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Patterns in the Distributions of Stream Fishes in Michigan's Lower Peninsula

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Abstract.–We examined distribution and abundance patterns of 69 commonly occurring fishes at several hundred sites in Lower Michigan streams. We used cluster analysis to group fishes that commonly occurred together at stream sites. These seventeen clusters explained about 39% of the variation in species abundances among the stream sites, providing a reasonable, albeit simplified picture of general associations of fishes in Lower Michigan streams. Known ecological differences among species and further analyses suggested that a single measure of cluster abundance should not be used to predict abundances of its constituent species.

We used measures of stream size and hydrology as landscape-scale, habitat axes (a "macro-template") for comparing streams. We identified catchment area (CA) and low-flow yield (90% exceedence flow divided by catchment area) as key driving variables that linked features of the landscape to multiple, site-scale characteristics of stream habitat (e.g. temperature, velocity, and depth) important to fishes. As a measure of groundwater loading to streams, low-flow yield (LFY) integrates geology, landform, and soil characteristics of catchments, reaching its highest values in basins with highly permeable soils and relatively steep topography. In Lower Michigan streams, high LFY values were generally associated with: greater portions of coarse-textured glacial deposits in catchments; higher stream gradients; coarser stream substrates; and cooler and less variable predicted July weekly temperatures. High CA values were generally associated with lower stream gradients, and warmer and less variable predicted July weekly temperatures.

Ordinations of fish clusters and species' abundances on LFY-CA axes provided insight into the structure of fish assemblages in Lower Michigan streams. The seventeen fish clusters spread out in a meaningful pattern when plotted on LFY-CA axes, reflecting stream size and temperature preferences of constituent species. Plots of abundances of individual species on LFY-CA axes showed differences among fishes in LFY and CA conditions where species occurred and were most abundant. These patterns supported the notion that stream fishes respond in an individualistic manner to stream conditions, and that species-specific models are needed to describe fish assemblage structure in streams. We used relations between LFY, CA, and fish abundances to describe longitudinal changes in stream conditions and fish assemblages both within streams, and among hydrologically different streams. These relations have also been used to characterize potential fish assemblages of stream valley segments. Relations between LFY, CA, and fish abundances that we described are specific to Lower Michigan streams, because relationships between LFY, CA, and stream temperature vary regionally. However, our approach could be used to develop similar models specific to other regions.

Study and management of river systems and their component fish assemblages should be conducted across the scales at which they operate (Wiley and Seelbach 1997; Levin 1992). Streams are products of the landscape, having properties that reflect both catchment-scale features of the landscape (e.g. geology and land use) and local features (e.g. valley character and riparian conditions) of the environments through which they flow (Seelbach et al. 1997). Fishes move throughout these systems during their lives (Schlosser 1991), being most abundant in areas where physical and biotic conditions are most suitable. However, until recently, few studies of stream fish ecology included analyses of reach or catchment-scale variables. New advances in remote sensing, computer, and Geographic Information System (GIS) technologies provided us the opportunity to focus on modeling complex, larger-scale stream processes (e.g. streamflow, temperature, and water chemistry conditions) using a comparative approach, i.e. by looking at many different rivers (Seelbach and Wiley 1997).

Comparative studies have much to offer stream ecologists. Contrasts of different systems can aid in identifying important ecological gradients that influence assemblage structure (i.e. species composition and relative abundance) of fishes and other aquatic organisms. Identification of these gradients or patterns is an important "first step" toward understanding the underlying processes that shape biological communities. An understanding of the diversity and types of stream systems within a region provides the context for describing individual systems. In other words, one will better know how a river compares to the "universe" of rivers within the region. Such perspective can aid fishery managers in evaluating a stream's potential, identifying problem areas, and in setting realistic management objectives. By placing a stream within this larger context one can better understand more specific issues, such as identifying the factors limiting fish abundance at a particular site.

We used a comparative approach to examine distribution patterns of fishes in Michigan's Lower Peninsula streams. The objectives of this study were two-fold. First, we were interested in identifying groups of fishes having similar spatial patterns in their distribution and abundance. Such groupings could simplify the process of describing fish assemblage structure, providing a useful "short-hand" for contrasting fish assemblages in Lower Michigan streams. Lower Michigan streams have diverse fish assemblages with over sixty species having been collected from individual river basins, and 30-40 species commonly occurring at individual sites (Towns 1987; Smith et al. 1981). Combining fishes having similar distributions into groups has never been done for stream fishes in Lower Michigan though it has been by researchers studying other regions (e.g. Smith and Fisher 1970; Rose and Echelle 1980; Hawkes et al. 1986; Matthews and Robison 1988; Halliwell 1989; Degerman and Sers 1992). However, it is important to understand the limitations of such