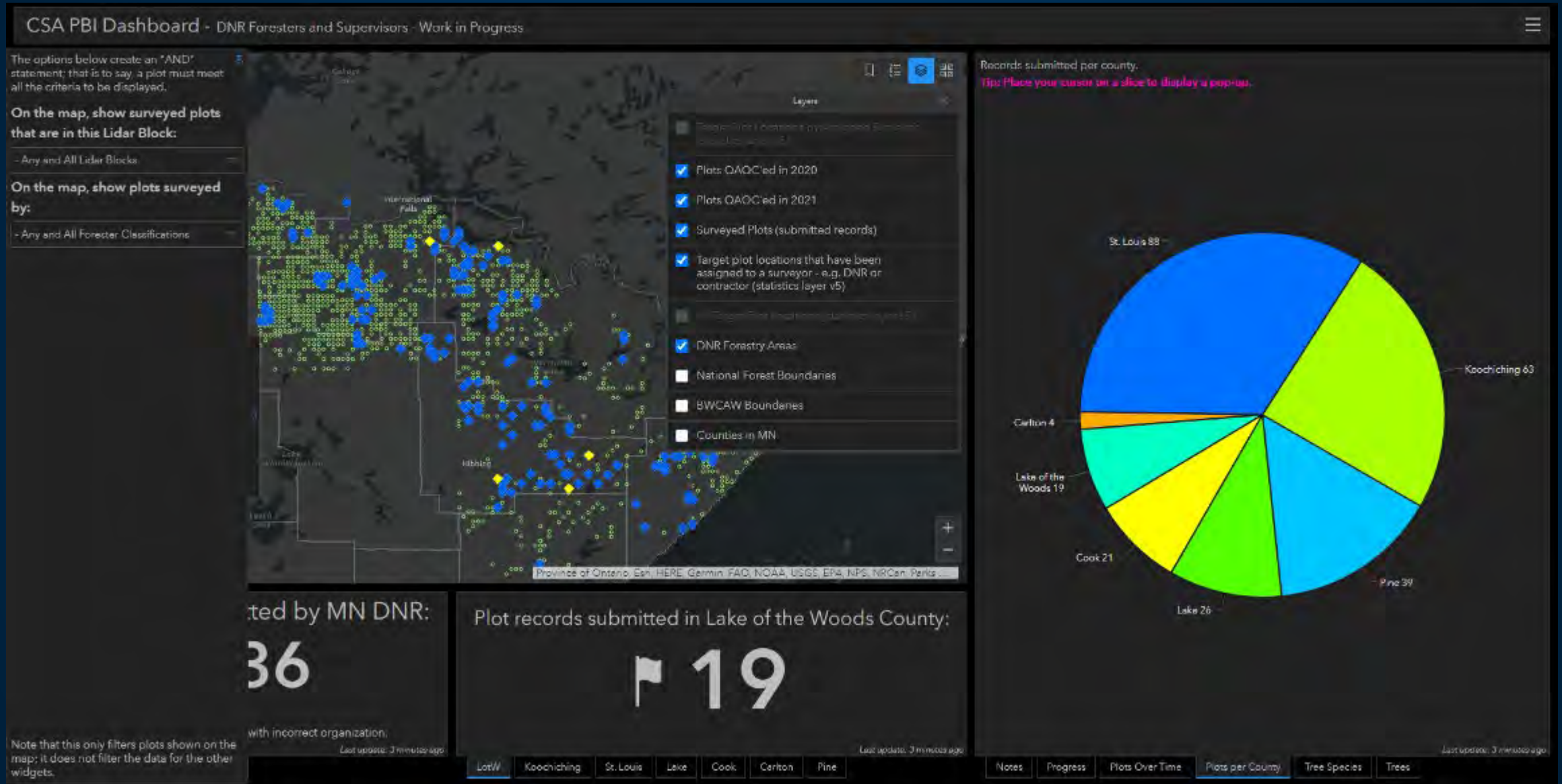
# Current Progress of PBI



- On State administered land: DNR forestry staff and contractors have completed 397 plots of 1493 plots in Rainy Lake and Lake Superior Blocks, and Pine County.
- Work started in June and will continue through the summer into next winter, rolling into the next Lidar Acquisition Block when completed with these areas.

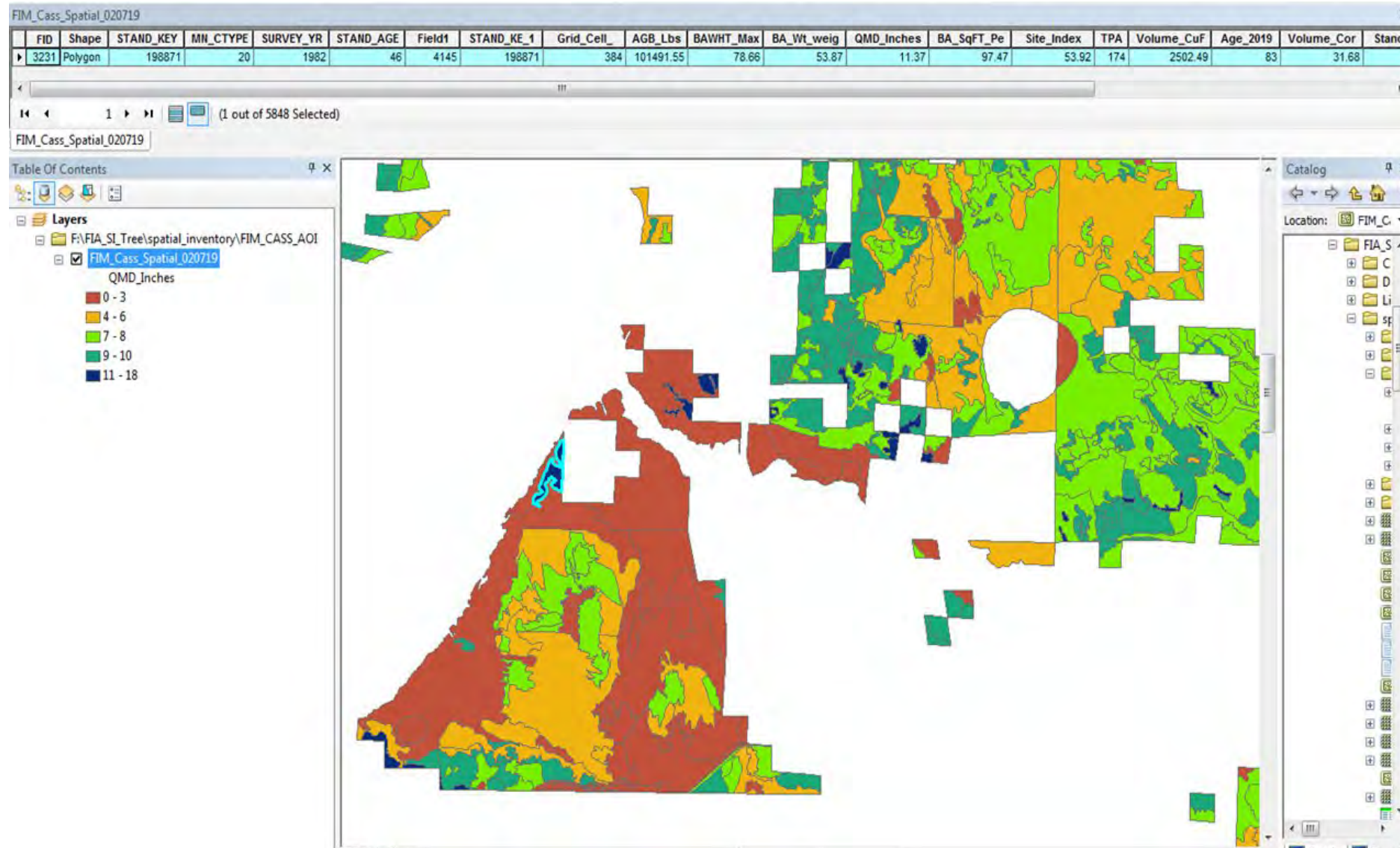


# New Forest Inventory - PBI Dashboard

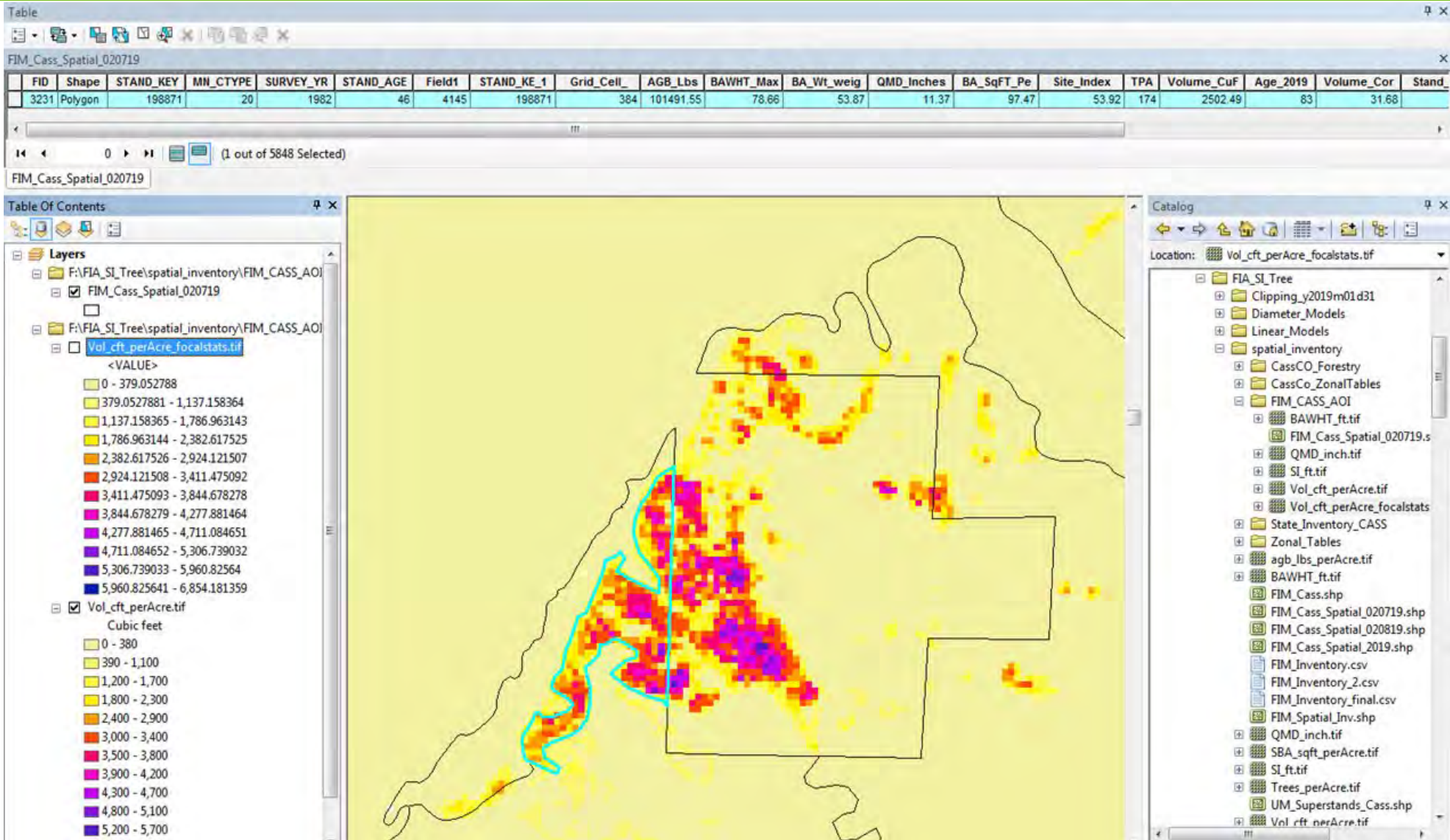




# Small Area Estimation - Any Area of Interest

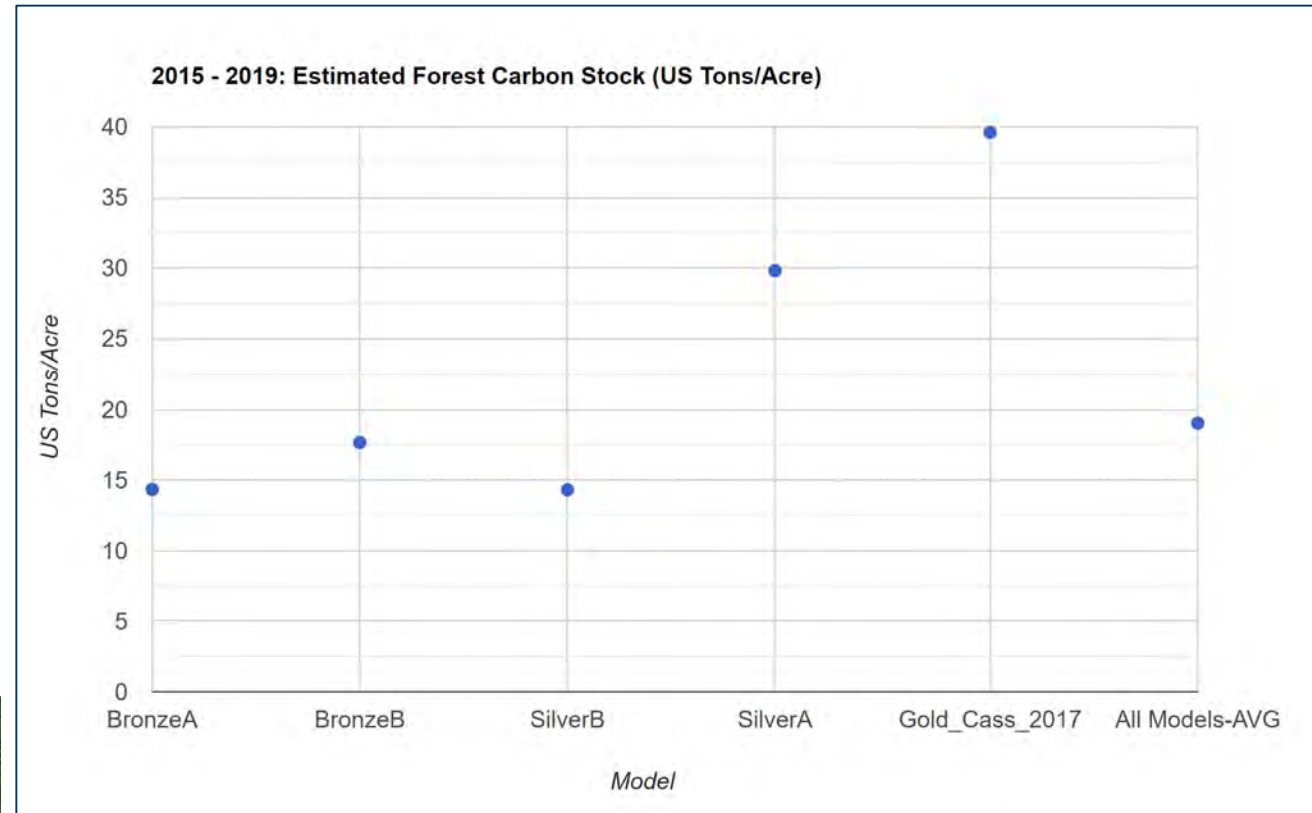
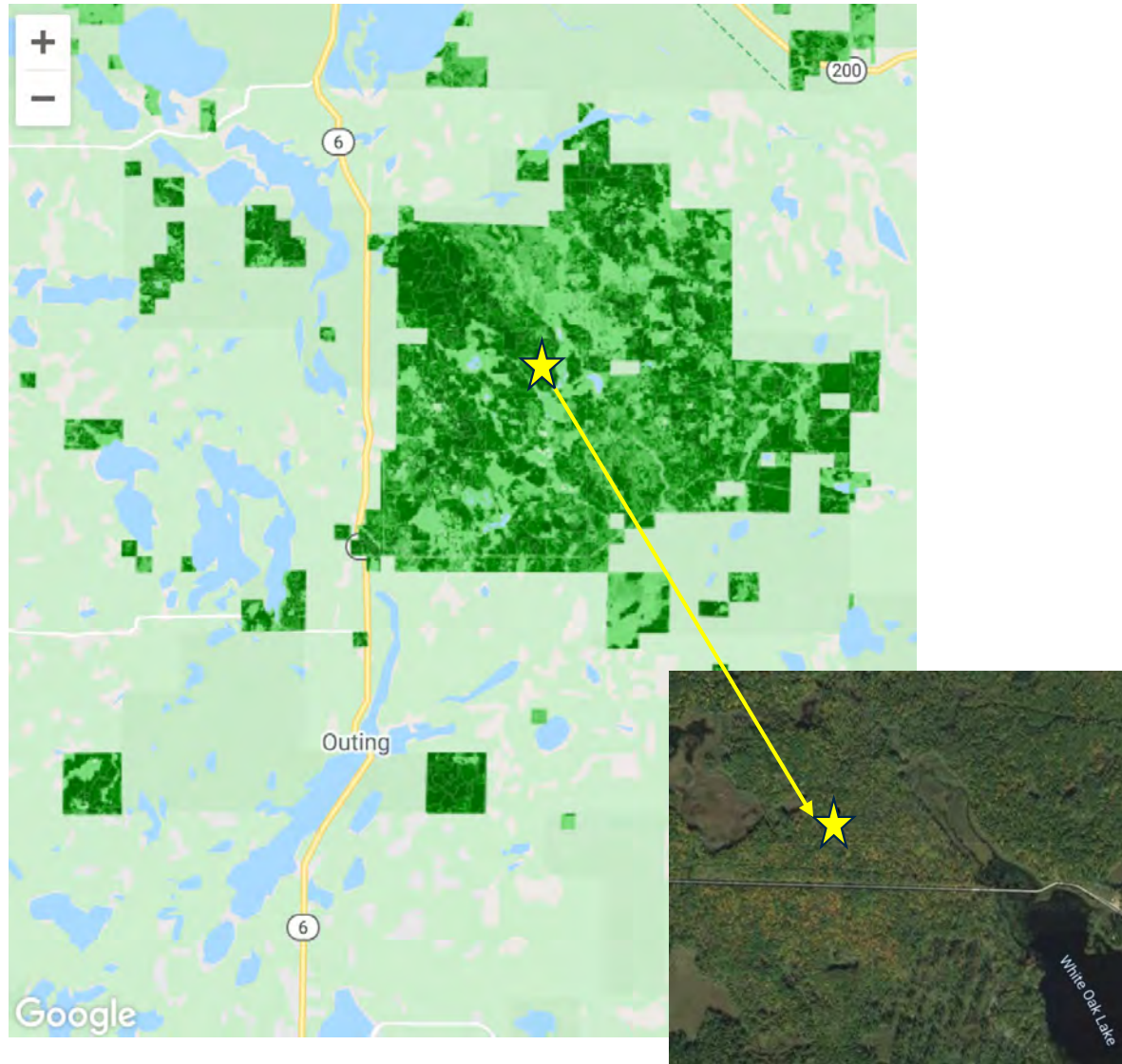


# Sub-Stand Information and Landscape Scale





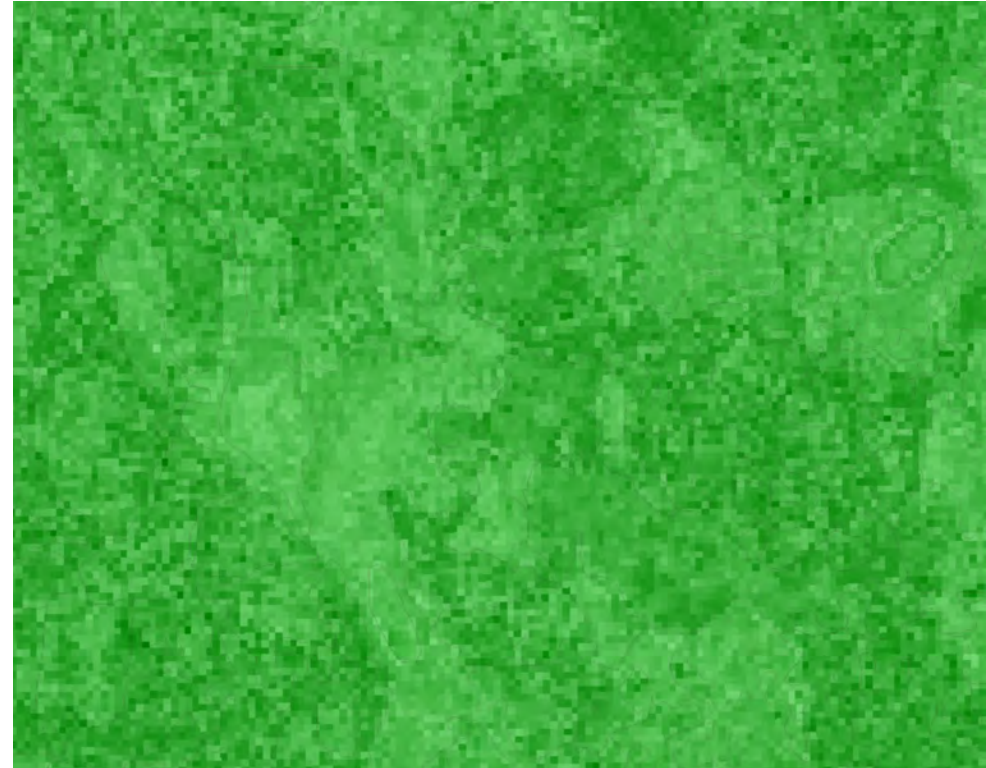
# Carbon Stock Model – Testing Methods



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Summer 2010 Image (NAIP)



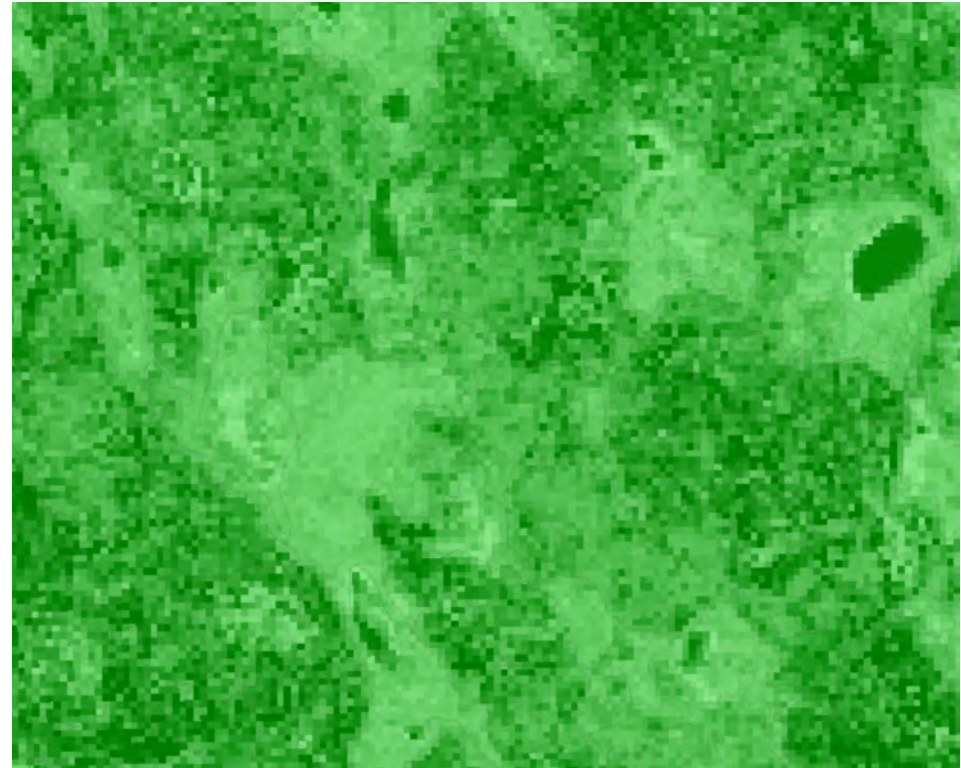
Bronze Model (Imagery Only, Fuzzed FIA Locations)



# Carbon Stock Model – Testing Methods



Summer 2010 Image (NAIP)

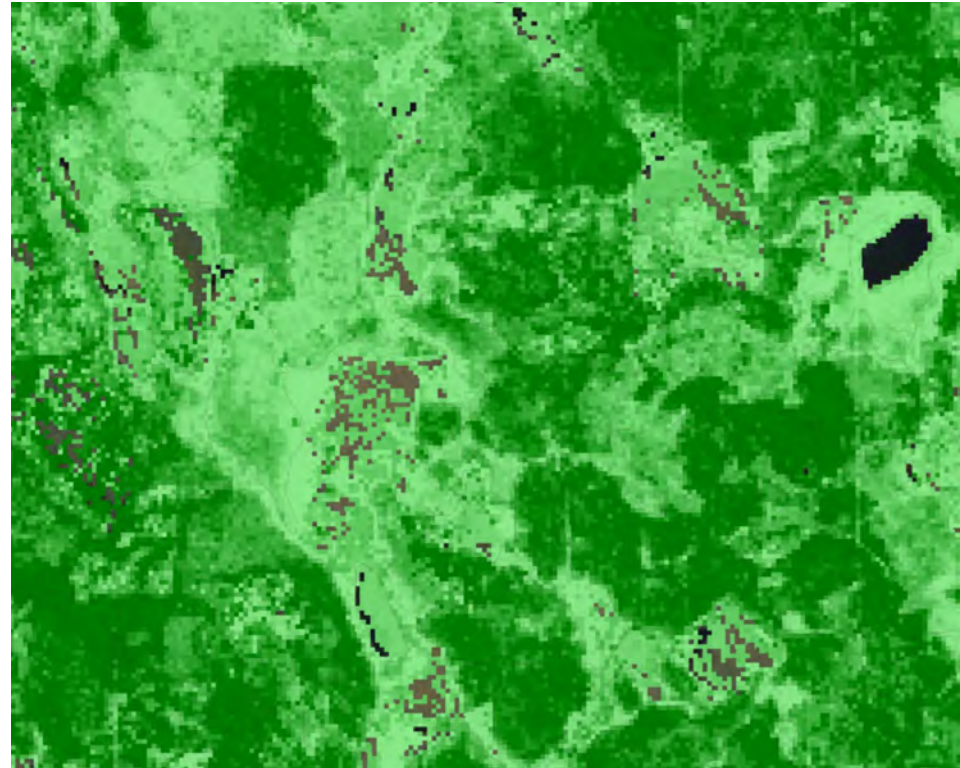


Silver B Model (Imagery Only, True FIA Locations)

# Carbon Stock Model – Testing Methods



Summer 2010 Image (NAIP)



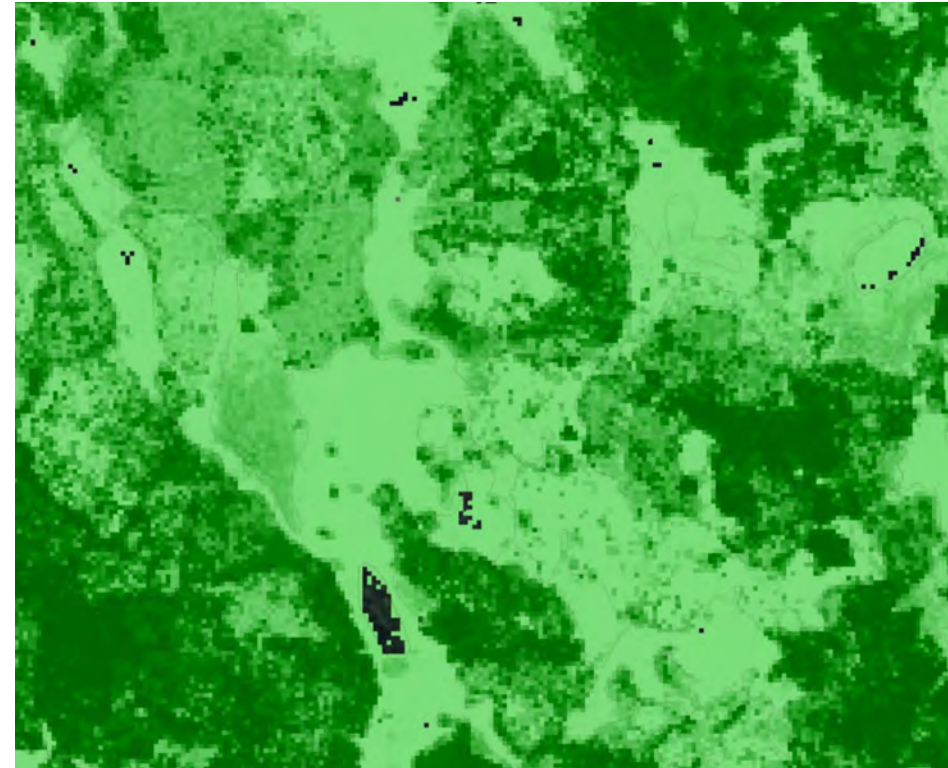
Silver A Model (Imagery, Lidar Height Metrics, and True FIA Locations)



# Carbon Stock Model – Testing Methods



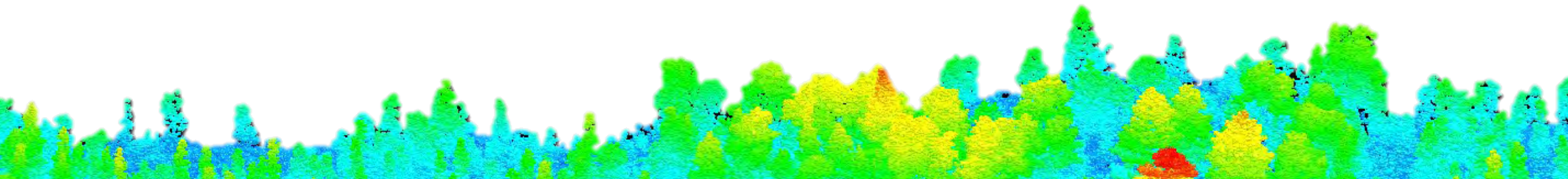
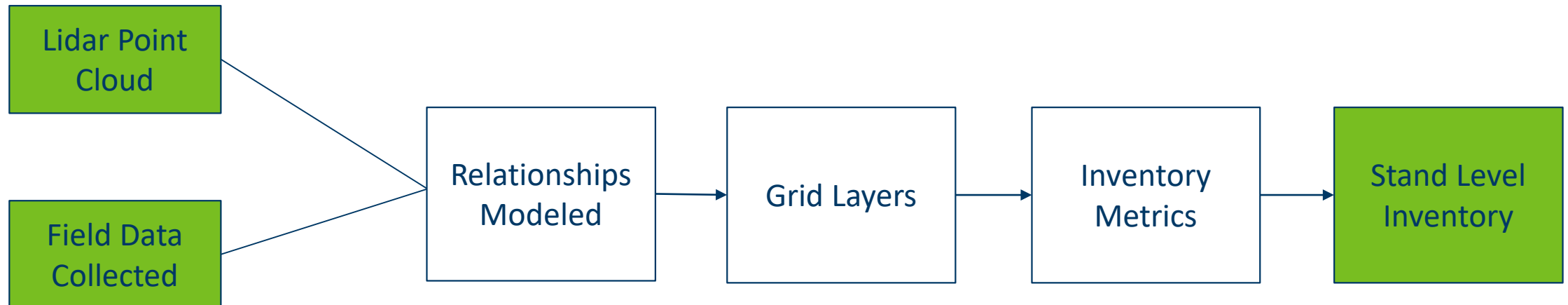
Summer 2019 Image (NAIP)



Gold Model (Imagery, High Density Lidar Height Metrics, and State Forest Inventory)

# Forestry Inventory - Pulling Elements Together

Lidar is Foundational Data for DNR





# *Next Steps - Pulling Elements Together*

Forest inventory engagement on other land ownerships

- Private forest land – collaboration for funding requests
- 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
- Additional partnerships needed

Information sharing and data hosting

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





*Questions &  
Discussion*



# Thank You!

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