TABLE OF CONTENTS

List of Figures

List of Tables

Identifying and Valuing Restoration Opportunities and Resource Improvements at Watershed and Subwatershed Scales

1. INTRODUCTION

When asked to identify potential restoration opportunities, many agencies and organizations focus on restoring wildlife, waterfowl, or endangered species habitat; rare or endangered plant communities; fish populations and fish community structure; and/or remediating polluted waters and contaminated sediments. The approach used by many is to examine land-use changes and link those changes to site-specific habitat degradation, biodiversity, and ecological function. Unfortunately, the linkages between land-use change and site-specific habitat degradation, biodiversity, and ecological function are highly variable, not systematic, and are difficult to quantify. This is in part due to the different spatial and temporal scales over which these interactions occur and the multivariate relationship between land-use change and the fundamental factors (and processes) that influence water resource sustainability, biodiversity, and ecological function. These fundamental factors include hydrology, physical habitat structure, water chemistry, connectivity, and biological composition and interactions (Ciruna 2004).

Within the last decade, there has been an increasing focus on these fundamental factors as measures of ecological health and indicators of environmental change. This is particularly true of hydrology where new methods and tools have been developed to measure the components of flow (magnitude, timing, duration, frequency, and rate-of-change) derived from the natural flow regime paradigm (Poff et al. 1997; Richter et al. 1996, 1997, 1998). These new methods and tools are currently being used to guide restoration activities at multiple sites within the Great Lakes basin (e.g. GLPF 2000, 2001).

Hydrologic restoration opportunities that improve the “waters and water-dependent natural resources of the Great Lakes” must be tied to existing hydrologic alterations (impairments) and have measurable hydrologic benefits that result in improved habitat, biodiversity and ecological function. To systematically identify hydrologic restoration opportunities, it is necessary to estimate natural hydrologic baseline conditions (natural flows), assess altered characteristics of flow that result in impairments, and identify the stressors causing those flow alterations and impairments. These impairments are created by altered flows and are caused by anthropogenic actions (i.e. stressors) within the watershed that are not easily detected or measured by changes in land use or more traditional landscape assessment approaches.

The primary objective of this project was to develop, test, compare, validate and apply a suite of integrated GIS watershed and hydrologic assessment tools and metrics that link hydrologic impairments with restoration opportunities within four pilot watersheds within the Great Lakes basin. As part of these assessments, a new suite of metrics were developed that when integrated, can be used to measure and assess the relative value of hydrologic improvements resulting from different types (or classes) of hydrologic restoration projects.

Following is a detailed summary of project accomplishments and results based on the project work plan outlined in the proposal. First, a description of the tools and metrics developed during this project is provided to illustrate the types of watershed and hydrologic analyses that can be used to identify hydrologic impairments and restoration opportunities in Great Lakes watersheds. Second, the results from the watershed and hydrologic analyses are summarized for each of the four pilot watersheds. Each of the four pilot watersheds has a unique combination of different hydrologic and landscape characteristics that allowed us to test these tools across a range of differing environmental conditions. Third, a synthesis section summarizes and compares results from the four pilot watersheds and includes examples of how different types of impairments and restoration opportunities were identified and valued based on a suite of metrics and protocols developed during this project. Finally, a description of lessons learned and recommendations for further work are provided at the end of the report.

2. TOOLS TO ASSESS ANTHROPOGENIC CHANGES AND HYDROLOGIC ALTERATIONS

2.1 Basinwide Geospatial Screening Tools

Data Reconnaissance and Assessment

The goal of this task was to produce a GIS database that identifies all available and relevant GIS information for the entire Great Lakes Basin. Project team evaluated an extensive list of geospatial datasets developed by other efforts in the basin (e.g. GLEI project, The Nature Conservancy, USGS, GLC, U.S. EPA). Critical datasets were acquired and catalogued on the AES central server and datasets important to the entire project team were uploaded to the project ftp site. Over 300 geospatial data files in approximately 30 different categories (approximately 150 gigabytes) were acquired or derived for this project. Approximately one-third to one-half of these datasets became useful in achieving the aims of this project. A summary list of datasets gathered or created for this project is given in Appendix 1. Many of these datasets are available for download via links to original sites and are included in Appendix 1.

Development of the Screening Tool

The project team developed a consistent and systematic method to screen Great Lakes watersheds for potential hydrologic restoration opportunities using available geospatial data. The objective was to identify a candidate list of watersheds that are broadly representative of watershed types within the Great Lakes Basin and to thoroughly evaluate, compare, and validate hydrologic and GIS watershed assessment models and tools. The project team compiled basin-wide GIS datasets that are relevant to understanding potential causes of hydrologic alteration. Through correlation analysis and professional judgment the team developed six independent indicators of potential hydrologic impairment from these datasets:

- Imperviousness
- Dam Storage Capacity
- Canals/Ditches
- Minor Road Intersections
- Major Road Intersections
- Potential Restorable Wetlands (hydric soils without wetlands)

The project team incorporated these key parameters into a decision matrix and produced a list of 20 candidate watersheds that meet general criteria for potential hydrologic alteration and also meet the criteria for the experimental design as outlined in the proposal. Watersheds were evaluated at the 8-digit Hydrologic Unit Code (HUC) level. The potential impairment score was calculated by first summarizing the above metric data by watershed and normalizing by area. These normalized values for each metric were then sorted and aggregated into five classes using the “natural breaks” method in ArcGIS 9.1. Watersheds were assigned a score from 1 to 5 for each data category depending on the potential degree of impairment resulting from that particular data category (with 1 representing the least impairment and 5 the most). Since the