Conserving Important Habitat for Amphibians and Other Wildlife: Compilation of Vernal Pool Mapping Efforts across the North Atlantic Region

A project of the North Atlantic Landscape Conservation Cooperative
Priority Science Program

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Project Description—We will compile a comprehensive GIS dataset of known and potential vernal pool locations in the NALCC region. Through a series of meetings and workshops with state agency staff, academics, NGOs, and others involved in vernal pool research and conservation, we will share information about the project, learn what geospatial data exist, and determine where data gaps occur. To ensure the participation of key collaborators, we will selectively offer travel support, compensation for significant, privately held geospatial data, and co-authorship on publications. We will also seek input from participants on the development of a regional framework for coordinating vernal pool data—the Vernal Pool Data Cooperative (VPDC). This database would provide a framework to organize observational and geospatial data on vernal pools, provide tools for data analysis and visualization, and include a metadata library cataloguing the original data sources. Cooperators will be able to upload geospatial and other data to the VPDC database through an online tool that allows contributors to set restrictions on data use. We will also compile and describe all the coordinated vernal pool mapping efforts in the region in a technical review document. Finally, we will develop a method to identify potential vernal pools using Light Detection and Ranging (LiDAR) technology and object-based image analysis (OBIA), a technique that focuses on meaningful landscape objects rather than individual pixels. To demonstrate the feasibility of the OBIA approach we will examine two pilot sites with well-developed vernal pool databases and where high-quality remote-sensing data exist (e.g., Vermont and New Jersey). Models will be field-verified using known vernal pool locations. This is a 2-year project that will begin Jan. 2014.

INTRODUCTION

The first step in developing effective conservation strategies for vernal pools and associated wildlife species is to know where on the landscape these small wetlands exist. Without this information, large-scale conservation planning and habitat modeling cannot be achieved. For example, the NALCC project, *Designing Sustainable Landscapes*—which assesses the capability of habitats to sustain wildlife populations in the North Atlantic region—has developed habitat-climate capability models for a variety of species of birds, mammals, and reptiles. However, lacking a regional map of vernal pool locations, these models cannot be developed for vernal pool-dependent species.

Several states in the Northeast region have initiated coordinated vernal pool mapping projects, including Massachusetts (Burne 2001), New Jersey (Lathrop et al. 2005), and Vermont (Faccio et al. 2013), while Maine (A. Calhoun, pers. comm.), New Hampshire (M. Marchand, pers. comm.), and New York (S. McNulty, pers. comm.) have mapped vernal pools on a more limited geographic scope. However, these projects have used varying methods to identify potential and verified vernal pools, and in many cases have defined vernal pools differently. Vernal pools have also been mapped on National Wildlife Refuges and National Parks and Historic Sites through the Amphibian Research and Monitoring Initiative (E. Grant, pers. comm.). Additional information on vernal pool locations within the region also exist, but these data are scattered among non-governmental organizations (including TNC, land trusts, and conservation organizations), universities, herp atlas projects, state agencies, municipalities, forestry professionals, and environmental consultants. Assembling these data into a single, comprehensive GIS dataset would not only help advance vernal pool conservation, but may ultimately lead to additional collaboration among various vernal pool stakeholders.

METHODS

Task 1 – Compile a comprehensive GIS dataset of currently mapped vernal pool locations in the NALCC region, including potential and verified pools.

We will first communicate directly with state agency staff (e.g., fish and wildlife, wetlands office, etc.) and Northeast Partners in Amphibian and Reptile Conservation (NEPARC) members to determine what vernal pool location data exist in each state within the NALCC region. At the same time, a list of vernal pool stakeholders will be developed for each state that will include individuals and organizations who may have vernal pool location data. In consultation with the North Atlantic LCC, we will also establish an advisory committee for the project.

We will then organize two regional workshops with stakeholders from each state to share information about the project, learn more about what data exist and in what formats, and determine where data gaps occur. We will also ask participants for input on a preliminary regional framework for coordinating vernal pool data in the future. Similar to the Avian Knowledge Network (see http://www.avianknowledge.net/content/about), the Vernal Pool Data Cooperative would provide a system for organizing observational and geospatial data on vernal pools and provide tools for data analysis and visualization. To ensure the participation of key collaborators, we will selectively offer travel support, compensation for significant, privately held geospatial data, and co-authorship on scientific publications expected to result from analysis of the compiled data. Supplementary outreach and data recruitment will also be done at important regional meetings, such as the Northeast Fish and Wildlife Conference, the annual meeting of NEPARC, and – pending an invitation – a meeting of the Northeast Fish and Wildlife Diversity Technical Committee. Throughout this process, we will stress that this project is focused on compiling geospatial data on vernal pool locations, along with basic information about physical and biological attributes of pools. We will not be requesting additional data from researchers with ongoing ecological studies on vernal pools or pool-breeding organisms. By the end of each workshop, we expect to have lists of cooperators willing to share vernal pool location data and metadata, along with a template of necessary data fields to be populated.

Next, we will build a database in which to archive the geospatial and associated physical and biological information, which will undoubtedly be in a variety of formats and projections, and exhibit a wide range of spatial accuracy. We will also build a metadata library cataloguing all the information about the original data source. Our plan will be to also develop an online tool that uploads data to the Vernal Pool Data Cooperative database, and allows contributors to set restrictions on data use.

Task 1 Key Events

1. Winter 2014 – Organize regional workshops
2. Spring 2014 – Host regional workshops (southern region and Northeast)
   – Convene an outreach meeting in April at Northeast Fish and Wildlife Conference, Portland, ME
3. Summer 2014 – Build database to archive geospatial and associated physical and biological attribute data.
   July – Host outreach/feedback workshop at NEPARC meeting (western NY)
4. Summer-Fall 2014 – Receive and archive data into database; proof and complete metadata.
   – Incorporate stakeholder feedback into a framework for expanded collaboration.

Task 2 – Compile and describe the various mapping and certification approaches currently being employed in the region.

Through workshops and ongoing discussions with the vernal pool conservation and research community, we will identify each coordinated mapping project within the region. We will then review methodologies and results of each project (via direct communication with project leaders and from project documents, reports, published papers, etc.) and describe the various approaches that have been or are currently being carried out in a technical review document. This document will include a matrix summarizing each project's geographic scope, methods, results, efficacy, and availability. We will also highlight the pros and cons of each approach, and recommend which are the most promising for future mapping efforts.

Task 2 Key Events

1. Spring-Summer 2014 – Identify and review all coordinated mapping projects.
2. Fall 2014 – Prepare review document.

Task 3 – Where mapping has not been undertaken, prioritize areas (e.g. through modeling) for future mapping based on likely density of vernal pools or density of high quality vernal pools.

The University of Vermont Spatial Analysis Laboratory (SAL) will develop a method to identify potential sites for vernal pools using Light Detection and Ranging (LiDAR) technology and object-based image analysis (OBIA). LiDAR technology has been used to map isolated wetlands in coastal plain locations (Leonard et al. 2012), and LiDAR return intensity has been combined with site-specific spatial associations (such as the juxtaposition of water and dry land) to predict the location of potential amphibian breeding ponds (Julian et al. 2009). These studies and others have developed an important framework for remote sensing of vernal pools. Still, additional progress is possible through object-based image analysis (OBIA), a technique that focuses on meaningful landscape objects rather than individual pixels (Benz et al. 2004). This focus on objects permits effective analysis of context, an essential element for discriminating nuanced ecological features. We have applied OBIA techniques to a variety of mapping efforts, including multiple land-use/land-cover and tree-canopy projects, producing high-resolution maps with direct value to landscape analysis and management (O'Neil-Dunne et al. 2012, MacFaden et al. 2012) and green-infrastructure planning (Locke et al. 2010).

To demonstrate the feasibility and utility of the OBIA approach, we will examine two sites in the North Atlantic region: one in the northern tier and one in the southern tier. These pilot sites will occur in states with well-developed vernal pool databases and where high-quality remote-sensing data exist (e.g., Vermont and New Jersey). Each site will encompass an area roughly equivalent to a county. This area matches the scale at which many LiDAR datasets are acquired and will be large enough to illustrate the

efficiency of OBIA methods. For each study site, we will collect the best available LiDAR, multispectral imagery, and thematic datasets. The use of existing data is a crucial part of our approach, avoiding the expense of new remote-sensing acquisitions and maximizing previous investments in public geographic information. It is also practical because interest in and use of LiDAR are expanding rapidly, meaning that it will ultimately be possible to export our approach across the North Atlantic region. With available LiDAR, we will derive additional input datasets, including: high-resolution digital elevation models (DEM); normalized digital surface models (nDSM) that indicate the height of above-ground features (i.e., trees); hydrological maps depicting fine-scale stream flows; local relief models; and local indicators of spatial association, which illustrate clustering patterns in local relief (Fig. 1).

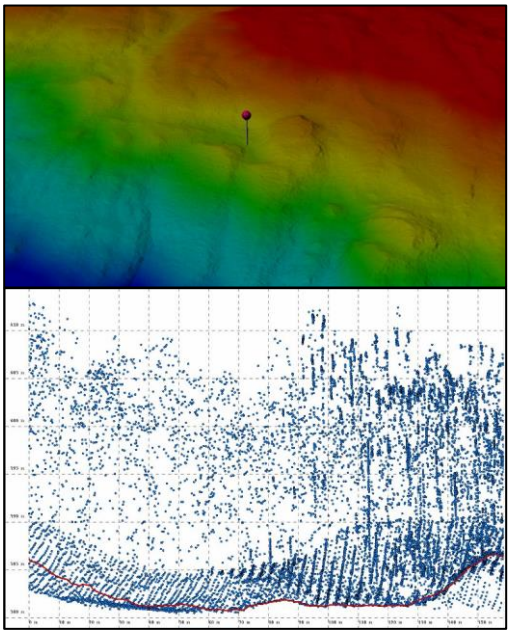

Fig. 1. Vernal pool depression illustrated using DEMs generated from LiDAR (top), and in side profile (bottom) (the blue points are the LiDAR returns, the red line is the bare earth profile from the DEM).

After acquiring and deriving all necessary datasets, we will analyze them in eCognition (Trimble), state-of-the-art OBIA software. Specifically, we will develop expert systems that segment and classify the available data into objects representing features on the ground. An expert system approximates human knowledge by incorporating rules that discriminate objects according to their individual characteristics and relationships to other objects. We will first incorporate rules that exclude areas unlikely to contain vernal pools, such as built areas, roads, and other impervious features. We will then identify concavities where water could collect during spring thaws and precipitation events. Because hydrological flows and shade also affect the function of vernal pools, we will further evaluate whether candidate sites have permanent outflows and canopy cover. Together, these rules will identify sites most likely to support viable vernal pools.

To evaluate the output maps, we will perform an accuracy assessment using known vernal pool locations. We will document all methods and results in a final report, and we will submit the final map of potential vernal pool locations to North Atlantic LCC with FGDC-compliant metadata. We will also submit all pertinent data sources, including each area-specific DEM, nDSM, LRM, and hydrological map. Assuming the assessment proves to be successful and useful, the final report will include information and a map on the current availability of LiDAR data across the region that is of sufficient quality or resolution for vernal pool mapping, a description of the level of effort and technical expertise likely to be required to apply the methods elsewhere, and lessons learned or other information that would be useful to others who would like to use the methods.

Sustaining the Project after the Period of the Grant

By initiating and funding this project, the NALCC is providing an opportunity to address a major need in vernal pool conservation. To compile a comprehensive dataset and establish a sustaining framework is a significant undertaking. The geographic scope, complexity of tasks, and diversity of stakeholders call for a long-term strategy that should produce peer-reviewed science to support landscape-scale decisions. VCE and its collaborators are committed to vernal pool conservation, and have invested significant time and resources into ecological studies, developing and testing monitoring protocols, and statewide mapping of vernal pools in Vermont. If awarded this opportunity, we plan to apply for additional funding from several charitable foundations (including Davis Conservation Fund, William P. Wharton Trust, and Conservation and Research Foundation) to support analysis, write-up, and packaging of information for NALCC and NEAFWA users. We will also seek additional opportunities to work with NALCC and NEAFWA to implement the Vernal Pool Data Cooperative and develop decision-support tools that satisfy the interests

of the Northeast's vernal pool research and conservation community. We also plan to pursue additional collaborations with the UVM Spatial Analysis Lab to further develop and refine remote sensing methodologies for detecting vernal pools.

LITERATURE CITED

Benz, U.C., P. Hofmann, G. Willhauck, I. Lingenfelder, and M. Heynen. 2004. Multi-resolution, object-oriented fuzzy analysis of remote sensing data for GIS-ready information. Photogrammetry & Remote Sensing 58:239-258.

Burne, M. R. 2001. Aerial photo survey of potential vernal pools. Massachusetts Natural Heritage and Endangered Species Program, Westborough, MA.

Faccio, S.D., M. Lew-Smith, and A. Worthley. 2013. Vermont Vernal Pool Mapping Project: Final report to the Natural Heritage Information Project. Vermont Department of Fish and Wildlife, Montpelier, VT.

Julian, J.T., J.A. Young, J.W. Jones, C.D. Snyder, and C.W. Wright. 2009. The use of local indicators of spatial association to improve LiDAR-derived predictions of potential amphibian breeding ponds. Journal of Geographical Systems 11:89-106.

Lathrop, R. G., P. Montesano, J. Tesauro, and B. Zarate. 2005. Statewide mapping and assessment of vernal pools: a New Jersey case study. Journal of Environmental Management 76:230–38.

Leonard, P.B., R.F. Baldwin, J.A. Homyack, and T.B. Wigley. 2012. Remote detection of small wetlands in the Atlantic coastal plain of North America: local relief models, ground validation, and high-throughput computing. Forest Ecology and Management 284:107-115.

Locke, D.H., J.M. Grove, J.W.T. Lu, A. Troy, J.P.M. O'Neil-Dunne, and B.D. Beck. 2010. Prioritizing preferable locations for increasing urban tree canopy in New York City. Cites and the Environment 3(1):article 4.

MacFaden, S.W., J.P.M. O'Neil-Dunne, A.R. Royar, J.W.T. Lu, and A.G. Rundle. 2012. High-resolution tree canopy mapping for New York City using LiDAR and object-based image analysis. Journal of Applied Remote Sensing 6:doi:10.1117/1.JRS.6.063567.

O'Neil-Dunne, J.P.M., S.W. MacFaden, A.R. Royar, and K.C. Pelletier. 2012. An object-based system for LiDAR data fusion and feature extraction. Geocarto International:doi:10.1080/10106049.2012.689015.

PROJECT BUDGET

Grantee agrees to conform to budget amounts and categories as specified in the grant proposal submitted to the Wildlife Management Institute.

GRANT			
	FEDERAL FUNDS	**NON-FEDERAL MATCH**	**TOTAL**
Salaries and/or Wages	$10,429	$7,676	$18,105
Fringe Benefits	$4,526		$4,526
Travel	$2,000		$2,000
Equipment			
Supplies & Materials	$2,000		$2,000
Contractual Services	$67,000		$67,000
Indirect Cost Rate 15 %	$14,045		$14,045
Total	$100,000	$7,676	$107,676