MichiganTech Research Institute

Using multi-temporal imagery and unmanned aerial vehicles to improve mapping and inventory of forested roads

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www.mtri.org

UNIVERSITY OF MARYLAND

Presentation Format

Unpaved Roads Project

Presentation Format

Unpaved Roads Project	Forested Roads Project

Presentation Format

Unpaved Roads Project	Forested Roads Project	Duck Lake Fire Analysis

Presentation Format

Unpaved Roads Project	Forested Roads Project	Duck Lake Fire Analysis	Questions

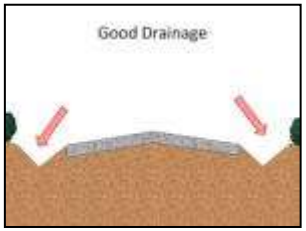
Implementation Assessment of Unpaved Road Condition with High-Resolution Aerial Remote Sensing

Colin N. Brooks, Michigan Tech Research Institute (MTRI)
Dr. Tim Colling, P.E., Michigan Tech Center for Technology and Training (CTT)
Christopher Roussi, MTRI
Caesar Singh, P.E., US Department of Transportation Research & Innovative Technology Administration (RITA)
David Dean (MTRI)
Richard Dobson (MTRI)
Dr. Melanie Kueber Watkins (CTT)

www.mtri.org/unpaved
integratedglobaldimensions.com/unpaved/

Road Characteristics

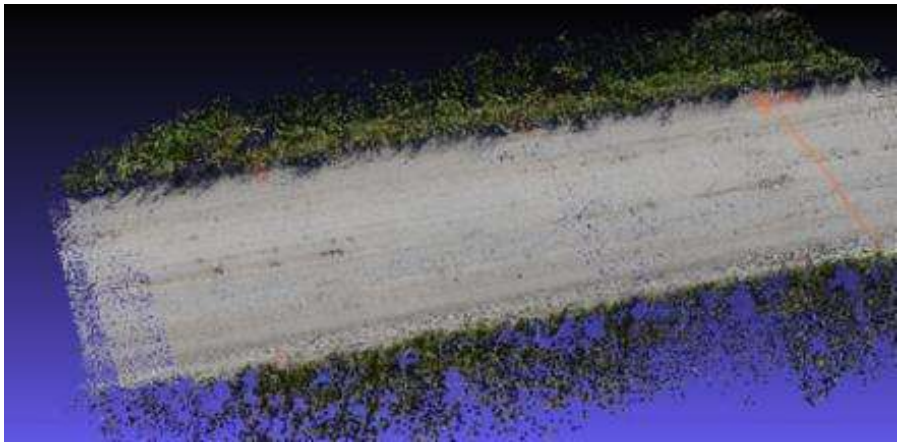
- Unpaved roads have common characteristics
  - Surface type
  - Surface width
    - Collected every 10', with a precision of +/- 4”
  - Cross Section (Loss of Crown)
    - Facilitates drainage, typically 2% - 4% (up to 6%) vertical change, sloping away from the centerline to the edge
    - Measure the profile every 10' along the road direction, able to detect a 1% change across a 9'-wide lane
  - Potholes
    - <1', 1'-2', 2'-3', >3‘ width bins
    - <2”, 2”-4”, >4” depth bins
  - Ruts
    - Detect features >5”, >10' in length, precision +/-2”
  - Corrugations (washboarding)
    - Classify by depth to a precision of +/-1”
      - <1”, 1”-3”, >3”
    - Report total area of the reporting segment affected
  - Roadside Drainage
    - System should be able to measure ditch bottom relative to road surface within +/-2”, if >6”
    - Detect the presence of water, elevation +/-2”, width +/-4”
  - Float aggregate (berms)



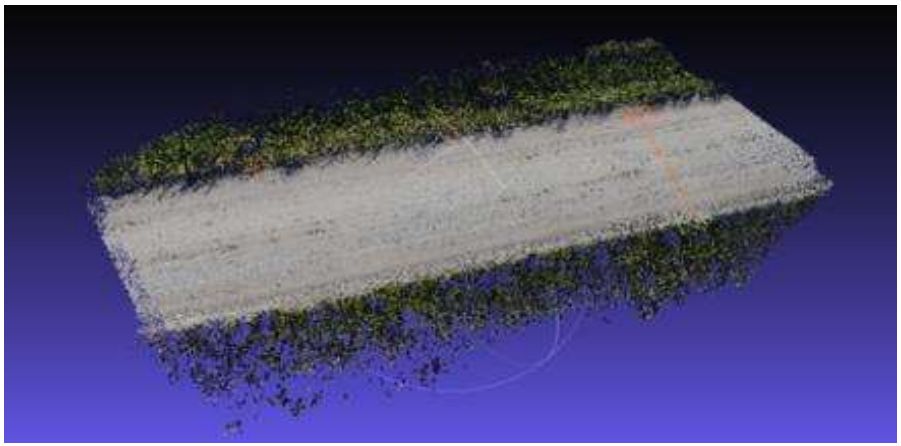
Helicopter Data – Garno Rd.
25m Altitude

Performance – Collected Imagery

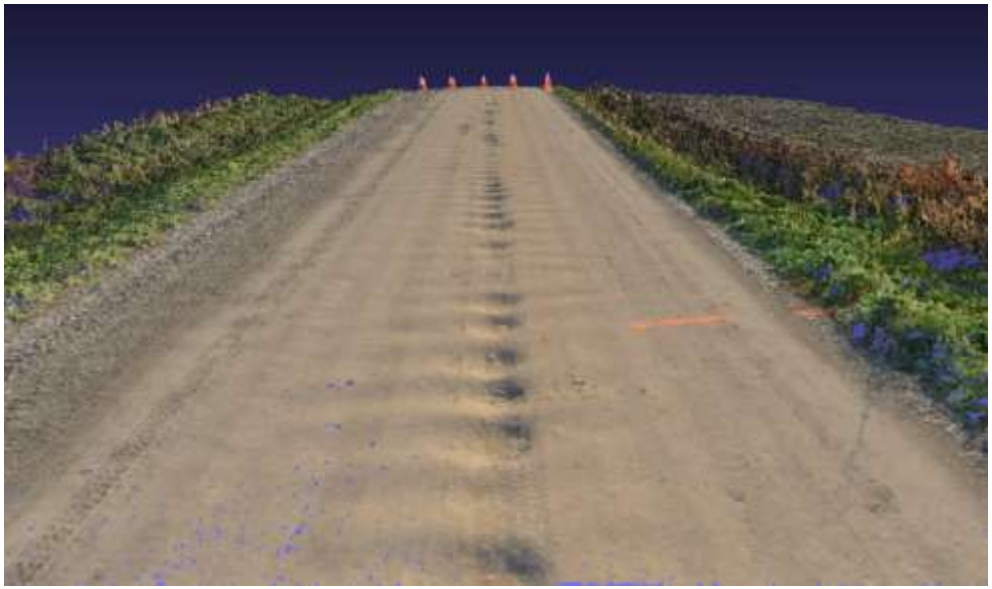
3D Reconstruction (Helicopter)



Initial point cloud



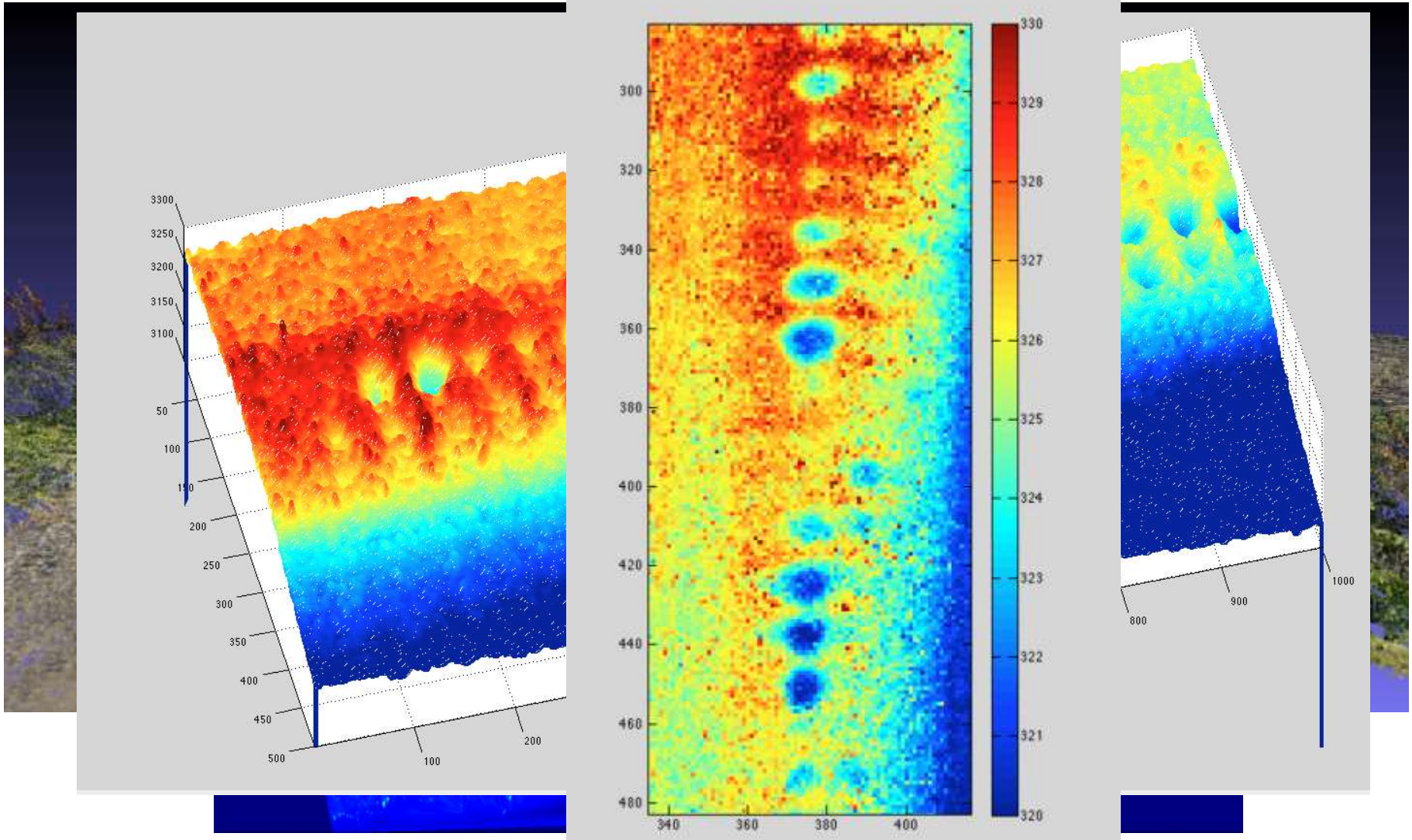
Densified point cloud



3D surface from point cloud

3D data examples

Important to categorizing distresses by severity
Obtaining 0.9 cm ground sample distance



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Using multi-temporal imagery to improve mapping and inventory of the Sturgeon and Black-Presque Isle Watersheds' forested roads

Colin Brooks, David Banach, Mark Fedora, Kim Mobley, Kaitlyn Smith

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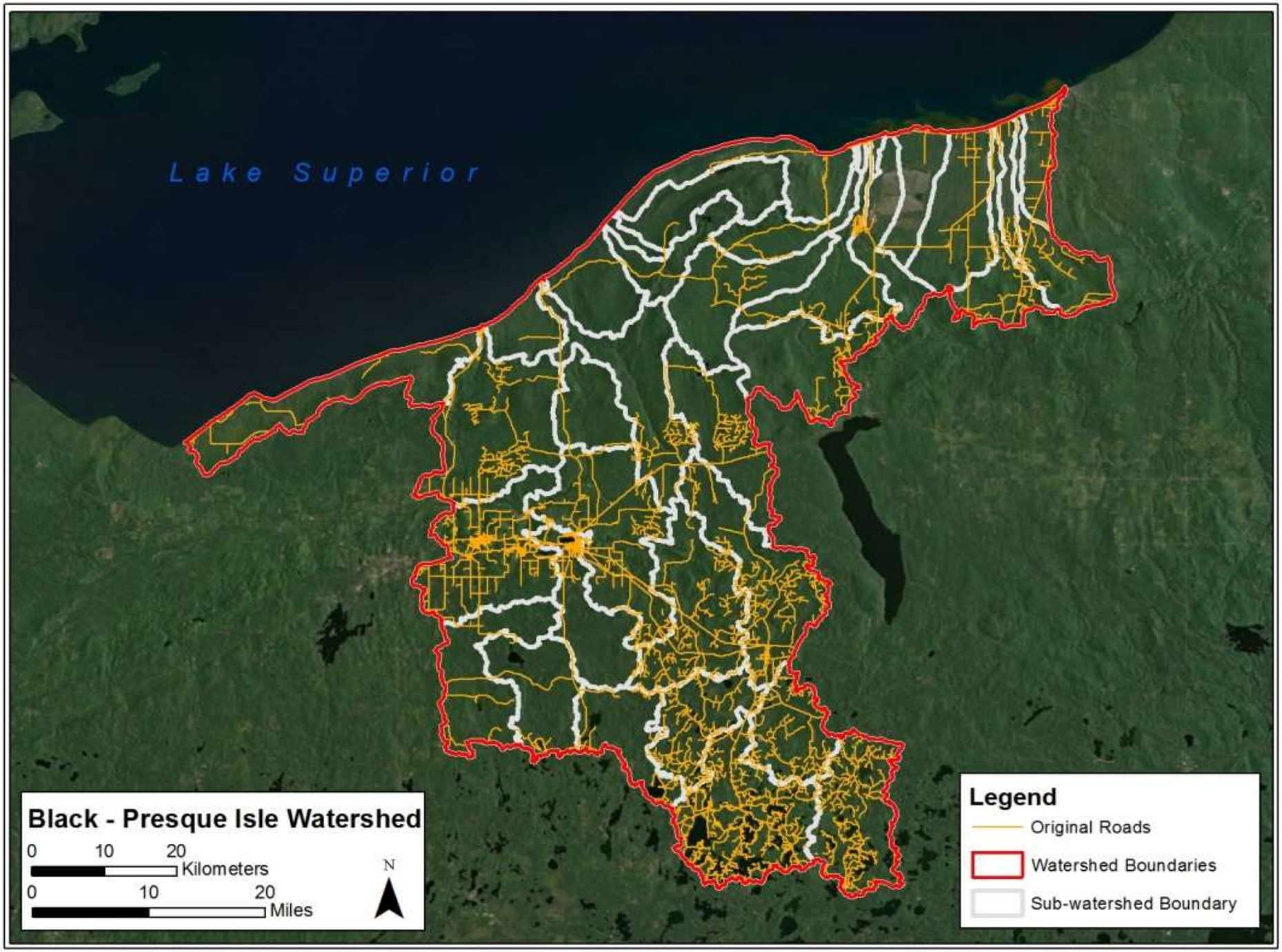
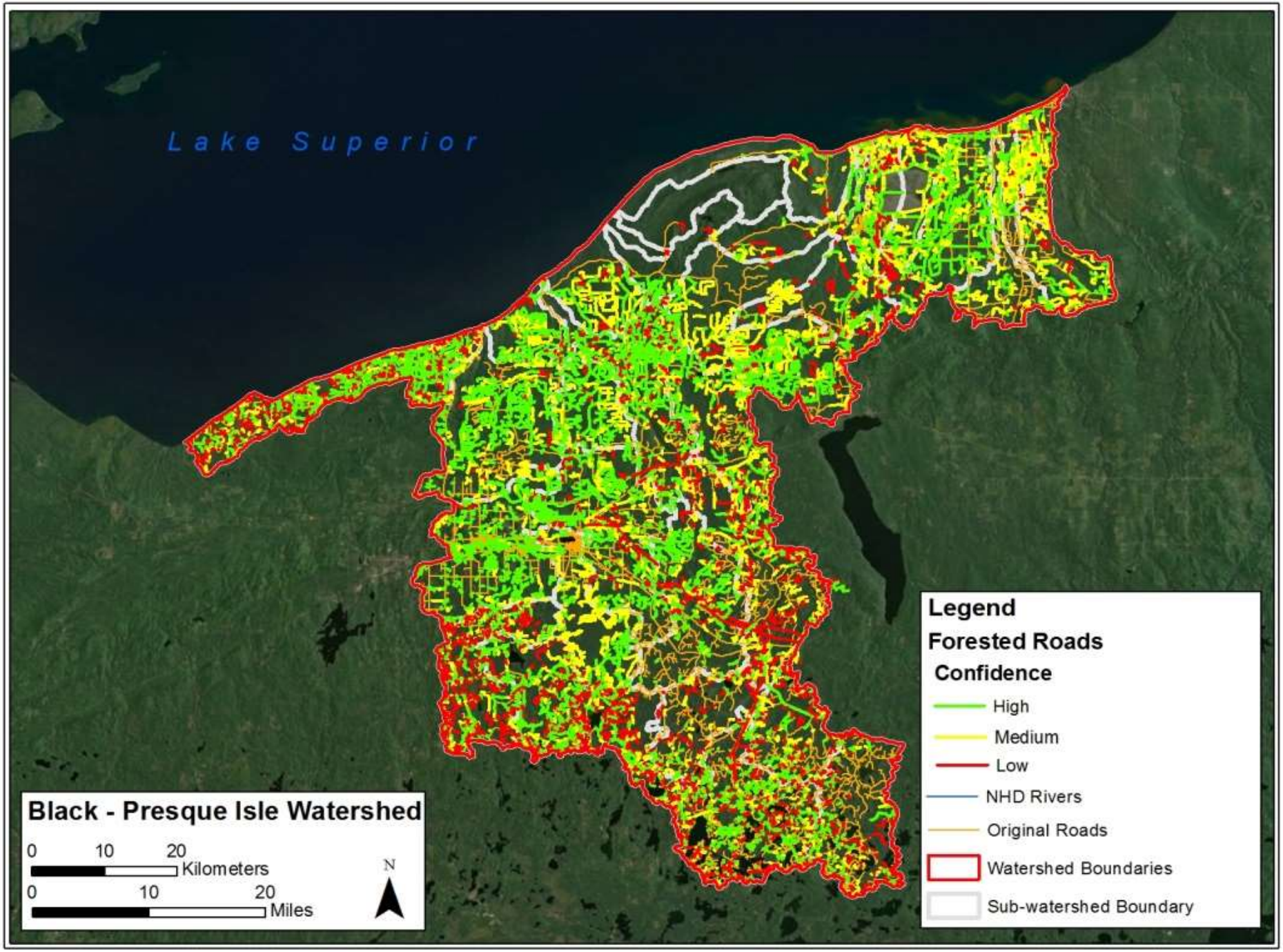
www.mtri.org

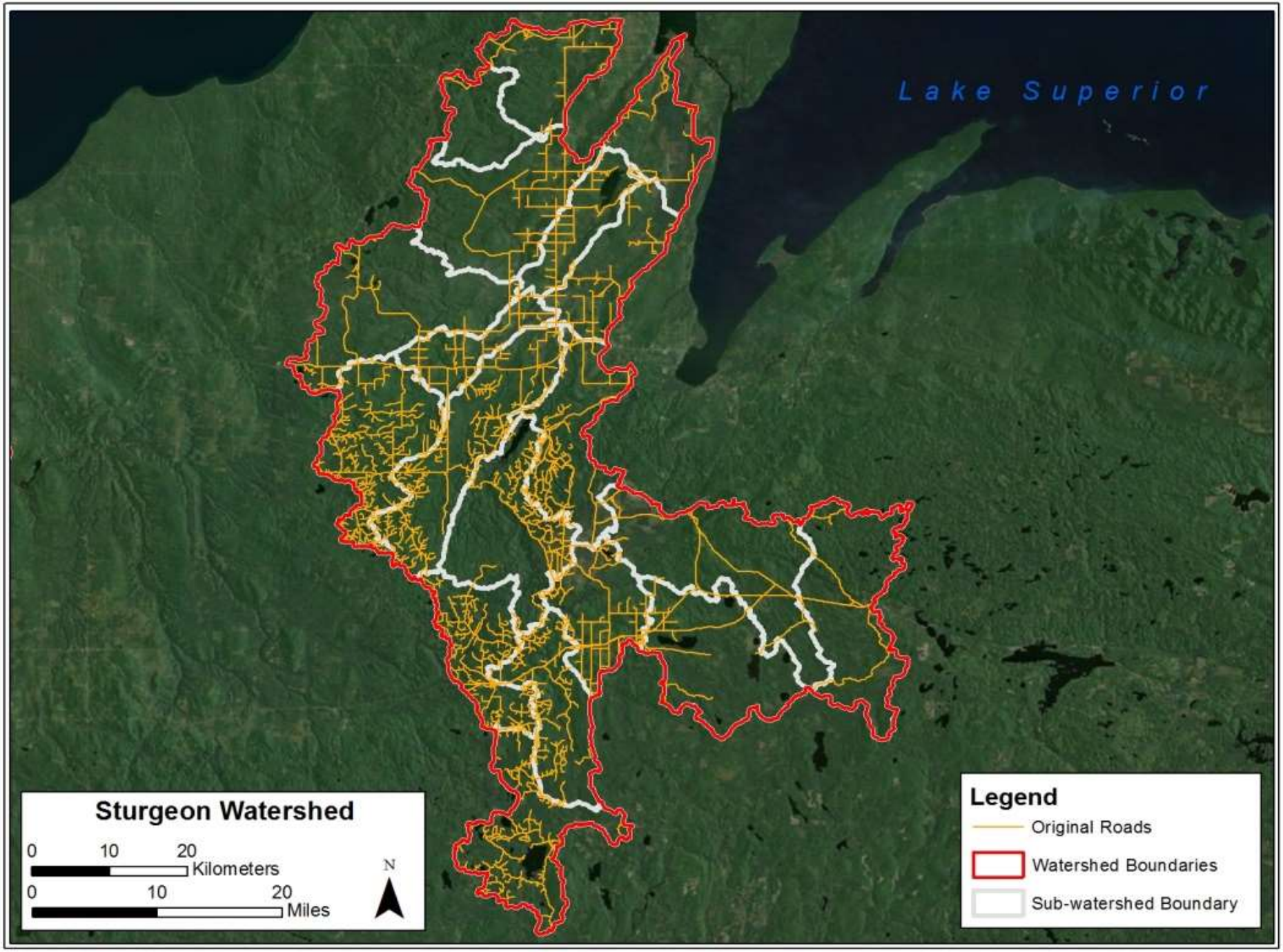

5/14/2011

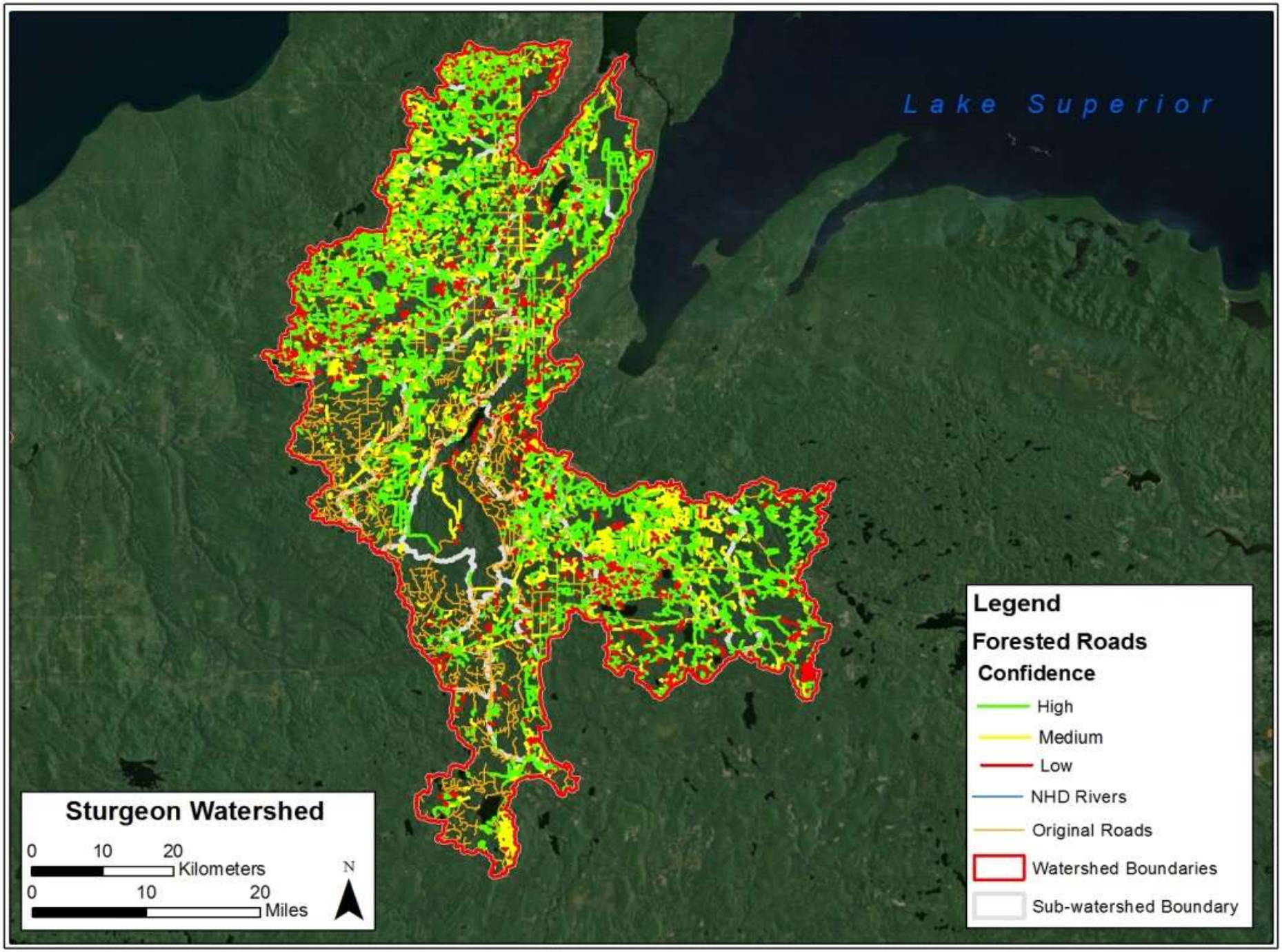
Building a GIS: Available Data

- Existing Roads Data:
  - Michigan Geographic Data Library (MiGDL) version 13a
  - USDA Forest Service 2014
  - TIGER 2010 Wisconsin Roads
- Imagery
  - National Agricultural Imagery Program (NAIP) 2009, 2010, 2012
  - Imagery available via Google Earth: USDA Farm Service Agency, NOAA
  - ESRI Basemap: 8/29/2011(Sturgeon) & 9/8/2011 (Black-Presque Isle)
- River Data:
  - National Hydrography Dataset (NHD)
    - 1:24,000 high resolution
- Watershed Boundaries
  - Sturgeon and Black-Presque Isle
  - Sub-watersheds: USDA Natural Resources Conservation Service
- Elements of Image Interpretation (Olson, 1960): **Location**, **Size**, **Shape**, Shadow, **Tone/Color**, Texture, Pattern, Height/Depth, **Site/Situation/Association**


Lake Superior
Black - Presque Isle Watershed
0 10 20
Kilometers
0 10 20
Miles
N
Legend
Original Roads
Watershed Boundaries
Sub-watershed Boundary


Lake Superior
Black - Presque Isle Watershed
0 10 20
Kilometers
0 10 20
Miles
N
Legend
Forested Roads
Confidence
High
Medium
Low
NHD Rivers
Original Roads
Watershed Boundaries
Sub-watershed Boundary


Lake Superior
Sturgeon Watershed
0 10 20
Kilometers
0 10 20
Miles
N
Legend
Original Roads
Watershed Boundaries
Sub-watershed Boundary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NHD Rivers
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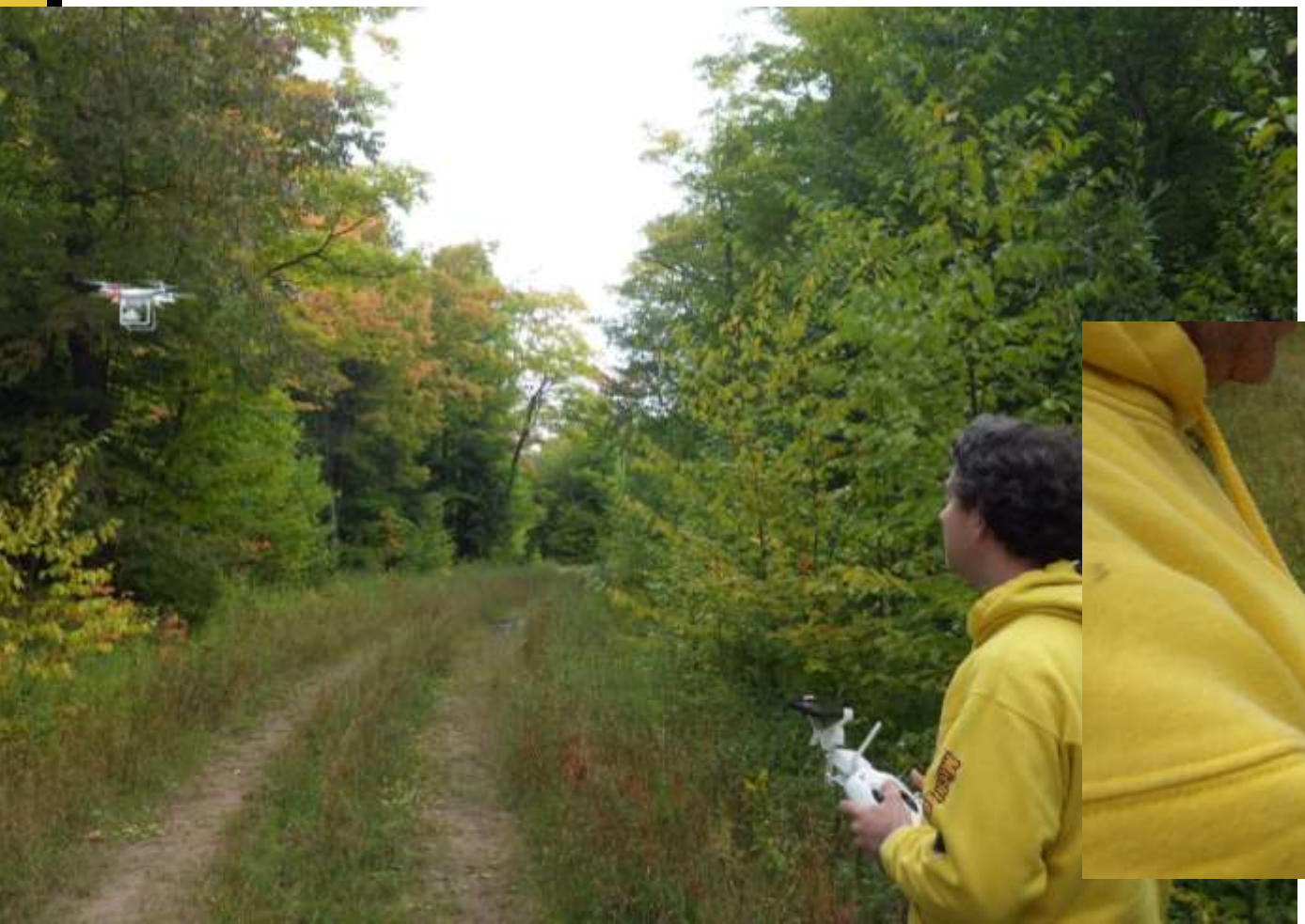
Watershed Boundaries
Sub-watershed Boundary

Fieldwork

- DJI Phantom 2 Vision - $899



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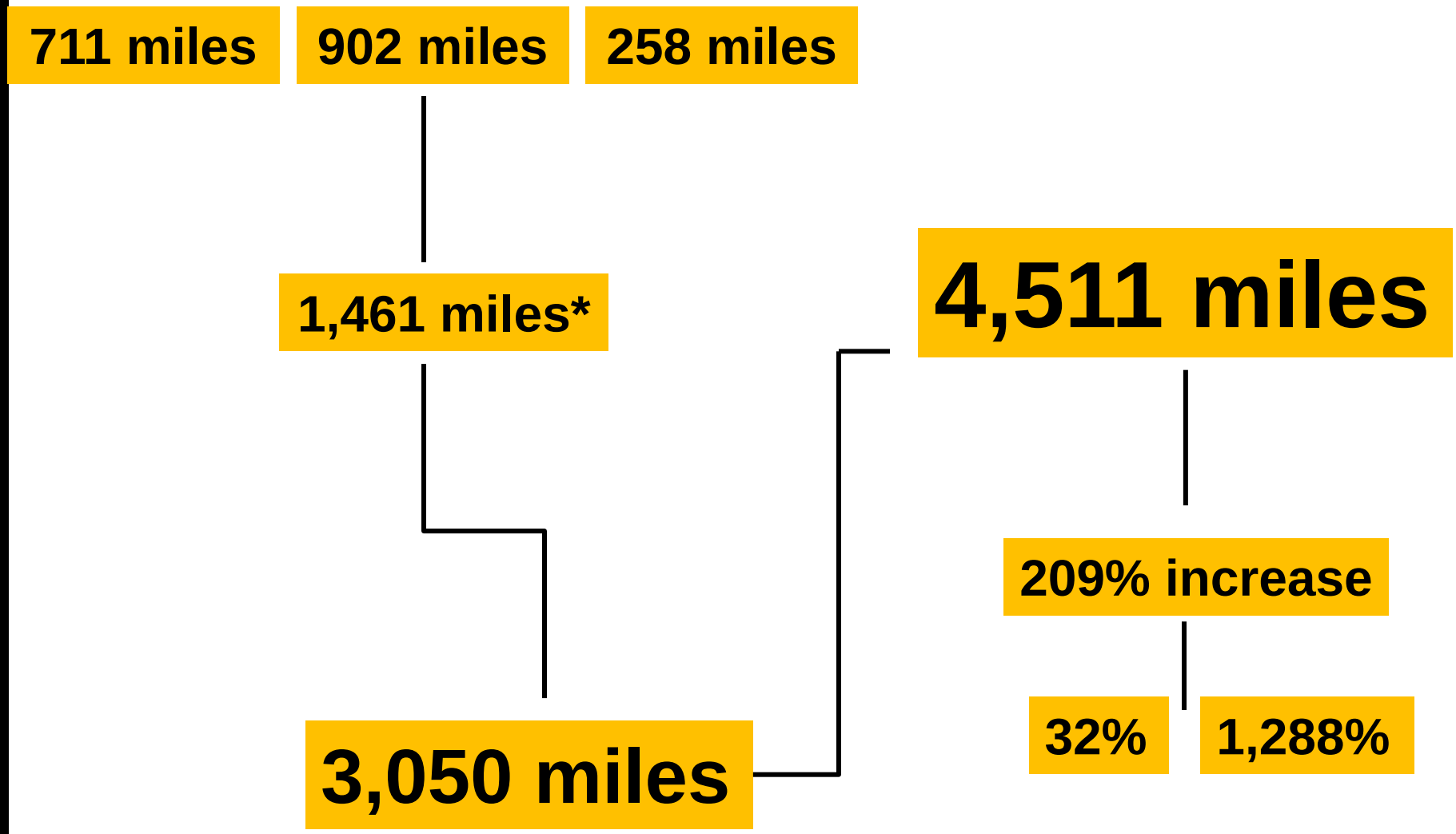
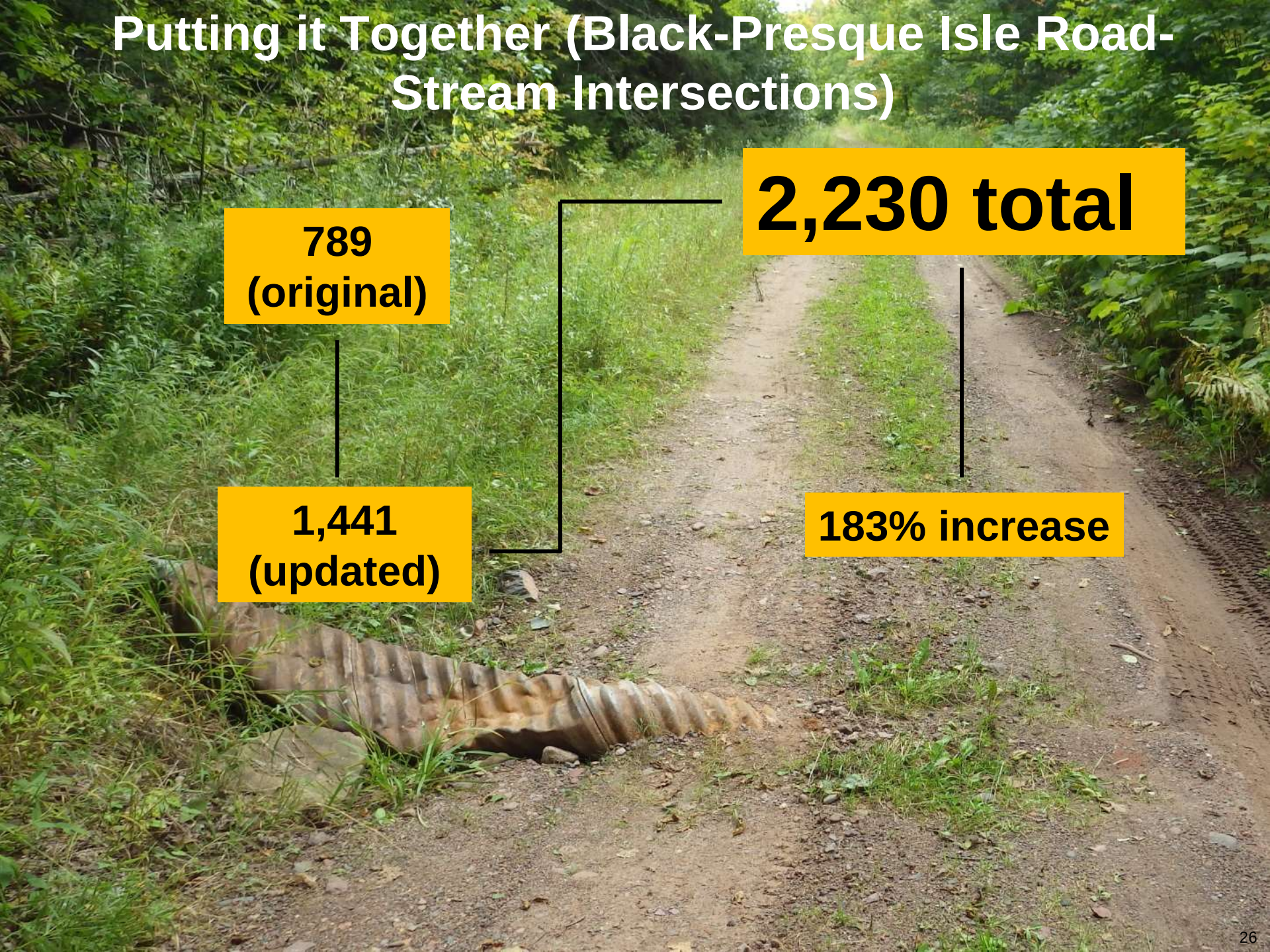
Fieldwork

Putting it Together (Black-Presque Isle Mileage)

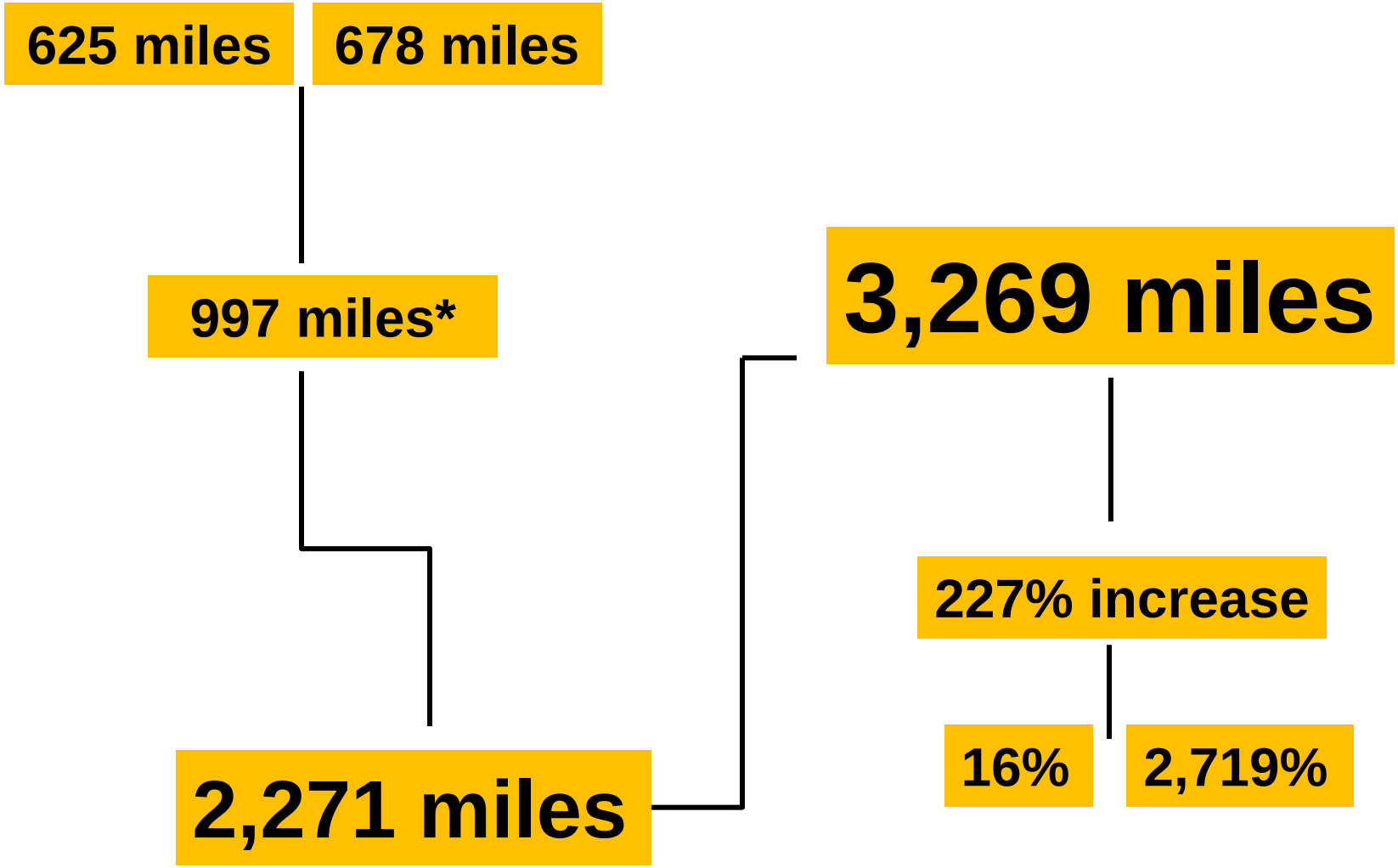


NOTE (*): Total Mileage is not the sum of State, FS , and Wisconsin mileages. This is due to the fact that both MiGDL and FS map similar streets, creating a false over reported mileage. Instead, it is the value created by integrating the three datasets together, integrating the layers based on a 20 meter distance, and dissolving the results.

Putting it Together (Black-Presque Isle Road-Stream Intersections)



Putting it Together (Sturgeon Mileage)



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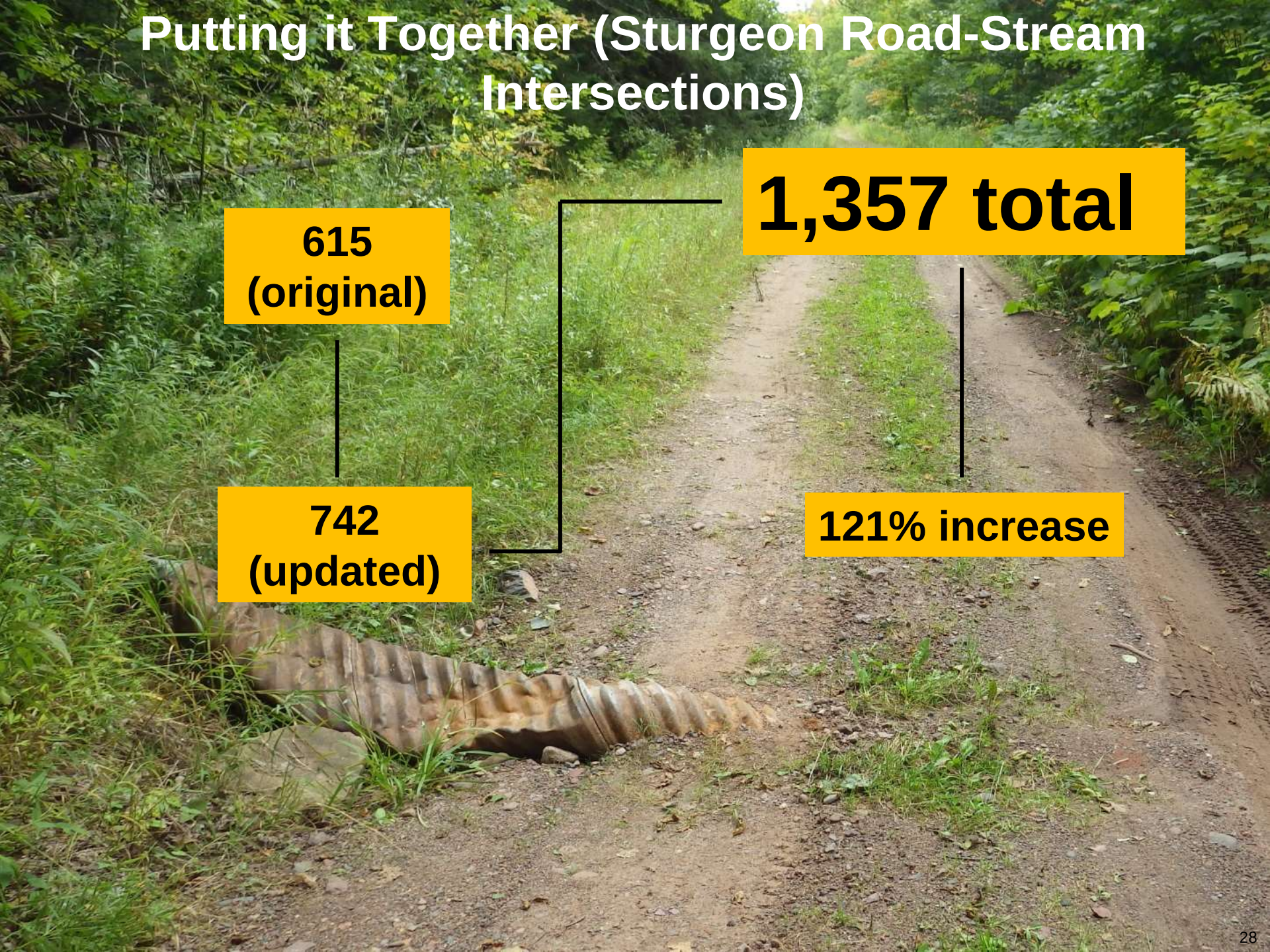
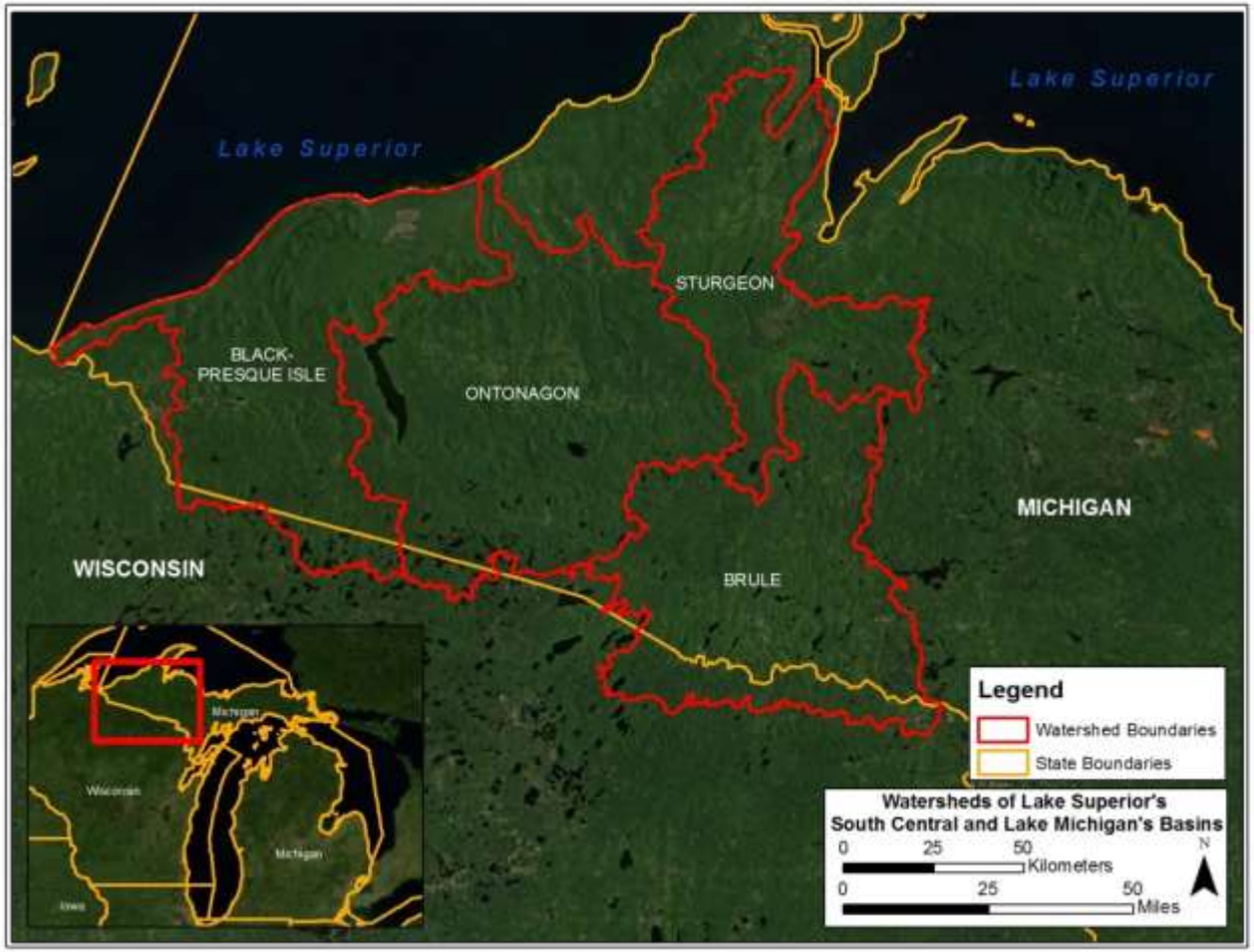
Putting it Together (Sturgeon Road-Stream Intersections)

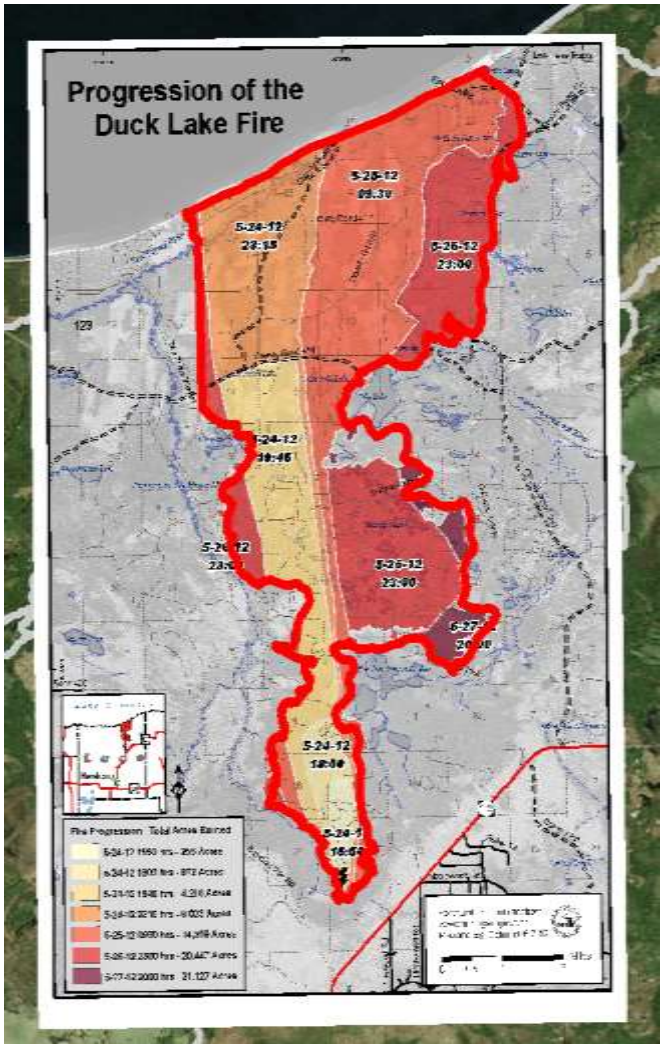


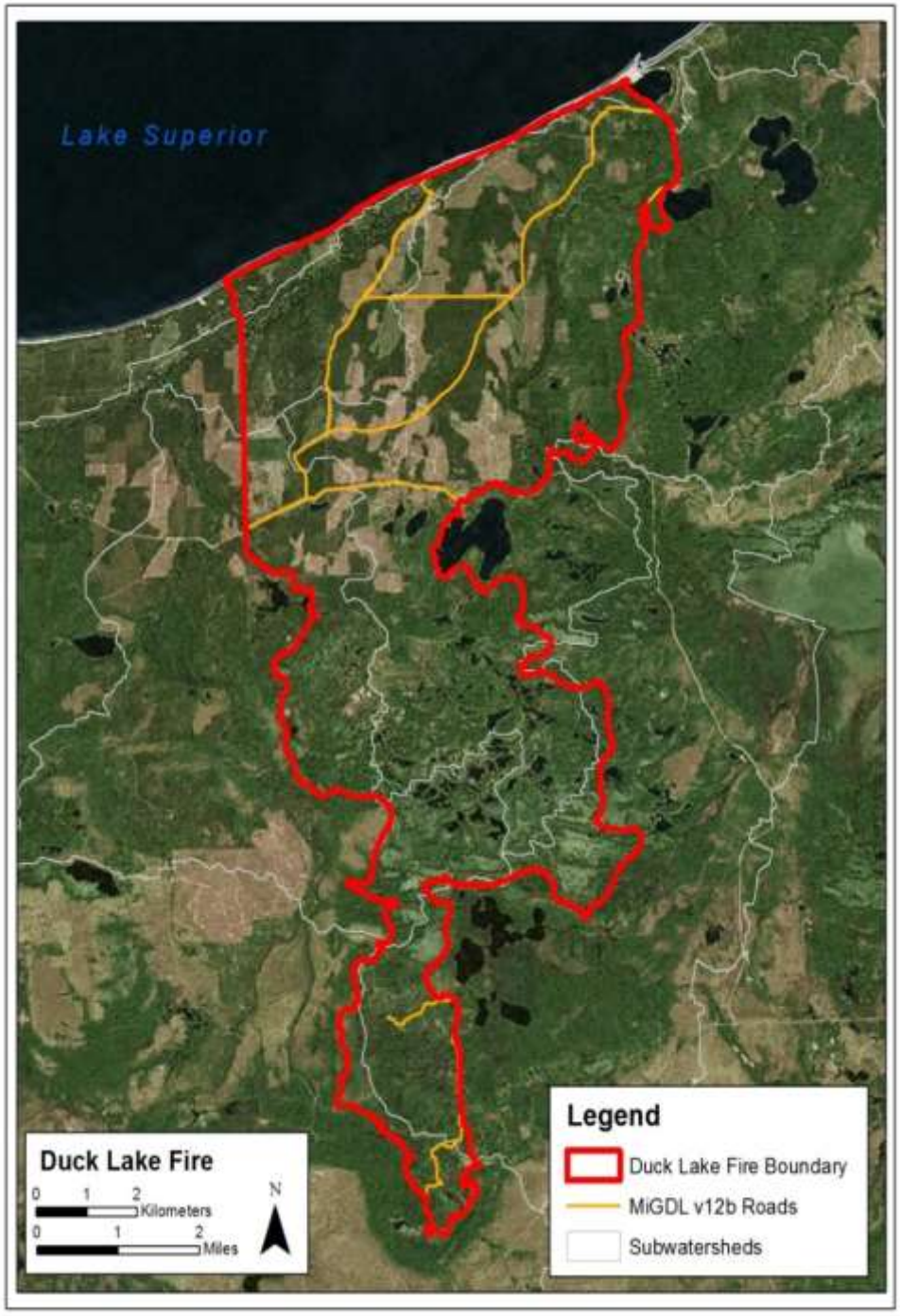
Project Continuation – Hydrologically impacted wetlands

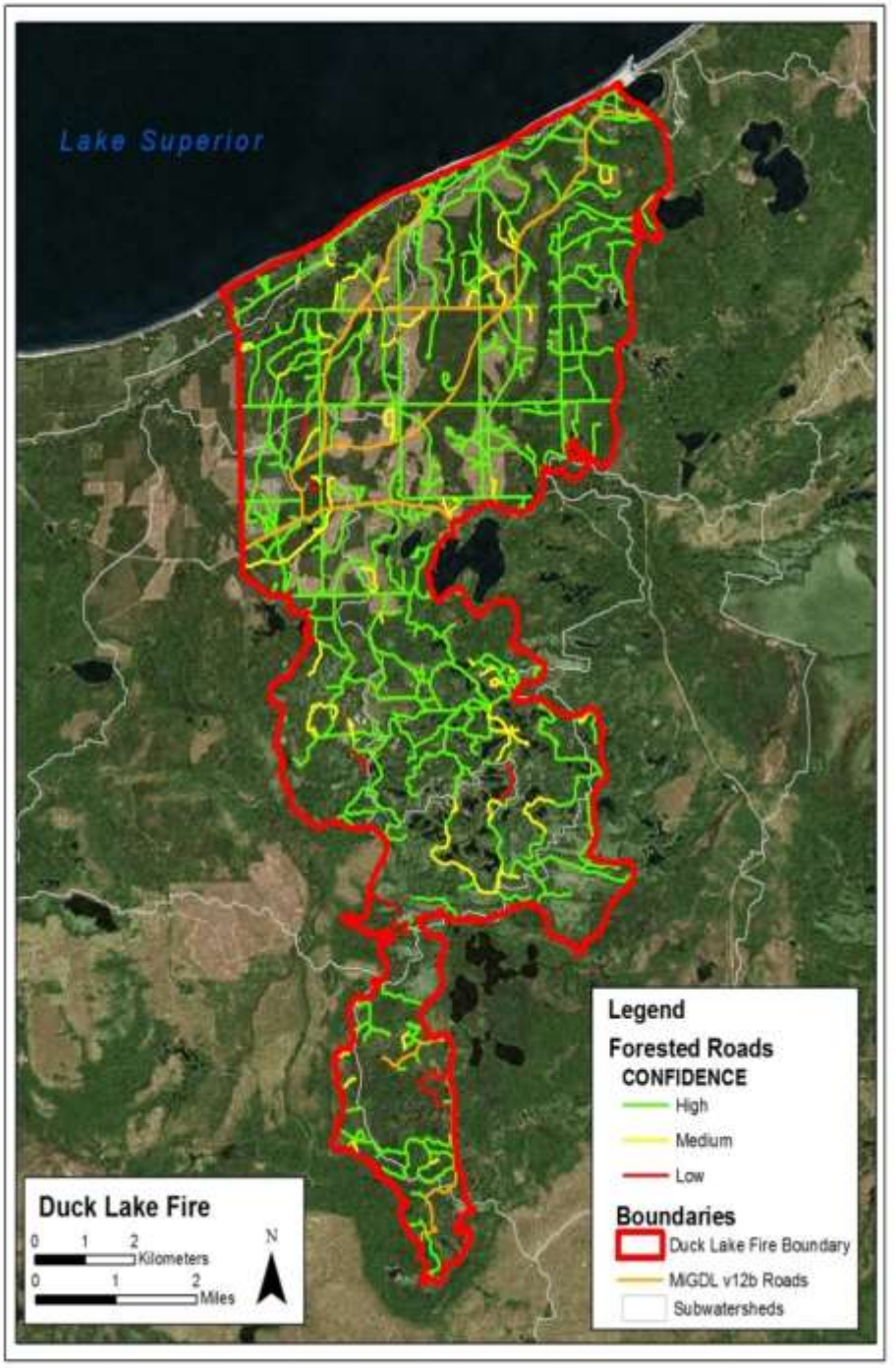


Applications to coursework

- “Using multi-temporal imagery to improve mapping and inventory of forested roads within the 2012 Duck Lake Fire burn scar – a road network analysis”
- Purpose: To develop an updated and improved road data layer for use in a wildfire / emergency transportation analysis




Lake Superior
Duck Lake Fire
0 1 2 Kilometers
0 1 2 Miles
N
Legend
Duck Lake Fire Boundary
MiGDL v12b Roads
Subwatersheds


Lake Superior
Duck Lake Fire
0 1 2 Kilometers
0 1 2 Miles
N
Legend
Forested Roads
CONFIDENCE
High
Medium
Low
Boundaries
Duck Lake Fire Boundary
MiGDL v12b Roads
Subwatersheds

Putting it Together (Duck Lake Mileage)

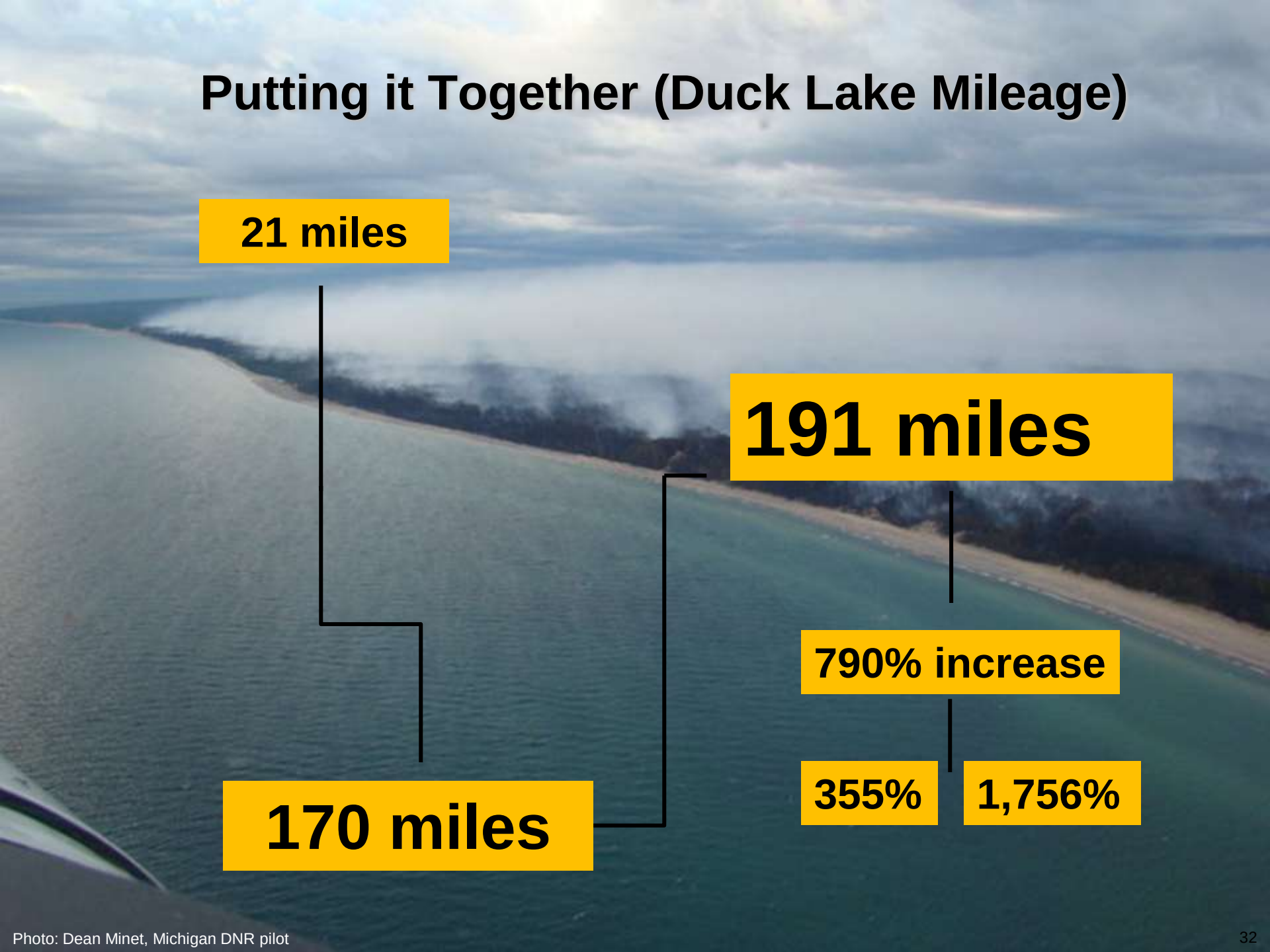
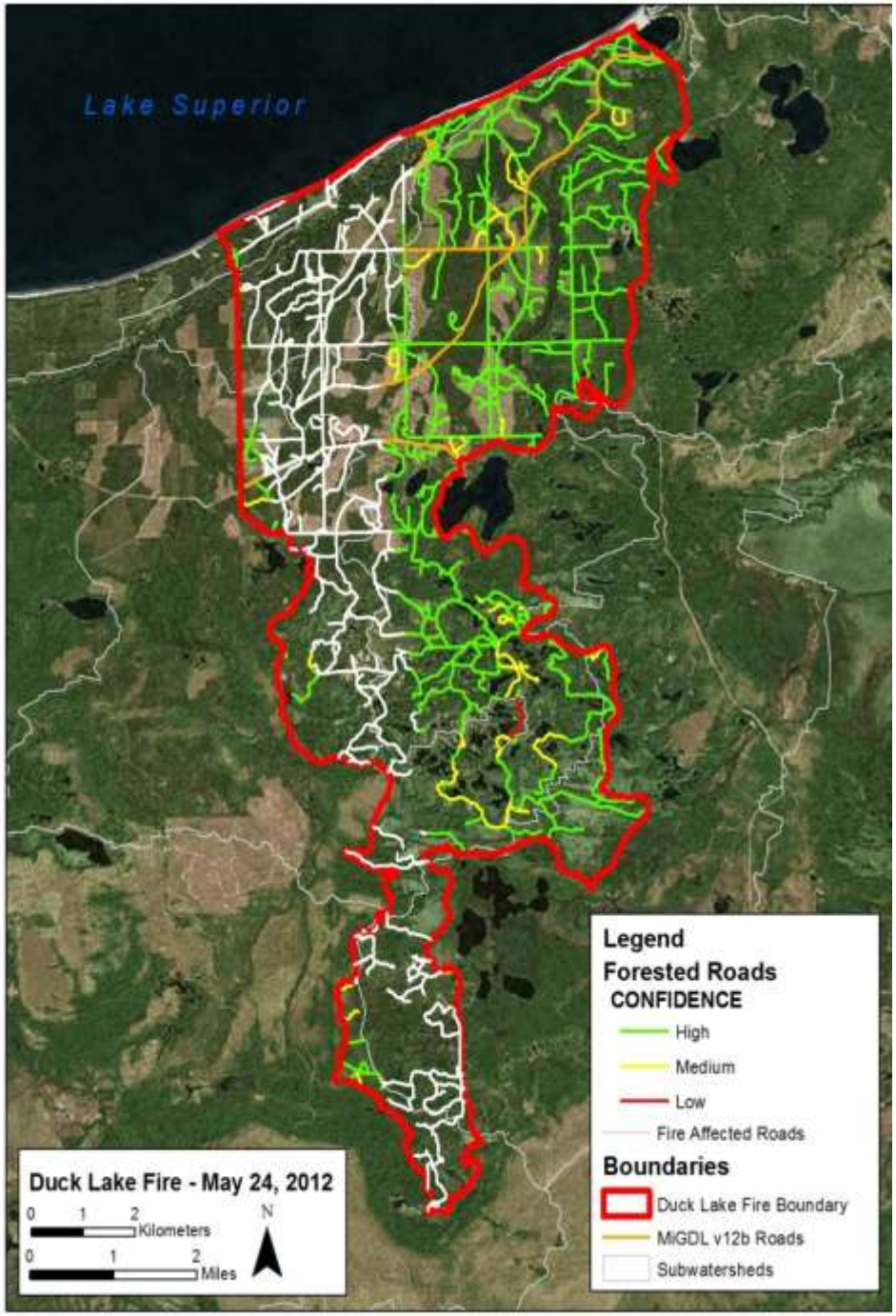
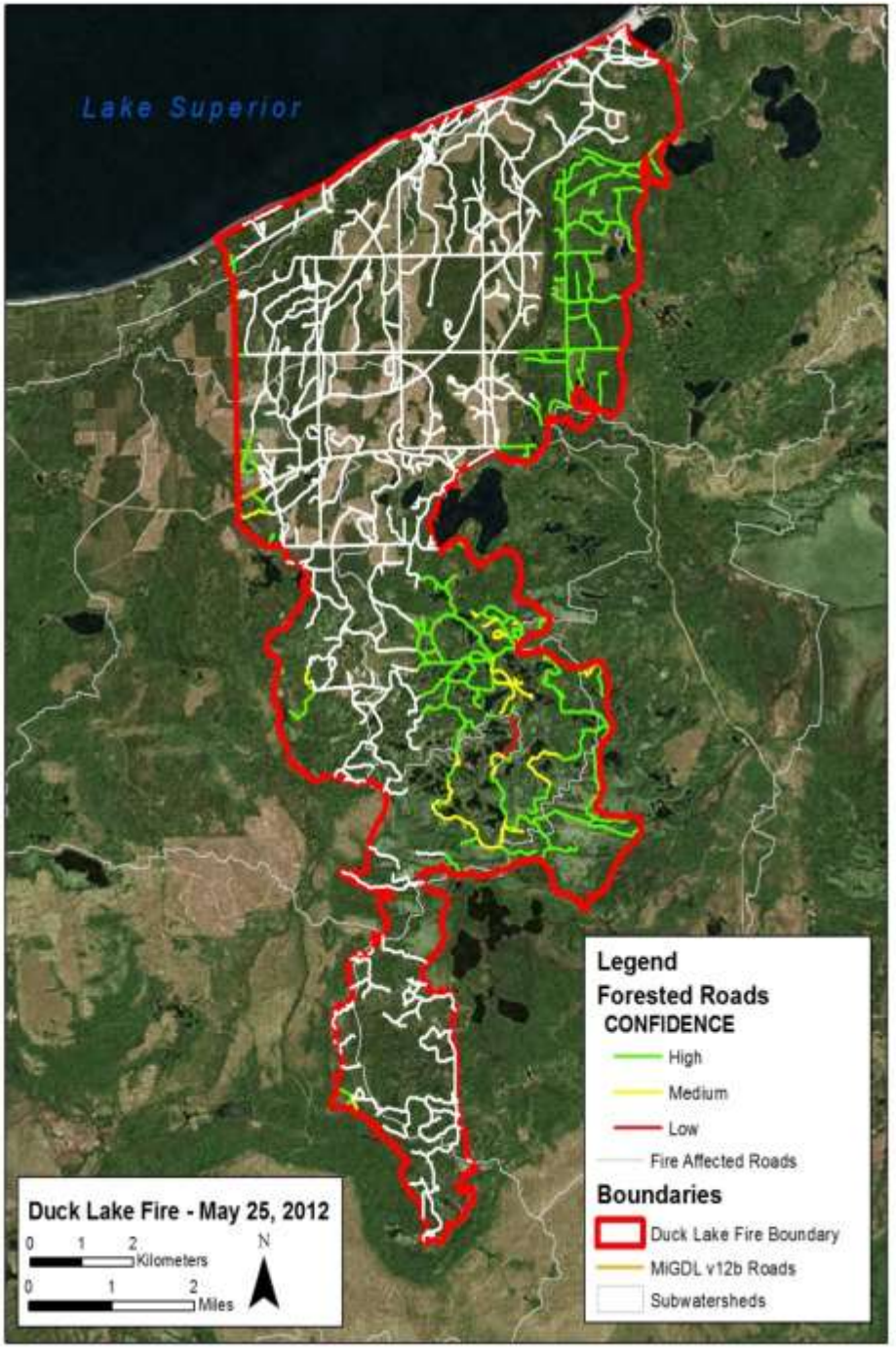
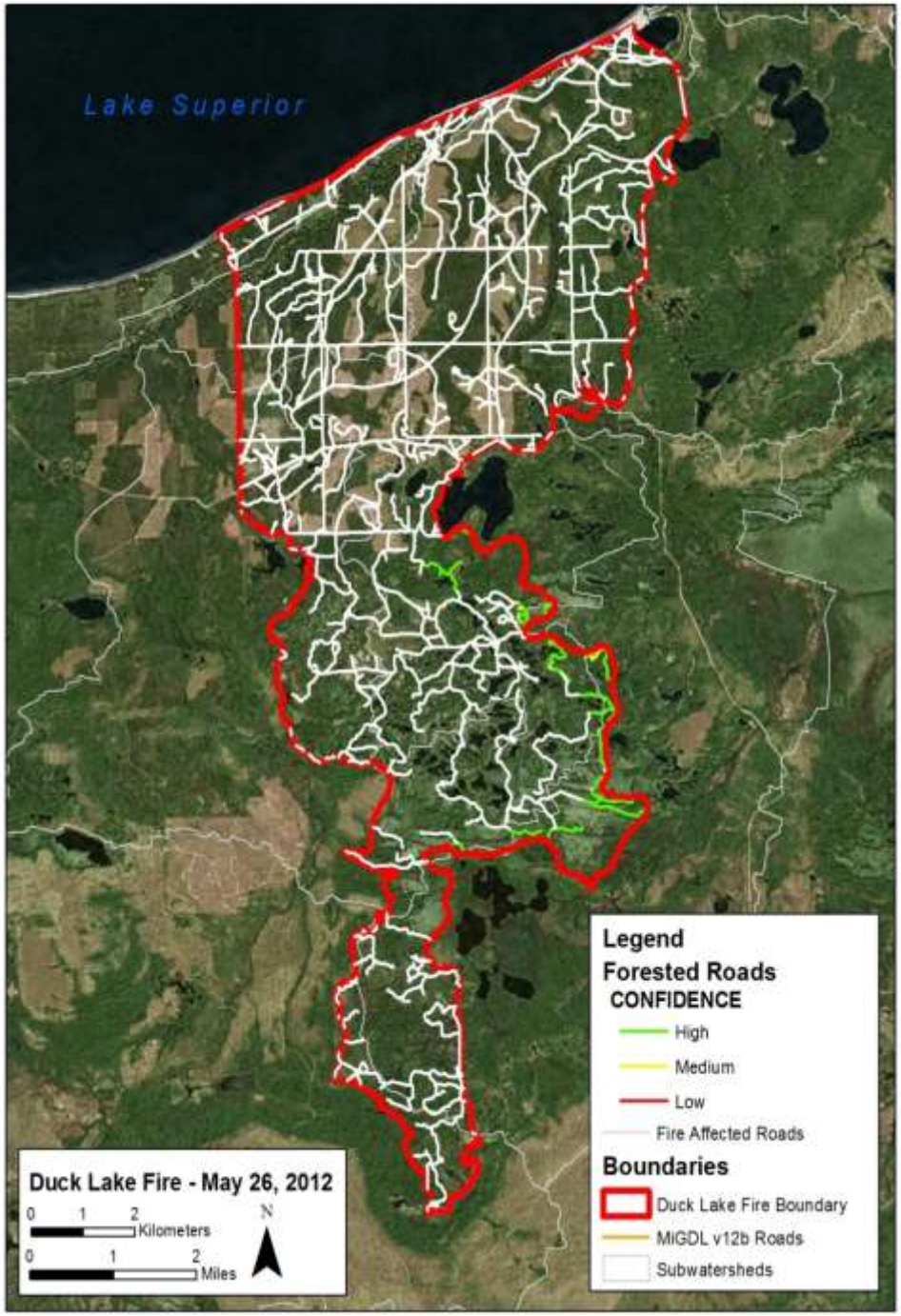


Photo: Dean Minet, Michigan DNR pilot


Lake Superior
Legend
Forested Roads
CONFIDENCE
High
Medium
Low
Fire Affected Roads
Boundaries
Duck Lake Fire Boundary
MiGDL v12b Roads
Subwatersheds
Duck Lake Fire - May 24, 2012
0 1 2 Kilometers
0 1 2 Miles
N


Lake Superior
Legend
Forested Roads
CONFIDENCE
High
Medium
Low
Fire Affected Roads
Boundaries
Duck Lake Fire Boundary
MiGDL v12b Roads
Subwatersheds
Duck Lake Fire - May 25, 2012
0 1 2 Kilometers
0 1 2 Miles
N


Lake Superior
Legend
Forested Roads
CONFIDENCE
High
Medium
Low
Fire Affected Roads
Boundaries
Duck Lake Fire Boundary
MiGDL v12b Roads
Subwatersheds
Duck Lake Fire - May 26, 2012
0 1 2 Kilometers
0 1 2 Miles
N

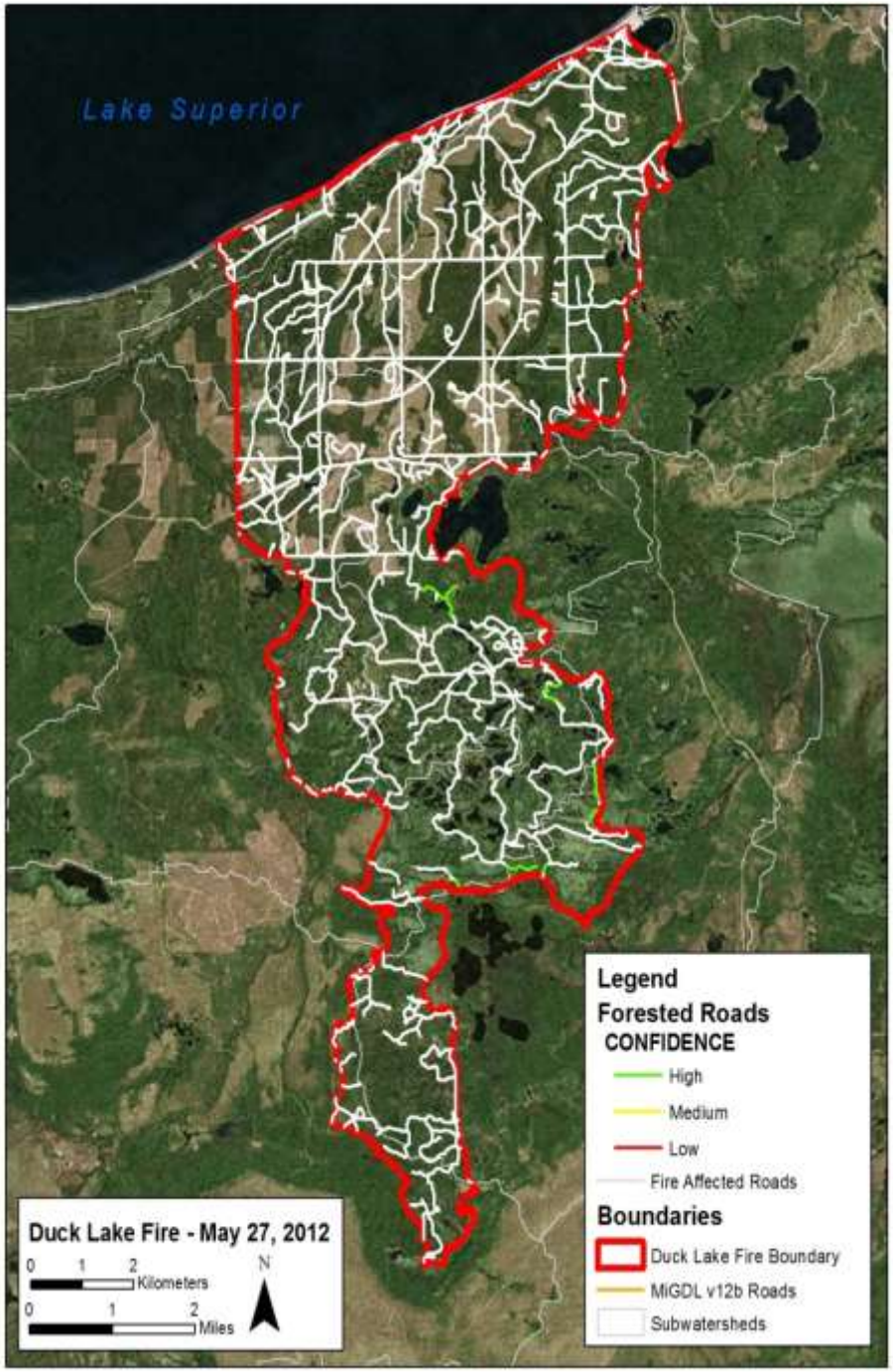

Lake Superior
Legend
Forested Roads
CONFIDENCE
High
Medium
Low
Fire Affected Roads
Boundaries
Duck Lake Fire Boundary
MiGDL v12b Roads
Subwatersheds
Duck Lake Fire - May 27, 2012
0 1 2 Kilometers
0 1 2 Miles
N


Photo: Michigan DNR

Day of Burn	MiGDL Mileage	Updated Roads Mileage	Miles Burned
May 24, 2012	9.7	62.3	72.0
May 25, 2012	9.0	54.0	63.0
May 26, 2012	2.7	43.8	46.5
May 27, 2012	0.0	6.1	6.1
TOTAL	21.4	166.2	187.6

Conclusions

- Spatial and quantitative results indicate that an updated road network should be incorporated into both State Framework and government agency road datasets.
- By including an updated and improved road dataset into future studies such as watershed health impairment, species diversity, land-use and land-change, or native fire regimes where accuracy is crucial, more in-depth analyses and results could potentially be produced.
- With such a high increase in total mileage and more importantly knowing where previously unmapped roads exist, emergency response personnel could potentially reroute vehicles if wildfire growth requires it.
- It is also important to note that all newly digitized roads may not be accessible. The only way to determine which roads are actually accessible is to visit these sites during fieldwork.
- *Accurate road data will be pivotal to a variety of future studies!*

QUESTIONS?

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734-751-7987 (c)