Understanding multitemporal landscape dynamics through remote sensing and paleoecological modeling in the Virginia Tech Environmental Tracking Lab

COLLEGE OF NATURAL RESOURCES AND ENVIRONMENT
GEOGRAPHY
VIRGINIA TECH

Virginia Tech Environmental Tracking Lab
232 Wallace Hall, Blacksburg VA

Ryley C. Harris, Lisa M. Kennedy, Troy Swift, Daniel Donahoe, Devon Burton

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SUMMARY

The Environmental Tracking Lab at Virginia Tech currently comprises five graduate students under the direction of Dr. Lisa Kennedy. Our team members have prior training in biogeography, physical geography, biology and ecology, geology, fish and wildlife conservation, ecosystem management and restoration, and geospatial and information science. The diverse training and experiences represented in our lab group provide a broad and integrative approach to understanding ecosystem and landscape change at varied temporal and spatial scales. Our members seek to model the ever-changing landscape, identify drivers of change, and predict future changes. Investigation of shorter-term changes using remote sensing, Lidar, and unmanned aerial systems (UAS) technologies, in conjunction with longer-term proxy data modeling, can provide a broad and deep window into environmental and landscape changes. Showcased in this poster are glimpses of a few of our research projects in various stages of execution. This presentation demonstrates some of our capabilities as a laboratory with the goal of increasing recognition and collaboration within our college, the university, and beyond.

Project: Long-term environmental history of an indigenous hunting camp in Monongahela National Forest, WV

This new project focuses on reconstructing the long-term environmental history of an indigenous hunting camp (archaeological site) in the Monongahela National Forest of WV, just a few steps from the VA state line. The research team will analyze environmental proxies, including pollen grains, spores, charcoal, and carbon isotopes, archived in bog sediment profiles and compare them with archaeological data to learn how fire, climate, bison, and indigenous people are linked to forest dynamics over the past few thousand years. Combining the proxy-based environmental history with the archaeological records (human history) will provide a more complete picture of the complex landscape history.

Figure 1: Reconnaissance of the mountaintop bog near the West Virginia border with VA.

Project: Assessing mortality of *Picea Rubens* in an isolated stand on Virginia's second tallest mountain, Whitetop.

This study investigated the applicability of a consumer grade UAV (Unmanned Aerial Vehicle) equipped with an RGB camera payload for assessing individual spruce tree (Picea rubens Sarg.) health within a 46-hectare sample plot of the red spruce forest on Whitetop Mountain, Virginia. The main goal of this research was to quantify forest health and instances of mortality, examine the associated spatial patterns, and provide data to the management organization to assist with forest treatments. We identified 9,402 red spruce trees and assessed their health using UAV-survey produced digital orthoimagery. Of those, 8,700 were classified as healthy (92.5%), 251 declining/dying (2.6%), and 451 dead (4.8%). To examine spatial aspects of forest health, we mapped individual spruce trees in each class and performed density analyses to produce kernel density maps.

Figure 2: Left photo is an aerial image of the summit of Whitetop Mountain, with notable dark-colored red spruce forest on top, bordered by Virginia's only southern Appalachian grass bald. The left image shows an eager pilot with *Picea rubens* visible in the background. April 2021.

Project: Tracking beaver-driven peatland ecotone dynamics using LiDAR and geomorphon analysis at Cranberry Glades, WV

This project investigates beaver impacts on boreal peatland ecotones at Cranberry Glades Botanical Area in West Virginia. Critical microtopographical elements are tracked using color infrared orthophotos and LiDAR; these feed landcover classification, digital bare-earth and canopy height models, and geomorphon analysis. Next steps include using drones to acquire higher resolution multispectral and LiDAR data and a more complete integration of historical imagery. *Collaborators:* Troy Swift and Lisa Kennedy (VT Geography), Val Thomas (VT FREC), Cully Hession (VT Biological Systems Engineering).

Figure 3: A beaver impoundment along Charles Creek intersects Cranberry Glades' perimeter trail TR253, ponding over the upstream stretch while overflowing down-trail into the heart of Cranberry Glades. *T. Swift, Oct 2020*

Project: The effects of evergreen shrub expansion on macroinvertebrate communities in the Southern Appalachian Mountains

Unchecked expansion of rhododendron in the Appalachian Mountains can be harmful to other species. These changes include rhododendron's ability to provide dense shade that often inhibits canopy tree recruitment and the alteration of allochthonous leaf litter inputs. Past literature has documented the additive effects of rhododendron leaf litter on aquatic macroinvertebrate abundance. This research will use multiple Landsat datasets to document the expansion of rhododendron in the Coweeta Creek basin and its relationship to changes in fluvial macroinvertebrate communities. *Research Collaborators:* Daniel Donahoe and Lisa Kennedy (VT Geography), Val Thomas (VT FREC) and Arvind Bhuta (US Forest Service)

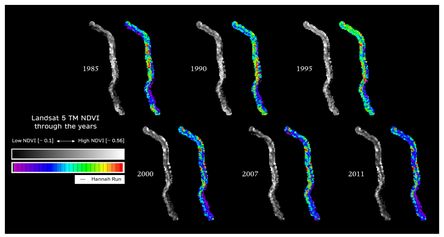

Figure 4: Results from a pilot study evaluating winter vegetation greenness along Hannah Run, Shenandoah National Park.

Phrag-ments in time: Investigating invasion patterns of Phragmites australis in the Great Dismal Swamp

Phragmites, also called the common reed, is a prolific grass species native to Eurasia. Through centuries it has spread throughout North America and disrupted ecosystems by outcompeting native plant species for energetic resources. *Phragmites* may have entered the Great Dismal Swamp in the 1700s during early efforts to drain, log, and settle the swamplands. More recently land managers have conducted prescribed burns to prevent the species from capitalizing on disturbed areas following the wildfires of 2008 and 2011. This research will document *Phragmites*' invasion patterns using a multimodal research approach, combining traditional tertiary research with empirical spatial data analysis focusing on remote sensing approaches with a variety of sensors and timeframes.

Figure 5: *Phragmites australis* growing in the West Lateral fire's exposed marshland

Investigating Landcover Impacts of Hurricane Gracie (1959) and Hurricane Matthew (2017) using Lidar and Historical Air Photos, Hunting Island, SC, USA.

Hunting Island (~2000 ha), 15 miles southeast of the city of Beaufort SC and a state park since 1935, has lost an average of 6 m of shoreline per year over the past century to erosion. As a barrier island, Hunting Island absorbs powerful winds and waves of storms and hurricanes, effectively insulating the marshes and mainland behind, including the city of Beaufort and its harbor. This project will document changes in the island's shoreline and vegetative cover after the powerful Hurricanes Gracie (1959) and Matthew (2017) through analysis of satellite imagery, including Lidar and historical aerial photography.

Figure 5: Photo of erosion of a state park road on Hunting Island caused by Hurricane Matthew in 2017. *L. Kennedy, Dec 2020*

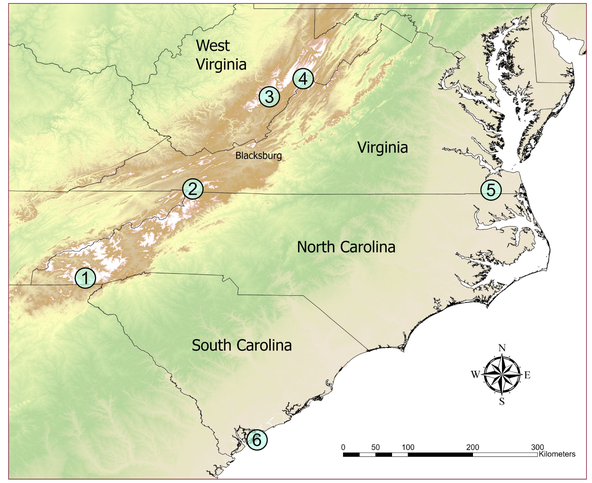

Figure 6: Map of the study sites represented in this poster.