Proposal to the Appalachian Landscape Conservation Cooperative, Science Need #2

Project Title:

A Stream Classification System for the Appalachian Landscape Conservation Cooperative

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

Principal Investigator:
Arlene Olivero, M.S.
The Nature Conservancy
Eastern Region
99 Bedford Street
Boston, MA 02111
Phone: 617-532-8300
fax: 617-532-8400
aolivero@tnc.org

Contract Hydrologist
Ryan A. McManamay, Ph.D.
Postdoctoral Research Associate
Oak Ridge National Laboratory
Environmental Sciences Division, Bldg 1504
Oak Ridge, TN 37831-6351
865-574-9154

Funds Requested: **$74,458.00**
Offered Match: **$21,200.00**
Total Cost of Project: **$95,658.00**

Project Summary
The goal of this project is to develop a hierarchical classification for stream and river systems within the Appalachian Landscape Conservation Cooperative (LCC). The classification will be developed under the leadership of the Nature Conservancy's Eastern Conservation Science office and guided by a steering committee representing all the included states. Additionally a hydrologic model and map will be developed through a contract staff from with the Oak Ridge National Laboratory. Final products will include: 1) a GIS stream data set based on the NHD+ medium resolution stream reaches attributed with the selected classification variables such as stream size, gradient, geology and pH, temperature, and hydrologic class, and 2) a report describing the method used to develop the classification, and a literature review of existing stream classifications in the Appalachian region.

Statement of Work

Title: A Stream Classification for the Appalachian Landscape Conservation Cooperative

Project Narrative: To support development of instream flow standards and aquatic conservation planning, this project will develop a classification system and GIS map for aquatic ecosystems in the Appalachian Landscape Conservation Cooperative region. This classification system will identify and consistently map ecologically similar types of rivers and streams using a flexible hierarchical set of geomorphic and hydrologic variables deemed appropriate for classification by the participating states and relevant to the spatial scale of management The Nature Conservancy's Eastern Conservation Science Office will conduct a literature review of existing classification efforts in the region and engage a workgroup of state, federal, university, and NGO representatives to participate in monthly conference calls to review the existing classifications, justify the chosen classification approach, and review the output of chosen classification variables and models. Additionally, we will contract with staff from Oak Ridge National Laboratory to develop a hydrologic model and classification for the area (McManamay et al. 2011a). Final products will include a downloadable summary report and GIS dataset which will provide users with a consistent aquatic spatial classification framework that incorporates geomorphic and hydrologic classification to define aquatic habitat unit types that are useful in further instream-flow research. The final products will be consistent with the stream classifications developed by this team for the North Atlantic LCC (Olivero and Anderson 2008) and the Southeast Aquatic Resource Partnership (in prep).

Important Background Information: The importance of natural flow regimes to the ecological integrity of rivers has been established for decades, but more specific river classification information is needed to develop and implement instream flow standards and management recommendations (Richter 2009, Richter et al. 2011, Poff et al. 2010). Only with more comprehensive spatially linked river classification data can we build scientifically credible regional environmental flow standards, and only by investing in these core aquatic classification datasets will environmental flows become integral to all water management decisions from the onset (Poff et al. 2010).

Aquatic habitat classification provides a critical foundation for flow-ecology research and is rooted a few key guiding principles and assumptions about the linkages between aquatic habitat structure and biological communities. 1) Aquatic communities exhibit distribution patterns that are predictable from the physical structure of aquatic ecosystems. (Schlosser 1982, Tonn 1990, Hudson et al. 1992); 2) Although aquatic habitats are continuous, we can make reasonable generalizations about discrete patterns and breaks to define habitat class types (Vannote et al. 1980, Schlosser 1982, Hudson et al. 1992); 3) Streams within a class are expected to have similar hydrologic and biologic properties and respond to flow alterations in a predictable way (Poff 2010), 4) Large-scale physiographic and climatic patterns influence the distribution of aquatic organisms and can be used to predict the expected range of community types within these large zones (Maxwell et al. 1995, Angermeier and Winston 1998); 5) By nesting small classification units within the large climatic and physiographic zones, we can account for aquatic community diversity that is difficult to observe or measure (taxonomic, genetic, ecological, evolutionary context) (Frissell et al. 1986, Angermeier and Schlosser 1995). These guiding principals

allow aquatic classification efforts to successfully represent the diverse patterns of aquatic biota and processes found on the landscape.

The Nature Conservancy's Eastern Conservation Science has a long track record of producing aquatic habitat classification products that take these principals into account. Our group has particular experience in developing regional aquatic classifications which are flexible, scaleable, represent the diversity of the region aquatic biota and processes, and which are practical to implement at a regional scale. Although developing a geomorphic and hydrologic classification system specifically at the same spatial extent and time is a new concept, making these layers jointly compatible at the same spatial scale is a robust approach that will allow much future utility to users.

In 2008 we completed a parallel project to this for thirteen Northeast and Mid-Atlantic states guided by a steering committee of agency biologists and funded by the NE Association of Fish and Wildlife Agencies. (For the report and spatial data see http://www.rcngrants.org/spatialData).This project is now being used by the individual states and is one of the foundation data sets for the North Atlantic LCC. The Appalachian LCC project area overlaps with the extent of the previous project that covered all of NY, PA, WV, VA, MD, and CT. We plan to make extensive use of this overlap to create a consistent stream classification across both the Landscape Conservation Cooperatives. Further we are just finishing a draft stream classification for the Southeast Aquatic Resource Partnership that also overlaps in extent.

Project Goal: The goal of this project is to develop a hierarchical classification for stream and river systems within the Appalachian LCC. The classification is meant to unify existing geomorphic and hydrologic classifications that occur within the LCC, to consistently represent the natural flowing-water aquatic habitat types across this region in a manner deemed appropriate and useful for building ecological flow ecology relationships and other conservation planning tools. Specifically the classification will: 1) provide a regional spatial classification foundation upon which further research can advance flow-ecology research and applications to flow policy and management; 2) provide common definitions and mapping of aquatic habitat types across state lines allowing each state to identify aquatic habitats consistently across jurisdictional borders; 3) facilitate a new understanding of aquatic biota and populations on a regional scale by allowing the linking biological datasets to these regional aquatic habitat types for reporting and analysis and 4) create a new opportunity to assess the condition and prioritize habitats since groups of streams that share similar hydrologic and geomorphic character may also share similar ecological properties and respond similarly to habitat alteration such as flow alteration, land conversion, and other impairments.

Deliverables: Final products will include: 1) a report describing the method used to develop the classification, and a literature review of existing stream classifications in the Appalachian region and 2) a GIS stream data set based on the NHD+ medium resolution stream reaches attributed with the selected classification variables. These variables will include factors such as stream size, gradient, geology and pH, temperature, and hydrologic class.

Staff Expertise: The Nature Conservancy's Eastern Conservation Science office includes expertise in terrestrial and aquatic ecology, GIS, and multivariate statistics. We have twenty-years of experience coordinating large complex multi-state projects. These include: the development of a stream classification

for the Northeast and Mid-Atlantic states, development of a draft stream classification for six Southeastern states, developing a terrestrial habitat map for the Northeast and Mid-Atlantic states, and nine ecoregional assessments of terrestrial , freshwater and marine resources. More information on our office as well as reports and data sets may be found at http://conserveonline.org/workspaces/ecs

Information and Coordination needs: To ensure the utility of this work to individual states, NGO's and federal partners, we will need to form a steering committee of representatives from each state and interested party. It may take 1-2 months to develop this list, contact the individuals, and get their commitment to participate in the workgroup. Additionally, we plan to contract with staff from the Oak Ridge National Lab (Ryan McManamay) to develop a hydrologic model for the region, a task that will take approximately two months.

Step-by-Step Process to Completion:

1) Month 1-2: Develop a steering committee of aquatic ecologists and hydrologists from the Appalachian LCC states. Develop contract with McManamay for Hydrologic classification and model.

2) Month 1-6: Compile existing classification reports and GIS data for the region, and conduct a literature review on approaches to hydrologic, geomorphic, and temperature classifications. Document the hierarchical, spatial scale, and hydrologic indices used.

3) Month 3-22. Initiate monthly conference calls with steering over the course of the project to develop consensus regarding the classification approach and to review modeled GIS variables. Topics as follows:

Introductory

Month 3: Introductions, Review of project work plan and time lines
Month 4: Review of Existing Classifications, Agree on variables for review

Begin review of variable s and results for the LCC region

Month 5: Stream Size
Month 6: Gradient
Month 7: Temperature
Month 8: Hydrologic Class
Month 9: pH
Month 10: Other variables (topographic confinement, adjacency to wetlands, etc).

Begin review of the complex modeling results

Month 11: Custom Hydrologic Classes from McManamay *see below
Month 12: Results of Predicting Custom Hydrologic Classes to all ungagged reaches
Month 13: Results of Modifying the Northeast Temperature Model
Month 14: Results of pH Model

Process information and create GIS products

Month 15-16: Integrate recommendations from the team from the last calendar year. Complete all stream reach GIS coding.

Web-ex calls with steering committee to review final classification

Month 17: Review classification progress and resultant stream types
Month 18: Finalize classification develop recommendations for simplification

Create final report and GIS data set

Month 19-20: Write report and create of final stream GIS dataset and .lyr files for symbolizing the data in ArcGIS 10.

Month 22: Circulate and submit final products.

Contract with Oak Ridge National Laboratory for Hydrologic Classification: We will contract Ryan A. McManamay of the Oak Ridge National Laboratory under the supervision of Mark Bevelhimer to develop and apply his hydrologic classification to the Appalachian LCC region. He has agreed to perform the work described below and to participate on the steering committee. We will identify the exact tasks and products need during the first month of this project but we anticipate the following steps based on our work with him in the Southeast Aquatic Resource Parntership:

- Compile streamflow information from undisturbed or low-disturbed USGS gages within the Appalachian LCC and expanded area using a Hydrologic Disturbance Index.
- Calculate a suite of flow statistics using the USGS Hydrologic Index Tool
- Conduct a mixture modeling cluster procedure in program R to produce stream classes at the spatial scale of the Appalachian LCC – following multivariate evaluations of correlation and principal components analysis.
- Re-conduct the cluster procedure at a larger spatial extent to determine how spatial scale influences the number and distributions of classes (Spatial scale effects cluster output
- Develop list of USGS gages, class memberships, and uncertainties

Publications that evaluate the validity of the proposed approach:

Higgins, J.V., M. Bryer, M. Khoury, and T. Fitzhugh. 2005. A Freshwater Classification Approach for Biodiversity Conservation Planning. Conservation Biology 9:432-445

Olivero, A., and M.G. Anderson. 2008. The Northeast Aquatic Habitat Classification. The Nature Conservancy, Eastern Conservation Science. 90 pp. http://www.rcngrants.org/spatialData

McManamay, R.A., Orth, D.J, Dolloff, C.A, and Frimpong, E.A. 2011. A regional Classification of Unregulated Stream Flows: Spatial Resolution and Hierarchical Frameworks. River Research and Applications 2011: DOI 10.1002/rra.1493

Melles, S.J., Jones, N.E., and Schmidt, B. 2011. Review of theoretical developments in stream ecology and their influence on stream classification and conservation planning. Freshwater Biology doi:10.111/j.1365-2427.2011.02716x

Poff, N. L.et. al.. 2010. The ecological limits of hydrologic alteration (ELOHA): a new framework for developing regional environmental flow standards. *Freshwater Biology* 55:147-170. http://www3.interscience.wiley.com/cgi-bin/fulltext/122588390/PDFSTART

Other Literature Cited

Angermeier, P.L, and M.R. Winston. 1998. Local vs. regional influences on local diversity in stream fish communities of Virginia. Ecology 79(3):911-927.

Frisell, C.A., W.J. Liss, C.E Warren, and M.D. Hurley. 1986. A hierarchical framework for stream habitat classification: viewing streams in a watershed context. Enviro. Mang. 10(2): 199-214

Hudson, P.L., R.W. Griffiths, and T.J. Wheaton. 1992. Review of habitat classification schemes appropriate to streams, rivers, and connecting channels in the Great Lakes drainage basin. In Busch, W.D.N. and P.G. Sly eds. The development of an aquatic habitat classification system for lakes. Boca Raton, FL: CRC Press.

Maxwell, J.R., C.J. Edwards, M.E. Jensen, S.J. Paustian, H. Parrott, and D.M. Hill. 1995. A Hierarchical Framework of Aquatic Ecological Units in North America (Neararctic Zone). General Technical Report NC-176. St. Paul, MN: U.S. Department of Agriculture, Forest Service.

Richter, B. D. 2009. Re-thinking environmental flows: from allocations and reserves to sustainability boundaries. River Research and Applications 22(8):1052-63. DOI: 10.1002/rra.1320

Richter, B. D., Davis, M., Apse, C., and Konrad, C. P. 2011. A presumptive standard for environmental flow protection. River Research and Applications. DOI: 10.1002/rra.1511

Attachment Materials

1) Answers to LCC Background and Context Questions
2) Timeline Table with distinct milestones, and initiation dates and deliverables for each milestone; include exact proposed start and completion dates assuming contract obligating funds is signed NLT April of 2012. IMPORTANT NOTE: Completion of milestones and deliverables can exceed one year's timeframe, however significant milestones/deliverables must be well demonstrated within first 6-12 months and timeline commitments must be adhered to unless written approval is obtained at least 4 months in advance from the Appalachian LCC Coordinator.
3) Detailed Budget Table with separate categories for direct costs such as salary, equipment, travel, etc. and indirect/overhead costs; include narrative on cost-effectiveness measures. List any planned or potential sub-awards and explain associated tasks/expenses. One initial advance payment may be made not to exceed 25% of the total award; after which, invoices will be accepted for payment as milestones are incrementally accomplished. Variations to this payment schedule must be approved in writing by the Appalachian LCC Coordinator.
4) A signed No Conflict Declaration regarding personal or organizational conflict of interest.
5) CVs of Key Staff involved and a brief vitae for each including contact information for Project Manager, Primary Investigator, and the individual who will be providing financial oversight for implementation.
6) Optional: Letter of Support from significant partner/collaborator (signatures do not have to be originals, but originals should be retained in your files).
7) Optional: Commitment of Resources statement from your organization, a partner, stakeholder, or grant source (this commitment will not be considered formal match and does not preclude you from using the same as match for a grant pursuit).

Background and Context Responses

Question #1. Describe any current program, initiative, or goal of your organization that this SOW would complement or contribute directly toward.

The Nature Conservancy has been a leader in developing aquatic classification methods (Higgins et al, 2005) and in defining ecological flow needs of river systems (Richter, et al. 2009, 20011). This project would directly complement and contribute to our efforts to further refine methods of aquatic classification that develop geomorphic and hydrologic parameters and that can be used in ecological flow management.

The Nature Conservancy's Eastern Science Office has a mission to compile baseline ecological, conservation status, and condition information for the ecosystems within our geographic area of responsibility. Since developing the Northeast Aquatic Habitat Classification System and Map (Anderson and Olivero 2008), our region's geographic responsibility has expanded from the northeast 13 states to cover an additional 5 southern states (SC, NC, GA, AL, and FL). The Appalachian LCC overlaps with 4 of these southern states and any stream classification work done in cooperation with the Appalachian LCC will directly benefit our ability to look at regional east coast biodiversity and condition patterns.

The consistent Appalachian stream classification product will also provide useful finer scale information to our TNC state office freshwater programs within the states of the Appalachian LCC. A number of our state programs have been working with state and federal partners on instream flow policy and using the existing Northeast Aquatic Habitat Classification in this work. Other states could now engage in this kind of work as the Appalachian LCC stream classification datasets became available.

Within the Department of Energy's (DOE) Water Power Program (WPP) at Oak Ridge National Laboratory (ORNL), the Instream Flow Project was initiated to provide stakeholders within the hydropower industry with tools to efficiently and effectively mitigate aquatic habitats influenced by hydropower production. These tools include providing a subset of relevant environmental flow metrics as focal points for management. Hydrologic and geomorphic classifications can provide a framework to organize these flow metrics by classes, and in turn, will aid in refining predictive relationships between flow and ecology. Furthermore, DOE benefits from broad-scale analyses that can be applied to numerous environmental situations related to energy development.

Question #2. Further describe any pre-existing infrastructure, activities or accomplishments, training, staff expertise, etc. that demonstrate your organization's readiness to successfully implement this SOW

Our most recent two aquatic classification efforts overlap substantially with the Appalachian LCC and demonstrate our organizations readiness to successfully implement this project. In 2008, The Nature Conservancy's Eastern Science Office completed the Northeast Association of Fish and Wildlife Agencies (NEAFWA) RCN funded Northeastern Aquatic Habitat Classification (NAHCS) and GIS map for 13 northeastern states (ME, NH, VT, MA, RI, CT, NY, PA, NJ, DE, MD, VA, WV, and DC. (Anderson and Olivero, 2008; http://www.rcngrants.org/spatialData). This classification and GIS dataset was designed to consistently represent the natural flowing aquatic habitat types across this region in a manner deemed appropriate and useful for conservation planning by the participating states. The project

was led by The Nature Conservancy's Eastern Conservation Science Office who engaged a workgroup over 30 state, federal, university, and NGO representatives to participate in monthly conference calls for nearly 2 years to develop the classification and consensus regarding the classification approach and modeled variables. The final product was not intended to override state classifications, but was meant to unify state classifications and allow for looking at aquatic biodiversity patterns across the region in a standardized manner.

In 2012, The Nature Conservancy's Eastern Conservation Office was contracted by the Southeast Aquatic Resources Partnership to provide baseline consistent stream classification attributes for the region to support the development of science-based instream flow information for water resource managers and policy makers in the region. Specifically TNC was asked to develop 1) basic stream classification attributes (size, gradient, freshwater ecoregion and ecological drainage unit) for the entire SARP geography (15 south and central U.S. states) and 2) to develop hydrologic model variables (soils, geology, landforms) and an estimate of hydrologic class for stream reaches in the Atlantic drainages of the eastern SARP geography (9 states: AL, FL, GA, KY, NC, SC, TN, WV, VA). This project has engaged experts in monthly conference calls to develop the classification variables, variable break points, and review model outputs. The process has been documented online at http://sifn.bse.vt.edu/sifnwiki/index.php/SIFN_Classification_Expert_Review. Already this project has compiled over 35 attributes for each stream reach, reached consensus on the size and gradient class breaks, and in the eastern SARP completed a draft model to successfully predict for each ungaged reach its McManamay hydrologic class (McManamay et al 2011). The project is ongoing and will be complete by Dec 2012.

Question #3. List potential partner(s) who might contribute expertise, other in-kind services or financial support to the activities under this SOW, and provide a Letter of Support from each partner(s) named.

This project will be guided by a steering committee made up of representative state agency biologists, The Nature Conservancy state staff, and the Southeast Aquatic Resources Partnership: Mary M. Davis, Ph.D., Aquatic Ecologist; Scott Robinson, Coordinator

Question #4. Describe your relationship to/with any key stakeholders (i.e. sponsors, participants, partners, host organizations, beneficiaries), including any stakeholder participation in the initial planning and development of this SOW.

As described above, we have been direction engaged with the North Atlantic LCC and our stream classification is one of their foundation datasets.

Question #5. Describe how the completed project outcomes could be shared with the science community and other stakeholders at completion (e.g. tool deployed, training provided, outreach accomplished).

The product would be posted on our TNC Eastern Conservation Science webpage (http://conserveonline.org/workspaces/ecs/), and our developing public facing website TNC Gateway. Additionally links to the report and datasets can be hosted on the LCC site.

Question #6. Are you aware of any impediments to the LCC's goal of accomplishing the project as described?

Our office has not historically worked with Indiana or Illinois state fish and game offices. Making contacts with these programs and accessing critical data such as geology and finding workgroup members in these states potentially more challenging for us than in the other Appalachian LCC states where we have previously worked with the states in various NEAFWA, SARP, or MOTT stream classification efforts.

Note : Citations in main proposal

Estimated Timeline

Please note: Due to current obligations and staff schedules, we will not be able to begin work on this project until October 2012 at the earliest, we envision starting this work in January 2013.

Jan. –Feb. 2013. Identify and convene steering committee. Develop contract with McManamay. Compile existing classification data and conducting literature review.
March-April 2013: Initiate Team calls. Introductions, Review of project work plan and classifications
May-Nov. 2013: Continue Team calls. Review of variables

Milestone: Interim report with literature review, selected variables, preliminary results

Dec.- March 2014: Continue team calls. Review of modeling results
April-May 2014: Finalize information and develop GIS products\
June – July 2014: Continue team calls: review of products and simplification methods
August-Sept. 2014: Prepare final report and data layers
October 2014: Submit final report and products.