Report as of FY2006 for 2006CT123B: "Development and evaluation of a multi-dimensional spatially and temporally dynamic mesohabitat classification model for stream management and water flow allocation planning in southern New England streams"

Publications

Project 2006CT123B has resulted in no reported publications as of FY2006.

Report Follows

Title: Development and evaluation of a multi-dimensional spatially and temporally dynamic mesohabitat classification model for stream management and water flow allocation planning in southern New England streams

Statement of regional or state water problem: Connecticut, through recent legislation, has entered a process to evaluate the allocation of stream waters between "human" and "environmental" uses. The State is seeking a better understanding of the biological and geomorphological significance of flow regimes to protect stream biota and ecosystem functions for all streams in the state. The question of how much water stream inhabitants really need has most often been answered using hydraulic models which cover a relatively short reach of stream. Such models make assumptions that modeled reaches are representative and inference from results are typically limited in space. To use this modeling approach for all streams in the state is essentially cost prohibitive. Connecticut has begun to evaluate the flow requirements of stream biota using a newer modeling approach based on mesohabitats (Parasiewicz 2001), which are also known as channel geomorphic units and hydraulic habitat units, among other names, but represent what are commonly known as pools, riffles, glides, etc. (Figure 1). The mesohabitat modeling approach covers a longer reach of river for the same cost and because of the larger spatial scale may be more transferable among similar streams. The question of transferability is under investigation at the University of Connecticut presently (R. Schimdt, personal communication). Mesohabitats are known to be important to the stream biota and have been shown to support distinct biotic assemblages (Rabeni and Jacobson 1993a, Peterson and Rabeni 2001b, Rabeni et al. 2002). While pools, riffles, and runs seem easy enough to identify, mesohabitats are flow dependent (i.e. they get bigger and smaller with changes in stream stage) and are more numerous in type than one might initially suspect. Pools, riffles and runs are more correctly categories of mesohabitats, for example pools have been subdivided into obstruction, lateral, bluff, plunge, and beaver pools. Not all regions have streams with the same compliment of mesohabitats and regional variant classification schemes are numerous. Researchers in the Rocky Mountains use a scheme with different mesohabitats than those in the Ozark Plateaus region and again different than those in the southern Appalachian Mountains. **Connecticut needs a regionalized southern New England classification scheme for mesohabitats if it is to defensibly use mesohabitats to determine the effects of flow diversion on stream biota habitat quantity.** To address this need, a sound, scientific empirically-based investigation of geomorphic, hydraulic and biological mesohabitat distinctness in Connecticut should be prerequisite to the development and use of a classification system to inform management decisions. That

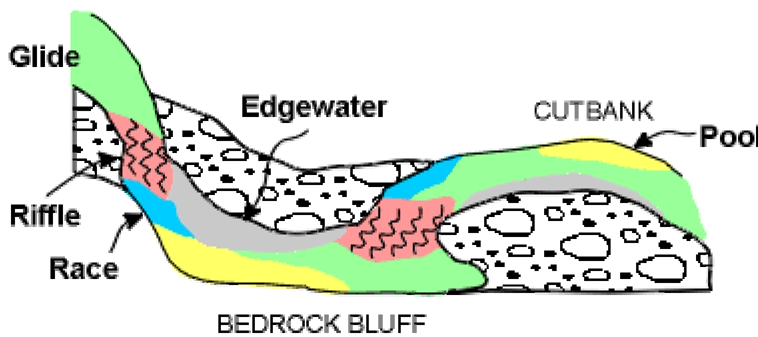

Figure 1. Sketch of a planview map of a stream reach with 5 mesohabitat types.

is to say, **definitions of physically distinct mesohabitats must be created and stream biota must show differences in assemblage structure and composition within these mesohabitats to be a meaningful basis for decision making.**

Statements of results or benefits: A physically distinct and biologically meaningful classification of mesohabitats for southern New England would result in the potential improvement of mesohabitat modeling efforts underway to quantify the effect of flow diversions on habitat quantity for stream biota. In addition, the classification scheme would serve to increase general understanding of stream ecosystems in the region. Future research and monitoring would benefit from the ability to stratify sampling among mesohabitats, increasing the quality of data and interpretations. Further, the evaluation of the classification scheme will also provide detailed information documenting the patterns of mesohabitat characteristics and size changes with varying discharge. This pattern of change is an extremely important underpinning of comparisons between high-water and low-water modeling scenarios. Furthermore, the significance of hydrogeomorphic classifications becomes more powerful when measurements are representative of the complete biologically significant variability within mesohabitats (e.g. three-dimensional vs. one dimensional velocity measurements).

Instream habitat classification has multiple management implications that require an ability to predict both the trajectory of the habitats themselves and the biota that live within the habitats. Classifications systems will have more utility if they have been verified biologically. It could be that a dozen or so physically distinct mesohabitats can be statistically defined in southern New England, but biologically only half of those may house distinct biotic assemblages. This information would inform managers that a collapsed set of mesohabitats may be important to conservation. Research has emphasized applications of minimum instream flow determination on regulated rivers (Newson and Newson 2000, Parasiewicz 2001), routine biological sampling (Poole et al. 1997, Rabeni 2002), and river rehabilitation and restoration (Sear 1994, Kemp et al. 1999). Our proposed empirical research would greatly improve the capability of mesohabitat models to contribute to these important management challenges.

Current mesohabitat delineation techniques in southern New England have to date been based on visual identification and limited (in both number and complexity) quantitative field measurements. Our proposed research will enable an unbiased, statistical delineation of mesohabitats based on objective hydrogeomorphological criteria. This refinement of mesohabitat classification will provide foundational background and definitions that will be helpful to the modeling efforts that are already in place.

Nature, scope, and objectives of the project, including a timeline: The proposed research is an integrated empirical field data collection and modeling study that will produce both a biologically meaningful classification of mesohabitats for southern New England streams and a model to predict spatio-temporal changes in these mesohabitats under variable streamflow conditions. The specific objectives of this research are to:

1) Collect hydraulic characterizations of mesohabitat channel units from three streams and use statistical classification to create a scheme of physically distinct mesohabitats based on channel morphology, flow depth and Froude number, and three-dimensional flow variability with stage

2) Develop a hydraulic model which demonstrates the spatio-temporal patterns of channel units as they vary with discharge
3) Collect macroinvertebrate and fishes (abundance, size classes, and species identity) from mesohabitats and statistically determine biological distinctness among channel units

The proposed research project began with intensive geomorphologic and hydraulic field data collection during summer 2006. Macroinvertebrate and fish sampling occurred during the summer and fall of 2006. Field work is complete. Data analysis of fish communities is complete. Data analysis of macroinvertebrates and hydraulic model development have taken longer than expected and will be completed by May 2008.

Methods, procedures, and progress: Three streams in southern New England were used for data collection, both physical and biological. Study reaches, one per stream, were 1-2 km in length and chosen to encompass heterogeneous habitat conditions. Streams sampled were the Willimantic River, the Still River (Farmington watershed) and Elldredge Brook.

Figure 2. Sampling crew at the Still River electrofishing within a mesohabitat.

Though mesohabitat spacing varies widely in nature, we attempted to sample 25 mesohabitat units within each study system. The geomorphology of each study reach was surveyed in detail using electronic total station surveying, sediment substrate characterization, and micro-habitat unit mapping. Hydraulic flow fields were characterized at low and moderate flows using a YSI FlowTracker acoustic doppler velocimeter (ADV). The combined geomorphic and hydraulic data will be used to generate a two-dimesional model of the study reaches using a well-established pre-packaged modeling program (River2D). This modeling software, when combined with our statistically-generated mesohabitat definitions (criteria) will enable quantification of mesohabitat aerial change with changing flow stage, as well as permit quantification of hydraulic variability in different mesohabitat units at multiple stages.

Macroinvertebrates and fish were collected from geo-referenced locations in the study reaches and will be later delineated to specific mesohabitats to generate species assemblage data for particular mesohabitats. Macroinvertebrates were sampled using a kick-net stream benthos sampler and fish with backpack and push-barge electrofishing gear. Fish species assemblages were compared among mesohabitat samples using principal component analysis and hierarchical cluster analysis (Peterson and Rabeni 2001b).

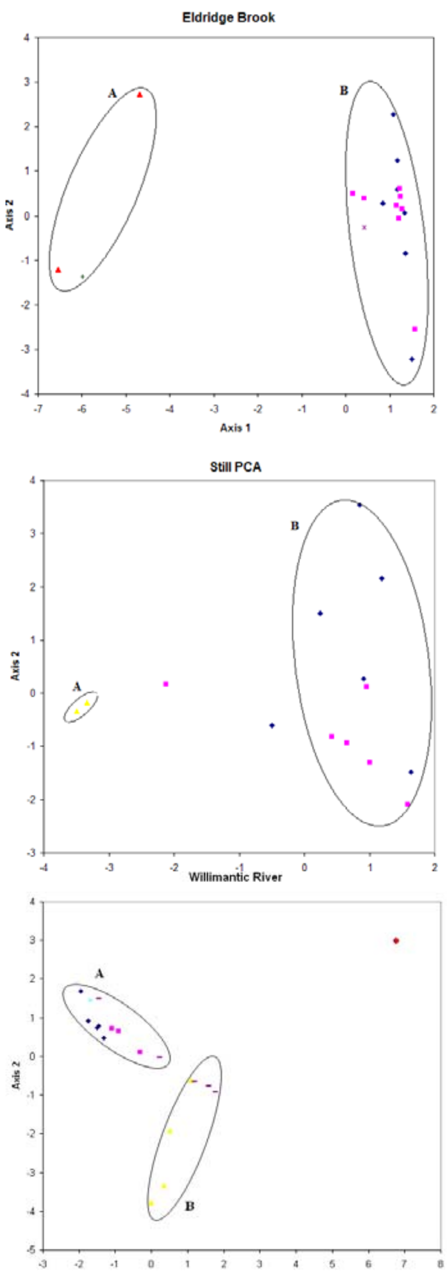

Figure 3. Pricipal components analyses of fish assemblage data collected in 2006

Results from the fish assemblage data analyses suggest that perhaps as few as two assemblages of fish occur in Connecticut streams. These two assemblages appear to relate to "fast-water" and "slow-water" habitats (Figure 3). While only part of the ecosystem, this may fortell that mesohabitat-level instream assessments using fish may be able to use a much simpler classification than recently employed.

Personnel status: Both senior personnel continue to work on the project. The research assistant that lead the biotic sampling during summer 2006 ended employment after six months as planned as in now enrolled in graduate school at Tennesse Technological University studying a crayfish species of conservation concern. A PhD student in Geopgraphy/fluyial geomorphology has taken up work on the hydrodynamic modeling and will use the techniques and some of the data produced by this project within the dissertation. A crew member from the field crew last summer will be finishing the macroinvertebrate sorting and analyses as an indepent study project during the fall 2007 semester. In total to date, nine different students have participated in project-related data collection activities.

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