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Integrating Field and Remote Sensing Methods to Improve Riparian and Aquatic Vegetation Mapping in Support of Ecosystem Flow Recommendations: Allegheny River Case Study

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Project Development

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Proponent(s)/District

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Other Partners: Pennsylvania Natural Heritage Program (PNHP), The Nature Conservancy, (TNC), and the U.S. Geological Survey (USGS)

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Research Need

This project will address the need to update monitoring and assessment methods for identifying ecosystem restoration impacts across large river reaches. The work aims to evaluate the integration of multi-platform/multi-sensor data (e.g., high-resolution satellite and airborne imagery and topobathymetric lidar) with strategically coordinated field surveys designed to maximize image analysis techniques for mapping reach-scale riparian and SAV vegetation. In addition, the proposed research will evaluate and develop methods for broad application and use in planning, operations, and Adaptive Management and Monitoring Plans (AMMPs) using a case study along the Allegheny River, representing an ideal location for developing methods to characterize and map near-baseline conditions of riparian forest and SAV habitat.

Project Purpose & Objectives

The overall purpose is to develop approaches that embrace new technologies for examining specific water resource issues and produce operational efficiencies that support USACE's ecosystem restoration and flood risk management missions. Specifically, the goal is to evaluate and develop methods for integrating field-based techniques with emerging remote sensing technology, in which the outcomes and products will improve ways to consistently and comprehensively document maintenance, success, or impact to terrestrial and aquatic riparian environments resulting from restoration or operational activities.

Data integration will focus on geographically and analytically complementary methods for mapping vegetation in challenging areas, while providing valuable data at the project-scale. The proposed foundational research will include the following objectives:

- Collect high resolution airborne and satellite imagery (e.g., Sentinel-2 and WorldView 2/3) in coordination with field surveys to identify and map major riparian vegetation/forest communities by dominant species with descriptive data for each mapped vegetation type to include density and abundance for species,
- In collaboration with the U.S. Geological Survey, explore airborne hyperspectral imagery and topobathymetric lidar reflectance data and SAV field data collected simultaneously to evaluate efficacy for mapping SAV presence (e.g., assess data limitations), and
- Provide a detailed report/publication(s) with data series highlighting methods and results for broad application and use in AMMPs. Tech transfer (publications and webinars) will enable Districts to incorporate new, integrative approaches for improved mapping of challenging riparian and SAV habitats. Stream and reservoir capabilities will allow users to characterize watershed-scale water quality impacts.

Value of Research and Development (Payoff)

Traditional field-based methods for monitoring riverine ecosystems are time-intensive and may not accurately capture conditions over expansive areas. However, better coupling of field-based techniques with remote sensing technology provides opportunities to document, quantify, and map larger areas on a more comprehensive level and to better prepare for and adapt to future water resource needs. Strategic integration of field surveys, through collaboration with local partners and stakeholders, and remote sensing techniques (maximizing resources available to DoD) offers a way to provide an integrated, interdisciplinary technical approach for consistent and comprehensive data collection and development (e.g., coverage and detail) and for linking restoration or operational impacts, such as those connected with riverine restoration projects or ecosystem flow (e-flow) implementation to ecosystem improvement. As such, research and development of integrated and updated mapping techniques, captured in multiple reports and a webinar, will ultimately enable Districts to implement new approaches for documenting riparian/SAV habitat condition, extent, and density. In turn, the proposed research and resulting products will help build foundational knowledge to improve riparian/SAV habitat evaluation and monitoring of impacts associated with all USACE restoration efforts. Additionally, the products and methods from this proposed research will likewise benefit planning efforts in which riparian ecological modeling requires habitat type and canopy characteristics as critical variables to inform stream and riparian restoration.

Products and Deliverables

Technical and Special Reports (TRs)

Reif, M.K. and N. Zamani. (2025). Review of remote-sensing methods for mapping riparian and submerged aquatic vegetation : support for ecosystem restoration monitoring and flood risk management (ERDC/EL SR-25-06), Special Report. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi. <https://dx.doi.org/10.21079/11681/49792>

Maxent model comparison for riparian vegetation: Allegheny River Case Study (Planned for FY26)

Integrating Field and Remote Sensing Methods to Improve Riparian Vegetation Mapping in Support of Ecosystem Restoration: Allegheny River Case Study (Planned for FY26)

Integrating Field and Remote Sensing Methods to Improve Freshwater Aquatic Vegetation Mapping in Support of Ecosystem Restoration: Allegheny River Case Study (Planned for FY26)

Technical Notes (TNs)

Lidar data evaluation for extracting detailed forest metrics (Planned for FY26)

Other Reports/Models/Tools/Datasets

Reif, M.K., S. Altman, M.T. Balazik, N.R. Beane, J.R. Shallock, L.C. Umlang, W.G. Cowan, C.J. Nim, A.S. Fitzgibbon, D.F. White, H. Harwood, E. Zimmerman, B. Daggs, S. Schuette and N. Yawn. (2025). Integrating Field and Remote Sensing Methods to Improve Riparian and Submerged Aquatic Vegetation Mapping: Habitat Field Data, Allegheny River, Northwest Pennsylvania. Dataset. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi. <https://dx.doi.org/10.21079/11681/49866>

Conference Presentations/Webinars/Workshops

Recorded Webinar. Integrating Field and Remote Sensing Methods to Improve Riparian and Aquatic Vegetation Mapping in Support of Ecosystem Restoration: Allegheny River Case Study (Planned for FY26)

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

CW Weekly Highlight, “Allegheny River Reconnaissance Site Visit and Survey Scoping Meeting” (Aug 2023)

CW Weekly Highlight, “Coordinated Field and Airborne Data Collection Surveys on the Allegheny River” (July 2024)

Riparian and SAV data collection and survey plan, “Allegheny River Recon Site Visit and Scoping Meeting Summary & Draft Survey Plan for FY24” (White paper and supporting documentation, July 2024)

IMAGES

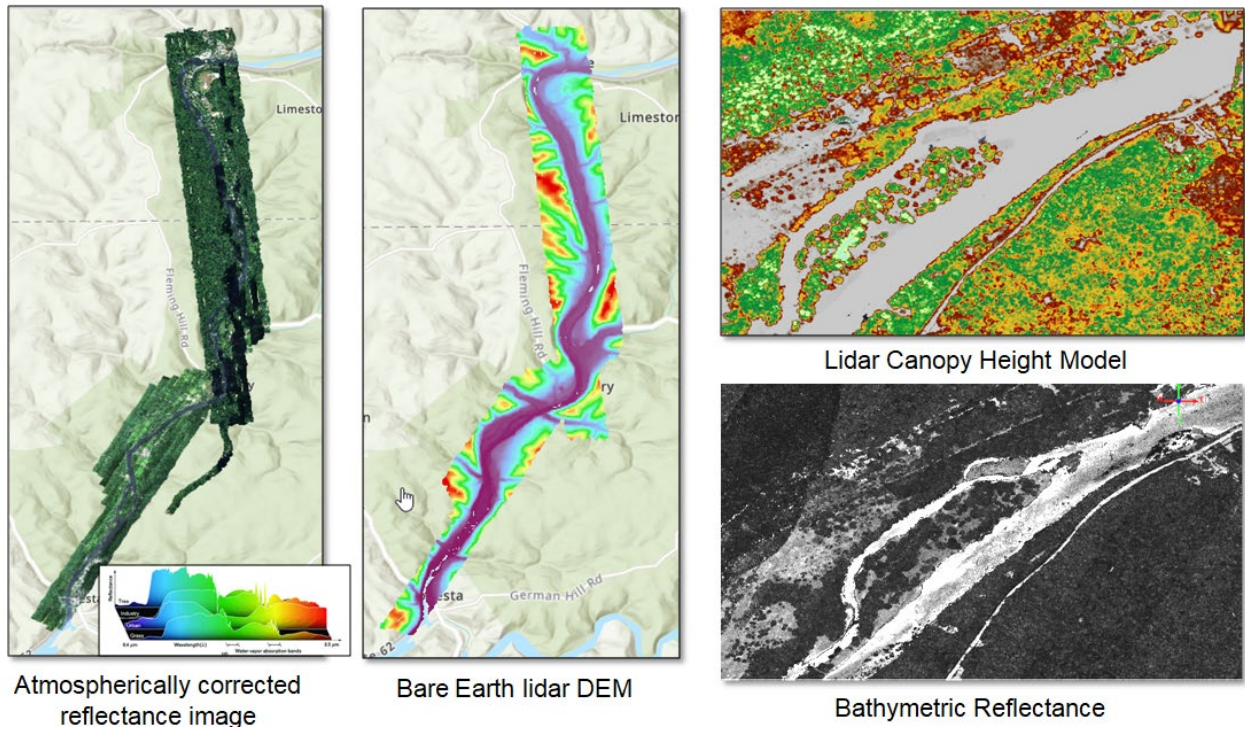


Figure 1. Airborne hyperspectral imagery and lidar data products collected during a test flight (July 9, 2020) along the Allegheny River case study area.



Figure 2. Allegheny River reconnaissance trip with PDT and external collaborators (July 25, 2023).



Figure 3. Project team members conducting field surveys to measure SAV and riparian community (e.g., floodplain forest and herbaceous) vegetation characteristics (July 15-21, 2024).