Advancing Remote Sensing Techniques to Quantify Performance, Resilience, and Recovery of Under-studied Wetlands

Reference SON: *SON-2021-1657/1659*

SON-2021-1657 - Remote Sensing for Back Bay Environments

SON-2021-1659 - Improved Methods and Best Practices for Monitoring and Surveying of Projects in Wetlands and Shallow Water Environments through Remote Sensing

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Research Need

Establishing performance standards or monitoring requirements for ecosystem restoration and natural resource management projects is important for maintaining, restoring, and maximizing beneficial ecological processes that support sustainable, resilient, and healthy wetland ecosystems. Commonly wetland monitoring includes links to structural and functional parameters such as vegetation health and biomass (typically related to established project goals) that require the appropriate monitoring temporal frequency and period. Additionally, these parameters are normally used in comparisons with historical, reference, or target conditions. However, the unique challenges for mapping and monitoring hard-to-access wetlands, due to their size, location, foliage architecture, and spectral characteristics, are intensified in these landscapes. Consequently, existing field-based, labor-intensive methods may not be fully adequate for these areas, highlighting the need for complementary monitoring approaches to evaluate wetland conditions and measure responses to environmental pressures and project actions.

Project Purpose & Objectives

The objective of this project is to assess the use of remotely sensed data and products to more efficiently and effectively evaluate key properties and conditions of difficult to monitor habitats (e.g., ephemeral ponds, multi-story wetlands, and back-bay environments). This will be accomplished by:

- Conducting a comprehensive search, review, and compilation of information regarding the current state of knowledge related to the use of remote sensing applications for wetland structure and function in target wetlands.
- Evaluating a range of remote sensors (e.g., UAS-mounted multispectral and hyperspectral sensors, and lidar sensor) and methods (e.g., sub-pixel value extraction, data fusion) to develop and apply vegetation metrics and multi-metric indices.

- Selecting study site(s) and collecting, processing, and analyzing air-borne and ground verification data.
- Performing cross-validations among remote sensors to assess correlations between ground- and remotely collected data and existing/developed metrics.
- Developing and testing semi-automated geospatial tools for extracting wetland properties and metrics from UAS.
- Documenting and disseminating tools and findings through publications, webinars, and conference presentations.

Value of Research and Development (Payoff)

Understanding the interactions that drive landscape change resulting from natural disturbances (e.g., hurricanes or floods) or management activities (e.g., restoration or water level management) in wetlands is critical. Yet many physical, biological, and chemical uncertainties exist, especially in hard to access or difficult to monitor wetlands. The proposed research and products will allow wetland resource managers to monitor and assess the condition, resilience, and recovery of wetland ecosystems across a wide range of wetland types, locations, pressures, and restoration strategies more efficiently. The proposed methods and tools will improve the understanding of wetland dynamics in these understudied ecosystems, assisting in the identification of actions required to enhance the sustainability and resiliency of those ecosystems, and ultimately promoting successful ecological and fiscal outcomes (including potential cost savings).

Products and Deliverables

Technical Reports (TR)

Suir, G.M., K. Glennemeier, R. Sliwinski, S. Jackson, and C. Saltus. (In Management Review). Assessing the Use of Unmanned Aircraft Systems to Monitoring Vegetation Dynamics in Forested Wetlands (ERDC/EL TR-XX-XX), Technical Report. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Technical Notes (TN)

Jackson, S., C. Saltus, K. Glennemeier, R. Sliwinski, G. Suir. 2025. Considerations and Lessons Learned for Remote Sensing Data Acquisition of Understudied Wetland Vegetation Metrics (ERDC/TN EMRRP-RQ-5), Special Report. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi. https://dx.doi.org/10.21079/11681/49967

Special Reports (SR)

Suir, G.M., K. Glennemeier, R. Sliwinski, and C. Saltus. 2025. Monitoring of Understudied Wetlands: State of Knowledge (ERDC/EL SR-25-5), Special Report. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi. https://dx.doi.org/10.21079/11681/49899

Other Reports/Models/Tools/Datasets

Suir, G.M. 2022. Field study plan and project records (White paper and supporting documentation)

Jackson, S., G. Suir, K. Matheson, M. Baker, J. Laird, C. Saltus, R. Sliwinski, and K. Glennemeier. 2023. Grainger Woods Conservation Preserve, IL Field Data Collection 2023: Geospatial Layers and Related Tables. Dataset. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi. *https://dx.doi.org/10.21079/11681/49942*

Saltus, C., K. Glennemeier, R. Sliwinski, S. Jackson, K. Matheson, C. Mckenzie, N. Beane, and W. Cowan. 2025. Grainger Woods Conservation Preserve, IL Field Sampling Plan (White paper)

Saltus, C., S. Jackson, K. Matheson, C. Mckenzie, N. Beane, W. Cowan, J. Laird, R. Sliwinski, and K. Glennemeier. 2025. Grainger Woods Conservation Preserve, IL Field Data Collection 2025: Geospatial Layers and Related Tables. Dataset. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi. *https://dx.doi.org/10.21079/11681/49951*

2025 Geospatial toolbox for WVCI metrics (Publish to ERDC Knowledge Core FY26)

2025 Grainger Woods species classification dataset (Planned for FY26)

SR – Wetland Value Condition Index (WVCI) Geospatial toolbox user's guide (Planned for FY26)

Conference Presentations/Webinars/Workshops

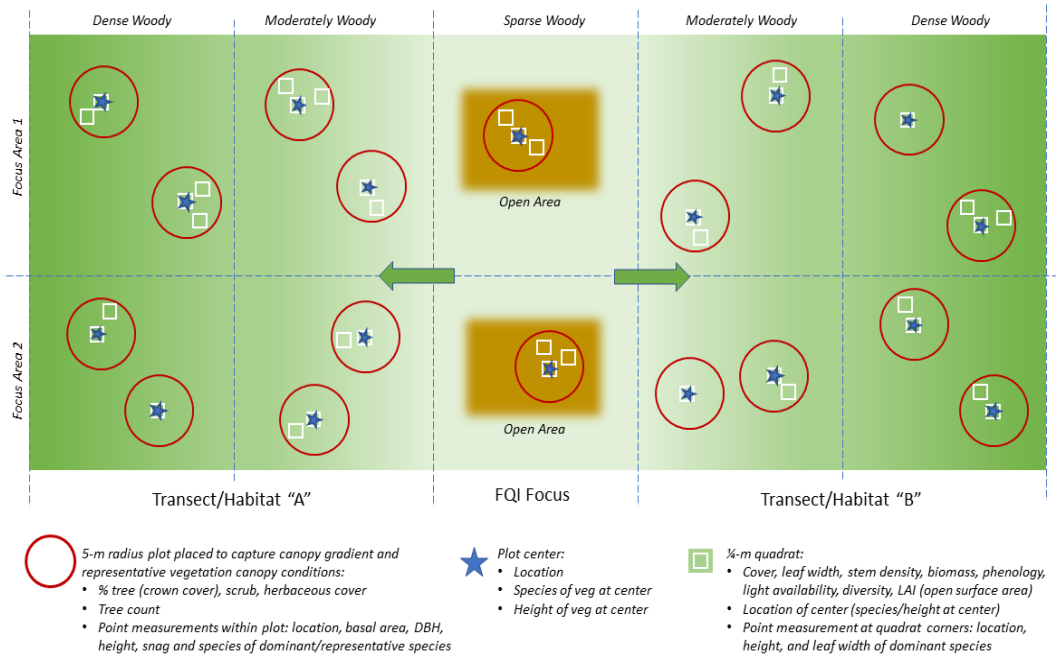
Webinar to present remote sensing methods and use of the WVCI toolbox (Planned for FY26)

Communication (Social Media, Videos, Podcasts, Photos, etc.)

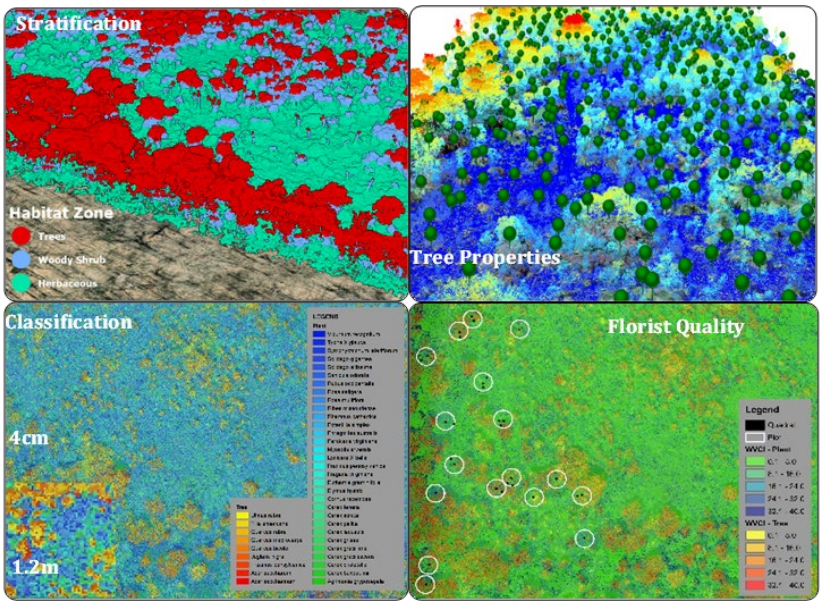
CW Weekly Highlight, "Field Campaign for Characterizing Forested Wetland Habitat using Ground-Based Measurements and Multiplatform Remote Sensing" (June 2025)

Images

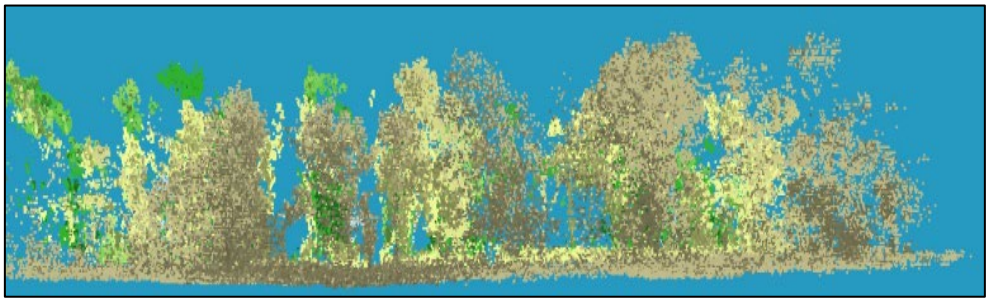
Picture 1. Grainger Woods study site, Mettawa, Illinois.



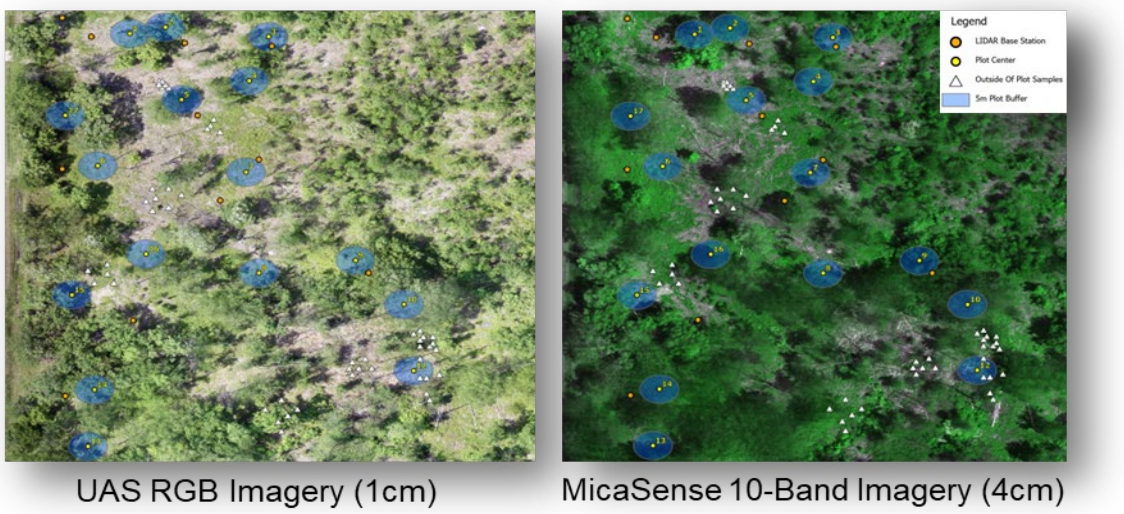
Picture 2. Schematic of sampling design as represented in TR. Suir et al. (In Management Review).



Picture 3. Sample of vegetation metric products from the Year 1 data collection.



Picture 4. Plot-based terrestrial lidar from the Year 2 data collection.



Picture 5. UAS-sensor mounted imagery capture from the Year 2 data collection.