

DRAFT
STATE MANAGEMENT PLAN
FOR
AQUATIC INVASIVE SPECIES

OHIO DEPARTMENT
OF
NATURAL RESOURCES



Ohio Department of Natural Resources
DIVISION OF WILDLIFE
wildohio.com

06/2012



TABLE OF CONTENTS

EXECUTIVE SUMMARY.....	Page 1
I. INTRODUCTION.....	Page 4
II. DEFINING THE PROBLEM.....	Page 7
Animals	
Plants	
III. GOALS, OBJECTIVES, AND STRATEGIES.....	Page 12
Goal 1 - Leadership.....	Page 12
Objective 1.1: Coordinate all AIS management programs	
Goal 2 - Prevention.....	Page 13
Objective 2.1: Establish a comprehensive process to identify AIS	
Objective 2.2: Identify potential prevention strategies	
Goal 3 - Early Detection and Rapid Response.....	Page 13
Objective 3.1: Enhance coordination within Ohio	
Objective 3.2: Create a master inventory of Ohio AIS	
Objective 3.3: Develop a Rapid Response Plan	
Goal 4 - Control and Management.....	Page 14
Objective 4.1: Prioritize organisms on which to focus control efforts	
Goal 5 - Research and Education.....	Page 15
Objective 5.1: Establish and coordinate an Ohio AIS research network	
Objective 5.2: Increase public awareness of AIS	
Objective 5.3: Target policy makers and Legislature	
IV. EXISTING AUTHORITIES AND PROGRAMS.....	Page 16
Federal Role	
Regional Role	
State Role	
V. PRIORITIES FOR ACTION.....	Page 25
VI. PROGRAM MONITORING AND EVALUATION.....	Page 26
Oversight	
Evaluation	
Dissemination	
VII. IMPLEMENTATION TABLE FOR PLAN GOALS.....	Page 27
VIII. LITERATURE CITED.....	Page 34
IX. GLOSSARY.....	Page 36
X. ACRONYMS.....	Page 37
XI. OHIO AQUATIC INVASIVE SPECIES COMMITTEE	Page 38

EXECUTIVE SUMMARY

Background

A number of animal and plant aquatic invasive species (AIS) have adversely affected the productivity and biodiversity of Ohio's native species and aquatic ecosystems. Most of these AIS introductions have been the result of human activities. There are many vectors and pathways for the introduction and spread of AIS including, but not limited to commercial shipping, aquaculture, live organism trade or release, commercial fishing, recreational equipment and activities, research activities, and water delivery and diversions. Potential threats may be prioritized by the degree of negative impact these species can have upon the environment, society, and economy. Negative impacts can include changes in river, lake, or wetland ecology including loss of biodiversity; changes in nutrient cycling; reduced habitat and water quality; reduced recreational opportunities; increased costs for industry; decreased property values; and threats to public safety.

The state of Ohio straddles two major North American watersheds. The northern third of Ohio lies within the Great Lakes basin, and the southern two-thirds of the state lies within the Mississippi River basin. Both of these basins have been significantly impacted by AIS, with the most significant invasions occurring in the last 30 years. It is likely that AIS impacts in the region will be the most significant in Lake Erie because it is shallow, warm, nutrient enriched and biologically productive making ideal habitat for many invading species.

The Great Lakes region has been impacted by both intentional and unintentional introductions of AIS since the settlement of the region. Since the 1800s, at least 182 non-native aquatic organisms have colonized habitats within the Great Lakes ecosystem. Potential for AIS to cause significant economic impacts in the Lake Erie region is because of the value of commercial and recreational industries. Ohio's nine ports on Lake Erie typically handle 55–60 million tons of cargo each year and support vital industries such as steelmaking, construction, salt mining, and power generation. The cargos shipped and received via Ohio's Lake Erie ports have an economic impact of \$8.6 billion and sustain more than 28,000 jobs statewide (Martin Associates 2011). The region's recreation and tourism industries are valued at \$15 billion annually, \$1.5 billion of which is direct expenditures on recreational fishing trips (U.S. Fish and Wildlife Service and U.S. Census Bureau 2006) with an estimated total impact related to the region's recreational fishing industry of nearly \$7.1 billion (Southwick Associates 2007). Placing an economic value on biological invasions in the Mississippi River Basin is not straightforward and is extremely complex, consequently, there is not a current and comprehensive aggregate estimate for the cost of AIS in this region or the portion of the state of Ohio contained within the Ohio River watershed (Windle et al. 2008).

Many partners share responsibility for protecting Ohio waters from the introduction of new AIS. Commitment and coordination between partners at federal, state, and local government levels; along with universities, non-government organizations (NGOs), businesses, and private landowners are needed to effectively combat AIS. Strategies used to prevent and abate AIS to date have included a number of regulatory and voluntary efforts by both public and private entities. Examples include voluntary Best Management Practices (BMPs) for the exchange of ballast water, as well as recently enacted ballast water regulations. Additionally, a variety of educational programs have increased awareness of introduction pathways and ways to prevent new AIS

introductions. Government agencies and nongovernment partner's will work together to monitor existing AIS, search for new AIS, and provide assessments of AIS management efforts. However, much work remains to control established invasive species and to protect Ohio waters from new introductions of AIS.

Plan Goals, Objectives, and Strategies

The primary focus of this State Management Plan (SMP) is the prevention of new AIS introductions to Ohio waters through interruption of the most significant pathways and vectors. The prevention actions recommended in this SMP are designed to be effective in preventing both the entry of new organisms into Ohio waters and the transfer and spread of organisms among and within water bodies in the state. This SMP also aims to minimize the impacts of invasive species on the environment, economy, and society and to protect and maintain biodiversity, industry, and recreational opportunities.

This SMP contains background information on both environmental and economic impacts. It describes current priority species based upon these impacts, and vectors of AIS entry into the state. This plan describes new strategies in addition to existing efforts to prevent the introduction of new AIS, prevent the dispersal of established AIS, detect and respond to new invaders, and abate the harmful effects of AIS in Ohio waters.

Beyond this background information, the core of the plan lies in 26 different management strategies organized within ten objectives under the following five goals: (1) leadership, (2) prevention, (3) early detection and rapid response, (4) control and management, and (5) research and education.

Existing Authorities and Programs

Addressing prevention and control of AIS requires coordination of policies and programs at many levels of government. Federal, regional, and state government all play a role in implementation of the federal Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA, Public Law 101-646) and the National Invasive Species Act of 1996 (NISA, Public Law 104-332). In addition to the above, the state of Ohio currently has a number of statutory and regulatory authorities detailed in both the Ohio Administrative Code (OAC) and Ohio Revised Code (ORC) with which it addresses issues of prevention and control of AIS. The majority of this authority lies within the Ohio Departments of Natural Resources (ODNR), Ohio Department of Agriculture (ODA), and the Ohio Environmental Protection Agency (OEPA).

Priorities for Action

All of the strategies listed under the five goals of this plan are important, but when it comes to implementation there is a need to prioritize strategies based upon the severity of the problem, the programmatic authority, capability and feasibility to resolve it, and the cost of the proposed solution. Priority actions in this plan target species and pathways that cause the most significant economic and/or ecological impacts. The following five priority actions are listed in order of importance:

1. **Early Detection and Rapid Response Plan:** Current AIS early detection programs must be re-evaluated to identify gaps and areas for improvement. Once new AIS are detected, there is the possibility of eradicating newly

discovered populations before they become established through the use of a rapid response plan.

2. **Effectiveness of Existing Tools:** Because it is most effective to combat AIS by preventing their introduction, a thorough evaluation of the effectiveness of existing management and regulatory tools for preventing the introduction of AIS into Ohio must be conducted to identify inadequacies and areas for improvement.
3. **Ohio AIS Committee:** To facilitate cooperation and coordination among a number of government and NGO's working to combat AIS, a committee dedicated to the implementation of this SMP must be appropriately staffed.
4. **Evaluate Control Strategies:** An evaluation of the cost-effectiveness of control strategies to minimize ecological and/or economic impacts of established AIS must be conducted.
5. **Outreach:** To increase public understanding and regard for the negative impacts of AIS, targeted outreach efforts that focus on dispersal pathways and risks associated with invasive species is needed.

I. INTRODUCTION

Aquatic ecosystems throughout Ohio are experiencing significant negative effects from established AIS, and Ohio waters are continually threatened by new invasions. AIS are non-native aquatic organisms that may cause economic and/or environmental harm. Newly introduced species can disrupt the balance of a natural ecosystem, often in its food web, leading to changes in the abundance and species composition of native plants and animals. This disruption can cause permanent, irreversible ecological damage and may increase the likelihood of additional AIS introductions because of the system's instability. The introduction of AIS is a source of biological pollution that threatens not only the ecology, but also causes economic, social, and public health impacts to the region. AIS can have significant economic effects on waterfront property values, tourism, utilities, fisheries, and other industries (Lovell and Stone 2005).

From a regional standpoint, Ohio is part of two major North American watersheds. The northern third of Ohio lies within the Great Lakes basin, and the southern two-thirds of the state lie within the Mississippi River Basin. Both basins have been significantly impacted by AIS. The Great Lakes basin is the largest freshwater system in the world and represents a top natural resource management priority. It is likely that AIS impacts will be the most significant in Lake Erie because it is shallow, warm, nutrient enriched, and biologically productive. These attributes make Lake Erie well-suited for many invading species. The Lake Erie watershed also contains the highest human population in the Great Lakes region; thereby, creating the greatest potential for human interactions with AIS.

The Great Lakes region has been impacted by both intentional and unintentional introductions of AIS since the settlement of the region by Europeans (Mills et al. 1993, Ricciardi 2001). Since the 1800s, at least 182 non-native aquatic organisms have colonized habitats within the Great Lakes ecosystem. These species include: 27 algae, 55 vascular plants, 66 invertebrates, 28 fish, and six bacteria and viruses (National Oceanic and Atmospheric Administration 2011). About 55 percent of these species are native to Eurasia, with an additional 13 percent native to the United States (US) Atlantic Coast.

Potential for AIS to cause significant economic impacts in the Great Lakes region is high because of the value of commercial and recreational industries. Ohio's nine ports on Lake Erie typically handle 55–60 million tons of cargo each year and support vital industries such as steelmaking, construction, salt mining, and power generation. The region's recreation and tourism industries are valued at \$15 billion annually, \$1.5 billion of which is direct expenditures on recreational fishing trips (U.S. Fish & Wildlife Service and U.S. Census Bureau 2006) with an estimated total impact related to the region's recreational fishing industry of nearly \$7.1 billion (Southwick Associates 2007). More than 58,000 jobs are supported by Great Lakes sport fisheries (Southwick Associates 2007), and commercial fisheries provide an additional 9,000 jobs (U.S. Fish & Wildlife Service 1994). Rosaen et al. (2012) estimate that aquatic invasive species likely costs the Great Lakes region significantly more in aggregate than \$100 million annually.

The Mississippi River basin is the largest river system in North America and its many tributaries drains all or parts of 31 US states and two Canadian provinces between the Rocky and Appalachian Mountains. Flowing entirely within the United States, the river itself originates in northern Minnesota and meanders southward for 2,530 miles to the

Mississippi River Delta at the Gulf of Mexico. The Mississippi River Basin has been greatly impacted by a number of invasive fish, plants, and mussels, and continues to be threatened by new AIS introductions. There are a reported 149 AIS established within the Mississippi River Basin, including 56 plants, 16 invertebrates, 75 fish, one amphibian, and one mammal (U.S. Geologic Survey 2012). Placing an economic value on biological invasions in the Mississippi River Basin is not straightforward and is extremely complex (Windle et al. 2008), consequently, there is not a current and comprehensive aggregate estimate for the cost of AIS in this region or to the portion of the state of Ohio contained within the Ohio River watershed.

There are many vectors and pathways for the introduction and spread of AIS including, but not limited to commercial shipping, aquaculture, live organism trade or release, commercial fishing, recreational equipment and activities, research activities, and water delivery and diversions. A changing climate is likely to increase opportunities for additional non-native species to successfully invade Ohio waters as warmer temperatures increase the likelihood of non-native species becoming established.

Actions taken to date to prevent the introduction of new AIS include regulatory and voluntary efforts by both public and private entities. Some of these activities serve as models using innovative, strategic approaches. These include voluntary BMPs for the exchange of ballast water as well as recently enacted ballast water regulations. A wide variety of educational programs (such as those aimed at recreational boating and aquatic species trade industries) have increased awareness of introduction pathways and ways to prevent new AIS introductions. Government agencies and nongovernment partners need to work together to monitor existing AIS, search for new AIS, and provide assessments of AIS management efforts. However, much work remains to control established invasive species and to protect Ohio waters from new introductions of AIS.

This comprehensive AIS SMP describes new strategies in addition to existing efforts to prevent the introduction of new AIS, prevent the dispersal of established AIS, detect and respond to new invaders, and abate the harmful effects of AIS in Ohio waters. This SMP identifies a goal related to each of five conceptual areas: (1) leadership, (2) prevention, (3) early detection and rapid response, (4) control and management, and (5) research and education.

Recent research has demonstrated that preventing the spread of invasive organisms from already colonized areas (i.e., containment) is the most effective way to reduce the likelihood of new invasions at the landscape scale (Drury and Rothlisberger 2008). Therefore, the focus of this SMP is on the prevention of new AIS to Ohio waters through interruption of the most significant pathways and vectors for new introductions. The preventative actions recommended in this SMP are designed to be effective with both the entry of new organisms into Ohio waters, and the transfer and spread of organisms among and within water bodies in the state. This SMP also aims to minimize the impacts of invasive species on the environment, economy, society, human health and to protect and maintain biodiversity and recreational sustainability.

While prevention of new invasions is a focus of this SMP, some new invasions are inevitable even with the best prevention programs. Therefore, early detection and further development of a response capacity for new invasions are also important components of the plan. Additionally, this SMP addresses management and control efforts to minimize impacts from established AIS populations using a coordinated, science-based approach.

Many partners share responsibility for protecting Ohio waters from the introduction of new AIS. Commitment and coordination between partners at federal, state, and local government levels, along with universities, NGOs, businesses, and private landowners are needed to effectively implement the provisions of this SMP and ensure organized commensurate actions. Initiatives at all of these levels have been and will continue to be important in the effort to prevent AIS introductions and dispersal, and to control existing AIS infestations. Implementation of this SMP on a statewide basis will require significant commitment and coordination between all of the previously mentioned groups.

Ohio's first SMP was approved in 1999 under the auspices of NISA. At the time it was among the first SMPs in the nation approved by the Aquatic Nuisance Species Task Force (ANSTF). In 2008, the ODNR Division of Wildlife (DOW) formed the Ohio Aquatic Invasive Species Committee (OAISC) to address AIS issues in Ohio, including the revision of Ohio's AIS SMP. The OAISC is made up of government, industry, university, and private groups. The revised SMP incorporated elements from the plans in Michigan and Pennsylvania. The ODNR DOW and Ohio Sea Grant prepared a draft SMP for review by the OAISC. Input from the OAISC was used to identify gaps and strengthen the overall SMP.

II. DEFINING THE PROBLEM

A number of animal and plant AIS have adversely affected the productivity and biodiversity of Ohio's native species and aquatic ecosystems. Most of these AIS introductions have been the result of human activities and a changing climate is likely to increase opportunities for additional non-native species to successfully invade Ohio waters. Warmer temperatures enhance reproductive cycles of some potential AIS and may increase the likelihood of non-native species becoming established. There are many vectors and pathways for the introduction and spread of AIS. Some pathways, such as the aquaculture industry, are currently regulated to minimize the risk of new AIS introductions, while other pathways have traditionally gone unchecked. Potential threats can be prioritized by the degree of negative impact these species can have upon the environment, industry, and economy. The following two sections describe the introduction, distribution, and impacts of animal and plant AIS currently established in or adjacent to Ohio waters. This list is not comprehensive, but includes some of the higher threat species.

Animals

The invasion of the **sea lamprey** *Petromyzon marinus*, a parasitic fish which kills other fish by attaching to its prey and feeding on body fluids, in the 1920s resulted in substantial economic losses to recreational and commercial fisheries, and has required annual expenditures of millions of dollars to finance control programs. Sea lamprey used the shipping canal system that circumnavigated Niagara Falls to move from Lake Ontario to the upper Great Lakes. During the 1940s and 1950s, the sea lamprey devastated populations of commercially and recreationally valuable whitefish and lake trout. The reduction in populations of these fishes permitted populations of less valuable fish to increase and proliferate. Of all AIS invasions into the Great Lakes, only the sea lamprey has been successfully managed at a level where their populations are low enough to minimize impacts. In 2012, the cost of sea lamprey control and research was approximately \$18 million annually (Rosaen et al. 2012). The total value of lost fishing opportunities plus indirect economic impacts from lamprey predation probably exceeds \$500 million annually (U.S. Office of Technology Assessment 1993).

Alewife *Alosa pseudoharengus* are perhaps best known for their invasion of the Great Lakes by using the Welland Canal to bypass Niagara Falls. Alewife colonized the Great Lakes and increased rapidly during the 1940s and 1950s because of the suitability of the habitat and the fact that predators were not sufficiently abundant to check their population growth. Declining water quality prior to the Clean Water Act, and the loss of large native planktivores like the lake herring or cisco *Coregonus artedii* from Lake Erie contributed to the establishment of alewife by creating an open niche. Like many herring species, alewives are prone to massive die-offs because of seasonal changes in water temperature. Periodic kills have fouled recreational beaches and blocked municipal and industrial water intakes. At the same time alewife out-competed and suppressed native whitefishes, yellow perch, and emerald shiners, and became a key prey species for salmonids. Unfortunately, alewives produce an enzyme (thiaminase) that breaks down thiamin or vitamin B1, and as a result, predatory fish with diets high in alewife are more susceptible to mortality. The alewife has permanently altered existing predator-prey relationships in the Great Lakes ecosystem, and caused instability in the forage base because of their population variability.

The **river ruffe** *Gymnocephalus cernuus*, a Eurasian fish of the perch family, was introduced to North America in the 1980s most likely through the ballast water of ocean-going vessels. Ruffe have few predators, no commercial or recreational value, and may be displacing native fishes. Since its introduction, the ruffe became established in the nearshore waters of western Lake Superior, with an estimated average rate of range expansion of 18 shoreline miles per year. By the fall of 1994, ruffe populations were found in Michigan waters of Lake Superior. Based on observations of present ruffe expansion rates, and life history aspects of the ruffe in Europe, there is high potential for future negative impacts to valuable native fish such as yellow perch in situations where the two are forced to compete for food resources. While this species has never been collected in Ohio's Lake Erie waters, its potential impacts warrant continued vigilance.

The **round goby** *Neogobius melanostomus* and **tubenose goby** *Proterorhinus semilunaris* were introduced into the Great Lakes via ballast water from ocean-going vessels. Tubenose goby is a smaller fish that has recently been substantially increasing in numbers around the Bass Island Chain in Lake Erie. Round goby were first detected in the St. Clair River near Detroit in 1990 and appeared in Cleveland harbor shortly thereafter. By 1998, they were widespread throughout all of Lake Erie. There has been at least one introduction to an inland Ohio water body, and other streams and lakes are potentially at risk. The primary concern with round goby is the tremendous population growth and range expansion it exhibited since its introduction in 1990, facilitated by its ability to spawn repeatedly within a given year and its efficient method of early juvenile dispersal.

It is an aggressive fish and a strong competitor with small bottom-feeding native fishes like mottled sculpin *Cottus bairdi*, darter species, and even juvenile game fishes like smallmouth bass *Micropterus dolomieu*. Gobies are voracious predators on snails, mussels, aquatic insects, and the eggs and fry of native fish species. Great Lakes fisheries have been profoundly impacted by round goby because of its robust characteristics and potential to displace native species from prime habitat and spawning areas (e.g., Winslow 2010, Steinhart et al. 2004). As an efficient nest predator, their potential to impact recruitment of native sport fishes led the State of Ohio to close Lake Erie's smallmouth bass fishery to harvest during the spawning season so that the male can stay on the nest to guard against predators. Round goby have also been implicated in reintroducing historically bioaccumulated contaminants back into food webs (Kwon et al. 2006). After years of declining levels, PCB concentrations in Lake Erie smallmouth bass tissue tripled on average following the establishment of round goby (Ohio Environmental Protection Agency, unpublished data).

The **spiny water flea** *Bythotrephes longimanus* and **fishhook water flea** *Cercopagis pengoi*, likely ballast water introductions, are tiny crustaceans with sharply barbed tail spines. The spiny water flea is a native of northern Europe and was first found in Lake Huron in 1984, and Lake Erie in 1986 (Bur et al. 1986). The fishhook water flea was first collected in Lake Erie's central basin in 2002. Both species are now found throughout the Great Lakes, and the spiny water flea has been found in some inland lakes. They can form dense blooms and clump on fishing line, making retrieval of gear difficult. Resource managers suspect that these invaders compete with native zooplankton and fish for food but may also be used by native fish as a food source.

The **zebra mussel** *Dreissena polymorpha* and **quagga mussel** *Dreissena bugensis*, both ballast water introductions, are two of the best known invaders of the Great Lakes

region and other areas of the country where they have spread. These AIS have caused serious economic and ecosystem impacts (e.g., Windle et al. 2008). Dreissenid mussels are highly opportunistic, reproduce rapidly, and consume plankton from the water column in large quantities. Major changes have occurred in Lake Erie after the dreissenid invasion, including the disappearance of native clams from many areas, greatly reduced planktonic diatom and rotifer densities, a substantial resurgence in blooms of potentially toxic cyanobacteria/blue-green algae, vastly increased water clarity, and reduction in the annual economic value of the sport fishery. The initial invasion and exponential increase in numbers of dreissenid mussels occurred coincidentally with the reduction of phosphorus levels induced by the Clean Water Act and Great Lakes Water Quality Agreement. Dreissenid mussels have been shown to accumulate contaminants and can pass those contaminants up the food web. Dreissenid mussels have spread to a number of inland lakes and reservoirs as well as the waters of the Ohio River along our entire border where they pose a serious threat to native mussels.

Potential impacts on fisheries can be profound because of changes in food availability and spawning areas. Economic impacts are as common as the ecosystem impacts. Great Lakes municipalities, utilities, and industries, because of the infestation of dreissenid mussels in their intake/discharge pipes, have incurred significant costs from monitoring, cleaning, and controlling infestations. For example, by 2008 the Cleveland Plain Dealer estimated dreissenid mussels had cost the region approximately \$1.5 billion in efforts to prevent such clogging/fouling. Commercial and recreational vessels and beach areas are also vulnerable to the negative impacts of dreissenids.

Northern studfish *Fundulus catenatus* are native to the southern portion of the gulf drainage (the shallow, gravelly stream margins along tributaries of the Mississippi), but have recently been encroaching into Ohio and Iowa and are now found throughout much of the Little Miami River system. Their initial introduction was probably a result of illegal releases of aquarium pets. Where they occur outside of their native range, northern studfish displace native topminnows.

The **northern snakehead** *Channa argus* prefers stagnant shallow ponds, swamps, and slow streams with mud or vegetated substrate, with temperatures ranging from 0° to over 30° C. This fish is popular in Asian cuisines, and most introductions were likely released fish procured for food. Northern snakeheads are established in Virginia, Maryland, Pennsylvania, New York, and Arkansas. The species is well established in the Potomac River and several of its tributaries in Virginia and Maryland (Starnes et al. 2011). These predatory fish compete with native species for food and habitat. Juveniles eat zooplankton, insect larvae, small crustaceans, and the fry of other fish. As adults they feed mostly on other fishes with the remainder of their diet comprised of crustaceans, frogs, small reptiles, and sometimes small birds and mammals.

Asian carps refer to a group of fishes that are native to Asia. The U.S. Fish and Wildlife Service (USFWS) specifically uses “Asian carp” to refer to bighead carp *Hypophthalmichthys nobilis*, silver carp *H. molitrix*, black carp *Mylopharyngodon piceus*, and grass carp *Ctenopharyngodon idella*. The larger group of Asian carps also includes the widespread invasive common carp *Cyprinus carpio* and goldfish *Carassius auratus*. Each of these species was intentionally introduced into the United States for different purposes, but they all pose a great threat to Ohio’s aquatic ecosystems. Bighead and silver carp were introduced into aquaculture and wastewater treatment facilities to control algae and escaped into the Mississippi River during floods in the early 1980s.

They have since spread upriver and have become the most abundant fish in some regions of the Mississippi, lower Ohio, and Illinois rivers. Black carp were brought to the United States to control snail populations in aquaculture facilities and escaped from holding ponds in Missouri in 1994. Recent collections suggest that the black carp are established in the lower part of the Mississippi River basin. Grass carp were imported into aquaculture facilities in Alabama and Arkansas in 1963 to control vegetation in rearing ponds. They were widely stocked and their range was expanded by intentional and non-intentional releases. Many of the 45 states where grass carp are now found, including Ohio, have banned the stocking of diploid grass carp, but allow the stocking of triploid (genetically sterile) grass carp by permitted aquaculture facilities.

Asian carps are a threat because of their reproductive success, long life spans, and feeding habits, thereby damaging habitat and disrupting food webs. Bighead and silver carp feed on plankton and are in direct competition with native organisms. Silver carp can also be hazardous to boaters and water-sport enthusiasts because, when startled by the sound of passing boat motor, they can jump six to ten feet out of the water into the path of moving boats, causing damage and injuring passengers. Grass carp are known to eradicate aquatic vegetation in lakes, altering habitat and interfering with the reproduction of native fish. Black carp feed primarily on mussels and snails which threaten native mollusk and snail populations (some of the most imperiled/endangered organisms in North America) as well as mollusk-feeding fish and birds. Common carp and goldfish feed on the bottom and are notorious (especially common carp) for altering their environments by destroying and uprooting submerged vegetation, negatively impacting other fish and waterfowl.

Plants

Purple loosestrife *Lythrum salicaria* is an invasive wetland plant from Europe and Asia that was introduced to the east coast of North America in the 1800s. Since then, it has spread to the Great Lakes region and inland waters in Ohio. It produces a brilliant spike of lavender flowers making it a popular garden plant, although only the variety *Lythrum virgatum* is allowed to be sold in Ohio (*L. salicaria* is listed as a noxious weed by the Ohio Department of Agriculture). Purple loosestrife invades marshes and lakeshores, displacing valuable native wetland plants. It can develop a monoculture which is unsuitable as cover, food, or nesting sites for a wide range of native wetland fish and wildlife species.

Eurasian watermilfoil *Myriophyllum spicatum* was unintentionally introduced to North America from Europe and has spread into inland lakes and ponds primarily by recreational boaters. Eurasian watermilfoil can reach high densities in lakes and cause serious problems for commercial fishing as well as recreational activities such as boating, fishing, and swimming. The plant's floating surface canopy can out-compete and eliminate native aquatic vegetation, thereby threatening native fish and wildlife populations.

Bushy pondweed/lesser naiad *Najas minor* and **Curly pondweed** *Potamogeton crispus* are two other non-native aquatic plants impacting inland lakes and ponds in Ohio. These submersed aquatic plants are especially abundant in eutrophic water where an overabundance of nutrients, often from fertilizer runoff or sewage waste, has altered the natural ecology. They can reduce native aquatic plant and fish diversity as well as impact recreational activities. When a large biomass of curly pondweed begins to die

late in the growing season, its decomposition can lead to oxygen depletion and fish kills in smaller inland waters.

Narrow-leaved cattail *Typha angustifolia* and **Hybrid cattail** *Typha X glauca* (its hybrid with the native broad-leaved cattail *Typha latifolia*) are aggressively spreading plants which tend to form dense colonies that displace native emergent plant species. Both plants can be distinguished from the native species by a narrow gap that separates the male and female flowers of the inflorescence as well as by narrower leaves. They both spread by rhizomes and airborne seeds.

Giant reed grass *Phragmites australis* has become a tremendous problem in Lake Erie coastal marshes and other wetlands throughout northern Ohio. This non-native grass forms extensive colonies with individual stalks often reaching 10–15 feet in height. It spreads primarily by rhizomes that run above or below the surface.

European or glossy buckthorn *Rhamnus frangula* is a wetland shrub that has become a serious problem in wetlands such as bogs, fens, wet prairies, and sedge meadows, particularly in northern Ohio. It can completely displace native vegetation over large areas of a wetland and is difficult to control as it spreads aggressively by seed and rhizomes.

Reed canary grass *Phalaris arundinacea* is a non-native grass that forms dense populations that can virtually eliminate all other plants. It has become a serious problem in several native wetland communities in Ohio including marshes, fens, and wet prairies.

Flowering-rush *Butomus umbellatus* has narrow, sword-like leaves beneath multiple long-stalked pink flowers on tall stems. The species spreads by seed, rhizomes, and bulbets that break off from the rhizomes. It has recently spread rapidly in the western Lake Erie marshes where it is now the dominant species, replacing purple loosestrife in many cases.

Hydrilla was released in the 1960s from aquariums into waterways in Florida and is now established in the southeast from Connecticut to Texas. *Hydrilla* is an aggressive plant that can form large dense mats that impact aquatic fish and wildlife along with recreationalists. By the 1990s, control and management were costing millions of dollars each year. *Hydrilla* can be controlled by aquatic herbicides, grass carp (itself an invasive species), and insects. Tubers pose a problem to control as they can lay dormant for a number of years. This has made it even more difficult to remove from waterways and estuaries. *Hydrilla* is established in the Ohio River and was recently identified in ponds in the Lake Erie watershed.

Japanese knotweed *Fallopia japonica* (syn. *Polygonum cuspidatum*) is a large, herbaceous perennial plant, native to eastern Asia. In North America and Europe the species is very successful and has been classified as an invasive species in several countries. It is a frequent colonizer of temperate riparian ecosystems, roadsides and waste places. It forms thick, dense colonies that completely crowd out any other herbaceous species and is now considered one of the worst invasive exotics in parts of the eastern United States.

III. GOALS, OBJECTIVES, AND STRATEGIES

Continuous effort is required to block the pathways that AIS use to enter and disperse in Ohio waters, as well as to detect and respond to new invaders, and to manage and control established populations. The goals of this SMP are designed to address different stages of AIS invasion: the introduction of AIS transported from water bodies outside of Ohio; the dispersal of established, reproducing AIS populations in Ohio to other water bodies within the state; and the colonization of AIS populations within water bodies.

The State of Ohio recognizes that to accomplish these goals, it must coordinate with jurisdictions inside and outside the state and build its strategies upon sound science. Therefore, mechanisms will be established to ensure that all strategies developed and implemented by the State under this plan are (1) done in cooperation with federal agencies, local governments, interjurisdictional organizations and other entities; (2) based upon the best scientific information available; and (3) conducted in an environmentally-sound manner.

The five goals of the SMP address:

- **Goal - 1 Leadership**
- **Goal - 2 Prevention**
- **Goal - 3 Early Detection and Rapid Response**
- **Goal - 4 Control and Management**
- **Goal - 5 Research and Education**

Goal 1 - Leadership: Provide leadership for AIS issues in Ohio among local, state, and federal agencies as well as other organizations in order effectively address AIS.

Objective 1.1: Coordinate all AIS management programs and activities within Ohio and establish multi-state cooperation and coordination within the Great Lakes and Mississippi River regions as well as nationally.

- **Strategy 1.1a:** Coordinate the OAISC to address AIS issues in Ohio. The Committee will be comprised of government, industry, university, and private groups and will meet annually to address relevant AIS issues.
- **Strategy 1.1b:** Partner with AIS management programs in nearby states through regional organizations (e.g., Great Lakes and Mississippi River Basin Panels) and national organizations (e.g., Aquatic Nuisance Species Task Force and Association of Fish and Wildlife Agencies) to ensure that AIS efforts in Ohio remain relevant and current; are based in the most recent science; and coordinated with regional, national, and local programs.
- **Strategy 1.1c:** Identify all sources of funding available and evaluate their utility for addressing Ohio's priority AIS issues. Identify the current funding capacity and identify priority resource needs and new funding opportunities. In cooperation with other partners, work with the Governor's Office and Legislature to establish a permanent funding mechanism for AIS management activities. Identify funding gaps and identify currently funded programs that are lower priority or not meeting their goals so that resources can be reallocated.

Goal 2 - Prevention: Identify AIS vectors and focus efforts on preventing the introduction and spread of AIS into Ohio.

Objective 2.1: Establish a comprehensive process to identify AIS of greatest concern that are not yet present in Ohio waters and prioritize highest-risk introduction pathways.

- **Strategy 2.1a:** Identify and rank, by short- and long-term risk assessment, the species or groups of species of greatest concern and conduct an analysis to determine the level of risk associated with their introduction. The species list will include species in the U.S. but not established in Ohio as well as species not yet in the U.S.
- **Strategy 2.1b:** Using the prioritized list of AIS with the greatest potential to invade Ohio waters, identify existing and potential pathways that would facilitate introductions of these species. Prioritize highest-risk pathways for future legislation, rules, research, and control efforts.
- **Strategy 2.1c:** Work with government and non-government stakeholders to develop a science-based, comprehensive screening system for evaluating risks associated with the introduction of all non-native aquatic species.

Objective 2.2: Identify potential prevention strategies for addressing AIS of greatest risk and high-risk introduction pathways.

- **Strategy 2.2a:** Evaluate the effectiveness of existing management and regulatory tools (incorporating pathway analysis) for preventing the introduction of priority AIS into Ohio by identifying potential gaps and improve existing tools. Develop and implement specific strategies and plans to reduce the likelihood of both intentional and unintentional introduction of harmful AIS through high-risk pathways.
- **Strategy 2.2b:** Identify "ecologically sensitive" aquatic resource areas that are free of AIS, and enhance protection through the (1) identification of potential introduction pathways and (2) establishment of additional precautionary measures including educational outreach and enforcement.
- **Strategy 2.2c:** Identify BMPs, codes-of-conduct, and potential certification options for key industry and user groups (e.g., pet and aquarium trades, water gardens, aquaculture industry, research community, commercial shipping, recreational boating, transportation industry, and bait retailers and suppliers) to help keep the priority AIS out of Ohio.

Goal 3 - Early Detection and Rapid Response: Implement early detection and rapid response actions so that newly introduced AIS can be located quickly and eliminated.

Objective 3.1: Enhance coordination within Ohio to detect new invasions, as well as range expansions of AIS within Ohio. Prioritize early-detection efforts and increase knowledge and expertise to enhance these efforts.

- **Strategy 3.1a:** Assemble a focused committee of agency, municipal, NGO, and academic professionals who survey aquatic organisms as part of their monitoring and research activities and have them evaluate current early-detection programs, identify gaps, and make recommendations for improved monitoring of priority AIS.

- **Strategy 3.1b:** Develop a list of experts within agencies, academia, NGO, and contractors that can help identify AIS and develop contract arrangements if necessary.
- **Strategy 3.1c:** Create a regional “watch” list for species that have potential to enter Ohio.
- **Strategy 3.1d:** Identify high “invasion likelihood” areas for targeted early detection surveying.
- **Strategy 3.1e:** Establish cooperative policies with states sharing watersheds for coordinated early detection efforts.

Objective 3.2: Create a master inventory of Ohio AIS that is regularly maintained, updated, and accessible.

- **Strategy 3.2a:** Create a compilation of AIS in Ohio held by various groups (local, county, state, federal, and private organizations). Identify inventory gaps, and develop strategies to address deficiencies.
- **Strategy 3.2b:** Integrate Ohio AIS location information into the United States Geologic Surveys Nonindigenous Aquatic Species Database.

Objective 3.3: Develop a Rapid Response Plan for the eradication of newly detected AIS and implement the plan under predetermined conditions.

- **Strategy 3.3a:** Work with the OAISC to develop a RRP for incorporation into Ohio’s AIS SMP.
- **Strategy 3.3b:** Implement Ohio’s RRP when there is a high likelihood that eradication efforts will be effective.

Goal 4 - Control: When feasible, control or manage AIS that have or may have significant impacts in Ohio.

Objective 4.1: Prioritize AIS on which to focus control efforts and explore and utilize the various methods available to control these populations.

- **Strategy 4.1a:** Implement scientific analyses to prioritize control efforts for both species and sites and consider the long-term, cost-effectiveness of all proposed strategies against the “no-action” alternative.
- **Strategy 4.1b:** Implement control strategies that are based on the best available scientific information and conducted in an environmentally sound manner. Coordinate control strategies with federal agencies, local governments, interjurisdictional organizations, and other appropriate entities. Establish protocols that will provide guidance in designing and implementing control and eradication strategies.
- **Strategy 4.1c:** Evaluate potential incentive programs or assistance for private landowners for the control of invasive species and restoration of impacted ecosystems.
- **Strategy 4.1d:** Develop means of modifying human activities in areas of AIS infestations to help prevent their spread.

Goal 5 - Research and Education: Increase research efforts on AIS, and educate the general public and individuals involved in related business, trade, research, recreation and government sectors about AIS issues.

Objective 5.1: Establish and coordinate an Ohio AIS research network by building on existing state, federal, and university programs.

- **Strategy 5.1a:** Identify all current AIS research needs and potential network members and prioritize the research specific to Ohio's freshwater habitats.

Objective 5.2: Increase public awareness of AIS impacts and strategies that can be implemented to reduce the establishment and spread of AIS in Ohio.

- **Strategy 5.2a:** Target outreach efforts and prioritize key audiences (e.g., live organism trades and aquatic user groups) to promote understanding of invasive species dispersal pathways and risks.
- **Strategy 5.2b:** Maintain a comprehensive and current AIS website and work to develop other types of media to inform the public of AIS issues.

Objective 5.3: Target policy makers and legislative staff for outreach efforts.

- **Strategy 5.3a:** Provide educational briefings on the threats, economic and ecological impacts, and solutions to AIS invasions in Ohio for decision makers and legislators. Keep legislators and decision makers informed and updated on the progress of Ohio AIS management efforts.

IV. EXISTING AUTHORITIES AND PROGRAMS

Addressing prevention and control of AIS requires coordination of policies and programs at many levels of government. The following overview describes the basic role of federal, regional, and state government in implementation of the federal Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA, Public Law 101-646) and the National Invasive Species Act of 1996 (NISA, Public Law 104-332). It also includes an assessment of Ohio's existing laws and programs that address prevention and control of AIS.

Federal Role

Nonindigenous Aquatic Nuisance Prevention and Control Act: The federal NANPCA calls upon states to develop and implement a comprehensive SMP to prevent introduction and control the spread of AIS. Section 1002 of NANPCA outlines five objectives of the law, as follows:

- To prevent further unintentional introductions of nonindigenous aquatic species
- To coordinate federally funded research, control efforts, and information dissemination
- To develop and carry out environmentally sound control methods to prevent, monitor, and control unintentional introductions
- To understand and minimize economic and ecological damage
- To establish a program of research and technology development to assist state governments.

NANPCA was primarily a response to the Great Lakes invasion of the zebra mussel, which has caused extensive ecological and socioeconomic impacts. Although the zebra mussel issue played a key role in prompting passage of the legislation, NANPCA was established to prevent occurrence of new unintentional introductions of AIS, and to limit dispersal and adverse impacts of invasive species currently inhabiting United States waters.

Section 1201 of the Act established the national ANSTF, co-chaired by the US Fish and Wildlife Service and the National Oceanic and Atmospheric Administration (NOAA). The ANSTF is charged with coordinating government led efforts related to AIS with the efforts of the private sector and other North American interests.

The group also facilitates national policy direction in support of the Act. The ANSTF (consisting of seven federal agency representatives and eight ex officio members representing nonfederal governmental agencies) has adopted the ANS Program under Section 1202 of NANPCA. That program recommends the following essential elements:

- Prevention: Establish a systematic risk identification, assessment and management process to identify and modify pathways by which AIS spread
- Detection and Monitoring: Create a National Nonindigenous Aquatic Nuisance Species Information Center to coordinate efforts to detect the presence and monitor the distributional changes of all nonindigenous AIS, identify and monitor native species and other effects, and serve as a repository for that information

- **Control:** The Task Force or any other potentially affected entity may recommend the initiation of a nonindigenous AIS control program. If the Task Force determines, using a decision process outlined in the control program, that the species is a nuisance and control is feasible, cost effective, and environmentally sound, a control program may be approved.

The ANSTF recommends research, education and technical assistance as strategies to support the elements listed above. The ANSTF also provides national policy direction as a result of protocols and guidance that have been developed through the efforts of the following working committees: Research Protocol/Coordination Committee, Intentional Introduction Policy Review Committee, Great Lakes Panel on Aquatic Nuisance Species, Ruffe Control Committee, Risk Assessment and Management Committee, Detection and Monitoring Committee, Zebra Mussel Coordination Committee, and Brown Tree Snake Control Committee.

National Invasive Species Act: NISA (1996) amended and expanded NANPCA, mandating regulations to prevent the introduction and spread of AIS into the Great Lakes through ballast water. Initially in response to round goby, it also authorized the dispersal barrier demonstration on the upper Mississippi watershed that is the current centerpiece of efforts to prevent silver and bighead carps from invading the Great Lakes. NISA authorized additional funding for AIS research, and required ballast water management programs to demonstrate technologies and practices to prevent nonindigenous species from being introduced.

Lacey Act: There are a few additional pieces of federal legislation that can be used in the prevention and management of AIS. The Lacey Act (1900) largely falls to the U.S. Fish and Wildlife Service for enforcement. It has the authority to list wild animals as “injurious” (and thus illegal for live interstate transport), but the process is lengthy and the species list is resultantly short, especially regarding fishes. As of 2012, potential AIS listed as injurious by the Lacey Act (and the date of their listing) are walking catfishes of the family Clariidae (1970), mitten crabs *Eriocheir* spp. (1989), zebra mussel (1991), snakehead fishes of the family Channidae (2002), silver carp (2007), largescale silver carp *Hypophthalmichthys harmandi* (2007), black carp (2007), and bighead carp (2010).

Plant Protection Act: The Plant Protection Act (2000) amounts to a comprehensive consolidation of earlier statutes and is coupled with several related statutes expanding jurisdiction to non-plant invasive species. Implementation largely falls to the U.S. Department of Agriculture’s Animal and Plant Health Inspection Service (APHIS) to prohibit, inspect, treat, quarantine, or require mitigation measures prior to allowing entry or interstate transport. APHIS can impose a relatively rapid response via proclamation, but that authority is usually invoked in response to pests or threats related to commercially valuable cultured organisms. For example, in October 2006 in response to viral outbreaks on the Great Lakes, APHIS imposed a federal order restricting international and interstate transport of fish species known to be susceptible to the invasive viral hemorrhagic septicemia (VHS) virus within or out of the at-risk region (i.e., states and provinces bordering the Great Lakes and St. Lawrence River). The stated purpose of this order was “to prevent the spread of VHS into aquaculture facilities.”

Asian Carp Prevention and Control Act: Concern over the potential for ecological and economic damage to the Great Lakes region if Asian carps successfully invade has prompted several recent pieces of federal legislation. The Asian Carp Prevention and

Control Act (2010) added bighead carp to the Lacey Act's injurious list and prohibited the importation and shipment of some other select carp species.

Water Resources Development Act: The Water Resources Development Act (2007) authorized the Secretary of the Army to construct various projects for improvements to rivers and harbors of the United States to provide for the conservation and development of water and related resources. This Act includes maintaining the AIS dispersal barrier on the upper Mississippi system.

Stop Invasive Species Act: The Stop Invasive Species Act (S. 2317, H.R. 4406) was introduced in April 2012 to stop Asian carps from destroying the Great Lakes ecosystem. It would require the expedited creation of a plan to block Asian carp from entering the Great Lakes through a number of surface water connections across the Great Lakes region. The act would require the Army Corps of Engineers to accelerate the release of their final action plan and develop a definitive plan to permanently prevent Asian carp from entering the Great Lakes. The bill remains in committee.

Asian Carp Regional Coordinating Committee: In 2007, an "Asian Carp Working Group" comprised of several agency and private stakeholder partners and under the direction of the USFWS submitted the Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States to the ANSTF (Conover et al. 2007). That working group has formed the basis of the Asian Carp Regional Coordinating Committee (ACRCC), largely directed by federal agency partners—the USFWS, U.S. Environmental Protection Agency (USEPA), U.S. Army Corps of Engineers (USACE), U.S. Coast Guard (USCG), NOAA, U.S. Geological Survey (USGS), U.S. Department of the Interior, Great Lakes Fishery Commission, state agencies around the Great Lakes, and the Metropolitan Water Reclamation District of Greater Chicago. This committee also receives input from diverse private and academic stakeholders throughout the Mississippi River and Great Lakes region. Federal agencies within the committee generated an Asian Carp Control Strategy Framework (ACRCC 2010). The ACRCC has also assembled a working group divided into three committees to advise on implementation of the aforementioned Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States, including: (1) Research, Assessment, and Monitoring Committee; (2) Prevention, Containment, and Control Committee; and (3) Outreach and Education Committee. Committee membership is diverse to ensure a thorough representation of economic and ecological interests and expertise. Ohio is currently represented on the research/monitoring and outreach/education committees.

Ballast water: The potential for ballast water introductions of AIS is of international concern. Policies must be implemented at some jurisdictional level, ideally federally, because of the interjurisdictional/interstate nature of the shipping industry. NANPCA initiated ballast water management regulations to limit introductions through transoceanic shipping. Regulations adopted by the USCG in 1993 apply to all vessels that have been operating outside the Exclusive Economic Zone (EEZ) of the U.S. or Canada, and enter the Snell Lock in New York carrying ballast water. Vessel masters have three options under these regulations: (1) demonstrate that a ballast exchange was done at sea beyond the EEZ in a depth exceeding 2,000 meters; (2) retain the ballast during the vessel's entire Great Lakes voyage, in which case tanks may be sealed; or (3) have an alternative environmentally-sound method of ballast water management approved by the USCG.

The USEPA has issued two draft vessel general permits that would regulate discharges from commercial vessels, excluding military and recreational vessels. The proposed permits would help protect the nation's waters from ship-borne pollutants and reduce the risk of introduction of invasive species from ballast water discharges.

The draft Vessel General Permit (VGP), which covers commercial vessels greater than 79 feet in length, would replace the current 2008 VGP, when it expires in December 2013. Under the Clean Water Act, permits are issued for a five-year period after which time USEPA generally issues revised permits based on updated information and requirements. The new draft Small VGP would cover vessels smaller than 79 feet in length and would provide such vessels with the Clean Water Act permit coverage they will be required to have as of December 2013.

A key new provision of the permit is a proposed numeric standard to control the release of non-indigenous invasive species in ballast water discharges. The new ballast water discharge standard addressing invasive species is based upon results from independent USEPA Science Advisory Board and National Research Council National Academy of Sciences studies. These limits are generally consistent with those contained in the International Maritime Organization's (IMO) 2004 Ballast Water Convention. The new standard is expected to substantially reduce the risk of introduction and establishment of non-indigenous invasive species in U.S. waters.

Prompted by AIS concerns worldwide, the United Nations' IMO held its Ballast Water Convention in 2004. Its requirements will enter into force 12 months after ratification by 30 nations representing 35 percent of world shipping tonnage. Thirty-three member nations (including Canada but still excluding the United States) representing nearly 25 percent of world shipping tonnage had ratified the convention as of January 2012.

Ultimately, the Convention intends to implement international Ballast Water Performance Standards in two phases. In Phase I (until January 2016), ballast of qualifying vessels must discharge fewer than 10 organisms that are greater than 50 μm in length (half the diameter of an average human hair) per cubic meter of ballast water. This would allow the discharge of up to 5,000 – 200,000 organisms depending on vessel size. Phase II (after January 2016) will require less than one organism per 100 cubic meters of ballast water, which would still allow discharge of up to 50 – 2,000 organisms depending on vessel size.

The IMO's interim measure calls for Ballast Water Exchange (BWE). The USCG and Joint Ballast Water Working Group began implementation of BWE on Great Lakes waters in 2004. In 2008, the St Lawrence Seaway and USCG required ocean-going vessels to exchange ballast water prior to entering the upper Great Lakes. The USCG issued its Final Rule on ballast water in March 2012 and it will require oceangoing vessels to meet the IMO standard, some as soon as 1 December 2013.

Regional Role

Regional AIS Panels: The activities of NANPCA, NISA, and (by extension) the ANSTF are coordinated through six regional panels; the state of Ohio is represented on two of those six panels. Section 1203 of NANPCA calls upon the Great Lakes Commission to convene the Great Lakes Panel on Aquatic Nuisance Species. Similarly, the Mississippi River Basin Panel of the ANSTF was first convened in 2003 and is hosted by the

Mississippi Interstate Cooperative Resource Association. Official state representatives must be employees of state management agencies, but broader panel membership is drawn from diverse federal, state, provincial, and regional agencies. Input from private sector user groups, Sea Grant programs, academic faculty and staff, and environmental organizations are also used to ensure that the positions of the panels provide a balanced and regional perspective on AIS issues. Panel responsibilities for the Great Lakes region and Mississippi River basin are fivefold: (1) identify priorities for activities within each relevant basin, (2) develop and submit recommendations to the ANSTF (established via Public Law 101-646), (3) coordinate aquatic nuisance species program activities within each basin, (4) advise public and private interests on control efforts, and (5) report to the ANSTF describing prevention, research, and control activities within each basin.

State Role

State Management Plan for AIS: The comprehensive SMPs for AIS are addressed in Section 1204 of NANPCA. Section 1204 requires that management plans identify "those areas or activities within the state, other than those related to public facilities, for which technical and financial assistance is needed to eliminate or reduce the environmental, public health, and safety risks associated with AIS." The content of each state plan is to focus on the identification of feasible, cost-effective management practices and measures to be used by state and local entities to prevent and control AIS infestations in a manner that is environmentally sound. As part of the plan, federal activities are to be identified for prevention and control measures, including direction on how these activities should be coordinated with state and local efforts. Section 1204 also states that in the development and implementation of the management plan, the state needs to involve appropriate local, state, and regional entities, as well as public and private organizations that have expertise in AIS prevention and control. The SMPs are to be submitted to the national ANSTF for approval. If the plan meets the requirements of the ANSTF, the plan becomes eligible for federal cost-share support. Plans may be implemented with other funds supplied by state and cooperative agencies.

The State of Ohio currently has a number of statutory and regulatory authorities detailed in both the Ohio Administrative Code (OAC) and Ohio Revised Code (ORC) with which it can address issues of prevention and control of AIS. These have been developed over time, generally in response to individual species and concerns as they arose. Consequently, there is not currently a comprehensive, coordinated, and vigorously enforced policy framework to deal with invasive species and their impacts. One task must be to identify gaps in Ohio's policies and statutes, and develop recommendations for improvements. Such improvements may entail developing new legislation and regulations; revising existing authorities; and developing methods for improving enforcement, coordination, and information dissemination regarding new or existing authorities.

The following existing authorities and policies have been identified relative to Ohio's management of AIS. Some sections of code are species-specific while others are more general with respect to species that may invade terrestrial, transitional, or aquatic ecosystems.

Purple loosestrife: The director of the ODA prohibits the sale and propagation of purple loosestrife pursuant to ORC 927.682. No person or governmental entity may sell, offer for sale or plant *Lythrum salicaria* without a permit issued by the director. The director

may issue a permit only for controlled experiments, but may exempt from the permit requirement any variety demonstrated not to be a threat to the environment (ORC 927.682).

Wild animal importing, exporting, selling and possession regulation: The state of Ohio's fishing regulations provide that exotic species of fish —i.e., any fish not naturally found in Ohio waters—or hybrids thereof may not be imported, sold or possessed for the purposes of introduction into any body of water that is connected to or drains into a flowing stream or other body of water that would allow egress of fish into public waters in the state. In addition, the possession, sale, and importation of grass carp capable of reproducing is prohibited. Importers and sellers of grass carp are required to certify that all grass carp handled are of the sterile triploid variety and must have prior written authorization from the chief of the DOW to import and sell this variety. It is also illegal to possess, import, or sell for any purpose at any time live individuals of any of the following species or their hybrids: walking catfish *Clarias batrachus*, diploid white amur/grass carp, silver carp/white bream, bighead carp/bighead amur, black amur/black carp, round goby, tubenose goby, snakeheads *Channa* or *Parachanna* spp., white perch *Morone americana*, three-spined stickleback *Gasterosteus aculeatus*, sea lamprey, or the subspecific eastern banded killifish *Fundulus diaphanus diaphanus*. Exceptions for such species may be made only for research, by zoos, public aquariums, and public displays and only after permission is obtained from the wildlife chief. In addition, it is illegal for any person to possess, import, or sell marron *Cherax tenuimanus*, yabby *C. destructor*, zebra mussel, quagga mussel, or rudd *Scardinius erythrophthalmus* (OAC 1501:31-19-01).

Aquaculture: ORC 1533.632 mandates that the DOW regulate the aquaculture industry, and allows for the issuance of permits for species which can include nonindigenous species. Class B species refer to species that are more ecologically sensitive and Class A species to those that are more common or do not pose a threat. Class B permits are to be issued on a case-by-case basis, and the chief shall take into account “the species for which the Class B permit is requested, the location of the aquaculture production facility, and any other information determined by the chief to be necessary to protect the wildlife and natural resources of this state.” According to rules promulgated by the DOW, a permit will not be granted until a Division representative determines the classification of the aquaculture facility based upon level of potential risk of escapement. Aquatic species or hybrids not native to a watershed or not established through stocking by the Division will not be considered for approval unless the facility has no risk of escapement at any time. Two levels of escapement prevention are required for Class B species and some named hybrids cultured outside their naturally occurring watersheds as detailed by OAC 1501:31-39-01.D.2.b (ORC 1533.632, OAC 1501:31-39-01).

Bait and bait dealers: Rules promulgated by the DOW regulate such sale in accordance with the Division’s statutory authority to protect and preserve the wild animals of the state, mostly related to the management of native stocks through regulation. Specifically related to potential AIS, it is illegal to sell or use as bait “any fish or minnow not already established in waters of Ohio over which the wildlife chief has control” (OAC 1501:31-13-04).

Other ODNR Division of Wildlife Authorities: The chief of ODNR’s DOW has general statutory authority and control over AIS in all matters pertaining to the protection, preservation, propagation, possession, and management of wild animals and may adopt

rules for the management of wild animals (ORC 1531.08). Specifically, as deemed necessary, the chief “shall adopt, and may amend and rescind, rules that are necessary for the administration and enforcement” of the ORC (ORC 1531.10). The Chief also has the authority to restrict the stocking of aquatic organisms in public waters through OAC 1501:31-13-01-7 which requires individuals stocking any species of fish into waters of the State to obtain permission from the Chief of the DOW. Waters of the state are defined as all waters except those private waters that are not connected with other natural surface waters. In addition, the chief “may adopt, amend, and rescind such rules as necessary to control or eradicate parasites and diseases of game birds, game quadrupeds other than captive white-tailed deer, fur-bearing animals, or nonnative wildlife” on “wholly enclosed preserves” as described in ORC 1533.71 (ORC 1533.79). Therefore, in instances where it is determined that the introduction and/or spread of nonindigenous aquatic species is potentially detrimental to the management of the wild animals of the state, the Division may adopt additional rules to check adverse impacts.

Other Ohio Department of Agriculture Authorities: The ODA has statutory authority to adopt rules necessary to carry out its responsibilities regarding plant pests (ORC 927.70). No person may harbor any plant pest which has been determined by the director of agriculture to be destructive or dangerously harmful. “Pest” is defined broadly as any organism that causes or may cause injury, disease, or damage to any plant part, or plant product. This apparently could be broadly applied if plants or natural systems were to be judged to be threatened by a pest species. Thus, broad rule-making authority exists, but an assessment of the need for additional rules may be required.

In addition, the director of the ODA has authority to label “dangerously contagious or infectious disease[s]” of animals as those diseases determined “to be of harmful effect on the animal or poultry industry or the public health and to be capable of transmission by any means from a carrier animal to a human or to another animal” (ORC 941.01). This includes diseases of cultured aquatic organisms (including potentially invasive diseases or diseases of potentially invasive host organisms used in aquaculture) that may also infect wild populations. The chief of the ODA’s Division of Animal Health is charged with preventing the spread of “dangerously contagious or infectious disease, providing for the control and eradication of such disease, and cooperating with the United States Department of Agriculture in such work” (ORC 940.02). If such a disease is detected, the director has authority to impose quarantine, including an individual animal or as by “geographic area” if the director determines such broad quarantine to be necessary (ORC 941.07). This authority was invoked in 2007 to issue quarantine on Ohio’s Lake Erie region in response to an outbreak of the invasive fish disease viral hemorrhagic septicemia among several wild populations of fishes within Lake Erie. The order prohibited the human transportation of susceptible fishes from the Lake Erie region as defined by the order.

ODNR Division of Watercraft Authorities: The director of the ODNR has statutory authority to create state wild, scenic, or recreational river areas along with their corridors up to one thousand feet from normal waterlines. Beginning in 2009, the chief of ODNR’s Division of Watercraft was given responsibility to develop “rules governing the use, visitation, protection, and administration” of such areas. The Division is further charged with providing conservation education and to “provide for corridor protection, restoration, habitat enhancement, and clean-up projects” within these areas. While the Division of Watercraft has rule-making authority with respect to management of lands within wild, scenic, and recreational river areas, it does not have authority to regulate activities with

respect to species that may be disruptive to the ecosystems being preserved. The ORC specifically prevents land use restrictions to be imposed by the Division upon private lands along wild, scenic, or recreational river corridors; however, the Division works with local governments to ensure that local zoning, flood plain, and forest buffers provide appropriate protection. The ORC states that the chief or chief's representative "may participate in watershed-wide planning with federal, state and local agencies in order to protect the values of wild, scenic, and recreational river areas" (ORC 1547.81).

Local Governments: Chapter 164 of the ORC details state disbursement of aid to local government for improvements. Natural resources assistance councils appointed by public works integrating committees are charged with reviewing various open space acquisition project proposals, including "acquisition of land or rights in land for parks, forests, wetlands, natural areas that protect an endangered plant or animal population, other natural areas, and connecting corridors for natural areas" as well as development of such land acquisitions to enhance their accessibility by the public. Such projects can emphasize "the reduction or elimination of nonnative, invasive species of plants or animals" and "shall not... encourage invasive nonnative species" (ORC 164.22).

Ohio Coastal Management Program: Within the Lake Erie watershed, enforceable authorities incorporated into the Ohio Coastal Management Program (OCMP: duties and definitions detailed in ORC 1506) can be enforced against federal agencies through application of the federal consistency provision (Section 307) of the federal Coastal Zone Management Act (16 U.S.C. 1541 et.seq.). The consistency provision applies to all federally conducted, funded, and permitted activities that may affect land or water uses of the coastal area, as defined by the OCMP, whether or not they occur directly within the OCMP management boundary. This took effect with implementation of the OCMP following federal approval by NOAA in 1997.

The Great Lakes-St. Lawrence River Basin Water Resources Compact: The Great Lakes-St. Lawrence River Basin Water Resources Compact (ORC 1522), while originally drafted through region-wide collaboration, is implemented at the state level. Passed by the states of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, and Wisconsin in 2008, and amended within Ohio in 2012, the Compact facilitates the interjurisdictional management of the use of the water resources of the Great Lakes. The compact makes little mention of AIS. However, communities that have corporate boundaries falling partly within the basin or partly within two Great Lakes watersheds do create some risk of AIS transfer. These communities are permitted some exception to the prohibition on water diversions given that the volume of water diverted from the Great Lakes basin is returned less an allowance for consumptive use. If some portion of the volume used to fulfill the replacement criterion originates outside the Great Lakes basin, it must be treated to meet water quality discharge standards and "to prevent the introduction of invasive species into the basin" (ORC 1522.4.9).

Research and Education: In addition to exercising its statutory and regulatory authorities, the state currently fosters extensive research and education/outreach programs through the ODNR, the OEPA, the Ohio Lake Erie Commission's Lake Erie Protection Fund, the Ohio Sea Grant College Program, the Great Lakes Aquatic Ecosystem Research Consortium, the Great Lakes Regional Research Information Network, the International Joint Commission's Council of Great Lakes Research Managers, the ACRCC, regional panels of the ANSTF, state universities, and others. Informational efforts focus upon educating recreational water users and commercial

enterprises regarding methods to reduce impacts of human activity related to the introduction and spread of AIS. Research efforts have focused upon pollutant uptake mechanisms, potential control methods, and effects of increased water clarity, predator-prey relationships, and other trophic level interactions. Some research effort has been made to quantify the economic impacts of AIS on the state or region (e.g., Rosaen et al. 2012, Windle et al. 2008). However, those efforts have been too few to date and have not been comprehensive simply because the data required to compile a comprehensive and defensible economic statement are not currently collected.

Control measures for non-native flora as a part of management plans for state-managed nature preserves and wildlife areas. Each nature preserve and wildlife area managed by the ODNR, DOW and the Division of Parks & Recreation's Natural Areas and Preserves program is governed by a management plan specific to that area. Each plan incorporates a statement of policy regarding control of invasive plants identified as problems within the nature preserve or wildlife area. Generally speaking, guidelines call for manual removal, burning, and treatment with herbicides. Management plans include provisions for monitoring and assessment to determine the extent of growth and nature of the disturbance, if any. Management plans and control efforts are tailored to the specific nature preserve or wildlife area and prescribe the treatment appropriate for each species depending upon the habitat type, extent of invasion, and management goals for the area.

Ohio Invasive Plants Council: The Ohio Invasive Plants Council (OIPC) was formed in 2005, this Council represents a broad partnership of agencies, organizations, and individuals concerned about the threats of invasive plants in Ohio. The mission of OIPC is to "participate in statewide efforts to address the threats of invasive species to Ohio's ecosystems and economy by providing leadership and promoting stewardship, education, research, and information exchange." OIPC holds annual meetings, research conferences, and regional workshops to improve awareness of invasive species. OIPC has developed a scientifically-based protocol for assessing invasiveness of plant species and is expected to have a revised Ohio invasive plant list initiated in late 2012. The current 2000 list was developed by the ODNR Division of Natural Areas & Preserves.

V. PRIORITIES FOR ACTION

All of the strategies listed under the five goals of this plan are important, but when it comes to implementation there is a need to prioritize strategies based upon the severity of the problem, the programmatic authority, capability and feasibility to resolve it, and the cost of the proposed solution. Priority actions in this plan target species and pathways that cause the most significant economic and/or ecological impacts. The following five priority actions are listed in order of importance:

1. **Early Detection and Rapid Response Plan:** Current AIS early detection programs must be re-evaluated to identify gaps and areas for improvement. Once new AIS are detected, there is the possibility of eradicating newly discovered populations before they become established through the use of a rapid response plan.
2. **Effectiveness of Existing Tools:** Because it is most effective to combat AIS by preventing their introduction, a thorough evaluation of the effectiveness of existing management and regulatory tools for preventing the introduction of AIS into Ohio must be conducted to identify inadequacies and areas for improvement.
3. **Ohio AIS Committee:** To facilitate cooperation and coordination among a number of government and NGO's working to combat AIS, a committee dedicated to the implementation of this SMP must be appropriately staffed.
4. **Evaluate Control Strategies:** An evaluation of the cost-effectiveness of control strategies to minimize ecological and/or economic impacts of established AIS must be conducted.
5. **Outreach:** To increase public understanding and regard for the negative impacts of AIS, targeted outreach efforts that focus on dispersal pathways and risks associated with invasive species is needed.

VI. PROGRAM MONITORING AND EVALUATION

The implementation of Ohio's SMP will enable us to monitor progress toward the five goals in the plan. We will be able to select appropriate management actions as well as make necessary "mid-course" corrections. By incorporating the best scientific and management knowledge with periodic public evaluation, we will be implementing an adaptive AIS management program (sensu Lee, 1993). This process will involve three components: (1) oversight, (2) evaluation, and (3) dissemination of information.

Oversight

The OAISC will act as the advisory committee and will examine progress on the plans goals, objectives and strategies and recommend future plan revisions.

Evaluation

The evaluation effort should not only examine progress toward stated goals, objectives, and strategies but place a special emphasis on success at identifying funding needs to accomplish goals and associated tasks. This information will prove useful in future program planning processes. Evaluation should also incorporate information from those groups affected by plan implementation through the OAISC.

Dissemination

A report will be produced at least every two years (or as resources allow) highlighting the progress of our management activities. This report will include information on the successes in achieving objectives towards the goals of the AIS Plan, as well as future plans and directions. Successes, failures, and new directions within Ohio will be evaluated in comparison with other state and regional plans. Reports will be made available to members of the general public and local, state, and federal agencies.

VII. IMPLEMENTATION TABLE FOR PLAN GOALS (See Section III)

Goal 1: Leadership: Provide leadership for AIS issues in Ohio among local, state, and federal agencies as well as other organizations in order effectively address AIS.

Objective	Strategic Action	Measure of Success	Target Date	Lead State Agency	Cooperating Agency or Organization	Estimated State Cost	Status
Objective 1.1: Coordinate all AIS management programs and activities within Ohio and establish multi-state cooperation and coordination within the Great Lakes and Mississippi River regions as well as nationally.	Strategy 1.1a: Coordinate the OAISC to address AIS issues in Ohio. The Committee will be comprised of government, industry, university, and private groups and will meet annually to address relevant AIS issues.	Meet annually to address relevant AIS issues.	Annual	DOW	OAISC	\$5,000	Ongoing
	Strategy 1.1b: Partner with AIS management programs in nearby states through regional organizations (e.g., Great Lakes and Mississippi River Basin Panels) and national organizations (e.g., Aquatic Nuisance Species Task Force and Association of Fish and Wildlife Agencies) to ensure that AIS efforts in Ohio remain relevant and current; are based in the most recent science; and coordinated with regional, national, and local programs.	Maintain membership on regional panels and national organizations. Attend meetings when possible and assume leadership roles when possible.	Ongoing	DOW	NA	\$5,000	Ongoing
	Strategy 1.1c: Identify all sources of funding available and evaluate their utility for addressing Ohio's priority AIS issues. Identify the current funding capacity and identify priority resource needs and new funding opportunities. In cooperation with other partners, work with the Governor's Office and Legislature to establish a permanent funding mechanism for AIS management activities. Identify funding gaps and identify currently funded programs that are lower priority or not meeting their goals so that resources can be reallocated.	Identify funding requirements to secure funding source for AIS.	2014	DOW	OAISC	\$5,000	Pending

Goal 2: Prevention: Identify AIS vectors and focus efforts on preventing the introduction and spread of AIS into Ohio.

Objective	Strategic Action	Measure of Success	Due	Lead State Agency	Cooperating Agency or Organization	Estimated State Cost	Status
Objective 2.1: Establish a comprehensive process to identify AIS of greatest concern that are not yet present in Ohio waters and prioritize highest-risk introduction pathways.	Strategy 2.1a: Identify and rank, by short- and long-term risk assessment, the species or groups of species of greatest concern and conduct an analysis to determine the level of risk associated with their introduction. The species list will include species in the U.S. but not established in Ohio as well as species not yet in the U.S.	List of AIS of greatest concern for Ohio	2014	DOW	OAISC	\$20,000	Pending
	Strategy 2.1b: Using the prioritized list of AIS with the greatest potential to invade Ohio waters, identify existing and potential pathways that would facilitate introductions of these species. Prioritize highest-risk pathways for future legislation, rules, research, and control efforts.	List of high risk pathways	2015	DOW	OAISC	\$20,000	Pending
	Strategy 2.1c: Work with government and non-government stakeholders to develop a science-based, comprehensive screening system for evaluating risks associated with the introduction of all non-native aquatic species.	AIS screening system	2016	DOW	OAISC	\$40,000	Pending

Goal 2: Prevention: Identify AIS vectors and focus efforts on preventing the introduction and spread of AIS into Ohio (continued).

Objective	Strategic Action	Measure of Success	Due	Lead State Agency	Cooperating Agency or Organization	Estimated State Cost	Status
Objective 2.2: Identify potential prevention strategies for addressing AIS of greatest risk and high-risk introduction pathways.	Strategy 2.2a: Evaluate the effectiveness of existing management and regulatory tools (incorporating pathway analysis) for preventing the introduction of priority AIS into Ohio by identifying potential gaps and improve existing tools. Develop and implement specific strategies and plans to reduce the likelihood of both intentional and unintentional introduction of harmful AIS through high-risk pathways.	Close high risk pathways	2017	DOW	OAISC	\$20,000	Pending
	Strategy 2.2b: Identify "ecologically sensitive" aquatic resource areas that are free of AIS, and enhance protection through the (1) identification of potential introduction pathways and (2) establishment of additional precautionary measures including educational outreach and enforcement.	List of ecologically sensitive areas and preventative measures.	2013	DOW	TNC	\$5,000	Pending
	Strategy 2.2c: Identify BMPs, codes-of-conduct, and potential certification options for key industry and user groups (e.g., pet and aquarium trades, water gardens, aquaculture industry, research community, commercial shipping, recreational boating, transportation industry, and bait retailers and suppliers) to help keep the priority AIS out of Ohio.	Offer Hazard analysis and critical control points (HACCP) training for selected user groups.	2014	DOW	OAISC	\$40,000	Pending

Goal 3: Early Detection and Rapid Response: Implement early detection and rapid response actions so that newly introduced AIS can be located quickly and eliminated.

Objective	Strategic Action	Measure of Success	Due	Lead State Agency	Cooperating Agency or Organization	Estimated State Cost	Status
Objective 3.1: Enhance coordination within Ohio to detect new invasions, as well as range expansions of AIS within Ohio. Prioritize early-detection efforts and increase knowledge and expertise to enhance these efforts.	Strategy 3.1a: Assemble a focused committee of agency, municipal, NGO, and academic professionals who survey aquatic organisms as part of their monitoring and research activities and have them evaluate current early-detection programs, identify gaps, and make recommendations for improved monitoring of priority AIS.	Comprehensive AIS monitoring program.	2013	DOW	OAISC	\$25,000	Pending
	Strategy 3.1b: Develop a list of experts within agencies, academia, NGO, and contractors that can help identify AIS and develop contract arrangements if necessary.	Expert AIS list	2013	DOW	OAISC	\$5,000	Pending
	Strategy 3.1c: Create a regional “watch” list for species that have potential to enter Ohio.	AIS watch list.	2013	DOW	OAISC	\$10,000	Pending
	Strategy 3.1d: Identify high “invasion likelihood” areas for targeted early detection surveying.	List of high risk areas for AIS invasions.	2014	DOW	OAISC	\$10,000	Pending
	Strategy 3.1e: Establish cooperative policies with states sharing watersheds for coordinated early detection efforts.	Cooperative agreements with adjacent states.	2014	DOW	Michigan, Indiana, Kentucky, West Virginia, Pennsylvania	\$5,000	Pending

Goal 3: Early Detection and Rapid Response: Implement early detection and rapid response actions so that newly introduced AIS can be located quickly and eliminated (Continued).

Objective	Strategic Action	Measure of Success	Due	Lead State Agency	Cooperating Agency or Organization	Estimated State Cost	Status
Objective 3.2: Create a master inventory of Ohio AIS that is regularly maintained, updated, and accessible.	Strategy 3.2a: Create a compilation of AIS in Ohio held by various groups (local, county, state, federal, and private organizations). Identify inventory gaps, and develop strategies to address deficiencies.	List of AIS location information.	2013	DOW	OAISC	\$20,000	Pending
	Strategy 3.2b: Integrate Ohio AIS location information into the United States Geologic Surveys Nonindigenous Aquatic Species Database.	Ohio information integrated into NAS database.	2013	DOW	OAISC	\$10,000	Pending
Objective 3.3: Develop a Rapid Response Plan for the eradication of newly detected AIS and implement the plan under predetermined conditions.	Strategy 3.3a: Work with the OAISC to develop a RRP for incorporation into Ohio's AIS SMP.	Ohio RRP	2012	DOW	OAISC	\$5,000	Ongoing
	Strategy 3.3b: Implement Ohio's RRP when there is a high likelihood that eradication efforts will be effective.	Successful implementation of Ohio RRP.	Case-by-case basis	DOW	OAISC	Unknown	Pending

Goal 4: Control: When feasible, control or manage AIS that have or may have significant impacts in Ohio.

Objective	Strategic Action	Measure of Success	Due	Lead State Agency	Cooperating Agency or Organization	Estimated State Cost	Status
<p>Objective 4.1: Prioritize AIS on which to focus control efforts and explore and utilize the various methods available to control these populations.</p>	<p>Strategy 4.1a: Implement scientific analyses to prioritize control efforts for both species and sites and consider the long-term, cost-effectiveness of all proposed strategies against the “no-action” alternative.</p>	<p>Prioritized list of control efforts.</p>	<p>2014</p>	<p>DOW</p>	<p>OAICS</p>	<p>\$20,000</p>	<p>Pending</p>
	<p>Strategy 4.1b: Implement control strategies that are based on the best available scientific information and conducted in an environmentally sound manner. Coordinate control strategies with federal agencies, local governments, interjurisdictional organizations, and other appropriate entities. Establish protocols that will provide guidance in designing and implementing control and eradication strategies.</p>	<p>Successful control program.</p>	<p>Case-by-case basis</p>	<p>DOW</p>	<p>OAISC</p>	<p>Unknown</p>	<p>Pending</p>
	<p>Strategy 4.1c: Evaluate potential incentive programs or assistance for private landowners for the control of invasive species and restoration of impacted ecosystems.</p>	<p>Private lands AIS control program.</p>	<p>Case-by-case basis</p>	<p>DOW</p>	<p>OAISC</p>	<p>Unknown</p>	<p>Pending</p>
	<p>Strategy 4.1d: Develop means of modifying human activities in areas of AIS infestations to help prevent their spread.</p>	<p>Abatement strategies</p>	<p>Case-by-case basis</p>	<p>DOW</p>	<p>OAISC</p>	<p>Unknown</p>	<p>Pending</p>

Goal 5: Research and Education: Increase research efforts on AIS, and educate the general public and individuals involved in related business, trade, research, recreation and government sectors about AIS issues.

Objective	Strategic Action	Measure of Success	Due	Lead State Agency	Cooperating Agency or Organization	Estimated State Cost	Status
Objective 5.1: Establish and coordinate an Ohio AIS research network by building on existing state, federal, and university programs.	Strategy 5.1a: Identify all current AIS research needs and potential network members and prioritize the research specific to Ohio's freshwater habitats.	Prioritized list of research efforts.	2014	DOW	OAICS	\$20,000	Pending
Objective 5.2: Increase public awareness of AIS impacts and strategies that can be implemented to reduce the establishment and spread of AIS in Ohio.	Strategy 5.2a: Target outreach efforts and prioritize key audiences (e.g., live organism trades and aquatic user groups) to promote understanding of invasive species dispersal pathways and risks.	Successful outreach program.	2013	Ohio Sea Grant	OAISC	\$30,000	Pending
	Strategy 5.2b: Maintain a comprehensive and current AIS website and work to develop other types of media to inform the public of AIS issues.	Updated web site	Ongoing	DOW	OAISC	\$5,000	Ongoing
Objective 5.3: Target policy makers and legislative staff for outreach efforts.	Strategy 5.3a: Provide educational briefings on the threats, economic and ecological impacts, and solutions to AIS invasions in Ohio for decision makers and legislators. Keep legislators and decision makers informed and updated on the progress of Ohio AIS management efforts.	Knowledgeable decision makers	2013	DOW	OAISC	\$5,000	Pending

VIII. LITURATURE CITED

Asian Carp Regional Coordinating Committee. 2010. 2011 Asian Carp Control Strategy Framework. Asian Carp Regional Coordinating Committee.

Bur, M. T., D. M. Klarer, and K. A. Krieger. 1986. First records of a European cladoceran, *Bythotrephes cederstroemi*, in Lakes Erie and Huron. *Journal of Great Lakes Research* 12:144–146.

Conover, G., R. Simmonds, and M. Whalen, editors. 2007. Management and control plan for bighead, black, grass, and silver carps in the United States. Asian Carp Working Group, Aquatic Nuisance Species Task Force, Washington, D.C.

Drury, K. L. S. and Rothlisberger, J. D. 2008. Offense and defense in landscape-level invasion control. *Oikos* 117:182–190

Kwon T. D., S. W. Fisher, G. W. Kim, H. Hwang, and J. E. Kim. 2006. Trophic transfer and biotransformation of polychlorinated biphenyls in zebra mussel, round goby, and smallmouth bass in Lake Erie, USA. *Environmental Toxicology and Chemistry* 25(4):1068–1078.

Lovell, S. J. and S. F. Stone. 2005. The economic impacts of aquatic invasive species: A review of the literature. NCEE Working Paper no. 05-02. U.S. Environmental Protection Agency, National Center for Environmental Economics, Washington, D.C.

Martin Associates. 2011. The Economic Impacts of the Great Lakes-St. Lawrence Seaway System. Martin Associates, Lancaster, PA.

Mills, E. L., J. H. Leach, J. T. Carlton, and C. L. Secor. 1993. Exotic species in the Great Lakes: A history of biotic crises and anthropogenic introductions. *Journal of Great Lakes Research* 19(1):1–54.

Ricciardi, A. 2001. Facilitative interactions among aquatic invaders: is an “invasional meltdown” occurring in the Great Lakes? *Canadian Journal of Fisheries and Aquatic Sciences* 58:2513–2525.

Rosaen, A.L., E.A. Grover, C.W. Spencer, and P.L. Anderson. 2012. The Costs of Aquatic Invasive Species to Great Lakes States. Anderson Economic Group LLC, East Lansing, MI.

Southwick Associates. 2007. Sportfishing in America: An economic engine and conservation powerhouse. Produced for the American Sportfishing Association (with funding from the Multistate Conservation Grant Program), Alexandria, VA.

Starnes, W. C., J. Odenkirk, and M. J. Ashton. 2011. Update and analysis of fish occurrences in the lower Potomac River drainage in the vicinity of Plummers Island, Maryland—Contribution XXXI to the natural history of Plummers Island, Maryland. *Proceedings of the Biological Society of Washington* 124(4):280–309.

Steinhart, G. B., E. A. Marschall, and R. A. Stein. 2004. Round goby predation on smallmouth bass offspring in nests during experimental catch-and-release angling. *Transactions of the American Fisheries Society* 133:121–131.

U.S. Fish and Wildlife Service. 1994. Great Lakes Fishery Resources Restoration Study: Report to Congress (Draft Report). *ANS Digest*: vol. 1, no. 1. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

U.S. Fish and Wildlife Service, and U.S. Census Bureau. 2006. National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, Census Bureau, Washington, D.C.

U.S. Congress, Office of Technology Assessment. 1993. Harmful non-indigenous species in the United States OTA-F565. U.S. Government Printing Office, Washington, D.C.

Windle, P. N., R. H. Kranz, and M. La. 2008. Invasive species in Ohio: Pathways, policies, and costs. Union of Concerned Scientists, Cambridge, MA.

Winslow, C. J. 2010. Competitive interactions between young-of-the-year smallmouth bass and round goby. PhD dissertation, Bowling Green State University, Bowling Green, OH.

IX. GLOSSARY

Aquatic invasive species (or aquatic nuisance species) – Animals, plants, or other organisms that adversely affect the habitats they invade economically, environmentally, and/or ecologically. Such invasive species may disrupt recreation, economy, and/or ecology by dominating a region.

Ballast water – Any water used to manipulate the trim and stability of a ship or boat.

Best management practices – A method or technique that has consistently shown results superior to those achieved with other means, and that is used as a benchmark.

Diploid – The natural state of having paired sets of chromosomes in a cell or cell nucleus allowing an animal to reproduce sexually.

Exotic – See “nonindigenous.”

Exclusive Economic Zone – The sea zone prescribed by the United Nations Convention on the Law of the Sea over which a state has special rights. It stretches from the seaward edge of the state's territorial sea out to 200 nautical miles from its coast.

Nonindigenous – A plant, animal, or other organism that is not native to a region.

Plankton – Small organisms that drift with water currents. Phytoplankton (including algae) and zooplankton (very small animals, like water fleas) form the basis of aquatic food webs.

Triploid – The state of having three sets of chromosomes in the cell or cell nucleus that prevents reproduction. Triploidy is induced in some managed, stocked animals.

Vector/Pathway – The path by which an organism can travel.

Watershed – The entire drainage basin of a water body or region including all living and nonliving components.

X. ACRONYMS

ACRCC - Asian Carp Regional Coordinating Committee
AIS - Aquatic invasive species
ANSTF - Aquatic Nuisance Species Task Force
BMPs - Best Management Practices
BWE - Ballast Water Exchange
DOW - Division of Wildlife
EEZ - Exclusive Economic Zone
IMO - International Maritime Organization's
NANPCA - Nonindigenous Aquatic Nuisance Prevention and Control Act
NGO - Non-government organizations
NISA – National Invasive Species Act
NOAA - National Oceanic and Atmospheric Administration
OAC - Ohio Administrative Code
OAISC - Ohio Aquatic Invasive Species Committee
OCMP - Ohio Coastal Management Program
ODA - Ohio Department of Agriculture
ODNR - Ohio Departments of Natural Resources
OEPA - Ohio Environmental Protection Agency
OIPC - Ohio Invasive Plants Council
ORC - Ohio Revised Code
SMP - State Management Plan
US – United States
USACE - U.S. Army Corps of Engineers
USCG - U.S. Coast Guard
USEPA - U.S. Environmental Protection Agency
USFWS – United States Fish & Wildlife Service
USGS – United States Geologic Survey
VGP - Vessel General Permit
VHS - Viral Hemorrhagic Septicemia

XI. OHIO AQUATIC INVASIVE SPECIES COMMITTEE

Eric Boyda	Appalachian Ohio Weed Control Partnership
Jennifer Hillmer	Cleveland Metroparks
Linda Sekura	Cleveland Museum of Natural History
Doug Warmolts	Columbus Zoo and Aquarium
Dave Smith	Freshwater Farms of Ohio
Don Arcuri	Great Lakes Fish Commission
Mike Matta	Great Lakes Fish Commission
Rick Graham	Izaak Walton League
Glen Nekvasil	Lake Carriers Association
Jeff Tyson	ODNR Division of Wildlife
Jennifer Windus	ODNR Division of Wildlife
John Navarro	ODNR Division of Wildlife
Kevin Kayle	ODNR Division of Wildlife
Natalie Pirvu	ODNR Division of Watercraft
Kristy Meyer	Ohio Environmental Council
Ben Rich	Ohio Environmental Protection Agency
Brian Hall	Ohio Environmental Protection Agency
Jeff Thomas	Ohio River Valley Water Sanitation Commission
Tory Gabriel	Ohio Sea Grant
Christopher Winslow	Ohio Sea Grant
Jim Wentz	Silvertip Productions
John Stark	The Nature Conservancy
Eugene Braig	The Ohio State University
Matt Misicka	The Ohio State University
Jay Hemdal	Toledo Zoo
Jeromy Applegate	US Fish and Wildlife Service