Proposal to North Atlantic Landscape Conservation Cooperative

Project Title:

Extending the Northeast Terrestrial Habitat Map to Atlantic Canada

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NALCC funds requested: $95,238.000

Abstract: The objective of this project is to develop a comprehensive terrestrial habitat map for the entire extent of the North Atlantic Landscape Conservation Cooperative (NALCC) region by extending the Northeast Terrestrial Habitat Map (Ferree and Anderson 2011) to Atlantic Canada and southern Quebec. The map will consist of a spatially comprehensive GIS grid of 30 meter pixels with a legend portraying the NatureServe Terrestrial Habitat Classification System (Comer et al. 2010), which is used in both the US and Canada as a basis for conservation inventory and species modeling. The proposed map will cover the Canadian portion of the NALCC including all of the land area of New Brunswick, Nova Scotia and Prince Edward Island, and southern Quebec. The project will be guided by a steering committee of Canadian ecologists from provincial agencies, academic institutions, and the Conservation Data Centre (CDC). Contributions of precisely located plot data, collected by the by the CDC and provincial forest inventory programs, are essential to the success of this project. Our mapping methods will follow those we developed to create the Northeast Terrestrial Habitat Map and are summarized below. We anticipate this project will take a minimum of 24 months and will include a subcontract with the Conservation Data Centre to assist us in tagging data points to the correct ecological system as well as one to the Nature Conservancy of Canada to aid in compiling forest inventory and stream information. The final map, and accompanying report, will be integrated with the US maps and made widely available as a single downloadable product.

Section 2: Project Summary

Title: Extending the Northeast Terrestrial Habitat Map to Atlantic Canada

Geography and Overview: The proposed map will cover the Canadian portion of the NALCC including all of the land area of New Brunswick, Nova Scotia and Prince Edward Island, and southern Quebec (see map at http://northatlanticlcc.org/pdfs/AtlanticCoast_NALCC_Edit_map.pdf.) The project will be guided by a steering committee of Canadian ecologists from provincial agencies, academic institutions, and the Conservation Data Centre (CDC).

Start Date and End Date: January 1, 2013 to January 1, 2015

Goal and Relevance: Our objective is to develop a comprehensive terrestrial habitat map for the entire extent of the North Atlantic Landscape Conservation Cooperative (NALCC) region by extending the Northeast Terrestrial Habitat Map (Ferree and Anderson 2011) to Atlantic Canada and southern Quebec. The map will consist of a spatially comprehensive GIS grid of 30 meter pixels with a legend portraying the NatureServe Terrestrial Habitat Classification System (Comer et al. 2010), which is used in both the US and Canada as a basis for conservation inventory and species modeling. The proposed map will cover the Canadian portion of the NALCC including all of the land area of New Brunswick, Nova Scotia and Prince Edward Island, and southern Quebec. In the US, the Northeast Terrestrial Habitat map and dataset, developed by the authors of this proposal, is a fundamental building block for the NALCC, and a foundational product for ecological analysis in the Landscape Conservation Cooperatives (LCCs). Expanding the mapping into Canada is a priority for the NALCC because a comparable and consistent dataset available for the entire international region would provide a platform for the coordination of projects with neighboring LCCs and into Canada.

Methods: The methods we will use to create this map were developed and refined during the three-year period in which we produced the Northeast Terrestrial Habitat Map. They make extensive use of field-collected data combined with national and provincial datasets. Early in the project much time will be committed to the compilation and development of 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 are used to identify the variables that best delineate the ecological systems, and then to model those systems. This final map is a composite of the individual models. Structural attributes like canopy density and datasets related to vegetation height and biomass may have a role in detailing forest successional stage.

Steps in the development of the map include:

1) Compile foundation datasets for entire region (landforms, geology, climate, land cover, etc.)

We will begin by assembling region-wide spatial datasets for environmental variables known to be drivers of ecological variability. The variables will include: bedrock and surficial geology, aspect, slope, and elevation, and landform and topographic roughness. These will be combined with upland and wetland land cover, stream reaches and hydrological networks, solar radiation, and bioclimatic datasets based on precipitation and temperature. In our US work, we derived about 60 variables for use in the analysis, and we anticipate a similar set for Canada. We will also compile and assemble a consistent land cover map for the area because the currently available maps differ across province boundaries.

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

We will work with provincial ecologists to develop the list and descriptions of all the ecological systems that occur in the region. The list will be based on a previous compilation of natural communities and vegetation types for the Northern Appalachian region (Anderson et al. 2006) that was created in conjunction with the Atlantic CDC and Quebec NCC ecologists. We will take advantage of recent descriptions and revisions completed for Maritime Canada (Basquill 2009) as well as the existing list of ecological systems developed by NatureServe in conjunction with the state and provincial ecologists for Eastern North America (Comer et al. 2010). Completion of this work will result in a guidance document that will direct and focus the mapping process.

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

We envision this step to be partially completed through a subcontract.

The compilation of known examples of ecological system types, and the accurate classification of each samples to the correct type, is a crucial and time-consuming step in our process. In the US, our known sample points for ecological systems totaled over 70,000 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. In Canada, the Canadian Conservation Data Centre (CDC) is a parallel entity to a State Natural Heritage Program in that the CDC tracks the locations of rare and unusual communities and the best examples of common communities. Working with the CDC and other provincial ecologists, we will compile natural community element occurrences (point locations) and each location will be cross-walked and tagged to an ecological system. In addition, CDC ecologists may provide supplemental plot data taken during the course of ecological inventories, and these will be put to a similar use. We will contract directly with the CDC, and contact other appropriate Canadian agency staff, for this step. Accuracy of the habitat/system tags will be evaluated by attributing confirming points and polygons with basic environmental information and viewing them in a GIS.

Detailed vegetation and natural community maps are available in some parts of the region, mostly associated with forest management inventories or conservation maps. These will be compiled, converted into points, and tagged to the appropriate ecological system types by NCC and CDC ecologists in conjunction with US scientists. We are currently investigating the availability of data comparable to the US Forest Inventory and Analysis points (e.g. perennial inventories of forest stands with information on composition and condition). We have located promising sources of this type of data in New Brunswick and Nova Scotia and we have held preliminary discussion with an experienced NCC Spatial Analyst familiar with this data. *We expect to contract with the Atlantic Canada office of Nature Conservancy Canada (NCC) for the compilation of this data set*. The points will be filtered to remove highly altered stands, and then classified into homogenous vegetation units based on their tree composition and ecological settings using a cluster analysis. The homogenous units will then be cross-walked to the regional ecosystem units by Nature Conservancy (TNC) scientists.

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 will be modeled using a decision-tree based process (RandomForest) with 100 acre hexagons as the basic analytical units. To perform the mapping, we will create a wall-to-wall map of hexagons (hundreds of thousands of hexagons) covering the entire ecoregion in a tessellated pattern, and each hexagon will be 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 will be attributed with the forest types as well as the ecological information. The RandomForest algorithm uses 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 will 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 will be to transfer the hexagon-based habitat information onto natural topographic units. We will use thematic segmentation software to break large cohesive landform features into smaller discrete units. For each unit, we will identify 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 would be assigned to that system, while a warm upper slope or ridge top associated with that same hexagon would be assigned to the second most likely forest type, in this case dry oak-pine system. The information transfer will be 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 will be 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 will be 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 will be 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 will assemble the individual maps and models into a single region-wide map and develop a legend using the Northeast Terrestrial Habitat Map legend as a starting point. The map will be merged with the US map to create a single consistent map for the region.

Steering Committee: To ensure the relevance of this work to NECSC, Provincial agencies, CDCs and to the North Atlantic Landscape Conservation Cooperative we will ask each participating province to nominate one or two agency staff to participate on a steering committee meeting quarterly by phone. Additionally, we will invite other UMASS staff involved in the current LCC project “designing sustainable landscapes” to participate on the steering committee. This collaborative network of scientists will participate in 1) reviewing the guidance document and initial methods, 2) review of the modeling results, 3) providing quality control of the final report. We will host periodic Web-ex calls with the steering committee to maintain communication about the project and discuss and review the results.

Products and Outcomes: Deliverables will include: 1) a comprehensive map of terrestrial habitats for the Canadian portion of the NALCC, seamless and fully consistent with the map for the US portion, 2) a report describing the methods used to develop the map, and 3) framework datasets (if distributable). The map and data layers will consist 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 will be published, distributed and made broadly available.

Budget.

Fiscal Contact;	Susan Hortenstine; 617-532-8335
Total project cost;	$220,238.00
Total NALCC funding request;	$ 95,238.00

Agency Partner Leverage Amount: In June, the USGS Northeast Climate Science Center approved funding of 125,000.000 for this project, anticipating a match from the North Atlantic LCC. We are exploring other sources as well.

Expense Category	Requested Funds (LCC)	Leveraged Funds (USGS)	Total Budget
Personnel	$ 56,838	$ 28,826	$ 85,664
Fringe Benefits	$ 23,872	$ 12,106	$ 35,978
Travel	$ -	$ 10,000	$ 10,000
Supplies	$ -	$ 500	$ 500
Contractual	$ -	$ 50,000	$ 50,000
Other	$ -	$ 4,500	$ 4,500
Total Direct	***$ 80,710***	$ 105,932	***$ 186,642***
Indirect	*$ 14,528*	$ 19,068	*$ 33,596*
TOTAL COSTS	**$ 95,238**	$ 125,000	**$ 220,238**

Description of Project Costs:

Personnel time is estimated at 320 days. Personnel providing hours on this project include the Director of Conservation Science, the Landscape Ecologist, and other TNC science staff. Fringe benefits are included in the Personnel line at 42% for regular TNC staff, in accordance with our July 1, 2011 NICRA with the U.S. Department of the Interior (copy available upon request).

Supplies and Other Expenses include the costs associated with hosting Web Ex meeting and final production costs such as printing, supplies. We do anticipate the need for face-to-face travel but much of the steering committee work can be done through teleconference and WebEx meetings. Supplies and Materials are estimated at $500.

Contractual costs are estimated for contractual support from the Conservation Data Center (Contract 1) to tag plot samples for the ecological system classification. Contract 2 is for Nature Conservancy Canada to compile forest inventory data from Provincial sources and to assemble stream GIS data.

Indirect costs will be charged in accordance with TNC's annually negotiated cost rate agreement with the U.S. Department of the Interior (copy available upon request). The rate changes each year on July 1st. The current rate for FY12 is 22.55%; the proposed rate for FY13 is 18%. Indirect costs will be adjusted annually throughout the life of the project.

Travel costs are for two TNC staff to attend three in-person workshops/meetings. This assumes separate two-day workshops in Quebec, New Brunswick and Nova Scotia and includes costs for air travel and overnight lodging.

Mark G. Anderson, PhD, is the Director of Conservation Science of The Nature Conservancy's Eastern Region where he developed and performed 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. Dr. Anderson has been with TNC since 1991 and his papers have appeared in journals ranging from Bioscience to Environmental Management. His most recent publication is a chapter on integrating ecoregional planning at greater spatial scales. in S.C. Trombulak and R.F. Baldwin (eds.), Landscape-scale Conservation Planning.

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

Kevin McGarigal, PhD is currently a professor in the Department of Environmental Conservation at the University of Massachusetts, Amherst, and Director of the Landscape Ecology Lab. His overall professional goal, achieved through research, teaching, and outreach, is to improve our understanding of how landscapes are structured physically and biologically and the agents responsible for those patterns, how these patterns affect the distribution and dynamics of animal populations, how these patterns and processes change over time, and how to apply this information to better manage natural resources over multiple spatial and temporal scales. He earned his PhD in the Forest Sciences Department at Oregon State University in 1993, where he studied the relationship between landscape structure and avian abundance patterns in the Oregon Coast Range.

Literature Cited

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Extending the Terrestrial Habitat map to Atlantic Canada: (January 1, 2013 to January 1, 2015)
Timeline

2013

January: **Establish key contacts and steering committee, Set up subcontracts**

Circulate proposal to potential Canadian partners, host web ex and establish preliminary contacts
Set up subcontracts with CDC and NCC

February – September: **Compile foundation datasets for entire region**

Assess current source and new data revisions for bedrock and surficial geology, aspect, slope, and elevation, and landform, landscape position, and topographic roughness, ecological regions, upland and wetland land cover, stream reaches and hydrological networks, solar radiation, and bioclimatic datasets based on precipitation and temperature. We will also compile and assemble a consistent land cover map for the area.

February – September: **Develop a list of ecological systems for Maritime Canada, Compile plot sample data sets for the region.**

Compile existing ecological systems lists.
Execute contracts for compilation of sample data (CDC data, forest inventory points, etc.)
Meet with Canadian state staff to review list, discuss data, finalize list.
Revise and expand list as needed.
Finalize guidance document
<u>Milestone: Datasets and Classification ready. Vet with Steering Committee</u>

October - January: **Tag compiled plot samples to appropriate ecological systems**

Assign and review all point samples for their appropriate ecological system

2014

February – May: **Develop models for matrix-forming forest using regression tree analysis**

Model tagged samples using data sets of ecological information.
Map the matrix forests onto the landscape using landform-based units.
<u>Milestone: Matrix forest types mapped. Vet with Steering Committee</u>

June - September: **Develop models for the wetland patch systems (swamps, marshes, bogs etc.) and the upland patch systems (barrens, glades, summits, cliffs etc.)**

Model tagged samples using data sets of ecological information.

October: **Host final review and vetting of map components with committee**

Host Web Ex discussions to engage steering committee in final review of map
<u>Milestone: Patch types mapped. Vet with Steering Committee</u>

November-December **Assemble models into one region-wide map and develop legend**

January 2015 **Finalize datasets and post map.**