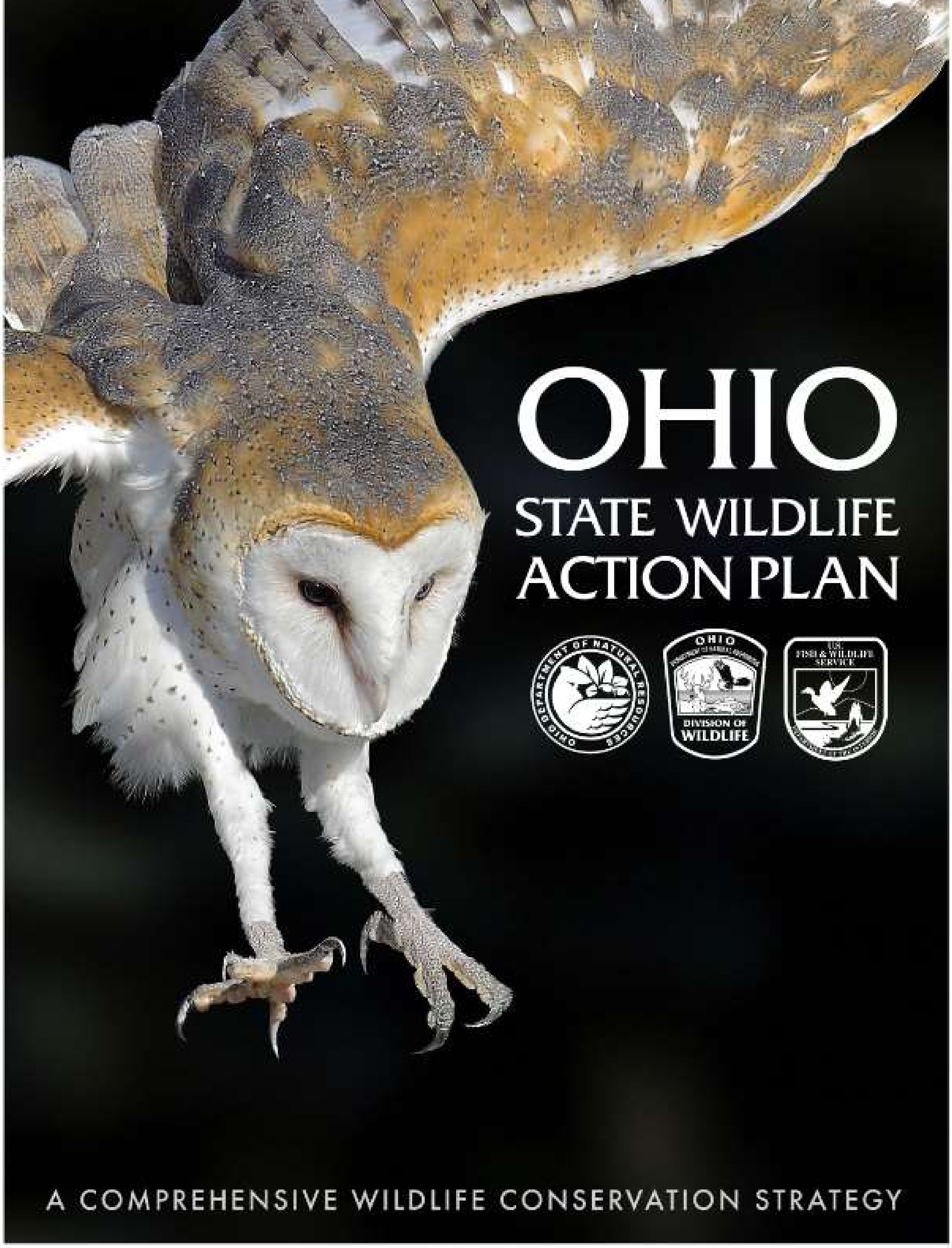

OHIO

STATE WILDLIFE ACTION PLAN

A COMPREHENSIVE WILDLIFE CONSERVATION STRATEGY

Ohio's State Wildlife Action Plan 2015

A Comprehensive Wildlife Conservation Strategy

Financial Support for this Action Plan development is provided in part by the Ohio Department of Natural Resources, Division of Wildlife U.S. Fish and Wildlife Service's State Wildlife Grant program

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This document represents the effort of many individuals both within and outside of the ODNR Division of Wildlife. While the list of all those who made Ohio's State Wildlife Action Plan possible is too numerous to mention here, the editors wish to acknowledge the extensive work of the following individuals: Carolyn Caldwell, Jim McCormac, John Navarro, Kate Parsons, Ray Petering, Jessica Piispanen, Nathan Reardon, and Kendra Wecker.

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Table of Contents

List of Figures

List of Tables

Foreword

Ohio's first Comprehensive Wildlife Conservation Strategy (CWCS), completed in 2006, is now in our conservation rear-view mirror. The decade during which this Strategy experienced implementation saw tremendous progress on a number of fronts. Ohio's conservation coalition grew as a result of efforts between the Division and the leadership of non-government conservation organizations from across the state. Productive dialog, planning, and efforts aimed at creating a better future for Ohio's imperiled species and habitats began. Over 65 wildlife diversity projects were implemented, with partners ranging from state and federal agencies, to universities, to conservation organizations, to citizen science volunteers. Thanks to the State Wildlife Grants program administered through the USFWS, money to fund these conservation efforts has been made available on an annual basis. Over $5.6 M has been spent in Ohio since the inception of the CWCS on surveys, monitoring, research, and management projects. As a result, populations of a number of species have been reintroduced, the status of other species has improved to the point of de-listing, and critical habitats have been protected. Most importantly, a new conservation momentum was generated upon which we can build for the future.

Updates of the state's conservation strategies are required every 10 years. In the pages that follow, we are happy to introduce Ohio's revision of the original CWCS, now referred to as the State Wildlife Action Plan (SWAP). Ohio's 2015 SWAP represents a major rewrite of the original plan, and is a result of contributions from many conservation partners. The new Action Plan leverages experience and knowledge gained during the first 10 years under the CWCS to produce a document that will be a more effective and user-friendly conservation tool for all Ohioans interested in the state's outdoor heritage and future. Significant changes have been made to the plan. The list of species of greatest conservation need (SGCN) has been updated based on our use of a new species scoring system to determine conservation status. The habitats section has also been expanded to include more habitat categories, and substantially more information about each. Within each habitat category, tables have been added that describe conservation threats to those habitats and species that live there, as well as conservation actions designed to abate those threats.

There has been much progress in the development of Ohio's conservation coalition since the first wildlife conservation strategy, and we look forward to the 2015 SWAP functioning as a vehicle to build on established partnerships as well as create new ones. The Action Plan is also intended to build upon existing conservation strategies, management tools, programs, and initiatives, as well as identify information gaps and research needs. The intent is for this Action Plan to function as a conservation roadmap and create a shared vision to bring all conservation partners together. Cooperation, coordination, and communication will be necessary as we move into the implementation phase. From a shared vision we can leverage time, resources, expertise, and available funding to do great things for Ohio's species and their habitats.

With great expectations, we look forward to the next 10 years of conservation under this Action Plan. Without question, new issues will arise that will demand attention. Expect revisions and updates to the Plan to occur in response to these. If we are able to learn and progress at the rate we did under the first plan, improvements to the 2025 plan will make Ohio's conservation future brighter than ever. It is our sincere hope that this Plan is wholly embraced, creates a conservation synergy, and a sense of ownership and accomplishment among all Ohioans.

Scott Zody
Chief
Ohio Department of Natural Resources – Division of Wildlife

Executive Summary

To provide additional funding for wildlife diversity, the U.S. Congress passed the Wildlife Conservation and Reinvestment Act in 2001 and State Wildlife Grant (SWG) legislation in 2002. In addition to providing annually-approved federal funding, the SWG program mandates each state and territory have a U. S. Fish and Wildlife Service approved State Wildlife Action Plan (formerly CWCS). Plans are to be revised and approved at 10 year intervals. This Action plan represents Ohio's first complete revision of the original CWCS that was approved in October 2005. The goal of the SWG program is to help ensure healthy fish and wildlife populations and wildlife diversity throughout the United States, especially species of greatest conservation need (SGCN).

State Wildlife Action Plan (SWAP) guidelines indicate that the document must include information on distribution and abundance of species of wildlife, location and condition of key habitats, problems associated with populations or their habitats, necessary actions for conserving priority species, plans for monitoring results, and a plan to review the document on a regular basis. In addition, each SWAP must be coordinated and developed with significant land holders and natural resource management agencies in the state, as well as involve broad public participation.

Ohio's Action Plan was assembled in part from existing strategic, tactical, and operational plans whose development included broad public and professional involvement and input. Updated information on SGCN, habitats, and conservation threats and actions was developed with input from a number of professional and public individuals from a variety of backgrounds, including academic, constituent groups, and non-government organizations.

The Action Plan also includes information about the process of reviewing the document, as well as information related to coordination of the plan with other conservation agencies and organizations, and detailed information about public involvement during development of the plan. The Plan is scheduled to be evaluated and updated every five years, although new data and emerging issues may be addressed at any time during plan implementation.

Ohio's Action Plan is organized into the following chapters and sections which describe the state, the conservation landscape, issues impacting Ohio's wildlife ecosystems, and the roadmap of actions to a better place for our species, habitats, and the people of Ohio.

Introduction to Ohio's State Wildlife Action Plan
The Introduction describes what the Action Plan is and its role in conservation in Ohio. It describes the development of the SWAP in terms of public participation and coordination with federal, state, and local agencies. In addition, a discussion of evaluation and adaptation of the Action Plan is included.

The Ohio Landscape
This chapter is intended to paint a picture of everything in Ohio that affects how conservation is practiced. It includes information on Ohio's climate and landscape, processes that influenced the state's natural resources as we know them today, and Ohio's wildlife and ecosystems. Information on demographics and economics is also contained in this chapter. This chapter includes a discussion of statewide threats and key conservation challenges, as well as Ohio's approach to conservation.

Ohio's First 10 Years of CWCS Implementation
This chapter highlights conservation efforts that occurred during, and facilitated by Ohio's first Comprehensive Wildlife Conservation Strategy. Projects accomplished by the Division of Wildlife and conservation partners are contained in lists organized by species and habitats. The fundamental differences between the original CWCS and revised SWAP are discussed in the context of what 10 years of experience has taught us. The chapter wraps up with a discussion of key goals for the next 10 years under the SWAP.

Monitoring, Evaluation, and Adaptive Management
Proper monitoring is key to our ability to track the success of conservation actions, ensuring the most efficient and effective use of staff, funds, and resources. As conditions change (e.g., land use patterns, climate change, population trends, new data and information acquired), adaptive management and implementation of the conservation actions identified in the Action Plan will allow us to respond appropriately.

This chapter describes how Ohio will use tools for information management and conservation planning to track the implementation and effectiveness of conservation actions. These tools are described in the Measuring the Effectiveness of State Wildlife Grants (AFWA 2011) final report, and the national Wildlife Tracking and Reporting Actions for the Conservation of Species (*TRACS*) database funded by U.S. Fish and Wildlife Service. The framework starts with a specific conservation action, and then a basic results chain is created linking the action to objectives, relevant threats, and targets (habitats and species). Appropriate indicators and measures are determined for each step in the chain, and monitoring data are used to track and populate those indicators. Information about the results chain, indicators, and measures is then entered into the *Wildlife TRACS* database. Effectiveness Measures is the process, and *TRACS* is the IT system used for reporting and tracking. Measurement of indicators for each step in the results chain provides the essential information needed for evaluating the effectiveness of conservation actions. Conservation actions will be monitored and measured throughout the 10-year implementation of Ohio's Action Plan.

Species of Greatest Conservation Need
This chapter begins with an explanation how Ohio's SGCN were chosen, and the rationale behind the choices made. It describes which taxa groups are included in the Action Plan, and how conservation status ranks for each species were calculated.

Following that, historical information and current status of "listed" species under each taxa group is presented. This section is intended to give the reader some perspective on how natural and anthropogenic changes have affected each of the taxa groups since Ohio was settled. Following the history/status of each taxa group is the SGCN table for that group. This table contains all of the species within that taxa group, ranked by conservation status score. Also contained in the SGCN table is the State and Federal listing designation (if one applies), habitat association, rangewide occurrence, statewide occurrence, and Ohio population trend. The SGCN chapter contains the 9 species groups (amphibians, birds, butterflies/skippers, crayfish, dragonflies/damselflies, fish, mammals, mussels, reptiles) for which enough information was available to calculate conservation status ranks.

Climate Change
The chapter on the effects of climate change discusses the status of the science of climate change as a threat to species and habitats in Ohio. Regional climate changes are described, and regional species and habitats at greatest risk and most vulnerable to climate impacts are highlighted. A general discussion of the impacts of and biological responses to climate change covers the most likely and most discussed impacts/responses in current scientific literature. Lastly, a table of adaptation strategies and actions in response to climate change is included.

Ohio's Habitats
A discussion of Ohio's 15 habitat categories and related conservation threats and actions constitutes the most extensive chapter of Ohio's Action Plan. This chapter begins with a listing of the habitat categories chosen for Ohio's SWAP, and the rationale behind the choices of those categories. A general description of each habitat category is presented. The next section describes the conservation threats and actions related to the habitat categories, including how the threat/action classifications were determined. A description of how "threat impact scores" and "conservation action priority ranks" were calculated is included. Maps indicating the general distribution of terrestrial and aquatic habitats follow. Accompanying tables contain conservation threats and actions for each habitat category.

Individual habitat category sections within this chapter include a distribution map, and information on status, habitat description, and associated SGCN. Within each habitat section, Conservation Opportunity

Areas (terrestrial habitats) and Conservation Opportunity Watersheds (aquatic habitats) are identified and described. Within each of the individual habitat category sections are Conservation Threat and Conservation Action tables that are specific to that habitat. Both use the categories and classification system described in Salafsky et al. (2008). In the Conservation Threats table, each individual threat has an accompanying threat impact rank calculated using the NatureServe Conservation Status Assessments system in Master et al. (2012). In the Conservation Actions table, each individual action has an accompanying priority rank calculated using the system developed by the Georgia DNR and described in their SWAP. Each individual action also carries a reference to the specific threat(s) it addresses from the habitat conservation threats tables.

The Plan concludes with a literature cited section and 3 appendices.

Introduction to Ohio's State Wildlife Action Plan

I. A Vehicle for Conservation Funding

The history of wildlife management as we know it today dates back to the early 19th century when hunters, anglers, and trappers began to notice declines in popular sport and commercial species. These early conservationists asked legislators for regulations on themselves, as well as restrictions on commercial harvest, so that the activities they cared so much about would be able to continue for future generations. Later that century, after years of lobbying by sportsmen, the first wildlife management agencies were created. These same sportsmen provided the funding for these agencies through license fees, and later excise taxes on their gear. This highly successful model (The North American Model of Wildlife Conservation) is stronger than ever today, and the reason why management of sport species is so well funded.

Through the years, many non-sport species have benefitted from management efforts directed at sport species and their habitats. However, a non-sport species analog to the sportfish and wildlife restoration program has never been developed. Limited funding has been provided through the Endangered Species Act in recent decades. Additionally, fundraising mechanisms such as tax check-offs, license plates, conservation stamps, and the like have been used to generate funding for non-sport and endangered species management. Unfortunately, none of these have generated a fraction of what sportsmen provide through well-established programs. As species and their habitats continue to decline (listed species have doubled in the past 10-20 years), clearly more needs to be done on the conservation front.

The idea for a national wildlife conservation effort for non-game and endangered species goes back several years. The initial effort was intended to provide stable funding for wildlife diversity and non-game species similar to the Pittman-Robertson and Dingell-Johnson funding mechanisms for game and sport fish. The effort was entitled "Teaming with Wildlife" and was focused on an excise tax based system that taxed outdoor-related and wildlife recreation related items such as binoculars, bird seed, camping gear, etc. The effort failed however, and Congress was forced to consider other options. Eventually, Congress passed a series of bills that provided funding to the states for the "species of greatest conservation need" utilizing general tax revenue dollars that had to be renewed on an annual basis.

To provide additional funding for wildlife diversity, the U.S. Congress passed the Wildlife Conservation and Reinvestment Act in 2001 – a one time national appropriation to the states. State Wildlife Grant (SWG) legislation passed in 2002. The goal of the SWG program is to help ensure healthy fish and wildlife populations and wildlife diversity throughout the United States, especially those species in greatest need of conservation. In addition to providing annually-approved federal funding, the SWG program mandates each state and territory submit a Comprehensive Wildlife Conservation Strategy (this revision of which is now referred to as the State Wildlife Action Plan (SWAP)) to the U. S. Fish and Wildlife Service.

Guidelines for development of the CWCS/SWAP and the criteria for approval were provided to state and territory fish and wildlife agencies. Through the State Wildlife Grants Program legislation, Congress has identified eight required elements for each state's Action Plan. Plans must identify and provide for information on the distribution and abundance of species of wildlife; locations and relative condition of key habitats; problems which may adversely affect species or their habitats; conservation actions to conserve the identified species and habitats; plans for monitoring species and habitats; procedures to review the Plan; development, implementation, review, and revision of the Plan with Federal, State, and local agencies that manage significant land and water areas within the state; and public participation in the development, revision, and implementation of the Plan.

Ohio's Action Plan is a strategic and tactical look at the combined conservation efforts needed to sustain species of greatest conservation need and their habitats across the state. The Plan is intended to serve as the foundation from which operational-level plans of the multiple conservation agencies and groups within Ohio are generated. Funding provided by the State Wildlife Grants Program will facilitate the development, coordination, and implementation of these plans (projects) through this Action Plan. The Plan is intended to be a living (thus adaptive) document that will continually be updated, revised, and improved based on the involvement and input of all those interested in Ohio's conservation future.

II. A Unifying Force for Conservation

The purpose of Ohio's SWAP is to provide strategic and tactical direction for conserving wildlife diversity in Ohio. It specifically addresses, but is not limited to, species in greatest need of conservation and their habitats, and the development of conservation actions to abate threats to those species and habitats as described by the U. S. Congress in the enabling legislation. In addition, the SWAP provides a vehicle to encourage partnerships and cooperation among conservation partners in Ohio.

Wildlife conservation in Ohio is a very important and very challenging task. The landscape and human population of the state is varied, with extremes of highly developed urban environments, largely undeveloped and forested environments, highly productive farmlands, and the waters of Lake Erie. More than 11 million people call Ohio home, yet very little of the state is in public ownership. This combination of high human population, urban and rural landscapes, extensive agriculture, and multiple state and national boundaries makes Ohio a challenge for wildlife conservation and management.

The task of conducting landscape-scale conservation in Ohio, in reality, will take all the time and resources that government regulatory agencies have, and still ask for more. The amount of work to be done, information needed, fiscal and personnel resources necessary, and time and location issues involved is beyond daunting. Add to that the fact that we are working with very dynamic systems, looming impacts of climate change, and the challenge of getting civilization and nature to coexist – and you begin to get a sense of the enormity of this conservation endeavor. To have any chance at large scale success necessitates that everyone from the governor's office to the average citizen work in a coordinated fashion towards common conservation goals. This starts with identifying a place that everyone wants to go (a conservation endpoint) and then mapping a strategy to get there with buy-in from all that are going to participate.

The Division of Wildlife was the lead agency in the development of Ohio's original Comprehensive Wildlife Conservation Strategy, as well as the revision now known as the State Wildlife Action Plan. However, neither of these documents could have been completed without a significant amount of help from our conservation partners. Partners contributed to development by providing valuable information on species, habitats, conservation threats and actions, and the relative priorities of those. Besides making this Action Plan a more complete and more useful document, the cooperative development of it should help promote a sense of ownership among all participants. In the end, it is paramount that the Action Plan be viewed as, and function as a tool for anyone interested, to participate in conservation.

Conceptually, the way the model should work and the part everyone plays is fairly straightforward. Holistic conservation will consist of the Action Plan as the source for identifying and prioritizing threats to species and habitats, and actions to abate those threats. Partnerships will then be utilized to implement on-the-ground projects that derive from prioritized actions, and the SWG program will provide the funding. The key is partnerships. Partnerships will provide the increases in efficiency and effectiveness needed to conduct landscape-scale conservation. Partnerships will increase the size of Ohio's conservation workforce.

Partnerships are made productive by focusing partners on aspects of projects that align with their authority, mission, and areas of expertise. As projects are developed and implemented, partners must be selected based upon their "fit" for specific aspects of those projects. This will help avoid duplication of effort, and efficiently align capabilities with tasks to be accomplished. Long-term success of Action Plan implementation will require the combined and coordinated efforts of the Division, its state and federal agency partners, academia, conservation organizations, and every Ohio citizen that values nature.

In a nutshell, Ohio's State Wildlife Action Plan will be the means to bring together all Ohioans with an interest in conservation, and help prioritize and direct conservation efforts for habitats and species so that they are as scientifically effective and financially efficient as possible.

III. Development of Ohio's SWAP

The Division of Wildlife adopted an approach of partnership and public participation in the development of Ohio's SWAP. The DOW has committed to building partnerships and public support for conservation by working with public and private groups and individuals with an interest in management of our natural resources. A broad range of state and federal agencies, conservation organizations, businesses, academics, stakeholders, and general public were invited to participate in the process. Together these groups represent the best resources available in terms of their contributions to our knowledge about Ohio's species, habitats, threats, and conservation actions.

As suggested in the AFWA Best Practices guide, our approach to public involvement included identifying key constituent groups, determining appropriate involvement goals for each, and developing strategies to get the most participation/feedback from each group. To reach out and involve conservation stakeholders in the development of Ohio's SWAP, a variety of strategies involving a number of communication channels were utilized. In each case, efforts were made to scale the level of public participation and information gathering to the level of the group in question. The following is a description of the methods used to facilitate public involvement in the development of Ohio's SWAP.

III-A. Public Participation

The Division of Wildlife has a long standing tradition of communicating with the public and seeking input on conservation issues, including development of planning documents such as the Comprehensive Wildlife Conservation Strategy and this revised State Wildlife Action Plan. Several activities were conducted to acquire public input into the development of the original CWCS and new SWAP, including public meetings, meetings with constituent groups, advertisement on the Division's website, and statewide conservation club leadership meetings.

The Division undertook numerous activities to gain both public input and agency/organization input into development of the CWCS/SWAP. These activities included:

- Regional Meetings (with surveys)
- Statewide Conservation Summit
- CWCS/SWAP presentations at meetings of the Ohio Wildlife Council (with surveys)
- CWCS/SWAP presentations at the Division's annual Wildlife Diversity Conference (with surveys)
- Advertisement on the Division's website
- Mailing of CWCS/SWAP document (via CD) and surveys to interested parties

III-A-1. The Process and Public Involvement

A series of five regional meetings were conducted with conservation organization leaders during development of the original CWCS. A summary of the Division's CWCS approach and proposed activities was presented at each meeting followed by an open house forum to exchange ideas and gain comments, questions, and concerns. A formal survey related to wildlife diversity activities and the CWCS was also distributed and collected at the end of each meeting. A total of 131 conservation group leaders, representing thousands of Ohioans attended these meetings and completed the CWCS survey.

The Division also hosted a statewide "Conservation Summit". Approximately 100 constituent leaders, academic professionals, and conservation organization leaders were invited to attend the summit. The summit involved a series of presentations regarding the development of the CWCS followed by an open house forum involving Division professionals and administrators. Participants at the summit were also invited and encouraged to complete a survey on current wildlife diversity activities. The CWCS was also presented to approximately 100 transportation planners at the *Ohio Transportation Planning Conference,* where a draft of the document was distributed and input requested from attending transportation professionals.

Input from the general public regarding the development of the CWCS/SWAP has been obtained by several methods. The Division's annual Wildlife Diversity Conference is hosted in Columbus and open to the general public. On average, 700-900 participants attend. The Ohio CWCS/SWAP has been a prominent component of the conference, and all participants have been invited to review drafts of the document and complete surveys about it. Surveys received during and after the conference are analyzed and then archived for future reference. Over the years, a number of relevant comments have impacted the content of the final draft of the CWCS and SWAP. Examples of recent public meetings and conferences include:

September 2013 Wildlife Diversity Leadership Conference – 50 conservation leaders attended; attendees were given the opportunity to comment on SGCN and habitats; surveys were filled out and attendees were asked to stay connected throughout the SWAP revision process

March 2014 Wildlife Open Houses – held at 5 locations around the state; SWAP informational display was used to solicit public input/comments; attendees were directed to the Division's website for access to the draft SWAP

March 2014 Wildlife Diversity Conference – 800 attendees included a mix of government, academia, and the public; SWAP information booth was used to communicate with attendees; attendees were directed to the Division's website for SWAP review and comment

September 2014 Wildlife Diversity Leadership Conference – 50 conservation leaders attended; attendees were given a presentation on conservation threats and actions; attendees were asked to review draft threats/actions online and continue to remain connected through the SWAP revision process

March 2015 Wildlife Diversity Conference – 800+ attendees included a mix of government, academia, and the public; SWAP review information was included in the registration packet; attendees were directed to the Division's website for SWAP review and comment

August 2015 Wildlife Diversity Leadership Conference – approximately 50 conservation leaders attended; attendees were given a presentation on the completed final draft of the SWAP, and how their groups could use the document; attendees were asked to access the SWAP online, and make it a tool for future conservation efforts.

Multiple CWCS/SWAP presentations have been made at the Ohio Wildlife Council meeting in Columbus. The Wildlife Council is appointed by the governor and approves all Wildlife rules. This group is a primary liaison between the Division of Wildlife and the public, and all Wildlife Council meetings are open to the public.

As suggested in the AFWA Best Practices guide, the public was notified of the state's intent to revise its SWAP and given the opportunity to review and comment on the Plan via the Division's website. SWAP content was first posted online in March of 2014. As sections of the document reached completed draft status, they were added to existing sections on the website for review and public comment.

In summary, the Ohio CWCS/SWAP has been presented to more than 1000 individuals from throughout Ohio. Public input resulting from review opportunities was evaluated and relevant information incorporated in the final CWCS/SWAP document. Participants at each public gathering were strongly encouraged to regularly communicate with the Division regarding wildlife diversity issues and activities.

III-A-2. General Public and Constituent Involvement in Conservation

Since adopting a Comprehensive Management System in the late 1980s, the Division of Wildlife has included the general public, constituent groups, and academia in its decision making and administrative processes. These groups have provided valuable information, opinions, and attitude assessments which have aided the Division with management, administrative, and regulatory decisions. A variety of formal and informal approaches are used to gather information from the public and constituent groups.

III-A-2.1 Formal Approaches to Public Involvement

In addition to a variety of informal approaches to public involvement, the Division of Wildlife also employees a wide array of more formal approaches for communicating and gathering information from the public, government agencies, conservation clubs, constituent groups, and other parties interested in natural resources management.

Wildlife Council

The Wildlife Council is the Division of Wildlife's formal connection to the public, and acts as the advisory group for all rules and regulations. All Division rules related to the establishment of hunting, trapping, and fishing seasons, bag limits, size, species, method of taking, and possession, including traditional game species and non-game species such as reptiles and amphibians, are adopted only with approval of the Wildlife Council. Wildlife Council meetings are open to the public, and typically occur at a rate of about 6-8 per year. At these meetings, the public has opportunities to interact with Council members as well as Division personnel. Presentations regarding the development of Ohio's SWAP were made at multiple Wildlife Council meetings.

Wildlife District Open Houses

The Division of Wildlife has adopted several formal methods for gathering public input concerning proposed wildlife regulations. One method is to hold five district open houses in March of every year. These open houses introduce the public to upcoming rule proposals, revisions, and/or modifications. The public is encouraged to offer comments and discuss the proposals with Division employees. Comments are taken in writing, and analyzed and archived. Strong sentiment by the public on a proposal(s) can influence the final version. In addition to public review of rule proposals, open houses are used to inform the public about emerging issues, new opportunities, and/or new programs related to conservation in Ohio. Open houses were used to inform attendees about Ohio's SWAP, and how they could participate in the development and implementation of the Plan.

State Fish and Wildlife Hearings

Following the district open houses, the Division reconsiders the proposed regulations and presents the final recommendations to the public at statewide hearings in the spring and fall. At the statewide hearings there is a formal reading of the proposed regulations followed by time for public input and formal comment. Both the open houses and the statewide hearings are publicized through Division publications and newspaper announcements and are open to the public. Records of public comments are kept as a formal part of the hearing process.

Public Attitude Surveys

The Division of Wildlife periodically conducts public attitude surveys to determine the public's opinion on, or level of understanding regarding wildlife, wildlife management, endangered species, and other aspects of conservation in Ohio. These surveys may be conducted online, or in person depending upon the type of survey and information to be collected.

Professional Memberships/Communication

The Division of Wildlife is active in a number of professional conservation organizations, and has been for many years. These organizations include the Ohio Biological Survey, the Ohio Fish and Wildlife Management Association, Ohio Chapters of the American Fisheries Society and The Wildlife Society, Ohio Lepidopterists, as well as several national organizations. This regular networking and communication has been an important tool in helping the Division connect with professional and academic communities. Through membership in these organizations, the Division directly communicates with groups and individuals who can provide views and opinions related to various conservation issues. These professionals include academic professionals, non-governmental organization professionals, statewide constituent group leaders, and professionals from other governmental agencies and organizations. Connections made through activity in these organizations facilitated identification of species and habitat experts that played key roles in the development of Ohio's SWAP.

Academic Cooperatives
Currently the Division has cooperative programs with The Ohio State University (OSU) and several other Ohio colleges and universities. At The Ohio State University, the Division supports both the Terrestrial Wildlife Ecology Laboratory (TWEL) and Aquatic Ecology Laboratory (AEL) which conduct valuable research for the Division. As part of the agreement with the OSU TWEL and AEL, the responsible departments host an annual review of their research. These gatherings of academic and agency professionals facilitate the exchange of ideas, topics of concern, future research needs, and other issues related to fisheries and wildlife management. Through research relationships created with Ohio's colleges and universities, a number of individuals were identified that assisted with the development of Ohio's SWAP.

Statewide Conservation Organization Meetings
Ohio is home to many conservation organizations that focus on species, habitats, ecosystems, and outdoor activities, and whose missions are the preservation and enhancement of these for future generations. The Division actively communicates and partners with these organizations on conservation-related issues in Ohio. These groups were given the opportunity to review and provide input on the development of Ohio's original CWCS as well as the newly revised SWAP. These groups will also play a role in the implementation of Ohio's SWAP going forward. To illustrate the diversity and breadth of these organizations, a sampling includes the following:

Beaver Creek Wildlife Education Center
Black Swamp Bird Observatory
Black Swamp Conservancy
Buckeye Big Bucks
Canton Audubon Society
Cleveland Metroparks
Columbus Audubon Society
Crawford County Parks
Erie Metroparks
Firelands Audubon Society
Friends of Magee Marsh
Friends of the National Rifle Association
Geauga County Parks
Grand River Partners Land Conservancy
Greater Mohican Audubon Society
Hamilton County Parks
Isaak Walton League
Lake County Metroparks
Lake Erie Charterboat Association
Native Plants Society of NE Ohio
Ohio Association of Garden Clubs
Ohio Audubon Council
Ohio BASS Chapter Federation
Ohio Blue Bird Society
Ohio Chapter of Ducks Unlimited
Ohio Chapter of Pheasants Forever
Ohio Chapter of the National Wild Turkey Federation
Ohio Environmental Council
Ohio Farm Bureau
Ohio Greenways
Ohio Historical Society
Ohio Huskie Muskie Club
Ohio Lepidopterists
Ohio Ornithological Society
Ohio Sea Grant
Ohio Smallmouth Alliance

Richland County Parks
Rivers Unlimited
Stark County Parks
Summit County Metroparks
The Nature Conservancy
The Wilds
Toledo Metroparks
Trout Unlimited

Citizen Science
Citizen Science is scientific research conducted by volunteers and its success depends on public participation. Current citizen science projects in Ohio are listed below. These projects allow the public to actively participate in conservation, and provide information that the Division would have difficulty collecting with its limited resources.

Ohio Frog and Toad Calling Survey
In Ohio, naturalists have been documenting the occurrence of amphibians for over 160 years. In 1838 Dr. Jared Kirtland published the first list of amphibians collected in Ohio. Since then a myriad of individuals have worked to determine how Ohio's frogs, toads, and salamanders are distributed. The Ohio Frog and Toad Calling Survey utilizes the efforts of volunteers from around the state to conduct audio surveys at selected breeding sites.

Breeding Bird Atlas II
A breeding bird atlas is a grid-based survey used to document the status and distribution of all bird species that breed within a given country, state, or county. Atlas projects are largely accomplished with the help and dedication of a statewide network of volunteers that document the breeding status of all bird species encountered. The ultimate success of Ohio's next breeding bird atlas depends on the active participation and efforts of birders and outdoor enthusiasts from throughout the state.

Bowhunter Survey
The Ohio Bowhunter Survey is a program the Division uses to track year-to-year changes in furbearer populations, and to record sightings of special interest species such as black bear, bobcat, and river otter. Because bowhunters typically spend many hours in the field observing wildlife, this group of outdoorsmen and women provide some of the best information on certain wildlife species that are difficult to monitor using other survey methods.

Spider Survey
The Ohio Spider Survey is an effort to find out how many species of spiders live in Ohio. The original list of Ohio Spiders was published by William Barrows in 1924 and included 306 species. The current project was begun in 1994 and the list of spider species known for Ohio has now reached 583. There are probably more species yet to be discovered. The aim of the Ohio Spider Survey is to fill a major data gap in our understanding of spider populations in Ohio.

III-A-2.2 Informal Approaches to Public Involvement and Communication
Less formal approaches to public involvement are many and varied. Many of these are aimed at building support for conservation by educating the public about species, habitats, and outdoor recreational opportunities. To help spread the conservation message, efforts are made to include members of Ohio’s outdoor media at newsworthy events. In order to build and maintain relationships with professional conservation partners, Division personnel are regular attendees of conservation-focused conferences and meetings.

WILD Ohio Magazine
WILD Ohio Magazine had a distribution of approximately 150,000 copies per edition, until transitioning to a paid subscription in 2012. Distribution has now decreased to approximately 12,000 copies per edition. The Division has been publishing *WILD Ohio* magazine for approximately 26 years. The magazine

showcases all aspects of conservation in Ohio, and is a significant means of communication between wildlife professionals and the public. Many important SGCN and habitats have been highlighted in *WILD Ohio* Magazine over the years. The magazine has also been an important tool for building support for key conservation issues.

WILD Ohio Video Magazine

WILD Ohio Video Magazine has been produced for approximately 23 years. The 30-minute show is distributed at no charge to Public Broadcasting Service Stations (via satellite link) and is also provided to local governments and cable stations. Like the print edition of the magazine, the TV show covers all aspects of conservation in Ohio and has been a great tool for cultivating interest in the outdoors.

Internet Communications

The Ohio Department of Natural Resources website hosts pages for all of the ODNR divisions, including the Division of Wildlife. Serving more than 2 million Internet visits each year, the Division of Wildlife Website serves the public through the dissemination of various technical publications, educational and instructional materials, and other value-added pieces of information. Ohio's SWAP was available through the Wildlife webpage for review and comment by the public. The SWAP in various stages (drafts) of completion was available online for 17 months.

Call Center Operations

The Division of Wildlife maintains a toll-free line for public requests, questions, and comments. This phone system is operated during regular work hours and receives about 80,000-100,000 calls per year.

E-mail Communications

As part of the Division's communications efforts, visitors to the website are invited and encouraged to submit comments, questions, or opinions directly to a wildlife specialist or other Division employee. In reviewing Ohio's SWAP, the public was encouraged to email comments to the SWAP revision coordinator.

Social Media

The public is now able to communicate with the Division and with each other regarding conservation issues and opportunities via Facebook and Twitter.

Project WILD

Project WILD is a supplementary education program emphasizing awareness, appreciation, and understanding of wildlife and natural resources in young people. The program teaches young people basic concepts about wild animals, their needs and importance, and their relationships to people and the environment. *Project WILD* activity guides are available to educators free of charge when they attend a workshop. Trained facilitators conduct educator workshops throughout the year. In addition, the Division of Wildlife conducts annual leadership workshops to train new facilitators

Personal Communication

The most basic, yet perhaps most important, communication channel with the public comes in the form of personal communication between Division personnel and the citizens of Ohio. County wildlife officer duties include not only wildlife law enforcement, but also speaking engagements and presentations for schools, youth groups, conservation clubs, and other interested groups. Wildlife and fisheries biologists and technicians routinely communicate with local and statewide conservation clubs, make presentations for interested groups.

Ohio is home to more than 100 local or county fairs and festivals throughout the year. The Division of Wildlife staffs displays at more than half of these events every year, helping to reach thousands of Ohio citizens with information about conservation in Ohio. The Division plays an important role in all of the major outdoor-related shows in the state. In addition, the Division maintains displays at garden shows and other similar events that attract a different outdoor crowd.

Angler Surveys
Surveys of anglers are conducted annually throughout Ohio, providing an important conduit for information exchange between the Division and the public regarding all facets of management and conservation of aquatic species and habitats.

Zoos, Museums, and Other Family Attractions
Ohio is fortunate to be home of some of the world's best and most prestigious zoos and museums. The Division of Wildlife emphasizes interaction and partnerships with these professional institutions. Over the years, cooperative programs have been developed related to conservation education, as well as endangered species propagation and reintroduction. Current or recent cooperative efforts involving these zoos and museums include:

Osprey rearing and hacking
Bald eagle fostering, rehabilitation, and release
Trumpeter swam rearing and reintroduction
Endangered freshwater mussel research, propagation, and reintroduction
American burying beetle propagation and reintroduction
Karner blue butterfly propagation and reintroduction
Eastern plains garter snake propagation and reintroduction
Western banded killifish propagation and reintroduction
Pirate perch propagation and reintroduction
Development & delivery of educational materials and workshops to promote stream conservation
Participation in zoo or museum sponsored symposia or professional meetings

Conferences and Meetings
The Division of Wildlife hosts, co-hosts, or cooperates with a number of professional conferences and meetings that focus on conservation. For the most part, these events are open to the public and offer a unique opportunity for Division personnel to interact with other professionals and conservation-minded members of the public in a more structured setting. A partial listing of these conferences and meetings includes:

Ohio Outdoor Writers Annual Conference
Ohio Fish and Wildlife Management Association
Ohio Wildlife Diversity Conference
Ohio Avian Ecology Conference
Audubon's IBA Technical Committee
Ohio Blue Bird Society Annual Meeting
Ohio Lepidopterists Society Annual Meeting
Ohio Prairie Conference
Ohio Herpetological Work Group
Bird Conservation Initiative Conference
Ohio Farm Bureau Conference
Ohio Natural History Conference
Ohio Wildlife Rehabilitators Conference
Wing Watch Birders Conference

III-B. Coordination with Federal, State, and Local Agencies
Coordination of fish and wildlife management plans and activities is found at all levels within the structure of the Division of Wildlife, and occurs cooperatively with federal, state, and local government partners. As a state bordered by five other states and one Canadian province, it is critical that all fish and wildlife management activities be conducted with coordination of all natural resource management agencies in both the state and the region.

The Division of Wildlife has a long standing tradition of partnering with other agencies, natural resource organizations, private landowners, and other natural resources-related groups. These partnerships have involved partnering on fish and wildlife management plans, management activities, land purchases, public displays, and other activities that further the conservation of fish and wildlife in Ohio.

The Division coordinates all fish and wildlife management activities with all the significant land owners in the state, both private and public. Major landowners include:

Wayne National Forest (US Forest Service)
ODNR, Division of Parks and Recreation
ODNR, Div. of Natural Areas and Preserves
ODNR, Division of Forestry
Cuyahoga National Park (National Park Service)
The Nature Conservancy
Ohio Historical Society
U.S. Fish and Wildlife Service
Numerous Metro Park and Local Park Agencies

All major and significant landowners, as well as natural resources agencies, were involved in development of the SWAP and were invited to comment on the Plan. There are no tribal lands in Ohio.

III-B-1. International Coordination and Cooperation
The Division of Wildlife participates in a number of international efforts to conserve and manage fish and wildlife resources in North America, most notably the Great Lakes Fisheries Commission, the Mississippi Flyway Council, and the Partners in Flight program. Each of these efforts involves cooperative activities across state and/or international boundaries, and the management efforts of the cooperating states are coordinated at an international or national level. Participating in these efforts ensures that the fish and wildlife management activities in Ohio are part of a larger, regional or national effort to conserve fish and wildlife populations throughout North America. Representatives from these efforts are consulted on a regular basis (including during development of Ohio's SWAP) to ensure that Ohio's conservation activities support national and international goals and objectives.

Examples of internationally coordinated organizations and initiatives in which Ohio actively participates include:

- Lake Erie Committee of the Great Lakes Fisheries Commission – involves coordination of fish management activities in all the Great Lakes; members include all Great Lakes states and provinces

- Lake Erie Water Snake Recovery Plan – involves population recovery of the state threatened (federally delisted in 2011) Lake Erie water snake; members and cooperators include Ohio DNR divisions, Toledo Zoo, Metropolitan Park District of the Toledo Area, The Nature Conservancy, Ohio Lepidopterists, Toledo/Lucas County Port Authority, Michigan DNR, American Zoological Association, and the U.S. Fish and Wildlife Service

- Convention on International Trade in Endangered Species (CITES) – a unit of the United Nations which focuses on international trade in endangered species; the Division of Wildlife coordinates the harvest of paddlefish and river otters with CITES and adheres to all relevant agreements

III-B-2. Coordination with National Agencies and Organizations
Significant federal land holdings in Ohio are limited to the Cuyahoga National Park near Cleveland, the Ottawa National Wildlife Refuge in northern Ohio, and the Wayne National Forest in the southeastern portion of the state. In addition, the Ohio Division of Wildlife cooperates extensively with the Ohio River Islands National Wildlife Refuge in West Virginia. These holdings are managed by the National Park Service, the U.S. Fish and Wildlife Service, and the U.S. Forest Service, respectively. There are no tribal lands in Ohio.

Fish and wildlife management activities in the Cuyahoga National Park are limited. The acreage of the Cuyahoga National Park is relatively small and management of the area does not greatly impact the overall fish and wildlife diversity of the state except in very specific instances. The Division of Wildlife and the National Park Service meet annually to discuss and coordinate fish and wildlife management activities, the status of endangered species, nuisance wildlife, and other issues. Additional meetings and discussion are held as needed.

The Ottawa National Wildlife Refuge (and its satellite areas) primarily represents some of the last remaining wetland complexes in northern Ohio and the few remaining undeveloped islands in Lake Erie. Management of the area is conducted by the U.S. Fish and Wildlife Service and coordination of fish and wildlife management activities is done in cooperation with the Division of Wildlife. The refuge staff meets regularly with Division of Wildlife staff to coordinate management activities and the management goals of both agencies.

The Wayne National Forest in southeastern Ohio represents the largest federal land holding in Ohio. As a multiple-use agency, the U.S. Forest Service manages the forest for timber, wildlife, recreation, and other sustainable uses. Division representatives meet with the Forest superintendent on a regular basis to discuss common areas of interest and areas of concern, including completion of the Wayne National Forest strategic plan. In addition, representatives from the Forest have been included in discussions involving the Division’s strategic and tactical plans, including the SWAP.

In addition to government agencies, the only national non-government organization that has significant land holdings in Ohio is The Nature Conservancy (TNC). The Edge of Appalachia preserve in southwestern Ohio and some properties in central Ohio represent the significant land holdings of The Nature Conservancy in the state. These properties are managed by TNC primarily as nature reserves, however limited recreational opportunities are permitted in cooperation with the Division of Wildlife under the guidance of the Division’s strategic and tactical plans, including the SWAP.

Examples of nationally coordinated initiatives and organizations with which the Division of Wildlife actively participates include:

- The Nature Conservancy (TNC) – critical habitat purchases
- American Zoological Association (AZA) – endangered species propagation and reintroduction
- Ohio Bird Conservation Initiative
- Mississippi Interstate Cooperative Resource Association (MICRA) and Ohio River Fisheries Management Team (ORFMT) – coordinate efforts to conserve and manage fisheries in the Mississippi River drainage including the Ohio River

III-B-3. Coordination with State Agencies and Organizations
Three state and one quasi-governmental agency have significant land holdings in Ohio – the Ohio Divisions of Parks and Recreation, Forestry, and Natural Areas and Preserves, and the Muskingum Watershed Conservancy District, respectively. Representatives from each of these agencies are included in discussions concerning statewide fish and wildlife management issues or activities, and local or regional issues are discussed on a case-by-case basis with the appropriate agency. These activities are coordinated and implemented as described in the Division’s strategic and tactical plans, and Ohio’s SWAP. Representatives from the Ohio Division of Forestry, Ohio Division of Parks and Recreation, and the Ohio Division of Natural Areas and Preserves were invited to review and comment on the SWAP.

Ohio also has several significant non-government agencies that are involved in natural resource management, including the Ohio Farm Bureau, the Ohio Forestry Council, Ohio Environmental Council, and Ohio Audubon Society. Representatives from each of these organizations, and others, have been included in all discussions and meetings involving statewide fish and wildlife management activities, including development of the Division’s strategic and tactical plans, and the SWAP.

Examples of statewide initiatives and organizations that the Division of Wildlife actively participates in include:

- Grand River Partners – habitat protection in the Grand River watershed
- Soil and Water Conservation Districts (SWCD) – habitat restoration and riparian protection projects
- Ohio Department of Transportation (ODOT) – habitat restoration and protection
- Columbus Zoo/The Wilds – endangered species propagation and research
- Ohio Departments of Health and Agriculture – coordinated efforts to control animal diseases

III-B-4. Coordination with Local Agencies and Organizations
Ohio is home to more than 700 local conservation organizations representing thousands of Ohioans concerned about fish, wildlife, and other natural resource issues. Each of these organizations has local interests and concerns, and the Division of Wildlife works closely with these organizations to ensure that local fish and wildlife management concerns are addressed as effectively and efficiently as possible. Each of these concerns, and others, are addressed using the guidance provided by the Division's strategic and tactical plans, and the SWAP.

In addition to local conservation organizations, Ohio also has numerous local park agencies. These agencies represent tens of thousands of acres of parkland throughout the state. The management of county, metro, and other local parks is important to the success of conservation in Ohio. Therefore representatives from the larger park districts in the state, as well as the professional organization representing Ohio's parks, the Ohio Parks and Recreation Association (OPRA), were invited and participated in various levels of development of Ohio's SWAP.

Many fish and wildlife issues for local park and recreation agencies involve either fish/lake management activities, or nuisance wildlife management and control. Any actions or activities related to these issues must be coordinated with the Division of Wildlife, as the permitting agency, using the guidance provided by the Division's strategic and tactical plans, including the SWAP.

In certain instances local park and recreation agencies have provided partnerships for acquiring valuable wildlife habitat, including critical habitat for the Karner Blue Butterfly in northwestern Ohio. In one case the Metropolitan Park District of the Toledo Area provided partial funding for purchasing Karner Blue Butterfly habitat in the Toledo area. The resulting wildlife area is managed in cooperation with the park district under the guidance of the Division of Wildlife's strategic and tactical plans, including the SWAP.
Other examples of locally coordinated initiatives in which the Division of Wildlife actively participates include local park district deer and geese control and management, monitoring and management of urban nesting peregrine falcons, and raccoon strain rabies control.

As Ohio's fish and wildlife resources face greater and more complex challenges, the Division of Wildlife must coordinate its efforts with other agencies and organizations in order to meet its goal of sustaining healthy fish and wildlife populations throughout the state. These efforts have resulted, in part, in the reintroduction of several extirpated species of wildlife, the stabilizing of endangered or threatened species, more widespread populations of common species, and increased opportunities for fish and wildlife related recreation. Additional conservation success stories are on the horizon as the Division of Wildlife continues to work with its national, state, and local partners.

For additional information on utilizing partnerships to increase the efficiency and effectiveness of conservation efforts, see Ohio's Approach to Conservation in Chapter 1.

IV. Evaluation and Adaptation of the SWAP
The Division's Comprehensive Management System mandates that planning documents (strategic plan, tactical plans, conservation opportunity area plans, etc.) be reviewed mid-cycle of the life of the plan (see Chapter 1, Action Plan Evaluation and Updates section for details). The SWAP will be reviewed on the same schedule, meaning that review will occur every five years for this document. Project reviews will occur annually in the form of performance or final project reports, with evaluations based on performance measures specific to each project. When possible, the SWAP review will be aligned with reviews of other

related conservation planning documents within the Division in order to identify shared conservation actions, objectives, and outcomes. Prior to the next revision, as recommended in the AFWA Best Practices document, a review and revision charter will be developed. This charter will formalize a structure, process, schedule, and anticipated workload to help delineate roles, responsibilities, and contributions for those involved.

IV-A. Conservation Partner Engagement
Conservation partners will be invited to participate in contributing information and completing tasks associated with reviews and revisions (see also Future Conservation Partner Involvement and Communication below). Their participation will be scaled the level of the type of review or revision (i.e., comprehensive, major, or minor). Outside partners with specific expertise will be utilized to help address SGCN, habitats, threats, and conservation actions. Mechanisms for selected conservation partners to engage in the review/revision process will be developed to further collaboration. Measures of success for partners that contribute information and complete tasks will be developed to help them understand how their input is used and valued. Conservation partners that contributed significantly to the SWAP will be recognized to help create a sense of ownership and desire to participate in implementation of the plan.

IV-B. Public Review and Comment
Public review and comment will be scaled with the type of review or revision (i.e., comprehensive, major, or minor) to make effective use of Division resources. Established public notification channels will be used for disseminating information and presenting schedules to garner internal and external support for the process.

The formal five-year review of the SWAP serves as a “worse-case scenario” benchmark for review. In reality, the Action Plan is a living document and will receive continual revision and updates as data gaps are filled, technology and methodologies are developed and/or improved, new information arises, new issues emerge, and additional public input is received. Reviews and revisions in response to these occurrences will take place as necessary at intervals shorter than the periods stated above. The Division will notify the USFWS Regional office by letter of intent to make minor revisions, and the letter will include a statement that addresses why the change is considered a minor revision.

IV-C. Emerging Issues
In the case of emerging issues, time may not allow the full revision process to be used. In these cases, changes to the Action Plan to reflect emerging issues will be addressed through documented coordination with the USFWS Regional Office. The process followed and changes made will be documented and included in the next SWAP revision in the Summary of Changes section.

IV-D. SWAP Use and Accessibility
As described in the AFWA Best Practices document, it is recommended that if time and resources allow, some/all of the following recommendations be instituted:

1. Include a section or companion document about “how to use this document” organized by the types of targeted audiences (e.g., land trusts, data providers, researchers, stewardship specialists, policy makers, legislators, private landowners, grant seekers).

2. Provide a Web link to the entire document as well as a segmented and searchable version of the SWAP, using software that is easily accessible and used by the public and diverse audiences (e.g., free software downloads online such as Adobe Reader for PDF file viewing). Ideally, provide a linked set of documents, references, tools, etc. that are easily updated, compared to a static, fixed documents.

3. Create a limited number of hardcopies and make available in state libraries.

4. Create a short and/or condensed version of the SWAP that is more easily printed and marketed to pique interest and participation.

IV-E. Future Conservation Partner Involvement and Communication
As recommended in the AFWA Best Practices document, we will use “Public TRACS” as a reporting and communication tool for conservation within Ohio and regionally. We will create an Ohio Portal that will contain information about ongoing projects, and reports for projects that have been completed. We will also include maps of species and habitat distributions. All data will be restricted to that which can be made available to the public without endangering sensitive species. Other states in the region will be able to access project information through the portal.

Public TRACS will help to ensure that Ohio’s SWAP functions as a tool that can be used by all conservation partners to facilitate development, implementation, evaluation, and adaptation of conservation actions. The numbers and breadth of conservation groups in Ohio make it difficult to monitor and coordinate programs and activities in a fashion that promotes some kind of consistency. Keeping all of Ohio’s conservation entities focused so that work being done is appropriate, and allows all involved to leverage the results of others is a daunting task. Public TRACS can be the communication and reporting channel that makes this kind of coordination possible. It will help focus conservation actions on high-priority issues, and allow all involved to benefit from project results and new data collected by others.

Chapter 1. The Ohio Landscape

1.0 Ohio's Climate and Land

1.0.1 Climate

The climate of Ohio is classified as a humid continental, warm summer type according to a climate classification system widely used in the United States. However, the state tends to encompass more than one type of climate because of variations in longterm average climatic factors within its borders, and its location at the transitional boundary between climate types. Ohio is situated in a region where prevailing winds are from the west, southwest, and northwest. The interior location that the state occupies on the continent is subject to the influence of both polar air and tropical maritime air masses. Alternation of low- and high-pressure air masses accompanying passage of cyclones and anticyclones produces irregularly spaced changes in the weather (Noble and Korsok 1975).

Ohio lies along the track of cyclonic systems that move across mid-continent from west to east. The vast majority of moisture producing precipitation in Ohio derives from cyclones that form in the lee of the Rocky Mountains. These cyclones track northeastward toward the Great Lakes Region and Ohio River Valley bringing tropical maritime air from the Gulf of Mexico. The cyclonic systems usually track farther north in summer than in winter. In summer, tropical maritime and continental tropical maritime air masses dominate producing high temperatures and frequently high humidity. In winter, polar continental air masses that produce cold dry weather dominate with intermittent, brief interjections of tropical maritime air bringing wet warmer weather (Noble and Korsok 1975).

Ohio's diverse climate is influenced on a large scale by its location on the continent, and locally by its own geography and topography. Locally, the climate in the northern (especially northeastern) part of the state is affected by Lake Erie, and the unglaciated southern and eastern parts of the state see topographical influences to their climate. The glaciated central, western, and northwestern parts of the state experience a continental climate without the modifying effects of large bodies of water or hills.

Temperature

Ohio's continental climate is typified by a wide range of seasonal variability that includes cold dry winters and warm humid summers. Falls tend to be dry and mild, and springs are generally a roller coaster of temperature fluctuations accompanied by significant precipitation. During the winter, arctic air masses that follow the jetstream down bring the coldest temperatures to Ohio. These "Alberta Clippers" can bring sub-zero temperatures to the state. At the opposite extreme, mid-latitude storms from the Gulf of Mexico can reach Ohio during the winter. These storms can produce significant precipitation in the form of snow, freezing rain, or rain depending upon the storm's interaction with other air masses (Pfingsten et al. 2013). Mean monthly high temperatures range from a low of 33 degrees F in January in northern Ohio to 41 degrees in extreme southern Ohio. Similarly, mean monthly highs in July range from 82 in the north to 87 in the south (U.S. Climate Data).

Mean annual temperatures vary by season, and as mentioned above, can vary across the state. Northwest Ohio is often the coldest part of the state – given the prevailing weather direction, northwestern Ohio's weather is largely unaffected by Lake Erie. The weather in northeastern Ohio is very much affected by Lake Erie. Falls tend to be protracted and mild due to the warm lake waters, but the spring warm-up can be delayed because of the influence of cold lake waters. Lake effect snows in winter can be significant in northeastern Ohio. Temperatures in the glaciated portion of Ohio tend to vary less than those in the unglaciated eastern and southeastern part of the state. The growing season differs by about 12% from the southern part of the state to the northern part as measured by "freeze-free" days (Pfingsten et al. 2013). Seasonal changes in temperature and other climatic factors force a cycle of vegetative growth and dormancy characteristic of the north temperate climatic zone (Schiefer 2002).

Precipitation
Due to its geographic location, Ohio experiences fairly consistent and significant precipitation throughout the year. The spring and summer months are typically the wettest while the fall and winter months are the driest. June and July are the wettest months with the state averaging nearly 4 inches of precipitation each month. October and February are the driest months with the state averaging about 2 1/4 inches of precipitation each month (ODNR 2011). Precipitation varies across the state with southern and northeast Ohio getting the most due to the influences of moist Gulf air and lake effect precipitation, respectively. Average annual precipitation is lowest in the northwestern part of the state Ohio can experience droughts during the spring and summer, but these occurrences are fairly rare. Flooding on the other hand is more common, occurring primarily in late winter and spring as snow melts and precipitation levels increase (Pfingsten et al. 2013).

Based on the 50-year period 1931-80, Ohio averages 37.57 inches of precipitation annually. Average annual precipitation ranges from a high of nearly 44 inches to less than 30 inches. Snowfall ranges from greater than 100 inches in the northeast (Ohio's snowbelt), to less than 20 inches in the south along the Ohio River. Snowfall contributes significantly to the average annual precipitation total in the snowbelt areas (ODNR 2011).

Frontal lifting of air masses associated with passage of cyclones is the primary mechanism triggering precipitation in Ohio. Normal passage of cyclonic depressions is supplemented with convectional precipitation in summer. The convectional precipitation is typically produced by thunderstorms moving as squall lines ahead of cold fronts. More stable air masses in fall make it the driest season in most parts of the state (Schiefer 2002).

Humidity
The statewide relative humidity averages about 75% throughout the year. Because the amount of moisture that can be held by cold air is less than that of warm air, at 75% relative humidity, the air is much drier in the winter than in the summer. Fog tends to vary seasonally in Ohio due to the conditions required for its creation. Fall and winter are the times when those conditions are most prevalent. Cloud cover peaks during the winter months in Ohio. On average, about 70% of the days during each month are cloudy during the winter (Pfingsten et al. 2013).

Wind & Severe Weather
The primary wind direction is southwest in Ohio, although high/low pressure systems and storms can create winds from any direction on any given day. Winds in general tend to be higher in the northern part of the state, and seasonal variation is seen statewide with higher winds in winter than summer.

Convective weather during the spring and summer can and does generate thunderstorm-induced severe weather. Hail, tornadoes, high winds, and localized flooding are often the result. Although Ohio is not located in the heart of tornado country, it does lie at the eastern end of "tornado alley", and some of the most famous tornado events have occurred here (Pfingsten et al. 2013).

1.0.2 Lands
At the time of European settlement, Ohio's landscape consisted primarily of a vast expanse of forest, with a few large grassland and wetland areas. Scattered throughout the state, in smaller amounts, there were other significant habitats, including the Lake Erie islands, oak savannas, boreal (snowbelt) communities, and caves. These habitats were delineated from the native vegetative communities described and mapped by the Ohio Biological Survey in "The Natural Vegetation of Ohio In Pioneer Days". Figure 1 is adapted from Gordon (1966).

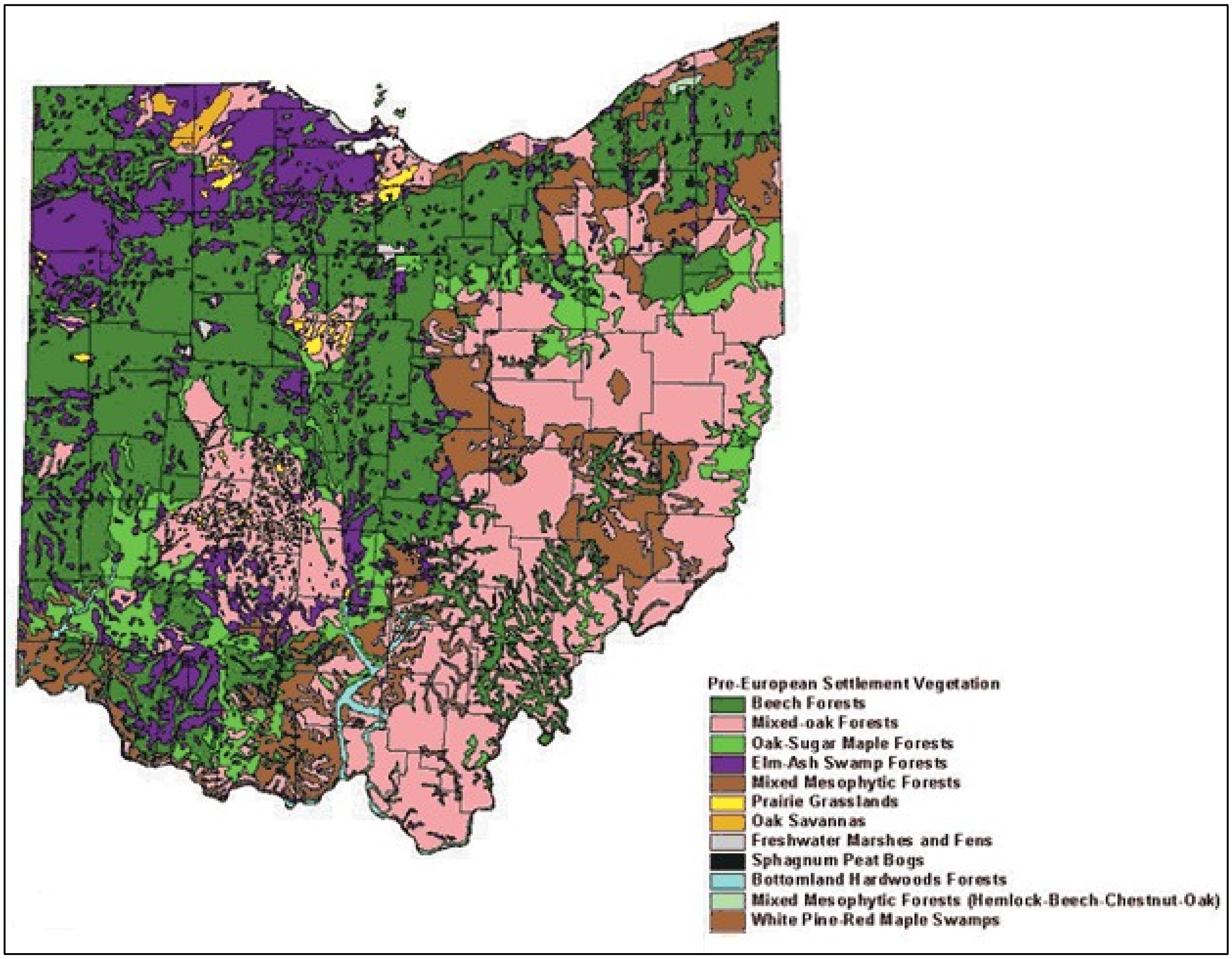


Figure 1. Natural vegetation of Ohio – pre-settlement (based on Gordon 1966).

According to the 2010 National Resources Inventory (USDA 2013) the total surface area of Ohio is 26,444,800 acres, including water areas. Over 80% of the state (21,491,500 acres) is characterized as nonfederal rural lands (nonfederal = all lands in private, municipal, state, or tribal ownership). Of this rural lands total, croplands account for about 52%, forestlands 33%, pastureland 10%, CRP lands 0.8%, and other rural land 4%. “Inland” water areas (not including Lake Erie) account for about 1.6% of Ohio’s surface area.

The following information regarding Ohio’s physiography, geology, soils, vegetation, land use, and water development is adapted from Schiefer (2002) except where otherwise indicated.

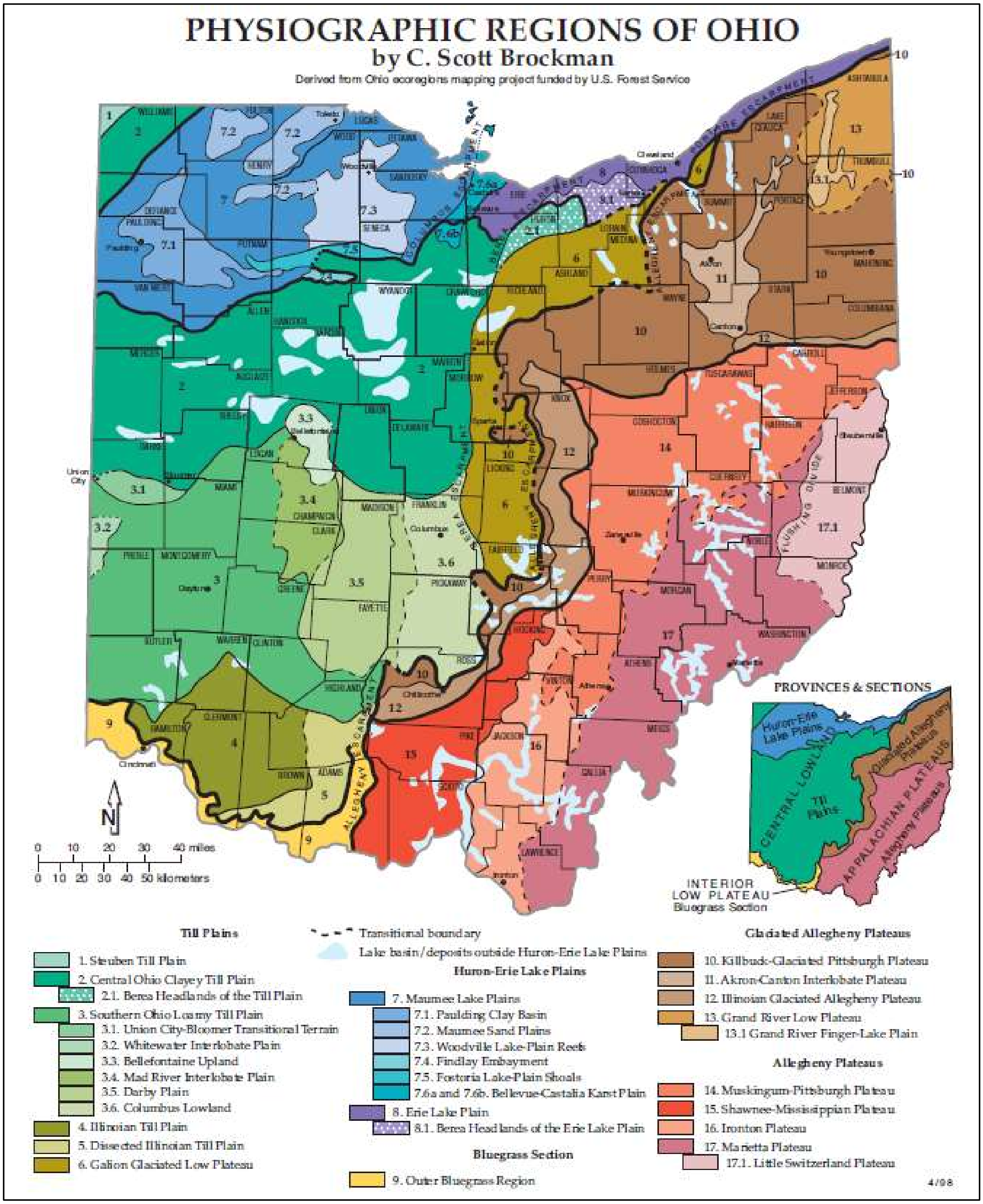


Figure 2. The Physiographic Regions of Ohio (Brockman 1998).

Physiography
Physiographic classifications provide a key to the general topography and character of the land surface in Ohio. Detailed physiographic classifications for Ohio are mapped and described by Brockman (1998). The physiographic regions in Ohio are shown in Figure 2.

Ohio overlaps parts of three physiographic provinces in the United States. Most of the western half of the state is in the Central Lowland Province while nearly all the eastern half is in the Appalachian Plateaus Province. The Bluegrass Section of the Interior Low Plateau Province extends across the Ohio River marginally into southwestern Ohio.

The Central Lowland Province in Ohio is separated from the Appalachian Plateaus Province by a transitional boundary that coincides with the Allegheny Escarpment of erosion resistant sandstones. Sandstones and shales are at or near the surface near the boundary while limestones, dolomites and shales underlie more distant land in the Central Lowland. The rocks in the Central Lowland part of the state are overlain with glacial tills and lacustrine deposits that form a relatively youthful plain only slightly scarred by streams. Two physiographic sections of the Central Lowland Province are represented in Ohio, the Till Plains and the Huron-Erie Lake Plain (Figure 2).

<u>Till Plains</u>
About one-third of Ohio is in the Till Plains Section of the Central Lowland Province.
This land is gently rolling for the most part, and covered with glacial deposits of moderate (100-200 feet) to moderately low (25-60 feet) relief. Moderately high relief (250 feet) exists in the Bellefontaine Upland of the Till Plains. Areas where morainal belts cross the Till Plains are undulating while intervening areas of ground moraine tend to be level. Transitional land bordering the Appalachian Plateaus is more rolling.

The Till Plains include land that drains to Lake Erie and to the Ohio River. Streams draining to Lake Erie are generally smaller and less numerous than those draining to the Ohio River. Streams draining to the Ohio River are more deeply entrenched (Cross and Hedges 1959).

The Till Plains in Ohio are divided into six physiographic regions (numbers below refer to regions of the map in Figure 2):

1) Steuben Till Plain – hummocky terrain with rolling hills interspersed with flats and closed depressions, few streams, deranged drainage, abundant wetlands

2) Central Ohio Clayey Till Plain – well-defined moraines with intervening flat-lying ground moraine and intermorainal lake basins, few large streams, limited sand and gravel outwash, surface of clayey till

3) Southern Ohio Loamy Till Plain – moraines commonly associated with boulder belts between relatively flat-lying ground moraine, cut by steep-valleyed large streams, stream valleys filled with outwash alternate between broad floodplains and narrows, surface of loamy till

4) Illinoian Till Plain – rolling ground moraine of older till lacking ice constructional features, loess cap till deposits, many buried valleys, modern valleys alternate between broad floodplains and bedrock gorges

5) Dissected Illinoian Till Plain – hilly former till plain with relatively high stream density, loess caps till deposits

6) Galion Glaciated Low Plateau – rolling upland mantled with thin to thick drift, transitional to Appalachian Plateaus

<u>Huron-Erie Lake Plains</u>
The Huron-Erie Lake Plain Section of the Central Lowland Province covers a large area of Ice-Age lake-bottom land in northwestern Ohio and a narrow band between Lake Erie and the Portage Escarpment across extreme northeastern Ohio. The boundary of the Lake Plain inland from modern Lake Erie coincides with the margin of the highest Pleistocene lake (Lake Maumee). The Lake Plains are flat with

low (10 feet) to extremely low (5 feet) relief. Although glaciated, much of the present land surface is covered with lacustrine deposits in the form of clay flats, sand plains, dunes, deltas, and beach ridges.

The larger western part of the Lake Plain is separated from the eastern part by a karst plain thinly mantled with till. Channels modified for agricultural drainage are pervasive in the western part of the Lake Plain where drainage density is about 2 miles of stream per square mile of drainage area, representing the lowest in the state (Brockman 1998).

The Huron-Erie Lake Plain in Ohio is divided into two physiographic regions (numbers below refer to regions of the map in Figure 2):

7) Maumee Lake Plains – flat lying lake basin with beach ridges, bars, dunes, deltas, and clay flats, slightly dissected by modern streams, contained the former Black Swamp

8) Erie Lake Plain – edge of very low relief Ice-Age lake basin separated from modern Lake Erie by shoreline cliffs, major streams in deep gorges

<u>Bluegrass Section</u>

The Bluegrass Section of the Interior Low Plateau Province covers land in extreme southwestern Ohio south of the Till Plains and east of the Appalachian Plateaus. This land in proximity to the Ohio River constitutes the Outer Bluegrass Region.

9) Outer Bluegrass Region – has an unglaciated eastern segment and a glaciated western segment. Both segments are dissected plateau of carbonate rocks with moderately high relief (300 feet). High gradient limestone and shale bedrock streams are common. The eastern segment is bounded by the maximum glacial margin and eastern high ridges are capped by non-carbonate rocks. Caves and other karst features are present in the eastern segment. The eastern segment is connected to the western segment by Ohio River bluffs. The western segment is bounded by nondissected till plain. Thin pre-Wisconsinan till covers narrow ridges in the western segment (Brockman 1998).

The western boundary of the Appalachian Plateaus Province is close to Lake Erie at the Ohio-Pennsylvania state line. From there it parallels the lake to Cleveland, then turns southwest across central parts of Ohio and crosses into Kentucky a little west of the Scioto River. The Appalachian Plateaus in Ohio are underlain with sandstones and shales including the coal measures. Two physiographic sections of the Appalachian Plateaus Province are represented in Ohio. These are the Allegheny Plateaus Section and the Glaciated Allegheny Plateaus Section.

<u>Glaciated Allegheny Plateaus</u>

The Glaciated Allegheny Plateaus Section of the Appalachian Plateaus Province covers most of northeastern Ohio and extends southward across central and southern parts of the state in a narrow irregular pattern along the Wisconsinan and Illinoian glacial margins. The glaciated plateaus in the northeastern part of the state are smoother and more rolling than the unglaciated plateaus to the south. Valleys are less deep due to glacial erosion of hills and glacial deposition that has filled bottomlands. Drainage density is lower than in the unglaciated plateaus as streams are more widely spaced; drainage patterns transition from dendritic to parallel and trellis forms. Land along the southward extension of the glaciated plateaus is rugged hills like the unglaciated plateaus (Brockman 1998).

The Glaciated Allegheny Plateaus in Ohio are divided into four physiographic regions (numbers below refer to regions of the map in Figure 2):

10) Killbuck Glaciated Pittsburgh Plateau – ridges and flat uplands covered with thin drift, dissected by steep valleys, valley segments alternate between broad drift filled and narrow rock walled reaches

11) Akron-Canton Interlobate Plateau – area dominated by kames, kame terraces, eskers, kettles, kettle lakes, and wetlands, deranged drainage and many natural lakes

12) Illinoian Glaciated Allegheny Plateau - rugged hills with loess and older drift on ridge tops, dissection similar to unglaciated plateau

13) Grand River Low Plateaus – gently rolling ground with thin to thick drift, poorly drained areas and wetlands common

Allegheny Plateaus

The Allegheny Plateaus Section of the Appalachian Plateaus Province covers about one-third of Ohio including all of the southeastern part of the state. It includes all of the unglaciated land except for that in the Bluegrass Section of the Interior Low Plateau Province. Land in the Allegheny Plateaus part of Ohio is mature hill country with moderate (300-600 feet) to high (400-800 feet) relief. The land is deeply incised by well developed stream systems leaving narrow ridges and hillocks separated by steep-walled valleys up to 300 feet deep. All of the streams in the area drain to the Ohio River. The largest streams flow in flat-bottom valleys at relatively low gradient. Tributaries to the larger streams are relatively high gradient. Headwater channels with intermittent flows actively engaged in down cutting are common. Drainage patterns are dendritic with drainage density about 5 miles of stream per square mile of drainage area, representing the highest in the state (Brockman 1998).

The Allegheny Plateaus in Ohio are divided into four physiographic regions (numbers below refer to regions of the map in Figure 2):

14) Muskingum-Pittsburgh Plateau – moderate to high relief, dissected with medium grained bedrock sequences, broad major valleys containing outwash terraces, and tributaries with lacustrine terraces

15) Shawnee-Mississippian Plateau – high relief, highly dissected with coarse and fine grained bedrock sequences, remnants of ancient clay-filled Teays drainage system extensive in lowlands

16) Ironton Plateau – moderately high relief, dissected with coarse grained coal bearing rock sequences more common than in other regions, lacustrine clayfilled Teays valley remnants common

17) Marietta Plateau – high relief, highly dissected with fine grained rocks, red shales and red soils common, remnants of ancient clay-filled Teays drainage system common

Geology

The landforms of Ohio are the culmination of geological and climatological conditions existent throughout geologic time. The various conditions of the past are evidenced by the bedrock sequences and surficial glacial deposits found in the state. The character of the rocks and surficial glacial deposits is a primary factor determining the amount of ground water storage in basins in Ohio.

Ohio is underlain with thousands of feet of sedimentary rocks formed during the Paleozoic Era. The sedimentary rock sequences provide evidence that Early Paleozoic environments were characterized by tropical and subtropical climates, shallow to moderately deep seas with an abundance of mud bars, sand bars, and reefs. Limestone and calcareous shales were the dominant sedimentary deposits. Later Paleozoic environments were characterized by tropical climates, terrestrial streams, deltas, coal swamps, and near shore seas. Sandstones, siltstones, and shales were the dominant sedimentary deposits. Tropical climates prevailed because the continental plate was located in equatorial regions during the Paleozoic 245 to 570 million years ago (Feldmann 1996).

The sedimentary rocks in Ohio and neighboring states have been subject to uplifting and subsidence caused by tectonic forces. The sedimentary rocks and permeable surficial deposits largely determine the amount of ground-water storage in drainage basins. Shallow ground-water systems affecting base flow of streams are generally confined to water bearing strata of the surface rocks and permeable surficial deposits, the latter having the greater influence (Stout et al. 1943). Regional flows of ground water from rock strata contribute significantly to base flows of streams in certain areas of the state.

During the period of erosion that preceded the first glaciation of the Pleistocene Epoch, the surface rocks in Ohio were deeply incised by Teays-Stage drainage systems. The Teays drainage gathered its headwaters in the Piedmont of Virginia and North Carolina. The main stem crossed the Highlands and flowed down the Teays valley to Ohio where it entered the state at Wheelersburg. From there, it flowed north to the vicinity of present day Chillicothe and then turned northwest crossing into Indiana through Mercer County to join the ancient Mississippi system. The Teays was a mature drainage system whose main stem cut a rock valley through Ohio averaging 1.5 miles wide with local relief of 300 to 600 feet. All but the northern and eastern parts of the state were drained by it. The northern and eastern parts were drained by streams contemporary with the Teays but flowing northeast to the Atlantic Ocean rather than to the Gulf of Mexico (Stout et al. 1943).

The Teays was blocked by the Kansan and pre-Kansan glaciation during the Early Pleistocene creating a glacial lake hundreds of feet deep. During the blockage, silt deposits averaging 20 to 40 feet deep accumulated in the lake bottom. Remnants of these deposits, termed Minford silts, appear as terraces along many present day streams in unglaciated parts of the state and in the bottoms of buried valleys in glaciated areas. The impounded water eventually overflowed to the southwest creating a new outlet known as the Cincinnati River. This post-Kansan drainage is referred to as the Deep Stage drainage because the general level of incising exceeded that of the Teays. Narrow rock valleys of the Deep Stage indicate that it was a more youthful system than the Teays (Stout et al. 1943).

The Deep Stage drainage was blocked by the Illinoian glaciation that extended south of the Cincinnati River and present day Ohio River. Impounded water overflowed to the northeast. The post-Illinoian drainage was at generally higher levels than either the Teays or Deep Stage and followed in part the course of northeastward flowing streams contemporary with the Teays. Many streams in unglaciated parts of the state reversed flow direction and cut new channels through low divides. The Illinoian glaciation deposited greater quantities of material than the Kansan glaciation leaving varied assortments of sand, gravel, silt and clay along its margin (Stout et al. 1943).

The post-Illinoian drainage was blocked by the Wisconsinan glaciation in the Late Pleistocene forcing impounded water to overflow again to the southwest along the course of the present day Ohio River. The Wisconsinan glaciation involved several major advances and retreats that left two-thirds of the state covered with varying depths of glacial tills including extensive ground moraine and end moraines in the form of morainal belts across the state.

Enormous quantities of sand and gravel were deposited in interlobate areas at the glacial margin. Glacial melt waters extended the impact of glaciation well beyond the margin through transport, sorting, and deposition of sand and gravel in the form of valley trains, terraces, and outwash plains. Loess deposits capped considerable areas in southwestern Ohio as the Late Wisconsinan glaciation retreated. Drainage in unglaciated areas underwent another cycle of realignment and stream flow reversals. Streams flowed through valleys representing a composite of valley reaches created during different post-glacial drainage cycles (Stout et al. 1943).

Ancestral lakes to present day Lake Erie formed during the retreat of Wisconsinan glaciation leaving widespread lacustrine deposits throughout the Lake Plains. Final retreat of the Late Wisconsinan glaciaton allowed for re-establishment of drainage to the northeast and for head cutting into the Till Plains by streams draining to the Ohio River. Ice front streams, wholly or partly aligned with morainal belts, drained to Lake Erie. Glacial lakes in areas of ground moraine became lacustrine lakebeds and in some places, peat bogs.

Soils and Natural Vegetation
Soils in the portion of Ohio that was covered by glacial ice during one or more glaciations (Figure 3) formed in glacial deposits. Most of the soils in the glaciated part of Ohio are very deep to bedrock. Soils in the unglaciated portion of Ohio formed from materials weathered from sedimentary rocks. Because soil forms more slowly from bedrock than from glacial material, soils in unglaciated east and southeast Ohio tend to be more shallow to bedrock (ODNR *Soil Regions of Ohio*).

Figure 3. Extent of glaciation in Ohio (from ODNR *Soil Regions of Ohio*).

Land in Ohio near the glacial margin during the Late Pleistocene supported spruce-dominated communities. As the Late Wisconsinan ice sheet retreated, spruce-dominated communities spread northward reforesting the glacial plains.

The cool, wet climate that prevailed during the Late Pleistocene changed rapidly to a warmer, drier climate about 10,000 years ago. This period of rapid climate change marked the end of the Pleistocene and the beginning of the Holocene. During the Early Holocene, oak-dominated communities replaced the spruce communities in Ohio. Composition of the forests became more mixed as a result of fluctuations in Holocene climate. Warm, humid periods favored development of mixed deciduous forests dominated by beech, maple, elm, ash, and walnut, while warm, dry periods favored oak and hickory (Feldmann 1996).

Most soils in Ohio developed under deciduous forest cover in a humid temperate climate. Ohio has a great variety of soils due mainly to differences in parent material. Differences in slope and drainage contribute to variety by allowing formation of different soils from the same parent material. Weathering and erosion of carbonate parent rock produced high-lime parent material in the western half of the state while weathering and erosion of sandstone and shales produced low-lime parent material in the eastern half of the state. Soils developed from high-lime parent material generally have lower acidity than those developed from low-lime parent material (Dotson 1954).

The most common soils with greatest areal coverage in Ohio can be categorized as glacially transported soils, lacustrine soils, or residual soils. Soils occupying relatively small but widely scattered areas in the state include alluvial soils and organic soils. Although relatively small in areal coverage, these latter soils tend to be highly fertile and of economic importance (Noble and Korsok 1975). Variation in infiltration rates and permeability of soils in basins is an important factor affecting ground-water recharge rates and low-flow regimens of streams.

Land Use

The U. S. Department of Agriculture has identified 24 distinct Land Resource Regions in the United States based on land use, elevation and topography, climate, water, soils, and potential natural vegetation. The regions have been subdivided into subregions termed Major Land Resource Areas. Boundaries of the Major Land Resource Areas in Ohio coincide with the soil region boundaries. Eight

Major Land Resource Areas (MLRA) are represented in Ohio. The location of the following MLRAs is shown in Figure 4:
Erie-Huron Lake Plain (MLRA 99)
Erie Fruit and Truck Area (MLRA 100)
Indiana and Ohio Till Plain (MLRA 111)
Southern Illinois and Indiana Thin Loess and Till Plain (MLRA 114)
Kentucky Bluegrass (MLRA 121)
Western Allegheny Plateau (MLRA 124)
Central Allegheny Plateau (MLRA 126)
Eastern Ohio Till Plain (MLRA139)

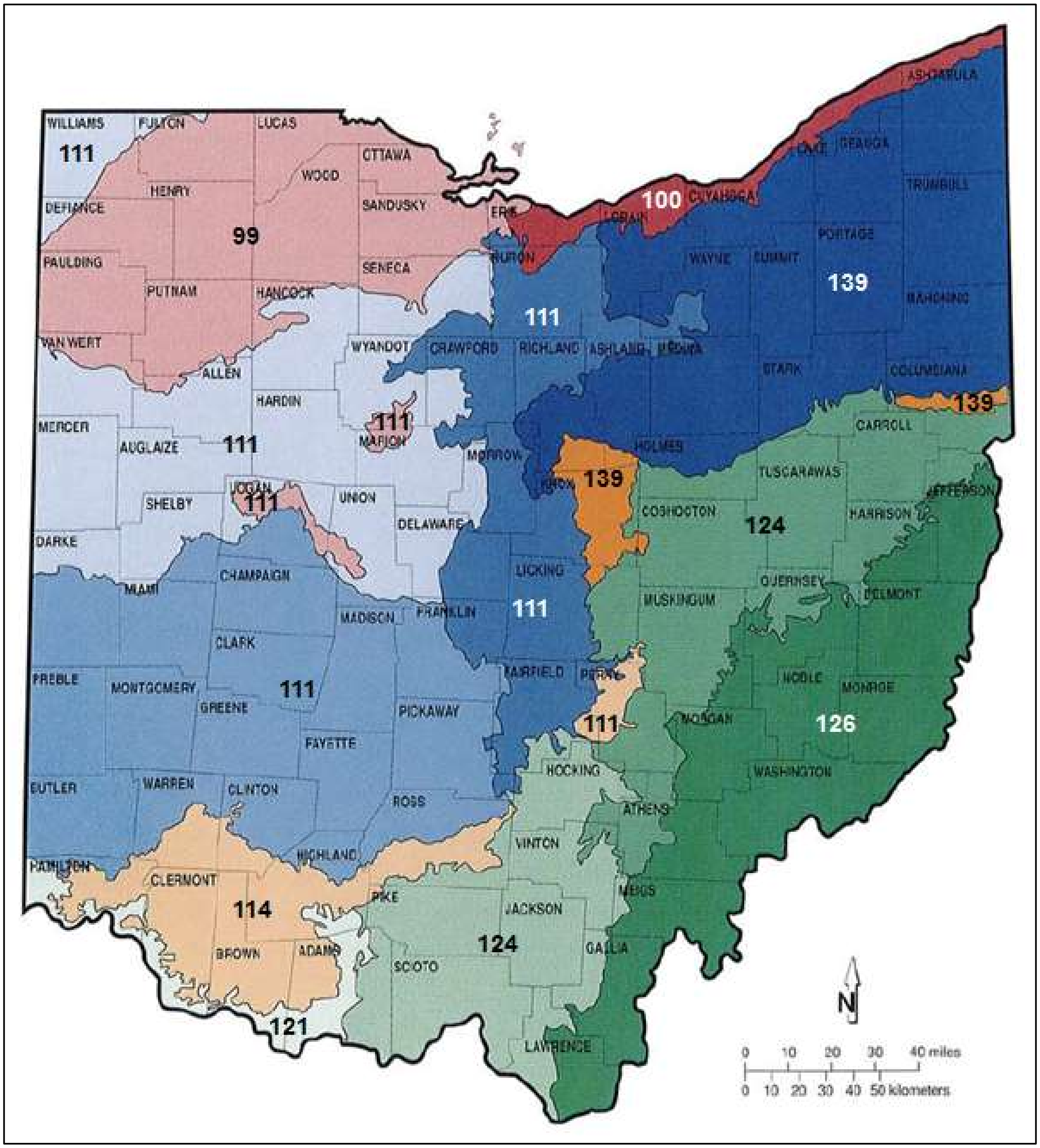


Figure 4. Major Land Resource Areas in Ohio (modified from ODNR *Soil Regions of Ohio*)

The Erie-Huron Lake Plain Resource Area (#99 in Figure 4) is characterized by nearly level crop fields with agricultural drainage ditches and subsurface drains. Stream habitat and water quality have been impacted by channelization, ditching, and agricultural activities. Soybean and corn production dominate, but a wide variety of agricultural activity exists in the area. Farmland accounts for nearly all land use outside of urban areas. Cropland typically accounts for 80 to 90 percent of farmland use, and pasture generally 10 percent or less. Forestland mostly in the form of woodlots accounts for about 3 to 8 percent of land use. The major area of continuous woodland is in the Oak Openings, a 5-10 mile wide belt along the Sand Plains in western Lucas and eastern Fulton Counties. Maumee State Forest and Oak Openings

Metro Park are located in the Oak Openings. This area contains some of the last remaining oak savanna habitat.

Agricultural activity in the Erie Fruit and Truck Resource Area (#100 in Figure 4) emphasizes production of fruit and vegetable crops as soil and climate advantage exists for these purposes. The area has the most intensive nursery and greenhouse operations in the state. Woodland covers about 15 to 20 percent of the land in this resource area. Urban, industrial, commercial, and other built up land accounts for a third or more of land use.

The Indiana and Ohio Till Plains Resource Area (#111 in Figure 4) is dominated by corn and soybean production, and livestock to a lesser degree. Outside of the major metropolitan areas, farmland generally accounts for nearly all land use. Farmland across the area receives similar use despite different emphasis in agricultural activity. About 90 percent of the farmland is used as cropland with pasture and woodlots accounting for the remainder.

The Southern Illinois and Indiana Thin Loess and Till Plain Resource Area (#114 in Figure 4) consists of about 50 percent cropland, 20 percent pasture, 25 percent forestland, and 5 to 10 percent urban and other land uses. Agricultural enterprises generally involve grain crops and livestock, but timber sales are an additional source of farm income in the eastern parts of this resource area.

The Kentucky Bluegrass Resource Area (#121 in Figure 4) is 20-30 percent forestland. Over half of the land in the western part of the area in the vicinity of Cincinnati is urban land. Nursery and greenhouse operations are common near this population center. In the eastern half of the resource area, crop and pastureland account for 50 to 60 percent of land use, and forestland most of the remainder.

The Western Allegheny Plateau Resource Area (#124 in Figure 4) includes the most heavily forested area in the state. The southern portion of the resource area is 60 to 70 percent forested. Logging operations are common, and national and state forests cover some of the land. Most of the hills remain in forest, with agriculture and residential developments are concentrated in the valleys. Pasture and cropland account for about 30 percent of land use. The northern portion of the resource area is about 40 to 50 percent forestland. Pasture and cropland account for about 30 to 40 percent of land use. Surface mining for coal affects land to varying degree in most parts of this resource area.

The Central Allegheny Plateau Resource Area (#126 in Figure 4) is about 50 to 60 percent forested. Forests dominate steeper hillsides. National and state forests cover some of the land. Pasture and cropland cover about 30 percent of the land, the majority being pasture. Cropland is largely limited to bottomlands. In northern parts of the area, 10 to 20 percent of the land is affected by strip mining, the most extensive in the state. The larger towns in the area border the Ohio River.

The Eastern Ohio Till Plain Resource Area (#139 in Figure 4) includes several counties that are highly urbanized with most land used for commercial, industrial, or residential purposes. Land being held for development purposes is typically former crop and pasture land. Extensive park systems along major streams including the Cuyahoga Valley National Recreation Area constitute most of the forestland in urban counties. Land use outside metropolitan areas in this resource area is generally about 25 percent crop and pasture, 25 percent forestland, and about half residential.

Water Development

In the early 1800s, thousands of small dams were built on the streams in Ohio to power grist and saw mills. Most of these mill dams no longer exist, and there is very little hydro-power developed because of the low available head. The major water developments have been for flood control and water supply.

Five large earthen dams were constructed on the major streams above Dayton in the 1920s by the Miami Conservancy District to control floods. These structures are automatic retarding basins with no movable gates and no permanent pools.

The Corps of Engineers and Muskingum Watershed Conservancy District built fourteen flood-control dams in the late 1930s in the Muskingum River Basin. All but three of these dams have permanent pools. Since the 1930s, the Corps of Engineers has constructed 14 additional multiple purpose reservoirs in Ohio including: 2 in the Muskingum River Basin, 3 in the Mahoning River Basin, 4 in the Scioto River Basin, 2 in the Little Miami River Basin, and one each in the Hocking River Basin, Mill Creek Basin, and Miami River Basin. All of these large dams significantly affect the flow regimen of streams.

Many water supply reservoirs exist in the state, some of large size such as those at Columbus, Akron, and Youngstown. Stream flow regimens are affected by the larger reservoirs. Many smaller impoundments with limited storage and nearly complete return of diverted flows through wastewater discharge have limited, local effect on streams.

Although surface water provides the majority of water supply used in Ohio, ground-water systems are far more numerous, some are of substantial size such as the ones at Dayton and Canton. Ground-water pumpage from buried valley deposits, where these large systems are located, significantly affects the low-flow regimen of streams.

Descriptions of Basins and Characteristics of Flow
Ohio lies along the topographic divide between the Lake Erie drainage and the Ohio River drainage. The relatively low divide is about 750 feet above mean sea level at Fort Wayne and rises irregularly across Ohio toward the northeast approaching Lake Erie closely in the northeast corner of the state. Because of its low profile, the divide has little effect on climatic factors in Ohio except in the snowbelt southeast and east of Cleveland.

The divide between the Lake Erie drainage and the Ohio River drainage in Ohio crosses the Till Plains and Glaciated Allegheny Plateaus roughly along the path of the Wabash End Moraine. All of the land in the Lake Erie Basin is glaciated while only part of the land in the Ohio River Basin is glaciated. Streams in the Lake Erie Basin are more youthful than those in the Ohio River Basin and tend to be smaller and shorter. Streams draining to the Ohio River are more deeply entrenched. Mean annual flows of streams draining to Lake Erie are generally lower than those draining to the Ohio River due to latitudinal variation in mean annual precipitation (with the exception of streams located in the snowbelt).

Lake Erie basin
About 30 percent of the land in Ohio is in the Lake Erie Basin. Land draining to Lake Erie includes all of the Huron-Erie Lake Plain in Ohio and portions of the Till Plains and Glaciated Allegheny Plateaus.

Streams east of Cleveland gather headwaters in the Glaciated Allegheny Plateaus and flow across a narrow band of Lake Plain to Lake Erie. The larger streams have cut deep gorges through the Portage Escarpment. These are relatively steep gradient streams except for the Grand River that has moderate gradient.

Tributaries to Lake Erie between Cleveland and Sandusky flow at more moderate gradients than those east of Cleveland, but at greater gradients than those west of Sandusky. Most of these streams gather headwaters in the Galion Galciated Plateau and flow across the Berea Headlands before crossing the narrow Lake Plain to Lake Erie. The larger streams west of Sandusky gather headwaters in end moraines of the Till Plains and flow at relatively low gradient to the Lake Plain where they continue at very low gradient to Lake Erie.

Ohio River basin
About 70 percent of the land in Ohio is in the Ohio River Basin. Land draining to the Ohio River in the eastern half of the state is in the Allegheny Plateaus and Glaciated Allegheny Plateaus. Land draining to the Ohio River in the western half of the state is mainly in the Till Plains. All of the land in the state beyond the glacial margin drains to the Ohio River.

The larger streams in the Allegheny Plateaus flow at relatively low gradient in flat bottom valleys confined by steep hillsides. Lower reaches of these streams are affected by high stages of the Ohio River.

Tributaries originating in the Allegheny Plateaus rise at relatively steep gradient in narrow valleys. These tributaries are prone to flash floods that descend rapidly from the hills filling the flat-bottom valleys of the larger streams.

The largest tributary streams to the Ohio River in the state originate in either the Glaciated Allegheny Plateaus or the Till Plains. All the streams originating in the Glaciated Allegheny Plateaus flow through the unglaciated Allegheny Plateaus to join the Ohio River. Some of the streams originating in the Till Plains flow through the Allegheny Plateaus while others flow directly to the Ohio River. Some streams originating in the Till Plains have unusual profiles where the flattest gradients are in upper channel reaches while the steepest gradients are along middle channel reaches. This reverse profile is due to glaciation – headwaters are in flat lying glacial moraine deposits and downstream reaches are in areas of greater of relief.

1.1 Ohio's People and Economy

Ohio is the 34th largest (by area), the 7th most populous, and the 10th most densely populated of the 50 United States. From just over 45,000 residents in 1800, Ohio's population grew at rates of over 10% per decade until the 1970 census, which recorded just over 10.65 million Ohioans (U.S. Census Bureau 1970). Growth then slowed for the next four decades. The United States Census Bureau estimates that the population of Ohio was 11,594,163 on July 1, 2014, a 0.5% increase since the 2010 census (U.S. Census Bureau 2014).

Wildlife-related recreation is big business in Ohio. Outdoor enthusiasts spend money on equipment, licenses, stamps, tags, permits, fuel, lodging, food, bait, ice, transportation, books/magazines/DVDs, clothes, guides, and equipment rental. These expenditures create jobs and tax revenues, and have a significant economic impact on the state. The 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (FHWAR) found that state residents and nonresidents spent $3.5 billion on wildlife recreation in Ohio. Survey data showed that 4.3 million Ohio residents and nonresidents 16 years old and older fished, hunted, or wildlife watched in Ohio. Of the total number of participants, 1.3 million fished, 553 thousand hunted, and 3.2 million participated in wildlife-watching activities, which includes observing, feeding, and photographing wildlife.

Ohio data from the 2011 FHWAR survey showed $1,903,619,503 in fishing retail sales that generated an economic impact of $2,925,344,790, in addition to $789,311,723 in salaries & wages, 26,354 jobs, federal tax revenues of $208,530,370, and state/local tax revenues of $203,191,366 (Southwick Associates 2012a). Similarly, Ohio data from the 2011 survey indicated $853,801,721 in hunting retail sales that generated an economic impact of $1,404,942,870, in addition to $490,289,685 in salaries & wages, 20,471 jobs, federal tax revenues of $111,472,383, and state/local tax revenues of $97,437,823 (Southwick Associates 2012b).

Lake Erie is known as the walleye capital of the world, and is the driver for Ohio's sportfishing industry. Ohio's Lake Erie, shoreline, and tributary sport fisheries generally harvest about 60% of the roughly 10 million pounds of the total Ohio catch each year. These Lake Erie sport fisheries combined contribute over $800 million to the Ohio economy (American Sportfishing Association 2008). While the exact number of anglers participating in these fisheries is unknown, data from Ohio fishing license sales locations and the USFWS National Fishing and Hunting Surveys suggest that it exceeds 300,000 annually. The Ohio charter boat industry includes approximately 800 licensed guides, and is the largest on the Great Lakes.

Ohio is also a top deer hunting destination in the U.S., boasting 3 of the top ten non-typical whitetails of all time. Deer hunting is the most popular kind of hunting in Ohio, and the quality of Ohio's deer herd draws hunters from across the country. Data from 2011 indicates that deer hunting generates an economic impact of $421,133,504 in Ohio (Southwick Associates 2012b).

Tourism is Ohio's 3rd largest industry. In 2013, 195 million people travelled in Ohio, spending of $29.9 billion. Of all tourism visits to Ohio, 83% were leisure related and 17% were business related (Ohio Tourism Division 2014). Ecotourism has increased in popularity in recent years. People travel to Ohio to visit animal/nature preserves, zoos, resorts, parks, state/national forests, botanical gardens, historic sites, paddle its lakes and rivers, hike, bicycle, go zip-lining, ride horses, and participate in numerous other low-impact outdoor activities.

Ohio's state and local economies also benefit from money and jobs created by industries based on natural resources. Ohio has more than 450,000 recreational boats, and ranks ninth in the country for registered boats. In 2013, more than $5.5 million was paid in boat registration and titling fees, and boaters paid about $15 million in state marine fuel taxes (ODNR Watercraft 2013 Annual Report). The value of Ohio's forest products industry is in excess of $15.1 billion annually, and employs about 119,000 Ohioans. Ohio ranks in the top five nationally in maple syrup production, and has led the nation in "Tree City USAs" for the past 27 years (ODNR 2009).

Ohio's geographic location has proven to be an asset for economic growth and expansion. Because Ohio links the Northeast to the Midwest, much cargo and business traffic passes through its borders along its well-developed highways. Ohio has the nation's 10th largest highway network, and is within a one-day drive of 50% of North America's population and 70% of North America's manufacturing capacity (ODOT 2003). Lake Erie's 312 miles of Ohio coastline is home to numerous cargo ports. To the south, 461 miles of the Ohio River support the movement of coal, aggregates, grain, and other raw materials.

Ohio's manufacturing and financial sectors are the largest industries by percentage of gross domestic product (GDP). Ohio has the largest bioscience sector in the Midwest, and is a national leader in the "green" economy. Ohio is the largest producer in the country of plastics, rubber, fabricated metals, electrical equipment, and appliances. Ohio's manufacturing sector is the third-largest of all fifty United States states in terms of GDP (Wikipedia). Ohio ranks fourth among the states in lime production and high in sand and gravel and crushed stone production. It is also among the national leaders in the production of clays, salt, ceramics, and glass.

Although most of the state's income is derived from commerce and manufacturing, Ohio also has an extensive agriculture industry. USDA data from 2012 indicated that Ohio had 75,462 farms occupying over 26 million acres. The top 5 agricultural commodities are soybeans, corn, dairy products, hogs, and cattle. Ohio is also a significant producer of oats, greenhouse and nursery products, wheat, hay, and fruit including apples, peaches, strawberries, and grapes.

1.2 Ohio's Wildlife and Ecosystems

1.2.1 Wildlife

Ohio is home to about **56 species of mammals, 200 species of breeding birds, 84 species and subspecies of amphibians and reptiles, 173 species of fish, 100 species of mollusks, 21 species of crustaceans, 100 species of trees, over 200 species of native plants, and thousands of native insects.**

The story of Ohio's wildlife since species records were first kept is one of rich flora and fauna, increasing human population, overharvest and habitat destruction resulting in extirpation of species, a realization that protection was needed, and a slow road to recovery through management, regulations, and species/habitat restoration. A brief timeline of the Ohio country highlighting wildlife species (adapted from ODNR/OEPA *Ohio Wildlife History Timeline*) is presented below:

1748 - The Ohio Company builds a trading post near Piqua to trade items made in England for furs; beaver pelts are in high demand
1770 - Wolves, cougars, bear, bison, and elk are found across the state
1803 - Ohio becomes a state. The last bison reported in the state is killed
1818 - The "War of Extermination" in Ohio is declared against bear and wolves
1829 - The first wild animal protection law is passed making it illegal to kill muskrats from May to mid-October, and marking the first time Ohioans recognize that wildlife should be conserved as a valuable resource
1840 - Elk, once found across the state, are now gone from Ohio

1850 - Ohio leads the nation in all kinds of farming, and Ohio’s population reaches 2 million, the third highest in the country
1855 - Bobcats, wolves, and mountain lions have been extirpated from the state
1857 - First law is enacted for the protection of fish, and the first non-game protection law is passed protecting songbirds
1875 - The Great Black Swamp is drained after a decade of ditch work and draining, marking the end of what was likely the last wilderness in the state
1881 - The last known black bear reported in Ohio is killed
1883 - Ohio’s original forest land that covered more than 24 million acres is now reduced to only 4 million acres
1886 - The Commission of Fish and Game is established, and the first game wardens are appointed
1909 - Wild turkeys and white-tailed deer are now extirpated from Ohio
1913 - The last year that ospreys are reported nesting successfully in the state
1914 - The last passenger pigeon in the world dies at the Cincinnati Zoo
1919 - The first coyote is seen in Ohio; these animals have been spreading from the western states into new areas as forests were cleared and wolves were eliminated
1900 - Lacey Act is passed, curbing trafficking in plumage and other wildlife products
1920 - The first Ohio wildlife area is purchased with license dollars
1943 - Ohio’s first “modern-day” deer season; only 3 of 88 counties are open for hunting
1947 - A survey of beaver populations finds only 100 animals scattered across 11 counties in Ohio
1956 - Wild turkeys are reintroduced into southeast Ohio where forests are recovering; Ohio’s first statewide deer season is held
1966 - The first wild turkey season is opened in limited counties
1970 - The blue pike is declared extinct in Great Lakes
1973 - Ohio’s Endangered Species law is passed
1975 - Only 4 pairs of bald eagles remain along Lake Erie
1978 - Blizzards decimate Ohio’s bobwhite quail population; Ohio’s beaver population tops 10,000 for the first time in decades.
1986 - River otters are reintroduced into 4 Ohio watersheds
1987 - Sandhill cranes return to Ohio - the first nesting pair observed since 1926
1988 - A pair of peregrine falcons nests on an old hotel building in Toledo; Ohio joins other states in establishing pairs in other Ohio cities as part of a regional effort to restore peregrine populations in the eastern U.S.
1995 - Ospreys return to Ohio nesting on an electrical tower along the Ohio River, and osprey restoration efforts begin the next year; Ohio’s deer herd now estimated at 550,000
1996 - Trumpeter swan restoration efforts begin with birds released at Magee Marsh
1999 - Snowshoe hares are reintroduced into Ashtabula and Geauga Counties
2002 - River otters are removed from Ohio’s Endangered Species list
2008 - A modern day record of 184 bald eagle nests in 48 of Ohio’s 88 counties
2009 - The Ohio Wildlife Legacy Stamp is introduced to bring attention to wildlife diversity issues and generate funding for wildlife diversity programs

Today, Ohio’s wildlife is a mixture of permanent resident north temperate species, and seasonal migrants. Winters play a large role in determining the composition, abundance, and distribution of Ohio’s wildlife species. Species that are unable to tolerate winter temperatures either migrate south or perish. Seasonal migrants that live and breed in Ohio during the warm weather months include many species of birds, as well as several species of butterflies and skippers. A total of 421 species of birds have been reported from Ohio, of which about 300 occur annually, and about 180 of these are known to breed here. About 1/3 of Ohio’s breeding species of birds spend winters in the Central and South America. Butterflies such as the monarch migrate to Mexico where they overwinter before returning to Ohio to breed during the summer. Other common butterfly migrants include the cloudless sulphur, little sulphur, sleepy orange, variegated fritillary, painted lady, buckeye, checkered skipper, fiery skipper, and sachem. Over 160 species of dragonflies/damselflies have been recorded from Ohio, and a number of these, such as the striped saddlebags appear far from their normal range. Whether these species wander here on their own, or ride large weather systems, they are not considered residents and they do not reproduce here.

Ohio's aquatic wildlife species for the most part are the typical cool and warmwater assemblage found throughout most of the Midwest, with a few exceptions. Central and eastern Lake Erie support trout and salmon, and these fish can be found in Lake Erie tributaries in northeastern Ohio from October to May. Ohio also has a few inland streams that receive enough groundwater to support stocked brown and rainbow trout, as well as native naturally reproducing brook trout. American eels occasionally make their way from the Sargasso Sea to rivers and streams in Ohio. Burbot, the only freshwater member of the cod family, are occasionally found in the Ohio waters of Lake Erie. Twenty-seven percent of all mussels known to be from North America have been found in Ohio (Watters et al. 2009). Ohio is home to some of the few remaining populations of purple and white catspaw mussels. The Norwood River crayfish to this point has only been found in Ohio.

The first list of Ohio's endangered wildlife was adopted in 1974 and included 71 species. An extensive examination of the list is conducted every five years. The Division seeks input from our staff along with other noted professional and amateur wildlife experts across Ohio. The Division uses six categories: endangered, threatened, species of concern, special interest, extirpated, and extinct, to define the status of applicable wildlife species. These categories and the species contained within them are revised as our knowledge of the status of Ohio's wildlife evolves.

State listing categories are defined as follows:
Endangered - a native species or subspecies threatened with extirpation from the state. The danger may result from one or more causes, such as habitat loss, pollution, predation, interspecific competition, or disease.
Threatened - a species or subspecies whose survival in Ohio is not in immediate jeopardy, but to which a threat exists. Continued or increased stress will result in its becoming endangered.
Species of Concern - a species or subspecies which might become threatened in Ohio under continued or increased stress. Also, a species or subspecies for which there is some concern, but for which information is insufficient to permit an adequate status evaluation. This category may contain species designated as a furbearer or game species, but whose statewide population is dependent on the quality and/or quantity of habitat and is not adversely impacted by regulated harvest.
Special Interest - a species that occurs periodically and is capable of breeding in Ohio. It is at the edge of a larger, contiguous range with viable population(s) within the core of its range. These species have no federal endangered or threatened status, are at low breeding densities in the state, and have not been recently released to enhance Ohio's wildlife diversity. With the exception of efforts to conserve occupied areas, minimal management efforts will be directed for these species because it is unlikely to result in significant increases in their populations within the state.
Extirpated - a species or subspecies that occurred in Ohio at the time of European settlement and that has since disappeared from the state.
Extinct - a species or subspecies that occurred in Ohio at the time of European settlement and that has since disappeared from its entire range.

Presently (2015) there are 276 state-listed species in Ohio. Of these, 119 are endangered, 54 threatened, and 102 species of concern (Table 1). Ohio's list includes 14 Federally-listed endangered species, and 3 Federally-listed threatened species. Aquatic species (fish and mussels in particular) make up the majority of Ohio's state-listed endangered species.

Table 1. Number of species in major taxa groups classified as Endangered, Threatened, Species of Concern, Special Interest, Extirpated, or Extinct in Ohio.

Taxon	Endangered	Threatened	Concern	Special Interest	Extirpated	Extinct
Mammals	3	2	19	1	10	0
Birds	13	5	13	33	6	2
Reptiles	5	4	11	0	0	0
Amphibians	5	1	2	0	0	0
Fishes	20	13	9	0	8	2
Mollusks	24	4	8	0	11	6
Crayfishes	0	2	3	0	0	0
Isopods	2	1	0	0	0	0
Psuedoscorpions	1	0	0	0	0	0
Dragonflies	13	3	1	0	0	0
Damselflies	3	3	0	0	0	0
Caddisflies	3	6	3	0	0	0
Mayflies	2	0	1	0	0	0
Midges	1	3	1	0	0	0
Crickets	0	0	1	0	0	0
Butterflies	8	1	2	1	1	0
Moths	14	4	22	11	0	0
Beetles	2	2	6	0	0	1
Total	**119**	**54**	**102**	46	36	11

1.2.2 Action Plan Habitats and Imperiled Ecosystems

Ohio’s State Wildlife Action Plan uses a habitat-based approach that divides the state into 15 habitat categories. Significant changes to the Ohio landscape since settlement have negatively impacted a number of these habitats. While the exact numbers vary, it is generally agreed that Ohio has lost about 90% of its original wetlands, over 95% of its original prairies, and about 68% of its original forestlands.

NatureServe’s assessment of the status of ecological communities and systems indicates a number of Ohio ecosystems that fall into the critically imperiled or imperiled categories (NatureServe 2015). The habitat categories in the NatureServe assessment are at a finer scale than the categories used in this Action Plan. Within this Action Plan’s habitat categories, NatureServe identifies 4 Forestland ecosystems, 12 Grassland ecosystems, 8 Wetland ecosystems, 2 Oak Savanna ecosystems, 1 Lake Erie Islands ecosystem, and 1 Boreal Community ecosystem that are either critically imperiled or imperiled. Within each of the habitat categories used in this Action Plan, the table below (Table 2) lists the NatureServe classification, Ohio Natural Heritage Database classification, and degree of imperilment for each ecosystem in the NatureServe assessment.

Table 2. NatureServe ecological communities and systems degree of imperilment by Ohio SWAP habitat category for ecosystems occurring in Ohio (CI = critically imperiled, I = imperiled).

NatureServe classification	Ohio Natural Heritage Database classification	degree of imperilment
FORESTLAND HABITAT		
Appalachian Cliff White-cedar Woodland	Arbor Vitae-Mixedwood Forest	I
Beech-Maple Glaciated Forest	Beech-Oak-Red Maple Forest &	I
	Beech-Sugar Maple Forest	
Beech-Hardwoods Till Plain Flatwoods	Beech-Oak-Red Maple Forest	I
Maple-Hickory Mesic Floodplain Forest	Mixed Floodplain Forest	I
GRASSLAND HABITAT		
Central Mesic Tallgrass Prairie	Big Bluestem Prairie	CI
Post Oak Chert Barrens	Post Oak Opening	CI
Central Shale Glade	Post Oak Opening	CI
Cottonwood Dune Open Woodland	Beach-dune Community	CI
Central Limestone Glade	Little Bluestem Prarie	I
Mesic Sand Tallgrass Prairie	Big Bluestem Prarie	I
Midwest Dry-Mesic Prairie	Little Bluestem Prarie	I
North-Central Dry-Mesic Limestone-Dolomite Prairie	Little Bluestem Prarie	I
Lakeplain Wet-Mesic Prairie	Big Bluestem Prairie	I
Lakeplain Wet Prairie	Slough Grass-Bluejoint Prairie	I
Twig-rush Wet Prairie	Twigrush-Wiregrass Wet Prairie	I
Midwest Sand Barrens	Sand Barren	I
WETLAND HABITAT		
Highland Rim Parnassia Seepage Fen	Seep	CI
Midwest Acidic Seep	Seep	I
Southern Tamarack-Red Maple Rich Swamp	Tamarack-Hardwood Bog	I
Northern (Great Lakes) Flatwoods	Oak-Maple Swamp	I
Pin Oak-Swamp White Oak Sand Flatwoods	Oak-Maple Swamp	I
Bur Oak-Swamp White Oak Mixed Bottomland Forest	Maple-Ash-Oak Swamp	I
Highbush Blueberry Poor Fen	Tall Shrub Bog	I
Dogwood-Willow-Poison Sumac Shrub Fen	Cinquefoil-Sedge Fen	I
LAKE ERIE ISLANDS HABITAT		
Alvar Nonvascular Pavement	Shoreline Alvar	I
OAK SAVANNA HABITAT		
Central Bur Oak Openings	Bur Oak Savanna	CI
Oak Savanna	Bur Oak Savanna	I
BOREAL COMMUNITY HABITAT		
Western Allegheny Tall Shrub Rich Fen	Cinquefoil-Sedge Fen	I

All of Ohio's habitats are deserving of conservation efforts, and the ecological communities described in the table above merit additional attention based upon their status relative to degree of imperilment. However, in making decisions about allocation of resources for conservation efforts, consideration must be given to leverage. Managing tiny parcels of extremely rare habitat that function more as "museums" rather than contributing to larger scale conservation may not always be the best choice – even when it seems to be the obvious choice. Each of the ecosystems listed above must be carefully considered in terms of “bang for the buck” conservation efforts. In the end, additional attention to these systems may be warranted – but this decision should not be solely based on the “rareity” or “uniqueness” of a given ecosystem. That said, the fine-scale NatureServe ecosystems referenced in the table above will be addressed within the context of the larger habitat categories in Ohio’s Action Plan. Conservation efforts directed at these ecosystems will flow through tactical and operational plans that can be tailored to the specific conditions that need to be addressed.

1.3 Statewide Threats

Threats to Ohio’s species and habitats are many and varied. Some act independently while others work synergistically. Some have immediate and noticeable impacts (shopping centers, chemical spills), while others have less obvious but long-term effects (pharmaceuticals in aquatic environments). Impacts of these threats are generally felt across habitats and species. In nearly every case, these threats are either a result of human activities on the landscape, or introduced species and diseases, or both. Looking forward, climate change acting in concert with existing threats could have a “multiplier effect”. Ecosystems already stressed by human activities and/or invasive species are at higher risk from and increased succeptibility to the effects of climate change.

Below is a brief overview of the primary threats to Ohio’s species and habitats. Threats are categorized and discussed based upon the description above.

1.3.1 Habitat Loss and Alteration from Development

Ohio’s population of about 11.6 million people equates to 282 residents per square mile, making Ohio the 10th most densely populated state in the United States. The infrastructure and resources necessary to sustain Ohio’s human population are substantial – and take their toll on the environment. Direct habitat loss results from development in the form of cities, towns, neighborhoods, commercial and industrial areas, roads, bridges, utility and service corridors, parking lots, and airports. Habitat alteration is caused by agriculture, parks, recreation ares, golf courses, and dams. In addition, the activities of 11.6 million humans have a profound effect on habitats and wildlife species.

The amount of development necessary to sustain Ohio’s human population often results in the fragmentation of remaining unaltered wildlife habitat. Fragmentation affects habitat function as well as the species that live there. The two primary fragmentation issues are population isolation for some species, and loss of ecological connectivity (with like or other habitats) which affects movement of individuals, populations, and genetic material. Loss of habitat function (e.g., altered hydrology) impacts resident species as well as the quality of the habitat itself.

1.3.2 Negative Impacts of Resource Use

Surface mining (after completion and reclamation) results in a tremendous loss of habitat and species diversity – typically leaving behind poor, thin soils and very limited plant/animal communities. Large scale timber harvest radically alters habitat, impacts resident species, and affects local hydrology. Groundwater withdrawal can affect local hydrology and impact baseflow for streams. Impacts to baseflow can alter stream temperature regimes if the reduction in baseflow is significant. Surface water withdrawal or diversion impacts aquatic habitats and wetlands, and these impacts are manifested in the plant and animal communities that occur there. Impacts are a result of changes to temperature, dissolved oxygen, flow, pH, and concentration of allochthonous substances that are caused by or exacerbated by reductions in water volume.

1.3.3 Negative Impacts of Effluents

Ohio’s human population generates a significant amount of “effluent” as a result of their activities on the landscape. Primary sources include household sewage and urban wastewater, industrial effluents, agricultural effluents, garbage and solid waste, and air-borne pollutants. A myriad of chemicals are released into terrestrial and aquatic ecosystems from anthropogenic sources. Impacts from these occur at many levels. Habitats and water quality are degraded, and mortality to resident species may be direct and rapid. Species can be impacted indirectly through compromised immune systems, reduced or eliminated reproductive ability, genetic defects, and alteration of food webs. Additionally, the speed with which water moves across the landscape (due to the amount of impervious surfaces) impacts local hydrology and affects the physical and chemical characteristics of aquatic ecosystems.

1.3.4 Introduced Species and Diseases

The Great Lakes basin is the aquatic gateway to the heartland of America, but it is also a major highway for aquatic invasive species (AIS) introductions. Since 1960, a new invasive species has been discovered every 28 weeks. Lake Erie is especially vulnerable due to the variety of habitat available to these non-native species (NOAA 2015). In addition to introductions into Lake Erie via the Welland Canal and ballast water, the aquarium trade is also a pathway for the introduction of AIS. Fortunately many popular aquarium species are tropical and will not survive an Ohio winter, but this is not always the case. Once established, AIS can expand their range through the bait industry and as aquatic hitchhikers on watercraft and related equipment. Invasive species negatively impact aquatic ecosystems through competition, predation, and the spread of disease. Ohio's primary AIS include sea lamprey, common carp, white perch, zebra mussel, quagga mussel, round goby, tubenose goby, ruffe, rusty crayfish, curlyleaf pondweed, flowering rush, purple loosestrife, phragmites – and the threat of Asian carp looms.

Approximately one-fourth of the plant species known to occur in Ohio are not native to the state. Most of these non-native plant species are not problematic, and have been part of the landscape for many years. Other species such as Japanese honeysuckle, Japanese knotweed, autumn olive, buckthorn, garlic mustard, multiflora rose, and bush honeysuckle can change community structure and composition. These species can displace or reduce native species, impact the wildlife that depend upon native plants, and reduce biological diversity. Non-native plants have been introduced through a number of pathways, but landscapers purchasing plants from nurserys and garden stores account for a high percentage of recent introductions.

While invasive aquatic species and insects tend to occupy the headlines, Ohio is also battling invasive feral swine, sometimes called wild boar or hogs. These destructive animals can damage important habitat that other wildlife species depend on. Other terrestrial invasive species include the European starling, mute swan, and Norway rat. The pet trade is a primary pathway for introductions in other parts of the country, but Ohio winters tend to check that pathway to a large degree.

Invasive insects and diseases have probably caused the most visible environmental damage in Ohio. Both can cause significant damage to native species and habitats, as well as being human health threats and causing substantial economic damage. In Ohio, Dutch elm disease and chestnut blight nearly wiped out both of these tree species. More recently, insects such as the Asian longhorned beetle, emerald ash borer, gypsey moth, hemlock wooly adelgid, and walnut twig beetle are using up the time and resources of state and federal agencies in control efforts.

1.3.5 Climate Change

Any long-term change (wetter, dryer, hotter, colder) in Ohio's climate will affect habitats and species. Lesser tolerant flora and fauna will be impacted first regardless of their condition. Also at risk will be ecosystems already stressed by previously mentioned threats. It is unlikely that much can be done for species on the edge of their range in terms of buffering them from the effects of climate change. However, healthy and connected habitats are likely the best chance that the remaining species have in terms of mitigating the effects of climate change.

1.3.6 The Relationship Between the Land and the Water – Aquatic Habitat Health

The following information comes from the Ohio EPA 2014 Integrated Report and provides a synopsis of the relationship between the land and the water, indicating why Ohio's aquatic systems are a product of their surrounding watersheds.

An examination of the aquatic life use (see the Determining the Condition of Ohio's Aquatic Habitats section in Ohio's Approach to Conservation for an explanation of aquatic life use) attainment status of individual sampling sites relative to the amount of land area drained by the stream at that point, reveals that unhealthy fish and aquatic insect populations are more common on smaller streams. In other words, the larger the drainage area (and usually the larger the stream), the more likely the stream is to be healthy. This phenomenon correlates well with the most widespread causes associated with aquatic life use impairment in watersheds. The top five aquatic life use impairment causes for the period 2003 through 2012 are:

• siltation/sedimentation
• nutrient enrichment
• organic enrichment
• habitat modification
• hydromodification/flow alteration

For watersheds, most impairment is related to modification of the landscape. These types of impairments have the most impact on smaller streams. Most of the impaired watershed units with current data had at least one of these causes contributing to impairment and many had two or more of the top five causes listed.

Of note is the prevalence of watersheds and large rivers that are impaired by the organic enrichment cause category. About 40 percent of impaired watersheds show “sewage” related impairments such as high biochemical oxygen demand, elevated ammonia concentrations, and/or in-stream sewage solids deposition. Over half of 19 impaired large rivers also have sewage-related causes. This suggests that adequate treatment and disposal of human and animal wastes via wastewater treatment plants, home sewage treatment systems, and land applications of septage and animal manure continue to be critical water quality issues in many Ohio watersheds.

The major causes and sources of water quality problems are described below:

Siltation/sedimentation describes the deposition of fine soil particles on the bottom of stream and river channels. Deposition typically follows high-flow events that erode and pick up soil particles from the land. Soil particles also transport other pollutants. As the flow decreases, the soil particles fall to the stream bottom and cover stream habitat available to aquatic organisms.
Nutrient enrichment describes the excess contribution of materials such as nitrogen and phosphorus used for plant growth. Excess nutrients are not toxic to aquatic life, but can have an indirect effect because algae flourish where excess nutrients exist. The algae die and their decay uses up the dissolved oxygen that other organisms need to live. The same nutrients that cause impairment of the aquatic life beneficial use also are a major contributing factor to the recent extensive harmful algal blooms (HABs) that have been observed in Lake Erie, the Ohio River, and many inland Ohio water bodies. Grand Lake St. Marys in western Ohio, and Lake Erie have been particularly affected. HABs, a visually identified concentration of cyanobacteria, can occur almost anywhere there is water: lakes, ponds, storm water retention basins, rivers, streams, or reservoirs. Many HAB-forming organisms are native to Ohio but only cause problems when environmental conditions favor them.
Organic enrichment is the addition of carbon-based materials from living organisms beyond natural rates and amounts. Natural decomposition of these materials can deplete oxygen supplies in surface waters. Dissolved oxygen is vital to fish and other aquatic life.
Habitat modification is the straightening, widening, or deepening of a stream’s natural channel. Habitat modification can also include the degrading or complete removal of vegetation from stream banks; such vegetation is essential to a healthy stream. These activities can effectively transform a stream from a functioning ecosystem to a simple drainage conveyance. Some aquatic life will not be protected from predators and stressful flows and temperatures. The stream also often loses its ability to naturally process water pollutants.
Hydromodification, or flow alteration, describes any disruption to the natural hydrology of a stream system. Flow alteration includes stream impoundment, increased peak flows associated with the urbanization of watersheds, and water-table regulation through sub-surface drainage. Such changes can cause extended periods without stream flow, more extreme or frequent floods, and loss of fast current habitat in dam pool areas.

1.4 Key Conservation Challenges

Successful implementation of Ohio's State Wildlife Action Plan will require an immense amount of cooperation and coordination – scientifically, politically, and culturally. Though often disjoint, the pieces exist to carry out an efficient and effective conservation program in Ohio. It will take buy-in from the highest political office to regulatory agencies to the suburban homeowner to the hobby farmer – and everyone in between. Equally important is it will take a change in mindset – a recognition of the importance of nature to the quality of life of all Ohioans. Everyone needs to take ownership. In the end, conservation of Ohio's wildlife species and their habitats will depend upon the commitment of Ohioans to their protection. This section highlights some of the challenges to creating and harnessing that committment.

1.4.1 Public Participation – Elevating the Priority of Conservation for Ohioans

Among the public in Ohio, there is a gradient of interest in the out-of-doors. This gradient begins with a vague awareness that there is a world outside of the house/office where weather happens, and animals live, and trees grow, and somebody(?) certainly takes care of it all. At the other end of this gradient are people whose feet hit the floor every morning in the name of the great outdoors. Life is worth living because of nature, and enjoying it and protecting it drive people at this end of the interest gradient. Conservation for these people is a meta-value, and therefore a lifestyle. The issue here however, is that not enough of the general population fall into this category. The $64,000 question is how do we (conservation meta-value folks) elevate the priority of conservation in the lives of people at lower levels of the outdoor interest gradient? How do we increase the importance of nature, and the conservation of it, in the value system of the average Ohioan? Can we?

We are quite adept these days at increasing "awareness". We have a myriad of electronic pathways with which to get the conservation message out. We have outdoor education programs for schools. We have camps and clinics. We have programs for citizens of all ages. The problem is that awareness does not necessarily equate to caring, and caring is what is necessary to take the next step, which is action. Action is what gets things done, action moves the proverbial needle, action is what the previously mentioned "conservation meta-value" folks are into! Having a public that is aware, but does not care enough to alter their behavior, or contribute financially – does not make conservation happen. Our public participation challenge may be the most daunting of any conservation challenge we face.

1.4.2 Ecological Data Collectors – Communication, Cooperation, Coordination

With limitations on time, money, and personnel, it makes no sense that ecological data collectors operate independently – regardless of mission or statutory authority. Time spent planning and coordinating the collection of data would more than pay for itself in increased efficiency. Additional time spent standardizing methods would tremendously increase the utility of data collected. Having access to a central data repository would be the payoff for all of the communication and coordination. The challenge here is to bring all the collectors together, and get them to agree on the sharing of data and the standardization of its collection to the fullest extent possible. The end result would often be the ability to avoid sending crews into the field to collect data that could be accessed from a computer in someone's office. Our ability to make regulatory and management decisions would be enhanced, and operating costs would be reduced.

1.4.3 Identifying and Filling Data Gaps

Data gaps for species and habitats limit our ability to prioritize and manage. For popular species (usually sport species or high-profile endangered species) lots of information on distribution, life history, population status and trends, genetics and management needs exists. For other species, simple distribution information is not even available. Lack of basic information on many species not only hampers management efforts, but makes it difficult to determine if, and how much, protection may be needed. There is no question that if we knew as much about invertebrates, insects, mussels, and other species groups as we do about largemouth bass and whitetail deer, our state and federal T&E species lists might look different than they do today.

Identifying data gaps for species and habitats, and launching at minimum survey and inventory efforts should be a priority. Habitat mapping in particular should be taking advantage of improvements in geospatial technology, habitat type characterization, imagery resolution, and other advanced technologies to produce accurate habitat information necessary to monitor the status of Ohio's habitats. To develop more effective and holistic conservation strategies, data gaps need to be identified and filled.

The issues affecting Ohio's wildlife and habitats today are incredibly complex. They cut across political, social, and economic boundaries – and property boundaries as well. No single jurisdiction, agency, or group in Ohio owns enough land or has enough authority to cover all the conservation bases. It will take the resources of all government agencies (state, county, municipal), academia, and conservation groups to be more successful in the future than we have been in the past. The passion and expertise of all of these groups working in a coordinated fashion, with a shared vision and common goal, will be needed to create the synergy necessary to fully implement Ohio's Action Plan.

Improving the level of cooperation and coordination among the previously mentioned groups will be the challenge if history has taught us anything. Historically we have underachieved in the area of working together for conservation. Regulatory agencies have different missions and statutory authorities, and do not always work well together. Turf wars are common, and cooperation and coordination are often inhibited. Additionally, there is enough redundancy between different levels of government that it confuses the the public, and creates a management conundrum because of often differing missions (e.g., state parks vs county parks vs metro parks). Academia often views applied research as a necessary evil, but the answers applied research provides are what natural resources managers need. National conservation organizations with state chapters, and in-state conservation groups do some excellent work, but generally have a fairly narrow focus.

The hope here is that Ohio's SWAP will serve as the vehicle to bring all levels of government, academia, and non-government conservation groups together in a coordinated fashion in the name of conservation. Each group playing their part, based upon their mission, authority, expertise, and available resources to achieve a common goal. Leadership will be the key – to overcome issues between groups, determine what needs done and get buy-in from all involved, and determin how best to use all of the "players" to accomplish the goal. The degree to which this Action Plan is implemented will play a large part in determining the future of Ohio's wildlife resources.

1.5 Ohio's Approach to Conservation

The health and well being of Ohio's wildlife resources are important, which means their sustainability is important. Ohio's citizens and visitors to the state enjoy Ohio's wildlife resources in many ways, making them important economically. Clean lakes and rivers, lush woodlands, and abundant and diverse flora and fauna enhance the quality of life for all Ohioans. Healthy wildlife and healthy habitats help make healthy Ohioans. The importance of Ohio's natural resources necessitates that every tool and technique be used to preserve and enhance them for today and for future generations. The following is an overview of Ohio's approach to conservation – it is our hope that everyone who enjoys the great outdoors will join us on this journey to conserve and improve Ohio's wildlife and their habitats for sustainable use and appreciation by all.

Effective conservation comes down to the ability to achieve a functional coexistence between wildlife, habitat, and people. The three are inextricably linked, and effective management actions recognize this fact. With more than 11 million people in Ohio and more than 95% of Ohio's land in private ownership, balancing the needs of all three represents a significant challenge.

The success of efforts to minimize and/or mitigate the effects of people and development on wildlife and habitats depends upon the ability of conservationists to elevate the value of nature to the general public. When the public values nature enough to make changes in the way they live for the benefit of wildlife and habitats, the effectiveness of conservation efforts will increase. Consequently, one could argue that Ohio's approach to conservation should focus primarily on the people component, and that improvements to species and habitats will naturally follow. Changing the environmental consciousness of society unfortunately cannot be achieved (if it can be achieved) in the amount of time that it would take to prevent the loss of species and habitats. Therefore, Ohio's approach to conservation will consist of a balanced strategy aimed at using the best science to manage species and habitats, with the best communication strategies to raise public awareness and appreciation for conservation.

Ohio's approach to conservation is founded upon the following five principles:

STEWARDSHIP - to foster healthy ecosystems that support diverse and abundant fish and wildlife populations
OPPORTUNITIES - to improve outdoor recreational opportunities for all Ohioans
CONNECTIONS - to create, expand, and improve public awareness, understanding, and appreciation of Ohio's fish and wildlife resources
TRADITIONS - to preserve and promote Ohio's tradition of conservation
PARTNERSHIPS - to create a conservation coalition aimed at improving communication, coordination, and cooperation among all with an interest in Ohio's outdoors

We recognize that a clean separation of conservation strategies, goals, and objectives for the management of the complex relationship between people/wildlife/habitat cannot be made. However, in the interest of maximizing the utility of this Action Plan among all levels of conservationists in Ohio, we have separated strategies based upon these three groups. Taken together, this approach addresses the full spectrum of challenges, issues, and opportunities related to conservation in Ohio

1.5.1 Wildlife

Evaluate the status of fish and wildlife populations using the best science available

Identify species information gaps regarding distribution, abundance, and population trends, and focus efforts on closing those gaps

Maintain a current and comprehensive database that stores data related to the distribution of state-listed and other rare plant and animal species as a tool for environmental review, research, conservation planning and species listing decisions

Identify ecosystem- or population-level threats through research, surveillance, monitoring, and inventory

Based upon the issues determined to be impacting fish and wildlife species, use existing or develop new methods to stabilize and enhance populations (e.g., reintroduction programs, regulations and enforcement, education programs, partnerships)

Develop and implement a comprehensive plan to address current known and emerging diseases in wildlife that includes prevention, detection, diagnosis and identification, monitoring outbreaks, and management of affected wildlife populations

Conduct inventory and monitoring efforts to determine the distribution and abundance of invasive species

Work to prevent the introduction of and control spread of invasive species through legislation, regulation, policy, management practices, education, and partnerships

Continue to pursue legislation to check the introduction and spread of species like feral hogs and captive deer that pose a threat to native free-ranging wildlife

Address climate change issues related to wildlife populations through the development of monitoring projects and coordination of adaptive management strategies among key conservation partners

Evaluate proposed energy development projects and existing energy producing facilities using established protocols to minimize impacts on wildlife

1.5.2 Habitat

Protect land and water resources through strategic acquisitions, easements, agreements, and partnerships

Manage an effective land/waters acquisition program by annually reviewing and prioritizing parcels containing key habitats for potential protection

Maintain a current and comprehensive database that stores data related to the distribution of habitats, significant geologic features, and lands managed for conservation as a tool for environmental review, research, and conservation planning

Manage and evaluate fish and wildlife habitats using the best available science

Restore and/or enhance habitats where appropriate

Protect habitats by preventing and/or mitigating incompatible ecosystem uses

Communicate and coordinate with landowners to manage wildlife habitat on private property

Form broad coalitions with other agencies, industry, and non-government organizations (NGO) to minimize impacts to aquatic ecosystems and effectively implement conservation and restoration programs at a watershed level.

Work to prevent the introduction of and control spread of invasive species that impact habitats (e.g., gypsy moth, emerald ash borer, garlic mustard, purple loosestrife) through legislation, regulation, policy, management practices, education, and partnerships

Address climate change issues related to wildlife habitats through the development of monitoring projects and coordination of adaptive management strategies among key conservation partners

Evaluate proposed energy development projects and existing energy producing facilities using established protocols to minimize impacts to wildlife habitat

1.5.3 People

Develop and maintain partnerships to better deliver the conservation message to Ohioans and promote opportunities to experience Ohio's fish and wildlife resources

Maintain a corps of conservation partners and volunteers to assist, lead, and promote outdoor programs

Develop and promote educational materials that address fish and wildlife management principles, conservation concepts, and outdoor skills

Develop programs and materials designed to stimulate interest in the outdoors that can be incorporated into school curricula

Partner with outdoor-oriented clubs and organizations to develop conservation recruitment programs

Recruit and retain a broad range of fish and wildlife enthusiasts to increase support for conservation

Use partnerships to leverage fish and wildlife conservation funding

Conduct research to better understand how and why people value wildlife

Enlist citizen-science groups to gather data and help promote the conservation message to the public

Identify and address the public's evolving information needs related to outdoor recreation and conservation

Utilize a variety of fish and wildlife exhibits, programs, educational materials, and hands-on experiences to increase knowledge and appreciation of Ohio's fish and wildlife resources

Utilize youth- and family-oriented events to promote participation in fish and wildlife recreation

Provide timely and accurate information about fish and wildlife recreational opportunities using state-of-the-art communication technologies

Work to bring outdoor recreational opportunities closer to home by providing opportunities in urban/suburban areas

Increase public access to land and water through purchases, easements, agreements, and partnerships

Provide information and guidance to reduce human/wildlife conflicts and improve interactions with fish and wildlife

1.5.4 Land Stewardship in Ohio
The following information and map regarding the status of conservation lands in Ohio was adapted from the 2007 USGS Ohio Aquatic Gap Analysis (Covert et al. 2007).

A patchwork of conservation lands in Ohio is owned and managed by a diverse group of Federal, state, regional, and local agencies and private organizations. Although state and Federal lands make up more than 80 percent of the conservation area in the state, a map of protected lands would be incomplete without considering other sources. A list of conservation land stewards in the state was generated and OH-GAP requested GIS data from these stewards. With one exception, where DLG lines were used to delineate Muskingum Watershed Conservancy District lands, no new GIS datasets were created for the map. Unfortunately, some counties and regions may be underrepresented in their mapped conservation lands from lack of available or usable GIS data. Nonetheless, conservation lands in 87 out of 88 counties in the state are represented, encompassing Federal, state, regional, local, and private land tracts.

The four GAP management (stewardship) status categories in Figure 5 can generally be defined as follows:

Status 1: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, and intensity) are allowed to proceed without interference or are mimicked through management.

Status 2: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive use or management practices that degrade the quality of existing natural communities.

Status 3: An area having permanent protection from conversion of natural land cover for the majority of the area, but one that is subject to extractive uses of either a broad, low intensity type or localized intense type. It also confers protection to federally listed endangered and threatened species throughout the area.

Status 4: Lack of irrevocable easement or mandate to prevent conversion of natural habitat types to anthropogenic habitat types. This status allows for intensive use throughout the tract. Also includes those tracts for which the existence of such restrictions or sufficient information to establish a higher status is unknown.

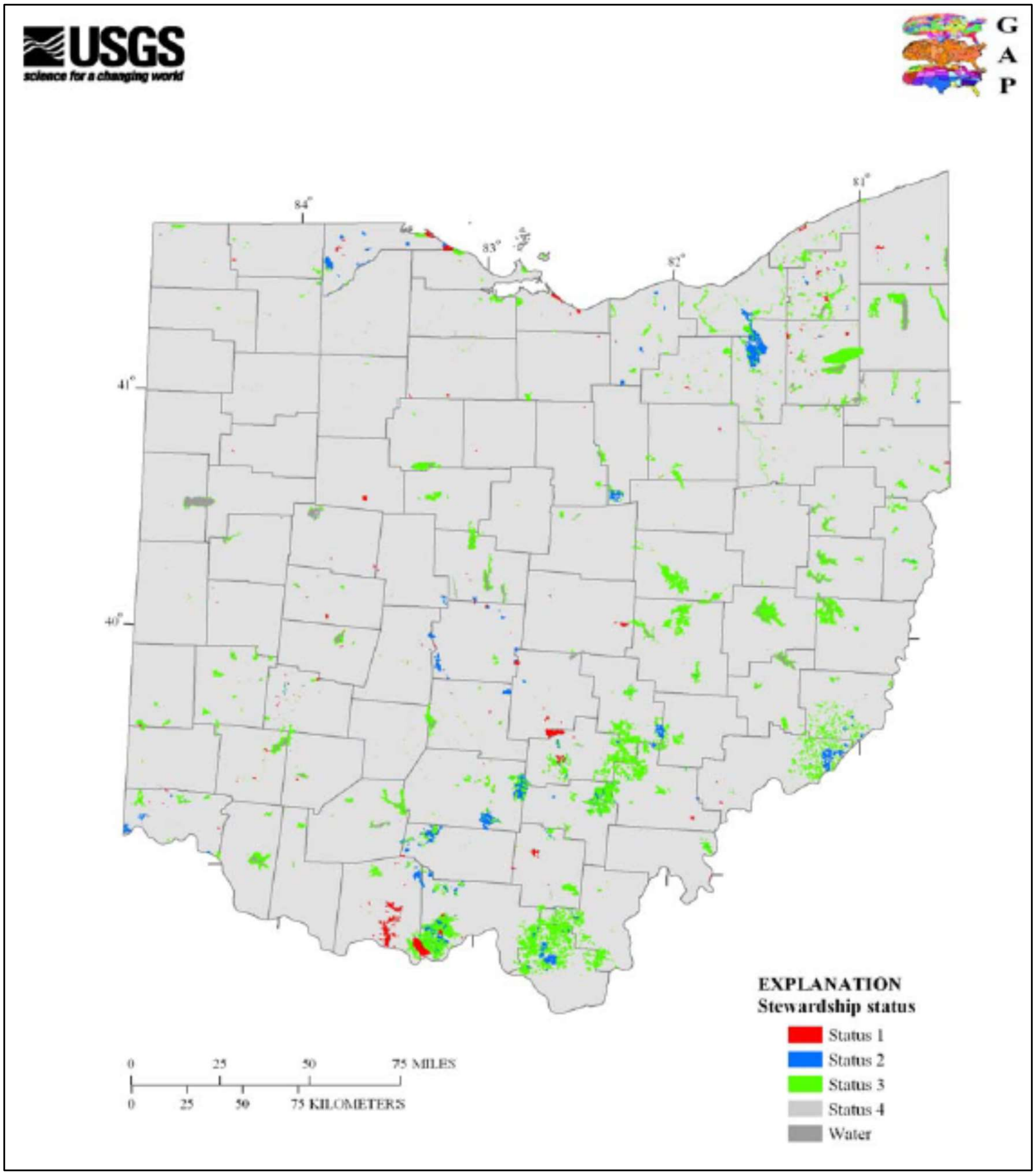


Figure 5. Gap Analysis Program (GAP) stewardship status categories for land in Ohio.

<u>Statewide Assessment</u>

Ohio has very little conservation land in public ownership (Figure 5). In a state dominated by agriculture and increasing urban land cover, only about 3.7 percent of the state's land is protected for conservation, either publicly or privately. Of this total, state agencies control about 52 percent and Federal agencies control about 29 percent. The ODNR and The Nature Conservancy manage the bulk (43.4 percent and 30.3 percent, respectively) of the status 1 lands. Status 1 lands, the most highly protected lands, account for 6 percent of the conservation lands and 0.2 percent of the total land area in Ohio (conservation and non-conservation lands).

Conservation lands are distributed throughout Ohio in 87 of 88 counties. This is largely due to ODNR, the largest land steward by area in Ohio, which protects lands in 86 counties (all but Van Wert and Union). These 86 counties include 32 counties, mostly in the northwest, that would otherwise not be represented on the map. A cursory look at the stewardship map shows that the size of the tracts of conservation lands are much smaller and more fragmented in the northwestern quarter of Ohio compared to other parts of the state. Many of these tracts are ODNR Division of Wildlife Habitat Restoration Program areas.

Although Federal and state stewards are responsible for more than 80 percent of the conservation lands in Ohio, regional and local governments also have an important role in Ohio's conservation. The metroparks around sprawling cities such as Columbus and Cincinnati protect and restore lands that otherwise may be converted to suburbs. Regional governments, like metroparks, are the stewards of 10.8 percent of all status 1 lands and 14.3 percent of status 2 lands.

1.5.5 Conserving Ohio's Aquatic Habitats and Species - a Watershed Approach

Ohio's water resources consist of approximately 61,532 miles of streams, 2.24 million acres of Lake Erie, over 188,000 acres of inland lakes and ponds, and 451 miles of the Ohio River, creating a variety of aquatic habitats.

Aquatic systems and their associated riparian habitats are the most biologically diverse systems in Ohio. The structural variability of these systems creates highly diverse habitats that are inhabited by many aquatic species including 168 fishes, 67 mussels, 21 crayfish, 14 amphibians, and thousands of aquatic invertebrates. Almost half of Ohio's state listed species are found in these aquatic systems, including 42 species of fish, 36 species of mussels, 23 species of odonates, and 5 species of crayfish.

For effective conservation of aquatic systems, a watershed approach that takes into account the link between terrestrial and aquatic systems is clearly the best strategy. Land uses within the watershed are extremely important in structuring aquatic communities in Ohio. The majority of conservation threats and actions related to aquatic systems are terrestrially linked (see Statewide Threats section in this chapter). This watershed approach is intended to focus on permanent aquatic systems, from small headwater streams to larger tributaries, and include man-made and natural lakes. Wetlands (ephemeral, natural, and controlled) are covered under terrestrial habitats.

To effectively implement a basin management approaches requires collaboration with other agencies and NGO's that share common goals regarding the status and function of watersheds within basins. Basins cut across county lines, consequently their management involves multiple government, administrative, and management jurisdictions. Broad coalitions must be formed to ensure effective planning, maximize resources, and efficiently implement conservation and restoration programs to achieve short and long-term management goals.

Studies conducted by various environmental regulatory agencies (OEPA, ODNR, USEPA, USGS) clearly demonstrate the connection between the land and aquatic ecosystems. Aquatic ecosystems are a product of the land and land use that surrounds them. In general, the quality of water, habitat, and life in aquatic systems varies inversely with the influence of humans in the surrounding watershed. Human impacts in the watershed (land uses) directly affect physical habitat and water quality in aquatic systems – which drives biotic communities. Aquatic systems have proven over time to be amazingly durable and adaptable. Their ability to withstand human induced perturbations, as well as recover from stressors once they are removed, is a testament to the resiliency of nature. However, using "uninfluenced" aquatic ecosystems as a benchmark, it is easy to see the impacts of human activities on Ohio's aquatic ecosystems. Compromised habitat and water quality push biotic communities in the direction of reduced diversity and "disturbance" tolerant species. Abatement of stressors on the system can result in a shift back to original habitat and water quality conditions – with a slow return of the biotic community that occupied the pre-disturbance system. Affects of individual stressors, multiple stressors, and synergistic effects of stressors acting on aquatic systems are often difficult to define due to the mitigating affects of the physical environment. Excess nutrient inputs may have a profound effect on one system, yet seemingly no effect on another due to size, volume, channel morphology, current, or substrate differences between the systems. Consequently, remediation and/or restoration strategies must be considered on a system-by-system basis.

Understanding how various land uses impact water quality is the key to effective prevention and restoration. Primary causes and sources of aquatic ecosystem impairment (from the 2014 Ohio EPA Integrated Report) include:

Row crop cultivation is a common land use in Ohio. Frequently, cultivated cropland involves tile drainage, and a challenge is to carry out actions that improve water quality while maintaining adequate drainage for profitable agriculture. The land application of manure, especially during winter months, is often a large source of both bacteria and nutrients entering streams and subsurface drainage tiles. Many cropland practices involve the channelization of streams, which creates deeply incised and straight ditches or streams. This disconnects waterways from floodplains, which has damaging impacts on the quality of the system. The regularity of the stream channel and lack of in-stream cover reduces biological diversity.

Land development is the conversion of natural areas or agriculture to residential, industrial, or commercial uses. Numerous scientific studies show that increasing impervious cover—hard surfaces such as roads, parking lots, rooftops, and lawns—harms water quality. More water runs off the hard surfaces and more quickly. The rate of erosion increases and streams become unstable. The resulting channel is less able to assimilate nutrients and other pollution. Higher runoff volume increases the amount of pollutants (e.g., nutrients, metals, sediment, salts, pesticides). Another problem is that stream temperatures can be raised when water runs over hot pavement and rooftops or sits in detention basins. When this heated water enters a stream, the higher temperatures reduce dissolved oxygen concentrations that aquatic life need to survive. With proper planning of development, many of these problems can be mitigated or avoided entirely.

Agricultural livestock operations can vary widely in how they are managed. Pasture land and animal feeding operations can be sources of nutrients and pathogens. Frequently livestock are permitted direct access to streams. Direct access not only allows direct input of nutrients and pathogens, but also erodes the stream bank, causing excess sediments to enter the stream and habitat degradation. The most critical aspect of minimizing water quality impacts from any size animal feeding operation is the proper management of manure in terms of application and storage.

Industrial and municipal point sources include wastewater treatment plants and factories. Wastewater treatment plants can contribute to bacteria, nutrient enrichment, siltation, and flow alteration problems. Industrial point sources, such as factories, sometimes discharge water that is excessively warm or cold, changing the temperature of the stream. Point sources may contain other pollutants such as chemicals, metals and solids.

Acid mine drainage impacts streams with high levels of acidity (low pH), high metal concentrations, elevated sulfate levels, and/or excessive dissolved and suspended solids and/or siltation. Acid mine drainage often has toxic effects on stream organisms and degrades habitat quality when deposited metals form a crust on the stream bed and susceptible soils erode from areas disturbed from mining. Ultimately it reduces biological diversity, eliminates sensitive aquatic life, and lowers ecosystem productivity.

1.5.5.1 Determining the Condition of Ohio’s Aquatic Habitats
The condition of Ohio’s aquatic habitats is determined primarily from Ohio EPA surveys and data. In monitoring water quality, habitat, and biological community health, OEPA uses a “life-use attainment” system where various indices are measured and compared to ecoregion standards. Depending upon how measured indices compare to standards, a particular water body may fully meet, partially meet, or not meet a designated aquatic life use. Given the length of time this system has been in place, the number of water bodies surveyed, and the amount of data collected – this system represents the best way to monitor aquatic habitat health both spatially and temporally.

The Ohio EPA 2014 Integrated Report provides a detailed description of how the health of Ohio's aquatic habitats are assessed and monitored:

Ohio's water quality standards (WQS) have seven subcategories of aquatic life uses for streams and rivers (see Ohio Administrative Code 3745-1-07, http://www.epa.ohio.gov/portals/35/rules/01-07.pdf). The WQS rule contains a narrative for each aquatic life use and the three most commonly assigned aquatic life uses have quantitative, numeric biological criteria that express the minimum acceptable level of biological performance based on three separate biological indices. These indices are the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb) for fish and the Invertebrate Community Index (ICI) for aquatic macroinvertebrates. A detailed description of Ohio EPA's biological assessment and biocriteria program including specifics on each index and how each was derived is available (see Biological Criteria for the Protection of Aquatic Life, http://www.epa.ohio.gov/dsw/bioassess/BioCriteriaProtAqLife.aspx).

Procedures established in a specially designed 1983-1984 U.S. EPA study known as the Stream Regionalization Project (Whittier et al. 1987) were used to select reference (or least impacted) sites, in each of Ohio's five Level III ecoregions (Omernik 1987). Biological data from a subset of these sites in addition to supplemental data from other least impacted Ohio reference sites were used to establish the ecoregion-specific biocriteria for each aquatic life use. Note that some criteria vary according to stream size and some indices do not apply in certain circumstances. Ohio's WQS rule stipulates that "biological criteria provide a direct measure of attainment of the warmwater habitat, exceptional warmwater habitat and modified warmwater habitat aquatic life uses" (OAC 3745-1-07(A)(6)). The numeric biological criteria based on IBI, MIwb, and ICI thresholds applicable to exceptional warmwater habitat (EWH), warmwater habitat (WWH), and modified warmwater habitat (MWH) waters are found in Table 7-15 of the WQS rule. Neither coldwater habitat (CWH) nor limited resource water (LRW) streams have numeric biological criteria at this time, so attainment status must be determined on a case-by-case basis. For sites and segments designated with these aquatic life uses, attainment status was determined by using biological data attributes (e.g., presence and abundance of coldwater species in CWH streams) and/or interim assessment index targets (*e.g.*, those for LRW streams, Lake Erie lacustuaries, Lake Erie nearshore) to assess consistency with the narrative aquatic life use definitions in the WQS.

Briefly defined, aquatic life use classifications are:

- Coldwater Habitat CWH - native cold water or cool water species; put-and-take trout stocking
- Seasonal Salmonid Habitat SSH - supports lake-run steelhead trout fisheries
- Exceptional Warmwater Habitat EWH - unique and diverse assemblage of fish and invertebrates
- Warmwater Habitat WWH - typical assemblages of fish and invertebrates
- Modified Warmwater Habitat MWH - tolerant assemblages of fish and macro-invertebrates
- Limited Resource Waters LRW - fish and macroinvertebrates severely limited by physical habitat or other irretrievable condition

A biological community at a EWH, WWH, or MWH sampling site must achieve the relevant criteria for all three indices, or those available and/or applicable, in order to be in full attainment of the designated aquatic life use criteria. Partial attainment is determined if one criterion is not achieved while non-attainment results when all biological scores are less than the criteria or if poor or very poor index scores are measured in either fish or macroinvertebrate communities.

Most of Ohio's water quality problems will not be solved by issuing a permit or building a new wastewater treatment system to treat point sources of pollution. Improving Ohio's surface water quality will require effectively managing land use changes to ensure that polluted runoff is either captured and treated or allowed to infiltrate through the soil before running off into a stream. Restoring and protecting natural stream functions so that pollutants may be more effectively assimilated by streams is also critical. These actions will require various programs and people working collaboratively on local water quality issues and concerns. Local educational efforts and enhanced water quality monitoring will also play important roles if we are to see significant water quality improvements throughout Ohio.

Many areas of the state are benefitting by the participation of individuals and organizations in local watershed organizations. Some of these organizations have been active for quite some time and are successfully influencing local land use decision making and implementing projects designed to improve water quality in their watershed. Since 2000, Ohio EPA has worked in conjunction with the Ohio Department of Natural Resources to provide section 319(h) grant funding assistance to hire local watershed coordinators to help facilitate the development of watershed action plans. In recent years, the emphasis has shifted from developing plans to implementing water quality improvement projects such as stream restoration, dam removals, agricultural best management practices and others. Ohio EPA is measuring improvements resulting from these projects; however, there remain challenges associated with changing land use decisions and consumer and producer attitudes.

1.6 Action Plan Evaluation and Updates

The "owners manual" describing how the Division of Wildlife operates is its Comprehensive Management System (CMS). A CMS is a method of developing and documenting a series of processes and procedures that organize an agency's "way of doing business." The four components of a CMS include Inventory and Scanning, Strategic and Tactical Planning, Operational Planning, and Control and Evaluation. While the comprehensive management system does not address all of the fish and wildlife resource needs, issues, and problems in Ohio, it provides the management framework of assessment and adaptation necessary to carry out effective conservation programs. The following is a brief description of how the Division uses the CMS, broken down by each of its four components.

1.6.1 Inventory and Scanning

The inventory and scanning process answers the questions, "Where are we, and what do we have to work with?" By definition, inventories are concerned with current conditions, whether they describe animal abundance, habitat quality, or number of recreational users. Oftentimes, however, inventory information is most useful when put into context with historical information or informed predictions. Inventories are performed at various steps in Ohio's CMS; hence, the types of inventories, their purposes, and their frequency vary widely. In reality, different types of inventories are conducted for different reasons at various steps in the CMS cycle on varying time intervals – and they form the critical first step in the CMS process.

Operational Inventories

Operational inventories are conducted either on a continuous basis or frequently (at least every biennium), and address both administrative and traditional resource survey needs. Resource inventories provide routine information on fish and wildlife abundance, habitat quality or quantity, and human use of and/or attitudes towards fish and wildlife resources. Examples of these routine inventories include annual waterfowl surveys, fish population surveys, harvest summaries, breeding bird surveys, and angler creel surveys. A variety of methods are used to collect information on attitudes towards wildlife and to estimate participation in wildlife-related recreation. Methods used to collect information include annual wildlife district open houses, website surveys, mail questionnaires, angler surveys, conservation club meetings, as well as contacts at county fairs, the state fair, and a host of outdoor shows.

Regardless of whether routine inventories are used to sample human dimensions or wildlife populations, ongoing survey projects are evaluated during operational planning to determine if the data are still needed, if the projects sufficiently meet management objectives, if the projects provide reliable data, and if the survey methodologies are efficient and up-to-date.

Tactical Inventories

Tactical inventories are usually conducted less frequently, at intervals that can range up to several years. Information from these inventories can be used during both the tactical plan development phase and the evaluation phase. Some tactical inventories are simply a compilation and synthesis of trend data taken from routine operational inventories, and in some cases, tactical inventory information is provided by external sources or partner agencies.

Tactical inventories obtained from external sources provide crucial information about long-term trends. Examples of resource inventories include the North American Breeding Bird Survey (USGS) and the Ohio Wetland Inventory (USFWS). Examples of demographic and human dimension inventories include the decennial census (US Census Bureau), the National Survey of Fishing, Hunting, and Wildlife Associated

Recreation (USFWS), and various industry trade organization reports (e.g. Recreational Boating and Fishing Foundation).

Tactical inventories can address both administrative and resource issues. Habitat and population inventories are used for developing tactical approaches to maintaining or improving habitat, and managing fish and wildlife populations. Human dimension and public attitude inventories are crucial for developing tactical approaches for facility and access development, recreational opportunities management/enhancement, and public communication.

Strategic Inventories

Strategic inventories are performed during the strategic plan development phase, and therefore are conducted less frequently than almost all other inventories. Inventories related to strategic planning involve an amalgam of inventory types including recent operational and tactical inventories. However, the long interval between strategic planning cycles demands that strategic inventories include not only a complete description of, “where are we”, but also a thorough examination of predicted changes that could dramatically influence strategic and tactical direction.

A situation analysis is used to provide a “future look” component to the strategic inventory. Sources of trend data related to people, wildlife, and habitat are assembled. Important types of information (and their sources) include: human demographics (US Census Bureau, Ohio Dept. of Development); outdoor recreation participation trends (USFWS, industry trade groups, social science research); habitat quantity and quality (Ohio Dept. of Agriculture, ODNR, USDA, USFWS, USGS, Ohio EPA). All of this inventory information is synthesized to produce statements regarding the current status of, and possible future trends of major factors that will impact conservation in Ohio.

1.6.2 Strategic Planning

The information collected at the inventory stage aids in strategic planning. The strategic plan creates a shared, common, vision of the future of conservation in Ohio. It is forward-looking and encourages action, anticipates needs of wildlife, habitat, and people – and identifies problems/opportunities related to those needs. Strategic planning defines direction, while specific actions are planned and implemented through tactical planning and operational planning processes.

The strategic plan is designed to make effective and efficient use of available resources. The plan identifies fundamental principles that will guide the future of conservation in Ohio, and involves the entire division staff, constituents and stakeholder groups, and other government agencies as part of the planning process. The strategic planning component answers the question, “Where do we want to go?”

The concept of the current strategic plan (2011-2030) is to “build on the past to prepare for the future.” The current plan is a landscape-view of Ohio, considering species and habitat types, their relationship and arrangement within the natural world, and the impact and interactions that people have with fish and wildlife.

Evaluation of the Strategic Plan

Evaluation of the strategic plan is a critical process and tool for administrators and managers within the division. Evaluation of the strategic plan measures the progress towards the preferred direction for each action stated in the plan. Evaluation of the strategic plan is formally completed every two years, and a final evaluation of the plan will occur at the beginning of the planning process for the Strategic Plan for 2031 and beyond.

The review considers each component of the plan, and each component is rated for applicability, effectiveness and inclusiveness. The existing strategic plan is then either affirmed, recommended for revision, or recommended for replacement by a new strategic plan.

The final evaluation of the strategic plan is an evaluation of the success of conservation efforts during the life of the plan. Did we successfully achieve the objectives? If not, why not? And what adjustments need to be made to better achieve them during the next strategic plan, assuming they are still appropriate. The final evaluation provides the foundation for the next Strategic Plan.

1.6.3 Tactical Planning

A tactical plan is a guidance document that provides multi-year operational direction for projects, and also provides specific outcomes and objectives for the implementation of strategic action areas identified in the strategic plan. Additionally, it includes a description of opportunities, problems, needs, or issues that will influence the accomplishment of outcomes and objectives.

The purposes of a tactical plan are to (1) provide linkage between the strategic plan and operational projects, (2) set tactical outcomes and objectives that correspond to strategic actions, (3) lay out the sequence of projects which are needed to address strategic actions, (4) provide a basis for the evaluation of operational projects, and (5) organize the multi-year operations of projects.

The scope of a tactical plan may be function specific, habitat/ecosystem specific, or species specific, or it may be based on strategic actions of the Strategic Plan. It may encompass elements of more than one strategic action, and/or be supported by one or more operational projects.

Evaluation of Tactical Plans

A biennial review, evaluation, and update of tactical plans helps to insure that each plan is helping address strategic actions of the strategic plan. Evaluation of tactical plans measure progress towards the preferred outcomes stated in that plan. The basis of evaluation should be the metrics associated with objective statements, including all quantities, qualities, and deadlines associated with the accomplishment of a particular objective.

Tactical plans are evaluated every two years. The review considers each component of the plan, and each component is rated for continued validity, effectiveness, and quality. A biennial review, evaluation, and update of tactical plans insures that each plan is helping address strategic actions of the strategic plan.

The final evaluation of tactical plans is an evaluation of the success of conservation efforts during the life of the plan. Were the desired outcomes achieved? If not, why not? And what adjustments need to be made so those goals can be achieved during the next tactical planning cycle, assuming those goals are still appropriate. The final evaluation provides the foundation for the next set of tactical plans.

1.6.4 Operational Planning

The operational planning process is an annual process which results in activities that put ideas into action. It is where specific outcomes, objectives, and strategies identified in tactical plans are turned into projects, in which tasks are organized and resources allocated. Each operational project identifies the need/justification for the project, the related objective(s), the approach and activities involved, the expected results or benefits, and costs. The operational planning component answers the question, “For this year, how are we going to get where we want to go?”

Operational Project Linkage to Strategic and Tactical Plans

In order to help accomplish the conservation mission, operational projects need to help achieve tactical plan outcomes, and where appropriate support objectives and strategies in tactical plans. This approach links operational projects to tactical plans in a fashion similar to how tactical plans link to the strategic plan. Strategic actions from the Strategic Plan provide broad direction and associated objectives. Tactical plans link to these objectives. Detailed information about what actions need to be taken for “on the ground” progress are found in tactical plans which provide a shorter term, specific view of how the desired future can be achieved. Tactical plans then link to detailed operational projects that put financial and human resources into action.

Project Monitoring

Project monitoring assures that every effort is made to accomplish operational project objectives. The project leader and associated advisory team monitor schedules, completion dates and fiscal information for project activities. Monitoring allows managers to identify potential problems and resolve them before they have an irreversible impact.

Project Evaluation and Performance Reports
Operational project evaluation measures the success of projects and helps identify improvements/modifications that may be needed in future years. Project performance reports close the loop for operational planning by providing project leaders an objective view of project performance and evaluation. All operational projects are evaluated every year. These reports focus on accomplishments, costs, and recommendations concerning the future of the project. Final reports mirror annual performance reports, but provide details for each project year and synthesize overall results.

1.6.5 Control and Evaluation
The control and evaluation component allows us to the answer the question, "Did we get there?" Regular feedback to determine how well strategies are working and if objectives have been met is an essential part of our comprehensive management system. This is a key component in improving conservation of Ohio's fish and wildlife resources.

Every operational project is evaluated at the end of each fiscal year - evaluation of project objectives allows us to determine if projects have been accomplished as planned. Strategic and tactical plans are evaluated by periodic formal and informal reviews. Surveys of fish and wildlife populations and input from constituents concerning use of these resources allows for the evaluation of direction and progress at several levels. Formal evaluation and modification of strategic and tactical plans occurs every two years. The information gathered from these evaluations is then used as part of the inventory component of subsequent strategic and tactical plans.

1.6.6 Evaluation and Adaptive Management
The condition of species and habitats is determined based upon the best data available at the time. Problems, opportunities, issues, and needs are determined, and priority is assigned regarding which ones to address first. Goals and actions are developed, and projects are implemented to produce some desired outcome related to an issue affecting species and/or habitats. To some degree during, but primarily at the end of some implementation timeframe, an assessment is made regarding progress toward the desired outcome. As is often the case, early efforts aimed at issues result more in increasing our understanding of the issue than they do resolving it. At this point, adaptation occurs and efforts continue. The process of effort, assessment, adaptation, and revised effort continues until the issue is resolved, or priorities change.

Ohio’s State Wildlife Action Plan will be implemented, reviewed, reported on, modified, updated, and rewritten (if necessary) according to CMS protocols. It is however important to keep in mind that the Action Plan is intended to be a flexible, adaptable, living document, and therein lies its strength. As our knowledge of species and habitats grows, and as new threats and conservation actions are identified – the Plan will be revised and updated. Some of the revision and updates will take place per the CMS described above. Others, when necessary, will be done less formally at various intervals. Formal and informal updates to the Action Plan will incorporate USFWS notification and opportunity for comment.

Chapter 2. Ohio's First 10 Years of CWCS Implementation

Ohio's first Comprehensive Wildlife Conservation Strategy served as a vehicle to strengthen existing relationships between the Division of Wildlife and conservation partners, as well as create new relationships. The CWCS was a product of an increased interest in wildlife diversity and the realization that more needed to be done for SGCN. What conservationists needed at that time was a rallying point – something tangible that could be used to channel their interest and passion – and the CWCS provided that. State Wildlife Grant funding provided the fuel for the CWCS vehicle, and in Ohio, wildlife diversity surveys, monitoring, research, and management progressed at a rate not seen before. A tremendous amount of knowledge regarding SGCN and their habitats resulted from the first 10 years of CWCS implementation. That knowledge essentially fell into two categories: (1) the accrual of new information, and (2) a cognizance of how much we don't know.

The Division worked with many partners in the form of state and federal agencies, academia, environmental groups, conservation organizations, and stakeholders during implementation of the first CWCS. The following section describes some of the conservation efforts that contributed to the "accrual of new information" category – efforts by the Division and its partners during the first ten years of CWCS implementation.

2.0 Conservation Efforts 2006-2015

Conservation projects focused on habitats

- Habitat management on conservation opportunity areas including forestlands, grasslands, and wetlands
- Forest conservation opportunity area inventory and management
- Forest habitat research in fragmented landscapes near Lake Erie
- Conservation of riparian forests in urbanizing landscapes
- Local and Landscape scale forest habitat attributes
- Lake Erie and other coastal wetlands research and surveys
- Conservation easements to protect habitat for endangered terrestrial wildlife
- Mechanistic understanding of landscape-scale responses of animal communities to urbanization
- Statewide stream conservation programs

Conservation projects focused on birds

- Peregrine falcon distribution and productivity
- Conservation of Cerulean warblers in the southeast Ohio
- Barn owl distribution and productivity
- Development of a habitat model for nesting barn owls
- Bald eagle research and management
- Trumpeter swan restoration program
- Osprey reintroduction research
- Sandhill crane restoration and monitoring
- Dispersal, behavior, and habitat use of non-breeding sandhill cranes
- Ohio sandhill crane migration study
- Common tern nesting colony protection and development
- Statewide bird conservation planning and coordination
- Research on needs of early and late successional habitat birds
- Radio-telemetry study of migrating birds in fragmented forests near Lake Erie
- Monitoring and demographic modeling of grassland birds on strip-mined lands
- North American breeding bird survey
- Ohio breeding bird atlas
- Ohio winter bird atlas
- Wetland habitat avian diversity surveys

- Importance of emerging aquatic insects to spring migrating landbirds
- Conserving birds in urbanizing landscapes
- Forest conservation opportunity area songbird monitoring survey
- Forest habitat attributes effect on abundance of stopover migrant land birds

Conservation projects focused on mammals
- Monitoring the status of bobcats
- Bobcat population genetics
- Protection and management of Indiana bat hibernacula
- Ecology, movement and site fidelity of black bears in Ohio
- Mammalian diversity in Ohio

Conservation projects focused on reptiles
- Captive propagation and augmentation of eastern plains garter snake populations
- Radio-telemetry study of Lake Erie water snakes
- Lake Erie water snake recovery plan implementation
- Ecology, status, conservation, and management of timber rattlesnakes
- Radio-telemetry study of eastern massasauga rattlesnakes
- Conservation genetics of eastern massasauga rattlesnakes
- Survey and distribution of eastern massasauga rattlesnakes
- GIS-enabled modeling of habitat suitability for state-listed eastern massasauga rattlesnakes in Ohio

Conservation projects focused on amphibians
- Distribution and status of Ohio frogs and toads
- Seasonal, temperature, and wetland correlates with ranid frogs
- Long-term salamander monitoring
- Response of salamanders to forest management practices in Ohio's southeastern oak-hickory forest

Conservation projects focused on butterflies
- Karner blue butterfly reintroduction
- Long-term butterfly monitoring

Conservation projects focused on mussels
- Mussel conservation, research, and surveys
- Mussel health assessment

Conservation projects focused on fish
- Restoration and protection of Ohio River fish diversity
- Statewide fish inventory and distribution
- Rare stream fishes restoration program

Conservation projects focused on invasive/nuisance species
- Establishment of purple loosestrife control agents
- Management and monitoring of double-crested cormorants

Conservation projects focused on statewide/multi-species issues
- Wildlife diversity database
- Surveys of state-listed terrestrial wildlife
- Conservation genetic approaches to conserving state-listed wildlife species
- Using citizen scientists to monitor frogs, toads, butterflies, salamanders, and birds
- Ohio biodiversity conservation partnership project
- Survey and monitoring of terrestrial species of greatest conservation need

- Wildlife diversity conservation
- Monitoring the impacts of climate change on wildlife and plant species
- Dam removal strategies to benefit aquatic SGCN

2.1 Revising the CWCS

At the time of creation of Ohio's first CWCS, no models, templates, or best practices guides existed to aid in its development. There were few diversity projects in existence, and staff was generally accustomed to dealing with diversity issues within the context of existing fish and wildlife management programs. Little funding earmarked for diversity species had existed prior to that time, and the general feeling was that diversity species benefitted from "sport" species conservation efforts. Putting together a CWCS document that focused exclusively on diversity species seemed a duplication of effort at the time, given how diversity issues had been handled in the past. It is not a surprise that the first CWCS was fit into a template that the Division was experienced and comfortable with. Ohio's 2006-2015 CWCS generally documented plans and processes that were already in place. It was a compendium of existing strategic, tactical, and operational plans, along with a significant amount of historical and statutory authority information. It demonstrated that effective conservation programs were in place, and that the Division understood the value of working with constituents and conservation partners – but probably stopped short of being a roadmap to a more productive relationship between all interested parties in the name of conservation in Ohio.

After 10 years of experience, it is clear that the format of this first Plan limited its utility as a conservation tool for our conservation partners. The original plan contained a tremendous amount of information, but most of that was geared towards wildlife professionals. That fact made it difficult for the average person to pick up the plan and identify a role for themselves in conservation in Ohio.

The goal of this revision is to make the SWAP a tool for all levels of conservationists. Statistics show that although participation in outdoor activities has changed through time, overall interest in the outdoors has not. The public has demonstrated interest in conservation to the point of creating their own organizations (e.g., Audubon, TNC, Ducks Unlimited, Rivers Unlimited, Ohio Bluebird Society) to provide money and effort for species and habitats. Given the financial and human capital available through these organizations, conservation efforts will be more effective if all conservation players are using the same playbook. Ohio's new State Wildlife Action Plan is written with the intent of facilitating conservation roles for all interested, and ensuring that funding and effort are used in concert with statewide priorities and strategies.

Issues experienced by Ohio with the first CWCS were also experienced to varying degrees by other states. In addition, it was clear that more continuity and standardization of action plans among states was going to be necessary to effectively address regional conservation issues. Recognizing this, the Association of Fish and Wildlife Agencies (AFWA) State Wildlife Action Plan Best Practices Working Group, working with the U.S. Fish and Wildlife Service, developed the "Best Practices for State Wildlife Action Plans". Ohio has used this as its primary guidance document for the revision of the original CWCS.

2.2 The Next 10 Years

The mile-high view of the next 10 years under implementation of Ohio's 2016-2025 SWAP consists of four primary themes - building new and strengthening existing partnerships, making progress on priority species and habitats, filling data gaps, and addressing regional conservation issues. Focus on the first three themes will occur largely within the confines of Ohio's borders, and involve conservationists, conservation issues, and conservation actions on a state scale. Theme number four will be addressed at a spatial scale dictated by the species and/or habitat requiring attention, without regard to state borders.

2.2.1 Building New and Strengthening Existing Partnerships

Efforts need to be made to build a stronger conservation coalition in Ohio. All of the conservation "players" need to be identified, as well as the expertise, resources, authority, and mission belonging to each. A plan can then be mapped out that puts each player in the best position to succeed. Conservation actions derive from the SWAP, and each player must be used in the most effective position to contribute to the overall effort. We must work to ensure that Ohio's SWAP is viewed as a state plan rather than state agency plan, and it will be important to promote ownership and buy-in of the Plan.

To make the conservation coalition work, there must be agreement on conservation priorities, direction, and appropriate strategies to get there. There must be better agency communication and cooperation. Missions and authority can (and will) differ, but that won't influence effectiveness if there is agreement to work together and agreement about what is being worked on. This new synergy has to start with leadership at the highest levels. With a sufficient level of consent among regulatory agencies in place, we can then leverage ngo conservationists – giving the conservation movement in Ohio the advantage of the numbers and passion of 11 million residents. With everyone pulling in the same direction, we can make efficient and effective conservation happen.

As recommended in the AFWA Best Practices Guide, some key strategies for partnership building, as well as effectively working with partners are:

- Revitalize and/or develop new Memoranda of Understanding (MOUs) to integrate SWAPs into the initiatives of other agencies. MOUs legitimize and institutionalize the importance of their initiatives, which may otherwise be overlooked due to their nonregulatory nature. Additionally, become familiar with MOUs at the federal level to capitalize on partnership opportunities.

- Cultivate a partnership with the Natural Resources Conservation Service (NRCS). Identify key NRCS staff and engage them in SWAP implementation committees. Participate in NRCS State Technical Committees to encourage the use of NRCS Farm Bill conservation programs to implement SWAP priorities and to influence priority setting in programs such as the Environmental Quality Incentives Program (EQIP), Wildlife Habitat Incentive Program (WHIP), and Healthy Forests Reserve Program (HFRP).

- Develop a familiarity with state Forest Action Plans to coordinate updates, identify common priorities, and find other ways to coordinate the two action plans.

- Develop a communications plan. Identify key constituent groups and audiences, and involvement goals appropriate to each audience. Define communication strategies that will be effective at getting information to, and gathering feedback from, affected groups.

- Host a SWAP Summit with identified stakeholders with goals that include reinvigorating partnerships, sharing information, soliciting input, sharing successes, and/or garnering support.

- Evaluate the state Teaming With Wildlife (TWW) Coalition and assess whether the coalition is meeting state needs – evaluate options for revitalizing the coalition if needed.

2.2.2 Making Progress on Priority Species and Habitats

We need to prioritize species and habitats in the most immediate need of attention. This exercise will involve initial prioritization based solely upon need, and then filtered by things like probability of success, regional status relative to Ohio status, overall contribution in terms of the big conservation picture, and conservation action bang-for-the-buck. Once we are in agreement as to priority, we can utilize our stronger conservation coalition to increase effectiveness and efficiency of actions, and focus them on the most pressing threats to those species and habitats.

2.2.3 Filling Data Gaps

In assessing the status of species and habitats during the development of this Action Plan, the amount of missing information (often basic distribution and abundance information) was significant. Closing those data gaps will take substantial effort. In the next 10 years, effort needs to be directed at identifying and prioritizing data gaps. Basic life history, distribution and abundance, population dynamics, and other aspects of Ohio's SGCN (especially invertebrates) is needed, particularly for those species whose abundance is unknown/low and whose population trend is unknown/declining. Where basic distribution and abundance data is missing, information collection can be maximized by employing our conservation coalition in the form of citizen scientists and other partnerships. As described above, this is an example of matching the expertise and resources of our conservation coalition “players”, with the appropriate facet of an issue needing addressed to contribute to the accomplishment of higher level conservation goals.

Another area in need of work relative to data gaps is habitat mapping. Improving the accuracy and resolution of our habitat maps will improve our ability to assess, monitor, and manage habitats. This kind of data acquisition demands a higher level of expertise than the basic species data discussed above. Identifying all data currently available, and utilizing the best GIS expertise (regardless of where it exists) will be the best way to ensure timely, accurate, and economical maps necessary for future conservation efforts. Working to fill this data gap must be a priority if we are to be able to assess the success of conservation actions aimed at habitats.

2.2.4 Addressing Regional Conservation Issues
The Action Plans developed by the states for 2016 and beyond will be more alike than those from 10 years ago. More consistent SWAPs should improve our ability to identify and agree upon pressing regional species and habitat issues. From there it becomes a matter of improving our ability to communicate and cooperate on regional scale. Partnerships with Landscape Conservation Cooperatives (LCCs) can help bring additional partners together to identify shared priorities and identify landscape-level actions. Through the LCCs work with neighboring state fish and wildlife agencies can be facilitated. Cooperation with neighboring agencies with similar SGCN and habitats will allow the pooling of resources for regional conservation efforts including problem identification, funding, mapping, and tracking the effectiveness of conservation actions. In addition, we need to work with our international conservation partners and conservation organizations to address the conservation needs of SGCN and habitats at a broader geographic scale.

In summary, the experience under implementation of Ohio’s initial CWCS has been a productive one. Knowledge gained on a number of fronts positions us well to face the conservation challenges of the next 10 years. We are better informed on a number of ecosystem-related issues, and we are also more aware of where we need better information. The pieces are in place to accomplish more under this Action Plan than we did under the previous one. In the end however, the amount of progress made on species and habitats will be directly related to our ability to elevate the value and priority of conservation in the hearts and minds of all Ohioans.

Chapter 3. Monitoring, Evaluation, and Adaptive Management

3.0 Introduction

Adaptive management will be the cornerstone of the Action Plan in terms of conservation actions and the threats they are focused upon. Actions in the Plan are developed using the best information available at the time. As we move forward, data will be collected, new information will be acquired, evaluations will be conducted, and new issues will arise. The process of conducting effective conservation programs is a continuous cycle of implementation, assessment, and adjustment.

Conservation actions identified to abate threats to species and habitats will drive project development. As projects are implemented, progress will be monitored, performance will be measured, and adaptation will occur where necessary. We will work with other public agencies and NGO conservation organizations to coordinate monitoring programs on a statewide basis. This will improve monitoring efficiency by leveraging expertise as well as proximity of personnel and resources to monitoring sites. Stakeholder and partner involvement will also aid data sharing and improvements to monitoring design.

Monitoring and evaluation will be conducted utilizing existing sampling and survey structures, and will be utilized to modify or adjust management activities. New survey or sampling protocols will be developed as needed in order to obtain the best and most useful information to effectively manage species and habitats. As discussed in Chapter 1 under Action Plan Evaluation and Updates, project reporting requirements necessitate an annual evaluation process, and the operational planning process facilitates annual project updates and modifications.

Proper monitoring is key to our ability to track the success of conservation actions, ensuring the most efficient and effective use of staff, funds, and resources. As conditions change (e.g., land use patterns, climate change, population trends, new data and information acquired), adaptive management and implementation of the conservation actions identified in Chapter 6 (Ohio's Habitats) will allow us to respond appropriately. Adaptive management has been built into the Division's Comprehensive Management System since inception (See Chapter 1 under Action Plan Evaluation and Updates).

This chapter describes how Ohio will use tools for information management and conservation planning to track the implementation and effectiveness of conservation actions. These tools are described in the Measuring the Effectiveness of State Wildlife Grants (AFWA 2011) final report, and the national Wildlife Tracking and Reporting Actions for the Conservation of Species (*TRACS*) database funded by U.S. Fish and Wildlife Service. The framework starts with a specific conservation action, then a basic results chain is created linking the action to objectives, relevant threats, and targets (habitats and species). Appropriate indicators and measures are determined for each step in the chain, and monitoring data are used to track and populate those indicators. Information about the results chain, indicators, and measures is then entered into the *Wildlife TRACS* database. Effectiveness Measures is the process, and *TRACS* is the IT system used for reporting and tracking. Measurement of indicators for each step in the results chain provides the essential information needed for evaluating the effectiveness of conservation actions. Conservation actions will be monitored and measured throughout the 10-year implementation of Ohio's Action Plan.

3.1 State Wildlife Grants Effectiveness Measures Project

In an effort to develop an approach for measuring the effectiveness of wildlife conservation activities funded under the USFWS's State Wildlife Grants (SWG) program, the Association of Fish and Wildlife Agencies' (AFWA) Teaming With Wildlife (TWW) Committee formed the Effectiveness Measures Working Group (Working Group) in September 2009. This Working Group included representatives from state fish and wildlife agencies and key conservation partners with expertise in wildlife conservation and performance management.

In 2011, the Working Group released a final report that includes an agreed upon set of effectiveness measures that can be used by states to improve performance reporting under the SWG program. The report recommends a set of common indicators for measuring status, trends, and/or effectiveness of 11 categories of generic conservation actions that are most commonly funded with SWG dollars. These actions include:

- direct management of natural resources
- species restoration
- creation of new habitat
- acquisition/easement/lease
- conservation area designation
- environmental review
- management planning
- land use planning
- training and technical assistance
- data collection and analysis
- education

The Effectiveness Measures process demonstrates that data can be collected in large part by taking advantage of existing datasets, integrated into the project management and reporting cycle currently used, and implemented. The Working Group report includes sample templates and forms that can be used for reporting the results of conservation activities, as well as a discussion of the specific methods by which these reporting methods could be incorporated into in the USFWS's grants management database. The report can be found at: www.fishwildlife.org/files/Effectiveness-Measures-Report_2011.pdf.

3.2 *Wildlife TRACS*

The State Wildlife Grants Effectiveness Measures process can utilize the *Wildlife TRACS* database designed by the USFWS to record information about conservation activities. *Wildlife TRACS* is intended to track and report project outputs, effectiveness measures, and species and habitat outcomes. *Wildlife TRACS* can also be used to track longer term outcomes for species and habitats, beyond the types of short-term output measures commonly tracked by funding agencies (e.g., number of publications, number of workshops, number of people contacted). The *Wildlife TRACS* database includes classifications of conservation actions and threats, based in part on the classifications developed jointly by the International Union for Conservation of Nature (IUCN) and the Conservation Measures Partnership (see Salafsky et al. 2008). More information about *Wildlife TRACS* can be found at: https://tracs.fws.gov/learning

3.3 Ohio's Monitoring Framework

Inventory and monitoring information on species and habitats is collected by numerous government (federal and state), academic, and conservation organizations in Ohio. Citizen science programs are also utilized to augment monitoring capacity where appropriate and practical. In concert with species and habitat monitoring recommendations in this Plan, efforts need to be made to identify, inventory, coordinate, and catalog the data being collected by all entities in the state.

Efficiency and effectiveness of monitoring efforts can be improved by taking a mile-high view of the data collection landscape in Ohio, and then taking steps to avoid duplication of effort, improve cost effectiveness of efforts, and focus efforts on priority conservation issues. Time, money, and resources can be saved by working in a coordinated fashion – particularly within the state and region. Increases in the amount and coverage of data collected can be leveraged in the implementation and evaluation of conservation actions from the Action Plan. Adaptive management will be facilitated by the amount and coverage monitoring data collected.

Ohio uses a number of monitoring programs to track the status and trends of species in the state, as well as the condition and location of key wildlife habitat areas. In addition to these status/trend measures, some of these monitoring programs also track the effectiveness of wildlife conservation activities. Ohio's monitoring framework considers the appropriate geographic scale to evaluate the status of species and the effectiveness of conservation actions. Implementation of the 2005 CWCS involved monitoring at a variety of geographic scales, including local, state, regional, national, and international, as appropriate to plans and programs.

Local trends revealed by monitoring activities are viewed in the context of multiple scales, both spatially and temporally. The status of species and habitats is best ascertained by considering range and distribution, without regard to state boundaries. At minimum, ecoregion scales are be used to gain an accurate assessment when trying to determine degree of imperilment. Similarly, assessing trends utilizes the broadest temporal look that legitimate data allows.

During the life of the original 2005 CWCS, Ohio was involved with a number of regional projects to address conservation and monitoring of SGCN species and their habitats. Examples include collaboration on Ohio River projects with the USFWS, Ohio River Fisheries Management Team (ORFMT), and Mississippi Interstate Cooperative Resource Association (MICRA), and on Lake Erie projects with regional state and federal agencies and the Ontario Ministry of Natural Resources (OMNR) through the Joint Strategic Plan for the Management of Great Lakes Fisheries and Lakewide Management Plan (LaMP). Ohio's monitoring framework includes the use of standardized regional protocols such as the Breeding Bird Survey, Partners in Flight, Upper Mississippi River and Great Lakes Region Joint Venture, North American Bat Monitoring Program, and regional LCC's. Use of such standardized protocols ensure that Ohio's data will be compatible with regional and national conservation efforts.

Statewide projects are managed by the Division, often in cooperation with a multitude of other partner organizations (see Chapter 2 Ohio's First 10 Years of CWCS Implementation). Data from these projects as well as process-related information from individual projects (e.g., number of meetings held, number of reports produced, number of people contacted through outreach efforts, number of plans developed, etc.) will be reported to the USFWS and tracked using the Wildlife TRACS database.

Ohio's monitoring framework also incorporates short, mid, and long-term time scales (short-term, interim and long-term) to monitor the status and condition of SGCN and their habitats, as well as effectiveness of conservation actions. Short-term monitoring measures the degree to which conservation actions have been implemented. Mid-term monitoring evaluates the degree to which conservation actions were successful in improving the status and/or condition of SGCN and key habitats – and facilitates adaptive management. Long-term monitoring tracks spatial and temporal abundance and condition of SGCN and key habitats.

We intend to follow AFWA Best Practices recommendations to ensure that monitoring activities use the appropriate geographic scale to evaluate the status of species or species groups and the effectiveness of conservation actions. Examples of AFWA recommendations that we intend to implement are:

- Assess populations, habitats, and conservation action effectiveness at multiple scales.

- Collaborate with other agencies and conservation partners in established, long-term, multistate efforts to contribute to, and gain from, broader spatiotemporal perspectives of status and trends. Examples could include the North American Breeding Bird Survey, Audubon Christmas Bird Count, Xerces Society Fourth of July Butterfly Count, and North American Amphibian Monitoring Program.

- Coordinate in-state habitat monitoring with regional habitat condition data available from groups such as the USDA Forest Service and National Fish Habitat Partnership

- Participate in research and conservation alliances such as Landscape Conservation Cooperatives (LCCs), international bird conservation groups, and regional agency associations.

3.3.1 Species Monitoring

In order to prioritize species of greatest conservation need within taxa groups, we chose to use a scoring system developed by Millsap et al. (1990) to determine a numeric rank conservation status for each species. This scoring system was developed to rank species according to biological vulnerability, extent of current knowledge of population status, and management needs. Primary components of the system are biological scores, action scores, and supplemental variables.

Biological scores were calculated by totaling individual scores for 7 variables that included: population size, population trend, range size, distribution trend, population concentration, reproductive potential, and ecological specialization. The way this system works, higher biological scores for a given species indicate a greater probability of extirpation. As a monitoring tool, changes in biological scores for a given species can be used as an indicator of species status as well as a representation of the effectiveness (or ineffectiveness) of conservation actions. Further, changes in the scores for each of the 7 variables that comprise the biological score can be used to explain what population metric is primarily responsible for biological score changes. By monitoring changes in biological scores and their individual components (7 variables), adaptive management can occur by focusing conservation actions where they are most needed.

Action scores are the total of individual scores for 4 variables that include knowledge of distribution in Ohio, knowledge of population trend in Ohio, knowledge of Ohio population limitations, and ongoing management activities in Ohio. In this system, higher action scores for a given species indicate a lower level of knowledge about the species itself, and a low (or absent) level of management activities focused on the species. Monitoring of action scores can help point out when knowledge is lacking and research is needed, or when management activities are lacking. Action scores will be indicators of the degree of conservation action implementation. In addition, monitoring the individual component (4 variables) scores can illuminate the specific aspects responsible for low or high composite scores, and thus future focal points for research and management activities.

The Florida scoring system we have chosen to use is the primary metric by which species status will be monitored. As the SGCN taxa group ranking list is evaluated and updated, changes in scores will be used to assess the effectiveness of, and degree to which conservation actions have been implemented. At the same time, as more data is collected for species not currently included on Ohio's SGCN lists, conservation status scores can be calculated, and the scoring system can then function as a monitoring tool for these species.

Ohio utilizes a variety of databases to store species information such as population distribution, size, and trends. As action-based conservation projects are implemented, these databases will be updated with data generated by these projects. Efforts will be focused on database compatibility as we move forward. Standardization will facilitate linkage of individual databases, which will make species monitoring efforts more efficient and effective. A list of the primary databases used in Ohio can be found in Chapter 4 Species of Greatest Conservation Need.

Monitoring will be conducted at appropriate biological levels including individual species, species guilds, or natural communities. Monitoring data will be evaluated at appropriate intervals and be used to refine protocols or develop new ones that will be more effective. Basic species metrics from these monitoring programs will be maintained by project leaders and submitted to the USFWS *TRACS* database. Also (as discussed in the section above) we will support and participate in partners plans that have recommended or identified standardized monitoring actions for broader spatial consistency (e.g., USFWS, Partners In Flight, Partners in Amphibian and Reptile Conservation, Upper Mississippi River and Great Lakes Region Joint Venture).

Marshbird surveys are an example of long term monitoring. In 1996, the Ohio Department of Natural Resources – Division of Wildlife, in cooperation with The Ohio State University implemented the wetland breeding bird survey (WBBS). The WBBS was one of the pioneer techniques in the country to detect marshbirds; however, the routes and survey points were not picked randomly so it was not possible to make an inference about marshbird abundance for the state. In 2011, the Division modified the WBBS to conform to the National Marshbird Monitoring Protocol (NMMP) so that Ohio's marshbird numbers could be used with other states to more adequately determine the status of marshbirds in the Mississippi Flyway. Points were picked randomly to allow for better inference regarding marshbird abundance in the state. Since 2011, 6 – 9 routes in some of the major wetland areas in the state (e.g. Killbuck Wildlife Area, Killdeer Plains Wildlife Area, and Magee Marsh Wildlife Area) have been surveyed annually. The routes are surveyed 3 times each breeding seasons from May to June. Targeted species are the state-endangered King Rail, American Bittern, Sandhill Crane, and Black Tern, the state-threatened Least Bittern, and the following state species of concern: Sora, Virginia Rail, and Marsh Wren. Pied-billed Grebe, American Coot, Willow Flycatcher, Swamp Sparrow, Common Gallinule and Wood Duck are also surveyed.

In cases where not enough information exists to monitor a species or group, or monitoring protocols have not yet been developed, this need is reflected in conservation actions that address information needs. This is true for some taxa groups (especially invertebrates) for which standardized protocols need to be developed, and where baseline data do not exist to form the basis of a monitoring protocol. In these cases, these overarching taxa needs are described in Chapter 4 under the appropriate taxa.
The status and trends of individual SGCN will be tracked utilizing existing databases (for example, Ohio Natural Heritage Database, Division's Wildlife and Fisheries databases). These databases include species occurrence records for flora and fauna that occur in Ohio, as well as protection status (federal and state). The Division's wildlife and fisheries databases are utilized by agency personnel as well as researchers under contract with the Division. The Natural Heritage Database can be accessed by anyone doing research and/or scientific work in Ohio (http://wildlife.ohiodnr.gov/species-and-habitats/ohio-natural-heritage-database). The Division's scientific collection permit system is tied into this database. For a researcher to renew their permit each year, they must submit the previous year's data for inclusion into the Natural Heritage Database. The database includes information from all Ohio lands without regard to protection status or ownership. The database is a clearinghouse and contains data collected by ODNR personnel, other state agency researchers, academics, and the general public.

3.3.2 Habitat Monitoring
Habitat monitoring involves both quantitative and qualitative aspects. Geographic Information Systems (GIS) have made it convenient to monitor land cover and habitat types on a landscape scale. However, most GIS systems in use do not contain all of the data layers necessary to function as a qualitative assessment tool. A goal of this Action Plan going forward needs to be to develop a habitat monitoring system that integrates sufficient data layers to coordinate and assess the success of conservation actions at the ecosystem level.

Scenic rivers, natural areas, wildlife areas, state parks, national forests, national wildlife refuges, county and metro parks, and lands owned by non-government conservation groups form the foundation of protected high-priority lands in Ohio. Additional habitat is periodically added to these areas through direct land acquisition. Habitat is also protected through incentive programs like the Conservation Reserve Enhancement Program and Conservation Reserve Program, and multiple easement programs for grassland, forest, and wetland habitats.

On a landscape scale, monitoring of habitats can be conducted by assessing changes in acreage of these protected lands. Implementation of habitat conservation actions from the Action Plan would be expected to produce increases in the amount of protected lands. Area increases provide a general quantitative assessment. For extremely small, fragmented, or rare habitats, a more detailed assessment will be necessary. Percent change in habitat amount however, is not always the best metric for assessing the success of conservation actions.

The quality of habitat is the other side of assessment of conservation actions. For some habitats, quantity does not necessarily rank above quality. A "no net loss" program that equates 10 acres of contiguous habitat with 10 one-acre habitat fragments will not provide a true picture of habitat status and function. Conservation actions in the Plan will focus on the condition of habitats as much as the percent change in area. Habitat quality assessment criteria need further development and refinement going forward in order to produce performance metrics that can be employed state and region wide.

Monitoring changes in habitat quantity with GIS, and habitat quality with appropriate metrics will indicate the success of Plan actions as well as the degree of action implementation. Work remains to be done on developing a GIS database that improves spatial and temporal components, in addition to adding habitat quality and species information. Consideration will be given to adding additional layers such as conservation threats and related actions that have been implemented. These additional data layers will significantly increase the utility of GIS as a monitoring tool for species, habitats, and conservation action effectiveness. A centralized system that could be accessed and updated by all conservation partners would contribute greatly to the robustness of the database.

Monitoring of habitats will be accomplished primarily through existing monitoring programs. They are the primary means for monitoring the distribution, condition, and status of key wildlife habitats identified in Ohio's Action Plan. Evaluating the success of conservation actions aimed at protection and improvement of key habitats will be accomplished through these monitoring programs. Basic habitat metrics will be maintained by project leaders and submitted to the USFWS *Wildlife TRACS* database.

Examples of habitat monitoring activities in Ohio include the Division's Fish Management stream survey program, Wildlife Management's land inventory and cover mapping projects, Ohio Environmental Protection Agency's statewide biological and water quality monitoring program, the Ohio River Sanitation Commission's (ORSANCO) Ohio River monitoring program, the Division sponsored Amphibian Habitat monitoring program, and various other habitat monitoring programs conducted by ODNR divisions.

Another example of habitat monitoring is the recently completed forest inventory of Division of Wildlife's Wildlife Areas. Oak-hickory is the dominant forest type and provides an important wildlife food resource in Ohio. However, an analysis of tree species composition by diameter class reveals a lack of oak and hickory, and a predominance of shade-tolerant species such as red maple, in smaller tree diameter classes (Widmann et al. 2009). The virtual absence of oak regeneration has been attributed to fire suppression and silvicultural practices that favor shade tolerant species and inhibit oak establishment. Maintaining oak-hickory forest types on publicly-owned lands will be critical to provide habitat for diverse and abundant wildlife populations. SILVAH (short for Silviculture of Allegheny Hardwoods) Oak is a forest management decision support tool developed by the USDA Forest Service that helps determine management needs for oak regeneration. It includes overstory, understory and other site variables in the analysis of future desired stand conditions and for making prescription recommendations. It will guide the Division on restoration, maintenance, and enhancement of these habitats. The Division recently collected data on more than 25,000 acres of forests on Wildlife Areas in a SILVAH Oak compatible format for subsequent analysis. Monitoring the forest habitat through time and adjusting management practices to support oak communities will help conserve Ohio's diverse wildlife.

Long-term monitoring of the key habitats will be accomplished using existing and new geographic information system (GIS) programs. A need to develop updated GIS systems has been identified (above). Expanding current programs such as updating the existing Ohio Aquatic GAP, adding a terrestrial GAP, and coordinating with other landscape level mapping projects would enhance the understanding of key habitats in a regional context.

At the state and local levels periodic updates of land use and land cover will allow the extent, distribution, and condition of habitats to be monitored as conservation actions and SWG projects are implemented. Mapping and monitoring of rare natural communities and habitats remains a statewide need. Specific areas where additional efforts are needed will be identified and incorporated as the SWAP is updated.

3.3.3 Addressing Data Gaps

The limited resources (funding, personnel, time) available to sustain monitoring programs makes it impossible to monitor many aspects of the environment relevant to fish and wildlife conservation efforts. Given that, high-priority target areas must be identified where additional data would facilitate the development of management strategies for Ohio's fish and wildlife resources. Chapter 4 and Chapter 6 both include high priority data gaps identified through the SWAP revision process. Developing monitoring programs to address high-priority gaps will be critical going forward to provide the species and habitat information necessary to implement effective conservation actions.

3.3.4 Effectiveness of Conservation Actions

The purpose of tracking effectiveness measures is to obtain the information necessary to adaptively manage species and habitats in the state. Ohio is committed to an adaptive management approach to fish and wildlife conservation. The next sections of this chapter describe a conceptual model for the SWAP with corresponding results chains, and illustrate how the SWG effectiveness measures function within an adaptive management context. The effectiveness of conservation actions described in Ohio's Action Plan will be measured using a set of standardized effectiveness measures that have been developed by AFWA and described in their 2011 *Measuring the Effectiveness of State Wildlife Grants: Final Report* (AFWA 2011). Actual values for these measures will be entered into the USFWS *Wildlife TRACS* database, and comparisons of the values of these measures over time will be used to establish the degree of effectiveness of individual projects as well as broader conservation programs. Terms and standard definitions are derived from Margoluis and Salafsky (1998) and Salafsky et al. (2008).

Performance of conservation actions will be measured at the species, habitat, and ecosystem levels. Additionally, performance will be measured at the threat level in terms of success in abating the conservation threats described in the Action Plan. Actions will be evaluated annually as part of the project performance report process described in Chapter 1 (Action Plan Evaluation and Updates section). Actions will also be evaluated during the Plan 5-year review cycle in terms of their degree of implementation. As mentioned earlier, conservation status scores for SGCN, changes in quantity and quality of habitats, and changes in the amount of data collected on species and habitats will serve as key evaluation metrics. Examples of performance measures for conservation actions could include:

- Increased proportion of development projects that are appropriately designed and located
- Reduced rate of conversion of natural habitats
- Increased landowner participation in wastewater/fertilizer applications control programs to control urban nutrient loads
- Increased agricultural community participation in riparian buffer programs, nutrient runoff reduction programs, and topsoil conservation programs
- Increased number of stream/riparian habitat miles that meet appropriate habitat and water quality standards
- Decreased number of acres impacted by invasive plants
- Decreased number of newly introduced invasive species

3.4 Conceptual Model for Ohio's State Wildlife Action Plan

Conceptual models are the foundation of adaptive management approaches for species and habitat conservation. Models illustrate a "theory of change" for a project – that is, the causal pathways by which managers believe that a project will achieve its desired results. Although there are many different kinds of conceptual models, Margoluis and Salafsky (1998) introduced a simple form of box-and-arrow diagram that shows causal linkages between the basic conservation elements for an individual project, including targets, threats, and conservation actions. While originally created as a tool for developing individual conservation projects, conceptual models can also be developed for a larger conservation program. The following conceptual model (Figure 6) for the SWAP illustrates the linkages between the core plan elements, including species and habitats, threats, and actions. This conceptual model is intended to be a generalized representation of the interactions between the plan elements. Not all of the threats and actions shown in the diagram will apply to every species or habitat. What the diagram shows is the set of possible threats and actions that could affect a particular species or habitat.

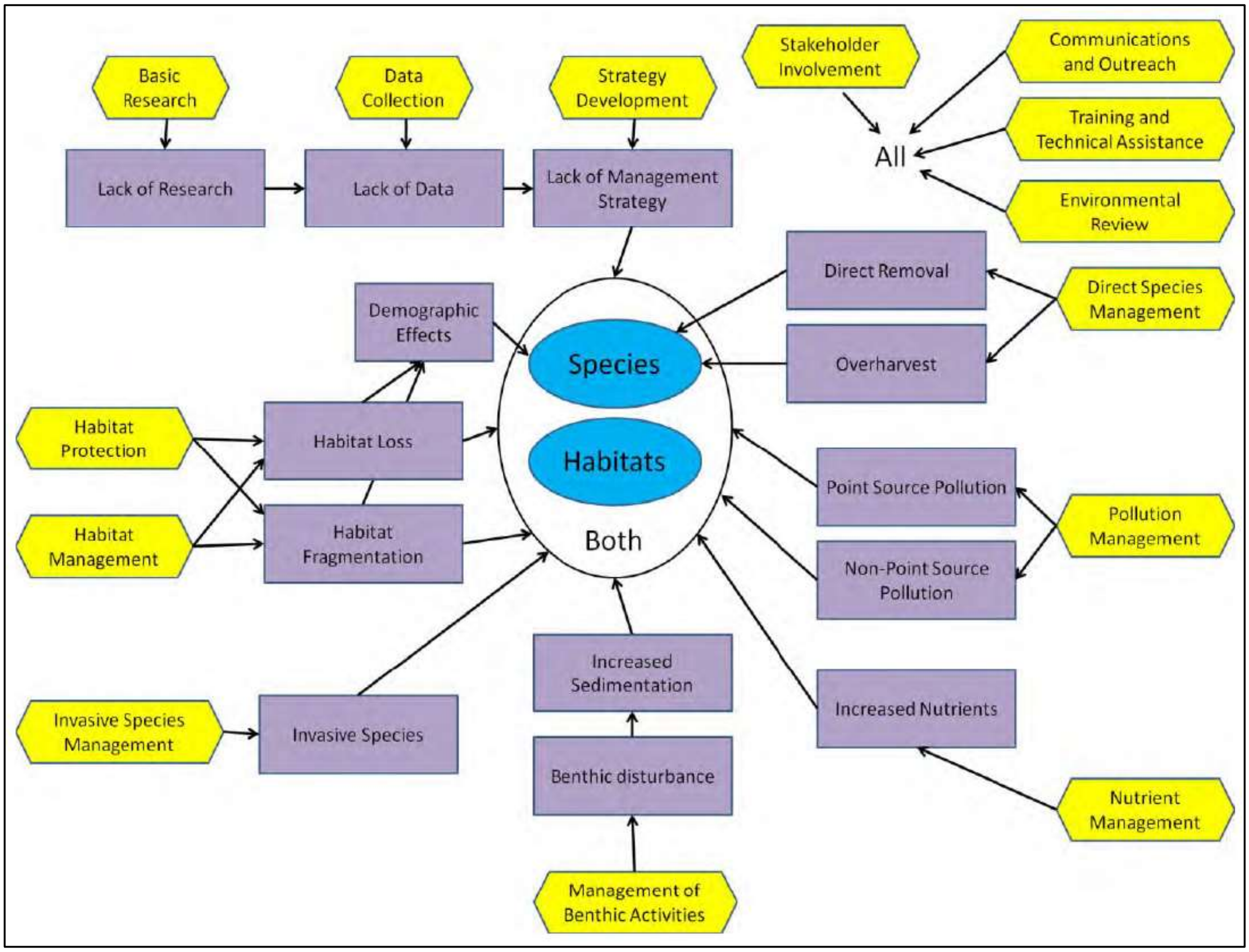
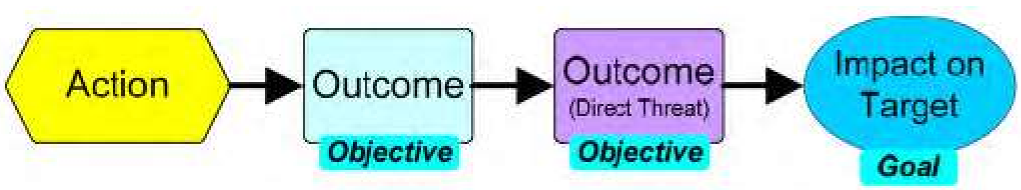


Figure 6. Conceptual model illustrating the linkages between Action Plan elements. Conservation actions = yellow hexagons; threats or information needs = lavender boxes; targets = blue ovals. Arrows indicate the logical causal linkages between the elements. Arrows between actions and threats show that the action is intended to abate the threat. Arrows between threats and targets show that the threat affects that target.

3.4.1 Results Chains

The conceptual model above can be used to construct a set of results chains for each of the different conservation actions (yellow hexagons). The results chain below shows the logical linkages between a conservation action and the target at which the action is directed. Results chains also include threats, in cases when the conservation action is intended to reduce a specific threat, and may also include intermediate outcomes between the action and its intended benefits to the target. Sample results chain:



Fully developed results chains incorporate indicators for each of the individual elements (actions, threats, outcomes, and targets). A specific measure is then identified for each indicator, showing how exactly that indicator will be measured over time. Data from existing monitoring programs can be used to track the values of these measures over time. Reviewing data from monitoring programs can help managers adjust their management strategies to adaptively manage species and their habitats.

From this Action Plan, the Division and its partners will develop project-specific results chains for the individual conservation actions selected for implementation. At the same time, we will use existing results chains that have been developed by AFWA to identify potential indicators and effectiveness measures for the categories of conservation actions in the conceptual model presented above.

3.4.2 Results Chains and Effectiveness Measures for Conservation Actions

Results chains were originally created as tools for developing an individual conservation project. However, It is also possible to develop generalized results chains that show the relationships between the basic classes of elements (actions, threats, outcomes, targets) for particular types or classes of conservation projects. These generalized results chains are useful in identifying indicators and measures that can help to track progress towards conservation goals across a suite of similar projects. If projects are tracked using identical or compatible indicators and measures, the information about project accomplishments can then be “rolled up” across the suite of projects in order to report broader progress to funding agencies and the general public.

AFWA developed sets of generalized results chains for common conservation actions described in the SWAPs. The AFWA report on SWG Effectiveness Measures (AFWA 2011) also included a set of recommended indicators for each of a set of generalized results chains. Because these indicators are intended to track progress on conservation projects, they are also known as “effectiveness measures” or “performance measures.” These effectiveness measures developed by the AFWA SWG Effectiveness Measures Working Group will be tracked for classes of conservation actions. These measures will then be reported and tracked as part of Ohio’s regular reporting to the USFWS via the *Wildlife TRACS* database.

3.4.3 Scenario: Shovelnose Sturgeon Reintroduction

The following example describes a proposed approach for Ohio’s framework for monitoring and effectiveness measures.

The shovelnose sturgeon is a large river species that prefers sand and gravel substrates with current. Shovelnose sturgeons have not been seen since the mid-1900’s and are listed as endangered in Ohio. Shovelnose sturgeon were once common in the Ohio River and its larger tributary rivers. They were reportedly abundant upstream as far as Washington County (Ohio) until about 1910.

The damming of large rivers has contributed significantly to this species’ decline by blocking access to ancestral spawning areas and greatly reducing its required habitat. The lack of pollution laws and increased siltation from changing land use patterns in the watershed also negatively impacted habitat and its primary food source of mussels and snails.

Priority conservation actions that have been identified to improve the conservation of shovelnose sturgeon and their riverine habitat include: (1) improve water and habitat quality by supporting riparian and habitat restoration projects; (2) supporting management plans that improve land-use practices in the Scioto watershed; (3) identification of a genetically similar brood source and development of techniques for production of large numbers (1000’s) of advanced fingerlings; and (4) reintroduction of fingerling shovelnose sturgeon to suitable habitat sites on the lower Scioto River.

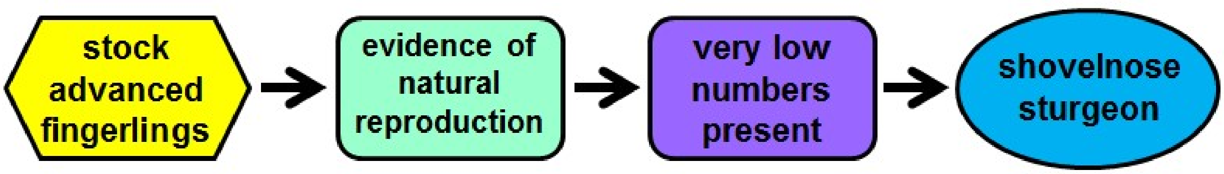
Priority research needs are to: (1) conduct a comprehensive survey in the lower Scioto River for potential reintroduction sites, and (2) identify a shovelnose sturgeon brood source and develop hatchery production techniques. Products of this research will help fill information gaps to identify potential reintroduction sites, and provide fingerling fish for stocking at those sites.

Key partners to implement these conservation actions include the U.S. Fish and Wildlife Service, Indiana DNR, and Illinois DNR for the collection of brood shovelnose sturgeon. The Division of Wildlife will partner with various land conservation organizations to protect riparian corridor on the Scioto River. The Division of Wildlife will also work with local Soil and Water Conservation Districts to promote best management land-use practices in the Scioto River watershed.

In this example, from the list of priority conservation actions above, we will focus on conservation action #4: *stock advanced fingerling shovelnose sturgeon in an effort to re-establish a self-sustaining population*.

For this example conservation action, a basic results chain which shows the connections between the four basic conservation elements is then developed: action, objectives, threats, and targets. In this example, these elements are defined as follows:

- **Action**: stock advanced fingerling shovelnose sturgeon
- **Objective**: establish a self-sustaining shovelnose sturgeon population
- **Threat**: extremely low (possibly extirpated) remaining numbers of shovelnose sturgeon - below threshold necessary for reproduction
- **Target**: Species = shovelnose sturgeon



For each element in the results chain above, an indicator and a method or measure by which that indicator will be tracked is identified.

AFWA's 2011 report on effectiveness measures for SWGs classifies stocking fish to re-establish a self-reproducing population as "Species Restoration". Recommended indicators and performance measures for projects that involve Species Restoration include the following:

- "Good" overall plan exists for restoring the species
- "Good" restoration plan completed for project site(s)
- Key stakeholders buy-in to plan
- Source population identified and/or propagated
- Species initially restored to sites (short-term)
- Species breeding at restoration sites (medium-term)
- Viability of SGCN improved

For the specific management action (stock advanced fingerlings), the indicator "percent of target number of units that are released" will be measured by tracking the number of advanced fingerling shovelnose sturgeon stocked each year.

For the objective (evidence of natural reproduction), the indicator "percent of sites with restored population successfully breeding" will be measured by conducting annual population surveys of unmarked sub-adult fish which would indicate natural reproduction.

For the threat (very low numbers present), the indicator "percent of sites with restored population" will be measured by conducting annual surveys to track the number of sturgeon per stream mile to assess the success of the stocking efforts.

For the target (shovelnose sturgeon), the indicators "species measures (e.g., population size, reproductive success)" can be measured. Population size will be estimated using mark-recapture techniques. Reproductive success will be measured using annual surveys of unmarked juvenile sturgeon and tracking changes over time.

In order to be able to track changes in these indicators over time, descriptions of the specific measures for each indicator must be established, including units for each measure, and benchmark values for those measures must be determined at the start of the project. In addition to activities involving project participants, other monitoring programs that may provide data on indicator measures should be identified. At the end of the project, basic results chains such as the one in the example above will be used to illustrate how the values of each indicator for the chain changed over the years post-project implementation.

The *Wildlife TRACS* database (specifically *Data TRACS*) will be the project data storehouse, and the project tracking and reporting tool for project partners. It will be the primary communication mechanism to inform the USFWS regarding activities, progress, and achievements. *Public TRACS* will be used to generate summary reports and other information that can be used to demonstrate conservation successes and program efficiency to diverse audiences, including conservation partners, landowners, and policymakers.

This process of measuring the effectiveness of conservation actions is the key to adaptive management, which requires building monitoring efforts into the overall project management cycle. Under an adaptive management approach, a theory of change is developed for each action, and relevant information is collected to evaluate its effectiveness. If the activity provides the expected results, effectiveness measures help communicate that success so others may utilize it. If on the other hand, the action does not work as hypothesized, then problems are identified, and either actions are modified or alternatives are chosen. The key to adaptive management is to learn from successes, informative failures, and useless failures and respond accordingly so programs can become more effective and efficient over time (AFWA 2011).

Chapter 4. Species of Greatest Conservation Need

4.0 Sources of Information

Wildlife species not threatened with extinction, or not managed as game animals, are generally not given sufficient consideration in land-use decisions in the context of large geographic regions or in relation to their actual habitats. Simply creating a consistent spatial framework for storing, retrieving, manipulating, analyzing, and updating the totality of our knowledge about the status of each animal species is a necessary and basic element for preventing the further degradation of biological resources (Covert and Simonson 2007).

The Division of Wildlife acquires information regarding the distribution and abundance of fish and wildlife species through a number of channels described throughout this Action Plan. For example, the Division regularly conducts surveys of reptiles and amphibians, neo-tropical songbirds, butterflies, waterfowl, as well as state-listed species. Aquatic species are surveyed similarly. For example, the Division has implemented an annual sampling/survey schedule on all inland waters to ascertain fish and aquatic wildlife populations. In addition, when necessary, both terrestrial and aquatic species are sampled or surveyed by third parties such as universities, private consultants, non-governmental organizations, and individuals recognized as species experts by the Division. This arrangement assures that the Division routinely obtains the most current and reliable information to make the best management decisions for Ohio's wildlife resources.

Information regarding the distribution and abundance of terrestrial and aquatic wildlife species for this Action Plan was assembled through a number of channels, beginning with the SGCN list from our 2005 CWCS (Ohio's Action Plan for 2005-2015). Data from surveys conducted since the completion of the 2005 CWCS were also included. Routinely conducted surveys by the Division of Wildlife were combined with a vast amount of data collected by agencies such as the US Fish and Wildlife Service (USFWS), US Geological Survey (USGS), US Environmental Protection Agency (USEPA), Ohio EPA, and Ohio Department of Natural Resources (ODNR) divisions (Parks, Natural Areas, Soil and Water, Forestry), as well as universities, non-governmental conservation organizations, and private consultants. Examples of sources of species information used to determine SGCN lists include:

Literature

- Ohio Breeding Bird Atlas
- Salamanders of Ohio Atlas
- Amphibians of Ohio
- Ohio Crayfish and Shrimp Atlas
- Mammals of Ohio
- The Fishes of Ohio
- The Freshwater Mussels of Ohio
- Annual *Ohio Wildlife Population Status Report*
- Literature Cited section of this Action Plan

Databases

- Ohio Natural Heritage Database
- Division of Wildlife's Wildlife Diversity Database
- Division of Wildlife's Fisheries Database
- Ohio ECOS
- USFWS National Wetlands Inventory
- USFWS Endangered Species
- NatureServe *Explorer*
- IUCN Redlist
- Butterflies and Moths of North America
- North American Breeding Bird Survey

- Ohio Wetland Breeding Bird Survey
- Ohio Frog and Toad Call Survey
- Longterm Butterfly Monitoring Survey
- Ohio Odonata Survey

Non-government Organizations
- The Nature Conservancy – Ohio Chapter
- Midwest Biodiversity Institute
- Ohio Biological Survey, Inc.
- Ohio Lepidopterists
- Ohio Odonata Society
- The Ohio State University

State/Federal Agencies
- Ohio EPA
- USEPA
- USFWS
- USGS
- USACOE
- ORSANCO (interstate commission)
- ODNR, divisions of Forestry, Natural Areas, Parks, Watercraft, Wildlife

Individuals
- Ryan Argo (fish) ORSANCO
- Dr. Brian Armitage (aquatic insects) Ohio Biological Survey
- Justin Baker (fish) OSU
- Dave Berg (mussels) Miami University (OH)
- Robert Glotzhober (odonates) Ohio Historical Society
- Dr. Mike Hoggarth (mussels) Otterbein University
- Marc Kibbey (fish) OSU
- Dr. Robert Krebs (mussels) Cleveland State University
- Kody Kuehnl (mussels) Franklin University
- Greg Lipps (amphibians) OSU
- Zac Loughman (crayfish) West Liberty University (WV)
- Larry Rosche (odonates) author
- Dr. Kristin Stanford (reptiles) OSU
- Nate Tessler (fish) ODOT
- Roger Thoma (crayfish) Midwest Biodiversity Institute
- Dr. G. Thomas Watters (mussels) OSU
- Doug Wynn (reptiles) species expert
- Brian Zimmerman (fish) OSU

4.1 SGCN List Development and Rationale

With the exception of invasive species, all native and naturalized wildlife species in Ohio were considered for Species of Greatest Conservation Need (SGCN) in this State Wildlife Action Plan revision. To help prioritize conservation efforts for species, we used the scoring system described by Millsap et al. (1990), modified slightly to fit Ohio (see Conservation Status Criteria below). This system had been used in Ohio's original CWCS to determine SGCN lists for terrestrial species, consequently we had experience with it and were comfortable that it met our needs. In addition, AFWA's Best Practices for SWAP's recommended that states use some kind of standardized ranking system to develop SGCN lists. The "Florida system" developed by Millsap et al. was one of the recommended systems.

All species for which there was sufficient information to calculate scores were scored within taxa groups (with the exception of avian species - see Avian Species Scoring below). Teams of internal and external species experts were assembled for amphibian, avian, butterfly, skipper, crayfish, dragonfly, damselfly, fish, mammal, mussel, and reptile taxa groups. Team members from outside of the Division of Wildlife included individuals from the Midwest Biodiversity Institute, Ohio Chapter of the Nature Conservancy, Ohio EPA, Ohio Biological Survey, Inc., The Ohio State University Department of Evolution, Ecology and Organismal Biology, other ODNR divisions, and numerous individuals recognized as species experts.

These teams used the best information available, and the scoring system described below to develop draft conservation status ranks for each species in these groups. These draft SGCN lists were then made available for review to additional species experts, stakeholders, conservationists, and members of the public at the 2014 and 2015 Ohio Wildlife Diversity Conference (~ 950 participants/event), the 2013 and 2014 Ohio Wildlife Diversity Leadership Conference (~ 50 participants/event), and 2014 Wildlife District Open Houses (5 sites around the state). In addition, the draft SGCN lists were posted on the Division's website for review and comment by the public. After combining all available data and considering input from all reviewers, the lists of SGCN were assigned final conservation status ranks which created the conservation priority order for species within each taxa group.

Working towards determining the final SGCN lists, a primary consideration was how much could realistically be accomplished during the life of the Action Plan. Using the complete list of scored species within each taxa group, internal species experts considered how much work could be completed during the 10-year life of the Plan. Projections were made regarding staff levels, available time, available funding, and conservation partner participation during the next 10 years. Based upon these estimates, SGCN lists were truncated for each taxa group. Using the truncated lists, consideration was then given to (1) the percentage of SGCN from the previous CWCS that were included on the new lists, (2) the percentage of state listed species included on the new lists, and (3) the percentage of federally listed species included on the new lists. Our feeling was that the new SGCN lists should contain a high percentage of species from these three categories. To generate the final SGCN lists then, the line of truncation (using conservation status ranks) was adjusted to include at least 75 percent of the species from the three categories above, with a very few minor exceptions. These exceptions were species that either could not be scored, or were SGCN from the 2005 CWCS for which work will continue during the 2015 SWAP.

Conservation Status ranks for species within these taxa groups are contained in tables 4-12 along with rankings for each species, notes describing species listing (if applicable), habitat association, rangewide occurrence, statewide occurrence, and Ohio population trend are also contained in the tables. The species lists, and ranks within lists within each SGCN table are considered working drafts, and as such are open for future discussion and modification.

4.2 Conservation Status Criteria

As discussed above, all native and naturalized wildlife species in Ohio – mammals, reptiles, amphibians, butterflies & skippers (within the terrestrial invertebrates group), dragonflies & damselflies (within the aquatic invertebrates group), fish, mussels, crayfish – with the exception of avians were scored using the Florida Fish and Wildlife Conservation Commission (FWC) Species Ranking developed by Millsap et al. (1990), with slight modifications to fit Ohio (described below).

To determine individual species scores using the FWC Species Ranking system, species experts were brought together to work through the scoring criteria as a team. Teams varied in size (usually 3-8 individuals), but were kept small enough that consensus could be reached on the many scoring criteria used in this system. Because teams were small, selection was based upon level of knowledge of the taxa group being scored, rather than affiliation of the team members. For this reason, some teams did not include Division of Wildlife personnel as scorers. Historical and current distribution and abundance data and extensive knowledge from species experts were used to determine scores for each criterion. Where differences of opinion occurred, discussion ensued, and consensus was reached. When consensus could not be reached, scores were averaged for each criterion across scorers (this was occasionally the case for fish and mussels). Scoring “meetings” were facilitated by Division of Wildlife SWAP Advisory Team members.

4.2.1 Modifications to FWC Species Ranking system

Aside from substituting “Ohio” for “Florida” throughout the document, two minor modifications were made to allow the FWC system to be used for scoring Ohio species.

(1) *Biological Variables* - #3 Range Size – size categories were adjusted to fit the state of Ohio in terms of land area.

(2) *Supplemental Variables* - #5 Harvest of the Taxon – for clarification purposes, the word “collected” was added to “harvested” so that each scoring choice read “harvested/collected”. Most native wildlife species in Ohio are not harvested, but many are collected.

4.2.2 Conservation Status and Numeric Ranks in SGCN Tables

In order to prioritize species of greatest conservation need within taxa groups, we chose to use a scoring system developed by Millsap et al. (1990) to determine a numeric rank conservation status for each species. This scoring system ranks species according to biological vulnerability, extent of current knowledge of population status, and management needs. Primary components of the system are biological scores, action scores, and supplemental variables. A detailed description of these components is presented in Chapter 3 Monitoring, Evaluation, and Adaptive Management.

The score from which conservation status (numeric rank in our SGCN tables) is derived is the sum of the biological score and action score for each species. As the Florida system functions, higher biological scores for a given species indicate a greater degree of imperilment. Conversely, lower action scores for a given species indicate a higher level of knowledge about the species itself, and a higher level of management activities focused on the species.

Species that score high in the biological and action categories have the highest conservation rank in our SGCN tables. High biological and action scores are reflective of species that (1) have a higher degree of imperilment, and (2) about which our knowledge of, and management activities directed towards - are lacking. Species which score low in both biological and action categories rank towards the bottom of our SGCN tables. In this case, degree of imperilment is low, and our knowledge about and management of the species is high. Species in the middle portion of the SGCN tables are there because they had high biological scores coupled with low action scores, or low biological scores coupled with high action scores. The second scenario here (low biological scores/high action scores) can cause listed species to rank lower in the SGCN tables than would be expected if the reader interprets the tables only as a measure of degree of imperilment.

4.2.3 Avian Species Scoring

As mentioned above, avian species were the one taxa group that was not scored using the Florida system. Attempts to use the Florida system for avian species failed because consensus could not be reached on many of the scoring criteria. Where other taxa group scoring teams were able to work out differences in such cases, the avian scoring group could not. A point was reached where we were forced to develop a system of our own to determine avian SGCN. That system was a weighted matrix that we used to identify the native and naturalized Ohio breeding avian species for prioritizing future conservation efforts. The matrix included an assessment of the following:

- the status of the species: Endangered, Threatened, Species of Concern, Species of Special Interest, Extirpated (scoring point values were Endangered = 3, Threatened = 2, Species of Concern = 1)
- the species ability to be self-sustained within designated conservation opportunity areas (COA) (scoring point values were 1 point for each COA (maximum of 10 possible points))
- species conservation status in the 2010 Ohio Bird Conservation Plan: Highest, High, or Moderate (scoring point values were highest = 3, high = 2, moderate = 1)
- no points were assigned to species identified as viable and broadly distributed in Ohio

4.3 Ohio's Species of Greatest Conservation Need
Ohio's 405 SGCN include species from the taxa groups mammals, birds, reptiles, amphibians, terrestrial invertebrates, aquatic invertebrates, fish, mussels, and crayfish (Table 3). In the case of invertebrates, these groups are represented by thousands of terrestrial and aquatic species for which varying degrees of data exist, and statutory authority varies. For these reasons, we were only able to calculate scores (and thus conservation priority ranks) for dragonflies, damselflies, butterflies, and skippers. However, there were some species that in our opinion needed to be included on SGCN lists, but for which no scores could be calculated. Our opinion was based on local knowledge as well as NatureServe and IUCN Red List information. These species were added to both the aquatic and terrestrial invertebrate SGCN lists, with notation indicating that scores could not be calculated at this time.

The majority of species on the following SGCN lists are species that have little or no dedicated funding. Most of these species have conservation needs that are not funded through the Endangered Species Act, and most are not directly funded with hunting/fishing license dollars. This Plan and the funds from the State Wildlife Grants program will provide the backbone for their conservation over the next 10 years.

Table 3. Ohio's SGCN by taxa group and associated number of state listed species.

SGCN		Listed Species Categories				
Taxonomic Group	**Number of Species**	**Endangered**	**Threatened**	**Species of Concern**	**Special Interest**	**Extirpated**
Mammals	30	3	1	16	1	1
Birds	61	11	5	11	3	0
Reptiles	26	5	4	8	0	0
Amphibians	23	5	1	1	0	0
Fishes	64	20	12	5	0	6
Mussels	57	24	4	7	0	9
Crayfishes	15	0	1	2	0	0
Aquatic Invertebrates	76	16	6	1	0	0
Terrestrial Invertebrates	53	10	1	2	1	0
Total	**405**	**94**	**35**	**53**	**5**	**16**

The species in Table 3 are distributed by taxa group in the SGCN tables that follow in this chapter. In the 10-year life of this Action Plan, it would be impossible to focus conservation actions and associated projects directly on each of the 405 species designated as SGCN. Time and resources being limited, will have to be apportioned carefully, and on high priority species and habitats. The conservation needs of the species in the table above vary from reintroduction/restoration on one end of the spectrum, to basic distribution and abundance surveys on the other. In the next 10 years, some species will receive a lot of attention in terms of research and management, and other species will likely receive none. Under Required Element 5, sub-element C calls for the Action Plan to explain why monitoring efforts for a species or group of species in the Plan may not be appropriate, necessary, or possible. For a small number of extirpated species (described in taxa group sections), conditions in Ohio are no longer conducive to their existence here. For the vast majority of the 405 SGCN in Ohio, we consider some kind of conservation effort for to be both appropriate and necessary – however, even under the best of circumstances, not always possible. Given that reality, we need to focus our conservation efforts on maximizing the "amount of good done" to "effort expended" ratio. We need to harness our conservation coalition to maximize coverage, keep our technical people focused on technical issues, utilize our citizen scientist network for the collection of basic information, and promote habitat projects that have the potential to benefit the largest number of species for the effort. As this Plan unfolds from this point forward, it will go without saying that conservation efforts not identified for a species or species group has everything to do with limited time, money, and resources – and nothing to do with whether efforts are appropriate or necessary.

4.4.1 Ohio's SGCN Taxa Groups – history and status of listed species

Given its past geologic and glacial history, Ohio contains a diversity of habitats that support an abundance of terrestrial and aquatic species. Three hundred and eighty terrestrial vertebrate wildlife species are recognized as native and naturalized. In addition, Ohio supports a diverse and abundant aquatic species community represented in part by 173 species of fish, 79 species of mussels, and 21 crayfish species. These numbers are presented as highlights, and are not meant to be a complete listing of species from Table 3 above. Also, these values represent historic numbers of species, and as such are not meant to align directly with SGCN lists.

Unfortunately, Ohio's landscape has changed significantly since settlement, and that has had a profound effect on resident fish and wildlife species. Changes to the quality and quantity of habitats have resulted in the extirpation of some species, and caused various levels of imperilment for others. Aquatic species constitute the majority of Ohio's threatened and endangered species and also represent the majority of extinctions and extirpations. Fish and mollusks, the two species groups for which the most historical information exists, appear to have been impacted the most by changes to Ohio's landscape since settlement.

The following sections describing the history and status of listed species for each taxa group contain only information on species that are considered SGCN in Ohio (tables 4-12). Some listed species from the SGCN tables are not included in these sections due to a lack of sufficient information. As data gaps are filled during the life of this Action Plan, this information will be added and these sections will be updated.

4.4.2 Taxa Group: Mammals

The species assemblage, abundance, and distribution of mammals have changed dramatically since Ohio was settled. This taxa group is extremely sensitive to natural and anthropogenic factors that affect its habitat and impact population levels. Mammals as a group require considerable space to sustain populations due to individual energy needs. In addition, low reproductive rates relative to other taxa groups make them more vulnerable to issues like habitat loss and overharvest, and slower to recover from the population reductions that result. Mammals have been subjected to habitat loss, degradation, and fragmentation since settlement. Their value to humans for meat and fur has been an issue for some species, and other species have been reduced or extirpated in the name of protection of people and livestock. The assemblage that remains in Ohio today is a reflection of all this taxa group has endured in the past, and its ability to adapt to the modern landscape.

Extirpated Mammals

Historically at least 10 mammals have been extirpated from Ohio. Mountain lions and gray wolves were eliminated from Ohio shortly after European settlement by over-trapping, habitat loss, and eradication due to an effort to protect people, livestock, and game species. Elk and bison were killed for their meat and hides. The marten and Canada lynx were probably never common in Ohio, and both species are currently confined to northern U.S. coniferous forests. All of these species were extirpated by the 1850s. The unique habitat and space required by them for survival and reproduction are no longer present in Ohio; thus, reintroduction is not a feasible option. The marsh rice rat, a semiaquatic North American rodent found primarily in the eastern and southern United States, has not been reported in Ohio since historic times. Their Ohio occurrence is known only from bones found in Native American archaeological sites. Reintroduction of this species is also not being considered.

The porcupine, which was extirpated by 1900, was once common in northeastern and northwestern Ohio. Although porcupines occasionally enter the state on their own, there are no plans to reintroduce this species because of possible conflicts with humans. However, recently a number of spatially concentrated sightings in Jefferson County suggest the possible establishment of a small breeding population. Fishers, one of the few natural predators of porcupines, are widespread throughout the northern forests of North America, and were once widespread in the Midwest, but similar to other extirpated predators, over-trapping and habitat loss eliminated them from Ohio by the mid-1800s. An isolated population exists in the Appalachians of West Virginia, and they were reintroduced to Pennsylvania in 1994 by the Pennsylvania Game Commission. Currently, they are abundant in parts of Pennsylvania - some within a 1-2 county radius of Ohio's eastern border, and occasional sightings of fishers occur in eastern Ohio and are becoming more frequent - although the presence of a breeding population is doubtful at this point. Nonetheless, the success of Pennsylvania's fishers and the self-repatriation of fishers in other parts of their range, suggest they may re-establish small breeding populations in Ohio in the future. Monitoring of porcupine and fisher sightings, and initiation of surveys in areas of possible re-establishment are warranted. Bobcats, once extirpated have returned to the state in numbers, occupying much of the southeastern portion of Ohio.

Endangered Mammals
The black bear, Indiana myotis (bat), and Allegheny woodrat are the endangered listed mammals from Ohio's SGCN list. Black bears were extirpated by 1850, but have returned to Ohio from adjacent states as Ohio's forest land recovered. They are provided full protection under the law as their population becomes established and grows. Black bear sightings have remained relatively consistent over the past decade. More importantly, the number of sightings of sows with cubs has remained low and fairly consistent, indicating a small but stable breeding population. Young female black bears tend to settle into home ranges adjacent to their mother, whereas young males tend to travel considerable distances before settling into a new home range. Because the peak of sightings (June and July) corresponds with the peak of breeding and dispersal, most of the sightings likely represent dispersing males. This is supported by the fact that all bears killed (most due to vehicle-related mortality) or trapped by ODOW employees (for relocation due to repeated bear-human conflicts) in Ohio to date (n = 20) have been males. For 3 years, extensive surveys utilizing techniques proven effective to survey black bears in nearby states (i.e., hair snares, camera traps) have failed to detect black bears in Ohio. This includes surveys located in the immediate vicinity of recent verified sightings, with survey stations at twice the minimum recommended density. These data suggest the possibility that a small and stable to slowly growing bear population exists in Ohio. Further monitoring of verified sightings, particularly those of females with cubs is warranted. Additional field surveys will be warranted when verified observations indicate a potential increase in bear population numbers that will make field surveys effective.

The Indiana bat was listed as endangered at the federal level in 1967 and at the state level in 1974 primarily due to loss of summer habitat and large numbers of deaths caused by human disturbance during hibernation. As is the case with many bat species, Indiana bat are extremely vulnerable to disturbance while they hibernate. Furthermore, because they hibernate in large numbers in only a few caves (the largest hibernation caves support from 20,000 to 50,000 bats) the loss of even one hibernaculum represents a huge loss for the species. More than 85% of the range-wide population of Indiana bat occupies nine "Priority One" hibernacula (i.e., hibernacula with recorded populations of >30,000 bats since 1960). Other threats include commercialization of caves, loss of summer habitat, pesticides and other contaminants, and most recently, white-nose syndrome (WNS). Ohio is home to a "Priority Two" hibernaculum (>500 but <30,000 bats) in Preble County (~9,000 Indiana bats prior to WNS in Ohio). Assessing hibernacula survey results at Ohio hibernacula from pre-WNS (pre-2011) to the most current (2014, post-WNS) results, the Division has reported approximately an 85% decline in the winter bat population, to include a 48% decline in Indiana bats. Continued monitoring and protection of hibernacula and summer habitat is imperative. Evaluation of maternity sites and hibernacula (mines and caves) are warranted. Further, description and delineation of summer habitat is needed. Protection of summer habitat and continued monitoring for WNS and associated population declines are also necessary to ensure the bat's protection in Ohio.

The Allegheny woodrat has always had a limited distribution in Ohio and has been listed as endangered since 1974. It has not been observed outside of Adams County for several years. The rapid decline of Allegheny woodrat populations throughout the northern portion of its range caused much concern about the species' future. The declines prompted researchers to examine possible causative factors. A primary factor is the parasite *Baylisascaris procyonis* (raccoon roundworm), a nematode that is fatal to woodrats. Increased habitat fragmentation may also be a factor. Fragmentation from roads and development causes loss of habitat, isolation, and increased exposure to parasitism, because these corridors also provide easy access for parasite hosts such as raccoons. Methods to protect remaining populations should be investigated (e.g., anthelminthic drugs), and intact forests that provide habitat for this species must be protected from further fragmentation and development. Furthermore, augmentation of Ohio's woodrat population via reintroduction into suitable habitats should be considered if roundworm prevalence can be curtailed.

Threatened Mammals

The eastern harvest mouse and Northern long-eared bat are presently Ohio's only threatened mammals. The mouse is in old fields, marshes, and wet meadows in the eastern United States. Little is known about this species' population distribution and trend in Ohio.

All counties within Ohio are within the summer and winter range of Northern long-eared bat. Literature has suggested that the habitat requirements for this species are associated with mature interior forests and the species is sensitive to fragmentation and destruction of forested habitat. The species has a significant site fidelity to their natal forests for future maternity sites and could be affected by winter alterations of habitat when they return for the summer. During the summer the species is known to move frequently (every 2-3 days) from roost tree to roost tree within a forested area, therefore the entire forested habitat is as important as the individual trees that they roost in. Populations of this species have declined significantly since white-nose syndrome (WNS) was first detected. Ohio has also experienced the rapid spread of the disease since the winter of 2011-2012 and has now confirmed in 20 counties across the state. Hibernacula counts that have occurred for more than 20 years in Ohio have detected significant declines in northern long-eared bats and other species. Furthermore, from 2011 and 2014, there has been a declining trend in the number of bat detections recorded during the mobile acoustic surveys, especially the *Myotids*. Continued monitoring and protection of hibernacula and summer habitat is imperative. Evaluation of maternity sites and hibernacula (mines and caves) are warranted. Further, description and delineation of summer habitat and continued monitoring for WNS and associated population declines are also necessary to ensure the bat's protection in Ohio.

Mammal Species of Concern

Of Ohio's mammal SGCN, 16 are designated as species of concern. These include the pygmy shrew, star-nosed mole, woodland jumping mouse, and southern red-backed vole. Pietkiewicz and Harder (pers. communication) conducted small mammal trapping throughout Ohio for 10 target species, including the species of concern. A total of 2,176 specimens, representing 19 of Ohio's 22 small mammal species were collected. Pygmy shrews accounted for only 4 captures, star-nosed moles 3 captures, woodland jumping mice 1 capture, and no southern red-backed voles were captured. Further research is needed to determine abundance and distribution, as well as factors limiting populations of these small mammals. Additional surveys will be required to determine if the southern red-backed vole continues to exist in Ohio or has been extirpated.

Ohio is within the summer and winter range of little brown bats, big brown bats, tri-colored bats, and eastern small-footed bats. Many of these species have seen winter population declines because of white-nose syndrome. Based on a 5 year average prior to white-nose syndrome compared to hibernacula surveys in 2014, little brown bats have declined 98-99.5%, big brown bats have declined approximately 40%, and tri-colored bats have seen a 97-98% decline. There are only five records of Eastern small-footed in Ohio during the summer, and no records for the winter thus little is known about the distribution and population size of this species. Eastern small-footed bats preference for shale habitat, which is unique among the sympatric bat species, makes it also vulnerable to mining and development. Ohio has historic records of Rafinesque's big-eared bat, but no recent records. Evening bats are rarely detected in Ohio, in part due to Ohio being on the edge of the range for this species. Silver-haired bats, Eastern red bats, and hoary bats (the migratory tree bats) are known to migrate through and summer in Ohio. Little is known about the statewide distribution and populations of these species. Surveys to determine the status of these species, including basic ecological requirements such as summer roost habitat characteristics, migration routes, and hibernacula, are needed.

Two carnivores, the ermine and badger are listed as species of concern. It is unknown if reproducing populations of ermines exist in Ohio. From the 1930's to 1987, three observations of ermines have been recorded, including 1 each in Cuyahoga, Lake, and Ashtabula counties. However, a study was conducted in 1987 in which trapping, specifically to document ermine presence, was conducted in Ashtabula and Trumbull counties. In a total of 243 trap nights resulted in the capture of 1 female and 4 male ermine. Thus, ermine may be rarely observed in areas they occur. Ermine occur throughout Michigan and Pennsylvania, and they are easily mistaken for the larger long-tailed weasel. Consequently, ermine may occur in Ohio in the extreme northeastern or northwestern portions of the state. The badger occurs primarily in western Ohio and primarily utilizes combinations of small agricultural patches and linear habitat corridors, such as hedgerows, grassland buffers, and riparian areas. These small agricultural patches are relics that have remained after the vast agricultural transformation in Ohio. Management of suitable habitat is a key factor in conserving this species. Additional surveys to determine population size and range in Ohio are warranted for these species, particularly the ermine.

Table 4. Ohio's Mammal Species of Greatest Conservation Need
The conservation status (rank) for each species represents input from professionals in mammal taxonomy, distribution, and abundance. This table represents the best professional knowledge available at this time, and as such is subject to modification as additional data is obtained.

Conservation Status Rank*	Common Name	Scientific Name	Species Listing Fed	Species Listing State	Habitat Association	Rangewide Occurrence	Statewide Occurrence	Ohio Population Trend
1	Eastern Small-footed Bat	*Myotis leibii*		SC	B, D	A	D	U
2	Northern Long-eared Bat	*Myotis septentrionalis*	T	T	B, D, Q, I	A	A	D
3	Rafinesque's Big-eared Bat	*Corynorhinus rafinesquii*		SC	B, D	B	E	U
4	Silver-haired Bat	*Lasionycteris noctivagans*		SC	B	A	E	U
5	Evening Bat	*Nycticeius humeralis*		SI	B	B	C	U
6	Eastern Red Bat	*Lasiurus borealis*		SC	B	A	E	U
7	Indiana Bat	*Myotis sodalis*	E	E	B, D, H, I	A	A	D
7	Tri-colored Bat	Perimyotis subflavus		SC	B, D	A	B	D
9	Hoary Bat	*Lasiurus cinereus*		SC	B	A	E	U
9	Southern Flying Squirrel	*Glaucomys volans*			B	A	A	U
11	Pygmy Shrew	*Sorex hoyi*		SC	A	A	B	U
12	Least Shrew	*Cryptotis parva*			A	A	A	U
13	Southern Red-backed Vole	*Myodes gapperi*		EX	G	B	U	U
14	Little Brown Bat	*Myotis lucifugus*		SC	B, D, H, I, Q	A	A	D
14	Big Brown Bat	*Eptesicus fuscus*		SC	B, D, I, Q	A	A	D
16	Ermine	*Mustela erminea*		SC	C, G	B	B	U
16	Thirteen-lined Ground Squirrel	*Spermophilus tridecemlineatus*			A, E, I	B	A	U
16	Badger	*Taxidea taxus*		SC	A, E	B	B	U
19	Pine Vole	*Microtus pinetorum*		SC	B	A	B	U
19	Smoky Shrew	*Sorex fumeus*		SC	B	A	B	U
19	Eastern Harvest Mouse	*Reithrodontomys humulis*		T	A	A	A	U
22	Hairy-tailed Mole	*Parascalops breweri*			B	B	B	U
22	Woodland Jumping Mouse	*Napaeozapus insignis*		SC	B, G	B	B	U

24	Allegheny Woodrat	*Neotoma magister*	E	B, D	B	D	U
25	Star-nosed Mole	*Condylura cristata*	SC	C	A	B	U
25	Eastern Chipmunk	*Tamias striatus*		B, I	A	A	U
25	Bobcat	*Felis rufus*		B	A	B	I
28	Meadow Jumping Mouse	*Zapus hudsonius*		A, H	A	A	U
28	Black Bear	*Ursus americanus*	E	B	A	B	I
n/r	Snowshoe Hare	*Lepus americanus*	SC	G	B	D	D

* Rank derived from Conservation Status Score calculated using Millsap et al. (1990) modified for Ohio. The order in which species with the same conservation status rank (i.e., ties) are listed does not imply differences between these species.

n/r added to SGCN list because of research and management activities that may continue under this this Action Plan

Habitat Association Key
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O = man-made lakes and ponds
P = natural lakes
Q = generalist

Statewide Occurrence Key
A = broadly distributed (>30 counties)
B = common (11-29 counties)
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Rangewide Occurrence Key
A = extensive range (multiple states/Canada) – which includes Ohio
B = periphery of range is in Ohio
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D = center of range in/near Ohio
E = very limited range with most of its rangewide population occurring in Ohio

Ohio Population Trend Key
D = decreasing
I = increasing
S = stable
U = unknown

Species Listing Key
E = endangered
T = threatened
SC = species of concern
SI = species of interest
EX = extirpated

4.4.3 Taxa Group: Birds

Historically, a total of 421 avian species have been recorded in the state. Of the 421 species recorded, 40 of those have only been seen once. About 300 species occur in Ohio annually, and of these, about 180 species breed in Ohio every year. The birds on our SGCN list (N=53) are a subset of the 180 birds presently considered to breed in Ohio. They were chosen according to the criteria described in section 4.1 SGCN List Development and Rationale. Additionally there are 22 avian species which occasionally breed in the state but their densities are relatively low. Their numbers in Ohio are dependent upon the success of their rangewide population. Two avian species, the passenger pigeon and Carolina parakeet, are extinct.

Extirpated Birds

The Swallow-tailed kite, greater prairie chicken, ivory-billed woodpecker, and Bachman's sparrow have been extirpated from Ohio for many years. Based on radiocarbon dating of materials from a Scioto County site, the ivory-billed woodpecker is believed to have disappeared from Ohio during the 15th or 16th century. Swallow-tailed kites nested in Ohio during the first half of the 19th century, but habitat destruction and human persecution eliminated this species. Swallow-tailed kites breed in mature, wetland forests and most of the remaining birds live in the southeastern U.S, primarily Florida. The greater prairie chicken was extirpated from the state by 1880 because of market hunting and the conversion of woodlands and prairie habitat to cropland. Greater prairie chickens require very large tracts of prairie grassland habitat. The last documented sighting of Bachman's sparrow was from Scioto County in 1978. There is no clear reason for their disappearance from Ohio or other adjacent states. They prefer pine woodlands and are a conservation concern in all states where they still exist. Ivory-billed woodpeckers, Greater prairie chickens, and Bachman's sparrows are all red list species on the National Audubon Society's Watchlist (i.e., declining rapidly and/or have very small populations or limited ranges and face major conservation threats). The swallow-tailed kite is a yellow list species (i.e., either declining or rare with national conservation concern). Because of their low population numbers and lack of required habitats in Ohio, reintroduction of these species is not biologically feasible at this time.

The golden-winged warbler, once locally common in the Oak Openings region, has been likely extirpated from the state. No nests were recorded in the 1980s and only 1 nest was recorded in the 1990s. The Breeding Bird Atlas II (2006-2011) has recorded 3 possible and 2 probable nests but no nests that were confirmed. Golden-winged warblers are a red list species on the American Bird Conservancy and National Audubon Society's Watchlist (i.e., declining rapidly and/or have very small populations or limited ranges and face major conservation threats). Declines have been caused by habitat loss, competition and hybridization with the blue-winged warbler, and nest site parasitism by brown-headed cowbirds.

Bewick's wrens are now believed to be extirpated from Ohio. Rapid declines of remnant populations of Bewick's wrens occurred from the mid-1950s to the mid-1960s. They were extremely rare by the 1990s. The 1982-1987 Breeding Bird Atlas verified 3 breeding pairs during this time, and summarized that Ohio probably had a maximum of 5 breeding pairs annually across the state. Only 1 possible nest was located during the Breeding Bird Atlas II in northern Ohio. Declines are believed to be from interspecific competition with house wrens and habitat loss. The USFWS lists Bewick's wrens as species of Conservation Concern in BCRs 13 and 28.

Endangered Birds

Recovery efforts are in place for the common tern and sandhill crane. Common terns have been monitored annually since 1993 for reproductive effort and population size. Efforts were made to establish secure artificial nest structures and to deter predators during the nesting season. Numbers of nests have ranged from 65-350 and young fledged have ranged from 3-345 over the last 16 years. Recovery efforts should continue for common terns with the goal of delisting. Sandhill cranes were last recorded nesting in Ohio in 1926 until a nest was confirmed in Wayne County in 1987. Since then cranes have been monitored annually to determine abundance and distribution in the state. Successful nest sites have varied from 1-41 since 1997. Sandhills have been located in 15 counties with an increasingly large non-breeding flock staying at Funk Bottoms Wildlife Area in Wayne County. Continued monitoring is necessary to assess their population status.

The upland sandpiper is a grassland bird that was very numerous after the forests of pre-settlement Ohio were replaced by open fields. However, the conversion of grassland to crops and market hunting severely reduced their population. Upland sandpipers require a variety of grassland heights for nesting, brood rearing and foraging. The Breeding Bird Atlas I found 5 possible, 8 probable, and 10 confirmed nests from 1982-1987. The Breeding Bird Atlas II so far has documented 1 possible nest, 13 probable nests, and 1 confirmed upland sandpiper nest, 2006-2010. The USFWS lists the upland sandpiper as a species of Conservation Concern in BCRs 13, 22 and 28.

Lark sparrows are at the extreme eastern limit of their range in Ohio and are unlikely to ever occur in viable numbers (>200 breeding pairs). Because Ohio is on the extreme edge of these birds' ranges, it is unlikely that management efforts would result in significant increases in their populations within the state. Therefore, with the exception of efforts to protect occupied areas, minimal management efforts will be directed for these species.

The American bittern, king rail, and black tern declined in Ohio with the loss of wetlands. They now breed in very limited numbers in Ohio, mostly on the shores of western Lake Erie. American bitterns, king rails, and black terns are listed in the "High" and "Highest" categories of Birds of Conservation Concern with the U.S. Fish and Wildlife Service (USFWS) in Bird Conservation Regions (BCR) 13 and 22. King rails have declined significantly in Ohio and over their entire breeding range. The USFWS developed a King Rail Conservation Plan that calls for 250 hectares (617 acres) of additional breeding habitat in Ohio to help increase the Midwestern population of king rails to 524 individuals. All 3 of these species are considered focal species for monitoring efforts and should be given conservation priority according to the Upper Mississippi Valley/Great Lakes (UMVGL) Waterbird Conservation Plan. Unless the amount of quality wetland habitat is increased considerably, these species will probably not return to viable population levels. Currently habitat that does exist for these species should be protected and improved whenever possible.

West Sister Island in Lake Erie contains the largest colonies of snowy egrets (10-15 pairs) and cattle egrets (8-12 pairs) in the Great Lakes. Although these species nest in low numbers in Ohio, habitat destruction by double-crested cormorants may decrease their numbers further. Control strategies that reduce the impact of cormorants on island vegetation need to be continued.

Northern harriers are associated with large grasslands, wet meadows, wet prairies, pastures, hayfields, and reclaimed surface-mined lands. Their numbers declined with the loss of grassland and wetland habitats, and through persecution. Harriers were rare in the 1950s through the 1980s with a slight increase in the 1990s, although few nests were reported in Ohio. The Breeding Bird Atlas I (1982-1987) reported 28 possible nests, 3 probable, and 4 confirmed nests. The Breeding Bird Atlas II (2006-2011) lists 71 possible nests, 9 probable, and 7 confirmed nests. Northern harriers have declined throughout their range from habitat loss. Management and restoration of large grasslands in Ohio would benefit this species. Continued monitoring is necessary to access population status.

Surveys for the loggerhead shrike at former breeding locations and surface-mined lands owned by the Division of Wildlife produced no observations of the species in 2002-2003. The Ohio Breeding Bird Atlas II found 1 confirmed nest of loggerhead shrikes in southwestern Ohio and 4 possible breeding locations in northern counties. They have declined across their range; the USFWS lists the loggerhead shrike as a Bird of Conservation Concern in BCRs 22 and 28. Declines are believed to be because of habitat loss and possibly poor over-winter survival in the southeastern U.S.

Threatened Birds
The trumpeter swan was downgraded from endangered to threatened in 2013, and the population continues to increase. Ohio released 154 trumpeter swans from 1996-2003 as part of a restoration effort. Since 2006, over 20 trumpeter swan nests have been observed each year and 44-73 cygnets have been produced annually. Reintroduction has been completed but trumpeter swans continue to be monitored annually to assess their recovery and re-evaluate their status.

Black-crowned night herons are considered a focal species for monitoring efforts and should be given high priority according to the UMVGL Waterbird Conservation Plan for monitoring in the Great Lakes. The plan calls for increasing populations in BCRs 13 and 22 by managing and protecting high-quality breeding habitats. Succession and damage by double-crested cormorants are currently reducing the vegetation necessary for black-crowned night herons to successfully nest on West Sister Island in Lake Erie. Control strategies need to be evaluated that will reduce the impact of succession and cormorants on island vegetation. Protection of nesting sites for black-crowned night herons on West Sister Island is imperative for the viability of this species in Ohio.

Before Ohio lost 90% of its wetlands, least bitterns were quite common in Ohio. The most dramatic declines were from the 1930s through 1965 when many marshes were drained. Least bitterns still nest in small numbers in the Western Lake Erie marshes and in very local, scattered inland marshes. They are listed as a species of Conservation Concern by the USFWS in BCRs 13 and 22. Least bitterns are considered a focal species and a high priority for monitoring efforts and should be given conservation priority according to the UMVGL Waterbird Conservation Plan.

Recovery programs are currently ongoing for barn owls. Barn owls and peregrine falcons have been down-listed from Ohio endangered to threatened status because of these recovery efforts. Peregrine falcons were also delisted from the Federal Threatened and Endangered Species list in 1999.

Bird Species of Concern
Henslow's sparrows (BCRs 13, 22, 28), cerulean warblers (BCRs 13, 22, 28), prothonotary warblers (BCR 22), and sedge wrens (BCR 28) are listed by the USFWS as species of Conservation Concern in several Ohio BCRs. Henslow's sparrows, cerulean warblers and prothonotary warblers are also focal species in the UMVGL Landbird Conservation Plan. The plan lists them as a high priority for monitoring efforts and should be given conservation priority. The National Audubon Society and the American Bird Conservancy's Watch List classifies Henslow's sparrows as red (i.e., declining rapidly and/or have very small populations or limited ranges and face major conservation threats) and cerulean warblers and prothonotary warblers as yellow (i.e., species that are either declining or rare, typically species of national conservation concern). These species should be given priority for monitoring and research to assess their status and to develop habitat plans to protect or restore critical habitats essential to their recovery when possible.

Populations of the northern bobwhite quail were decimated after severe winters in 1977 and 1978. Statewide survey indices have shown some population recovery in southwestern Ohio, but quail numbers have never reached pre-1977 levels. The North American Breeding Bird Survey (BBS) index for bobwhites in Ohio has declined by 6.3% per year since 1966 and by 9.4% annually since 1996. The Breeding Bird Atlas I listed 100 possible, 180 probable, and 122 confirmed nests. Breeding Bird Atlas II has recorded 97 possible, 265 probable, and 17 confirmed nests. The Northern Bobwhite Conservation Initiative (NBCI) plan states that the northern bobwhite may approach extirpation in some states by the end of the decade. The NBCI plan lists population and management goals for BCRs 22, 24, and 28 in Ohio. Monitoring and restoration of bobwhite quail and their habitat should continue, especially in the southwestern portion of the state.

Other species listed under this category should be monitored to assess their population status, and/or develop methods to learn more about their populations in Ohio.

Table 5. Ohio's Avian Species of Greatest Conservation Need
The conservation status (rank) for each species represents input from professionals in avian taxonomy, distribution, and abundance. This table represents the best professional knowledge available at this time, and as such is subject to modification as additional data is obtained.

Conservation Status Rank*	Common Name	Scientific Name	Species Listing		Habitat Association	Rangewide Occurrence	Statewide Occurrence	Ohio Population Trend
			Fed	State				
1	Cerulean Warbler	*Setophaga cerulea*		SC	B	A	C	D
1	Henslow's Sparrow	*Ammodramus henslowii*		SC	A, I	A	A	S
3	Northern Bobwhite	*Colinus virginianus*		SC	A	A	C	D
3	Sedge Wren	*Cistothorus platensis*		SC	A, C	A	D	S
5	Northern Harrier	*Circus cyaneus*		E	A, C	A	D	S
5	King Rail	*Rallus elegans*		E	C	A	C	U
5	Virginia Rail	*Rallus limicola*		SC	C	A	C	S
5	Sora	*Porzana carolina*		SC	C	A	C	S
5	Marsh Wren	*Cistothorus palustris*		SC	C	A	C	S
10	American Bittern	*Botaurus lentiginosus*		E	C	A	C	S
10	Upland Sandpiper	*Bartramia longicauda*		E	A, I	A	C	D
10	Common Tern	*Sterna hirundo*		E	C, J	A	D	S
10	Black Tern	*Chlidonias niger*		E	C, F	A	D	U
10	American Black Duck	*Anas rubripes*		SI	C	A	C	U
10	Least Bittern	*Ixobrychus exilis*		T	C	A	C	S
10	Black-crowned Night-Heron	*Nycticorax nycticorax*		T	C, F	A	C	S
10	Blue-winged Warbler	*Vermivora cyanoptera*			B	A	A	D
10	Worm-eating Warbler	*Helmitheros vermivorum*			B	A	B	S
10	Great Egret	*Ardea alba*		SC	C, F, H	A	A	S
10	Sharp-shinned Hawk	*Accipiter striatus*		SC	B	A	A	S
10	Common Gallinule	*Gallinula galeata*			C	A	C	D
10	Prothonotary Warbler	*Protonotaria citrea*		SC	C, H, O	A	A	U
10	Bobolink	*Dolichonyx oryzivorus*		SC	A	A	A	D

24	Snowy Egret	*Egretta thula*	E	C, F	A	D	U
24	Loggerhead Shrike	*Lanius ludovicianus*	E	A	A	D	S
24	American Woodcock	*Scolopax minor*		B, C	A	A	S
24	Wood Thrush	*Hylocichla mustelina*		B	A	A	S
24	Trumpeter Swan	*Cygnus buccinator*	T	C	B	C	I
24	Blue-winged Teal	*Anas discors*		A, C	A	C	S
24	Peregrine Falcon	*Falco peregrinus*		I	A	C	I
24	Black-billed Cuckoo	*Coccyzus erythropthalmus*		B	A	A	S
24	Barn Owl	*Tyto alba*	T	A, I	A	C	I
24	Eastern Whip-poor-will	*Antrostomus vociferus*		B	A	B	D
24	Red-headed Woodpecker	*Melanerpes erythrocephalus*		B	A	A	D
24	Prairie Warbler	*Setophaga discolor*		B	A	B	D
24	Sandhill Crane	*Grus canadensis*	E	A, C	A	B	I
24	Cattle Egret	*Bubulcus ibis*	E	A, C, F	B	D	U
38	Lark Sparrow	*Chondestes grammacus*	E	A, E, I	B	C	U
38	Acadian Flycatcher	*Empidonax virescens*		B	A	A	S
38	Wood Duck	*Aix sponsa*		B, H, C	A	A	S
38	Great Blue Heron	*Ardea herodias*		C, F, H	A	A	S
38	Wilson's Phalarope	*Phalaropus tricolor*	SI	A, C	B	D	U
38	Yellow-billed Cuckoo	*Coccyzus americanus*		B, H	A	A	D
38	Short-eared Owl	*Asio flammeus*	SI	A, C	B	D	U
38	Great Crested Flycatcher	*Myiarchus crinitus*		B	A	A	S
38	Bell's Vireo	*Vireo bellii*	SI	A	B	C	U
38	Yellow-throated Vireo	*Vireo flavifrons*		B	A	A	S
38	Blue-gray Gnatcatcher	*Polioptila caerulea*		B	A	A	S
38	Veery	*Catharus fuscescens*		B	A	B	S
38	Black-and-white Warbler	*Mniotilta varia*		B	A	A	S
38	American Redstart	*Setophaga ruticilla*		B	A	A	S

38	Vesper Sparrow	*Pooecetes gramineus*		A, I	A	A	S
38	Eastern Meadowlark	*Sturnella magna*		A	A	A	D
n/r	Dickcissel	*Spiza americana*		A	B	A	S
n/r	Yellow-breasted Chat	*Icteria virens*		B	A	A	D
n/r	Chimney Swift	*Chaetura pelagica*		I	A	A	S
n/r	Hooded Warbler	*Setophaga citrina*		B	A	A	S
n/r	Louisiana Waterthrush	*Parkesia motacilla*		H	A	A	S
n/r	Grasshopper Sparrow	*Ammodramus savannarum*		A	A	A	D
n/r	Field Sparrow	*Spizella pusilla*		A	A	A	S
n/r	Kentucky Warbler	*Geothlypis formosa*		B	A	A	S

* Rank derived from Conservation Status Score calculated using weighted matrix described in the Avian Species Scoring section. The order in which species with the same conservation status rank (i.e., ties) are listed does not imply differences between these species.

n/r added to SGCN list because of research and management activities that need to be conducted under this Action Plan

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4.4.4 Taxa Group: Reptiles

This taxa group consists of snakes, turtles, lizards, and skinks. Habitat alteration, limited mobility, and human persecution have shaped the abundance and distribution of Ohio's reptiles. Much remains to be learned about this species group. Their generally secretive nature makes them prime candidates for habitat loss as well as direct mortality from human activities. Until more distribution information on both the macro and micro-scale is obtained, it will be difficult to protect habitat for some species. Improving public perception of certain species (snakes for example) will help to alleviate human persecution issues. Overall, basic life history and ecology information for reptiles lags behind that of other taxa groups, and limits our ability to conserve many of these species.

Endangered Reptiles

There are 2 endangered reptiles on Ohio's SGCN list. They have suffered habitat destruction, degradation, and fragmentation, as well as intentional killing and over-collecting. In addition, they have very limited statewide distributions.

Recovery efforts are currently underway for the timber rattlesnake. Timber rattlesnakes are a woodland species. The Division's management plan for this species is to protect existing populations as opposed to increasing their occupied range. Public sightings and annual surveys are important sources of information concerning their distribution and relative abundance. Educational programs aimed at segments of the public most likely to encounter rattlesnakes are exceptionally valuable tools in conserving populations of these venomous snakes

U.S. Fish and Wildlife Service Recovery Plans have been completed for the copperbelly watersnake. The principle limiting factor for copperbelly watersnakes is the availability of wetland/upland complexes of sufficient size (hundreds of acres are needed to maintain a population). Additional factors include human persecution, inadequate habitat management, and road-related mortality. The copperbelly watersnake is known only to persist in Ohio in Williams County. The CRP State Acres for Wildlife Enhancement (SAFE) program in Ohio is aimed at creating conservation practices to address high priority objectives through targeted habitat restoration. Williams County is within a priority area, and the copperbelly watersnake is a target species.

Threatened Reptiles

The 3 threatened reptiles on Ohio's SGCN list have been primarily impacted by habitat loss and alteration, although exploitation from the pet trade has also taken a toll. The Kirtland's snake occupies moist, open meadow or wet prairie habitats. Their occupied Ohio range appears to be declining, but because of their secretive nature and habitat preference, confirmed sightings are infrequent. The ecology and behavior of Kirtland's snake are also poorly understood and warrant further research. The presence of crayfish burrows seems to be an important factor because they are the presumed hibernation, aestivation, and refuge sites. They appear to rely heavily on earthworms as prey. Suitable habitat may also remain unoccupied due to chemical contamination. The spotted turtle is associated with fens. Spotted turtles frequently use a multitude of wetland areas, and shift between them often. Uplands are used extensively, and provide important habitats for nesting, aestivating, and as travel corridors between wetlands. Blanding's turtle is essentially imperiled rangewide in the U.S., and it has been given state conservation status in 14 of the 15 states in which it occurs. Both diet and reproduction are essential elements for the species recovery, however both are tied to the quality and availability of habitat. Current research in Ohio, failed to document recruitment of Blanding's turtles. Management plans for the Kirtland's snake, spotted turtle, and Blanding's turtle should be focused on maintaining and increasing required habitat components in the landscape.

Reptile Species of Concern

There are 8 reptiles designated as species of concern. Habitat destruction and fragmentation has impacted the eastern box turtle. This isolates individuals from mates and/or food, increases road crossings, and subsequently increases mortality. The commercial pet trade also has had a tremendous impact on eastern box turtles. Their slow reproductive rate increases recovery time for this species. The eastern black kingsnake is limited in Ohio to Adams, Scioto, Jackson, and Lawrence counties, and even in this area it is relatively uncommon. It shows a marked preference for the Scioto and Ohio River bottomlands. The apparent decline in populations across the range is somewhat surprising given their broad diet and habitat capacity. Understanding basic ecological requirements and behavior of eastern kingsnakes is paramount to successful conservation and management in Ohio.

The preferred habitat for the short-headed garter snake has largely disappeared as old farms have been developed or abandoned and reforested in some areas. A population of short-headed garter snakes in Youngstown (Mahoning County) exists, although it is uncertain whether these snakes were introduced or native. The northern rough greensnake lives in the extreme southern quarter of the state and is comparatively uncommon throughout its range. It may be reduced in some areas where insecticides are applied.

The queensnake is found in small rivers and streams with rocky shores and bottoms. Rarity is largely due to loss of habitat, and water pollution and sedimentation affect both habitat quality and food availability. This species is known to communally hibernate in old bridge abutments, fractured dams, and in some deep rip-rap, and is vulnerable when actions are taken to repair or remove these structures. Freshly molted crayfish provide more than 90% of the queensnake's diet. Information on other aspects of its natural history is lacking. Results of a recent study suggested an overall decline in the queensnake.

The smooth earthsnake occurs only in the southern quarter of the state, especially in the forested area of Shawnee and Pike state forests. It is extremely secretive and little is known concerning its biology. The smooth greensnake is also comparatively uncommon throughout its range, and has likely been reduced by habitat destruction and widespread use of insecticides. The Ouachita map turtle appears to have a very limited distribution in Ohio, being found only in the Scioto River and associated oxbows. Status and distribution are poorly understood because of identification problems and confusion in the literature. Research is needed to document the distribution and abundance of this species, and to fill in gaps in our knowledge concerning their natural history.

Table 6. Ohio's Reptile Species of Greatest Conservation Need
The conservation status (rank) for each species represents input from professionals in reptile taxonomy, distribution, and abundance. This table represents the best professional knowledge available at this time, and as such is subject to modification as additional data is obtained.

Conservation Status Rank*	Common Name	Scientific Name	Species Listing Fed	Species Listing State	Habitat Association	Rangewide Occurrence	Statewide Occurrence	Ohio Population Trend
1	Shortheaded Garter Snake	Thamnophis brachystoma		SC	I	B	D	I
2	Eastern Smooth Earth Snake	*Virginia valeriae valeriae*		SC	B	B	B	D
3	Rough Green Snake	*Opheodrys aestivus*		SC	B, H, M, N	B	D	D
4	Spotted Turtle	*Clemmys guttata*		T	C, G	A	C	D
5	Kirtland's Snake	*Clonophis kirtlandii*		T	A, C	D	C	D
6	Eastern Hognose Snake	*Heterodon platirhinos*		SC	B, E, H	A	A	D
7	Midland Smooth Softshell	*Apalone mutica mutica*			H, K, M, N	A	A	D
8	Butler's Garter Snake	*Thamnophis butleri*			A	B	C	D
8	Black Racer	*Coluber constrictor constrictor*			A, B	A	A	D
8	Blue Racer	*Coluber constrictor flaviventrus*			A	A	A	D
8	Smooth Green Snake	*Liochlorophis vernalis*		E	A	A	C	D
12	Broadhead Skink	*Eumeces laticeps*			B	B	C	D
13	Eastern Box Turtle	*Terrapene carolina carolina*		SC	B	A	B	D
13	Eastern Ribbon Snake	*Thamnophis sauritus sauritus*			A, C	A	A	D
13	Northern Ribbon Snake	*Thamnophis sauritus septentrionalis*			A, C	B	B	D
13	Black Kingsnake	*Lampropeltis getula nigra*		SC	B	B	D	D
17	Northern Copperhead	*Agkistrodon contortrix mokasen*			B	B	A	S
18	Timber Rattlesnake	*Crotalus horridus horridus*		E	B	B	C	D
19	Common Map Turtle	*Graptemys geographica*			C, H, K, M, N	B	C	S
19	Ouachita Map Turtle	*Graptemys ouachitensis*		SC	H, K, M, N	B	D	D
19	Queen Snake	*Regina septemvittata*		SC	H, K, M, N	A	A	D
22	Blanding's Turtle	*Emydoidea blandingii*		T	C, F	B	C	D
22	Copperbelly Water Snake	*Nerodia erythrogaster neglecta*	E	E	B, C	A	D	D

n/r	Lake Erie Water Snake	*Nerodia sipedon insularum*	T	F	E	D	S
n/r	Eastern Massasauga	*Sistrurus catenatus catenatus*	E	C	A	B	D
n/r	Eastern Plains Garter Snake	*Thamnophis radix radix*	E	A	B	D	D

* Rank derived from Conservation Status Score calculated using Millsap et al. (1990) modified for Ohio. The order in which species with the same conservation status rank (i.e., ties) are listed does not imply differences between these species.

n/r = added to SGCN list because of previous research and management activities that will continue under this Action Plan

<u>Habitat Association Key</u>
A = grassland
B = forest
C = wetlands
D = caves & mines
E = oak savannahs
F = Lake Erie islands
G = boreal communities
H = riparian corridors
I = artificial/man-made environments
J = Lake Erie
K = Lake Erie Tributaries
L = Ohio River
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N = headwater and small inland streams
O = man-made lakes and ponds
P = natural lakes
Q = generalist

<u>Statewide Occurrence Key</u>
A = broadly distributed (>30 counties)
B = common (11-29 counties)
C = uncommon (6-10 counties)
D = rare (<5 counties)
E = unknown

<u>Rangewide Occurrence Key</u>
A = extensive range (multiple states/Canada) – which includes Ohio
B = periphery of range is in Ohio
C = disjunct from main portion of its range; occurs in Ohio
D = center of range in/near Ohio
E = very limited range with most of its rangewide population occurring in Ohio

<u>Ohio Population Trend Key</u>
D = decreasing
I = increasing
S = stable
U = unknown

<u>Species Listing Key</u>
E = endangered
T = threatened
SC = species of concern
SI = species of interest
EX = extirpated

4.4.5 Taxa Group: Amphibians

Ohio's amphibian taxa group includes 25 species and subspecies of salamanders and 14 species of frogs and toads. The majority of amphibians spend part of their life in aquatic habitats and part of it in terrestrial habitats. This characteristic amplifies the potential impacts of habitat destruction/degradation. Protecting multiple habitat types becomes necessary for species that require different habitats during different portions of their life cycle. That, combined with their generally secretive nature makes this taxa group very vulnerable to the activities of humans on the landscape. Like reptiles, basic life history and ecology information lags behind some of the other taxa groups. Consequently, there is much work to be done to make conservation of amphibians in Ohio as effective as it can be.

Endangered Amphibians

Eastern hellbenders, blue-spotted salamanders, green salamanders, cave salamanders and the Eastern spadefoot are endangered in Ohio because of habitat loss and small populations in few, isolated locations. Eastern hellbenders, the largest amphibian in the state, are found in swift flowing streams in southeast Ohio. Ohio represents the extreme southern edge of the blue-spotted salamander's range, which is found in a few locations in the Oak Openings Region southwest of Toledo, and in Williams County. The green salamander is only known from 3 counties along the Ohio River. The cave salamander is found in limestone areas of 3 southern Ohio counties. Only 30 specimens are known from this state. There are 5 distinct populations of the eastern spadefoot, found in sandy soils associated with river valleys of 7 southern Ohio counties. Protection of the few remaining breeding locations of all 5 of these species will be critical in maintaining existing populations in Ohio.

Threatened Amphibians

The mud salamander has been found in 9 south-central Ohio counties. Ohio represents the northern edge of the mud salamander's range and only 20 voucher specimens exist for this species. Little is known about its life history or current statewide distribution. A survey of historical locations and other areas with suitable habitat should be initiated to better delineate the salamanders occupied range.

Amphibian Species of Concern

The four-toed salamander is the smallest Ohio salamander. It requires mature forests with bogs to complete their life cycle. Specimens have been found in 34 counties, however, its current range and population size needs to be assessed.

Research is also needed to assess the effects of forest management practices on survival and reproduction of all state-listed amphibians.

Table 7. Ohio's Amphibian Species of Greatest Conservation Need
The conservation status (rank) for each species represents input from professionals in amphibian taxonomy, distribution, and abundance. This table represents the best professional knowledge available at this time, and as such is subject to modification as additional data is obtained.

Conservation Status Rank*	Common Name	Scientific Name	Species Listing Fed	Species Listing State	Habitat Association	Rangewide Occurrence	Statewide Occurrence	Ohio Population Trend
1	Northern Spring Salamander	*Gyrinophilus porphyriticus porphyriticus*			B	B	B	D
2	Streamside Salamander	*Ambystoma barbouri*			B, H	A	B	D
3	Kentucky Spring Salamander	*Gyrinophilus porphyriticus duryi*			B	B	D	D
4	Smallmouth Salamander	*Ambystoma texanum*			B	A	A	D
5	Mud Salamander	*Pseudotriton montanus*		T	C, B	B	D	D
6	Green Salamander	*Aneides aeneus*		E	B	A	D	S
7	Jefferson Salamander	*Ambystoma jeffersonianum*			B, C	A	A	D
7	Northern Red Salamander	*Pseudotriton ruber ruber*			B, H	A	B	S
9	Eastern Tiger Salamander	*Ambystoma tigrinum tigrinum*			A, B, C	A	B	D
10	Marbled Salamander	*Ambystoma opacum*			A, B	A	B	D
11	Four-toed Salamander	*Hemidactylium scutatum*		SC	B, C, G	A	C	D
12	N. Ravine Salamander	*Plethodon richmondi*			B	A	B	S
13	Longtailed Salamander	*Eurycea longicauda longicauda*			B, H	A	A	S
14	Mudpuppy	*Necturus maculosus maculosus*			K, M, N, O	A	A	D
15	Cave Salamander	*Eurycea lucifuga*		E	D, I, N	B	D	D
15	Eastern Spadefoot	*Scaphiopus holbrookii*		E	B, C, I	A	D	D
17	Northern Dusky Salamander	*Desmognathus fuscus fuscus*			B, H	A	A	S
18	Mountain Chorus Frog	*Pseudacris brachyphona*			B, C	A	B	D
19	Blue-spotted Salamander	*Ambystoma laterale*		E	E	B	C	D
20	Red-spotted Newt	*Notophthalmus viridescens viridescens*			B, C, O, P	A	A	S
20	Western Chorus Frog	*Pseudacris triseriata triseriata*			A, B, C	A	B	D
22	Wood Frog	*Rana sylvatica*			B	A	A	D
23	Eastern Hellbender	*Cryptobranchus alleganiensis*		E	M	A	C	D

* Rank derived from Conservation Status Score calculated using Millsap et al. (1990) modified for Ohio. The order in which species with the same conservation status rank (i.e., ties) are listed does not imply differences between these species.

Habitat Association Key
A = grassland
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4.4.6 Taxa Group: Fish

Two fish species that once occurred in Ohio are listed as extinct. The last reported collections for the extinct harelip sucker are from the Blanchard and Auglaize rivers in 1893, and the last blue pike was collected from Lake Erie in the late 1960s. Eight fish species are listed as extirpated, with most of them having been absent for many years, including the diamond darter (last seen in Ohio in 1899), pugnose shiner (1931), longhead darter (1939) and alligator gar (1946). Most extirpated species, including the blacknose shiner, are the victims of habitat loss, requiring conditions that no longer exist in much of Ohio. For other species like the Mississippi silvery minnow and spoonhead sculpin, Ohio likely represented the edge of their ranges. The extirpated diamond darter now occupies only a small stretch of the lower Elk River in West Virginia.

Endangered Fish

Twenty fish species are presently listed as endangered in Ohio. Cisco, once the most important commercially harvested species in Lake Erie are now a very rare species, though a small population still remains in the central and eastern basins. The popeye shiner was thought to have disappeared from Ohio prior to 1900 until a population was discovered in Scioto Brush Creek in southern Ohio in the mid 1980's. The shoal chub has not been found in Ohio waters since the early 1980's, the gilt darter since 1893, and the Scioto madtom since 1957 – these species may have become extirpated. Pirate perch had not been collected since 1942, and a reintroduction effort attempted in the 1990s does not appear to have been successful. Lake sturgeon (1971) and shovelnose sturgeon (1939) have been absent from Ohio for many years, but appear to be increasing in the Great Lakes and Ohio River drainage thanks to reintroduction programs.

As is the case with extinct and extirpated species, most of the endangered fish species are suffering from habitat loss/degradation and degraded water quality as development, dams, and agriculture have changed the landscape of Ohio. As expected, the majority of endangered fish are lesser tolerant species requiring clean, clear, often vegetated waters. Many of these now only occur in isolated locations around Ohio (e.g., goldeye, Iowa darter, northern madtom, popeye shiner, pugnose minnow, shortnose gar, spotted gar, spotted darter, western banded killifish). Ohio represents the extreme southern edge of the range of the longnose sucker.

Six of the seven species of lampreys that occur in Ohio are native, and three of those are listed as endangered (Ohio lamprey, northern brook lamprey, mountain brook lamprey). Lampreys require two or three distinctly different habitats that are connected by free flowing (free of dams) stretches of streams. Unfortunately the habitats necessary for lampreys to complete their life cycles have become degraded, and these species are now confined to a few locations around the state. Ohio lampreys are only found in the Ohio River and the lower portion of its tributary streams. Northern brook lampreys have been found in the Grand and St. Joeseph Rivers in the Lake Erie drainage and several tributaries to the Scioto River in the Ohio River drainage. However, they have only been found in the upper Grand River in recent years. Mountain brook lampreys are only found in the Mahoning river drainage in Ohio. The only known existing populations are in Eagle Creek and the West Branch of the Mahoning River.

Threatened Fish

Thirteen species of fish are listed as threatened in Ohio, and nearly all are river/stream species whose ranges have decreased as the habitat and water quality that they require has decreased. The bigeye shiner is one of several minnow species that were once much more abundant in Ohio than they are today. This species was once well distributed in the historically small, meandering, clear prairie streams of western Ohio. Today these streams have mostly been converted to straight muddy drainage ditches that are uninhabitable to this and other sensitive species. Bigmouth shiners have a small distribution in Ohio, primarily in the Rocky and Black river drainages of Lake Erie.

The western tonguetied minnow is only found in southwest Ohio in the Great Miami and Little Miami River systems. They were once rather well distributed in the upper portion of both of these river systems but today can only be found in the Mad River and tributaries of it in the Great Miami River system. The mountain madtom had been reduced to a few remnant populations but because of improvements in water quality they appear to be making a comeback. Populations now occur in parts of the Little Miami, Muskingum, Walhonding, and Tuscarawas Rivers. Paddlefish are found in the Ohio River and up to the first dam on its larger tributaries. Historically they were much more common and could be found as far up the Ohio River as Pennsylvania. It is also probable that there was a small population in Lake Erie at one time. Today paddlefish are most common in the Ohio River from Portsmouth downstream to the Indiana state line. Blue suckers are not uncommon in fast, gravel-bottomed chutes of the lower Scioto River, from around Piketon downstream to the Ohio River. They are also present in the lower portions of the Great and Little Miami, Muskingum, and Hocking Rivers, and can be found in the Ohio River.

Historically the Tippecanoe darter was found in the Walhonding River, the lower Muskingum River, and in the Olentangy River, Big Walnut Creek, Big Darby Creek, and Deer Creek of the Scioto River drainage. Since the early 1980's they have expanded their distribution in the Scioto River drainage. Unfortunately they appear to have been extirpated from the Muskingum River drainage with the exception of a small population in the lower end of the Muskingum River.

Channel darters appear to be a victim of invasive species in a significant portion of their range. Up until the invasion of the round goby, large schools of channel darters could be observed on the bars around the Lake Erie islands. It is now likely the Lake Erie population no longer exists. They are still found in the Ohio River and the lower portion of the Scioto, Muskingum and Hocking Rivers. There may also be a small remnant population in the lower Maumee and Sandusky Rivers in the Lake Erie drainage. Greater redhorse are now largely confined to limited portions of the Sandusky, Maumee, and Grand River systems where water quality and substrates are less impacted by local land use. The river darter has historically been found in some of the larger western Lake Erie tributaries, but there are no recent reports of them from the Lake Erie drainage. This species is now limited to the Ohio River and the lower portion of larger tributaries such as the Scioto, Hocking, and Muskingum Rivers. The American eel which spends most of its life in freshwater, but spawns in saltwater may be found at times in any stream in Ohio and in Lake Erie. Sightings of this catadromous species are rare however.

Lake chubsuckers, because of the destruction of much of the permanent wetlands this species relies on, are one of the rarest sucker species found in Ohio. They are primarily found in glacially formed natural lakes often referred to as pothole or kettle lakes. Historically they were found in Nettle Lake of extreme NW Ohio, a group of small pothole lakes between Bellefontaine and Urbana Ohio, and in many small pothole lakes in NE Ohio. Today they are still present in those natural lakes that have clear water and an abundance of aquatic vegetation. Additionally, they can be found in a few larger wetlands like Killbuck marsh, and small populations may still be present in Nettle Lake, Indian Lake, and parts of the Portage Lakes.

Fish Species of Concern

Five fish are listed as species of concern on Ohio’s SGCN list. Two species, (lake whitefish and burbot) are unique to Lake Erie, and are all on the southern edge of their range there. Burbot have never been extremely abundant, but lake whitefish made a substantial contribution to the Lake Erie commercial harvest in the late 1800’s and early 1900’s. Today both species are still present in some numbers.

River redhorse and the eastern sand darter are found in rivers/streams of both the Lake Erie and Ohio River drainage in Ohio. Both species are considered intolerant, and have consequently undergone range reductions. Least darters are relatively well distributed in the western part of Ohio in small sluggish prairie streams that have clear water and significant aquatic vegetation. They are also found in natural lakes and permanent wetlands that also contain large amounts of aquatic vegetation and clear water. Historically this species was probably more widely distributed where appropriate habitat was present.

Table 8. Ohio's Fish Species of Greatest Conservation Need
The conservation status (rank) for each species represents input from professionals in fish taxonomy, distribution, and abundance. This table represents the best professional knowledge available at this time, and as such is subject to modification as additional data is obtained.

Conservation Status Rank*	Common Name	Scientific Name	Species Listing Fed	Species Listing State	Habitat Association	Rangewide Occurrence	Statewide Occurrence	Ohio Population Trend
1	Scioto Madtom	*Noturus trautmani*	E	E	N	E	D	U
2	Diamond Darter	*Crystallaria cincotta*		EX	L, M	B	U	U
3	Popeye Shiner	*Notropis ariommus*		E	K	A	D	U
4	Longhead Darter	*Percina macrocephala*		EX	N	A	U	U
5	American Eel	*Anguilla rostrata*		T	K, L, M	A	C	U
6	Gilt Darter	*Percina evides*		E	L	A	D	U
7	Western Tonguetied Minnow	*Exoglossum laurae*		T	N	A	D	U
8	Spotted Darter	*Etheostoma maculatum*		E	N	A	D	S
9	Paddlefish	*Polyodon spathula*		T	L, M	A	B	I
10	Northern Madtom	*Noturus stigmosus*		E	N	A	D	D
11	Shoal Chub	*Macrhybopsis hyostoma*		E	L, M	B	D	D
12	Bigeye Shiner	*Notropis boops*		T	N	A	D	S
13	Ohio Lamprey	*Ichthyomyzon bdellium*		E	L, M, N	A	D	S
14	Spoonhead Sculpin	*Cottus ricei*		EX	J	B	U	U
15	Alligator Gar	*Lepisosteus spatula*		EX	L, M	B	U	U
16	Mountain Brook Lamprey	*Ichthyomyzon greeleyi*		E	N	A	D	S
17	Lake Sturgeon	*Acipenser fulvescens*		E	J, K, L, M	A	D	S
18	Blue Sucker	*Cycleptus elongatus*		T	L, M	A	D	S
19	Shovelnose Sturgeon	*Scaphirhynchus platorynchus*		E	L, M	A	C	S
20	Tippecanoe Darter	*Etheostoma tippecanoe*		T	M, N	A	D	S
21	Mountain Madtom	*Noturus eleutherus*		T	N	A	D	S
22	Blacknose Shiner	*Notropis heterolepis*		EX	J, K, N, P	A	U	U
23	Northern Brook Lamprey	*Ichthyomyzon fossor*		E	N	A	D	S
24	Mottled Sculpin	*Cottus bairdi*			J, N	A	B	S

25	Bluebreast Darter	*Etheostoma camurum*		L, M, N	A	C	I
26	Silver Lamprey	*Ichthyomyzon unicuspis*		J, K, N	A	C	S
27	Pugnose Minnow	*Opsopoeodus emiliae*	E	N	A	D	D
28	American Brook Lamprey	*Lampetra appendix*		N	A	B	I
29	Eastern Sand Darter	*Ammocrypta pellucida*	SC	J, K, L, M, N	A	C	S
30	Western Banded Killifish	*Fundulus diaphanus menona*	E	J, K, N, P	A	D	D
31	Redside Dace	*Clinostomus elongatus*		N	A	B	I
32	Gravel Chub	*Erimystax x-punctatus*		M, N	A	C	S
33	Least Darter	*Etheostoma microperca*	SC	N	A	C	I
33	Cisco	*Coregonus artedi*	E	J	B	C	D
35	Least Brook Lamprey	*Lampetra aepyptera*		N	A	B	I
36	Burbot	*Lota lota*	SC	J	A	C	S
36	Silver Chub	*Macrhybopsis storeriana*		J, K, L, M	A	B	I
38	Iowa Darter	*Etheostoma exile*	E	J, K, N, P	A	D	S
39	Goldeye	*Hiodon alosoides*	E	L, M	A	C	S
39	Rosyside Dace	*Clinostomus funduloides*		N	B	D	S
41	Streamline Chub	*Erimystax dissimilis*		M, N	A	D	S
42	Bigeye Chub	*Hybopsis amblops*		K, M, N	A	A	S
43	Central Mudminnow	*Umbra limi*		N	A	B	S
44	Channel Darter	*Percina copelandi*	T	J, K, L, M	A	C	S
45	Spotted Gar	*Lepisosteus oculatus*	E	J, K	A	C	D
46	Lake Chubsucker	*Erimyzon sucetta*	T	N, O	A	C	D
47	Longnose Sucker	*Catostomus catostomus*	E	J	B	D	D
48	Bigmouth Shiner	*Notropis dorsalis*	T	N	A	D	S
48	Black Redhorse	*Moxostoma duquesnei*		J, K, L, M, N	A	B	I
50	Mooneye	*Hiodon tergisus*		J, K, L, M	A	B	S
51	Pirate Perch	*Aphredoderus sayanus*	E	N, P	B	D	D
52	Silver Redhorse	*Moxostoma anisurum*		K, L, M, N	A	B	I

53	Variegate Darter	*Etheostoma variatum*		M, N	A	B	S
54	Southern Redbelly Dace	*Phoxinus erythrogaster*		N	A	A	I
55	Greater Redhorse	*Moxostoma valenciennesi*	T	K, N	A	C	S
56	Black Buffalo	*Ictiobus niger*		L, M	A	B	S
57	Lake Whitefish	*Coregonus clupeaformis*	SC	J	A	C	D
58	Dusky Darter	*Percina sciera*		L, M, N	A	C	S
58	Creek Chubsucker	*Erimyzon claviformis*		N	A	B	S
60	Shortnose Gar	*Lepisosteus platostomus*	E	L, M	A	D	S
61	River Darter	*Percina shumardi*	T	J, K, L, M	A	D	S
62	Mississippi Silvery Minnow	*Hybognathus nuchalis*	EX	L, M	B	U	U
63	River Redhorse	*Moxostoma carinatum*	SC	L, M	A	C	S
63	Smallmouth Redhorse	*Moxostoma breviceps*		L, M, N	A	B	I

* Rank derived from Conservation Status Score calculated using Millsap et al. (1990) modified for Ohio. The order in which species with the same conservation status rank (i.e., ties) are listed does not imply differences between these species.

Habitat Association Key
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C = wetlands
D = caves & mines
E = oak savannahs
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H = riparian corridors
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4.4.7 Taxa Group: Mussels

In light of their historical decreasing abundance and distribution, mussels are generally considered to be the most imperiled group of organisms in North America. In Ohio, over half of our native mussel species are now listed (24 endangered, 4 threatened, 8 species of concern), extirpated (11), or extinct (6). Habitat degradation/destruction and harvest have historically been the primary culprits in the decline of mussel species, and recently ANS in the form of zebra mussels have contributed.

Ohio has an especially rich heritage of freshwater mussels, from both a biological and a historical perspective. Eighty species have been reported from the state. This number represents 27% of all mussel species known to be from North America (Watters et al. 2009). Major factors responsible for the decline in mussel species diversity and distribution have been the construction of impoundments, dredging of streams for navigation and flood control, sediments from agricultural and construction activities, and the addition of a wide spectrum of solid, semisolid, and liquid waste materials from the industries of a rapidly growing human population (Watters et al. 2009). Mussel research in Ohio has focused primarily on trying to stem the tide of extirpations – consequently listed mussel species have been at the forefront of most of these efforts. Recent research has included the construction of refugia for mussel species facing extirpation due to the expansion of the zebra mussel, laboratory efforts to identify hosts for imperiled mussel species, captive rearing of listed species, and reintroduction efforts.

The following species information has been assembled from Watters (1992,1995), Watters et al. (2009), NatureServe (2014), and the USFWS Midwest Endangered Species website at http://www.fws.gov/midwest/endangered/index.html unless otherwise noted.

Endangered Mussels

The northern riffleshell was historically found in the Ohio River and Maumee River drainages, and in a few tributaries of western Lake Erie. Today, the northern riffleshell occurs only in Big Darby Creek. Similarly, the clubshell historically was commonly found in the Ohio River basin and tributaries of western Lake Erie. Presently it is known from relatively few streams in Ohio, including Big Darby Creek. Efforts to augment the Big Darby Creek population of both the northern riffleshell and clubshell began in 2008 with the translocation of mussels from Pennsylvania.

The rabbitsfoot was once common in Lake Erie and Ohio River drainages. Today it is known only from Fish Creek, Killbuck Creek, Big Darby Creek, Little Darby Creek, and the Walhonding River. The rayed bean historically occurred in parts of the upper and lower Great Lakes systems, and throughout most of the Ohio and Tennessee River systems. It was common in many Ohio River system streams, and the population in Lake Erie was once considerable (but has been eliminated by the zebra mussel). Today the distribution of the rayed bean has been limited to Swan Creek, Fish Creek, Blanchard River, Tymochtee Creek, Walhonding River, Mill Creek, Big Darby Creek, Scioto Brush Creek; Great Miami River, Little Miami River (including the East Fork), and Stillwater River.

The snuffbox has been historically found in both the Lake Erie and Ohio River drainages. It has declined rangewide and is now estimated to occupy about 38 percent of originally occupied streams. It is estimated that total range reduction and overall population losses for the snuffbox each approximate 90 percent. Its current distribution Ohio is now limited to the Grand River, Ohio River, Muskingum River, Walhonding River, Killbuck Creek, Olentangy River, Big Darby Creek, Little Darby Creek, Salt Creek, Scioto Brush Creek, South Fork of Scioto Brush Creek, Little Miami River, and Stillwater River. Most populations are small and isolated, further increasing their risk of extinction.

The white cat's paw is currently known to exist only in a 3-mile portion of Fish Creek in Williams County in northwest Ohio. Records indicate that the white cat's paw historically occurred in the Maumee and St. Joseph rivers, and Fish Creek. It may have also occurred in the Ohio River. The last observation of a live white cat's paw pearly mussel occurred in 1999. The eastern pondmussel is present in Lake Erie and the Cuyahoga River, the Bass Islands of Lake Erie, and much of Lake Erie proper. Previous records from the Muskingum River are thought to be erroneous. Invasive zebra mussels are a major threat to this species in the lower Great Lakes. The purple lilliput is very rare if not extirpated. It was previously found in the

Maumee River drainage (Fish Creek, St. Joseph River, Blanchard River). Also a single record for the Little Miami River exists.

The fanshell historically occurred in the Ohio River and many of its large tributaries in Ohio. Presently, the fanshell is believed to be reproducing in only three rivers in Kentucky, Tennessee and Virginia. A few small (likely nonreproducing) populations (based on the collection of a few old specimens in the 1980s) may still persist in the Muskingum River. The pink mucket was historically found in the Ohio River tributaries in Ohio, but may now be extirpated in Ohio. The purple cat's paw historically occurred in the Ohio River and its larger tributaries in Ohio. Today it is one of the rarest mussels, considered to be on the brink of extinction. When listed as endangered in 1990 it was considered functionally extinct. However in 1994 a reproducing population was discovered in Killbuck Creek in northeast Ohio.

Historically, the sheepnose occurred in the Ohio River drainage and tributaries including the Muskingum, Tuscarawas, Walhonding, Mohican, Scioto, and Little Miami rivers. Today the sheepnose is found (but rare) in most mainstem pools of the Ohio River. Two additional rivers, the Muskingum River and its tributary the Walhonding River, have unknown populations. The ebonyshell is now extirpated from the Scioto River (where it formerly occurred up to Columbus), the lower Muskingum River, and much of the Ohio River. The butterfly is presently limited to the lower Muskingum River and Ohio River, but can be locally common.

The elephantear is common in the Ohio River and rarer in the upstream sections of smaller tributaries, but does not reach the Lake Erie drainage. It historically was found in the Scioto River to Columbus and Tuscarawas River at New Philadelphia. The longsolid is believed extirpated from the Scioto River (where it formerly occurred up to Columbus), and Great Miami River (only a single record known). It is now limited to the Muskingum River system where it is rare, including Tuscarawas and Walhonding Rivers. The pocketbook was once found in larger creeks and rivers throughout Ohio, but today may only occur in the Muskingum and Scioto River drainages (where it is rare), and perhaps Ohio Brush Creek. It is extirpated from the Black River as well as the Great Miami River.

The yellow sandshell is now extirpated from the state except for one site in lower Ohio Brush Creek where the last live specimen was collected in 1988. It is however, locally common below the Gallipolis Lock and Dam in the Ohio River. The washboard is sporadic in many streams in the southern part of the state, but may only be reproducing in the lower Muskingum River and Ohio River mainstem. It is absent from the Lake Erie drainage. The Ohio pigtoe is limited to the lower Muskingum River, Big Darby Creek, and a few sites in the Ohio River. This species was recently reported for the first time in Ohio Brush Creek (Matter et al., 2006). It is apparently extirpated from a number of other tributaries in Ohio.

The pyramid pigtoe historically occurred in the Ohio River from Marietta to Cincinnati, the Muskingum River to the Tuscarawas River, and the Scioto River in Pickaway County, but today is limited to the lowest reaches of the lower Muskingum River where it is rare. The wartyback historically may have lived in the lowest reaches of larger Ohio River tributaries, but is now limited to the Ohio River at Cincinnati and Ohio Brush Creek. It was historically as far upstream in the Ohio River as Portsmouth, and is now extirpated from the lower Great Miami River, and only a single stray record exists from the Scioto River at Columbus. The little spectaclecase is uncommon and on the northern edge of its range in Ohio, but occurs in Salt Ceek, Symmes Creek, Little Miami River, Ohio Brush Creek, Pine Creek, and several other southern Ohio creeks. The monkeyface is now limited to the lower Muskingum and Ohio Rivers.

Threatened Mussels

The black sandshell was historically found in most of Ohio, but now only in the mainstem and west branch of the St. Joseph River, Big Darby Creek, Muskingum River, and Walhonding River. The threehorn wartyback is sporadic in rivers in the southern part of the state, including Ohio Brush Creek (Hoggarth et al. 2007), the Muskingum River, Little Miami River, and Scioto River. It may be extirpated from the Lake Erie drainage. The fawnsfoot is now found in some Ohio River tributaries (Little Miami, Scioto, Muskingum, and Hocking rivers), and western Lake Erie and tributaries (Maumee, Portage, and Vermillion rivers), but is rare in the Ohio River. It was recently found in Ohio Brush Creek (Matter et al. 2006). The pondhorn is localized in prairie areas like Hellbranch Run, Big Darby Creek, Olentangy River (all upper Scioto drainage), and Salt Creek (lower Scioto drainage) in Jackson County. It has also been found in Lake Erie embayments and tributaries.

Mussel Species of Concern
The purple wartyback is found in the Ohio River drainage (Great and Little Miami, upper Muskingum, and Scioto rivers, and Ohio Brush Creek), and the western Lake Erie drainage (absent from northeast Ohio), including the Maumee and Sandusky rivers.

The round pigtoe was historically widespread but has declined, with only a few recent records from the St. Joseph River and tributaries in Williams County, Olentangy River, Big and Little Darby creeks, Caesar Creek, Walhonding River, lower Muskingum River, and western basin of Lake Erie. The salamander mussel is considered rare (but widespread) in Ohio, and is known from the Grand River, St. Joseph River, Big Darby Creek, Little Miami River, Ohio Brush Creek, lower Little Scioto River, Salt Creek, and Symmes Creek (Raccon Creek basin) (Hoggarth et al. 2007). It was historically recorded from the Ohio Canal at New Philadelphia, Tuscarawas River, Scioto River at Columbus, Sandusky Bay, upper Scioto River, and Licking River. Weathered shells have recently been found in the Muskingum River at Marietta.

The deertoe is uncommon but apparently widespread in Ohio. Likewise, the kidneyshell is widespread but sporadic, though it can be locally abundant in locations like Fish Creek and Big and Little Darby Creeks. The elktoe has over 100 occurrences primarily in larger free-flowing creeks in many Ohio River and Lake Erie tributaries. It is rare in unglaciated Ohio and likely extirpated from Swan Creek (lower Maumee drainage) (Grabarciewicz 2008). The creek heelsplitter is found throughout (but sporadically) the Lake Erie and Ohio River drainages, Swan Creek (lower Maumee drainage) (Grabarciewicz 2008), and Raccoon Creek (Hoggarth et al. 2007).

Table 9. Ohio's Mussel Species of Greatest Conservation Need The conservation status (rank) for each species represents input from professionals in mussel taxonomy, distribution, and abundance. This table represents the best professional knowledge available at this time, and as such is subject to modification as additional data is obtained.								
Conservation Status Rank*	Common Name	Scientific Name	Species Listing Fed	 State	Habitat Association	Rangewide Occurrence	Statewide Occurrence	Ohio Population Trend
1	White Wartyback	*Plethobasus cicatricosus*	E	EX	L, M	B	U	U
2	White Catspaw	*Epioblasma obliquata perobliqa*	E	E	N	E	D	D
3	Purple Catspaw	*Epioblasma obliquata obliquata*	E	E	N	E	D	D
3	Pink Mucket	*Lampsilis abrupta*	E	E	L	B	D	U
5	Snuffbox	*Epioblasma triquetra*		E	J, K, M	C	B	D
6	Long Solid	*Fusconaia subrotunda*		E	L, M	C	C	D
7	Little Spectaclecase	*Villosa lienosa*		E	N	B	D	D
8	Pyramid Pigtoe	*Pleurobema rubrum*		E	L, M	A	D	D
8	Ebonyshell	*Fusconaia ebena*		E	L, M	A	D	U
8	Elephantear	*Elliptio crassidens*		E	L, M	A	C	D
8	Eastern Pondmussel	*Ligumia nasuta*		E	J, K	A	C	D
12	Orange-foot Pimpleback	*Plethobasus cooperianus*	E	EX	L, M	B	U	U
13	Ohio Pigtoe	*Pleurobema cordatum*		E	L, M	A	C	D
13	Sheepnose	*Plethobasus cyphyus*	E	E	L, M	A	D	D
15	Purple Lilliput	*Toxolasma lividum*		E	K, N	B	D	D
16	Monkeyface	*Quadrula metanevra*		E	L, M	A	C	D
16	Slippershell Mussel	*Alasmidonta viridis*			J, K, L, M, N	A	A	D
18	Winged Mapleleaf	*Quadrula fragosa*	E	EX	L, M	B	U	U
18	Ring Pink	*Obovaria retusa*		EX	L, M	B	U	U
18	Scaleshell	*Leptodea leptodon*		EX	L, M	B	U	U
21	Rayed Bean	*Villosa fabalis*	E	E	J, K, M, N	A	C	D
21	Butterfly	*Ellipsaria lineolata*		E	L, M	A	C	D
23	Creek Heelsplitter	*Lasmigona compressa*		SC	J, K, M, N	A	A	D
23	Pondhorn	*Uniomerus tetralasmus*		T	J, N, M	A	D	D

25	Rabbitsfoot	*Quadrula cylindrica*	T	E	K, M, N	A	C	D
25	Wartyback	*Quadrula nodulata*		E	L, M	A	D	D
25	Salamander Mussel	*Simpsonaias ambigua*		SC	K, M, N	A	C	D
25	Fanshell	*Cyprogenia stegaria*	E	E	L, M	A	D	D
29	Grooved Fingernailclam	*Sphaerium simile*			Q	A	A	U
29	Long Fingernailclam	*Musculium transversum*			Q	A	A	U
29	Ridged-back Peaclam	*Pisidium compressum*			Q	A	A	U
29	River Fingernailclam	*Sphaerium fabale*			Q	A	A	U
29	River Peaclam	*Pisidium fallax*			Q	A	A	U
29	Striated Fingernailclam	*Sphaerium striatinum*			Q	A	A	U
35	Rough Pigtoe	*Pleurobema plenum*	E	EX	L, M	A	U	U
35	Clubshell	*Pleurobema clava*	E	E	K, M, N	A	C	D
37	Yellow Sandshell	*Lampsilis teres*		E	L, M	A	D	D
37	Purple Wartyback	*Cyclonaias tuberculata*		SC	K, M, N	A	B	D
39	Spectaclecase	*Cumberlandia monodonta*		EX	L, M	A	U	U
40	Washboard	*Megalonaias nervosa*		E	L, M	B	C	D
40	Threeridge	*Amblema plicata*			J, K, L, M, N	A	A	D
42	Pocketbook	*Lampsilis ovata*		E	L, M	A	D	D
42	Round Hickorynut	*Obovaria subrotunda*			J, K, M, N	A	C	D
42	Cracking Pearlymussel	*Hemistena lata*	E	EX	L, M	A	U	U
45	Pond Fingernailclam	*Musculium securis*			Q	A	A	U
45	Ubiquitous Peaclam	*Pisidium casertanum*			Q	A	A	U
47	Black Sandshell	*Ligumia recta*		T	K, M, N	A	B	S
48	Kidneyshell	*Ptychobranchus fasciolaris*		SC	J, K, M, N	A	A	D
48	Northern Riffleshell	*Epioblasma torulosa rangiana*	E	E	J, K, L, M	A	D	D
50	Rainbowshell	*Villosa iris*			J, K, N, M	A	B	D
50	Round Pigtoe	*Pleurobema sintoxia*		SC	J, K, L, M, N	A	B	D
52	Elktoe	*Alasmidonta marginata*		SC	J, K, L, M	A	A	D

53	Deertoe	*Truncilla truncata*	SC	J, K, L, M	A	B	D
53	Fawnsfoot	*Truncilla donaciformis*	T	J, K, L, M	A	B	D
55	Threehorn Wartyback	*Obliquaria reflexa*	T	J, K, L, M	A	B	S
56	Fat Pocketbook	*Potamilus capax*	E EX	L, M	A	U	U
56	Cylindrical Papershell	*Anodontiodes ferussacianus*		J, K, M, N	A	A	S

* Rank derived from Conservation Status Score calculated using Millsap et al. (1990) modified for Ohio. The order in which species with the same conservation status rank (i.e., ties) are listed does not imply differences between these species.

Habitat Association Key
A = grassland
B = forest
C = wetlands
D = caves & mines
E = oak savannahs
F = Lake Erie islands
G = boreal communities
H = riparian corridors
I = artificial/man-made environments
J = Lake Erie
K = Lake Erie Tributaries
L = Ohio River
M = Ohio River Tributaries
N = headwater and small inland streams
O = man-made lakes and ponds
P = natural lakes
Q = generalist

Statewide Occurrence Key
A = broadly distributed (>30 counties)
B = common (11-29 counties)
C = uncommon (6-10 counties)
D = rare (<5 counties)
E = unknown

Rangewide Occurrence Key
A = extensive range (multiple states/Canada) – which includes Ohio
B = periphery of range is in Ohio
C = disjunct from main portion of its range; occurs in Ohio
D = center of range in/near Ohio
E = very limited range with most of its rangewide population occurring in Ohio

Ohio Population Trend Key
D = decreasing
I = increasing
S = stable
U = unknown

Species Listing Key
E = endangered
T = threatened
SC = species of concern
SI = species of interest
EX = extirpated

4.4.8 Taxa Group: Crayfish

The list of crayfishes of the United States and Canada includes 363 taxa. The conservation status categories of “Possibly Extinct”, “Endangered”, “Threatened”, or “Vulnerable” are recognized for 174 taxa (47.9%). Of these, 2 (< 1%) are possibly Extinct, 66 (18.2%) are Endangered, 52 (14.3%) are Threatened, and 54 (14.9%) are Vulnerable. Taxa classified as currently stable total 189 (52.1%). The number of imperiled crayfishes (48%) is on a level similar to that of freshwater mussels (Taylor et al. 2007).

For many crayfishes, limited natural range (e.g., one locality or one drainage system) drives recognition as Endangered or Threatened; but for many others, status assignments continue to be hampered by a lack of current distributional information. While progress has been made in this area, basic ecological and current distributional information are lacking for 60% of the U.S. and Canadian fauna. In addition, threats such as habitat loss and the introduction of nonindigenous crayfishes are greatly magnified by the limited distributions of many species. While taxa with restricted natural ranges are particularly vulnerable to habitat destruction or degradation, the recognized displacement abilities of nonindigenous crayfishes when coupled with a high level of endemism represent a threat of unequalled severity (Taylor et al. 2007).

Twenty-one species of crayfish occur in Ohio – on Ohio’s SGCN list the cavespring crayfish is listed as threatened, and the northern clearwater crayfish and virile crayfish are listed as species of concern.

Threatened Crayfish

The cavespring crayfish is know from only two sites in unglaciated sections of Ohio (R. Thoma, personal communication), however, rangewide there are no known major threats for this species and population numbers are believed to be stable.

Crayfish Species of Concern

The northern clearwater crayfish is confined to the Lake Erie basin, primarily in northeast Ohio where it is found in the lake and its tributaries. It has either disappeared or been reduced in abundance from much of its original Ohio range (Thoma and Jezerinac 2000). Like a number of crayfish species, it is impacted by water quality as well as the presence of rusty crayfish. The virile crayfish has a very restricted range in Ohio, being found only in the East branch of the Chagrin River. This population in the Chagrin basin is believed to be a relict remaining from a wider distribution that existed when the climate was colder (Thoma and Jezerinac 2000).

Table 10. Ohio's Crayfish Species of Greatest Conservation Need
The conservation status (rank) for each species represents input from professionals in crayfish taxonomy, distribution, and abundance. This table represents the best professional knowledge available at this time, and as such is subject to modification as additional data is obtained.

Conservation Status Rank*	Common Name	Scientific Name	Species Listing Fed	Species Listing State	Habitat Association	Rangewide Occurrence	Statewide Occurrence	Ohio Population Trend
1	Teays River Crayfish	*Cambarus sciotensis*			M	E	C	D
2	Norwood River Crayfish	*Orconectes raymondi*			M	E	D	D
3	Devil Crayfish	*Cambarus diogenes*			C, N	B	D	D
4	Northern Clearwater Crayfish	*Orconectes propinquus*		SC	J, K, N	B	C	D
5	Digger Crayfish	*Fallicambarus fodiens*			C, F	B	B	D
6	Sanborn's Crayfish	*Orconectes sanbornii*			K, M, N	D	A	D
7	Big Water Crayfish	*Cambarus robustus*			J, K, M	A	B	D
8	Paintedhand Mudbug	*Cambarus polychromatus*			C, K, M, N	A	B	S
9	Little Brown Mudbug	*Cambarus thomai*			C, K, M, N	A	A	S
10	Ortman's Mudbug	*Cambarus ortmanni*			N	A	B	S
11	Spiney Stream Crayfish	*Orconectes cristavarius*			M, N	B	D	D
12	Cave Spring Crayfish	*Cambarus tenebrosus*		T	D, N	B	D	S
13	Red Swamp Crayfish	*Procambarus clarkii*			C, J, M	C	D	I
13	Papershell Crayfish	*Orconectes immunis*			K, N, M	B	B	S
13	Virile Crayfish	*Orconectes virilis*		SC	K, N, M	B	D	D

* Rank derived from Conservation Status Score calculated using Millsap et al. (1990) modified for Ohio. The order in which species with the same conservation status rank (i.e., ties) are listed does not imply differences between these species.

Habitat Association Key
A = grassland
B = forest
C = wetlands
D = caves & mines
E = oak savannahs
F = Lake Erie islands
G = boreal communities
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SI = species of interest
EX = extirpated

4.4.9 Taxa Group: Aquatic Invertebrates

The Division's statutory authority for management of aquatic invertebrates is limited to species classified as endangered only. Consequently, data on the status of the majority of aquatic invertebrates is extremely limited, and the primary reason that conservation status ranks have not been determined for most invertebrate species groups. The Division of Wildlife has statutory authority for the conservation of 22 species of aquatic invertebrates designated as endangered in Ohio, 17 of which occur on Ohio's SGCN list (13 dragonflies, 3 damselflies, 1 midge). As noted earlier in this section however, the only taxa group for which sufficient data exists to permit calculation of conservation status scores/ranks is dragonflies and damselflies.

As a group, odonates are not well understood, and our knowledge of the status of Odonata in Ohio is certainly limited by lack of information. Odonates are not an easy group to study for a number of reasons. Approximately 20% of North American species cannot be accurately identified as larvae. There are also very few detailed analyses of the total life history of Odonata species. Several species observed in Ohio are only accidentals, such as the Georgia River Cruiser, Striped Saddlebags, Little Blue Dragonlet, Band-winged Dragonlet, and Golden-winged Skimmer.

To date, 164 species of odonates have been recorded in Ohio, many of which have appeared outside of their normal range. The newest addition to Ohio's Odonata were several striped saddlebags which were found in late summer of 2006 at Magee Marsh Wildlife Area on western Lake Erie – far from their normal range in the extreme southern U.S. Dragonflies and damselflies spend the majority of their life as eggs or larvae in the water. Since Ohio has lost over 90 percent of its wetlands and many of its rivers and streams have been adversely impacted by pollution, it's not surprising that 16 species of Odonata have been listed as endangered in Ohio. The cause of endangerment in every case has been habitat destruction or degradation. The solution to protecting dragonflies and damselflies is to protect our aquatic resources.

Endangered Dragonflies & Damselflies

The yellow-sided skimmer is known from only a single site in Ohio - an acidic sphagnum pond in a sand mining site privately owned in Pike County. The racket-tailed emerald was known historically from a single boggy pond in Geauga County, but not seen there since 1924. An apparently healthy population was discovered in 1999 at Singer Lake Bog in Summit County and a smaller population was found in 2002 near the historic site in Geauga County. Since the racket-tailed emerald seems confined to boggy pond and lake edges, the draining of wetlands likely caused significant loss of this species.

Throughout its range, the elfin skimmer lives in widely scattered populations. Ohio's populations are 130 miles apart, and an equal distance from the next closest known populations. Elfins were known to occur at three areas around the state between 1930 and 1960 before they disappeared due to drainage for agriculture and other habitat changes. This species is currently known only from Cedar Bog Nature Preserve in Champaign County, and Singer Lake Bog and Myersville Fen Preserve in Summit County. It is unknown why this species does not survive at other remnant fens or bogs in Ohio.

The Hine's emerald dragonfly was discovered by Professor James Hine, first curator of natural history of the Ohio Historical Society, from specimens in a shallow stream near Indian Lake in west central Ohio. Once known from the Indian Lake area of Logan County, around Mud Lake in Williams County, and the Oak Openings of Lucas County, it is possibly now extirpated from Ohio, having not been found since 1961.

The river jewelwing has been reported from Geauga, Portage, and Williams counties.

Threatened Dragonflies & Damselflies

The riffle snaketail has been reported from Columbiana, Geauga, Jefferson, and Lake counties.

Dragonfly & Damselfly Species of Concern

The tiger spiketail has been reported from Adams, Ashland, Belmont, Fairfield, Hocking, Licking, Richland, and Ross counties.

Table 11. Ohio's Aquatic Invertebrate Species of Greatest Conservation Need
The conservation status (rank) for each species represents input from professionals in odonate taxonomy, distribution, and abundance. This table represents the best professional knowledge available at this time, and as such is subject to modification as additional data is obtained.

Conservation Status Rank*	Common Name	Scientific Name	Species Listing Fed	Species Listing State	Habitat Association	Rangewide Occurrence	Statewide Occurrence	Ohio Population Trend
1	Appalachian Jewelwing	*Calopteryx angustipennis*			K	B	D	D
2	Atlantic Bluet	*Enallagma doubledayi*			O	C	D	D
3	Riverine Clubtail	*Stylurus amnicola*			K, M	B	D	D
4	Little Blue Dragonlet	*Erythrodiplax minuscula*			N, O	B	D	D
5	Taper-Tailed Darner	*Gomphaeschna antilope*			C	B	D	D
6	Variable Darner	*Aeshna interrupta*			K, O	C	D	D
6	Incurvate Emerald	*Somatochlora incurvata*			C	B	D	U
6	Kennedy's Emerald	*Somatochlora kennedyi*			C	C	D	U
9	Spine-crowned Clubtail	*Gomphus abbreviatus*			K	B	D	D
10	Sphagnum Sprite	*Nehalennia gracilis*			C, N	A	C	D
10	Hine's Emerald	*Somatochlora hineana*	E	E	C, N	B	D	D
12	Tiaga Bluet	*Coenagrion resolutum*			C, O	B	D	D
13	Hagen's Bluet	*Enallagma hageni*			C, O	A	B	D
14	Golden-winged Skimmer	*Libellula auripennis*			K, O	B	D	D
15	Eastern Red Damsel	*Amphiagrion saucium*			C, N	A	A	S
15	Mottled Darner	*Aeshna clepsydra*		E	O	B	D	D
17	Seepage Dancer	*Argia bipunctulata*		E	N, O	C	D	D
18	Band-Winged Dragonlet	*Erythrodiplax umbrata*			C, O	C	D	D
19	Yellow-sided Skimmer	*Libellula flavida*		E	C	B	D	D
20	Umber Shadowdragon	*Neurocordulia obsoleta*			K, M, O	B	C	D
21	Green-faced Clubtail	*Gomphus viridifrons*		T	K, M	A	C	D
22	Boreal Bluet	*Enallagma boreale*		T	C, K, O	B	C	D
23	Saffron-winged Meadowhawk	*Sympetrum costiferum*			O	A	C	D
24	River Jewelwing	*Calopteryx aequabilis*		E	K, N	A	C	D

24	Marsh Bluet	*Enallagma ebrium*	T	C, O	A	B	D
24	Furtive Forktail	*Ischnura prognata*		C, O	C	D	D
24	Canada Darner	*Aeshna canadensis*	E	C	A	D	D
28	Eastern Ringtail	*Erpetogomphus designatus*		K, M	B	D	D
29	Elusive Clubtail	*Stylurus notatus*		K, M, O	A	B	S
30	Aurora Damsel	*Chromagrion conditum*		C, N	A	A	D
30	Turquoise Bluet	*Enallagma divagans*		K, M, N	A	B	D
32	Cherry-faced Meadowhawk	*Sympetrum internum*		C, K, M, O	A	C	D
33	Southern Pygmy Clubtail	*Lanthus vernalis*		N	B	D	S
34	Striped Saddlebags	*Tramea calverti*		O	C	D	U
35	American Emerald	*Cordulia shurtleffii*	E	C	B	D	D
36	Sedge Sprite	*Nehalennia irene*		C, O	A	B	D
37	Harlequin Darner	*Gomphaeschna furcillata*	T	C	B	D	S
37	Skillet Clubtail	*Gomphus ventricosus*		K, M	A	C	S
37	Northern Pygmy Clubtail	*Lanthus parvulus*		N	B	B	D
37	Brown Spiketail	*Cordulegaster bilineata*		C	A	D	D
37	Racket-tailed Emerald	*Dorocordulia libera*	E	C, O	B	D	S
42	Smokey Rubyspot	*Hetaerina titia*		K, M	A	C	D
43	Georgia River Cruiser	*Macromia illinoiensis georgina*		K	A	D	D
43	Stygian Shadowdragon	*Neurocordulia yamaskanensis*		K, M, O	A	C	D
43	Plains Emerald	*Somatochlora ensigera*		N	B	D	D
46	Gray Petaltail	*Tachopteryx thoreyi*		C	A	B	S
46	Frosted Whiteface	*Leucorrhinia frigida*	E	C, O	A	D	S
46	Elfin Skimmer	*Nannothemis bella*	E	C	A	D	D
49	Allegheny River Cruiser	*Macromia alleghaniensis*		K, M	B	C	D
49	Brush-tipped Emerald	*Somatochlora walshii*	E	C, N	B	D	D
51	Spatterdock Darner	*Aeshna mutata*		C	A	B	D
52	Northern Bluet	*Enallagma cyathigerum*	T	C, O	A	D	D

53	Rapids Clubtail	*Gomphus quadricolor*		K, M, N, O	A	B	I
53	Uhler's Sundragon	*Helocordulia uhleri*	E	N, O	B	D	D
55	Riffle Snaketail	*Ophiogomphus carolus*	T	N	B	D	D
56	Laura's Clubtail	*Stylurus laurae*		K, M, N	B	D	D
57	Tiger Spiketail	*Cordulegaster erronea*	SC	N	A	C	I
58	Splendid Clubtail	*Gomphus lineatifrons*		K, N	A	C	S
59	Dusky Clubtail	*Gomphus spicatus*		C, O	A	B	D
60	Lilypad Forktail	*Ischnura kellicotti*	E	O	B	D	S
60	Russet-tipped Clubtail	*Stylurus plagiatus*		K, M, O	B	C	S
60	Gilded River Cruiser	*Macromia pacifica*		K, M, O	B	C	I
60	Smoky Shadowdragon	*Neurocordulia molesta*		K, M	B	B	S
64	Ocellated Darner	*Boyeria grafiana*		N, O	A	C	S
64	Handsome Clubtail	*Gomphus crassus*		K, M, N	A	C	U
64	Chalk-fronted Corporal	*Libellula julia*	E	C, O	A	D	D
67	Beaverpond Baskettail	*Epitheca canis*		K, O	B	D	S
68	Common Sanddragon	*Progomphus obscurus*		K, M, N, O	A	B	I
69	Rusty Snaketail	*Ophiogomphus rupinsulensis*		N	A	B	S
69	Delta-spotted Spiketail	*Cordulegaster diastatops*		N	B	C	S
69	Twin-spotted Spiketail	*Cordulegaster maculata*		K, M, N	A	B	S/I
69	Arrowhead Spiketail	*Cordulegaster obliqua*		N	A	B	S
73	Wabash River Cruiser	*Macromia wabashensis*		K, M, O	E	D	S
74	Comet Darner	*Anax longipes*		C, O	A	B	I
74	Plains Clubtail	*Gomphus externus*	E	K, M	B	C	S/I
n/r	Midge	*Rheopelopia acra*	E	K	E	D	U

* Rank derived from Conservation Status Score calculated using Millsap et al. (1990) modified for Ohio. The order in which species with the same conservation status rank (i.e., ties) are listed does not imply differences between these species.

n/r = insufficient information on the species to calculate a Conservation Status Score using Millsap et al. (1990)

Habitat Association Key
A = grassland
B = forest
C = wetlands
D = caves & mines
E = oak savannahs
F = Lake Erie islands
G = boreal communities
H = riparian corridors
I = artificial/man-made environments
J = Lake Erie
K = Lake Erie Tributaries
L = Ohio River
M = Ohio River Tributaries
N = headwater and small inland streams
O = man-made lakes and ponds
P = natural lakes
Q = generalist

Statewide Occurrence Key
A = broadly distributed (>30 counties)
B = common (11-29 counties)
C = uncommon (6-10 counties)
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Rangewide Occurrence Key
A = extensive range (multiple states/Canada) – which includes Ohio
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Ohio Population Trend Key
D = decreasing
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Species Listing Key
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T = threatened
SC = species of concern
SI = species of interest
EX = extirpated

4.4.10 Taxa Group: Terrestrial Invertebrates

The Division's statutory authority for management of terrestrial invertebrates is limited to species classified as endangered only. Consequently, data on the status of the majority of terrestrial invertebrates is extremely limited, and the primary reason that conservation status ranks have not been determined for most invertebrate species groups. As data gaps are filled in the future, more species will be given conservation status ranks. The Division of Wildlife has statutory authority for the conservation of 24 terrestrial invertebrate species designated as endangered in Ohio, 9 of which occur on Ohio's SGCN list (6 butterflies, 1 skipper, 2 beetles). As noted earlier in this section however, the only taxa group for which sufficient data exists to permit calculation of conservation status scores/ranks is butterflies and skippers.

Endangered Invertebrates

The Mitchell's satyr butterfly is associated with fens supporting lush stands of sedges and bullrush. It was recorded in 1 location in northeastern Ohio in the 1920s and may be extirpated. However, continued attempts to locate this species in Ohio and identify its host plant are needed. Both the swamp metalmark and the purplish copper butterflies are also found in association with fens. The swamp metalmark is known from only 2 locations while the purplish copper has a wider western (10 counties) distribution. Continued surveys by members of the Ohio Lepidopterists Society may find additional locations for these 2 butterflies.

The regal fritillary butterfly is associated with tall grass prairie and other open sites including wet meadows, marshes, and wet fields. It is rapidly declining over much of its range. In addition to development or conversion of grasslands to agriculture, remaining prairie has been affected by pesticide use and fire (usually prescribed burning) in ways that impact butterfly populations. A better understanding of the impact of fire on butterfly populations, and efforts to restore prairies and wetlands in areas where the regal fritillary still occur may help stabilize its population.

The eastern Persius dusky wing butterfly and the frosted elfin butterfly occur in open woods, oak savannas, and forest openings. Oak savannas in Ohio are limited to the northwestern portion of the state, in parts of Henry, Fulton, and Lucas counties. Protection of this area will provide the necessary habitat to sustain viable populations of the eastern Persius dusky wing and frosted elfin butterflies.

The grizzled skipper inhabits eastern shale barrens and has been declining in part due to the widespread spraying for gypsy moths. Immediate action should be taken to protect existing populations from further habitat degradation and loss. Fire suppression has encouraged the closing of formerly open-canopied oak and oak-pine barrens and reduced the size and quality of adjoining open lands or prairies. Managing the prairie and barrens communities, especially through carefully controlled prescribed burns is critical to the long-term survival of this skipper.

U.S. Fish and Wildlife Service Recovery Plans are being implemented for the American burying beetle. There is one cave beetle on Ohio's endangered species list. The Ohio cave beetle has been collected from a cave system in Adams County. The now extinct Kramer's cave beetle was formerly collected from this same area. There are many *Pseudanophthalmus* (cave beetle) species described from the limestone caves of Kentucky and Tennessee, but the Ohio cave beetle and Kramer's cave beetle are the only two known from north of the Ohio River. They were most likely cut off from the cave systems of Kentucky when the Teays River changed course during a glaciation event.

Threatened Invertebrates

Little is known concerning the habitat and life history requirements, or threats faced by the silver-bordered fritillary.

Invertebrate Species of Concern

The two-spotted skipper typically occupies wetland areas, whereas the dusted skipper is an inhabitant of grasslands, old fields, and savannahs. More information is needed concerning their habitat and life history requirements, as well as reasons for their declines. The olympia marblewing butterfly is designated as species of special interest. While it is occasionally documented within the state, it is not believed to have viable populations. In the future, if increased numbers and locations of this species are found, its status will be further evaluated.

Table 12. Ohio's Terrestrial Invertebrate Species of Greatest Conservation Need
The conservation status (rank) for each species represents input from professionals in butterfly/skipper taxonomy, distribution, and abundance. This table represents the best professional knowledge available at this time, and as such is subject to modification as additional data is obtained.

Conservation Status Rank*	Common Name	Scientific Name	Species Listing Fed	Species Listing State	Habitat Association	Rangewide Occurrence	Statewide Occurrence	Ohio Population Trend
1	Mitchell's Satyr	*Neonympha mitchellii*	E	E	C, G	C	D	U
2	Persius Dusky Wing	*Erynnis persius*		E	E	B	D	D
3	Grizzled Skipper	*Pyrgus centaureae wyandot*		E	B	B	D	D
4	Olympia Marble	*Euchloe olympia*		SI	B	A	D	D
5	Gold-banded Skipper	*Autochton cellus*			B	B	C	D
6	Swamp Metalmark	*Calephelis mutica*		E	C	B	D	D
6	Confused Cloudy Wing	*Thorybes confusis*			A, B	B	D	U
6	Duke's Skipper	*Euphyes dukesi*			B, C	B	C	I
9	Diana Fritillary	*Speyeria diana*			B	B	D	D
9	Mottled Dusky Wing	*Erynnis martialis*			A, B	B	B	D
11	Regal Fritillary	*Speyeria idalia*		E	A	B	C	D
11	Harris Checkerspot	*Chlosyne harrisii liggetti*			A, C	B	C	D
11	Two-spotted Skipper	*Euphyes bimacula*		SC	C	B	C	S
14	Cobweb Skipper	*Hesperia metea*			A, B	B	C	S
14	Mulberry Wing Skipper	*Poanes massasoit*			C	B	C	S
14	Broad-winged Skipper	*Poanes viator viator*			C	A	C	I
17	Dusted Skipper	*Atryonopsis hianna*		SC	A, E	B	C	D
18	Frosted Elfin	*Incisalia irus*		E	E	B	D	D
19	Silver-bordered Fritillary	*Boloria selene myrina*		T	A, C	A	C	I
20	Dion Skipper	*Euphyes dion*			C	A	C	I
21	Black Dash Skipper	*Euphyes conspicua*			C	A	B	I
22	Silvery Blue	*Glaucopsyche lygdamus*			B	B	B	S
23	Atlantis Fritillary	*Speyeria atlantis*			B	A	C	I
23	Gray Comma	*Polygonia progne*			B, C	B	B	D

25	Zebra Swallowtail	*Eurytides marcellus*		B, H	B	A	D
26	Dusky Azure	*Celastrina nigra*		B	B	C	I
27	Northern Oak Hairstreak	*Fixsenia favonius ontario*		A, B	B	D	D
28	Falcate Orange Tip	*Anthocharis midea annickae*		B	B	B	S
28	Eastern Pine Elfin	*Incisalia niphon*		B	A	B	I
28	Northern Metalmark	*Calephelis borealis*		B	B	B	S
31	Early Hairstreak	*Erora laeta*		B	B	D	D
32	Baltimore Checkerspot	*Euphydryas phaeton*		C	A	A	S
33	Edward's Hairstreak	*Satyrium edwardsii*		A, B, E	A	C	I
34	White M Hairstreak	*Parrhasius m-album*		B	B	C	S
34	Compton Tortoise Shell	*Nymphalis l-album*		B	B	B	I
34	Eyed Brown	*Satyrodes eurydice*		C	B	B	I
37	Goatweed Butterfly	*Anaea andria*		A, B	B	C	U
37	Hayhurst's Scalloped Sootywing	*Staphylus hayhurstii*		B	B	C	S
39	Acadian Hairstreak	*Satyrium acadicum*		C	B	A	I
39	Hickory Hairstreak	*Satyrium caryaevorum*		B	A	A	I
41	Dog Face	*Colias cesonia*		A	B	C	U
41	Leonard's Skipper	*Hesperia leonardus*		A, B	B	A	S
41	Indian Skipper	*Hesperia sassacus*		A, E	A	B	I
41	Long Dash Skipper	*Polites mystic*		A	A	A	I
45	West Virginia White	*Pieris virginiensis*		B	B	C	S
45	Purplish Copper	*Lycaena helloides*	E	C	B	C	D
45	Brown Elfin	*Incisalia augustinus croesoides*		B, C	B	C	D
45	Appalachian Blue	*Celastrina negelectamajor*		B	B	B	S
45	Pepper & Salt Skipper	*Amblyscirtes hegon*		B	A	B	I
n/r1	Karner Blue	*Lycaeides melissa samuelis*	E E	E	B	D	D
n/r2	Monarch	*Danaus plexippus*		A, B, H, I	B	A	U
n/r3	American Burying Beetle	*Nicrophorus americanus*	E E	A, B	C	D	U

n/r3	Ohio Cave Beetle	*Pseudanophthalmus ohioensis*	E	D	E	D	U

* Rank derived from Conservation Status Score calculated using Millsap et al. (1990) modified for Ohio. The order in which species with the same conservation status rank (i.e., ties) are listed does not imply differences between these species.

n/r1 = added to SGCN list because of previous research and management activities that will continue under this Action Plan
n/r2 = added to SGCN list while its status is updated (at which point it will be assigned a conservation status rank)
n/r3 = insufficient information on the species to calculate a Conservation Status Score using Millsap et al. (1990)

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Chapter 5. Climate Change and Conservation

There is a significant amount of work to be done in Ohio related to climate change, its impacts on species and habitats, and what can be done to mitigate these impacts. Since the 1970s, conservation threats/actions have largely focused on efforts to remediate habitat and water quality issues, deal with invasive species, and contain emerging diseases. Significant effort has been directed at improving land use practices and improving water quality. A more than substantial amount of time and money has been spent trying to prevent the introduction of invasive species, and contain the spread of those already here. Conservation practices have been developed to contain and/or eliminate diseases such as VHS and CWD. Recent efforts to work with the agricultural community to prevent harmful algal blooms have been significant. Climate change has certainly been on the conservation radar, but at this point lags behind the issues just mentioned in terms research and management plans.

For the duration of this 2015 SWAP, efforts related to climate change will focus primarily on data collection and planning. There is much to be done to integrate climate change issues into our strategic, tactical, and operational planning. This chapter will lay the groundwork for incorporating climate change into future conservation efforts using the SWAP to coordinate planning and implementation. The following discussion is adapted from Integrating Climate Change into the State Wildlife Action Plans (Staudinger et al., in review).

5.0 Regional Climate Changes

Climate change science indicates that the climate is changing in ways that will directly impact wildlife and their habitats. While species and habitats have had to adapt to and evolve with climate changes throughout history, evidence suggests that current changes are occurring at a more rapid rate than in the past. A summary of climate changes predicted and/or occurring in the Northeast and Midwest regions that are relevant to wildlife and ecosystems includes the following:

- Warming is occurring in every season, particularly in winter, at higher latitudes, at higher elevations, and inland (away from lake coasts)
- Precipitation amounts are increasing, particularly in winter, and as high-intensity events in summer
- Extreme heat events are increasing
- Snow is shifting to rain
- Atmospheric moisture is increasing
- Streamflow patterns may be intensifying with increases in precipitation
- Streams are warming
- Severe weather may become more common
- Floods are intensifying and occurring more often with heavier rainfall events, yet droughts are also on the rise
- Growing seasons are getting longer, with more growing degree days expected
- The Great Lakes are warming
- Winter maximum lake ice extent is shrinking
- Lake evaporation rates are increasing
- Lake effect snow events are likely to become more severe, and shift to rain, but occur less often

5.1 Regional Species and Habitats at Greatest Risk and Most Vulnerable to Climate Impacts

Climate change vulnerability is comprised of three separate but related components – exposure, sensitivity, and adaptive capacity. Exposure is a reflection of the type, degree, and duration of climate induced change. The degree to which the effects of that change are felt is related to the sensitivity of the object being acted upon. Adaptive capacity is a measure of object’s ability to persist in the face of the change. Climate change vulnerability assessments targeting ecological systems can be focused at the species, habitat, or ecosystem level. It is important to note that there are different interpretations, treatments, and approaches to assessing climate change vulnerability.

Climate change vulnerability studies for the Northeast and Midwest regions scored freshwater mussels, amphibians, and fish as either extremely or highly vulnerable, while the majority of birds and mammals received low vulnerability rankings. Similar studies focused on habitat vulnerability classified spruce-fir, lowland conifer, Appalachian northern hardwood forests, bogs, fens, and freshwater aquatic habitats as highly vulnerable to climate change.

Climate Change Vulnerability Assessments (CCVAs) have already been conducted for a number of species and habitats across the Northeast and Midwestern region. A synthesis of methods, information on the locations (e.g., States) where vulnerability assessments were conducted, lists of individual species and habitats and their respective vulnerability rankings, and comparisons of how vulnerability rankings were determined among studies is provided in Staudinger et al. (in review) .

5.2 Impacts of and Biological Responses to Climate Change

As discussed above, the Northeastern and Midwestern U.S. are experiencing, and will continue to experience increased air and water temperatures, changes in precipitation, and an increase in extreme weather events, including more extreme high and low temperatures, drought, and floods. These changes will subsequently result in impacts including changes in lake levels, hydrological flows, water quality, increased storms, beach and dune erosion, and ultimately shifts in vegetation and even ecosystems.

Climate changes will have cascading effects upon ecological systems. Predictions are that species' distributions will shift northward, upslope, and upstream, and the species that rely on them will either shift in response or adapt in place. These shifts will not happen at the same time, as species respond to different cues and at different paces. Shifts will be influenced by degree of habitat connectivity, as well as life history traits or genetic diversity that influence movement or adaptation. Changes in species abundance and distribution are more likely to occur at the edge of a species range than in its center. Increased disturbance related to climate change likely will exacerbate and/or work synergistically with many existing threats such as habitat loss and fragmentation, invasive species, altered fire regimes, water pollution, and wildlife diseases. This could in turn lead to more ecological disturbance resulting in community turnover, with changing species assemblages.

Biological responses to climate change will vary across taxa in the northeast and Midwest. Species that have broad distributions across the region are likely to be able to adapt to changing temperatures and precipitation. Other species that rely on habitats that are at the southern edge of their distribution may be forced to shift their range northward. Species with limited mobility will be the most highly impacted.

There are many ways in which climate change can impact species and habitats, both directly and indirectly. From a species perspective, in general we know that as the effects of climate change manifest themselves:

- Habitat generalists will fare better than habitat specialists
- Food generalists will fare better than species with more specific dietary needs
- Tolerant species will fare better than species with narrow ranges of tolerance
- Species nearer the center of their range will fare better than edge of range species
- Mobile species will fare better than limited mobility or non-mobile species

Direct effects of climate change include the impact of changing temperature and precipitation regimes on species and habitats. Indirect effects are many and varied, and often complex. A list of some the most prominent and most discussed impacts in current scientific literature includes:

- Impacts of habitat changes on resident species
- Impacts of changing species assemblages on local habitat

- Range shifts that change species assemblages or put species proximate to each other that under normal circumstances are not – impact species through increased competition, predation, disease transmission, hybridization
- Predators may be affected by climate change impacts to prey abundance and distribution
- The concentrating effect of shrinking habitats can increase the vulnerability of species to predators and diseases
- Climate change may cause phenological mismatches where the timing of interactions between species, food, and habitat is thrown off because each is using a different cue (e.g., photoperiod vs temperature)
- Impacts of local land use/development on species as they attempt to react to climate change by shifting ranges or find local refugia (e.g., coastal habitat "squeeze" caused by water level rises combined with nearshore human development)
- Impacts to species that rely on other species for some part of their life cycle – hosts may be negatively affected by climate change
- Impacts to species caused by warmer winters allowing diseases and parasites to be more active

5.3 Adaptation Strategies and Actions in Response to Climate Change

Climate change adaptation is a relatively new and rapidly growing field focused on preparing for and responding to the current and future impacts of climate change. Climate change introduces high uncertainty to the decision making process as we are unable to exactly predict future climate conditions, how species and systems will respond to climate change and other stressors that act synergistically or cumulatively, as well as human response and behavior. Therefore managers must take action and make informed decisions that consider a range of possible futures.

The table below (modified from Butler et al. 2012 in Staudinger et al. (in review)) highlights different strategies and approaches being used across the region, and is intended to demonstrate the range of possible options for natural resource management under future global change.

Table 13. Ten broad strategies and approaches for climate change adaptation.

Strategy	**Approaches**
Sustain fundamental ecological functions	Maintain or restore habitat quality and nutrient cycling Maintain or restore hydrology Maintain or restore riparian, shoreline, or coastal areas
Reduce the impact of existing biological stressors	Maintain or improve the ability of habitats to resist pests and pathogens Prevent the introduction and establishment of invasive species and remove existing invasives Manage herbivory and other predation to protect or promote regeneration and growth of desired species

Protect habitats from severe fire and wind disturbance	Alter habitat structure or composition to reduce risk or severity of fire Establish fuelbreaks or other management actions to slow the spread of catastrophic fire and other events Alter habitat structure to reduce severity or extent of wind and ice damage
Maintain or create refugia	Prioritize and protect existing populations on unique and rare sites Prioritize and protect sensitive or at-risk species or communities Establish artificial reserves for at-risk and displaced species
Maintain and enhance species and structural diversity	Promote diverse age classes Maintain and restore native biodiversity Retain biological legacies Restore fire to fire-adapted ecosystems Establish reserves to protect ecosystem diversity
Increase ecosystem redundancy across the landscape	Manage habitats over a range of sites and conditions Expand the boundaries of reserves to increase diversity
Promote landscape connectivity	Use landscape-scale planning and partnerships to reduce fragmentation and enhance connectivity Establish and expand reserves and reserve networks to link habitats and protect key communities Maintain and create habitat corridors through reforestation and other restoration actions
Enhance genetic diversity	Use genetic material (e.g., seeds) from across a wide geographic range Favor existing genotypes that are better adapted to future conditions Increase diversity of early life stages to increase the likelihood of success of those species or genotypes

Facilitate community adjustments through species transitions	Anticipate and respond to species decline Favor or restore native species that are expected to be better adapted to future conditions Manage for species and genotypes with wide environmental (e.g., moisture and temperature) tolerances Guide species composition at early stages of development Protect future-adapted regeneration and population growth from predation Establish or encourage new mixes of native species Identify and move species to sites that are likely to provide future habitat
Plan for and respond to disturbance	Prepare for more frequent and more severe disturbances Prepare to realign management of significantly altered ecosystems to meet expected future environmental conditions Promptly restore sites after disturbance Allow for areas of natural regeneration after disturbance Maintain seed or nursery stock of desired species for use following severe disturbance Remove or prevent establishment of invasive species and other competitors following disturbance

While there is much work to be done regarding the integration of climate change into our strategic, tactical, and operational planning, there are many efforts underway or in the planning stages that address conservation threats related to climate change. Efforts to re-establish or enhance species populations (e.g., American burying beetle, Karner blue butterfly, lake sturgeon), protect and improve habitat (e.g., conservation easements, invasive species control, water quality improvements), or improve habitat connectivity (e.g., dam removals, connecting fragmented habitats) are all actions that can help mitigate the impacts of climate change. In this Action Plan, habitat specific conservation threats and actions related to climate change, and data gathering/analysis/planning are contained within each of the habitat sections in the Ohio’s Habitats chapter.

Chapter 6. Ohio's Habitats

The purpose of Ohio's State Wildlife Action Plan (SWAP) is to provide strategic and tactical direction for conserving wildlife diversity in Ohio. A rich diversity of wild animals is a valuable ecological, social, and economic asset for Ohio. Wildlife populations have been stressed by a number of factors such as invasive species, chemicals in the environment, and climate variability to name a few. However, in Ohio habitat quantity and quality are unquestionably the principal factors influencing the status of Ohio's wildlife species. Consequently, Ohio's SWAP is focused on habitats from an organizational standpoint. This habitat approach to organization of conservation threats and actions allows species to be arranged into manageable categories, with the habitats serving to focus the conservation threats and actions intended to benefit wildlife species. However, despite the fact that the Action Plan is organized around habitat categories, it is species that are the metric for determination of the success of conservation actions. Success of habitat-based conservation actions will be reflected in the condition of the fish and wildlife that inhabit them.

The majority of conservation actions, in order to benefit the most species, will be aimed at maintaining and improving their associated habitats. Implementation of habitat-based conservation actions is key to sustaining wildlife diversity in Ohio. Many of the threats and actions contained within the Plan may not be directly related to the species they are intended to benefit. However, the cumulative effect of these actions – direct upon habitats, indirect upon species – will lead to healthy and sustained wildlife populations. Actions that maintain and improve the quality, quantity, and connectivity of habitats will have as much positive impact on species as actions focused directly on the species themselves.

Like most other states, there is no single statewide comprehensive habitat classification system for Ohio. Ohio's SWAP draws from a number of habitat data sources to classify and categorize the diversity of habitat types across the state. Fifteen habitat categories form the basis for Ohio's SWAP – and these are based on Ohio's pre-settlement habitat, habitat information from the ODNR Division of Natural Areas and Preserves Natural Heritage Database Program, the National Land Cover Database, and expert opinions. The habitat categories chosen are somewhat broad, and often include several sub-habitat categories (e.g., Wetlands includes natural marshes, diked marshes, vernal pools, bogs, and fens). Arguments can be made for and against using broad versus very specific habitat categories. Our intent here was to choose habitat categories that identify landscape-scale terrestrial and aquatic ecosystems, and as mentioned above, provide an organizational framework for arranging of wildlife, and related conservation threats/actions. We felt that there was more utility in using broad habitat categories, and that the more specific sub-categories could be adequately addressed within the threats/actions under each broad category.

There are limitations to the habitat classification/categorization system that Ohio has chosen to use in this Action Plan. Information in the habitat chapters should be interpreted and used with these limitations in mind. These limitations stem primarily from the fact that it is not possible to fit a very complex and dynamic natural environment into a very structured systematic classification system. The interface between habitat boundaries is often not clearly delineated and habitat boundaries change over time. Habitats often tend to bleed into one and other – and "hybridize" to a degree. Habitats affect and are affected by surrounding habitats. The quality of habitat data varies – and often does not accurately reflect the true spatial extent and/or configuration of individual habitats. The natural world simply does not lend itself to fine scale mapping/classification, especially on a protracted temporal scale. Acknowledging that Ohio is an interwoven system of habitats, the information and maps in this Action Plan are intended to be used as a general guide for the types and distribution of habitats across the state.

6.0 Habitat Categories

Fifteen habitat categories provide the foundation for Ohio's SWAP. Split between terrestrial (7), aquatic (7), and one habitat type that encompasses both, they represent the breadth of Ohio's ecosystems – albeit on a relatively broad scale. The categories chosen are a reflection of the state of habitat data available today. Finer scale habitat types within these larger categories are acknowledged and addressed within the conservation threats and actions for each of the following categories:

Terrestrial Habitats
Forests - Composition (oak-hickory, beech, etc.), Growth Stage (early successional through mature)
Grasslands - Prairies, Pastures/Hayfields, Old Fields
Wetlands - Marshes (Natural, Diked), Vernal Pools, Bogs, Fens
Lake Erie Islands
Oak Savannas
Boreal Communities
Caves & Mines
Artificial/Man-made Environments (Agricultural Fields, Skyscrapers, Bridges/Overpasses, Human Structures (boat docks, lowhead dams, etc.), Urban/Suburban Homes/Yards, Barns & Other Rural Structures)

Aquatic Habitats
Lake Erie
Lake Erie Tributaries
Ohio River
Ohio River Tributaries
Headwater and Small Inland Streams
Man-made Lakes and Ponds
Natural Lakes

6.0.1 Forests, Grasslands, Wetlands
The focus will be to identify strategies that will guide the Division on restoration, maintenance, and enhancement of these habitats and the diversity of wildlife species that occupy them. Emphasis will be on providing adequate quality and quantities of each of these habitat types to meet these goals. The management strategies for these habitats will be statewide in nature, leaving site-specific (Conservation Opportunity Area) initiatives to be addressed by individual tactical plans.

6.0.2 Lake Erie Islands, Oak Savannas, Boreal Communities, Caves & Mines
At the time of European settlement, Ohio's landscape was primarily a vast expanse of forest, with a few large grassland and wetland areas. Also scattered throughout the state, in smaller amounts, were other significant habitats – Ohio's primary examples of these include Lake Erie islands, oak savannas, the boreal (snowbelt) community, and both natural and man-made caves/mines. While most of our native wildlife needs will be addressed through the major terrestrial habitat programs (grasslands, forests, wetlands), some species (including several listed species) are dependent upon these very specialized habitat types that are not addressed by the major habitat programs. These habitat types generally occur in relatively small quantities and relatively isolated areas. They are capable of supporting types of wildlife with highly specialized habitat requirements or species at the fringe of their wider U.S. range – for example snowshoe hares were only found in boreal communities in northeastern Ohio. These habitats must be protected, and in some cases enhanced to ensure survival of several wildlife species. Management strategies will focus on providing adequate amounts of these habitats, and the focus will be much narrower in scope compared to the other terrestrial habitat programs.

6.0.3 Artificial/Man-made Environments (this habitat category contains both aquatic and terrestrial components)
Ohio is the 34th largest, 7th most populous, and 10th most densely populated state – consequently very little of this state has not been altered to some degree. The most significant alteration in terms of scale is the conversion of wetlands, grasslands, and forests to agriculture. Urban/suburban development is also extensive, and the amount of man-made infrastructure is significant. While the extensive alteration (and sometimes loss) of natural habitats has extirpated a number of species, many others have adapted and taken advantage of the food, shelter, and breeding habitat that man-made environments provide. Many species of wildlife feed in grain fields, peregrine falcons nest on skyscrapers, barn owls nest in old barns, bats utilize mines as hibernacula and bridge expansion joints/seams as roosting sites, and fish use docks,

piers, and bridge abutments for cover and feeding areas – just to name a few. Management strategies for this habitat category will revolve around ways to make existing and future development more wildlife friendly. Many opportunities exist to enhance man-made structures which simulate natural habitats for a variety of wildlife species.

6.0.4 Lake Erie, Lake Erie Tributaries
The Lake Erie program addresses Ohio's 2.24 million acre portion of Lake Erie. The lake's tributaries will be addressed separately for the purposes of this Action Plan, but are clearly an important component of the lake ecosystem, and affected by lake-related management strategies. Lake Erie's tributaries are important habitats for a number of lake species. The interjurisdictional nature of the lake (4 states and Ontario share this resource) complicates management, and necessitates constant communication and cooperation among partners. Lake Erie and its tributaries contain a diverse mix of economically important species (walleye, yellow perch, smallmouth bass), as well as rare species (lake sturgeon, popeye shiner, cisco, burbot). Invasive species and water quality issues affect our management ability on the lake more so than on most other aquatic ecosystems around the state.

6.0.5 Ohio River, Ohio River Tributaries
The southern boundary of Ohio includes 451 miles of the Ohio River. The Ohio River program will cover the mainstem and tributary embayments. Ohio River tributaries will be addressed separately, but clearly have a large influence on the river itself. Ohio River tributaries drain huge watersheds, impacting river water quality and flow. While the Ohio River is an extremely modified system due to the numerous dams, hydropower, and navigation systems, it contains many wildlife populations of economic, social, and ecological significance. Like Lake Erie, the interjurisdictional nature of the Ohio River (West Virginia and Kentucky share the river adjacent to Ohio) complicates management efforts and necessitates good working relationships with our partner states.

6.0.6 Headwater and Small Inland Streams
This program focuses on the inland streams that combine to create the primary tributaries to Lake Erie and the Ohio River. These are important habitats for a diverse assemblage of aquatic species, especially species that need good water quality and stream gradient to survive. A number of listed fish, mussels, crayfish, and aquatic insects are dependent upon these types of habitats. While primarily an aquatic wildlife habitat program, management strategies may also benefit species of terrestrial wildlife due to the importance of riparian corridor habitat. The strategies for this program will be statewide in nature, leaving site-specific (Conservation Opportunity Watersheds) initiatives to be addressed by individual tactical plans.

6.0.7 Man-made Lakes & Ponds
Between Lake Erie and the Ohio River, Ohio's numerous lakes and ponds support diverse populations of aquatic wildlife. These waters range from small farm ponds and borrow pits to large reservoirs. While functioning as important habitats for aquatic species, many were created for multiple purposes, some of which are incompatible with wildlife management. On-stream lakes are affected by, and in turn affect the stream they impound. Lake water quality may be compromised by silt and excess nutrients delivered by inflowing streams, and excessive withdrawal of water could exacerbate the downstream hydrologic alteration caused by the dam. Dam operation (timing, frequency, duration, and magnitude of water releases) also affects downstream hydrology and habitat.

6.0.8 Natural Lakes
The majority of Ohio's natural lakes formed in the aftermath of the most recent ice age. A few are post-glacial in origin, created from cutoff stream oxbows. There are 110 natural lakes in Ohio larger than five acres, covering a total surface area of 4,658 acres. These lakes occur in 21 of Ohio's 88 counties. Many of Ohio's natural lakes have been altered to some degree by human activities. Some lakes have been enlarged by the addition of levees or dikes, and some have had outlet control structures installed, or outlet streams enlarged, to allow for controlling of lake levels (Black 1991). While not a significant habitat on an acreage basis, several listed fish species occur in natural lakes (blacknose shiner, western banded killifish, Iowa darter, pirate perch).

6.1 Conservation Opportunity Areas (CO Areas)

The Division of Wildlife's approach to enhancing and maintaining the highest level of terrestrial wildlife diversity in the state is to use a conservation opportunity area concept to sustain viable populations of as many native species of wildlife as possible. The idea is to concentrate efforts and resources to provide all the necessary habitat requirements in a few, relatively large landscapes of major habitat types, along with the remnants of other significant but rare habitats, for species that are of limited distribution or have low populations.

Conservation Opportunity Areas (referred to as Focus Areas in Ohio's original CWCS) were identified for each terrestrial habitat category. Areas chosen are of sufficient size and quality to maintain viable populations of most native wildlife species dependent upon that particular habitat type. Within each CO Area the goal is the development of specific habitat objectives to benefit priority wildlife species as identified in state, federal, and regional conservation plans, and conducting a coordinated monitoring protocols to determine the success of these efforts. Within each terrestrial habitat category are detailed descriptions of the locations, habitat specifics, and management plans for each Conservation Opportunity Area.

This multi-scale conservation approach ensures the persistence and potential recovery of species at risk while simultaneously keeping the common species abundant. Several widely separated Conservation Opportunity Areas for each of the forestland, grassland, and wetland habitats have been selected to reduce the risk of extirpation of species as a result of natural disasters, disease outbreaks, etc. Typically, CO Areas are associated with relatively large holdings of public land where future land practices can be managed. In addition, they were selected because they contain the largest amount of the best remaining habitat of that type currently available. Within each CO Area the habitat requirements of the more vulnerable species were used to calculate the minimum area needed to maintain viable self-sustaining populations.

6.2 Conservation Opportunity Watersheds (CO Watersheds)

While many of Ohio's historically degraded streams/watersheds have received considerable funding and restoration efforts to improve habitat and water quality, many of the state's high quality (i.e., least impacted) streams have received less funding and attention. The objective of conservation opportunity watersheds is to prioritize high quality streams/watersheds on a statewide basis using a multi-metric approach involving stream monitoring results from four categories – physical habitat, biological integrity, biological diversity, and recreational opportunity. With limited funding dedicated to stream protection, the goal is to prioritize streams to make sure the funding that is available is well directed. It is less expensive to protect healthy streams/watersheds and their faunas than to try and restore them later.

Conservation Opportunity Watersheds (referred to as Focus Watersheds in Ohio's original CWCS) were identified from previous work in Ohio and were derived from *ODNR Candidate Streams for Protection and Restoration* (Figure 7). This system rates Ohio watersheds by integrating measures of physical and biological integrity, biodiversity, and recreational opportunity. All watersheds received a prioritization score which ranks their relative importance for protection and restoration activities. The DOW has identified 11 Conservation Opportunity Watersheds in which to concentrate efforts related to the aquatic portion of this SWAP (Figure 8). These include the highest scoring watersheds in Ohio. Watersheds in both the Lake Erie and Ohio River drainages representing all of Ohio's major ecoregions have been included. All have diverse habitat types with high aquatic life use designations and excellent biodiversity, and most are Ohio Scenic Rivers.

The state of Ohio has approximately 61,532 total miles of streams. Of the 4,223 named streams, more than 1,588 have had fish and or aquatic macroinvertebrate assemblages sampled. The majority of biological data collected from Ohio streams is stored in the Environmental Conservation Online System (Ohio ECOS), a statewide multi-agency biological database maintained by the Ohio Environmental Protection Agency. Although less than half of all Ohio streams have been sampled, virtually all of the unassessed streams are small headwater streams many of which have drainage areas of less than 20 square miles. Until these streams can be assessed, the CO Watershed designation will apply only to watersheds for which there is adequate data to make this determination.

A total of 17 stream attributes within four categories (physical habitat, biological diversity, biological integrity, and recreational opportunities) were used to rank Ohio streams. Each attribute had a minimum quantitative or qualitative value associated with it to allow the attributes to function as metrics. A brief description of each attribute is listed in Appendix 1. Streams were then scored on a met/not met basis for each of the 17 attributes.

As the result of this study, 196 Ohio streams (Appendix 2) were scored for each of the 17 attributes listed in Appendix 1. Streams that met 4 or more of the criteria are listed in Table 14. Approximately 71% of Ohio's land area is contained within the 11 Conservation Opportunity Watersheds.

Within the Lake Erie Tributaries and Ohio River Tributaries habitat categories are detailed descriptions of the physical and hydrological characteristics of the Conservation Opportunity Watersheds taken from Schiefer (2002). Data for figures showing land cover and protected lands in Conservation Opportunity Watersheds was provided by the ODNR Division of Natural Areas and Preserves' Natural Heritage Database Program.

Table 14. Ohio's Conservation Opportunity Watersheds.

Watershed*	Prioritization Score	Ohio Drainage (mi^2)
Little Miami River	14	1755
Grand River	11	705
Scioto River	11	6510
Paint Creek	11	
Big Darby Creek	13	
Little Darby Creek	10	
Muskingum River	11	8038
Kokosing River	9	
Walhonding River	9	
Great Miami River	10	3948
Stillwater River	6	
Cuyahoga River	8	425
Ohio Brush Creek	8	435
Little Beaver Creek	7	510
Maumee River	6	4862
Sandusky River	6	1420
Chagrin River	4	264
	Total:	28,872
	Ohio (land area):	40,953

Percentage of Ohio covered by Conservation Opportunity Watersheds = 71%
**Italicized* are important sub-watersheds within the CO Watersheds

Figure 7. Candidate streams for protection and restoration. Prioritization scores are out of a maximum possible 17 points (no streams scored higher than 14 points in this study).

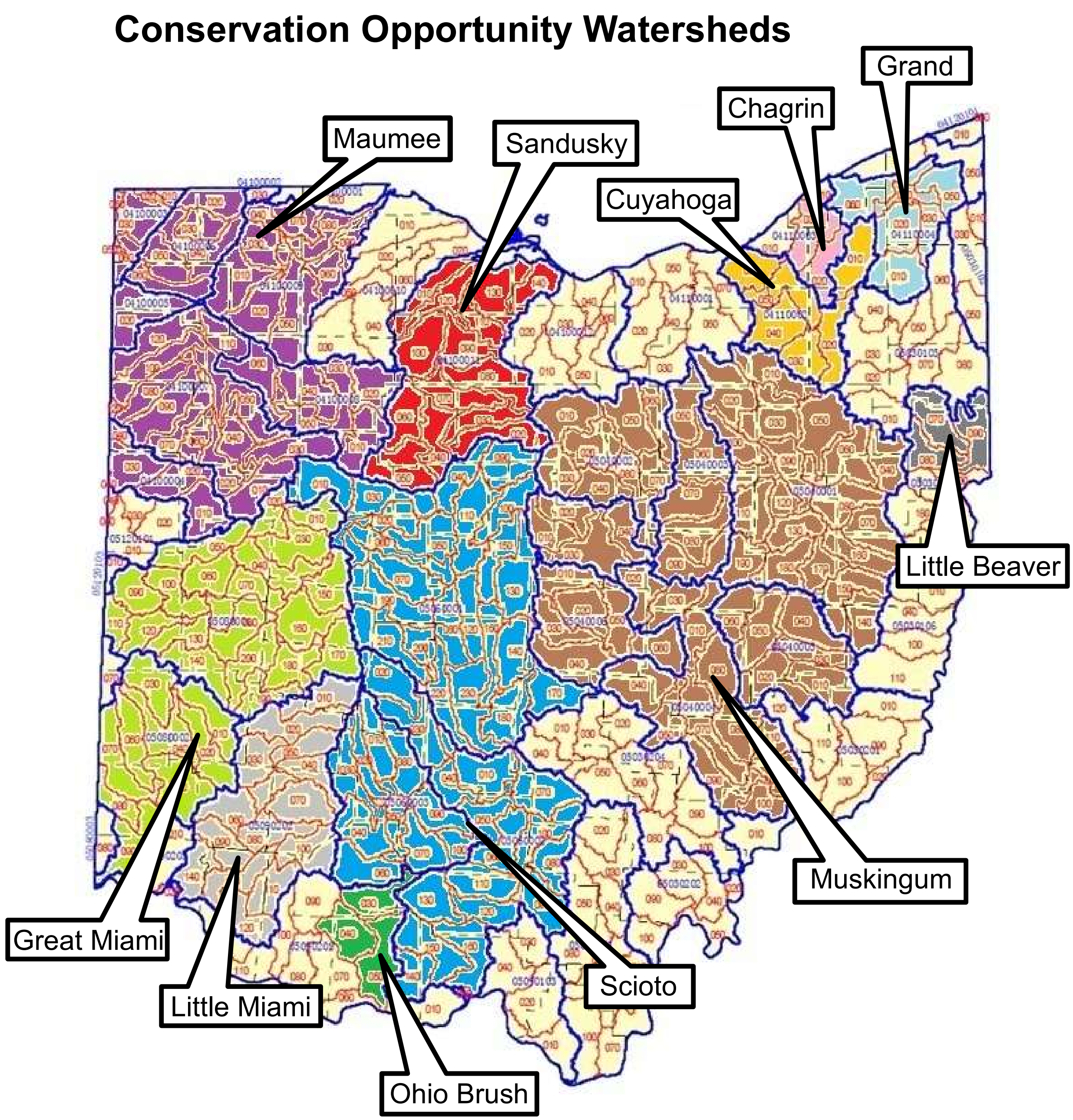


Figure 8. Conservation Opportunity Watersheds derived from candidate streams for protection and restoration (------ = HUC 8 basin boundaries). Each CO Watershed is color coded (Maumee, Sandusky, Cuyahoga, Chagrin, Grand, Little Beaver, Muskingum, Scioto, Ohio Brush, Little Miami, Great Miami).

Conservation Opportunity Watershed Objectives
The following issues and objectives represent a list common to all of Ohio's CO Watersheds. Watershed-specific information, threats, and conservation actions are contained in the aquatic habitat categories sections in this chapter.

Ohio's aquatic species and their habitats are continually impacted by development. An environmental review process established in Revised Code provides a means to influence the severity of those impacts.

- Impacts to fish and wildlife resources are minimized through a streamlined environmental review process for permits and projects.
- The amount of time needed to complete project reviews is minimal to help reduce impacts to aquatic species and their habitats.
- The environmental review process is consistent, especially within specific project categories, in order to minimize impacts to aquatic resources
- All projects conducted by ODNR staff are reviewed for compliance with applicable environmental regulations to minimize impacts to aquatic resources

Aquatic invasive species (AIS) negatively impact Ohio's aquatic species and their habitats statewide.

- Leadership on AIS issues in Ohio is provided by the Division which maintains an active role in the Ohio AIS Committee and regional and national AIS groups.
- Forward looking management and regulatory actions have been taken to reduce the introduction of new AIS into Ohio
- An effective and comprehensive AIS monitoring program is in place to provide for effective early detection of new AIS in Ohio.
- A system is in place to prioritize existing AIS problems focus management activities, prioritize AIS research, and focus outreach efforts.

Ohio's Conservation Opportunity Watersheds can serve as models for the restoration/enhancement of aquatic species and their habitats.

- Restoration of stream connectivity is a high priority among Ohio's conservation community
- Protection and/or restoration of riparian habitat on private and public lands is a high priority among Ohio's conservation community
- Education programs are in place at multiple levels to help the public understand the value of steams and watersheds.
- Additional sources of funding have been identified/developed for streams and watersheds projects.

A centralized database to facilitate Conservation Opportunity Watershed research and management activities will increase efficiency and effectiveness.

- The Ohio Biodiversity Database is a current and comprehensive storehouse of data related to the distribution of state-listed and other rare plant and animal species, significant natural habitats, geologic features and lands managed for conservation
- The Ohio Biodiversity Database is an effective tool to help direct conservation efforts - including environmental review, research, conservation planning and species listing decisions.

6.3 Conservation Threats/Actions Related to Habitat Categories

The tables following this section contain a summary of conservation threat impacts among Ohio's terrestrial and aquatic habitat categories. As suggested in AFWA's Best Practices for SWAPs guide, we used the definitions and hierarchical classification in Salafsky et al. (2008) *A Standard Lexicon for Biodiversity Conservation: Unified Classifications of Threats and Actions* to describe and to categorize threats and actions. Adopting a consistent framework for threats and conservation actions will help ensure consistency across SWAPs and will facilitate the identification of shared threats across states.

Threat impact scores (Tables 15 & 17) were calculated using the IUCN Threats Calculator, with scores based on estimates of the scope, severity, and timing for applicable individual threats to the species or ecosystem (Master et al.2012). Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Other categories of threat impacts are Negligible (used when scope or severity is negligible), and Not a Threat (used when severity is scored as neutral or potential benefit). See the Habitat Categories Template section for a more detailed description.

To help facilitate the order in which conservation actions may be carried out in the future, an objective way of prioritizing those actions was needed. A system described by the Georgia DNR in their SWAP, in our opinion, provided the consistency in method and appropriateness of ranking criteria to produce a logical and defensible priority order for conservation actions. Consequently, conservation action priority ranks (Tables 16 and 18) were determined using the seven ranking criteria developed by the Georgia Department of Natural Resources – Wildlife Resources Division (Georgia DNR 2005) where rating reflects the relative contribution or significance of a conservation action for each criterion. Internal species/habitat experts assessed the contribution of each conservation action for each of these criteria and assigned scores. The resulting point totals were used to sort the conservation actions into categories by priority. See the Habitat Categories Template section for a more detailed description.

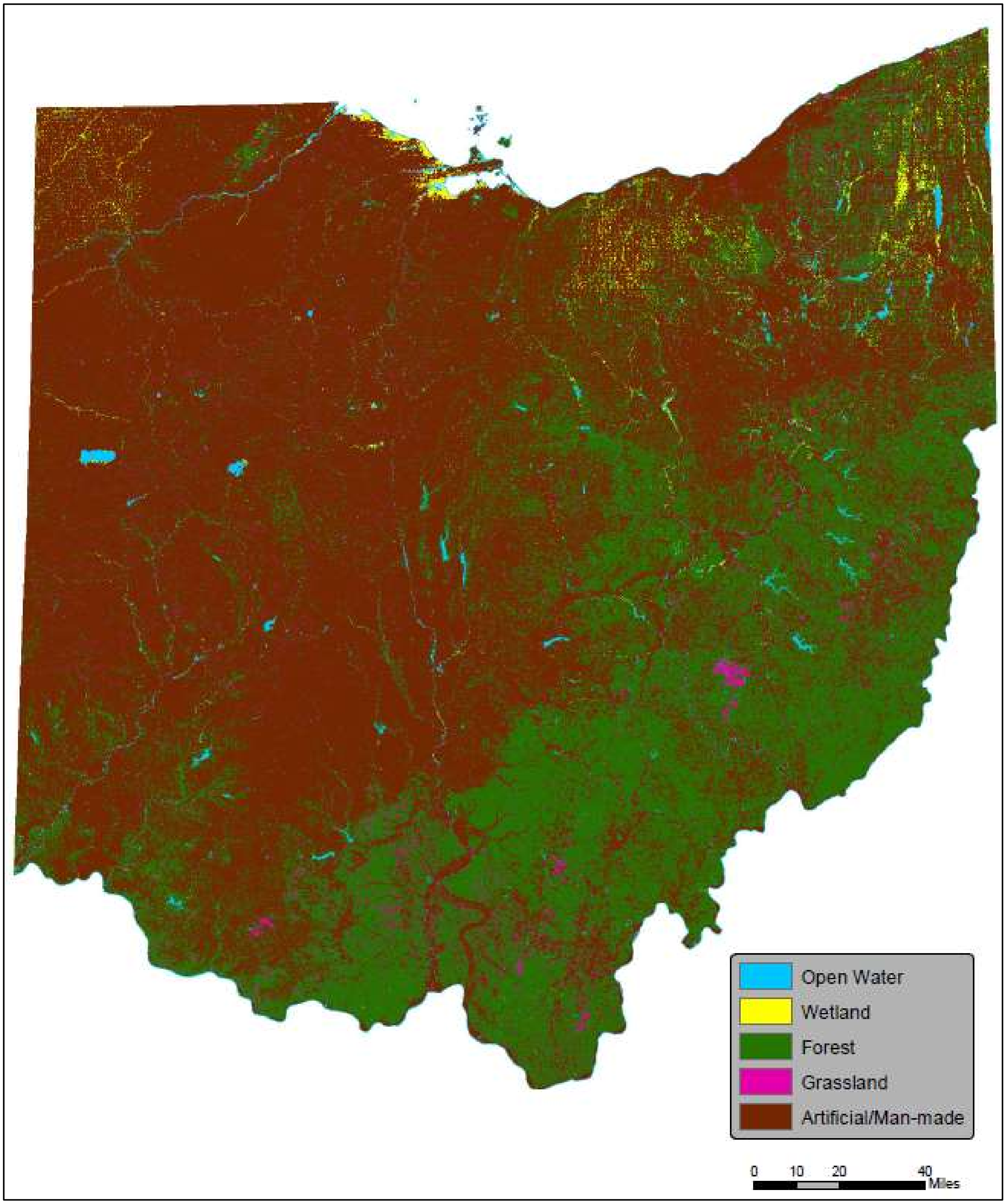


Figure 9. Ohio's State Wildlife Action Plan terrestrial habitat categories (*note: caves and mines not included, oak savannas included in grassland, boreal community included in forest*).

Table 15. Direct threats impact by habitat category for each terrestrial habitat, and overall threat impact for all terrestrial habitats combined. Overall threat impact is the threat impact averaged across all habitat categories, and rounded up when the average value fell between impact ranks.

DIRECT THREATS FOR 1st & 2nd LEVEL OF CLASSIFICATION*	THREAT IMPACT BY HABITAT CATEGORY								OVERALL THREAT IMPACT
	FOREST	GRASSLAND	WETLAND	LAKE ERIE ISLANDS	OAK SAVANNAS	BOREAL COMMUNITY	CAVES And MINES	ARTIFICIAL/ MAN-MADE ENVIRONMENTS	ALL HABITAT CATEGORIES
Residential & Commercial Development	medium	low	high	high	high	medium	medium	very high	high
housing and urban areas	high	low	high	high	high	high	medium	very high	high
commercial & industrial areas	low	low	medium	high	high	low	medium	very high	high
tourism & recreation areas	low	not a threat	low	high	low	low	medium	medium	medium
Agriculture & Aquaculture	low	medium	low	medium	low	low	negligible	high	medium
annual & perennial non-timber crops	negligible	very high	medium	high	low	low	negligible	very high	high
wood & pulp plantations	low	not a threat	negligible	negligible	medium	low	negligible	negligible	low
livestock farming & ranching	low	low	low	low	low	low	negligible	not a threat	low
marine & freshwater aquaculture	negligible	negligible	low	negligible	negligible	negligible	negligible	negligible	negligible
Energy Production & Mining	high	low	medium	low	low	low	medium	high	medium
oil & gas drilling	high	low	low	negligible	low	medium	low	high	medium
mining & quarrying	high	low	low	medium	medium	low	high	low	medium
renewable energy	low	low	medium	negligible	low	low	negligible	medium	low
Transportation & Service Corridors	low	negligible	high	high	low	medium	low	low	medium
roads & railroads	medium	negligible	high	high	medium	medium	negligible	low	medium
utility & service lines	medium	negligible	high	medium	low	medium	low	low	medium
shipping lanes	negligible	negligible	medium	negligible	negligible	negligible	negligible	negligible	negligible
flight paths	negligible	negligible	low	medium	negligible	negligible	negligible	negligible	low
Biological Resource Use	low	negligible	medium	low	low	low	low	low	low
hunting & collecting terrestrial animals	negligible	not a threat	low	low	low	negligible	low	negligible	low
gathering terrestrial plants	low	negligible	low	negligible	low	negligible	negligible	medium	low
logging & wood harvesting	medium	negligible	medium	negligible	low	low	negligible	negligible	low
fishing & harvesting aquatic resources	negligible	negligible	medium	negligible	negligible	negligible	low	negligible	negligible
Human Intrusions & Disturbance	low	low	medium	high	low	low	medium	low	medium
recreational activities	medium	negligible	medium	high	medium	low	medium	low	medium
war, civil unrest & military exercises	low	negligible	negligible	negligible	negligible	low	negligible	negligible	negligible
work & other activities	low	medium	medium	low	low	low	low	low	low
Natural System Modifications	low	low	medium	low	low	low	medium	medium	low
fire & fire suppression	low	negligible	low	negligible	medium	low	low	medium	low
dams & water management/use	low	negligible	medium	negligible	negligible	low	low	medium	low
other ecosystem modifications	low	low	low	low	low	low	medium	medium	low
Invasive & Other Problematic Species & Genes	medium	high	medium	high	medium	high	medium	medium	high
invasive non-native/alien species	high	medium	high	high	high	very high	high	high	high
problematic native species	low	high	low	medium	low	high	medium	medium	medium
introduced genetic material	low	low	medium	negligible	low	low	negligible	negligible	low
Pollution	low	low	medium	low	low	low	low	low	low
household sewage & urban wastewater	low	negligible	low	low	low	low	negligible	low	low
industrial & military effluents	low	negligible	low	low	low	low	high	low	low
agricultural & forestry effluents	low	medium	high	negligible	low	low	low	low	low
garbage & solid waste	low	negligible	low	low	low	low	low	low	low
air-borne pollutants	low	not a threat	low	negligible	negligible	medium	negligible	low	low
excess energy	low	negligible	low	negligible	negligible	low	negligible	low	low

Table 15. continued

Geological Events	low	negligible	low	low	negligible	low	low	negligible	low
volcanoes	negligible	negligible	negligible	negligible	negligible	negligible	negligible	negligible	negligible
earthquakes/tsunamis	low	negligible	low	negligible	negligible	low	medium	negligible	low
avalanches/landslides	low	negligible	low	low	negligible	low	low	negligible	low
Climate Change & Severe Weather	low	negligible	high	low	medium	medium	negligible	high	medium
habitat shifting & alteration	low	negligible	high	low	medium	high	negligible	high	medium
droughts	low	negligible	high	negligible	high	low	negligible	very high	medium
temperature extremes	low	negligible	medium	low	medium	low	negligible	medium	low
storms & flooding	low	negligible	high	low	low	low	low	high	medium
OVERALL THREAT IMPACT FOR EACH HABITAT	medium	low	high	high	medium	medium	medium	high	

*for each category, 1st level threats in **bold**, 2nd level threats in *italics*

Table 16. Conservation actions by habitat category for each terrestrial habitat, and overall action benefits for all terrestrial habitats combined.

ACTIONS FOR 1st & 2nd LEVEL OF CLASSIFICATION*	ACTION BY HABITAT CATEGORY								OVERALL ACTION BENEFIT
	FOREST	GRASSLAND	WETLAND	LAKE ERIE ISLANDS	OAK SAVANNAS	BOREAL COMMUNITY	CAVES and MINES	ARTIFICIAL/ MAN-MADE ENVIRONMENTS	ALL HABITAT CATEGORIES
Land/water Protection	high	high	high	medium	medium	high	high	high	high
site/area protection	high	high	high	medium	high	high	high	high	high
resource & habitat protection	medium	high	medium	medium	low	high	high	high	high
Land/water Management	high	medium	medium	medium	medium	high	high	medium	high
site/area management	medium	medium	low	low	low	medium	high	medium	medium
invasive/problematic species control	high	medium	high	high	medium	high	high	medium	high
habitat & natural process restoration	high	high	medium	medium	medium	high	high	low	high
Species Management	high	medium	high	medium	medium	high	medium	medium	high
species management	high	medium	high	high	medium	high	low	medium	high
species recovery	high	medium	high	low	medium	high	high	medium	high
species reintroduction	medium	medium	medium	low	medium	low	low	low	medium
ex situ conservation	medium	medium	low	low	low	medium	medium	low	medium
Education & Awareness	high	medium	medium	high	low	medium	high	high	high
formal education	high	medium	medium	high	low	high	high	high	high
training	high	high	medium	high	low	medium	high	medium	high
awareness & communications	low	medium	medium	high	low	low	high	high	medium
Law & Policy	high	medium	medium	medium	low	medium	medium	high	medium
legislation	high	high	medium	medium	low	low	high	high	high
policies & regulations	high	medium	medium	medium	low	medium	medium	high	medium
private sector standards & codes	medium	medium	medium	high	medium	medium	medium	medium	medium
compliance & enforcement	medium	medium	medium	low	low	medium	medium	medium	medium
Livelihood, Economic, & Other Incentives	low	medium	medium	low	low	medium	medium	medium	medium
linked enterprises & livelihood alternatives	low	high	medium	low	low	high	low	low	medium
substitution	low	medium	low	low	low	low	low	low	low
market forces	medium	medium	high	low	low	low	medium	medium	medium
conservation payments	medium	high	medium	low	low	high	high	medium	medium
nonmonetary values	low	low	low	low	low	low	high	medium	low
External Capacity Building	medium	high	medium	low	medium	high	high	high	high
institutional & civil society development	medium	high	medium	low	medium	medium	high	high	medium
alliance & partnership development	medium	high	medium	low	medium	high	high	high	high
conservation finance	high	high	medium	medium	medium	high	high	medium	high
OVERALL ACTION BENEFIT FOR EACH HABITAT	medium	high	medium	low	low	medium	high	medium	

*for each category, 1st level threats in **bold**, 2nd level threats in *italics*

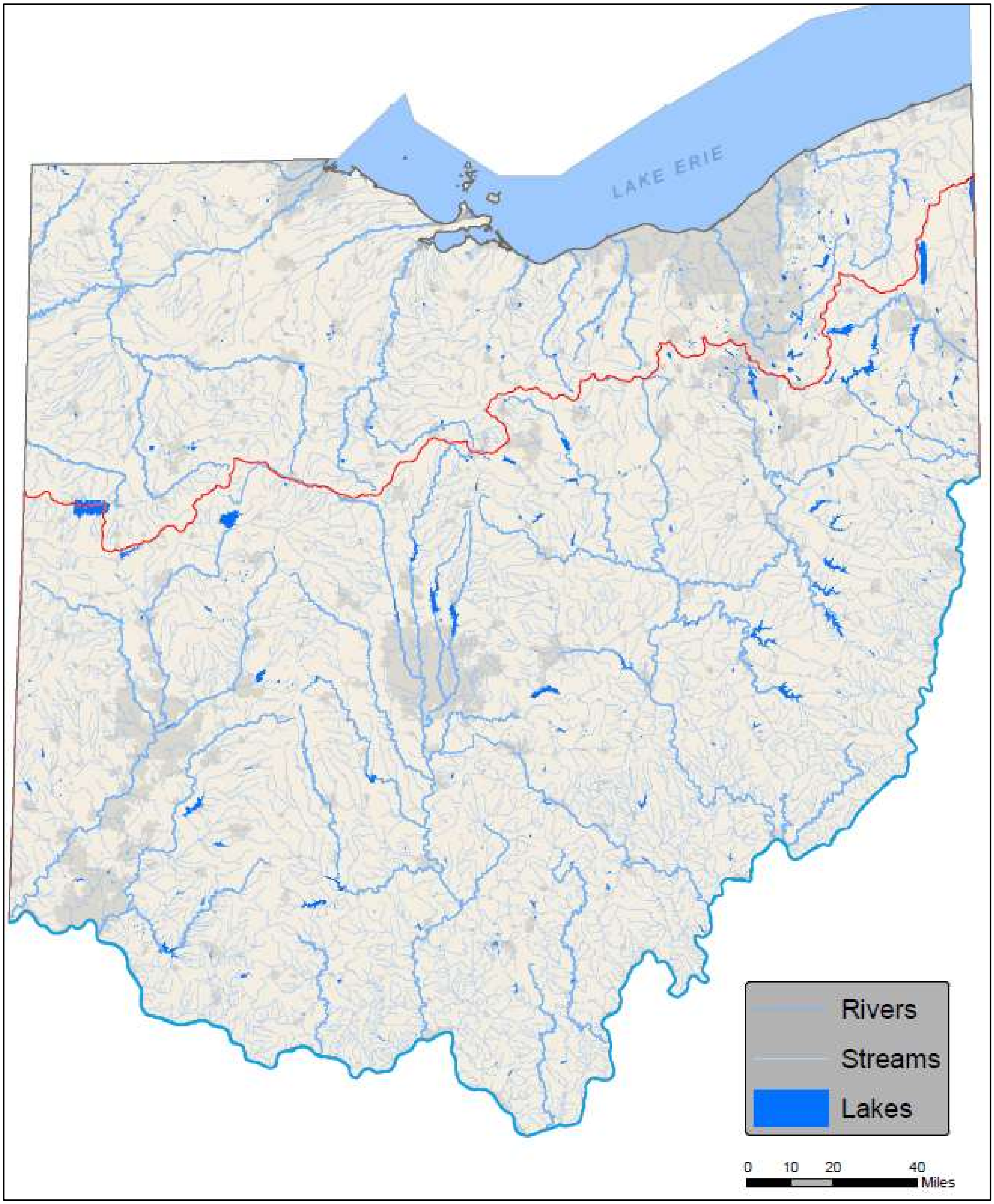


Figure 10. Ohio's State Wildlife Action Plan aquatic habitat categories. The red line separates the Lake Erie and Ohio River drainages.

Table 17. Direct threats impact by habitat category for each aquatic habitat, and overall threat impact for all aquatic habitats combined. Overall threat impact is the threat impact averaged across all habitat categories, and rounded up when the average value fell between impact ranks.

DIRECT THREATS FOR 1st & 2nd LEVEL OF CLASSIFICATION*	THREAT IMPACT BY HABITAT CATEGORY							OVERALL THREAT IMPACT
	LAKE ERIE	LAKE ERIE TRIBUTARIES	OHIO RIVER	OHIO RIVER TRIBUTARIES	HEADWATER & SMALL INLAND STREAMS	MAN-MADE LAKES & PONDS	NATURAL LAKES	ALL HABITAT CATEGORIES
Residential & Commercial Development	medium	medium	low	medium	high	low	high	medium
housing & urban areas	medium	medium	low	medium	high	low	very high	high
commercial & industrial areas	medium	low	low	low	medium	low	low	medium
tourism & recreation areas	low	low	low	low	not a threat	low	low	low
Agriculture & Aquaculture	medium	medium	low	medium	high	low	medium	medium
annual & perennial non-timber crops	high	high	low	high	high	low	medium	high
wood & pulp plantations	negligible	negligible	low	low	negligible	low	low	low
livestock farming & ranching	low	low	low	low	low	low	medium	low
marine & freshwater aquaculture	negligible	negligible	negligible	negligible	negligible	negligible	negligible	negligible
Energy Production & Mining	low	low	low	low	high	medium	low	medium
oil & gas drilling	negligible	low	low	low	high	medium	low	medium
mining & quarrying	negligible	low	low	low	low	negligible	low	low
renewable energy	low	low	low	low	negligible	negligible	negligible	low
Transportation & Service Corridors	medium	medium	medium	low	medium	low	low	medium
roads & railroads	low	low	low	low	high	low	low	medium
utility & service lines	negligible	low	low	low	low	low	low	low
shipping lanes	medium	medium	medium	negligible	negligible	low	negligible	low
flight paths	negligible	negligible	negligible	negligible	negligible	negligible	negligible	negligible
Biological Resource Use	low	low	low	low	low	low	low	low
hunting & collecting terrestrial animals	negligible	negligible	negligible	negligible	negligible	negligible	negligible	negligible
gathering terrestrial plants	negligible	negligible	negligible	negligible	negligible	negligible	negligible	negligible
logging & wood harvesting	negligible	negligible	low	low	high	negligible	low	medium
fishing & harvesting aquatic resources	low	low	low	low	negligible	low	negligible	low
Human Intrusions & Disturbance	low	low	low	low	low	medium	low	low
recreational activities	low	low	low	low	negligible	medium	negligible	low
war, civil unrest & military exercises	negligible	negligible	negligible	negligible	negligible	negligible	negligible	negligible
work & other activities	negligible	negligible	low	negligible	low	negligible	low	low
Natural System Modifications	low	medium	high	medium	high	high	medium	high
fire & fire suppression	negligible	negligible	negligible	negligible	negligible	negligible	negligible	negligible
dams & water management/use	low	medium	high	medium	high	high	medium	high
other ecosystem modifications	low	medium	low	medium	low	low	high	medium
Invasive & Other Problematic Species & Genes	high	high	high	high	low	medium	high	high
invasive non-native/alien species	high	high	high	high	low	medium	high	high
problematic native species	low	low	low	low	negligible	low	low	low
introduced genetic material	negligible	negligible	low	low	negligible	low	negligible	low
Pollution	high	high	high	high	medium	medium	high	very high
household sewage & urban wastewater	high	high	high	high	low	low	high	high
industrial & military effluents	low	medium	medium	medium	low	low	low	medium
agricultural & forestry effluents	very high	very high	high	very high	high	high	high	very high
garbage & solid waste	low	low	low	low	low	low	low	low
air-borne pollutants	low	low	low	low	low	low	low	low
excess energy	negligible	negligible	low	negligible	negligible	negligible	negligible	negligible

Table 17. continued

Geological Events	negligible	negligible	negligible	negligible	negligible	negligible	negligible	negligible
volcanoes	negligible	negligible	negligible	negligible	negligible	negligible	negligible	negligible
earthquakes/tsunamis	negligible	negligible	negligible	negligible	negligible	negligible	negligible	negligible
avalanches/landslides	negligible	negligible	negligible	negligible	negligible	negligible	negligible	negligible
Climate Change & Severe Weather	low	low	low	low	medium	low	high	medium
habitat shifting & alteration	low	low	low	low	high	low	very high	medium
droughts	low	low	low	low	low	low	low	low
temperature extremes	low	low	low	low	low	low	negligible	low
storms & flooding	medium	medium	medium	medium	low	low	negligible	medium
OVERALL THREAT IMPACT FOR EACH HABITAT CATEGORY	medium	medium	medium	medium	high	low	high	

*for each category, 1st level threats in **bold**, 2nd level threats in *italics*

Table 18. Conservation actions by habitat category for each aquatic habitat, and overall action benefits for all aquatic habitats combined.

ACTIONS FOR 1st & 2nd LEVEL OF CLASSIFICATION*	ACTION BY HABITAT CATEGORY							OVERALL ACTION PRIORITY
	LAKE ERIE	LAKE ERIE TRIBUTARIES	OHIO RIVER	OHIO RIVER TRIBUTARIES	HEADWATER & SMALL INLAND STREAMS	MAN-MADE LAKES & PONDS	NATURAL LAKES	ALL HABITAT CATEGORIES
Land/water Protection	medium	medium	high	medium	high	high	high	high
site/area protection	low	low	medium	low	high	medium	high	medium
resource & habitat protection	medium	high	high	high	high	high	high	high
Land/water Management	high	high	high	high	medium	medium	medium	high
site/area management	medium	low	low	low	low	low	medium	low
invasive/problematic species control	high	high	high	high	low	medium	medium	high
habitat & natural process restoration	high	high	high	high	high	high	high	high
Species Management	low	low	low	low	medium	low	medium	low
species management	low	low	medium	medium	low	low	low	low
species recovery	medium	medium	low	low	low	low	medium	medium
species reintroduction	low	low	low	low	medium	low	medium	low
ex situ conservation	low	low	low	low	medium	low	medium	low
Education & Awareness	medium	high	medium	high	high	medium	high	high
formal education	low	low	low	low	high	low	medium	medium
training	high	high	high	high	high	medium	high	high
awareness & communications	medium	high	medium	high	medium	medium	medium	medium
Law & Policy	high	high	medium	high	high	medium	medium	high
legislation	high	high	medium	high	high	medium	medium	high
policies & regulations	high	high	medium	high	medium	medium	medium	high
private sector standards & codes	low	low	low	low	high	medium	low	low
compliance & enforcement	medium	medium	low	medium	medium	medium	low	medium
Livelihood, Economic, & Other Incentives	medium	medium	medium	medium	medium	medium	low	medium
linked enterprises & livelihood alternatives	low	low	low	low	low	low	low	low
substitution	low	low	low	low	low	low	low	low
market forces	medium	high	medium	high	low	medium	low	medium
conservation payments	medium	high	medium	high	medium	medium	low	medium
nonmonetary values	low	low	low	low	high	low	low	low
External Capacity Building	medium	medium	medium	medium	high	medium	medium	medium
institutional & civil society development	medium	medium	low	medium	medium	medium	medium	medium
alliance & partnership development	high	high	high	high	medium	high	low	high
conservation finance	low	low	low	low	high	low	medium	low
OVERALL HABITAT PRIORITY FOR ALL ACTIONS COMBINED	medium	high	medium	high	high	medium	medium	

*for each category, 1st level threats in **bold**, 2nd level threats in *italics*

6.4 The Habitat Categories Template

This section describes the information contained within each habitat category, and how that information is organized. The following template is used to describe all of Ohio's terrestrial and aquatic habitats:

6.4.1 Statewide Habitat Distribution Map

The maps indicate statewide habitat distribution based upon the best information available. Given the statewide scale, the accuracy of these maps is compromised relative to habitat boundaries, and the locations of isolated habitat fragments. The maps are simply intended to give the viewer a qualitative representation of the distribution of each habitat category, and are not meant to be used for any kind of quantitative habitat analysis.

6.4.2 Habitat Status

This section contains a brief assessment of the current condition, condition trend, size, statewide scale relative to other habitats, and general distribution for each habitat category. The total area in acres and/or miles for each habitat is estimated from the best GIS data available.

6.4.3 Habitat Description

A historical perspective on how the habitat has changed over time is presented here. Habitat condition and distribution is characterized using the best and most current information available. Effects of an increasing population, changing land use practices, industrialization and urbanization are presented and discussed. Present day ownership of each habitat, benefits to wildlife, as well as current issues are also discussed.

6.4.4 Associated SGCN

Each habitat chapter contains a list of SGCN associated with that particular habitat. These habitat associations are not exclusive, but represent the most important and highly used habitats for the species on each list. Species lists are grouped by taxa (mammals, birds, fish, reptiles, etc.), and the order of species within each taxa reflects conservation status rank, as described in Chapter 3 – Species of Greatest Conservation Need.

6.4.5 Conservation Opportunity Areas/Conservation Opportunity Watersheds

Within some of the habitat categories, conservation opportunity areas (terrestrial) and watersheds (aquatic) are highlighted. These areas were designated "conservation opportunity" because of the quality of the habitat they contain, and their ability to support populations of species of greatest conservation need. These attributes make them worthy of additional conservation efforts to preserve and enhance these ecosystems. Maps of each area, habitat descriptions, management plans, noteworthy species, and other pertinent information are contained in this section.

6.4.6 Conservation Threats Table

For each habitat/species assessment there is a table illustrating the results using the IUCN-CMP (World Conservation Union–Conservation Measures Partnership) unified threats classification system. The direct threats classification uses a hierarchical approach with 3 different levels. Each first level threat category is sub-divided into several second level categories, and these in turn are divided into third level categories. The classifications are comprehensive and exclusive for the first and second levels – consequently we limited our threat analysis to first and second level categories. Determination of specific threats for each individual habitat (and associated SGCN) was guided by the second level categories (see Tables 15 and 17). These habitat-specific threats were then grouped under the first level categories in the threat tables for each habitat, with references to the second level categories to which they apply.

With this system, threats are characterized by determining the scope, severity, and timing of each. Subsequently, threat "impact" scores were calculated using the IUCN Threats Calculator, with scores based on estimates of the scope, severity, and timing for applicable individual threats to the species or ecosystem (Master et al. 2012). The threat classification system is described in detail by Salafsky et al. (2008). In the habitat specific threats tables, each threat includes an impact rank calculated as described above.

Direct threats are in general limited to human activities – with the exception of geological events, climate change, and severe weather. The rationale for these exceptions is that when humans put pressure on species and ecosystems, the effects of natural events can be more detrimental than they would otherwise be (Salafsky et al. 2008).

The specific threats for each habitat and associated SGCN were determined using information from a number of sources. Internal and external habitat and species experts (many of whom participated in the development of SGCN lists) provided the majority of the information. Ohio's Natural Heritage Database, as well as the Division's fisheries and wildlife databases provided key information for determining threats. Numerous survey reports by the Ohio EPA were consulted, especially for aquatic habitats and species (see Literature Cited). In addition, information from publications on a number of species (e.g., birds, amphibians, crayfish, fish, mussels) was extremely useful in the development conservation threats. Other useful information was taken from surveys by the USFWS, USGS, USEPA, ORSANCO, and a number of in-state conservation groups. Chapter 3 Species of Greatest Conservation Need contains more comprehensive list of sources of information used.

6.4.7 Conservation Actions Table

For each habitat/species assessment there is a table illustrating the results using the IUCN-CMP classification of conservation actions described by Salafsky et al. (2008). The conservation actions classification uses a hierarchical approach with 3 different levels. Each first level action category is sub-divided into several second level categories, and these in turn are divided into third level categories. The classifications are comprehensive and exclusive for the first and second levels – consequently we limited our conservation action analysis to first and second level categories.

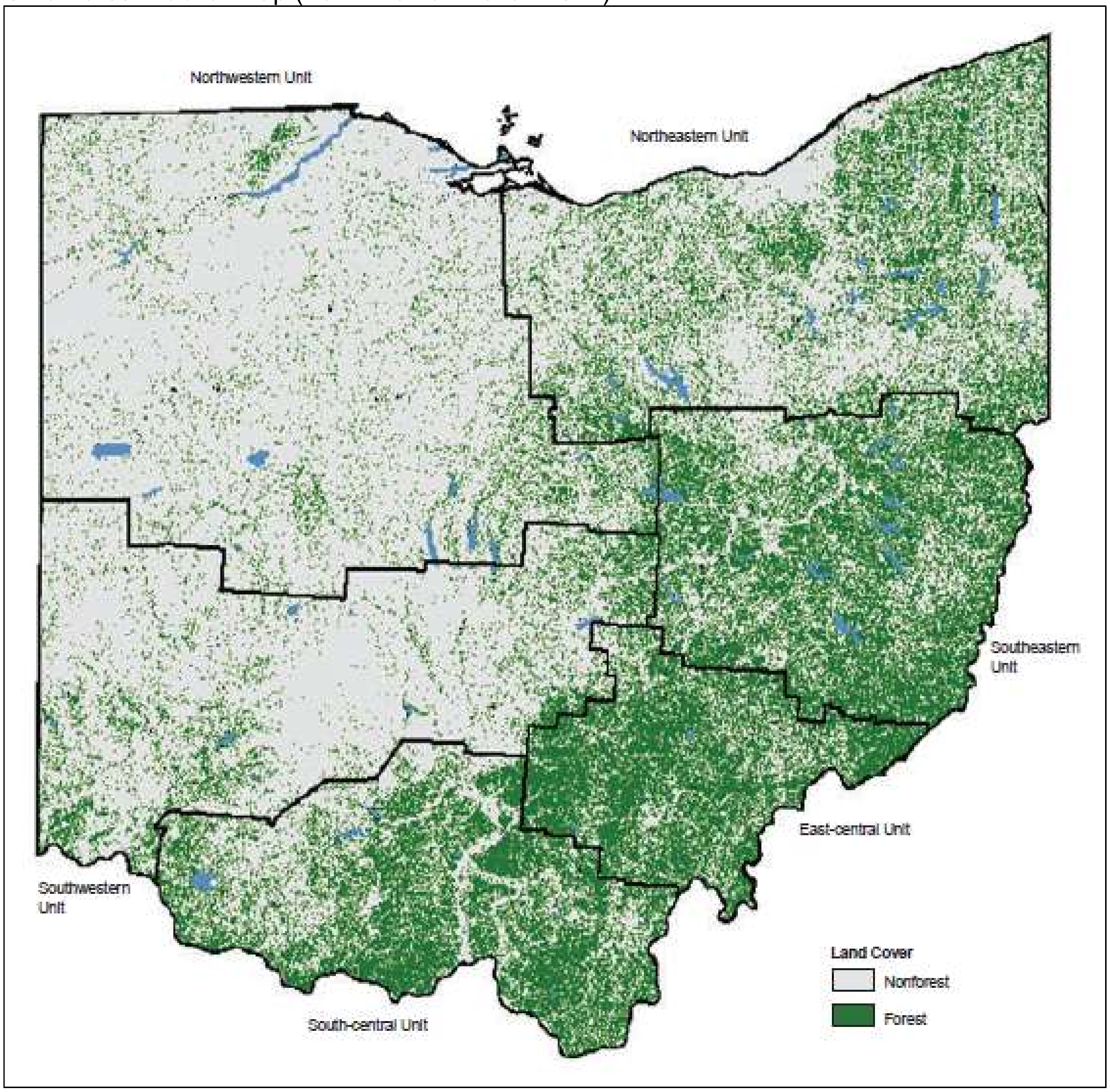
Conservation action priority ranks were then determined using the seven ranking criteria (see bullets below) developed by the Georgia Department of Natural Resources (Georgia DNR 2005) where rating reflects the relative contribution or significance of a conservation action for each criterion. Internal species/habitat experts assessed the contribution of each conservation action for each of these criteria and assigned scores (1-3 points for each). The resulting point totals were used to sort the conservation actions into three categories: high priority (17-21 points), medium priority (12-16 points), and low priority (7-11 points).

Each conservation action in the table was evaluated and assigned a priority score using the following criteria:

- Benefits for High Priority Species/Habitats
- Addresses Un(der)funded Needs
- Importance to Ongoing Local Efforts
- Timeliness or Urgency
- Connections with Other Conservation Actions
- Building Public Support for Wildlife Conservation
- Probability of Success

6.5 Forest Habitat

Ohio Forest Habitat Map (from Widmann et al. 2011)



6.5.1 Status

Since 2006, forest land has increased by 2.1 percent in Ohio. Currently, forestland comprises about 31 percent of the State's land area (approx. 8.1 million acres). Forestlands are not uniformly distributed across the state. Forest cover in glaciated, western counties averages less than 15 percent, whereas counties in unglaciated southeastern Ohio average 67 percent forest cover. Overall Ohio's forests are maturing and trees continue to shift to larger diameter size classes. By volume, red maple, yellow poplar and sugar maple dominate. Fourteen percent of Ohio's forestland acreage is in public ownership, with the remaining 86% privately owned (Widmann et al. 2011).

6.5.2 Description

Forest habitat is classified by composition (ex., oak-hickory, beech), and growth stage (early successional through mature) for management purposes.

The Ohio landscape has undergone dramatic changes since the late 1700s, when nearly 95 percent of the state was forested. Massive deforestation occurred throughout Ohio during settlement as land was cleared and swamps were drained for farmland. Forest cover was reduced to a low of 12 percent in Ohio by 1942. This destruction of forest habitat, along with unregulated hunting, resulted in the extirpation of many native animals from Ohio including the gray wolf, elk, mountain lion, and the extinction of the passenger pigeon.

Since the 1940s, Ohio's forestlands have more than doubled in area due to the reversion of unproductive and abandoned farmland and pastures back to forests. The steady increase in forest habitat in recent decades has been the major factor leading to the successful reintroduction, return, or resurgence of many forest-dependent wildlife species such as white-tailed deer, wild turkey, beaver, and bobcat.

The vast majority of forestlands are owned by private landowners in Ohio. Forest fragmentation and development pressures present an increasing threat as private woodland owners choose to sell forestland to developers. Few landowners have management plans for their forests and many do not know where to turn for technical advice. Increasing the capacity and delivery of forest habitat technical guidance will be an important goal to increase the amount of private forestland that is being sustainably managed in Ohio.

Acorns are an important food source for many forest wildlife species. Numerous studies have linked the abundance of acorn mast crops to body condition, winter survival, and reproductive success of wildlife (McShea and Healy 2002). However, an emerging shift in tree species composition has become apparent in Ohio's forests. Although oak-hickory is still the dominant forest type and provides an important wildlife food resource in Ohio, an analysis of tree species composition by diameter class reveals a lack of oak and hickory, and a predominance of shade-tolerant species such as red maple, in smaller tree diameter classes (Widmann et al. 2009). The virtual absence of oak regeneration has been attributed to fire suppression and silvicultural practices that favor shade tolerant species and inhibit oak establishment.

Early-successional habitat important to many forest wildlife species is declining as Ohio's forests are maturing. Since 1968, acreage in the seedling/sapling size class (trees < 5 inches d.b.h.) has declined by 73% from 3.7 to 1.0 million acres, whereas acreage in the sawtimber size class (trees $\geq$11 inches d.b.h.) more than doubled from 1.9 to 4.8 million acres (Widmann et al. 2009). As of 2006, the age/size class distribution of Ohio's forestland habitat was 12% seedling/sapling, 24% pole timber, and 63% saw timber (Widmann et al. 2009). The ruffed grouse has declined dramatically since the early 1980s due to loss of early-successional habitat. Furthermore, several bird species that use early-successional forest habitats including the American woodcock, prairie warbler, and blue-winger warbler have been identified as species of highest conservation priority by the Appalachian Mountains Joint Venture.

The Forest Habitat chapter addresses the major issues facing forestlands in Ohio. Increasing the capacity and delivery of forest habitat technical guidance will be an important goal to increase/improve the amount of private forestland being managed. Maintaining oak-hickory forest types and providing a sustainable balance of forest age classes, including early-successional habitats, on publicly-owned lands will be critical to provide habitat for diverse and abundant wildlife populations. Implementation of the Forest Habitat conservation actions in this section will foster healthy forest ecosystems, create/maintain opportunities for forest wildlife recreation, and improve public awareness, understanding, and appreciation of Ohio's forest wildlife on both public and private lands.

6.5.3 Associated Species of Greatest Conservation Need

Ohio's forestland historically supported hundreds of avian species, mammals, reptiles, amphibians, lepidopterans, and many other invertebrates. This wide assemblage of native fauna is dependent on forest habitat for survival and reproduction. Each species has unique habitat requirements. Some species can survive and reproduce only in the earliest stages of forest succession, whereas others need mature forest with large, tall trees. Some species require a broken forest with a good interspersion of age classes, whereas others need large expanses of unbroken mature forest with little or no edge.
The following species have been identified as Forest habitat species of greatest conservation need (conservation status rank in parentheses):

<u>Amphibians</u>

Northern Spring Salamander (1)	*Gyrinophilus porphyriticus porphyriticus*
Streamside Salamander (2)	*Ambystoma barbouri*
Kentucky Spring Salamander (3)	*Gyrinophilus porphyriticus duryi*
Smallmouth Salamander (4)	*Ambystoma texanum*
Mud Salamander (5)	*Pseudotriton montanus*
Green Salamander (6)	*Aneides aeneus*
Jefferson Salamander (7)	*Ambystoma jeffersonianum*
Northern Red Salamander (7)	*Pseudotriton ruber ruber*
Eastern Tiger Salamander (9)	*Ambystoma tigrinum tigrinum*
Marbled Salamander (10)	*Ambystoma opacum*
Four-toed Salamander (11)	*Hemidactylium scutatum*
N. Ravine Salamander (12)	*Plethodon richmondi*
Longtailed Salamander (13)	*Eurycea longicauda longicauda*
Eastern Spadefoot (15)	*Scaphiopus holbrookii*
Northern Dusky Salamander (17)	*Desmognathus fuscus fuscus*
Mountain Chorus Frog (18)	*Pseudacris brachyphona*
Red-spotted Newt (20)	***Notophthalmus viridescens viridescens***
Western Chorus Frog (20)	*Pseudacris triseriata triseriata*
Wood Frog (22)	*Rana sylvatica*

<u>Birds</u>

Cerulean Warbler (1)	*Dendroica cerulea*
Blue-winged Warbler (10)	*Vermivora pinus*
Sharp-shinned Hawk (10)	*Accipiter striatus*
Worm-eating Warbler (10)	*Helmitheros vermivorus*
Black-billed Cuckoo (24)	*Coccyzus erythropthalmus*
Red-headed Woodpecker (24)	*Melanerpes erythrocephalus*
Whip-poor-will (24)	*Antrostomus vociferus*
American Woodcock (24)	*Scolopax minor*
Wood Thrush (24)	*Hylocichla mustelina*
Prairie Warbler (24)	*Setophaga discolor*
Acadian Flycatcher (38)	*Empidonax virescens*
Wood Duck (38)	*Aix sponsa*
Yellow-billed Cuckoo (38)	*Coccyzus americanus*
Great Crested Flycatcher (38)	*Myiarchus crinitus*
Yellow-throated Vireo (38)	*Vireo flavifrons*
Blue-gray Gnatcatcher (38)	*Polioptila caerulea*
Veery (38)	*Catharus fuscescens*
Black-and-white Warbler (38)	*Mniotilta varia*
American Redstart (38)	*Setophaga ruticilla*

<u>Terrestrial Invertebrates</u>

Grizzled Skipper (3)	*Pyrgus centaureae wyandot*
Olympia Marble (4)	*Euchloe olympia*
Gold-banded Skipper (5)	*Autochton cellus*
Confused Cloudy Wing (6)	*Thorybes confusis*
Duke's Skipper (6)	*Euphyes dukesi*
Diana Fritillary (9)	*Speyeria diana*
Mottled Dusky Wing (9)	*Erynnis martialis*
Cobweb Skipper (14)	*Hesperia metea*
Silvery Blue (22)	*Glaucopsyche lygdamus*
Atlantis Fritillary (23)	*Speyeria atlantis*
Gray Comma (23)	*Polygonia progne*
Zebra Swallowtail (25)	*Eurytides marcellus*
Dusky Azure (26)	*Celastrina nigra*

Northern Oak Hairstreak (27)	*Fixsenia favonius ontario*
Falcate Orange Tip (28)	*Anthocharis midea annickae*
Eastern Pine Elfin (28)	*Incisalia niphon*
Northern Metalmark (28)	*Calephelis borealis*
Early Hairstreak (31)	*Erora laeta*
Edward's Hairstreak (33)	*Satyrium edwardsii*
White M Hairstreak (34)	*Parrhasius m-album*
Compton Tortoise Shell (34)	*Nymphalis l-album*
Goatweed Butterfly (37)	*Anaea andria*
Hayhurst’s Scalloped Sootywing (37)	*Staphylus hayhurstii*
Hickory Hairstreak (39)	*Satyrium caryaevorum*
Leonard's Skipper (41)	*Hesperia leonardus*
West Virginia White (45)	*Pieris virginiensis*
Brown Elfin (45)	*Incisalia augustinus croesoides*
Appalachian Blue (45)	*Celastrina negelectamajor*
Pepper & Salt Skipper (45)	*Amblyscirtes hegon*
Monarch (n/r)	*Danaus plexippus*
American Burying Beetle (n/r)	*Nicrophorus americanus*

<u>Mammals</u>

Eastern Small-footed Bat (1)	*Myotis subulatus leibii*
Northern Long-eared Bat (2)	*Myotis septentrionalis*
Rafinesque’s Big-eared Bat (3)	*Corynorhinus rafinesquii*
Silver-haired Bat (4)	*Lasionycteris noctivagans*
Evening Bat (5)	*Nycticeius humeralis*
Red Bat (6)	*Lasiurus borealis*
Indiana Bat (7)	*Myotis sodalis*
Tri-colored bat (7)	*Perimyotis subflavus*
Hoary Bat (9)	*Lasiurus cinereus*
Southern Flying Squirrel (9)	*Glaucomys volans*
Little Brown Bat (14)	*Myotis lucifugus*
Big Brown Bat (14)	*Eptesicus fuscus*
Pine Vole (19)	*Microtus pinetorum*
Smoky Shrew (19)	*Sorex fumeus*
Hairy-tailed Mole (22)	*Parascalops breweri*
Woodland Jumping Mouse (22)	*Napaeozapus insignis*
Allegheny Woodrat (24)	*Neotoma magister*
Eastern Chipmunk (25)	*Tamias striatus*
Bobcat (25)	*Felis rufus*
Black Bear (28)	*Ursus americanus*

<u>Reptiles</u>

Eastern Smooth Earth Snake (2)	*Virginia valeriae valeriae*
Rough Green Snake (3)	*Opheodrys aestivus*
Eastern Hognose Snake (6)	*Heterodon platirhinos*
Broadhead Skink (12)	*Eumeces laticeps*
Eastern Box Turtle (13)	*Terrapene carolina carolina*
Black Kingsnake (13)	*Lampropeltis getula nigra*
Northern Copperhead (17)	*Agkistrodon contortrix mokasen*
Timber Rattlesnake (18)	*Crotalus horridus horridus*
Copperbelly Water Snake (22)	*Nerodia erythrogaster neglecta*

6.5.4 Forest Conservation Opportunity Areas (COAs)

The Division of Wildlife's approach to enhancing and maintaining the highest level of terrestrial wildlife diversity in the state is to use a conservation opportunity area concept to sustain viable populations of as many native species of wildlife as possible. The idea is to concentrate efforts and resources to provide all the necessary habitat requirements in a few, relatively large landscapes of major habitat types, along with the remnants of several unique habitats, for species that are of limited distribution or have low populations.

In the Division's last strategic plan, two forest conservation opportunity areas were identified - the Appalachian Foothills and Tecumseh Forest Conservation Opportunity Areas, both of sufficient size (>60,000 acres) to maintain viable populations of most native forest dependent wildlife species, except black bears. Important partnerships were developed and great strides were made to inventory forest resources and discuss cooperative management of forest conservation opportunity areas during the last several years. The next steps will require development of specific habitat objectives to benefit priority wildlife species as identified in state, federal, and regional conservation plans, and conducting a coordinated monitoring protocol to determine the success of these efforts.

Addition of forest conservation opportunity areas in the future will be considered on a case-by-case basis as opportunities arise. Identification of private lands of strategic conservation value within existing COA's, and working with private landowners are high priority conservation actions for forest habitats (see Table 20).

6.5.4.1 Appalachian Foothills Forest Conservation Opportunity Area

The Appalachian Foothills Conservation Opportunity Area, primarily located in Vinton and Athens counties, includes the Zaleski State Forest (28,604 ac.), Vinton Furnace State Experimental Forest (12,089 ac.), Waterloo (2,635 ac.), Turkey Ridge Wildlife Area (377 ac.), Vinton Furnace Wildlife Area (3,405 ac.), Lake Hope State Park (2,635 ac.), and surrounding private lands (Figure 11). Current habitat conditions on inholdings and adjacent privately-owned properties within the focus area landscape will be identified with satellite imagery and considered along with public lands as forest management plans are developed within the conservation opportunity area. Private lands of strategic conservation value within the area will be identified and prioritized for acquisition and/or conservation easements.

The Appalachian Foothills Conservation Opportunity Area landscape is primarily an oak-hickory forest type, and contains a heterogeneous composition of forest species referred to as the Central Upland Hardwoods. Mixed oak species are located on upper slopes and ridges, with mixed mesophytic trees of more tolerant and later climax species located in the hollows and low areas. Principal species include red, white, and black oak, red and sugar maple, various hickories, beech, yellow poplar, ash, and occasional walnut and scattered other species. Plantations of conifers are common throughout the area. Principal species include white, red, and shortleaf pine.

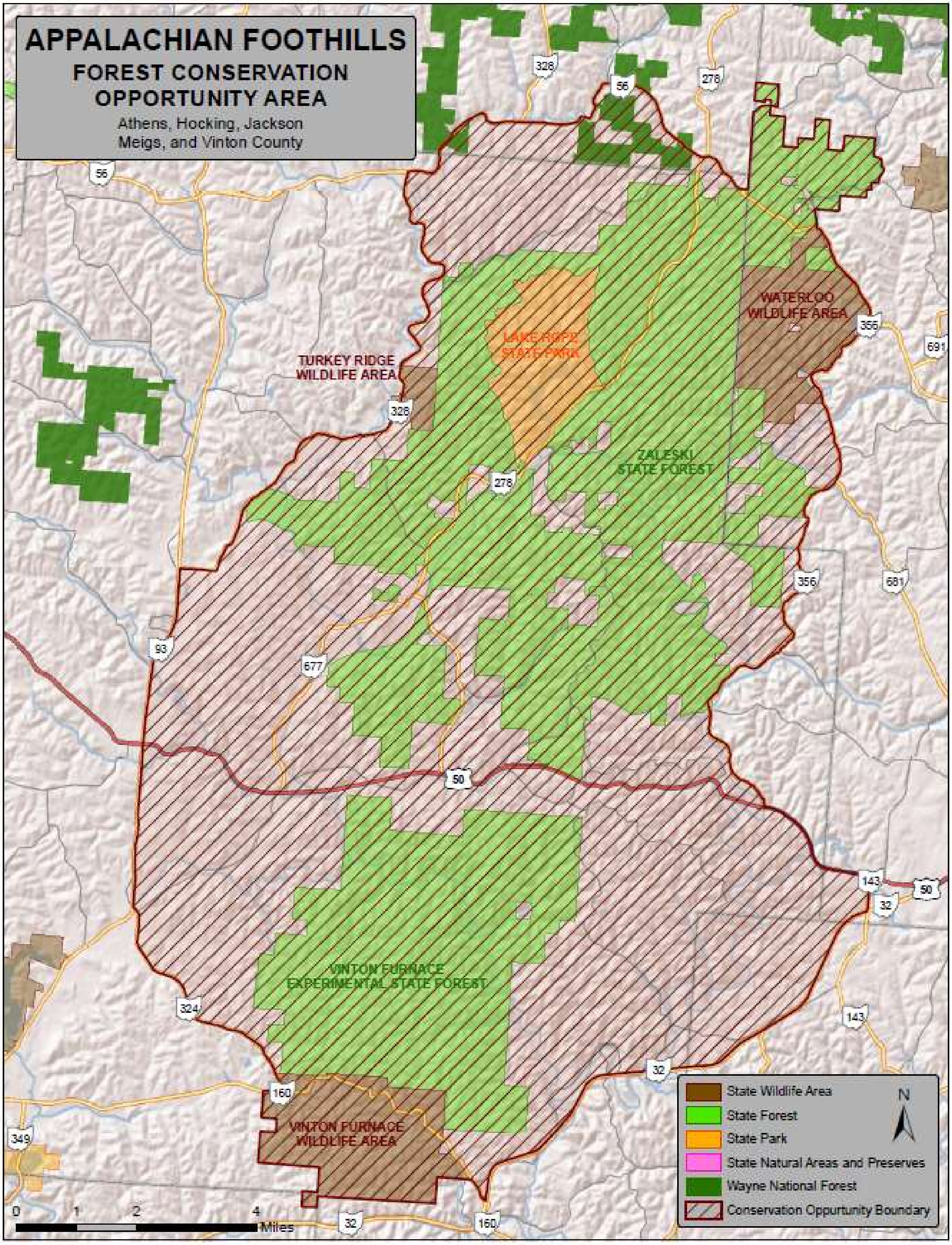


Figure 11. Appalachian Foothills Forest Conservation Opportunity Area.

6.5.4.2 Tecumseh Forest Conservation Opportunity Area
The Tecumseh Forest Conservation Opportunity Area, located in Scioto and Adams counties, includes Shawnee State Forest (63,747 ac.), Shawnee State Park (852 ac.), Raven Rock State Nature Preserve (95 ac.), and surrounding private lands (Figure 12 – the boundaries of this area are currently being revised). Current habitat conditions on inholdings and adjacent privately-owned properties within the area landscape will be identified with satellite imagery and considered along with public lands as forest management plans are developed within the conservation opportunity area. Private lands of strategic conservation value within the area will be identified and prioritized for acquisition and/or conservation easements.

The Tecumseh Forest Conservation Opportunity Area is part of the overall Central Hardwood Region and contains two major forest types: mixed-mesophytic and oak-hickory, as well as small stands of other forest types spread throughout the forest. The relatively narrow ridges and steep upper slopes typical of the region support trees of the oak-hickory forest type with the occasional stands of native pine. The main hardwood species include scarlet, chestnut, white, black, and northern red oaks, pignut, shagbark and mockernut hickories, and sassafras. Native conifers include Pitch, Virginia, and shortleaf pines. Depending upon the aspect, many sites support mixed-mesophytic hardwood species such as chestnut, white, black, and northern red oaks, red and sugar maple, basswood, yellow-poplar, yellow buckeye, blackgum, white ash, beech, red elm, hackberry, aspen, and several species of hickory. The coves, depending on site class and aspect, support high quality hardwoods such as yellow poplar, black walnut, white ash, black cherry, and red oak.

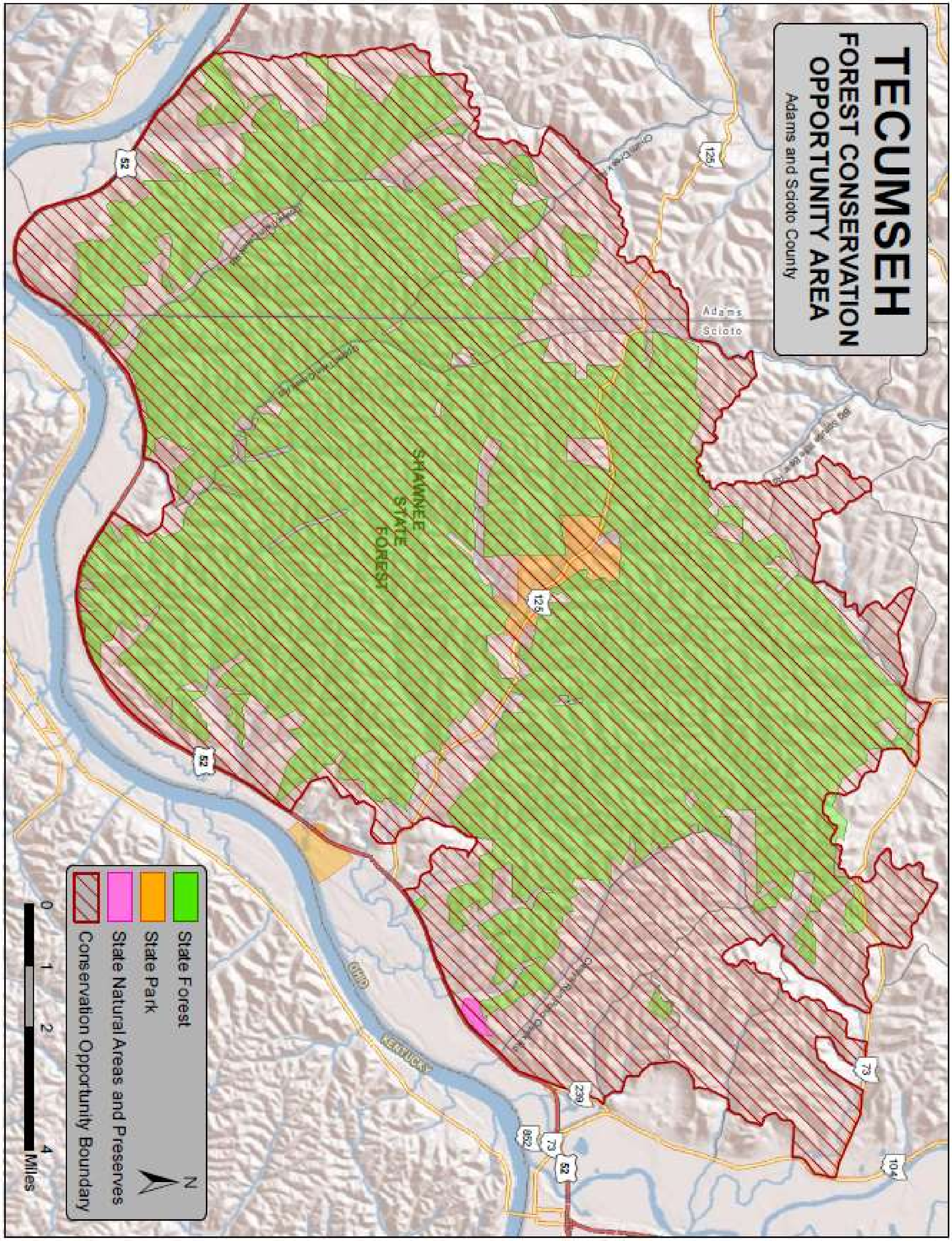


Figure 12. Tecumseh Forest Conservation Opportunity Area.

Table 19. CONSERVATION THREATS TO FOREST HABITAT.
The following threats negatively impact or have the potential to negatively impact Forest habitat. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		medium
A	Changing land ownership patterns are increasing fragmentation, parcelization, and urbanization of forestlands	housing & urban areas commercial & industrial areas	high low
B	Habitat destruction, fragmentation, altered hydrology from commercial development	commercial & industrial areas	low
C	Habitat destruction, fragmentation, altered hydrology from urban/suburban development	housing & urban areas	high
II	**agriculture and aquaculture**		low
A	Loss of forest habitat because of conversion to agriculture	annual & perennial non-timber crops livestock farming & ranching	negligible low
B	Loss of forest habitat due to increase in intensity of agricultural practices – conversion of fencerows and other imbedded forest habitat	annual & perennial non-timber crops	negligible
III	**energy production and mining**		high
A	Mining, oil and gas extraction - can directly damage and destroy forest habitat, and indirectly have negative impacts by altering hydrology and causing chemical contamination	oil & gas drilling mining & quarrying	high high
IV	**transportation and service corridors**		low
A	Roads and utilities can destroy and fragment forest habitat, and alter hydrology	roads & railroads utility & service lines	medium medium
V	**biological resource use**		low
A	Logging and timber harvest can destroy and/or alter forest habitat	logging & wood harvesting	medium
VI	**human intrusions and disturbance**		low
A	Incompatible recreational activities	recreational activities	medium
B	Creation of recreational facilities can alter/destroy forest habitat	recreational activities	medium
VII	**natural system modifications**		low
A	Our ability to manage/protect forestlands is limited because nearly 73% of forest land is owned by private landowners in Ohio	other ecosystem modifications	low
B	Increased opposition to prescribed burning in forestlands	fire & fire supression	low
C	Lack of forest inventory data, and a database system to analyze that data limits our ability to manage	other ecosystem modifications	low
D	Our ability to manage forestlands is limited by available staff and funding	other ecosystem modifications	low
E	Forest tree species composition is shifting in Ohio from oaks and hickories – important wildlife habitat – to less desirable species such as red maple	other ecosystem modifications	low

F	Wildlife species dependent on early-successional habitats have declined as Ohio forests have matured into older age classes.	other ecosystem modifications	low
G	Incompatible forestry practices that result in changes to species composition, changes in habitat structural complexity, changes in hydrology – and resulting impacts to wildlife normally associated with these habitats	other ecosystem modifications	low
H	Our ability to address habitat objectives in some forests stands (management by selective cutting) may be limited because there may be no market for the timber	other ecosystem modifications	low
I	Lack of forestland associated species data limits our ability to manage for current threats and limits our ability to develop plans for impending issues like climate change	other ecosystem modifications	low
VIII	**invasive and other problematic species and genes**		medium
A	Introduction and/or spread of invasive plants and animals	invasive non-native/alien species	high
B	Introduction and/or spread of nuisance plants and animals	problematic native species	low
C	Introduction and spread of diseases (plants and animals)	invasive non-native/alien species problematic native species	high low
IX	**pollution**		low
A	Urban effluent	household sewage & urban wastewater industrial & military effluents garbage & solid waste air-borne pollutants	low low low low
B	Agriculture effluent	agricultural & forestry effluents	low
X	**geological events**		low
---	none	---	---
XI	**climate change and severe weather**		low
A	Climate change could effect plant species composition, which in turn could affect wildlife species	habitat shifting & alteration droughts temperature extremes storms & flooding	low low low low

Table 20. CONSERVATION ACTIONS FOR FOREST HABITAT.
The following actions will help abate or have the potential to help abate threats to Forest habitat. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	actions	2nd level action classification(s)	action priority rank	threat(s) addressed*
I	**LAND/WATER PROTECTION**		high	
1	Annually identify and prioritize properties within the existing Forest Conservation Opportunity Areas for strategic acquisitions, conservation easements, management agreements, or partnerships	site/area protection	high	I, II, VII-D
2	Protect forest lands through strategic acquisitions, easements, and partnerships	resource & habitat protection	med	I, II, III, IV, V, VI
3	Use State Wildlife Grant funds for potential acquisitions	resource & habitat protection	med	I, II, III, IV, V, VI
4	Site new recreational facilities such as golf courses and ball fields on already disturbed land whenever possible to limit disturbance to higher quality habitats in the area	resource & habitat protection	med	VI-B
II	**LAND/WATER MANAGEMENT**		high	
1	Develop a forest wildlife monitoring protocol	habitat & natural process restoration	high	VII-C,I
2	Assure that wildlife/habitat interests are considerations in all forestry practices	habitat & natural process restoration	high	V, VII-G
3	Support research on wildlife species for which knowledge of habitat requirements and/or population status is incomplete	habitat & natural process restoration	high	VII-C,I
4	Collect and evaluate data from legitimate citizen scientist-based monitoring surveys, such as the Ohio Lepidopterist Society's Long-term Butterfly Monitoring Program, the Breeding Bird Survey, and the Frog and Toad Call Survey	habitat & natural process restoration	high	VII-C,D,I
5	Assign lower priority to potential Forest Conservation Opportunity Area acquisitions in which mineral or timber rights have been severed from surface rights	habitat & natural process restoration	high	I, II, III
6	Work with the National Resource Conservation Service to increase the number and the promotion of forest habitat management practices eligible for cost-share funding in WHIP, CSP, HFRP, and EQIP programs	habitat & natural process restoration	high	VII-A
7	Train additional wildlife management staff in oak ecology and silvicultural methods	habitat & natural process restoration	high	VII-E,F
8	Collaborate with the Division of Forestry to accomplish appropriately-timed burns on forestlands to promote oak regeneration	habitat & natural process restoration	high	VII-B,E,F
9	Seek technical assistance from Division of Forestry land management foresters when implementing silvicultural techniques to promote oak regeneration	habitat & natural process restoration	high	VII-D,E

10	Obtain forest inventory data to develop stand maps and silvicultural prescriptions to maintain and regenerate oak species	habitat & natural process restoration	high	VII-C,E
11	Contract with a forest consulting firm to obtain forest stand inventory data for all wildlife areas with >500 contiguous acres of forestland	habitat & natural process restoration	high	VII-C,D
12	Collaborate with Division of Forestry (DOF) to reduce inventory costs and acquire data that are compatible with the DOF's Genus database management system	habitat & natural process restoration	high	VII-C,D
13	Use forest inventory to identify and protect large blocks of mature forest, streamside management zones, and unique/rare habitats	habitat & natural process restoration	high	I, II, III, IV, V, VI
14	Use annual timber sale revenue to pay for inventory and data management costs	habitat & natural process restoration	high	VII-C,D
15	Update and improve the accuracy of landcover data in Ohio by using advanced GIS modelling to determine habitat distribution and quality	habitat & natural process restoration	high	VII-C
16	Develop a database management system to store, access, map, and analyze forest inventory data	habitat & natural process restoration	high	VII-C,I
17	Obtain forest stand inventory data to assess current age composition of forest landscapes in unglaciated Ohio	habitat & natural process restoration	high	VII-C
18	Develop plans to manage invasive species on forest management and reclamation projects	invasive/ problematic species control	high	VIII
19	Treat invasive plant species as an integral component of forest management plans on wildlife areas	invasive/ problematic species control	high	VIII
20	Establish an early-detection rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	high	VIII
21	Promote forest restoration/reclamation on lands impacted by surface mines or other disturbances	habitat & natural process restoration	high	I, II, III
22	Partner with the Wildlife Management Institute to secure additional funds to achieve early-successional forest habitat objectives	habitat & natural process restoration	high	VII-D,F
23	Actively market and offer timber sales to achieve early-successional forest habitat objectives	habitat & natural process restoration	high	VII-D,H
24	Work towards a sustainable balance of early, mid, and late-successional habitats within forested landscapes in unglaciated Ohio	habitat & natural process restoration	high	VII-E,F
25	Identify ecosystem or population-level threats through research, surveillance, monitoring, and inventory	habitat & natural process restoration	high	I, II, III, IV, V, VI, VII-I, VIII, IX, XI
26	Develop compatible recreational activities criteria that can be used to evaluate impacts to habitat/species from recreational activities	habitat & natural process restoration	high	VI
27	Manage Forest Conservation Opportunity Areas to provide appropriate habitat to sustain viable populations of all forest dependent wildlife species native to Ohio	site/area management	med	VII-E,F VIII, IX

28	Develop habitat objectives for Forest Conservation Opportunity Areas based on Habitat Suitability Index (HSI) modeling results for forest wildlife species of highest conservation priority	site/area management	med	VII-C,I
29	Conduct annual wildlife population monitoring of SGCN within Forest Conservation Opportunity Areas to evaluate wildlife population status in response to forest management strategies	site/area management	med	VII-C,E,F,G,I
30	Annually hire a research technician and seasonals to conduct wildlife population surveys in Forest Conservation Opportunity Areas	site/area management	med	VII-D,I
31	Obtain information on habitat requirements and HSI models for all native forest wildlife species that occur in Forest Conservation Opportunity Areas	site/area management	med	VII-C,I
32	Create a Division of Wildlife/Division of Forestry jointly-funded forest habitat biologist position to conduct Forest Conservation Opportunity Area habitat modeling, and to provide wildlife habitat consultations to agencies and partners	site/area management	med	VII-D,G,I
33	Develop forest management plans to maintain, restore, or regenerate oak-hickory forest types totaling 10,000 acres on at least 5 different wildlife areas by 2020	site/area management	med	VII-E
34	Obtain current timber inventory data to model wildlife habitat quality in Forest Conservation Opportunity Areas	site/area management	med	VII-C
35	Annually review and provide wildlife habitat recommendations for all 21 Division of Forestry State Forest Management Plans and applicable Wayne National Forest management projects	site/area management	med	V, VI, VII-G
36	Identify 5 early-successional management units totaling at least 5,000 acres on Wildlife Areas outside of Forest Conservation Opportunity Areas	site/area management	med	VII-F
37	Develop management plans and create at least 500 acres of habitat on 5 early-successional management units on Wildlife Areas outside of Forest Conservation Opportunity Areas	site/area management	med	VII-F
III	**SPECIES MANAGEMENT**		high	
1	Develop species-specific conservation plans as needs are identified to clearly define the actions the Division will/or will not implement concerning the state-listed species	species management	high	VII-F,G,I
2	Identify, design, and conduct appropriate species-specific surveys, inventories, or monitoring projects to determine species distribution and abundance	species management	high	VII-C,F,G,I
3	Develop a feral hog management plan designed to minimize introductions and control expansion	species management	high	VIII-B
4	Reintroduce and restore forestland species where appropriate	species reintroduction	med	I, II, VII-F,G,I
5	Continue to support research and develop plans for restoration of American chestnut on surface mine reclamation areas	species reintroduction	med	I, II, VII-E

IV	EDUCATION AND AWARENESS		high	
1	Enhance forest wildlife habitat technical guidance by providing assistance to landowners through partnerships and education	training	high	VII-A
2	Provide forest wildlife habitat management practices training to Division of Forestry service foresters, Soil and Water Conservation District wildlife specialists, and National Research Conservation Service biologists every 2 years	training	high	V-A VII-G
3	Conduct additional forest habitat field days in conjunction with OSU-Extension, Farm Science Review, Woodland Owner groups, and Wildlife Conservation NGOs	training	high	V-A VII-A,G
4	Provide additional training to wildlife management staff to increase knowledge of forestry practices	training	high	VII-D,G
5	Maintain a corps of Division of Wildlife-trained partners and volunteers to assist, lead, and promote special programs	training	high	V-A VII-A,G
6	Increase the amount and delivery of technical assistance to non-industrial private forest landowners in Ohio	awareness & communications	low	VII-A
7	Target forest landowners for technical services through a variety of media based on enrollment in Forest Tax Law or similar programs	awareness & communications	low	VII-A
8	Inform forest landowners about services available to them and who to contact for management guidance or to obtain professionally designed management plans	awareness & communications	low	VII-A
9	Develop and coordinate an advertising campaign for forest wildlife management advice similar to Call Before You Cut program	awareness & communications	low	V-A VII-A,G
10	Publish a comprehensive forest wildlife habitat management technical guide for private landowners and forest practitioners	awareness & communications	low	V-A VII-A,G
11	Partner with The Ohio State University – Extension and the Terrestrial Wildlife Ecology Laboratory to reduce costs and increase distribution of a forest wildlife habitat management technical publication	awareness & communications	low	V-A VII-A,G
12	Revise and incorporate existing Division of Wildlife woodland habitat management factsheets and OSU-extension bulletins into a comprehensive forest wildlife habitat management technical publication	awareness & communications	low	V-A VII-A,G
13	Provide guidance to landowners for eradication/control of invasive and nuisance species	awareness & communications	low	VII-A VIII-A,B
14	Educate the public about the negative effects of exotic and nuisance animals – encourage responsible disposal of unwanted animals	awareness & communications	low	VIII-A,B
15	Develop additional wildlife habitat interpretation/educational materials for the Division of Forestry's forest management driving tours and/or demonstration areas at Mohican-Memorial State Forest, Zaleski State Forest, and the Vinton Furnace State Experimental Forest	awareness & communications	low	V-A VII-A,G

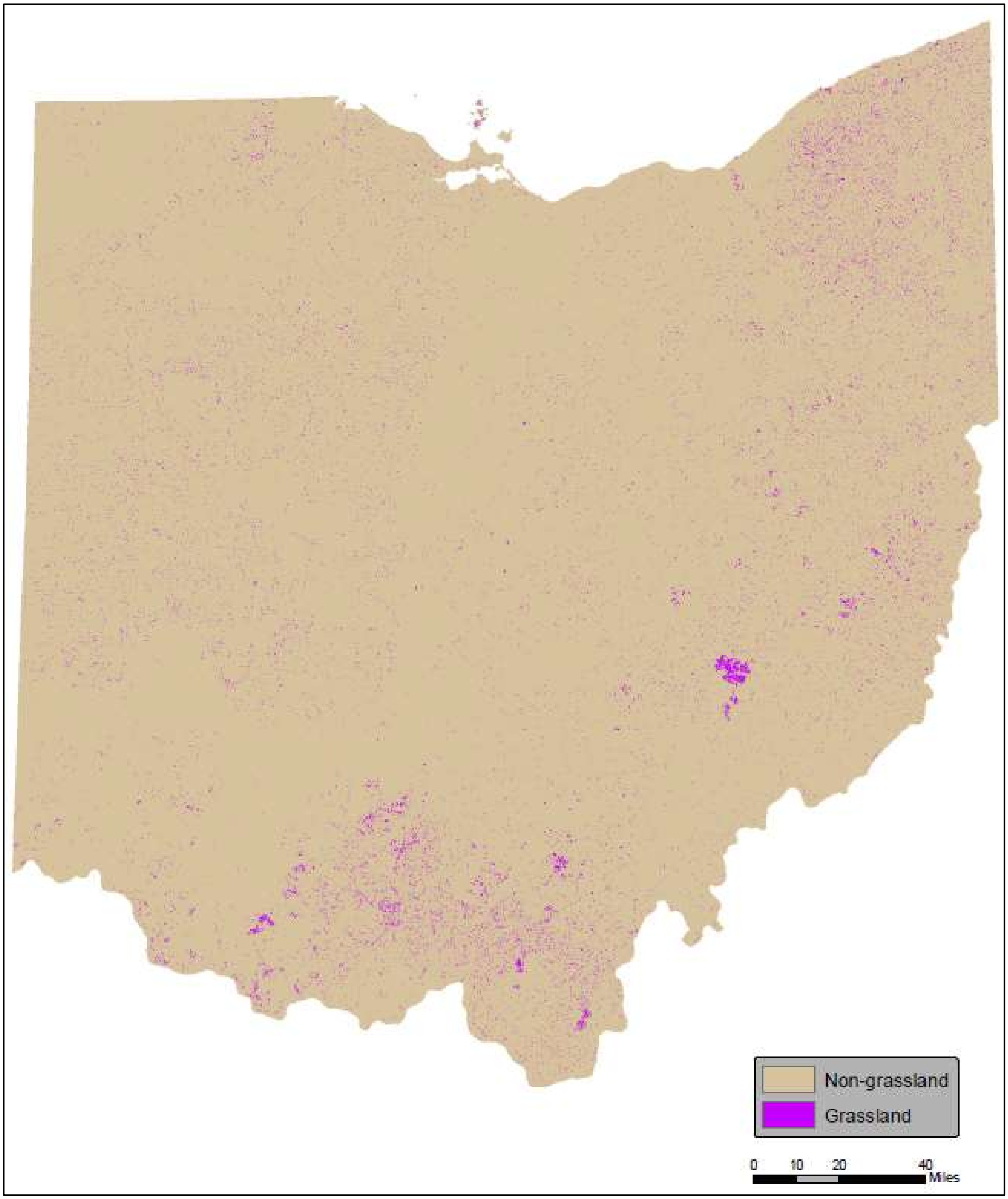
16	Synthesize research results from the Ohio State University's Terrestrial Wildlife Ecology Laboratory's forest wildlife research projects into practical management guidelines	awareness & communications	low	V-A VII-C,D,G
17	Educate landowners, maintenance staff, municipalities, etc. on ways to reduce impacts to adjacent forest habitat	awareness & communications	low	I, II VII-A
18	Resolve the issue of various, and often conflicting, sources of forest management technical information are available through multiple outlets, agencies, and organizations	awareness & communications	low	VII-A
V	**LAW AND POLICY**		high	
1	Balance the needs of fish and wildlife with the needs of people by mitigating incompatible ecosystem uses	policies & regulations	high	I, II, III, IV, V, VI
2	Participate in the policy-making process at Federal level to influence conservation programs	policies & regulations	high	VII-A,G
3	Support legislation promoting eco-friendly energy development and use	legislation policies & regulations	high high	III-A
4	Encourage the preservation of habitat connectivity in all land use planning	policies & regulations private sector standards & codes	high med	I, IV
5	Create incentives (laws, policies) to prevent loss and/or minimize impacts to forest lands due to development	policies & regulations	high	I, II, IV
6	Develop regulations to deter introduction of invasive/nuisance species	legislation policies & regulations	high high	VIII
7	Develop and implement a risk-assessment system in the approval process for bringing live animals/plants into Ohio, or moving them within the state	legislation policies & regulations	high high	VIII
VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		low	
1	Support the creation of incentives for the protection and restoration of forest habitat	linked enterprises & livelihood alternatives substitution market forces conservation payments non-monetary values	low low med med med	I, II, III, IV, VII-A

2	Support incentives that encourage landowners to maintain/preserve existing forest habitat on agricultural lands	market forces conservation payments non-monetary values	med med low	II
3	Support incentives for private landowners to practice forest management that focuses on preserving native habitat and wildlife species	conservation payments non-monetary values	med low	VII-A
4	Support creation of incentives to incorporate wildlife habitat into recreational facilities such as parks and golf courses	market forces conservation payments non-monetary values	med med low	VI-B
5	Develop incentives for private landowners to eradicate/control invasive plant species	conservation payments non-monetary values	med low	VII-A VIII
VII	**EXTERNAL CAPACITY BUILDING**		med	
1	Create partnerships among research scientists and other key partners to plan coordinated wildlife monitoring and implement this protocol across ownership boundaries within Forest Conservation Opportunity Areas	alliance & partnership development	med	VII-C,D,I
2	Support and actively participate in an Ohio Prescribed Fire Council	alliance & partnership development	med	VII-B
3	Help create and support partnerships of conservation-minded groups to protect and manage forest habitat	alliance & partnership development	med	I, II, V-A, VII-C,D
4	Support legitimate citizen scientist-based monitoring efforts of wildlife species and habitats	institutional & civil society development	med	VII-C,D,I
5	Create a multiagency invasive species prevention and control group that would be responsible for all invasive species issues	alliance & partnership development	med	VIII
6	Through interagency coordination, work to assure that wildlife interests are taken into consideration in road, bridge, causeway, and utilities design, construction, and maintenance	alliance & partnership development	med	IV

*refers to the Forest Habitat Conservation Threats in Table 19

6.6 Grassland Habitat

Ohio Grassland Habitat



6.6.1 Status

Fair and declining. Never a very abundant habitat in terms of acreage, grassland habitat is second only to wetlands in terms of habitat loss in Ohio. Ohio's grasslands are threatened primarily by conversion to urban/suburban development and agriculture, and to a lesser degree by reversion to forestland. Since the federal government required ethanol to be blended with motor fuels, significant acres of grasslands have been lost to agriculture – including many of those created by the Conservation Reserve Program. The absence of periodic fires (except in intensively managed grassland areas) to retard succession is also responsible for the loss of some of Ohio's grasslands.

6.6.2 Description

Grassland ecosystems, which include prairies, pastures, hayfields, meadows, and old fields, are highly valued by Ohioans for their rich diversity of plant and wildlife resources. Historic grasslands in Ohio, such as native prairies and wet meadows, comprised only 2.5%, or 1,000 square miles of Ohio's landscape before European settlement. Grassland-dependent wildlife was likely not as abundant as during later, post-settlement times. European settlement resulted in broad changes to Ohio's landscape as forests were cleared for agriculture. Grassland habitats, including native grass pasture, hayfields, and small grain fields, increased as a consequence of this activity, and resulted in population and range expansions of grassland-associated wildlife. These wildlife populations are still valued today, including those of northern bobwhite quail, various grassland songbirds, the American badger, and the introduced ring-necked pheasant. After World War II, a growing human population and changes in agricultural practices (including the introduction of cool season, exotic pasture grasses) and agricultural economics decreased or degraded the grassland habitats available to wildlife in Ohio. The dominance of row crops such as corn or soybeans in agricultural systems, the prevalence of larger equipment, and decreased reliance on diversified agricultural operations meant less need for fence field dividers, small pastures, and other areas that once supported diverse wildlife populations. Suburban development, and in some areas, forest regeneration, have further contributed to Ohio's loss of grassland habitats.

6.6.2.1 Identifying Current Ohio Grasslands

Dramatic population declines of many grassland bird species, including northern bobwhite quail, ring-necked pheasant, Henslow's sparrow, bobolink, eastern meadowlark, upland sandpiper, and others have resulted because of reductions in the amount of Ohio's grassland habitats during the last 50 years. Some species like the northern bobwhite and the barn owl have not only experienced population declines but also range contractions and are no longer present in many areas of Ohio. Other grassland bird species like the field sparrow and red-winged blackbird that are perceived to be common have experienced population declines in Ohio and throughout the Midwest.

Grassland-dependent birds and other wildlife are attracted to a variety of habitat features, including tract size, vegetation height and density, availability of shrub cover, and amount of edge, among others. Whereas much effort has been made to identify the distribution and cover types of wetland and forest habitats, similar information is generally lacking for grassland ecosystems throughout Ohio. Grassland habitats are an early successional state and ephemeral on the landscape over the timeframe in which they may be mapped and catalogued (i.e. National Land Cover Database). In addition, grassland habitats that provide sufficient structure and resources for wildlife are often difficult to distinguish from pastured and hayed lands that might offer suitable conditions for only a few species. Nonetheless, knowledge about the distribution and types of grasslands available throughout Ohio can be important in understanding how wildlife populations are distributed, what habitat conditions need to be improved to reverse declines among priority populations, and to identify the grassland types and locations that may be under the greatest threat of conversion to other cover types.

6.6.2.2 Prioritizing Grassland Management Efforts

Providing grassland resources of sufficient quality for Ohio's upland and priority grassland species is a challenge given continued growth in Ohio's human population, changes in agricultural practices, and the resulting alterations to Ohio's landscape. The primary goal for grassland management on private and public lands should be to reverse declines in wildlife populations associated with these habitats. The approach taken in this grassland chapter is to promote intensive management on select critical grassland areas while maintaining no net loss of grassland habitats on DOW-managed properties and private lands, and preserving large (>50 acres) grassland mosaics wherever possible for the benefit of priority grassland wildlife. Under this approach, intensive management would occur at 1) private and public lands within conservation opportunity areas based on the Partners In Flight model for avian conservation for grassland-dependent wildlife, 2) priority areas that contain expansive grassland tracts to support populations of area-sensitive birds of regional importance, and 3) private and public lands within priority areas designed to benefit northern bobwhite or ring-necked pheasant populations.

6.6.3 Associated Species of Greatest Conservation Need

Grassland wildlife populations are influenced primarily by habitat and weather factors. Habitat quality, also, can be directly impacted by weather conditions. Much of the annual variation shown by small game populations, for example, can be the result of weather conditions during critical periods (i.e., nesting, brood-rearing, and winter). Long-term trends, however, tend to be tied more directly to habitat quality, quantity, and distribution.

Weather, then, is of primary importance in interpreting annual fluctuations in grassland wildlife populations. Severe winter weather, consisting of prolonged periods of deep snow or ice and colder than normal temperatures, tends to result in higher than normal overwinter mortality and, thus, reduced brood stock in the spring. Cold, wet periods in the spring and early summer can impact survival of young wildlife by chilling eggs or young animals or flooding nests. Extended periods of drought can affect vegetation growth and, thus, cover quality. Drought can also make insects and seeds less available as food for growing wildlife. Land-use and technological changes are of primary importance in explaining long-term population trends for grassland species. An increasing human population with the resultant increase in urbanization and residential and commercial development yields fewer acres for wildlife. Likewise, modern farming’s emphasis on more efficient and larger equipment and increased reliance on chemicals reduces the quantity and quality of available habitat. On the other hand, federal farm policy that idles agricultural land and requires herbaceous cover crops can improve habitat conditions for farmland wildlife.

Most of Ohio is in private ownership, and, thus, habitat management on public lands is of little value in terms of impacting grassland wildlife populations at the state level. However, land-use practices that benefit grassland wildlife can result from regional or federal government programs and policies. For example, the Conservation Reserve Program (CRP) created by the 1985 Farm Bill and continued by the 1990, 1996, and 2002 bills idled more than 300,000 acres of cropland in Ohio. Most of this acreage now supports a cover crop of grasses, legumes, and wild forbs. To the extent that this acreage is not disturbed during the nesting season, these areas provide moderate to good quality nesting cover for many grassland birds. Pheasants, in particular, showed a numerical response to the availability of additional safe nesting cover resulting from this federal program in its early years. This program has changed focus over time, particularly in the 1996 bill, but continues to provide habitat for grassland nesting species.

Wildlife species that live in grasslands are well adapted to the distinctive habitat that grasslands provide. The grassland species assemblage includes grazing animals that feed on the grasses (deer, rabbits), burrowing animals that avoid predators by spending a significant portion of their lives below ground (mice, voles, groundhogs), and specialized grassland predators (hawks, owls, coyotes, snakes). Grasslands are also home many species of birds – neotropical migrants, short distance migrants, and resident species – that use them as breeding habitat. Species such as the upland sandpiper, ring-necked pheasant, northern harrier, common barn-owl, short-eared owl, horned lark, bobolink, eastern meadowlark, vesper sparrow, savannah sparrow, grasshopper sparrow, Henslow's sparrow, Le conte's sparrow, dickcissel, and sedge wren utilize grassland habitats in Ohio for breeding. Unfortunately, owing to the disappearance and fragmentation of grasslands, grassland birds have declined more than any other group of birds.

The following species have been identified as grassland species of greatest conservation need (conservation status rank in parentheses):

<u>Amphibians</u>

Eastern Tiger Salamander (9)	*Ambystoma tigrinum tigrinum*
Western Chorus Frog (20)	*Pseudacris triseriata triseriata*

<u>Birds</u>	
Henslow's Sparrow (1)	*Ammodramus henslowii*
Northern Bobwhite (3)	*Colinus virginianus*
Sedge Wren (3)	*Cistothorus platensis*
Northern Harrier (5)	*Circus cyaneus*
Upland Sandpiper (10)	*Bartramia longicauda*
Bobolink (10)	*Dolichonyx oryzivorus*
Loggerhead Shrike (24)	*Lanius ludovicianus*
Blue-winged Teal (24)	*Anas discors*
Barn Owl (24)	*Tyto alba*
Sandhill Crane (24)	*Grus canadensis*
Cattle Egret (24)	*Bubulcus ibis*
Lark Sparrow (38)	*Chondestes grammacus*
Wilson's Phalarope (38)	*Phalaropus tricolor*
Short-eared Owl (38)	*Asio flammeus*
Bell's Vireo (38)	*Vireo bellii*
Vesper Sparrow (38)	*Pooecetes gramineus*
Eastern Meadowlark (38)	*Sturnella magna*

<u>Terrestrial Invertebrates</u>	
Confused Cloudy Wing (6)	*Thorybes confusis*
Mottled Dusky Wing (9)	*Erynnis martialis*
Regal Fritillary (11)	*Speyeria idalia*
Harris Checkerspot (11)	*Chlosyne harrisii liggetti*
Dusted Skipper (17)	*Atryonopsis hianna*
Cobweb Skipper (14)	*Hesperia metea*
Silver-bordered Fritillary (19)	*Boloria selene myrina*
Northern Oak Hairstreak (27)	*Fixsenia favonius ontario*
Edward's Hairstreak (33)	*Satyrium edwardsii*
Goatweed Butterfly (37)	*Anaea andria*
Dog Face (41)	*Colias cesonia*
Leonard's Skipper (41)	*Hesperia leonardus*
Indian Skipper (41)	*Hesperia sassacus*
Long Dash Skipper (41)	*Polites mystic*
Monarch (n/r)	*Danaus plexippus*
American Burying Beetle (n/r)	*Nicrophorus americanus*

<u>Mammals</u>	
Pygmy Shrew (11)	*Sorex hoyi*
Least Shrew (12)	*Cryptotis parva*
Thirteen-lined Ground Squirrel (16)	*Spermophilus tridecemlineatus*
Badger (16)	*Taxidea taxus*
Eastern Harvest Mouse (19)	*Reithrodontomys humulis*
Meadow Jumping Mouse (28)	*Zapus hudsonius*

<u>Reptiles</u>	
Kirtland's Snake (5)	*Clonophis kirtlandii*
Butler's Garter Snake (8)	*Thamnophis butleri*
Black Racer (8)	*Coluber constrictor constrictor*
Blue Racer (8)	*Coluber constrictor flaviventrus*
Smooth Green Snake (8)	*Liochlorophis vernalis*
Eastern Ribbon Snake (13)	*Thamnophis sauritus sauritus*
Northern Ribbon Snake (13)	*Thamnophis sauritus septentrionalis*

6.6.4 Grassland Conservation Opportunity Areas

The Division of Wildlife's approach to enhancing and maintaining the highest level of terrestrial wildlife diversity in the state is to use a conservation opportunity area concept to sustain viable populations of as many native species of wildlife as possible. The idea is to concentrate efforts and resources to provide all the necessary habitat requirements in a few, relatively large units of the major habitat types, along with the remnants of several unique habitats, for species that are of limited distribution or have low populations. Grassland conservation opportunity areas were designed to consider the needs of Ohio's grassland-dependent birds, although wildlife populations of other taxa are also expected to benefit. Several of these birds (e.g., upland sandpiper, Henslow's sparrow, bobolink, and savannah sparrow) are highly sensitive to habitat fragmentation and the size of the grassland tract. It is unlikely that many of these species would consistently nest in an area of <250 acres of contiguous grassland habitat. Further, although the exact number of pairs needed for a minimum viable population for each of these species is unknown, this number can be reasonably estimated at 200 breeding pairs. The most sensitive of these species is unlikely to nest at a density higher than 1 pair per 25 acres of suitable habitat in a large grassland complex. Thus, a conservation opportunity area should contain at least 5,000 acres of suitable, undisturbed grassland habitat to have a reasonable likelihood of supporting viable populations of Ohio's grassland-dependent birds (i.e., 200 pairs x 25 acres per pair = 5,000 acres of grass).

Outside of reclaimed mined lands, the Ohio landscape is unlikely to support such a vast sea of grassland habitat given current land ownership patterns and land-use practices. An approach suggested by Partners in Flight (PIF) and others may have merit under these conditions. This approach would allow the 5,000 acres of grass to occur within a 12,500-acre conservation opportunity area centered on a 2,500-acre block of grassland habitat (core area). The 10,000 acres surrounding the core would need to be at least 25% grassland habitat with 50% or more of the grassland tracts at least 250 acres in size. Based on the above, a 12,500-acre grassland conservation opportunity area is likely able to provide all the habitat requirements necessary to support viable populations of Ohio's highly area-sensitive birds and other grassland-dependent species native to the region. Species excluded from this include the northern harrier, short-eared owl, and extirpated greater prairie-chicken due to their extreme area requirements, estimated to equal or exceed 30,000 acres of grassland habitat. This concept also precludes any reintroduction attempt for greater prairie-chickens in the foreseeable future since sufficient habitat is unlikely to be created to support such an effort. We believe it is simply impractical and unrealistic to attempt to provide such a vast grassland complex in Ohio. The landscapes surrounding Lake LaSuAn Wildlife Area (Williams Co.) and Big Island and Killdeer Plains Wildlife Areas (Marion and Wyandot Co's.) currently offer the best opportunities to utilize this management approach. These 3 sites have been identified by the Audubon Society as Important Bird Areas.

Habitats for Area-sensitive Species: Bird Priority Areas

Ideally, concentrating management on individual 5,000 acre tracts of habitat likely provides the best opportunity for maintaining populations of area-sensitive birds. Former surface-mined lands that have been planted in herbaceous cover (primarily grasses) as part of the reclamation process provide unique opportunities for management of grassland-dependent wildlife that are not available throughout the rest of Ohio's landscape. Currently, Woodbury Wildlife Area (Coshocton Co.), Tri-Valley Wildlife Area (Muskingum Co.), Egypt Valley Wildlife Area (Belmont Co.), and Crown City Wildlife Area (Gallia Co.) are the only Division of Wildlife properties containing large tracts of contiguous grasslands that are suited to this management approach as Bird Priority Areas. Populations of Henslow's sparrows have been documented on these 4 sites and have been present in high enough densities that these locations are likely regionally and nationally important. Being under public ownership and management, these sites can offer long-term conservation protection for these populations. Grassland habitats that are similar in type and expanse to the above 4 wildlife areas, created through surface-mine reclamation at The Wilds property in Noble County, have already been recognized by the Audubon Society as an Important Bird Area.

6.6.4.1 Killdeer Plains/Big Island Grassland Conservation Opportunity Areas

The Killdeer Plains and Big Island Wildlife Areas currently exhibit some of the best examples of the grassland wildlife habitat that existed in western Ohio prior to European settlement. The Killdeer Plains Wildlife Area is located primarily in Wyandot County, and the Big Island Wildlife Area is located in Marion

County, approximately 12 miles to the south of Killdeer (Figure 13). The majority of land adjacent to and between these 2 Wildlife Areas is in private ownership, characterized by large farms in continuous row crop production.

These 2 Wildlife Areas are part of the Sandusky Plains, historically known as one of the largest prairies that existed in Ohio. Prior to European settlement of this area, the Sandusky Plains was comprised of islands of open grassland prairie that covered over 80,000 acres in portions of Crawford, Marion and Wyandot Counties. Intensive agricultural development of the area did not begin until the late 1800s because of poor drainage of the land. With the advent of modern drainage equipment in the early 1900s, most of these prairies were converted to small grains, pasture and small fields of row crops. Further changes in agricultural technologies in the 1950s resulted in a shift from small grains, pasture and hayfields to predominantly row crops, larger farm and field sizes, and increased fall plowing. This extensive loss of native prairie, pasture and small grains has led to a significant decline in grassland-dependent wildlife species throughout both areas, with grassland nesting birds showing the greatest declines.

The Killdeer Plains and Big Island Wildlife Areas are both owned and managed by the Division of Wildlife, and comprise nearly 13,000 acres of public land, with grassland acreage totaling 4,300 acres. Because of the 12 mile distance between these 2 wildlife areas, a separate Grassland Conservation Opportunity Area has been centered on each. Efforts will be made to link the Killdeer Plains and Big Island Conservation Opportunity Areas with smaller grassland patches and corridors resulting in a large grassland complex with 2 core areas.

Killdeer Plains Conservation Opportunity Area
This area consists of 13,404 acres, with private land accounting for 5,395 acres, or 40%. Approximately 61% of the area consists of agricultural land, 21% wetland, and 18% woodland. Currently 2,493 acres of the agricultural land in the conservation opportunity area is established in grassland habitat, with the vast majority of this grassland located on the wildlife area. As of 2002, approximately 371 acres of grassland currently occur on private lands within the conservation opportunity area.

Big Island Conservation Opportunity Area
This area consists of 13,541 acres, with private land accounting for 8,532 acres, or 63%. Approximately 80% of the area consists of agricultural land, 7% wetland, and 13% woodland. As of 2002, 2,445 acres of the agricultural land in the conservation opportunity area is established in grassland habitat, with the vast majority of this grassland located on the wildlife area. Approximately 253 acres of grassland currently occur on private lands within the conservation opportunity area.

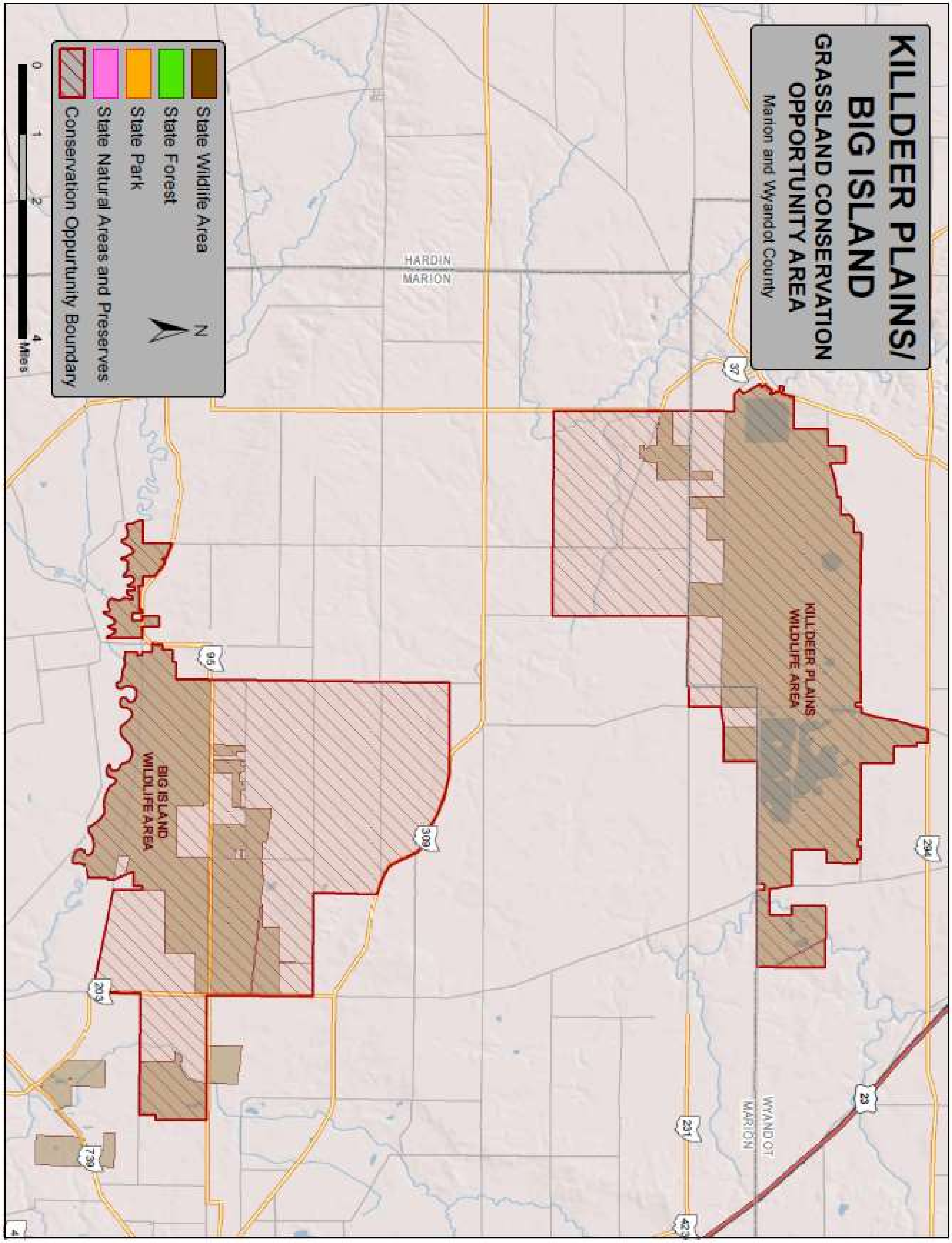


Figure 13. Killdeer Plains/Big Island Grassland Conservation Opportunity Areas.

6.6.4.2 Lake LaSuAn Grassland Conservation Opportunity Area

The Lake LaSuAn Grassland Conservation Opportunity Area, located in Williams County, is an important breeding, foraging and/or migration area for numerous grassland-dependent wildlife species. Lake LaSuAn Wildlife Area is included in the Conservation Opportunity Area (Figure 14). The Wildlife Area is 2,430 acres, of which approximately 1,073 acres are in cool and warm-season grasses. The majority of land adjacent to the wildlife area is in private ownership, characterized by row crops, CRP fields and woodlots. Private land comprises about 85% of the Conservation Opportunity Area. This area is home to the majority of Ohio's endangered copperbelly water snake population.

The Lake LaSuAn Conservation Opportunity Area is situated on the Wabash end moraine deposited during the Wisconsin glaciation. At the time of European settlement, the Lake LaSuAn Focus Area was a beech-maple hardwood forest with scattered poorly-drained wooded wetlands. Post-European settlement resulted in a dramatic decrease in forested acres as the land was cleared for agriculture. Further changes in agricultural technologies in the 1950s resulted in a shift from small fields supporting a variety of crops, hayfields, pastures and single family livestock operations to predominantly row crops, larger farm and field sizes, and increased fall plowing which greatly reduced grassland habitat in the region. Implementation of the 1985 USDA Farm Bill resulted in Williams County leading Ohio in Conservation Reserve Program set-aside acres.

The Lake LaSuAn Conservation Opportunity Area is in a very rural area of northwestern Ohio with little development. The area is characterized by gentle rolling hills carved out by many creeks and rivers. The soils in the area formed mainly in stratified, water-deposited material. Most of the soils within the area are classified as highly erodible and offer an opportunity to reduce the efforts of erosion within the St. Joseph River watershed through grassland management on both private and public lands.

This Conservation Opportunity Area consists of 14,500 acres. Once habitat work is accomplished, the area is expected to provide all habitat requirements necessary to support a viable population of Ohio's area-sensitive grassland bird species, and is thus likely to support viable populations of all other native grassland species, with the exception of northern harriers, short-eared owls, and prairie chickens (extirpated).

To meet the minimum habitat requirements, at least 5,800 acres of undisturbed grassland will need to be provided within the Conservation Opportunity Area, including a 2,500 acre core area. Lake LaSuAn Wildlife Area currently does not meet the core area requirement of 2,500 acres of grassland habitat. LaSuAn currently has about 800 acres of warm-season and cool-season grasses planted; an additional 550 acres of grassland can be planted in the next 10 years. Private land within the Conservation Opportunity Area is comprised of row-crop agriculture and a limited amount of pasture (250 acres) and hay crop (100 acres). There are also at least 3,400 acres enrolled in the Conservation Reserve Program on private lands in the area. These acreage figures suggest that the biggest challenge in the area may be creating a spatial arrangement of grassland habitats that produces a core area.

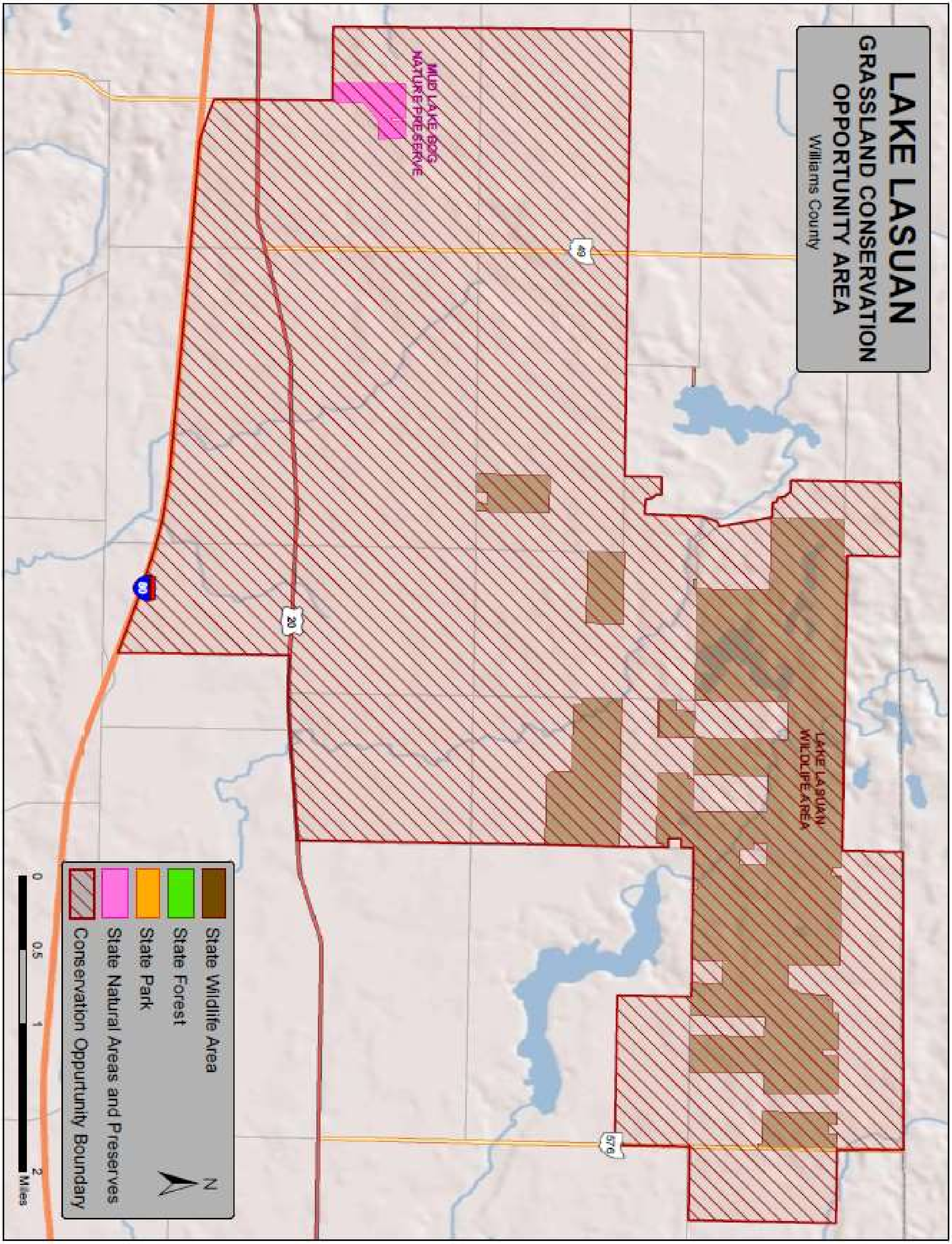


Figure 14. Lake LaSuAn Grassland Conservation Opportunity Area.

Table 21. CONSERVATION THREATS TO GRASSLAND HABITAT.
The following threats negatively impact or have the potential to negatively impact Grassland habitat. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		low
A	Large tracts of grassland habitats, and the wildlife species dependent upon them, have declined in Ohio because of changes in land ownership patterns	housing & urban areas	low
B	Habitat destruction, fragmentation, altered hydrology from commercial development	commercial & industrial areas	low
C	Habitat destruction, fragmentation, altered hydrology from urban/suburban development	housing & urban areas	low
II	**agriculture and aquaculture**		medium
A	Loss of grassland habitat because of conversion to agriculture	annual & perennial non-timber crops livestock farming & ranching	very high low
B	Loss of grassland habitat due to increase in intensity of agricultural practices – conversion of fencerows and other imbedded grassland habitat	annual & perennial non-timber crops	very high
C	It is unlikely that we will meet habitat objectives within the Big Island/Killdeer Plains Conservation Opportunity Area because of the amount of land (>10,000 acres) owned by corporate farming operations in the area	annual & perennial non-timber crops	very high
III	**energy production and mining**		low
A	Mining, oil and gas extraction - can directly damage and destroy grassland habitat, and indirectly have negative impacts by altering hydrology and causing chemical contamination	oil & gas drilling mining & quarrying	low low
B	Wind turbines can negatively impact birds and bats that utilize grassland habitat	renewable energy	low
IV	**transportation and service corridors**		negligible
A	Roads and utilities can destroy and fragment grassland habitat, and alter hydrology	roads & railroads utility & service lines	negligible negligible
V	**biological resource use**		negligible
A	Biofuels could threaten grassland habitat	gathering terrestrial plants	negligible
VI	**human intrusions and disturbance**		low
A	Incompatible recreational activities	recreational activities	negligible
B	Creation of recreational facilities can alter/destroy grassland habitat	recreational activities	negligible
VII	**natural system modifications**		low
A	Losing grassland habitat – or missing out on opportunities to create additional grassland acreage – because financial benefits of some conservation programs may be insufficient to encourage private landowner enrollment	other ecosystem modifications	low
B	Lack of periodic burning resulting in habitat cover change and impacts to grassland wildlife species	fire & fire supression	negligible

C	Lack of grassland inventory data, and a database system to analyze that data limits our ability to manage	other ecosystem modifications	low
D	Our ability to manage grasslands is limited by available staff and funding	other ecosystem modifications	low
E	Habitat program availability generally relies on the political climate and funds made available through the Farm Bill	other ecosystem modifications	low
F	Lack of private landowner participation in available habitat programs in critical areas	other ecosystem modifications	low
G	Habitat destruction, fragmentation, altered hydrology due to proximity of development	other ecosystem modifications	low
H	The Division of Wildlife has no regulatory authority over federal conservation programs, and so has limited influence over the quality of habitats established under the Conservation Reserve Program (CRP)	other ecosystem modifications	low
I	Lack of grassland associated species data limits our ability to manage for current threats and limits our ability to develop plans for impending issues like climate change	other ecosystem modifications	low
VIII	**invasive and other problematic species and genes**		high
A	Introduction and/or spread of invasive plants and animals	invasive non-native alien species	medium
B	Introduction and/or spread of nuisance plants and animals	problematic native species	high
C	Introduction and spread of diseases (plants and animals)	invasive non-native alien species problematic native species	medium high
IX	**pollution**		low
A	Urban effluent	household sewage & urban wastewater industrial & military effluents garbage & solid waste	negligible negligible negligible
B	Agriculture effluent	agricultural & forestry effluents	medium
X	**geological events**		negligible
---	none	---	---
XI	**climate change and severe weather**		low
A	Climate change could effect plant species composition, which in turn could affect wildlife species	habitat shifting & alteration droughts temperature extremes storms & flooding	low low low negligible

Table 22. CONSERVATION ACTIONS FOR GRASSLAND HABITAT.
The following actions will help abate or have the potential to help abate threats to Grassland habitat. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	actions	2nd level action classification(s)	action priority rank	threat(s) addressed*
I	**LAND/WATER PROTECTION**		high	
1	Protect grasslands through strategic acquisitions, easements, and partnerships	resource & habitat protection	high	I, II, III, IV, V, VI
2	Use State Wildlife Grant funds for potential acquisitions	resource & habitat protection	high	I, II, III, IV, V, VI
3	Obtain through purchase or permanent easement sufficient acreage to meet core area requirements (2,500 acres of managed grasslands) at Killdeer Plains, Big Island, and Lake LaSuAn Conservation Opportunity Areas	site/area protection	high	II-C
4	Obtain through purchase or permanent easement 1,000 acres of land to serve as a link between Big Island and Killdeer Plains Conservation Opportunity Areas	site/area protection	high	II-C
5	Strive for no net loss of large grassland tracts on DOW-managed and private lands to benefit area-sensitive species	resource & habitat protection	high	I, II, VII-A
6	Site new recreational facilities such as golf courses and ball fields, on already disturbed land	resource & habitat protection	high	VI-B
II	**LAND/WATER MANAGEMENT**		med	
1	Inventory the distribution and quantity of grassland habitats and priority grassland wildlife species	habitat & natural process restoration	high	VII-C,I
2	Investigate alternative management strategies to promote diverse stands of grassland habitat compatible with multiple wildlife species	habitat & natural process restoration	high	VII-C,I
3	Make use of existing data, including National Land Cover Database (NLCD), National Agricultural Statistics Service (NASS), North American Breeding Bird Survey (BBS), the Second Ohio Breeding Bird Atlas, DOW surveys, and others to develop best estimates of grassland availability and bird distribution in Ohio	habitat & natural process restoration	high	VII-C,I
4	By 2016, develop statewide grassland habitat goals required to stabilize grassland wildlife populations	habitat & natural process restoration	high	VII-C,I
5	Review and summarize relevant literature since Swanson (1996) and Herkert (1993) papers about grassland bird habitat use	habitat & natural process restoration	high	VII-C,I
6	Collect and evaluate data from legitimate citizen scientist-based monitoring surveys, such as the Ohio Lepidopterist Society's Long-term Butterfly Monitoring Program, the Breeding Bird Survey, and the Frog and Toad Call Survey, through 2020	habitat & natural process restoration	high	VII-C,D,I

7	Identify gaps in knowledge relative to wildlife populations and grasslands, and address through research	habitat & natural process restoration	high	VII-C,I
8	Identify collaborative partners (The Wilds, USFS, AEP, etc.) that manage similar habitats to exchange information on management strategies and possibly cost-share on equipment or other management expenses	habitat & natural process restoration	high	VII-C,D,I
9	Work with conservation partners like the USDA Farm Services Agency to make use of geospatial data about grassland habitats restored or established through federal programs	habitat & natural process restoration	high	VII-C
10	Incorporate habitat and population estimates for priority species identified within the Ohio Bird Conservation Initiative All-Bird Plan and other regional and Joint Venture plans	habitat & natural process restoration	high	VII-I
11	Use grasslands established through reclamation efforts on former strip-mined lands as opportunities to manage large (e.g., >5,000 acre) tracts of grassland habitats for area-sensitive species	habitat & natural process restoration	high	VII-A,E,F,H,I
12	Annually maintain grassland parcels of >75 acres on DOW managed areas that are outside of grassland conservation opportunity areas, area-sensitive bird priority areas, or gamebird priority areas	habitat & natural process restoration	high	VII-A,E,F,H
13	On private lands outside of gamebird priority areas and grassland conservation opportunity areas, promote grassland tracts ≥50 acres for the benefit of area-sensitive grassland wildlife species	habitat & natural process restoration	high	VII-A,E,F,H,I
14	Research alternative grassland habitats that would not be affected by farm commodity prices (ex. - wind turbine fields, solar panel fields, livestock haying/grazing operations, new urban development design, roadsides, carbon sequestration fields, corporate facility landscaping, well fields, urban green space, etc)	habitat & natural process restoration	high	VII-C
15	Update and improve the accuracy of landcover data in Ohio by using advanced GIS modelling to determine habitat distribution and quality	habitat & natural process restoration	high	VII-C
16	Determine Ohio-specific population and trend estimates for wildlife species to aid our ability to identify appropriate habitat objectives	habitat & natural process restoration	high	VII-C,I
17	Determine the importance of native warm season vs. exotic cool season grass management relative to avian community structure, species density, and population demographics	habitat & natural process restoration	high	VII-C,I
18	Develop habitat programs where the DOW establishes rules for participation and sets standards for habitat quality - identify target townships and market aggressively to landowners	habitat & natural process restoration	high	VII-A,E,F,H
19	Increase management efficiency by increasing communication among wildlife area managers regarding common solutions to management issues - use management plans and GIS tools to help identify common solutions and prioritize management activities	habitat & natural process restoration	high	VII-D

20	Identify ecosystem or population-level threats through research, surveillance, monitoring, and inventory	habitat & natural process restoration	high	I, II, III, IV, V, VI, VII-I, VIII, IX, XI
21	Develop compatible recreational activities criteria that can be used to evaluate impacts to habitat/species from recreational activities	habitat & natural process restoration	high	VI
22	Develop ways to encourage mega-farm, hobby farm, and rural estate owners to participate in habitat programs	habitat & natural process restoration	high	VII-A,F
23	Manage Grassland Conservation Opportunity Areas to provide appropriate habitat to sustain viable populations of all grassland dependent wildlife species native to Ohio	site/area management	med	VII-B,G VIII, IX
24	Conduct research on species-habitat relationships within grassland conservation opportunity areas to help direct management decisions	site/area management	med	VII-C,I
25	Obtain information on habitat requirements and HSI models for all native grassland wildlife species that occur in Grassland Conservation Opportunity Areas	site/area management	med	VII-C,I
26	Annually manage 2,500 acres of diverse grasslands as habitat cores within Killdeer Plains, Big Island, and Lake LaSuAn Grassland Conservation Opportunity Areas	site/area management	med	II-C
27	Establish and maintain large grassland mosaics (at least 250 acres) on Big Island, Killdeer Plains, and Lake LaSuAn Grassland Conservation Opportunity Areas	site/area management	med	II-C
28	Within Grassland Conservation Area boundaries, promote managed grasslands on private lands with a goal of establishing 2,500 acres of grassland around each conservation opportunity area core by 2020 - of these grassland acres, 50% should be in tracts of at least 250 acres in size	site/area management	med	VII-A,E,F,H
29	Designate 4 Bird Priority Areas for area-sensitive bird populations of regional significance at Woodbury, Tri-Valley, Crown City, and Egypt Valley Wildlife Areas	site/area management	med	I-A, VII-I
30	On each Bird Priority Area, annually manage multiple fields of continuous grassland habitats that are >250 acres to provide a diverse mosaic of large (e.g. >5,000 acres) grassland habitat	site/area management	med	I-A, VII-I
31	Establish staffing/funding levels commensurate with the amount of management activities at grassland conservation opportunity areas	site/area management	med	VII-D
32	Prevent introduction and control the spread of harmful species through legislation, regulation, policy, management practices, education, and partnerships	invasive/ problematic species control	med	VIII
33	Investigate methods of invasive species management appropriate to the spatial scale of wildlife area grasslands on former strip-mined lands	invasive/ problematic species control	med	VIII
34	Establish an early-detection rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	med	VIII
III	**SPECIES MANAGEMENT**		med	
1	Reintroduce and restore grassland species where appropriate	species reintroduction	med	I, II, VII-B,G

2	Develop species-specific conservation plans as needs are identified to clearly define the actions the Division will/or will not implement concerning the state-listed species	species management	med	VII-I
3	Identify, design, and conduct appropriate species-specific surveys, inventories, or monitoring projects to determine species distribution and abundance	species management	med	VII-C,I
4	Develop a feral hog management plan designed to minimize introductions and control expansion	species management	med	VIII-B
IV	**EDUCATION AND AWARENESS**		med	
1	Provide workshops or training opportunities to learn management techniques and exchange ideas	training	high	VII-D
2	Educate USDA Farm Service Agency staff about upland bird management and habitat needs as it relates to CRP and mid-contract management	training	high	VII-H
3	Maintain a corps of Division of Wildlife-trained partners and volunteers to assist, lead, and promote special programs	training	high	VII-A,F
4	Educate private landowners about participation in habitat programs relative to the enrollment process (particularly when multiple agencies/offices are involved), rental equipment available, vendors available to do habitat work, and local program administration	awareness & communications	med	VII-A,F
5	Provide education/information about grassland habitats and wildlife, and opportunities for establishment on private lands; provide technical assistance to landowners for habitat establishment and maintenance	awareness & communications	med	VII-A,F
6	Educate and inform the public and other agency personnel on the importance and necessity for prescribed burning as a safe and effective tool for grassland habitat management	awareness & communications	med	VII-B
7	Provide technical assistance to public and private landowners concerning the use of prescribed burning as a safe and effective management tool	awareness & communications	med	VII-B
8	Educate the public about the negative effects of exotic and nuisance animals – encourage responsible disposal of unwanted animals	awareness & communications	med	VIII-A,B
9	Provide guidance to landowners for eradication/control of invasive and nuisance species	awareness & communications	med	VIII-A,B
10	Educate landowners, maintenance staff, municipalities, etc. on ways to reduce impacts to adjacent grassland habitat	awareness & communications	med	I, II, VII-G
V	**LAW AND POLICY**		med	
1	Support legislation promoting eco-friendly energy development and use	legislation policies & regulations	high med	III-A,B
2	Develop and implement a risk-assessment system in the approval process for importing or moving live animals and plants	legislation policies & regulations	high med	VIII
3	Balance the needs of fish and wildlife with the needs of people by mitigating incompatible ecosystem uses	policies & regulations	med	I, II, III, IV, V, VI

4	Participate in the policy-making process at Federal level to influence conservation programs	policies & regulations	med	VII-A,E,H
5	Encourage the preservation of habitat connectivity in all land use planning	policies & regulations private sector standards & codes	med med	I, IV
6	Create incentives (laws, policies) to prevent loss and/or minimize impacts to grasslands due to development	policies & regulations	med	I, II, IV
VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		med	
1	Provide incentives for grassland establishment on private lands, especially within priority areas or where large tracts could benefit declining wildlife populations - work with private lands conservation partners (NGO's and agencies) to develop funding opportunities	conservation payments non-monetary values	high low	VII-A,E,F
2	Engage in research to understand social and economic influences on landowner decisions to participate in habitat programs, and use information to influence where and how programs are marketed	conservation payments non-monetary values	high low	VII-A,F
3	Support incentives that encourage landowners to maintain/preserve existing grassland habitat on agricultural lands	market forces conservation payments non-monetary values	med high low	II
4	Support the creation of incentives for the protection and restoration of grassland habitat	linked enterprises & livelihood alternatives substitution market forces conservation payments non-monetary values	high med med high low	I, II, III, IV, VII-A
5	Support creation of incentives to incorporate wildlife habitat into recreational facilities such as parks and golf courses	market forces conservation payments non-monetary values	med high low	VI-B

6	Develop incentives for private landowners to eradicate/control invasive plant species	conservation payments non-monetary values	high low	VIII
VII	**EXTERNAL CAPACITY BUILDING**		high	
1	Provide collaborative support to Pheasants Forever Farm Bill biologists in Ohio	alliance & partnership development	high	VII-D
2	Work with cooperating conservation agencies to streamline the enrollment process for new landowners in CRP or similar programs	alliance & partnership development	high	VII-A,F,H
3	Investigate alternative uses or markets for biomass produced by invasive plants on reclaimed strip-mined lands to recover some management costs - seek alternative funding sources (WHIP, USFWS) for woody species management	conservation finance	high	VII-D
4	Create a multiagency invasive species prevention and control group that would be responsible for all invasive species issues	alliance & partnership development	high	VIII
5	Through interagency coordination, work to assure that wildlife interests are taken into consideration in road, bridge, causeway, and utilities design, construction, and maintenance	alliance & partnership development	high	IV
6	Support and actively participate in an Ohio Prescribed Fire Council	alliance & partnership development	high	VII-B
7	Help create and support partnerships of conservation-minded groups to protect and manage forest habitat	alliance & partnership development	high	I, II, VII-D
8	Support legitimate citizen scientist-based monitoring efforts of wildlife species and habitats	institutional & civil society development	high	VII-C,D

*refers to the Grassland Habitat Conservation Threats in Table 21

6.7 Wetland Habitat

Ohio Wetland Habitat (U.S. Fish and Wildlife Service)

6.7.1 Status

Depleted but relatively stable. Ohio contains an estimated 880,000 wetland acres based on the 2009 USFWS National Wetland Inventory (NWI) update. Major wetland classification types within the NWI include wet-woods (35%), shrub swamps (9%), and marshes (11%). Ohio's wetlands have experienced losses unlike any other habitat type in the state. While "no net loss" programs have generally checked overall losses, fragmentation continues to threaten Ohio's wetland habitat. Mitigation wetlands isolated from other wetland complexes significantly contribute to fragmentation. Most of Ohio's wetlands are in private ownership, but the majority of consistently high quality wetlands are managed by the Division of Wildlife, the U.S. Fish and Wildlife Service, and several private hunting clubs. The Division has stepped up wetland protection, restoration, and enhancement efforts throughout Ohio under the North American Waterfowl Management Plan, the National Shorebird Plan, and the All-Bird Conservation Initiative.

6.7.2 Description

Before European settlement, Ohio's wetlands covered 18.9% (5 million acres) of the state. The majority of these wetlands were swamp forest, 3 million acres of which were covered by the Great Black Swamp in northwest Ohio. This massive swamp was approximately 120 miles long and 40 miles wide. As settlers moved west, they drained the wetlands for timber and farming, thus eliminating over 90% of the original wetlands.

Today, Ohio has a diversity of wetland types within its borders. The conservation threats and actions contained within this section apply to all of the wetland types listed below:

- Marsh – a shallow wetland that is subject to frequent or continuous flooding and is characterized by aquatic vegetation such as cattail, arrowhead, and sedges
- Swamp – a wetland fed primarily by surface water (stream, river) and is dominated by trees and shrubs
- Bog – wetland containing spongy peat deposits and is characterized by evergreen trees, sphagnum moss, and acidic water
- Fen – wetland fed by mineral rich groundwater covered with grasses, sedges, willow, and birch trees and containing alkaline or neutral water
- Vernal pools – shallow temporary wetlands that fill annually from rain and/or snow, dry out every year or every other year, and do not have a population of predatory fish

The wetland habitats that remain in Ohio are stressed by a number of factors, reducing our ability to maintain the quality and quantity of wetland acreage. The three primary issues impacting Ohio's wetlands are habitat loss, fragmentation, and aquatic invasive species.

6.7.2.1 Wetland Habitat Loss

Ohio ranks second only to California in percentage of wetland loss since 1780. Ohio's population density per square mile is 9th among all U.S. states, despite the fact that the rate of population growth is slower than most of the nation. Nevertheless, the rate of land converted to urban and commercial use happens at a much faster rate than population growth would indicate. Ohio has seen a decrease in population in core metropolitan areas and a dramatic increase in low-density housing in "exurban" areas. This development pattern puts further expansion and redevelopment in conflict with wetland habitats.

Since the early 1980s, federal and state programs have slowed the loss of wetlands, and several agricultural/conservation programs now exist which provide incentives to restore wetlands. Wetland mitigation also serves to keep wetlands on the map, but compared to the original wetland, the quality, function, and location of mitigated wetlands are oftentimes less than equivalent.

An evaluation of vegetation and wildlife responses to newly constructed wetlands needs to be conducted to ensure that mitigated wetlands are functionally equivalent to the original wetlands they replace. The quantity and quality of Ohio's wetlands must be maintained because a decline in either will decrease the suitability of this critical habitat to support sustainable wildlife populations.

The Upper Mississippi River and Great Lakes Region Joint Venture created habitat objectives for each state in the Joint Venture. Ohio has about 110,000 acres of emergent marsh according to the NWI – however, the JV habitat objectives require 133,000 acres for migrating birds and 118,000 for breeding birds. Restoration of marshes as well as maintenance of existing wetlands is paramount if the habitat objectives are to be met.

6.7.2.2 Fragmentation of Remaining Wetlands

Land use changes continue to fragment Ohio's remaining wetland habitat thus reducing the state's overall ecological capacity. Consequently, many of Ohio's remaining wetlands are small, isolated habitats surrounded by suburbia or farm fields. That isolation decreases habitat suitability for many wildlife species. To counter the fragmentation of the state's remaining wetland habitat, the Division must prioritize landscape-level ecology within concentrated focus areas. The majority of remaining wetlands in the state are in private ownership, which places a premium on the Division to develop strategies for technical assistance and education.

6.7.2.3 Aquatic Invasive Species

The biodiversity of wetlands have been impacted by invasive plants and animals more than other habitat types. Several non-native invasive plant species in particular, are a focus of management/control efforts:

- Common Reed (*Phragmites australis*)
- Purple loosestrife (*Lythrum salicaria*)
- Reed canary grass (*Phalaris arundinacea*)
- Eurasian watermilfoil (*Myriophyllum spicatum)*
- Flowering rush (*Butomus umbellatus)*

6.7.2.4 Wetland Bioassessment Program Update (from the Ohio EPA 2014 Integrated Report)

Numerous grants from U.S. EPA over many years have funded work that is advancing the science of wetland assessment methodologies in Ohio. Published work includes an amphibian index of biotic integrity (AmphIBI) for wetlands, a vegetation index of biotic integrity (VIBI) for wetlands, and a comparison of natural and mitigation (constructed) wetlands. A number of wetland reports are available on the Division of Surface Water web page (http://www.epa.ohio.gov/dsw/wetlands/WetlandEcologySection_reports.aspx) including (1) an assessment of the condition of wetlands in the Cuyahoga River watershed, (2) a study on the condition and functions of urban wetlands, (3) a comparison of the ecological condition of 25 randomly selected mitigation wetlands from around the state with results from Ohio's natural wetlands, and (4) the development of a GIS tool to identify potential vernal pool habitat restoration areas.

Studies currently in progress include (1) an in-depth analysis of the relationship between stream and wetland condition and function in the Big Run Scioto River watershed, (2) incorporating wetland information with data from other surface water resources to develop a total maximum daily load analysis of a watershed, and (3) assessment of the ecological condition of 50 randomly selected natural wetlands located across Ohio in order to generate a "scorecard" of wetland condition. These studies will add to data collected as part of U.S. EPA's National Wetland Condition Assessment conducted across the United States in 2011. Future research will include a detailed study of hydrologic functioning within natural and constructed wetlands, and continued investigations of various taxonomic groups (e.g., birds, bryophytes, algae, etc.) to determine their potential use in new and improved wetland assessment techniques.

6.7.2.5 Ohio EPA Wetland Protection Program

Ohio's Wetland Water Quality Standards (OAC 3745-1-50 to -54) contain definitions, beneficial use designations, narrative criteria and antidegradation provisions that guide Ohio EPA's review of projects in which applicants are seeking authorization to discharge dredged or fill material into wetlands. Ohio Administrative Code 3745-1-53 gives all wetlands the "wetland" designated beneficial aquatic life use. However, wetlands are further defined as Category 1, 2, or 3 based on the wetland's relative functions and values, sensitivity to disturbance, rarity, and potential to be adequately compensated for by wetland mitigation.

Category 1, 2, and 3 wetlands demonstrate minimal, moderate and superior wetland functions, respectively. Category 1 wetlands are typified by low species diversity, a predominance of non-native species, no significant habitat or wildlife use, and limited potential to achieve beneficial wetland functions. Category 2 wetlands are dominated by native species but generally without the presence of, or habitat for rare, threatened or endangered species. Additionally, these wetlands may be degraded, but have reasonable potential for re-establishing lost wetland functions. Category 3 wetlands typically possess high levels of diversity, a high proportion of native species, high functional values, and may contain the presence of, or habitat for rare, threatened and endangered species. Wetlands that are scarce, either regionally or statewide, form a subcategory of Category 3 wetlands for which, when allowable, short-term disturbances may be authorized.

The rigor of the Antidegradation Review conducted under 3745-1-50 through 54 is based on the category of the wetlands proposed to be impacted. Category 1 wetlands are classified as Limited Quality Waters and may be impacted after examining avoidance and minimization measures and determining that no significant impacts to water quality will result from the impacts. Category 2 and 3 wetlands are classified as General High Quality Waters, and may be impacted only after a formal examination of alternatives and a determination that the lowering of water quality is necessary to accommodate social and economic development. In addition, an applicant must demonstrate that "public need" is achieved in order to receive authorization to impact Category 3 wetlands. Compensatory mitigation ratios are based on wetland category, vegetation class, and proximity of the mitigation to the impact site.

6.7.3 Associated Species of Greatest Conservation Need

Ohio's wetland wildlife is a varied resource consisting of both resident and migratory species. Estimates suggest that <25% of Ohio's original wetland habitat remains today. It's not surprising that over half of Ohio's threatened and endangered species are dependent on wetlands as crucial habitat. Ohio's wetlands are an essential part of the life cycle of migratory birds which travel through the state each spring and fall between their wintering and nesting grounds. Monitoring populations of wetland wildlife, particularly migratory birds and furbearers, is a complex year-round task that involves the cooperation of many states and countries throughout North America. Participation by the Ohio Division of Wildlife (Division) in the Mississippi Flyway Council, Association of Fish and Wildlife Agencies, Midwest Furbearers Group, Partners-In-Flight, and other conservation groups and initiatives ensures wise monitoring and conservation of wetland wildlife.

Wetland wildlife populations are affected by many factors including habitat quality and quantity, weather, and the actions of humans. For migratory birds these factors may occur far from Ohio, but they have a major impact on the abundance of wetland wildlife species that frequent our state. Ohio's wetlands were once part of a very complex ecosystem covering millions of acres. An important result of settlement was the "taming" of wetlands through extensive subsurface drains and ditches. Road building also altered the course of water forever. Today, wetland management is an art and science of manipulating water levels to simulate the natural drying and flooding that once occurred in Ohio's wetlands. These manipulations entail mimicking natural drought and rainfall conditions to simulate these natural cycles. Drawdowns expose mudflats to heat and oxygen which stimulates the germination of seeds and growth of emergent vegetation. Shallow flooding attracts shorebirds that later give way to waterfowl and waders as water levels rise. The end result is an ecosystem that is one of the most productive available for a wide variety of wildlife.

The following species have been identified as Wetland species of greatest conservation need (conservation status rank in parentheses):

<u>Amphibians</u>

Mud Salamander (5)	*Pseudotriton montanus*
Jefferson Salamander (7)	*Ambystoma jeffersonianum*
Eastern Tiger Salamander (9)	*Ambystoma tigrinum tigrinum*
Four-toed Salamander (11)	*Hemidactylium scutatum*
Eastern Spadefoot (15)	*Scaphiopus holbrookii*
Mountain Chorus Frog (18)	*Pseudacris brachyphona*

Red-spotted Newt (20)	***Notophthalmus viridescens viridescens***
Western Chorus Frog (20)	*Pseudacris triseriata triseriata*

<u>Birds</u>

Sedge Wren (3)	*Cistothorus platensis*
King Rail (5)	*Rallus elegans*
Marsh Wren (5)	*Cistothorus palustris*
Northern Harrier (5)	*Circus cyaneus*
Sora (5)	*Porzana carolina*
Virginia Rail (5)	*Rallus limicola*
American Black Duck (10)	*Anas rubripes*
American Bittern (10)	*Botaurus lentiginosus*
Black Tern (10)	*Chlidonias niger*
Black-crowned Night-Heron (10)	*Nycticorax nycticorax*
Common Gallinule (10)	*Gallinula galeata*
Common Tern (10)	*Sterna hirundo*
Great Egret (10)	*Ardea alba*
Least Bittern (10)	*Ixobrychus exilis*
Prothonotary Warbler (10)	*Protonotaria citrea*
American Woodcock (24)	*Scolopax minor*
Blue-winged Teal (24)	*Anas discors*
Snowy Egret (24)	*Egretta thula*
Trumpeter Swan (24)	*Cygnus buccinator*
Sandhill Crane (24)	*Grus Canadensis*
Cattle Egret (24)	*Bubulcus ibis*
Great Blue Heron (38)	*Ardea herodias*
Short-eared Owl (38)	*Asio flammeus*
Wilson's Phalarope (38)	*Phalaropus tricolor*
Wood Duck (38)	*Aix sponsa*

<u>Terrestrial Invertebrates</u>

Mitchell's Satyr (1)	*Neonympha mitchellii*
Swamp Metalmark (6)	*Calephelis mutica*
Duke's Skipper (6)	*Euphyes dukesi*
Harris Checkerspot (11)	*Chlosyne harrisii liggetti*
Two-spotted Skipper (11)	*Euphyes bimacula*
Mulberry Wing Skipper (14)	*Poanes massasoit*
Broad-winged Skipper (14)	*Poanes viator viator*
Silver-bordered Fritillary (19)	*Boloria selene myrina*
Dion Skipper (20)	*Euphyes dion*
Black Dash Skipper (21)	*Euphyes conspicua*
Gray Comma (23)	*Polygonia progne*
Baltimore Checkerspot (32)	*Euphydryas phaeton*
Eyed Brown (34)	*Satyrodes eurydice*
Acadian Hairstreak (39)	*Satyrium acadicum*
Purplish Copper (45)	*Lycaena helloides*
Brown Elfin (45)	*Incisalia augustinus croesoides*

<u>Mammals</u>

Ermine (16)	*Mustela erminea*
Star-nosed Mole (25)	*Condylura cristata*

<u>Reptiles</u>

Spotted Turtle (4)	*Clemmys guttata*
Kirtland's Snake (5)	*Clonophis kirtlandii*
Eastern Ribbon Snake (13)	*Thamnophis sauritus sauritus*

Northern Ribbon Snake (13)	*Thamnophis sauritus septentrionalis*
Common Map Turtle (19)	*Graptemys geographica*
Blanding's Turtle (22)	*Emydoidea blandingii*
Copperbelly Water Snake (22)	*Nerodia erythrogaster neglecta*

6.7.4 Wetland Conservation Opportunity Areas
The Division of Wildlife's approach to enhancing and maintaining the highest level of terrestrial wildlife diversity in the state is to use a "conservation opportunity area" concept to sustain viable populations of as many native species of wildlife as possible. The idea is to concentrate efforts and resources to provide all the necessary habitat requirements in a few, relatively large units of the major habitat types, along with the remnants of several unique habitats, for species that are of limited distribution or have low populations.

6.7.4.1 Lake Erie Marsh Conservation Opportunity Area
The Lake Erie Marsh Conservation Opportunity Area (Figure 15) lies along the Western Basin of Lake Erie. It stretches from the eastern edge of Maumee Bay along the Lake Erie shoreline and ends just west of the City of Sandusky in Sandusky Bay. The Lake Erie Marsh Conservation Opportunity Area is situated in a rapidly developing area of the Great Lakes. Development in the form of marinas, condominiums, and support industries continues to occur. Many small wetlands have succumbed to this development, and larger marsh complexes have been encroached upon. The area is also heavily farmed, with many wetlands converted for agricultural production. The current threat to remaining and restorable wetlands is high.

The region is an important staging area for migrant songbirds as they rest before the passage around or over Lake Erie in the spring. Lake Erie represents the largest migration barrier to many of these species after they cross the Gulf of Mexico. The western Lake Erie shoreline supports one of the most dramatic buildups of neotropical migrants in North America during spring migration.

Wetlands of the Lower Great Lakes are one of the six original continental areas designated as a "priority habitat range" in the North American Waterfowl Management Plan. The Lake Erie marshes are at the crossroads of the Mississippi and Atlantic flyways, and they annually attract hundreds of thousands of migrating waterfowl. The Lake Erie marshes are also the most important migration staging area on the continent for black ducks. This high concentration of black ducks in the marshes represents nearly 17 percent of the continental black duck population. Although predominantly utilized by waterfowl during migration, several species also nest within the region including mallards, blue-winged teal, wood ducks, trumpeter swans and Canada geese.

The Lake Erie Marsh Conservation Opportunity Area includes the Ottawa National Wildlife Refuge (9,000 acres) and several Division of Wildlife-owned properties (Pipe Creek, Pickerel Creek, Willow Point, Little Portage, Toussaint Creek, Metzger Marsh, Magee Marsh, Mallard Club) that total 9,758 acres. Publicly-managed lands constitute 41% of the total wetland acreage within this area.

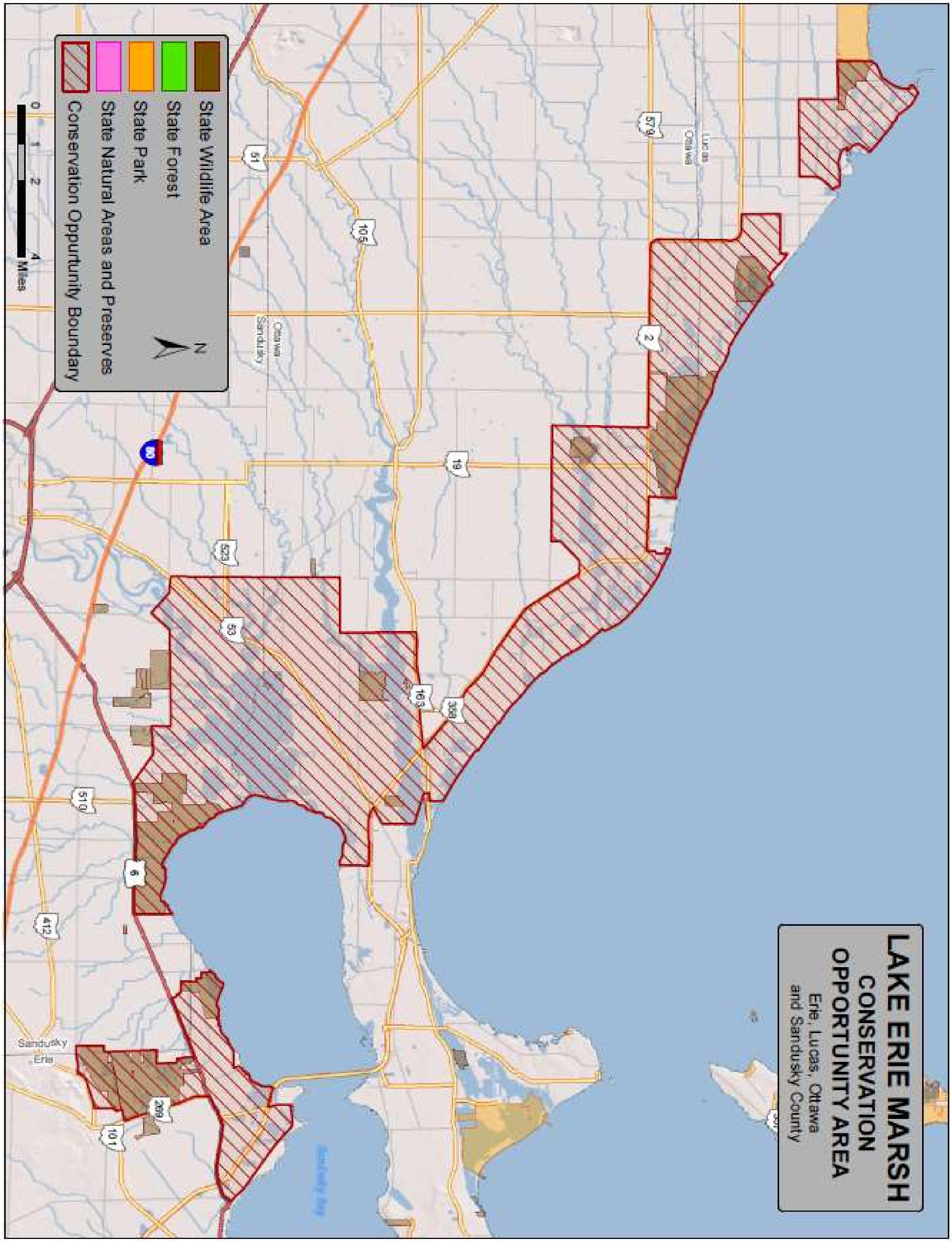


Figure 15. Lake Erie Marsh Conservation Opportunity Area.

6.7.4.2 Killbuck Marsh Conservation Opportunity Area

The Killbuck Marsh Conservation Opportunity Area (Figure 16) in east-central Ohio extends through the Killbuck Creek Valley and through portions of Wayne, Holmes, and Coshocton counties. Killbuck Creek is the central natural feature within the area. Over 40 miles of Killbuck Creek are included within the Conservation Opportunity Area. The creek's low gradient creates many acres of productive, emergent wetlands. The town of Millersburg lies between the two halves of the Conservation Opportunity Area (2.4 stream miles) in a location where past channelization and a narrow valley floor have resulted in reduced wetland habitat. However, from an area south of Millersburg to the confluence of the Killbuck and Walhonding River in Coshocton County, the stream gradient and wetland habitat are similar in nature to the northern portion of the Conservation Opportunity Area, and contain extensive wetlands.

Inland wetlands like those in the Killbuck Conservation Opportunity Area are important staging areas for thousands of waterfowl during spring and fall migration. As many as 23 species of ducks have been identified using the area. Shorebirds and a variety of other wildlife and listed species also depend heavily on these inland wetlands.

In 1988, the first recorded Ohio nesting attempt of the state endangered sandhill crane in more than 60 years was documented nearby at Funk Bottoms Wildlife Area. Sandhills now nest regularly at both the Killbuck Conservation Opportunity Area and Funk Bottoms Wildlife Area. The first recorded nesting of bald eagles in the Killbuck Marsh Conservation Opportunity Area occurred in 2000. In 1991, Killbuck Marsh Wildlife Area was the site for a successful reintroduction of river otters, which have subsequently expanded into adjoining watersheds.

Trumpeter swans were reintroduced in the Killbuck marshes in 1997 to re-establish this endangered species, and two nesting attempts were documented in 2000. Additionally, sightings of the eastern massasauga rattlesnake (currently a candidate species for federal endangered status) are known to have occurred in the Killbuck Valley.

The Killbuck Marsh Wildlife Area in north central Holmes County represents the largest remaining inland marsh in Ohio. This 5,500 acre wetland complex is composed of a wide variety of habitats, including seasonally flooded bottomland hardwoods, shrub-scrub swamps, emergent marshes, shallow ponds with submergent vegetation, and wet meadows. Restoration of diked wetlands such as the Wright Marsh (350 acres in 1990) and the Moore Marsh (50 acres in 1991) have added to the diversity of habitats. Presently 5,650 acres of Division of Wildlife-owned lands (38% of total acreage) are located within the Killbuck Marsh Conservation Opportunity Area.

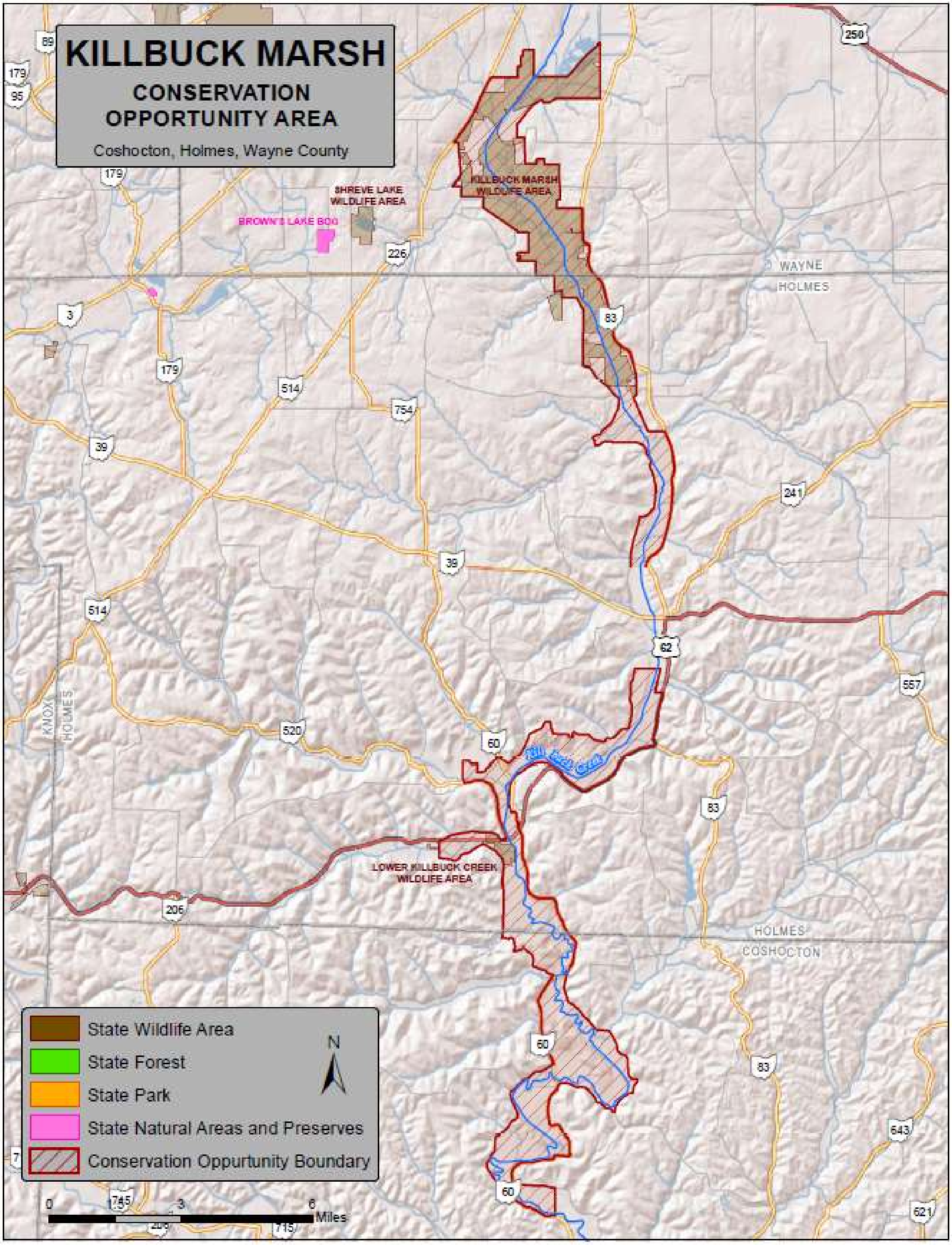


Figure 16. Killbuck Marsh Conservation Opportunity Area.

6.7.4.3 Grand River/Mosquito Creek Conservation Opportunity Area

Approximately 43% of Ohio's human population is located in northeast Ohio, with over 3 million people living within 35 miles of the Grand River/Mosquito Creek Conservation Opportunity Area (Figure 17). Despite this concentration of human activity, productive wetland systems still exist in Northeast Ohio. Together, the Grand River and Mosquito Creek Wildlife Areas comprise 86% of this 16,028 acre Conservation Opportunity Area. Current habitat conditions within the area are characterized by numerous beaver swamps, riparian wetlands, bottomland forests, vernal pools, and adjacent agricultural lands. Topography in the area is extremely flat and the soils are poorly drained.

The western portion of this Conservation Opportunity Area consists primarily of the Grand River Wildlife Area (over 7,400 acres), which was established in 1956 and is located at the southern end of the Grand River Lowlands. The "Lowlands" are recognized as a distinct physiographic region that developed from the ancestral lakebed of a finger lake that once stretched from northern Trumbull County through the western half of Ashtabula County. The Grand River itself has been identified as having the highest diversity of fish and mussels of any river of its size in the Lake Erie drainage. Due to the quality and quantity of the wetland habitat in the vicinity, the Grand River was selected as the first release site for river otters when restoration efforts were initiated in 1986.

The eastern portion of this Conservation Opportunity Area is comprised primarily of Mosquito Creek Wildlife Area (over 9,000 acres) which lies within Ohio's portion of the Ohio River drainage basin. The Mosquito Creek Reservoir Project was authorized in 1938 to provide flood control and a water supply for industry downstream. Full operation of the reservoir by the U.S. Army Corps of Engineers was initiated in 1944. The Ohio Division of Wildlife was granted a license by the Secretary of the Army in 1946 for fish and wildlife management on the over 9,000 acres of land and water north of State Route 88. The federal land was used as a public hunting area from 1946 to 1962. The state of Ohio established a land acquisition unit adjacent to the federal land in 1956.

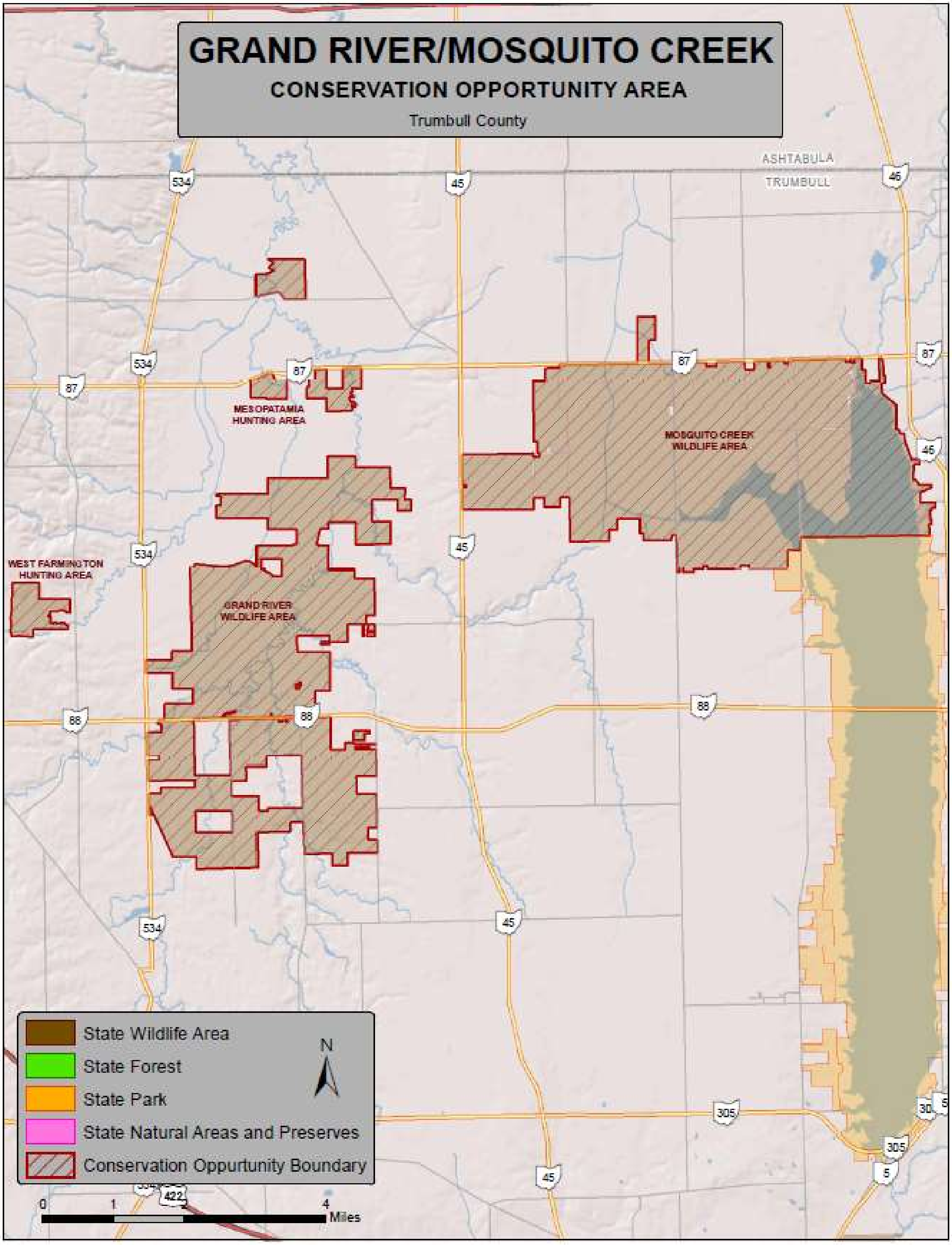


Figure 17. Grand River/Mosquito Creek Conservation Opportunity Area.

Table 23. CONSERVATION THREATS TO WETLAND HABITAT.
The following threats negatively impact or have the potential to negatively impact Wetland habitat. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		high
A	Wetlands in Ohio have become highly fragmented due to development	housing & urban areas commercial & industrial areas	high medium
B	Habitat destruction and altered hydrology from commercial development	commercial & industrial areas	medium
C	Habitat destruction and altered hydrology from urban/suburban development	housing & urban areas	high
D	Wetland construction/restoration far from other wetlands (fragmentation) as a result of mitigation from development	housing & urban areas commercial & industrial areas	high medium
E	No authority to control private land uses and development related to federal and state programs supporting wetland restoration	housing & urban areas	high
II	**agriculture and aquaculture**		low
A	Loss of wetland habitat because of conversion to agriculture	annual & perennial non-timber crops livestock farming & ranching	medium low
B	Loss of wetland habitat due to increase in intensity of agricultural practices – conversion of imbedded wetland habitat	annual & perennial non-timber crops	medium
III	**energy production and mining**		medium
A	Oil and gas extraction - can directly damage and destroy wetland habitat, and indirectly have negative impacts by altering hydrology and causing chemical contamination	oil & gas drilling mining & quarrying	low low
B	Wind turbines can negatively impact birds and bats that utilize wetland habitat	renewable energy	medium
IV	**transportation and service corridors**		high
A	Roads and utilities can destroy and fragment wetland habitat, and alter hydrology	roads & railroads utility & service lines	high high
V	**biological resource use**		medium
---	none	---	---
VI	**human intrusions and disturbance**		medium
A	Incompatible recreational activities	recreational activities	medium
B	Creation of recreational facilities can alter/destroy wetland habitat	recreational activities	medium
VII	**natural system modifications**		medium
A	Wetlands could be converted (drained) to CRP as 30 year Wetland Reserve Program (WRP) contracts expire and the landowner no longer receives payment	dams & water management/use	medium

B	Insufficient funds available to build/maintain wetland habitat on private lands – resulting in lack of management and subsequent habitat degradation	dams & water management/use	medium
C	Lack of wetland inventory data, and a database system to analyze that data limits our ability to manage	other ecosystem modifications	low
D	Our ability to manage wetlands is limited by available staff and funding	other ecosystem modifications	low
E	Landowners do not want to cede development rights to the state related to federal and state programs supporting wetland restoration	other ecosystem modifications	low
F	Construction costs associated with restoring private land wetlands continues to rise resulting in fewer wetland acres restored for the price	other ecosystem modifications	low
G	Habitat destruction, fragmentation, altered hydrology due to proximity of development	other ecosystem modifications	low
H	Aging wetland infrastructures can affect the quantity and the quality of wetlands	dams & water management/use	medium
I	Altered hydrologic regimes due to ditching and diking, water control structures, etc	dams & water management/use	medium
J	Lack of wetland associated species data limits our ability to manage for current threats and limits our ability to develop plans for impending issues like climate change	other ecosystem modifications	low
VIII	**invasive and other problematic species and genes**		medium
A	Introduction and/or spread of invasive plants and animals	invasive non-native/alien species	high
B	Introduction and/or spread of nuisance plants and animals	problematic native species	low
C	Introduction and spread of diseases (plants and animals)	invasive non-native/alien species problematic native species	high low
D	Landowners not aware of which species of vegetation to control, and how to control them	invasive non-native/alien species problematic native species	high low
E	Lack of accessibility and cost of herbicides for non-licensed landowners for control of vegetation	invasive non-native/alien species problematic native species	high low
IX	**pollution**		medium
A	Urban effluent	household sewage & urban wastewater industrial & military effluents garbage & solid waste air-borne pollutants	low low low low

B	Agriculture effluent	agricultural & forestry effluents	high
X	**geological events**		low
---	none	---	---
XI	**climate change and severe weather**		high
A	Climate change could effect plant species composition, which in turn could affect wildlife species	habitat shifting & alteration droughts temperature extremes storms & flooding	high high medium high

Table 24. CONSERVATION ACTIONS FOR WETLAND HABITAT.
The following actions will help abate or have the potential to help abate threats to Wetland habitat. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	actions	2nd level action classification(s)	action priority rank	threat(s) addressed*
I	**LAND/WATER PROTECTION**		high	
1	Annually identify and prioritize properties within the existing Wetland Conservation Opportunity Areas for strategic acquisitions, conservation easements, management agreements, or partnerships	site/area protection	high	I, II, VII-A, D
2	Protect wetlands through strategic acquisitions, easements, and partnerships	resource & habitat protection	med	I, II, III, IV, V, VI
3	Use State Wildlife Grant funds for potential acquisitions	resource & habitat protection	med	I, II, III, IV, V, VI
4	Work with land conservation partners to secure conservation easements and other protection for wetlands coming out of federal contracts	resource & habitat protection	med	VII-A,D
5	Site new recreational facilities such as golf courses and ball fields on already disturbed land	resource & habitat protection	med	VI-B
II	**LAND/WATER MANAGEMENT**		med	
1	Prevent introduction and control the spread of harmful species through legislation, regulation, policy, management practices, education, and partnerships	invasive/ problematic species control	high	VIII
2	Establish an early-detection rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	high	VIII-A,B
3	Stop or reduce the spread of wetland invasive vegetation in the three wetland conservation opportunity areas	invasive/ problematic species control site/area management	high low	VIII-A,B

4	Annually control 1,000 to 1,500 acres of wetlands containing invasive species on public land with an emphasis in the conservation opportunity areas	invasive/ problematic species control site/area management	high low	VIII-A,B
5	Utilize aerial spray for invasive species control/eradication in larger problem areas	invasive/ problematic species control	high	VIII-A,B
6	Use seasonal water level management to control invasive species	invasive/ problematic species control	high	VIII-A,B
7	Develop a standardized monitoring program to recognize potential threats from invasive species	invasive/ problematic species control	high	VIII
8	Assist with control of invasive vegetation on 500 acres of private wetlands annually through 2020	invasive/ problematic species control	high	VII-B, VIII-A,B,D,E
9	Use GIS to annually map the extent of invasive plants on selected wetlands, beginning with the wetland conservation opportunity areas	invasive/ problematic species control	high	VII-C, VIII-A,B
10	Increase and maintain adequate Division staffing in core areas for management of invasive species	invasive/ problematic species control	high	VII-D, VIII
11	Maintain 400,000 acres of privately owned, high quality wetlands in Ohio through 2020, as indexed by the private lands database and Conservation Reserve Program (CRP) acreages	habitat & natural process restoration	med	VII-A,B,E,F,H,I
12	Prioritize restoration/maintenance of Division-managed wetlands at greatest risk	habitat & natural process restoration	med	VII-C
13	Work with fisheries biologists to integrate fisheries considerations when restoring wetlands	habitat & natural process restoration	med	VII-G,H,I
14	Conduct aerial surveys of wetlands in selected areas during the summer and autumn - assess the percentage cover of emergent and floating leafed vegetation	habitat & natural process restoration	med	VII-C
15	Assess the quality of privately owned wetlands that have been restored with federal and/or state assistance by 2020	habitat & natural process restoration	med	VII-C
16	Randomly sample restored wetlands to determine their contribution to wildlife habitat	habitat & natural process restoration	med	VII-C,J
17	Use research and monitoring data to increase understanding of how land-use changes impact the watersheds of coastal wetlands	habitat & natural process restoration	med	VII-C,G
18	Develop a survey technique that adequately captures all aspects of the quality of a wetland	habitat & natural process restoration	med	VII-C,J
19	Include private wetlands on the marshbird monitoring protocol	habitat & natural process restoration	med	VII-C,J

20	Focus efforts on monitoring the priority species listed in the Upper Mississippi River and Great Lakes Region Joint Venture Implementation Plan	habitat & natural process restoration	med	VII-C,J
21	Encourage wetland owners to record wildlife use of their particular wetlands, and integrate the data into a database to track wildlife use of wetland types across the state	habitat & natural process restoration	med	VII-C,D,J
22	Collect and evaluate data from legitimate citizen scientist-based monitoring surveys, such as the Ohio Lepidopterist Society's Long-term Butterfly Monitoring Program, the Breeding Bird Survey, and the Frog and Toad Call Survey	habitat & natural process restoration	med	VII-C,J
23	Update and improve the accuracy of landcover data in Ohio by using advanced GIS modelling to determine habitat distribution and quality	habitat & natural process restoration	med	VII-C
24	Increase Division private lands biologist staffing in core wetland areas to work with landowners during CRP mid-contract management checks to insure they are utilizing proper wetland management techniques (*Guidelines for Management of Ohio's Wetland Habitat*)	habitat & natural process restoration	med	VII-D
25	Maintain the private lands biologist program on regional basis	habitat & natural process restoration	med	VII-D
26	Identify ecosystem or population-level threats through research, surveillance, monitoring, and inventory	habitat & natural process restoration	med	I, II, III, IV, V, VI, VII-J, VIII, IX, XI
27	Develop compatible recreational activities criteria that can be used to evaluate impacts to habitat/species from recreational activities	habitat & natural process restoration	med	VI
28	Develop ways to encourage mega-farm, hobby farm, and rural estate owners to participate in habitat programs	habitat & natural process restoration	med	VII-A,B,E,F
29	Manage Wetland Conservation Opportunity Areas to provide appropriate habitat to sustain viable populations of all wetland dependent wildlife species native to Ohio	site/area management	low	I, II, VIII, IX
30	Develop and maintain 28,500 acres of Division-owned wetlands in the wetland conservation opportunity areas as Category III wetlands (as defined by the Army Corps of Engineers) by 2020	site/area management	low	I, II, IX
31	Restore/enhance 600 acres of wetlands in District 1, 1,650 acres in District 2, 450 acres in District 3, and 300 acres in District 5 by 2020, with 3,200 acres of the restorations occurring within the three wetland conservation opportunity areas	site/area management habitat & natural process restoration	low med	I-D
32	Assess the quality of wetlands in the wetland conservation opportunity areas	site/area management	low	VII-C
33	Assure that publicly owned wetlands in wetland conservation opportunity areas are high quality	site/area management	low	VII-G,H,I
34	Conduct biological surveys on Division-managed wetlands within each conservation opportunity area in 2015 and 2020	site/area management	low	VII-C,J

35	Obtain information on habitat requirements and HSI models for all native wetland wildlife species that occur in Wetland Conservation Opportunity Areas	site/area management	low	VII-C,J
36	Evaluate and update management plans for priority species on Division-managed properties in wetland conservation opportunity areas	site/area management	low	VII-C,J
37	Incorporate all wetland conservation opportunity areas into statewide marshbird monitoring protocol	site/area management	low	VII-C,J
38	Increase Division staffing within the three Wetland Conservation Opportunity Areas	site/area management	low	VII-D
39	Annually budget funding for conservation opportunity areas capital projects on a rotating basis to maintain water control structures on highest priority wetlands	site/area management	low	VII-H
III	**SPECIES MANAGEMENT**		high	
1	Develop species-specific conservation plans as needs are identified to clearly define the actions the Division will/or will not implement concerning the state-listed species	species management	high	VII-J
2	Identify, design, and conduct appropriate species-specific surveys, inventories, or monitoring projects to determine species distribution and abundance	species management	high	VII-C,J
3	Identify the causes for the decline of the black-crowned night heron populations and develop a recovery plan by 2016	species recovery	high	VII-C,J
4	Reintroduce and restore wetland species where appropriate	species reintroduction	med	I, II
IV	**EDUCATION AND AWARENESS**		med	
1	Offer wetland management technical assistance to NRCS by providing long-term management plans to landowners enrolled within WRP	awareness & communications	med	VII-A,B
2	Make 40 substantive contacts relating to federal and state programs supporting wetland restoration each year	awareness & communications	med	I-E VII-B,E,F
3	Educate landowners about the importance of land stewardship and the value of wetlands on private lands - and inform them of best management practices for their wetland habitats	awareness & communications	med	VII-A,B,E,F
4	Provide guidance to landowners for eradication/control of invasive and nuisance species	awareness & communications	med	VIII-A,B,D,E
5	Conduct restoration and conservation demonstrations to transfer management capacity to benefit coastal wetland management	training	med	VII-D
6	Maintain a corps of Division of Wildlife-trained partners and volunteers to assist, lead, and promote special programs	training	med	VII-D
7	Educate landowners, maintenance staff, municipalities, etc. on ways to reduce impacts to adjacent wetland habitat	awareness & communications	med	I, II, VII-G
8	Deliver science-based training and information that supports wetland stewardship to decision-makers	training	med	I, II, VII-G
9	Educate the public about the negative effects of exotic and nuisance animals – encourage responsible disposal of unwanted animals	awareness & communications	med	VIII-A,B

V	**LAW AND POLICY**		med	
1	Balance the needs of fish and wildlife with the needs of people by mitigating incompatible ecosystem uses	policies & regulations	med	I, II, III, IV, V, VI
2	Participate in the policy-making process at Federal level to influence conservation programs	policies & regulations	med	I-E, VII-A,B,E,F
3	Create an interagency team to explore streamlining the permitting process for wetland restoration projects	policies & regulations	med	VII-E,F
4	Foster legislative support for private lands wetland conservation to continue the wetlands financial incentives in future Farm Bill titles and editions	legislation	med	VII-A,B
5	Encourage the preservation of habitat connectivity in all land use planning	policies & regulations private sector standards & codes	med med	I, IV
6	Create incentives (laws, policies) to prevent loss and/or minimize impacts to wetlands due to development	policies & regulations	med	I, II, IV
7	Support legislation promoting eco-friendly energy development and use	legislation policies & regulations	med med	III
8	Develop regulations to deter introduction of invasive/nuisance species	legislation policies & regulations	med med	VIII-A,B,C
9	Develop and implement a risk-assessment system in the approval process for importing or moving live animals and plants	legislation policies & regulations	med med	VIII-A,B,C
VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		med	
1	Create incentives for vegetated buffers along all waterways to reduce nutrient loads and sediment	market forces conservation payments non-monetary values	high med low	IX-B
2	Support incentives that encourage landowners to maintain/preserve existing wetland habitat on agricultural lands	market forces conservation payments non-monetary values	high med low	II
3	Support creation of incentives to incorporate wildlife habitat into recreational facilities such as parks and golf courses	market forces conservation payments non-monetary values	high med low	VI-B

4	Support creation of incentives for landowners to build wetlands	market forces conservation payments non-monetary values	high med low	VII-B
5	Explore tying eligibility for grant money, loans, and cost-share programs to nutrient loading levels for agriculture – the lower the nutrient levels in their effluent, the more money they would be eligible for	conservation payments	med	IX-B
6	Engage in research to understand social and economic influences on landowner decisions to participate in habitat programs, and use information to influence where and how programs are marketed	conservation payments non-monetary values	med low	VII-A,B,E,F
7	Create incentives to promote land use that incorporates wetland habitat friendly planning	linked enterprises & livelihood alternatives market forces conservation payments non-monetary values	med high med low	I, II, III, IV
8	Create incentives for controlled wetland owners to improve water control structures and subsequently improve habitat conditions for fish and wildlife	conservation payments non-monetary values	med low	VII-B,H
9	Develop incentives for private landowners to eradicate/control invasive plant species	conservation payments non-monetary values	med low	VIII
10	Seek Federal grant money to assist with chemical applications to control invasive species	conservation payments	med	VIII-D,E
11	Seek competitive grant funding to support wetland restoration/maintenance efforts	conservation payments	med	VII-B,D,E,F
12	Increase funding for projects which don’t meet the Farm Bill requirements	conservation payments	med	VII-A,B,E,F
13	Maintain state matching grants for created wetlands	conservation payments	med	VII-A,B,E,F
VII	**EXTERNAL CAPACITY BUILDING**		med	
1	Utilize partnerships with university research programs to evaluate the most cost-effective technique to determine wetland quality	alliance & partnership development	med	VII-C,D

2	Maintain partnerships with US Fish and Wildlife Service (USFWS), Ducks Unlimited (DU), Farm Service Administration (FSA), National Resource Conservation Service (NRCS), and Ohio Soil and Water Conservation Districts (SWCD)	alliance & partnership development	med	VII-C,D
3	Encourage partnerships of conservation minded groups to protect and manage wetland habitat	alliance & partnership development	med	I, II, VII-D
4	Support legitimate citizen scientist-based monitoring efforts of wildlife species and habitats	institutional & civil society development	med	VII-C,D,J
5	Create a multiagency invasive species prevention and control group that would be responsible for all invasive species issues	alliance & partnership development	med	VIII-A,B,C
6	Through interagency coordination, work to assure that wildlife interests are taken into consideration in road, bridge, causeway, and utilities design, construction, and maintenance	alliance & partnership development	med	IV
7	Facilitate the development of cooperative weed management areas	alliance & partnership development	med	VII-D

*refers to Wetlands Habitat Conservation Threats in Table 23

6.8 Lake Erie Islands

Ohio Lake Erie Islands Habitat Map (Wikipedia)

6.8.1 Status

Lake Erie island habitat varies based upon the level of human development and disturbance. Some islands – particularly North, South, and Middle Bass, and Kelleys – have year round residents, influxes of tourists during the summer, and considerable development supporting the tourism industry. Other islands have no development, and are only occasionally visited by people. Development on populated islands, and habitat destruction from colonies of cormorants on un- or lesser populated islands continue to impact island habitat.

6.8.2 Description

The Lake Erie Islands constitute an archipelago of 22 islands lying between the Canadian and American shores of the western basin of Lake Erie (Figure 18). Ohio has jurisdiction over 13 of the islands (Kelleys, North Bass, Middle Bass, South Bass, Green, Rattlesnake, Sugar, Gibralter, Ballast, Starve, West Sister, Mouse, Johnson's) which range in size from the 1.2-acre Starve Island with 0.186 miles of shoreline, to the 2,824-acre Kelleys Island which has 11.6 miles of shoreline. Twenty-seven percent (1,616 ac) of the 5,892 acres comprising the four largest islands (Kelleys, South Bass, Middle Bass and North Bass) is owned by the Ohio Department of Natural Resources, U.S. Fish and Wildlife Service, and conservation-minded non-governmental organizations.

The Lake Erie islands, although distinct from the neighboring mainland in climate and topography, are considered to be vegetatively indistinguishable from the surrounding mainland. Shoreline characteristics vary from island to island but consist of beaches of sand, gravel/small stones, loose rocks, alvars, and sheer cliffs – all with varying amounts of vegetative cover.

The conversion of the Lake Erie islands' landscape has been dramatic. Island forests were cleared for agricultural endeavors, and limestone quarrying was an important industry through the 1800s. Since the early 1900s, the islands have been developed at a quickening pace as summertime residences, and to meet the needs of the growing tourism industry. Today, nearly a million tourists visit the islands each summer to camp, bike, boat, sail, fish, and sightsee. Human disturbance, habitat degradation and destruction, coupled with shoreline alteration and development are the most serious threats to island-dependent wildlife. The Lake Erie water snake's population will need to be monitored through 2016 (and beyond) to ensure long-term sustainability.

Data is needed to quantify impacts to colonial waterbirds and other avian communities affected by vegetation changes resulting from roosting/nesting cormorants. Cormorants also compete with these birds for nest sites. Information is needed to determine if the cormorant management plan is effective. On Lake Erie islands, cormorants nest primarily in trees in close proximity to other colonial-nesting species. Habitat alteration and competition is a potential problem given the lack of alternative nesting sites for colonial waterbirds. Consequently, conservation of nesting sites should be the emphasis of management activities for these waterbirds. Finally, fluctuating water levels in the lake, shoreline erosion, pollution/contaminants, and the impacts of aquatic invasive species on the prey base are also unknown factors which may be detrimental to island-dependent wildlife.

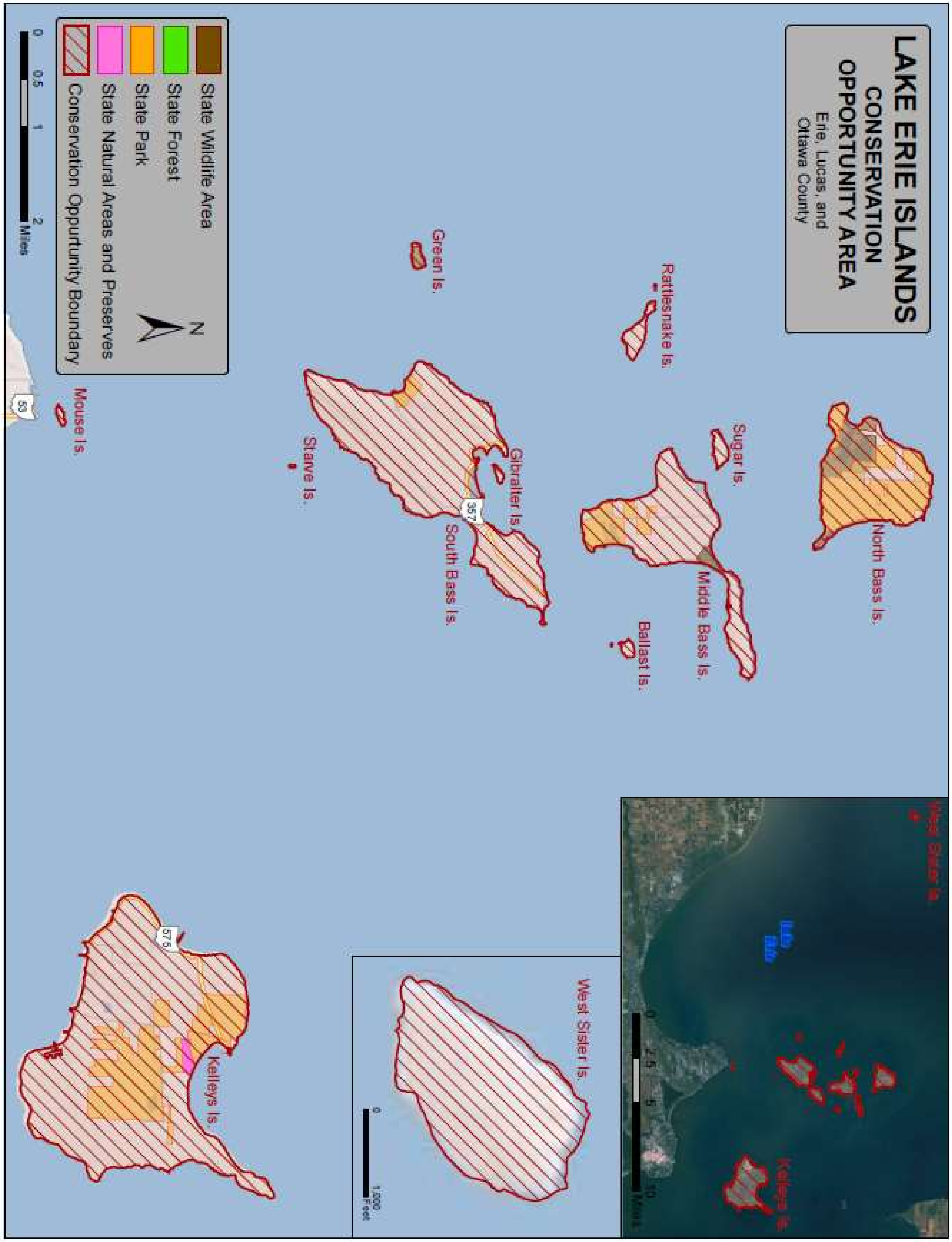


Figure 18. Lake Erie Islands Conservation Opportunity Area.

6.8.3 Associated Species of Greatest Conservation Need

The Lake Erie islands historically have been an important staging and stopover location for a variety of migratory avian species. In addition, West Sister Island currently supports a significant percentage of all the herons and egrets nesting in the U.S. Great Lakes. The islands also support the largest colony of snowy egrets, the only little blue heron colony, and the largest colonies of great blue herons, great egrets, and black-crowned night-herons found within the Great Lakes. The entire population of the Lake Erie water snake is restricted to 8 Lake Erie islands. The snake's population declined through the 1990s resulting in the species being listed as federally threatened in 1999 and state endangered in 2000. Today, with enough protected habitat to sustain a viable population, abundant prey in the form of the round goby, and a significant reduction in direct mortality from people through intensive public outreach efforts, the snake population appears secure and growing throughout its range. In 2011 the snake was removed from the list of federally threatened species, and downlisted to state threatened in 2012.

The following species have been identified as Lake Erie Islands species of greatest conservation need (conservation status rank in parentheses):

<u>Birds</u>

Black-crowned Night Heron (10)	*Nycticorax nycticorax*
Great Egret (10)	*Casmerodius albus*
Snowy Egret (24)	*Egretta thula*
Cattle Egret (24)	*Bubulcus ibis*
Great Blue Heron (38)	*Ardea herodias*

<u>Reptiles</u>

Blanding's Turtle (22)	*Emydoidea blandingii*

Table 25. CONSERVATION THREATS TO LAKE ERIE ISLANDS HABITAT.
The following threats negatively impact or have the potential to negatively impact Lake Erie Islands habitat. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		high
A	Habitat destruction, fragmentation, altered hydrology from tourism-related development	tourism & recreation areas	high
B	Habitat destruction, fragmentation, altered hydrology from residential development	housing & urban areas	high
C	The market value of undeveloped land on the Lake Erie Islands is exceptionally, high making land acquisition for protection purposes problematic	housing & urban areas tourism & recreation areas	high high
II	**agriculture and aquaculture**		medium
A	Loss of island habitat because of conversion to agriculture (primarily vinyards)	annual & perennial non-timber crops	high
III	**energy production and mining**		low
A	Mining (primarily quarrying) can directly damage and destroy island habitat, and indirectly have negative impacts by altering hydrology	mining & quarrying	medium
B	Wind turbines can negatively impact birds and bats that utilize island habitat	renewable energy	negligible

IV	**transportation and service corridors**		high
A	Roads and utilities can destroy and fragment island habitat, and alter hydrology	roads & railroads utility & service lines	high medium
V	**biological resource use**		low
A	Killing of Lake Erie watersnakes	hunting & collecting terrestrial animals	low
VI	**human intrusions and disturbance**		high
A	Incompatible recreational activities	recreational activities	high
B	Creation of recreational facilities can alter/destroy island habitat	recreational activities	high
VII	**natural system modifications**		low
A	Fluctuating water levels in Lake Erie and shoreline erosion can negatively impact island-dependent wildlife	other ecosystem modifications	low
B	The use of chemical controls for the control/eradication of the gypsy moth and mosquitoes is known to negatively impact non-target lepidopteran and amphibians	other ecosystem modifications	low
C	Habitat destruction, fragmentation, altered hydrology due to proximity to development	other ecosystem modifications	low
D	Our ability to manage island habitat is limited by available staff and funding	other ecosystem modifications	low
E	The amount of land in private/corporate ownership on the islands limits our ability to manage	other ecosystem modifications	low
F	Lack of island habitat inventory data, and a database to analyze that data limits our ability to manage	other ecosystem modifications	low
G	Lack of island associated species data limits our ability to manage for current threats and limits our ability to develop plans for impending issues like climate change	other ecosystem modifications	low
VIII	**invasive and other problematic species and genes**		high
A	Introduction and/or spread of invasive plants and animals	invasive non-native/alien species	high
B	Introduction and/or spread of nuisance plants and animals	problematic native species	medium
C	Introduction and spread of diseases (plants and animals)	invasive non-native/alien species problematic native species	high medium
D	Colonial waterbirds and other avian communities are impacted by vegetation changes and nest site competition resulting from roosting/nesting cormorants	problematic native species	medium
IX	**pollution**		low
A	Urban effluent	household sewage & urban wastewater industrial & military effluents garbage & solid waste air-borne pollutants	low low low negligible

B	Agriculture effluent	agricultural & forestry effluents	negligible
X	**geological events**		low
---	none	---	---
XI	**climate change and severe weather**		low
A	Climate change could effect plant species composition, which in turn could affect wildlife species	habitat shifting & alteration droughts temperature extremes storms & flooding	low negligible low low
B	Lake levels impacts on shoreline species due to climate change	habitat shifting & alteration storms & flooding	low low

Table 26. CONSERVATION ACTIONS FOR LAKE ERIE ISLANDS HABITAT.
The following actions will help abate or have the potential to help abate threats to Lake Erie Islands habitat. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	actions	2nd level action classification(s)	action priority rank	threat(s) addressed*
I	**LAND/WATER PROTECTION**		med	
1	Protect island habitat through strategic acquisitions, easements, and partnerships	resource & habitat protection	med	I, II, III, IV, V, VI
2	Use State Wildlife Grant funds for potential acquisitions	resource & habitat protection	med	I, II, III, IV, V, VI
3	Establish permanent buffer areas around island habitats to ensure their long-term viability	resource & habitat protection	med	I, II, III, IV, VI
4	Conserve and connect island habitats through acquisition, conservation easements, land donations, and other innovative strategies together with conservation-minded NGO partners and federal, state, and local governments	resource & habitat protection	med	I, II, III, IV, VI
5	Develop new and build on existing relationships with Land Trusts purchasing lands and conservation easements	resource & habitat protection	med	I, II, III, IV, VI
6	Add 100 acres of protected lands on the Lake Erie islands through conservation easement or purchase by 2016	site/area protection	med	I, II, III, IV, VI, VII-C,E
7	Site new recreational facilities such as golf courses and ball fields on already disturbed land	resource & habitat protection	med	VI-B
II	**LAND/WATER MANAGEMENT**		med	
1	Prevent introduction and control the spread of harmful species through legislation, regulation, policy, management practices, education, and partnerships	invasive/ problematic species control	high	VIII

2	Implement strategies identified in the Wildlife Stewardship Tactical Plan to avoid, minimize or eliminate the adverse impacts of non-native and/or problematic species in island habitats	invasive/ problematic species control	high	VIII
3	Establish an early-detection rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	high	VIII-A,B,C
4	Implement strategies identified in the Wildlife Stewardship Tactical Plan to avoid, minimize or eradicate diseases in wildlife associated with island habitats	invasive/ problematic species control	high	VIII-C
5	Identify, investigate, and conduct research on the causes of habitat loss or impairment and develop strategies to minimize further habitat loss	habitat & natural process restoration	med	I, II, III, IV, VI, VII-C
6	Develop a list and prioritize research needs associated with habitat loss or impairment	habitat & natural process restoration	med	I, II, III, IV, VI, VII-C
7	Identify and implement strategies to minimize the effects of residential development adjacent to existing protected/preserved habitats	habitat & natural process restoration	med	I, IV, VI, VII-C
8	Design and implement surveys to determine the status and distribution of wildlife species associated with island habitats - evaluate the success of habitat restoration, enhancement, and management measures being implemented	habitat & natural process restoration	med	VII-F,G
9	Continue to research habitat requirements for the suite of wildlife associated with Lake Erie Island habitats	habitat & natural process restoration	med	VII-F,G
10	Assemble and/or develop GIS-based data layers and associated tables of known island habitats, including publicly-owned or conservation-minded NGO managed lands, and make it available for public-land managers and conservation-minded NGOs	habitat & natural process restoration	med	VII-F
11	Develop a comprehensive baseline inventory of historic versus current distribution and abundance of island habitats	habitat & natural process restoration	med	VII-F
12	Identify, design, and conduct appropriate habitat-based projects to evaluate the quality, quantity, connectivity, and distribution of “undeveloped/natural” Lake Erie Island habitat	habitat & natural process restoration	med	VII-F
13	Develop a management plan for colonial waterbirds on the Lake Erie islands	habitat & natural process restoration	med	VIII-B,D
14	Determine the effectiveness of habitat manipulation on Lake Erie islands to enhance colonial waterbird habitat	habitat & natural process restoration	med	VIII-B,D
15	Collect and evaluate data from legitimate citizen scientist-based monitoring surveys such as the Ohio Breeding Bird Survey	habitat & natural process restoration	med	VII-D,G
16	Identify ecosystem or population-level threats through research, surveillance, monitoring, and inventory	habitat & natural process restoration	med	I, II, III, IV, V, VI, VII-G, VIII, IX, XI
17	Develop compatible recreational activities criteria that can be used to evaluate impacts to habitat/species from recreational activities	habitat & natural process restoration	med	VI

18	Identify, protect, restore, and enhance 100 acres of island habitats that will support viable populations of the wildlife species dependent upon these habitats on public and private lands by 2025	site/area management	low	I, II, III, IV, V, VI, VII-B,C, VIII, IX
III	**SPECIES MANAGEMENT**		med	
1	Develop species-specific conservation plans as needs are identified to clearly define the actions the Division will/or will not implement concerning the state-listed species	species management	high	VII-G
2	Identify, design, and conduct appropriate species-specific surveys, inventories, or monitoring projects to determine species distribution and abundance	species management	high	VII-G
3	Biannually meet with appropriate department personnel to ensure compliance with the Lake Erie Watersnake Management Plan for island properties owned or managed by ODNR	species management	high	V
4	Continue Lake Erie watersnake population surveys through 2016 as designed in the post-delisting monitoring protocol	species management	high	V
5	Continue to implement the cormorant management plan through 2020 and revise its content as needed	species management	high	VIII-D
6	Identify the causes for the decline of the black-crowned night heron populations and develop a recovery plan by 2020	species recovery	low	VII-G
7	Reintroduce and restore Lake Erie Island species where appropriate	species reintroduction	low	I, II, VII-C
8	By 2016, develop and implement recovery/conservation plans for the state-listed species dependent upon island habitats starting with the Blanding's turtle	species recovery	low	VII-G
IV	**EDUCATION AND AWARENESS**		high	
1	Promote the value of island habitat/species conservation by developing and distributing new publications, educational materials, website information, and digital presentations	awareness & communications	high	I, II, III, IV, V, VI, VII-C,E
2	Provide technical assistance to private landowners who wish to protect, restore and/or enhance island habitats	awareness & communications	high	VII-E
3	Provide guidance to landowners for eradication/control of invasive and nuisance species	awareness & communications	high	VII-E, VIII
4	Continue to provide technical assistance to Lake Erie island shoreline residents and businesses to ensure open rock cribs are used in the construction of new or refurbished docks	awareness & communications	high	VI-B, VII-C
5	Provide technical guidance on coastal development plans as relates to fish and wildlife interests	awareness & communications	high	I, IV, VI, VII-C
6	Provide technical assistance to public land managers and NGOs to ensure island habitats under their management continue to be protected, restored and/or enhanced	awareness & communications	high	VII-D,E
7	Maintain a corps of Division of Wildlife-trained partners and volunteers to assist, lead, and promote special programs	training	high	V, VI, VII-D

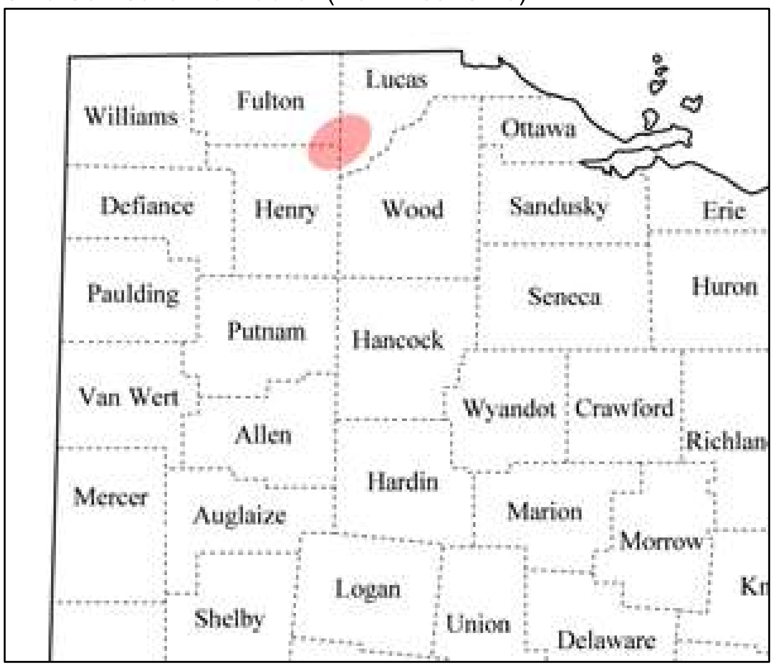
8	Utilize the Ohio Wildlife Legacy Stamp as a tool to illustrate the value of Ohioans in wildlife conservation and to convey the connection between wildlife, people, and habitat	awareness & communications	high	V, VI, VII-E
9	Educate the public about the negative effects of exotic and nuisance animals – encourage responsible disposal of unwanted animals	awareness & communications	high	VIII-A,B,C
V	**LAW AND POLICY**		med	
1	Balance the needs of fish and wildlife with the needs of people by mitigating incompatible ecosystem uses	policies & regulations	med	I, II, III, IV, V, VI
2	Participate in the policy-making process at Federal level to influence conservation programs	policies & regulations	med	I, II, III, IV
3	Encourage the preservation of habitat connectivity in all land use planning	policies & regulations private sector standards & codes	med high	I, IV
4	Create incentives (laws, policies) to prevent loss and/or minimize impacts to island habitats due to development	policies & regulations	med	I, II, IV
5	Support legislation promoting eco-friendly energy development and use	legislation policies & regulations	med med	III
6	Develop regulations to deter introduction of invasive/nuisance species	legislation policies & regulations	med med	VIII-A,B,C
7	Develop and implement a risk-assessment system in the approval process for importing or moving live animals and plants	legislation policies & regulations	med med	VIII-A,B,C
VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		low	
1	Support incentives that encourage landowners to maintain/preserve existing island habitat on their properties	market forces conservation payments non-monetary values	low low low	I, VII-E

2	Support the creation of incentives for the protection and restoration of island habitat	linked enterprises & livelihood alternatives substitution market forces conservation payments non-monetary values	low low low low low	I, II, III, IV, VII-E
3	Support creation of incentives to incorporate wildlife habitat into recreational facilities such as parks and golf courses	market forces conservation payments non-monetary values	low low low	VI-B
4	Develop incentives for private landowners to eradicate/control invasive plant species	conservation payments non-monetary values	low low	VII-E, VIII-A,B,C
VII	**EXTERNAL CAPACITY BUILDING**		low	
1	Actively promote and engage in partnerships to conserve and enhance island habitats and the species dependent upon them	alliance & partnership development	low	I, II, V-A, VII-D
2	Support legitimate citizen scientist-based monitoring efforts of wildlife species and habitats	institutional & civil society development	low	VII-D
3	Develop new and strengthen existing partnerships with the Lake Erie Island Chapter of the Black Swamp Conservancy and Land Trust organizations working on the Lake Erie islands	alliance & partnership development	low	VII-D
4	Create a multiagency invasive species prevention and control group that would be responsible for all invasive species issues	alliance & partnership development	low	VIII
5	Through interagency coordination, work to assure that wildlife interests are taken into consideration in road, bridge, causeway, and utilities design, construction, and maintenance	alliance & partnership development	low	IV

*refers to the Lake Erie Islands Habitat Conservation Threats in Table 25

6.9 Oak Savanna Habitat

Ohio Oak Savanna Habitat (Northwest Ohio)



6.9.1 Status

The oak savanna was once one of the most common vegetation types in the Midwest. However, since the middle of the 19th century declines due primarily to settlement and loss of the normal fire regime have led this habitat to be listed as globally imperiled. Oak savannas are one of the rarest plant communities today. Most remaining oak savannas, including those in Ohio, are small and fragmented.

6.9.2 Description

Ohio's Oak Savannas lay a region in the northwestern portion of the state, along a sandy belt of soil known as the Oak Openings (Figure 19). This area is 22 miles long, 6 miles wide, and encompasses 130 to 140 square miles in parts of Henry, Fulton, and Lucas counties. These oak savannas are upland, dry areas dominated by drought-resistant prairie plants such as little bluestem, lupine, and widely-spaced oak trees with a park-like appearance. This community is often interspersed with areas of poor drainage that support wetlands.

In 1859, Lucas County Commissioners led the effort to develop an extensive network of drainage ditches throughout the county to drain the wet prairies and make the land available to agriculture. The water table was lowered and the oak savannas and wet prairies were converted to pastures and farms. Draining the wet areas of the Oak Openings enabled farms and homes to exist in areas that were formerly wetlands. Over the years, numerous farms in the area were abandoned for the more fertile soils found in the nearby Black Swamp region. During the 1930s, farmed-out areas were planted in pines to keep sand from blowing across roads and against houses.

The Oak Openings Region Green Ribbon Initiative consists of a number of local partners intent on conserving habitat by creating a biological/recreational corridor of preserved lands. This initiative has identified 6,000 acres of high-quality green space running through the area. Within this green space, approximately 1,000 acres of oak savanna habitat is actively maintained by the ODNR and The Nature Conservancy. Remnant oak savannas, wet prairies, and sand dunes are also scattered throughout an additional 8,300 acres owned by the Division of Forestry and the Toledo Metroparks. Remnant oak savanna plant communities still exist on many residential properties throughout the region.

Periodic fires which once sustained the oak savanna plant community by retarding succession, now only occur in intensively managed areas. Invasive plant species also change the composition and structure of the plant community, making restoration more difficult. In addition, the use of chemical controls (e.g., demilin, and Bt) for the eradication of the gypsy moth is known to impact non-target lepidopteran species. This could be very problematic for lepidopterans with distributions limited to the Oak Openings.

It is difficult to quantify the minimum habitat necessary to sustain viable populations of the oak savanna wildlife. Efforts should be made to enhance, restore, and connect fragmented oak savanna habitat in the largest block of protected lands possible. Habitat should be maintained in a mosaic of open prairie grass areas with native lupines and nectaring plants (95%) interspersed with widely scattered oaks (3%) and small wetlands (2%).

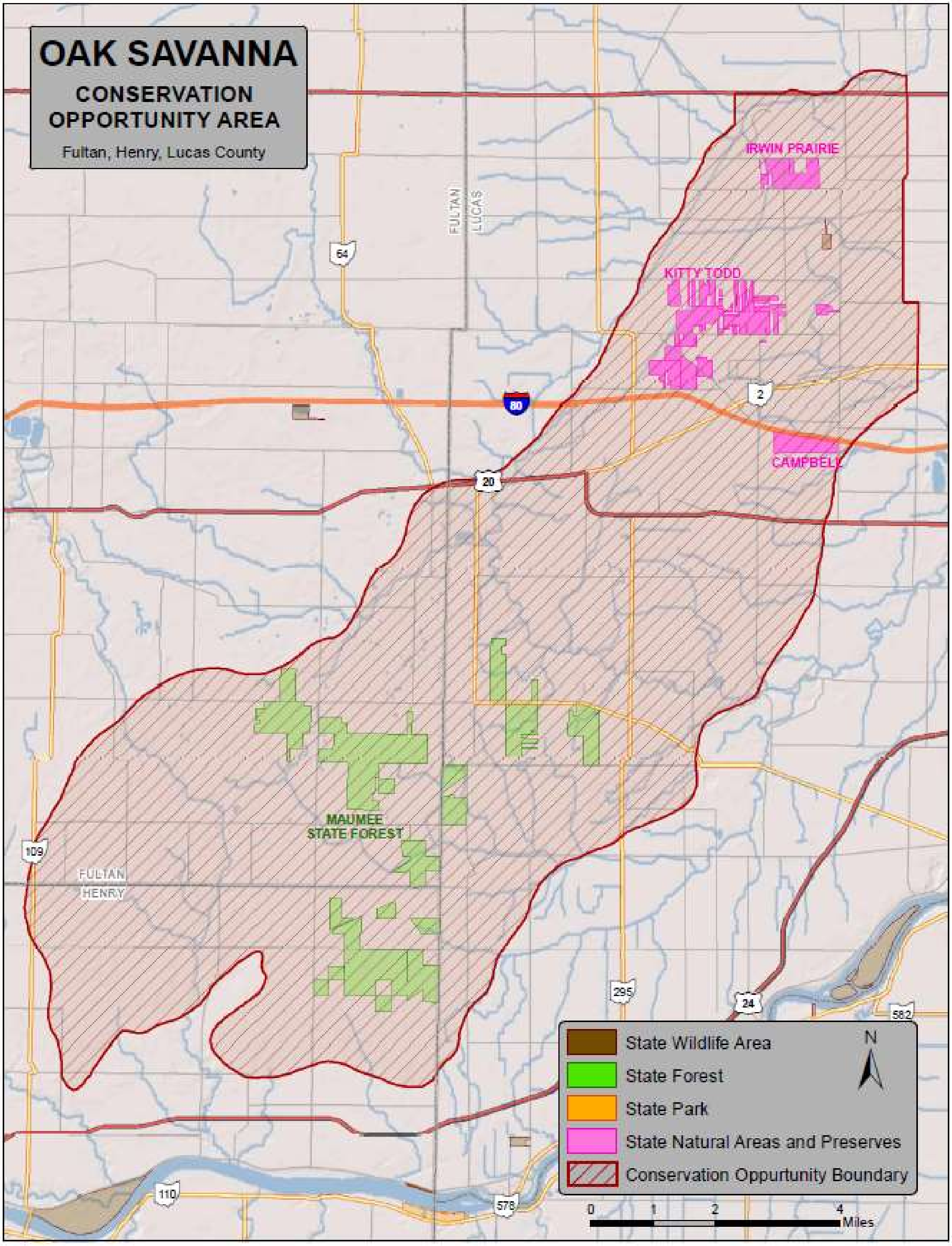


Figure 19. Oak Savanna Conservation Opportunity Area.

6.9.3 Associated Species of Greatest Conservation Need

Oak savannas provide a variety of habitats for many species of wildlife. Oak trees provide habitat as well as food for birds, rodents, deer, turkey, and a host other species. The diversity of ground vegetation (grasses, forbs) also supports numerous wildlife species that utilize this habitat for food and cover.

A self-sustaining population of the Karner blue butterfly has been successfully reintroduced in this habitat in the Oak Openings region. Efforts continue to expand the Karner's distribution to suitable habitat within its historic range. Habitat specificity for the Eastern Persius dusky wing butterfly and the frosted elfin butterfly is being researched. The distribution and abundance of the blue-spotted salamander also need to be determined so that sound management practices can be implemented to conserve a viable population within the Oak Savanna area.

The following species have been identified as Oak Savanna species of greatest conservation need (conservation status rank in parentheses):

<u>Amphibians</u>
Blue-spotted Salamander (19) *Ambystoma laterale*

<u>Birds</u>
Lark Sparrow (38) *Chondestes grammacus*

<u>Terrestrial Invertebrates</u>
Persius Dusky Wing Butterfly (2) *Erynnis persius*
Dusted Skipper (17) *Atryonopsis hianna*
Frosted Elfin Butterfly (18) *Incisalia irus*
Edward's Hairstreak (33) *Satyrium edwardsii*
Indian Skipper (41) *Hesperia sassacus*
Karner Blue (n/r) *Lycaeides melissa samuelis*

<u>Mammals</u>
Thirteen-lined Ground Squirrel (16) *Spermophilus tridecemlineatus*
Badger (16) *Taxidea laxus*

<u>Reptiles</u>
Eastern Hognose Snake (6) *Heterodon platirhinos*

Table 27. CONSERVATION THREATS TO OAK SAVANNA HABITAT.
The following threats negatively impact or have the potential to negatively impact Oak Savanna habitat. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		high
A	Habitat destruction, fragmentation, altered hydrology from commercial development	commercial & industrial areas	high
B	Habitat destruction, fragmentation, altered hydrology from urban/suburban development	housing & urban areas	high
C	The market value of undeveloped land in the Oak Openings Region is exceptionally high, making land acquisition for protection purposes problematic	commercial & industrial areas housing & urban areas	high high

II	**agriculture and aquaculture**		low
A	Loss of Oak Savanna habitat because of conversion to agriculture	annual & perennial non-timber crops wood & pulp plantations livestock farming & ranching	low medium low
B	Loss of oak savanna habitat due to increase in intensity of agricultural practices – conversion of imbedded oak savanna habitat	annual & perennial non-timber crops	low
III	**energy production and mining**		low
A	Mining, oil and gas extraction - can directly damage and destroy habitat, and indirectly have negative impacts by altering hydrology and causing chemical contamination	oil & gas drilling mining & quarrying	low medium
B	Wind turbines can negatively impact birds and bats that utilize Oak Savanna habitat	renewable energy	low
IV	**transportation and service corridors**		low
A	Roads and utilities can destroy and fragment Oak Savanna habitat, and alter hydrology	roads & railroads utility & service lines	medium low
V	**biological resource use**		low
---	none	---	---
VI	**human intrusions and disturbance**		low
A	Incompatible recreational activities	recreational activities	medium
B	Creation of recreational facilities can alter/destroy island habitat	recreational activities	medium
VII	**natural system modifications**		low
A	Periodic fires which once sustained the oak savanna plant community by retarding succession only occur in intensively managed areas	fire & fire supression	medium
B	The use of chemical controls for the control/eradication of the gypsy moth and mosquitoes is known to negatively impact non-target lepidopteran and amphibians	other ecosystem modifications	low
C	Habitat destruction, fragmentation, altered hydrology due to proximity to development	other ecosystem modifications	low
D	Our ability to manage Oak Savanna habitat is limited by available staff and funding	other ecosystem modifications	low
E	While remnant oak savanna plant communities still exist on many residential properties, larger, intact oak savanna habitat is limited and few areas are connected leaving isolated oak savanna habitat scattered throughout the region	other ecosystem modifications	low
F	Less than 2% of the complex of dunes and swales that supported the sedge meadows, tallgrass prairies, barrens, and oak savannas remain	other ecosystem modifications	low
G	Lack of oak savanna inventory data, and a database system to analyze that datalimits our ability to manage	other ecosystem modifications	low
H	Lack of oak savanna associated species data limits our ability to manage for current threats and limits our ability to develop plans for impending issues like climate change	other ecosystem modifications	low

VIII	**invasive and other problematic species and genes**		medium
A	Introduction and/or spread of invasive plants and animals	invasive non-native/alien species	high
B	Introduction and/or spread of nuisance plants and animals	problematic native species	low
C	Introduction and spread of diseases (plants and animals)	invasive non-native/alien species problematic native species	high low
IX	**pollution**		low
A	Urban effluent	household sewage & urban wastewater industrial & military effluents garbage & solid waste air-borne pollutants	low low low negligible
B	Agriculture effluent	agricultural & forestry effluents	low
X	**geological events**		negligible
---	none	---	---
XI	**climate change and severe weather**		medium
A	Climate change could effect plant species composition, which in turn could affect wildlife species	habitat shifting & alteration droughts temperature extremes storms & flooding	medium high medium low

Table 28. CONSERVATION ACTIONS FOR OAK SAVANNA HABITAT.
The following actions will help abate or have the potential to help abate threats to Oak Savanna habitat. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	actions	2nd level action classification(s)	action priority rank	threat(s) addressed*
I	**LAND/WATER PROTECTION**		med	
1	Add 250 acres of protected lands within the Oak Openings region through purchase or conservation easement by 2020	site/area protection	high	I, II, III, IV, VI-C,E
2	Protect oak savanna habitat through strategic acquisitions, easements, and partnerships – with special emphasis on the Oak Openings region	resource & habitat protection	low	I, II, III, IV, V, VI
3	Use State Wildlife Grant funds for potential acquisitions	resource & habitat protection	low	I, II, III, IV, V, VI

4	Establish permanent buffer areas around oak savanna habitats to ensure their long-term viability	resource & habitat protection	low	I, II, III, IV, VI
5	Conserve and connect oak savanna habitats through acquisition, conservation easements, land donations, and other innovative strategies together with conservation-minded NGO partners and federal, state, and local governments	resource & habitat protection	low	I, II, III, IV, VI
6	Develop new and build on existing relationships with Land Trusts purchasing lands and conservation easements	resource & habitat protection	low	I, II, III, IV, VI
7	Site new recreational facilities such as golf courses and ball fields on already disturbed land	resource & habitat protection	low	VI-B
II	**LAND/WATER MANAGEMENT**		med	
1	Identify, investigate, and conduct research on the causes of habitat loss or impairment and develop strategies to minimize further habitat loss	habitat & natural process restoration	med	I, II, III, IV, VI, VII-C
2	Develop a list and prioritize research needs associated with habitat loss or impairment	habitat & natural process restoration	med	I, II, III, IV, VI, VII-C
3	Design and implement surveys to determine the status and distribution of wildlife species associated with oak savanna habitats - evaluate the success of habitat restoration, enhancement, and management measures being implemented	habitat & natural process restoration	med	VII-G,H
4	Continue to research habitat requirements for the suite of wildlife associated with oak savanna habitats	habitat & natural process restoration	med	VII-G,H
5	Conduct research on the elements and complexity of the symbiotic relationship among wildlife species associated with oak savannas	habitat & natural process restoration	med	VII-H
6	Assemble and/or develop GIS-based data layers and associated tables of oak savanna habitats, including publicly-owned or conservation-minded NGO managed lands, and make it available for public-land managers and conservation-minded NGOs	habitat & natural process restoration	med	VII-G
7	Develop a comprehensive baseline inventory of historic versus current distribution and abundance of oak savanna habitats	habitat & natural process restoration	med	VII-G
8	Identify, design, and conduct appropriate habitat-based projects to evaluate the quality, quantity, connectivity, and distribution of “undeveloped/natural” oak savanna habitat	habitat & natural process restoration	med	VII-G
9	Collect and evaluate data from legitimate citizen scientist-based monitoring surveys, such as the Ohio Lepidopterist Society’s Long-term Butterfly Monitoring Program, the Breeding Bird Survey, and the Frog and Toad Call Survey, through 2020	habitat & natural process restoration	med	VII-D,H
10	Prevent introduction and control the spread of harmful species through legislation, regulation, policy, management practices, education, and partnerships	invasive/ problematic species control	med	VIII

11	Implement strategies identified in the Wildlife Stewardship Tactical Plan to avoid, minimize or eliminate the adverse impacts of non-native and/or problematic species in oak savanna habitats	invasive/ problematic species control	med	VIII
12	Establish an early-detection rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	med	VIII
13	Implement strategies identified in the Wildlife Stewardship Tactical Plan to avoid, minimize or eradicate diseases in wildlife associated with island habitats	invasive/ problematic species control	med	VIII-C
14	Identify ecosystem or population-level threats through research, surveillance, monitoring, and inventory	habitat & natural process restoration	med	I, II, III, IV, V, VI, VII-H, VIII, IX, XI
15	Develop compatible recreational activities criteria that can be used to evaluate impacts to habitat/species from recreational activities	habitat & natural process restoration	med	VI
16	Identify, protect, restore, and enhance 100 acres of oak savanna habitat that will support viable populations of the wildlife species dependent upon this habitat on public and private lands by 2020	site/area management	low	I, II, III, IV, V, VI, VII-B,C, VIII, IX
17	Identify and implement strategies to minimize the effects of residential development adjacent to existing protected/preserved unique habitats by 2020 beginning in the Oak Openings region	site/area management	low	I, IV, VI, VII-C
18	Identify and prioritize corridors to connect fragmented parcels of unique habitat to allow for wildlife movement between areas beginning in the Oak Savanna Conservation Opportunity Area	site/area management	low	I, II, VII-E,G
19	Contact local government agencies within the Oak Openings Region to encourage them to stop spraying insecticides that adversely impact the lepidopteran and amphibians associated with oak savanna habitat	site/area management	low	VII-B
III	**SPECIES MANAGEMENT**		med	
1	Reintroduce and restore oak savanna species where appropriate	species reintroduction	med	I, II, VII-C
2	Develop species-specific conservation plans as needs are identified to clearly define the actions the Division will/or will not implement concerning the state-listed species	species management	med	VII-H
3	By 2016, develop and implement recovery/conservation plans for the state-listed species dependent upon oak savanna habitats starting with the blue-spotted salamander and endangered butterflies	species recovery	med	VII-H
4	Continue reintroduction and monitoring efforts for the Karner blue butterfly until viable, self-sustaining populations have been restored or through 2020	species reintroduction	med	VII-H
5	Identify, design, and conduct appropriate species-specific surveys, inventories, or monitoring projects to determine species distribution and abundance	species management	med	VII-G,H
6	Develop a feral hog management plan designed to minimize introductions and control expansion	species management	med	VIII-B

IV	**EDUCATION AND AWARENESS**		low	
1	Promote the value of oak savanna habitat/species conservation by developing and distributing new publications, educational materials, website information, and digital presentations	awareness & communications	low	I, II, III, IV, V, VI, VII-C
2	Provide technical assistance to private landowners who wish to protect, restore and/or enhance oak savanna habitats	awareness & communications	low	VII-E
3	Provide guidance to landowners for eradication/control of invasive and nuisance species	awareness & communications	low	VII-E, VIII
4	Provide technical assistance to public land managers and NGOs to ensure island habitats under their management continue to be protected, restored and/or enhanced	awareness & communications	low	VII-D,E
5	Continue to educate and inform the public and other agency personnel on the importance and necessity for prescribed burning as a safe and effective tool for oak savanna habitat management	awareness & communications	low	VII-A,E
6	Provide technical assistance to public and private landowners concerning the use of prescribed burning as a safe and effective management tool	awareness & communications	low	VII-A,E
7	Support efforts to identify, develop, and distribute appropriate informational and educational materials concerning the value of prescribed burning as a safe and effective tool for oak savanna habitat management to local residents, grassroots conservation groups, and local government agencies	awareness & communications	low	VII-A,D,E
8	Maintain a corps of Division of Wildlife-trained partners and volunteers to assist, lead, and promote special programs	training	low	V, VI, VII-D
9	Utilize the Ohio Wildlife Legacy Stamp as a tool to illustrate the value of Ohioans in wildlife conservation and to convey the connection between wildlife, people, and habitat	awareness & communications	low	V, VI, VII-E
10	Educate the public about the negative effects of exotic and nuisance animals – encourage responsible disposal of unwanted animals	awareness & communications	low	VIII
V	**LAW AND POLICY**		low	
1	Balance the needs of fish and wildlife with the needs of people by mitigating incompatible ecosystem uses	policies & regulations	low	I, II, III, IV, V, VI
2	Participate in the policy-making process at Federal level to influence conservation programs	policies & regulations	low	VII-E,F
3	Encourage the preservation of habitat connectivity in all land use planning	policies & regulations private sector standards & codes	low med	I, IV
4	Create incentives (laws, policies) to prevent loss and/or minimize impacts to oak savanna habitat due to development	policies & regulations	low	I, II, IV
5	Support legislation promoting eco-friendly energy development and use	legislation policies & regulations	low low	III

6	Develop regulations to deter introduction of invasive/nuisance species	legislation policies & regulations	low low	VIII
7	Develop and implement a risk-assessment system in the approval process for importing or moving live animals and plants	legislation policies & regulations	low low	VIII
VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		low	
1	Support incentives that encourage landowners to maintain/preserve existing oak savanna habitat on their properties	market forces conservation payments non-monetary values	low low low	I, VII-E
2	Support the creation of incentives for the protection and restoration of oak savanna habitat	linked enterprises & livelihood alternatives substitution market forces conservation payments non-monetary values	low low low low low	I, II, III, IV, VII-E
3	Support creation of incentives to incorporate wildlife habitat into recreational facilities such as parks and golf courses	market forces conservation payments non-monetary values	low low low	VI-B
4	Develop incentives for private landowners to eradicate/control invasive plant species	conservation payments non-monetary values	low low	VII-E, VIII
5	Engage in research to understand social and economic influences on landowner decisions to participate in habitat programs, and use information to influence where and how programs are marketed	conservation payments non-monetary values	low low	VII-E
VII	**EXTERNAL CAPACITY BUILDING**		med	
1	Actively promote and engage in partnerships to conserve and enhance oak savanna habitats and the species dependent upon them	alliance & partnership development	med	I, II, VII-D
2	Support legitimate citizen scientist-based monitoring efforts of wildlife species and habitats	institutional & civil society development	med	VII-D,G,H

3	Develop new and strengthen existing partnerships with Land Trust organizations working in the Oak Openings region	alliance & partnership development	med	VII-D
4	Create a multiagency invasive species prevention and control group that would be responsible for all invasive species issues	alliance & partnership development	med	VIII
5	Support partner organizations utilizing prescribed burning and other techniques to restore and enhance oak savannas	alliance & partnership development	med	VII-A,D
6	Become an active participant in the Green Ribbon Initiative in the Oak Openings region	alliance & partnership development	med	VII-D
7	Through interagency coordination, work to assure that wildlife interests are taken into consideration in road, bridge, causeway, and utilities design, construction, and maintenance	alliance & partnership development	med	IV
8	Beginning in the Toledo area, identify local planners and initiate dialogue promoting the value of oak savanna habitat conservation in local planning and zoning decisions	alliance & partnership development	med	I, II, III, IV

*refers to the Oak Savanna Habitat Conservation Threats in Table 27

6.10 Boreal Community Habitat

Ohio Boreal Community Habitat

6.10.1 Status

The extensive boreal forest which extends from Alaska through Canada and into the northeast United States was never a dominant habitat type in Ohio. What boreal community did occur in Ohio was restricted to the northeast part of the state. Extensive logging that occurred from the time of settlement through the early part of the 20th century reduced the amount of boreal habitat in Ohio. Boreal habitat remaining today faces additional threats from the population density and accompanying development in this part of the state.

6.10.2 Description

Boreal communities are peatlands (e.g., hemlock-hardwood swamps and other boggy swamps, bogs, and fens) generally thought of as areas which occur in northern regions of the United States and Canada. However, both boreal flora and fauna occur in the snowbelt region of extreme Northeastern Ohio. The Boreal Community Area (Figure 20) includes portions of Ashtabula County, the eastern 1/3 of Geauga County, and the northern 1/3 of Trumbull County where the average annual snowfall exceeds 60 inches.

Boreal communities once covered thousands of acres in the snowbelt region, but since European settlement, these lands have been drained or flooded. Many existing boreal communities are degraded by human impacts and invasive species. Hemlock swamps are very rare in Ohio, occurring only in the snowbelt region. Bogs and fens are not limited to this region, however numerous boreal species only occur or have been reported to occur in this region's bogs and fens. Some of the region's best examples of boreal communities (e.g., the Pymatuning Bog in Eastern Andover Township, Ashtabula County) existed into the 1930s but were drained and burned for conversion to agricultural fields, pastures, and other land uses. Based on field surveys conducted through 2009, roughly a few dozen examples of boreal communities still exist in the region. These remaining boreal communities are threatened by an increasing abundance of invasive species and incompatible land uses.

Approximately 43% of the state's human population resides in northeastern Ohio. Losses of boreal habitat can be attributed primarily to agriculture, but also to recreation, water level changes, mining, and development. Many boreal areas have been destroyed, fragmented, and isolated as a result of commercial, industrial, and residential development. As a result of wetland regulations, active non-profit conservation organizations, and state agencies – a number of boreal communities have been protected, and opportunities exist to conserve additional areas. All remaining quality boreal communities should be protected and managed for the wildlife dependent upon them.

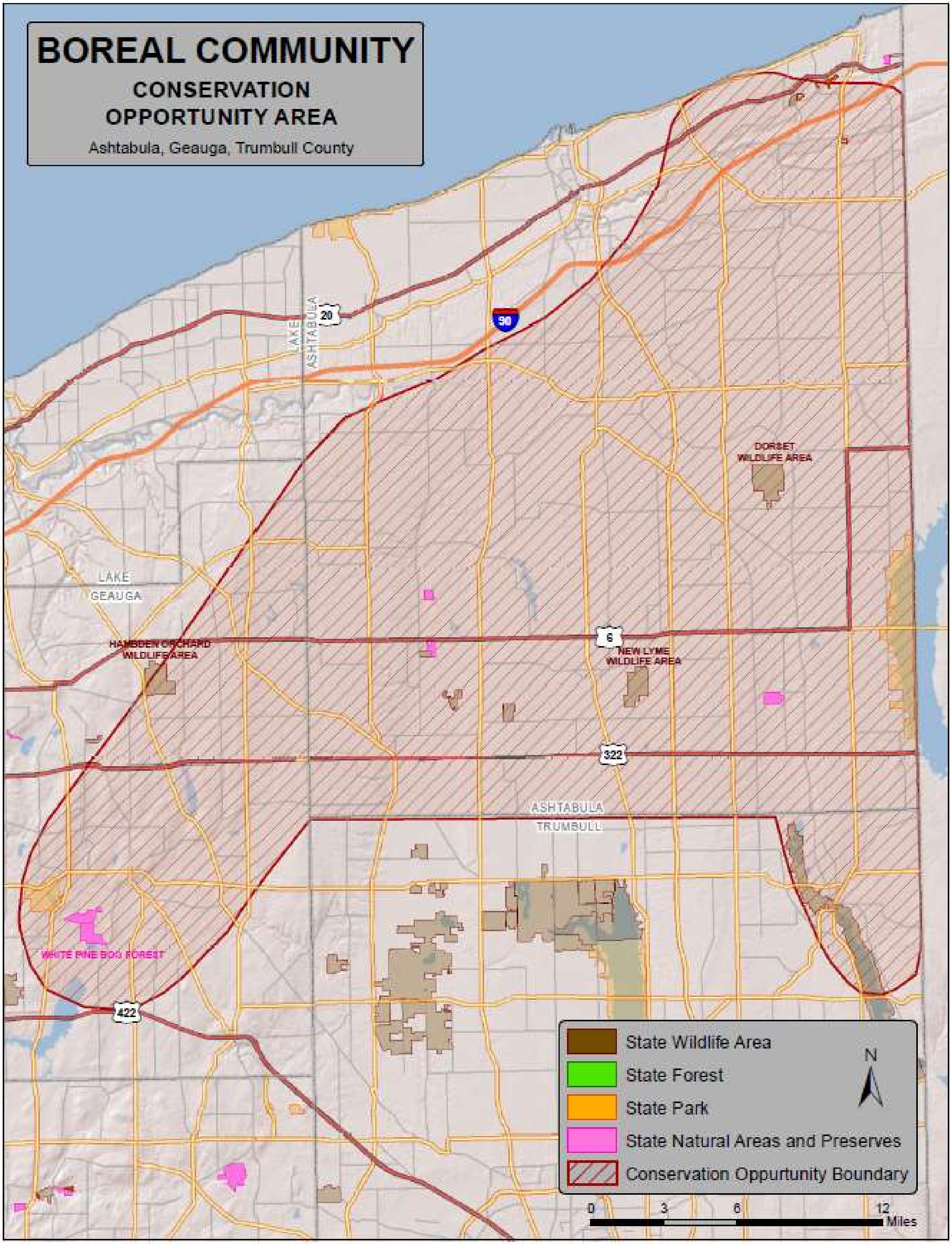


Figure 20. Boreal Community Conservation Opportunity Area.

6.10.3 Associated Species of Greatest Conservation Need

Four boreal-dependent wildlife species have been extirpated (fisher, lynx, porcupine, and snowshoe hare). The fisher and lynx probably were never common in Ohio and it is not likely that restoration efforts for either of these species would be successful. The porcupine, which was extirpated by 1900, was once common in extreme northeastern and northwestern Ohio. Since 2005, public observations of porcupines have increased in northeastern and eastern Ohio. A survey to determine the status of porcupines in the state would be appropriate. Snowshoe hares were extirpated from Ohio by 1940 but have been reintroduced starting in 2000 in eastern Geauga County. Repatriation of the snowshoe hare began in January 2000. This species is capable of breeding within a very limited range in Ohio, which is at the southern fringe of a large contiguous range with an abundant population. During 2000-2007, more than 740 hares were translocated from Michigan and Maine to northeastern Geauga and southwestern Ashtabula counties. This was a collaborative effort with the OSU School of Natural Resources. Data collected via annual track-count transects (2000-2013) suggested that repatriation efforts were unsuccessful. We presume that many of the more suitable forest tracts have matured beyond the ideal successional stage for hare populations in Ohio. The Ohio Division of Wildlife has no current plans to revive translocation efforts and habitat conditions in Ohio are such that feasible management actions are unlikely to result in significant population increases. Designated as state-listed Species of Concern, little is known about the current distribution and abundance of the ermine, southern red-backed vole, and woodland jumping mouse. Surveys need to be initiated to assess their status and distribution.

The following species have been identified as Boreal Community species of greatest conservation need (conservation status rank in parentheses):

<u>Amphibians</u>
Four-toed Salamander (11) — *Hemidactylium scutatum*

<u>Mammals</u>
Southern Red-backed Vole (13) — *Myodes gapperi*
Ermine (16) — *Mustela ermine*
Woodland Jumping Mouse (22) — *Napaeozapus insignis*

<u>Reptiles</u>
Spotted Turtle (4) — *Clemmys guttata*

<u>Terrestrial Invertebrates</u>
Mitchell's Satyr (1) — *Neonympha mitchellii*

Table 29. CONSERVATION THREATS TO BOREAL COMMUNITY HABITAT.
The following threats negatively impact or have the potential to negatively impact Boreal Community habitat. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		medium
A	Habitat destruction, fragmentation, altered hydrology from commercial development	commercial & industrial areas	low
B	Habitat destruction, fragmentation, altered hydrology from urban/suburban development	housing & urban areas	high
C	The market value of undeveloped land in the Boreal Community region is exceptionally high, making land acquisition for protection purposes problematic	commercial & industrial areas housing & urban areas	low high
II	**agriculture and aquaculture**		low
A	Loss of Boreal habitat because of conversion to	annual & perennial	low

	agriculture	non-timber crops	
		wood & pulp plantations	low
		livestock farming & ranching	low

B	Loss of Boreal habitat due to increase in intensity of agricultural practices – conversion of imbedded boreal habitat	annual & perennial non-timber crops	low
III	**energy production and mining**		low
A	Mining, oil and gas extraction - can directly damage and destroy habitat, and indirectly have negative impacts by altering hydrology and causing chemical contamination	oil & gas drilling mining & quarrying	medium low
IV	**transportation and service corridors**		medium
A	Roads and utilities can destroy and fragment Boreal habitat, and alter hydrology	roads & railroads utility & service lines	medium medium
V	**biological resource use**		low
A	Logging and timber harvest can destroy/damage habitat	logging & wood harvesting	low
VI	**human intrusions and disturbance**		low
A	Incompatible recreational activities	recreational activities	low
B	Creation of recreational facilities can alter/destroy island habitat	recreational activities	low
VII	**natural system modifications**		low
A	The use of chemical controls for the control/eradication of the gypsy moth and mosquitoes is known to negatively impact non-target lepidopteran and amphibians	other ecosystem modifications	low
B	Habitat destruction, fragmentation, altered hydrology due to proximity to development	other ecosystem modifications	low
C	Our ability to manage boreal habitat is limited by available staff and funding	other ecosystem modifications	low
D	Lack of boreal habitat inventory data, and a database system to analyze that data limits our ability to manage	other ecosystem modifications	low
E	Lack of boreal habitat associated species data limits our ability to manage for current threats and limits our ability to develop plans for impending issues like climate change	other ecosystem modifications	low
VIII	**invasive and other problematic species and genes**		high
A	Introduction and/or spread of invasive plants and animals	invasive non-native/alien species	very high
B	Introduction and/or spread of nuisance plants and animals	problematic native species	high
C	Introduction and spread of diseases (plants and animals)	invasive non-native/alien species problematic native species	very high high

IX	**pollution**		low
A	Urban effluent	household sewage & urban wastewater industrial & military effluents garbage & solid waste air-borne pollutants	low low low medium
B	Agriculture effluent	agricultural & forestry effluents	low
X	**geological events**		low
---	none	---	---
XI	**climate change and severe weather**		medium
A	Climate change could effect plant species composition, which in turn could affect wildlife species	habitat shifting & alteration droughts temperature extremes storms & flooding	high low low low

Table 30. CONSERVATION ACTIONS FOR BOREAL COMMUNITY HABITAT.
The following actions will help abate or have the potential to help abate threats to Boreal Community habitat. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	actions	2nd level action classification(s)	action priority rank	threat(s) addressed*
I	**LAND/WATER PROTECTION**		high	
1	Protect boreal community habitat through strategic acquisitions, easements, and partnerships	resource & habitat protection	high	I, II, III, IV, V, VI
2	Use State Wildlife Grant funds for potential acquisitions	resource & habitat protection	high	I, II, III, IV, V, VI
3	Establish permanent buffer areas around boreal community habitats to ensure their long-term viability	resource & habitat protection	high	I, II, III, IV, VI
4	Conserve and connect boreal habitats through acquisition, conservation easements, land donations, and other innovative strategies together with conservation-minded NGO partners and federal, state, and local governments	resource & habitat protection	high	I, II, III, IV, VI
5	Develop new and build on existing relationships with Land Trusts purchasing lands and conservation easements	resource & habitat protection	high	I, II, III, IV, VI
6	Add 100 acres of protected lands within the boreal community region through purchase or conservation easement by 2025	site/area protection	high	I, II, III, IV, VI, VII-B

7	Site new recreational facilities such as golf courses and ball fields on already disturbed land	resource & habitat protection	high	VI-B
II	**LAND/WATER MANAGEMENT**		high	
1	Identify, investigate, and conduct research on the causes of habitat loss or impairment and develop strategies to minimize further habitat loss	habitat & natural process restoration	high	I, II, III, IV, VI, VII-B
2	Develop a list and prioritize research needs associated with habitat loss or impairment	habitat & natural process restoration	high	I, II, III, IV, VI, VII-B
3	Identify and implement strategies to minimize the effects of residential development adjacent to existing protected/preserved unique habitats	habitat & natural process restoration	high	I, IV, VI, VII-B
4	Design and implement surveys to determine the status and distribution of wildlife species associated with boreal community habitats - evaluate the success of habitat restoration, enhancement, and management measures being implemented	habitat & natural process restoration	high	VII-D,E
5	Continue to research habitat requirements for the suite of wildlife associated with boreal habitats	habitat & natural process restoration	high	VII-D,E
6	Conduct research on the distribution and abundance of wildlife species associated with boreal communities	habitat & natural process restoration	high	VII-D,E
7	Assemble and/or develop GIS-based data layers and associated tables of boreal community habitats, including publicly-owned or conservation-minded NGO managed lands, and make it available for public-land managers and conservation-minded NGOs	habitat & natural process restoration	high	VII-D
8	Develop a comprehensive baseline inventory of historic versus current distribution and abundance of boreal community habitats	habitat & natural process restoration	high	VII-D
9	Identify, design, and conduct appropriate habitat-based projects to evaluate the quality, quantity, connectivity, and distribution of “undeveloped/natural” boreal community habitat	habitat & natural process restoration	high	VII-D
10	Identify and prioritize corridors to connect fragmented parcels of boreal habitat to allow for wildlife movement between areas	habitat & natural process restoration	high	I, II, VII-B,D
11	Collect and evaluate data from legitimate citizen scientist-based monitoring surveys such as the Ohio Breeding Bird Survey	habitat & natural process restoration	high	VII-C,D,E
12	Prevent introduction and control the spread of harmful species through legislation, regulation, policy, management practices, education, and partnerships	invasive/ problematic species control	high	VIII
13	Implement strategies identified in the Wildlife Stewardship Tactical Plan to avoid, minimize or eliminate the adverse impacts of non-native and/or problematic species in boreal community habitats	invasive/ problematic species control	high	VIII
14	Establish an early-detection rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	high	VIII

15	Implement strategies identified in the Wildlife Stewardship Tactical Plan to avoid, minimize or eradicate diseases in wildlife associated with boreal community habitats	invasive/ problematic species control	high	VIII-C
16	Identify ecosystem or population-level threats through research, surveillance, monitoring, and inventory	habitat & natural process restoration	high	I, II, III, IV, V, VI, VII-E, VIII, IX, XI
17	Develop compatible recreational activities criteria that can be used to evaluate impacts to habitat/species from recreational activities	habitat & natural process restoration	high	VI
18	Identify, protect, restore, and enhance 100 acres of boreal habitat that will support viable populations of the wildlife species dependent upon this habitat on public and private lands by 2016	site/area management	med	I, II, III, IV, VI, VII-A,B, VIII, IX
III	**SPECIES MANAGEMENT**		high	
1	Develop species-specific conservation plans as needs are identified to clearly define the actions the Division will/or will not implement concerning the state-listed species	species management	high	VII-E
2	Initiate surveys to determine the current distribution and abundance of the ermine, southern red-backed vole, and woodland jumping mouse	species management	high	VII-E
3	Identify, design, and conduct appropriate species-specific surveys, inventories, or monitoring projects to determine species distribution and abundance	species management	high	VII-E
4	Develop a feral hog management plan designed to minimize introductions and control expansion	species management	high	VIII-B
5	Reintroduce and restore boreal community species where appropriate	species reintroduction	low	I, II, VII-C
6	Continue reintroduction and monitoring efforts for the snowshoe hare until viable, self-sustaining populations have been restored or through 2020	species reintroduction	low	VII-E
IV	**EDUCATION AND AWARENESS**		med	
1	Maintain a corps of Division of Wildlife-trained partners and volunteers to assist, lead, and promote special programs	training	med	VII-B
2	Promote the value of oak savanna habitat/species conservation by developing and distributing new publications, educational materials, website information, and digital presentations	awareness & communications	low	I, II, III, IV, V, VI, VII-B
3	Provide technical assistance to private landowners who wish to protect, restore and/or enhance boreal habitats	awareness & communications	low	I, II
4	Provide guidance to landowners for eradication/control of invasive and nuisance species	awareness & communications	low	VIII
5	Provide technical assistance to public land managers and NGOs to ensure boreal habitats under their management continue to be protected, restored and/or enhanced	awareness & communications	low	VII-B
6	Utilize the Ohio Wildlife Legacy Stamp as a tool to illustrate the value of Ohioans in wildlife conservation and to convey the connection between wildlife, people, and habitat	awareness & communications	low	VI, VII-B

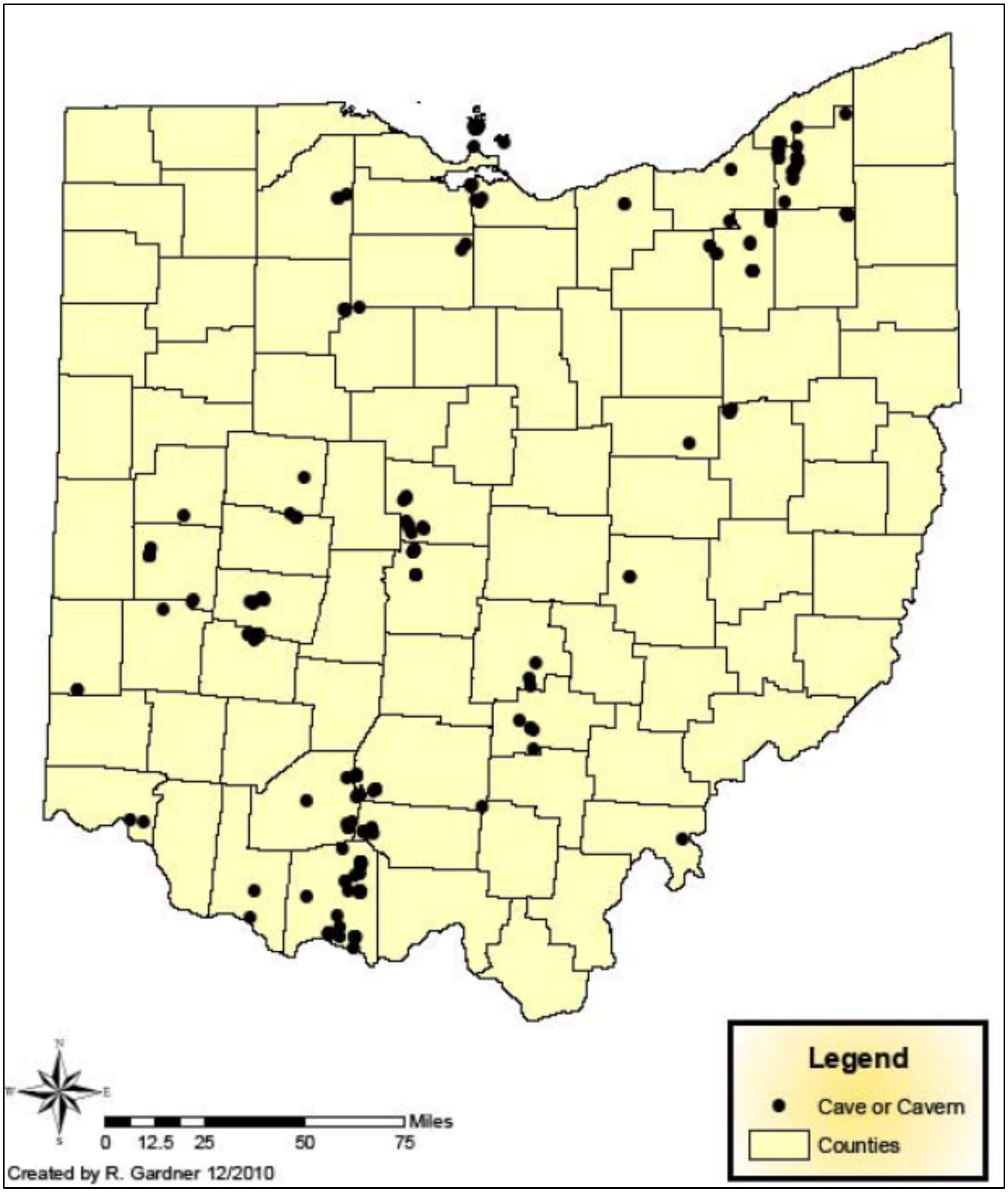
7	Educate the public about the negative effects of exotic and nuisance animals – encourage responsible disposal of unwanted animals	awareness & communications	low	VIII
V	**LAW AND POLICY**		med	
1	Balance the needs of fish and wildlife with the needs of people by mitigating incompatible ecosystem uses	policies & regulations	med	I, II, III, IV, V, VI
2	Participate in the policy-making process at Federal level to influence conservation programs	policies & regulations	med	I, II, III, IV
3	Encourage the preservation of habitat connectivity in all land use planning	policies & regulations private sector standards & codes	med med	I, IV
4	Create incentives (laws, policies) to prevent loss and/or minimize impacts to boreal habitat due to development	policies & regulations	med	I, II, III, IV
5	Support legislation promoting eco-friendly energy development and use	legislation policies & regulations	low med	III
6	Develop regulations to deter introduction of invasive/nuisance species	legislation policies & regulations	low med	VIII
7	Develop and implement a risk-assessment system in the approval process for importing or moving live animals and plants	legislation policies & regulations	low med	VIII
VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		med	
1	Support the creation of incentives for the protection and restoration of boreal community habitat	linked enterprises & livelihood alternatives substitution market forces conservation payments non-monetary values	high low low high low	I, II, III, IV
2	Develop incentives for private landowners to eradicate/control invasive plant species	conservation payments non-monetary values	high low	VIII

3	Support incentives that encourage landowners to maintain/preserve existing boreal habitat on their properties	market forces conservation payments non-monetary values	low high low	I
4	Support creation of incentives to incorporate wildlife habitat into recreational facilities such as parks and golf courses	market forces conservation payments non-monetary values	low high low	VI-B
VII	**EXTERNAL CAPACITY BUILDING**		high	
1	Actively promote and engage in partnerships to conserve and enhance boreal community habitats and the species dependent upon them	alliance & partnership development	high	I, II, VII-C
2	Create a multiagency invasive species prevention and control group that would be responsible for all invasive species issues	alliance & partnership development	high	VIII
3	Work with partners in northeast Ohio to restore and/or enhance hydrologic regime of boreal communities	alliance & partnership development	high	VII-C
4	Through interagency coordination, work to assure that wildlife interests are taken into consideration in road, bridge, causeway, and utilities design, construction, and maintenance	alliance & partnership development	high	IV
5	Support legitimate citizen scientist-based monitoring efforts of wildlife species and habitats	institutional & civil society development	med	VII-C
6	Develop new and strengthen existing partnerships with Land Trust organizations working in Boreal Communities	institutional & civil society development	med	VII-C

*refers to the Boreal Community Habitat Conservation Threats in Table 29

6.11 Caves & Mines Habitat

Ohio Cave locations



6.11.1 Status
In 2007 the ODNR Division of Natural Areas, in partnership with Wittenberg University, initiated a multi-year survey of Ohio's cave resources. In total, the cave survey identified 400 caves – 211 in carbonate bedrock and 189 in non-carbonate bedrock. Caves that have formed in limestone and dolomite bedrock are located in western Ohio. Non-carbonate caves, including rock shelters and recesses, are the common cave type in eastern Ohio. Although Ohio's caves may be few in number and relatively small compared to other states, they are fragile ecosystems that have important geological (unique rock formations), biological (important habitats), and archaeological values (native American culture).

6.11.2 Description
Approximately 300 caves span Ohio in a 40-mile-wide track of land aligned north-south from the Lake Erie islands to Adams County. A 3-year survey of the plant and animal species associated with Ohio caves was initiated in 2007 by the Division of Natural Areas and Preserves and gathered considerable data. In addition to naturally formed caves, there are 4,000+ recorded inactive underground mines resulting from mineral extraction. Of the 4,000+ recorded mines, less than 20% are believed to have external entrances which are still open. Both natural caves and man-made mines provide critical habitat for wildlife. The features common to most caves include total darkness, relative permanence (in contrast to more ephemeral environments like a forest), and relatively constant environmental conditions (temperature, humidity, air flow). Two equally important features are caves' long history of isolation and their individuality.

To secure populations of most of the cave-dependent wildlife, it is estimated that a minimum of 25% of all caves or quality mines should be protected. This can be accomplished by installing bat-friendly gates in all high quality mine entries and conserving natural buffer zones (a minimum of 200 acres) around cave or mine entries known to support hibernating bats.

Human disturbance including but not limited to recreational vehicle use, caving, commercialization, and vandalism pose a serious threat to unique habitat-dependent wildlife. Sealing and improper gating reduces or eliminates the availability of mines to wildlife. Properly designed and installed gating can provide secure environments for cave-dependent wildlife, while eliminating human disturbance. Opportunities may exist to provide quality hibernacula for Indiana bats by enhancing internal features of man-made mines to simulate the humidity, airflow, and micro-habitat required by these bats. The feasibility of enhancing these mine features needs to be researched. Additional surveys and research are needed to adequately assess the population status of cave dwelling bat species. The impacts of White-nose Syndrome must be assessed and monitored. All Ohio bats are insectivores and are known to feed over a variety of habitats including riparian corridors, forests, grasslands, and agricultural fields. In addition to protecting caves and mines, adjacent lands must be conserved to ensure adequate amounts of quality foraging habitat exist near cave entrances.

6.11.3 Associated Species of Greatest Conservation Need
The 2007 Division of Natural Areas survey placed special emphasis on the identification of all living organisms found within each cave. Typical cave fauna discovered include types of planaria, spiders, isopods, beetles, pseudoscorpions, and bats. In total, 261 species of invertebrates and invertebrates were found to utilize Ohio's caves. Twenty of these species are considered obligate cavernicoles – meaning they are entirely dependent upon the cave environment.

The following species have been identified as Caves and Mines species of greatest conservation need (conservation status rank in parentheses):

<u>Amphibians</u>

Cave Salamander (15)	*Eurycea lucifuga*

<u>Terrestrial Invertebrates</u>

Ohio Cave Beetle (n/r)	*Pseudanophthalmus ohioensis*

Mammals

Eastern Small-footed Bat (1)	*Myotis subulatus leibii*
Northern Long-eared Bat (2)	*Myotis septentrionalis*
Rafinesque's Big-eared Bat (3)	*Corynorhinus rafinesquii*
Indiana Bat (7)	*Myotis sodalis*
Tri-colored Bat (7)	*Perimyotis subflavus*
Little Brown Bat (14)	*Myotis lucifugus*
Big Brown Bat (14)	*Eptesicus fuscus*
Allegheny Woodrat (24)	*Neotoma magister*

Table 31. CONSERVATION THREATS TO CAVES AND MINES HABITAT.
The following threats negatively impact or have the potential to negatively impact Caves and Mines habitat. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		medium
---	none	---	---
II	**agriculture and aquaculture**		negligible
---	none	---	---
III	**energy production and mining**		medium
A	Mining, oil and gas extraction - can directly damage and destroy habitat, and indirectly have negative impacts by altering hydrology and causing chemical contamination	oil & gas drilling mining & quarrying	low high
IV	**transportation and service corridors**		low
---	none	---	---
V	**biological resource use**		low
---	none	---	---
VI	**human intrusions and disturbance**		medium
A	Incompatible recreational activities	recreational activities	medium
B	The spread of pathogens from cave to cave by humans could seriously impact cave-dependent wildlife	recreational activities work & other activities	medium low
C	Disturbance of bat hibernacula	recreational activities work & other activities	medium low
VII	**natural system modifications**		medium
A	Sealing and improper gating mine entrances eliminates or reduces the availability of underground mines to wildlife	other ecosystem modifications	medium
B	Disturbance of foraging habitat near cave entrances can compromise bats' ability to store adequate fat reserves prior to entering a hibernaculum, and to find food upon spring emergence	other ecosystem modifications	medium
C	Our ability to manage cave and mine habitat is limited by available staff and funding	other ecosystem modifications	medium
D	Lack of cave and mine inventory data, and a database to analyze that data limits our ability to manage	other ecosystem modifications	medium
E	Lack of cave and mine associated species data limits our ability to manage for current threats and limits our ability to develop plans for impending issues like climate change	other ecosystem modifications	medium

VIII	**invasive and other problematic species and genes**		medium
A	Introduction and/or spread of invasive plants and animals	invasive non-native/alien species	high
B	Introduction and/or spread of nuisance plants and animals	problematic native species	medium
C	Introduction and spread of diseases (especially white-nose syndrome)	invasive non-native/alien species problematic native species	high medium
IX	**pollution**		low
A	Most caves have not been mapped and their connectivity to the surface remains unclear. As a result the potential for cave degradation from non-point source pollution is unknown but likely to occur	household sewage & urban wastewater industrial & military effluents agricultural & forestry effluents	negligible high low
X	**geological events**		low
---	none	---	---
XI	**climate change and severe weather**		negligible
---	none	---	---

Table 32. CONSERVATION ACTIONS FOR CAVES AND MINES HABITAT.
The following actions will help abate or have the potential to help abate threats to Caves and Mines habitat. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	**actions**	**2nd level action classification(s)**	**action priority rank**	**threat(s) addressed***
I	**LAND/WATER PROTECTION**		high	
1	Protect cave and mine habitat through strategic acquisitions, easements, and partnerships	resource & habitat protection	high	III, VI, VII, VIII, IX
2	Use State Wildlife Grant funds for potential acquisitions	resource & habitat protection	high	III, VI, VII, VIII, IX
3	Establish permanent buffer areas around cave and mine habitats to ensure their long-term viability	resource & habitat protection	high	III, VI, VII, VIII, IX
4	Develop new and build on existing relationships with Land Trusts purchasing lands and conservation easements	resource & habitat protection	high	III, VI, VII, VIII, IX
II	**LAND/WATER MANAGEMENT**		high	
1	Identify, investigate, and conduct research on the causes of habitat loss or impairment and develop strategies to minimize further habitat loss	habitat & natural process restoration	high	III, VI, VII-B
2	Develop a list and prioritize research needs associated with habitat loss or impairment	habitat & natural process restoration	high	III, VI, VII-B

3	Identify and implement strategies to minimize the effects of residential development adjacent to existing protected/preserved habitats	habitat & natural process restoration	high	VI, VII-B
4	Design and implement surveys to determine the status and distribution of wildlife species associated with mine and cave habitats - evaluate the success of habitat restoration, enhancement, and management measures being implemented	habitat & natural process restoration	high	VII-D,E
5	Continue to research habitat requirements for the suite of wildlife associated with cave and mine habitats	habitat & natural process restoration	high	VII-D,E
6	Conduct research on the distribution and abundance of wildlife species associated with cave and mine habitats	habitat & natural process restoration	high	VII-D,E
7	Develop and implement recovery/conservation plans for the state-listed species dependent upon cave and mine habitats	habitat & natural process restoration	high	VII-E
8	Assemble and/or develop GIS-based data layers and associated tables of cave and mine habitats, including publicly-owned or conservation-minded NGO managed lands, and make it available for public-land managers and conservation-minded NGOs	habitat & natural process restoration	high	VII-D
9	Develop a comprehensive baseline inventory of historic versus current distribution and abundance of cave and mine habitats	habitat & natural process restoration	high	VII-D
10	Continue locating and protecting, with bat-friendly gates, mines and caves serving as hibernation sites for Indiana Myotis and other species	habitat & natural process restoration	high	VI
11	Support the mapping of caves, as feasible, to ensure their conservation and the long-term viability of cave-dependent wildlife	habitat & natural process restoration	high	VII-D
12	Evaluate the feasibility of creating suitable hibernacula zones for Indiana myotis by enhancing internal features of the Preble Mine in areas of the mine currently unoccupied by bats by 2016	site/area management	high	VI
13	Continue biannual surveys of all bat species in the Preble County underground mine to assess population size and evaluate health and condition	site/area management	high	VI
14	Prevent introduction and control the spread of harmful species through legislation, regulation, policy, management practices, education, and partnerships	invasive/ problematic species control	high	VIII
15	Implement strategies identified in the Wildlife Stewardship Tactical Plan to avoid, minimize or eliminate the adverse impacts of non-native and/or problematic species in cave and mine habitats	invasive/ problematic species control	high	VIII
16	Establish an early-detection rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	high	VIII
17	Implement strategies identified in the Wildlife Stewardship Tactical Plan to avoid, minimize or eradicate diseases in wildlife associated with cave and mine habitats	invasive/ problematic species control	high	VI-B, VIII-C
18	Identify ecosystem or population-level threats through research, surveillance, monitoring, and inventory	habitat & natural process restoration	high	III, VI, VII, VII-E, VIII, IX

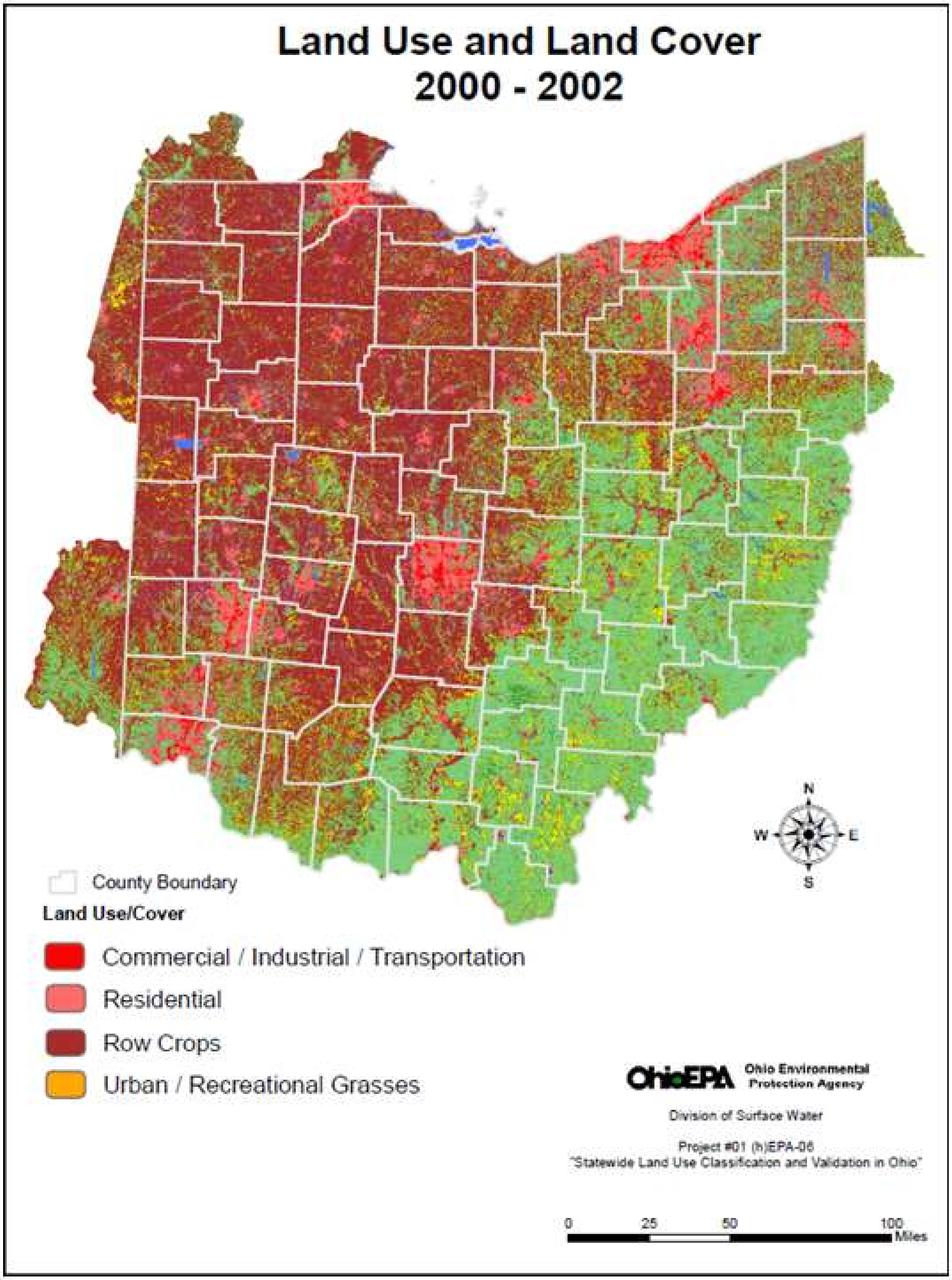
19	Develop compatible recreational activities criteria that can be used to evaluate impacts to habitat/species from recreational activities	habitat & natural process restoration	high	VI
III	**SPECIES MANAGEMENT**		med	
1	Develop species-specific conservation plans as needs are identified to clearly define the actions the Division will/or will not implement concerning the state-listed species	species management	low	VII-E
2	Annually revise and distribute the ODNR Indiana Bat Management Strategy	species management	low	VI, VII
3	Identify, design, and conduct appropriate species-specific surveys, inventories, or monitoring projects to determine species distribution and abundance	species management	low	VII-E
IV	**EDUCATION AND AWARENESS**		high	
1	Promote the value of cave and mine habitat/species conservation by developing and distributing new publications, educational materials, website information, and digital presentations	awareness & communications	high	VI, VII
2	Provide technical assistance to public land managers and NGOs to ensure cave and mine habitats under their management continue to be protected, restored and/or enhanced	awareness & communications	high	VII-C
3	Maintain a corps of Division of Wildlife-trained partners and volunteers to assist, lead, and promote special programs	training	high	VII-C
4	Utilize the Ohio Wildlife Legacy Stamp as a tool to illustrate the value of Ohioans in wildlife conservation and to convey the connection between wildlife, people, and habitat	awareness & communications	high	VI, VII
V	**LAW AND POLICY**		med	
1	Support legislation promoting eco-friendly energy development and use	legislation policies & regulations	high med	III, IX
2	Develop regulations to deter introduction of invasive/nuisance species	legislation policies & regulations	high med	VIII
3	Balance the needs of fish and wildlife with the needs of people by mitigating incompatible ecosystem uses	policies & regulations	med	III, VI, VII
4	Participate in the policy-making process at Federal level to influence conservation programs	policies & regulations	med	III, IX
5	Create incentives (laws, policies) to prevent loss and/or minimize impacts to cave and mine habitat due to development	policies & regulations	med	VII-B

VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		med	
1	Support incentives that encourage landowners to maintain/preserve existing cave and mine habitat on their properties	market forces conservation payments non-monetary values	med high high	VII-C
VII	**EXTERNAL CAPACITY BUILDING**		high	
1	Actively promote and engage in partnerships to conserve and enhance cave and mine habitats and the species dependent upon them	alliance & partnership development	high	VII-C
2	Meet routinely with state and federal agency personnel to ensure bat-friendly gating is used when sealing entries to abandoned underground mines with known or potential use by bats	alliance & partnership development	high	VI, VII-A
3	Support legitimate citizen scientist-based monitoring efforts of wildlife species and habitats	institutional & civil society development	high	VII-C,D,E

*refers to the Caves and Mines Habitat Conservation Threats in Table 31

6.12 Artificial/man-made Environments

Ohio Artificial/man-made Environments



6.12.1 Status

Ohio's population growth is currently relatively static, and urban areas seem to reflect this in terms of growth. As far as developed areas are concerned, suburban areas show the most growth. Residential neighborhoods, condominium complexes, townhouses/apartments, and the like are responsible for the majority of recent development. The number of acres in agriculture has decreased by about 10%, and the number of farms has decreased by about 13% in the last 30 years (USDA 2012). During this time, the number of farms under 1000 acres have decreased, while farms over 1000 acres have increased.

6.12.2 Description

Artificial/man-made Environments are primarily divided between areas of human development of varying intensity (urban a suburban areas) and agriculture. In both cases, natural habitats have been replaced artificial environments, and the species that occupied these natural habitats have been replaced by a substantially reduced assemblage of tolerant/adaptable species. These environments create an ecosystem of their own with altered hydrology, climate, plant and animal communities, and a host of other development-induced characteristics.

Urban/suburban environments are a complex mixture of above ground structures (buildings, bridges, towers, power lines & supports) and altered surfaces (roads, parking lots, lawns). Some of the artificial environments in this category offer significant opportunities for wildlife conservation. With proper planning, wildlife habitat can be included in parks, golf courses, airport properties, cemeteries, and residential areas. Areas of intense development (cities) offer fewer opportunities, but still have structures that can mimic natural habitats that are utilized by certain wildlife species (ex., peregrine falcons nesting on tall buildings, bats roosting in bridge expansion joints).

Agricultural lands convert diverse natural communities into large areas of relative monoculture. Large acreages may be planted in row crops (primarily corn and soybeans) or other field crops such as wheat and hay, or may exist as pastures, orchards, or vineyards. Available wildlife habitat often varies by season. At the peak of the growing season, structural complexity in agricultural fields is at its maximum, and food and shelter are readily available for a number of wildlife species adapted to such conditions. After harvest and through the winter months, available habitat is at a minimum and large expanses of land may offer little to wildlife species in terms of food or shelter. Applications of fertilizers, herbicides, and pesticides can have far reaching effects to agricultural land ecosystems, and the natural ecosystems that surround them. Opportunities to include wildlife habitat on agricultural lands are numerous and varied.

A third but much smaller category of artificial environments are man-made structures placed into aquatic habitats. Structures such as docks, piers, bridge supports, breakwaters, marinas, and rip-rapped shorelines often increase structural complexity in aquatic systems. By increasing complexity, these structures can actually add habitat, and there can be community benefits resulting from these artificial habitats in aquatic systems. However, many of these structures replace significant amounts of natural habitat, cause habitat degradation and affect water quality during their construction, and can result in changes to natural water and animal movements (dams).

6.12.3 Associated Species of Greatest Conservation Need

In an evolutionary sense, artificial environments have not existed long enough to have developed their own suite of associated species. Over time however, a number of terrestrial and aquatic species have demonstrated the ability to adapt very well to these environments. While none of these species would be considered to call artificial environments "home", many are able to make use of different aspects that these artificial habitats offer, and some spend their entire life (and have for generations) living in these artificial environments. Species such as deer, coyote, raccoon, opossum, groundhog, cardinals, and robins have developed urban/suburban populations. These species are able to find the necessary food and cover to survive/reproduce, and are highly tolerant of human activity.

In agricultural areas, a number of wildlife species live in or adjacent to crop fields, and utilize crops as a primary food source. Agricultural fields create edge habitat, and some species that require a patchwork of habitat types and the edge-effect they create have flourished in agricultural areas. Ohio's countryside today supports more whitetail deer than did the same land before settlers arrived. Grain fields can be important food stops for migrating birds and waterfowl. In general however, agricultural lands support a much less diverse species assemblage than the habitats they replaced, despite the fact that some well adapted species (deer) have prospered in these areas.

Species found in artificial environments are there because of their ability to adapt. Artificial environments are not “preferred habitat” for any wildlife species, and there are not species that are dependent upon artificial habitats for their survival. Opportunistic/adaptable species over time have simply taken advantage of an unoccupied niche that provides enough of life’s necessities for them to survive. Consequently, we do not feel that a list of species of greatest conservation need is appropriate for artificial man-made environments.

Table 33. CONSERVATION THREATS TO ARTIFICIAL/MAN-MADE ENVIRONMENTS.
The following threats negatively impact or have the potential to negatively impact Artificial/man-made Environments. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		very high
A	Loss of agricultural land to residential development	housing & urban areas	very high
B	Loss of agricultural land to commercial development	commercial & industrial areas	very high
II	**agriculture and aquaculture**		high
---	none	---	---
III	**energy production and mining**		high
A	Energy extraction, production, and mining can directly damage and destroy habitat, and indirectly have negative impacts by altering hydrology and causing chemical contamination	oil & gas drilling mining & quarrying renewable energy	high low medium
IV	**transportation and service corridors**		low
A	Roads and associated traffic in urban/suburban areas impact wildlife movement and cause mortality	roads & railroads	low
B	Power lines are a source of wildlife mortality	utility & service lines	low
V	**biological resource use**		low
---	none	---	---
VI	**human intrusions and disturbance**		low
A	Incompatible recreational activities	recreational activities	low
B	Human activities in urban/suburban areas	work & other activities	low
VII	**natural system modifications**		medium
A	Incompatible wildlife management strategies - managed to control/reduce wildlife species	other ecosystem modifications	medium
B	Agricultural lands are managed to focus on a particular crop, resulting in reduced habitat diversity	other ecosystem modifications	medium
C	Artificial environments cause altered hydrology, water quality, species composition/community structure	other ecosystem modifications	medium
D	Lack of artificial/man-made environment associated species data limits our ability to manage for current threats and limits our ability to develop plans for impending issues like climate change	other ecosystem modifications	medium
E	Our ability to manage artificial/man-made environments is limited by available staff and funding	other ecosystem modifications	medium

VIII	**invasive and other problematic species and genes**		medium
A	Introduction and/or spread of invasive plants and animals	invasive non-native/alien species	high
B	Introduction and/or spread of nuisance plants and animals	problematic native species	medium
C	Introduction and spread of diseases (plants and animals)	invasive non-native/alien species problematic native species	high medium
IX	**pollution**		low
A	Herbicides, pesticides, fertilizers, chemicals, solid waste, other toxic substances	household sewage & urban wastewater industrial & military effluents agricultural & forestry effluents garbage & solid waste air-borne pollutants	low low low low low
B	Light pollution in urban/suburban areas	excess energy	low
C	Noise pollution in urban/suburban areas	excess energy	low
X	**geological events**		negligible
---	none	---	---
XI	**climate change and severe weather**		high
A	Climate change could impact habitats, water quality, and species	habitat shifting & alteration droughts temperature extremes storms & flooding	high very high medium high

Table 34. CONSERVATION ACTIONS FOR ARTIFICIAL/MAN-MADE ENVIRONMENTS.
The following actions will help abate or have the potential to help abate threats to Artificial Man-made Environments. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	actions	2nd level action classification(s)	action priority rank	threat(s) addressed*
I	**LAND/WATER PROTECTION**		high	
1	Use acquisitions, conservation easements, etc. to protect key habitats/species	resource & habitat protection	high	IV, VI, VII-C, IX
2	Use State Wildlife Grant funds for acquisitions to protect important habitats that are interspersed in artificial man-made environments	resource & habitat protection	high	IV, VI, VII-C, IX
3	Create parks, open spaces, greenways	site/area protection	high	IV, VII-C, IX

4	Develop new and build on existing relationships with Land Trusts purchasing lands and conservation easements	resource & habitat protection	high	IV, VI, VII-C, IX
II	**LAND/WATER MANAGEMENT**		med	
1	Prevent introduction and control the spread of harmful species through legislation, regulation, policy, management practices, education, and partnerships	invasive/ problematic species control	med	VIII
2	Implement strategies identified in the Wildlife Stewardship Tactical Plan to avoid, minimize or eliminate the adverse impacts of non-native and/or problematic species in Artificial/man-made Environments	invasive/ problematic species control	med	VIII
3	Establish an early-detection rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	med	VIII
4	Implement strategies identified in the Wildlife Stewardship Tactical Plan to avoid, minimize or eradicate diseases in wildlife associated with artificial man-made environments	invasive/ problematic species control	med	VIII-C
5	Identify, investigate, and conduct research on the causes of habitat loss or impairment and develop strategies to minimize further habitat loss	habitat & natural process restoration	low	I, III, IV, VII-C
6	Develop a list and prioritize research needs associated with habitat loss or impairment	habitat & natural process restoration	low	I, III, IV, VII-C
7	Minimize effects of lighting, noise, activity on wildlife	habitat & natural process restoration	low	VI-B, IX-B,C
8	Design and implement surveys to determine the status and distribution of wildlife species associated with Artificial/man-made Environments - evaluate the success of habitat restoration, enhancement, and management measures being implemented	habitat & natural process restoration	low	VII-D
9	Continue to research habitat requirements for the suite of wildlife associated with Artificial/man-made Environments	habitat & natural process restoration	low	VII-D
10	Develop and implement recovery/conservation plans for the state-listed species that utilize Artificial/man-made Environments	habitat & natural process restoration	low	VII-D
11	Include wildlife/habitat in land use planning	habitat & natural process restoration	low	I, IV, VII-C, IX
12	Restore hydrology by removing obsolete water control structures	habitat & natural process restoration	low	VII-C
13	Identify ecosystem or population-level threats through research, surveillance, monitoring, and inventory	habitat & natural process restoration	low	I, III, IV, VI, VII, VIII, IX, XI
14	Develop compatible recreational activities criteria that can be used to evaluate impacts to habitat/species from recreational activities	habitat & natural process restoration	low	VI-A

III	**SPECIES MANAGEMENT**		med	
1	Develop species-specific conservation plans as needs are identified to clearly define the actions the Division will/or will not implement concerning the state-listed species	species management	med	VII-D
2	Identify, design, and conduct appropriate species-specific surveys, inventories, or monitoring projects to determine species distribution and abundance	species management	med	VII-D
IV	**EDUCATION AND AWARENESS**		high	
1	Educate landowners, homeowners, city maintenance personnel, etc. on the proper use of chemicals – pesticides, herbicides	awareness & communications	high	IX
2	Educate landowners, homeowners, maintenance personnel, etc. on identification and control of invasive and nuisance species	awareness & communications	high	VIII
3	Educate the public about the negative effects of exotic and nuisance animals – encourage responsible disposal of unwanted animals	awareness & communications	high	VIII
4	Educate planners, developers, homeowners, farmers, policy makers, etc. on ways to benefit wildlife/habitat	awareness & communications	high	I, III, IV, VI, VII, IX
5	Promote the value of habitat/species conservation by developing and distributing new publications, educational materials, website information, and digital presentations	awareness & communications	high	IV, VI, VII, VIII, IX
6	Utilize the Ohio Wildlife Legacy Stamp as a tool to illustrate the value of Ohioans in wildlife conservation and to convey the connection between wildlife, people, and habitat	awareness & communications	high	IV, VI, VII, VIII, IX
7	Maintain a corps of Division of Wildlife-trained partners and volunteers to assist, lead, and promote special programs	training	med	VII-E
V	**LAW AND POLICY**		high	
1	Balance the needs of fish and wildlife with the needs of people by mitigating incompatible ecosystem uses	policies & regulations	high	I, III, IV, VI, VII-B, C, IX
2	Participate in the policy-making process at Federal level to influence conservation programs	policies & regulations	high	I, III, IV, IX
3	Create incentives to prevent loss and/or minimize impacts to existing wildlife habitat	policies & regulations private sector standards & codes	high med	I, III, IV, VI, VII-B, C, IX
4	Develop regulations to deter introduction of invasive/nuisance species	legislation policies & regulations	high high	VIII
5	Develop and implement a risk-assessment system in the approval process for importing or moving live animals and plants	legislation policies & regulations	high high	VIII

VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		med	
1	Provide economic incentives for wildlife friendly development in urban/suburban areas	market forces conservation payments non-monetary values	med med med	I, IV, VI, VII-C, IX
2	Develop incentives for landowners to eradicate/control invasive plant species	conservation payments non-monetary values	med med	VIII
3	Promote land use practices that minimize the need for hardened shorelines	market forces conservation payments non-monetary values	med med med	VII-C
4	Provide incentives for habitat restoration in agricultural areas	linked enterprises & livelihood alternatives market forces conservation payments non-monetary values	low med med med	VII-B, IX
VII	**EXTERNAL CAPACITY BUILDING**		high	
1	Create a coalition of outdoor enthusiast groups (garden clubs etc) to volunteer for green projects in urban/suburban areas	institutional & civil society development	high	VII-E
2	Create a coalition of farmers and rural landowners interested in wildlife/habitat - and facilitate projects for them	institutional & civil society development	high	VII-B
3	Create a multiagency invasive species prevention and control group that would be responsible for all invasive species issues	alliance & partnership development	high	VIII
4	Through interagency coordination, work to assure that wildlife interests are taken into consideration in road, bridge, causeway, and utilities design, construction, and maintenance	alliance & partnership development	high	IV

*refers to the Artificial Man-made Environments Habitat Conservation Threats in Table 33

6.13 Lake Erie

Ohio waters of Lake Erie (Google maps)

6.13.1 Status

The current condition of Lake Erie is best described as stressed. Lake Erie is subjected to more stress from urbanization, industrialization, and agriculture than any other Great Lake. About one-third of the total population of the Great Lakes basin resides within the Lake Erie watershed. Not surprising given the fact that the Lake Erie basin supports the largest population, it surpasses all the other Great Lakes in the amount of effluent received from sewage treatment plants (Lake Erie LaMP 2000). Lake Erie is the Great Lake most subjected to sediment loading. Intensive agricultural development, particularly in southwest Ontario and northwest Ohio, contributes huge sediment loads to the lake. The Lake Erie Basin also receives the most phosphorus of any Great Lake, and 44 percent of the total for the entire Great Lakes (NRCS 2011). Invasive species have entered Lake Erie in numbers via the Welland Canal, ballast water from commercial shipping, and intentional introductions.

6.13.2 Description

The Lake Erie habitat category applies to the 2.3 million acres of Ohio waters in Lake Erie, the 312 miles of Ohio shoreline, and Ohio's Lake Erie tributaries up to the first impediment to fish passage. It should be noted that while Lake Erie tributaries are treated as a separate habitat category (see Lake Erie Tributaries in the next section), the line of separation between the Lake Erie and Lake Erie Tributaries habitat categories is a biological one, rather than a line on a map. Riffles and dams provide some measure of biological separation between systems, and align themselves with how these habitat categories are managed. The Ohio waters of Lake Erie account for about 90 percent of Ohio's water area by acres.

Lake Erie is the second smallest (by area) of the Great Lakes, smallest by volume, shallowest, and the most biologically productive. Multiple jurisdictions share the lake including the states of New York, Pennsylvania, Ohio, Michigan, and the Canadian Province of Ontario. Lake Erie is divided into three basins - the western basin is very shallow with an average depth of 24 ft., the central basin is deeper with the average depth of 60 ft., and the eastern basin is the deepest of the three with an average depth of 82 ft. Eighty percent of Lake Erie's total inflow comes from the Detroit River, and the Niagara River is the main outflow from the lake (Lake Erie LaMP 2000). The water volume of the western basin is approximately one-fifth of Lake Erie, but it drains about 65 percent of the Lake Erie watershed (Ohio EPA 2010c). Unlike the central and eastern basins, the western basin rarely thermally stratifies (Lake Erie LaMP 2011).

Lake Erie has undergone significant physical, chemical, and biological changes over time. These changes have primarily been a result of human influence on the lake itself, and in the basin. Overfishing, pollution, and habitat destruction began to take a toll in the late 1800s. Lake Erie was the first of the Great Lakes to experience problems with eutrophication. Its shallow basin made it the warmest and most biologically productive of the Great Lakes, however by the 1950's nutrient inputs finally pushed the trophic status of the lake to the point where algal blooms and turbidity reduced water quality and impacted aquatic species (Lake Erie LaMP 2000).

The Clean Water Act of 1972 started Lake Erie on the road to recovery relative to nutrient inputs, and by the 1990s the lake had essentially achieved the phosphorus levels established under the Great Lakes Water Quality Agreement as those needed to eliminate the effects of eutrophication. However, the models used to determine the maximum allowable annual phosphorus load did not account for the influence of such a major ecosystem disrupter as the zebra mussel. Attempting to manage the lake system by simply managing phosphorus inputs appears no longer workable, at least until more is understood about the internal dynamics of phosphorus cycling in the lake (Lake Erie LaMP 2000).

Recent summers on Lake Erie have been characterized by blue-green algal blooms similar to those seen in the 1960's. Water quality data shows increases in total, particulate, and dissolved reactive phosphorous loading since the mid 1990's. The summers of 2010 and 2011 brought massive algal blooms to Lake Erie. The Ohio Lake Erie Phosphorus Task Force concluded that while there are multiple contributors of phosphorus into Lake Erie, agriculture is the leading source due to the majority of the land use in agriculture (about 80%) in the Maumee River watershed (Ohio Lake Erie Phosphorus Task Force II Final Report 2013). Phosphorus delivered to rivers and streams in the Lake Erie Basin from cultivated cropland represented 61% of the total phosphorus load from all sources. Because of its location, high discharges, and high loads and concentrations of total and dissolved phosphorus, the Maumee River watershed is the primary driver of algal blooms in the Western Basin of Lake Erie (NRCS 2011). While agricultural practices have been identified as the primary culprit, the effects of other nutrient sources, climate change, and invasive species on nutrient cycling cannot be discounted (Lake Erie LaMP 2000).

Lake Erie has been the unfortunate recipient of many aquatic invasive species over the past century. Most of the major introductions prior to 1980 were fishes that entered the lake through the Welland Shipping Canal, such as the sea lamprey, alewife, and white perch. Other non-native fishes (rainbow smelt and common carp) were intentionally introduced. All of these species now have naturalized reproducing populations in Lake Erie. After 1980, the most important introductions of invasive species have occurred through ballast-water discharge from commercial freighters, including zebra and quagga mussels, the round and tubenose goby, spiny and fishhook water fleas, the bloody red shrimp, and a unique strain of viral hemorrhagic septicemia, all of which persist in Lake Erie today. The potential introduction of Asian carp into Lake Erie is the newest invasive species threat. The long-term impacts of invasive species on native fauna are highly uncertain, but are clearly not beneficial. Control programs have been implemented only for sea lamprey.

Changes in land use, development, and the construction of various shore structures have significantly altered the original habitat available along the Lake Erie shoreline. Many of the wetlands have been drained, filled, or altered so they no longer function naturally. Shore structures associated with development or built to protect shore property from high water levels have inhibited the natural flow of beach building materials along the shoreline, and consequently the natural habitat (Lake Erie LaMP 2000). From 2011-2013, Ohio EPA assessed nearshore fish communities from sites spread along Ohio's Lake Erie shoreline, including the islands. In general, areas assessed showed significant impairment due primarily to tributary loadings of nutrients and sediment, exacerbated by trophic disruptions caused by the proliferation of exotic species, algal blooms, and shoreline habitat modifications. Of the 38 sites sampled, only 13 percent of fish community collections were assessed as fully attaining the designated EWH aquatic life use, 34 percent were assessed as partially attaining, and the remaining 53 percent were in non-attainment (Ohio EPA 2014a).

Land use practices and nutrient loading are the primary human activities affecting the future state of the Lake Erie ecosystem. Land use practices affect habitat, influence hydrology and sediment runoff, and contribute to inputs of nutrients and contaminants. Other issues of concern are the continued introduction of invasive species, the effects of climate change, and understanding the role and impacts of phosphorus management in the Lake Erie system (Lake Erie LaMP 2000).

The major priority for future sustainability of Lake Erie fish populations lies in the protection, enhancement, and restoration of critical habitat, especially spawning and nursery habitats that are created in large part by hydrological processes in the watershed and nearshore environments (Davies et al. 2005). As these processes were disrupted or degraded over the past century by human activities, native fish stocks/species (e.g., lake sturgeon, lake trout, sauger, blue-pike, lake herring), as well as other aquatic species (mussels, crayfish, invertebrates) were lost or suffered significant population declines. Healthy habitats will help buffer impacts to native species from severe weather patterns, such as storms or extended droughts, and potentially improve resiliency of the fish community against the impacts of invasive species.

6.13.3 Associated Species of Greatest Conservation Need

Lake Erie has a long history of natural and anthropogenic changes. The forests, grasslands, and wetlands that once comprised the Lake Erie watershed are largely gone. Urban, industrial, and agricultural lands now dominate the landscape. Tributary streams and rivers have experienced major changes in their hydrology owing to dams, channelization, tiling of agricultural fields, and an increase in hard surfaces that speed overland flow of water. The lake's shorelines have been hardened and coastal wetlands drowned. River mouths have been dredged and turned into ports, at a loss of important estuarine habitat. Exotic species have been intentionally and unintentionally introduced.

All of these events have altered the lake's physical and chemical environment and produced changes in the aquatic community composition and abundance. Recent history indicates significant eutrophication throughout most of the 20th century, followed by a period of water quality improvement due to nutrient reductions/establishment of zebra mussels, and again followed by increasing phosphorous levels that today are causing severe blooms of diatoms and blue-green algae.

The Lake Erie species assemblage has, and will continue to shift with the physical and chemical environment of the lake. As the human influence on the lake is reduced, we can expect species composition and numbers reflective of what Lake Erie once was. At the other end of the scale, the deleterious effects of present day land-use will manifest themselves in an aquatic community able to tolerate the conditions. The most highly ranked species in terms of conservation need will always be the species on the fringe of tolerance relative to the existing physical and chemical environment in the lake.

The following species have been identified as Lake Erie species of greatest conservation need (conservation status rank in parentheses):

<u>Fish</u>

Spoonhead Sculpin (14)	*Cottus ricei*
Lake Sturgeon (17)	*Acipenser fulvescens*
Blacknose Shiner (22)	*Notropis heterolepis*
Mottled Sculpin (24)	*Cottus bairdi*
Silver Lamprey (26)	*Ichthyomyzon unicuspis*
Eastern Sand Darter (29)	*Ammocrypta pellucida*
Western Banded Killifish (30)	*Fundulus diaphanus menona*
Cisco (33)	*Coregonus artedi*
Burbot (36)	*Lota lota*

Silver Chub (36)	*Macrhybopsis storeriana*
Iowa Darter (38)	*Etheostoma exile*
Channel Darter (44)	*Percina copelandi*
Spotted Gar (45)	*Lepisosteus oculatus*
Longnose Sucker (47)	*Catostomus catostomus*
Black Redhorse (48)	*Moxostoma duquesnei*
Mooneye (50)	*Hiodon tergisus*
Lake Whitefish (57)	*Coregonus clupeaformis*
River Darter (58)	*Percina shumardi*

<u>Crayfish</u>

Northern Clearwater Crayfish (4)	*Orconectes propinquus*
Big Water Crayfish (7)	*Cambarus robustus*
Red Swamp Crayfish (13)	*Procambarus clarkii*

<u>Mussels</u>

Eastern Pondmussel (8)	*Ligumia nasuta*
Slippershell Mussel (16)	*Alasmidonta viridis*
Rayed Bean (21)	*Villosa fabalis*
Creek Heelsplitter (23)	*Lasmigona compressa*
Pondhorn (23)	*Uniomerus tetralasmus*
Threeridge (40)	*Amblema plicata*
Round Hickorynut (42)	*Obovaria subrotunda*
Kidneyshell (48)	*Ptychobranchus fasciolaris*
Northern Riffleshell (48)	*Epioblasma torulosa rangiana*
Rainbowshell (50)	*Villosa iris*
Round Pigtoe (50)	*Pleurobema sintoxia*
Elktoe (52)	*Alasmidonta marginata*
Deertoe (53)	*Truncilla truncata*
Fawnsfoot (53)	*Truncilla donaciformis*
Threehorn Wartyback (55)	*Obliquaria reflexa*
Cylindrical Papershell (56)	*Anodontiodes ferussacianus*

Table 35. CONSERVATION THREATS TO LAKE ERIE.
The following threats negatively impact or have the potential to negatively impact Lake Erie. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		medium
A	Coastal development and its effect on nearshore habitat and species	housing & urban areas commercial & industrial areas tourism & recreation areas	medium medium low
B	Hydrological effects caused by hard surfaces such as roof tops, roads, parking lots, etc.	housing & urban areas commercial & industrial areas tourism & recreation areas	medium medium low

C	The market value of undeveloped land on the Lake Erie shoreline is exceptionally high, making land acquisition for protection purposes problematic	housing & urban areas commercial & industrial areas tourism & recreation areas	medium medium low
II	**agriculture and aquaculture**		medium
A	Watershed conversion to agriculture alters hydrology	annual & perennial non-timber crops livestock farming & ranching	high low
III	**energy production and mining**		low
A	Oil and gas extraction - can physically damage and destroy habitat, and cause negative impacts from chemical contamination	oil & gas drilling	negligible
B	Wind turbines can negatively impact birds and bats that utilize lake habitat	renewable energy	low
IV	**transportation and service corridors**		medium
A	Dredging/modification shipping lanes causes habitat loss, water quality impacts	shipping lanes	medium
B	Coastal development such as roads, bridges, causeways, utilities, etc. - impact shoreline/nearshore habitats	roads & railroads utility & service lines	low negligible
V	**biological resource use**		low
A	Fishing pressure and fishing gear impacts from recreational and commercial fishing	fishing & harvesting aquatic resources	low
VI	**human intrusions and disturbance**		low
A	Incompatible recreational activities	recreational activities	low
B	Creation of recreational facilities can alter/destroy nearshore habitat	recreational activities	low
C	Vessel impacts to fragile habitats and water quality	recreational activities work & other activities	low negligible
VII	**natural system modifications**		low
A	Loss of wetland function as spawning and nursery habitat due to wetlands being isolated from the lake by dikes/levees	dams & water management/use	low
B	Hardened shoreline structures such as dikes, seawalls, breakwaters, causeways, etc. that do not allow the shoreline to move naturally with fluctuating water levels	other ecosystem modifications	low
C	Natural sediment transport is disrupted by shoreline development	other ecosystem modifications	low
D	Some species populations have been reduced to levels below what is necessary to recover on their own	other ecosystem modifications	low
E	Lack of data for some species and habitats limits our ability to develop plans for threats like climate change	other ecosystem modifications	low
VIII	**invasive and other problematic species and genes**		high
A	Introduction and/or spread of invasive plants and animals	invasive non-native/alien species	high
B	Introduction and/or spread of nuisance plants and animals	problematic native species	low

C	Introduction and spread of diseases (plants and animals)	invasive non-native/alien species problematic native species	high low
IX	**pollution**		high
A	Urban effluent carries a variety of substances that impact water quality and aquatic species	household sewage & urban wastewater industrial & military effluents garbage & solid waste air-borne pollutants	high low low low
B	Agricultural effluent from row crops as well as confined animal operations impacts water quality and aquatic species	agricultural & forestry effluents	very high
C	Harmful algal blooms affect water quality, aquatic species, and can be toxic to terrestrial species	agricultural & forestry effluents	very high
D	Industrial spills impact water quality and aquatic species	industrial & military effluents	low
X	**geological events**		negligible
---	none	---	---
XI	**climate change and severe weather**		low
A	Climate change could impact habitats, water quality, and species	habitat shifting & alteration droughts temperature extremes storms & flooding	low low low medium
B	Climate change induced fluctuating lake levels could impact nearshore species and habitats	droughts temperature extremes storms & flooding	low low medium

Table 36. CONSERVATION ACTIONS FOR LAKE ERIE.
The following actions will help abate or have the potential to help abate threats to Lake Erie habitat. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	actions	2nd level action classification(s)	action priority rank	threat(s) addressed*
I	**LAND/WATER PROTECTION**		med	
1	Protect coastal properties through acquisition, partnerships, conservation easements, etc.	site/area protection resource & habitat protection	low med	I, II, III-A, IV-B, VI-B, VII-A,B,C, XI-B

2	Quantify and map critical habitat areas in Cleveland Harbor for future protection	site/area protection	low	I-A, IV-A,B, VI-B,C, VII-B,C,
II	**LAND/WATER MANAGEMENT**		high	
1	Use physical enhancements in areas such as Maumee and Sandusky rivers and bays where human activities have permanently altered the natural hydrology	habitat & natural process restoration	high	I-A,B, II, IV, VI-B,C, VII-A,B, XI
2	Work to restore natural hydrological connections and flow regimes in tributary/near-shore areas	habitat & natural process restoration	high	I-A,B, IV-B, VI-B, VII-A,B,C, XI
3	Improve our understanding of the effects of manageable actions (e.g., dredging, energy generation, barriers to fish access, nutrient loading) and unmanageable/environmental factors (e.g., weather, climate change, land use practices, invasive species, etc.) on the Lake Erie ecosystem	habitat & natural process restoration	high	I-A,B, II, III, IV, V, VI, VII, VIII, IX, XI
4	Identify upland uses for dredge material and end open lake dumping of dredge spoil	habitat & natural process restoration	high	IV-A
5	Use lowest impact techniques and timing for dredging activities	habitat & natural process restoration	high	IV-A
6	Create and use wetlands for stormwater treatment	habitat & natural process restoration	high	I-A, IX-A
7	Establish an early-detection/rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	high	VIII-A,B
8	Continue to work with federal and state Great Lakes partners to prevent the introduction of Asian Carp	invasive/ problematic species control	high	VIII-A
9	Develop a way to quantify habitat impacts caused by development so that they can be mitigated for	habitat & natural process restoration	high	I-A, III-A, IV, VI-B, VII-A,B,C,E
10	Develop a process for coordinating disparate data sources of distribution and abundance of aquatic SGCN	habitat & natural process restoration	high	I-A, III-B, IV-A,B, VI-B, VII-E, XI
11	Review existing species and habitat data to identify data gaps and needs for additional surveys, research, and management actions	habitat & natural process restoration	high	I, II, III, IV, V, VI, VII, VIII, IX, XI
12	Conduct comprehensive surveys of freshwater mussels	habitat & natural process restoration	high	IV-A,B, VI-B,C, VII-E, XI
13	Identify critical habitat areas (through research, literature, data mining) to help delineate management options for their protection/enhancement	site/area management habitat & natural process restoration	med high	I-A,B, II, III, IV, V, VI, VII, VIII-A, XI
14	Develop standardized nearshore monitoring programs for habitats and species	site/area management	med	I-A, III-B, IV-B, VI-B,C, VII-A,B,C,E, VIII-A,B, XI

III	**SPECIES MANAGEMENT**		low	
1	Determine if lake sturgeon sightings reported by the public can be used to monitor relative abundance	species management species recovery	low med	VII-D
2	Monitor the status of lake sturgeon through reported sightings from sport and commercial fisheries, fish assessment surveys, and the general public to assist with restoration efforts	species management species recovery	low med	VII-D
3	Assess population status, habitat suitability, and probability for restoration of lake sturgeon spawning stocks in Ohio tributaries	species management species recovery	low med	VII-D
4	Develop a restoration strategy for sauger in the Maumee and Sandusky Rivers	species reintroduction	low	VII-D
5	Assess spawning and nursery habitat suitability for lake trout at natural reefs in Ohio waters of the western and central basins of Lake Erie	species reintroduction	low	VII-D
6	Assess population status, habitat suitability, and probability for restoration of fish, mussels, and crayfish listed as SGCN	species reintroduction	High	VII-D, VII-E
7	Develop a restoration strategy for high priority fish, mussels, and crayfish	species reintroduction	High	VII-D, VII-E
IV	**EDUCATION AND AWARENESS**		medium	
1	Educate waterfront landowners and commercial pesticide/herbicide applicators on responsible chemical use, and the negative impacts to wildlife from toxic chemicals	training	high	I-A,C, IX-A
2	Promote conservation easements along shoreline habitat	training awareness & communic-ations	high med	I, II, IV-B, VI-B, VII-A,B,C, XI
3	Provide technical guidance on coastal development plans as relates to fish and wildlife interests	training	high	I, IV-B, VI-B, VII-A,B,C, XI
4	Support the Ohio Clean Lakes Initiative - educating and training farmers and other interested parties on agricultural nutrient management and stewardship	training	high	II, IX-B,C
5	Educate the public about the negative effects of exotic and nuisance animals – encourage responsible disposal of unwanted animals	awareness & communic-ations	med	VIII
V	**LAW AND POLICY**		high	
1	Support legislation promoting eco-friendly energy development and use	legislation	high	III
2	Support the ban on oil and gas drilling in Lake Erie	legislation policies & regulations	high high	III-A
3	Develop and implement a risk-assessment system in the approval process for importing or moving live animals and plants	legislation policies & regulations	high high	VIII
4	Support more stringent ballast water regulations to	legislation	high	VIII

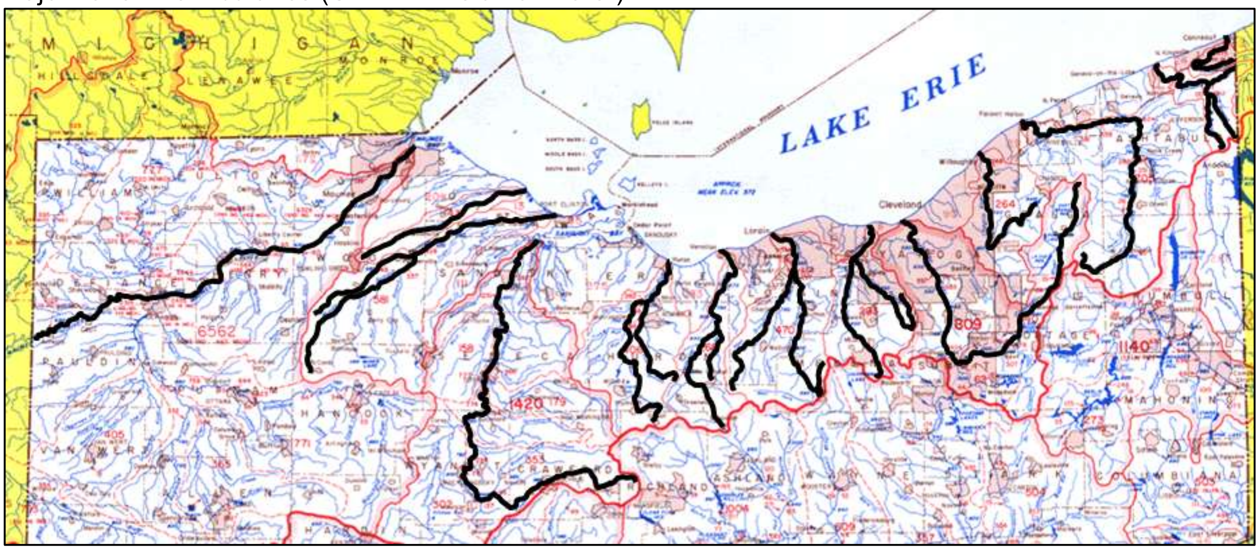
	stop the introduction of invasive species	policies & regulations	high	
5	Support legislation aimed at preventing Asian carp from entering the Great Lakes	legislation	high	VIII-A
6	Find innovative ways to mandate the inclusion of fish and wildlife interests in development plans	policies & regulations private sector standards & codes	high low	I, IV-B, VI-B, VII, XI
7	Increase enforcement of stormwater regulations	compliance & enforcement	med	I-B, IX-A
VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		med	
1	Explore tying eligibility for grant money, loans, and cost-share programs to nutrient loading levels for agriculture – the lower the nutrient levels in their effluent, the more money they would be eligible for	market forces conservation payments	med med	IX-B,C, XI
2	Create incentives for vegetated buffers along all waterways to reduce nutrient loads and sediment	market forces conservation payments	med med	I-B, IX-A,B,C, IX-A
3	Create incentives to promote eco-friendly energy development and use	market forces conservation payments non-monetary values	med med low	III
4	Support the creation of incentives to protect coastal habitat	market forces conservation payments	med med	I-A,C, IV-B, VI-B, VII-A,B,C, XI
5	Support clean marina and clean vessel programs	market forces conservation payments	med med	VI-C
6	Develop incentives for municipalities to use stormwater management systems that minimize negative impacts to aquatic habitats	market forces conservation payments	med med	I-A, IX-A
7	Support incentives for development plans involving water frontage that take into account wildlife and habitat needs	market forces conservation payments non-monetary values	med med low	I, IV-B, VI-B, VII-A,B,C, XI
VII	**EXTERNAL CAPACITY BUILDING**		med	
1	Work with ODA and OEPA to minimize nutrients in runoff, and develop BMPs for pesticide/herbicide use	alliance & partnership development	high	IX
2	Create an interagency spill response team – update contacts and training on a regular basis	alliance & partnership	high	IX-D

		development		
3	Consider creating a multiagency invasive species prevention and control group that would handle all invasive species issues – include appropriate agencies from bordering states/provinces	alliance & partnership development	high	VIII
4	Through interagency coordination, work to assure that wildlife interests are taken into consideration in road, bridge, and causeway design, construction, and maintenance	alliance & partnership development	high	IV-B
5	Use interagency partnerships to augment data used to assess population status, habitat suitability, and probability for restoration of lake sturgeon spawning stocks in Ohio tributaries	alliance & partnership development	high	VII-D
6	Through partnerships with the U.S. and Ohio EPA, U.S. Dept. Agriculture, and the U.S. Army Corps, implement actions on manageable biotic and abiotic factors affecting Lake Erie, such as phosphorus regulation and dredging activities – include appropriate agencies from bordering states/provinces	alliance & partnership development	high	I-B, II, IV-A, IX-A,B
7	Use existing, and develop new partnerships with watershed managers, property owners, and funding/regulatory groups, etc. to affect land use practices in the Lake Erie basin	alliance & partnership development	high	I-B, II, IX-A,B,C, XI-A
8	Work with scientific community partners to understand longer-term trends in unmanageable environmental factors and their impacts on aquatic communities	institutional & civil society development alliance & partnership development	med high	XI
9	Increase personnel and expertise available for SGCN surveys/research through partnerships with other government agencies (including bordering states/provinces), universities, and conservation-minded NGO's	institutional & civil society development alliance & partnership development	med high	I, II, III, IV, V, VI, VII, VIII, IX, XI

*refers to the Lake Erie Habitat Conservation Threats in Table 35

6.14 Lake Erie Tributaries

Major Lake Erie tributaries (ODNR Division of Water)



6.14.1 Status

Stable to improving. Ohio Environmental Protection Agency (Ohio EPA) surveys indicate general improvement in the physical habitat, water quality, and biological communities of most of the streams in the Lake Erie watershed. Ohio’s large rivers continue to show improvement as tracked over the last 20 years. The “100% full attainment by 2020” aquatic life goal statistic remains steady at 89.2% full attainment. Taken collectively since the 1980s, the quality of aquatic life in all of Ohio’s large rivers has shown a remarkable improvement. Then, only 21% of the large rivers met water quality standards, increasing to 62% in the 1990s, to 89% today. Areas not meeting the standards have decreased from 79% in the 1980s to 38% in the 1990s to 11% today (Ohio EPA 2014a).

6.14.2 Description

In the upper third of Ohio, Lake Erie tributaries drain north across the 11,714 square mile Lake Erie watershed. The four largest tributaries include the Maumee River (drains 6,608 square miles), the Sandusky River (drains 1,420 square miles), the Cuyahoga River (drains 809 square miles), and the Grand River (drains 712 square miles). Tributary physical attributes, water quality, habitat, and biological communities tend to follow a west to east gradient across northern Ohio. This gradient results from geographical differences as well as changes in land use practices in the watersheds. The trend is from relatively flat watersheds dominated by agriculture in the west, to watersheds with more relief dominated by forests and urban/suburban land use in the east. Streams across this gradient reflect the impacts and impairments that result from land uses within the watershed.

Along Ohio’s portion of the Lake Erie shoreline, 56 different streams empty directly into Lake Erie. From west to east, those tributary streams are: Halfway Creek, Ottawa River, Maumee River, Duck Creek, Swan Creek, Otter Creek, Wolf Creek, Cedar Creek, Crane Creek, Turtle Creek, Toussaint River, Lacarpe Creek, Portage River, Muddy Creek, Sandusky River, South Creek, Raccoon Creek, Pickerel Creek, Little Pickerel Creek, Cold Creek, Mills Creek, Pipe Creek, Plum Brook, Sawmill Creek, Huron River, Old Woman Creek, Cranberry Creek, Chapel Creek, Sugar Creek, Darby Creek, Sherod Creek, Vermilion River, Brownhelm Creek, Quarry Creek, Beaver Creek, Martin Run, Black River, Porter Creek, Cahoon Creek, Rocky River, Cuyahoga River, Doan Brook, Ninemile Creek, Euclid Creek, Chagrin River, Marsh Creek, Grand River, McKinley Creek, Big Creek, Wheeler Creek, Cowles Creek, Indian Creek, Red Brook, Ashtabula River, Conneaut Creek, and Turkey Creek (ODNR 2001).

Significant tributaries (watersheds >100 square miles) flowing directly into Lake Erie include the Ottawa River, Maumee River, Toussaint River, Portage River, Sandusky River, Huron River, Vermilion River, Black River, Rocky River, Cuyahoga River, Chagrin River, Grand River, Ashtabula River, and Conneaut Creek. A brief description of the habitat, water quality, and biological communities for each of these tributaries follows.

6.14.2.1 Ottawa River

The following information was assembled from *Biological and Water Quality Study of the Ottawa River Lower Nine Miles* (Ohio EPA 2007b) and *Biological and Water Quality Study of the Ottawa River and Principal Tributaries, 2010* (Ohio EPA 2013a).

The Ottawa River watershed is located in northwestern Ohio and drains into Maumee Bay in Lucas County. The 221 square mile watershed of the Ottawa River spans both sides of the Michigan-Ohio border. The western portion of the watershed is primarily crop land, while the eastern portion is almost entirely urban development. The watershed occupies two distinct ecoregions - the Eastern Corn Belt Plain (ECBP) and the Huron-Erie Lake Plains (HELP). The transition to the HELP ecoregion from the ECBP ecoregion occurs approximately at RM 17.5 on the Ottawa River mainstem.

The leading cause and source of aquatic life use impairments in the upper Ottawa River mainstem is nutrient enrichment/eutrophication from nonpoint source inputs (tile discharged to modified tributaries or surface runoff). In lower reaches of the Ottawa, the main causes of impairment are nutrient enrichment and organic enrichment from urban sewer overflow inputs, and municipal and industrial discharges. Recent surveys by the Ohio EPA however, indicate that pollution abatement efforts to date have yielded water quality improvements, and indicate that the Ottawa River has entered a phase of strong environmental recovery.

As measured by the Qualitative Habitat Evaluation Index (QHEI), the quality of near and in-stream macrohabitat throughout most of the Ottawa River appeared capable of supporting diverse, functionally organized, and well-structured assemblages of aquatic organisms, consistent with its respective ecoregional ECBP and HELP benchmarks. Most areas contain a complement of positive channel, substrate and riparian features at least minimally compatible with the river‘s Warmwater Habitat (WWH) aquatic life-use designation. However, conditions are not uniform, and the Ottawa River mainstem consists of a patchwork of high to moderate quality free-flowing reaches found largely within the rural portions of the ECBP, and lower quality channel with modified and/or impounded segments within the HELP ecoregion and the greater Lima area.

The river exists in a relatively natural or unmodified state upstream from Lima. Macrohabitat quality and resulting QHEI scores fall sharply as the Ottawa River enters the greater Lima area. Habitat quality metrics point to a predominance of modified features including historic channel modification, impoundment, and sedimentation. Progressing downstream into the heart of urban/industrial Lima, the Ottawa River enters a series of five dam pools contained within an approximately three mile river reach. Leaving the urban center of Lima, the Ottawa River is again free flowing and continues so for approximately ten river miles. Habitat metrics indicate WWH potential through this stretch, despite ample evidence of past channel modification. Before entering the lake plain proper (HELP ecoregion), the Ottawa River flows through approximately nine miles of lacustrine deposits contained in the ECBP ecoregion where stream gradient drops precipitously in comparison to upstream reaches. Habitat metrics reflect the change in topography and associated steam characteristics, but despite reduced stream power and diminished macrohabitat quality, most QHEI values remained within the WWH range. The lower 17 miles of the Ottawa River are contained within the HELP ecoregion. Gradients are further reduced through this segment and are typically half of that observed within the free-flowing reaches within the ECBP ecoregion. The increase in the level of sedimentation and diminishing channel form and function (through the loss of stream power) resulted in reduced QHEI scores for this stretch of river.

Ohio EPA surveys from 2010 indicated that about 76% (linear stream miles) of the mainstem were found to support an assemblage of fish at least minimally consistent with WWH biocriteria. The remaining 24.3% failed to support WWH assemblages; however, the magnitude of the departure was not great, as community performance below the fair range was not observed. Compared against historical results, common stations in nearly every instance supported richer communities and a greater number of environmentally sensitive taxa in 2010.

Fifty fish species and four hybrids were collected from the Ottawa River during 2010 Ohio EPA surveys. Numerically predominant species were bluntnose minnow (33.7%), greenside darter/longear sunfish (~7.0%), white sucker/redfin shiner (~5.0%), and central stoneroller/spotfin shiner/bluegill sunfish (~4%). In terms of relative biomass, dominant species were common carp (25.3%), white sucker (17.6%), golden redhorse (8.5%), smallmouth bass (6.2%), and rock bass/channel catfish (5.2%). Over a quarter of the community, measured in terms of numerical abundance and biomass, was concentrated in two highly tolerant and ecological generalist species - bluntnose minnow and common carp, respectively. Nearly 47% of all fish and 51% of total fish biomass collected from the mainstem were pollution tolerant taxa. State listed species included only the greater redhorse. Other intolerant, rare, declining or otherwise ecologically significant species included mimic shiner and stonecat madtom.

The macroinvertebrate community in the Ottawa River mainstem was also assessed in the 2010 survey. Twenty-one of 26 Ottawa River mainstem survey sample sites (81%) attained the designated WWH aquatic life-use criterion. During this survey, the Ottawa River reach upstream from Lima and the lower 28.8 river miles of the Ottawa River mainstem met the WWH macroinvertebrate ecoregional biological performance criteria. The Invertebrate Community Index (ICI) scores attaining WWH status from the 2010 survey ranged from good to exceptional.

6.14.2.2 Maumee River

The following information was assembled from *Total Maximum Daily Loads for the Maumee River (lower) Tributaries and Lake Erie Tributaries Watershed* (Ohio EPA 2012e) and *Western Lake Erie Basin Study Upper Maumee Watershed Assessment* (U.S. Army Corps of Engineers 2009), except where otherwise noted.

The Maumee River is the largest tributary in the Great Lakes basin, draining all or part of 17 Ohio counties, five Indiana counties, and two Michigan counties. The entire watershed covers 8,316 square miles. The mainstem of the Maumee River is approximately 140 miles in length, the downstream 105 miles of which lie in Ohio. The Maumee drains a total of 5,024 square miles in Ohio before it empties into Lake Erie (Maumee Bay) at Toledo (Maumee RAP 2006).

The watershed is predominantly comprised of cultivated crops with some urban development, hay and pasture lands, and forest. The watershed covers a combination of Huron-Erie Lake Plain and Indiana and Ohio Till Plain ecoregions. The topography ranges from gently sloping glacial till plain to nearly level broad lake plains with some beach ridges and lower moraines. The gradient of the Maumee averages between 1-5 feet per mile throughout its length.

The 43-mile portion of the Maumee River extending from the Indiana/Ohio border to the Ohio Route 24 bridge (RM 68) near Defiance is designated as a State Scenic River. An additional 53 mile segment is designated as a State Recreational River from about RM 68 to RM 15. These two designated areas have special restrictions on development, permitted discharge, etc. within them. The lower 22.8 miles of the Maumee River is included in the Maumee River Area of Concern (Maumee RAP 2006).

The entire length of the Maumee River (in Ohio) has not been completely assessed since 1997. Ohio EPA surveys from the 1990’s revealed that only about half of mainstem sites sampled met Warmwater Habitat (WWH) aquatic life-use criteria. Agricultural practices, stream channelization, and urbanization contributed to the loss and/or degredation of many landscape features that once attenuated flows, provided detention, and retained sediment. In general, negative impacts from agriculture are more prevalent in the upper Maumee River, while the effects of urbanization manifest themselves more so in the lower portion of the river.

Of note for the lower portion of the Maumee River is the fact that it supports a significant spring run of spawning walleyes and serves as important spawning habitat for a number of Lake Erie species. A more detailed discussion of the Maumee River watershed is provided in Lake Erie Tributaries Conservation Opportunity Watersheds later in this section.

6.14.2.3 Toussaint River

The following information was assembled from *Biological and Water Quality Study of the Toussaint River and Rusha Creek Basins* (Ohio EPA 2005a) and *Total Maximum Daily Loads for the Toussaint River Watershed* (Ohio EPA 2006d).

The Toussaint River is a tributary to western Lake Erie, draining 143 square miles in Wood, Ottawa, and Sandusky counties.The mainstem of the river is 37 miles long and empties into Lake Erie in Ottawa County. Upstream from its confluence with Packer Creek, the Toussaint has historically been considered a creek. The Toussaint widens as it reaches lake elevation where the riverine habitat is affected by the intrusion of water levels from Lake Erie.

The watershed is located entirely in the Huron-Erie Lake Plains (HELP) ecoregion. The HELP ecoregion is a broad, fertile, nearly flat plain. Most of the area has been cleared and artificially drained for agricultural crop production. Stream habitat and water quality have been degraded by channelization and agricultural activities. Landcover data from 2003 show the watershed contains mixed row crops/open space/yards (56%), cultivated crop land (9%), forest (12%), developed land (11%), and grassland (8%).

Habitat (QHEI) scores for the Toussaint watershed indicate that the majority of very poor habitat areas are found in small tributary streams. Agricultural practices, including riparian cover removal, channelization, and dredging, as well as nutrient enrichment and siltation, have resulted in a degradation of available habitat to instream biological communities. Habitat quality modestly improves as drainage area increases, but in general, the highly modified conditions present throughout the majority of the watershed have resulted in a reduction in diversity and numbers of aquatic species.

2003 surveys of the resident fish community by the Ohio EPA produced a total of 18,076 fish, consisting of 46 species and 7 hybrids. No endangered or threatened species were collected during the sampling effort, though five moderately intolerant species, including smallmouth bass, brook silverside, sand shiner, logperch darter and greenside darter, were collected. Numerically predominant were tolerant fish species including bluntnose minnow (18.6%), fathead minnow (13.1%), and stoneroller minnow (10.6%). Species that dominated in biomass included common carp (52.9%), creek chub (7.5%) and largemouth bass (3.8%).

A total of 208 separate macroinvertebrate taxa were collected in the Toussaint watershed during 2003 sampling. Moderately intolerant or sensitive taxa comprised 27% of the total taxa collected. Pollution-tolerant taxa comprised approximately 22% of the total taxa collected. The lotic stream sites on Toussaint Creek mostly achieved the macroinvertebrate WWH biocriteria. Farther downstream, the lacustrine sites on the Toussaint River did not achieve minimum lacustrine performance expectations.

6.14.2.4 Portage River

The following information was assembled from *Biological and Water Quality Study of the Portage River Basin, Select Lake Erie Tributaries, and Select Maumee River Tributaries, 2006 - 2008* (Ohio EPA 2010a) and *Total Maximum Daily Loads for the Portage River Watershed* (Ohio EPA 2011c).

The Portage River is located in northwest Ohio, extending from headwaters near Findlay and Fostoria and emptying into Lake Erie at Port Clinton in Ottawa County. The watershed drains 585 square miles and encompasses parts of Wood, Hancock, Ottawa, Sandusky, and Seneca counties. The Portage River is fed by four major tributaries, the North Branch, the Middle Branch, the South Branch and the East Branch. The lower 30 miles of river is characterized by a single channel that meanders to Lake Erie, with its final reach from Oak Harbor to Port Clinton essentially an estuary controlled by Lake Erie. The majority of the watershed is located in the Huron-Erie Lake Plain (HELP) Ecoregion. The most upstream portion of the East Branch Portage River lies within the Eastern Corn Belt Plains (ECBP) ecoregion.

There is little topographic relief in the watershed. The overall stream gradient averages less than three feet per mile. Drainage practices (primarily drainage ditches) which faciliatated agricultural activities led to alteration of the landscape. Row crop agriculture is by far the dominant land use accounting for over 76% of the total Portage River watershed area. Developed land amounts to about 11% of the total. Forest and wetlands constitute 5.5% and 2.3% of the total, respectively.

Ohio EPA sampling indicated forty percent of the sites on the Portage River mainstem did not meet standards for aquatic life uses. The tributary streams showed slightly lower quality with a 47% overall impairment rate. Within all of the study area, most of the water quality impairments could be linked to nonpoint sources such as fertilizer and manure runoff, sedimentation from agricultural crop production, and failing home sewage systems. Agricultural practices such as the habitat alteration, channelization/maintenance of streams and ditches, and the drainage of farm fields through subsurface tiles caused habitat and flow alteration impairments. The average habitat (QHEI) score for the watershed was towards the low end of the “fair” range. This low average score reflects the low habitat quality throughout the study area which is a direct result of extensive channel modifications.

A total of 96,207 fish representing 66 species were collected from the study area between June 2006 and October 2008. Three very sensitive species were collected, though twelve tolerant species, often in high numbers, were also collected throughout the study area. Portage River mainstem sites sampled during 2008 achieved the applicable Warmwater Habitat (WWH) fish biocriteria at 64% of the locations evaluated.

Macroinvertebrate communities reflected habitat and water quality throughout the watershed. In less impacted areas of the Portage River and tributaries, macroinvertebrate communities were evaluated as good to exceptional in terms of number of individuals and taxa. In more heavily impacted areas – generally tributary headwaters and the lacustrine area of the lower Portage – communities did not meet WWH status. Macroinvertebrate communities in these areas were characterized by lower numbers of individuals, reduced diversity, and dominated by pollution tolerant species.

Thirteen species of freshwater mussels (Unionidae) were collected live or fresh-dead from the Portage River watershed. State listed species collected in this watershed were *Truncilla donaciformis* (Fawnsfoot-Threatened Species) from the Portage River, *Truncilla truncata* (Deertoe-Species of Concern) from the Portage River and Middle Branch Portage River, and *Uniomerus tetralasmus* (Pondhorn-Threatened Species) from the North Branch Portage River. The collection of *Uniomerus tetralasmus* during this study was the first time that species was recorded in the Portage River watershed.

6.14.2.5 Sandusky River

The following information was assembled from *Biological and Water Quality Study of the Sandusky River and Selected Tributaries 2001* (Ohio EPA 2003b), *Biological and Water Quality Study of the Lower Sandusky River Watershed 2009* (Ohio EPA 2011a), and *Total Maximum Daily Loads for the Sandusky River (lower) and Bay Tributaries Watershed* (Ohio EPA 2014b).

The Sandusky River drains 1,850 square miles from 12 counties in northwest Ohio before emptying into Lake Erie at Sandusky Bay. The Sandusky River mainstem is 133 miles long. The upper two-thirds of the river are relatively flat, characterized by broken ridges which are representative of end moraines deposited by glaciers. The northern one-third is flat to gently rolling and is characterized by shorelines from ancient lakes formed as glaciers receded. The Sandusky basin straddles the Eastern Corn Belt Plains (ECBP) ecoregion and Huron/Erie Lake Plain (HELP) ecoregion. Land use in the watershed is approximately 75% row crops, 10% developed land, 9% forest, 3% grassland/pasture/hay, and 2% wetlands. Approximately 70 miles of the Sandusky River between Upper Sandusky and Fremont is designated as a state scenic river.

The Sandusky basin, like other watersheds in north-central and northwest Ohio, is dominated by agricultural land use, including both cultivated row crops and pasture land for livestock grazing. Agricultural drain tiles were installed in the Sandusky basin to lower the water table for crop production and channels and ditches were installed to efficiently route water. Both practices significantly affect the hydrology of the region and affect the water quality of the streams due to rapid delivery of excess nutrients. This area, along with other agricultural areas in northwestern Ohio, represents some of the most intensively tile-drained crop land in the United States.

The lower portion of the Sandusky River mainstem and small direct tributaries to Sandusky Bay and Lake Erie are lacustrine, meaning that waters from the streams and Lake Erie mix within an estuary. These lacustrine areas are slack water that can ebb and flow as lake seiches affect water levels, and are generally located between the farthest downstream riffle of the tributary and Lake Erie proper.

Ohio EPA sampled 21 sites on the upper Sandusky mainstem during 2001. Habitat, as reflected by QHEI scores generally met the Warmwater Habitat (WWH) minimum criteria at all sites. In terms of WWH aquatic life use, 66% of sites met minimal aquatic life use criteria, 24% were in partial attainment, and the remaining 10% did not meet minimum WWH criteria. Index of Biotic Integrity (IBI) scores met WWH criteria for fish communities at 71% of sites, and Modified Index of Well-being (MIwb) scores indicated healthy fish communities at 57% of sites. Macroinvertebrate communities achieved the minimum ICI scores for WWH at 85% of sites sampled. Health of biotic communities generally improved in a downstream direction on this section of the Sandusky mainstem.

Impediments to full attainment of designated aquatic life uses within the assessment area can be largely attributed to agricultural practices within the watershed. Sedimentation and substrate embeddedness were the most common impacts where aquatic life use attainment was not fully met. The channelizing of streams, removal of riparian trees, and field tiling to facilitate drainage have reduced the volume of water present during dry weather periods.

On the lower Sandusky River mainstem, the free-flowing reaches generally had good habitat and water quality. Of 18 sites sampled on the lower mainstem – 66% were in full attainment of WWH aquatic life use criteria, 6% were in partial attainment, and 28% were in non-attainment. The Sandusky River mainstem from Tymochtee Creek to Wolf Creek is impaired by sedimentation. Sources are individually permitted point sources, storm water from developed land, failing home septic systems, and agriculture. Model results indicate that the dominant source of sediment load is cultivated cropland (96%). The Sandusky mainstem from Wolf Creek to the mouth is impaired by sedimentation/siltation, nutrient/eutrophication, substrate embeddedness, and direct habitat alteration. The sources of pollutant loads are individually permitted point sources, storm water from developed land, failing home septic systems, and agriculture. Again, model results indicate that the dominant source of loading is cultivated cropland: 95% of total phosphorus loads, ~69% of nitrate/nitrite loads, and ~93% of sediment loads.

A more detailed discussion of the Sandusky River watershed is provided in the Lake Erie Tributaries Conservation Opportunity Watersheds later in this section.

6.14.2.6 Huron River

The following information was assembled from *Total Maximum Daily Loads for the Huron River Watershed* (Ohio EPA 2005b) except where otherwise noted.

The Huron River watershed is located on the south shore of Lake Erie between Toledo and Cleveland, in Huron, Erie, Seneca, Richland and Crawford counties. The Huron River is 59.7 miles long and drains 403 square miles. Land cover is primarily agricultural with approximately 74% cropland, 15% woodland, and 3-11% urban and other land uses.

Headwaters of the Huron River gather along the Fort Wayne and Defiance Moraines. The West Branch and East Branch of the Huron River flow relatively close to each other throughout much of the basin. From the confluence of West Branch and East Branch just west of Milan, the Huron River flows about 14 stream miles across the Lake Plain to its mouth in Lake Erie at Huron (Shiefer 2002).

The Huron River watershed spans the Eastern Corn Belt Plains (ECBP) and the Erie-Ontario Drift and Lake Plain (EODLP) ecoregions. The ECBP ecoregion is a rich agricultural area that covers approximately 70% of the watershed. Extensive grain and livestock production occurs in this ecoregion.

The turbid, low gradient streams in the ECBP ecoregion generally do not support exceptional fish communities. The EODLP ecoregion is a nearly level coastal strip of lacustrine deposits, and urban and industrial land use is more prevalent in this region of the Huron River watershed.

Despite the increase in conservation tillage practices on agricultural lands in recent years, the Huron River remains as having among the highest suspended sediment yields in the state of Ohio, and the second highest in the Lake Erie Basin. Many small streams have been channelized to assist drainage in the level, poorly drained soils of Huron and Seneca counties. With the exception of municipal sources, biological and water quality impairment in the Huron basin was most often associated with agricultural land use. The most common causes of impairment in these areas are siltation, channelization, and/or nutrient enrichment.

Despite past water quality issues, a 2002 Ohio EPA biological and water quality survey of the Huron River watershed found significant improvement in portions of the basin, particularly in the East and West Branches. Excluding the lacustrine segment, the Huron River mainstem and most of the East Branch and the West Branch are now in full attainment of Warmwater Habitat (WWH) aquatic life-use criteria. Approximately 80% of the over 80 free-flowing river miles in the mainstem and major branches met WWH criteria in 2002. With the exception of a few stream segments, fish and macroinvertebrate community performance was generally in the good to exceptional ranges. Not coincidentally, areas of high biological performance also tended to have intact physical habitats and riparian corridors. Based on QHEI habitat scores, attaining segments in the mainstem and major branches had good to exceptional physical habitat quality.

6.14.2.7 Vermilion River
The following information was assembled from *Biological and Water Quality Study of the Vermilion River, Old Woman Creek, Chappel Creek, Sugar Creek, and Select Lake Erie Tributaries 2002* (Ohio EPA 2004a), and *Total Maximum Daily Loads for the Vermilion River Watershed* (Ohio EPA 2005c).

The Vermilion River is 66.9 miles long and drains 269 square miles in north-central Ohio as it flows through Ashland, Erie, Huron, Lorain and Richland counties before emptying into Lake Erie at Vermilion. The predominant land cover within the Vermilion River basin is agriculture (72.8%) and forest (25.3%), with wetlands, open water, and urban areas accounting for the remaining 1.9%.

The upper portion of Vermilion River and its tributaries originate in the Erie-Ontario Drift and Lake Plain (EODLP) ecoregion consisting of low rolling hills and end moraines blanketed with low line drift and lacustrine deposits. The mid-section of the watershed in Erie, Huron and Lorain counties flows through the Eastern Corn Belt Plains (ECPB) ecoregion which is characterized by rolling till plains and end moraines. The lower portion of the watershed is located in the EODLP ecoregion, characterized by nearly level coastal lacustrine land with beach ridges and swales.

In a 2002 assessment by the Ohio EPA, habitat in the Vermilion mainstem and branches generally met Warmwater Habitat (WWH) criteria based upon QHEI scores. Sampling locations in the Vermilion mainstem and upper branches achieved minimum WWH criteria at 83% and 87% of sites, respectively. In the Vermilion watershed, most of the sites not meeting the QHEI habitat targets have drainage areas less than 30 square miles. QHEI scores tended to increase with drainage area for stream segments in the watershed. Primary causes of impairment were excess nutrients, siltation, and habitat and flow alteration. Similar to other watersheds in northwestern and north central Ohio, agriculture's influence on headwater and smaller tributary streams is reflected in the causes of impairment. The biological communities present in the headwater streams typically do not meet WWH criteria due to the historical and current habitat alterations, channelization, and nutrient enrichment.

A total of 26,103 fish, comprising 57 species and 4 hybrids were collected throughout the Vermilion basin during the 2002 Ohio EPA study. No endangered or threatened species were collected, though several intolerant species including the black redhorse, river chub, bigeye chub, silver shiner, rosyface shiner, mimic shiner and stonecat madtom were collected. Numerically predominant fish species included bluntnose minnows (18.2%), creek chub (15%), and stoneroller minnow (10.9%). Species that dominated in biomass included common carp (32.5%), rock bass (10.9%), golden redhorse (8.7%), and white sucker (8.5%).

The fish community index for the upper Vermilion River ranged between very good and fair – the index improved in a downstream direction as sinuosity and stream cover improved. The fish community index for the middle portion of the Vermilion ranged between good and excellent. The higher quality fish assemblage found here was due to more natural stream conditions which offered diverse substrates, increased sinuosity, and high quality stream cover. The fish community index for the lower Vermilion ranged between good and excellent at sites outside of the lacustrine area. The lacustrine site index was fair to poor due to high percentage of exotic species and tolerant species. The lacustrine portion of the mainstem has exhibited poor biological performance from both fish and macroinvertebrate communities over time. The lacustrine area acts as a sink for silt and nutrients generated from upstream agricultural and development activities. In addition, the mouth of the mainstem is maintained for navigational purposes for both commercial and recreational use.

Uppermost sites on the Vermilion River reflected an improving trend in the condition of the macroinvertebrate community with increasing drainage area. Macroinvertebrate communities sampled in the majority of sites in the lotic portion of the Vermilion met WWH criteria. Impounded areas of the Vermilion supported lower diversity of macroinvertebrate fauna. Lacustrine sites also supported limited macroinvertebrate fauna. About half of the upstream tributaries in the watershed supported macroinvertebrate communities with indexes of marginally good to good. In the lower portion of the watershed about two-thirds of the macroinvertebrate communities met WWH criteria.

6.14.2.8 Black River

The following information was assembled from *Biological and Water Quality Study of The Black River Basin* (1999b), and *Total Maximum Daily Loads for the Black River Watershed* (Ohio EPA 2008) except where otherwise noted.

The Black River drains a 470 square mile watershed in Ashland, Huron, Medina, Cuyahoga and Lorain counties before emptying into Lake Erie in the City of Lorain. The East and West branches are about 42 and 30 miles long, respectively. The Black River watershed lies entirely within the Erie-Ontario Drift and Lake Plain (EODLP) ecoregion. The EODLP ecoregion is characterized by gently rolling plains from previous glaciation, unconsolidated glacial deposits, sandstone and shale bedrock, and glacial end moraines.

Headwaters of the Black River gather along the Defiance Moraine. The two main branches of the river, East Branch and West Branch, join at Elyria. From the confluence of East Branch and West Branch, the Black River flows about 16 stream miles to its mouth in Lake Erie at Lorain (Shiefer 2002).

Prominent land cover in the Black River watershed is 44% cropland, 25% forest, 18% residential/urban development, and 8% pasture. The subbasins of the greater Black River watershed exhibit distinctly different characters. The Black River mainstem area is urban and industrial in nature. In the French Creek sub-basin and the eastern areas of the northern East Branch, rapid suburban development is altering the formerly agricultural landscape. The southern regions of the watershed remain predominantly rural and agricultural, although extensive development has occurred in and around the Lodi area.

Because of a legacy of environmental impacts to water and habitat quality, the Black River was designated as a Great Lakes Area of Concern (AOC) and a remedial action plan (RAP) has been in place. Unique and diverse communities of fish, mussels and aquatic insects live in the streams of the Black River watershed, but recent studies confirm degraded water quality and stream habitat. In the agricultural upper watershed areas, the modification of stream channels (for drainage improvement), failing home sewage treatment facilities, and row crop/livestock production have resulted in habitat degradation, sedimentation, and high nutrient and pathogen loadings. In the Black River mainstem, major municipal and industrial discharges, combined sewer overflows, and urban runoff result in high nutrient and organic loads, poor habitat quality, siltation, and low dissolved oxygen concentrations. Among the most visible threats to the Black River today is the conversion of farm, forest and stream bank acreage to suburban and commercial uses. Portions of the Black River watershed are experiencing unprecedented development. Ohio EPA studies of the overall watershed showed that 37% of sampled sites were meeting water quality goals, 30% were partially meeting the goals, and 38% were not meeting goals.

The free flowing reach of the Black River mainstem contains excellent habitat. The sinuous free flowing river combined with glacial tills and woody debris provide for habitat complexity, heterogeneity of the substrates, and good channel development. Habitat in the East Branch of the Black River is impacted by agriculture and encroachment into riparian areas – but despite these impacts, the habitat was sufficient to support warmwater communities. Habitat (QHEI) scores for West Branch sites were low.

Fish communities in the free flowing portion of the Black River mainstem have improved over time. The number of darter and sucker species, while improving slightly compared to previous surveys, remained below expectations. The absence of intolerant species, and the low numbers of darter and sucker species is a legacy of prior point source pollution, and an indication of continued watershed-scale habitat impairment. Nearly all sites sampled in the Black River lacustrine area remain in the poor to very poor range of Index of Biotic Integrity (IBI) scores. Some slight improvement was observed in the stream segment associated with contaminated sediment removal (from USS/Kobe outfalls), but IBI scores are still poor. This area as well as the rest of the lacustrine area remains strongly influenced by nutrient enrichment derived from point sources and nonpoint pollution. Within a mile of Lake Erie, the influx of cleaner water low in nutrients from the lake has created conditions more favorable to healthy fish communities. Nearer the lake, fish communities remain poor in response to habitat loss in the navigation channel. The Black River from approximately river mile 2.8 to Lake Erie is periodically dredged to support its use as a navigation channel. Vertical sheet piling and cement sea walls provide little habitat for fish.

As with the Black River mainstem, the legacy of nonpoint pollution and habitat degradation in the East Branch was evident in the absence of intolerant fish species, and low numbers of darter and sucker species. Habitat and water quality issues also limited fish communities in the West Branch. Macroinvertebrate communities in the Black River upstream from the Lake Erie lacustrine area were in the good to exceptional range in the 1997 study, but communities in the lacustrine area (below RM 5.6) scored below lacustrine criteria. In the East Branch, macroinvertebrate communities were very good to exceptional at all sites sampled.

6.14.2.9 Rocky River

The following information was assembled from *Biological and Water Quality Study of the Rocky River and Selected Tributaries* (Ohio EPA 1999c), and *Total Maximum Daily Loads for the Rocky River Basin* (Ohio EPA 2001) except where otherwise noted.

The Rocky River watershed drains a total of 265 square miles in all or parts of Cuyahoga, Summit, Medina, and Lorain Counties in northeastern Ohio. The Rocky empties into Lake Erie on the west side of Cleveland. Land cover within the watershed is primarily a mix of forest (44%), agriculture (40%), and urban areas (14%). The northern portion of the watershed is predominantly urban, while the southern half is dominated by forest and agriculture.

The Rocky River gathers headwaters in the hilly moraines that cross through Medina County into southern parts of Cuyahoga County. West Branch of the Rocky River originates south of Medina in the Wabash Moraine and flows through the Defiance Moraine along a northward course. East Branch of the Rocky River originates along the distal side of the Defiance Moraine in southern Cuyahoga County and flows southward to the Fort Wayne Moraine where it reverses course and flows back northward through the Defiance Moraine to its confluence with West Branch just north of Berea. From the confluence of East Branch and West Branch, the Rocky River flows about 12 stream miles to its mouth in Lake Erie on the west side of Cleveland (Shiefer 2002).

The watershed is located in the Erie-Ontario Drift and Lake Plain (EODLP) ecoregion. The EODLP ecoregion is characterized by northern hardwood vegetation (maple, birch, beech, hemlock) and glacial plains interspersed with high remnant beach ridges, drumlins, glacial till ridges, till plains, and outwash terraces. The Rocky River basin is a flat plateau with extremely narrow and dissected canyons.

The mainstem of the Rocky River is protected by the Cleveland Metroparks for almost its entire length. However, the area surrounding the metropark is heavily urbanized. For much of its mainstem, the Rocky River is fairly shallow and free flowing with good velocity and a fractured bedrock substrate. The mouth of the river has been modified to accommodate boating – Rocky River Harbor consists of the lower 4,200 feet of Rocky River.

Based on the performance of the biological communities, 71% of the surveyed reach of the Rocky River mainstem, including the lacustrine zone (the portion influenced by Lake Erie) were in partial attainment of the designated aquatic life use. The remaining 29% was in non-attainment. Attainment status, where both fish and invertebrates were sampled, was largely determined by the performance of the fish assemblage. While the macroinvertebrates at least marginally achieved ecoregional criteria, one or both fish indices (IBI and MIwb) performed at a fair to poor level throughout the mainstem.

The East and West branches of the Rocky River were assessed in 1997. Full attainment of Warmwater Habitat (WWH) aquatic life use was achieved for 66% of the East Branch and 70% of the West Branch. The remaining surveyed stretches of both branches partially met the designated aquatic life use. Departure from the WWH biocriteria was driven solely by fair fish community performance in both branches, as the macroinvertebrate community consistently exceeded ecoregional criteria. The North Branch of the Rocky River supported diverse biological communities, including good numbers of pollution sensitive taxa, and was found to be in full attainment of the WWH aquatic life use.

More recent studies of the Rocky mainstem and East Branch (Northeast Ohio Regional Sewer District 2012, 2013) indicated that habitat (QHEI scores), fish community (MIwb and IBI scores), and the macroinvertebrate community (ICI scores) met warmwater habitat aquatic life use criteria. Data collected was minimal compared to the previously referenced Ohio EPA studies, but suggests improvement in the water quality, habitat, and biological communities of the Rocky River in recent years.

6.14.2.10 Cuyahoga River
The following information was assembled from *Total Maximum Daily Loads for the Middle Cuyahoga River* (Ohio EPA 2000), *Total Maximum Daily Loads for the Lower Cuyahoga River* (Ohio EPA 2003a), and *Total Maximum Daily Loads for the Upper Cuyahoga River* (2004b).

The Cuyahoga River is 84.9 miles long and drains 813 square miles in Geauga, Portage, Summit and Cuyahoga counties before emptying into Lake Erie at Cleveland. The river is one of the few rivers in the world that changes flow direction and creates a u-shaped watershed. The basin is situated within the Erie-Ontario Drift and Lake Plain (EODLP) ecoregion, characterized by glacial formations that can have a significant local relief of up to 300 feet and exhibits a mosaic of cropland, pasture, woodland, and urban areas. Land use patterns vary greatly from the upper basin that is primarily forest/agricultural/rural, to the lower basin which is among the most densely populated and industrialized urban areas in the state. The Cuyahoga River, from the Ohio Edison Dam to the mouth and the nearshore area has been identified as an Area of Concern (AOC) by the International Joint Commission.

Upper River
The upper Cuyahoga River flows through Geauga and Portage counties. This portion of the watershed is predominately rural in nature with significant amounts of wetlands. Based on Ohio EPA's monitoring, a number of water bodies within this watershed appear on Ohio's list of impaired waters. The Ohio EPA identified the upper Cuyahoga River watershed as a priority impaired water in 2002. The primary causes of impairment in the upper Cuyahoga River watershed are hydromodification, nutrient enrichment, low dissolved oxygen, and habitat degradation.

Among mainstem stations evaluated within the upper Cuyahoga River, only 33% were found to support an assemblage of fish fully attaining the Warmwater Habitat (WWH) aquatic life use designation. The majority of the stream reaches in this segment were characterized by low stream gradient, historic channel modification, hydromodification, and influences from extensive natural wetland complexes. Fish and macroinvertebrate communities were in non and partial attainment of WWH in the upper reaches of the mainstem downstream from East Branch reservoir. The stream reaches upstream from East Branch reservoir were found to be fully attaining Ohio's WWH biocriteria.

Much of the West Branch of the Cuyahoga is a low gradient swamp-marsh influenced stream with attendant habitat limitations, and consequently the fish community is limited by the habitat. Despite these limitations, excellent habitat features are present owing to light development in the watershed, and as a result, biological community health throughout most of the West Branch was quite good.

Middle River
The middle Cuyahoga River watershed covers portions of Portage, Summit and Stark Counties. The middle Cuyahoga River mainstem has been identified as a priority impaired water on Ohio's list of impaired waters. Biological and chemical stream surveys from 1989 through 1998 indicated that habitat alteration, excessive nutrient levels, and low dissolved oxygen were the primary causes of impairment in this stream segment. Index of Biotic Integrity (IBI) scores decrease downstream from Lake Rockwell relative to the free-flowing reach upstream primarily because the river is impounded, causing habitat loss and resulting in an increase in the relative abundance of tolerant fishes. Modified Index of Well-being (MIwb) scores also decreased in the reach downstream from Lake Rockwell. Consequently, neither fish index met the respective WWH criterion. The invertebrate community, being less dependent on habitat, was found to be in better condition than the fish community.

Lower River
The Lower Cuyahoga River watershed flows through Summit and Cuyahoga counties before emptying into Lake Erie. Historical pollution has occurred in this section of the river as a result of heavy industrial and urban centers located between the cities of Akron and Cleveland. Based on Ohio EPA's monitoring of the Lower Cuyahoga River watershed, a number of streams appear on Ohio's list of impaired waters. Organic enrichment, nutrients, bacteria, flow alteration, toxicity, and degraded habitats are cited as the primary causes of impairment. Physical habitat attributes in most of the mainstem and tributaries are generally of high quality and typically include natural stream channels, coarse substrates and wooded riparian corridors.

Biological impairment in the Cuyahoga River downstream from Akron was manifest most strongly in the fish. Fish communities were poor or very poor at nearly all sites between Akron and Cleveland. Both fish and macroinvertebrate communities were in the fair to very poor ranges downstream from the Akron. In contrast to the fish communities, macroinvertebrates gradually improved and reached very good to exceptional quality upstream from Cleveland. Biological community health declined below Akron but year 2000 results showed significant improvement over past surveys.

Sampling downstream from Tinkers Creek found the first Full attainment of WWH ever recorded by Ohio EPA in the Cuyahoga River downstream from Akron. Full attainment is believed to extend downstream to the confluence with Mill Creek. Downstream of Mill Creek the fish communities declined to the poor range. Fish improved to fair downstream from Southerly resulting in partial attainment.

The lower section of the Cuyahoga River contains a navigation channel. Ohio EPA sampling indicates that adult fish are able to utilize the navigation channel for passage upstream to suitable habitat. Cumulative loadings and flows from steel plant outfalls make it one of the largest point source discharges in the Cuyahoga River basin. Poor and very poor biological communities coincide with the lack of suitable habitat, low dissolved oxygen, and chronically elevated ammonia and zinc levels between the steel plant and Lake Erie.

A more detailed discussion of the Cuyahoga River watershed is provided in the Lake Erie Tributaries Conservation Opportunity Watersheds later in this section.

6.14.2.11 Chagrin River
The following information was assembled from *Biological and Water Quality Study of the Chagrin River and Selected Tributaries 2003-04* (Ohio EPA 2006b), and *Total Maximum Daily Loads for the Chagrin River Watershed* (Ohio EPA 2007d).

The Chagrin River is located in northeast Ohio, flowing through Portage, Geauga, Cuyahoga, and Lake Counties on its way to Lake Erie. The Chagrin River watershed is located in the Erie-Ontario Drift and Lake Plain (EODLP), which is formerly glaciated and characterized by low rounded hills, scattered end moraines, kettles, and areas of wetlands. The resulting soils and geologic deposits contribute to the high quality and varied habitats of the watershed. The Main Branch of the Chagrin River begins as the Upper Main Branch above Bass Lake in Geauga County, and flows over 49 miles before entering Lake Erie in the City of Eastlake, comprising a drainage area of 267 square miles.

The Chagrin River is deeply entrenched over the lower 25 miles of its length and flows on bedrock in narrow valleys through much of the watershed. The southern portion of the watershed is a mixture of urban development, agricultural land uses, and forest. The southern and western portions of the watershed are predominantly comprised of urban development. Primary land cover in the basin is forest 65.4%, commercial/industrial/residential 21.2%, crops 7.6%, pasture/urban/recreational grasses 3.2%, and wetlands 1.2%.

The Aurora Branch, East Branch, and Chagrin mainstem are included in the State of Ohio Scenic River system. Seventy-one miles of streams in the watershed are designated as a Scenic Rivers. Stream impacts are generally noted in the tributary streams, while the main stem is generally meets aquatic life-use designation. Although the watershed is experiencing significant development pressure from Cleveland's population migration to outlying suburbs, the majority of the river retains its riparian forest cover. The river valley offers a diversity of terrestrial and aquatic plant communities, wildlife, unique rock outcroppings, and extensive headwater wetlands.

Overall, habitat quality in the Chagrin River watershed is very good. Of the sites assessed, only 7.1% failed to meet the QHEI Warmwater Habitat (WWH) score minimum. However, the Ohio EPA identified the Chagrin River as a priority impaired water on the 2004 and 2006 lists of impaired waters. Studies show that organic enrichment, nutrients, flow alteration, and degraded habitats are the primary causes of impairment. Stream surveys conducted in 2003 and 2004 found impairments for some biological communities.

Upper River
The upper reaches of the Chagrin River do not completely meet applicable biocriteria. Fish communities in the upstream-most (upper 7.5 miles) sampling locations were all degraded by direct channelization, and by removal of riparian habitat. Macroinvertebrate communities also show signs of impact, but most sites sampled met WWH biological criteria. The river recovers to full attainment downstream of the headwaters, and maintains full attainment to downstream from the Aurora Branch confluence. Several sites in this area demonstrate exceptional biological communities. The section between Dewdale Creek and the Aurora Branch contained a very good to exceptional macroinvertebrate community.

The Aurora Branch shows impairments of both fish and macroinvertebrate indices. The fish community showed an elevated relative abundance of pollution tolerant species and omnivores. The stream generally recovers to full attainment farther downstream. Ninety-three percent of macroinvertebrate samples collected in the Aurora Branch of the Chagrin River met their aquatic performance expectations. The Aurora Branch and its tributaries, despite having the highest combined intensity of agricultural and residential land use in the basin, generally had good to excellent habitat. Approximately two-thirds of the tributaries sampled in this part of the Chagrin basin are designated Coldwater Habitat (CWH). Where habitat is intact and stable, brook trout reintroductions have been successful in a number of small tributaries in the upper Chagrin and Aurora Branch subwatersheds.

Lower River
The entire lower mainstem of the Chagrin River is in full attainment of its life-use biocriteria. Habitat quality in the mainstem of the Chagrin River downstream from the confluence with the Aurora Branch is good to excellent, and possesses all the necessary attributes to fully support a diverse and robust fish community. Overall, the lower mainstem macroinvertebrate community quality was generally very good with Invertebrate Community Index (ICI) scores ranging from good to exceptional.

The East Branch Chagrin River, due to habitat and flow alterations declined in the upstream reaches and did not meet its designated CWH aquatic life use in the lower mainstem. The East Branch is unique among Ohio streams in that it harbors a strong population of longnose dace, a coolwater/coldwater fish species with the southern limit of its distribution in Northeast Ohio. Most sites sampled in the East Branch and its tributaries harbored fish communities that met numeric water quality standards for biological integrity. The strong population of longnose dace and the presence of numerous young-of-the-year steelhead trout in the mainstem and tributaries indicate that the East Branch continues to maintain its coldwater character. The macroinvertebrate community in the East Branch was rated exceptional in upstream areas, with a very good macroinvertebrate community present downstream. There are several small cold-water tributaries to the Chagrin River that serve as some of the few remaining streams supporting naturally reproducing brook trout in Ohio.

A more detailed discussion of the Chagrin River watershed is provided in the Lake Erie Tributaries Conservation Opportunity Watersheds later in this section.

6.14.2.12 Grand River

The following information was assembled from *Biological and Water Quality Study of the Grand River Basin 2003-2004* (Ohio EPA 2006c), Biological *and Water Quality Study of the Grand River Basin* (Ohio EPA 2009a), *Total Maximum Daily Loads for the Grand River (lower) Watershed* (Ohio EPA 2012c), and *Total Maximum Daily Loads for the Grand River (upper) Watershed* (Ohio EPA 2013b).

The Grand River is located in northeastern Ohio and drains a total of 707 square miles as it flows through all or part of Ashtabula, Geauga, Lake, Portage, and Trumbull counties. The watershed is a mixture of forest, agricultural land (crops, pasture, hay), and urban land. The Grand River basin is contained within the Erie-Ontario Drift and Lake Plain (EODLP) ecoregion. Portions of the 102.7 mile long Grand River have Wild and Scenic River designations.

Upper River

The upper Grand River flows through Ashtabula, Geauga, Portage and Trumbull counties and drains 418 square miles. Land cover in the upper Grand River watershed is dominated by forest (41.5%), cultivated crops and pasture lands (36.1%), and wetlands (8.9%). A large complex of wetlands is located near the center of the watershed, and forest and agricultural lands are spread throughout the watershed. Developed land (6.3%) is primarily located in the northern portion of the upper watershed.

The condition of biological communities in the upper Grand River basin is governed principally by post-glacial physiography. The dominant feature of the basin is the glacial lake-plain and lacustrine deposits which have essentially resulted in three classes of streams: lowland streams, upland headwaters, and the Grand River mainstem. Because the lowland streams are sluggish and have fine-grained substrates, they cannot in all cases be reasonably expected to support biological communities typical of the ecoregion. At the other extreme, some of the headwaters drain areas where bedrock is very close to the surface, and consequently, flow is not sustained through the summer because the shallow soil horizon does not store water. Apart from these natural limitations, some of the sites evaluated in the upper watershed were impacted by pollution or loss of habitat.

Non and partial attainment of aquatic life-use criteria in the watershed tended to result from natural conditions (flow or habitat), excess nutrients, and organic enrichment. Sixty-three percent of sites assessed within the watershed by the Ohio EPA fully attained water quality standards, 23% partially attained, and 14% were in non-attainment. Overall habitat QHEI scores ranged from fair to excellent in the headwaters of the Grand River subwatershed. Where the topography is flat, and the substrates are composed primarily of lacustrine silts and clays, habitat quality was generally poor and not conducive to stream faunas typical of the ecoregion. The headwaters on the western side tend to have high gradients, and possess the energy to form well-developed channels through coarse substrates. Typically, the faunas in these headwaters were not limited by habitat quality.

Within the headwaters area, the Grand River transitions rapidly from a small upland coldwater stream, to a large lowland swamp stream. Near the northern subwatershed boundary, the river begins to support a fauna typical of larger streams and rivers including redhorse suckers and walleye. Fish communities were sampled at several locations along the Grand River mainstem. Headwater sites above RM 88.5 did not meet applicable standards, but fish communities met criteria for Warmwater Habitat (WWH) from RM 88.5 downstream to RM 48.6. Northern brook lamprey ammocoetes and sand darters were found in the Grand River near RM 88.5. Starting at RM 44.5 the Grand River is designated Exceptional Warmwater Habitat (EWH). Functionally, the fish community at the site represents one of the closest approximations Ohio has to an intact, lowland, large river fish fauna. No other river in Ohio has native, naturally reproducing populations of muskellunge, northern pike and walleye occurring together.

Macroinvertebrate communities collected from the three most upstream stations on the Grand River (above RM 94.3) were performing at an exceptional level with high diversity and sensitive taxa. The remaining Grand River sites were located in a lowland area with low gradient (glacial Grand River Lake lacustrine deposits). Macroinvertebrate communities at these stations were performing at good to exceptional levels, with generally lower diversity and sensitive taxa.

Lower River
The lower Grand River flows through Lake, Ashtabula and Geauga counties and drains 287 square miles. The river empties into Lake Erie at Painesville. The Grand River downstream from Mill Creek transitions from a low-gradient swamp stream to a higher-gradient bedrock stream. Land use in the lower Grand River watershed transitions from urban/suburban on the western edge to rural and agricultural in the eastern two-thirds. The watershed is a mixture of forest (43%), agricultural land (29%), and urban land (16%).

The character and physical habitat of the Grand River changes abruptly near RM 44.5 where the river makes its westward turn toward Lake County and its eventual union with Lake Erie. Upstream from RM 44.5 the river flows through the lacustrine deposits of a former glacial lake. There, the river is a classic swamp-wetland type stream with low gradient (<1 ft/mi), fine sediments (typically small gravels to clay), and few riffles. Consequently, large woody debris, rootwads, rootmats, undercut banks and deep pools characterize the habitat. The fish fauna in this reach very much resembles a swamp-stream association: trout-perch, silver redhorse, sunfish and blackside darters are common. The wetland environs also provide spawning habitat for the Great Lakes muskellunge and northern pike. A native population of walleye exists as well. In short, the habitat in this reach of the Grand River supports one of the few intact type-locality faunal assemblages found anywhere in Ohio.

Downstream from RM 44.5 the gradient increases and the river flows in a series of pools, glides, runs, and riffles through a shale gorge. Long stretches of shallow bedrock alternate with aggregations of glacial till to form glides and riffles, and deeper pools exist where the river erodes former depositional areas. Water quality in the river is protected by the shale gorge that the river flows through and the scouring flows that formed it – the steep bluffs and regular flooding generally preclude development within the floodplain. Habitat quality in this reach of the river is among the best anywhere in Ohio.

In 2003 and 2004, the Ohio EPA evaluated the biological health and water quality of the lower Grand River watershed. The results of that survey show that the Grand River and its tributaries continue to harbor a rich and diverse biological assemblage containing many rare and threatened species, and several state endangered species. Fish communities in the Grand River have an exceptionally high degree of biological integrity. This is evident in the consistently high Index of Biotic Integrity (IBI) scores along the length of the mainstem and in the unusually high percent composition of pollution intolerant species. The population of Great Lakes muskellunge subspecies (*Esox masquinongy masquinongy*) in the Grand River may well be a truly endemic strain. As it stands, it is the last naturally reproducing muskellunge population found in any of Ohio's Lake Erie tributaries.

Aquatic life in the Grand River is fully attaining standards for EWH from RM 42.2 to RM 5.2, and is fully meeting standards for WWH downstream from there. The entire free-flowing Grand River mainstem sampled in this study from RM 44.0 to 6.1 was supporting exceptional macroinvertebrate communities. High numbers of sensitive taxa and sensitive taxa diversity existed throughout this reach. In addition, three lacusturine stations scored high on the lacustrine Invertebrate Community Index (ICI). The free flowing lower Grand River has maintained exceptional macroinvertebrate communities since the late 1980s. ICI scores and sensitive taxa diversity in 2004 were as high or higher than previous years.

Twenty-three sensitive taxa (excluding freshwater mussels) found in this assessment unit are noteworthy because they are not commonly collected in statewide collections. In addition to these, the state listed Species of Concern crayfish *Orconectes propinquus* (Great Lakes Crayfish) was collected at 19 of the 35 stations in this assessment unit. Seventeen species of freshwater mussels (Unionidae) were collected from the lower Grand River. In total, this study found two state endangered species, three state Threatened species, and four state Species of Concern to be present in the lower Grand River basin. This assessment unit had an unusually high number of uncommonly collected sensitive taxa and state listed species, which is an indication of the exceptional resource quality in the lower Grand River basin.

A more detailed discussion of the Grand River watershed is provided in the Lake Erie Tributaries Conservation Opportunity Watersheds later in this section.

6.14.2.13 Ashtabula River

The following information was assembled from *Biological and Water Quality Study of The Grand and Ashtabula River Basins including Arcola Creek, Cowles Creek and Conneaut Creek* (Ohio EPA 1997), *Biological Study of the Lower Ashtabula River and Conneaut Creek* (Ohio EPA 2006a), and *Fish Community Aquatic Life Use Attainment Study Upper Mainstem Ashtabula River, 2007* (Ohio EPA 2007c).

The Ashtabula River is a tributary to Lake Erie that drains an area of about 137 square miles. The majority of the watershed is contained within Ashtabula County in Ohio, with 8.91 square miles located in Pennsylvania. The mainstem of the Ashtabula River is 27.55 miles long, beginning at the confluence of the East and West Branches, and discharging into Lake Erie in the City of Ashtabula. The lacustrine portion (where water levels vary with the elevation of Lake Erie) of the Ashtabula River extends to river mile 2.5. The Ashtabula River mainstem has an average gradient of 11.6 feet per mile. The Ashtabula River watershed is located within the Erie-Ontario Drift and Lake Plain ecoregion (EODLP).

The southern portion of the watershed is a mixture of agricultural land and forest. The northern portion of the watershed includes some urban development near the Lake Erie shoreline. The Ashtabula River is designated a State Scenic River and has 46 continuous designated river miles on three stream segments including the mainstem (25 miles), East Branch (12 miles), and West Branch (9 miles).

Upper River

Habitat quality as assessed by the Qualitative Habitat Evaluation Index (QHEI) was found to be more than suitable to support the Warmwater Habitat (WWH) aquatic life use throughout the monitored reach. Land cover within the study area is dominated by forest and mixed agricultural uses. The riparian corridor along the Ashtabula River within the study area was almost completely forested.

Fish community assessments were conducted in 2007 along the upper reaches of the Ashtabula River mainstem in Ashtabula County to determine the attainment status for the WWH aquatic life use. Survey results for both the Index of Biotic Integrity (IBI) and the Modified Index of Well-being (MIwb) were in Full attainment of the ecoregional criteria for the fish community. A total of 24 fish species were collected during the survey. Most notable among the species collected were the northern bigeye chub and the northern mimic shiner. Both are listed as declining fish species in Ohio. Healthy populations of both species were found at all three sampling locations. In addition, all three sites supported robust populations of rock bass and smallmouth bass. The presence of larval sea lamprey in the Ashtabula River study area indicates that the river is breeding habitat for this invasive species. The 2007 survey of the upper portion of the Ashtabula River did not include an assessment of macroinvertebrate communities.

Lower River
The lower Ashtabula River empties into Lake Erie at Ashtabula, where the mouth and immediate upstream area have been modified to accommodate commercial shipping. The bottom sediments, bank soils, and biota of Ashtabula tributary Fields Brook (approximately RM 1.6) have been severely contaminated by unregulated discharges of hazardous substances. Hazardous substances have migrated downstream from Fields Brook to the Ashtabula River and Harbor, contaminating bottom sediments, fish, and wildlife. The lower two miles of the Ashtabula River and its outer harbor were designated an Area of Concern due to severe pollution problems by U.S. EPA in 1988.

Fish and macroinvertebrate communities were sampled in the lacustrine areas of the Ashtabula River during 2003 and 2005 by the Ohio EPA and U.S. Fish and Wildlife Service. Partial attainment of the interim lacustrine Index of Biotic Integrity (IBI) and Modified Index of Well-being (MIwb) biocriteria for fish was noted in the Ashtabula River at RM 1.3 during 2005. Lacustrine IBI scores were in the fair to good range, and MIwb scores were reflective of fair to good conditions. Fish species considered moderately to highly intolerant of pollution were collected in this lacustrine area – these included included silver redhorse, black redhorse, golden redhorse, smallmouth bass, brook silverside, and logperch.

In the lower Ashtabula River, the macroinvertebrate community was exceptional to good at the upstream sites, but in the vicinity of Fields Brook the macroinvertebrate community was poor to very poor. The macroinvertebrate community improved downstream and returned to good condition at the most downstream sampling location. The macroinvertebrate community is impaired within the area where Fields Brook flow mixes with the Ashtabula River.

6.14.2.14 Conneaut Creek
The following information was assembled from *Biological and Water Quality Study of The Grand and Ashtabula River Basins including Arcola Creek, Cowles Creek and Conneaut Creek* (Ohio EPA 1997), and *Biological Study of the Lower Ashtabula River and Conneaut Creek* (Ohio EPA 2006a).

The Conneaut Creek basin drains an area of 38 square miles in extreme northeast Ohio. The entire watershed, including the portion in Ohio, encompasses about 190 square miles. The Conneaut Creek mainstem originates south of Conneautville in Crawford County, Pennsylvania. In general Conneaut Creek flows in a northwesterly direction to the town of Conneaut where it enters Lake Erie. The mainstem is 56.8 miles in length, (22.3 in miles in Ohio). The Conneaut Creek mainstem has an average gradient of 11.3 feet per mile. All principal tributaries to Conneaut Creek are located in Pennsylvania.

The lower portion of the watershed is a mixture of urban development and forest. The upper portion of the watershed is predominantly comprised of forest, with some hay and pasture lands and cultivated crops. The Conneaut Creek watershed is situated within the Erie-Ontario Drift and Lake Plain ecoregion. The Ohio portion of Conneaut Creek is designated a State Wild and Scenic River.

The lacustrine area (estuary) is impacted from urbanized municipal and industrial activities. Major coal handling operations have resulted in layers of coal dust in the substrate. There are no marinas in Conneaut Creek harbor, however, the west shore has been bulkheaded and embankment reshaping has occurred along the eastern embankment. Most of the banks of Conneaut Creek in the lower two miles have been extensively modified with rip-rap and sheet piling. Undisturbed shorelines exist upstream from RM 2.0.

In the lacustrine zone, predominant bottom substrates included sand, muck, hardpan, and cobble, with lesser amounts of boulder, gravel, bedrock, and silt. Aquatic vegetation included pond lilies, wild celery, waterweed, cattail, Eurasian milfoil, and algae mats. Conneaut Creek lacustrine fish communities were in the fair to good range during 2003 and 2005. Modified Index of Well-being scores were fully attaining the interim lacustrine biocriterion during 2003 and 2005. Interim lacustrine Index of Biotic Integrity (IBI) results revealed attainment of the biocriteria during 2005. Conneaut Creek biological monitoring documented full attainment of the interim Lacustrine Invertebrate Community Index (LICI) biocriterion at all macroinvertebrate sampling locations during 2003. LICI scores were reflective of good to exceptional biological conditions.

Upstream, excellent habitat quality was noted at all sites evaluated. Fractured bedrock and glacial tills provided substrates with a variety of sizes and high complexity, and channel development was excellent. Riffles were free of embedding silt, and silt in the slower channels was confined to depositional areas. Wide mature riparian vegetation covered the undeveloped flood plain, providing woody debris for in-stream cover. Upstream fish communities in Conneaut Creek met Exceptional Warmwater Habitat (EWH) criteria at all sampling locations. Fish species considered moderately to highly intolerant of pollution collected in Conneaut Creek included silver redhorse, black redhorse, golden redhorse, shorthead redhorse, northern hog sucker, rosyface shiner, and smallmouth bass. Upstream macroinvertebrate communities were consistently in the exceptional range at all sampling locations. Invertebrate Community Index (ICI) scores, and mayfly/stonefly/caddisfly taxa richness were consistently among the highest in the survey. Conneaut Creek has consistently been among the highest quality streams in the state of Ohio with regards to macroinvertebrate community performance.

6.14.3 Associated Species of Greatest Conservation Need

The characteristics of Ohio’s Lake Erie tributaries change significantly from west to east, and with them the associated aquatic communities. Western tributary species tend to be more tolerant of degraded conditions, low stream gradient and velocity, turbidity, and compromised habitat. Eastern tributary aquatic communities contain species that require better habitat and water quality. All of Ohio’s Lake Erie tributaries are utilized by a number of lake fish species at certain times of the year. Several of the western tributaries experience significant spring spawning runs, and a number of eastern tributaries are used by steelhead during the cold weather months. Overall, generalist species are found across the entire gradient of tributaries, and species less tolerant of human disturbance tend to be more abundant in eastern tributaries.

The following species have been identified as Lake Erie Tributary species of greatest conservation need (conservation status rank in parentheses):

<u>Fish</u>	
Popeye Shiner (3)	*Notropis ariommus*
American Eel (5)	*Anguilla rostrata*
Lake Sturgeon (17)	*Acipenser fulvescens*
Blacknose Shiner (22)	*Notropis heterolepis*
Silver Lamprey (26)	*Ichthyomyzon unicuspis*
Eastern Sand Darter (29)	*Ammocrypta pellucida*
Western Banded Killifish (30)	*Fundulus diaphanus menona*
Silver Chub (36)	*Macrhybopsis storeriana*
Iowa Darter (38)	*Etheostoma exile*
Bigeye Chub (42)	*Hybopsis amblops*
Channel Darter (44)	*Percina copelandi*
Spotted Gar (45)	*Lepisosteus oculatus*
Black Redhorse (48)	*Moxostoma duquesnei*
Mooneye (50)	*Hiodon tergisus*
Silver Redhorse (52)	*Moxostoma anisurum*
Greater Redhorse (55)	*Moxostoma valenciennesi*
River Darter (61)	*Percina shumardi*
<u>Crayfish</u>	
Northern Clearwater Crayfish (4)	*Orconectes propinquus*
Sanborn's Crayfish (6)	*Orconectes sanbornii*
Big Water Crayfish (7)	*Cambarus robustus*
Paintedhand Mudbug (8)	*Cambarus polychromatus*
Little Brown Mudbug (9)	*Cambarus thomai*
Papershell Crayfish (13)	*Orconectes immunis*
Virile Crayfish (13)	*Orconectes virilis*

Mussels

Snuffbox (5)	*Epioblasma triquetra*
Eastern Pondmussel (8)	*Ligumia nasuta*
Purple Lilliput (15)	*Toxolasma lividum*
Slippershell Mussel (16)	*Alasmidonta viridis*
Rayed Bean (21)	*Villosa fabalis*
Creek Heelsplitter (23)	*Lasmigona compressa*
Rabbitsfoot (25)	*Quadrula cylindrica*
Salamander Mussel (25)	*Simpsonaias ambigua*
Clubshell (35)	*Pleurobema clava*
Purple Wartyback (37)	*Cyclonaias tuberculata*
Threeridge (40)	*Amblema plicata*
Round Hickorynut (42)	*Obovaria subrotunda*
Black Sandshell (47)	*Ligumia recta*
Kidneyshell (48)	*Ptychobranchus fasciolaris*
Northern Riffleshell (48)	*Epioblasma torulosa rangiana*
Rainbowshell (50)	*Villosa iris*
Round Pigtoe (50)	*Pleurobema sintoxia*
Elktoe (52)	*Alasmidonta marginata*
Deertoe (53)	*Truncilla truncata*
Fawnsfoot (53)	*Truncilla donaciformis*
Threehorn Wartyback (55)	*Obliquaria reflexa*
Cylindrical Papershell (56)	*Anodontiodes ferussacianus*

Amphibians

Mudpuppy (14)	*Necturus maculosus maculosus*

Reptiles

Midland Smooth Softshell (7)	*Apalone mutica mutica*
Common Map Turtle (19)	*Graptemys geographica*
Ouachita Map Turtle (19)	*Graptemys ouachitensis*
Queen Snake (19)	*Regina septemvittata*

6.14.4 Lake Erie Tributaries Conservation Opportunity Watersheds

6.14.4.1 Maumee River CO Watershed (consists of HUC 04100003, HUC 04100004, HUC 04100005, HUC 04100006, HUC 04100007, HUC 04100008, and HUC 04100009)

The Maumee River forms at the confluence of the St. Joseph River and the St. Marys River and flows about 140 stream miles to its mouth in Maumee Bay. The St. Joseph River and the St. Marys River are both ice front streams that flow along the outer edge of the Fort Wayne Moraine. These rivers discharged to the west before retreat of the glacial ice allowed flow along the present day Maumee. Each river is about 100 miles long. Drainage area of the St. Joseph River at Fort Wayne is 1,085 square miles while that of the St. Marys is 839 square miles.

East Branch and West Branch of the St. Joseph River gather headwaters in the morainal hills of southern Michigan and flow into Ohio joining north of Montpelier. All of the larger tributaries to the St. Joseph lie northwest of the river and gather headwaters in the Wabash Moraine. The largest of these tributaries are Fish Creek with a drainage area of 109 square miles and Cedar Creek with a drainage area of 273 square miles.

Headwaters of the St. Marys River gather along the St. Johns Moraine and flow northward through the Wabash Moraine to the Fort Wayne Moraine. Numerous small tributaries gather along the Wabash Moraine and join the St. Marys as it flows toward Fort Wayne. The largest of these tributaries are Black Creek with a drainage area of 54 square miles and Blue Creek with a drainage area of 82 square miles.

The drainage area of the Maumee River increases from 1,924 square miles at Fort Wayne to 2,315 square miles at Defiance through addition of relatively small drainages along its course, the largest being Gordon Creek with 44 square miles of drainage area. At Defiance, the drainage area of the Maumee and the size of the river channel increase dramatically with the addition of the Tiffin River drainage of 777 square miles and the Auglaize River drainage of 2,435 square miles.

The Tiffin River originates in the morainal hills northwest of Morenci, Michigan in the same general area as the East Branch of the St. Joseph River. Bean Creek, as the Tiffin River is known in Michigan, enters Ohio near Powers in Fulton County and flows southwestward to its confluence with the Maumee River at Defiance. The larger tributaries to the Tiffin in downstream order are Beaver Creek, Brush Creek, Lick Creek, and Mud Creek with drainage areas of 45, 66, 106, and 59 square miles, respectively.

The Auglaize River originates along the St. Johns Moraine and flows westward along the distal side of the Wabash Moraine to Wapakoneta where it turns abruptly northward. The river crosses the Fort Wayne Moraine as it enters Allen County and is joined by Jennings Creek with a drainage area of 69 square miles just north of Delphos. In Putnam County the Ottawa River with a drainage area of 365 square miles joins the Auglaize doubling its drainage area to 703 square miles. Not far downstream, the Blanchard River with a drainage area of 771 square miles joins the Auglaize, doubling its drainage area to 1,496 square miles. Major tributaries to the Auglaize between the Blanchard and the Maumee in downstream order include Little Auglaize River, Blue Creek, Flatrock Creek, and Powell Creek with drainage areas of 405, 108, 195, and 98 square miles, respectively.

From the confluence with the Auglaize River, drainage area of the Maumee River increases from 5,528 square miles to 6,608 square miles at Maumee Bay. The largest tributaries contributing to the increase in downstream order are South Turkeyfoot Creek, North Turkeyfoot Creek, Bad Creek, Beaver Creek, and Swan Creek with drainage areas of 149, 75, 65, 186, and 204 square miles, respectively.

The Ottawa River (Ten Mile Creek) lies north of the Maumee River and drains 172 square miles directly to Lake Erie. Some of the land west of the Ottawa River drainage in northern Fulton County drains to the River Raisin in Michigan.

Removal of forest cover in the Maumee River Basin for agriculture has been so extensive that only about 3 to 5 percent of the land remains wooded. Scattered woodlots and river corridors account for most of the woodland. The largest contiguous woodlands are on the Sand Plains in the Oak Openings Metro Park and Maumee State Forest.

Surface and subsurface drainage works completed to eliminate the Black Swamp and facilitate farming operations in the Maumee River Basin are some of the most extensive works of this type that exist anywhere. Most of the headwater channels and tributaries of the major streams in the southern part of the basin are channelized. Extensive surface drainage modifications were completed before systematic stream flow measurements began in the 1920s. Historic observations of flow conditions before major drainage work in the basin are sparse.

Physiography

The central portion of the Maumee River Basin is in the Huron-Erie Lake Plains while peripheral areas are in the Till Plains. The Ottawa River and bordering tributaries to the River Raisin are in the Lake Plains.

Headwaters of the St. Joseph River and its western tributaries gather along the Wabash Moraine in the Steuben Till Plain, a hummocky terrain of moderately low relief with rolling hills, interspersed flats and closed depressions, wetlands, and deranged drainage. The main stem of the river flows in the Central Ohio Clayey Till Plain along a highly sinuous course at average gradient of about 1.5 feet per mile. Headwaters of the St. Marys River gather along the St. Johns Moraine in the Central Ohio Clayey Till Plain. The St. Marys flows across the Central Ohio Clayey Till Plain at an average gradient of about 2.5 feet per mile and joins the St. Joseph River at the western edge of the Maumee Lake Plain. The moraine along the southern boundary of the basin is gently rolling and more subdued than the hummocky moraine along the boundary in the Steuben Till Plain.

The Maumee River between Fort Wayne and Defiance meanders along a winding course with a very low gradient of about 1.2 feet per mile. The river flows onto the Paulding Clay Bottom not far inside Ohio and joins the Tiffin and Auglaize River at the eastern edge of the Paulding Plain in Defiance.

Headwaters of the Tiffin River gather in the hummocky terrain of the Steuben Till Plain and flow across the Central Ohio Clayey Till Plain onto the Maumee Lake Plain. The Tiffin flows across the Maumee Sand Plains in Fulton County as does Brush Creek, its major eastern tributary. Along its lower reaches, the Tiffin flows across the Paulding Clay Bottom.

Headwaters of the Auglaize River gather along the St. Johns Moraine in the Central Ohio Clayey Till Plain. The river flows along a winding course at average fall of about 3.2 feet per mile northward to its confluence with the Maumee. The Auglaize crosses from till plain to the lake plain in northern Allen County and enters the Paulding Clay Bottom in Putnam County. The largest tributary to the Auglaize, the Blanchard, originates in Hardin County on the Central Ohio Clayey Till Plain and flows north to the Findlay Embayment, a lacustrine plain with relatively coarse sediments. The Blanchard flows at average fall of about 1 foot per mile along the Findlay Embayment and Defiance Moraine onto the Paulding Clay Bottom in western Hancock County. Streams in the Auglaize River Basin have cut through thin till to bedrock in many locations. Channel bottoms of bedrock with shifting alluvial sediments are common along lower reaches of the Blanchard River.

The Maumee River between Defiance and Maumee Bay flows in a much more linear pattern than the reach between Fort Wayne and Defiance. Gradient of the river is very low averaging about 1.2 feet per mile, but the gradient varies considerably. Between Waterville and Maumee, the river flows on bedrock at gradient of about 5 feet per mile. North Turkeyfoot Creek, South Turkeyfoot Creek, and Beaver Creek are mainly confined to the Lake Plains while Bad Creek and Swan Creek flow across areas of the Sand Plains before joining the Maumee. Waters of the Ottawa River gather on the Lake Plains and flow across the Sand Plains to the lake.

<u>Geology</u>
The Maumee River Basin lies along the western flank of the Findlay Arch where Silurian, Devonian, and Mississippian-age rocks occur at or near the surface. Rocks in the eastern part of the basin along the axis of the arch are the oldest with successively younger rocks surfacing toward the northwestern part of the basin. The bedrock in the basin is relatively dense with limited ground water storage in rock fractures. Although rock exposures along streams in the basin are common, the effect of ground water discharge from the rock on base flows is not great.

Surficial deposits in the Lake Plains portion of the basin consist of wave-planed glacial till and lacustrine deposits of fine sand, silt, and clay. These deposits are of low permeability in most areas, but deep deposits of relatively permeable sand exist mainly in the sand plains. Beach ridges in the Lake Plains generally consist of shallow permeable sand with limited ground-water storage that is typically perched on top of low permeability till or lake clays.

Surficial deposits in the Till Plains portion of the basin consist of glacial drift and lacustrine deposits. The glacial drift is in the form of ground moraine with a series of end moraines superimposed as morainal belts. Thickness of the ground moraine atop the bedrock varies greatly within the basin and is generally of low permeability. Lens of permeable sand and gravel are common in much of the thicker ground moraine. Some lacustrine areas of relatively impermeable silt and clay exist amid the ground moraine in the southern portion of the basin.

Four morainal belts cross the southern portion of the basin including the Defiance, Fort Wayne, Wabash, and St. Johns. Portions of the St. Johns Moraine along the southern boundary of the basin contain permeable sands and gravel in the form of kames and eskers. The other moraines contain limited amounts of permeable deposits. The Fort Wayne and Wabash Moraines extend northward from Fort Wayne across extreme northwestern Ohio into southern Michigan. Deep permeable sands and gravel along these moraines store considerable ground water to sustain stream flows.

Soils
The Lake Plains in the central portion of the Maumee River Basin are dominated by Hoytville-Nappanee-Paulding-Toledo soils. The Till Plain portions of the basin are dominated by Blount-Pewamo-Glywood soils.

Slowly permeable Hoytville clay loam is the most wide spread soil in the Maumee Lake Plains. Toledo clay soils dominant the Paulding Clay Plain and lake plain areas in and around Toledo. The Sand Plains and beach ridges contain areas of moderate to rapidly permeable soils including Ottokee, Tedrow, and Oakville sandy loams and sands.

The extensive areas of slowly permeable soils and limited ground water storage that exist in most of the basin results in low volumes of ground water discharge to sustain base flows of streams. Streams that gather headwaters in the morainal hills along the northwestern part of the basin, however, receive substantial ground water discharge to sustain base flows.

Water Development
The relatively flat topography of the Maumee River Basin presents few good sites for development of on-stream reservoirs, and not many large ones have been constructed. Cedarville Reservoir on the St. Joseph River is an important on-stream reservoir that supplies Fort Wayne. At Defiance, there is a relatively large hydroelectric power dam on the Auglaize River. Grand Lake straddles the Lake Erie-Ohio River divide capturing water from tributaries of the Wabash River and St. Marys River for the Ohio-Erie Canal. There are three large low head dams of canal era vintage on the Maumee River at Independence and Grand Rapids.

Off-stream reservoirs are well suited for storage of water supply in the Maumee River Basin and are common. These reservoirs are created by enclosing land with earth embankments. Water is pumped from nearby streams during high flow periods to fill the impoundment. Communities in the basin with off-stream storage reservoirs include: Lima, Van Wert, Paulding, Findlay, Ottawa, Archbold, Wauseon, Delta, Swanton, and Metamora.

Many of the smaller communities in the Maumee Basin obtain adequate source of supply from bedrock aquifers, but development of large quantities of supply from these aquifers is generally restrained by dewatering conflicts and highly mineralized water at greater depths.

Abundant sand and gravel deposits in deep till in extreme northwestern Ohio and neighboring areas of Michigan and Indiana yield ground water for communities in the area. Auburn, located along Cedar Creek in Indiana, has the largest ground water supply system in the Maumee Basin. Wapakoneta with the second largest is situated over a sizeable outwash area along the Wabash Moraine.

Many industries in the Maumee Basin obtain part or all of their supply from ground water sources. Return flows from independent industrial supplies significantly augment stream flows at Fort Wayne and Lima.

Most communities located along the Maumee River downstream from Fort Wayne obtain supply from the river. Bowling Green, although not located along the river, obtains its supply from the river and discharges wastewater to the Portage River Basin. Toledo and Oregon obtain large quantities of water supply directly from Lake Erie. Toledo distributes water as far west as eastern Fulton County.

Flow Characteristics
The Maumee River Basin includes streams with some of the lowest mean annual flows in the state. Mean annual runoff of the Maumee River at Waterville equates to 10.7 inches, ranking at the low end of the range for Ohio streams. Mean annual precipitation is relatively low and fairly evenly distributed across the basin such that mean annual runoff of streams deviates little from that at Waterville.

Mean annual runoff is slightly higher in the northwestern part of the basin than elsewhere. Mean annual runoff of the St. Joseph River and Tiffin River each equate to about 11 inches. The Maumee River at Antwerp has mean annual flow of 10.9 inches, an amount that is representative of runoff from both the St.

Marys River and St. Joseph River. Mean annual runoff of streams in the southern portion of the basin is generally lower than those in the northwestern part of the basin. Mean annual flow of the Auglaize River near Defiance is 10.4 inches. Municipal and industrial water supply operations at Lima result in relatively high mean annual flow of 11.1 inches in the Ottawa River at Allentown. The Blanchard River at Findlay with 10.1 inches of runoff is the lowest registered in the basin. Mean annual runoff of the Ottawa River at Toledo and Swan Creek are probably at least as low as the Blanchard because of lower mean annual precipitation near the lake.

Base-flow characteristics of streams in the Maumee River Basin are much more variable than mean annual flow characteristics. Mean base-flow indices indicate that ground water may contribute as little as 25 percent of mean annual flow of streams in the southern till plains area of the basin while streams in the northwestern part may derive as much as 65 percent of mean annual flow from ground water discharge. Streams in the latter category include the St. Joseph River and Tiffin River that originate in the morainal hills of southern Michigan and receive ground-water contributions from abundant sand and gravel deposits. The relatively low mean base-flow index of Unnamed Tributary to Lost Creek at Farmer of 25.6 is noteworthy because it is indicative of the minimal ground water that tributaries to the lower Tiffin River receive from the inner flank of the Fort Wayne Moraine. Streams representative of the relatively low base-flow indices in the southern portion of the basin include Town Creek near Van Wert that originates on the inner flank of the Fort Wayne Moraine and Eagle Creek at Findlay that originates on the ground moraine south of Findlay. Swan Creek with a relatively high mean base-flow index of 50 apparently receives substantial ground-water contribution from the extensive deep sand deposits of the Maumee Sand Plains.

Fifty percent duration flows of streams in the Maumee River Basin vary in similar manner as the base-flow indices. The median flows for streams in the upper basin are moderate at about 0.3 cfs per square mile indicating moderate amounts of ground-water storage to sustain base flows. Fifty percent flows of streams in the southern till plain areas of the basin are relatively low, averaging about 0.2 cfs per square mile indicating minimal amounts of ground-water storage to sustain flows. The 50-percent duration flow of the Maumee River at Waterville of 0.27 cfs per square mile indicates moderate amounts of ground-water storage exist in the basin to sustain base flows. The 50-percent duration flow of 0.37 cfs per square mile for the Maumee River near Defiance is unusually high, but is the result of a relatively short and wetter period of record. The lowest 50-percent duration flows occur in the Blanchard River Basin. Eagle Creek with 50-percent duration flow of 0.11 cfs per square mile is very low.

Streams in the western and northwestern parts of the Maumee River Basin have higher 90-percent duration flows than those in other parts of the basin. Bean Creek at Powers with 90-percent duration flow of 0.08 cfs per square mile is highest in the basin. Tributaries downstream of Powers like Beaver Creek near Stryker with 90-percent duration flow of 0.03 cfs per square mile contribute relatively less ground water to sustain stream flow resulting in 90-percent duration flow for Tiffin River at Stryker of 0.06 cfs per square mile. East Branch of St. Joseph River near Pioneer with 90-percent duration flow of 0.06 cfs per square mile is representative of the St. Joseph Basin. The 90-percent duration flow of 0.07 cfs per square mile of the Maumee River at Antwerp reflects augmentation at Fort Wayne as the relative base flow in the St. Marys River is less than in the St. Joseph River.

The 90-percent duration flows of streams in the Auglaize River Basin are low compared to those in the upper part of the Maumee Basin. The 90-percent duration flow of the Auglaize River near Defiance of 0.017 cfs per square mile is representative of base-flow conditions in the basin. The Auglaize River at Uniopolis gathers along the St. Johns Moraine where it receives limited ground-water contribution to sustain 90-percent duration flow of 0.013 cfs per square mile. The 90-percent duration flow of the Auglaize River at Buckland reported in Bulletin 40 is 0.025 cfs per square mile. Ground-water contributions from outwash deposits at Wapakoneta and wastewater discharge add to base flow at the Buckland station. The 90-percent duration flow of the Auglaize River near Fort Jennings is relatively high at 0.05 cfs per square mile reflecting further contribution to base flow from Grand Lake canal diversions and wastewater discharge at Delphos. The 90-percent duration flow for Ottawa River at Allentown of 0.119 cfs per square mile is exceptionally high for the Maumee Basin and due primarily to wastewater discharge at Lima and return flows from independent industrial supplies. Smaller streams such as the Blanchard River at Mount Blanchard and Eagle Creek near Findlay have 90-percent duration flows of zero or near zero. The 90-percent duration flow of the Blanchard River at Findlay of 0.025 cfs per square mile is relatively low despite the gage location directly downstream of the wastewater outfall for Findlay. The relatively low 90-percent duration flow of 0.008 cfs per square mile for North Turkeyfoot Creek near Liberty Center is typical of tributary streams in clayey areas of the Maumee Lake Plain.

The relatively high 90-percent duration flow of the Ottawa River at Toledo of 0.06 cfs per square mile is for a period of record that includes substantial upstream wastewater discharge at Sylvania. Bulletin 40 gives 90-percent duration flow of 0.008 cfs per square mile based on period of record before relatively large amounts of wastewater where discharged.

The 10-percent duration flows of streams in the Maumee River Basin are relatively low averaging about 2.2 cfs per square mile. Peak discharges for 2-year recurrence interval floods are also relatively low averaging about 8 cfs per square mile for the larger streams and proportionately more for smaller streams. Low permeability of soils in much of the basin favors direct surface runoff, but the flat topography tends to attenuate flood peaks. Areas of hummocky terrain in the northwestern parts of the basin contain large amounts of natural storage that attenuates flood peaks. Floods in the Maumee Basin are characterized by slowly rising flood stages of prolonged duration. Extensive channelization in the basin has resulted in many enlarged channels.

<u>State Listed Species by County with Records of Occurrence from the Maumee River Watershed</u> (from the Ohio Natural Heritage Database)
The following species are dependent upon aquatic habitats to complete their life cycle – this dependence may be for all or a portion of their life:

Williams County
Eastern cricket frog, blanding's turtle, spotted turtle, copperbelly watersnake, Canada darner, mottled darner, marsh bluet, plains clubtail, lilypad forktail, chalk-fronted corporal, frosted whiteface, blackchin shiner, pugnose minnow, lake chubsucker, Iowa darter, greater redhorse, eastern sand darter, wavyrayed lampmussel, creek heelsplitter, clubshell, round pigtoe, kidneyshell, rabbitsfoot, salamander mussel, purple lilliput, rayed bean, purple wartyback, white catspaw, northern riffleshell, black sandshell

Fulton County
Blanding's turtle, four-toed salamander, greater redhorse

Lucas County
Eastern cricket frog, spotted turtle, Blanding's turtle, Kirtland's snake, persius dusky wing, plains clubtail, frosted elfin, chalk-fronted corporal, frosted whiteface, Canada darner, channel darter, greater redhorse, lake sturgeon, muskellunge, round pigtoe, fawnsfoot, deertoe, rayed bean, eastern pondmussel, black sandshell, threehorn wartyback, purple wartyback, creek heelsplitter

Defiance County
Eastern cricket frog, marsh bluet, greater redhorse, elktoe, purple wartyback, northern riffleshell, black sandshell, threehorn wartyback, clubshell, round pigtoe, rabbitsfoot, fawnsfoot, deertoe

Henry County
Spotted turtle, Blanding's turtle, Kirtland's snake, four-toed salamander, greater redhorse, eastern sand darter, threehorn wartyback, creek heelsplitter, deertoe

Wood County
Eastern cricket frog, four-toed salamander, river redhorse, muskellunge, eastern sand darter, western banded killifish, threehorn wartyback, deertoe, creek heelsplitter

Paulding County
Four-toed salamander, marsh bluet, plains clubtail, deertoe, purple wartyback

Putnam County
Least darter, greater redhorse, pugnose minnow, elktoe, purple wartyback, white catspaw, wavyrayed lampmussel, creek heelsplitter, round pigtoe, rabbitsfoot, wartyback, purple lilliput, deertoe, rayed bean, clubshell

Hancock County
Eastern cricket frog, Kirtland's snake, four-toed salamander, plains clubtail, western banded killifish, northern crayfish, elktoe, creek heelsplitter, black sandshell, clubshell, round pigtoe, kidneyshell, salamander mussel, purple lilliput, deertoe, rayed bean

Allen County
Least darter, greater redhorse, purple wartyback, wavyrayed lampmussel, creek heelsplitter, clubshell, purple lilliput, deertoe

Hardin County
Four-toed salamander, least darter, creek heelsplitter, pondhorn, rayed bean

Mercer County
Eastern cricket frog, deertoe, pondhorn

Auglaize County
Least darter, greater redhorse, rayed bean

Shelby County
Least darter, purple wartyback

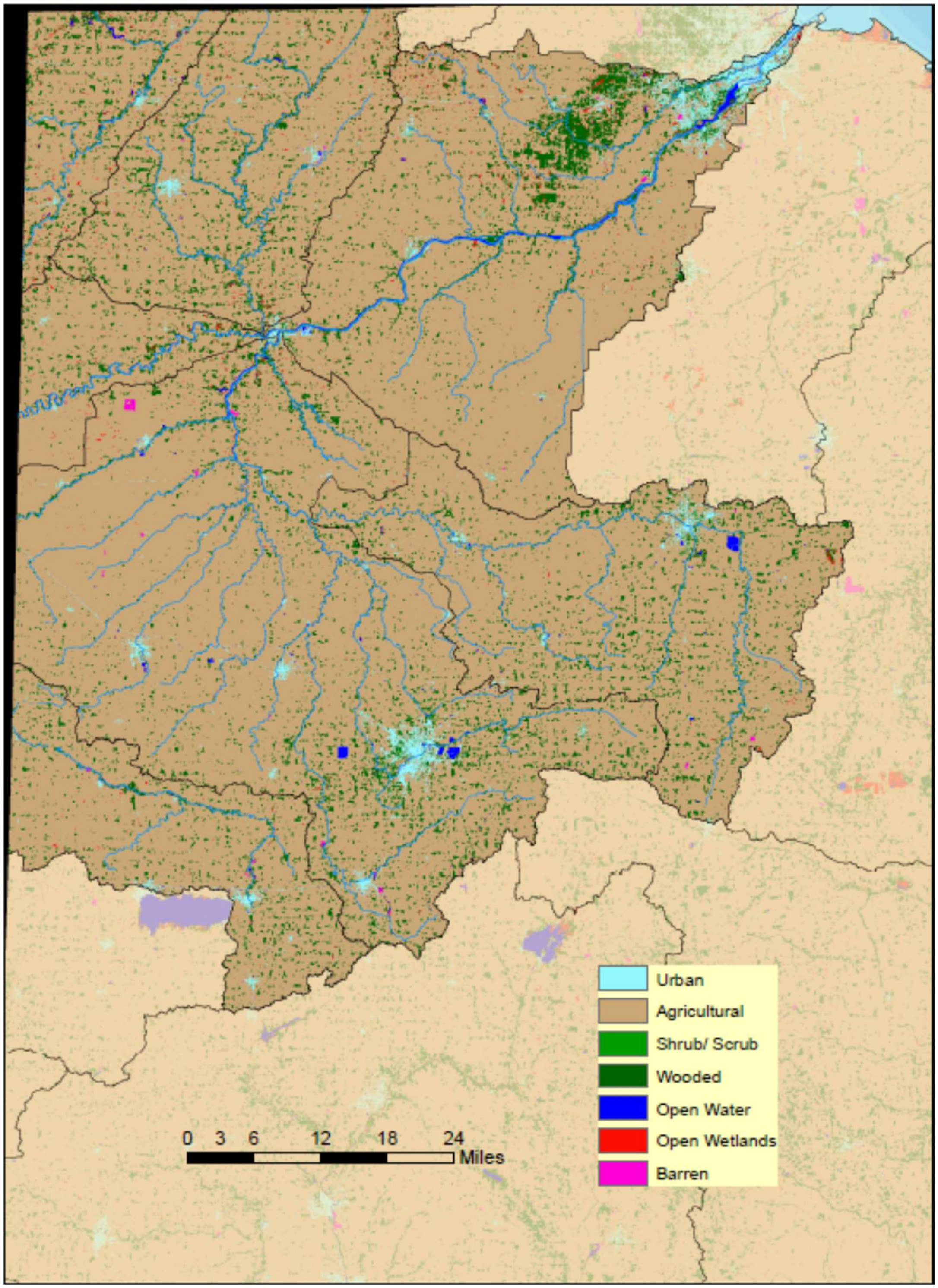


Figure 21. Maumee River Conservation Opportunity Watershed – Land Cover.

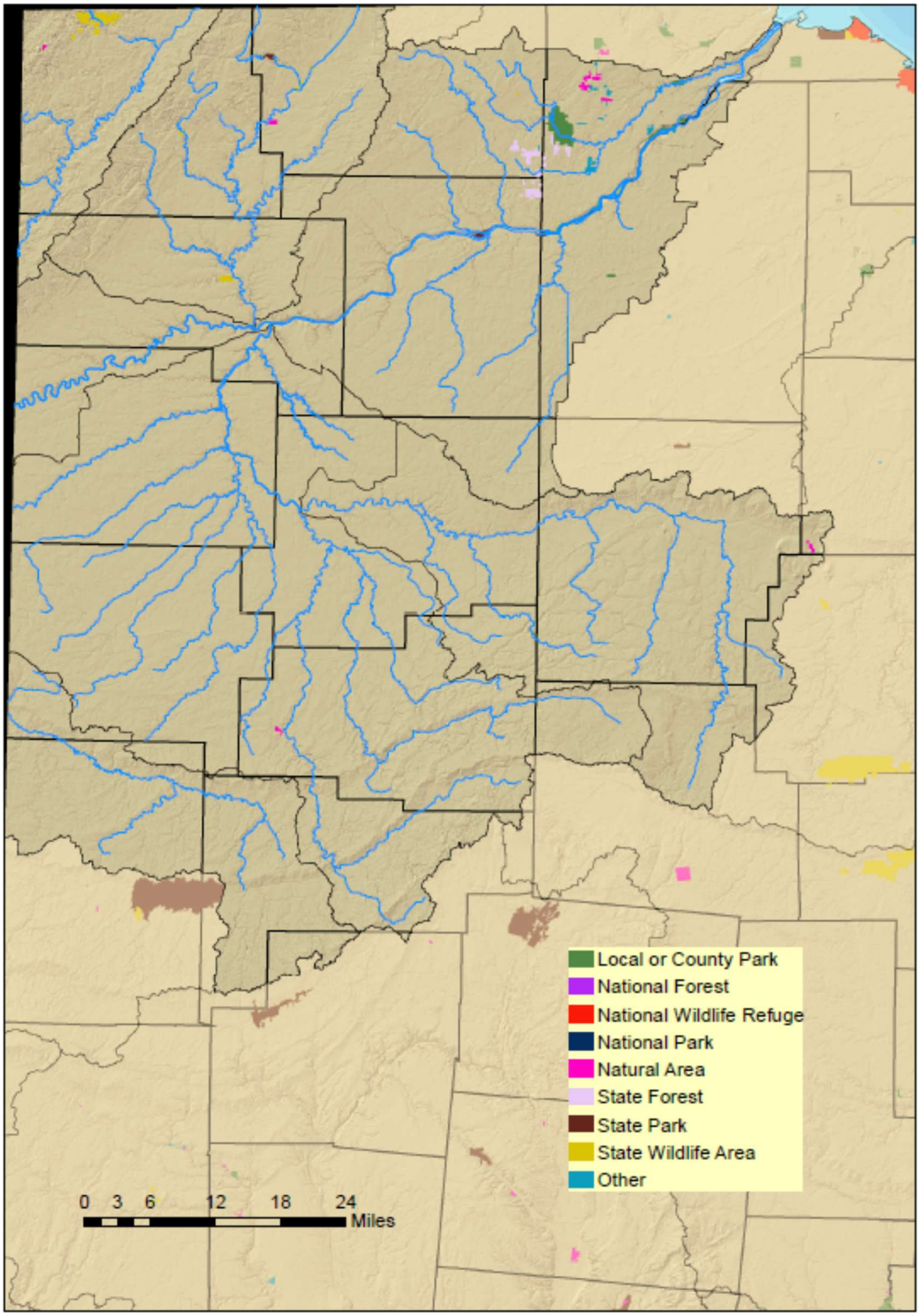


Figure 22. Maumee River Conservation Opportunity Watershed – Protected Lands.

6.14.4.2 Sandusky River CO Watershed (HUC 04100011)

The Sandusky River forms at the confluence of Paramour Creek and Allen Run winding through northwest Ohio to its mouth in Sandusky Bay. Paramour Creek gathers in morainal hills near Crestline. The Sandusky River is joined by Broken Sword Creek southwest of Nevada. The Broken Sword has drainage area of 95 square miles. Not far downstream, the Little Sandusky contributes 38 square miles of drainage area. Tymochtee Creek drains 302 square miles in the western part of the upper basin and joins the Sandusky about midway between Upper Sandusky and Tiffin.

Sycamore Creek, Honey Creek, and Rock Creek flow into the Sandusky from the east contributing 64, 179, and 35 square miles, respectively. Most of the western half of the lower basin is drained by Wolf Creek with a drainage area of 158 square miles. Muskellunge Creek drains 47 square miles of the lower western basin joining the Sandusky north of Fremont. Green Creek drains 81 square miles of the lower eastern part of the basin and joins the Sandusky at its mouth in Sandusky Bay.

Physiography

The Sandusky River Basin is about equally divided between the Till Plains and the Lake Plains. The upper portion of the basin is in the Central Ohio Clayey Till Plain while the lower portion is in the Maumee Lake Plains. Paramour Creek, at the head of the Sandusky River, gathers in the Galion Glaciated Low Plateau. From the confluence of Paramour Creek and Allen Run, the Sandusky flows southwestward along the outer margin of the Wabash End Moraine. At the Crawford-Wyandot county line, the river crosses the moraine and flows northwest toward Upper Sandusky crossing the Fort Wayne Moraine along the way. About midway between Upper Sandusky and Tiffin the river crosses the Defiance End Moraine. At Tiffin, it leaves the till plain and flows onto the lake plain.

The gradient of the Sandusky River is extremely variable. In some places the fall is 2 feet per mile and in other places, such as north of Tiffin, it is 25 feet per mile. The stream gradient reflects underlying substrates. Just north of Tiffin the substrate is thick erodible deltaic silt; near Fremont the stream flows directly on Silurian dolomite. In many places the river and its tributaries have cut through thin till to bedrock. Cobble and gravel substrate along its reaches consist of rounded granite and carbonate rock fragments. Upper reaches in the Galion Glaciated Low Plateaus contain sandstone and shale bed material. The Sandusky is a mildly entrenched river that meanders considerably along its course.

Geology

Nearly all the Sandusky River Basin consists of limestone, dolomite, and shale of Silurian and Devonian age. Headwater streams of the Sandusky are underlain with sandstone, limestone, and shale of Late Mississippian age. The bedrock is relatively dense and ground water storage is not great. The water table in the rock generally lies at or below drainage. The overburden of glacial drift and lacustrine deposits is generally thin and for the most part consists of materials with relatively low permeability. Sandy lacustrine deposits are generally shallow and underlain by material of low permeability. Fractures in till afford some passages for ground water recharge.

Headwater areas of the Sandusky River gather where drift thickens in end moraines with relatively greater amounts of permeable sand and gravel deposits. The portion of the Defiance End Moraine where the Sandusky crosses contains significant amounts of sand and gravel deposits, and there are buried valleys with permeable deposits in the area. Flowing springs near the river are indicative of a ground water discharge area. East of Fremont, a shallow buried valley exists along Green Creek. The buried valley contains sand and gravel deposits that yield considerable amounts of ground water.

Soils

Soils in the Sandusky River Basin are more varied than in the Portage River Basin. Hoytville silty clay loam dominates the lower Lake Plain portion of the basin with less extensive areas of Ottokee and Tedrow sandy loam. Blount-Pewamo-Glynwood soils dominate the upper western portion of the basin while Bennington-Cardington soils dominate the eastern part of the upper basin. Blount-Pewamo-Glynwood soils of the upper western basin have slow permeability similar to Hoytville soils of the lower basin. Bennington-Cardington soils are moderately to slowly permeable.

Water Development

The Sandusky River serves as source of water supply for Bucyrus, Upper Sandusky, Tiffin and Fremont. Bucyrus and Upper Sandusky pump water into off-stream storage while Tiffin and Fremont withdraw water directly from behind low-head dams. The Ballville low-head dam at Fremont has about 180 million gallons of storage. Attica and New Washington obtain source of supply from Honey Creek utilizing off-stream impoundments. An off-stream reservoir near Marseilles in Wyandot County is filled from Tymochtee Creek and supplies water for wetland management on the Killdeer Plains Wildlife Area. A number of communities obtain source of supply from ground water, the largest systems being at Crestline and Carey. Green Springs obtains water supply from wells. Wastewater return flows generated by water supply systems in the basin affect low-flow characteristics of streams to varying degrees. A number of rock quarries discharge ground water to tributaries of the Sandusky River.

Flow Characteristics

Mean annual flow of the Sandusky River at Fremont equates to 11.2 inches, typical runoff for most streams in the basin. Areas east of Bucyrus receive greater amounts of annual precipitation, and this is reflected in the higher mean annual flow of 13.2 inches at Bucyrus. The relatively low mean annual flow of 10.3 inches given in Table 2 for Sandusky River at Mexico is mainly due to differences in period of record rather than basin hydrology. Base flow in the Sandusky River generally accounts for about one-third of mean annual runoff. This amount of base flow is in the lower range for streams in Ohio. Fifty percent duration flows at gaging stations along the Sandusky average about 0.2 cfs per square mile, a relatively low value indicating that ground-water storage in the basin is not great.

The 90-percent duration flows at various stations along the Sandusky are uniformly low averaging about 0.03 cfs per square mile. The uniformity of low flows is somewhat contrary to what the physiology of the basin suggests as the till plain of the upper basin yields only modest ground-water accretions to streams and even less to the lake plain of the lower basin.. Low-flow augmentation from municipal wastewater discharges and dewatering flows from quarries contribute to the uniformity of low flows, but the basin geology remains the most important factor determining the low-flow regimen of streams. Paramour Creek at Leesville and the Sandusky River near North Robinson exhibit relatively high base-flow characteristics compared to those for the Sandusky River at downstream stations. Wastewater discharge at Crestline could account for the higher base flows, as might ground-water discharge from permeable materials in the morainal drift. Low flows of the Sandusky River at Bucyrus are affected by wastewater discharge that enters immediately upstream of the gage, but marked declines in effluent discharge during dry spells has historically lessened the direct impact on low flows.

Between Bucyrus and Upper Sandusky, the river may receive modest contributions of ground water from the end moraine and alluvial deposits bordering the channel. Baseflow characteristics of Broken Sword Creek and Tymochtee Creek are very low with 90- percent duration flow of 0.006 to 0.007 cfs per square mile. The Broken Sword receives little ground-water contribution from the Fort Wayne End Moraine that it flows along. Tymochtee Creek gathers in a lacustrine plain and flows across till plain neither yielding much ground water to sustain flows.

About half of the drainage area of the Sandusky River at Mexico is contained in the Broken Sword and Tymochtee drainages. That by itself should cause less favorable base flow at Mexico than observations reveal. Wastewater discharge at Upper Sandusky and Carey combined with dewatering flows from the rock quarry at Carey provide some augmentation flows but not of sufficient amount to explain the magnitude of base flows at Mexico. The Sandusky River apparently receives significant ground-water contribution as it crosses through the Defiance End Moraine in vicinity of McCutchenville.

Honey Creek at Melmore has base-flow characteristics slightly more favorable than Broken Sword Creek or Tymochtee Creek, but it receives little ground water to sustain flows from the Defiance Moraine that borders it. Rock Creek, that traverses the Defiance Moraine, has relatively high sustained flows, but the drainage area is too small to make much contribution to sustaining flows in the Sandusky.

Streams in the western portion of the lower basin contribute little base flow to sustain flows in the Sandusky River. The 90-percent duration flows of Wolf Creek and East Branch of Wolf Creek reported in

Bulletin 40 are zero or near zero flow. Ground-water discharge to sustain flows in lower reaches of the Sandusky below Tiffin may originate with tributaries draining from the east and from rock exposures along the river. Base flows of Green Creek near Fremont appear as an anomaly in the Sandusky River Basin. The 90-percent duration flow for Green Creek near Fremont equates to 0.18 cfs per square mile, an exceptionally high value for the Sandusky Basin. Base flow of Green Creek is sustained by ground-water discharge from artesian springs originating in the limestone bedrock in the Green Springs area.

The 10-percent duration flows for streams in the Sandusky River Basin are comparatively low averaging 2.2 cfs per square mile. The 2-year recurrence interval flood-peak discharges are also relatively low, ranging from about 40 cfs per square mile for smaller gaged streams to about 12 cfs per square mile for the largest streams. Flat to moderately rolling topography of the basin and the relatively mild gradient of streams allows floodwaters to rise at moderate rates and recede gradually. Violent flash floods are not common in the basin. Channel forming flows being relatively low, tend to favor channels with comparatively narrow bankfull widths. Accelerated runoff is common in headwater areas where streams have been channelized for drainage and flood control purposes.

<u>State Listed Species by County with Records of Occurrence from the Sandusky River Watershed</u> (from the Ohio Natural Heritage Database)
The following species are dependent upon aquatic habitats to complete their life cycle – this dependence may be for all or a portion of their life:

Ottawa County
Blanding's turtle, Lake Erie watersnake, Canada darner, lake sturgeon, eastern sand darter, muskellunge, western banded killifish, spotted gar, burbot, channel darter, eastern pondmussel, black sandshell, pocketbook, purple wartyback, northern riffleshell, snuffbox, threehorn wartyback, kidneyshell, fawnsfoot, deertoe, pondhorn, rayed bean

Erie County
Eastern cricket frog, spotted turtle, Blanding's turtle, Kirtland's snake, Lake Erie watersnake, marsh bluet, plains clubtail, lake sturgeon, longnose sucker, lake whitefish, muskellunge, channel darter, purple wartyback, eastern pondmussel, black sandshell, threehorn wartyback, fawnsfoot, deertoe

Sandusky County
Blanding's turtle, muskellunge, western banded killifish, river redhorse, greater redhorse, eastern pondmussel, threehorn wartyback, fawnsfoot, deertoe

Seneca County
Spotted turtle, Blanding's turtle, plains clubtail, river redhorse, greater redhorse, purple wartyback

Wyandot County
Kirtland's snake, plains clubtail, greater redhorse, elktoe, purple wartyback, northern riffleshell, creek heelsplitter, rayed bean

Crawford County
Pondhorn

Marion County
Snuffbox, wavy-rayed lampmussel, Ohio pigtoe, round pigtoe, pondhorn, rayed bean

Hardin County
Four-toed salamander, least darter, creek heelsplitter, pondhorn, rayed bean

Richland County
Least darter, greater redhorse, pugnose minnow, elktoe, purple wartyback, white catspaw, wavyrayed lampmussel, creek heelsplitter, clubshell, round pigtoe, rabbitsfoot, wartyback, purple lilliput, deertoe, rayed bean

Huron County
Pondhorn

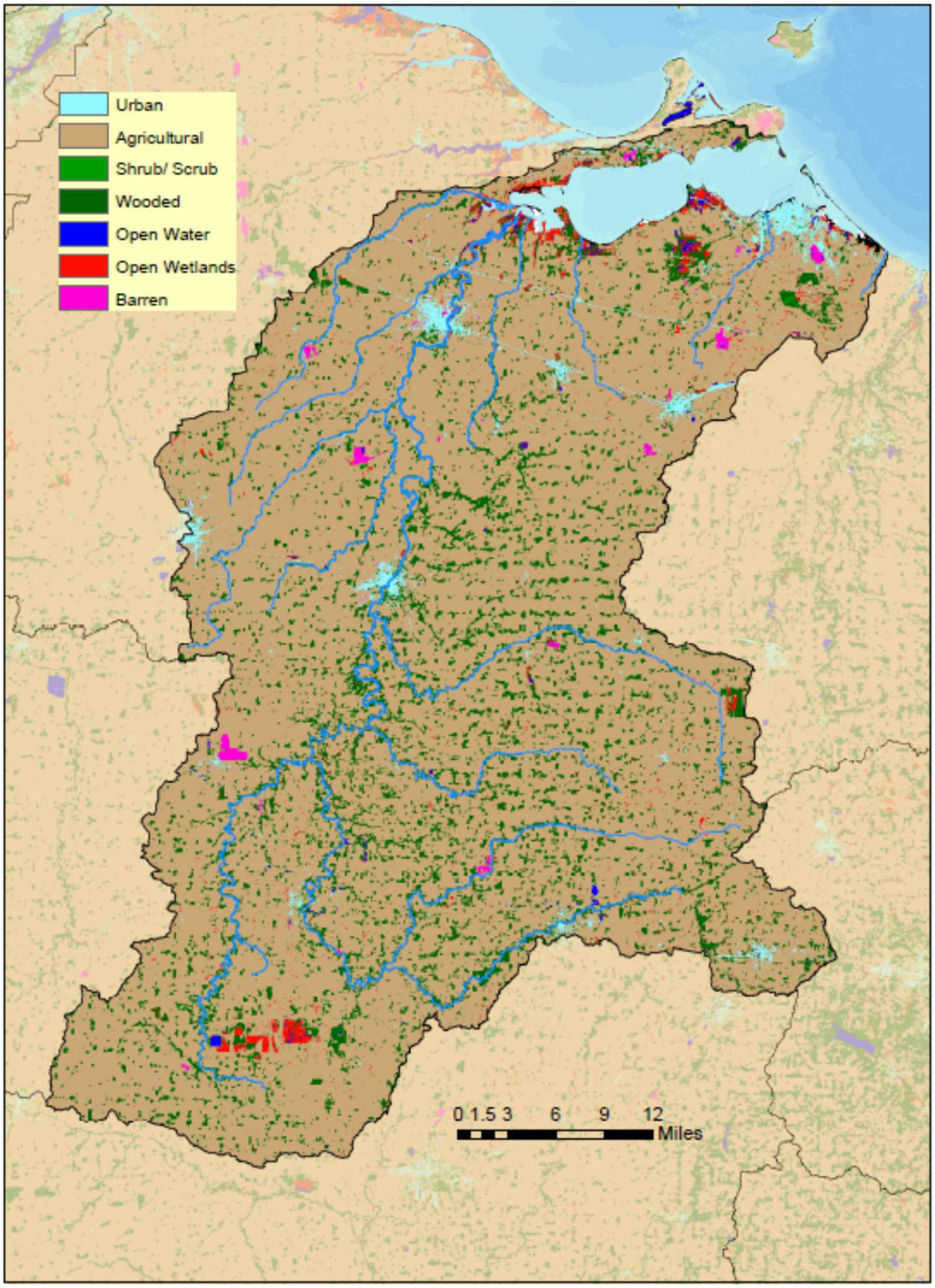


Figure 23. Sandusky River Conservation Opportunity Watershed – Land Cover.

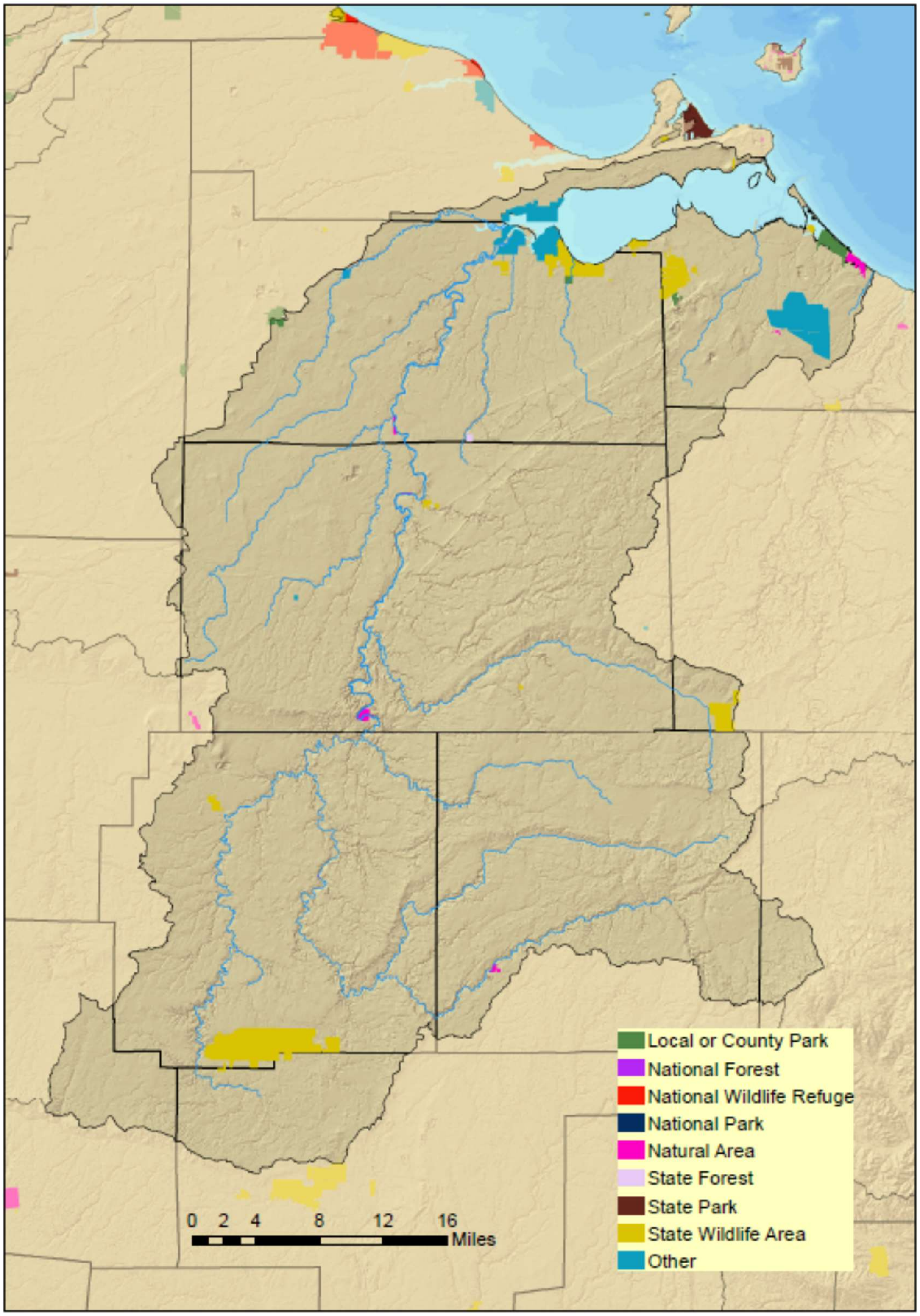


Figure 24. Sandusky River Conservation Opportunity Watershed – Protected Lands.

6.14.4.3 Cuyahoga River CO Watershed (HUC 04110002)

The Cuyahoga River originates in Geauga County in the extreme northern part of the Akron-Canton Interlobate Plateau. From its headwaters area, the river flows southwestward in a relatively long, narrow basin toward Akron. Downstream of Cuyahoga Falls, the river turns abruptly northward and flows in a wide, deep preglacial valley to Cleveland and its mouth in Lake Erie. The peculiar shape of the basin with its long eastern arm is the result of drainage changes brought about by glaciation.

In the upper part of the eastern basin near Burton, the East Branch, West Branch, and Bridge Creek converge to give the Cuyahoga River a drainage area of about 150 square miles. Downstream at Kent, Congress Lake Outlet adds about 79 square miles of drainage area. At Akron, the Little Cuyahoga joins the Cuyahoga River contributing 62 square miles of drainage area. North of Akron, a series of smaller tributaries drain into the Cuyahoga from both sides of the basin, the largest of these being, Mud Brook, Yellow Creek, Furnace Run, Brandywine Creek, and Chippewa Creek. Near Bedford, Tinkers Creek joins the Cuyahoga contributing 96 square miles of drainage area. Additional smaller tributaries flow into the Cuyahoga in Cleveland – the largest being Big Creek with 38 square miles of drainage area.

<u>Physiography</u>

The topography of the Cuyahoga River Basin varies from flat lake plain to relatively rough glaciated, dissected plateau. Most of the basin is in the Glaciated Allegheny Plateaus; only the extreme lower part lies in the Erie Lake Plain. Relief is generally moderate except where the river has cut a deep valley, and where there is local steepness created by smaller streams.

The northern part of the Akron-Canton Interlobate Plateau, where the eastern arm of the basin is located, is hummocky and dominated by kames, kame terraces, eskers, bogs, and natural lakes. The river flows in a relatively shallow channel cut in lacustrine deposits and drift at very low gradient of about 3 feet per mile. Kame terraces and outwash exist along most of the channel. The channel reach in Geauga County cuts through lacustrine deposits.

Congress Lake Outlet and the Little Cuyahoga River are in the central part of the interlobate area where considerable amounts of outwash material exists. The river flows north of the outwash area in a deep narrow gorge cut in Pennsylvanian-age sandstone dropping about 220 feet in 1.5 miles through a series of steep rapids and falls. Along the northward course, the river flows in a wide, deep preglacial valley that contains Pleistocene lacustrine deposits and alluvium of more recent time. The river meanders at moderately low gradient of about 6 feet per mile. Upland areas draining to the valley of the lower Cuyahoga are in areas of ground moraine and end moraine. Tinkers Creek gathers in lacustrine areas with extensive wetlands and flows northward along the Defiance End Moraine atop a buried valley before turning westward at Bedford and descending at steep gradient to the Cuyahoga River.

The Cuyahoga River flows across the Erie Lake Plain in a deep wide valley at Cleveland. Most of the lake plain tributary to the Cuyahoga on the west side of the river in Cleveland is drained by Big Creek.

<u>Geology</u>

The surface rocks in the Cuyahoga River Basin range in age from Devonian to Pennsylvanian. Devonian-age shales outcrop along the lower Cuyahoga Valley and lake plain area. Upland areas along the lower reach of the Cuyahoga are underlain with Mississippian sandstones and shales. Berea sandstone outcrops along Tinkers Creek just downstream of Bedford. Pennsylvanian-age sandstones and shales underlie much of the basin along the upper Cuyahoga. The narrow gorge at Cuyahoga Falls is cut in Sharon Conglomerate of Pennsylvanian age. As a whole, ground water from the rock strata has little effect on stream flow except locally where streams have cut through sandstone formations.

The glacial drift in the basin varies greatly in thickness and character, ranging from a few feet to as much as 200 feet in thickness and consisting of deep impermeable till in some places to highly permeable sand and gravel in other places. Deep buried valleys are present throughout the basin, but it is ground water from outwash material in high-level terraces, kames, and kame terraces that support the dry-weather flow of the Cuyahoga River.

The shales underlying the lake plain at Cleveland are thinly mantled with till and clayey lacustrine deposits. Uplands tributary to the lower reach of the Cuyahoga are generally covered with moderate amounts of clayey till except along the moraines where till thickness is greater and contains some permeable deposits. The Cuyahoga Valley is hundreds of feet deep to bedrock. The buried valley along the Cuyahoga between Newburg Heights and downtown Cleveland contains permeable deposits that yield substantial amounts of ground water to wells.

Pennsylvanian- and Mississippian-age sandstones and shales are covered with till and extensive amounts of sand and gravel deposits in the upper basin. Large deposits of permeable outwash material exist in the interlobate area between the Grand River and Killbuck Lobes of the Wisconsinan glaciation. Depths of these deposits vary from a few feet to as much as 100 feet in some places.

Soils

The Glaciated Allegheny Plateaus part of the Cuyahoga River Basin that comprises the vast majority of the basin is in the Mahoning-Canfiel-Rittman-Chili soil region. The narrow Erie Lake Plain part of the basin at Cleveland is in Conotton-Conneaut-Allis soil region.

Soils on the Erie Lake Plain at Cleveland are largely urban land complexes wherein imperious surfaces constitute a large percentage of the complex. Mahoning urban complex dominates the lake plain with lesser amounts of Oshtemo urban complex. The Mahoning soil developed from clay loam and clayey till and is slowly permeable. Oshtemo developed on sandy beach ridges and has rapid permeability.

The ground moraine and end moraines in the Killbuck-Pittsburgh Glaciated Plateau part of the basin are dominated by Mahoning and Rittman soils. Rittman developed from medium to fine textured till and has a fragipan that is slowly permeable. Soils developed from lacustrine deposits amid the end moraines have slow permeability.

Chili-Canfield soil associations dominate the interlobate area in the upper basin. Chili soil developed from loamy outwash on kames, kames terraces, and outwash fans common in the interlobate area. Chili is underlain with sand and gravel and has rapid permeability. Canfield soil developed from medium-textured till and has a fragipan that is slowly permeable.

Soil developed in alluvium along the lower Cuyahoga and upper reaches of Tinkers Creek are mostly Chagrin silt loams with moderate permeability. Permeability of soils on high-level terraces along the lower Cuyahoga vary from rapid to slow depending on the texture of the sediments.

Permeable outwash soils in the Cuyahoga Basin are limited in extent but highly significant ground water recharge areas for the ground water aquifers of the Cuyahoga Basin. Overall, however, most of the soils in the basin are slowly permeable.

Water Development

The City of Akron has several water supply reservoirs in the upper Cuyahoga River Basin. These include East Branch Reservoir, LaDue Reservoir, and Lake Rockwell. Water is released from East Branch and LaDue to maintain water levels in Lake Rockwell where the city water supply intakes are located. Wastewater return flows from Akron and enters the Cuyahoga below Old Portage several miles downstream of the confluence with the Little Cuyahoga.

Kent and Cuyahoga Falls obtain water supply from well fields located in sand and gravel deposits along the upper Cuyahoga. Some smaller communities in the upper basin including Burton obtain water supply from wells, but most obtain supply from either Akron or Cuyahoga Falls. Individual supply is generally available from sandstones of the Pottsville Group, mainly the Sharon Conglomerate, and from permeable deposits in buried valleys.

The city of Cleveland obtains water from Lake Erie and distributes it throughout Cuyahoga County and to some communities in neighboring counties. All of the communities in Cuyahoga County except Berea obtain supply from Cleveland. Return flows enter the Cuyahoga though the Cleveland Southerly Wastewater Treatment Plant at Cuyahoga Heights.

Some water is diverted from the Tuscarawas River Basin to the Cuyahoga River Basin through the Ohio-Erie Canal system at Akron. Water from Portage Lakes is diverted to the Ohio Canal for industrial use and discharged through Summit Lake to the Little Cuyahoga River. Mogador Reservoir on the Little Cuyahoga River was built for industrial supply and recreation.

Flow Characteristics

Mean annual flows of streams in the Cuyahoga River Basin range from about 12 inches to 21 inches. Upper reaches of the Cuyahoga in Geauga County are in an area that receives some of the greatest amounts of mean annual precipitation in the state. This accounts for the relatively high mean annual flow of 20.2 inches at Hiram Rapids.

Tinkers Creek is also in an area receiving relatively high amounts of mean annual precipitation. This largely but not entirely accounts for the 21.7 inches of runoff recorded at Bedford. The flow of Tinkers Creek at the gage site is augmented by wastewater originating from wells and imported waters. The Little Cuyahoga River is in an area of lower mean annual precipitation averaging about 36 inches at Akron. Mean annual runoff of the Little Cuyahoga is correspondingly lower at about 12 inches. Mean annual flow of 14.9 inches for the Cuyahoga River at Old Portage excludes water diverted from Lake Rockwell for use at Akron and returned downstream of Old Portage. This diversion is partly offset by canal diversions from the Portage Lakes into the Cuyahoga River. On balance, mean annual flow at Old Portage without the diversions should be closer to 17 inches. Mean annual flow of the Cuyahoga at Independence of 16.4 inches represents the composite of mean annual flows of streams in the basin. The relatively high mean annual flow of Big Creek at Cleveland is due to industrial wastewater discharge and shorter, wetter period of record.

Base flows of the Cuyahoga River at all of the gaging stations are affected by regulation. Base flows at Hiram Rapids are affected by evaporative losses and releases from East Branch and LaDue. Base flows at Old Portage are largely a function of releases from Lake Rockwell and flows from Congress Lake Outlet and the Little Cuyahoga. The gaging records for Yellow Creek give some insight to the affect of permeable deposits on base flows. The basin upstream of Ghent is situated in an area of kames and outwash deposits. This accounts for the relatively high mean base-flow index of 68 and 90-percent duration flow of 0.213 cfs per square mile for Yellow Creek at Ghent. North Fork at Bath Center includes areas of ground moraine containing much less permeable material. The mean base-flow index of 44 and 90-percent duration flow of 0.072 cfs per square mile reflects this difference in geology. Yellow Creek at Boltzum with 90-percent duration flow of 0.16 cfs per square mile and mean base-flow index of 54 represents a composite of basin characteristics.

Tinkers Creek with mean base-flow index of 48 and 90-percent duration flow of 0.24 cfs per square mile contains some permeable deposits along the Defiance End Moraine but not to the same degree as Yellow Creek. Base flows in Tinkers Creek are augmented significantly by wastewater discharges from municipal and industrial plants.

The base-flow record for Cuyahoga River at Independence excludes water diverted into the Ohio Canal upstream at Brecksville. The 90-percent duration flow of 0.184 cfs per square mile and the 7-day, 2-year low-flow index of 0.153 are lower than they would be if the diversions were included. The relatively high base-flow indices for Big Creek are due to industrial wastewater discharge upstream of the gaging station.

The median flow or 50-percent duration flow of 0.69 cfs per square mile for the Cuyahoga River at Independence is representative of flow conditions at gaging sites along the Cuyahoga and its major tributaries. This median flow rate is at the high end of the range for Ohio streams and reflects the combination of relatively large amounts of ground-water storage, substantial artificial and natural surface-water storage, and significant flow regulation from water supply and wastewater operations in the basin. The 10-percent duration flows of streams in the Cuyahoga River Basin are at the high end of the range for streams in Ohio. This indicates that although significant storage exists in the basin, it is limited as far as attenuation of larger floods. Relatively low 2-year recurrence interval flood-peak discharges characteristic of the streams in the basin indicate that basin storage nevertheless provides some attenuation of flood flows. The 10-percent duration flows at stations along the Little Cuyahoga River are relatively low because of the large reservoirs located upstream of the gaging sites.

<u>State Listed Species by County with Records of Occurrence from the Cuyahoga River Watershed</u> (from the Ohio Natural Heritage Database)
The following species are dependent upon aquatic habitats to complete their life cycle – this dependence may be for all or a portion of their life:

Cuyahoga County
Spotted turtle, tiger spiketail, *Chimarra socia* (caddisfly), muskellunge, bigmouth shiner, channel darter, longnose dace, great lakes crayfish

Geauga County
Blanding's turtle, spotted turtle, four-toed salamander, river jewelwing, tiger spiketail, American emerald, boreal bluet, northern bluet, marsh bluet, harlequin darner, riffle snaketail, *Litobrancha recurvate* (mayfly), *Psilotreta indecisa* (caddisfly), *Stenonema ithaca* (mayfly), lake chubsucker, Iowa darter, longnose dace, brook trout, creek heelsplitter, eastern pondmussel, great lakes crayfish, northern crayfish

Summit County
Spotted turtle, four-toed salamander, racket-tailed emerald, boreal bluet, marsh bluet, harlequin darner, chalk-fronted corporal, elfin skimmer, brush-tipped emerald, lake chubsucker, Iowa darter, western banded killifish, pugnose minnow, paddlefish

Portage County
Spotted turtle, four-toed salamander, American emerald, racket-tailed emerald, northern bluet, harlequin darner, frosted whiteface, brush-tipped emerald, *Psilotreta indecisa* (caddisfly), eastern sand darter, lake chubsucker, Iowa darter, least darter, mountain brook lamprey, creek heelsplitter, eastern pondmussel, Allegheny crayfish

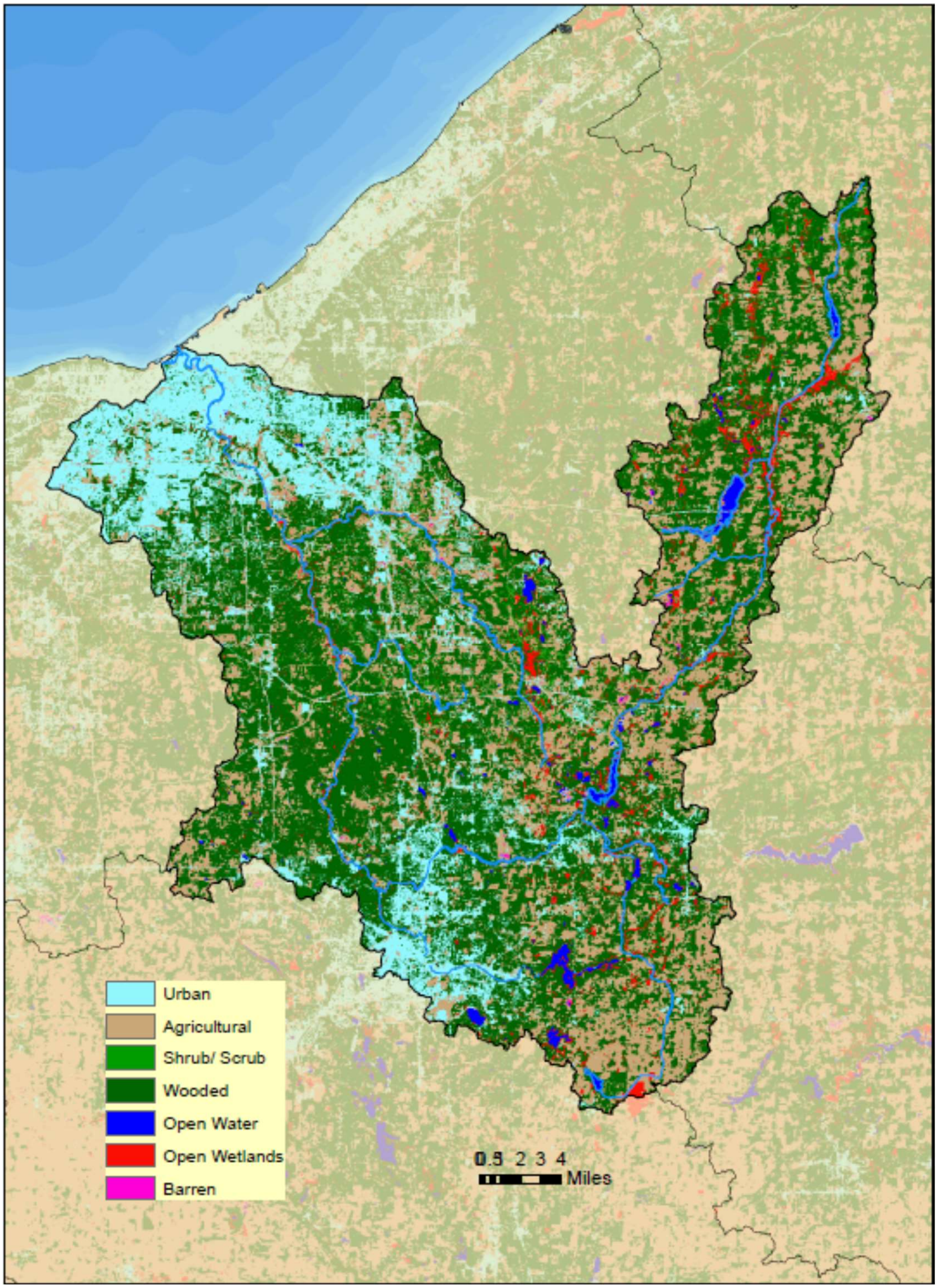


Figure 25. Cuyahoga River Conservation Opportunity Watershed – Land Cover.

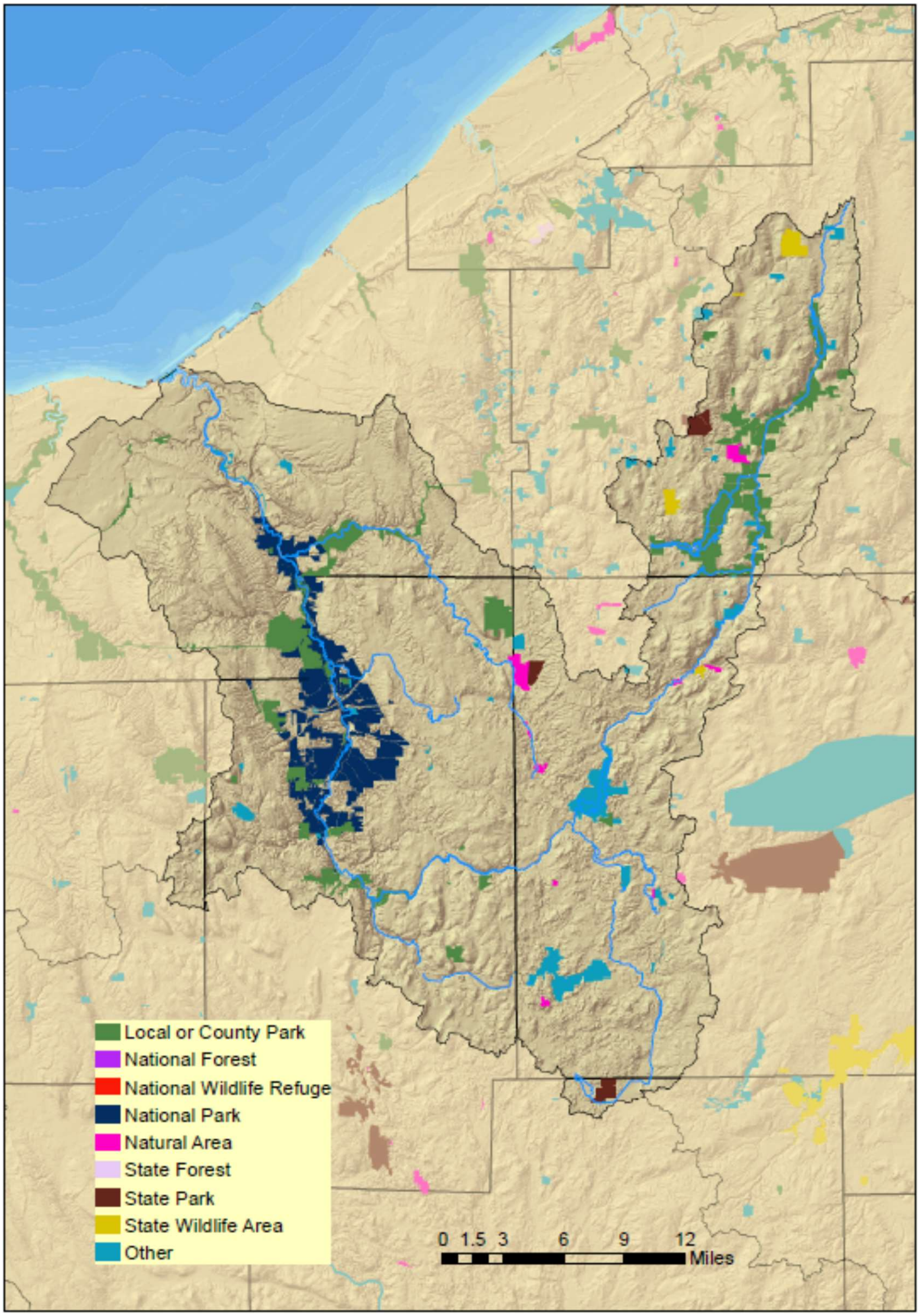


Figure 26. Cuyahoga River Conservation Opportunity Watershed – Protected Lands.

6.14.4.4 Chagrin River CO Watershed (consists of the southern ~ 75% of HUC 04110003)
The Chagrin River originates in Geauga County at Chardon and flows southwest to Chagrin Falls where its drainage area is 60.6 square miles. Just west of Chagrin Falls, Aurora Branch with 58.2 square miles of drainage area joins the river from the south. From the confluence with Aurora Branch, the Chagrin flows northward in a preglacial valley to Willoughby and its mouth in Lake Erie at Fairport Harbor. East Branch with drainage area of 51.1 square miles joins the river at Willoughby. The total drainage basin is approximately 264 square miles.

Physiography
The main tributaries to Lake Erie east of the Cuyahoga River lie mostly in the Glaciated Allegheny Plateaus with only the extreme lower reaches in the Erie Lake Plain. The Erie Lake Plain is separated from the Glaciated Allegheny Plateaus by the Portage Escarpment, an irregular slope 2 to 4 miles wide descending from elevation of about 1200 feet to 700 or 800 feet above mean sea level. The main tributaries have cut deep gorges in the Portage Escarpment. The smaller tributaries to the lake typically gather in and along the south side of the escarpment.

The Chagrin River Basin is mostly in the Killbuck Glaciated Pittsburgh Plateau and is rougher than that of the other main tributaries to the east. The terrain is rolling hills with moderate relief. The river flows on bedrock in some places and on valley fill of silts and clays in other places. Rock outcrops along the upper reaches of the Chagrin and its main tributaries are mainly that of Sharon Conglomerate. The upper reach between Chardon and Chagrin Falls flows at relatively steep gradient averaging about 25 feet per mile. At Chagrin Falls the river drops through a series of rapids about 100 feet over the course of a mile. Aurora Branch flows at average gradient of about 20 feet per mile and drops about 60 feet through a series of rapids near Chagrin Falls. The lower reach of the Chagrin River flows at relatively low gradient of about 4 feet per mile in a preglacial valley filled with silts and clays. The river flows in a deep gorge cut in Devonian-age shales at the Portage Escarpment. East Branch originates on the west side of Chardon and flows at relatively steep gradient averaging about 35 feet per mile to its confluence with the Chagrin River in the Portage Escarpment at Willoughby.

Geology
The surface rocks along the Erie Lake Plain are shales of Devonian age. These rocks continue at the surface south of the Portage Escarpment toward the midpoint of the basins. South and east, sandstone and shales of Mississippian age are at the surface. The Pennsylvanian-age Pottsville Group including the Sharon Conglomerate interfaces with the Mississippian-age rocks in upper parts of the Chagrin River Basin. The Berea sandstone of Mississippian age forms the falls at Chagrin Falls. A buried valley exists along the general course of Aurora Branch and the lower Chagrin River. Although the Berea sandstone yields some ground water to streams, it is the Sharon Conglomerate that yields large quantities. The shales yield little ground water to streams. The overburden of glacial drift covering the basin as a whole is relatively impermeable. Two recessional moraines cross the area, and there are some local deposits of outwash material.

Soils
Basins of the main tributaries to Lake Erie east of the Cuyahoga River are largely in the Mahoning-Canfield-Rittman-Chili soil region. Parts of the basin in the Erie Lake Plain and Portage Escarpment are in Conotton-Conneaut-Allis soil region.

Mahoning soil is dominant in the northern and eastern parts of the Grand River Low Plateau where the main tributaries east of the Cuyahoga River are located. Mahoning soil developed from clay loam and clayey till and has slow permeability. Platea soil is also common. It has a fragipan that is very slowly permeable. Soils in the Grand River Finger Lake Plain developed from medium- to fine-textured till and lacustrine deposits. They have slow permeability. Soils developed in loamy outwash at various places have rapid permeability. For the most part, however, soils in Grand River Low Plateau of the tributary basins have slow permeability that impeded ground water recharge. Conneaut soil is dominant in the Erie Lake Plain eastward from Cleveland. This slowly permeable soil developed from lacustrine deposits of lacustrine silt loam and silty glacial till. Rapidly permeable soils are on beach ridges. Conotton soil formed on beach ridges along the Portage Escarpment. Conotton is rapidly permeable.

Water Development
Communities along Lake Erie from Cleveland to Conneaut are supplied with water from Lake Erie. Source of supply for the communities distant from the lake includes both surface water and ground water. The Grand River is source of supply for Rock Creek. Roaming Rock Lake on Rock Creek serves as source of supply for Roaming Shores. Sand and gravel lens in glacial drift supply Orwell. Chardon has wells near Bass Lake at the head of the Chagrin River. Chagrin Falls obtains supply from Cleveland.

Flow Characteristics
The Chagrin River at Willoughby and Aurora Branch near Chagrin Falls have relatively high base flow largely due to discharges from the Sharon Conglomerate and some outwash deposits. Big Creek and Painsville Creek gather in outwash near Chardon like the Chagrin and have relatively high base flows. East Branch of the Chagrin River is characterized as cold-water habitat and likely has high base flow similar to the Chagrin River.

State Listed Species by County with Records of Occurrence from the Chagrin River Watershed (from the Ohio Natural Heritage Database)
The following species are dependent upon aquatic habitats to complete their life cycle – this dependence may be for all or a portion of their life:

Lake County
Spotted turtle, four-toed salamander, tiger spiketail, racket-tailed emerald, boreal bluet, northern bluet, marsh bluet, green-faced clubtail, Uhler's sundragon, riffle snaketail, *Chimarra social* (caddisfly), *Psilotreta indecisa* (caddisfly), *Rheopelopia acra* (midge), muskellunge, northern brook lamprey, eastern sand darter, river redhorse, pugnose minnow, longnose dace, great lakes crayfish, northern crayfish, elktoe, snuffbox, wavyrayed lampmussel, black sandshell, round pigtoe, kidneyshell, salamander mussel, fawnsfoot, deertoe

Cuyahoga County
Spotted turtle, tiger spiketail, *Chimarra socia* (caddisfly), muskellunge, bigmouth shiner, channel darter, longnose dace, great lakes crayfish

Geauga County
Blanding's turtle, spotted turtle, four-toed salamander, river jewelwing, tiger spiketail, American emerald, boreal bluet, northern bluet, marsh bluet, harlequin darner, riffle snaketail, *Litobrancha recurvate* (mayfly), *Psilotreta indecisa* (caddisfly), *Stenonema ithaca* (mayfly), lake chubsucker, Iowa darter, longnose dace, brook trout, creek heelsplitter, eastern pondmussel, great lakes crayfish, northern crayfish

Portage County
Spotted turtle, four-toed salamander, American emerald, racket-tailed emerald, northern bluet, harlequin darner, frosted whiteface, brush-tipped emerald, *Psilotreta indecisa* (caddisfly), eastern sand darter, lake chubsucker, Iowa darter, least darter, mountain brook lamprey, creek heelsplitter, eastern pondmussel, allegheny crayfish

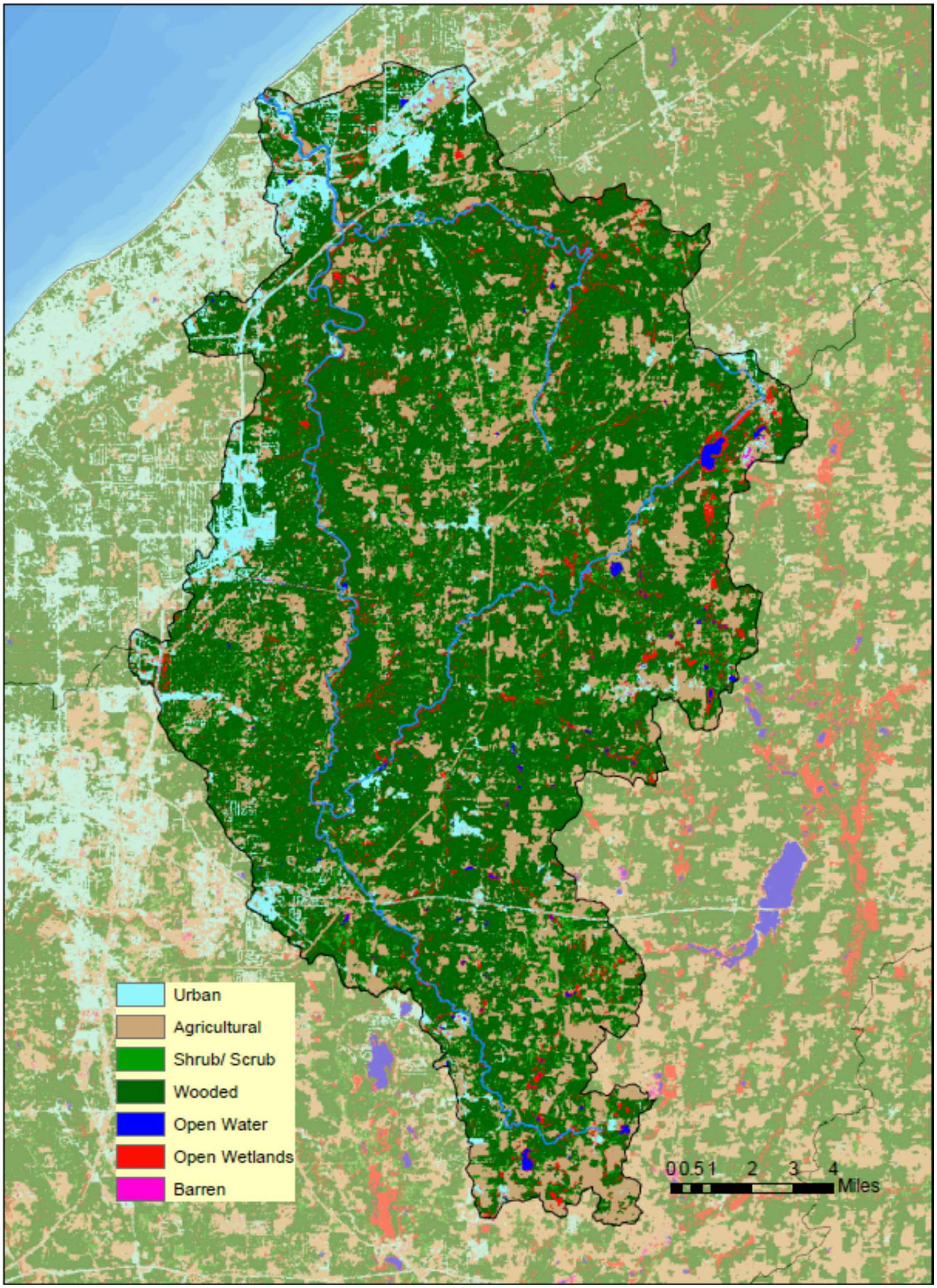


Figure 27. Chagrin River Conservation Opportunity Watershed – Land Cover.

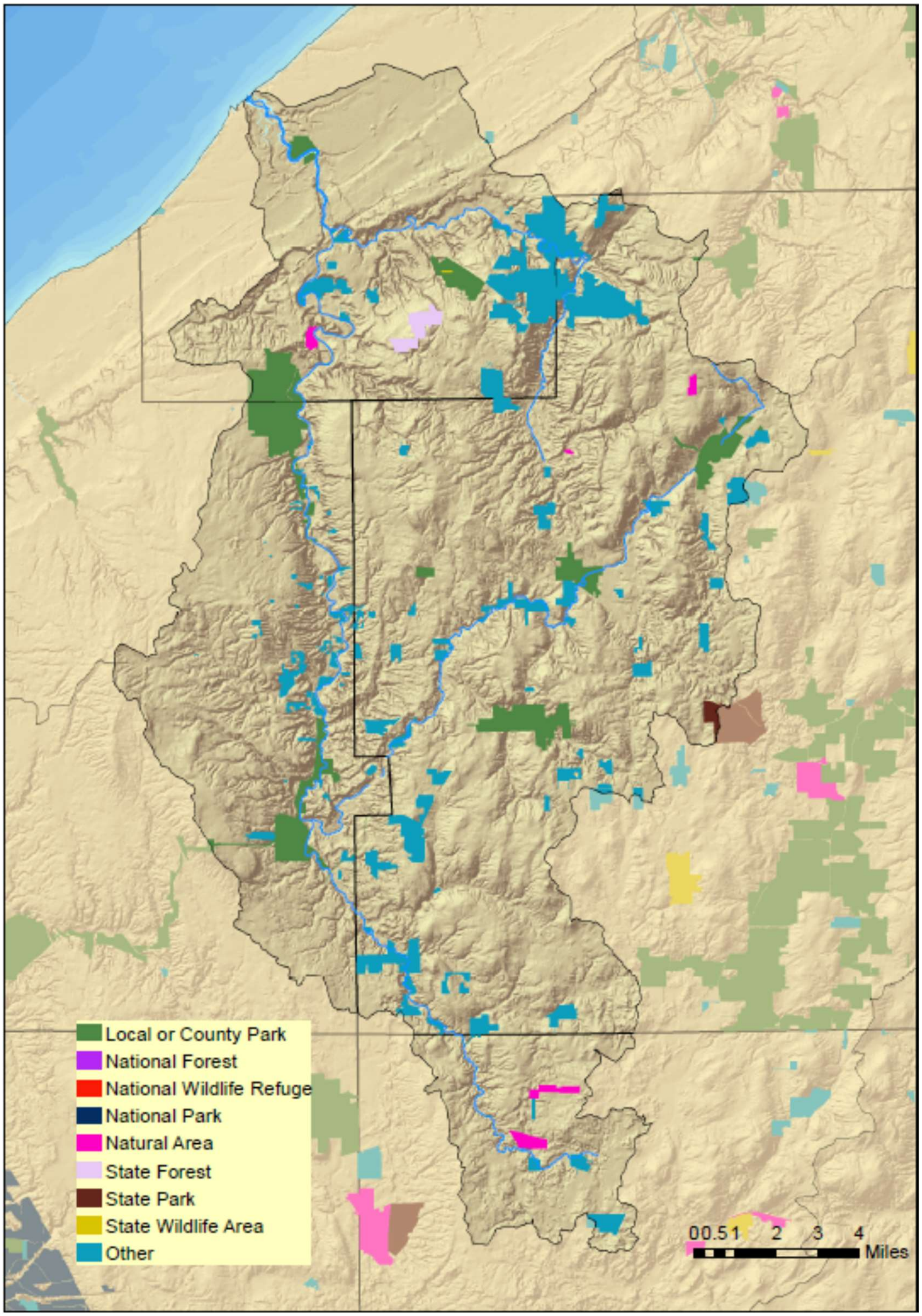


Figure 28. Chagrin River Conservation Opportunity Watershed – Protected Lands.

6.14.4.5 Grand River CO Watershed (HUC 04110004)

Draining 705 square miles, the Grand River gathers in morainal hills around the southern end of the Grand River Finger Lake Plain. The river meanders northward picking up drainage from relatively small tributaries to the west include Swine Creek, Phelps Creek, and Hoskins Creek with drainage areas of 30.9, 29.2, and 26.9 square miles, respectively. Larger tributaries join the Grand River from the east including Rock Creek with drainage area of 70.7 square miles and Mill Creek with drainage area of 103 square miles. At the north end of the Grand River Finger Lake Plain, the river turns west and meanders toward Painesville in a relatively deep, flat bottom valley in the Lake Escarpment. Paine Creek and Big Creek with drainage areas of 28.9 and 50.1 square miles flow into the river from the south along the Lake Escarpment. At Painesville, the river cuts north across the narrow Erie Lake Plain to its mouth in the lake.

<u>Physiography</u>

The Grand River Basin occupies nearly all of the Grand River Finger-Lake Plain located in the western part of the Grand River Low Plateau. The broad trough-like preglacial valley that the river flows north in is filled with surficial lacustrine deposits and till. Relief in the Finger-Lake Plain is very low as is the gradient of the river. Tributaries joining the Grand River from the west descend into the valley at relatively steep gradient while those flowing in from the east have more moderate gradient. The lower westward reach of the Grand River flows in a deep gorge along the Portage Escarpment to Painesville where it crosses the narrow Erie Lake Plain. Paine Creek and Big Creek that join the Grand River along its westward course, originate north of Chardon in the Killbuck Glaciated Pittsburgh Plateau.

<u>Geology</u>

The surface rocks along the Erie Lake Plain are shales of Devonian age. These rocks continue at the surface south of the Portage Escarpment toward the midpoint of the basins. South and east, sandstone and shales of Mississippian age are at the surface. Although the Berea sandstone yields some ground water to streams, it is the Sharon Conglomerate that yields large quantities. The shales yield little ground water to streams. The overburden of glacial drift covering the basin as a whole is relatively impermeable. Two recessional moraines cross the area, and there are some local deposits of outwash material.

<u>Soils</u>

Mahoning soil is dominant in the northern and eastern parts of the Grand River Low Plateau where the main tributaries east of the Cuyahoga River are located. Mahoning soil developed from clay loam and clayey till and has slow permeability. Platea soil is also common. It has a fragipan that is very slowly permeable. Soils in the Grand River Finger Lake Plain developed from medium- to fine-textured till and lacustrine deposits. They have slow permeability. Soils developed in loamy outwash at various places have rapid permeability. For the most part, however, soils in Grand River Low Plateau of the tributary basins have slow permeability that impeded ground water recharge.

<u>Water Development</u>

Communities along Lake Erie from Cleveland to Conneaut are supplies with water from the lake. Source of supply for the communities distant from the lake includes both surface water and ground water. The Grand River is source of supply for Rock Creek. Roaming Rock Lake on Rock Creek serves as source of supply for Roaming Shores. Sand and gravel lens in glacial drift supply Orwell. Chardon has wells near Bass Lake at the head of the Chagrin River. Chagrin Falls obtains supply from Cleveland.

<u>Flow Characteristics</u>

Actual mean annual runoff of the Grand River is likely around 18 inches. Areas with large amounts of snow pack and extensive wetlands present limitations for the hydrograph separation techniques used to derive mean base-flow indices. Overall, the Grand River has relatively low base flow.

The 10-percent duration flows of streams in the area are relatively high indicating that high water is not uncommon. The relatively low 2-year recurrence interval flood-peak discharge of 15 cfs per square mile for Grand River at Madison reflects the attenuating effects of the Finger Lake Plain. The watershed of Hoskins Creek upstream of Hartsgrove is a relatively flat till plain with extensive wetlands. This explains the 37.6 cfs per square mile peak discharge of Hoskins Creek versus 69.5 cfs per square mile for nearby Phelps Creek that gathers in the end moraine where the terrain is hilly and the relief is greater.

State Listed Species by County with Records of Occurrence from the Grand River Watershed (from the Ohio Natural Heritage Database)
The following species are dependent upon aquatic habitats to complete their life cycle – this dependence may be for all or a portion of their life:

Lake County
Spotted turtle, four-toed salamander, tiger spiketail, racket-tailed emerald, boreal bluet, northern bluet, marsh bluet, green-faced clubtail, Uhler's sundragon, riffle snaketail, *Chimarra social* (caddisfly), *Psilotreta indecisa* (caddisfly), *Rheopelopia acra* (midge), muskellunge, northern brook lamprey, eastern sand darter, river redhorse, pugnose minnow, longnose dace, great lakes crayfish, northern crayfish, elktoe, snuffbox, wavyrayed lampmussel, black sandshell, round pigtoe, kidneyshell, salamander mussel, fawnsfoot, deertoe

Ashtabula County
Spotted turtle, four-toed salamander, racket-tailed emerald, marsh bluet, green-faced clubtail, chalk-fronted corporal, brush-tipped emerald, *Chimarra socia* (caddisfly), *Rheopelopia acra* (midge), *Stenonema ithaca* (mayfly), eastern sand darter, muskellunge, northern brook lamprey, burbot, river redhorse, longnose dace, great lakes crayfish, elktoe, elephant-ear, snuffbox, wavyrayed lampmussel, creek heelsplitter, eastern pondmussel, black sandshell, clubshell, round pigtoe, kidneyshell, salamander mussel

Geauga County
Blanding's turtle, spotted turtle, four-toed salamander, river jewelwing, tiger spiketail, American emerald, boreal bluet, northern bluet, marsh bluet, harlequin darner, riffle snaketail, *Litobrancha recurvate* (mayfly), *Psilotreta indecisa* (caddisfly), *Stenonema ithaca* (mayfly), lake chubsucker, Iowa darter, longnose dace, brook trout, creek heelsplitter, eastern pondmussel, great lakes crayfish, northern crayfish

Trumbull County
Spotted turtle, four-toed salamander, *Psilotreta indecisa* (caddisfly), eastern sand darter, northern brook lamprey, mountain brook lamprey, great lakes crayfish, northern crayfish, creek heelsplitter, black sandshell, round pigtoe, salamander mussel

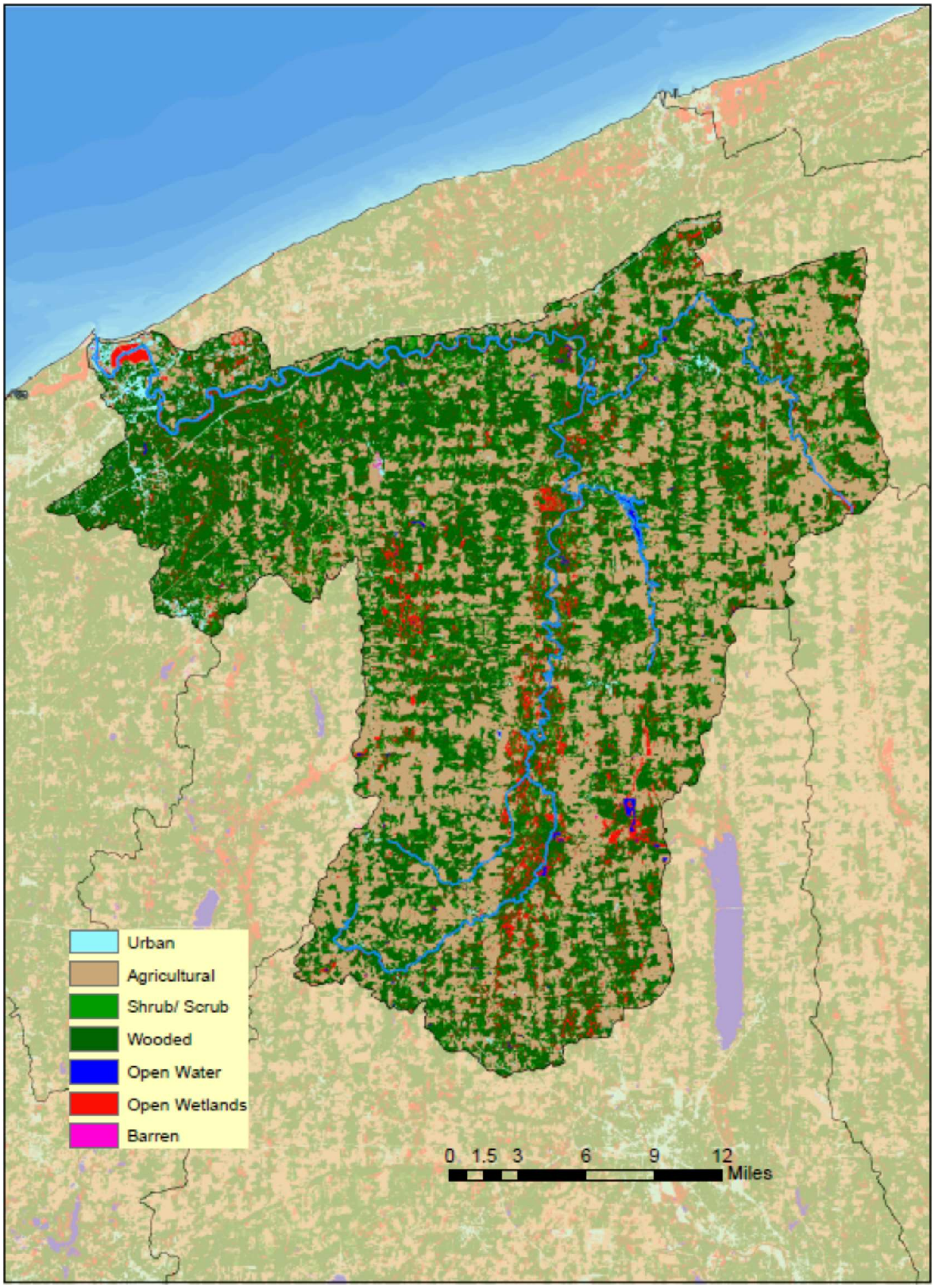


Figure 29. Grand River Conservation Opportunity Watershed – Land Cover.

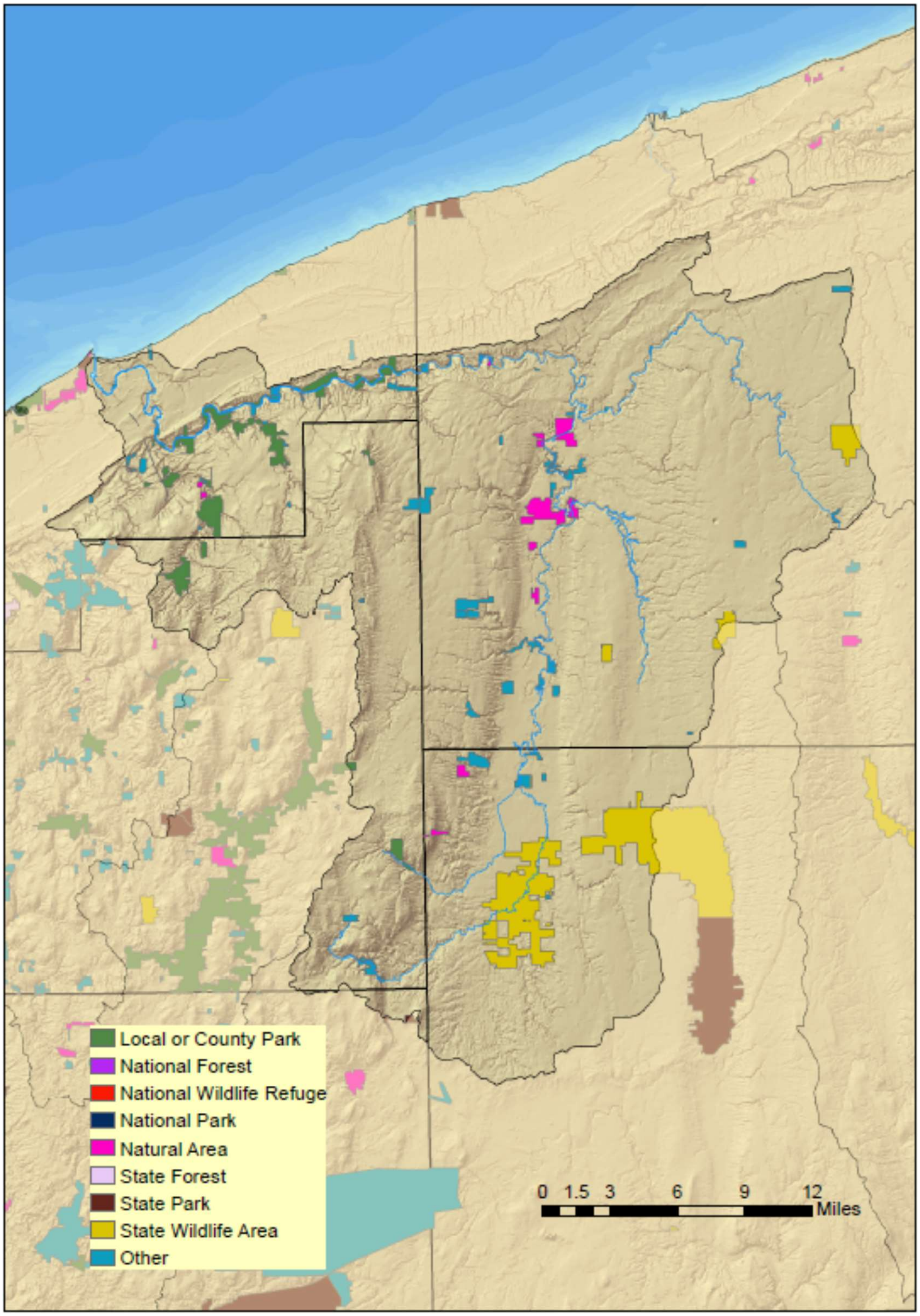


Figure 30. Grand River Conservation Opportunity Watershed – Protected Lands.

Table 37. CONSERVATION THREATS TO LAKE ERIE TRIBUTARIES.
The following threats negatively impact or have the potential to negatively impact Lake Erie Tributaries. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		medium
A	Watershed conversion to urban/commercial development alters hydrology	housing & urban areas commercial & industrial areas	medium low
B	Riparian development and its negative effect on habitat and species	housing & urban areas commercial & industrial areas tourism & recreation areas	medium low low
C	Increasing land prices limit our ability to protect riparian corridors	housing & urban areas commercial & industrial areas tourism & recreation areas	medium low low
II	**agriculture and aquaculture**		medium
A	Loss of riparian corridor to agriculture	annual & perennial non-timber crops livestock farming & ranching	high low
B	Watershed conversion to agriculture alters hydrology	annual & perennial non-timber crops livestock farming & ranching	high low
III	**energy production and mining**		low
A	Oil and gas extraction - can have negative impacts by causing chemical contamination	oil & gas drilling	low
B	Hydropower facilities disrupt stream connectivity and kill aquatic species	renewable energy	low
C	Water withdrawal for fracking can alter hydrology	oil & gas drilling	low
D	Sand/gravel operations destroy habitat	mining & quarrying	low
IV	**transportation and service corridors**		medium
A	Channel modification, dredging river mouths - causes habitat loss, water quality impacts	shipping lanes	medium
B	Roads, bridges, causeways, utilities, impact shoreline/nearshore habitats	roads & railroads utility & service lines	low low
V	**biological resource use**		low
A	Fishing pressure and fishing gear impacts	fishing & harvesting aquatic resources	low
VI	**human intrusions and disturbance**		low
A	Incompatible recreational activities	recreational activities	low

B	Creation of recreational facilities can alter/destroy nearshore habitat	recreational activities	low
C	Vessel impacts to nearshore habitats and water quality	recreational activities work & other activities	low negligible
VII	**natural system modifications**		medium
A	Dams cause habitat loss, sedimentation, decreased water quality, reduced biodiversity, and reduce movement of aquatic species and species abundance	dams & water management/use	medium
B	Conflicting water control management objectives of controlling agencies (DOW – USACOE)	dams & water management/use	medium
C	Some species' populations have been reduced to levels below what is necessary to recover on their own	other ecosystem modifications	medium
D	Lack of data for some species and habitats limits our ability to develop plans for threats like climate change	other ecosystem modifications	medium
VIII	**invasive and other problematic species and genes**		high
A	Introduction and/or spread of invasive plants and animals	invasive non-native/alien species	high
B	Introduction and/or spread of nuisance plants and animals	problematic native species	low
C	Introduction and spread of diseases (plants and animals)	invasive non-native/alien species problematic native species	high low
IX	**pollution**		high
A	Urban effluent carries a variety of substances that impact water quality and aquatic species	household sewage & urban wastewater industrial & military effluents garbage & solid waste air-borne pollutants	high medium low low
B	Agricultural effluent from row crops as well as confined animal operations impacts water quality and aquatic species	agricultural & forestry effluents	very high
C	Harmful algal blooms affect water quality, aquatic species, and can be toxic to terrestrial species	agricultural & forestry effluents	very high
D	Industrial spills impact water quality and aquatic species	industrial & military effluents	medium
X	**geological events**		negligible
---	none	---	---
XI	**climate change and severe weather**		low
A	Climate change could impact habitats, water quality, and species	habitat shifting & alteration droughts temperature extremes storms & flooding	low low low medium

Table 38. CONSERVATION ACTIONS FOR LAKE ERIE TRIBUTARIES.
The following actions will help abate or have the potential to help abate threats to Lake Erie Tributaries habitat. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	actions	2nd level action classification(s)	action priority rank	threat(s) addressed*
I	**LAND/WATER PROTECTION**		med	
1	Protect riparian corridors through acquisition, partnerships, conservation easements, etc.	site/area protection resource & habitat protection	low high	I, II, IV-B, VI-B
2	Quantify and map critical habitat areas in the Cuyahoga River for future protection	site/area protection	low	I-A, IV-A,B, VI-B,C, VII-C
II	**LAND/WATER MANAGEMENT**		high	
1	Work with OEPA, ODOT, USACE, and other government agencies to focus mitigation activities on riparian habitats in conservation opportunity watersheds	habitat & natural process restoration	high	I-A, II-A, IV-B, VI-B, XI
2	Work with landowners to develop and implement habitat improvement projects on private lands	habitat & natural process restoration	high	I, II, XI
3	Remove dams to restore stream connectivity and improve water quality	habitat & natural process restoration	high	VII-A, XI
4	Develop criteria for prioritizing candidate dams for removal – give extra emphasis to dams in conservation opportunity watersheds	habitat & natural process restoration	high	III-B, VII
5	Research fish passage improvements for dams that are not candidates for removal	habitat & natural process restoration	high	III-B, VII
6	Identify and prioritize restoration projects (channel restoration, floodplain and backwater reconnection, etc.) in conservation opportunity watersheds	habitat & natural process restoration	high	I-A,B, II, IV, VII-B, XI
7	Complete a geomorphological restoration project in each conservation opportunity watershed on an average of every 5 years beginning in 2016	habitat & natural process restoration	high	I-A,B, II, IV, VII, XI
8	Develop model stream protection guidelines aimed at slowing the overland flow of water into streams	habitat & natural process restoration	high	I-A, II-B, IX-A,B
9	Use lowest impact techniques and timing for dredging activities	habitat & natural process restoration	high	III-D, IV-A, VII-B
10	Create and use wetlands for stormwater treatment	habitat & natural process restoration	high	I-A, IX-A
11	Establish an early-detection/rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	high	VIII-A,B

12	Develop ways to control invasive plant species in flowing waters	invasive/ problematic species control	high	VIII-A,B
13	Develop a process for coordinating disparate data sources of distribution and abundance of aquatic SGCN with special emphasis on conservation opportunity watersheds	habitat & natural process restoration	high	I-B, III-B,D, IV-A,B, VI-B, VII-A,D, XI
14	Review existing species and habitat data to identify data gaps and needs for additional surveys, research, and management actions	habitat & natural process restoration	high	I, II, III, IV, V, VI, VII, VIII, IX, XI
15	Conduct comprehensive surveys of freshwater mussels in all conservation opportunity watersheds	habitat & natural process restoration	high	I-B, III-C,D, IV-A,B, VI-B, VII, XI
16	Conduct watershed studies to identify and prioritize restoration opportunities	habitat & natural process restoration	high	I-B, II-A, IV-A, VI-B, VII, XI
17	Stabilize severely eroding streambanks with bio-engineering techniques	habitat & natural process restoration	high	I-A,B, II, VI-C
18	Reconnect stream channels with natural floodplains	habitat & natural process restoration	high	I-A,B, II, IV, VII-B, XI
19	Restore/stabilize riparian habitat by planting native grasses, shrubs, and trees	habitat & natural process restoration	high	I-B, II-A, IV-B
20	Develop GIS tools to archive and monitor the status of protected lands in conservation opportunity watersheds	site/area management	low	XI
III	**SPECIES MANAGEMENT**		low	
1	Assess population status, habitat suitability, and probability for restoration of lake sturgeon spawning stocks in Ohio tributaries to Lake Erie	species management species recovery	low med	VII-C
2	Develop a restoration strategy for sauger in the Maumee and Sandusky Rivers	species reintroduction	low	VII-C
3	Assess population status, habitat suitability, and probability for restoration of fish, mussels, crayfish, invertabrates, and amphibians listed as SGCN	species reintroduction	High	VII-C, VII-D
4	Develop a restoration strategy for high priority fish, mussels, crayfish, invertebrates, and amphibians	species reintroduction	High	VII-C, VII-D
IV	**EDUCATION AND AWARENESS**		high	
1	Educate waterfront landowners and commercial pesticide/herbicide applicators on responsible chemical use, and the negative impacts to wildlife from toxic chemicals	training	high	I-B,C, IX-A
2	Promote conservation easements to protect riparian habitat	training awareness & communic-ations	high high	I, II, IV-B, VI-B, XI
3	Conduct shoreline protection/stabilization workshops	training	high	I-B, II-A, IV-B, VI-B
4	Provide technical guidance on shoreline development plans as relates to fish and wildlife interests	training	high	I, IV-B, VI-B, XI
5	Support the Ohio Clean Lakes Initiative - educating	training	high	II, IX-B,C

	and training farmers and other interested parties on agricultural nutrient management and stewardship			
6	Educate the public about the negative effects of exotic and nuisance animals – encourage responsible disposal of unwanted animals	awareness & communic-ations	high	VIII
7	Provide training to road construction/maintenance personnel for runoff/sediment control	training	high	I-B, IV-B, VI-B
8	Educate the public and legislators on the benefits of dam removals	training awareness & communic-ations	high high	VII-A
9	Provide training in geomorphological, fluvial, and in-stream flow processes for DOW personnel	training	high	III-B,C,D, IV, VI-B, VII-A,B
10	Develop and provide streams/watersheds educational materials for landowners, schools, public officials, and the general public	training awareness & communic-ations	high high	I, II, IX-A,B, XI
11	Create and implement demonstration projects aimed at reducing urban effluent – such as rain gardens, bioretention, etc.	training awareness & communic-ations	high high	I-A,B, IX-A
12	Conduct outreach for landowners on private land management, conservation practices, and water quality	training awareness & communic-ations	high high	I, II, IX-A,B
V	**LAW AND POLICY**		high	
1	Support legislation promoting eco-friendly energy development and use	legislation	high	III-A,B,C
2	Support sewage sludge/animal manure disposal standards to regulate application rates and timing	policies & regulations	high	IX-A,B,C
3	Develop and implement a risk-assessment system in the approval process for importing or moving live animals and plants	legislation policies & regulations	high high	VIII
4	Support more stringent ballast water regulations to stop the introduction of invasive species	legislation policies & regulations	high high	VIII
5	Encourage and support minimum flow regulations that protect downstream aquatic habitats	policies & regulations	high	III-B, VII-A,B, IX-A,B
6	Support the creation of additional and/or increased enforcement of stormwater regulations	policies & regulations compliance & enforcement	high med	I-A, IX-A
7	Find innovative ways to mandate the inclusion of fish and wildlife interests in development plans	policies & regulations private sector	high low	I, III-B,C,D, IV-B, VI-B, VII-C, XI

		standards & codes		
8	Support the use of buffers between development and tributary shorelines	policies & regulations private sector standards & codes	high low	I-A,B, IV-B, IX-A
9	Promote riparian protection ordinances that prevent floodplain encroachment and riparian habitat removal	policies & regulations private sector standards & codes	high low	I, II, IV-B, VI-B
10	Support increased regulation of home sewage treatment systems	compliance & enforcement	med	IX-A
VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		med	
1	Explore tying eligibility for grant money, loans, and cost-share programs to nutrient loading levels for agriculture – the lower the nutrient levels in their effluent, the more money they would be eligible for	market forces conservation payments	high high	IX-B,C, XI
2	Create incentives for vegetated buffers along all waterways to reduce nutrient loads and sediment	market forces conservation payments	high high	I, II, IX-A,B,C, XI
3	Create incentives to promote eco-friendly energy development and use	market forces conservation payments non-monetary values	high high low	III-A,B,C
4	Support the creation of incentives to protect riparian habitat	market forces conservation payments	high high	I, II, IV-B, VI-B, XI
5	Support clean marina and clean vessel programs	market forces conservation payments	high high	VI-C
6	Develop incentives for municipalities to use stormwater management systems that minimize negative impacts to aquatic habitats	market forces conservation payments	high high	I-A, IX-A
7	Support incentives for development plans involving water frontage that take into account wildlife and habitat needs	market forces conservation payments non-monetary values	high high low	I, IV-B, VI-B, XI
8	Support payments to offset losses (revenue from crops) resulting from implementation of conservation practices aimed at reducing sediment loads	conservation payments	high	IX-B,C

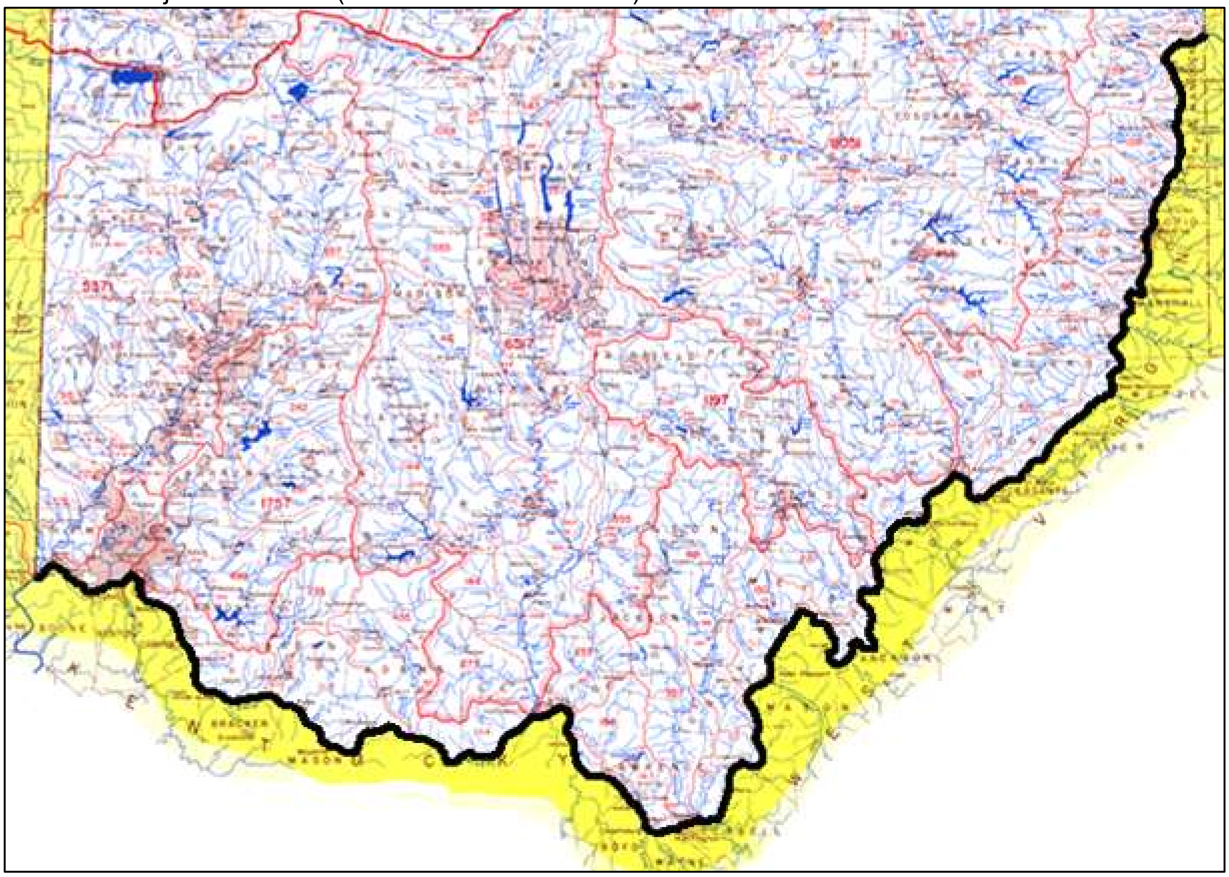
9	Create incentives to encourage the use of conservation tillage – especially in impaired watersheds	market forces conservation payments	high high	IX-B,C
10	Support incentives for conservation farming practices – including nutrient management plans and livestock waste management plans	market forces conservation payments	high high	IX-B,C
11	Encourage the use of cover crops for idle agricultural fields	market forces conservation payments	high high	IX-B,C
12	Promote drainage water management such as grassed waterways, 2-stage channels, and over-wide ditches	market forces conservation payments	high high	II, IX-B,C
13	Promote waterway conservation livestock practices such as exclusion fencing, livestock crossings, alternative water supplies, livestock access lanes	market forces conservation payments	high high	II-A, IX-B,C
VII	**EXTERNAL CAPACITY BUILDING**		med	
1	Work with ODA and OEPA to minimize nutrients in runoff, and develop BMPs for pesticide/herbicide use	alliance & partnership development	high	IX
2	Create an interagency spill response team – update contacts and training on a regular basis	alliance & partnership development	high	IX-D
3	Consider creating a multiagency invasive species prevention and control group that would handle all invasive species issues	alliance & partnership development	high	VIII
4	Through interagency coordination, work to assure that wildlife interests are taken into consideration in road, bridge, and causeway design, construction, and maintenance	alliance & partnership development	high	IV-B
5	Create a multi-agency dam removal task force	alliance & partnership development	high	VII
6	Use inter-agency cooperation to influence watershed health	alliance & partnership development	high	I, II, IX, XI
7	Pursue partnerships with local, state, and federal agencies to secure funding for projects benefitting streams and watersheds	alliance & partnership development conservation finance	high low	I, II, III, IV, VI, VII, VIII, IX, XI
8	Work with OEPA to encourage the reuse of point source discharge water	alliance & partnership development	high	IX-A
9	Work with OEPA and municipalities to eliminate CSO's and SSO's – especially in impaired watersheds	alliance & partnership development	high	I-A, IX-A
10	Work with OEPA to encourage completion of TMDL studies for all streams in the Lake Erie drainage	alliance & partnership development	high	IX-A,B,C

11	Work with OEPA and local watershed groups to remediate contaminated sediments, and restore habitat in conjunction with remediation	alliance & partnership development	high	I-B, IX-A
12	Work with regulatory agencies and local watershed groups on programs to restore natural stream and flood plain function	alliance & partnership development	high	I-A,B, II, IV, VII-A,B, XI
13	Develop partnerships with land trusts, watershed and conservation groups, and government agencies to guide acquisition and protection activities in each conservation opportunity watershed	institutional & civil society development alliance & partnership development	med high	I, II, III, IV, VI, XI
14	Increase personnel and expertise available for SGCN surveys and research through partnerships with other government agencies and, universities, and conservation-minded NGO's	institutional & civil society development alliance & partnership development	med high	I, II, III, IV, V, VI, VII, VIII, IX, XI
15	Encourage/facilitate the establishment of watershed groups & watershed coordinator to promote watershed improvement activities	institutional & civil society development	med	I, II, IX, XI

*refers to the Lake Erie Tributaries Habitat Conservation Threats in Table 37

6.15 Ohio River

Ohio River adjacent to Ohio (ODNR Division of Water)



6.15.1 Status

Generally good, and stable. All pools adjacent to Ohio met aquatic life-use designations. Water quality has improved over time, although industrial spills continue to occur. The percentage of pollution tolerant fishes has declined over time. Despite dams, hydropower facilities, and commercial navigation, the river supports a tremendous diversity of terrestrial and aquatic species – although this species assemblage has changed significantly since the river was modified to facilitate commercial navigation.

6.15.2 Description

The Ohio River is formed in Pittsburgh, Pennsylvania by the confluence of the Allegheny and Monongahela rivers and flows 981 miles to Cairo, Illinois where it enters the Mississippi River. The river forms the entire 451-mile southern boundary between Ohio and West Virginia/Kentucky. Adjacent to Ohio, the river comprises 91,300 surface acres of water. The U.S. Army Corps of Engineers began modifying the Ohio River to improve navigation in 1824 by dredging sandbars and removing snags. The first lock and dam was completed in 1885 about five miles below Pittsburgh, and 12 more were built in 1910. Channelization of the river was completed in 1929 with 50 lock and dam structures in operation. This system was later replaced by a high rise system of 20 dams. Nine navigational projects (locks and dams) are in operation today along the stretch of the Ohio River adjacent to Ohio (http://watercraft.ohiodnr.gov/ohioriver).

The nine locks and dams located on the 451-mile section of the Ohio River adjacent to Ohio are (from east to west): New Cumberland, Pike Island, Hannibal (hydro), Willow Island (hydro), Belleville, Racine (hydro), RC Byrd, Greenup (hydro), and Meldahl. These locks and dams divide the river into a series of pools that provide adequate navigation depths and allow freight to be transported the length of the river. Freight on the river is primarily coal, aggregrates, and grain moved by barges.

This habitat chapter refers to the 451 miles of the Ohio River mainstem along Ohio's southern border, and its tributaries to the first riffle or dam. It should be noted that while Ohio River tributaries are treated as a separate habitat category (see Ohio River Tributaries in the next section), the line of separation between the Ohio River and Ohio River Tributaries habitat categories is a biological one, rather than a line on a map. Riffles and dams provide some measure of biological separation between systems, and align themselves with how these habitat categories are managed.

The Ohio River is an extremely altered system, due to the numerous dams, hydropower facilities, and commercial navigation. In spite of these perturbations, the river supports many unique wildlife populations, e.g., freshwater mussels, tiger beetles, paddlefish, waterfowl, ospreys and bald eagles. The Ohio River contains a diverse fish community that includes over 150 different species.

Shared ownership of the Ohio River with Kentucky along the Ohio-Kentucky border, and ownership of the Ohio River by West Virginia along the Ohio-West Virginia border, creates opportunities for cooperative management as well as unique inter-jurisdictional challenges. Fisheries management is conducted under the context of the Ohio River Fisheries Management Team, which is composed of natural resource personnel from the six states bordering the river. Shared jurisdiction necessitated cooperative management and led to the development of a Memorandum of Understanding among natural resource agencies that manage fisheries in Pennsylvania, West Virginia, Ohio, Kentucky, Indiana, and Illinois.

The following water quality, habitat, and biological assessment of the Ohio River comes from the Ohio River Valley Water Sanitation Commission (ORSANCO 2012). Ohio River pool assessments are from http://www.orsanco.org/biological-programs-55/10-mainpages/orsanco-programs/115-biological-surveys – and additional information can be found at www.orsanco.org.

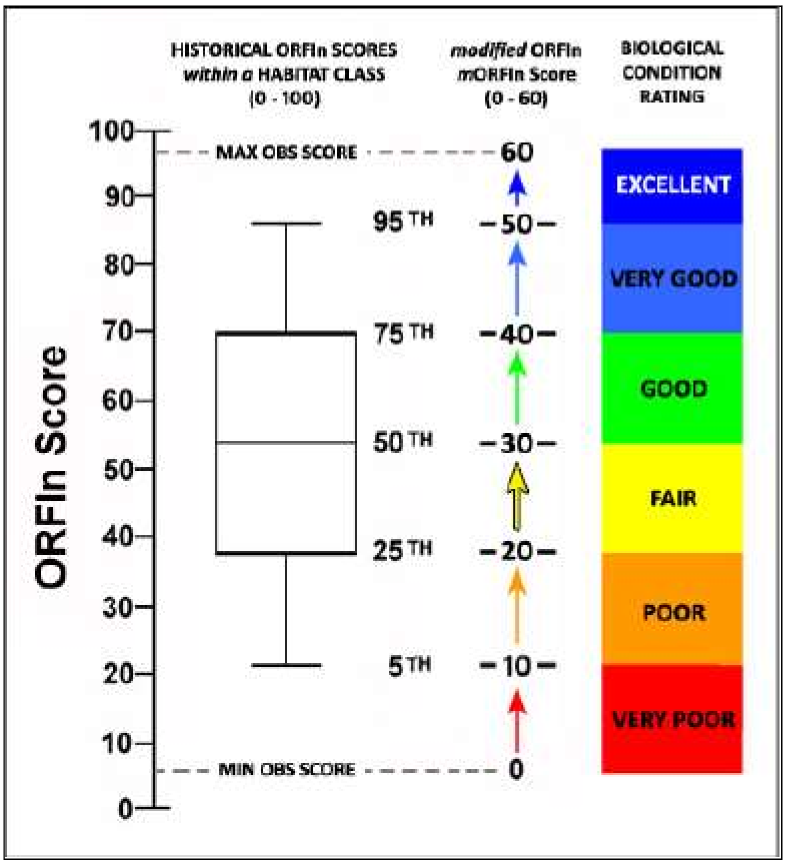
ORSANCO is a water pollution control agency established in 1948 by an interstate Compact. The eight member states - Illinois, Indiana, Kentucky, New York, Ohio, Pennsylvania, Virginia, and West Virginia - pledge to cooperate in the control of water pollution within the Ohio River Basin. ORSANCO coordinates activities and facilitates an exchange of information and technology among federal agencies and the water pollution control and natural resource agencies of the member states.

Maintaining the biological integrity of the Ohio River through the protection of aquatic life and habitat is a goal of both the Compact and the Clean Water Act. Chemical and physical parameters are monitored to assess pollution levels in the river. In addition, the effects of pollution on aquatic life monitored using biological assessment tools. Monitoring biological communities can reveal stressors, such as pollution or habitat degradation, which may not be detected by chemical or physical measurements.

Since 2004, aquatic life has been assessed on a pool-by-pool basis. For aquatic life assessments, the river has been divided into independent Assessment Units (AUs) based on the pools created by high-lift dams. These AUs are sampled each year on a rotating basis, such that complete coverage of the river every five years is achieved. ORSANCO evaluates biological condition using an index specifically designed for the Ohio River, the ORFIn, which has been updated recently and is now referred to as the *modified* Ohio River Fish Index (*m*ORFIn). The *m*ORFIn combines various attributes of the fish community to assign a score to the river based on biological characteristics.

The *m*ORFIn is comprised of metrics which serve as surrogate measures of more complicated processes. Examples of metrics include number of species, number of pollution tolerant individuals, and percent of top piscivores in the fish community. A *m*ORFIn score is calculated for each site by comparing observed ORFIn values to statistical thresholds in historical ORFIn scores within each habitat class. ORSANCO uses three distinct habitat classes in performing habitat assessments - designated as Class A, B, and C. Each class has a different expectation on the ORFIn scale, depending on the habitat composition. Habitat A sites contain coarse substrates such as boulders and cobble, provide the most cover and food, and therefore score the highest. Habitat C sites contain smaller substrates such as sand, are less attractive to fish, and usually score at the lower end of the ORFIn scale. Habitat B sites have a combination of sand, cobble, and other substrates. Bottom substrate percentages reported for the individual pools are limited to “hard” materials (boulder, cobble, gravel, sand) – the remaining percentage generally consists of “soft” materials (silt, mud, muck).

ORFIn scores decrease significantly at locations influenced heavily by human activity and are higher at less-impacted sites. Higher scores indicate a more desirable fish community that is reflective of improved water quality. Biological condition ratings are then assigned to a pool based on the average *m*ORFIn score. Attainment is assessed as either “fully supporting” indicating no impairment, “partially supporting” meaning the segment is impaired due to violations of chemical water quality criteria for the protection of aquatic life or biological data, or “not supporting” meaning biological and water quality data indicate impairment. A description of *m*ORFIn scores and how they relate to biological condition ratings is shown in the figure below:



A brief synopsis of ORSANCO Ohio River pool descriptions and assessments (moving in a downstream direction from east to west) follows:

6.15.2.1 New Cumberland Pool (2011 data)
The New Cumberland pool is 22.7 miles long, averages 1439 feet wide and 22 feet deep, and has an average gradient of 0.2 feet per mile. The upper 9 miles of the pool flow within the state of Pennsylvania, while the remaining 13.7 miles are bordered by Ohio and West Virginia. The pool lies 31.7 miles downstream of the City of Pittsburgh in a portion of the Ohio River heavily influenced by industry. The pool receives water primarily from Little Beaver Creek and Yellow Creek. The pool's watershed is primarily forested (>65%), with some agriculture and urban influences. In unmodified sections of the pool the shoreline consists of coarse substrates. Cobble/gravel/sand make up over 75% of the bottom substrate. ORSANCO sampling indicated the following families dominated the fish species composition of the pool: Cyprinids 48.5%, Clupeids 22.6%, Centrarchids 8.6%, Catostomids 8.4%, Ictalurids 4.5%.

New Cumberland Pool - Results Overview

Sampling Results

Environmental Measures

Dominant Habitat Class: C – equal mix of coarse and fines
Notable Measures: relatively high percentage of coarse shoreline

Biological Measures

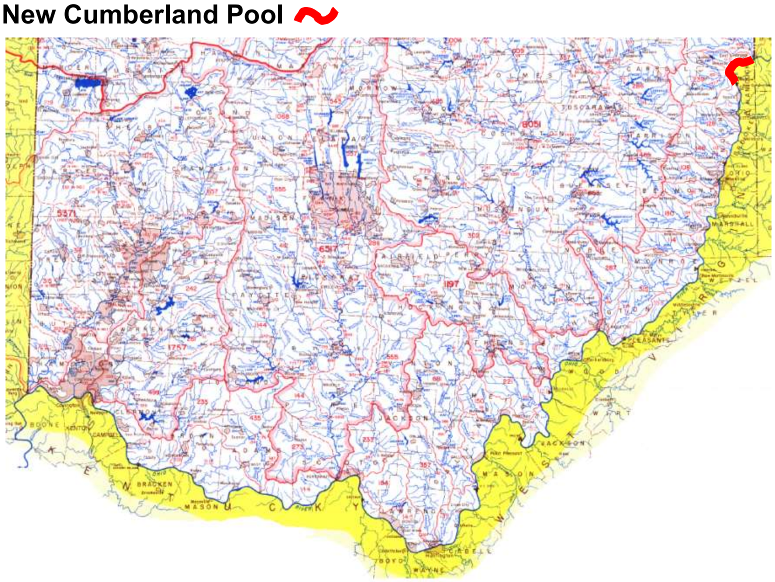
Total No. of Fish Species: 39
Average No. of Individuals: 149
Dominant Family (*minus herring/shad)*: Minnows/Carp
Dominant Species (*minus shad/shiners*): golden redhorse
Threatened & Endangered Species: mooneye, silver chub (PA)
Rare Ohio River Mainstem Species: channel darter
Notable Catch: abundant game fishes (sm. bass and bluegill)

Assessment Results

Highest scoring ORFIn metric (*minus DELTs*): % Non-natives
Lowest scoring ORFIn metric: % Piscivores
Sites Above 25th percentile (i.e. *m*ORFIn Score = 20): 9
Sites Below 25th percentile (i.e. *m*ORFIn Score = 20): 6
Aquatic Life-Use Designation: Met

Overall Biological Condition Rating: Fair

New Cumberland Pool



6.15.2.2 Pike Island Pool (2012 data)

The Pike Island pool is 29.8 miles long, averages 1338 feet wide and 19 feet deep, and has an average gradient of 0.4 feet per mile. The pool is located in a portion of the Ohio River heavily influenced by industry, with significant barge activity. The pool receives water primarily from Buffalo Creek (WV) and Short Creek. The pool's watershed is primarily forested (>64%), with some agriculture and urban influences. The shorelines of this pool support a moderate degree of aquatic vegetation, and littoral zones are dominated by invasive species (Hydrilla spp.). Boulder/cobble/gravel/sand make up about 75% of the bottom substrate. ORSANCO sampling indicated the following families dominated the fish species composition of the pool: Clupeids 62.8%, Cyprinids 18.6%, Centrarchids 8.5%, Catostomids 3.1%.

Pike Island Pool - Results Overview

Sampling Results

Environmental Measures

Dominant Habitat Class: C - equal mix of coarse and fines

Notable Measures: abundant aquatic vegetation (15 of 15 sites)

Biological Measures

Total No. of Fish Species: 42

Average No. of Individuals: 137

Dominant Family (*minus herring/shad*): Minnows/Carp

Dominant Species (*minus shad/shiners*): smallmouth bass

Species of Concern: river redhorse (OH)

Rare Ohio River Mainstem Species: rainbow darter

Notable Catch: northern pike

Assessment Results

Highest scoring ORFIn metric (*minus DELTs*): % Non-natives

Lowest scoring ORFIn metric: Great River Species

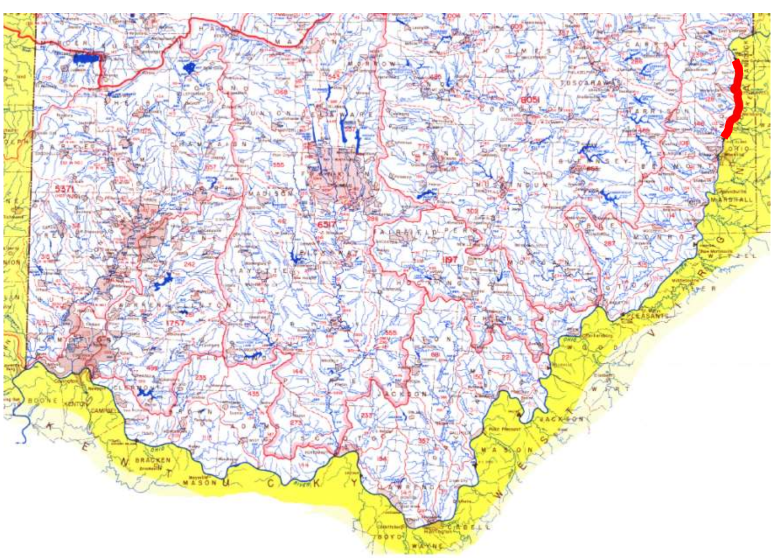
Sites Above 25th percentile (i.e. *m*ORFIn Score = 20): 12

Sites Below 25th percentile (i.e. *m*ORFIn Score = 20): 3

Aquatic Life-Use Designation: Met

Overall Biological Condition Rating: Good

Pike Island Pool



6.15.2.3 Hannibal Pool (2013 data)
The Hannibal pool is 42.2 miles long, averages 1133 feet wide and 21 feet deep, and has an average gradient of 0.5 feet per mile. The pool is located in a portion of the Ohio River heavily influenced by industry with significant barge activity. The pool receives water primarily from Wheeling Creek (OH), Wheeling Creek (WV), McMahon Creek, Grave Creek (WV), Captina Creek, Fish Creek (WV), and Sunfish Creek. The pool's watershed is primarily forested (>64%), with some agriculture and urban influences. The shorelines of this pool support a moderate degree of aquatic vegetation, and littoral zones are dominated by invasive species (Hydrilla spp.). Boulder/cobble/gravel/sand make up about 65% of the bottom substrate. ORSANCO sampling indicated the following families dominated the fish species composition of the pool: Centrarchids 44.3%, Catostomids 18.6%, Cyprinids 16.4%, Percids 9.1%, Ictalurids 4.3%.

Hannibal Pool - Results Overview

Sampling Results

Environmental Measures

Dominant Habitat Class: C - equal mix of coarse and fines

Notable Measures: Above average flows and poor water clarity were observed during the sampling period

Biological Measures

Total No. of Fish Species: 48

Average No. of Individuals: 169

Dominant Family (*minus herring/shad)*: Sunfishes/Black Bass

Dominant Species (*minus shad/shiners*): bluegill

Species of Concern (WV): highfin carpsucker

Rare Ohio River Mainstem Species: greenside darter

Notable Catch: river darter & channel darter (threatened in OH)

Assessment Results

Highest scoring ORFIn metric (*minus DELTs*): % Non-natives

Lowest scoring ORFIn metric (*minus GR Species*): % Lithophils

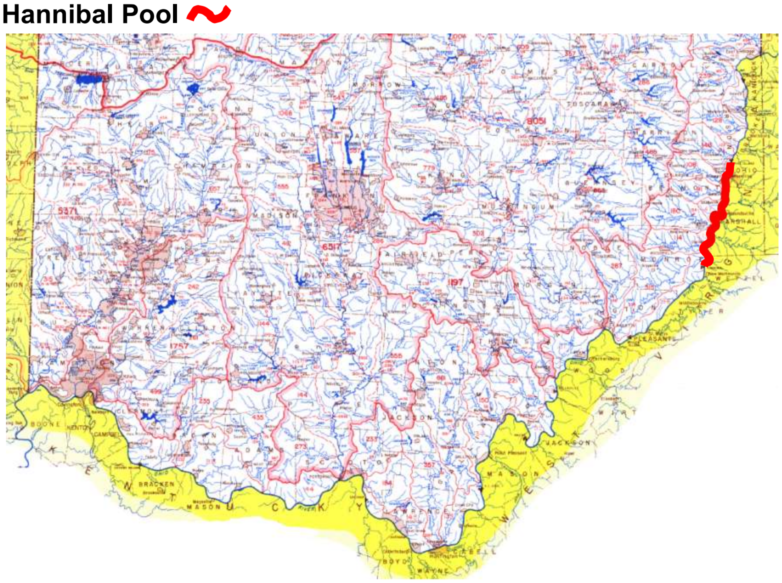
Sites Above 25th percentile (i.e. *m*ORFIn Score = 20): 13

Sites Below 25th percentile (i.e. *m*ORFIn Score = 20): 2

Aquatic Life-Use Designation: Met

Overall Biological Condition Rating: Good

Hannibal Pool



6.15.2.4 Willow Island Pool (2011 data)
The Willow Island pool is 35.3 miles long, averages 1194 feet wide and 21 feet deep, and has an average gradient of 0.6 feet per mile. The pool receives water primarily from Fishing Creek (WV), Middle Island Creek (WV), and the Little Muskingum River. The pool's watershed is primarily forested (>65%), with some agriculture and urban influences. Almost the entire Ohio shoreline is federally protected national forest (Wayne National Forest). Boulder/cobble/gravel/sand make up about 54% of the bottom substrate. ORSANCO sampling indicated the following families dominated the fish species composition of the pool: Cyprinids 42.3%, Centrarchids 27.3%, Clupeids 9.4%, Catostomids 4.4%.

Willow Island Pool - Results Overview

Sampling Results

Environmental Measures

Dominant Habitat Class: D - shallow sand/fines
Notable Measures: abundant inshore structure and vegetation

Biological Measures

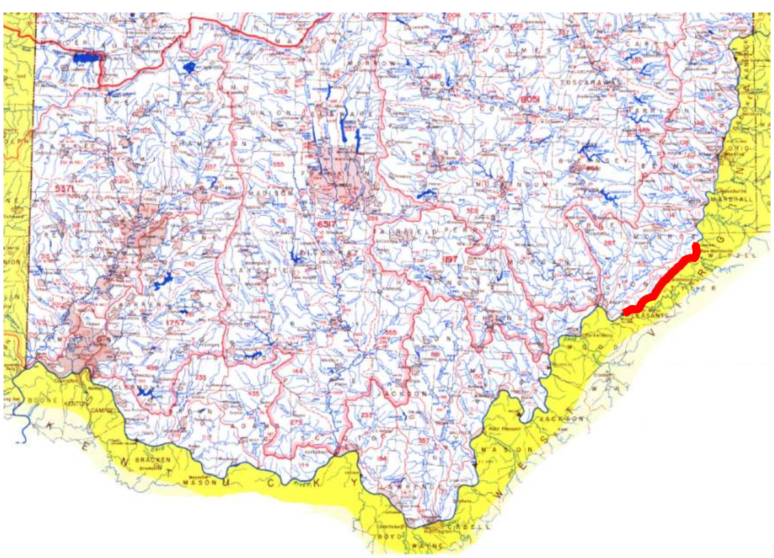
Total No. of Fish Species: 48
Average No. of Individuals: 182
Dominant Family (*minus herring/shad)*: Minnows/Carp
Dominant Species (*minus shad/shiners*): bluegill
Endangered Species: banded killifish (OH)
Rare Ohio River Mainstem Species: yellow bullhead
Notable Catch: abundant game fishes (bass and bluegill)

Assessment Results

Highest scoring ORFIn metric (*minus DELTs*): Centrarchid score
Lowest scoring ORFIn metric: % Lithophils
Sites Above 25th percentile (i.e. *m*ORFIn Score = 20): 13
Sites Below 25th percentile (i.e. *m*ORFIn Score = 20): 2
Aquatic Life-Use Designation: Met

Overall Biological Condition Rating: Fair

Willow Island Pool



6.15.2.5 Belleville Pool (2009 data)
The Belleville pool is 42.2 miles long, averages 1327 feet wide and 24 feet deep, and has an average gradient of 0.5 feet per mile. The pool is located in a portion of the basin moderately influenced by industry and barge activity. The pool receives water primarily from Duck Creek, Muskingum River, Little Kanawha River (WV), Little Hocking River, and the Hocking River. The pool's watershed is primarily forested (>65%), with some agriculture and urban influences. The pool has multiple islands scattered throughout its reach. Boulder/cobble/gravel/sand make up about 77% of the bottom substrate. ORSANCO sampling indicated the following families dominated the fish species composition of the pool: Cyprinids 46.7%, Centrarchids 17.3%, Clupeids 12.3%, Catostomids 10.4%, Percids 5.3%.

Belleville Pool - Results Overview

Sampling Results

Environmental Measures

Dominant Habitat Class: C - mix of coarse and fine substrates
Notable Measures: rocky shorelines were still to be found, woody debris and aquatic vegetation were both very common

Biological Measures

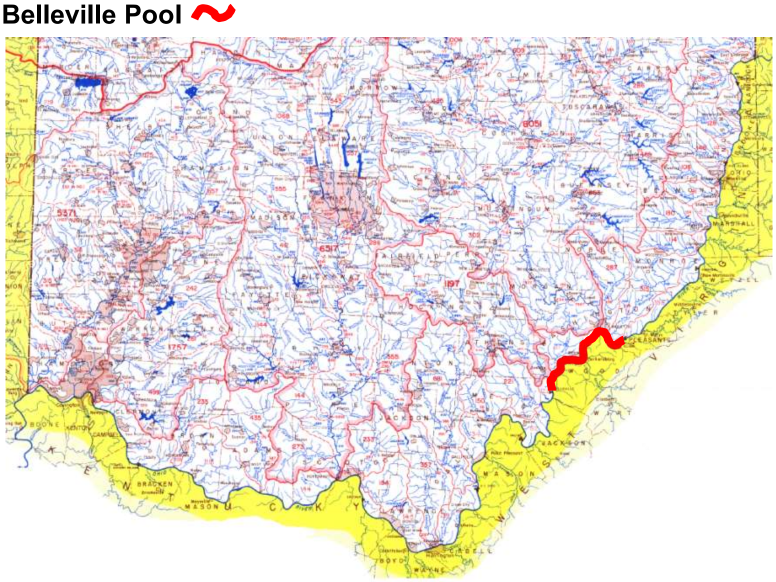
Total No. of Fish Species: 52
Average No. of Individuals: 167
Dominant Family (*minus herring/shad)*: Minnows/Carp
Dominant Species (*minus shad/shiners*): mimic shiner
Threatened/Endangered: Ohio lamprey (E) & river darter (T)
Rare Ohio River Mainstem Species: rainbow darter
Notable Catch: muskellunge and large flathead catfish

Assessment Results

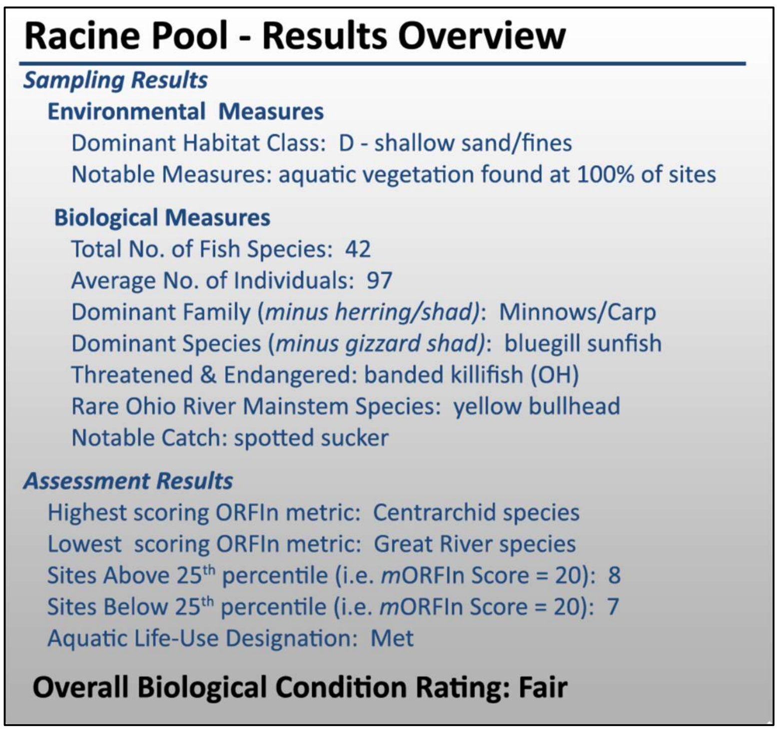
Highest scoring ORFIn metric (*minus DELTs*): % Non-Natives
Lowest scoring ORFIn metric: % Piscivores & Great River Species
Sites Above 25th percentile (i.e. *m*ORFIn Score = 20): 14
Sites Below 25th percentile (i.e. *m*ORFIn Score = 20): 1
Aquatic Life-Use Designation: Met

Overall Biological Condition Rating: Good

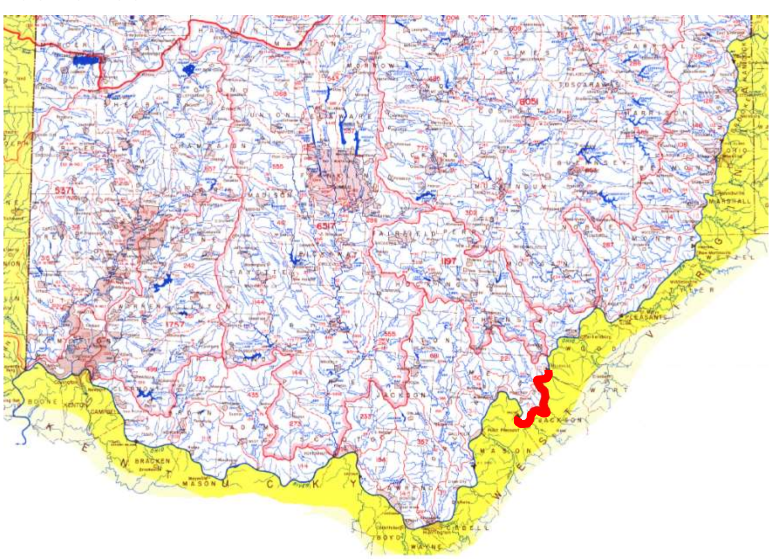
Belleville Pool



6.15.2.6 Racine Pool (2010 data)
The Racine pool is 33.6 miles long, averages 1275 feet wide and 24 feet deep, and has an average gradient of 0.5 feet per mile. The pool is located in a relatively undeveloped portion of the basin with little influence of industry. The pool receives water primarily from the Shade River, Shady Creek (WV), and Mill Creek (WV). The pool's watershed is primarily forested (>65%), with some agriculture and residential influences. The shoreline conditions are conducive to the growth of aquatic vegetation, which is found in large quantities throughout the pool. Boulder/cobble/gravel/sand make up about 65% of the bottom substrate. ORSANCO sampling indicated the following families dominated the fish species composition of the pool: Clupeids 35.1%, Cyprinids 17.9%, Centrarchids 14.9%, Sciaenids 8.5%, Serranids 8.4%.



Racine Pool



6.15.2.7 R.C. Byrd Pool (2013 data)
The R. C. Byrd pool is 41.7 miles long, averages 1154 feet wide and 26 feet deep, and has an average gradient of 0.6 feet per mile. The pool is located in a portion of the basin heavily influenced by industry, with significant barge activity. The pool receives water primarily from Leading Creek, Kanawha River (WV), and Raccoon Creek. The pool's watershed is primarily forested (>65%), with some agriculture and residential influences. Littoral zones are dominated by invasive aquatic vegetation species (Hydrilla spp.). Boulder/cobble/gravel/sand make up about 57% of the bottom substrate. ORSANCO sampling indicated the following families dominated the fish species composition of the pool:, Cyprinids 41.2%, Centrarchids 20.4%, Catostomids 8.1%, Clupeids 8.0%, Ictalurids 7.0%.

R. C. Byrd Pool - Results Overview

Sampling Results

Environmental Measures

Dominant Habitat Class: C - equal mix of coarse and fines
Notable Measures: The lowest performing sites were found downstream of the confluence of the Kanawha River

Biological Measures

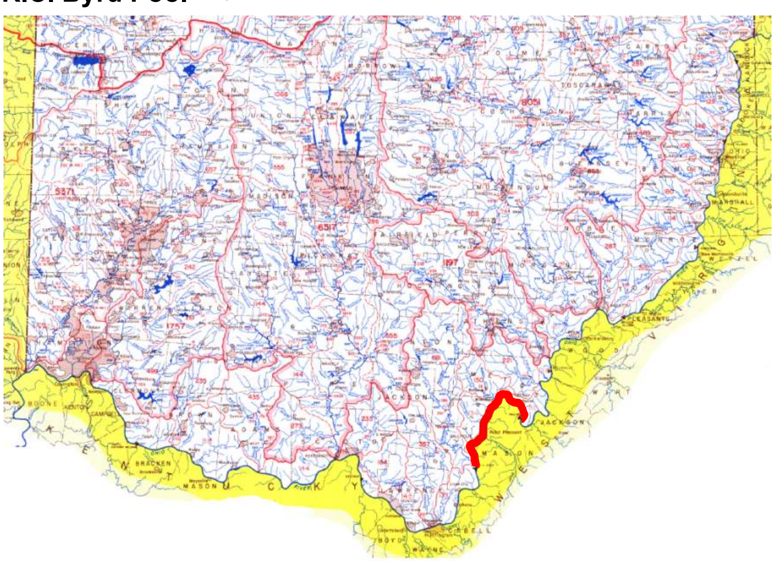
Total No. of Fish Species: 33
Average No. of Individuals: 121
Dominant Family (*minus herring/shad)*: Minnows/Carp
Dominant Species (*minus shad/shiners*): bluegill
Species of Concern: highfin carpsucker (WV) & river redhorse (OH)
Rare Ohio River Mainstem Species: spottail shiner
Notable Catch: striped bass (common in reservoirs & lower OH R.)

Assessment Results

Highest scoring ORFIn metric (*minus DELTs*): % Tolerants
Lowest scoring ORFIn metric (*minus GR Species*): CPUE
Sites Above 25th percentile (i.e. *m*ORFIn Score = 20): 10
Sites Below 25th percentile (i.e. *m*ORFIn Score = 20): 5
Aquatic Life-Use Designation: Met

Overall Biological Condition Rating: Good

R.C. Byrd Pool



6.15.2.8 Greenup Pool (2011 data)

The Greenup pool is 61.8 miles long, averages 1111 feet wide and 26 feet deep, and has an average gradient of 0.4 feet per mile. The pool is located in a portion of the basin heavily influenced by industry, with significant barge activity. The pool receives water primarily from the Guyandotte River (WV), Symmes Creek, Twelvepole Creek (WV), Big Sandy River (WV) and Little Sandy River (KY). The pool's watershed is primarily forested (>65%), with some agriculture and urban influences. Boulder/cobble/gravel/sand make up about 67% of the bottom substrate. ORSANCO sampling indicated the following families dominated the fish species composition of the pool: Cyprinids 59.4%, Centrarchids 13.6%, Ictalurids 7.5%, Sciaenids 7.4%, Catostomids 4.5%.

Greenup Pool - Results Overview

Sampling Results

Environmental Measures

- Dominant Habitat Class: C – equal mix of coarse and fines
- Notable Measures: relatively high percentage of barge traffic

Biological Measures

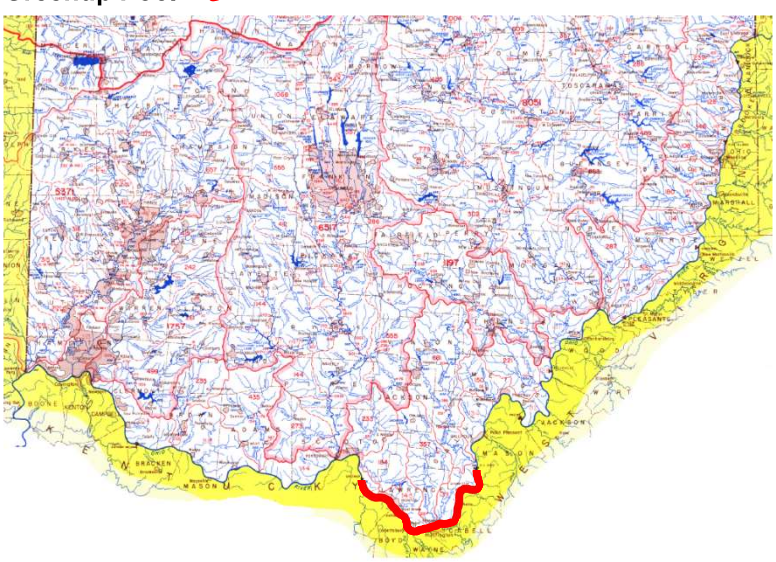
- Total No. of Fish Species: 47
- Average No. of Individuals: 183
- Dominant Family (*minus herring/shad*): Minnows/Carp
- Dominant Species (*minus shad/shiners*): bluegill
- Species of Concern: river redhorse (OH), black buffalo (KY)
- Rare Ohio River Mainstem Species: bowfin
- Notable Catch: river redhorse, numerous catfish and basses

Assessment Results

- Highest scoring ORFIn metric (*minus DELTs*): % Tolerants
- Lowest scoring ORFIn metric: % Lithophils
- Sites Above 25th percentile (i.e. *m*ORFIn Score = 20): 15
- Sites Below 25th percentile (i.e. *m*ORFIn Score = 20): 0
- Aquatic Life-Use Designation: Met

Overall Biological Condition Rating: Good

Greenup Pool



6.15.2.9 Meldahl Pool (2012 data)
The Meldahl pool is 95.2 miles long, averages 1603 feet wide and 23 feet deep, and has an average gradient of 0.3 feet per mile. The pool receives water primarily from Pine Creek, Little Scioto River, Tygarts Creek, Scioto River, Kinniconnick Creek, Ohio Brush Creek, Eagle Creek, and Whiteoak Creek. The shorelines support a moderate degree of aquatic vegetation. The pool's watershed is primarily forested (>65%), with significant agricultural influence. Historically, Meldahl is consistently rated as one of the better pools on the Ohio River. Boulder/cobble/gravel/sand make up about 72% of the bottom substrate. ORSANCO sampling indicated the following families dominated the fish species composition of the pool: Clupeids 79%, Cyprinids 11.8%, Sciaenids 3.1%, Centrarchids 2.3%, Catostomids 1.4%.

Meldahl Pool - Results Overview

Sampling Results

Environmental Measures

Dominant Habitat Class: E - deep sand/fines
Notable Measures: high occurance of woody structure

Biological Measures

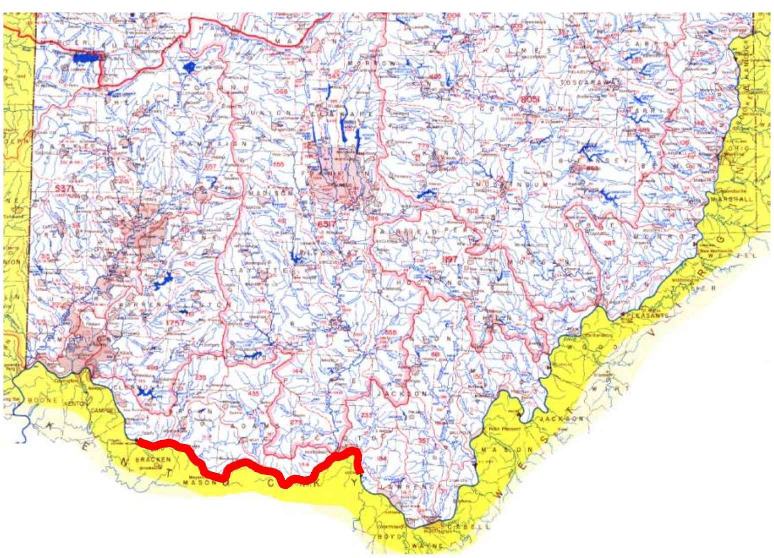
Total No. of Fish Species: 41
Average No. of Individuals: 191
Dominant Family (*minus herring/shad*): Minnows/Carp
Dominant Species (*minus shad/shiners*): freshwater drum
Threatened and Endangered Species: channel darter (T)
Rare Ohio River Mainstem Species: slenderhead darter
Notable Catch: walleye (more common upstream)

Assessment Results

Highest scoring ORFIn metric (*minus DELTs*): % Non-natives
Lowest scoring ORFIn metric: % Lithophils
Sites Above 25th percentile (i.e. *m*ORFIn Score = 20): 14
Sites Below 25th percentile (i.e. *m*ORFIn Score = 20): 1
Aquatic Life-Use Designation: Met

Overall Biological Condition Rating: Good

Meldahl Pool



6.15.2.10 Markland Pool (2009)

The Markland pool is 95.3 miles long, averages 1594 feet wide and 31 feet deep, and has an average gradient of 0.4 feet per mile. The lower 39 miles of the pool are bordered by Indiana and Kentucky. The pool is located in a portion of the basin heavily influenced by industry, with significant barge activity. The pool receives water primarily from the Little Miami River (OH), Great Miami River (OH), and Licking River (KY) – as well as several smaller tributaries. The pool's watershed is primarily forested (>50%), with significant agriculture and urban influence. Boulder/cobble/gravel/sand make up about 58% of the bottom substrate. ORSANCO sampling indicated the following families dominated the fish species composition of the pool: Cyprinids 21.6%, Sciaenids 18.4%, Centrarchids 17.1%, Catostomids 15.4%, Percids 13.7%.

Markland Pool - Results Overview

Sampling Results

Environmental Measures

Dominant Habitat Class: D - shallow sand/fines

Notable Measures: some degree of woody cover was observed at each of the 15 sites

Biological Measures

Total No. of Fish Species: 45

Average No. of Individuals: 207

Dominant Family (*minus herring/shad)*: Drum

Dominant Species (*minus shad/shiners*): freshwater drum

Species of Concern (OH): black buffalo

Rare Ohio River Mainstem Species: warmouth

Notable Catch: river darter & channel darter (threatened in OH)

Assessment Results

Highest scoring ORFIn metric (*minus DELTs*): % Tolerants

Lowest scoring ORFIn metric (*minus GR Species*): CPUE (i.e. total catch)

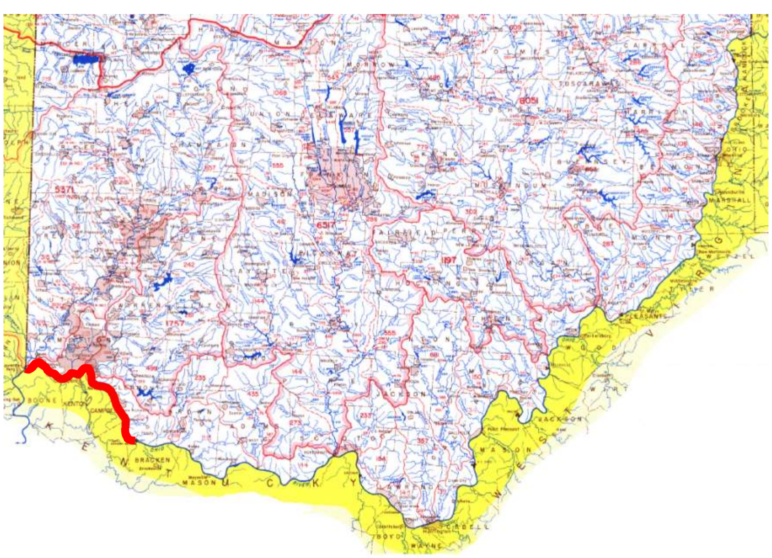
Sites Above 25th percentile (i.e. *m*ORFIn Score = 20): 15

Sites Below 25th percentile (i.e. *m*ORFIn Score = 20): 0

Aquatic Life-Use Designation: Met

Overall Biological Condition Rating: Very Good

Markland Pool



6.15.3 Associated Species of Greatest Conservation Need

Considering that the Ohio River today bears no resemblance to the river that existed in pre-settlement days, the river still supports tremendous numbers and diversity of aquatic species. The riffles, pools, and runs that were the Ohio River are long gone – covered by water of adequate depth to support commercial navigation. A number of aquatic species that existed in the pre-dams Ohio are also gone. Today the river has more in common with large southern reservoirs than it does with the free flowing stream that it once was. The species found in the river today are a reflection of that. Improved water quality in recent years has been mirrored by a shift in the species assemblage – in the direction of species characteristic of better quality lakes/streams. Owing to the reduction in gradient in a downstream direction, the lower pools of the Ohio are longer, wider, warmer, and generally contain softer substrates than their upstream counterparts. As the physical and chemical environment of the river changes, shifts in species composition and abundance are apparent.

The following species have been identified as Ohio River species of greatest conservation need (conservation status rank in parentheses):

<u>Fish</u>	
Diamond Darter (2)	*Crystallaria cincotta*
American Eel (5)	*Anguilla rostrata*
Gilt Darter (6)	*Percina evides*
Paddlefish (9)	*Polyodon spathula*
Shoal Chub (11)	*Macrhybopsis hyostoma*
Ohio Lamprey (13)	*Ichthyomyzon bdellium*
Alligator Gar (15)	*Lepisosteus spatula*
Lake Sturgeon (17)	*Acipenser fulvescens*
Blue Sucker (18)	*Cycleptus elongatus*
Shovelnose Sturgeon (19)	*Scaphirhynchus platorynchus*
Bluebreast Darter (25)	*Etheostoma camurum*
Eastern Sand Darter (29)	*Ammocrypta pellucida*
Silver Chub (36)	*Macrhybopsis storeriana*
Goldeye (39)	*Hiodon alosoides*
Channel Darter (44)	*Percina copelandi*
Black Redhorse (48)	*Moxostoma duquesnei*
Mooneye (50)	*Hiodon tergisus*
Silver Redhorse (52)	*Moxostoma anisurum*
Black Buffalo (56)	*Ictiobus niger*
Dusky Darter (58)	*Percina sciera*
Shortnose Gar (60)	*Lepisosteus platostomus*
River Darter (61)	*Percina shumardi*
Mississippi Silvery Minnow (62)	*Hybognathus nuchalis*
River Redhorse (63)	*Moxostoma carinatum*
Smallmouth Redhorse (63)	*Moxostoma breviceps*
<u>Mussels</u>	
White Wartyback (1)	*Plethobasus cicatricosus*
Pink Mucket (3)	*Lampsilis abrupta*
Long Solid (6)	*Fusconaia subrotunda*
Ebonyshell (8)	*Fusconaia ebena*
Elephantear (8)	*Elliptio crassidens*
Pyramid Pigtoe (8)	*Pleurobema rubrum*
Orange-foot Pimpleback (12)	*Plethobasus cooperianus*
Ohio Pigtoe (13)	*Pleurobema cordatum*
Sheepnose (13)	*Plethobasus cyphyus*
Monkeyface (16)	*Quadrula metanevra*
Slippershell Mussel (16)	*Alasmidonta viridis*
Ring Pink (18)	*Obovaria retusa*

Scaleshell (18)	*Leptodea leptodon*
Winged Mapleleaf (18)	*Quadrula fragosa*
Butterfly (21)	*Ellipsaria lineolata*
Fanshell (25)	*Cyprogenia stegaria*
Wartyback (25)	*Quadrula nodulata*
Rough Pigtoe (35)	*Pleurobema plenum*
Yellow Sandshell (37)	*Lampsilis teres*
Spectaclecase (39)	*Cumberlandia monodonta*
Threeridge (40)	*Amblema plicata*
Washboard (40)	*Megalonaias nervosa*
Cracking Pearlymussel (42)	*Hemistena lata*
Pocketbook (42)	*Lampsilis ovata*
Northern Riffleshell (48)	*Epioblasma torulosa rangiana*
Round Pigtoe (50)	*Pleurobema sintoxia*
Elktoe (52)	*Alasmidonta marginata*
Deertoe (53)	*Truncilla truncata*
Fawnsfoot (53)	*Truncilla donaciformis*
Threehorn Wartyback (55)	*Obliquaria reflexa*
Fat Pocketbook (56)	*Potamilus capax*

Table 39. CONSERVATION THREATS TO THE OHIO RIVER.
The following threats negatively impact or have the potential to negatively impact the Ohio River. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		low
A	Watershed conversion to urban/commercial development alters hydrology	housing & urban areas commercial & industrial areas	low low
B	Shoreline development and its negative effect on habitat and species	housing & urban areas commercial & industrial areas tourism & recreation areas	low low low
C	Increasing land prices limit our ability to protect riparian corridors	housing & urban areas commercial & industrial areas tourism & recreation areas	low low low
II	**agriculture and aquaculture**		low
A	Loss of riparian corridor to agriculture	annual & perennial non-timber crops livestock farming & ranching	low low

B	Watershed conversion to agriculture alters hydrology	annual & perennial non-timber crops livestock farming & ranching	low low
III	**energy production and mining**		low
A	Oil and gas extraction - can have negative impacts by causing chemical contamination	oil & gas drilling	low
B	Hydropower facilities disrupt stream connectivity and kill aquatic species	renewable energy	low
C	Sand/gravel operations destroy habitat	mining & quarrying	low
IV	**transportation and service corridors**		medium
A	Channel modification, dredging shipping lanes - causes habitat loss, water quality impacts	shipping lanes	medium
B	Roads, bridges, causeways, utilities, impact shoreline/nearshore habitats	roads & railroads utilities & service lines	low low
C	Barge traffic impacts water quality, nearshore habitat, and aquatic species	shipping lanes	medium
V	**biological resource use**		low
A	Fishing pressure and fishing gear impacts from recreational and commercial fishing	fishing & harvesting aquatic resources	low
B	Exploitation of Ohio listed species by sport/commercial fisheries in other Ohio River states	fishing & harvesting aquatic resources	low
VI	**human intrusions and disturbance**		low
A	Incompatible recreational activities	recreational activities	low
B	Creation of recreational facilities can alter/destroy nearshore habitat	recreational activities	low
C	Creation of commercial facilities can alter/destroy nearshore habitat	work & other activities	low
D	Vessel impacts to nearshore habitats and water quality	recreational activities work & other activities	low low
VII	**natural system modifications**		high
A	The interjurisdictional nature, conflicting priorities, overlapping regulatory responsibilities and limited Ohio ownership complicates management	other ecosystem modifications	low
B	Dam operations can affect movement of aquatic species, impact water quality, and impact habitat (through changing water levels)	dams & water management/use	high
C	Conflicting water control management objectives of controlling agencies (DOW – USACOE)	dams & water management/use	high
D	Some species' polulations have been reduced to levels below what is necessary to recover on their own	other ecosystem modifications	low
E	Lack of data for some species and habitats limits our ability to develop plans for threats like climate change	other ecosystem modifications	low
VIII	**invasive and other problematic species and genes**		high
A	Introduction and/or spread of invasive plants and animals	invasive non-native/alien species	high
B	Introduction and/or spread of nuisance plants and animals	problematic native species	low

C	Introduction and spread of diseases (plants and animals)	invasive non-native/alien species problematic native species	high low
D	Possible genetic contamination of native fish stocks from introduced hybrid fishes	introduced genetic material	low
IX	**pollution**		high
A	Urban effluent carries a variety of substances that impact water quality and aquatic species	household sewage & urban wastewater industrial & military effluents garbage & solid waste air-borne pollutants	high medium low low
B	Agricultural effluent from row crops as well as confined animal operations impacts water quality and aquatic species	Agricultural & forestry effluents	high
C	Industrial spills impact water quality and aquatic species	industrial & military effluents	medium
X	**geological events**		negligible
---	none	---	---
XI	**climate change and severe weather**		low
A	Climate change could impact habitats, water quality, and species	habitat shifting & alteration droughts temperature extremes storms & flooding	low low low medium

Table 40. CONSERVATION ACTIONS FOR THE OHIO RIVER.
The following actions will help abate or have the potential to help abate threats to Ohio River habitat. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	actions	2nd level action classification(s)	action priority rank	threat(s) addressed*
I	**LAND/WATER PROTECTION**		high	
1	Protect shoreline habitats through acquisition, partnerships, conservation easements, etc.	site/area protection resource & habitat protection	med high	I, II, IV-B, VI-B,C, XI
II	**LAND/WATER MANAGEMENT**		high	
1	Increase habitat diversity in the Ohio River (construct riffles and “T” dikes, dredge embayments, connect backwaters to the mainstem, build islands and wetlands, etc.)	habitat & natural process restoration	high	III-C, IV, V, VI-B,C,D, VII, XI

2	Work with USACOE to minimize negative impacts to fish and wildlife species from dam operations	habitat & natural process restoration	high	III-B, VII-B,C
3	Use lowest impact techniques and timing for dredging activities	habitat & natural process restoration	high	III-C, IV-A, VII-A
4	Work with the USACOE on upland disposal sites for dredge material, or develop innovative ways to create habitat	habitat & natural process restoration	high	IV-A
5	Create and use wetlands for stormwater treatment	habitat & natural process restoration	high	I-A, IX-A
6	Establish an early-detection/rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	high	VIII-A,B
7	Develop a process for coordinating disparate data sources of distribution and abundance of aquatic SGCN with special emphasis on conservation opportunity watersheds	habitat & natural process restoration	high	I-B, III-B,C, IV, V-B, VI-B, C, VII-B,E, XI
8	Review existing species and habitat data to identify data gaps and needs for additional surveys, research, and management actions	habitat & natural process restoration	high	I, II, III, IV, V, VI, VII, VIII, IX, XI
9	Conduct comprehensive surveys of freshwater mussels	habitat & natural process restoration	high	I-B, III-C, IV, VI-B,C,D, VII, XI
10	Compile Ohio River hydrological/limnological datasets and assess the potential these data may have to explain variations in Ohio River fish populations	habitat & natural process restoration	high	V, VII-B,D,E, VIII-D
11	Evaluate the efficacy of alternative sampling gears for providing accurate and precise estimates of population metrics for important fishes	habitat & natural process restoration	high	V, VII-D,E, VIII-D
III	**SPECIES MANAGEMENT**		low	
1	Determine the genetic structure of Ohio River *Sander* spp. populations	species management	med	VIII-D
2	Monitor for the presence of Asian carp in pools adjacent to Ohio	species management	med	VIII-A
3	Assess population status, habitat suitability, and probability for restoration of fish, mussels, crayfish, invertabrates, and amphibians listed as SGCN	species reintroduction	High	VII-D, VII-E
4	Develop a restoration strategy for high priority fish, mussels, crayfish, invertebrates, and amphibians	species reintroduction	High	VII-D, VII-E
IV	**EDUCATION AND AWARENESS**		med	
1	Educate waterfront landowners and commercial pesticide/herbicide applicators on responsible chemical use, and the negative impacts to wildlife from toxic chemicals	training	high	I-B,C, IX-A
2	Promote conservation easements along important shoreline habitat (backwaters, embayments, etc.)	training awareness & communic-ations	high med	I, II, IV-B, VI-B,C, XI
3	Provide technical guidance on shoreline development plans as relates to fish and wildlife interests	training	high	I, IV-B, VI-B,C, XI
4	Provide training to road construction/maintenance personnel for runoff/sediment control	training	high	I-B, IV-B, VI-B,C

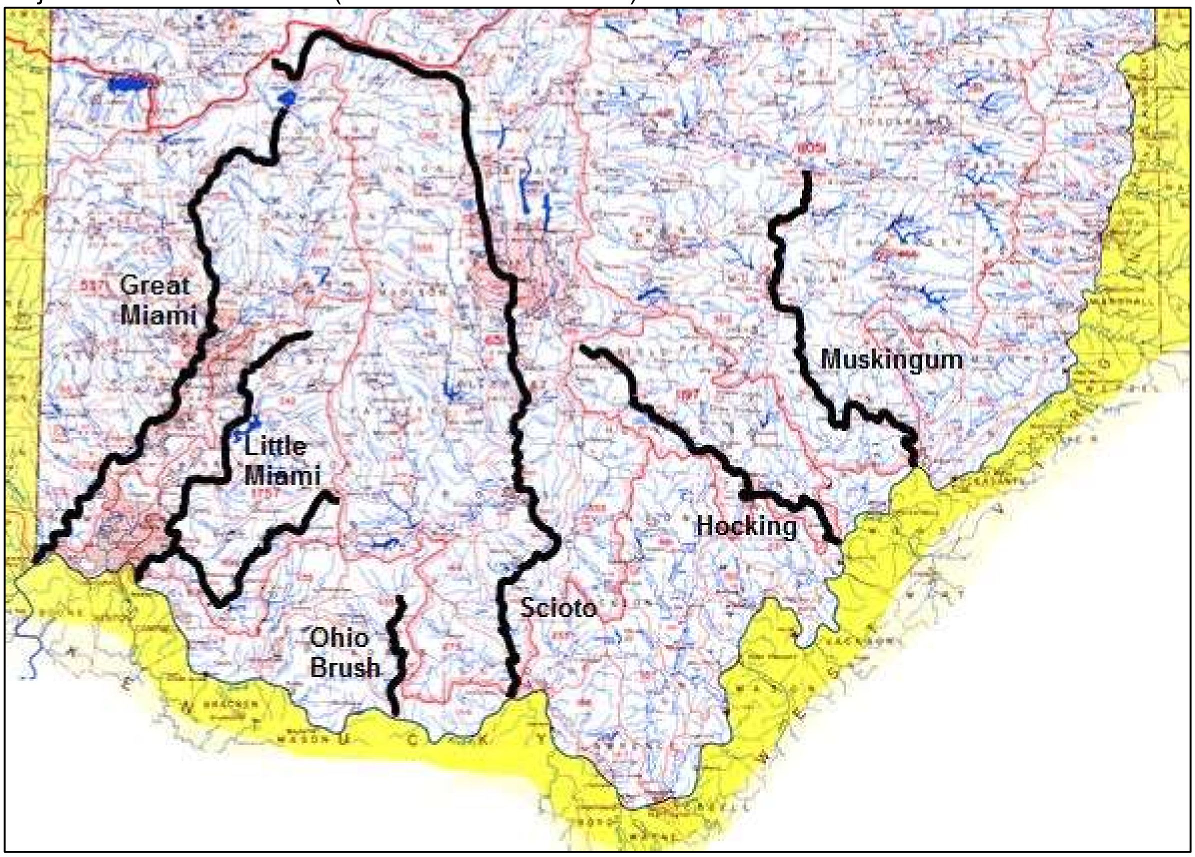
5	Educate the public about the negative effects of exotic and nuisance animals – encourage responsible disposal of unwanted animals	awareness & communic-ations	med	VIII-A,B,C
V	**LAW AND POLICY**		med	
1	Support legislation promoting eco-friendly energy development and use	legislation	med	III-A,B
2	Develop and implement a risk-assessment system in the approval process for importing or moving live animals and plants	legislation policies & regulations	med med	VIII
3	Find innovative ways to mandate the inclusion of fish and wildlife interests in development plans	policies & regulations private sector standards & codes	med low	I, III-B,C, IV-B, VI-B,C, VII-D, XI
4	Support the use of buffers between development and tributary shorelines	policies & regulations private sector standards & codes	med low	I-A,B, IV-B, IX-A
5	Support the creation of additional and/or increase enforcement of stormwater regulations	compliance & enforcement	low	I-A, IX-A
VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		med	
1	Explore tying eligibility for grant money, loans, and cost-share programs to nutrient loading levels for agriculture – the lower the nutrient levels in their effluent, the more money they would be eligible for	market forces conservation payments	med med	IX-B,C, XI
2	Create incentives for vegetated buffers along all waterways to reduce nutrient loads and sediment	market forces conservation payments	med med	I, II, IX-A,B,C, XI
3	Create incentives to promote eco-friendly energy development and use	market forces conservation payments non-monetary values	med med low	III-A,B
4	Support the creation of incentives to protect shoreline habitat	market forces conservation payments	med med	I, II, IV-B, VI-B,C, XI
5	Support clean marina and clean vessel programs	market forces conservation payments	med med	VI-D
6	Develop incentives for municipalities to use stormwater management systems that minimize negative impacts to aquatic habitats	market forces conservation payments	med med	I-A, IX-A

7	Support incentives for development plans involving water frontage that take into account wildlife and habitat needs	market forces conservation payments non-monetary values	med med low	I, IV-B, VI-B,C, XI
VII	**EXTERNAL CAPACITY BUILDING**		med	
1	Work with ODA and OEPA to minimize nutrients in runoff, and develop BMPs for pesticide/herbicide use	alliance & partnership development	high	IX
2	Create an interagency spill response team – update contacts and training on a regular basis	alliance & partnership development	high	IX-C
3	Consider creating a multiagency invasive species prevention and control group that would handle all invasive species issues	alliance & partnership development	high	VIII-A,B,C
4	Through interagency coordination, work to assure that wildlife interests are taken into consideration in road, bridge, and causeway design, construction, and maintenance	alliance & partnership development	high	IV-B
5	Improve inter-jurisdictional relationships within the Ohio River Fisheries Management Team – share data and data gathering	alliance & partnership development	high	I-B, III-B, IV, V, VI, VII, VIII, IX-C, XI
6	Use inter-agency cooperation to influence watershed health, reduce in-stream habitat degradation, and implement projects to improve habitats	alliance & partnership development	high	I, II, III-C, IV, VI-B,C,D, VII-D, IX, XI
7	Collaborate on interjurisdictional management strategies that benefit the resource and constituents, unify regulations, and meet statutory responsibilities	alliance & partnership development	high	VII-A,C
8	Develop or improve reciprocal agreements with Kentucky and West Virginia for fish and wildlife management and wildlife law enforcement	alliance & partnership development	high	VII-A
9	Work with OEPA to encourage completion of TMDL studies for all streams in the Ohio River drainage	alliance & partnership development	high	IX-A,B
10	Encourage/facilitate the establishment of watershed groups and watershed coordinator to promote watershed improvement activities	institutional & civil society development alliance & partnership development	low high	I, II, IX, XI
11	Increase personnel and expertise available for SGCN surveys and research through partnerships with other government agencies and, universities, and conservation-minded NGO's	institutional & civil society development alliance & partnership development	low high	I, II, III, IV, V, VI, VII, VIII, IX, XI

*refers to the Ohio River Habitat Conservation Threats in Table 39

6.16 Ohio River Tributaries

Major Ohio River tributaries (ODNR Division of Water)



6.16.1 Status
Stable to improving. Ohio Environmental Protection Agency (Ohio EPA) surveys indicate general improvement in the physical habitat, water quality, and biological communities of most of the streams in the Ohio River watershed. Ohio's large rivers continue to show improvement as tracked over the last 20 years. The "100% full attainment by 2020" aquatic life goal statistic remains steady at 89.2% full attainment. Taken collectively since the 1980s, the quality of aquatic life in all of Ohio's large rivers has shown a remarkable improvement. Then, only 21% of the large rivers met water quality standards, increasing to 62% in the 1990s, to 89% today. Areas not meeting the standards have decreased from 79% in the 1980s to 38% in the 1990s to 11% today (Ohio EPA 2014a).

6.16.2 Description
In the southern two-thirds of Ohio, tributaries drain south across the 34,361 square mile Ohio River watershed. The five largest tributaries include the Muskingum River (drains 8051 square miles), the Scioto River (drains 6517 square miles), the Great Miami River (drains 5371 square miles), the Little Miami River (drains 1757 square miles), and the Hocking River (drains 1197 square miles). Tributary physical attributes, water quality, habitat, and biological communities tend to follow a west to east gradient across southern Ohio. This gradient results from geographical differences as well as changes in land use practices in the watersheds. The trend is for relief in watersheds to increase from west to east as a result of past glaciation. In the western third of Ohio, the upper reaches of tributary watersheds tend to be relatively flat, with stream gradients increasing as they enter the Ohio River valley. Land use in this part of the state is dominated by urban/suburban development and agriculture. In the unglatiated eastern two-thirds of Ohio, relief is greater, watersheds are smaller, and stream gradients higher. The

predominant land cover in this part of the state is forest, and agriculture is the dominant land use. Streams across this gradient reflect the impacts and impairments that result from land uses within the watershed.

Along Ohio's portion of the Ohio River shoreline, 204 different streams empty directly into the Ohio River. From west to east, those tributary streams are: Great Miami River, Muddy Creek, Rapid Run, Mill Creek, Little Miami River, Fivemile Creek, Eightmile Creek, Tenmile Creek, Pond Run, Twelvemile Creek, Little Indian Creek, Boat Run, Indian Creek, Little Indian Creek, Ray Run, Maple Creek, Bear Creek, Crooked Run, Ryan Run, Bullskin Creek, Moon Hollow Run, Miranda Run, Hog Run, Whiteoak Creek, Straight Creek, Levanna Branch, Cornick Run, Redoak Creek, Eagle Creek, Threemile Creek, Fishing Gut Creek, Little Threemile Creek, Buzzardroost Creek, Elk Run, McClelland Run, Isaacs Creek, Island Creek, Lindsey Creek, Donaldson Run, Cummings Creek, Upper Sister Creek, Spring Run, Ohio Brush Creek, Alex Run, Smokey Creek, Stout Run, Long Lick Run, Wikoff Run, Sulphur Creek, Little Sulphur Creek, Gilpen Run, McCall Run, Rock Run, Lower Twin Creek, Upper Twin Creek, Moore Run, Spencer Run, McAtee Run, Old Pond Run, Pond Run, Nace Run, Turkey Creek, Carey Run, Slab Run, Scioto River, Munn Run, Little Scioto River, Pine Creek, Patton Run, Ginat Creek, Gervais Run, Norman Run, Osburn Run, Storms Creek, Ice Creek, Lick Creek, Salliday Creek, Buffalo Creek, Symmes Creek, Indian Guyan Creek, Paddy Creek, Twomile Creek, Federal Creek, Stillhouse Branch, Swan Creek, Hildebrand Run, Teens Run, Burrels Run, Raccoon Creek, Sardis Run, Long Run, Clark Run, Evans Run, Chickamauga Creek, Mill Creek, George Creek, Campaign Creek, Kyger Creek, Stores Run, Leading Creek, Forest Run, Jesse Run, Bowman Run, Wolf Run, Dunham Run, Tupper Run, Johns Run, Mill Run, Tanner Run, Toms Run, Oldtown Creek, Granny Run, Silver Creek, Savers Run, Groundhog Creek, Dry Run, Locks Run, Wells Run, DeWitt Run, Long Run, Shade River, Guyan Run, Forked Run, Little Forked Run, Sugarcamp Run, Indian Run, Hocking River, Swan Run, Dunfee Run, Sawyer Run, Little Hocking River, Davis Creek, Congress Run, Crooked Run, Mile Run, Muskingum River, Duck Creek, Little Muskingum River, Sheets Run, Allen Run, Bells Run, Newell Run, Danas Run, Reynolds Run, Davis Run, Reas Run, Leith Run, Sheets Run, Collins Run, Mill Creek, Jims Run, Miller Run, Deadhorse Run, Parker Run, Barnes Run, Narrows Run, Patton Run, Pool Run, Havely Run, Texas Creek, Bares Run, Fisher Run, Ueltsch Run, Narrows Run, Litman Run, Muhleman Run, Opossum Creek, Bishop Creek, Sunfish Creek, Gardner Run, Stillhouse Run, Blair Run, Big Run, Captina Creek, Little Captina Creek, Pipe Creek, Big Run, Wegee Creek, McMahon Creek, Indian Run, Whiskey Run, Moore Run, Wheeling Creek, Glenns Run, Patton Run, Deep Run, Short Creek, Little Rush Run, Rush Run, Salt Run, Tarrs Run, Cross Creek, Wells Run, Wills Creek, Island Creek, Croxton Run, Jeremy Run, Goose Run, Brimstone Run, Yellow Creek, McQueen Run, Little Yellow Creek, Wells Run, California Hollow (ODNR 2001).

A brief description of the habitat, water quality, and biological communities for six of the seven largest tributaries to the Ohio River follows (Raccoon Creek is not included at this time because recent data is not available).

6.16.2.1 Great Miami River

The following information was assembled from *Total Maximum Daily Loads for the Great Miami River (upper) Watershed* (Ohio EPA 2012d) except where otherwise noted.

The Great Miami River watershed is located in southwestern Ohio and southeastern Indiana and includes all or part of 15 Ohio counties. The river's headwaters begin near Indian Lake, and the Great Miami flows 170 miles in a southweaterly direction before it empties into the Ohio River west of Cincinnati. Most of the Great Miami River Watershed lies within the Eastern Corn Belt Plains Ecoregion which is characterized by rolling till plains with local moraines. Extreme southern portions of the watershed lie within the Northern Bluegrass Ecoregion characterized by more rugged and deeply dissected terrain (Miami Conservancy District 2012).

In general, the northern portion of the watershed is more agricultural while the southern portion is more urban and suburban developed land. Land cover in the upper Great Miami River watershed is comprised of 71% cultivated crops, 8% pasture/hay, 9% forest and 9% developed land. Land cover in the middle section of the watershed is dominated by cultivated crops (65%) and developed land (20%), with an additional 8% forest and 5% pasture/hay. Land cover in the lower portion of the watershed is dominated by developed urban and residential land (nearly 40%), agricultural land (28%) and forest (19%).

In 2008, Ohio EPA sampled 78 sites on streams in the upper Great Miami River watershed. Overall the watershed met criteria for aquatic life use at 64% of sites, partially met at 26%, and did not meet aquatic life use criteria at 10% of the sites. The causes of impairments included habitat alteration, excess nutrients, silt, flow alteration, organic enrichment, low dissolved oxygen, excess dissolved solids, and bacteria. In the 2008 survey, 79% of sites evaluated for habitat quality had experienced some form of channelization and 62% were still negatively influenced by channelization. Eighteen percent of sites have recovered from historical modification, and only 21% of site channels were considered natural and unmodified.

Bacteriological impairment was pervasive throughout the upper watershed. Primary Contact Recreation criteria were exceeded at 73% of sites. Row crop agriculture was a suspected source of contamination at all of the impaired sites. Normal row crop agricultural activity may also include manure application to farm fields – and portions of the Great Miami basin drain some of the highest manure-producing counties in the state. Biosolids from the larger local municipal wastewater treatment plants are also spread on area fields near the facilities. The lower watershed shows similar causes of impairment, although due to the increasingly urban nature of the watershed in this area, sources of impairment shift to a variety of runoff and discharges from municipalities.

A more detailed discussion of the Great Miami River watershed is provided in the Ohio River Tributaries Conservation Opportunity Watersheds later in this section.

6.16.2.2 Little Miami River
The following information was assembled from *Total Maximum Daily Loads for the Upper Little Miami River* (Ohio EPA 2002), and *Lower Little Miami River Watershed Draft TMDL Report* (Ohio EPA 2010b).

The Little Miami River watershed is located in southwestern Ohio and drains a total of 1,758 square miles as it flows through all or part of 11 counties. The 110-mile-long river joins the Ohio River in Hamilton County on the east side of Cincinnati. The eastern portion of the watershed is predominantly comprised of cultivated crops with pockets of forest and pasture/hay lands. The western portion of the watershed is a mixture of forest, pasture/hay lands and urban development. The majority of the watershed is located within the Eastern Corn Belt Plains ecoregion, which is characterized by level to gently sloping land. Designated a State and National Scenic River, the Little Miami River mainstem contains some of Ohio's most scenic and diverse riverine habitat.

Upper River
The upper Little Miami River watershed covers portions of six counties and drains approximately 657 square miles. The topography of this northern section has been influenced by glaciation which left distinctive land forms and thick deposits of silt, sand, and gravel.

The habitat quality in the upper Little Miami watershed ranges from poor to excellent. For the mainstem, detailed results from Ohio EPA studies show that two patterns are apparent. First, the headwaters upstream from Clifton possess a greater number of human derived habitat attributes than natural attributes. Row crop agriculture strongly influences this part of the basin. Habitat attributes associated with impaired biological performance included sparse cover, no sinuosity, and channelization. The other pattern evident is that the riffles are at least moderately embedded with fine gravel, sand and silt. These two patterns are related – the practices resulting in modified habitat attributes in the headwaters and tributaries result in the bedload of sediment that infiltrates the riffles throughout the mainstem. Two other pervasive sources of sediment loads affecting the mainstem are eroding banks, especially where the riparian buffers have been removed, and suburban development. Downstream from Clifton, the habitat is capable of supporting Exceptional Warmwater Habitat (EWH) communities, with the habitat characterized by natural features derived from a free flowing channel interacting with glacial till and a mature riparian corridor.

Lower River
The lower Little Miami River watershed covers portions of 5 counties and drains about 1100 square miles. Land cover in the watershed is predominantly agriculture (40% cropland, 11% pasture) and forest (30%). About 17% of the watershed is developed or urban land, mostly in the southern portion when current land development is most rapid.

In 2007, the Ohio EPA collected biological, chemical, and physical data in the lower watershed. The mainstem of the Little Miami River showed exceptional quality, as twenty-four of twenty-five locations achieved the State's highest standards for aquatic life. The smaller tributary streams met goals for aquatic communities at 57% of the sites, partially met at 35%, and dis not meet at 12% of the sites. The reason for not meeting aquatic life goals at over half of the impaired sites was low stream flow due to an unusually dry year. The other impaired sites were most impacted by wastewater discharges, where nutrients and organic substances are the pollutants of concern. An excessive amount of fine sediment on the streambed was a problem at some survey sites. This was likely the result of surface or stream bank erosion in cropland areas due to exposed soil, changes in hydrology, and ditch maintenance.

The following information was assembled from *Biological and Water Quality Study of Little Miami River and Tributaries 2012* (Midwest Biodiversity Institute 2013).

Seventeen Little Miami R. mainstem sites were evaluated under the Warmwater Habitat (WWH) suite of uses and biocriteria. Of these, 24% were in full attainment of EWH biocriteria, and the remaining 76% were in partial attainment. The 2012 results represent a decline in attainment status compared to the most recent 2007 Ohio EPA results. The decline was the result of the failure of the fish Index of Biotic Integrity (IBI) to meet the EWH biocriterion. The reduction in the quality of the fish assemblage was substantial and widespread. A total of eight fish species that were present in 2007 were missing in 2012, and 16 additional species exhibited marked declines in distribution and abundance. Fifteen of these 24 species are classified as highly intolerant to pollution. Seven species increased in distribution and abundance and four of these are classified as moderately to highly tolerant of pollution.

Eleven mainstem sites on the East Fork of the Little Miami River were evaluated under the WWH suite of uses and biocriteria. Of these, 1 site was in full attainment of the EWH use and the remaining 10 in partial attainment. Causes of impairment included flow fluctuations, low dissolved oxygen, organic enrichment, habitat modifications, and siltation.

A number of sites on tributaries to the Little Miami River were also evaluated. In general, the majority of sites either did not meet the warmwater habitat aquatic life use criteria, or only partially attained it. The partial and non-attainment of WWH was mostly due to poor quality fish assemblages, and at some locations, poor quality macroinvertebrate assemblages also. The water quality in these tributary streams was typical of watersheds with a high degree of urban development, and urban effluents were the primary source of causes of impairment.

A more detailed discussion of the Little Miami River watershed is provided in the Ohio River Tributaries Conservation Opportunity Watersheds later in this section.

6.16.2.3 Ohio Brush Creek
The following information was assembled from *Biological and Water Quality Study of Ohio Brush Creek and Selected Tributaries 2007* (Ohio EPA 2011b).

Ohio Brush Creek is a moderate sized Ohio River tributary in south central Ohio, draining 435 square miles in portions of 5 counties before it empties into the Ohio River in Adams County just downstream of the town of Rome. The average mainstem gradient is 8.7 ft./mile. The West Fork is the only significant Ohio Brush tributary. Smaller tributaries are numerous, with gradients frequently exceeding 40 ft./mile. These steep gradients are a result of the high relative relief of the uplands.

Ohio Brush Creek watershed is located in the Interior Plateau (IP) Ecoregion. Land cover in the IP varies with topography, but is primarily livestock, pasture, cropland, and forest. Most of the basin is sparsely populated, and within the heart of the watershed (Adams County) land use is roughly split between agriculture and forest. Due to a diverse geology creating diverse habitat types, Adams County supports some of the highest numbers of State listed species in Ohio.

By and large, the channel configuration of the Ohio Brush Creek mainstem is in a natural state, displaying adequate sinuosity and development. Dominant substrates are coarse, consisting of a mixture of native limestone, dolomite, shale, sandstone, and tills. Riparian areas at most sites are vegetated, more often wooded, attenuating sunlight and providing in-stream structure in the form of woody debris and rootwad formations. As measured by the Qualitative Habitat Evaluation Index, the quality of near and in-stream macrohabitat through the length of Ohio Brush Creek appeared capable of supporting diverse, functionally organized, and well-structured assemblages of aquatic organisms, consistent with its existing Exceptional Warmwater Habitat aquatic life use.

Surface flow or stream discharge of Ohio Brush Creek fluctuates widely. Runoff is rapid in the hill county and peak flows generally follow shortly after heavy precipitation. In contrast, during extended dry periods, surface flows often go intermittent or very low, due to a paucity of sustained ground water input. The latter was directly observed during the 2007 Ohio EPA survey which coincided with an extreme drought.

Of the 152 aggregate linear stream miles of the Ohio Brush Creek watershed assessed in 2007, 59.9% were found to fully support existing and recommended aquatic life uses. Partial attainment was indicated for 38.1%, and non-attainment for the remaining 2.0%. By far the leading associated cause and source of the aquatic life use impairments throughout the basin was the significant reduction, diminution and at times elimination of surface flow, due to an extreme drought experienced throughout south-central Ohio in 2007. Nearly all (98.4%) of the impaired stream miles had as their primary cause and source of impairment “low flow” resulting from a prolonged regional drought. Although other stressors were identified for many waterbodies, nearly all of these factors had as their antecedent, diminished surface flow due to an exceptionally dry summer.

The effects of the drought on the fish and macroinvertebrate indices were largely the cause of the low attainment percentages. It is uncommon to find such a high percentage of impaired river miles within a rural and relatively undeveloped watershed, as that observed for Ohio Brush Creek in 2007. The vast majority of fish stations were found to support a diverse and well organized assemblage of fish, showing high species richness and a good representation of sensitive taxa. In contrast, the performance of macroinvertebrates at the same locations typically performed no better than fair, and in almost every instance were the organism group driving attainment status.

A more detailed discussion of the Ohio Brush Creek watershed is provided in the Ohio River Tributaries Conservation Opportunity Watersheds later in this section.

6.16.2.4 Scioto River

The following information was assembled from *Biological and Water Quality Study of the Middle Scioto River and Select Tributaries, 2010* (Ohio EPA 2012a), *Biological and Water Quality Study of the Upper Scioto River Watershed 2009 & 2011* (Ohio EPA 2012b), and *Ohio 2014 Integrated Water Quality Monitoring and Assessment Report* (Ohio EPA 2014a).

The Scioto River watershed is located in central and south central Ohio and drains a total of 6,513 square miles in all or part of 31 counties. The Scioto River flows into the Ohio River at Portsmouth in Scioto County. The main stem of the Scioto River is over 236 miles long and has an average gradient of 2.3 feet per mile. The watershed is located in the Eastern Corn Belt Plains (ECBP) ecoregion. The northern portion of the watershed is predominantly comprised of cultivated crops with some areas of substantial urban development. The southern portion of the watershed is primarily comprised of forest with pockets of agricultural lands.

Upper River
The upper Scioto River watershed is located in the northwestern portion of central Ohio. The predominant land cover in this part watershed is cultivated crops at 80%. Other relatively common land cover types include developed land (8%), forest (6%) and pasture/hay (4%).

In 2009, 23 streams in the upper Scioto River watershed were assessed by the Ohio EPA. Scioto River mainstem habitat quality was highly variable and ranged from very poor to excellent. The average Qualitative Habitat Evaluation Index (QHEI) score for the upper Scioto River mainstem reflected overall good habitat quality. However, for more than sixteen miles the mainstem is severely modified from channelization, and habitats scored in the poor to fair range. Excellent physical habitat was scored outside of this reach, which helped increase the diversity and biological recruitment potential in the fish communities. High quality tributaries were rarely encountered in the upper Scioto River basin and a majority of samples reflected degraded or marginal quality. As a result of widespread impairment encountered in the upper Scioto basin, high quality biological communities were rarely found.

Fish sampling was conducted during the upper Scioto River watershed assessment in 2009 and 2011. The upper Scioto River headwater site was the only biologically exceptional fish community sampled and had five darter species in the community. The Scioto River downstream of Kenton scored very good, while 40% of mainstem sites scored good and the other 47% were found to have only marginally good or fair quality fish communities.

Macroinvertebrates were sampled at 14 locations along the upper Scioto River mainstem in 2009. Scioto River mainstem sites achieved the applicable Warmwater Habitat (WWH) macroinvertebrate biocriterion at all sites evaluated. The average Invertebrate Community Index (ICI) score was generally reflective of good to very good biological quality. Communities maintained good to exceptional quality from Kenton to the Little Scioto River confluence.

Throughout the study area, channelization and nutrient enrichment associated with agriculture were considered the most common and widespread stressors at these lower quality sites. For macroinvertebrates, the negative effects of these activities were manifest in low total taxa, low sensitive taxa richness, and a predominance of facultative, nutrient and silt tolerant populations. These mostly facultative populations included a number of flatworms, blackflies, midges and riffle beetles, along with several common varieties of baetid mayflies and net-spinning caddisflies.

Middle River
The middle Scioto River watershed is located in central Ohio. Forty-five percent of the basin is developed to some degree (ranging from high to low density development) while cropland by itself accounts for another forty percent of the area. Forest and pastureland account for an additional six and five percent respectively. The middle Scioto River mainstem has a designated aquatic life use of WWH throughout the study area, except for the 2.5 miles impounded by the Greenlawn Avenue dam. In addition, two stretches of the middle Scioto River are impounded by reservoirs: O'Shaugnessy Reservoir (6.6 miles) and Griggs Reservoir (5.9 miles).

Nearly half of the sites within the middle Scioto River basin did not meet the biological integrity goal, as only 58% were in full attainment of the WWH aquatic life use designation. The remaining sites were in partial (19%) or non-attainment (19%) of WWH criteria. Full attainment of a reduced-goal aquatic life use was achieved at the remaining 4%. While 84.6% of the Scioto River mainstem from the Little Scioto River to Big Darby Creek were in full attainment of the designated aquatic life use, organic enrichment downstream of Columbus contributed to 8.1% of partial attainment in the lower reach of the river.

Excellent stream habitat was noted at 39% of sites sampled, good stream habitat was recorded at another 39% of sites, fair habitat was noted at 18% of locations, and poor habitat accounted for the remaining 4%. The average QHEI score for the watershed reflected generally good habitat quality throughout the study area. The Scioto River mainstem had excellent to good habitat quality at 88% of sampling locations. Two sites scored within the fair range as a result of impounded conditions caused by dams.

A total of 82 species of fish were collected from the study area between June 2009 and September 2010. Fourteen very sensitive species were collected, reflecting the overall integrity of the middle Scioto River basin. Scioto River mainstem sites sampled achieved the applicable WWH biocriteria at all sites with this aquatic life use designation. Exceptional fish communities were recorded at all but two sites sampled.

The macroinvertebrate communities from 18 locations in the middle Scioto River and 20 locations in tributaries to the middle Scioto River watershed were sampled in 2009 and 2010. The middle Scioto River mainstem achieved the WWH macroinvertebrate biocriterion at 78% of sites sampled. The average ICI score for the Scioto River mainstem was reflective of overall good biological quality. The four sites that did not meet WWH criteria were impacted by either dams or by the influence urban/suburban effluent.

Lower River
The lower Scioto River watershed is located in south central Ohio. Predominant land cover in this part of the watershed includes forest (47%), cultivated crops (26%) and pasture/hay (13%). Approximately 7.5% of the watershed is developed land. The lower Scioto River from the confluence of Big Darby Creek to the mouth at the Ohio River (101 miles) was in 100% attainment of aquatic life use.

A more detailed discussion of the Scioto River watershed is provided in the Ohio River Tributaries Conservation Opportunity Watersheds later in this section.

6.16.2.5 Hocking River
The following information was assembled from *Total Maximum Daily Loads for the Hocking River Watershed* (Ohio EPA 2009b).

The Hocking River watershed, including Sunday and Monday creeks, is located in southeastern Ohio and drains a total of 1,196 square miles in all or part of seven counties. The Hocking River mainstem is over 102 miles long, emptying into the Ohio River at Hockingport. The northern portion of the watershed is predominantly comprised of cultivated crops. The southern portion of the watershed is predominantly forest, with some hay and pasture lands, and pockets of urban development. Overall, land cover in the watershed is predominantly forest (62%) and agricultural lands (27%). About 9% of the watershed is developed or urban land.

The Hocking River watershed is located within parts of the three different ecoregions: the Eastern Corn Belt Plains (ECBP), the Erie-Ontario Lake Plains (EOLP), and the Western Allegheny Plateau (WAP). The ECBP ecoregion consists primarily of rolling till plains with local end moraines. Corn, soybean, and livestock production is widespread. The EOLP ecoregion is characterized by low lime drift overlying rolling to level terrain with scattered end moraines and kettles. The WAP has a more rugged, unglaciated terrain with local relief up to 500 feet. The underlying strata of the WAP contain significant coal, oil, and gas deposits. Extraction of coal, oil, and gas has had and continues to have a major effect on the ecology of the region. Steep slopes in the region limit crop and cattle production to valley floors that reduces riparian corridors and concentrates animal wastes near the stream.

Ohio EPA conducted a comprehensive physical, chemical, and biological survey in portions of the Hocking River watershed from 2003 to 2005. Aquatic life uses were fully met at nearly 70% of sampling sites throughout the watershed. Just over 20% of the sites sampled were found to be in partial attainment where one or two of the three biological indices (habitat, fish, invertebrates) were met. About 10% of the sites failed to meet any of the biological criteria. The Upper Rush Creek assessment unit is severely impacted by acid mine drainage (AMD) along the mainstem of Rush Creek and some of its small tributaries. These streams are essentially devoid of fish and macroinvertebrates. Due to the overwhelming impact from the AMD, some streams and stream segments are designated as limited resource waters. Primary sources of non-attainment in the watershed were excess nutrients/organic enrichment, sedimentation, habitat alteration, and acid mine drainage.

Based upon Qualitative Habitat Evaluation Index (QHEI) scores, the Hocking River mainstem had good to excellent habitat quality at 66% of sampling locations. In general, habitat quality improved in a downstream direction. Habitat scores in tributary streams were good to excellent in areas not impacted by agriculture or mine drainage. Impacted stream sampling sites generally did not meet Warmwater Habitat (WWH) criteria.

Fish communities met WWH or Exceptional Warmwater Habitat (EWH) criteria at about 70% of sites sampled on the Hocking mainstem. Community scores improved in a downstream direction. Fish community scores in tributary streams usually met WWH or EWH unless impacted by mine drainage. Macroinvertebrate communities met WWH criteria or better at about 90% of Hocking mainstem sites. Macroinvertebrate communities from tributary streams were rated moderately good or better at about 80% of sites sampled.

6.16.2.6 Muskingum River
The following information was assembled from *2006 Biological and Water Quality Study of the Muskingum River* (Ohio EPA 2007a).

Located in eastern Ohio, the Muskingum River drains the largest watershed in the state, encompassing 8,051 square miles in all or part of 27 counties. The mainstem is 112 miles long and enters the Ohio River near Marietta. The Muskingum River is located in the Western Allegheny Plateau (WAP) ecoregion. The northern portion of the watershed is a mixture of urban development, agricultural land, and forest. The southern portion of the watershed is predominantly comprised of forest, with some hay and pasture lands and pockets of urban development.

Ten locks and dams are currently located on the mainstem of the lower 85 miles of the Muskingum River. This system of dams and locks, built to allow commercial use of the river, was one of the earliest slack water systems in the United States. The Muskingum River is no longer used for commercial navigation. Today, recreational boaters use the river, with more than 5,800 boats “locking through” the river’s navigation system annually.

Biological sampling in the Muskingum River during 2006 demonstrated that the entire length of river is fully attaining the Warmwater Habitat (WWH) aquatic life-use designation. Surveys of the fish and macroinvertebrate communities of the Muskingum River revealed healthy populations of numerous pollution sensitive species, along with localized populations of rare, threatened, and endangered species. Most of the free-flowing and tailwater sites supported exceptional biological communities, and chemical water testing results were generally reflective of good water quality.

A total of 65 species of fish were collected from the Muskingum River during 2006 surveys. Muskingum River fish communities at 93% of sampling locations achieved the WWH biocriterion. Index of Biotic Integrity (IBI) scores and Modified Index of Well-being scores were all within the marginally good to exceptional range. An evaluation of fish communities by habitat type (free-flowing upper section, tailwaters, and impounded sections) reveals that the free-flowing and tailwater sites were largely reflective of very good to exceptional conditions, and at or approaching Exceptional Warmwater Habitat (EWH) levels of biological integrity. Physical habitat features at the free-flowing and tailwater sections were adequate for supporting the EWH aquatic life-use designation.

Ohio threatened (T), or species of concern (SC) fish collected during this survey included blue sucker (T), mountain madtom (T), river redhorse (SC), and eastern sand darter (SC). Fish species collected which are intolerant of water pollution included mooneye, blue sucker, river redhorse, bigeye chub, streamline chub, silver shiner, rosyface shiner, mimic shiner, stonecat madtom, mountain madtom, slenderhead darter, eastern sand darter, banded darter, variegate darter, and bluebreast darter. River redhorse and mimic shiner, two species intolerant of water pollution, were recorded at a number of sampling sites on the Muskingum River. Mimic shiners were recorded from impounded and freeflowing (including tailwater) sites, with fish collected from 22 of 28 sampling locations. River redhorse, a fish species which prefers moderate to swift water habitat, were recorded from 15 of 16 free-flowing sites.

Macroinvertebrate sampling results from 2006 indicate that all sampled sites were in full attainment of the WWH biocriterion. A more detailed discussion of the Muskingum River watershed is provided in the Ohio River Tributaries Conservation Opportunity Watersheds later in this section.

6.15.3 Associated Species of Greatest Conservation Need

The physical and chemical characteristics of Ohio River tributaries change as you move from unglaciated eastern Ohio and transition to the glaciated western part of the state. Changes in gradient and land cover drive changes in stream characteristics from east to west. The eastern portion of the Ohio River watershed is predominantly comprised of forest with some areas of crops, pasture, and hay lands. The central portion of the watershed is a more even mixture of crops, pasture and hay lands, and forest. The western portion of the watershed is primarily comprised of urban development and agriculture. The aquatic communities of Ohio River tributaries are a reflection of the glaciated versus unglaciated differences in the watershed.

The following species have been identified as Ohio River Tributary species of greatest conservation need (conservation status rank in parentheses):

Fish	
Diamond Darter (2)	*Crystallaria cincotta*
American Eel (5)	*Anguilla rostrata*
Paddlefish (9)	*Polyodon spathula*
Shoal Chub (11)	*Macrhybopsis hyostoma*
Ohio Lamprey (13)	*Ichthyomyzon bdellium*
Alligator Gar (15)	*Lepisosteus spatula*
Lake Sturgeon (17)	*Acipenser fulvescens*
Blue Sucker (18)	*Cycleptus elongatus*
Shovelnose Sturgeon (19)	*Scaphirhynchus platorynchus*
Tippecanoe Darter (20)	*Etheostoma tippecanoe*
Bluebreast Darter (25)	*Etheostoma camurum*
Eastern Sand Darter (29)	*Ammocrypta pellucida*
Gravel Chub (32)	*Erimystax x-punctatus*
Silver Chub (36)	*Macrhybopsis storeriana*
Goldeye (39)	*Hiodon alosoides*
Streamline Chub (41)	*Erimystax dissimilis*
Bigeye Chub (42)	*Hybopsis amblops*
Channel Darter (44)	*Percina copelandi*
Black Redhorse (48)	*Moxostoma duquesnei*
Mooneye (50)	*Hiodon tergisus*
Silver Redhorse (52)	*Moxostoma anisurum*
Variegate Darter (53)	*Etheostoma variatum*
Black Buffalo (56)	*Ictiobus niger*
Dusky Darter (58)	*Percina sciera*
Shortnose Gar (60)	*Lepisosteus platostomus*
River Darter (61)	*Percina shumardi*
Mississippi Silvery Minnow (62)	*Hybognathus nuchalis*
River Redhorse (63)	*Moxostoma carinatum*
Smallmouth Redhorse (63)	*Moxostoma breviceps*

Crayfish	
Teays River Crayfish (1)	*Cambarus sciotensis*
Norwood River Crayfish (2)	*Orconectes raymondi*
Sanborn's Crayfish (6)	*Orconectes sanbornii*
Big Water Crayfish (7)	*Cambarus robustus*
Paintedhand Mudbug (8)	*Cambarus polychromatus*
Little Brown Mudbug (9)	*Cambarus thomai*
Spiney Stream Crayfish (11)	*Orconectes cristavarius*
Papershell Crayfish (13)	*Orconectes immunis*
Red Swamp Crayfish (13)	*Procambarus clarkii*
Virile Crayfish (13)	*Orconectes virilis*

Mussels

White Wartyback (1)	*Plethobasus cicatricosus*
Snuffbox (5)	*Epioblasma triquetra*
Long Solid (6)	*Fusconaia subrotunda*
Ebonyshell (8)	*Fusconaia ebena*
Elephantear (8)	*Elliptio crassidens*
Pyramid Pigtoe (8)	*Pleurobema rubrum*
Orange-foot Pimpleback (12)	*Plethobasus cooperianus*
Ohio Pigtoe (13)	*Pleurobema cordatum*
Sheepnose (13)	*Plethobasus cyphyus*
Monkeyface (16)	*Quadrula metanevra*
Slippershell Mussel (16)	*Alasmidonta viridis*
Ring Pink (18)	*Obovaria retusa*
Scaleshell (18)	*Leptodea leptodon*
Winged Mapleleaf (18)	*Quadrula fragosa*
Butterfly (21)	*Ellipsaria lineolata*
Rayed Bean (21)	*Villosa fabalis*
Creek Heelsplitter (23)	*Lasmigona compressa*
Pondhorn (23)	*Uniomerus tetralasmus*
Fanshell (25)	*Cyprogenia stegaria*
Rabbitsfoot (25)	*Quadrula cylindrica*
Salamander Mussel (25)	*Simpsonaias ambigua*
Wartyback (25)	*Quadrula nodulata*
Clubshell (35)	*Pleurobema clava*
Rough Pigtoe (35)	*Pleurobema plenum*
Purple Wartyback (37)	*Cyclonaias tuberculata*
Yellow Sandshell (37)	*Lampsilis teres*
Spectaclecase (39)	*Cumberlandia monodonta*
Threeridge (40)	*Amblema plicata*
Washboard (40)	*Megalonaias nervosa*
Cracking Pearlymussel (42)	*Hemistena lata*
Pocketbook (42)	*Lampsilis ovata*
Round Hickorynut (42)	*Obovaria subrotunda*
Black Sandshell (47)	*Ligumia recta*
Kidneyshell (48)	*Ptychobranchus fasciolaris*
Northern Riffleshell (48)	*Epioblasma torulosa rangiana*
Rainbowshell (50)	*Villosa iris*
Round Pigtoe (50)	*Pleurobema sintoxia*
Elktoe (52)	*Alasmidonta marginata*
Deertoe (53)	*Truncilla truncata*
Fawnsfoot (53)	*Truncilla donaciformis*
Threehorn Wartyback (55)	*Obliquaria reflexa*
Cylindrical Papershell (56)	*Anodontiodes ferussacianus*
Fat Pocketbook (56)	*Potamilus capax*

Amphibians

Mudpuppy (14)	*Necturus maculosus maculosus*

Reptiles

Rough Green Snake (3)	*Opheodrys aestivus*
Midland Smooth Softshell (7)	*Apalone mutica mutica*
Common Map Turtle (19)	*Graptemys geographica*
Ouachita Map Turtle (19)	*Graptemys ouachitensis*
Queen Snake (19)	*Regina septemvittata*

6.15.4 Ohio River Tributaries Conservation Opportunity Watersheds

6.15.4.1 Great Miami River Watershed (consists of HUC 05080001 and HUC 05080002)

The Miami River drains 5,385 square miles, of which 1,437 square miles are in Indiana, mainly in the Whitewater River Basin. The highest point in Ohio (1,550 feet above mean sea level) is in the Miami River drainage near Bellefontaine, and the lowest point in the state (about 430 feet above mean sea level, low water level in the Ohio River at the Indiana line) is just below the mouth of the Miami River.

Physiography

The entire basin is in the Till Plains. The level to gently rolling plain is broken by the wide valleys of the major streams. Toward Cincinnati the topography is hilly and more dissected, but is not as rugged as some other parts of southern and southeastern Ohio. The principal terrain features north of Middletown are the kames, eskers, and end moraines left by the glaciers.

Geology

The bedrock units exposed in the basin consist of limestone, dolomite, and shale of Ordovician and Silurian age. These strata are relatively dense and do not allow for the storage of large volumes of ground water. In the northern part of the basin, where the Silurian dolomites prevail, ground-water storage may influence streamflow to a minor degree.

The glacial drift is deep over the upper part of the basin, exceeding 300 feet in places, but thinning toward the south. The glaciers left extensive deposits of washed material, particularly outwash, valley-train deposits, kames, eskers, and kame moraines. Many deep preglacial or interglacial stream valleys are filled with permeable sands and gravels.

Soils

The soils in the basin are derived from glacial deposits of both early and late Wisconsin age. Miamian, Celina, Crosby, and Kokomo are the dominant soils of the late Wisconsin till area, and Russell, Xenia, and Fincastle are the principal soils of the early Wisconsin area. Classification of these soils depends on the drainage condition under which they developed. The less well-drained soils are relatively impermeable. Rather extensive terrace and alluvial soils occur, generally with good drainage and high permeability. Eldean, Ockley, and associated soils are prevalent on the terraces. Genesee soils are the dominant alluvial soils.

Water Development

Flood-control works of the Miami Conservancy District include five detention dams (dry reservoirs except during flood periods) that have automatic outlets. The dams provide flood protection for Dayton and other cities along the Miami River. In 1972, the Corps of Engineers completed Buck Creek Reservoir on Buck Creek at Springfield. The City of Dayton obtains its water supply from large well fields along the Miami River and Mad River.

Flow Characteristics

The amount of ground-water storage, the controlling factor influencing the low-flow characteristics of streams, is greatest in the upper part of the Miami River Basin, and diminishes toward the south. It is of interest to note that as early as 1896 a geologist with the U. S. Geological Survey (Leverett) recognized the influence of ground-water discharge on streamflow. Leverett states (in U. S. Geological Survey, Monogram 41, 1902) that "The streams in this basin (Miami River Basin) seldom reach a very low stage in seasons of drouth, for the valleys are usually filled with gravelly or sandy deposits which furnish strong springs. Even in the small tributaries, water bearing beds outcrop along the banks or bluffs."

Above Dayton three principal streams, Stillwater River, Miami River, and Mad River, all of which converge at Dayton to form the main valley, drain the basin. Of the three branches, Stillwater River has the lowest index of dry-weather flow and Mad River the highest. Throughout most of its course, Stillwater River follows a preglacial valley containing moderately permeable outwash deposits. Above Covington the Stillwater lies between two moraines, and although it flows through a till plain, its tributaries extend into the morainal areas to the north and south. The morainal material is largely till but sufficiently extensive sand and gravel deposits are present to support the fairly good sustained flow in the Stillwater River.

The effects of morainal deposits are clearly shown on Greenville Creek. This stream is of ice-front origin and parallels the southern edge of the Union Moraine from Covington to the Indiana line. The dry-weather flow index at Bradford is double that of the Stillwater River above the mouth of Greenville Creek.

Below Covington the chief source of the sustained flow in the Stillwater River is the outwash and valley train deposits in the valley. Ground-water contribution from the limestone and dolomite that form the valley walls is relatively small. Above Dayton the sustained flow in the Miami River is relatively high. With the exception of a short reach above Piqua, the channel is cut into valley fill of glacial origin. At the col above Piqua, the channel is cut into the bedrock. The sustained flow is maintained largely from ground-water flow originating in the extensive kame moraine, end moraine, and kame terrace deposits above Quincy in Logan County. Downstream from Piqua the chief source is form high-level terrace deposits.

The tributary, Loramie Creek, has a poor sustained flow. The area drained is till plain in which most of the surface materials are dense and impermeable. It is believed that Loramie Reservoir has little effect on the flow of Loramie Creek. The same holds true for Indian Lake at the head of the Miami River.

The greatest contribution to the sustained flow of the Miami River is received from the Mad River. The Mad River occupies a broad trough-like valley of preglacial and interglacial origin and most of its course lies between the morainal ridges deposited by the Miami and Scioto lobes of the Wisconsin glacier. The surface material in the interlobate area consists of extensive permeable drift such as kames, kame terraces and end moraines accompanied by high-level outwash in the uplands and valley train in the main valleys. At no other place in the state is there such an accumulation of permeable material and, as a result, the Mad River has some of the highest median- and low-flow indices of all the streams in Ohio. Similar conditions prevail in the area drained by Buck Creek and Beaver Creek although glacial drift in this area is less gravelly in nature and tends to be more dominantly till. Regional discharge from limestone contributes some ground water to sustain base flows of the Mad River.

Analyses of the gaging records for the Mad River show that the greatest influx of ground water occurs between Urbana and Springfield. This is due mainly to flow from Buck Creek and partly from greater ground-water influx along the river between Urbana and Springfield. The Mad River (similar to the Miami River at Piqua) has a short reach where it is shallow to limestone just west of Springfield. Between Springfield and Dayton there is a decrease in the index of flow. Miscellaneous discharge measurements made in this area in 1948 revealed that many of the tributary streams are dry during dry weather periods.

From Dayton to Hamilton there is a general decrease in the dry-weather flow indices of the Miami River except at Miamisburg where the effects of municipal and industrial wastewater return flows from Dayton are noticeable. Municipal and industrial water supplies are derived from gravel deposits along the Miami River and Mad River in Dayton and discharged as wastewater upstream of the Miamisburg gage. Part of the water supply is diverted to the Little Miami River through the wastewater system. Tributaries such as Wolf Creek and Twin Creek have moderate sustained flows and tend to maintain the low flow in the Miami River.

<u>State Listed Species by County with Records of Occurrence from the Great Miami River Watershed</u> (from the Ohio Natural Heritage Database)
The following species are dependent upon aquatic habitats to complete their life cycle – this dependence may be for all or a portion of their life:

Hamilton County
Kirtland's snake, cobblestone tiger beetle, plains clubtail, lake sturgeon, eastern sand darter, blue sucker, burbot, river redhorse, bigeye shiner, mountain madtom, northern madtom, channel darter, river darter, paddlefish, Sloan's crayfish, elktoe, purple wartyback, butterfly, elephantear, snuffbox, ebonyshell, washboard, threehorn wartyback, sheepnose, Ohio pigtoe, monkeyface, wartyback, fawnsfoot, deertoe

Butler County
Kirtland's snake, cave salamander, plains clubtail, blue corporal, tonguetied minnow, Sloan's crayfish

Warren County
Spotted turtle, Kirtland's snake, blue corporal, goldeye, river redhorse, bigeye shiner, paddlefish, Sloan's crayfish, elktoe, snuffbox, washboard, threehorn wartyback, round pigtoe, purple lilliput, fawnsfoot, deertoe, rayed bean

Preble County
Kirtland's snake, least darter, Sloan's crayfish

Montgomery County
Kirtland's snake, seepage dancer, plains clubtail, eastern sand darter, least darter, burbot, river redhorse, Sloan's crayfish, elktoe, snuffbox, wavyrayed lampmussel, pondhorn, rayed bean

Greene County
Spotted turtle, Kirtland's snake, seepage dancer, tonguetied minnow, snuffbox, wavyrayed lampmussel, creek heelsplitter, clubshell, fawnsfoot

Darke County
Plains clubtail, least darter, Sloan's crayfish, wavyrayed lampmussel, creek heelsplitter

Miami County
Iowa darter, least darter, creek heelsplitter

Clark County
Spotted turtle, Kirtland's snake, seepage dancer, Iowa darter, least darter, tonguetied minnow

Champaign County
Spotted turtle, Kirtland's snake, seepage dancer, elfin skimmer, *Litobrancha recurvata* (mayfly), *Radotanypus florens* (midge), lake chubsucker, least darter, tonguetied minnow, clubshell, rayed bean

Shelby County
Least darter, purple wartyback

Mercer County
Eastern cricket frog, deertoe, pondhorn

Logan County
Spotted turtle, eastern hellbender, swamp metalmark, lake chubsucker, Iowa darter, tonguetied minnow, elktoe, purple wartyback, wavyrayed lampmussel, creek heelsplitter, kidneyshell, rayed bean

Auglaize County
Least darter, greater redhorse, rayed bean

Hardin County
Four-toed salamander, least darter, creek heelsplitter, pondhorn, rayed bean

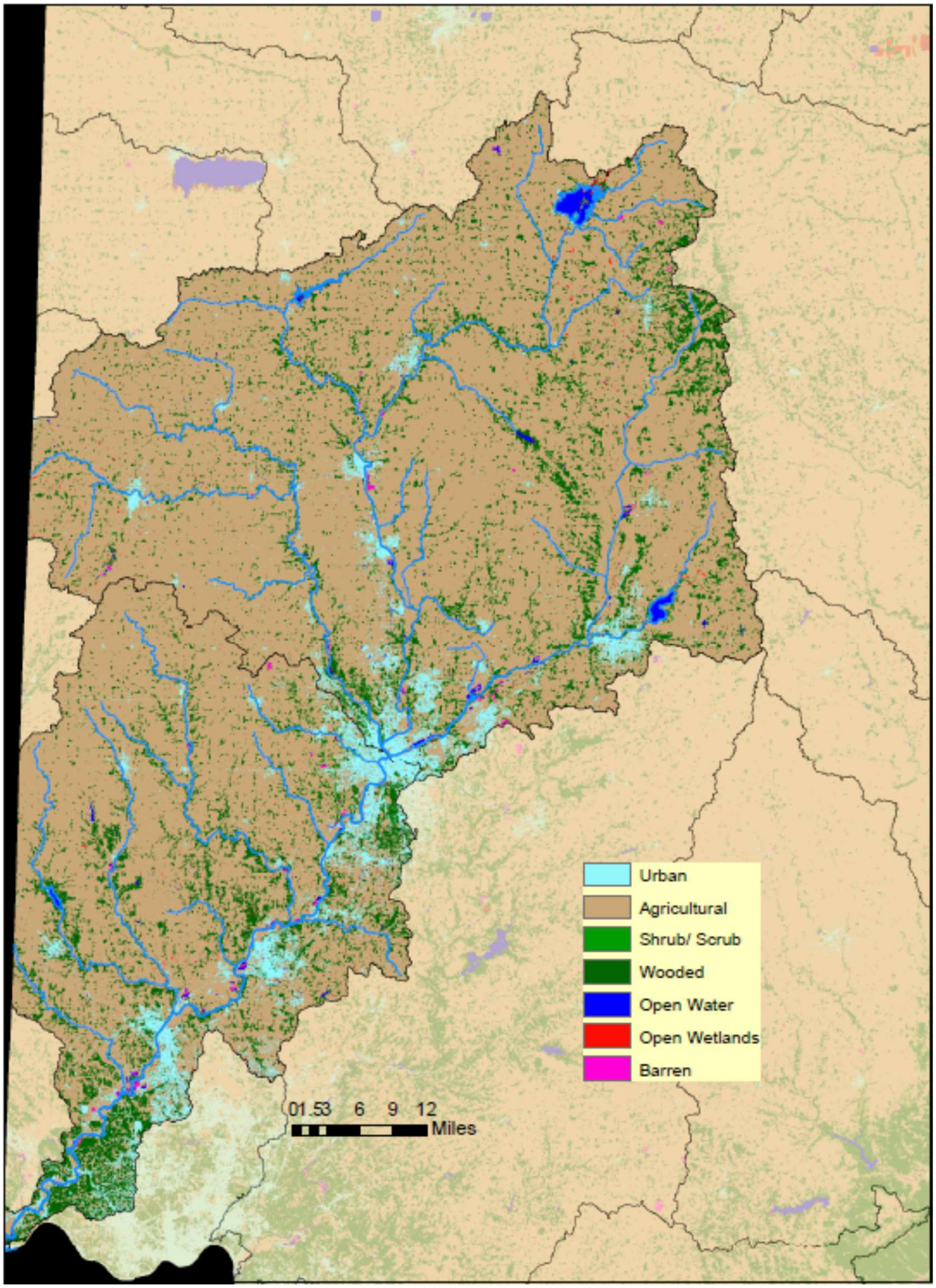


Figure 31. Great Miami River Conservation Opportunity Watershed – Land Cover.

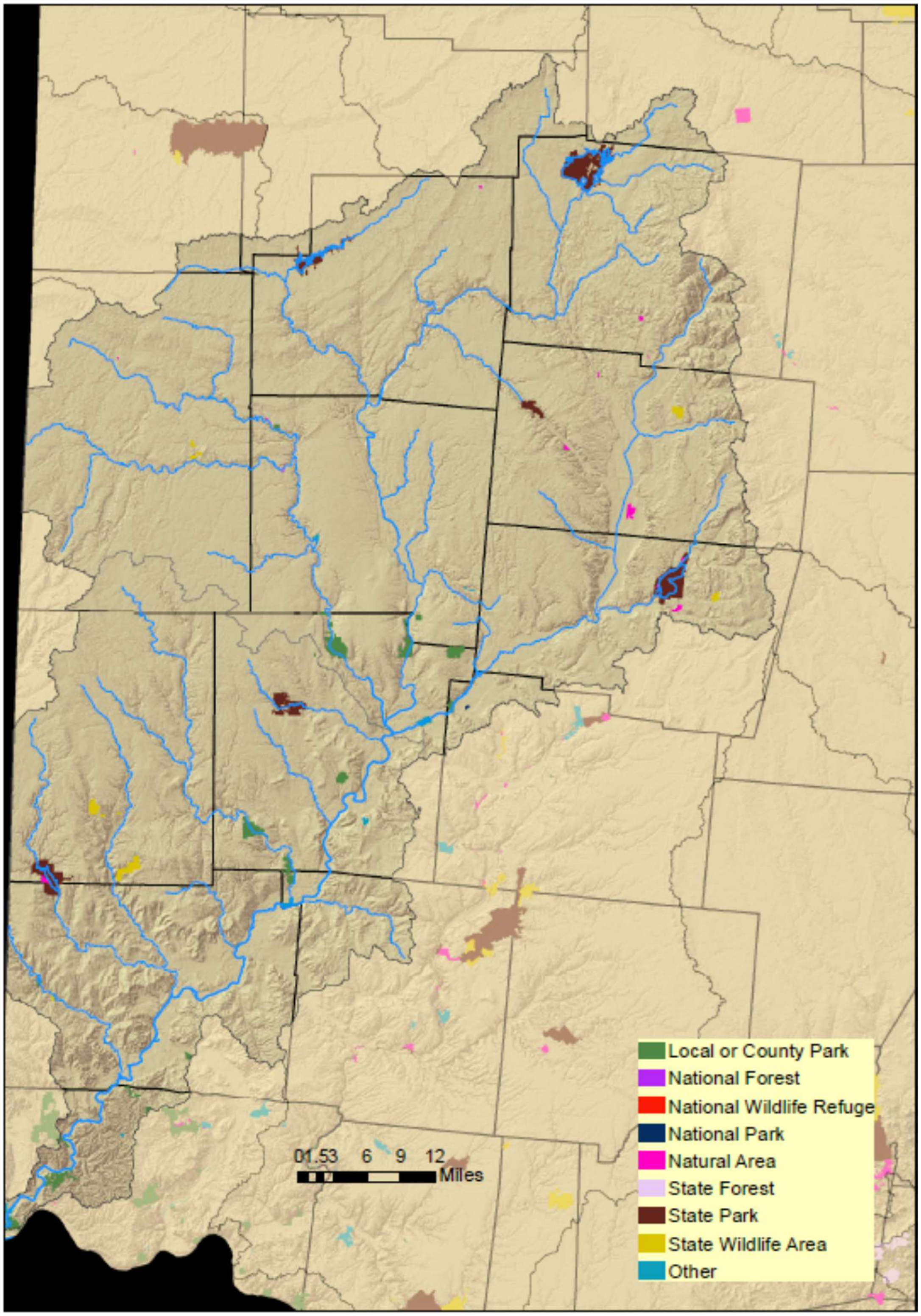


Figure 32. Great Miami River Conservation Opportunity Watershed – Protected Lands.

6.15.4.2 Little Miami River CO Watershed (HUC 05090202)
The Little Miami River Basin drains an area of 1,755 square miles. The source of the main stream is a few miles southeast of Springfield, and the mouth is just east of Cincinnati. East Fork, its principal tributary, originates near Hillsboro and joins the main stream about 12 miles above the mouth. East Fork drains 501 square miles of the total area comprising the Little Miami Basin.

Physiography
The entire basin lies within the Till Plains. The northern part of the area is flat to gently rolling but with occasional deep gorges, such as Clifton Gorge near Yellow Springs. Generally to the south the relief is greater, although a large area in the East Fork drainage is flat swampland. The valleys are generally relatively narrow and bordered by rock buffs. At places where the streams traverse preglacial drainage lines, the valleys are broad and flat-bottomed.

Geology
Dense calcareous shale, dolomite, and limestones of Ordovician and Silurian age underlie the basin. There is minor karst sinkhole terrain in the Silurian limestone, but it is poorly developed. Although there are springs and spring lines where a relatively permeable limestone outcrops over impermeable shale, their effect on streamflow is negligible. Glacial deposits of two ice advances occupy the area of the Little Miami Basin. Approximately the upper half of the basin is covered by drift of Wisconsinan age and the lower half by Illinoian deposits.

Soils
The soils in this basin vary widely. In areas of late Wisconsin drift are Miamian, Celina, Crosby, Kokomo, Birkbeck, Reesville, and Ragsdale soils. They range from very poorly drained to well drained and are for the most part slowly permeable. The moderately to slowly permeable Russell, Xenia, and Fincastle are the important soils series in areas of early Wisconsin drift. Rossmoyne, Clermont, and Avonburg are the dominant soils in the Illinoian drift area. The well-drained Bonnell and Jessup soils are common in areas in the southern part of the basin where the Illinoian till deposits are thin. These soils are slowly permeable. There are also terrace and alluvial soils with good drainage but these are rather limited in extent.

Water Development
The Corps of Engineers completed Caesar Creek Reservoir on Caesar Creek in 1973 and East Fork Reservoir on East Fork Little Miami River in 1977.

Flow Characteristics
There is a wide range of difference in the flow characteristics of the streams in this basin. The effects of glacial material on flow characteristics are manifest in this area. As the drift thins toward the south and changes from dominantly gravel terrain to till cover, the dry-weather flow decreases in relative magnitude from the source to the mouth. The gaging station on the Little Miami at Spring Valley shows an exceptionally high sustained flow as a result of the widespread gravel deposits that lie above drainage in the headwater area of the basin. High-level outwash materials in the form of valley fill, terraces, and kame terraces are present in northern Greene county and southern Clark County. These materials, which are highly permeable, absorb large quantities of rainfall and release it rather uniformly throughout the year. In addition to the ground water contribution from the glacial deposits, a minor amount is contributed by the limestone and dolomite formations.

The record of flow at the Oldtown gage on the Little Miami River indicates a relatively high index of median flow in the upper part of the Little Miami valley. Fifty percent of the time the flow exceeded about 0.5 cubic feet per second per square mile which is above average for an uncontrolled stream. The record at the Spring Valley station has an even higher median-flow index although augmented by wastewater discharges. Between Spring Valley and Fort Ancient, the Little Miami follows the course of a preglacial valley in which more than 100 feet of unconsolidated valley fill is present. However, there are no high-level glaciofluvial deposits that greatly affect streamflow. The relatively high base-flow index at the Fort Ancient is a reflection of the influence of ground-water discharge in the headwater area above Spring Valley and flow augmentation from wastewater discharges. Caesar Creek that is the principal tributary above Fort Ancient is cut into the shale bedrock throughout much of its course and the unregulated flow relatively low during dry periods.

The record of flow at the Milford gaging station shows a high dry-weather flow index. This is still a reflection of the influence of conditions in the headwater area, although some additional flow is contributed by terrace deposits in the valley north of Milford and releases from Caesar Creek Reservoir.

Cowan Creek drains an area in which impervious shale and dense till predominate. This accounts for the very low indices of flow indicated by the records near Wilmington and at Clinton County Air Force Base.

The index of flow of East Fork of Little Miami River should be similar to that of Whiteoak Creek because of the similarity of geologic conditions in the two basins. East Fork drains an area in which the surface material is almost entirely glacial till of Illinoian.

<u>State Listed Species by County with Records of Occurrence from the Little Miami River Watershed</u> (from the Ohio Natural Heritage Database)
The following species are dependent upon aquatic habitats to complete their life cycle – this dependence may be for all or a portion of their life:

Brown County
Bigeye shiner, channel darter, river darter, purple wartyback, butterfly, elephantear, ebonyshell, yellow sandshell, washboard, threehorn wartyback, sheepnose, Ohio pigtoe, monkeyface, wartyback, salamander mussel, fawnsfoot, deertoe, rayed bean, little spectaclecase

Highland County
Tiger spiketail, bigeye shiner

Clinton County
Cobblestone tiger beetle

Greene County
Spotted turtle, Kirtland's snake, seepage dancer, tonguetied minnow, snuffbox, wavyrayed lampmussel, creek heelsplitter, clubshell, fawnsfoot

Clark County
Spotted turtle, Kirtland's snake, seepage dancer, Iowa darter, least darter, tonguetied minnow

Montgomery County
Kirtland's snake, seepage dancer, plains clubtail, eastern sand darter, least darter, burbot, river redhorse, Sloan's crayfish, elktoe, snuffbox, wavyrayed lampmussel, pondhorn, rayed bean

Warren County
Spotted turtle, kirtland's snake, blue corporal, goldeye, river redhorse, bigeye shiner, paddlefish, Sloan's crayfish, elktoe, snuffbox, washboard, threehorn wartyback, round pigtoe, purple lilliput, fawnsfoot, deertoe, rayed bean

Clermont County
Kirtland's snake, goldeye, blue catfish, shortnose gar, river redhorse, bigeye shiner, mountain madtom, northern madtom, channel darter, paddlefish, elktoe, purple wartyback, butterfly, elephantear, snuffbox, ebonyshell, wavyrayed lampmussel, black sandshell, threehorn wartyback, sheepnose, Ohio pigtoe, monkeyface, wartyback, salamander mussel, fawnsfoot, deertoe, rayed bean, little spectaclecase

Hamilton County
Kirtland's snake, cobblestone tiger beetle, plains clubtail, lake sturgeon, eastern sand darter, blue sucker, burbot, river redhorse, bigeye shiner, mountain madtom, northern madtom, channel darter, river darter,

paddlefish, Sloan's crayfish, elktoe, purple wartyback, butterfly, elephantear, snuffbox, ebonyshell, washboard, threehorn wartyback, sheepnose, Ohio pigtoe, monkeyface, wartyback, fawnsfoot, deertoe

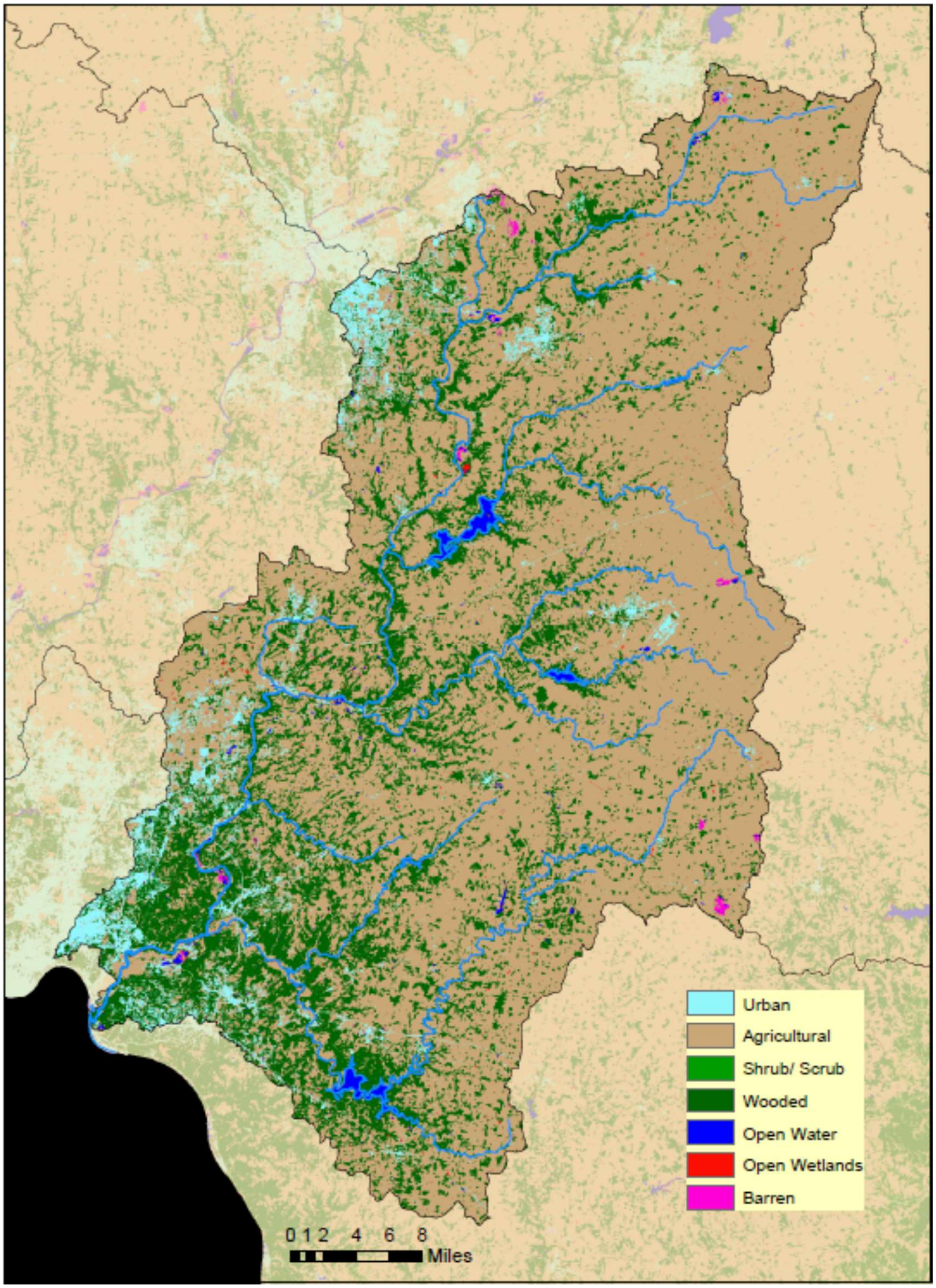


Figure 33. Little Miami River Conservation Opportunity Watershed – Land Cover.

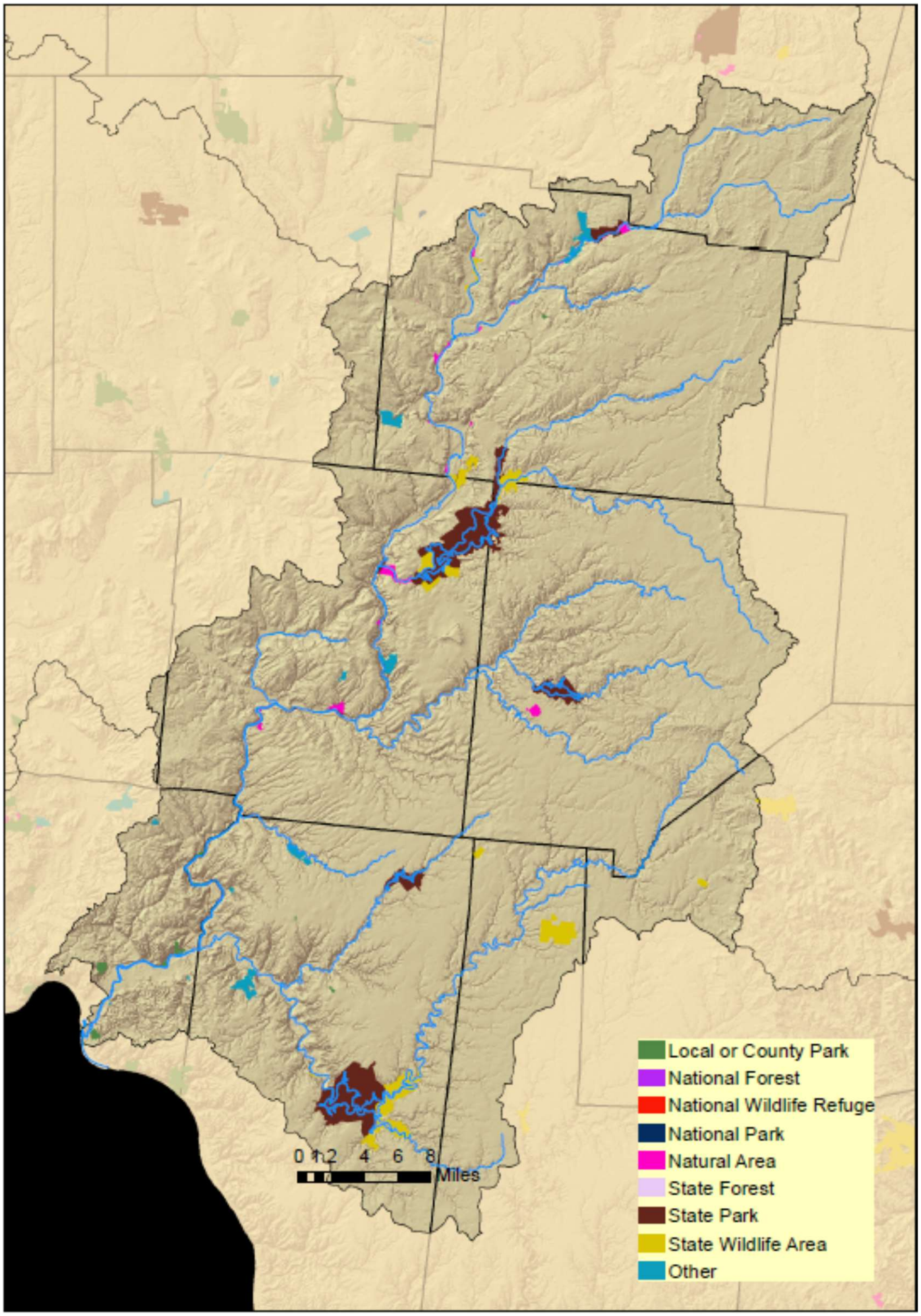


Figure 34. Little Miami River Conservation Opportunity Watershed – Protected Lands.

6.15.4.3 Ohio Brush Creek CO Watershed (consists of the central 33% of HUC 05090201)
There are 1,336 square miles contributing to the Ohio River drainage between the Scioto and Little Miami rivers; Ohio Brush Creek drains 435 square miles of this area.

Physiography
Most of Adams County is an unglaciated limestone area, considered physiographically to be part of the Bluegrass Section of the Interior Low Plateau Province, but the soils are thin, the topography rough, and there is little resemblance to the fertile Kentucky Bluegrass region. North and west of Adams County the area is in the Till Plains, but the terrain is rugged and the drift relatively thin.

Geology
The surface rocks are extremely variable, ranging from sandstone and shale in the eastern part to dolomite and limestone in the central part and to calcareous shale in the western sector. The western part of the area is covered with Illinoian drift, generally thin, but with some local areas of thick and relatively impermeable deposits. The glaciated area has lower dry-weather streamflow than the unglaciated, but not as low as in the Little Miami River Basin.

Soils
The soils of this area may be placed in three groups according to their parent materials and physiographic relationship: (1) those derived from limestone and shale that are generally shallow and occur on steep, hilly topography; (2) those derived from relatively shallow Illinoian glacial till on undulating to gently rolling relief; and (3) soils derived from sandstone and shale on steep, hilly topography. Principal soils in the first group are the Eden, Bratton, Brushcreek, and Cedarville. The permeability of these soils is generally moderate to slow. Soils of the second group include the moderately slow to slowly permeable Jessup, Bonnell, and Rossmoyne soils series. In the third group, the principal soils are the steep phases of Shelocta, Latham, and Rarden. There are some alluvial soils, but the valleys are narrow and of limited extent, except along the Ohio River where there are areas of moderately permeable soils.

Water Development
There are no large inland water developments in the watershed.

Flow Characteristics
Ohio Brush Creek has relatively low sustained flow. With the exception of a small area in the headwaters, Ohio Brush Creek drains an unglaciated area. Some alluvium and glacial outwash is present under the valley floor. The Brassfield limestone of Silurian age, which is a notable spring horizon, is exposed along the valley of Ohio Brush Creek throughout a large portion of its course. The spring water and possibly some discharge from the alluvium support the rather low dry-weather flow.

State Listed Species by County with Records of Occurrence from the Ohio Brush Creek Watershed (from the Ohio Natural Heritage Database)
The following species are dependent upon aquatic habitats to complete their life cycle – this dependence may be for all or a portion of their life:

Adams County
Green salamander, cave salamander, four-toed salamander, tiger spiketail, green-faced clubtail, Uhler's sundragon, blue corporal, goldeye, river redhorse, channel darter, river darter, paddlefish, purple wartyback, yellow sandshell, black sandshell, washboard, threehorn wartyback, clubshell, rabbitsfoot, wartyback, salamander mussel, fawnsfoot, deertoe

Pike County
Seepage dancer, plains clubtail, yellow-sided skimmer, blue sucker, goldeye, shortnose gar, river redhorse, bigeye shiner, paddlefish, shovelnose sturgeon, snuffbox, ebonyshell, yellow sandshell, creek heelsplitter, washboard, threehorn wartyback, sheepnose, fawnsfoot, deertoe

Highland County
Tiger spiketail, bigeye shiner

Brown County
Bigeye shiner, channel darter, river darter, purple wartyback, butterfly, elephantear, ebonyshell, yellow sandshell, washboard, threehorn wartyback, sheepnose, Ohio pigtoe, monkeyface, wartyback, salamander mussel, fawnsfoot, deertoe, rayed bean, little spectaclecase

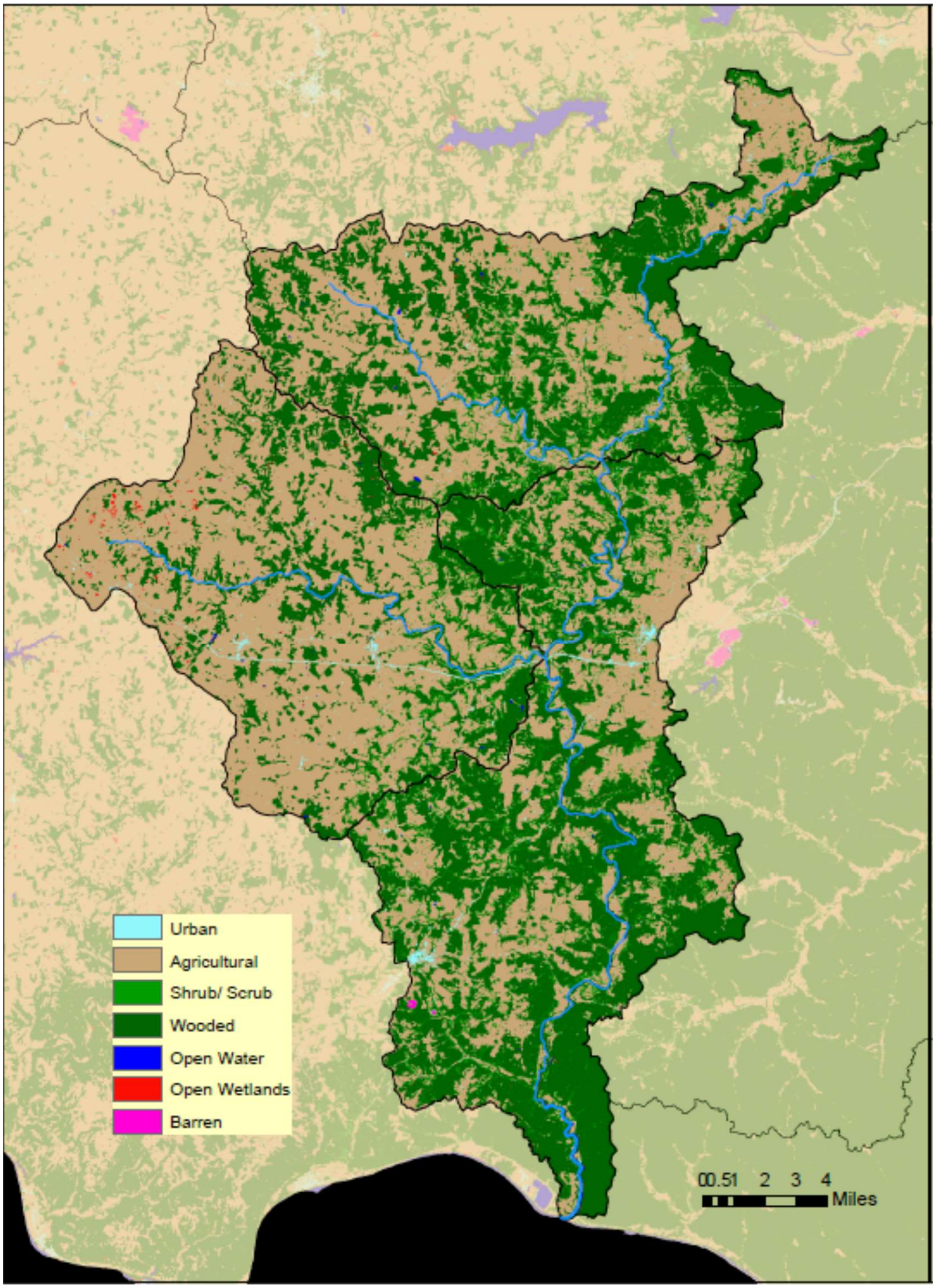


Figure 35. Ohio Brush Creek Conservation Opportunity Watershed – Land Cover.

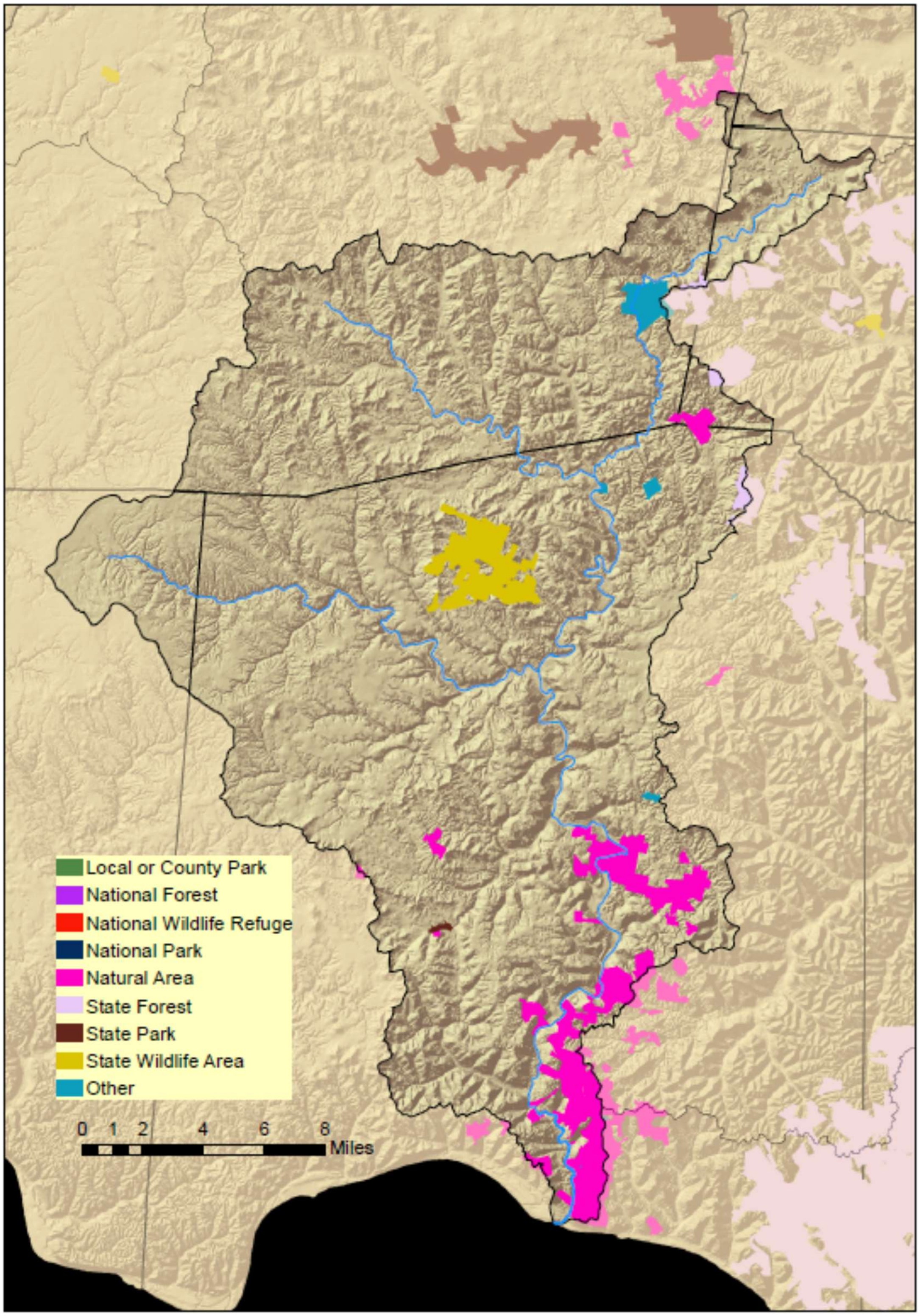


Figure 36. Ohio Brush Creek Conservation Opportunity Watershed – Protected Lands.

6.15.4.4 Scioto River CO Watershed (consists of HUC 05060001, HUC 05060002, and HUC 05060003)

The Scioto River drains 6,510 square miles and has the third largest drainage basin in the state. It is about 240 miles in length. The topography of the basin is extremely varied, from flat swamplands near the source to the rugged terrain of the unglaciated plateau near the mouth.

Physiography

Three physiographic sections are represented in the basin. About 65 percent of the area is in the Till Plains Section of the Central Lowlands Province. This northern part of the basin varies from an almost level plain to gently rolling terrain with thick glacial drift mantling the bedrock and filling the preglacial valleys. The streams flow in wide valleys, and a part of the area is swampy. The eastern margin of the basin from Chillicothe north is in the Glaciated Allegheny Plateaus Section of the Appalachian Plateaus Province. Here the topography is more rolling, with rounded hills and with valleys filled with glacial deposits. The southern and southeastern quarter of the basin is in the unglaciated Allegheny Plateaus Section with steep slopes and rugged topography.

The profile of the river is peculiar because of glaciation. The upper reaches are swampy and flat. From Marion County to Columbus the gradient is steeper, averaging 4 feet fall per mile, and the river is confined in a narrow gorge. South of Columbus the river flows in a wide preglacial or interglacial valley, and the gradient averages 1.7 feet per mile. The valley width in this lower section is about 1.5 miles.

Geology

The rock strata underlying the Scioto Basin ranges in age from Silurian to Pennsylvanian. East of an approximate north-south line through Columbus, the bedrock is predominantly dense, impervious shale. West of this line the rocks are dolomite and limestone that contain relatively large quantities of ground water in solution channels and joint systems. South of the Pickaway-Ross County line the dominant rock types become interbedded Mississippian and Pennsylvanian shales, siltstones, and sandstones.

Despite the fact that the underlying rocks store appreciable quantities of ground water in most of the basin, the effect of the bedrock character on streamflow is relatively unimportant. The glacial drift, particularly the melt-water deposits such as outwash, valley train, kame, and esker sands and gravels, store huge quantities of water and markedly affect low-water streamflow. The greatest influences occur where a present day stream flows in a preglacial valley over deep sand and gravel. Some of the till plain drift is relatively impermeable, and in these areas there is little sustained flow in streams.

Soils

Soils of glacial origin cover most of this area. The principal soils are those of the Miamian and Blount catenas in the glacial limestone area, and the Bennington catena of soils in the glacial sandstone and shale area. Generally, the till soils are moderately slow to slowly permeable; however, some moderately permeable soils occur. Terrace and alluvial soils are generally more permeable. The predominant soils are the Eldean and Genesee. There are some muck soils in the basin. South of the glacial boundary the soils are residual. The dominant soils include the Shelocta, Brownsville, and Latham soil series. Alluvial and terrace soils in this area include some well-drained permeable soils, but generally, permeability of the soils in the basin is moderate to slow.

Water Development

The City of Columbus has two water supply reservoirs on the Scioto River, Griggs Reservoir built in 1905 and O’Shaughnesy Reservoir built in 1925. Hoover Reservoir on Big Walnut Creek was added to the municipal supply system in 1954.

The Corps of Engineers completed construction of Delaware Reservoir on the Olentangy River near Delaware in 1951, Deer Creek Reservoir on Deer Creek in 1968, Paint Creek Reservoir on Paint Creek in 1971, and Alum Creek Reservoir on Alum Creek in 1973.

Flow Characteristics

There are wide differences in streamflow characteristics in adjacent areas, or even within the same subbasin. For example, Big Walnut Creek has about four times the sustained flow, in cubic feet per second per square mile, at the downstream station as compared with the upstream station. This is caused apparently by the presence of thick and permeable glacial deposits in the lower reach of the stream, the upper station being in an area of predominantly shallow till overlying dense shale. Alum Creek at Columbus is similarly affected by the heavy overburden of glacial drift east and northeast of Columbus. Another anomaly is the sustained flow of Rocky Fork, that is much greater that of adjacent areas of equal size. A major portion of this flow is derived from its tributary, Clear Creek, which has its headwater in the Cuba Moraine, and flows on glacial outwash material throughout most of its course.

Generally, the streams in the northern part of the Scioto River Basin above Columbus have lower sustained flows than those in the southern part. There is a remarkable consistency in the sustained flows at stations in the upper half of the basin. The bedrock in the above areas contributes a negligible amount of ground water to streamflow, and the overburden of glacial drift consists mainly of impervious till.

The Scioto River above Prospect is an ice-front stream in origin and derives its low flow from morainal masses both to the north and south. Rock exposures are few in this area. The channel is in glacial drift throughout practically its entire course and the morainal hills rise from 50 to 100 feet above the valley floor. Although the sustained flow above Prospect is not great, it clearly shows the effect of the relatively permeable morainal hills in contrast with flow of streams in strictly till areas.

Darby Creek and Deer Creek drain areas that have very similar surface features. Both streams flow through areas in which the glacial drift is relatively thick but variable in its physical characteristics. Deer Creek is influenced somewhat by the moraine south and west of Marysville.

The dry-weather flow index of Paint Creek at Bourneville prior to completion of Paint Creek Reservoir was three times that at Greenfield and remains about the same. Above Greenfield the stream drains an area of thin till that yields little ground water to sustain streamflow. Ground-water discharge from the buried valley deposits that underlie the floodplain of Paint Creek in the area between Bainbridge and Bourneville and contributions made by Rocky Fork apparently account for the higher dry-weather flow at Bourneville.

At first glance, the low-flow index for Rocky Fork at Barretts Mills appears abnormally high. As mentioned above, the high sustained flow is attributable to storage in the glacial deposits, particularly on Clear Creek, but it appears probable that storage in the cavernous limestone and dolomite may be a contributing factor. Also, the average annual precipitation in Highland and Clinton counties is greater than any other place in the state.

The low-flow index of Salt Creek at Londonderry is slightly greater than that of Little Salt Creek at Richmond. A considerable volume of permeable outwash material may be present along Salt Creek in the vicinity of Laurelville and south of the Pine Cottage col where a drainage reversal occurred during glacial times. Little Salt Creek drains an area underlain by lower Pennsylvanian strata that as a whole are quite impermeable. Mine drainage may contribute somewhat to the flow.

In the Scioto River Basin there are areas of both relatively high and relatively low dryweather flow indices. On the average, the indices are lower than those of other large tributaries to the Ohio River, but higher than those of most Lake Erie tributaries. The median-flow indices and the high-flow indices are below the average for the state. The Scioto River is not as much of a flood-producing stream as some others, although large floods have occurred at intervals.

State Listed Species by County with Records of Occurrence from the Scioto River Watershed (from the Ohio Natural Heritage Database)

The following species are dependent upon aquatic habitats to complete their life cycle – this dependence may be for all or a portion of their life:

Pickaway County
Plains clubtail, eastern sand darter, lake chubsucker, spotted darter, Tippecanoe darter, goldeye, northern brook lamprey, blue catfish, shortnose gar, river redhorse, northern madtom, Scioto madtom, paddlefish, elktoe, purple wartyback, elephantear, northern riffleshell, snuffbox, longsolid, wavyrayed lampmussel, pocketbook, black sandshell, washboard, threehorn wartyback, clubshell, Ohio pigtoe, round pigtoe, kidneyshell, rabbitsfoot, salamander mussel, fawnsfoot, deertoe, rayed bean

Fairfield County
Tiger spiketail, blue corporal, eastern sand darter, popeye shiner, northern brook lamprey, creek heelsplitter, clubshell, round pigtoe, kidneyshell, rabbitsfoot

Madison County
Riffle snaketail, least darter, Tippecanoe darter, river redhorse, elktoe, purple wartyback, elephantear, northern riffleshell, snuffbox, wavyrayed lampmussel, creek heelsplitter, clubshell, round pigtoe, kidneyshell, rabbitsfoot, rayed bean

Franklin County
Four-toed salamander, spotted darter, Tippecanoe darter, goldeye, northern brook lamprey, shortnose gar, river redhorse, paddlefish, elktoe, purple wartyback, elephantear, northern riffleshell, snuffbox, wavyrayed lampmussel, pocketbook, black sandshell, washboard, threehorn wartyback, clubshell, round pigtoe, kidneyshell, rabbitsfoot, salamander mussel, fawnsfoot, deertoe, pondhorn, rayed bean

Licking County
Spotted turtle, eastern hellbender, four-toed salamander, tiger spiketail, green-faced clubtail, eastern sand darter, lake chubsucker, longsolid, sheepnose, pondhorn

Champaign County
Spotted turtle, Kirtland's snake, seepage dancer, elfin skimmer, *Litobrancha recurvata* (mayfly), *Radotanypus florens* (midge), lake chubsucker, least darter, tonguetied minnow, clubshell, rayed bean

Union County
River redhorse, purple wartyback, snuffbox, wavyrayed lampmussel, creek heelsplitter, clubshell, round pigtoe, kidneyshell, rabbitsfoot, rayed bean

Delaware County
Marsh bluet, elktoe, purple wartyback, snuffbox, wavyrayed lampmussel, clubshell, kidneyshell, rabbitsfoot, salamander mussel, pondhorn, rayed bean

Logan County
Spotted turtle, eastern hellbender, swamp metalmark, lake chubsucker, Iowa darter, tonguetied minnow, elktoe, purple wartyback, wavyrayed lampmussel, creek heelsplitter, kidneyshell, rayed bean

Hardin County
Four-toed salamander, least darter, creek heelsplitter, pondhorn, rayed bean

Marion County
Snuffbox, wavyrayed lampmussel, Ohio pigtoe, round pigtoe, pondhorn, rayed bean

Crawford County
Pondhorn

Morrow County
Snuffbox, creek heelsplitter, rayed bean

Scioto County
Eastern hellbender, four-toed salamander, blue corporal, eastern sand darter, blue sucker, muskellunge, goldeye, shortnose gar, river redhorse, popeye shiner, bigeye shiner, mountain madtom, northern madtom, channel darter, river darter, purple wartyback, butterfly, elephantear, snuffbox, ebonyshell, pocketbook, yellow sandshell, black sandshell, washboard, threehorn wartyback, sheepnose, Ohio pigtoe, monkeyface, wartyback, salamander mussel, fawnsfoot, deertoe, rayed bean, little spectaclecase

Adams County
Green salamander, cave salamander, four-toed salamander, tiger spiketail, green-faced clubtail, Uhler's sundragon, blue corporal, goldeye, river redhorse, channel darter, river darter, paddlefish, purple wartyback, yellow sandshell, black sandshell, washboard, threehorn wartyback, clubshell, rabbitsfoot, wartyback, salamander mussel, fawnsfoot, deertoe

Pike County
Seepage dancer, plains clubtail, yellow-sided skimmer, blue sucker, goldeye, shortnose gar, river redhorse, bigeye shiner, paddlefish, shovelnose sturgeon, snuffbox, ebonyshell, yellow sandshell, creek heelsplitter, washboard, threehorn wartyback, sheepnose, fawnsfoot, deertoe

Jackson County
Kirtland's snake, four-toed salamander, lake chubsucker, pondhorn, little spectaclecase

Vinton County
Eastern hellbender, four-toed salamander, Uhler's sundragon, blue corporal, eastern sand darter, Ohio lamprey, northern brook lamprey, pocketbook, little spectaclecase

Hocking County
Kirtland's snake, four-toed salamander, tiger spiketail, Uhler's sundragon, blue corporal, eastern sand darter, tonguetied minnow, northern brook lamprey, pocketbook, clubshell

Ross County
Spotted turtle, eastern hellbender, tiger spiketail, plains clubtail, cobblestone tiger beetle, eastern sand darter, blue sucker, spotted darter, tippecanoe darter, goldeye, shortnose gar, river redhorse, northern madtom, elephantear, snuffbox, yellow sandshell, washboard, threehorn wartyback, clubshell, winged mapleleaf, salamander mussel, fawnsfoot, rayed bean, little spectaclecase

Highland County
Tiger spiketail, bigeye shiner

Fayette County
Least darter, river redhorse, clubshell

Clinton County
Cobblestone tiger beetle

Greene County
Spotted turtle, Kirtland's snake, seepage dancer, tonguetied minnow, snuffbox, wavyrayed lampmussel, creek heelsplitter, clubshell, fawnsfoot

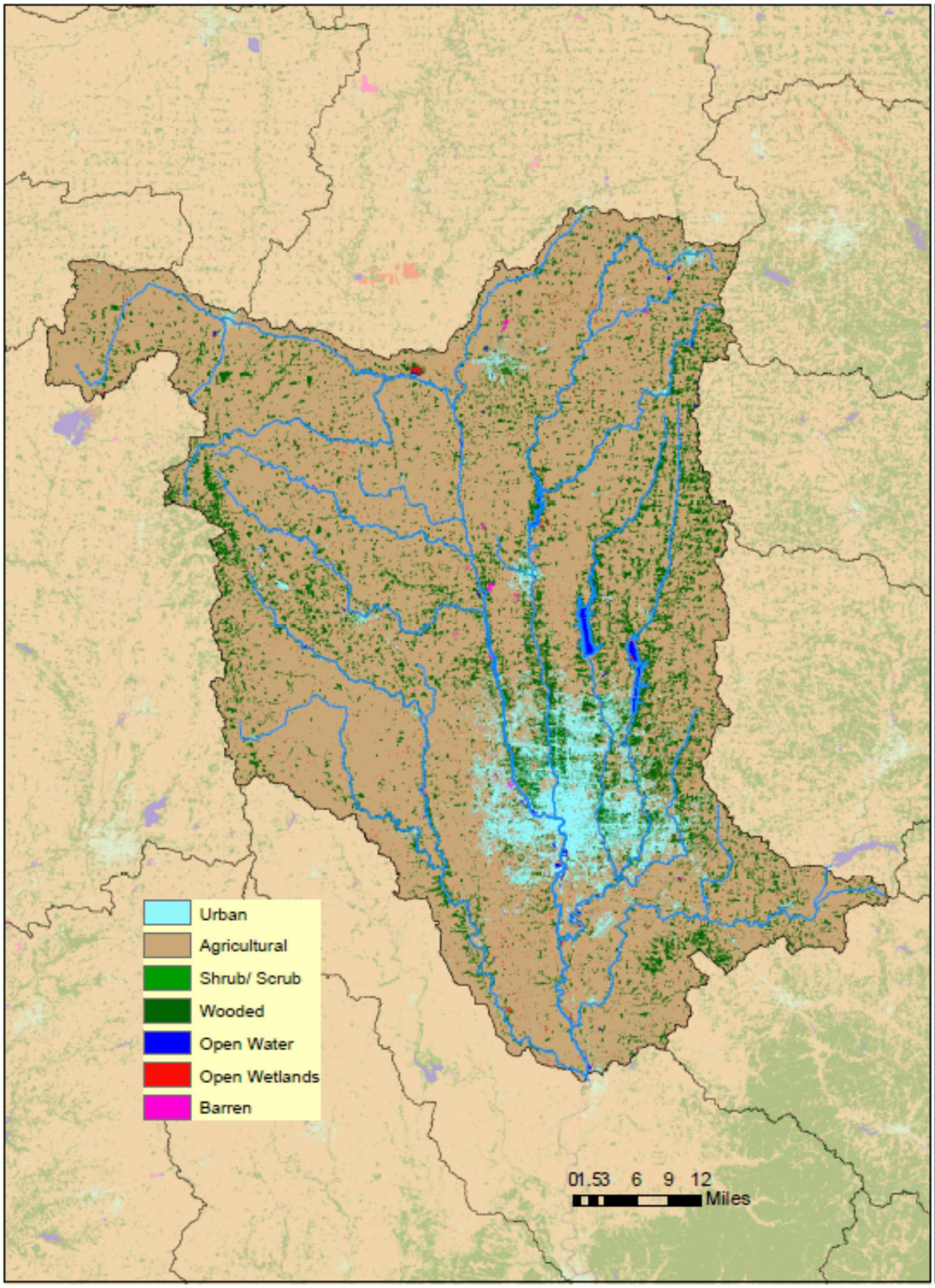


Figure 37. Upper Scioto River Conservation Opportunity Watershed – Land Cover.

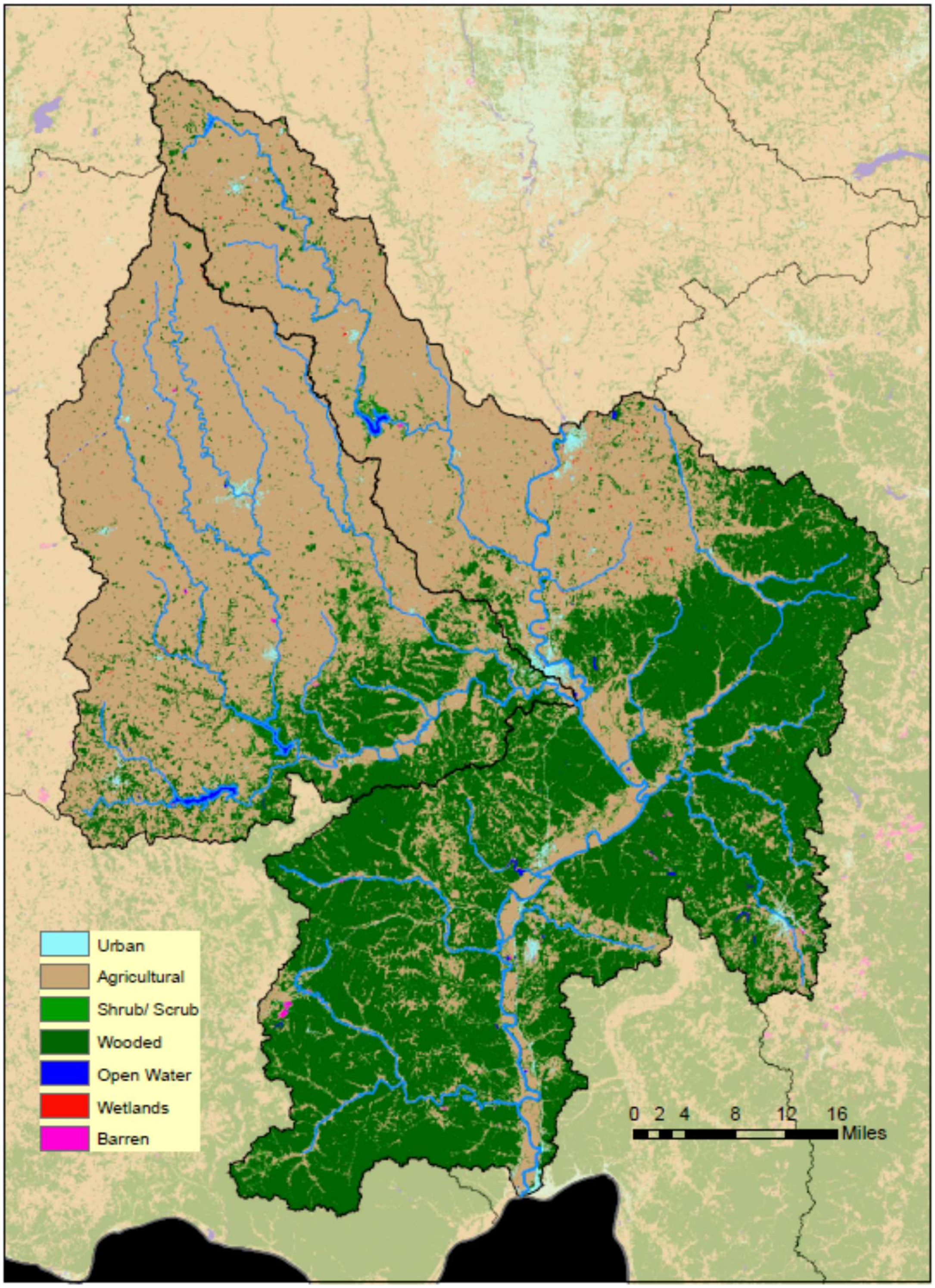


Figure 38. Lower Scioto River Conservation Opportunity Watershed – Land Cover.

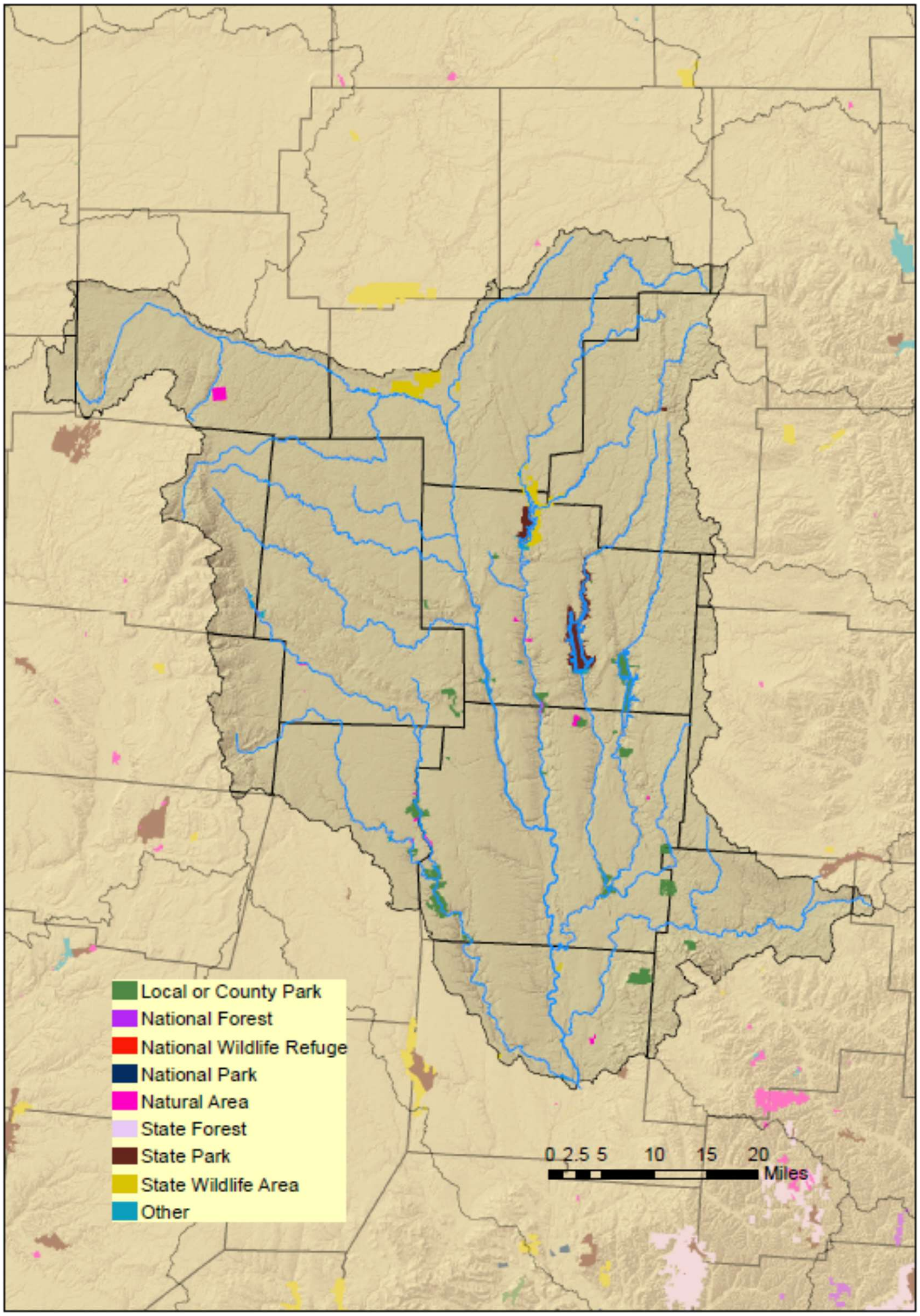


Figure 39. Upper Scioto River Conservation Opportunity Watershed – Protected Lands.

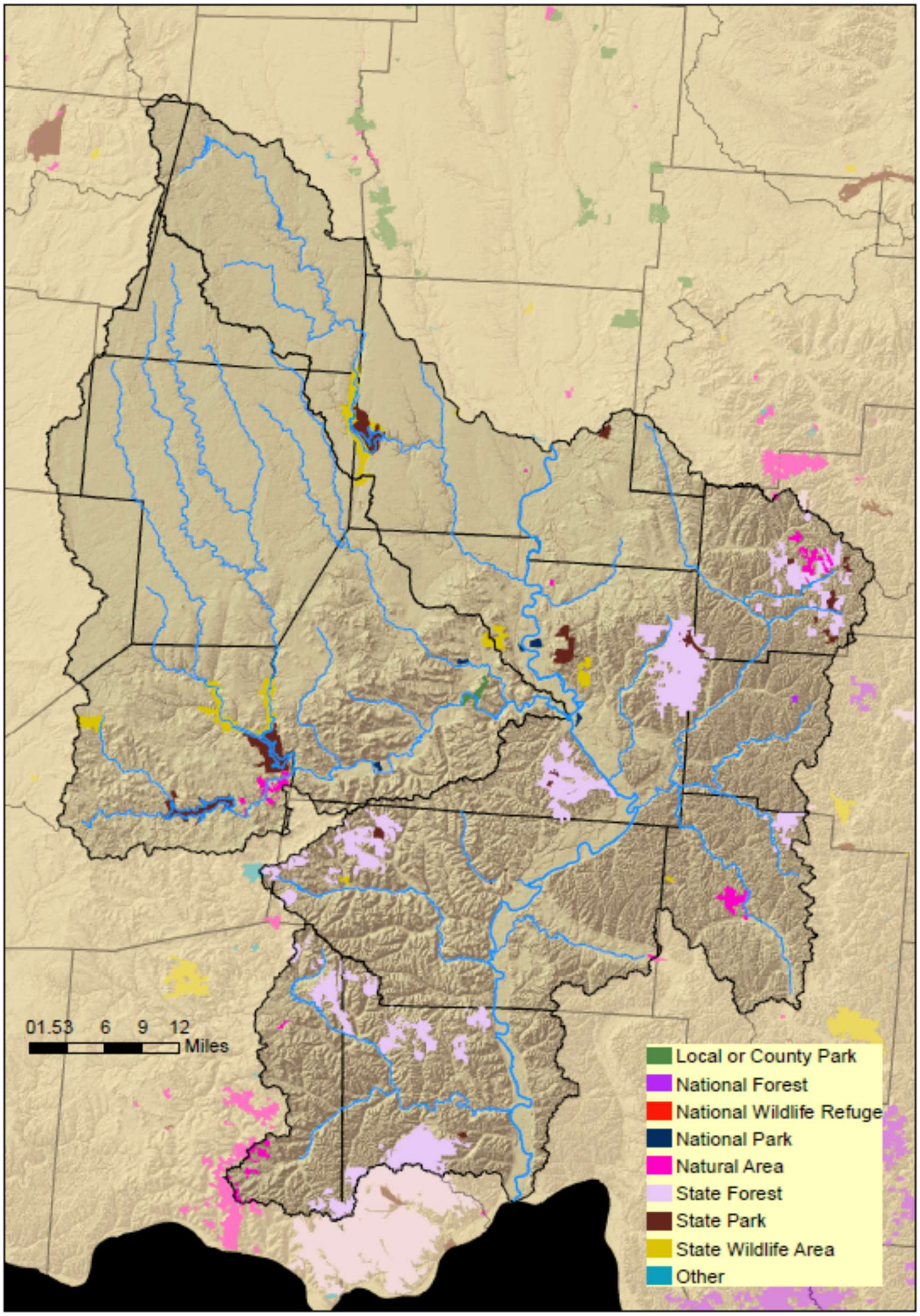


Figure 40. Lower Scioto River Conservation Opportunity Watershed – Protected Lands.

6.15.4.5 Muskingum River CO Watershed (consists of HUC 05040001, HUC 05040002, HUC 05040003, HUC 05040004, HUC 05040005, and HUC 05040006)

The Muskingum River is the largest stream in the state and drains 8,038 square miles, or about one-fifth of Ohio. Within the basin, the physiographic, geologic, and soil conditions vary greatly. The Muskingum River forms at the junction of the Walhonding and Tuscarawas rivers near Coshocton, and flows 109 miles to the south and east to enter the Ohio River at Marietta. The northern and western edges of the basin are glaciated.

Physiography

The basin is entirely within the Allegheny Plateaus province. The line of glaciation marking the farthest southward advance of the ice sheets extends west from northern Tuscarawas County to the vicinity of Loudonville, thence almost directly south, leaving the basin in Perry County. The glaciated area is generally gently rolling with some flat topography, and the unglaciated plateau is generally rough and well dissected.

Geology

The bedrock formations dip generally to the southeast about 20 to 40 feet to the mile. The rocks are of Mississippian, Pennsylvanian, and Permian ages, and consist of interbedded sandstones and shales, with some coal and clay beds and occasional thin limestone formations. Several of the sandstone beds are important sources of ground water, but generally the rocks have little direct influence upon streamflow. The productive sandstones are at depth below stream drainage.

The glacial deposits vary from thin and relatively impermeable till to thick sand and gravel beds. The melt water deposits, such as valley train deposits, kames and kame terraces are generally well sorted and permeable. Such beds, where extensive, have a profound influence on streamflow particularly in buried valleys filled with permeable material with a present-day stream flowing over the top of the ancient valley. The valleys of Sandy Creek and Nimishillen Creek in the vicinity of Canton, for example, have enormous ground-water storage in the thick permeable gravels and are one of the best areas in the state from this standpoint. In nearby areas the till is thin and impervious, and there is little natural storage in the ground. Every county that is in the glaciated part of the Muskingum River Basin has some thick valley deposits, but detailed surveys are required to determine the extent of such fills.

Soils

The soils in the glaciated area of this basin are generally developed from late Wisconsin drift. Over large areas of the upland in the north the soils are predominantly the well drained and moderately permeable Wooster and the moderately well drained, slowly permeable Canfield. Moderately large areas of slowly permeable Rittman and Wadsworth silt loams occur in the northern part of the glaciated area. Amanda and Alexandria silt loams and associated soils are prevalent along the western part of the glaciated area. The permeability of these soils varies from moderate to slow. More permeable soils are found in the valleys. Chili, Chagrin, and Tioga loams and silt loams are the more important soils there. Below the glacial boundary, the principal upland soils are the Gilpin, Brownsville, Berks, Westmoreland, Coshocton, Keene, and Wellston loams and silt loams, with Upshur in some areas of reddish clay shale in the southern part of the basin. These are moderately deep or deep residual soils developed on a variety of contrasting bedrock. Their profile characteristics depend almost entirely on the kind of parent rock on which the soils developed. Generally these soils are moderately to slowly permeable. In the broader valleys, there are areas of alluvial and terrace soils which are well drained and permeable.

Water Development

In 1938, the Corps of Engineers completed 14 flood control reservoirs in the Muskingum River Basin for the Muskingum Conservancy District. This system of reservoirs is the most important water development in the basin. In 1960, the Corps of Engineers completed Dillon Reservoir on the Licking River for flood protection at Zanesville. Canal Era locks and dams on the Muskingum River facilitated commercial navigation as far as Dresden, 91 miles above the mouth, but now serve recreational watercraft needs. Some flow from the upper reaches of the Tuscarawas River (Portage Lakes) is diverted into the Cuyahoga River by a feeder canal. Buckeye Lake, in Licking River drainage, was formed to provide water for the summit level of the old Ohio Canal, but it is now used for recreational purposes only.

Flow Characteristics

The gaging stations on the Tuscarawas River at Clinton and Massillon have high indices of dry-weather flow. The effect of the Portage Lakes during the low-flow period is probably small. The effect of the Barberton Reservoir on Wolf Creek is negligible on the overall flow of Tuscarawas River above Massillon. It is believed that the high sustained flow in this part of the basin is derived from the kame moraine area east of the Portage Lakes. The morainal material is highly permeable and absorbs large quantities of rainfall. Associated with the morainal material are buried valley deposits and high-level outwash material. Discharge of ground water in this area supports the dry-weather flow in the Tuscarawas River. As a whole the Tuscarawas River flows over relatively thick glacial deposits. A buried valley that contains about 200 feet of fill underlies the flood plain between Clinton and Massillon. This valley extends to the northwest under Chippewa Creek. Although Chippewa Creek may contribute some flow to the sustained flow of the Tuscarawas, it is quite likely that the high index of flow of the Tuscarawas is the result of ground-water contribution from glacial deposits associated with the Tuscarawas valley in Summit and Stark counties.

Analysis of flow in Sandy Creek reveals the effect of the sands and gravels on dryweather flow. For the most part the Sandy Creek basin lies below the glacial boundary; only the extreme upper part drains the terminal moraine area. However, the floodplain of Sandy Creek and several of its tributaries such as Little Sandy Creek, Hugle Run, and Middle Branch are underlain by sand and gravel deposits of outwash origin. The gaging stations at Waynesburg and Sandyville show indices of dry-weather flow well above average.

There is a wide difference in the indices of flow between Middle Branch of Nimishillen Creek at Canton and Nimishillen Creek at North Industry. The entire area is glaciated, the drift consisting of end moraine that varies from tight till to gravel, ground moraine of varying character, kames and kame terraces and outwash and valley train gravel. With such surface features, high sustained flows should be expected. The discrepancy between the two stations is the result of ground-water pumpage at the Canton northeast well field where up to 11 million gallons per day has been pumped from the gravel formation underlying the flood plain of Middle Branch. Field studies have shown that recharge to the well field is derived from river infiltration.

Below Massillon, the gaging stations on the Tuscarawas River are affected by regulation of the Muskingum Watershed Conservancy District reservoirs. Prior to the regulation, however, records indicate a high sustained flow. Throughout most of its course, the Tuscarawas River flows on extensive valley train gravels.

The record on Home Creek near New Philadelphia is significant in that it shows the small influence of ground-water storage in bedrock on streamflow in the basin. Home Creek is in the unglaciated area and flows on bedrock of Pennsylvanian age.

Stillwater Creek at Uhrichsville, although regulated at present, has a low index of dryweather flow as determined by the record from 1923 to 1936, prior to regulation. Ground-water contribution from the rock strata is almost negligible in this basin. Underlying the floodplain of Stillwater Creek is 100 feet or more of valley fill. This material is largely silt, clay, or fine sand and thus adds little to streamflow. Similar conditions prevail in Wills Creek.

The Walhonding River and all of its major tributaries have high indices of dry-weather flow. The tributary system in this basin follows essentially the Deep Stage drainage system, which was inaugurated in interglacial times. Thus, the Walhonding and its principal tributaries flow through valleys that are underlain by deep valley fill. Headwaters of the Kokosing River, Mohican River, and Killbuck Creek extend well into the glaciated area where a variety of surface conditions prevail. End moraines of Wisconsin and Illinoian glacial stages are present and the material ranges from tight till to porous gravel. The ground moraine is chiefly till although locally it may be sandy or gravelly. High-level outwash gravels are present locally and some areas have extensive kame and kame terrace deposits. As a whole the Walhonding Basin has a high percent of permeable glacial deposits capable of absorbing and releasing large quantities of water. Furthermore, the extensive sandstone of the Blackhand formation of Mississippian age lays at or near the surface in places in Knox and Richland counties and undoubtedly contributes ground water to the flow of the Kokosing and Mohican tributaries.

Of the records available in the Walhonding Basin, two streams, Mill Creek near Coshocton and Jerome Fork at Jeromesville, show relatively low indices compared with other streams in the basin. Mill Creek is cut into impermeable Pennsylvanian strata except in the lower three miles of its course where it flows on unconsolidated valley fill. Above Jeromesville, Jerome Fork drains an area in which the surface materials are chiefly dense ground moraine.

The moderately sustained flow of Wakatomika Creek near Frazeysburg is influenced by conditions in both glacial deposits and bedrock. Wakatomika Creek had its inception during Illinoian glaciation and it has not changed greatly since that time. The stream in places flows over deep valley fill and over bedrock in other portions of its course. It drains an area partly occupied by the terminal moraine of Illinoian age. The morainal material varies from dense till to loose porous gravel. Additional sand and gravel deposits are present in the form of valley train and high-level outwash. Underlying the drift cover in the headwater area is the sandstone of the Blackhand formation that has a large ground-water storage capacity and undoubtedly contributes somewhat to the flow of Wakatomika Creek.

The Licking River is formed by the confluence of North Fork, Raccoon Creek, and South Fork at Newark. The flows equaled or exceeded 90 percent of the time in North Fork at Utica and Raccoon Creek at Granville are both about 0.05 cubic feet per second per square mile. Flow equaled or exceeded 90 percent of the time in South Fork near Millersport is about 0.06 cubic feet per second per square mile. Flow equaled or exceeded 90 percent of the time in the Licking River at Newark, however, is about 0.13 cubic feet per second per square mile. Miscellaneous measurements at low water indicate varying rates of increase in flow below the North Fork gage at Utica, and the 90 percent of the time flow in North Fork near Newark is about 0.12 cubic feet per second per square mile.

Study of glacial geology in the Newark area, aided by soil maps, provides an explanation for the streamflow characteristics. The tributaries forming the Licking River flow through areas of ground moraine and end moraine largely composed of till. The lower part of North Fork and the main stem of the Licking River at Newark flow through an area of kame terraces, valley train, and outwash plains. A marked increase in flow at Vanatta north of Newark is explained by the presence of a low outwash fan upon the main valley train.

On average, the dry-weather flow of streams in the Muskingum River Basin is higher than that of any other large area in the state, equaling the Miami River average. Median flow indices are also relatively high. High-flow indices are correspondingly low, on average, but large floods have occurred at intervals in the basin. The reservoir system significantly attenuates floods on the major streams, but tends to increase the 10-percent duration flow indices, by increasing the duration of medium high flows.

<u>State Listed Species by County with Records of Occurrence from the Muskingum River Watershed</u> (from the Ohio Natural Heritage Database)
The following species are dependent upon aquatic habitats to complete their life cycle – this dependence may be for all or a portion of their life:

Washington County
Eastern hellbender, eastern spadefoot, green-faced clubtail, Uhler's sundragon, blue corporal, eastern sand darter, Tippecanoe darter, goldeye, Ohio lamprey, river redhorse, mountain madtom, northern madtom, pugnose minnow, channel darter, river darter, paddlefish, purple wartyback, fanshell, butterfly, elephantear, snuffbox, longsolid, pink mucket, pocketbook, black sandshell, washboard, threehorn wartyback, sheepnose, Ohio pigtoe, rough pigtoe, pyramid pigtoe, round pigtoe, monkeyface, salamander mussel, fawnsfoot, deertoe

Noble County
Creek heelsplitter

Morgan County
Eastern spadefoot, eastern sand darter, goldeye, river redhorse, mountain madtom, northern madtom, pugnose minnow, purple wartyback, fanshell, butterfly, elephantear, snuffbox, longsolid, black sandshell, threehorn wartyback, sheepnose, Ohio pigtoe, pyramid pigtoe, round pigtoe, salamander mussel, fawnsfoot

Monroe County
Green-faced clubtail, blue corporal, eastern sand darter, Ohio lamprey, channel darter

Perry County
None reported

Muskingum County
Eastern hellbender, eastern spadefoot, tiger spiketail, plains clubtail, eastern sand darter, river redhorse, mountain madtom, northern madtom, purple wartyback, snuffbox, longsolid, pocketbook, creek heelsplitter, black sandshell, threehorn wartyback, pyramid pigtoe, rabbitsfoot, fawnsfoot, rayed bean

Guernsey County
None reported

Licking County
Spotted turtle, eastern hellbender, four-toed salamander, tiger spiketail, green-faced clubtail, eastern sand darter, lake chubsucker, longsolid, sheepnose, pondhorn

Coshocton County
Eastern hellbender, eastern spadefoot, plains clubtail, eastern sand darter, spotted darter, Tippecanoe darter, river redhorse, mountain madtom, elktoe, purple wartyback, fanshell, purple catspaw, snuffbox, longsolid, wavyrayed lampmussel, pocketbook, creek heelsplitter, black sandshell, sheepnose, clubshell, Ohio pigtoe, round pigtoe, kidneyshell, rabbitsfoot, salamander mussel, rayed bean

Tuscarawas County
Eastern hellbender, eastern spadefoot, plains clubtail, eastern sand darter, mountain madtom, northern madtom, clubshell

Belmont County
Eastern hellbender, tiger spiketail, river redhorse, paddlefish, wavyrayed lampmussel

Harrison County
None reported

Carroll County
Four-toed salamander, *Brachycentrus numerosus* (caddisfly), *Psilotreta indecisa* (caddisfly)

Stark County
Spotted turtle, four-toed salamander, brush-tipped emerald, seepage dancer, Iowa darter

Columbiana County
Spotted turtle, eastern hellbender, tiger spiketail, riffle snaketail, *Psilotreta indecisa* (caddisfly), *Stenonema ithaca* (mayfly), channel darter, wavyrayed lampmussel, creek heelsplitter

Summit County
Spotted turtle, four-toed salamander, racket-tailed emerald, boreal bluet, marsh bluet, harlequin darner, chalk-fronted corporal, elfin skimmer, brush-tipped emerald, lake chubsucker, Iowa darter, western banded killifish, pugnose minnow, paddlefish

Medina County
Tiger spiketail, bigmouth shiner

Wayne County
Kirtland's snake, four-toed salamander, riffle snaketail, lake chubsucker, creek heelsplitter

Holmes County
Iowa darter, creek heelsplitter, kidneyshell

Knox County
Eastern hellbender, eastern sand darter, spotted darter, mountain brook lamprey, speckled chub, purple wartyback, northern riffleshell, longsolid, black sandshell, clubshell, round pigtoe, kidneyshell, rabbitsfoot

Ashland County
Least darter, greater redhorse, purple wartyback, wavyrayed lampmussel, creek heelsplitter, clubshell, purple lilliput, deertoe

Richland County
Least darter, greater redhorse, pugnose minnow, elktoe, purple wartyback, white catspaw, wavyrayed lampmussel, creek heelsplitter, clubshell, round pigtoe, rabbitsfoot, wartyback, purple lilliput, deertoe, rayed bean

Morrow County
Snuffbox, creek heelsplitter, rayed bean

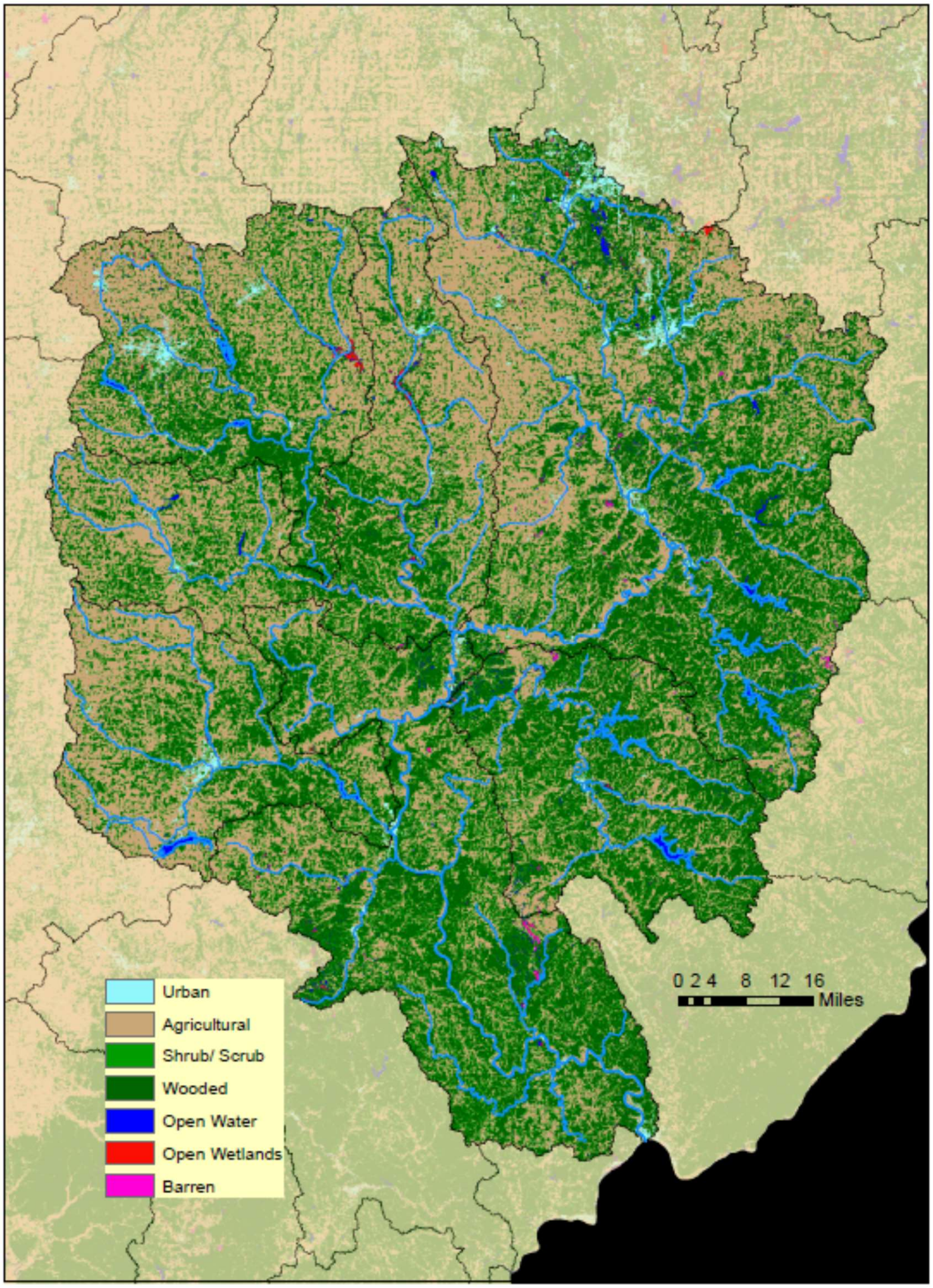


Figure 41. Muskingum River Conservation Opportunity Watershed – Land Cover.

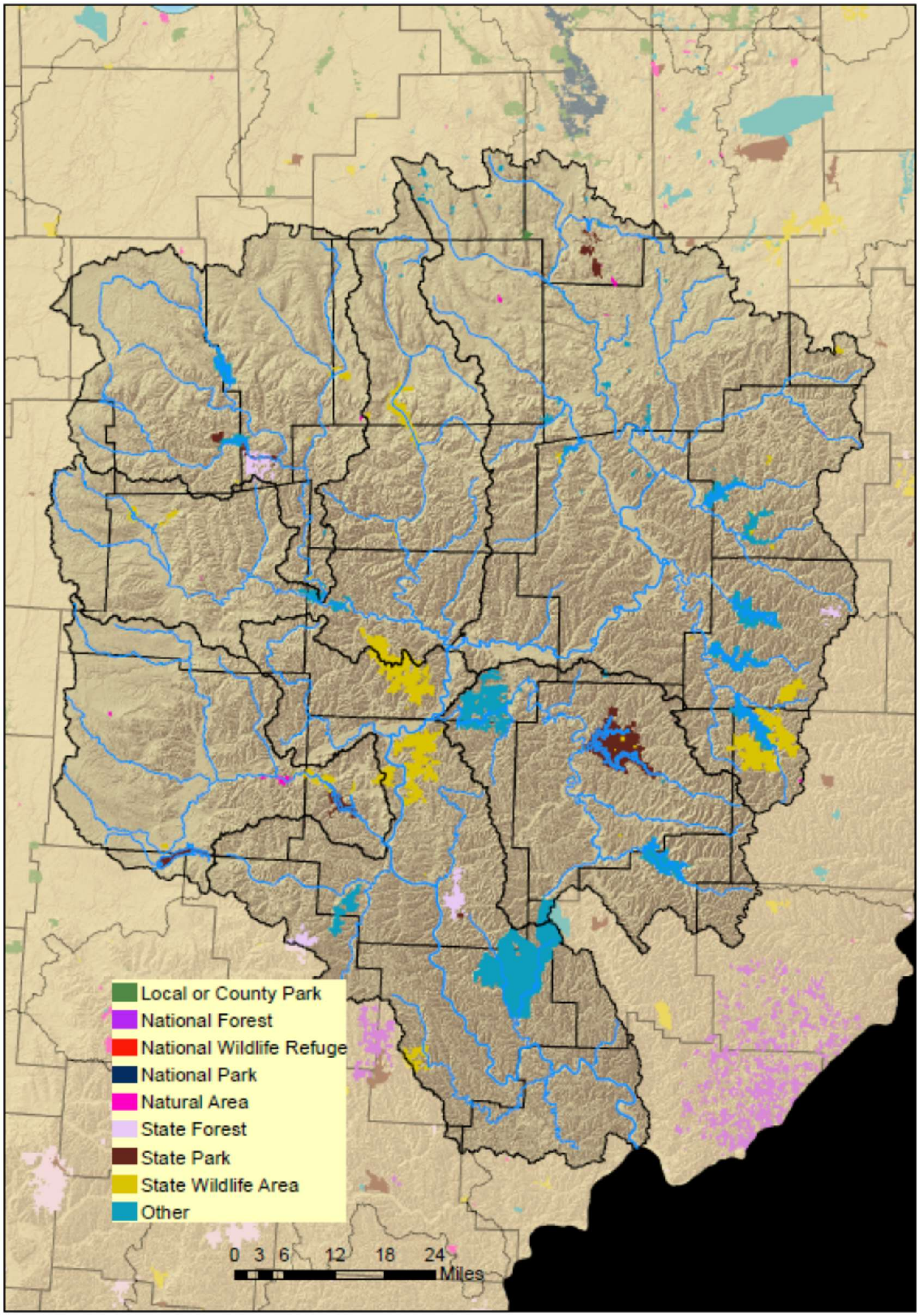


Figure 42. Muskingum River Conservation Opportunity Watershed – Protected Lands.

6.15.4.6 Little Beaver Creek CO Watershed (consists of the northern half of HUC 05030101)
Between the Mahoning River and the Muskingum River in southeastern Ohio is an area of about 2,500 square miles drained by several small tributaries of the Ohio River. The largest stream is Little Beaver Creek, with an area of 510 square miles.

Physiography
Most of the Little Beaver Creek Basin is glaciated but the remainder of the area is part of the unglaciated Allegheny Plateau. The plateau is well dissected and the topography is rough, with the steepest slopes near the Ohio River. The northern part of Columbiana County, in the Little Beaver Creek drainage, is a broken glacial plain. South of this area is a belt of terminal moraines, with generally thin till but with occasional hills and lobes of thick drift.

The unglaciated plateau is decidedly hilly, with deep valleys, and in the lower ends of several streams, narrow gorges. The thick sandstone formations are resistant and form steep cliffs, particularly toward the Ohio River. The lower courses of Short Creek and Yellow Creek, for example, are entrenched, narrow and sinuous. The upland areas are flatter, but rough terrain predominates.

Geology
The rocks exposed in this area dip toward the southeast and consist of sandstones, shales, coal, and clay with occasional thin calcareous formations. The rocks are of Pennsylvanian and Permian age.

The glacial drift and outwash has some appreciable effect on the flow characteristics of Little Beaver Creek. South of the glacial boundary the soils are thin, and there is relatively little natural storage in the bedrock. The sandstones are permeable and contribute toward sustained dry-weather flow of streams, but generally storage is small. Many of the coarser sandstone units are well above stream drainage. There are large areas denuded by strip mining.

Soils
The soils of the glaciated part of this area are predominantly the well-drained, moderately permeable Wooster and the moderately well drained, slowly permeable Canfield soils series. These soils developed from Wisconsin medium-textured glacial till on sandstone and shale. South of the glacial boundary the soils are shallow, with thin fill even in the valleys. Steep topography and erosion have prevented the normal development of soil profiles. Over large areas the soils are classified as the Gilpin, Berks, Hazleton, Westmoreland, Lowell, and Upshur series, with surface textures ranging from gravelly loam to silty clay loam. These are residual soils, and differences in their profile characteristics are due almost entirely to the underlying rock on which they developed. Permeability of the soils is generally moderate to slow.

Water Development
The only significant water development in the watershed is Guilford Lake. Completed in 1932, Guilford Lake was impounded by an earth-filled dam constructed across the West Fork Branch of Little Beaver Creek. The water level of the 361 acre lake is controlled by a concrete spillway and valve. Smaller impoundments in the watershed include Salem Reservoir and Lake Tomahawk.

Flow Characteristics
In the northern part of the area the streams are affected somewhat by glacial deposits.
The higher low-flow index for Little Beaver Creek indicates the additional increment of ground water furnished by the glacial deposits. North Fork and Middle Fork contribute the major portion of the dry-weather flow of Little Beaver Creek. These tributaries extend into the glaciated area and their main channels are underlain with glacial outwash deposits.

State Listed Species by County with Records of Occurrence from the Little Beaver Creek Watershed (from the Ohio Natural Heritage Database)
The following species are dependent upon aquatic habitats to complete their life cycle – this dependence may be for all or a portion of their life:

Mahoning County
Allegheny crayfish

Columbiana County
Spotted turtle, eastern hellbender, tiger spiketail, riffle snaketail, *Psilotreta indecisa* (caddisfly), *Stenonema ithaca* (mayfly), channel darter, wavyrayed lampmussel, creek heelsplitter

Carroll County
Four-toed salamander, *Brachycentrus numerosus* (caddisfly), *Psilotreta indecisa* (caddisfly)

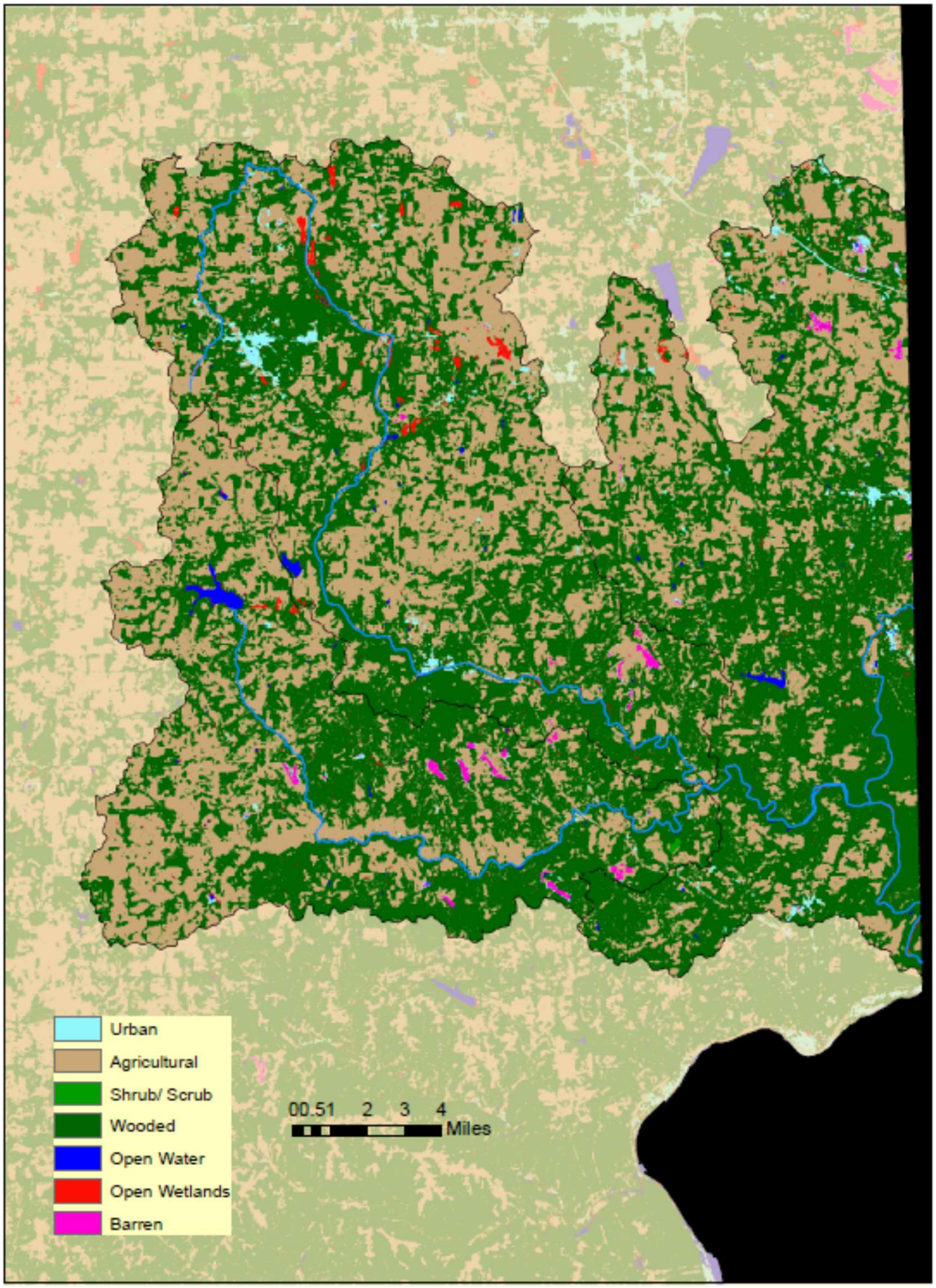


Figure 43. Little Beaver Creek Conservation Opportunity Watershed – Land Cover.

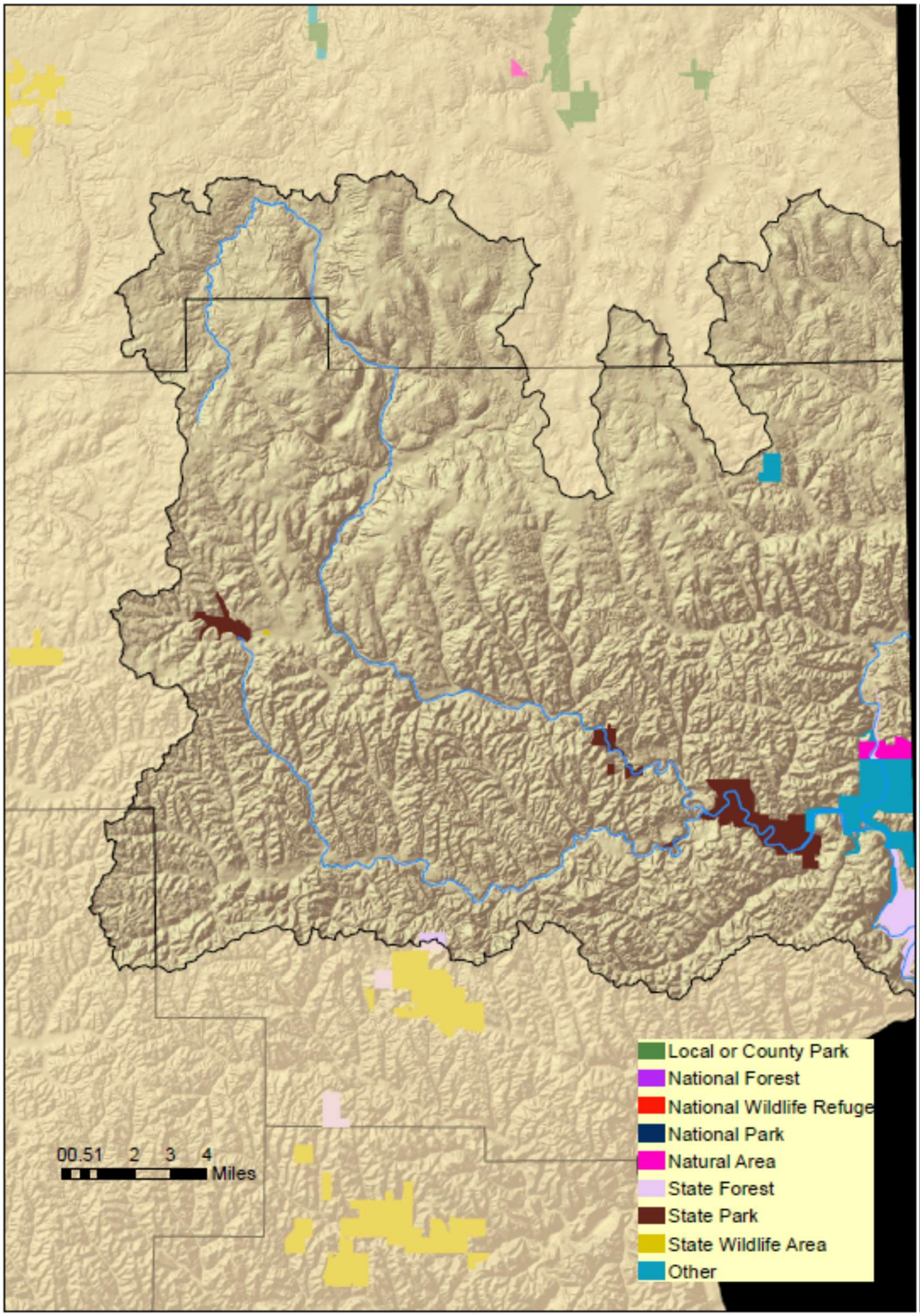


Figure 44. Little Beaver Creek Conservation Opportunity Watershed – Protected Lands.

Table 41. CONSERVATION THREATS TO OHIO RIVER TRIBUTARIES.
The following threats negatively impact or have the potential to negatively impact Ohio River Tributaries. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		medium
A	Watershed conversion to urban/commercial development alters hydrology	housing & urban areas commercial & industrial areas	medium low
B	Shoreline development and its effect on habitat and species	housing and urban areas commercial & industrial areas tourism & recreation areas	medium low low
C	Increasing land prices limits our ability to protect riparian corridors	housing and urban areas commercial & industrial areas tourism & recreation areas	medium low low
II	**agriculture and aquaculture**		medium
A	Loss of riparian corridor to agriculture	annual & perennial non-timber crops livestock farming & ranching	high low
B	Watershed conversion to agriculture alters hydrology	annual & perennial non-timber crops livestock farming & ranching	high low
III	**energy production and mining**		low
A	Oil and gas extraction - can have negative impacts by causing chemical contamination	oil & gas drilling	low
B	Hydropower facilities disrupt stream connectivity and kill aquatic species	renewable energy	low
C	Water withdrawal for fracking alters hydrology	oil & gas drilling	low
D	Instream sand/gravel operations destroy habitat	mining & quarrying	low
E	Coal mining can result in acid mine drainage	mining & quarrying	low
IV	**transportation and service corridors**		low
A	Channel modification/dredging causes habitat loss, water quality impacts	shipping lanes	negligible
B	Roads, bridges, causeways, utilities, impact shoreline/nearshore habitats	roads & railroads utility & service lines	low low

V	**biological resource use**		low
A	Fishing pressure and fishing gear impacts	fishing & harvesting aquatic resources	low
VI	**human intrusions and disturbance**		low
A	Incompatible recreational activities	recreational activities	low
B	Creation of recreational facilities can alter/destroy nearshore habitat	recreational activities	low
C	Vessel impacts to nearshore habitats and water quality	recreational activities work & other activities	low negligible
VII	**natural system modifications**		medium
A	Dams cause habitat loss, sedimentation, decreased water quality, reduced biodiversity, and reduce movement of aquatic species and species abundance	dams & water management/use	medium
B	Conflicting water control management objectives of controlling agencies (DOW – USACOE)	dams & water management/use	medium
C	Lack of data for some species and habitats limits our ability to develop plans for threats like climate change	other ecosystem modifications	medium
D	Some species' polulations have been reduced to levels below what is necessary to recover on their own	other ecosystem modifications	Low
VIII	**invasive and other problematic species and genes**		high
A	Introduction and/or spread of invasive plants and animals	invasive non-native/alien species	high
B	Introduction and/or spread of nuisance plants and animals	problematic native species	low
C	Introduction and spread of diseases (plants and animals)	invasive non-native/alien species problematic native species	high low
D	Possible genetic contamination of native fish stocks from introduced hybrid fishes	introduced genetic material	low
IX	**pollution**		high
A	Urban effluent carries a variety of substances that impact water quality and aquatic species	household sewage & urban wastewater industrial & military effluents garbage & solid waste air-borne pollutants	high medium low low
B	Agricultural effluent from row crops as well as confined animal operations impacts water quality and aquatic species	agricultural & forestry effluents	very high
C	Industrial spills impact water quality and aquatic species	industrial & military effluents	medium
X	**geological events**		negligible
---	none	---	---

XI	climate change and severe weather		low
A	Climate change could impact habitats, water quality, and species	habitat shifting & alteration droughts temperature extremes storms & flooding	low low low medium

Table 42. CONSERVATION ACTIONS FOR OHIO RIVER TRIBUTARIES.
The following actions will help abate or have the potential to help abate threats to Ohio River Tributaries habitat. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	actions	2nd level action classification(s)	action priority rank	threat(s) addressed*
I	**LAND/WATER PROTECTION**		med	
1	Protect riparian corridors through acquisition, partnerships, conservation easements, etc.	site/area protection resource & habitat protection	low high	I, II, IV-B, VI-B
II	**LAND/WATER MANAGEMENT**		high	
1	Work with OEPA, ODOT, USACE, and other government agencies to focus mitigation activities on riparian habitats in conservation opportunity watersheds	habitat & natural process restoration	high	I-A, II-A, IV-B, VI-B, XI
2	Work with landowners to develop and implement habitat improvement projects on private lands	habitat & natural process restoration	high	I, II, XI
3	Remove dams to restore stream connectivity and improve water quality	habitat & natural process restoration	high	VII-A, XI
4	Develop criteria for prioritizing candidate dams for removal – give extra emphasis to dams in conservation opportunity watersheds	habitat & natural process restoration	high	III-B, VII
5	Research fish passage improvements for dams that are not candidates for removal	habitat & natural process restoration	high	III-B, VII
6	Identify and prioritize restoration projects (channel restoration, floodplain and backwater reconnection, etc.) in conservation opportunity watersheds	habitat & natural process restoration	high	I-A,B, II, IV, VII-B, XI
7	Complete one geomorphological restoration project in each conservation opportunity watershed every 5 years	habitat & natural process restoration	high	I-A,B, II, IV, VII, XI
8	Develop model stream protection guidelines aimed at slowing the overland flow of water into streams	habitat & natural process restoration	high	I-A, II-B, IX-A,B
9	Use lowest impact techniques and timing for dredging activities	habitat & natural process restoration	high	III-D, IV-A, VII-B

10	Create and use wetlands for stormwater treatment	habitat & natural process restoration	high	I-A, IX-A
11	Establish an early-detection/rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	high	VIII-A,B
12	Develop ways to control invasive plant species in flowing waters	invasive/ problematic species control	high	VIII-A,B
13	Develop a process for coordinating disparate data sources of distribution and abundance of aquatic SGCN with special emphasis on conservation opportunity watersheds	habitat & natural process restoration	high	I-B, III-B,D, IV-A,B, VI-B, VII-A,C, XI
14	Review existing species and habitat data to identify data gaps and needs for additional surveys, research, and management actions	habitat & natural process restoration	high	I, II, III, IV, V, VI, VII, VIII, IX, XI
15	Conduct comprehensive surveys of freshwater mussels in all conservation opportunity watersheds	habitat & natural process restoration	high	I-B, III-C,D, IV-A,B, VI-B, VII, XI
16	Conduct watershed studies to identify and prioritize restoration opportunities	habitat & natural process restoration	high	I-B, II-A, III-E, IV-A, VI-B, VII, XI
17	Stabilize severely eroding streambanks with bio-engineering techniques	habitat & natural process restoration	high	I-A,B, II, VI-C
18	Reconnect stream channels with natural floodplains	habitat & natural process restoration	high	I-A,B, II, IV, VII-B, XI
19	Restore/stabilize riparian habitat by planting native grasses, shrubs, and trees	habitat & natural process restoration	high	I-B, II-A, IV-B
20	Use treatment techniques to control the pH of effluent on abandoned mine lands	habitat & natural process restoration	high	III-E
21	Develop GIS tools to archive and monitor the status of protected lands in conservation opportunity watersheds	site/area management	low	XI
III	**SPECIES MANAGEMENT**		low	
1	Monitor for the presence of Asian carp in the lower portions of large tributaries	species management	med	VIII-A
2	Assess population status, habitat suitability, and probability for restoration of fish, mussels, crayfish, invertabrates, and amphibians listed as SGCN	species reintroduction	High	VII-C, VII-D
3	Develop a restoration strategy for high priority fish, mussels, crayfish, invertebrates, and amphibians	species reintroduction	High	VII-C, VII-D
IV	**EDUCATION AND AWARENESS**		high	
1	Educate waterfront landowners and commercial pesticide/herbicide applicators on responsible chemical use, and the negative impacts to wildlife from toxic chemicals	training	high	I-B,C, IX-A

2	Promote conservation easements to protect riparian habitat	training awareness & communic-ations	high high	I, II, IV-B, VI-B, XI
3	Conduct shoreline protection/stabilization workshops	training	high	I-B, II-A, IV-B, VI-B
4	Provide technical guidance on shoreline development plans as relates to fish and wildlife interests	training	high	I, IV-B, VI-B, XI
5	Educate the public about the negative effects of exotic and nuisance animals – encourage responsible disposal of unwanted animals	awareness & communic-ations	high	VIII
6	Provide training to road construction/maintenance personnel for runoff/ sediment control	training	high	I-B, IV-B, VI-B
7	Educate the public and legislators on the benefits of dam removals	training awareness & communic-ations	high high	VII-A
8	Provide training in geomorphological, fluvial, and in-stream flow processes for DOW personnel	training	high	III-B,C,D, IV, VI-B, VII-A,B
9	Develop and provide streams/watersheds educational materials for landowners, schools, public officials, and the general public	training awareness & communic-ations	high high	I, II, IX-A,B, XI
10	Create and implement demonstration projects aimed at reducing urban effluent – such as rain gardens, bioretention, etc.	training awareness & communic-ations	high high	I-A,B, IX-A
11	Conduct outreach for landowners on private land management, conservation practices, and water quality	training awareness & communic-ations	high high	I, II, IX-A,B
V	**LAW AND POLICY**		high	
1	Support legislation promoting eco-friendly energy development and use	legislation	high	III-A,B,C,E
2	Develop and implement a risk-assessment system in the approval process for importing or moving live animals and plants	legislation policies & regulations	high high	VIII
3	Support sewage sludge/animal manure disposal standards to regulate application rates and timing	policies & regulations	high	IX-A,B
4	Encourage and support minimum flow regulations that protect downstream aquatic habitats	policies & regulations	high	III-B, VII-A,B, IX-A,B
5	Support the creation of additional and/or increased enforcement of stormwater regulations	policies & regulations compliance & enforcement	high med	I-A, IX-A
6	Find innovative ways to mandate the inclusion of fish and wildlife interests in development plans	policies & regulations	high	I, III-B,C,D,E, IV-

		private sector standards & codes	low	B, VI-B, XI
7	Support the use of buffers between development and tributary shorelines	policies & regulations private sector standards & codes	high low	I-A,B, IV-B, IX-A
8	Promote riparian protection ordinances that prevent floodplain encroachment and riparian habitat removal	policies & regulations private sector standards & codes	high low	I, II, IV-B, VI-B
9	Support increased regulation of home sewage treatment systems	compliance & enforcement	med	IX-A
VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		med	
1	Explore tying eligibility for grant money, loans, and cost-share programs to nutrient loading levels for agriculture – the lower the nutrient levels in their effluent, the more money they would be eligible for	market forces conservation payments	high high	IX-B, XI
2	Create incentives for vegetated buffers along all waterways to reduce nutrient loads and sediment	market forces conservation payments	high high	I, II, IX-A,B, XI
3	Create incentives to promote eco-friendly energy development and use	market forces conservation payments non-monetary values	high high low	III-A,B,C,E
4	Support the creation of incentives to protect riparian habitat	market forces conservation payments	high high	I, II, IV-B, VI-B, XI
5	Support clean marina and clean vessel programs	market forces conservation payments	high high	VI-C
6	Develop incentives for municipalities to use stormwater management systems that minimize negative impacts to aquatic habitats	market forces conservation payments	high high	I-A, IX-A
7	Support incentives for development plans involving water frontage that take into account wildlife and habitat needs	market forces conservation payments non-monetary values	high high low	I, IV-B, VI-B, XI
8	Support payments to offset losses (revenue from	conservation	high	IX-B

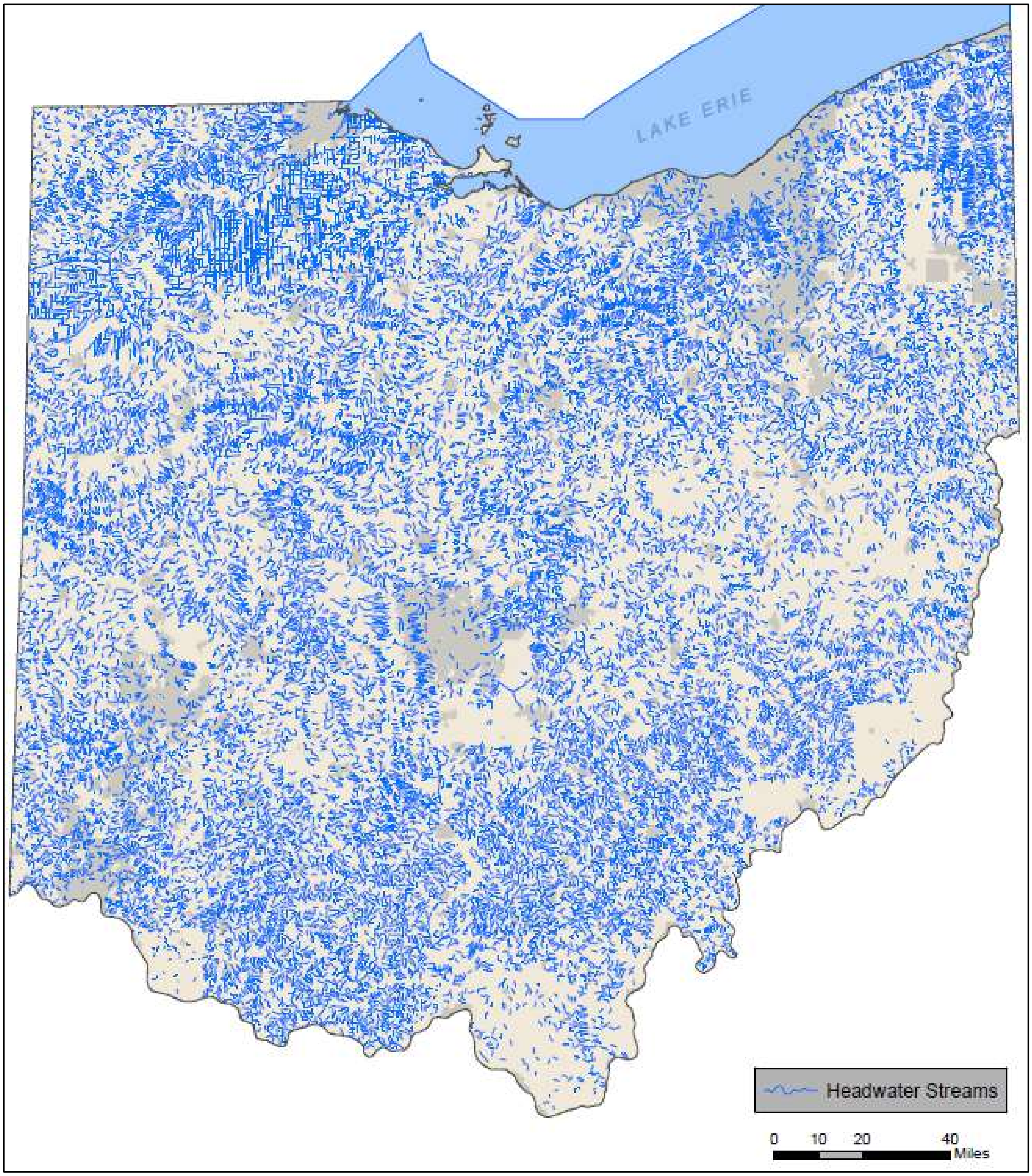
	crops) resulting from implementation of conservation practices aimed at reducing sediment loads	payments		
9	Create incentives to encourage the use of conservation tillage – especially in impaired watersheds	market forces conservation payments	high high	IX-B
10	Support incentives for conservation farming practices – including nutrient management plans and livestock waste management plans	market forces conservation payments	high high	IX-B
11	Encourage the use of cover crops for idle agricultural fields	market forces conservation payments	high high	IX-B
12	Promote drainage water management such as grassed waterways, 2-stage channels, and over-wide ditches	market forces conservation payments	high high	II, IX-B
13	Promote waterway conservation livestock practices such as exclusion fencing, livestock crossings, alternative water supplies, livestock access lanes	market forces conservation payments	high high	II-A, IX-B
VII	**EXTERNAL CAPACITY BUILDING**		med	
1	Work with ODA and OEPA to minimize nutrients in runoff, and develop BMPs for pesticide/herbicide use	alliance & partnership development	high	IX
2	Create an interagency spill response team – update contacts and training on a regular basis	alliance & partnership development	high	IX-C
3	Consider creating a multiagency invasive species prevention and control group that would handle all invasive species issues	alliance & partnership development	high	VIII
4	Through interagency coordination, work to assure that wildlife interests are taken into consideration in road, bridge, and causeway design, construction, and maintenance	alliance & partnership development	high	IV-B
5	Create a multi-agency dam removal task force	alliance & partnership development	high	VII
6	Use inter-agency cooperation to influence watershed health	alliance & partnership development	high	I, II, IX, XI
7	Pursue partnerships with local, state, and federal agencies to secure funding for projects benefitting streams and watersheds	alliance & partnership development conservation finance	high low	I, II, III, IV, VI, VII, VIII, IX, XI
8	Work with OEPA to encourage the reuse of point source discharge water	alliance & partnership development	high	IX-A
9	Work with OEPA and municipalities to eliminate CSO's and SSO's – especially in impaired watersheds	alliance & partnership development	high	I-A, IX-A
10	Work with OEPA to encourage completion of TMDL	alliance &	high	IX-A,B

	studies for all streams in the Ohio River drainage	partnership development		
11	Work with OEPA and local watershed groups to remediate contaminated sediments and restore habitat in conjunction with remediation	alliance & partnership development	high	I-B, IX-A
12	Work with regulatory agencies and local watershed groups on programs to restore natural stream and flood plain function	alliance & partnership development	high	I-A,B, II, IV, VII-A,B, XI
14	Develop partnerships with land trusts, watershed and conservation groups, and government agencies to guide acquisition and protection activities in each conservation opportunity watershed	alliance & partnership development	high	I, II, III, IV, VI, XI
15	Increase personnel and expertise available for SGCN surveys and research through partnerships with other government agencies, universities, and conservation-minded NGO's	institutional & civil society development alliance & partnership development	med high	I, II, III, IV, V, VI, VII, VIII, IX, XI
13	Encourage/facilitate the establishment of watershed groups & watershed coordinator to promote watershed improvement activities	institutional & civil society development	med	I, II, IX, XI

*refers to the Ohio River Tributaries Habitat Conservation Threats in Table 41

6.17 Headwater and Small Inland Streams

Ohio Headwater/Inland Streams



6.17.1 Status

Improving. State and federal legislation have created water quality standards, new technologies, stricter enforcement, and successful permitting and monitoring programs. Point source pollution has been significantly reduced and the quality of many streams has markedly improved as a result. Biological communities in these streams generally show improvement commensurate with improvements to habitat and water quality.

In general, the percent of stream miles in attainment of their aquatic life use designations tends to increase from north to south in Ohio. Recent data indicates that unhealthy fish and aquatic insect populations are more common for smaller streams. For headwater streams (<20 sq. mi. drainage), 54% of sites sampled during 2003-2012 were in full attainment of their aquatic life use designation, compared to moderate sized streams (20-50 sq. mi. drainage) at 60%, and principal streams (50-500 sq. mi. drainage) at 67%. The larger the drainage area (and usually the larger the stream), the more likely the stream is to be healthy. This phenomenon correlates well with the most widespread causes associated with the aquatic life impairment in these watersheds. Habitat alteration and non-point source pollution remain issues today – new abatement efforts are increasingly focused on nonpoint sources such as runoff from urban and agricultural lands (Ohio EPA 2014a).

6.17.2 Description

Ohio rivers and streams represent more than 60,000 mi of flowing waters. Fifteen of the 3,300 named streams in Ohio have watersheds larger than 1,000 square miles (Sanders 2000). In the upper one-third of Ohio these streams drain north across the 11,714 square mile Lake Erie watershed, whereas in the lower two-thirds of Ohio they drain south across the 34,361 square mile Ohio River watershed. This aquatic habitat chapter focuses on the inland tributary streams that combine to form direct tributaries to Lake Erie and the Ohio River. The differentiation between this habitat category and the Lake Erie Tributaries and Ohio River Tributaries habitat categories is one of stream order. This habitat category contains primarily 1st and 2nd order streams.

Approximately 28,900 miles of the over 58,000 miles of stream channels digitally mapped in Ohio are headwater streams. However, the digital maps currently available for Ohio do not include the smallest of headwater channels. Results of a special study of primary headwater streams (drainage areas less than 1 sq. mi.) place the estimate of primary headwaters between 146,000 to almost 250,000 miles. Some of these primary headwater streams are in fact perennial habitats for aquatic life, and supply base flow to larger streams (Ohio EPA 2014a).

More than 75% of the streams in Ohio are first- or second-order streams - small headwater streams with drainage areas of less than 5 square miles (see the list from Ward et al. (2008) below). Many of the headwater streams in the Midwest region of the United States are constructed agricultural ditches or are natural streams that have been straightened and deepened to facilitate the removal of excess water from agricultural fields.

Stream Order	Drainage Area (square miles)	Total Length (miles)	Percentage of stream miles	Cumulative % of stream mi.
1	0.2 – 1.0	67,530	51.5	51.5
2	1.0 – 4.7	33,138	25.3	76.8
3	4.7 – 23	15,963	12.2	89.0
4	23 – 109	7803	6.0	95.0
5	109 – 518	3810	2.9	97.9
6	518 – 2460	1861	1.4	99.3
7	2460 – 11,700	908	0.7	100.0

Ohio's generally low gradient landscape results in the majority of headwater streams being Rosgen type C and E streams. Type C streams are slightly entrenched, meandering systems characterized by well-developed floodplains with riffle-pool bed forms that are typically wider than they are deep. Type E streams have a low width-to-depth ratio and exhibit a wide range of sinuosity with well developed floodplains. Less than 10 percent of Ohio's first and second order streams are of the Rosgen type A or B – typically steep, entrenched, confined channels found in narrow valleys of rolling hill landforms with channel beds consisting of a series of rapids and cascades with irregular scour pools (think mountain streams/brooks) (Ward et al. 2008).

The importance of headwater streams and their protection
As discussed in *Association between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* (Ohio EPA 1999a), headwater streams represent a significant source of assimilative capacity for the protection of downstream reaches. The aggregate condition of headwater streams is correlated with the quality of water and aquatic life resources in larger streams, and reflects the integrity of the watershed as a whole. Headwaters represent the primary interface between the landscape and aquatic ecosystems, and are the initial entry points for energy and nutrients into lotic ecosystems. The form, manner, and rate at which nutrients are delivered to headwaters and eventually transported downstream profoundly affect the ecological integrity of the larger streams and rivers. While headwater streams are proportionally smaller in terms of physical size and volume, their sheer numbers imply importance in cumulative terms for downstream water bodies.

For watersheds, most impairment is related to modification of the landscape – and these impairments have the greatest impact on smaller streams. The top five aquatic life impairment causes for the period 2003 through 2012 are: siltation/sedimentation, excess nutrients, habitat modification, hydromodification, and organic enrichment/dissolved oxygen. Most of the impaired watershed units with current data had at least one of these causes contributing to impairment and many had two or more of the top five causes listed (Ohio EPA 2014a).

Headwater stream protection approaches should be focused on the improved management of riparian zones in attempts to reduce sediment and nutrient delivery (*i.e.*, encouraging sediment and nutrient interception, processing, and storage within the riparian areas of headwater streams). Vegetated riparian buffers are a vital functional component of the stream ecosystem and are instrumental in the detention, removal and assimilation of nutrients from or by the water column. The riparian zone is essentially a component of instream habitat. It contributes food and nutrients in forms that desirable aquatic assemblages are adapted for, and contributes to the habitat heterogeneity by influencing channel morphology via large woody debris and bank stabilization (Ohio EPA 1999a).

Illustrating the importance of the riparian zone to headwater stream ecology is the fact that biological community performance in headwaters and wadable streams has been found to be highest (based upon Index of Biotic Integrity [IBI] or Invertebrate Community Index [ICI] values) where total phosphorous (TP) concentrations are lowest. The quality of the riparian corridor influences TP levels in the stream by its ability to detain, remove, and assimilate P before it enters the stream. The lowest TP concentrations were also associated with the highest quality stream habitats (based upon Qualitative Habitat Evaluation Index [QHEI] scores). The correlation of low TP with high quality lotic habitat is thought to be the result of TP being sequestered by the well-organized, diverse, and trophically dynamic aquatic assemblages that are typically associated with high quality habitat (Ohio EPA 1999a).

Excess nutrients can have negative effects by altering trophic dynamics, increasing algal production, increasing turbidity, decreasing dissolved oxygen (D.O.) concentrations, and increasing daily fluctuations in D.O. and pH. Changes caused by excessive nutrient concentrations result in shifts in species composition away from functional assemblages of intolerant species, benthic insectivores and top carnivores (*e.g.,* darters, insectivorous minnows, redhorse, sunfish, and black basses) typical of high quality warmwater streams, towards less desirable assemblages of tolerant species, niche generalists, omnivores, and detritivores (*e.g.,* creek chub, bluntnose minnow, white sucker, carp, green sunfish) typical of degraded warmwater streams (Ohio EPA 1999a).

Since more than 88 percent of Ohio is privately or locally owned, the well-being of Ohio's streams and watersheds is very dependent upon the attitudes and conservation stewardship of landowners and local communities. Increasingly, community-based watershed groups and partnerships comprised of many stakeholders are collectively working to protect and restore their local streams and watersheds. As water resources become increasingly important, it will be the willingness of private landowners and these groups to practice voluntary conservation on private and local lands that will determine the need for future regulations related to the health of streams and watersheds throughout Ohio (Sanders 2000).

6.17.3 Associated Species of Greatest Conservation Need

With more than 1,200 species, aquatic insects are the largest group of Ohio stream wildlife. An amazing number of fish – historically over 160 species – have also been recorded from Ohio streams. Ohio's least impacted streams are characterized free-flowing diverse aquatic habitats, forested riparian corridors, islands, associated wetlands, unregulated flow regimes, and sparsely populated watersheds. These streams contain diverse and abundant biological assemblages that include pollution-sensitive, rare, and endangered species (Sanders 2000). Headwater and small inland streams however, are very succeptible to natural and anthropogenic influences due to their small size. In many of Ohio's watersheds, biological communities improve as stream size increases. Size can buffer the impacts of issues such as variable flows, pollution, land-use practices, and climate. Headwater and small inland streams are fragile systems who's aquatic species assemblages can be severly impacted by events that would have little effect upon larger systems. At any point in time, the aquatic community present in a small inland stream may be a reflection of the condition/activities in the watershed, a recent event that negatively impacted the stream (e.g., chemical spill), or both.

The following species have been identified as Headwater and Small Inland Streams species of greatest conservation need (conservation status rank in parentheses):

<u>Aquatic Invertebrates</u>

Hines Emerald Dragonfly	*Somatochlora hineana*
Eastern Red Damsel	*Amphiagrion sauclum*
Aurora Damsel	*Chromagrion conditum*
Arrowhead Spiketail Dragonfly	*Cordulegastor obliqua*

<u>Fish</u>

Scioto Madtom (1)	*Noturus trautmani*
Longhead Darter (4)	*Percina macrocephala*
Western Tonguetied Minnow (7)	*Exoglossum laurae*
Spotted Darter (8)	*Etheostoma maculatum*
Northern Madtom (10)	*Noturus stigmosus*
Bigeye Shiner (12)	*Notropis boops*
Ohio Lamprey (13)	*Ichthyomyzon bdellium*
Mountain Brook Lamprey (16)	*Ichthyomyzon greeleyi*
Tippecanoe Darter (20)	*Etheostoma tippecanoe*
Mountain Madtom (21)	*Noturus eleutherus*
Blacknose Shiner (22)	*Notropis heterolepis*
Northern Brook Lamprey (23)	*Ichthyomyzon fossor*
Mottled Sculpin (24)	*Cottus bairdi*
Bluebreast Darter (25)	*Etheostoma camurum*
Silver Lamprey (26)	*Ichthyomyzon unicuspis*
Pugnose Minnow (27)	*Opsopoeodus emiliae*
American Brook Lamprey (28)	*Lampetra appendix*
Eastern Sand Darter (29)	*Ammocrypta pellucida*
Western Banded Killifish (30)	*Fundulus diaphanus menona*
Redside Dace (31)	*Clinostomus elongatus*
Gravel Chub (32)	*Erimystax x-punctatus*
Least Darter (33)	*Etheostoma microperca*
Least Brook Lamprey (35)	*Lampetra aepyptera*
Iowa Darter (38)	*Etheostoma exile*
Rosyside Dace (39)	*Clinostomus funduloides*
Streamline Chub (41)	*Erimystax dissimilis*
Bigeye Chub (42)	*Hybopsis amblops*
Central Mudminnow (43)	*Umbra limi*
Lake Chubsucker (46)	*Erimyzon sucetta*
Bigmouth Shiner (48)	*Notropis dorsalis*
Black Redhorse (48)	*Moxostoma duquesnei*

Pirate Perch (51)	*Aphredoderus sayanus*
Silver Redhorse (52)	*Moxostoma anisurum*
Variegate Darter (53)	*Etheostoma variatum*
Southern Redbelly Dace (54)	*Phoxinus erythrogaster*
Greater Redhorse (55)	*Moxostoma valenciennesi*
Creek Chubsucker (58)	*Erimyzon claviformis*
Dusky Darter (58)	*Percina sciera*
Smallmouth Redhorse (63)	*Moxostoma breviceps*

Crayfish

Devil Crayfish (3)	*Cambarus diogenes*
Northern Clearwater Crayfish (4)	*Orconectes propinquus*
Sanborn's Crayfish (6)	*Orconectes sanbornii*
Paintedhand Mudbug (8)	*Cambarus polychromatus*
Little Brown Mudbug (9)	*Cambarus thomai*
Ortman's Mudbug (10)	*Cambarus ortmanni*
Spiney Stream Crayfish (11)	*Orconectes cristavarius*
Cave Spring Crayfish (12)	*Cambarus tenebrosus*
Papershell Crayfish (13)	*Orconectes immunis*
Virile Crayfish (13)	*Orconectes virilis*

Mussels

White Catspaw (2)	*Epioblasma obliquata perobliqa*
Purple Catspaw (3)	*Epioblasma obliquata obliquata*
Little Spectaclecase (7)	*Villosa lienosa*
Purple Lilliput (15)	*Toxolasma lividum*
Slippershell Mussel (16)	*Alasmidonta viridis*
Rayed Bean (21)	*Villosa fabalis*
Creek Heelsplitter (23)	*Lasmigona compressa*
Rabbitsfoot (25)	*Quadrula cylindrica*
Salamander Mussel (25)	*Simpsonaias ambigua*
Clubshell (35)	*Pleurobema clava*
Purple Wartyback (37)	*Cyclonaias tuberculata*
Threeridge (40)	*Amblema plicata*
Round Hickorynut (42)	*Obovaria subrotunda*
Black Sandshell (47)	*Ligumia recta*
Kidneyshell (48)	*Ptychobranchus fasciolaris*
Rainbowshell (50)	*Villosa iris*
Round Pigtoe (50)	*Pleurobema sintoxia*
Cylindrical Papershell (56)	*Anodontiodes ferussacianus*

Amphibians

Mudpuppy (14)	*Necturus maculosus maculosus*
Cave Salamander (15)	*Eurycea lucifuga*

Reptiles

Rough Green Snake (3)	*Opheodrys aestivus*
Midland Smooth Softshell (7)	*Apalone mutica mutica*
Common Map Turtle (19)	*Graptemys geographica*
Ouachita Map Turtle (19)	*Graptemys ouachitensis*
Queen Snake (19)	*Regina septemvittata*

Table 43. CONSERVATION THREATS TO HEADWATER AND SMALL INLAND STREAMS.
The following threats negatively impact or have the potential to negatively impact Headwater and Small Inland Streams. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		high
A	Watershed conversion to urban/commercial development alters hydrology	housing & urban areas commercial & industrial areas	high medium
B	Shoreline development and its effect on habitat and species	housing & urban areas commercial & industrial areas	high medium
C	Increasing land prices limit our ability to protect riparian corridors	housing & urban areas commercial & industrial areas	high medium
II	**agriculture and aquaculture**		high
A	Loss of riparian corridor to agriculture	annual & perennial non-timber crops livestock farming & ranching	high low
B	Watershed conversion to agriculture alters hydrology	annual & perennial non-timber crops livestock farming & ranching	high low
III	**energy production and mining**		high
A	Oil and gas extraction - can have negative impacts by causing chemical contamination	oil & gas drilling	high
B	Water withdrawal for fracking alters hydrology	oil & gas drilling	high
C	Coal mining can result in acid mine drainage	mining & quarrying	low
IV	**transportation and service corridors**		medium
A	Roads/bridges/causeways and utilities can destroy habitat, alter hydrology	roads & railroads utility & service lines	high low
V	**biological resource use**		low
A	Fishing pressure and fishing gear impacts	fishing & harvesting aquatic resources	negligible
B	Removal of trees from streambanks and the watershed impacts water quality	logging & wood harvesting	high
VI	**human intrusions and disturbance**		low
A	Incompatible recreational activities	recreational activities	negligible
VII	**natural system modifications**		high
A	Forestry practices can negatively impact water quality	other ecosystem modifications	low
B	Altering channel morphology to facilitate agriculture impacts habitat and species	dams & water management/use	high
C	Dams cause habitat loss, sedimentation, decreased water quality, reduced biodiversity, and reduce movement of aquatic species and species abundance	dams & water management/use	high

D	Lack of data for some species and habitats limits our ability to develop plans for threats like climate change	other ecosystem modifications	low
E	Some species' polulations have been reduced to levels below what is necessary to recover on their own	other ecosystem modifications	Low
VIII	**invasive and other problematic species and genes**		low
A	Introduction and/or spread of invasive plants and animals	invasive non-native/alien species	low
B	Introduction and/or spread of nuisance plants and animals	problematic native species	negligible
C	Introduction and spread of diseases (plants and animals)	invasive non-native/alien species problematic native species	low negligible
IX	**pollution**		medium
A	Urban effluent carries a variety of substances that impact water quality & aquatic species	household sewage & urban wastewater industrial & military effluents garbage & solid waste air-borne pollutants	low low low low
B	Agricultural effluent from row crops as well as confined animal operations impacts water quality & aquatic species	agricultural & forestry effluents	high
C	Pesticides/herbicides from waterfront property owners impacts water quality	household sewage & urban wastewater	low
D	Mine drainage negatively impacts water quality and reduces species & species abundance	industrial & military effluents	low
X	**geological events**		negligible
---	none	---	---
XI	**climate change and severe weather**		medium
A	Climate change could impact habitats, water quality, and species	habitat shifting & alteration droughts temperature extremes storms & flooding	high low low low

Table 44. CONSERVATION ACTIONS FOR HEADWATER AND SMALL INLAND STREAMS.
The following actions will help abate or have the potential to help abate threats to Headwater and Small Inland Streams habitat. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	actions	2nd level action classification(s)	action priority rank	threat(s) addressed*
I	**LAND/WATER PROTECTION**		high	
1	Protect riparian corridors through acquisition, partnerships, conservation easements, etc.	site/area protection resource & habitat protection	high high	I, II, IV, V-B, VII-B
II	**LAND/WATER MANAGEMENT**		med	
1	Work with OEPA, ODOT, USACE, and other government agencies to focus mitigation activities on riparian habitats in conservation opportunity watersheds	habitat & natural process restoration	high	I-A, II-A, IV, XI
2	Work with landowners to develop and implement habitat improvement projects on private lands	habitat & natural process restoration	high	I, II, IX-C, XI
3	Remove dams to restore stream connectivity and improve water quality	habitat & natural process restoration	high	VII-C, XI
4	Develop criteria for prioritizing candidate dams for removal – give extra emphasis to dams in conservation opportunity watersheds	habitat & natural process restoration	high	VII-C
5	Research fish passage improvements for dams that are not candidates for removal	habitat & natural process restoration	high	VII-C
6	Identify and prioritize restoration projects (channel restoration, floodplain and backwater reconnection, etc.) in conservation opportunity watersheds	habitat & natural process restoration	high	I-A,B, II, IV, VII-B, XI
7	Complete one geomorphological restoration project in each conservation opportunity watershed every 5 years	habitat & natural process restoration	high	I-A,B, II, IV, VII-B,C, XI
8	Develop model stream protection guidelines aimed at slowing the overland flow of water into streams	habitat & natural process restoration	high	I-A, II-B, IX-A,B
9	Create and use wetlands for stormwater treatment	habitat & natural process restoration	high	I-A, IX-A
10	Develop a process for coordinating disparate data sources of distribution and abundance of aquatic SGCN with special emphasis on conservation opportunity watersheds	habitat & natural process restoration	high	I-B, IV, VII-B,C,D, XI
11	Review existing species and habitat data to identify data gaps and needs for additional surveys, research, and management actions	habitat & natural process restoration	high	I, II, III, IV, V, VI, VII, VIII, IX, XI
12	Conduct comprehensive surveys of freshwater mussels in all conservation opportunity watersheds	habitat & natural process restoration	high	I-B, III-B,C, IV, VII, XI

13	Expand the DOW livestock exclusion fencing program to SWCDs in all counties in conservation opportunity watersheds	habitat & natural process restoration	high	II-A, VII-B, IX-B
14	Conduct watershed studies to identify and prioritize restoration opportunities	habitat & natural process restoration	high	I-B, II-A, III-C, IV, V-B, VII, XI
15	Reconnect stream channels with natural floodplains	habitat & natural process restoration	high	I-A,B, II, IV, VII-B, XI
16	Restore/stabilize riparian habitat by planting native grasses, shrubs, and trees	habitat & natural process restoration	high	I-B, II-A, V-B, VII-B
17	Use treatment techniques to control the pH of effluent on abandoned mine lands	habitat & natural process restoration	high	III-C
18	Develop GIS tools to archive and monitor the status of protected lands in conservation opportunity watersheds	site/area management	low	XI
19	Sample fish assemblages and assess aquatic habitat in currently non-assessed tributaries	site/area management	low	I, II, III, IV, V, VI, VII, VIII, IX, XI
20	Establish an early-detection/rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	low	VIII-A,B
21	Develop ways to control invasive plant species in flowing waters	invasive/ problematic species control	low	VIII-A,B
III	**SPECIES MANAGEMENT**		med	
1	Assess population status, habitat suitability, and probability for restoration of fish, mussels, crayfish, invertabrates, and amphibians listed as SGCN	species reintroduction	High	VII-D, VII-E
2	Develop a restoration strategy for high priority fish, mussels, crayfish, invertebrates, and amphibians	species reintroduction	High	VII-D, VII-E
IV	**EDUCATION AND AWARENESS**		high	
1	Educate waterfront landowners and commercial pesticide/herbicide applicators on responsible chemical use, and the negative impacts to wildlife from toxic chemicals	training	high	I-B,C, IX-A
2	Conduct shoreline protection/stabilization workshops	training	high	I-B, II-A, IV, V-B, XI
3	Provide technical guidance on shoreline development plans as relates to fish and wildlife interests	training	high	I, IV, XI
4	Provide training to road construction/maintenance personnel for runoff/sediment control	training	high	I-B, IV
5	Conduct stream-related demonstrations or presentations to schools, watershed groups, and the general public	training	high	I, II, IX-A,B,C, XI
6	Provide training in geomorphological, fluvial, and in-stream flow processes for DOW personnel	training	high	III-B, IV, V-B, VII-B,C
7	Promote conservation easements to protect riparian habitat	training awareness & communic-ations	high med	I, II, IV, V-B, IX, XI

8	Educate the public and legislators on the benefits of dam removals	training awareness & communic-ations	high med	VII-C
9	Develop and provide streams/watersheds educational materials for landowners, schools, public officials, and the general public	training awareness & communic-ations	high med	I, II, IX-A,B,C, XI
10	Educate the public about the negative effects of exotic and nuisance animals – encourage responsible disposal of unwanted animals	awareness & communic-ations	med	VIII
V	**LAW AND POLICY**		high	
1	Support legislation promoting eco-friendly energy development and use	legislation	high	III
2	Develop and implement a risk-assessment system in the approval process for importing or moving live animals and plants	legislation policies & regulations	high med	VIII
3	Find innovative ways to mandate the inclusion of fish and wildlife interests in development plans	policies & regulations private sector standards & codes	med high	I, III-B,C, IV, IX-A, XI
4	Promote riparian protection ordinances that prevent floodplain encroachment and riparian habitat removal	policies & regulations private sector standards & codes	med high	I, II, IV, V-B, VII-A,B
5	Support the use of buffers between development and stream shorelines	policies & regulations private sector standards & codes	med high	I-A,B, IV, IX-A
6	Support the creation of additional and/or increased enforcement of stormwater regulations	policies & regulations compliance & enforcement	med med	I-A, IX-A
7	Support groundwater protection efforts	policies & regulations	med	III-B, VII-C, IX
8	Support sewage sludge/animal manure disposal standards to regulate application rates and timing	policies & regulations	med	IX-A,B
9	Encourage and support minimum flow regulations that protect downstream aquatic habitats	policies & regulations	med	III-B, VII-C, IX
VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		med	
1	Explore tying eligibility for grant money, loans, and cost-share programs to nutrient loading levels for agriculture – the lower the nutrient levels in their effluent, the more money they would be eligible for	conservation payments	med	IX-B, XI

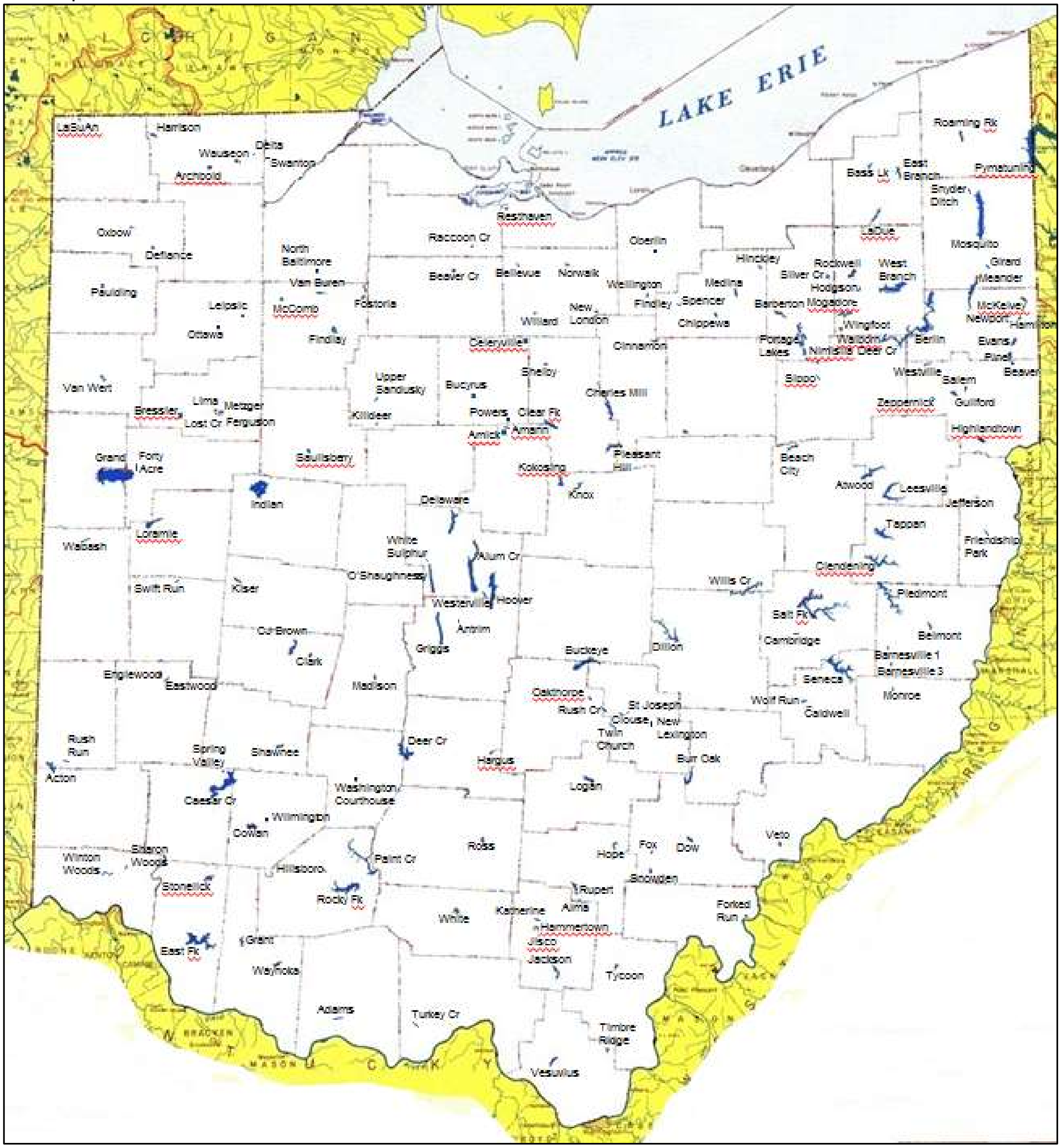
2	Support payments to offset losses (revenue from crops) resulting from implementation of conservation practices aimed at reducing sediment loads	conservation payments	med	IX-B
3	Create incentives for vegetated buffers along all waterways to reduce nutrient loads and sediment	market forces conservation payments	low med	I, II, V-B, VII-A,B, IX-A,B, XI
4	Create incentives to promote eco-friendly energy development and use	market forces conservation payments non-monetary values	low med high	III
5	Support the creation of incentives to protect riparian habitat	market forces conservation payments	low med	I, II, IV, V-B, VII-A,B, XI
6	Create/support programs that encourage buffers between development and inland streams	market forces conservation payments	low med	I-A,B, IV, IX-A
7	Develop incentives for municipalities to use stormwater management systems that minimize negative impacts to aquatic habitats	market forces conservation payments	low med	I-A, IX-A
8	Create incentives to encourage the use of conservation tillage – especially in impaired watersheds	market forces conservation payments	low med	IX-B
9	Support incentives for conservation farming practices – including nutrient management plans and livestock waste management plans	market forces conservation payments	low med	IX-B
10	Encourage the use of cover crops for idle agricultural fields	market forces conservation payments	low med	IX-B
11	Promote drainage water management such as grassed waterways, 2-stage channels, and over-wide ditches	market forces conservation payments	low med	II, VII-B, IX-B
12	Promote waterway conservation livestock practices such as exclusion fencing, livestock crossings, alternative water supplies, livestock access lanes	market forces conservation payments	low med	II-A, IX-B
VII	**EXTERNAL CAPACITY BUILDING**		high	
1	Pursue partnerships with local, state, and federal agencies to secure funding for projects benefitting streams and watersheds	alliance & partnership development conservation finance	med high	I, II, III, IV, V-B, VII, VIII, IX, XI
2	Work with ODA and OEPA to minimize nutrients in runoff, and develop BMPs for pesticide/herbicide use	alliance & partnership	med	IX

		development		
3	Create an interagency spill response team – update contacts and training on a regular basis	alliance & partnership development	med	IX-A,B
4	Consider creating a multiagency invasive species prevention and control group that would handle all invasive species issues	alliance & partnership development	med	VIII
5	Develop a multi-agency group to design wildlife/habitat friendly stream crossings	alliance & partnership development	med	I-B, II-A, IV, VI
6	Through interagency coordination, work to assure that wildlife interests are taken into consideration in road, bridge, and causeway design, construction, and maintenance	alliance & partnership development	med	IV
7	Create a multi-agency dam removal task force	alliance & partnership development	med	VII-C
8	Use inter-agency cooperation to influence watershed health	alliance & partnership development	med	I, II, V-B, VII-A,B, IX, XI
9	Attend and actively collaborate with watershed partnerships	institutional & civil society development alliance & partnership development	med med	I, II, III, IV, V-B, VI, VII, VIII, IX, XI
10	Develop partnerships with land trusts, watershed and conservation groups, and government agencies to guide acquisition and protection activities in each conservation opportunity watershed	alliance & partnership development	med	I, II, III, IV, V-B, VII-A,B, XI
11	Increase personnel and expertise available for SGCN surveys and research through partnerships with other government agencies, universities, and conservation-minded NGO's	institutional & civil society development alliance & partnership development	med med	I, II, III, IV, V, VI, VII, VIII, IX, XI

*refers to the Headwater and Small Inland Streams Habitat Conservation Threats in Table 43

6.18 Man-made Lakes and Ponds

Ohio's public lakes >20 acres



6.18.1 Status

Assessment data for this habitat category is limited and lagging behind assessment of rivers and streams. Inputs from the surrounding watershed as well as tributary streams affect habitat and water quality of lentic systems. Ohio's largest lakes/reservoirs are heavily influenced by sedimentation, nutrient enrichment, and turbidity. Canal lakes are extremely productive systems, but due to degraded habitat and water quality, are dominated by tolerant species. Overall, ponds provide the best combination of water quality and habitat primarily because of the landcover in their smaller drainage areas.

6.18.2 Description

Ohio is estimated to have 2,293 lakes and reservoirs >5 acres, totaling 142,006 acres (ODNR 1980). Considering smaller waters, the US Environmental Protection Agency (EPA) estimated that Ohio has 5,130 lakes, reservoirs and ponds totaling 188,461 acres, whereas the ODNR estimated over 50,000 water bodies totaling 200,000 acres during this same time. Numerous small ponds counted by the ODNR were not identified by the US EPA due to differences in methods (Davic et al. 1996). The most recent estimate of all inland lentic waters, regardless of size, is over 52,000 ponds, lakes, and reservoirs statewide (Miami University 2005). Maintaining a current inventory of lakes, reservoirs, and ponds is challenging, as new waters are periodically constructed, while others are occasionally “decommissioned” by draining or breaching the dam.

Ohio’s man-made lakes and ponds fall into three categories related to construction. On-stream reservoirs (dammed impoundments) are constructed by placement of a dam across a stream or creek to impound water. Upground reservoirs are constructed in flat terrain by constructing an earthen levee above ground level, and then pumping water into the basin that is created. The third category (dug-out lakes) is created by excavating a hole and allowing it to fill with water.

Of the 422 man-made public lakes discussed in this section, 279 (66.1%) are dammed impoundments, 86 (20.4%) are upground reservoirs, and 57 (13.5%) are dug-out lakes. Three lakes are more than 5000 acres: Grand Lake St. Marys at 12,700 acres, Mosquito Creek Reservoir at 7,850 acres, and Indian Lake at 5,104 acres (Pymatuning Lake is 14,658 acres, but the majority lies in Pennsylvania). An additional 27 lakes range between 1,000 and 5,000 acres. Together, the 30 lakes larger than 1000 acres represent 84,336 (71%) of the total acres of inland public lake water in Ohio. A large number of public lakes (282) are from 5 to 50 acres in size, but these lakes collectively represent only 3.9 % (4,657 acres) of the total acres of public water (Davic et al. 1996). All of these waters have become important multi-use resources and provide important habitat for a number of aquatic and terrestrial species.

Ohio reservoirs are generally shallow (median depth 13.5 feet), and fertile. Ohio’s deepest reservoirs are East Fork and Caesar Creek, with maximum depths of nearly 121 feet, but all other reservoirs have maximum depths of less than 72 feet. Sixty percent of Ohio reservoirs are eutrophic, 19% are mesotrophic, 17% are hypereutrophic, and less than 5% are oligotrophic based on Carlson Trophic State Indicators (Davic et al. 1996). The range of productivity can vary greatly statewide depending upon landcover in the watershed. Knoll et al. (2003) found ranges of phosphorus from 27-153 ug/l, and chlorophyll-a from 5-56 ug/l in 12 tributary reservoirs with watersheds that spanned a gradient of 29% to 89% agricultural land use. Trophic state values do not differ substantially statewide by lake type except for lower values in upground reservoirs, that because of their morphology, control runoff. Another pattern that emerges is the distribution of low trophic state scores in the relatively nutrient poor Western Allegheny Plateau ecoregion and the higher scores in the intensively farmed Huron Erie Lake Plain. This pattern matches that observed for streams and rivers in Ohio (Davic et al. 1996).

Land cover across Ohio is 59% agricultural, 31% forest, 6% urban, and 3% wetland, with the balance in other cover types, but reservoir watersheds are predominately agriculture (64%) with very little urban use (3%) (Renwick and Andereck 2005). Agricultural land use can cause significant soil erosion and sedimentation, resulting in increased nitrogen and phosphorus loading, reduced storage capacity, and shortened reservoir life expectancy. Renwick and Andereck (2005) found reservoir sedimentation rates in 68 Ohio reservoirs to be highly variable, ranging from 2.4-23.8 yd^3/ac/y – values typical in Midwestern reservoirs. Extensive sedimentation often occurs in reservoirs with rapid exchange of water volume resulting from large watershed area to reservoir storage volume ratios. Ohio reservoirs with high watershed area to reservoir volume ratios can completely exchange total reservoir volume in less than three weeks (e.g. Dillon, Delaware, O’Shaughnessy, Paint Creek, Charles Mill, and Stonelick reservoirs). However, the median time to complete replacement of volume is 155 days (ODNR unpublished data). Throughout the Midwest, sedimentation rates have been reduced through improved agricultural practices

(Renwick and Andereck 2005; Renwick et al. 2005), suggesting that land management may be more important than land use in addressing sedimentation.

Of the 136 public lakes/ponds/reservoirs assessed by the Ohio EPA relative to aquatic life use attainment, 93 (68%) fully met, 30 (22%) partially met, and 13 (10%) did not meet designated life-use criteria. Major and moderate sources of non-attainment are primarily nonpoint in origin. Agricultural nonpoint sources are by far having the greatest influence with major and moderate effects on over 12,000 acres and threatening over 28,000 more. Other significant nonpoint sources with major and moderate magnitude impacts include hydromodification (> 4,000 acres), construction (>2,000 acres), urban runoff (>1,000 acres) and septic systems (1,400 acres). Point sources (all categories) have major or moderate impacts on greater than 7,000 acres of Ohio lakes. These sources of impact mirror those in Ohio rivers and streams (i.e., the predominance of nonpoint sources) and support a movement toward a watershed approach to water resource restoration in Ohio (Davic et al. 1996).

Most (probably all) Ohio lakes/reservoirs/ponds have been altered due to management and/or restoration activities. Primary alterations result from activities that (1) affect the biological community (fish stocking, nuisance fish removal, aquatic plant and algae control), and/or (2) influence productivity (nutrient addition or nutrient reduction), and alter physical habitat (dredging, shoreline alteration, drawdowns, artificial structure additions).

6.18.3 Associated Species of Greatest Conservation Need
The water bodies that comprise this habitat category were for the most part not constructed with aquatic species in mind. Man-made reservoirs/lakes/ponds serve a number of purposes, with water supply and flood control topping the list. Recreational opportunities vary with the size of the water body, but are rarely the primary intended purpose. Consequently, little to no regard for aquatic habitat goes into the construction and subsequent management of these waters. What habitat exists is to a large degree influenced by the watershed to surface acres ratio of a given body of water. On-stream impoundments in particular tend to serve as settling basins for sediment transported by source streams. The result after several years of existence is a homogenization of habitats from silt/sediment deposition. In addition, fluctuating water levels negatively impact littoral habitats and aquatic species throughout the year.

Despite the issues described above, a number of aquatic species survive and flourish in these systems. While species diversity is not extremely high, and threatened/rare species are not usually represented, these waters still provide significant habitat for a number of warm and cool water species. Man-made reservoirs/lakes/ponds are the primary habitat for sunfish species (Centrarchidae), and constitute a significant portion of habitat for catfishes (Ictaluridae), minnows (Cyprinidae), suckers (Catostomidae), a handful of mussel species, and the mudpuppy. Overall, the fish and invertebrate community tends to be a combination of resident species from the impounded stream that can tolerate the lentic conditions of the reservoir that has been created, and introduced species (both natural and stocked).

The following species have been identified as Man-made Lakes and Ponds species of greatest conservation need (conservation status rank in parentheses):

<u>Fish</u>
Lake Chubsucker (46) *Erimyzon sucetta*

<u>Amphibians</u>
Mudpuppy (14) *Necturus maculosus maculosus*
Red-spotted Newt (20) ***Notophthalmus viridescens viridescens***

Table 45. CONSERVATION THREATS TO MAN-MADE LAKES AND PONDS.
The following threats negatively impact or have the potential to negatively impact Man-made Lakes and Ponds. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		low
A	Watershed conversion to urban/commercial development alters hydrology	housing & urban areas commercial & industrial areas	low low
B	Waterfront development and its effect on nearshore habitat and species	housing & urban areas tourism & recreation areas	low low
C	Increasing land prices limit our ability to protect riparian corridors - which affects water quality and habitat in lakes	housing & urban areas commercial & industrial areas	low low
II	**agriculture and aquaculture**		low
A	Loss of riparian corridor to agriculture - which affects water quality and habitat	annual & perennial non-timber crops livestock farming & ranching	low low
B	Watershed conversion to agriculture alters hydrology	annual & perennial non-timber crops livestock farming & ranching	low low
III	**energy production and mining**		medium
A	Oil and gas extraction - can have negative impacts by causing chemical contamination	oil & gas drilling	medium
B	Water withdrawal for fracking alters hydrology	oil & gas drilling	medium
IV	**transportation and service corridors**		low
A	Roads/bridges/causeways and utilities can destroy habitat, alter hydrology	roads & railroads utility & service lines	low low
B	Dredging to accommodate recreational watercraft can destroy habitat and affect water quality	shipping lanes	low
V	**biological resource use**		low
A	Fishing pressure and fishing gear impacts	fishing & harvesting aquatic resources	low
VI	**human intrusions and disturbance**		medium
A	Incompatible recreational activities	recreational activities	medium
B	Creation of recreational facilities can alter/destroy nearshore habitat	recreational activities	medium
C	Negative impacts of recreational watercraft on water quality and nearshore habitat	recreational activities	medium
VII	**natural system modifications**		high
A	Aging of reservoirs and the sediment they have collected destroys habitat and reduces species diversity and abundance	dams & water management/use	high

B	Dam operations affect habitat and species by changing water levels	dams & water management/use	high
C	Conflicting water control management objectives of controlling agencies (DOW – USACOE)	dams & water management/use	high
D	Seasonal hypolimnetic hypoxia and anoxia in many Ohio lakes and reservoirs substantially reduces deepwater habitat available to aquatic species	other ecosystem modifications	low
E	Chemical treatments applied to upground reservoirs to reduce algal production, for the purpose of maintaining the quality of municipal drinking water, can retard the production of the zooplankton needed to support the feeding of fish early life stages	other ecosystem modifications	low
F	Lack of data for some species and habitats limits our ability to develop plans for threats like climate change	other ecosystem modifications	low
VIII	**invasive and other problematic species and genes**		medium
A	Introduction and/or spread of invasive plants and animals	invasive non-native/alien species	medium
B	Introduction and/or spread of nuisance plants and animals	problematic native species	low
C	Introduction and spread of diseases (plants and animals)	invasive non-native/alien species problematic native species	medium low
IX	**pollution**		medium
A	Urban effluent carries a variety of substances that impact water quality and aquatic species	household sewage & urban wastewater industrial & military effluents garbage & solid waste air-borne pollutants	low low low low
B	Agricultural effluent from row crops as well as confined animal operations impacts water quality and aquatic species	agricultural & forestry effluents	high
C	Pesticides/herbicides from waterfront property owners impact water quality	household sewage & urban wastewater	low
D	Harmful algal blooms affect water quality, aquatic species, and can be toxic to terrestrial species	agricultural & forestry effluents	high
X	**geological events**		negligible
---	none	---	---
XI	**climate change and severe weather**		low
A	Climate change could impact habitats, water quality, and species	habitat shifting & alteration droughts temperature extremes storms & flooding	low low low low

Table 46. CONSERVATION ACTIONS FOR MAN-MADE LAKES AND PONDS.
The following actions will help abate or have the potential to help abate threats to Man-made Lakes and Ponds. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	actions	2nd level action classification(s)	action priority rank	threat(s) addressed*
I	**LAND/WATER PROTECTION**		high	
1	Protect shoreline habitat and upstream riparian habitat through acquisition, partnerships, conservation easements, etc.	site/area protection resource & habitat protection	med high	I, II, IV-A, VI-B
II	**LAND/WATER MANAGEMENT**		med	
1	Identify the watershed characteristics that have the strongest influence on the quality of lake and reservoir habitats	habitat & natural process restoration	high	I-A, II-B, VII-A, IX
2	Develop a protocol for the collection and analysis of physical habitat data using high-frequency side scan sonar	habitat & natural process restoration	high	IV-B, VI-C, VII-A
3	Support and encourage efforts by the Ohio EPA and other agencies to assess the overall condition of Ohio's lakes	habitat & natural process restoration	high	I, II, III, IV, V, VI, VII, VIII, IX, XI
4	Annually collect lower trophic data to understand watershed impacts on fish communities, and how changes in land use may influence lake/reservoir productivity	habitat & natural process restoration	high	I-A, II-B, VII-A, IX
5	Research how reservoir aging affects productivity and influences abundance and condition of aquatic species	habitat & natural process restoration	high	VII-A
6	Complete development of a reservoir classification system that improves our understanding of the physical, chemical, and biological characteristics of reservoirs in a way that allows us to better manage aquatic species	habitat & natural process restoration	high	I, II, III, IV, V, VI, VII, VIII, IX, XI
7	Create and use wetlands for stormwater treatment	habitat & natural process restoration	high	I-A, IX-A
8	Develop a process for coordinating disparate data sources of distribution and abundance of aquatic SGCN with special emphasis on conservation opportunity watersheds	habitat & natural process restoration	high	I-B, IV, VI-B, VII-A,B,C,F, XI
9	Review existing species and habitat data to identify data gaps and needs for additional surveys, research, and management actions	habitat & natural process restoration	high	I, II, III, IV, V, VI, VII, VIII, IX, XI
10	Conduct comprehensive surveys of freshwater mussels in all conservation opportunity watersheds	habitat & natural process restoration	high	I-B, III-B, IV, VII-A,B,C,D,F, XI
11	Establish an early-detection/rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	med	VIII-A,B

12	Determine the effect that spatial and temporal variations in water temperature and dissolved oxygen have on the quantity and quality of habitat	site/area management	low	VII-B,C,D
13	Evaluate the affect of common water level management practices and control structure type on in-lake habitat	site/area management	low	VII-B,C,D
14	Research how hydrologic pulsing influences aquatic species, as well as reservoir productivity	site/area management	low	VII-B,C
15	Develop compatible recreational activities criteria that can be used to evaluate impacts to habitat/species from recreational activities	site/area management	low	VI
III	**SPECIES MANAGEMENT**		low	
---	none	---	---	---
IV	**EDUCATION AND AWARENESS**		med	
1	Educate waterfront landowners and commercial pesticide/herbicide applicators on responsible chemical use, and the negative impacts to wildlife from toxic chemicals	training	med	I-B,C, IX-A,C
2	Promote conservation easements to protect riparian habitat of inlet streams	training awareness & communic-ations	med med	I, II, IV-A, VI-B, VII-A,D, IX, XI
3	Provide technical guidance on shoreline development plans as relates to fish and wildlife interests	training	med	I, IV-A, VI-B, XI
4	Educate the public about the negative effects of exotic and nuisance animals – encourage responsible disposal of unwanted animals	awareness & communic-ations	med	VIII
5	Provide training to road construction/maintenance personnel for runoff/sediment control	training	med	I-B, IV-A
6	Educate boaters about the negative impacts power boats can have on aquatic habitats	training awareness & communic-ations	med med	VI-A,C
V	**LAW AND POLICY**		med	
1	Support legislation promoting eco-friendly energy development and use	legislation	med	III
2	Find innovative ways to mandate the inclusion of fish and wildlife interests in development plans	policies & regulations private sector standards & codes	med med	I, III, IV, VI-B, IX-A, XI
3	Support the creation of additional and/or increased enforcement of stormwater regulations	policies & regulations compliance & enforcement	med med	I-A, IX-A
4	Develop and implement a risk-assessment system in the approval process for importing or moving live animals and plants	legislation policies & regulations	med med	VIII
5	Encourage and support minimum flow regulations that protect downstream aquatic habitats	policies & regulations	med	III-B, VII-C, IX

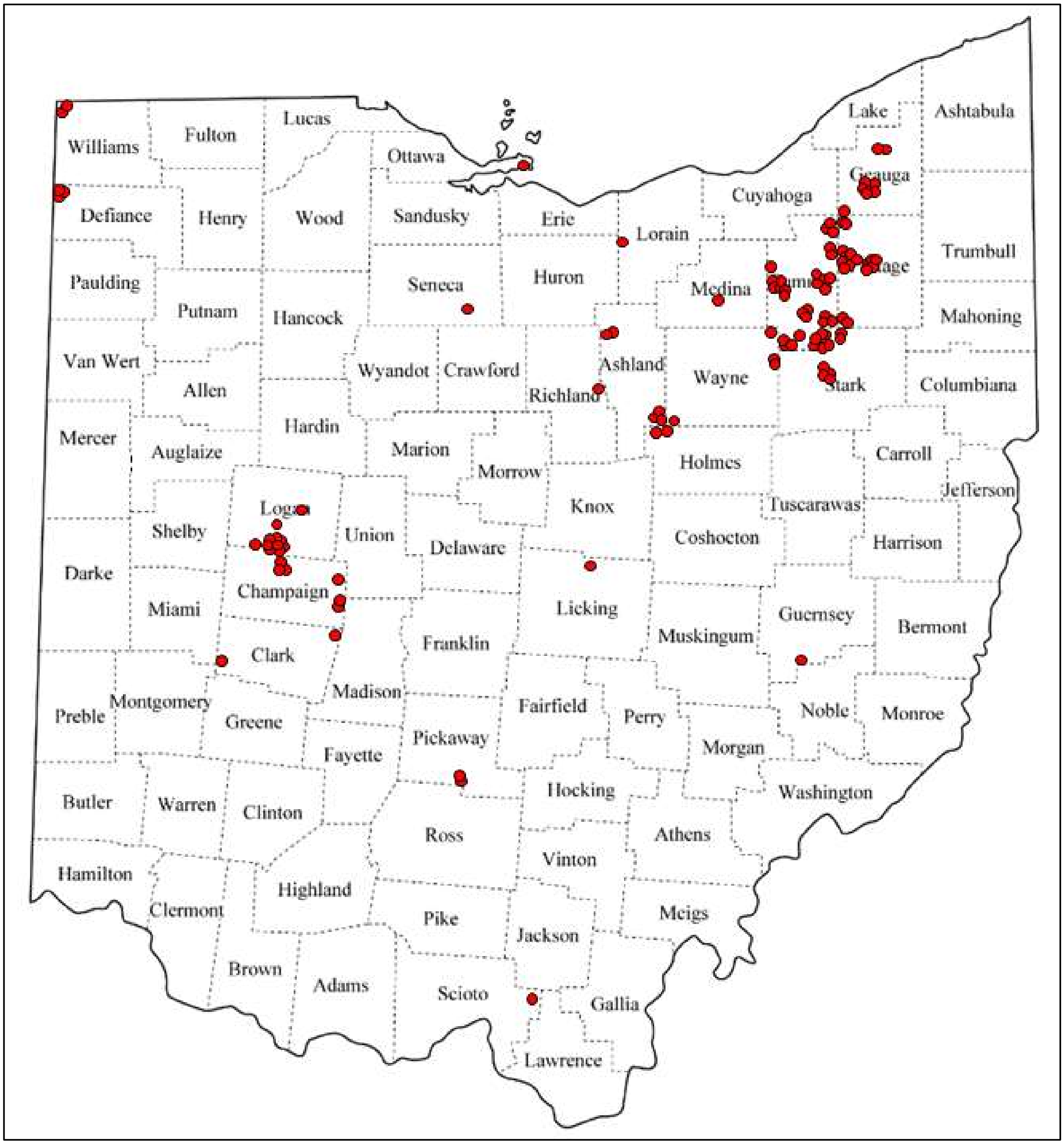
6	Support increased regulation of home sewage treatment systems	compliance & enforcement	med	IX-A
VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		med	
1	Explore tying eligibility for grant money, loans, and cost-share programs to nutrient loading levels for agriculture – the lower the nutrient levels in their effluent, the more money they would be eligible for	market forces conservation payments	med med	IX-B, XI
2	Create incentives for vegetated buffers along all waterways to reduce nutrient loads and sediment	market forces conservation payments	med med	I, II, VII-A,D, IX, XI
3	Create incentives to promote eco-friendly energy development and use	market forces conservation payments non-monetary values	med med low	III
4	Support the creation of incentives to protect shoreline habitat	market forces conservation payments	med med	I, II, IV-A, VI, XI
5	Develop incentives for municipalities to use stormwater management systems that minimize negative impacts to aquatic habitats	market forces conservation payments	med med	I-A, IX-A
6	Support incentives for development plans involving water frontage that take into account wildlife and habitat needs	market forces conservation payments non-monetary values	med med low	I-B, IV-A, VI-B, IX-A,C
7	Support clean marina and clean vessel programs	market forces conservation payments	med med	VI-C
VII	**EXTERNAL CAPACITY BUILDING**		med	
1	Work with ODA and OEPA to minimize nutrients in runoff, and develop BMPs for pesticide/herbicide use	alliance & partnership development	high	IX
2	Consider creating a multiagency invasive species prevention and control group that would handle all invasive species issues	alliance & partnership development	high	VIII
3	Through interagency coordination, work to assure that wildlife interests are taken into consideration in road, bridge, and causeway design, construction, and maintenance	alliance & partnership development	high	IV-A
4	Through interagency coordination work to establish an inland lake monitoring program to collect baseline and long-term chemical, physical, and biological data for all of Ohio's public lakes	alliance & partnership development	high	I, II, III, IV, V, VI, VII, VIII, IX, XI

5	Use inter-agency cooperation to influence watershed health	alliance & partnership development	high	I, II, VII-A,D, IX, XI
6	Work with controlling authorities (i.e., US Army Corps of Engineers) to develop water management plans that are conducive to sustaining reservoir aquatic species populations and habitats	alliance & partnership development	high	IV-B, VI, VII-B,C,D
7	Attend and actively collaborate with watershed partnerships	institutional & civil society development alliance & partnership development	med high	I, II, III, IV-A, VI-A,B, VII-A,D, IX, XI
8	Increase personnel and expertise available for SGCN surveys and research through partnerships with other government agencies, universities, and conservation-minded NGO's	institutional & civil society development alliance & partnership development	med high	I, II, III, IV, V, VI, VII, VIII, IX, XI

*refers to the Man-made Lakes and Ponds Habitat Conservation Threats in Table 45

6.19 Natural Lakes

Ohio’s Natural Lakes >5 acres



6.19.1 Status

Generally good, although much like man-made lakes and ponds, assessment data is limited. Aquatic life use data available for natural lakes indicated a high degree of attainment.

6.19.2 Description

The following information was assembled from *Natural Lakes in Ohio* (Black 1991).

There are 110 natural lakes in Ohio larger than five acres, covering a total surface area of 4,658 acres. These lakes occur in 21 of Ohio's 88 counties. Summit County has the most natural lakes with 34, followed by Portage County with 16, and Geauga County with 9.

Many (probably most) of Ohio's natural lakes have been altered to some degree by human activities. Some lakes have been drained, others completely inundated by manmade reservoirs. Some lakes have been enlarged by the addition of levees or dikes. Some lakes have had outlet control structures installed or outlet streams enlarged, thereby controlling lake levels. The vast majority of Ohio's natural lakes formed in the aftermath of the most recent ice age. A few are post-glacial in origin, created from cutoff stream oxbows.

The 20 largest natural lakes in Ohio are:
1. Aurora Pond, Portage County 345 acres
2. Chippewa Lake, Medina County 324 acres
3. Turkeyfoot Lake, Summit County 318 acres
4. Wingfoot Lake, Portage County 262 acres
5. Congress Lake, Stark County 200 acres
6. Springfield Lake, Summit County 200 acres
7. Lake Hodgson, Portage County 190 acres
8. Lake Pippen, Portage County 143 acres
9. Meyers Lake, Stark County 134 acres
10. Bass Lake, Geauga County 128 acres
11. Odell Lake, Holmes County 107 acres
12. Punderson Lake, Geauga County 101 acres
13. Summit Lake, Summit County 100 acres
14. Nettle Lake, Williams County 94 acres
15. West Twin Lake, Portage County 91 acres
16. Silver Lake, Summit County 91 acres
17. Sandy Lake, Portage County 90 acres
18. Sippo Lake, Stark County 88 acres
19. Muzzy Lake, Portage County 82 acres
20. Lake Nesmith, Summit County 80 acres

6.19.3 Associated Species of Greatest Conservation Need
While natural lakes do not constitute a large portion of Ohio’s aquatic habitats, either numerically or from an acreage standpoint, they are home to some of Ohio’s rare species. State listed (endangered) western banded killifish, Iowa darters, and pirate perch for example, have been found in natural lakes – primarily in the northern part of the state.

The following species have been identified as Natural Lakes species of greatest conservation need (conservation status rank in parentheses):

<u>Amphibians</u>

Red-spotted Newt (20)	***Notophthalmus viridescens viridescens***

<u>Fish</u>

Blacknose Shiner (22)	*Notropis heterolepis*
Western Banded Killifish (30)	*Fundulus diaphanus menona*
Iowa Darter (38)	*Etheostoma exile*
Pirate Perch (51)	*Aphredoderus sayanus*

Table 47. CONSERVATION THREATS TO NATURAL LAKES.
The following threats negatively impact or have the potential to negatively impact Natural Lakes. Threat categories/classification from Salafsky et al. (2008), and threat impact rank calculations from Master et al. (2012).

ID	threats	2nd level threat classification(s)	threat impact rank
I	**residential and commercial development**		high
A	Watershed conversion to urban/commercial development alters hydrology	housing & urban areas commercial & industrial areas	very high low
B	Waterfront development and its effect on nearshore habitat and species	housing & urban areas tourism & recreation areas	very high low
C	Increasing land prices limit our ability to protect riparian corridors - which affects water quality and habitat in lakes	housing & urban areas commercial & industrial areas	very high low
II	**agriculture and aquaculture**		medium
A	Loss of riparian corridor to agriculture - which affects water quality and habitat	annual & perennial non-timber crops livestock farming & ranching	medium medium
B	Watershed conversion to agriculture alters hydrology	annual & perennial non-timber crops livestock farming & ranching	medium medium
III	**energy production and mining**		low
A	Oil and gas extraction - can have negative impacts by causing chemical contamination	oil & gas drilling	low
B	Water withdrawal for fracking alters hydrology	oil & gas drilling	low
IV	**transportation and service corridors**		low
A	Roads/bridges/causeways and utilities can destroy habitat, alter hydrology	roads & railroads utility & service lines	low low
V	**biological resource use**		low
A	Fishing pressure and fishing gear impacts	fishing & harvesting aquatic resources	negligible
VI	**human intrusions and disturbance**		low
A	Incompatible recreational activities	recreational activities	negligible
B	Creation of recreational facilities can alter/destroy nearshore habitat	recreational activities	negligible
C	Negative impacts of recreational watercraft on water quality and nearshore habitat	recreational activities	negligible
VII	**natural system modifications**		medium
A	Seasonal hypolimnetic hypoxia and anoxia can substantially reduce deepwater habitat available to aquatic species	other ecosystem modifications	high
B	Lack of data for some species and habitats limits our ability to develop plans for threats like climate change	other ecosystem modifications	high

C	Some species' polulations have been reduced to levels below what is necessary to recover on their own	other ecosystem modifications	Low
VIII	**invasive and other problematic species and genes**		high
A	Introduction and/or spread of invasive plants and animals	invasive non-native/alien species	high
B	Introduction and/or spread of nuisance plants and animals	problematic native species	low
C	Introduction and spread of diseases (plants and animals)	invasive non-native/alien species problematic native species	high low
IX	**pollution**		high
A	Urban effluent carries a variety of substances that impact water quality and aquatic species	household sewage & urban wastewater industrial & military effluents garbage & solid waste air-borne pollutants	high low low low
B	Agricultural effluent from row crops as well as confined animal operations impacts water quality and aquatic species	agricultural & forestry effluents	high
C	Pesticides/herbicides from waterfront property owners impact water quality	household sewage & urban wastewater	high
D	Harmful algal blooms affect water quality, aquatic species, and can be toxic to terrestrial species	agricultural & forestry effluents	high
X	**geological events**		negligible
---	none	---	---
XI	**climate change and severe weather**		high
A	Climate change could impact habitats, water quality, and species	habitat shifting & alteration droughts temperature extremes storms & flooding	very high low negligible negligible

Table 48. CONSERVATION ACTIONS FOR NATURAL LAKES.
The following actions will help abate or have the potential to help abate threats to Natural Lakes. Action categories/classification from Salafsky et al. (2008), and action priority rank calculations from Georgia DNR (2005).

ID	actions	2nd level action classification(s)	action priority rank	threat(s) addressed*
I	**LAND/WATER PROTECTION**		high	
1	Protect shoreline habitat and upstream riparian habitat through acquisition, partnerships, conservation easements, etc.	site/area protection resource &	high high	I, II, IV, VI-B

		habitat protection		
II	**LAND/WATER MANAGEMENT**		med	
1	Develop a process for coordinating disparate data sources of distribution and abundance of aquatic SGCN with special emphasis on conservation opportunity watersheds	habitat & natural process restoration	high	I-B, IV, VI-B, VII, XI
2	Review existing species and habitat data to identify data gaps and needs for additional surveys, research, and management actions	habitat & natural process restoration	high	I, II, III, IV, V, VI, VII, VIII, IX, XI
3	Conduct comprehensive surveys of freshwater mussels in all conservation opportunity watersheds	habitat & natural process restoration	high	I-B, III-B, IV, VII, XI
4	Annually collect lower trophic data to understand watershed impacts on fish communities, and how changes in land use may influence lake/reservoir productivity	habitat & natural process restoration	high	I-A, II-B, VII-A, IX
5	Create and use wetlands for stormwater treatment	habitat & natural process restoration	high	I-A, IX-A
6	Support and encourage efforts by the Ohio EPA and other agencies to assess the overall condition of Ohio's lakes	habitat & natural process restoration	high	I, II, III, IV, V, VI, VII, VIII, IX, XI
7	Establish an early-detection rapid-response system for dealing with invasive and nuisance species	invasive/ problematic species control	med	VIII
8	Develop compatible recreational activities criteria that can be used to evaluate impacts to habitat/species from recreational activities	site/area management	med	VI
III	**SPECIES MANAGEMENT**		med	
1	Assess population status, habitat suitability, and probability for restoration of fish, mussels, crayfish, invertabrates, and amphibians listed as SGCN	species reintroduction	High	VII-B, VII-C
2	Develop a restoration strategy for high priority fish, mussels, crayfish, invertebrates, and amphibians	species reintroduction	High	VII-B, VII-C
IV	**EDUCATION AND AWARENESS**		high	
1	Educate waterfront landowners and commercial pesticide/herbicide applicators on responsible chemical use, and the negative impacts to wildlife from toxic chemicals	training	high	I-B,C, IX-A,C
2	Provide training to road construction/maintenance personnel for runoff/sediment control	training	high	I-B, IV
3	Promote conservation easements along shoreline habitat and riparian habitat of inlet streams	training awareness & communic-ations	high med	I, II, IV, VI-B, VII, IX, XI
4	Educate boaters about the negative impacts power boats can have on aquatic habitats	training awareness & communic-ations	high med	VI-A,C
5	Educate the public about the negative effects of exotic and nuisance animals – encourage responsible disposal of unwanted animals	awareness & communic-ations	med	VIII

V	**LAW AND POLICY**		med	
1	Support legislation promoting eco-friendly energy development and use	legislation	med	III
2	Develop and implement a risk-assessment system in the approval process for importing or moving live animals and plants	legislation policies & regulations	med med	VIII
3	Find innovative ways to mandate the inclusion of fish and wildlife interests in development plans	policies & regulations private sector standards & codes	med low	I, III, IV, VI-B, IX-A, XI
4	Support the creation of additional and/or increased enforcement of stormwater regulations	policies & regulations compliance & enforcement	med low	I-A, IX-A
VI	**LIVELIHOOD, ECONOMIC AND OTHER INCENTIVES**		low	
1	Explore tying eligibility for grant money, loans, and cost-share programs to nutrient loading levels for agriculture – the lower the nutrient levels in their effluent, the more money they would be eligible for	market forces conservation payments	low low	IX-B, XI
2	Create incentives for vegetated buffers along all waterways to reduce nutrient loads and sediment	market forces conservation payments	low low	I, II, VII, IX, XI
3	Create incentives to promote eco-friendly energy development and use	market forces conservation payments non-monetary incentives	low low low	III
4	Support the creation of incentives to protect shoreline habitat	market forces conservation payments	low low	I, II, IV, VI, XI
5	Develop incentives for municipalities to use stormwater management systems that minimize negative impacts to aquatic habitats	market forces conservation payments	low low	I-A, IX-A
6	Support incentives for development plans involving water frontage that take into account wildlife and habitat needs	market forces conservation payments non-monetary values	low low low	I-B, IV, VI-B, IX-A,C

VII	EXTERNAL CAPACITY BUILDING		med	
1	Attend and actively collaborate with watershed partnerships	institutional & civil society development alliance & partnership development	med low	I, II, III, IV, VI-A,B, VII, IX, XI
2	Increase personnel and expertise available for SGCN surveys and research through partnerships with other government agencies, universities, and conservation-minded NGO's	institutional & civil society development alliance & partnership development	med low	I, II, III, IV, V, VI, VII, VIII, IX, XI
3	Work with ODA and OEPA to minimize nutrients in runoff, and develop BMPs for pesticide/herbicide use	alliance & partnership development	low	IX
4	Consider creating a multiagency invasive species prevention and control group that would handle all invasive species issues	alliance & partnership development	low	VIII
5	Through interagency coordination, work to assure that wildlife interests are taken into consideration in road, bridge, and causeway design, construction, and maintenance	alliance & partnership development	low	IV
6	Use inter-agency cooperation to influence watershed health	alliance & partnership development	low	I, II, VII, IX, XI

*refers to the Natural Lakes Habitat Conservation Threats in Table 47

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Appendix A. Scoring categories, attributes, and description for selection of ODNR candidate streams for protection and restoration.

Category	
Attribute:	Description
Physical Habitat:	
Scenic:	All streams with a State Scenic, Wild, and Recreational River Designation.
QHEI:	A list of streams with Qualitative Habitat Evaluation Index (QHEI) scores ranging from 100 to 90 was created from a database query of sampled (fish) streams in Ohio ECOS. This range of scores is generally indicative of Exceptional Warmwater Habitat.
Gorge:	All known streams with well defined bedrock gorges and adjacent outcrops were listed. This category was included to represent esthetic and scenic qualities.
Biological Integrity:	
IBI:	Streams with a high biotic Index of Biotic Integrity (IBI) were listed from a chart ranking based on the 75th percentile IBI scores (Ohio EPA data). The IBI is one of two fish indices used as biocriteria (state water quality standards) by Ohio EPA. The IBI consists of 12 metrics which assess fish assemblages based on species richness and composition, trophic composition, abundance, and health. It is used to measure the degree of environmental disturbance as compared to reference or least impacted sites.
MIwb:	Streams with Modified Index of well-being (MIwb) scores from 10.0 to 11.4 were listed based on a database query of Ohio ECOS. The MIwb is the other fish index used as biocriteria (state water quality standards) by Ohio EPA. The MIwb is a measure of the fish community based on calculation using relative number, biomass, and the Shannon Diversity Index (based on numbers and weight) from which highly tolerant and exotic fishes are removed from numbers and biomass calculations. It is also used to measure the degree of environmental disturbance.
ICI:	Streams with the highest Invertebrate Community Index (ICI) scores were listed based on an Ohio ECOS database query for scores greater than or equal to 56. The ICI is similar to the IBI, but evaluates aquatic insect assemblages. Scores included the top 1.2 percent of the database.
CSHQ:	Streams were selected from Ohio EPA's List of Candidates for Superior High Quality Waters with scores from 50 to 100.
DOW:	Streams were listed from the ODNR Division of Wildlife's Priority List For High Aquatic Diversity, Endangered Species, and Sport Fishing.
Biological Diversity:	
Fish:	Streams with the most diverse fish assemblages were listed from an Ohio ECOS database query of sites with a species richness greater than or equal to 35.
Macr:	Streams with the most diverse aquatic insect assemblages were listed from an Ohio ECOS database query of sites with a taxa richness greater than or equal to 90. Scores included the top 0.8 percent of the database.
Mbed:	Streams were with the best and most significant mussel beds were listed under this attribute through consultation with malocologist experts (Dr. G. Thomas Watters and Dr. Michael Hoggarth).
Emus:	The streams with the best populations of each endangered mussel species was listed through consultation with malocology experts (Dr. G. Thomas Watters and Dr. Michael Hoggarth).
Efish:	The streams with the best populations of each endangered fish species was listed through consultation with stream ichthyology experts (Randy Sanders and Dan Rice).
Eoth:	The streams with the best populations of stream related endangered bird, mammal, and herp species were listed (Dan Rice and Randy Sanders).

Recreational Opportunity:

Sfish: Streams with the highest relative number of sport fish species were listed based on an Ohio ECOS database query by species.

Boat: Ohio's most popular canoeing and boating streams were listed (Steve Goodwin, Dan Rice, and Randy Sanders).

Slake: Streams draining into ODNR State Park Lakes were listed.

Appendix B: Stream scores

Stream Name	***SCORE***	***Scenic***	***QHEI***	***Gorge***	***IBI***	***ICI***	***Miwb***	***CSHQ***	***DOWs***	***Fish***	***Macr***	***MBeds***	***Emus***	***Sfish***	***Boat***	***Slake***	***Efish***	***Eoth***	***Length***	***D.Area***
Maumee River (in OH)	**6**	**X**	**X**			**X**								**X**	**X**	**X**			**105.4**	**4856.2**
Tiffin River (in OH)	1				X														59.2	553.5
Mill Creek (to Bean Cr.)	1															X			15.5	32
St. Joseph River (in OH)	3								X			X	X						44.3	238
Fish Creek (in OH)	5				X	X		X					X	X					4.7	17.3
West Branch (in OH)	2								X				X						11	15.8
St. Marys River (in OH)	1																X		59.1	457.7
Auglaize River	4						X		X					X			X		101.9	2341.6
Blanchard River (upper)	3								X			X	X						91	762.4
Ottawa River	1		X																52.7	372.7
Portage River	**1**													**X**					**60.6**	**601.8**
M. Branch Portage	1																X		27.8	219.4
Sandusky River	**6**	**X**					**X**		**X**			**X**		**X**				**X**	**130.2**	**1420.7**
Sugar Creek	1		X																10.4	14.3
Huron River	**2**		**X**											**X**					**59.7**	**403.4**
W. Branch Huron River	1					X													46	261
Vermilion River	**3**		**X**		**X**			**X**											**58.7**	**271.7**
SW Branch Vermillion River	1										X								10.4	32.8
Buck Creek	1		X																8.3	22.3
E. Branch Black River	**1**		**X**																**56.7**	**215.9**
Rocky River	**2**							**X**						**X**					**48**	**293.8**
E. Branch Rocky River	2				X	X													34.5	80.4
W. Branch Rocky River	1				X														36.2	188.3
Wellington Creek	1															X			?	?
Cuyahoga River (upper)	**8**	**X**			**X**		**X**		**X**		**X**		**X**	**X**				**X**	**100.1**	**813.3**
Breakneck Creek	1													X					?	?
Tare Creek	1					X													8	12.2
Chagrin River	**4**	**X**			**X**									**X**				**X**	**47.9**	**267**
Aurora Branch	3	X			X	X													16.1	57.6
Smith Creek	1		X																?	?
East Branch	1	X																	19.4	50.8
Spring Brook	1																X		1	?
Woodie Brook	1																X		1	?
Silver Creek	2					X					X								6.2	13.4
Grand River	**11**	**X**	**X**		**X**		**X**		**X**	**X**	**X**	**X**		**X**			**X**	**X**	**102.7**	**712.1**
Mill Creek	2		X														X		13	20.2

Appendix B: Stream scores

Stream Name	***SCORE***	***Scenic***	***QHEI***	***Gorge***	***IBI***	***ICI***	***Miwb***	***CSHQ***	***DOWs***	***Fish***	***Macr***	***MBeds***	***Emus***	***Sfish***	***Boat***	***Slake***	***Efish***	***Eoth***	***Length***	***D.Area***
Big Creek	2		X														X		15.6	37
Cemetary Creek	2		X														X		?	?
Swine Creek	2					X											X		14.1	30.8
Baughman Creek	1																X		9.8	20.9
Trumbull Creek	1																X		12.2	20.6
Crooked Creek	1																X		5.2	18.5
Hoskins Creek	1																X		7.4	26.8
Indian Creek	1																X		5.2	6.3
Phelps Creek	1																X		13	29.6
Andrews Creek	1																X		5.3	8.7
Dead Branch	1																X		9	23.8
Conneaut Creek (in OH)	**3**		**X**								**X**			**X**					**22.3**	**37.7**
Ohio River (in OH)	**8**				**X**		**X**		**X**			**X**	**X**	**X**	**X**		**X**		**451**	**29547.9**
Beaver Creek (to Wabash R.)	1															X			13	55.9
Great Miami River	**10**		**X**		**X**	**X**	**X**	**X**	**X**	**X**				**X**		**X**	**X**		**170**	**3947.9**
McKee Cr. (to Stony Cr.)	1							X											10.2	17.8
Loramie Creek	1															X			36.5	268.5
Stillwater River	6	X	X		X		X	X					X						67.2	673.2
Greenville Creek (in OH)	5	X	X		X	X		X											34.1	166.8
Painter Creek	1					X													13.5	48
Lost Creek	2						X	X											17.4	59.3
Honey Creek	1							X											18.6	91.6
Mad River (lower)	5		X		X		X				X			X					60.2	656
Macochee Cr. (Logan Co)	3					X		X						X					8.2	18.8
Kings Creek	1													X					9	41.8
Buck Creek	2													X		X			15.5	141.1
Twin Creek	5		X		X		X	X			X								46.2	315
Little Twin Creek	1					X													7.8	22.6
Bantas Fork	4		X			X		X			X								16.8	35.4
Elk Creek	3		X				X	X											12.6	48
Fourmile Creek (in OH)	6		X		X		X	X						X		X			38.2	301.4
Mosquito Creek	1															X			11.5	27.6
Sevenmile Creek	3				X		X	X											32.5	138.4
Spring Creek	1																X		12.4	26.4
Indian Creek (in OH)	1						X												22.9	71.6
Whitewater River (in OH)	7		X			X	X	X	X	X				X					7.3	143

Appendix B: Stream scores

Stream Name	***SCORE***	***Scenic***	***QHEI***	***Gorge***	***IBI***	***ICI***	***Miwb***	***CSHQ***	***DOWs***	***Fish***	***Macr***	***MBeds***	***Emus***	***Sfish***	***Boat***	***Slake***	***Efish***	***Eoth***	***Length***	***D.Area***
Little Miami River (LMR)	**14**	**X**	**X**	**X**	**X**	**X**	**X**		**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**		**105.5**	**1755.3**
N. Fork LMR	1	X																	13.2	37.7
Yellow Springs Creek	2							X			X								2.5	11.5
Massies Creek	1										X								9.5	86.6
Caesar Creek	3		X					X								X			33.9	238.6
Anderson Fork	2						X									X			28.3	93.3
Cowan Ck (to Todd Fk)	1															X			22.4	54.9
Turtle Creek	2						X							X					12	65.5
O'Bannon Creek	1							X											12	58.5
E. Fork LMR	10		X		X	X	X	X	X	X	X			X		X			81.7	500.7
Stonelick Creek	3						X			X						X			22.9	77.6
Whiteoak Creek (inc. E. Fk.)	**3**						**X**				**X**			**X**					**49.3**	**234.3**
E. Fork Whiteoak Creek	3						X	X			X								22	80.8
Ohio Brush Creek	**8**		**X**		**X**		**X**	**X**	**X**	**X**	**X**		**X**						**57.1**	**435**
W. Fork Ohio Brush	3				X		X	X											21.5	134.4
M. Fork Baker Fork	1						X												7	20.6
Lick Creek	1															X			7.6	31.2
Turkey Creek	**1**															**X**			**13.4**	**48.1**
Scioto River	**11**		**X**		**X**	**X**	**X**	**X**	**X**	**X**	**X**			**X**			**X**	**X**	**230.8**	**6509.9**
Taylor Creek	2					X					X								7.8	32.1
Mill Creek	3		X		X									X					37.8	185.5
Olentangy River	8	X	X		X	X	X	X						X		X			88.5	536.3
Whetstone Creek	6		X		X		X	X			X					X			35	113.7
Big Walnut Creek	5				X		X	X		X									74.2	556.7
Alum Creek	3							X						X		X			55.8	200.7
Blacklick Creek	1		X																25.5	61.3
Rocky Fork	3		X					X									X		13	28.1
Walnut Creek (Little)	1						X												49.8	280.7
Big Darby Creek	13	X	X		X	X	X	X	X	X	X	X	X	X			X		78.7	556.6
Little Darby	10	X	X		X	X	X	X	X		X	X	X						69.1	176
Spring Fork	3		X				X	X											12	38.3
Pleasant Run	1							X											8	9.48
Spain Creek (L. Darby)	1							X											4.5	7.2
Hargus Creek	1															X			6.6	20.2
Yellowbud Creek	1									X									10.6	35.2
Scippo Creek	3				X		X	X											17.5	52.8

Appendix B: Stream scores

Stream Name	***SCORE***	***Scenic***	***QHEI***	***Gorge***	***IBI***	***ICI***	***Miwb***	***CSHQ***	***DOWs***	***Fish***	***Macr***	***MBeds***	***Emus***	***Sfish***	***Boat***	***Slake***	***Efish***	***Eoth***	***Length***	***D.Area***
Deer Creek	8					X	X	X	X	X	X			X		X			67.1	408.4
Paint Creek	11		X	X	X	X	X	X	X	X	X			X		X			94.7	1142.7
N. Fork Paint	3						X	X		X									46.6	236.2
Compton Creek	3					`	X	X		X									19.9	61
Rocky Fork	4		X	X	X											X			27.5	144.7
Clear Creek	3					X		X											11.9	46
Salt Creek	9			X	X	X	X	X	X	X	X		X						45.4	553.4
Laurel Run	1							X											12.9	55
M. Fork Laurel Run	1							X											6.2	11.4
Queer Creek	1							X											9	35
E. Fork Queer Ck	1							X											5.5	13.7
Beech Fork	1						X												?	?
Peepee Creek	1															X			14.5	79.4
Sunfish Creek	3		X		X		X												26.5	144.6
Scioto Brush Creek	6			X			X	X		X			X				X		36	273.5
Mill Creek	1							X											5	17.5
Rarden Creek	1							X											6.6	18.4
S. Fork Scioto Brush	1							X											18.2	112.6
Little Scioto River	**3**								**X**				**X**					**X**	**41.3**	**232.6**
Symmes Creek	**1**												**X**						**70**	**355.7**
Black Fork	1															X			17	62.8
Pine Creek	**2**									**X**			**X**						**48**	**184.7**
Raccoon Creek	**1**															**X**			**109**	**683.5**
Little Raccoon Ck	1															X			36.5	157.8
Forked Run	**1**															**X**			**8.4**	**9.1**
Hocking River	**4**				**X**	**X**	**X**							**X**					**94.9**	**1200**
Hunters Run	1					X													7.5	10.4
Clear Creek	1								X										23	91.3
Clear Fork (to Scotts Cr.)	1															X			7.4	15.9
Duck Creek	1															X			4.7	8.3
Sunday Creek	1															X			27.2	138.5
Stroud Run	1															X			4.5	7.3
Federal Creek	1							X											23.8	144.9
Pawpaw Cr. (E.Fk. Duck Cr.)	1						X												11.6	23.5
Muskingum River	**11**		**X**		**X**		**X**	**X**	**X**			**X**	**X**	**X**	**X**	**X**	**X**		**111.9**	**8037.6**
Tuscarawas River (lower)	5		X		X	X		X						X					129.9	2589.7

Appendix B: Stream scores

Stream Name	***SCORE***	***Scenic***	***QHEI***	***Gorge***	***IBI***	***ICI***	***Miwb***	***CSHQ***	***DOWs***	***Fish***	***Macr***	***MBeds***	***Emus***	***Sfish***	***Boat***	***Slake***	***Efish***	***Eoth***	***Length***	***D.Area***
Craborchard Creek	1					X													6.7	11.5
Sugar Creek	1		X																45	356.2
Nimishillen Cr. (Sandy)	1		X																24.5	186.8
Walhonding River	9		X		X	X	X	X	X	X		X	X						23.5	2252
Kokosing River	9	X	X		X		X	X	X		X						X	X	57.2	482
N. Branch Kokosing	2	X						X											18.3	96.7
Little Jelloway Creek	1							X											10.5	19.5
Schenck Creek	1							X											12.1	41.8
Killbuck Creek (lower)	4								X			X	X	X					81.7	612.9
Doughty Creek	2					X		X											20.1	60.2
Mohican Riv (inc. Clear Fk)	2					X									X				64.2	998.7
Lang Cr. (Jerome Fk.)	2					X		X											9.3	32.7
Redhaw Cr. (Muddy Fk)	1					X													3.5	11.8
Clear Fork	4		X	X										X		X			36.6	218.5
Black Fork	2													X		X			?	?
Black Fork (to Moxahala Cr.)	1		X																7.7	28.3
Wakatomika Creek	6		X		X		X	X	X	X									42.6	233.9
Winding Fork	1							X											8	21.3
Sugartree Fork (Salt Fk.)	3					X					X					X			13.4	62.8
Turkey Run	3		X			X		X											2.3	8.5
Brushy Fork (Salt Fk.)	1															X			7.5	38.2
West Branch Wolf Creek	1							X											45	144.2
Licking River (inc. N. Fk)	3				X									X		X			67.5	780.5
Reservoir Feeder	1															X			?	?
S. Fork Licking River	4				X		X				X			X					33.9	288
Raccoon Creek	1						X												27.5	103.8
N. Fork Licking River	2				X		X												38.4	239
Rocky Fork	1							X											20.2	79.6
Long Run	2						X	X											5.3	6.1
Lost Run	1							X											10.2	23.5
Manns Fork (to Salt Cr.)	1															X			7.5	19.9
Olive Green Creek	1							X											22	82.7
Wolf Run (W. Fk. Duck Cr.)	1															X			4	6.4
Little Muskingum River	**4**				**X**				**X**								**X**	**X**	**69.7**	**314.5**
Leith Run	2							X						X					8.4	10.2
Sunfish Creek	**4**						**X**	**X**	**X**					**X**					**31.4**	**113.8**

Appendix B: Stream scores

Stream Name	***SCORE***	***Scenic***	***QHEI***	***Gorge***	***IBI***	***ICI***	***Miwb***	***CSHQ***	***DOWs***	***Fish***	***Macr***	***MBeds***	***Emus***	***Sfish***	***Boat***	***Slake***	***Efish***	***Eoth***	***Length***	***D.Area***
Captina Creek (inc. S. Fk)	**5**				**X**		**X**	**X**	**X**	**X**									**38.6**	**180.8**
N. Fork Captina Creek	2						X	X											10.5	33
S. Fork Captina Creek	1							X											14	36.2
Bend Fork	1							X											13	27.1
Barkcamp Creek (McMah)	1															X			4.3	5
Yellow Creek	**1**				**X**														**34**	**240.1**
Elkhorn Creek	1							X											8.9	34.3
Shenango River (in OH)	**1**															**X**			**1**	**283.7**
Pymatuning Creek (in OH)	2												X	X					28.2	148.9
Mahoning River (in OH)	**3**						**X**							**X**		**X**			**97.1**	**1077.6**
Mosquito Creek	3						X							X		X			33.7	139.2
West Branch	1															X			29.2	108.6
Little Beaver Creek (in OH)	**7**	**X**				**X**	**X**	**X**	**X**							**X**		**X**	**49.5**	**407.8**
W. Fork L. Beaver	6	X	X		X		X		X							X			25.2	111.7
N. Fork L. Beaver (in OH)	3	X	X				X												14.1	107
M. Fork L. Beaver	4	X	X					X											36.2	147.4

Appendix C. SWAP Review Form – Region 3

Yes	**No**	**1st Element. Information on the distribution and abundance of species of wildlife, including low and declining populations as the State fish and wildlife agency deems appropriate, that are indicative of the diversity and health of the State's wildlife.**

A. The Strategy indicates sources of information (e.g., literature, data bases, agencies, individuals) on wildlife abundance and distribution consulted during the planning process.

Within the Introduction, the section on **Development of Ohio's SWAP** (pages 3-12) contains sources of information on wildlife abundance and distribution consulted during the planning and development process.

Within Chapter 1, the sections on **Ohio's Wildlife and Ecosystems** (pages 29-36), and **Ohio's Approach to Conservation** (pages 38-46) contain references to sources of abundance and distribution information.

In Chapter 2, the section on **Conservation Efforts 2006-2015** (pages 50-52) contains a list of projects that provided data on wildlife abundance and distribution.

In Chapter 3 the **Ohio's Monitoring Framework** section contains information on projects and databases used to get information on species abundance and distributions (pages 56-60).

Chapter 4 contains sources of information on wildlife abundance and distribution consulted during the planning and development process in the **Sources of Information** section (pages 65-66).

Chapter 5 contains sources of information consulted during the planning process in the **Regional Species and Habitats at Greatest Risk and Most Vulnerable to Climate Impacts** (pages 112-113) section.

Chapter 6 contains sources of information on wildlife abundance and distribution consulted during the planning and development process in the terrestrial habitats sections (**Forest** pages 136-137, **Wetland** pages 170-172, **Caves and Mines** page 221), and aquatic habitats sections (**Lake Erie** pages 234-236, **Lake Erie Tributaries** pages 244-260, **Ohio River** pages 298-310, **Ohio River Tributaries** pages 318-325, **Headwater and Small Inland Streams** pages 370-371 **Man-made Lakes and Ponds** pages 382-383) and **Conservation Opportunity Watersheds** section (pages 120-121), and **Lake Erie Tributaries Conservation Opportunity Watersheds** (pages 261-297) and **Ohio River Tributaries Conservation Opportunity Watersheds** (pages 328-368).

B. The Strategy includes information about both abundance and distribution for species in all major groups to the extent that data are available. There are plans for acquiring information about species for which adequate abundance and/or distribution information is unavailable.

In Chapter 1 in the section on **Ohio's Wildlife and Ecosystems**, Table 1 contains Ohio's listed species. Also, plans for acquiring information about species for which adequate abundance and/or distribution information is unavailable is contained in Chapter 1 in the sections on **Key Conservation Challenges** (pages 37-38), **Ohio's Approach to Conservation** (pages 38-41), and **Action Plan Evaluation and Updates** (pages 46-49).

Additional information is contained in Chapter 2 in the **Next 10 Years** section (pages 52-54).

Chapter 3 describes plans for acquiring information about species in the **Ohio's Monitoring Framework** section (pages 56-60).

To the extent data are available, Chapter 4 contains a table of state listed species (Table 3), as well as habitat association, rangewide occurrence, statewide occurrence, and population trend information for mammals (Table 4), birds (Table 5), reptiles (Table 6), amphibians (Table 7), fish (Table 8), mussels (Table 9), crayfish (Table 10), aquatic invertebrates (Table 11), and terrestrial invertebrates (Table 12).

Chapter 5 contains plans for acquiring information in the **Introduction** (page 112), **Regional Species and Habitats at Greatest Risk and Most Vulnerable to Climate Impacts** (pages 112-113), and **Adaptation Strategies and Actions in Response to Climate Change** (pages 114-116) sections.

Chapter 6 contains wildlife abundance and distribution information in the terrestrial habitats sections (**Forest** pages 136-143, **Grassland** pages 152-160, **Wetland** pages 169-179, **Lake Erie Islands** pages 189-191, **Oak Savannas** pages 199-201, **Boreal Community** pages 210-212, **Caves and Mines** pages 220-221), and aquatic habitats sections (**Lake Erie** pages 234-236, **Lake Erie Tributaries** pages 244-289, **Ohio River** pages 298-311, **Ohio River Tributaries** pages 318-360, **Headwater and Small Inland Streams** pages 369-373, **Man-made Lakes and Ponds** pages 381-383, **Natural Lakes** pages 390-391). Also, in Chapter 6 the **Conservation Action** tables in each of the habitat categories contain plans for acquiring information for species for which it is currently unavailable (Tables 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48).

C. The Strategy identifies low and declining populations to the extent data are available.

Chapter 1 in the section **Ohio's Wildlife and Ecosystems** contains a table of Ohio listed species (Table 1).

To the extent data are available, Chapter 4 contains a table of state listed species (Table 3), as well as species listing (state and federal) and Ohio population trend information for mammals (Table 4), birds (Table 5), reptiles (Table 6), amphibians (Table 7), fish (Table 8), mussels (Table 9), crayfish (Table 10), aquatic invertebrates (Table 11), and terrestrial invertebrates (Table 12).

Chapter 6 contains an **Associated SGCN** section for each habitat type (**Forest** page 137, **Grassland** page 154, **Wetland** page 172, **Lake Erie Islands** page 192, **Oak Savannas** page 202, **Boreal Community** page 213, **Caves and Mines** page 221), (**Lake Erie** page 236, **Lake Erie Tributaries** page 260, **Ohio River** page 311, **Ohio River Tributaries** page 326, **Headwater and Small Inland Streams** page 372, **Man-made Lakes and Ponds** page 383, **Natural Lakes** page 391), as well as a **State Listed Species** section for each Conservation Opportunity Watershed **(Lake Erie Tributaries Conservation Opportunity Watersheds** (pages 261-297) and **Ohio River Tributaries Conservation Opportunity Watersheds** (pages 328-368).

D. All major groups of wildlife have been considered or an explanation is provided as to why they were not (e.g., including reference to implemented marine fisheries management plans). The State may indicate whether these groups are to be included in a future Strategy revision.

With the exception of invasive species, all native and naturalized wildlife species in Ohio were considered for SGCN status.

Chapter 4 describes how Ohio's SGCN were chosen with an explanation of why some species were not and plans to include them in future revisions in the **Sources of Information** (pages 65-66), **SGCN List Development and Rationale** (pages 66-67), **Conservation Status Criteria** (pages 67-68), and **Ohio's Species of Greatest Conservation Need** (pages 69-70) sections. Additional information is contained in the text for each taxa group that proceeds their SGCN table - mammals (pages 70-72), birds (pages 75-77), reptiles (pages 81-82), amphibians (page 85), fish (pages 88-89), mussels (pages 93-95), crayfish (page 99), aquatic invertebrates (page 102), and terrestrial invertebrates (pages 107-108).

E. The Strategy describes the process used to select the species in greatest need of conservation. The quantity of information in the Strategy is determined by the State with input from its partners, based on what is available to the State.

The process used to select the species in greatest need of conservation is described in Chapter 4 in the **Sources of Information** (pages 65-66), **SGCN List Development and Rationale** (pages 66-67), **Conservation Status Criteria** (pages 67-68), and **Ohio's Species of Greatest Conservation Need** (pages 69-70) sections.

Yes **No** **2nd Element. Descriptions of locations and relative condition of key habitats and community types essential to conservation of species identified in the 1st element.**

A. The Strategy provides a reasonable explanation for the level of detail provided; if insufficient, the Strategy identifies the types of future actions that will be taken to obtain the information.

The basis for the Action Plan's statewide habitat maps is the 2011 National Landcover Database. This classification system most closely aligned itself with the Action Plan's needs, particularly on a terrestrial level.

A general description of the Ohio in terms of habitats is provided in Chapter 1 in the **Ohio's Climate and Land** section (pages 16-28), the **Ohio's Wildlife and Ecosystems** section (pages 32-34), and the **Ohio's Approach to Conservation** section (pages 40-43).

Chapter 3 contains a discussion of habitat monitoring in the **Ohio's Monitoring Framework** section (pages 56-60).

Chapter 6 contains an explanation of the level of detail used in habitat mapping (pages 117-123). Locations and conditions of key habitats are described throughout Chapter 6. The habitat categories in Ohio's Action Plan are depicted on two statewide maps – one for terrestrial habitats (Figure 9) and one for aquatic habitats (Figure 10). These maps represent the best GIS data available, but due to the statewide scale and necessary resolution, these maps are intended only to give the reader a general location and size sense of each habitat category. Better detail is available on the individual habitat maps included at the beginning of each habitat chapter (**Forest** page 136, **Grassland** page 152, **Wetland** page 169, **Lake Erie Islands** page 189, **Oak Savannas** page 199, **Boreal Community** page 210, **Caves and Mines** page 220), **Artificial/man-made Environments** page 227, **Lake Erie** page 234, **Lake Erie Tributaries** page 244, **Ohio River** page 298, **Ohio River Tributaries** page 318, **Headwater and Small Inland Streams** page 369, **Man-made Lakes and Ponds** page 381, **Natural Lakes** page 390). Also, in Chapter 6 the **Conservation Action** tables in each of the habitat categories contain plans for acquiring information for habitats for which information is currently unavailable (Tables 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48).

B. Key habitats and their relative conditions are described in enough detail such that the State can determine where (i.e., in which regions, watersheds, or landscapes within the State) and what conservation actions need to take place.

While this Action Plan uses 15 categories to describe Ohio's habitats, the Ohio Natural Heritage Database classification system identifies 45 community types contained within 12 categories. GIS coverage however, is incomplete for this level of habitat category resolution. Available data varies by property ownership, and a number of other issues make the Natural Heritage database untenable as a habitat classification system at this time.

The categories chosen for this Action Plan are map-able on a statewide basis, and state habitat management plans are aligned with the terrestrial and aquatic categories used in this Plan. The habitat categories chosen presently offer the most utility in determining conservation threats and focusing conservation actions – as well as monitoring habitat size and condition.

In Chapter 1 the **Ohio's Approach to Conservation** section contains information about key habitats (pages 41-43).

Chapter 4 contains the SGCN tables which contain key habitat association information for mammals (Table 4), birds (Table 5), reptiles (Table 6), amphibians (Table 7), fish (Table 8), mussels (Table 9), crayfish (Table 10), aquatic invertebrates (Table 11), and terrestrial invertebrates (Table 12).

Detailed information regarding the condition of each habitat (and community types within habitat categories, when appropriate) is contained in the individual habitat sections in Chapter 6: **Forest** page 136, **Grassland** page 152, **Wetland** page 169, **Lake Erie Islands** page 189, **Oak Savannas** page 199, **Boreal Community** page 210, **Caves and Mines** page 220), **Artificial/man-made Environments** page 227, **Lake Erie** page 234, **Lake Erie Tributaries** page 244, **Ohio River** page 298, **Ohio River Tributaries** page 318, **Headwater and Small Inland Streams** page 369, **Man-made Lakes and Ponds** page 381, **Natural Lakes** page 390. Additional information is contained in the Conservation Opportunity Areas **(Forest** pages 140-143**, Grassland** pages 156-160**, Wetland** pages 174-179**, Lake Erie Islands** page 189-191**, Oak Savanna** page 199-201**, Boreal Community** page 210-212)**,** and Conservation Opportunity Watersheds (**Lake Erie Tributaries Conservation Opportunity Watersheds** pages 261-297, and **Ohio River Tributaries Conservation Opportunity Watersheds** pages 328-368).

Yes No 3rd Element. Descriptions of problems which may adversely affect species identified in the 1st element or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats.

A. The Strategy indicates sources of information (e.g., literature, databases, agencies, or individuals) used to determine the problems or threats.

As suggested in the AFWA Best Practices guidance document, we followed the Conservation Threat Classification system described in Salafsky et al. (2008), *A Standard Lexicon for Biodiversity Conservation: Unified Classifications of Threats and Actions* to describe the general components of conservation projects, and to categorize threats. Our goal here was to facilitate the identification of shared regional threats (across states) which would ultimately lead to more effective and efficient conservation actions. Use of this classification system provides a better way of comparing information across projects within Ohio, as well as within the three ecoregions (LCCs) that Ohio is part of.

Definitions of key conservation terms used throughout are those described in Salafsky et al. (2008). The unified direct-threats classification system described in Table 1 (in Salafsky et al. 2008) was used to identify and describe threats to species and their habitats.

Chapter 1 the **Ohio's Wildlife and Ecosystems** section contains sources of information used to determine problems/threats (pages 32-34) as well as the **Ohio's Approach to Conservation** section (pages 41-43).

In Chapter 2 the **Conservation Efforts 2006-2015** section contains projects conducted under the original CWCS, many of which helped us determine some of the threats contained in this SWAP (pages 50-52).

In Chapter 3, the **Species Monitoring** section (pages 58-59) contains sources of information.

Chapter 4 contains sources of information used in developing SGCN lists, but which also contained information that helped in determining problems/threats in the **Sources of Information** section (pages 65-66). In addition the scoring system used to determine SGCN and conservation status contained criteria that was useful in illuminating problems/threats – it is described in the **Conservation Status Criteria** section (pages 67-68).

Chapter 5 contains sources of information about the problems and threats related to climate change (pages 112-116).

Threat sources of information details are contained in Chapter 6 Ohio's Habitats in the section **Conservation Threats/Actions Related to Habitat Categories** (pages 124-133), and in the **Habitat Categories Template** section (pages 134-135). Direct threats impact by habitat category and overall threat impact for all terrestrial habitats combined are described in Table 15. Direct threats impact by habitat category and overall threat impact for all aquatic habitats combined are described in Table 17. Additional sources of information used to determine threats are contained in each individual habitat section: **Forest** page 136, **Grassland** page 152, **Wetland** page 169, **Lake Erie Islands** page 189, **Oak Savannas** page 199, **Boreal Community** page 210, **Caves and Mines** page 220), **Artificial/man-made Environments** page 227, **Lake Erie** page 234, **Lake Erie Tributaries** page 244, **Ohio River** page 298, **Ohio River Tributaries** page 318, **Headwater and Small Inland Streams** page 369, **Man-made Lakes and Ponds** page 381, **Natural Lakes** page 390.

B. The threats/problems are described in sufficient detail to develop focused conservation actions (for example, “increased highway mortalities” or “acid mine drainage” rather than generic descriptions such as “development”, or “poor water quality”).

Chapter 5 describes threats/problems related to climate change in the **Regional Species and Habitats at Greatest Risk and Most Vulnerable to Climate Impacts** (pages 112-113), **Impacts of and Biological Responses to Climate Change** (pages 113-114), and **Adaptation Strategies and Actions in Response to Climate Change** (pages 114-116) sections.

Tables containing habitat-specific threats are included in each habitat section in Chapter 6. These habitat-specific threats are of sufficient detail to allow development of conservation actions. In addition, the habitat-specific conservation actions tables contained within each habitat section specifically reference the threat(s) that each action addresses. In Chapter 6 habitat-specific threats are contained in each individual habitat section: **Forest** (Table 19), **Grassland** (Table 21), **Wetland** (Table 23), **Lake Erie Islands** (Table 25), **Oak Savanna** (Table 27), **Boreal** (Table 29), **Caves & Mines** (Table 31), **Artificial/man-made Environments** (Table 33), **Lake Erie** (Table 35), **Lake Erie Tributaries** (Table 37), **Ohio River** (Table 39), **Ohio River Tributaries** (Table 41), **Headwater and Small Inland Streams** (Table 43), **Man-made Lakes and Ponds** (Table 45), and **Natural Lakes** (Table 47).

C. The Strategy considers threats/problems, regardless of their origins (local, State, regional, national and international), where relevant to the State’s species and habitats.

While most are local, all threats were considered regardless of origin. The threats analysis process conducted by species and habitat experts was designed to identify all habitat-specific threats regardless of threat origins – local, state, regional, national, or international.

Chapter 1 contains a discussion of threats (irrespective of source) in the **Statewide Threats** section (pages 34-36).

Chapter 2 contains information on addressing regional conservation issues in the section **The Next 10 Years** (pages 52-54).

Chapter 5 discusses state, regional, national, and global threats to species and habitats related to climate change (pages 112-116).

Individual habitat category sections in Chapter 6 contain tables of specific threats relevant to species and habitats: **Forest** (Table 19), **Grassland** (Table 21), **Wetland** (Table 23), **Lake Erie Islands** (Table 25), **Oak Savanna** (Table 27), **Boreal** (Table 29), **Caves & Mines** (Table 31), **Artificial/man-made Environments** (Table 33), **Lake Erie** (Table 35), **Lake Erie Tributaries** (Table 37), **Ohio River** (Table 39), **Ohio River Tributaries** (Table 41), **Headwater and Small Inland Streams** (Table 43), **Man-made Lakes and Ponds** (Table 45), and **Natural Lakes** (Table 47).

D. If available information is insufficient to describe threats/problems, research and survey efforts are identified to obtain needed information.

In Chapter 1 the **Key Conservation Challenges** section research and survey efforts needed (pages 37-38) and the **Ohio's Approach to Conservation** section identifies research and survey needs (page 40).

In Chapter 2 the The Next 10 Years section discusses future research and survey needs (pages 52-54).

Chapter 5 describes research and survey needs related to climate change in the **Regional Species and Habitats at Greatest Risk and Most Vulnerable to Climate Impacts** (pages 112-113), **Impacts of and Biological Responses to Climate Change** (pages 113-114), and **Adaptation Strategies and Actions in Response to Climate Change** (pages 114-116) sections.

Lack of sufficient information to manage species and/or habitats was considered a threat (where it applied) in this exercise. Research and surveys are some of the actions described in habitat-specific tables in cases where data was insufficient to guide the development of effective conservation actions. That information is contained in Chapter 6 in Conservation Action tables in each habitat section: **Forest** (Table 20), **Grassland** (Table 22), **Wetland** (Table 24), **Lake Erie Islands** (Table 26), **Oak Savanna** (Table 28), **Boreal** (Table 30), **Caves & Mines** (Table 32), **Artificial/man-made Environments** (Table 34), **Lake Erie** (Table 36), **Lake Erie Tributaries** (Table 38), **Ohio River** (Table 40), **Ohio River Tributaries** (Table 42), **Headwater and Small Inland Streams** (Table 44), **Man-made Lakes and Ponds** (Table 46), and **Natural Lakes** (Table 48).

E. The priority research and survey needs, and resulting products, are described sufficiently to allow for the development of research and survey projects after the Strategy is approved.

All conservation actions related to research and survey needs are described with the intent of being developed into projects at some point in time. Priority ranks calculated for conservation actions (included in the habitat-specific conservation action tables within each habitat chapter) are intended to highlight the most pressing needs.

In Chapter 1, the importance of, and need for research and surveys is discussed in the **Key Conservation Challenges** (pages 37-38) and **Ohio's Approach to Conservation** (page 40) sections.

Chapter 2 contains a discussion of future research and survey needs in the section **The Next 10 Years** (page 52-54).

Chapter 3 discusses research and survey needs in the **Ohio's Monitoring Framework** section (pages 56-60).

Chapter 5 describes research and survey needs related to climate change that will allow for development of projects in the **Regional Species and Habitats at Greatest Risk and Most Vulnerable to Climate Impacts** (pages 112-113), **Impacts of and Biological Responses to Climate Change** (pages 113-114), and **Adaptation Strategies and Actions in Response to Climate Change** (pages 114-116) sections.

Throughout the Action Plan - SGCN taxa group descriptions (Chapter 4), conservation opportunity area descriptions (**Forest** pages 140-143**, Grassland** pages 156-160**, Wetland** pages 174-179**, Lake Erie Islands** pages 189-191**, Oak Savanna** pages 199-201**, Boreal Community** page 210-212), conservation opportunity watershed descriptions (**Lake Erie Tributaries Conservation Opportunity Watersheds** pages 261-297, and **Ohio River Tributaries Conservation Opportunity Watersheds** pages 328-368), habitat category sections (**Forest** page 136, **Grassland** page 152, **Wetland** page 169, **Lake Erie Islands** page 189, **Oak Savannas** page 199, **Boreal Community** page 210, **Caves and Mines** page 220), **Artificial/man-made Environments** page 227, **Lake Erie** page 234, **Lake Erie Tributaries** page 244, **Ohio River** page 298, **Ohio River Tributaries** page 318, **Headwater and Small Inland Streams** page 369, **Man-made Lakes and Ponds** page 381, **Natural Lakes** page 390), and conservation threats/actions tables (Tables 19-48) – research and survey needs are identified. Threats related to our lack of species/habitat data (see Threat tables) are directly linked to conservation actions (see Action tables in the "Threat(s) Addressed" field) which will in turn generate projects/activities during the life of this Action Plan.

Yes **No** **4th Element. Descriptions of conservation actions determined to be necessary to conserve the identified species and habitats and priorities for implementing such actions.**

As suggested in the AFWA Best Practices document, to increase consistency among SWAP's we followed the Conservation Action Classification system described in Salafsky et al. (2008) *A Standard Lexicon for Biodiversity Conservation: Unified Classifications of Threats and Actions* to describe the general components of conservation projects, and to categorize conservation actions. Our goal here was to facilitate the regional sharing of conservation actions (successful and unsuccessful) which would ultimately lead to more effective and efficient decisions by resource managers. Use of this classification system provides a better way of comparing information across projects within Ohio, as well as within the three ecoregions (LCCs) that Ohio is part of.

Definitions of key conservation terms used throughout are those described in Salafsky et al. (2008). The unified conservation actions classification system described in Table 2 (in Salafsky et al. 2008) was used to identify and prioritize actions to abate threats to species and their habitats. Efforts were made to write conservation actions broadly enough to allow flexibility, yet with enough specificity to develop projects, measure performance, and engage partners.

A. The Strategy identifies how conservation actions address identified threats to species of greatest conservation need and their habitats.

Using Salafsky et al. (2008), direct threats are divided into 11 first level categories and 40 second level categories for each habitat category. Tables containing habitat-specific threats are included in each habitat section. These habitat-specific threats are of sufficient detail to allow development of conservation actions. Following the threats table in each habitat section is a table containing habitat-specific conservation actions. Each of these tables specifically references the threat(s) that each action addresses (see Action tables "Threat(s) Addressed" field).

In Chapter 6, habitat-specific conservation actions are contained in each individual habitat section: **Forest** (Table 20), **Grassland** (Table 22), **Wetland** (Table 24), **Lake Erie Islands** (Table 26), **Oak Savanna** (Table 28), **Boreal** (Table 30), **Caves & Mines** (Table 32), **Artificial/man-made Environments** (Table 34), **Lake Erie** (Table 36), **Lake Erie Tributaries** (Table 38), **Ohio River** (Table 40), **Ohio River Tributaries** (Table 42), **Headwater and Small Inland Streams** (Table 44), **Man-made Lakes and Ponds** (Table 46), and **Natural Lakes** (Table 48).

B. The Strategy describes conservation actions sufficiently to guide implementation of those actions through the development and execution of specific projects and programs.

Chapter 1 the **Ohio's Wildlife and Ecosystems** discusses conservation actions for habitats (pages 32-34), and the **Key Conservation Challenges** section (pages 37-38) and **Ohio's Approach to Conservation** section (pages 38-41) also discuss conservation actions.

Chapter 2 the **The Next 10 Years** section describes conservation actions for partnership building, filling data gaps, and addressing regional conservation issues (pages 52-54).

Chapter 5 contains a discussion of conservation actions related to climate change in the **Adaptation Strategies and Actions in Response to Climate Change** section (pages 114-116).

In Chapter 6, habitat-specific conservation actions are of sufficient detail to guide implementation. Habitat-specific actions are contained in each individual habitat section: **Forest** (Table 20), **Grassland** (Table 22), **Wetland** (Table 24), **Lake Erie Islands** (Table 26), **Oak Savanna** (Table 28), **Boreal** (Table 30), **Caves & Mines** (Table 32), **Artificial/man-made Environments** (Table 34), **Lake Erie** (Table 36), **Lake Erie Tributaries** (Table 38), **Ohio River** (Table 40), **Ohio River Tributaries** (Table 42), **Headwater and Small Inland Streams** (Table 44), **Man-made Lakes and Ponds** (Table 46), and **Natural Lakes** (Table 48).

C. The Strategy links conservation actions to objectives and indicators that will facilitate monitoring and performance measurement of those conservation actions (outlined in Element #5).

Chapter 1 the **Ohio's Wildlife and Ecosystems** section contains listed species and key habitats whose status going forward will serve as performance indicators (pages 30-34). Also in the **Ohio's Approach to Conservation** contains a discussion of objectives (pages 39-41).

Chapter 3 contains a discussion of indicators, monitoring, and performance measurement in the **Introduction** (page 55), **Ohio's Monitoring Framework** (pages 56-60), and **Effectiveness of Conservation Actions** (page 60-61) sections.

Chapter 4 contains tables describing habitat association, rangewide occurrence, statewide occurrence, and population trend information for mammals (Table 4), birds (Table 5), reptiles (Table 6), amphibians (Table 7), fish (Table 8), mussels (Table 9), crayfish (Table 10), aquatic invertebrates (Table 11), and terrestrial invertebrates (Table 12). These can be used as indicators and performance measures for conservation actions directed at SGCN.

Chapter 5 contains objectives, strategies, and approaches related to climate change that can serve as indicators and performance measures in the **Adaptation Strategies and Actions in Response to Climate Change** section (pages 114-116).

Conservation actions in each habitat category section are linked to individual conservation threats. Changes in the severity of threats (reduction or elimination) will provide a performance measurement for conservation actions. In Chapter 6, specifics are outlined in each terrestrial habitat category section (**Forest** page 136, **Grassland** page 152, **Wetland** page 169, **Lake Erie Islands** page 189, **Oak Savannas** page 199, **Boreal Community** page 210, **Caves and Mines** page 220), **Artificial/man-made Environments** page 227), conservation opportunity areas (**Forest** pages 140-143**, Grassland** pages 156-160**, Wetland** pages 174-179**, Lake Erie Islands** pages 189-191**, Oak Savanna** pages 199-201**, Boreal Community** page 210-212), aquatic habitat category section (**Lake Erie** page 234, **Lake Erie Tributaries** page 244, **Ohio River** page 298, **Ohio River Tributaries** page 318, **Headwater and Small Inland Streams** page 369, **Man-made Lakes and Ponds** page 381, **Natural Lakes** page 390), and conservation opportunity watersheds (**Lake Erie Tributaries Conservation Opportunity Watersheds** pages 261-297, and **Ohio River Tributaries Conservation Opportunity Watersheds** pages 328-368) that link to objectives and indicators that will facilitate monitoring and performance measurement of those conservation actions. The **Conservation Opportunity Watershed Objectives** section (page 124) contains objectives common to all CO Watersheds.

D. The Strategy describes conservation actions (where relevant to the State's species and habitats) that could be addressed by Federal agency or regional, national or international partners and shared with other States.

Implementation of the conservation actions in Ohio's Action Plan will require the communication, cooperation, and coordination of all conservation partners to be successful. The conservation actions necessary to address the many threats identified in the Action Plan in most cases will require participation by federal, state, and local government agencies, as well as our non-government conservation partners. Actions were developed with only one goal – to effectively abate conservation threats. The agencies/partners necessary for successful implementation of the actions was not a part of the decision-making process regarding whether to include certain actions or not. Participation by conservation partners will be driven by authority, expertise, and resources available to address the action in question. Partners are identified in many of the conservation actions in the tables within each habitat section.

The Introduction discusses participation/coordination with federal, international, and national partners in the Coordination with Federal, State, and Local Agencies section (pages 9-12).

Chapter 1 the Key Conservation Challenges section discusses communication, cooperation, and coordination with partners (pages 37-38)

Chapter 2 addresses participation at the state, regional, national, and international levels in the section **The Next 10 Years** (pages 52-54).

Chapter 3 discusses partnerships related to monitoring and adaptive management in the **Ohio's Monitoring Framework** section (pages 56-57).

Chapter 5 describes actions related to climate change that will necessitate involvement by federal, regional, national, and international partners in the **Regional Species and Habitats at Greatest Risk and Most Vulnerable to Climate Impacts** (pages 112-113), **Impacts of and Biological Responses to Climate Change** (pages 113-114), and **Adaptation Strategies and Actions in Response to Climate Change** (pages 114-116) sections.

In Chapter 6, habitat-specific actions identified to abate threats are contained in each individual habitat section: **Forest** (Table 20), **Grassland** (Table 22), **Wetland** (Table 24), **Lake Erie Islands** (Table 26), **Oak Savanna** (Table 28), **Boreal** (Table 30), **Caves & Mines** (Table 32), **Artificial/man-made Environments** (Table 34), **Lake Erie** (Table 36), **Lake Erie Tributaries** (Table 38), **Ohio River** (Table 40), **Ohio River Tributaries** (Table 42), **Headwater and Small Inland Streams** (Table 44), **Man-made Lakes and Ponds** (Table 46), and **Natural Lakes** (Table 48). Many of these actions will require assistance by other agencies, including state, federal, and international.

E. If available information is insufficient to describe needed conservation actions, the Strategy identifies research or survey needs for obtaining information to develop specific conservation actions.

In Chapter 1, the importance of, and need for research and surveys is discussed in the **Key Conservation Challenges** (pages 37-38) and **Ohio's Approach to Conservation** (pages 38-41) sections.

Chapter 2 contains a discussion of future research and survey needs in the section **The Next 10 Years** (pages 52-54).

Chapter 3 discusses research and survey needs in the **Ohio's Monitoring Framework** section (pages 56-60)

Chapter 4 contains tables describing habitat association, rangewide occurrence, statewide occurrence, and population trend information for mammals (Table 4), birds (Table 5), reptiles (Table 6), amphibians (Table 7), fish (Table 8), mussels (Table 9), crayfish (Table 10), aquatic invertebrates (Table 11), and terrestrial invertebrates (Table 12). The information or lack thereof in these categories can be used to identify research and survey needs.

Chapter 5 contains a discussion of future research and survey needs related to climate change in the section **Adaptation Strategies and Actions in Response to Climate Change** (pages 114-116).

Lack of sufficient information to manage species and/or habitats was considered a threat (where it applied) in this exercise. Research and surveys are some of the actions described in habitat-specific tables in cases where data was insufficient to guide the development of effective conservation actions. That information is contained in Chapter 6 in Conservation Action tables in each habitat section: **Forest** (Table 20), **Grassland** (Table 22), **Wetland** (Table 24), **Lake Erie Islands** (Table 26), **Oak Savanna** (Table 28), **Boreal** (Table 30), **Caves & Mines** (Table 32), **Artificial/man-made Environments** (Table 34), **Lake Erie** (Table 36), **Lake Erie Tributaries** (Table 38), **Ohio River** (Table 40), **Ohio River Tributaries** (Table 42), **Headwater and Small Inland Streams** (Table 44), **Man-made Lakes and Ponds** (Table 46), and **Natural Lakes** (Table 48).

Throughout the Action Plan - SGCN taxa group descriptions (Chapter 4), conservation opportunity area descriptions (**Forest** pages 140-143**, Grassland** pages 156-160**, Wetland** pages 174-179**, Lake Erie Islands** pages 189-191**, Oak Savanna** pages 199-201**, Boreal Community** page 210-212), conservation opportunity watershed descriptions (**Lake Erie Tributaries Conservation Opportunity Watersheds** pages 261-297, and **Ohio River Tributaries Conservation Opportunity Watersheds** pages 328-368), habitat category sections (**Forest** page 136, **Grassland** page 152, **Wetland** page 169, **Lake Erie Islands** page 189, **Oak Savannas** page 199, **Boreal Community** page 210, **Caves and Mines** page 220), **Artificial/man-made Environments** page 227, **Lake Erie** page 234, **Lake Erie Tributaries** page 244, **Ohio River** page 298, **Ohio River Tributaries** page 318, **Headwater and Small Inland Streams** page 369, **Man-made Lakes and Ponds** page 381, **Natural Lakes** page 390), and conservation threats/actions tables (Tables 19-48) – research and survey needs are identified. Threats related to our lack of species/habitat data (see Threat tables) are directly linked to conservation actions (see Action tables in the "Threat(s) Addressed" field) which will in turn generate projects/activities during the life of this Action Plan.

F. The Strategy identifies the relative priority of conservation actions.

Chapter 2 contains a discussion of priority conservation actions in the section **The Next 10 Years** (pages 52-54).

Chapter 5 identifies high priority actions related to climate change in the section **Adaptation Strategies and Actions in Response to Climate Change** (pages 114-116).

Conservation action priority ranks (Tables 16 and 18) were determined using the seven ranking criteria developed by the Georgia Department of Natural Resources – Wildlife Resources Division (Georgia DNR 2005) where rating reflects the relative contribution or significance of a conservation action for each criterion. Internal species/habitat experts assessed the contribution of each conservation action for each of these criteria and assigned scores. The resulting point totals were used to sort the conservation actions into categories by priority. Chapter 6 has a detailed description of prioritization of conservation actions in the **Habitat Categories Template** section (pages 134-135).

In Chapter 6 priority ranks are included in the habitat-specific conservation action tables within each habitat section. The priority ranks provide a useful initial analysis of the actions and a good starting point, but could be modified in the future as additional data and information becomes available. Habitat-specific actions and their associated priority ranks are contained in each individual habitat section: **Forest** (Table 20), **Grassland** (Table 22), **Wetland** (Table 24), **Lake Erie Islands** (Table 26), **Oak Savanna** (Table 28), **Boreal** (Table 30), **Caves & Mines** (Table 32), **Artificial/man-made Environments** (Table 34), **Lake Erie** (Table 36), **Lake Erie Tributaries** (Table 38), **Ohio River** (Table 40), **Ohio River Tributaries** (Table 42), **Headwater and Small Inland Streams** (Table 44), **Man-made Lakes and Ponds** (Table 46), and **Natural Lakes** (Table 48).

☐Yes ☐No 5th Element. Descriptions of the proposed plans for monitoring species identified in the 1st element and their habitats, for monitoring the effectiveness of the conservation actions proposed in the 4th element, and for adapting these conservation actions to respond appropriately to new information or changing conditions

A. The Strategy describes plans for monitoring species identified in element 1, and their habitats.

In Chapter 1 the **Action Plan Evaluation and Updates** section discusses monitoring (pages 46-49).

Chapter 3 contains a discussion monitoring in the **Introduction** (page 55), **Ohio's Monitoring Framework** (pages 56-60), and **Effectiveness of Conservation Actions** (page 60-61) sections

In Chapter 6 monitoring plans are contained in the Conservation Opportunity Area sections (**Forest** pages 140-143**, Grassland** pages 156-160**, Wetland** pages 174-179**, Lake Erie Islands** pages 189-191**, Oak Savanna** pages 199-201**, Boreal Community** page 210-212, **Caves and Mines** pages 220-221). Monitoring is also discussed in the **Conservation Opportunity Watershed Objectives** section (page 124).

In Chapter 6 conservation actions (some of which are species monitoring, and some of which will lead to the development of monitoring projects) are contained in each individual habitat section: **Forest** (Table 20), **Grassland** (Table 22), **Wetland** (Table 24), **Lake Erie Islands** (Table 26), **Oak Savanna** (Table 28), **Boreal** (Table 30), **Caves & Mines** (Table 32), **Artificial/man-made Environments** (Table 34), **Lake Erie** (Table 36), **Lake Erie Tributaries** (Table 38), **Ohio River** (Table 40), **Ohio River Tributaries** (Table 42), **Headwater and Small Inland Streams** (Table 44), **Man-made Lakes and Ponds** (Table 46), and **Natural Lakes** (Table 48).

B. The Strategy describes how the outcomes of the conservation actions will be monitored.

In Chapter 1 the **Action Plan Evaluation and Updates** section discusses monitoring (pages 46-49).

Chapter 3 describes monitoring the outcome of conservation actions in the **Introduction** (page 55), **Ohio's Monitoring Framework** (pages 56-60), and **Effectiveness of Conservation Actions** (page 60-61) sections

Chapter 4 contains tables describing habitat association, rangewide occurrence, statewide occurrence, and population trend information for mammals (Table 4), birds (Table 5), reptiles (Table 6), amphibians (Table 7), fish (Table 8), mussels (Table 9), crayfish (Table 10), aquatic invertebrates (Table 11), and terrestrial invertebrates (Table 12). These can be used as indicators and performance measures for monitoring the outcome of conservation actions.

Chapter 5 contains objectives, strategies, and approaches related to climate change that can serve as indicators and performance measures for conservation actions in the **Adaptation Strategies and Actions in Response to Climate Change** section (pages 114-116).

C. If monitoring is not identified for a species or species group, the Strategy explains why it is not appropriate, necessary or possible.

In Chapter 1 the **Key Conservation Challenges** section describes research and survey needed because not enough information exists to implement conservation actions (pages 37-38). Also the **Ohio's Approach to Conservation** section identifies research and survey needs (page 40).

Chapter 2 contains a discussion information needs (which prevent actions & monitoring) in the section **The Next 10 Years** (pages 52-54).

Chapter 3 discusses monitoring limitations in the **Addressing Data Gaps** (page 60) section.

Chapter 4 contains a discussion of conservation efforts relative to what is appropriate, necessary, or impossible in the **Ohio's Species of Greatest Conservation Need** section (pages 69-70). In addition, information about why conservation efforts will not be directed at some species is contained in the the text for each taxa group that proceeds their SGCN table - mammals (pages 70-72), birds (pages 75-77), reptiles (pages 81-82), amphibians (page 85), fish (pages 88-89), mussels (pages 93-95), crayfish (page 99), aquatic invertebrates (page 102), and terrestrial invertebrates (pages 107-108).

D. Monitoring is to be accomplished at one of several levels including, individual species, guilds, or natural communities

In Chapter 1 the Action Plan Evaluation and Updates section discusses monitoring (pages 46-49).

Chapter 3 contains a discussion monitoring levels in the **Ohio's Monitoring Framework** (pages 56-60), and **Effectiveness of Conservation Actions** (page 60-61) sections.

In Chapter 6 monitoring plans are contained in the Conservation Opportunity Area sections (**Forest** pages 140-143, **Grassland** pages 156-160, **Wetland** pages 174-179, **Lake Erie Islands** pages 189-191, **Oak Savanna** pages 199-201, **Boreal Community** page 210-212, **Caves and Mines** pages 220-221). Monitoring is also discussed in the **Conservation Opportunity Watershed Objectives** section (page 124).

In Chapter 6 conservation actions (some of which are species monitoring, and some of which will lead to the development of monitoring projects) are contained in each individual habitat section: **Forest** (Table 20), **Grassland** (Table 22), **Wetland** (Table 24), **Lake Erie Islands** (Table 26), **Oak Savanna** (Table 28), **Boreal** (Table 30), **Caves & Mines** (Table 32), **Artificial/man-made Environments** (Table 34), **Lake Erie** (Table 36), **Lake Erie Tributaries** (Table 38), **Ohio River** (Table 40), **Ohio River Tributaries** (Table 42), **Headwater and Small Inland Streams** (Table 44), **Man-made Lakes and Ponds** (Table 46), and **Natural Lakes** (Table 48).

E. The monitoring utilizes or builds on existing monitoring and survey systems or explains how information will be obtained to determine the effectiveness of conservation actions.

Chapter 1 the **Ohio's Approach to Conservation** section discusses existing monitoring and survey systems and how information will be obtained (pages 38-41). Also the **Action Plan Evaluation and Updates** section describes monitoring and survey systems (pages 46-49).

Chapter 2 contains a list of projects that are products of existing monitoring and survey systems (which will be utilized in the future) in the section **Conservation Efforts 2006-2015** (pages 50-52).

Chapter 3 contains a discussion monitoring in the **Introduction** (page 55), **Ohio's Monitoring Framework** (pages 56-60), and **Effectiveness of Conservation Actions** (page 60-61) sections.

Chapter 5 discusses ways to obtain information related to climate change that can serve as indicators and performance measures in the **Adaptation Strategies and Actions in Response to Climate Change** section (pages 114-116).

In Chapter 6 monitoring plans are contained in the Conservation Opportunity Area sections (**Forest** pages 140-143, **Grassland** pages 156-160, **Wetland** pages 174-179, **Lake Erie Islands** pages 189-191, **Oak Savanna** pages 199-201, **Boreal Community** page 210-212, **Caves and Mines** pages 220-221). Monitoring is also discussed in the **Conservation Opportunity Watershed Objectives** section (page 124).

In Chapter 6 conservation actions (some of which are species monitoring, and some of which will lead to the development of monitoring projects) are contained in each individual habitat section: **Forest** (Table 20), **Grassland** (Table 22), **Wetland** (Table 24), **Lake Erie Islands** (Table 26), **Oak Savanna** (Table 28), **Boreal** (Table 30), **Caves & Mines** (Table 32), **Artificial/man-made Environments** (Table 34), **Lake Erie** (Table 36), **Lake Erie Tributaries** (Table 38), **Ohio River** (Table 40), **Ohio River Tributaries** (Table 42), **Headwater and Small Inland Streams** (Table 44), **Man-made Lakes and Ponds** (Table 46), and **Natural Lakes** (Table 48).

F. The monitoring considers the appropriate geographic scale to evaluate status of species or species groups and the effectiveness of conservation actions.

Chapter 3 contains a discussion monitoring scales in the **Ohio's Monitoring Framework** (pages 56-60), and **Effectiveness of Conservation Actions** (page 60-61) sections.

Chapter 5 contains objectives, strategies, and approaches related to climate change at multiple geographic scales in the **Adaptation Strategies and Actions in Response to Climate Change** section (pages 114-116).

In Chapter 6 monitoring plans are contained in the Conservation Opportunity Area sections (**Forest** pages 140-143**, Grassland** pages 156-160**, Wetland** pages 174-179**, Lake Erie Islands** pages 189-191**, Oak Savanna** pages 199-201**, Boreal Community** page 210-212, **Caves and Mines** pages 220-221). Monitoring is also discussed in the **Conservation Opportunity Watershed Objectives** section (page 124).

In Chapter 6 conservation actions (some of which are species monitoring, and some of which will lead to the development of monitoring projects) are contained in each individual habitat section: **Forest** (Table 20), **Grassland** (Table 22), **Wetland** (Table 24), **Lake Erie Islands** (Table 26), **Oak Savanna** (Table 28), **Boreal** (Table 30), **Caves & Mines** (Table 32), **Artificial/man-made Environments** (Table 34), **Lake Erie** (Table 36), **Lake Erie Tributaries** (Table 38), **Ohio River** (Table 40), **Ohio River Tributaries** (Table 42), **Headwater and Small Inland Streams** (Table 44), **Man-made Lakes and Ponds** (Table 46), and **Natural Lakes** (Table 48).

G. The Strategy is adaptive in that it allows for evaluating conservation actions and implementing new actions accordingly.

In the Introduction the **Evaluation and Adaptation of the SWAP** section (pages 12-14)

In Chapter 1 the **Action Plan Evaluation and Updates** section (pages 46-49) discusses adaptive management.

Chapter 2 Ohio's First 10 Years of CWCS Implementation in the section **The Next 10 Years** discusses adaptation taking place as a result of the original CWCS (pages 52-54)

Chapter 3 contains a discussion of adaptive management in the **Introduction** (page 55), **Ohio's Monitoring Framework** (pages 56-60), **Effectiveness of Conservation Actions** (page 60-61), **Conceptual Model for Ohio's SWAP** (pages 61-62), and **Scenario** (pages 62-64) sections.

Chapter 5 contains objectives, strategies, and approaches related to climate change that can serve as indicators and performance measures for conservation actions (and thus facilitate adaptation) in the **Adaptation Strategies and Actions in Response to Climate Change** section (pages 114-116).

In Chapter 6 information about evaluating conservation actions and adaptation is contained in the Conservation Opportunity Area sections (**Forest** pages 140-143**, Grassland** pages 156-160**, Wetland** pages 174-179**, Lake Erie Islands** pages 189-191**, Oak Savanna** pages 199-201**, Boreal Community** page 210-212, **Caves and Mines** pages 220-221).

In Chapter 6 conservation actions (which will be evaluated for effectiveness) are contained in each individual habitat section: **Forest** (Table 20), **Grassland** (Table 22), **Wetland** (Table 24), **Lake Erie Islands** (Table 26), **Oak Savanna** (Table 28), **Boreal** (Table 30), **Caves & Mines** (Table 32), **Artificial/man-made Environments** (Table 34), **Lake Erie** (Table 36), **Lake Erie Tributaries** (Table 38), **Ohio River** (Table 40), **Ohio River Tributaries** (Table 42), **Headwater and Small Inland Streams** (Table 44), **Man-made Lakes and Ponds** (Table 46), and **Natural Lakes** (Table 48).

☐Yes	☐No	**6th Element. Descriptions of procedures to review the Strategy/Plan at intervals not to exceed ten years.**

A. The State describes the process that will be used to review the Strategy within the next ten years.

Within the Introduction in the **Evaluation and Adaptation of the SWAP** section (pages 12-14) is information regarding review and update of the Action Plan.

In Chapter 1 the **Action Plan Evaluation and Updates** section (pages 46-49) describes the formal process by which the Action Plan will be reviewed and evaluated.

Chapter 3 discusses key monitoring and effectiveness measure tools that will contribute to the review of the strategy in the **Introduction** (page 55), **Ohio's Monitoring Framework** (pages 56-60), and **Effectiveness of Conservation Actions** (page 60-61) sections.

Chapter 4 describes scoring systems that will be used to update the conservation status of SGCN during the life of this Action Plan in the **SGCN Development and Rationale** (pages 66-67) and **Conservation Status Criteria** (pages 67-68) sections.

☐Yes	☐No	**7th Element. Descriptions of the plans for coordinating, to the extent feasible, the development, implementation, review, and revision of the Plan-Strategy with Federal, State, and local agencies and Indian tribes that manage significant land and water areas within the State or administer programs that significantly affect the conservation of identified species and habitats**

A. The State describes the extent of its coordination with and efforts to involve Federal, State, local agencies, and Indian Tribes in the development of its Strategy.

In the Introduction, the **Development of Ohio's SWAP** section (pages 9-12) describes coordination with federal, state, and local agencies.

Chapter 1 the **Key Conservation Challenges** section discusses communication, cooperation, and coordination with partners (pages 37-38).

Chapter 3 describes coordination with federal, state, and local agencies in the **Ohio's Monitoring Framework** (pages 56-60) section.

Chapter 4 describes coordination with Federal, State, and local agencies in the development of SGCN lists in the **Sources of Information** (pages 65-66), **SGCN List Development and Rationale** (pages 66-67), and **Conservation Status Criteria** (pages 67-68) sections.

B. The State describes its continued coordination with these agencies and tribes in the implementation, review and revision of its Strategy.

In the Introduction, the **Evaluation and Adaptation of the SWAP** section (pages 12-14) describes review and revision of the strategy including partner agency involvement.

In Chapter 1 the **Ohio's Approach to Conservation** section (pages 38-41) describes continued partner involvement.

Chapter 2 addresses participation at the state, regional, national, and international levels in the section **The Next 10 Years** (pages 52-54).

Chapter 3 describes continued coordination with federal, state, and local agencies in the **Ohio's Monitoring Framework** (pages 56-60) section.

Keeping SGCN lists updated will require the continued coordination with the federal, state, and local agencies described in Chapter 4 in the **Sources of Information** (pages 65-66), **SGCN List Development and Rationale** (pages 66-67), and **Conservation Status Criteria** (pages 67-68) sections.

Chapter 5 describes actions related to climate change that will necessitate involvement by federal, state, and local agencies in the **Regional Species and Habitats at Greatest Risk and Most Vulnerable to Climate Impacts** (pages 112-113), **Impacts of and Biological Responses to Climate Change** (pages 113-114), and **Adaptation Strategies and Actions in Response to Climate Change** (pages 114-116) sections.

In Chapter 6 the conservation action tables in each habitat section contain actions that will lead to the development of projects that will require coordination with federal, state, and local agencies to implement. In addition, a number of conservation actions listed explicitly describe coordination with these agencies: **Forest** (Table 20), **Grassland** (Table 22), **Wetland** (Table 24), **Lake Erie Islands** (Table 26), **Oak Savanna** (Table 28), **Boreal** (Table 30), **Caves & Mines** (Table 32), **Artificial/man-made Environments** (Table 34), **Lake Erie** (Table 36), **Lake Erie Tributaries** (Table 38), **Ohio River** (Table 40), **Ohio River Tributaries** (Table 42), **Headwater and Small Inland Streams** (Table 44), **Man-made Lakes and Ponds** (Table 46), and **Natural Lakes** (Table 48).

☐Yes ☐No 8th Element. Descriptions of the necessary public participation in the development, revision, and implementation of the Plan.

A. The State describes the extent of its efforts to involve the public in the development of its Strategy.

In the Introduction, the **Development of Ohio's SWAP** section (pages 3-9) describes public participation in the development of the SWAP.

Chapter 1 the **Key Conservation Challenges** section discusses communication, cooperation, and coordination with partners (pages 37-38).

Chapter 4 describes public involvement in the development of SGCN lists in the **Sources of Information** (pages 65-66), **SGCN List Development and Rationale** (pages 66-67), and **Conservation Status Criteria** (pages 67-68) sections.

B. The State describes its continued public involvement in the implementation and revision of its Strategy.

In the Introduction, the **Development of the SWAP** section (pages 3-9) describes public involvement efforts that are ongoing. Also, the **Evaluation and Adaptation of the SWAP** section (pages 12-14) describes review and revision of the strategy including public involvement.

In Chapter 1 the **Key Conservation Challenges** section (pages 37-38) and the **Ohio's Approach to Conservation** section (pages 38-41) describe continued partner involvement.

Chapter 2 addresses partner participation in the section **The Next 10 Years** (pages 52-54).

Chapter 3 describes continued public involvement in the **Introduction** (page 55) and **Ohio's Monitoring Framework** (pages 56-60) sections.

Keeping SGCN lists updated will require continued involvement with the public described in Chapter 4 in the **Sources of Information** (pages 65-66), **SGCN List Development and Rationale** (pages 66-67), and **Conservation Status Criteria** (pages 67-68) sections.

Chapter 5 describes actions related to climate change that will necessitate involvement by our public conservation partners in the **Regional Species and Habitats at Greatest Risk and Most Vulnerable to Climate Impacts** (pages 112-113), **Impacts of and Biological Responses to Climate Change** (pages 113-114), and **Adaptation Strategies and Actions in Response to Climate Change** (pages 114-116) sections.

In Chapter 6 the conservation action tables in each habitat section contain actions that will lead to the development of projects that will require public involvement to implement. In addition, a number of conservation actions listed explicitly describe public involvement: **Forest** (Table 20), **Grassland** (Table 22), **Wetland** (Table 24), **Lake Erie Islands** (Table 26), **Oak Savanna** (Table 28), **Boreal** (Table 30), **Caves & Mines** (Table 32), **Artificial/man-made Environments** (Table 34), **Lake Erie** (Table 36), **Lake Erie Tributaries** (Table 38), **Ohio River** (Table 40), **Ohio River Tributaries** (Table 42), **Headwater and Small Inland Streams** (Table 44), **Man-made Lakes and Ponds** (Table 46), and **Natural Lakes** (Table 48).

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