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A Screening Method for Identifying Fish Passage Barriers at Road Crossings Using LiDAR-Derived Elevation Data

M. Diebel
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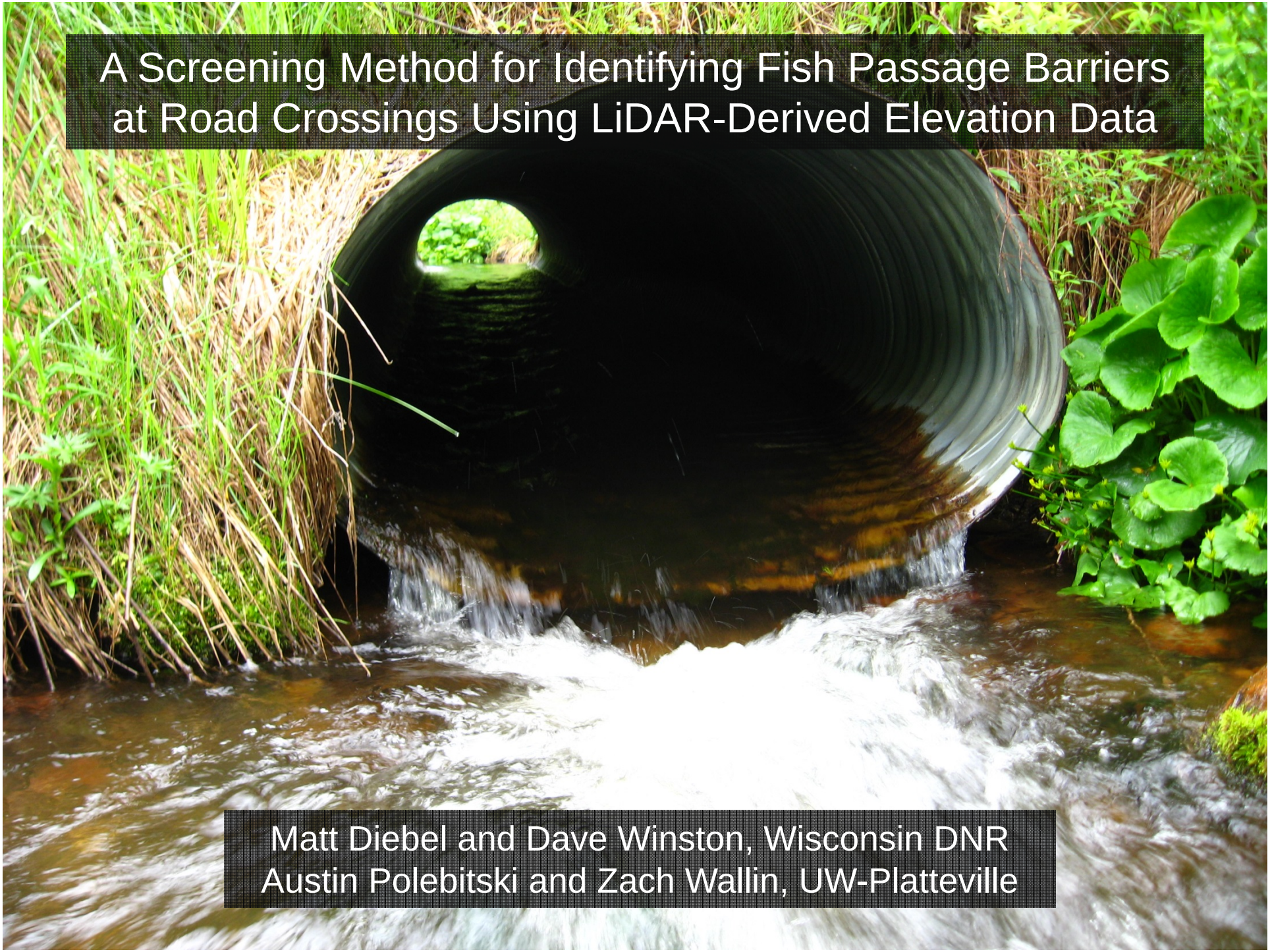
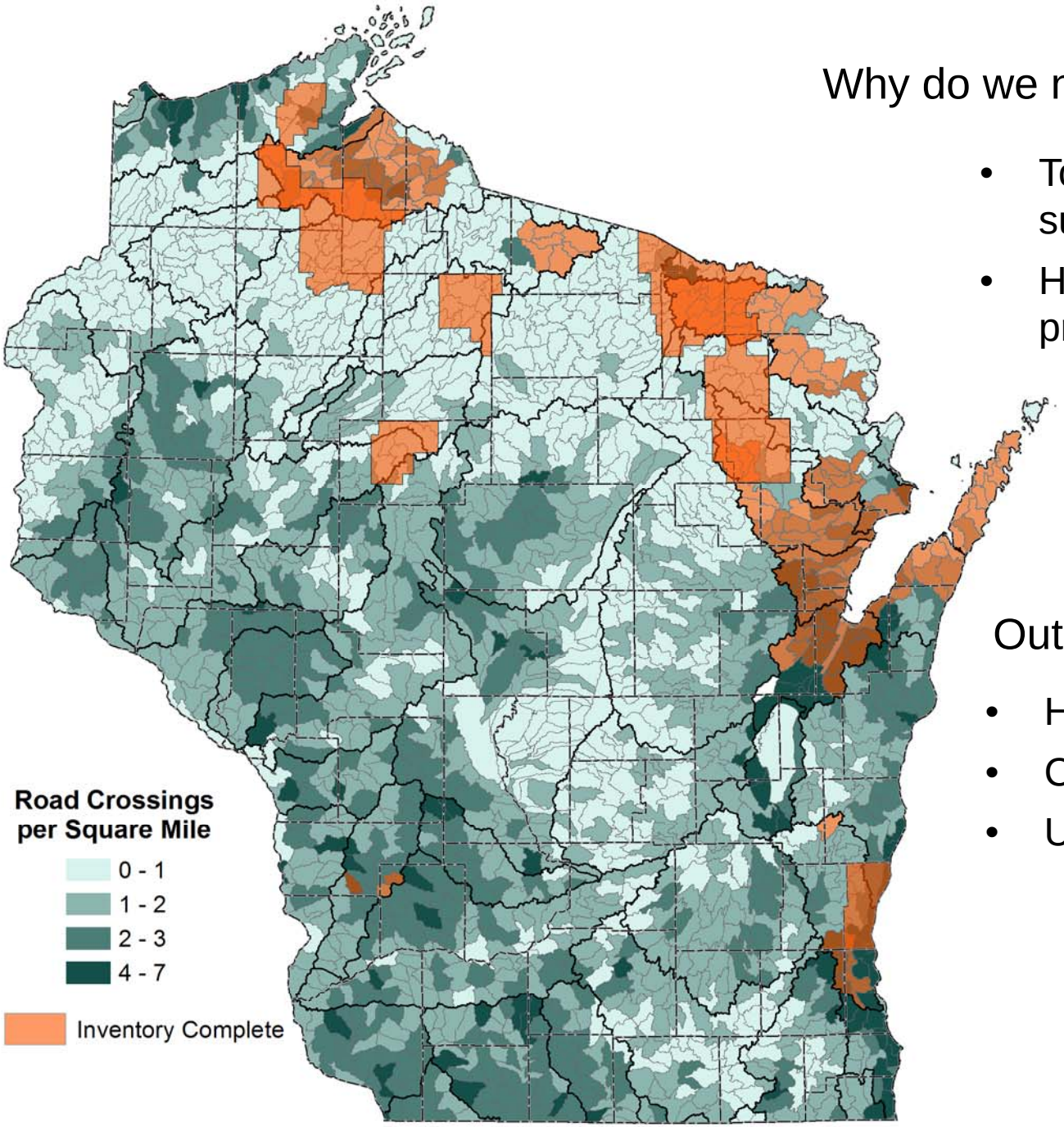
A Screening Method for Identifying Fish Passage Barriers at Road Crossings Using LiDAR-Derived Elevation Data



Matt Diebel and Dave Winston, Wisconsin DNR
Austin Polebitski and Zach Wallin, UW-Platteville



Why do we need a screening tool?

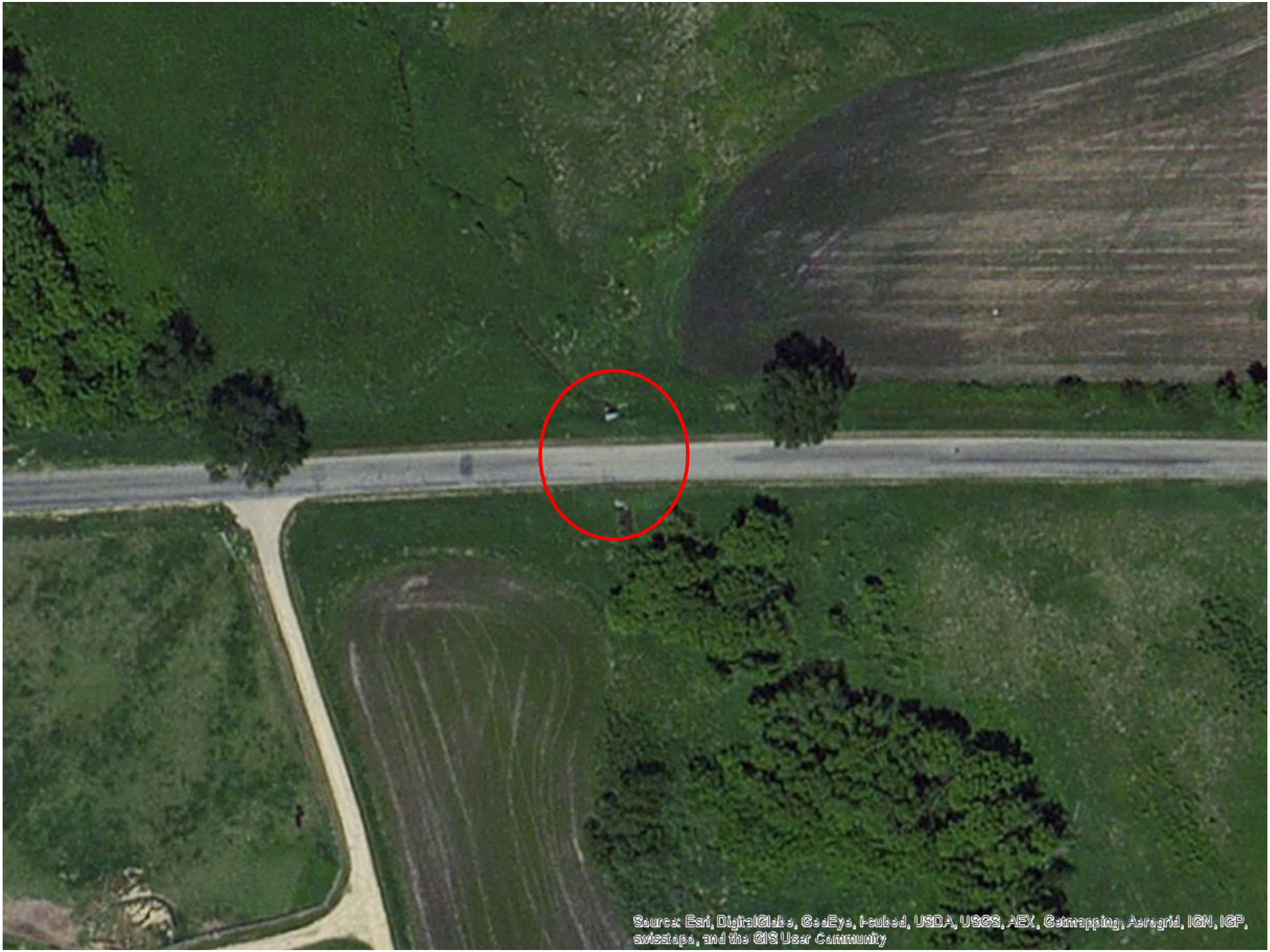
- Too many crossings to survey in field
- Help local governments prioritize projects

Outline

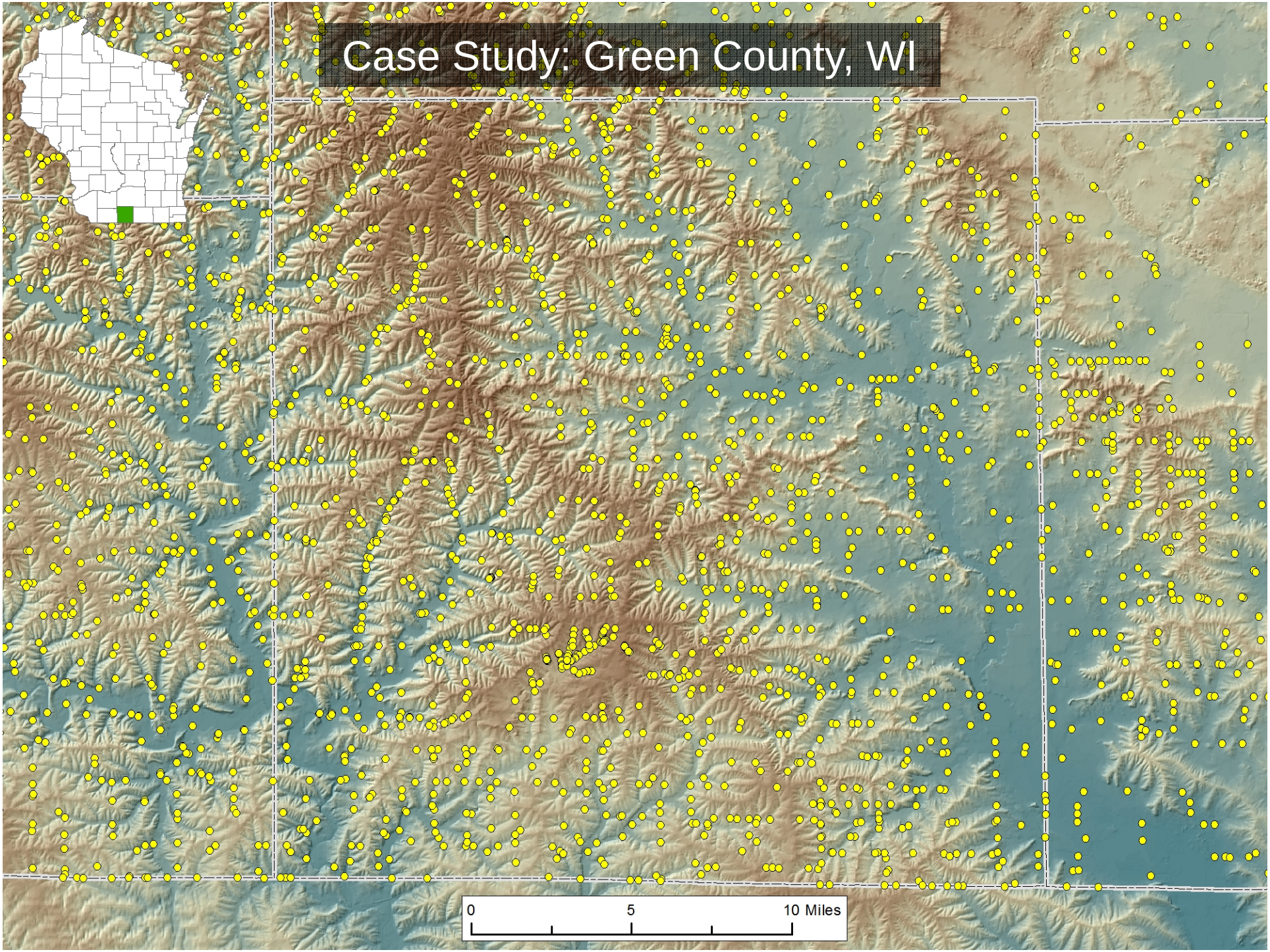
- How the method works
- Case study
- Uses and feasibility

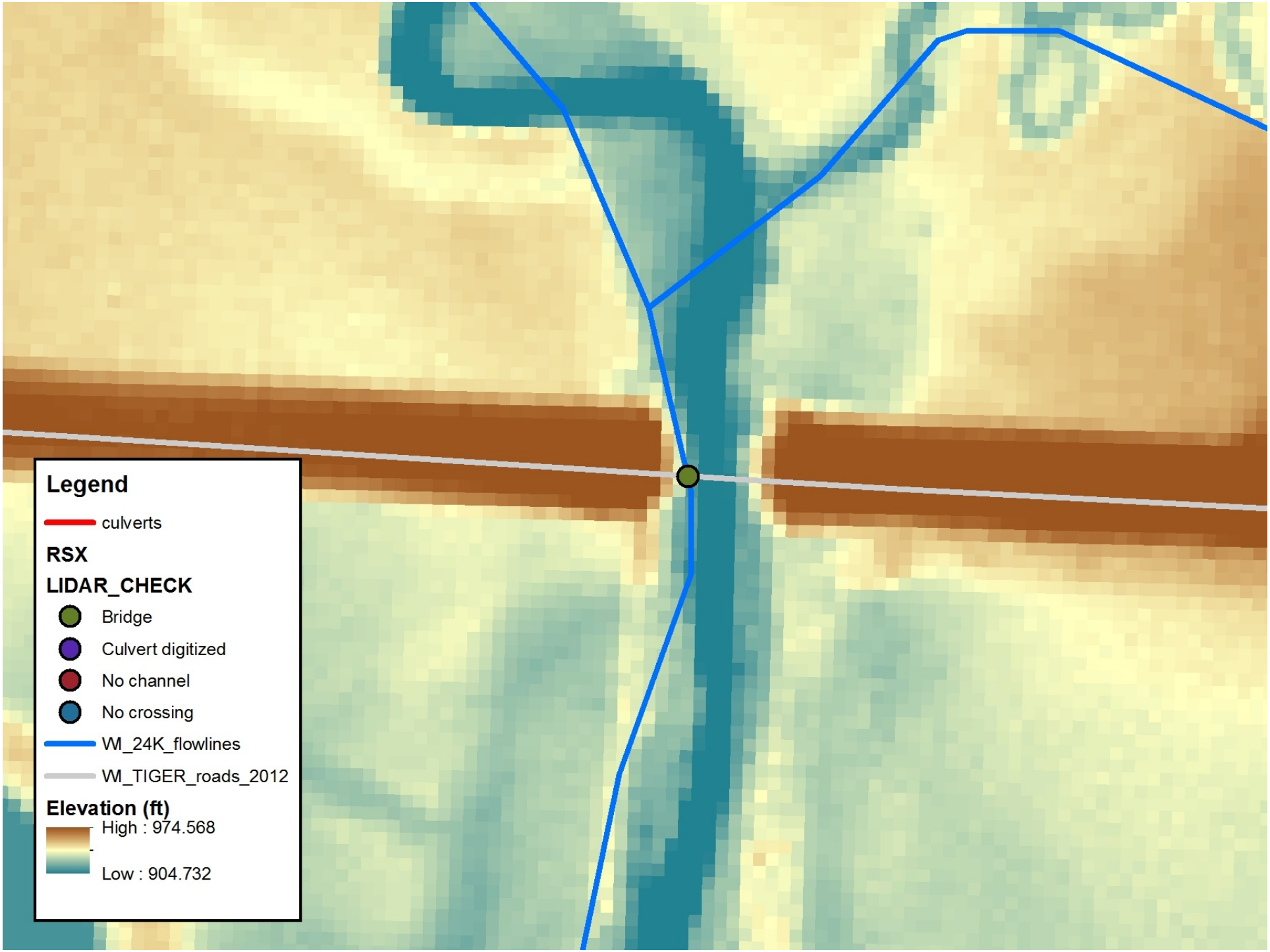
LiDAR Basics

- Light Detection And Ranging
- Raw “point cloud” converted to bare-earth digital elevation model (DEM)
- Returns from water are usually surface
- Common horizontal resolution is 5 ft
- Common vertical accuracy is 10 cm

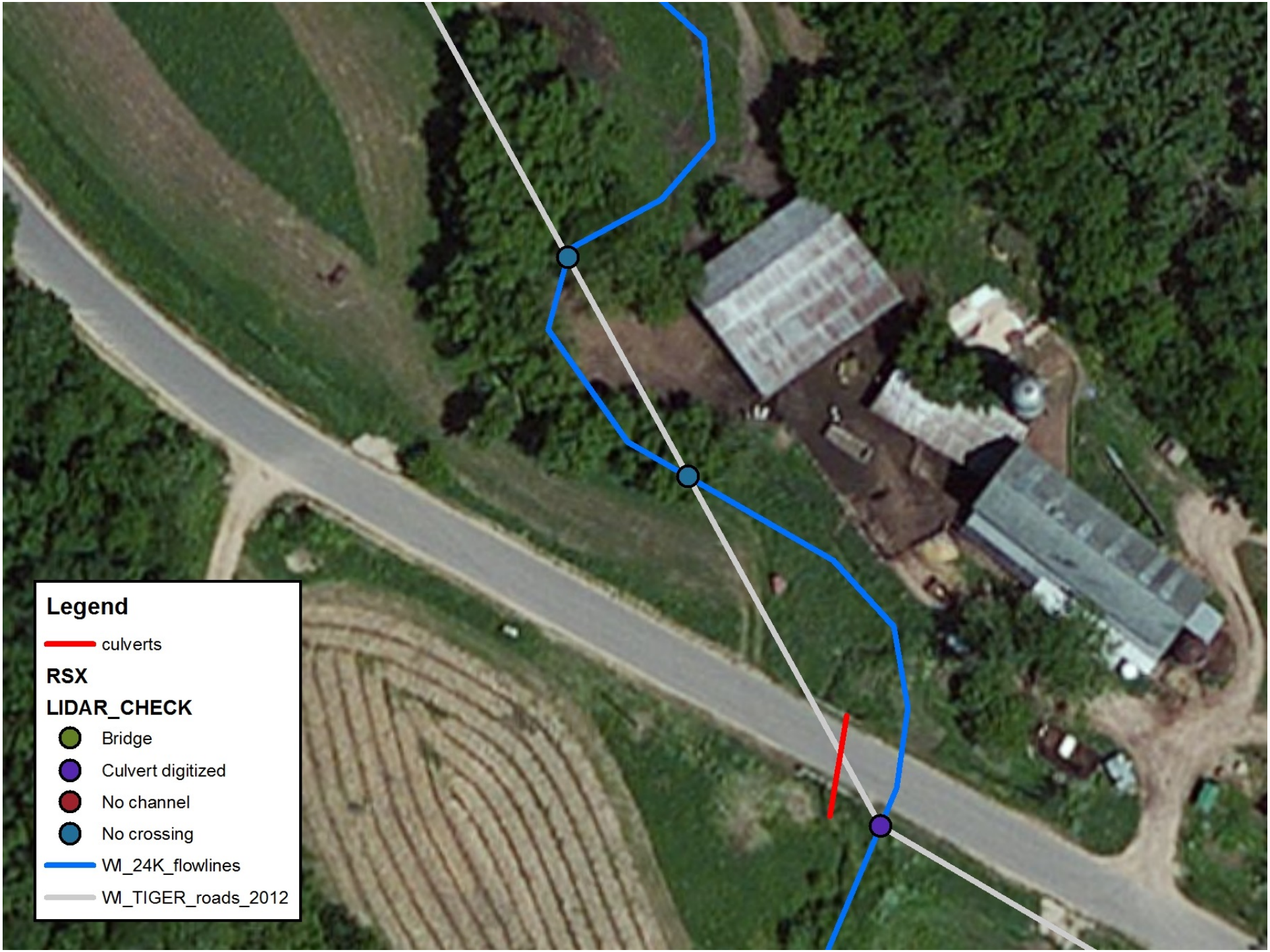

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Stream
Flow


Case Study: Green County, WI
0
5
10 Miles


Legend
culverts
RSX
LIDAR_CHECK
Bridge
Culvert digitized
No channel
No crossing
WI_24K_flowlines
WI_TIGER_roads_2012
Elevation (ft)
High : 974.568
Low : 904.732

Legend
culverts
RSX
LIDAR_CHECK
Bridge
Culvert digitized
No channel
No crossing
WI_24K_flowlines
WI_TIGER_roads_2012


Legend
culverts
RSX
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Bridge
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WI_24K_flowlines
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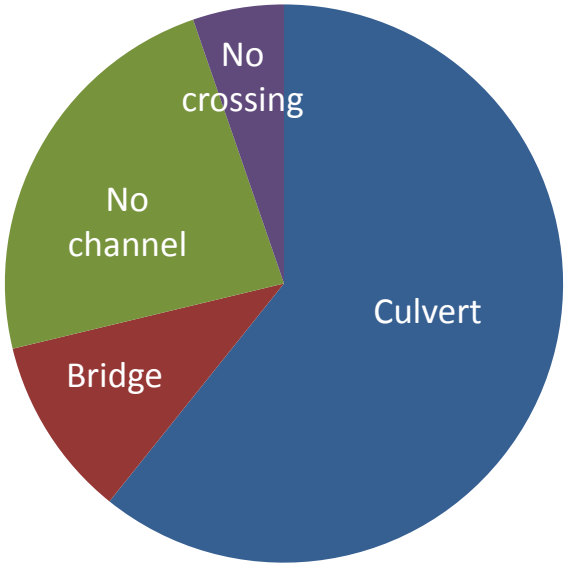
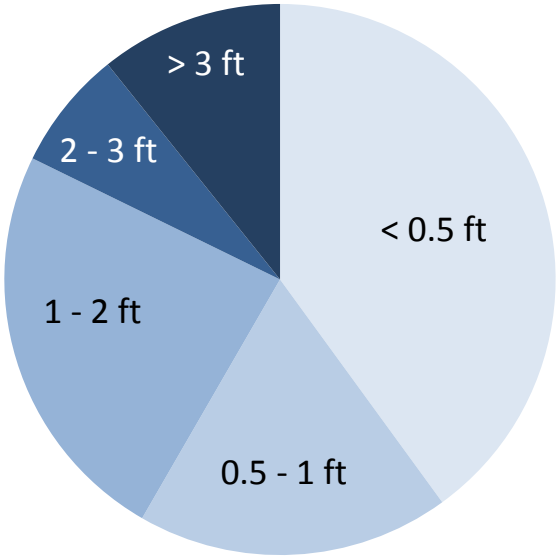
Green County, WI Road Crossings

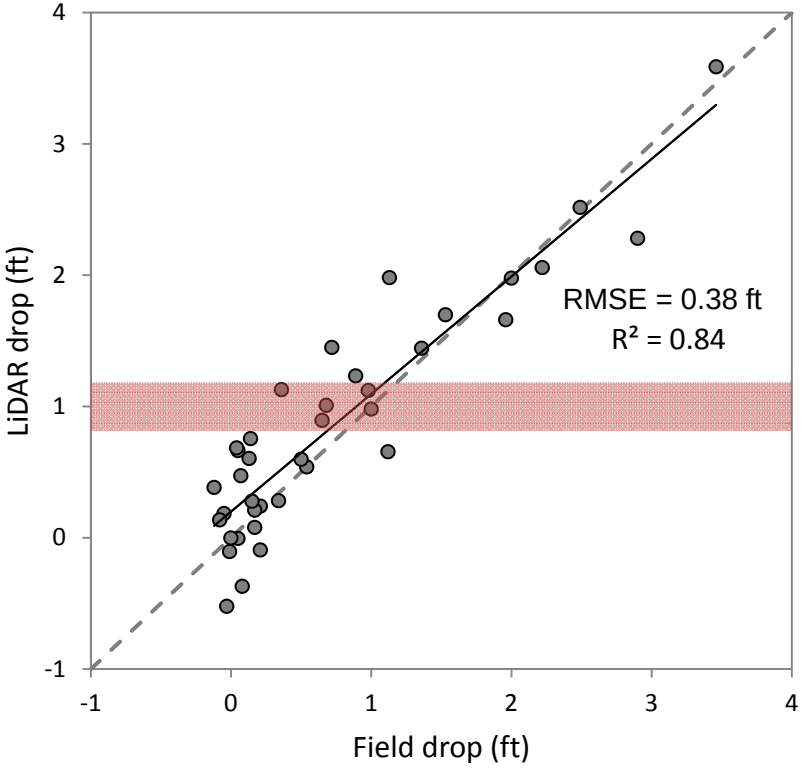
All Road Crossings (1,363)

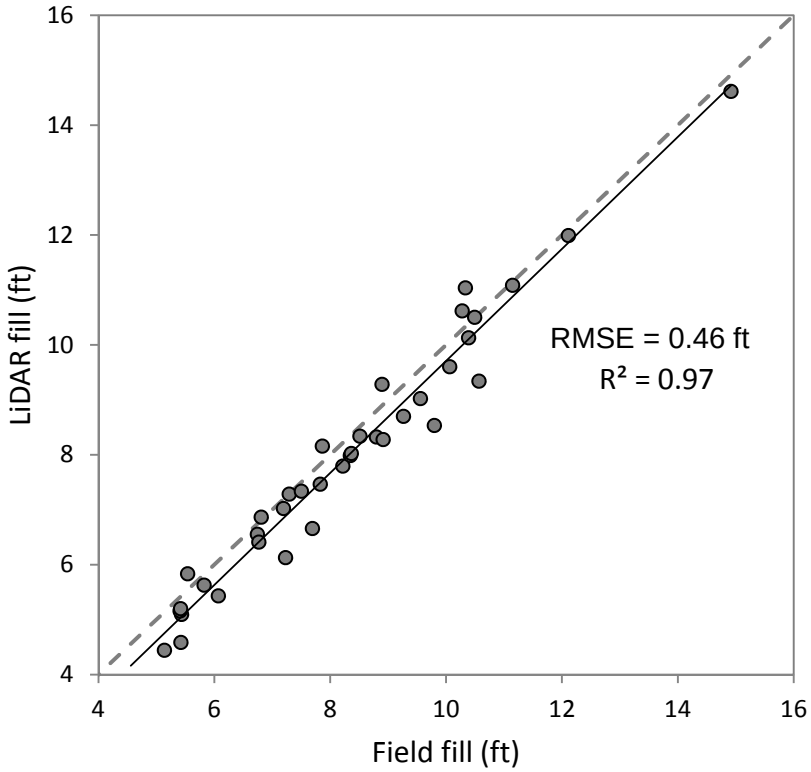


Culverts (Vertical Drop)



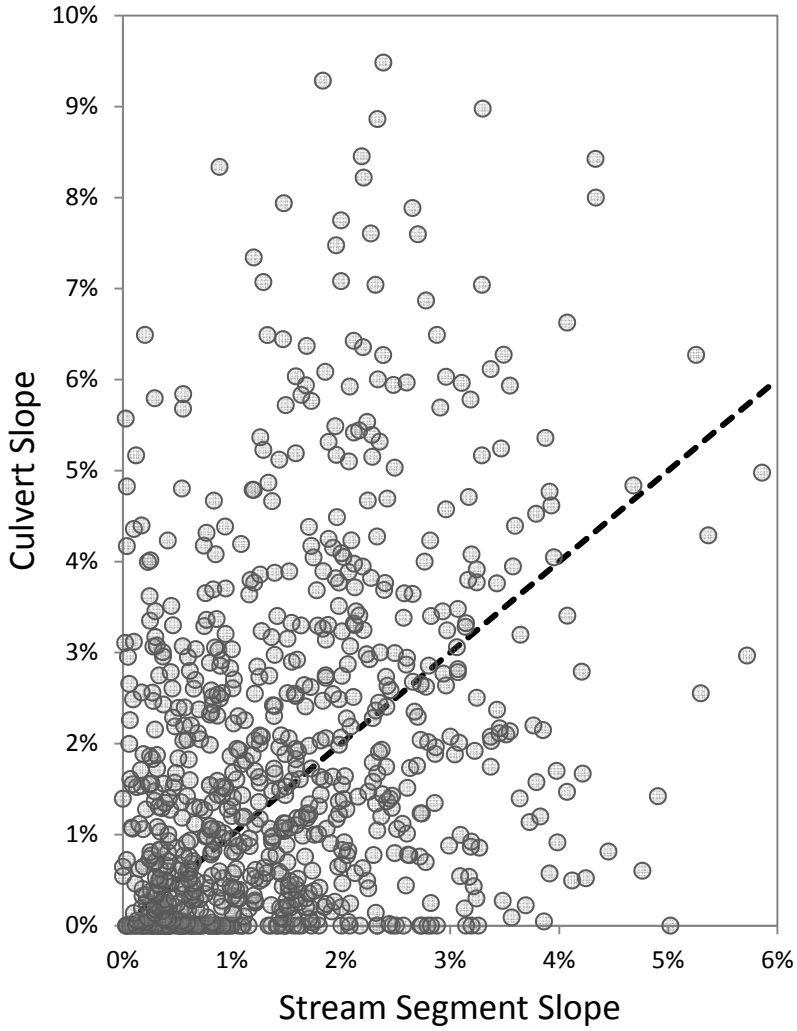
Accuracy of LiDAR Assessment





Overall accuracy of DEM: RMSE = 0.38 ft (12 cm)

How much drop or slope is a problem?



Limitations

1. Cannot assess culvert size, condition, or detailed hydraulic profile
2. Requires high resolution and quality DEM
    a. Works best with streams that are wider than DEM resolution
    b. Works best in locations without tree canopy
    c. Be aware of hydrologic conditioning used in DEM development

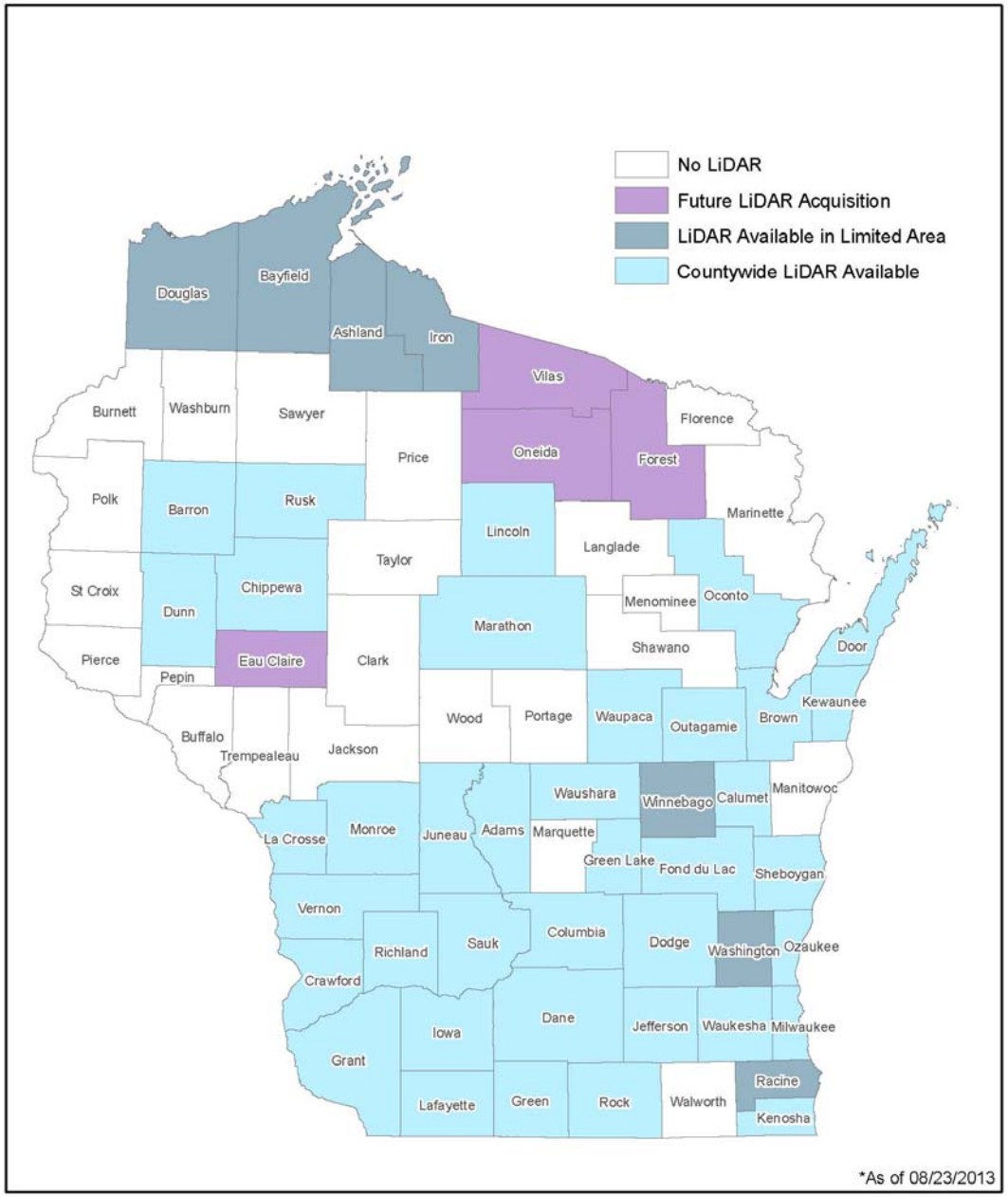
Comparison of Methods

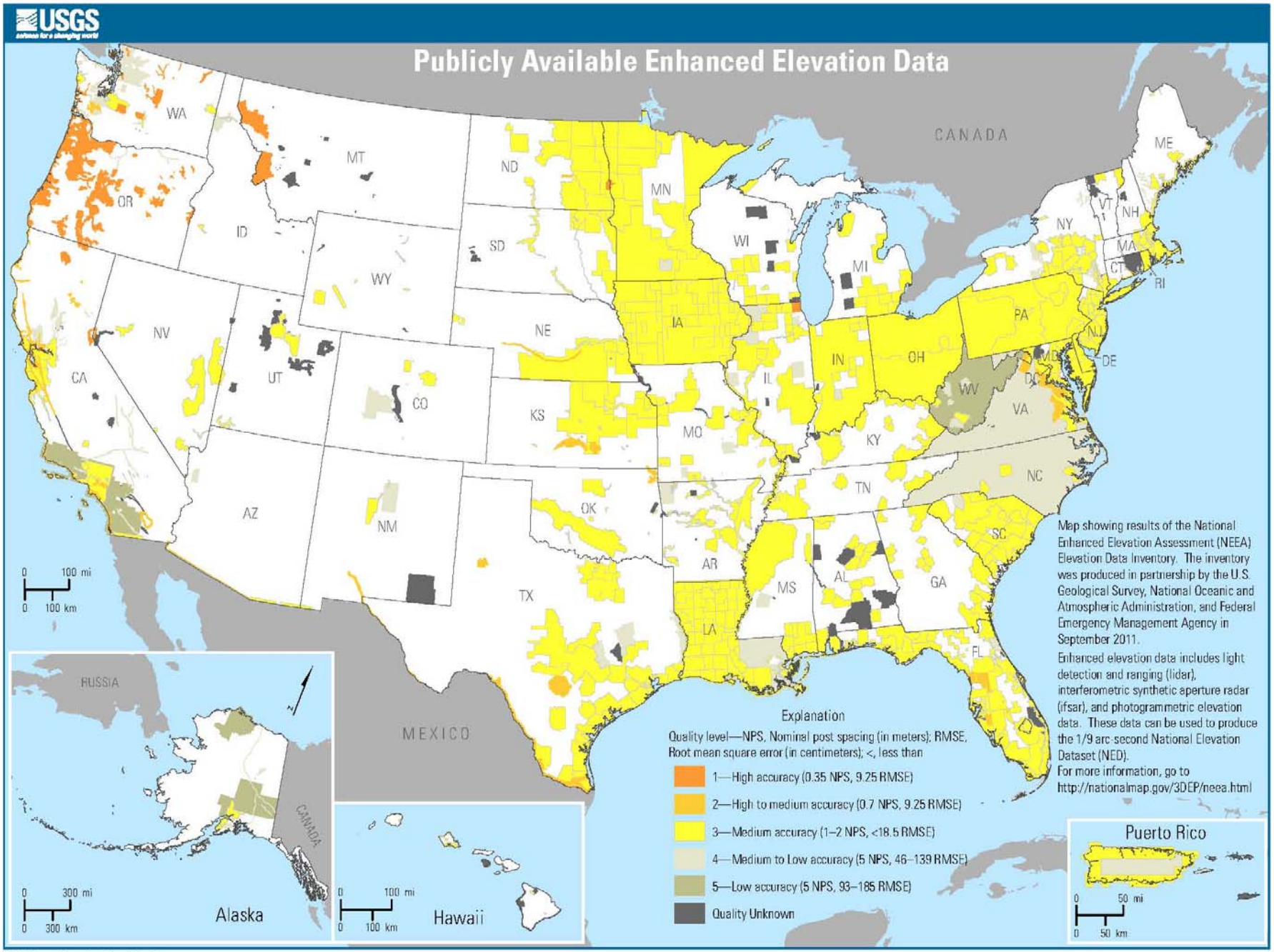
<table>
<tr><th colspan="2">Criteria</th><th>Fish Xing</th><th>Field Surveys</th><th>LiDAR</th><th>Statistical Model</th></tr>
<tr><td rowspan="2">Accuracy</td><td>Passability</td><td>Highest</td><td>High</td><td>Moderate-High</td><td>Low-Moderate</td></tr>
<tr><td>Cost</td><td>Highest</td><td>High</td><td>Moderate-High</td><td>Low-Moderate</td></tr>
<tr><td colspan="2">Speed</td><td>1 site/day</td><td>20 sites/day</td><td>400 sites/day</td><td>Completed for all RSX in GL Basin</td></tr>
<tr><td colspan="2">Completeness</td><td colspan="2">Depends on methods used to identify crossings for field surveys</td><td>Highest</td><td>Moderate</td></tr>
<tr><td colspan="2" rowspan="2">Other</td><td>Estimate how passability varies with flow</td><td colspan="2">Identify defined channels / fish habitat</td><td rowspan="2">Evaluate landscape factors that influence passability</td></tr>
<tr><td colspan="2">Identify site-specific factors that influence replacement cost</td><td>Condition DEM for hydrography development</td></tr>
</table>

Next Steps

1. Complete assessment for all Wisconsin counties with adequate LiDAR-based DEMs
2. Prioritize road crossings based on benefit to fish per dollar
3. Evaluate automated methods for identifying culvert ends in DEM
4. Assess correspondence between finding of “no channel” in DEM and field-based navigability determination
5. Continue accuracy testing

Status of LiDAR in Wisconsin





U.S. Department of the Interior
U.S. Geological Survey