Project Title:

Revisions to the Northeast Terrestrial Habitat Map

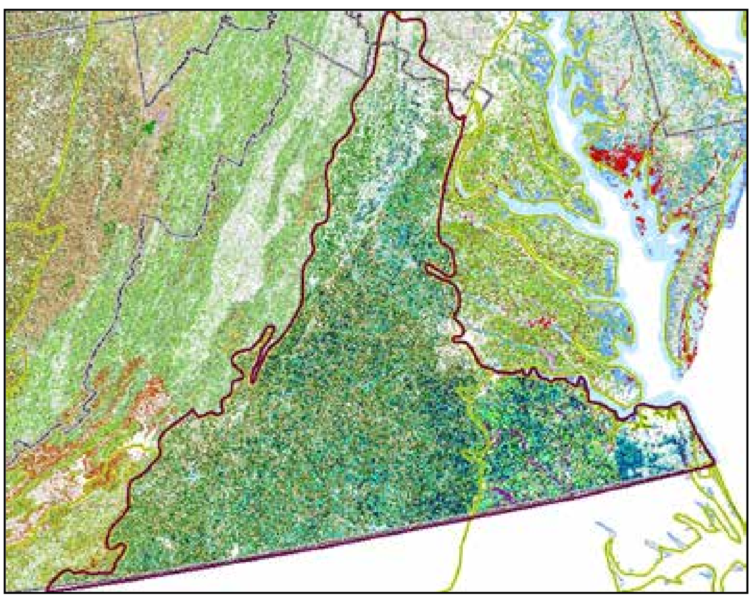
A Habitat Map for Virginia Piedmont and Coastal Plain

Project Director
Mark G. Anderson, Ph.D.
Director of Conservation Science
The Nature Conservancy
Eastern North America Division
99 Bedford Street
Boston, MA 02111
Phone: 617-532-8354,
fax: 617-532-8400
manderson@tnc.org

Principle Investigator:
Charles Ferree, M.S.
The Nature Conservancy
Eastern Region
99 Bedford Street
Boston, MA 02111
Phone: 617-532-8300
fax: 617-532-8400
cferree@tnc.org

Abstract: The objective of this project was to revise the Northeast Terrestrial Habitat Map (Ferree and Anderson 2011) for the Peidmont and Coastal plain sections of Virginia. The revised map consists of a spatially comprehensive GIS grid of 30 meter pixels with a legend portraying the NatureServe Terrestrial Habitat Classification System (Figure 1, Comer et al. 2010). The project was guided by a steering committee of Virginia ecologists, Agency biologists and spatial analysts. Contributions of precisely located plot data were provided by the Virginia Natural Heritage Program and the USFS Forest Inventory and Analysis program. Our mapping methods followed those we developed to create the Northeast Terrestrial Habitat Map and the final map was integrated with the rest of the Northeast Map to create a single, seamless, and comprehensive coverage of terrestrial habitats across fourteen US states (Figure 1). The map and data is posted at: http://conserveonline.org/workspaces/ecs/documents/ne-terrestrial-habitat-mapping-project

Figure 1. Left: close up of area covered by these revisions (red line) showing the final map of terrestrial habitats. Right: image of region-wide habitat map incorporating the revised sections of Virginia.



Title: **A Habitat Map for Virginia Piedmont and Coastal Plain**

Geography and Overview: The revised map covers the piedmont and coastal plain portions of Virginia and extends slightly into Maryland.

Date of Completion: June 23, 2012

Goal and Relevance: The objective of this project was to revise the Northeast Terrestrial Habitat Map (NETHM **-** Ferree and Anderson 2011) for the Piedmont and Coastal plain sections of Virginia. Data for the previous version of this area were originally adopted from the Southeast GAP map so that the habitat map would be fully consistent with the rest of the southeast piedmont and coastal plain maps to the south. However, when agency biologists from Virginia reviewed the product they requested that it be revised to make it fully consistent with the rest of the state and with the region to the north.

The revised map consists of a spatially comprehensive GIS grid of 30 meter pixels with a legend portraying the NatureServe Terrestrial Habitat Classification System (Figure 1, Comer et al. 2010). The project was guided by a steering committee of Virginia ecologists and Agency biologists and spatial Analysts and the final product was approved by this team. Contributions of precisely located plot data were provided by the Virginia Natural Heritage Program and the USFS Forest Inventory and Analysis program. The final map was integrated with the NETHM data to create a single downloadable product that provides a seamless and comprehensive coverage of terrestrial habitats across the Northeast and Mid-Atlantic states (Figure 1).

Steering Committee: To ensure the relevance of this work to the Virginia Agency staff we formed a committee consisting of five scientists and managers: Becky Gwynn (DGIF), Kendell Ryan (DGIF), Chris Burkett (DGIF), Jim Husband (DGIF) and Steve Fuller (NA LCC). Additionally, we consulted regularly with Gary Fleming and Karen Patterson of the Virginia Natural Heritage program. The steering committee participated in three WEBEX seminars to 1) review the initial methods and data, 2) review of the modeling results, 3) quality control of the final map.

Methods: The methods we used to create this map were developed and refined during the three-year period in which we produced the Northeast Terrestrial Habitat Map. A longer document detailing the methods is under production and will be available by June 2013. The approach makes extensive use of field-collected data combined with national and state datasets. Early in the project we spent time developing spatial datasets of important environmental variables, and in compiling numerous plot-based samples of various ecological systems. The modeling process combines the plot-based samples, tagged to the correct ecological system, with the region-wide GIS data layers. Regression trees were used to identify the variables that best delineate the ecological systems, and then to model those systems. The final map is a composite of the individual models.

Steps in the development of the map include:

1) Compile foundation datasets for entire region (landforms, geology, climate, land cover, etc.)
We assembled region-wide spatial datasets for environmental variables known to be drivers of ecological variability including: bedrock and surficial geology, aspect, slope, and elevation, and landform and topographic roughness. These were combined with upland and wetland land cover, stream reaches and hydrological networks, solar radiation, and bioclimatic datasets based on precipitation and temperature. In total we derived about 60 variables for use in the analysis.

2) Develop a list of ecological systems, and meet with appropriate state staff to understand their distribution, scale, and landscape pattern.

We worked with ecologists at the Virginia Natural Heritage program to develop the list and descriptions of all the ecological systems that occur in the region. The list was based on a previous compilation of natural communities and vegetation types for the region (Gawler 2008, Comer et al. 2010) and on Fleming and Patterson (2010) Natural Communities of Virginia. Study and discussion resulted in a list of ecological system for the area of interest that directed and focused the mapping process.

3) Compile plot samples for ecological systems using Natural Heritage program data, forest inventory points, and other sources. Tag each sample with the appropriate ecological system.

The compilation of known examples of ecological system types, and the accurate classification of each samples to the correct type, was a crucial and time-consuming step in our process. Our known sample points for ecological systems totaled over 1,000 locations and included Forest Inventory and Analysis (FIA) points, State Natural Heritage Program inventory data and natural community maps, and vegetation maps on public lands, the latter contributed by the steering committee. FIA points were filtered to remove highly altered stands, and then classified into homogenous vegetation units based on their tree composition and ecological settings. The samples were cross-walked to a standard list of ecological systems (Gawler 2008).

4) Develop models for matrix-forming forest using regression tree analysis of tagged plot samples on the data sets of ecological information.

The dominant or matrix-forming forest systems of the region were modeled using a decision-tree based process (RandomForest) with 100 acre hexagons as the basic analytical units. To perform the mapping, we created a wall-to-wall map of hexagons (hundreds of thousands of hexagons) covering the entire region in a tessellated pattern, and each hexagon was attributed with the full set of ecological information described above (solar radiation, land cover, topography, etc.) Hexagons constructed around each confirmed location of a specific forest habitat type were attributed with the forest types as well as the ecological information. The RandomForest algorithm used this information to construct models for discriminating each of the matrix forest types based on the ecological signature of the hexagon. The RandomForest decision trees were then be used to classify every hexagon to the most probable ecological system type based on the ecological attributes of the hexagon.

5) Map the matrix forests onto the landscape using landform-based units.

The next step in the forest mapping process was to transfer the hexagon-based habitat information onto natural topographic units. We used thematic segmentation software to break large cohesive landform features into smaller discrete units. For each unit, we identified the 100-acre hexagon associated with it and use set of decision rules to assign each one to a given ecological system type, based on the RandomForest-assigned system for its parent hexagon. For example, low hills or cool slopes associated with a hexagon classified to the mesic oak forest system were assigned to that system, while a warm upper slope or ridge top associated with that same hexagon were assigned to the second most likely forest type, in this case dry oak-pine system. The information transfer was guided by the RandomForest-generated probabilities and signatures for the matrix forest systems within each hexagon.

6) Develop models for the wetland patch systems (swamps, marshes, bogs etc.) and the upland patch systems (barrens, glades, summits, cliffs etc.)

Wetlands and upland patch-scale communities for the region were modeled individually based on locations of known occurrences of each system type that occur in the region. Published descriptions of and ecological criteria for each type were used in concert with information on habitat ranges, elevation limits, edaphic/geologic factors, land cover and canopy cover, topographic factors like exposure, solar influx, surface roughness, and other landscape characteristics. Unlike the matrix-forest types the patch communities were modeled directly to the appropriate wetland polygon or landform unit based on the ecological information attributing each feature.

7) Assemble models into one region-wide map, develop legend, and merge with US map.
We assembled the individual maps and models into a single region-wide map and developed the legend using the Northeast Terrestrial Habitat Map legend as a starting point. The map was merged with the US map to create a single consistent map for the region.

Products and Outcomes: Deliverables consist of a revised version of the Northeast Terrestrial Habitat Map that is seamless and fully consistent across all included states. The map and data layers are of a spatially comprehensive GIS grid of 30 meter pixels with a legend portraying the NatureServe Terrestrial Habitat Classification System. The finished products, methods, and techniques used to develop the map are available at: http://conserveonline.org/workspaces/ecs/documents/ne-terrestrial-habitat-mapping-project

Investigators

Mark G. Anderson, PhD is the Director of Conservation Science of The Nature Conservancy's Eastern North America Division where he leads ecological and biophysical assessments of large regions. Dr. Anderson developed the ecoregion assessment methodology and led science teams to apply the methodology to 8 ecoregion and in measuring conservation progress across TNC's eastern region. He has been with TNC since 1991 and his papers have appeared in journals ranging from Bioscience to Environmental Management.

Charles Ferree, MS, is a Landscape Ecologist in TNC's Eastern Conservation Science Office. Mr. Ferree is responsible for development of ecological land units, modeling species distribution, mapping ecological systems and maintaining location data for terrestrial species. He has been with TNC since 2001 and is co-leader of the Northeast Terrestrial Habitat mapping project.
http://conserveonline.org/workspaces/ecs/documents/ne-terrestrial-habitat-mapping-project

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