Use of Aerial LiDAR Survey to Support Restoration and Management Objectives for Mitigation Wetlands in Marquette, MI, USA

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NORTHERN MICHIGAN UNIVERSITY

MARQUETTE COUNTY CONSERVATION DISTRICT

Introduction

- 2011
  - Overarching project began as a partnership between:
    - City of Marquette
    - Marquette County Conservation District (MCCD)
    - Northern Michigan University (NMU)
  - 4 mitigation wetlands constructed to restore 4.17 acres of forested wetlands
  - Continuous monitoring for native and non - native plant species
    - Common tansy & reed canary grass
- 2023
  - My work contributes to this larger project

Objectives

- **Generate** a high-resolution digital elevation model (**DEM**) and Topographic Wetness Index (**TWI**) using a LiDAR survey
  - Short-term objective, main focus of this presentation

- **Integrate** the DEM and TWI with existing vegetation and hydrological monitoring to compare the four wetlands and improve restoration and management outcomes
  - Long-term objective, could be a focus of future students

Study Area - Presque Isle Mitigation Wetland Area

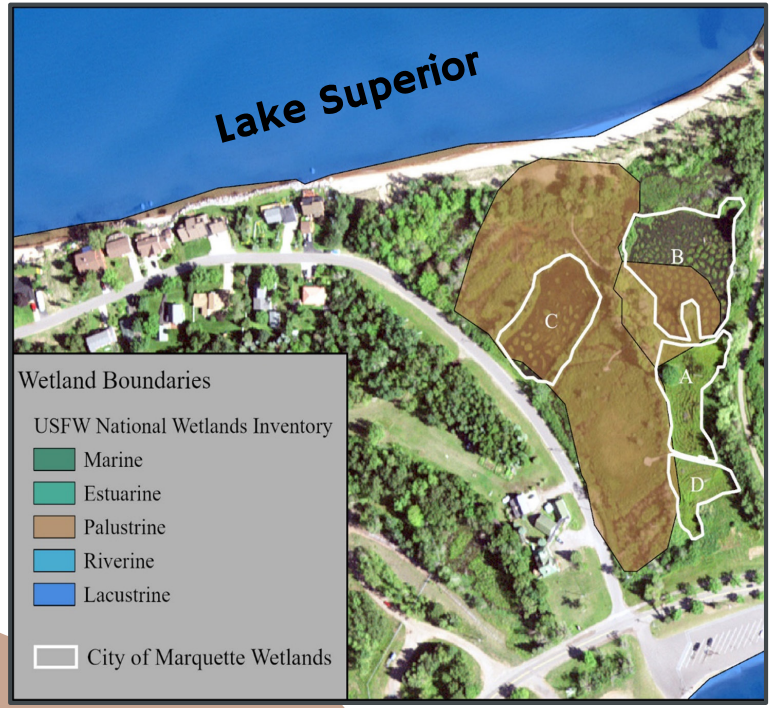

Figure 1. Wetland boundaries defined by the City of Marquette outlined and labeled in white. Lake Superior abuts the mitigation wetland area to the north and south.

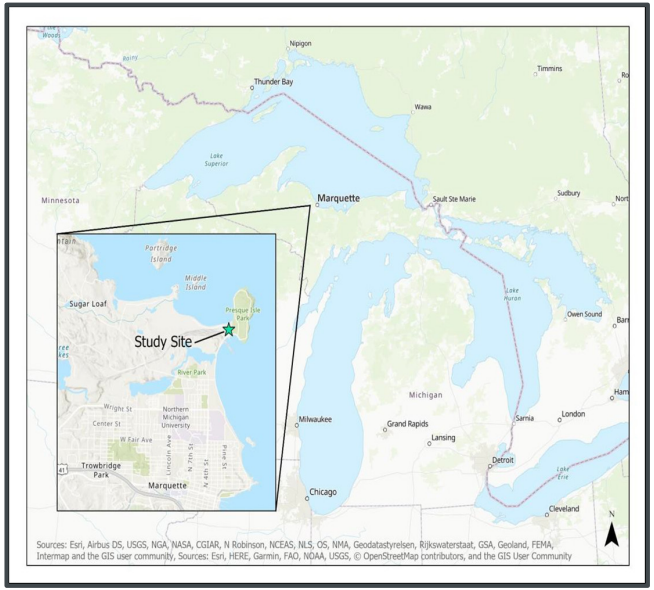

Figure 2. Marquette is located on the southern shore of Lake Superior in the Upper Peninsula of Michigan. Presque Isle Park is a peninsula jutting into the lake.

Methods: Data Collection

- Fall 2022: LiDAR flight at Presque Isle Mitigation Wetland Area
  - UAV
    - DJI M300 RTK
    - Zenmuse L1 Lidar sensor
    - RGB sensor
  - 28.9 total acres
    - **Includes** 4.17 acres of mitigation wetlands

Figure 3. NMU students Mary Kelly and Rhayna Lillie program the UAV for the flight at the Presque Isle Mitigation Wetland Area.

Methods: Data Collection (cont.)

- LiDAR return data + visible images
  - Altitude: 50 m
  - 60% forward, 20% side overlap
  - 3 returns

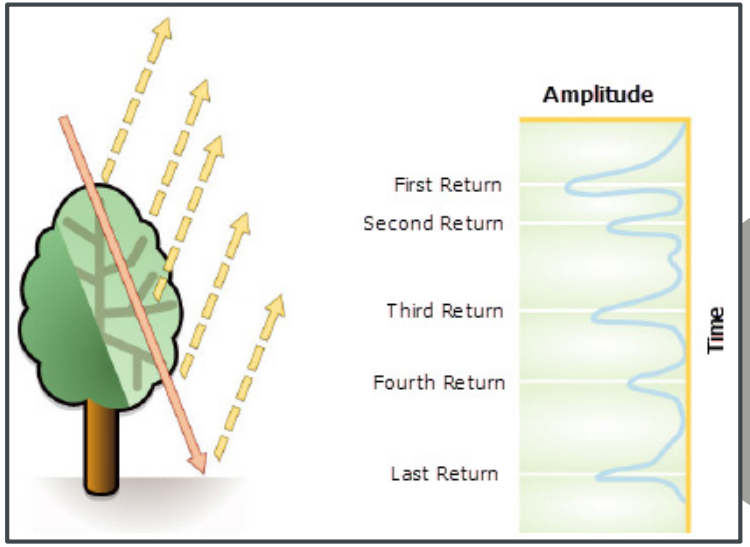

Figure 4. LiDAR laser returns. Image courtesy of Esri.

Methods: Data Analysis

- **Winter/Spring 2023**
  - DJI Terra 3.6.6
    - Reconstruct data into point cloud
  - ArcGIS Pro 2.6
    - Classify and extract ground elevation points
    - Convert to DEM with 0.5 m spatial resolution
    - DEM + ArcGIS hydrology tools to develop TWI

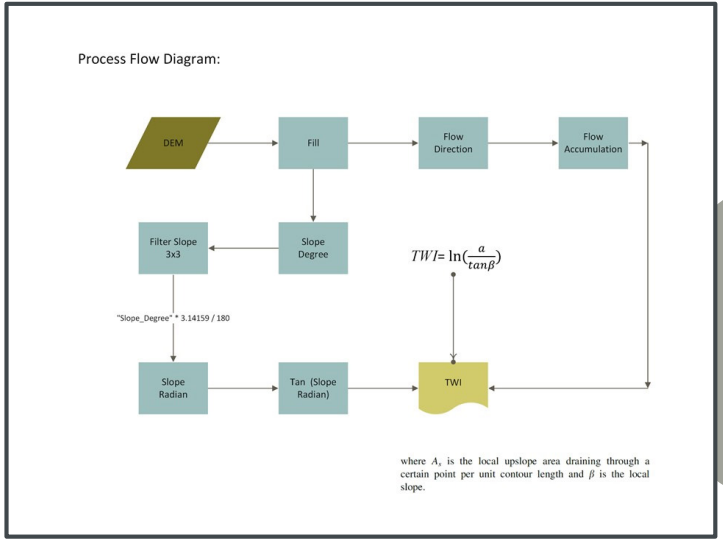

Figure 5. Topographic wetness index modeling steps. Image courtesy of Esri.

Results: Digital Elevation Model (DEM)

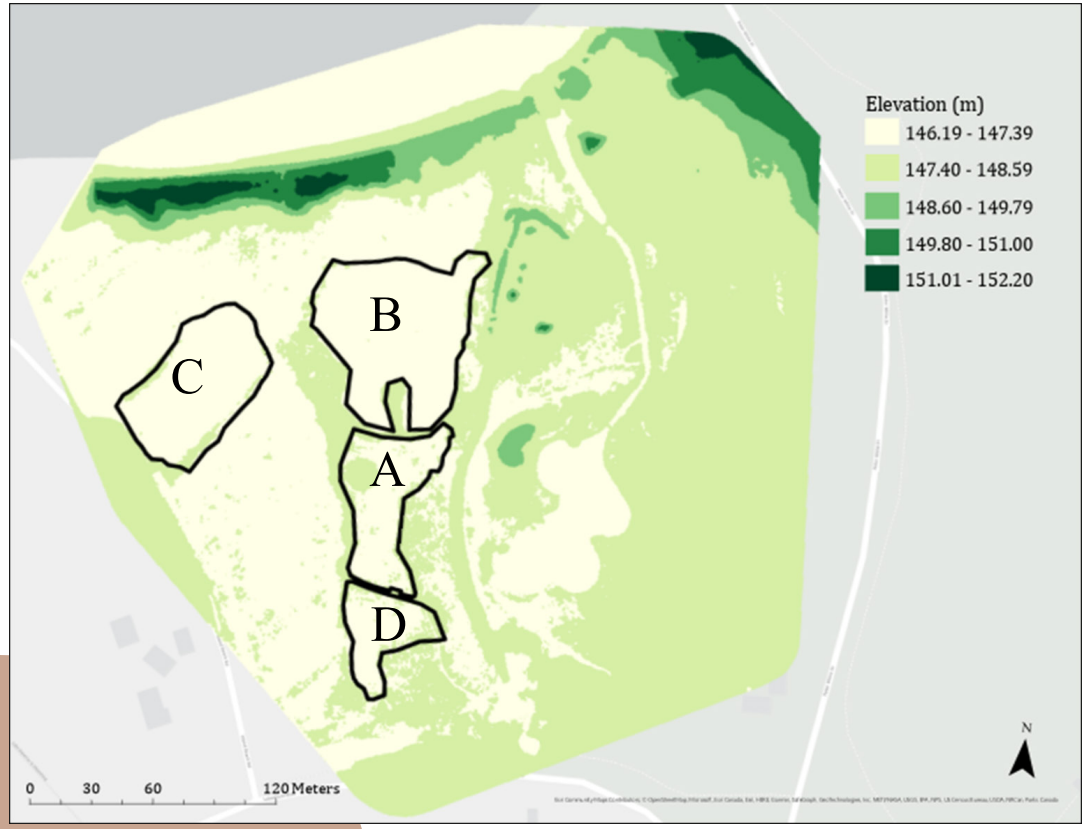

Figure 6. Results of the DEM.

Results: Topographic Wetness Index (TWI)

Figure 7. Results of the TWI.

Results: Single - factor ANOVA

Table 1. Results of the single - factor ANOVA test

Mitigation Wetland	Count	Sum	Average	Variance
A	10035	97853	9.75	39.10
B	20450	237419	11.61	34.24
C	14409	170624	11.84	39.06
D	5636	25021	4.44	17.73

Results: Tukey - Kramer

Table 2. Results of the Tukey - Kramer test

Comparison	Abs. Mean Difference	Q Critical	P-Value	Null Hypothesis
A - B	1.86	3.63	> 0.05	Fail to reject
A - C	2.09	3.63	> 0.05	Fail to reject
A - D	5.31	3.63	< 0.05	Reject
B - C	0.23	3.63	> 0.05	Fail to reject
B - D	7.17	3.63	< 0.05	Reject
C - D	7.40	3.63	< 0.05	Reject

Discussion

- Given the DEM and TWI, hypothesize that:
  - In **wetland D**, we might expect to find weaker establishment of invasive reed canary/common tansy
    - Lower TWI
    - Diligent abatement efforts by MCCD
    - Soil or topography aspects
- If invasives are **not** establishing in D, devote more attention to the remaining 3 for future monitoring
- MCCD could use the DEM and/or TWI to **determine specific areas of concern**, lowering the risk of future invasive species establishment

Discussion (cont.)

- Future directions
  - Accomplishing goal # 2!
    - Projects utilizing other aspects of the DEM
    - 10+ years of vegetation data

Figure 8. Presque Isle Mitigation Wetland LiDAR flight

Conclusion

Figure 9. Presque Isle Mitigation Wetland LiDAR flight

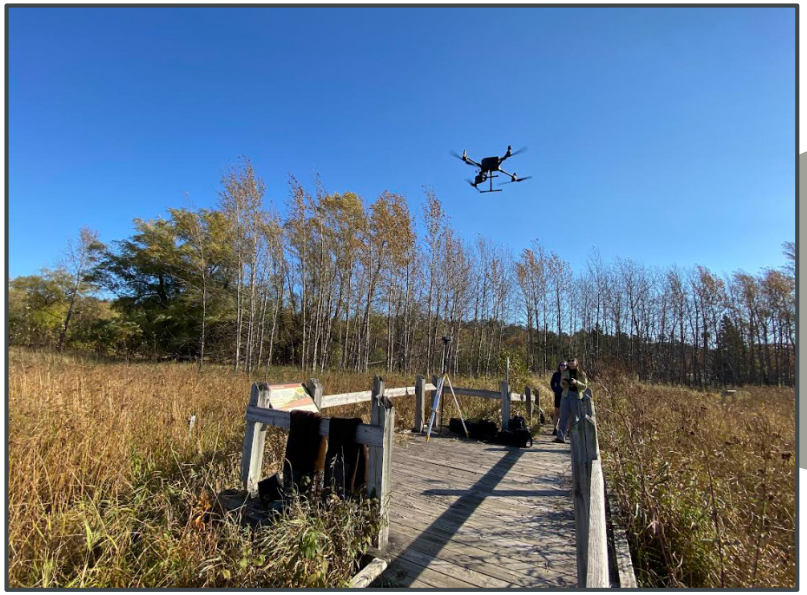

Figure 10. Presque Isle Mitigation Wetland LiDAR flight

Acknowledgements

- NMU Department of Earth, Environmental, and Geographical Sciences
- Dr. Susy Ziegler
- Randy Swaty
- Rhayna Lillie
- Kaitlyn Larsen

Thank you!