Models as Tools In Assessing River Biota

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Models represent a cost-effective means of assessing the biota in aquatic systems. A number of different types of models may be suitable as assessment tools in Appalachian rivers. Among these models are, bioenergetics models, ecosystem models, indices of biotic integrity, regression models (e.g. of EMAP data sets), habitat suitability models, and spatial models.

Bioenergetics models have been widely used in aquatic studies in the last 15 years and have accounted for well over 100 publications in peer-reviewed journals during that time. Bioenergetics models are most often used to assess the way changes in habitat such as temperature, dissolved oxygen levels, or contaminants may be expressed in terms of fish production or body burden. Usually bioenergetics models are used with single species, but recently some linking of multiple species models has been completed and community bioenergetics models for rivers should be attainable.

Ecosystem models represent the opposite end of the complexity spectrum from bioenergetics models. Ecosystem models are "data hungry" and represent a compromise between reality/complexity and simplifying assumptions that detract from the realism of the models. Ecosystem models are well developed in areas like the Great Lakes and Chesapeake Bay where such models have been used to assess "what if" questions regarding nutrient reduction impacts upon fish production and water quality, or contaminant cycling and zebra mussel effects.

Indices of biotic integrity represent assessment tools designed for small to medium streams. By combining metrics of abundance and diversity of sensitive taxa relative to tolerant taxa an index of the relative health of a stream is produced. Because certain species are more or less tolerant, the indices can be sensitive indicators of ecosystem health. Although they may not point out the source of the problem they do detect the effects at the community level and point out areas where further investigation is needed. The major obstacle to use of these indices in Appalachian rivers is the lack of research on the community taxa diversity and abundance of large rivers from which to develop and test indices for these systems.

Regression models represent analysis of data on habitat variables and taxa abundance and diversity. Effectively these types of models represent statistical analysis of the data used in indices of biotic integrity. By measuring habitat parameters such as water temperature, dissolved oxygen, conductivity, chl-a, etc. and testing whether any of these variables are

significantly related to community indices. These types of models have the advantage of pointing fingers at possible causal factors in affecting low diversity, but still stop short of cause and effect.

Habitat suitability models have been widely used in assessing habitat quality for various species of fish and animals. Mostly these measurements are used in trading habitat units for mitigation purposes. HIS models do relate back to habitat quality by evaluation of relevant parameters relative to the theoretical ideal for that parameter. The resulting HSI index is the product of habitat ratings for key parameters such as breeding habitat, rearing habitat, feeding habitat, etc. The index is a value between 0 and 1 with 1 being highest quality habitat for that species. A drawback is that what is good habitat for one species may be poor for another (e.g. johnny darters vs. flathead catfish). Thus, a combined, community-based habitat suitability model may be better. To date, no efforts have been made to link these models in a community framework. However, much of the information needed to do so is available in the literature.

Spatial models are a group of models that contain a spatial component. Most of the models previously mentioned treat the river as a single homogenous unit without any spatial heterogeneity. Spatial models include everything from GIS applications of IBI or bioenergetics models to spatial ecosystem models.

There are a number of reasons we should consider using models in assessing river biota. First, fishing and tourism represent the #2 industry in the state of West Virginia. Increasing human populations and the proximity to large population centers such as Washington, D.C. will continue to put increasing demands on limited natural resources. Additional fishing demands and increasing demand for water for recreation and industrial uses will place additional pressure on aquatic biota. Models are cost-effective and can be used to assess what-if questions while pointing out areas where biota are impacted or possible problem areas. Further, models can help us to determine “what the ecosystem can stand” which may be an aspect particularly important to planning and management goals and limitations.

A variety of models could be adapted to Appalachian Rivers – we have many of the pieces, but need more info and more specific studies. These models should be pursued as possible assessment tools for a number of reasons. In addition to being cost-effective, models represent a form of technology transfer bringing together a variety of disciplines (limnologists, hydrologists, ecologists, toxicologists, and engineers). The particular type of model to be used in assessing river biota will ultimately depend upon the questions to be asked. However, many of these models have already been developed in other systems and need only to be adapted to Appalachian rivers to be a useful assessment tool.