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Overview of the Michigan Rivers Inventory (MRI) Project

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Abstract.–The sound, scientific management of lower Michigan's expansive river systems will require a sophisticated understanding of their ecological structures and processes, and a careful evaluation of the state of these rivers as they currently exist—i.e. a comprehensive inventory. To this end we developed a partnership in 1988 between scientists at the Michigan Department of Natural Resources—Institute for Fisheries Research, and the University of Michigan—School of Natural Resources and Environment, known as the Michigan Rivers Inventory (MRI) project. Our strategy for studying the comparative ecology of Michigan rivers has four primary components: conducting an *Inventory*, developing *Descriptions and Predictive Models*, developing an *Ecological Classification System*, and developing *Management Applications*. The foundation of the inventory was a large Geographic Information System (GIS); i.e. a collection of maps and a relational, geo-referenced database containing key physical and biological characteristics for a large number (~675) of river sites representative of rivers draining the Lower Peninsula of Michigan. Data incorporated in the MRI came from a variety of sources and included (1) field measurements made by project personnel; (2) numerous existing datasets that were compiled by other State and University research groups; (3) mapped data of various origins that could be processed and related to MRI study sites by manipulation in a GIS; and (4) "synthetic" data produced by modeling site-scale variables (for example stream flows) from summaries of catchment landscape characteristics for a subset of sites. To explore linkages between different-scale habitat variables and fishes, we emphasized data development at 3 distinct spatial scales of influence: (1) the catchment landscape; (2) the local channel reach; and (3) the immediate sampling site. The temporal extent of the data covered the past 2.5 decades, providing a reasonable summary of the current nature of Michigan's rivers. We used the GIS to develop several graphical summaries and statistical models of habitat and fish community characteristics. These helped to identify broad patterns within the data, explore the underlying relationships between local ecological conditions and the larger-scale processes that drive them, and to provide predictive capabilities. We likewise developed an ecological classification for the river valley segments of Michigan's Lower Peninsula, incorporating both physical and biotic

segment attributes. The multi-scale framework of the MRI approach provides a toolbox for addressing many local river management issues. Viewing a system in its larger-scale (landscape) context helps managers to define key variables and constraints that shape site-scale problems. MRI models provide the complimentary ability to predict specific site-scale attributes for developing management expectations and targets. Comprehensive regional assessments like the MRI ultimately should provide a platform for more-informed, broader-scale thinking and communication about river ecosystems. The MRI is an ongoing project; current work includes extending geographical coverage to Michigan's Upper Peninsula and further refinement of the valley segment ecological classification system.

Hundreds of permanently-flowing streams drain Michigan's Lower Peninsula. These form about 20 major river ecosystems, and scores of smaller, coastal systems. Managed wisely these fluvial resources can provide a rich suite of ecological, water supply, recreational, and aesthetic benefits for years to come. Sound scientific management of these expansive systems will require a sophisticated understanding of their ecological structures and processes, and a careful evaluation of the state of these rivers as they currently exist-- i.e. a comprehensive inventory. Extensive historical data sets on many aspects of Michigan's rivers already exist. In Appendix 1 we provide a guide to key references that illustrate both the disciplinary breadth and the impressive histories of earlier Michigan river survey efforts. But as is commonly observed (Chamberlin 1984), most of these studies have been carried out by separate agencies, were purposefully narrow in focus, and the results of many are difficult to locate and utilize. Despite the fact that large amounts of detailed information have been collected (often through routine government monitoring), available data are not well integrated, nor have they been examined from a holistic perspective. There is a pressing need to gather and synthesize the wealth of relevant information on Michigan's rivers.

To this end we developed a partnership in 1988 between scientists at the Michigan Department of Natural Resources--Institute for Fisheries Research, and the University of Michigan--School of Natural Resources and Environment, known as the Michigan Rivers Inventory (MRI) project. This collaboration has been largely informal, built initially around the project "Inventory and classification of Michigan rivers" (funded primarily by Federal Sportfish Restoration monies and several small university grants). The combined platform of the state agency and the university has consistently provided many logistic and technical resources. More recently, MRI work has been developed further through a series of more specifically-focused, externally-funded research projects (Table 1).

The overall purpose of the MRI has been to study the comparative ecology of Michigan rivers. Though interested in the full spectrum of rivers found in Michigan, we felt the Lower Peninsula represented a natural study unit of a scale consistent with our logistical abilities to conduct field sampling from our operating base in Ann Arbor (located in southeast MI). Lower Peninsula rivers also represent an interesting, very hydrologically-diverse set; some rivers are nearly entirely runoff-driven, while others are nearly entirely groundwater-driven.

Conceptually, we view rivers as large-scale hydrologic, geomorphic, and biological systems, rather than as aggregations of distinct sites (Wiley and Seelbach 1997). As rivers are expansive, landscape-scale systems, we have also drawn upon the fundamental principles of the discipline of Landscape Ecology (Risser et al. 1983; Ricklefs 1987; Levin 1992; Pickett and Cadenasso 1995). For example: (1) River system dynamics involve the transfer of water and sediment downslope across complex mosaics of landscape units; in the MRI we focused on hydrology as a key discipline linking landscape, channel, and ecological processes. (2) Large-scale patterns in ecosystem structure and dynamics exist within and among rivers; in the MRI, we searched for patterns in ecological characteristics of rivers that could be quantified