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A Landscape-Based Ecological Classification System for River Valley Segments in Lower Michigan (MI-VSEC Version 1.0)

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Abstract–Through ecological classification, researchers both (1) identify and (2) describe naturally-occurring, ecologically-distinct, spatial units from a holistic perspective. An ecological river classification involves the identification of structurally homogeneous spatial units which emerge along the channel network as a result of catchment processes interacting with local physiographic features. Our observations of Michigan rivers suggest that the natural ecological unit, as defined by the spatial scales of riverine physical and biological processes, is most closely approximated by the physical channel unit termed the valley segment. Valley segments are generally quite large, and characterized by relative homogeneity in hydrologic, limnologic, channel morphology, and riparian dynamics. Valley segment characteristics often change sharply at stream junctions, slope breaks, and boundaries of local landforms. We followed several steps in developing an ecological classification for the rivers of lower Michigan. Step 1 – We first selected catchment size, hydrology, water chemistry, water temperature, valley character, channel character, and fish assemblages as fundamental attributes to describe ecological character of river valley segments. Steps 2-3 – Two experienced aquatic ecologists worked together, interpreting map information on catchment and valley characteristics from a GIS, using their combined knowledge of ecological processes and interactions. We initially examined several key maps to become familiar with the general landscape patterns of a particular catchment; and to then identify initial valley segment units as defined by catchment and valley characteristics, and fish assemblages. Boundary definition required the integration of terrain features observed on several thematic maps (e.g., major stream network junctions, slope breaks, boundaries of major physiographic units or land cover units; or changes in stream sinuousity and meander wavelength patterns, riparian wetlands, or valley shape), combined with knowledge of fish distributions. We next developed categorizations for each component attribute

and assigned category values for attributes to each segment unit. Assignments were based on map-interpretation rules drawn from modeling, survey data, and field experiences. Step 4 – our results were stored as a map and a table in ArcView 3.0 format. In all, we partitioned and classified the 19 largest river systems in lower Michigan. Summaries of the attributes assigned to over 270 river valley segments (covering mainstems and major tributaries) provided an initial description of the river resources of lower Michigan. Managers of lower Michigan rivers will be able to develop many of their thoughts and activities within this framework of ecological units. Development of this system is intended to be ongoing; with the extension of coverage to upper Michigan, the continued validation of attribute codings, and the addition of new attributes.

The utility of classification systems in ecosystem management is widely accepted (Anonymous 1993). The tremendous diversity of ecological systems makes it difficult to generalize our management experiences or protocols from place to place. Ecological classification (defined as integrating both physical and biological elements) provides a way of simplifying this complexity, allowing generalization across relatively homogeneous spatial units; and providing a spatial framework for organizing data, and extrapolating from site-specific models and information (Barnes et al. 1982; Rowe 1991; Hudson et al. 1992; Albert 1994; Maxwell et al. 1995). Ecological classification also has a tremendous educational value. It can provide a comprehensible summary of the complex array of physical and biological processes which, over time, shape the natural world around us. Learning to recognize the landscape as a mosaic of distinct ecological units is valuable training for resource managers, providing a short-hand for thinking and communicating about the consequences of complex ecological processes (Bailey et al. 1978; Rowe 1984, 1991; Levin 1992).

Description of ecological classification

Through ecological classification we both (1) identify and (2) describe naturally-occurring, ecologically-distinct, spatial units from a holistic perspective. Ecological classification differs from habitat classification in the explicit use of biological criteria, in addition to abiotic criteria, for delineating unit boundaries. The ecological character of each unit emerges as the unified expression of its unique, abiotic (e.g., aspects of climate and geology) and biological (e.g., photosynthesis, respiration, and population interactions) processes (Spies and Barnes 1985; Rowe and Barnes 1994). These ecological units are observable places where constituent air, water, sediment, and organisms co-occur as a distinct bio-physical system (Rowe 1984, 1991; Rowe and Barnes 1994).

Location and delineation of units is the key, first step in ecological classification; this occurs “from above”, from a larger map-scale (Rowe 1984; Rowe and Barnes 1994). The operating hypothesis is that relatively-homogeneous ecological units exist; and can be recognized in the spatial correspondence of selected physical and biological traits, using ecological theory and field experience (Barnes et al. 1982; Spies and Barnes 1985; Rowe 1991; Rowe and Barnes 1994). Traits that drive numerous ecological processes are often given extra weight; in terrestrial work for example, physiography (land composition and form) is considered fundamental, as it is relatively stable and helps shape local climate, soils, and vegetation patterns (Rowe 1984; Spies and Barnes 1985; Rowe 1991). The distributions of biota are also given special weight as an important delimiting criteria, though they are inherently variable due to their dependence on both ecological and historical processes. Biota can be important driving variables that help shape the ecological unit, and their characteristics typically integrate and express the overall ecological signature of the unit (Rowe 1961;