USGS
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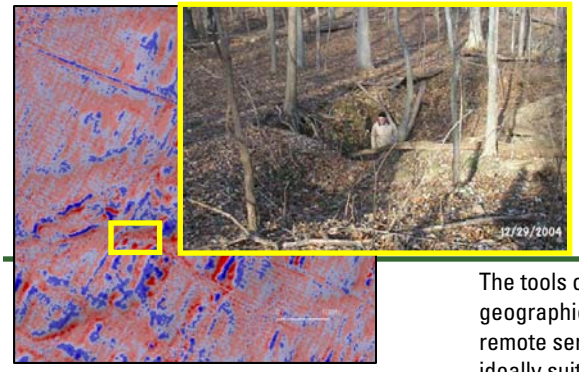
Eastern Region
Leetown Science Center

Landscape Ecology



Light Detection and Ranging (LiDAR) imagery was processed and analyzed by researchers at LSC-AEB to map sinkholes and other possible threats to groundwater recharge for a study of water availability at LSC (PI: Young)

Over the next few years, the Leetown Science Center (LSC) would like to establish an expanded capability for conducting landscape ecology research.

Overview

Landscape ecology is the study of the relationship between spatial pattern and ecological process. This discipline addresses the importance of spatial configuration for ecological processes at watershed or regional levels much larger than those traditionally studied in ecology. The recent prominence of landscape ecology is the result of a need to address broad-scale environmental issues, new scale-related concepts in ecology, and technological advances in computers, software, and the availability of spatial data. This surge in interest also has become manifest in a wave of recent efforts by Department of the Interior (DOI) bureaus and other Federal agencies, states, and others to incorporate principles of landscape ecology into policies and guidelines for managing public and private lands. Those principles can be used to address impacts of habitat fragmentation; track spread and impacts of invasive species; recover declining species; track and understand spread of disease; build predictive/spatial models; track land-use changes; establish conservation reserves; and evaluate water quality and quantity.

The tools of landscape ecology – geographic information systems (GIS), remote sensing, and spatial statistics – are ideally suited to represent and examine environmental attributes and interrelationships over large areas. This relatively young discipline holds much promise for evaluating ecological relationships and assessing management decisions, for in many cases spatial configuration can be more important than other ecological components.

Justification

Needs by U.S. Geological Survey (USGS) partners and clients for scientific tools and results to address issues at the landscape level are ubiquitous and growing in number and urgency. The National Park Service (NPS) and U.S. Fish and Wildlife Service (FWS) have need of advanced applications of spatial tools and landscape-scale data to help them manage and predict changes to the natural resources under their stewardship. While most National Parks, National Wildlife Refuges and FWS offices have access to and use GIS, these systems are primarily utilized for basic thematic mapping and inventory. In general, DOI bureaus and state agencies do not have the expertise to develop advanced geospatial models to predict potential distributions of target species, evaluate landscape-level impacts of stressors, or address other issues related to spatial processes. However, they often have the means to implement such models as planning tools, if these were available.

Specific research needs in the Eastern United States include tracking and management of invasive species in the Shenandoah and Great Smoky Mountains National Parks (recently [re]listed by the National Park Conservation Association as two of America's 10 most endangered parks); tracking the spread of disease among fish in Chesapeake Bay and its tributaries; evaluating threats of poaching of rare plants on National Parks, National Wildlife Refuges, and National Forests; identification of metapopulations and metapopulation dynamics of declining unionid mussels, amphibians, and mammals (e.g., Louisiana black bear); spread and control of *Phragmites* on coastal National Wildlife Refuges; assessment of habitat requirements of aquatic and terrestrial organisms; restoration of extirpated or endangered species (e.g., elk, Florida black bear), and developing user-friendly tools for habitat mitigation assessment with broad applicability to threatened and endangered species (e.g., Florida panther).

Current Capabilities at LSC

LSC maintains state-of-the-art GIS capabilities and staff expertise at its Southern Appalachian and Aquatic Ecology Branches and uses this capability to gather and analyze mapped, aerial, and remotely sensed data, and to construct predictive spatial models. We have been successful in building our GIS and advanced analytical capability in landscape ecology, and in securing research funding to address a variety of client needs. To date, however, these efforts have not had a programmatic

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focus within the LSC organizational structure. For example, modeling efforts have been specific to individual parks, species, or research topics and there has been little effort to distribute the tools generically. Expansion of our efforts and expertise will allow for broader applications, increased analytical and remote sensing capabilities, development of decision support tools, direct programmatic linkage to NBII components, and stronger data-sharing capabilities among Leetown research branches, and internal and external partners.

Recent and Ongoing Research Activities

Scientists at LSC have been conducting landscape-focused ecological research for a number of years. Examples of previous investigations include impacts of upland and riparian land cover on aquatic species, assessment of vegetation communities in relation to environmental gradients, terrain-based survey designs for biodiversity assessments, modeling vulnerability of forest stands to insect defoliation based on landscape setting, geostatistical analysis of allele presence to assess impacts of habitat fragmentation, and habitat modeling for protection of plant species at risk to poaching. While we have been successful at applying landscape ecology principles to aquatic and terrestrial systems, our work to date has been primarily client-focused, applied research that is not well integrated across LSC's research branches. We seek to initiate a more focused landscape ecology research program that builds on our past successes and moves our research into areas beneficial to our clients, the broader scientific community, and society at large.

Proposed Research Direction

The goal of this initiative is to move LSC's landscape ecology research forward as an integrated program that can capitalize on the strengths of our staff across multiple research branches, and that can draw on our expertise in aquatic and wildlife ecology, conservation genetics, animal health, spatial modeling, and statistics to address important societal and environmental resource management issues. We see several emerging areas where LSC is uniquely positioned to advance landscape ecology research, including (but not limited to) landscape ecology and pathology of riverine systems, and genetic impacts of fragmented landscapes.

Integration within Leetown, across the USGS, and throughout the DOI

Within the Center, landscape ecology is a common thread for scientists within all its research components. Virtually every biological research activity at Leetown would benefit from a stronger linkage to elements of landscape ecology. Likewise, *across the USGS*, landscape ecology can serve as a mechanism to integrate research activities across the Biology Discipline with the Geography, Geology, and Water Disciplines, as each are truly interrelated at the landscape scale. For example, Leetown is engaged in an ongoing dialog with the Geology Discipline to examine the influence of geological gradients in the structuring of plant and amphibian populations. Providing a focal point at Leetown will enhance these collaborations. Potential collaborations across the USGS Disciplines include:

- Influence of water quantity and quality changes on aquatic populations and habitats (Geography, Water, Geology, and Biology Disciplines);
- Landscape variables influencing the distribution and spread of mortality in coral ecosystems (Geography, Water, Geology, and Biology Disciplines);
- Influences of bedrock geology on distributions of rare species in national parks, national wildlife refuges, and other conservation areas (Geology and Biology Disciplines);
- Application of newly available remote sensing technologies for mapping aquatic habitats in wetlands, streams, and rivers (Geography, Water, and Biology Disciplines); and,
- Impacts of habitat fragmentation on species range shifts due to climate change (Geography and Biology Disciplines).
- Finally, *throughout the DOI*, landscape ecology will enable USGS researchers to address ecosystem management issues faced by our sister bureaus, by developing a variety of ecological management tools that could easily be incorporated into subsequent management actions. These opportunities are exemplified by two DOI agencies, the FWS and NPS, with which Leetown already has a strong programmatic relationship.

The FWS is vigorously pursuing a strategic habitat conservation initiative (SCH) in order to expand its capacity to apply population/habitat modeling, landscape characterization and assessment, integrated monitoring at various spatial scales, and biological information management. A dynamic and robust aquatic and terrestrial landscape ecology program within Leetown and across the Bureau provides the USGS with the opportunity to expand our capacity for population and ecological modeling, increase our emphasis on developing monitoring techniques for key environmental indicators, and collaborate with the FWS on place-based information delivery and strengthened support for adaptive management.

The NPS is interested in applying landscape ecology approaches to their "Vital Signs" Inventory and Monitoring Program so they can (1) better understand the dynamic nature and condition and of wildlife and habitats on NPS lands, and (2) better integrate this natural resource inventory and monitoring information into National Park Service planning, management, and decision making. LSC has been actively engaged in studies in the National Parks, and our scientists serve on advisory committees for design and implementation of monitoring programs.

LSC seeks to expand our partnerships within the USGS and DOI, and to develop and apply landscape ecology approaches to the benefit of all our research partners.

Biological surveys, field mapping, and spatial analysis of pond habitats in Delaware Water Gap NRA are being used to determine population status, breeding habitat usage, and potential threats to pond breeding amphibians from near park development. (PI: Snyder, Young)