C. Project Narrative

1. Statement of Need:

Natural resource managers need to make decisions about all catchments within their jurisdiction, but there is rarely sufficient information about enough of these catchments. Flexible and transparent models that predict current and future conditions for sampled and unsampled catchments can be very useful to help prioritize catchments and to identify potential remediation actions. In this project, investigators will work with managers to fine-tune models for streams to their specific information needs.

The mission of the North Atlantic Landscape Conservation Cooperative (LCC) is to provide a partnership where the conservation community can guide more effective conservation actions in the face of resource threats amplified by a rapidly changing climate. To accomplish this mission, critical needs exist to 1) expand existing and develop new decision support tools for conservation decision making and 2) facilitate adoption of these tools by resource managers and policy makers. Extending previously supported work for forecasting changes in aquatic systems and aquatic populations can play an important role in addressing both of these needs. This project would build on existing work funded by the North Atlantic LCC and others to develop useful models for streams. Previous accomplishments include:

- Daily stream temperature and annual stream flow models for headwater streams for much of the New England and New York region.
- Projections of relative sensitivity of stream temperature to changes in air temperature.
- Brook trout occupancy models, based on current and projected future climate, for New England and New York, at the local catchment scale.
- Prototype decision-support tool to allow users to use the model results in conservation and restoration planning.

This project will expand the spatial scale of these models and will more fully integrate modeling results with management. Some of the results are currently available in the primary scientific literature (for example, Kanno et al. 2012, 2013, Sigourney et al. 2012, Whiteley et al. 2012, Steinschneider et al. 2012).

2. Project Goals and Objectives:

The goal of this project is to improve natural resources management by providing effective, flexible, portable, and transparent modeling results and decision support tools to managers.

The objectives include:

1) *Expand existing tools to additional portions of LCC region*

a) Extend the stream temperature and stream flow models to the full geographic area of the North Atlantic LCC, plus the headwaters of the Atlantic-draining watersheds (e.g., Chesapeake, Delaware, Hudson).

b) In coordination with the Eastern Brook Trout Joint Venture and other researchers studying brook trout, expand the brook trout occupancy models to the same region as the stream temperature and flow models.

2) *Integrate models with management and policy*

Build upon recent meetings with state agencies to apply the North Atlantic LCC-supported models within the state decision-making processes, such as revisions to state water quality criteria for stream temperature. The Connecticut DEEP and Massachusetts DEP have agreed to participate in this pilot, which will be designed for adoption by interested managers across the region. Specific tasks will include: a) further adapting stream and fish models; b) customizing maps and graphics for decision support; c) modifying the existing map viewer for prioritization of watersheds; and d) exploring the potential for real-time updates of model results based on state-provided data.

3. Project Activities, Methods and Timetable:

Objective #1 includes several tasks (see timeline below). Task 1 is to collect environmental data for the entire region. As these data come from web server sources (NLCD, NHDPlus, SSURGO and Daymet), this task simply requires running scripts for the new regions. Running the flow and temperature models with the updated data (Task 2) also does not require model development, but just the task of rerunning models for the new regions. Updating the map viewer (Task 3) is also straightforward. Tasks 4-7 involve developing consensus on a regional brook trout occupancy model and the development of a unified trout database. Investigators will meet with the Eastern Brook Trout Joint Venture and other researchers to establish the common database and modeling approach (Task 4-6). Once established, the model will be run (Task 7) and the map viewer will be updated (Task 8).

To integrate modeling results with management and policy development, investigators will meet with managers (Task 1) and adapt the existing decision support tool (Tasks 2, 3) to accommodate recommendations from managers. For this phase of the project, they will work directly with the MA Department of Environmental Protection and the CT Department of Energy and Environmental Protection. Preliminary meetings have established coordination and mutual interest in continuing joint development of models and linking models with natural resources decisions. During the process of working with the states, the investigators will also evaluate the potential for the development of a data-database-model-viewer system to explicitly link all components of the modeling effort (Task 4). This system would allow ‘real-time’ updating of model results following new data uploads from the states. The investigators will also run workshops for interested users of the stream flow and temperature and occupancy modeling work (Task 5).

Timeline					
Objective	Task	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Expand existing models	1. Collect environmental data	■			
	2. Run flow and temp models		■		
	3. Update map viewer		■		
	4. Meet with regional fish modelers	■			
	5. Establish common fish database	■	■		
	6. Establish common occupancy model	■	■		
	7. Run occupancy model		■		
	8. Update map viewer			■	
Integrate models with policy	1. Meet with managers	■	■		
	2. Customize maps and other output		■	■	
	3. Modify existing map viewer		■	■	
	4. Explore real-time updating of modeling system			■	■
	5. Workshops for users			■	■

4. Stakeholder Coordination/Involvement:

Coordination in this project will occur at two levels, 1) with other researchers involved in stream flow and temperature and brook trout occupancy modeling and 2) with managers and policy makers who will use modeling results to improve decision-making. Investigators will continue discussions with other researchers who are willing to discuss model integration, where possible. Funding from the USGS will provide support for a meeting to establish common databases and modeling efforts. The investigators have also met with CT and MA state personnel, and these agency staff will be heavily involved in guiding the model development, model visualization and model application. There is good potential for model results to be incorporated directly into policy for both states. The project described here will serve as a pilot and, if successful, could be expanded to other states or organizations. The North Atlantic LCC partnership of federal and state agencies, tribes, and nongovernmental organizations will be closely involved in the project. The Eastern Brook Trout Joint Venture will also be involved.

5. **Project Monitoring and Evaluation:**
The U.S. Fish and Wildlife Service and North Atlantic LCC will contribute to monitoring and evaluation through oversight meetings and partnership involvement. Because the investigators will be working directly with the states on this project, there will be considerable oversight for all tasks by these agencies. Model results will be delivered as maps on a web map viewer. The map viewer will be the primary tool for integrating model results into decision making. Quarterly reports will be reviewed by the Project Officer and a final report will be peer-reviewed by independent reviewers chosen by the Fish and Wildlife Service and North Atlantic LCC.

6. **Description of Entities Undertaking the Project**: The University of Massachusetts, Amherst is a State University within the Commonwealth of Massachusetts. This project will be led by Dr. Ben Letcher, =, 413 863-3803, an adjunct professor in the Department of Environmental Conservation at the University of Massachusetts and the leader of the Ecology Section at the USGS Conte Anadromous Fish Research Center.

7. **Sustainability:** This project is part of a larger effort to provide resource managers with useful scientific information. The larger project has been funded by the USGS, the Northeast Climate Science Center, the MA DOT and the USGS National Climate Science Center. Investigators anticipate that they will continue to receive funding to move the larger project forward.

8. **Literature Cited:**

Kanno, Y., J. C. Vokoun, K. E. Holsinger, and B. H. Letcher. 2012. Estimating size-specific brook trout abundance in continuously sampled headwater streams using Bayesian mixed models with zero inflation and overdispersion. Ecology of Freshwater Fish:1–16.

Kanno, Y., J. C. Vokoun, and B. Letcher. 2013. Paired stream-air temperature measurements reveal fine-scale thermal heterogeneity within headwater brook trout streams networkse. River Research and Applications 10.1002/rr.

Sigourney, D. B., S. B. Munch, and B. H. Letcher. 2012. Combining a Bayesian nonparametric method with a hierarchical framework to estimate individual and temporal variation in growth. Ecological Modelling 247:125–134.

Steinschneider, S., A. Polebitski, C. Brown, and B. H. Letcher. 2012. Toward a statistical framework to quantify the uncertainties of hydrologic response under climate change. Water Resources Research 48:W11525.

Whiteley, A. R., J. a. Coombs, M. Hudy, Z. Robinson, K. H. Nislow, and B. H. Letcher. 2012. Sampling strategies for estimating brook trout effective population size. Conservation Genetics.

9. **Map of Project Area:** see below. The project area includes the U.S. portion of the North Atlantic LCC, plus the full extent of Atlantic-draining watersheds that intersect with the North Atlantic LCC.