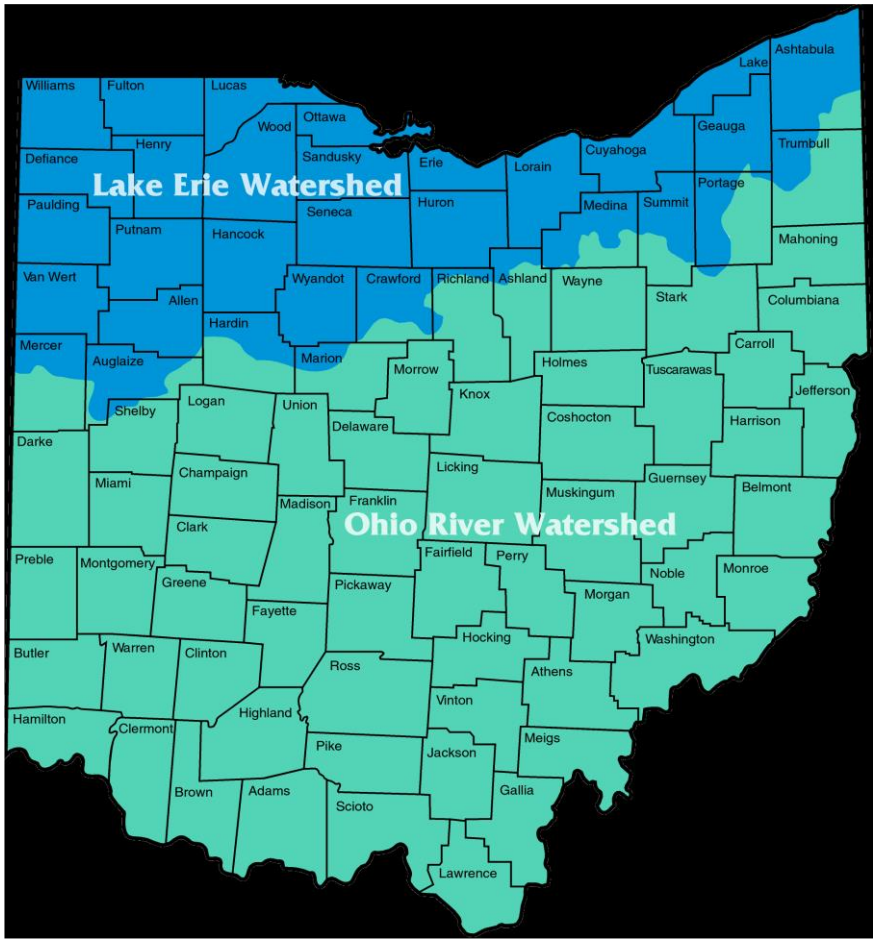
Invasive Carp Tactical Plan 2021-2030

Ohio Department of Natural Resources

Division of Wildlife



April 2021

Mission Statement:
The mission of the Ohio Department of Natural Resources (ODNR) Division of Wildlife is to conserve and improve fish and wildlife resources and their habitats for sustainable use and appreciation by all.

Acknowledgements:

- Scott Hale, Executive Administrator, Fish Management and Research
- John Navarro, Aquatic Stewardship Program Administrator
- Travis Hartman, Lake Erie Fisheries Program Administrator
- Rich Zweifel, Inland Fisheries Program Administrator
- Eric Weimer, Supervisor, Sandusky Fisheries Research Unit

Recommended Citation:
ODNR Division of Wildlife. 2019. Lake Erie Grass Carp Response Strategy: 2019-2023. Ohio Department of Natural Resources, Division of Wildlife. Columbus, Ohio.

Contents:

I. Executive Summary

"Invasive Carp" refers to a select group of cyprinid fishes (minnow family) that are native to Asia. The United States Fish and Wildlife Service (USFWS) specifically uses "Invasive Carp" to refer to Bighead Carp *Hypophthalmichthys nobilis*, Silver Carp *H. molitrix*, Grass Carp *Ctenopharyngodon idella*, and Black Carp *Mylopharyngodon piceus*. Each of these species was brought to the United States as a biological control and are now in the wild and pose a threat to Ohio's aquatic ecosystems. In Ohio, the Invasive Carp of greatest concern are Bighead Carp and Silver Carp. Bighead Carp and Silver Carp are filter feeders that feed primarily on zooplankton and phytoplankton and are considered a detriment to aquatic food webs and potential competitors with native Ohio fishes. Black Carp are a molluscivore that could impact native snail and mussel populations if they show up in Ohio and Grass Carp are a threat because of their potential to negatively impact aquatic vegetation which provides an important food source for waterfowl and habitat for native fishes.

Ohio is part of two major watersheds and some perspectives of the Invasive Carp threat are unique to each watershed. The northern third of Ohio is within the Lake Erie watershed and currently does not have an established population of Bighead, Silver, or Black carp but has a reproducing population of Grass Carp in the western basin. The southern two-thirds of Ohio are within the Ohio River watershed where adult Bighead Carp are found in low numbers throughout Ohio's entire portion of the Ohio River mainstem and Silver Carp are found in low numbers up to the R.C. Byrd Pool of the Ohio River below Gallipolis, Ohio. Adult Black Carp are not yet in Ohio but are found in the lower part of the Ohio River in Illinois and could eventually invade. Due to these circumstances, the Ohio Department of Natural Resources, Division of Wildlife (DOW) approach to Invasive Carp management will be based on the current distribution, threat level, availability of resources (staff and funding), and our ability to effectively manage the situation; therefore, this tactical plan has chapters to address:

- Lake Erie watershed, where there are reproducing Grass Carp in the western basin of the lake but where Bighead, Silver, and Black carps are not present.
- Ohio River watershed, where Bighead, Silver, and Grass carps are present and where there are captures of adult Black Carp in the lower end of the Ohio River in Illinois.
- Communication among agencies, non-governmental organizations, universities, and the public.

The Invasive Carp Tactical Plan focuses on relative risks and meaningful strategies developed to respond to threats from these invasive fishes, including:

1. Ensure the potential for unintentional introductions are minimized and connections between the Ohio River and Lake Erie watersheds are closed to the greatest extent possible.
2. Utilize regional partnerships supported by federal funding sources to reduce the number of grass carp in the Lake Erie watershed with the intent of eradication.
3. Characterize current populations of Invasive Carps and the locations of potential new introductions; and
4. Communication between agencies and with the public.

The Ohio Invasive Carp Tactical Plan provides a foundation for on-the-ground work that will be conducted during 2021 -2030 and future planning. Experience gained from plan development and implementation should promote adaptive progress and continual improvement well into the future. The core components of the plan are steps to accomplish five broad outcomes (goals) and their associated objectives by 2030.

II. Invasive Carp Invasion: A Problem for Ohio Waters

"Invasive Carp" refers to a select group of cyprinid fishes (minnow family) that are native to Asia. The United States Fish and Wildlife Service (USFWS) specifically uses "Invasive Carp" to refer to Bighead Carp *Hypophthalmichthys nobilis*, Silver Carp *H. molitrix*, Grass Carp *Ctenopharyngodon idella*, and Black
Carp *Mylopharyngodon piceus*. Other invasive cyprinids include 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, and all pose a threat to Ohio's aquatic ecosystems.
Bighead Carp, and Silver Carp were brought to the United States in 1972 and 1973, respectively, as aquaculture products, to control plankton, and improve water quality in aquaculture and wastewater treatment facilities. By the early 1980s, both species had escaped into the Mississippi River watershed during floods. Additional fish escaped during the 1980s and began migrating into the Missouri and Illinois Rivers following heavy flooding of the Mississippi River during the early 1990s. They have since spread upriver and become among the most abundant fishes in some regions of the Mississippi, lower Ohio, and Illinois rivers (Figures 1 and 2). The USFWS has listed Bighead Carp (2011), Silver Carp (2007), and Black Carp (2007) as "injurious species", making live transport of these species illegal under the federal Lacy Act. Recent legal challenges have weakened the Lacy Act so individual states in the Great Lakes basin have tightened their regulations and these species are currently illegal to possess alive in any of the Great Lakes states.

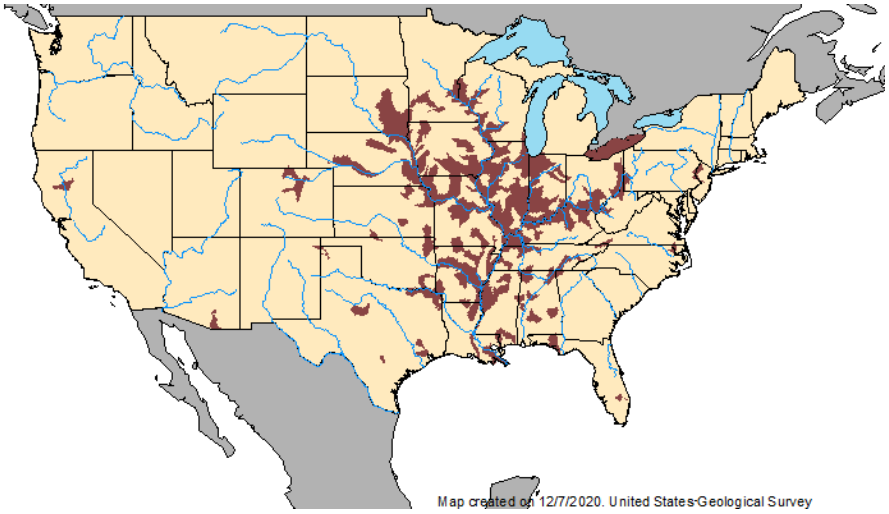


Figure 1. Distribution of Bighead Carp *Hypophthalmichthys nobilis*. The map was generated using data from the USGS Nonindigenous Aquatic Species Database as of December 2020. Even though three Bighead Carp were collected in Lake Erie in the 1980's, none have been collected sense and they are not considered established.

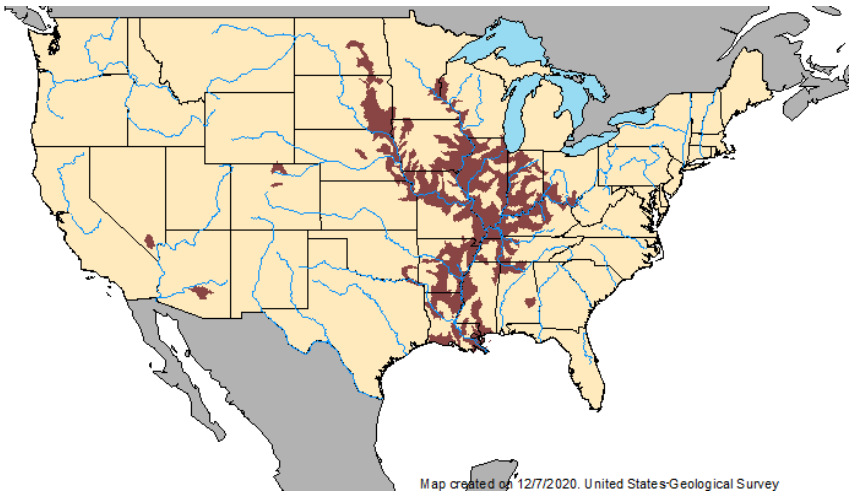


Figure 2. Distribution of Silver Carp *Hypophthalmichthys molitrix*. The map was generated using data from the USGS Nonindigenous Aquatic Species Database as of December 2020.

Grass Carp were imported into Alabama and Arkansas aquaculture facilities in 1963 to control vegetation in rearing ponds. They were widely stocked in aquaculture facilities or into public waterways, and their range was expanded by intentional releases and accidental escapes. Many of the 45 states where Grass Carp are now found, including Ohio, have banned stocking fertile diploid Grass Carp but allow the sale and stocking of sterile triploid Grass Carp by permitted aquaculture facilities. Among states in the Great Lakes Basin, Grass Carp are either illegal to possess or sterile fish must be used. Ohio has allowed the stocking of triploid Grass Carp since 1988. Current Grass Carp distribution is shown in Figure 3.

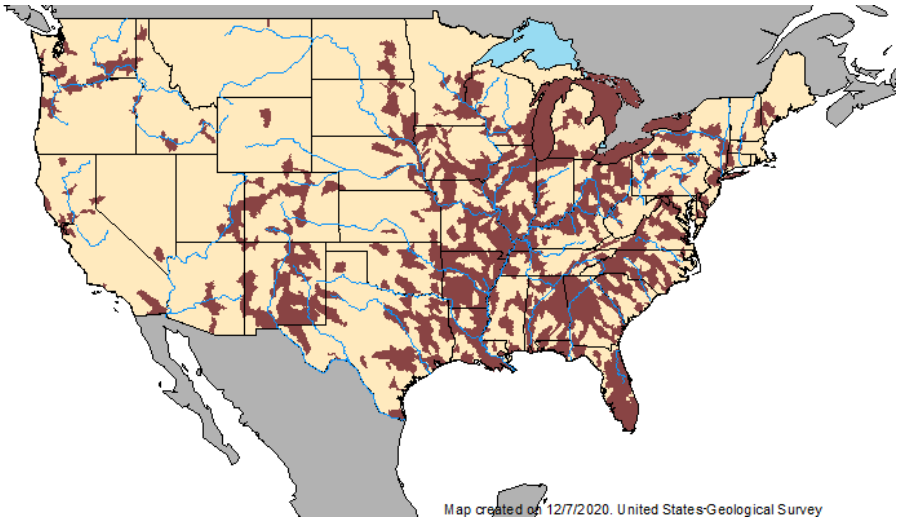


Figure 3. Distribution of Grass Carp *Ctenopharyngodon idella*. The map was generated using data from the USGS Nonindigenous Aquatic Species Database as of December 2020.

Black Carp were brought to the United States to control snail populations in private aquaculture facilities and escaped from holding ponds in Missouri during 1994 when high water flooded a facility near Lake of the Ozarks and allowed the loss of fish. Recent collections suggest that the Black Carp are

established in the lower portion of the Mississippi River basin and the lower portion of the Ohio River (Figure 4).

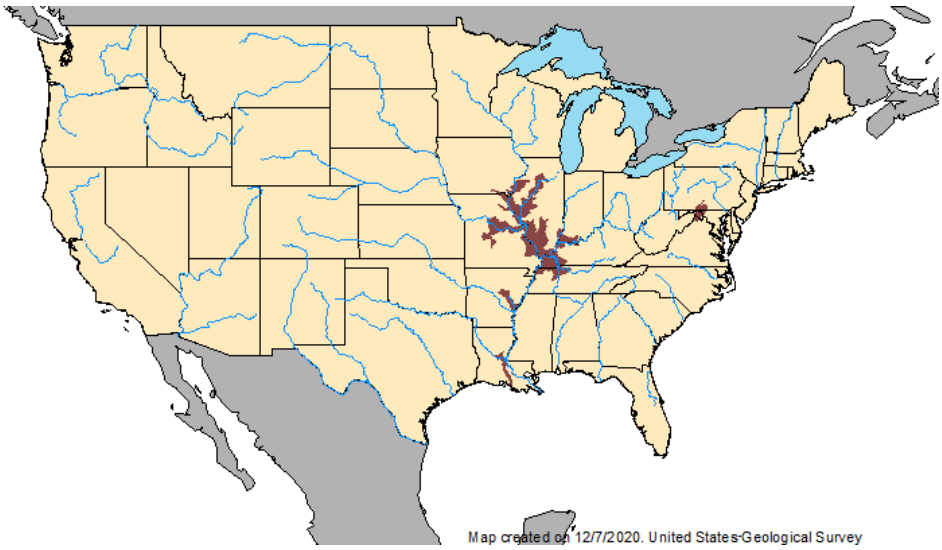


Figure 4. Distribution of Black Carp *Mylopharyngodon piceus*. The map was generated using data from the USGS Nonindigenous Aquatic Species Database as of December 2020.

Threat to Ohio

In Ohio, the Invasive Carps of greatest concern are Bighead Carp and Silver Carp. Both fishes can live more than 20 years and grow too large sizes, with individual Bighead Carp approaching 100 pounds and Silver Carp approaching 60 pounds (Conover et al. 2007). Bighead Carp and Silver Carp are filter feeders that primarily eat phytoplankton and zooplankton but also consume aquatic insects and detritus (Conover et al. 2007). They are potential competitors with native planktivores such as Gizzard Shad, Emerald Shiners, Bigmouth Buffalo, Paddlefish, and juvenile sport fishes, likely affecting aquatic ecosystems through food web interactions.

Bighead Carp was first found in the Ohio River near Smithland Dam (River Mile 919) in 1981 and Bighead Carp and Silver Carp are now established in the Ohio River mainstem and major tributaries downstream of the McAlpine Dam (River Mile XXX), near Louisville, Kentucky. If Bighead Carp and Silver Carp were to become established in Ohio waters, the extent of the effect these species would have is unclear, however, in the Mississippi and Illinois rivers where dense populations have been established for decades they are causing reductions in native fishes that rely on plankton for food, including early life stages (Sampson et al. 2003; Irons et al. 2007; Schuyler et al. 2009). Additionally, because Silver Carp will jump when disturbed by boat motors, areas of high density are now a hazard to boaters and has decreased the recreational value of those waters.

Models of Bighead Carp and Silver Carp diet and bioenergetics indicate that some areas of the Great Lakes, particularly western Lake Erie, have sufficient food resources to support populations of Bighead Carp and Silver Carp (Herborg et al. 2007; Cooke and Hill 2010; Chapman, personal communication). Other locations within Lake Erie that likely have suitable food resources include harbors and bays such as Presque Isle Bay, Long Point Bay, and Rondeau Bay. Preliminary ecosystem modeling of Bighead Carp and Silver Carp effects in Lake Erie suggest potential reductions in planktivore biomass and larval fish densities, but modest increases in piscivore biomass associated with predation on young Bighead

Carp and Silver Carp (Dr. Edward Rutherford, NOAA-GLERL, personal communication). A risk analysis by Cudmore et al. (2012) suggested a greater than 50% probability of successful Bighead Carp or Silver Carp spawning each year in Lake Erie. Additionally, analysis of United States tributaries to Lake Erie indicated that there is suitable spawning habitat for Bighead Carp and Silver Carp, with the Maumee and Sandusky rivers identified as the most likely tributaries to support successful spawning (Kolar et al. 2005; Kocovsky et al. 2012; Garcia et al. 2013).

There is high potential for Bighead Carp and Silver Carp to cause significant economic effects in the Great Lakes because of the value of the commercial and recreational fisheries the lakes support. Michigan Sea Grant (2020) indicated that the Great Lakes support more than 1.3 million jobs that generate $82 billion in annual wages. The coastal counties of the eight Great Lakes states produce 21% of the gross domestic product in the region and 5.8% of the U.S. GDP (The Dynamic Great Lakes Economy: employment trends from 2009-2018).

Ohio is bordered on the south by the Ohio River, which is a tributary of the Mississippi River, the largest river system in North America. The Mississippi River and its many tributaries drain all or part of 31 states and two provinces between the Rocky and Appalachian Mountains. Flowing entirely within the United States, the Mississippi River originates in northern Minnesota and meanders southward for 4,074 km (2,530 mi) to the Gulf of Mexico. Aquatic systems have been greatly affected by several invasive fishes, plants, and mussels, and continue to be threatened by new AIS introductions. Placing an economic value on biological invasions in the Mississippi River Basin is not straightforward (Windle et al. 2008); consequently, there is not a comprehensive aggregate estimate for the cost of the invasion of Bighead Carp and Silver Carp in this region, however it has the potential to be significant.

Ohio is part of two major watersheds (Figure 5) and the threats posed by Invasive Carp are unique to each watershed. The northern third of Ohio is within the Lake Erie watershed and currently does not have an established population of Bighead, Silver, or Black carps. The southern two-thirds of Ohio falls within the Ohio River watershed where adult Bighead Carp are found in low numbers throughout Ohio's portion of the Ohio River mainstem and Silver Carp are found in low numbers up to the R.C. Byrd Pool of the Ohio River mainstem below Gallipolis, Ohio. Grass Carp are found throughout the state, in both watersheds, with a reproducing population in the western basin of Lake Erie. Adult Black Carp have been found in the lower part of the Ohio River in Illinois and could eventually invade Ohio waters. Due to these circumstances, the DOW approach to management of Bighead, Silver, and Grass carps will be based on the current distribution, threat level, resources available (i.e., funding and staff) and our ability to manage the situation; therefore, this tactical plan has chapters to address:

- Lake Erie watershed, where there are reproducing Grass Carp in the western basin of the lake but where Bighead, Silver, and Black carps are not present.
- Ohio River watershed, where Bighead, Silver, and Grass carps are present and where there are captures of adult Black Carp in the lower end of the Ohio River in Illinois.
- Communication among agencies, non-governmental organizations, universities, and the public.

Figure 5. Delineation of the Ohio River and Lake Erie watersheds

Black carp are not yet considered a threat to Ohio because they are still only found in the lower reaches of the Ohio River. Should this situation change, Black Carp would be added to the Invasive Carp Tactical Plan rather than being addressed in the more general Ohio Aquatic Invasive Species Plan (ODNR 2013). The Invasive Carp Tactical Plan focuses on relative risks and meaningful strategies related to Bighead, Silver, and Grass carps, including:

- Ensure the potential for unintentional introductions are minimized and connections between the Ohio River and Lake Erie watersheds are closed to the greatest extent possible.
- Utilize regional partnerships supported by federal funding sources to reduce the number of grass carp in the Lake Erie watershed with the intent of eradication.
- Characterize current populations of Invasive Carps and the locations of potential new introductions; and
- Communication between agencies and with the public.

The Asian Carp Regional Coordinating Committee (ACRCC) was originally formed to focus on preventing Bighead Carp and Silver Carp movement through the Chicago Area Waterway System (CAWS) and is comprised of several agencies, stakeholders, and partners. The ACRCC now focuses on all four Invasive

Carp species throughout the entire Great Lakes Basin and uses the Management and Control Plan for Bighead, Black, Grass, and Silver carps in the United States (Conover et al. 2007). Other partners engaged in the Invasive Carp efforts include the Great Lakes Commission (GLC), the Ohio Lake Erie Commission (OLEC), Great Lakes Fishery Commission (GLFC), Lake Erie Committee of the GLFC (LEC), Great Lakes and Mississippi River basin AIS panels (MRBP and GLP), and the Ohio River Fisheries Management Team (ORFMT). Management authority and responsibility for fisheries management resides within each state or province; however, cooperative inter-agency partnerships are essential in addressing regional, national, and international AIS issues.

The threat of Bighead Carp and Silver Carp entering the Great Lakes through the CAWS has generated national interest and the Great Lake states are working with Federal agencies to provide a one-way barrier to the movement of AIS from the Mississippi River and the Great Lakes at Brandon Road Lock and Dam. Efforts at the CAWS was also the basis of the initiation of the Great Lakes Mississippi River Inter-basin Study (GLMRIS) by the U.S. Army Corps of Engineers (USACE) to determine if other direct water connections exist that could facilitate AIS movement into the GL basin. Four connections were identified in Ohio, two of which were identified as medium risk for the transfer of AIS, including Bighead Carp and Silver Carp. The Ohio GLMRIS project summaries and status are as follows:

- Low Risk
    - Mosquito Creek Lake (Trumbull County): This connection is at the north end of Mosquito Creek Lake and has the potential to form a connection during flooding conditions. A Preliminary engineering assessment determined that the risk for AIS transfer at this location was minimal, consequently the project was not advanced for closure.
    - Grand Lake St Marys (Auglaize County): This connection is at Grand Lake St Marys and the solution is a screening structure at the east end of the lake to prevent AIS movement from the Ohio River basin to the Lake Erie basin. The preliminary design is complete, and the next steps are final design and construction.
- Medium Risk
    - Ohio Erie Canal (Summit County): This connection is at the historic Ohio Erie Canal and was closed to the movement of AIS by the USACE in 2020. The ODNR Division of Wildlife is responsible for long-term maintenance.
    - Little Killbuck Creek (Medina County): This connection is a low-lying area between Little Killbuck Creek (Ohio River watershed) and the Black River (Lake Erie watershed) that connects during flood conditions. The solution is a rock berm to prevent AIS movement between the basins. The 25% design is complete and the final steps and land acquisition, final design, and construction.

There is also a renewed interest in controlling the movement of Bighead Carp and Silver Carp in the Mississippi River basin. Recent Federal funding has been made available to focus efforts on the Mississippi River basin and an Ohio River Sub-Basin Invasive Carp Action Plan was developed.

III. Division of Wildlife Position Statement

Stopping expansion and/or new introductions of AIS is the most cost-effective approach to combat AIS; once an AIS becomes established, it is practically impossible to eradicate these populations. Invasive Carp pose serious threats to Ohio's sport and commercial fisheries, ecosystem integrity, and

economy should populations become established. At this time Bighead Carp and Silver Carp are not known to be present in the Lake Erie watershed. Individual Bighead Carp were collected in Lake Erie decades ago, but no individuals have been collected since and we consider these an anomaly. Recent monitoring in the Ohio River has revealed low abundances of Bighead Carp throughout Ohio's portion of the Ohio River and low numbers of Silver Carp upstream to the R.C. Byrd Pool of the Ohio River below Gallipolis, Ohio. Triploid Grass Carp have been stocked throughout Ohio to control aquatic vegetation, but some Grass Carp have been identified as diploids with the potential to reproduce. Reproduction of Grass Carp has been confirmed in Lake Erie and steps are being taken to eradicate these populations. Black Carp have not yet reached Ohio but their expansion into the lower reach of the Ohio River in Illinois indicates that they will show up eventually and will need to be addressed.

The differing status and circumstance of the Invasive Carp species in Ohio necessitate development of strategies to address each separately. The DOW seeks to:

- Prevent establishment of invasive Bighead Carp, Silver Carp, and Black Carp in the Lake Erie watershed.
- Prevent further expansion of Ohio River Bighead Carp and Silver Carp populations to other inland waters within the Ohio River watershed.
- Prevent importation of diploid Grass Carp from outside of Ohio.
- Prevent establishment of reproducing populations of Grass Carp and eradicate reproductively viable fish from Lake Erie.
- Continue to monitor Black Carp populations and prepare for their eventual invasion into Ohio.

The DOW will use strategic and measured approaches to:

- Plan and implement actions that are deliberate, realistic, and associated with desired outcomes and clear objectives.
- Address sources and vectors of Invasive Carp to prevent expansion.
- Communicate issues and findings effectively among partner agencies, non-governmental organizations, universities, and the public.
- Collaborate with state, provincial, and federal partners through existing organizations such as the LEC, ORFMT, ACRCC, and others.
- Support research that fills knowledge gaps pertaining to the general biology, distribution, habitat use, and ecological role of Invasive Carp.
- Apply new or emerging science as tools or technologies developed to prevent the introduction or minimize the spread of Invasive Carp.
- In collaboration with other agency and university partners, work to eradicate Grass Carp from Lake Erie.
- Maintain updated contingency response plans in the event of unexpected findings of Invasive Carp in either watershed.

The DOW response to Invasive Carp must be adaptive, consistent with agency authority and responsibility, and have continued Federal support. Adaptive approaches are essential to capitalize on new information or perspectives, whether derived from lessons learned through adaptive management, collaborative insights, and closing knowledge gaps though research. Agency authority and responsibility identified in Ohio Revised Code (ORC) and Ohio Administrative Code (OAC) present legal sideboards associated with laws, regulations, and jurisdiction that must be considered.

Sustainable approaches are essential because Invasive Carp present a long-term threat to many Ohio water bodies that the DOW manages. As a result, tactical responses must be prudent and cannot tax agency resources to an extent that it compromises the agency's mission and core responsibilities to manage fish and wildlife. Collaboration with partner agencies, federal support, and shared benefits from existing agency and partner work is critical to ensuring that an effective and meaningful response to Invasive Carp in Ohio is possible and sustainable.

The DOW operates under an organizational approach referred to as a Comprehensive Management System, or CMS (CMS Steering Committee 2011), a process for agency function that is summarized in Appendix A.

IV. Lake Erie Watershed

Background and Situation Analysis

Ohio's jurisdiction of Lake Erie includes 937,000 ha (2.3 million acres) and 502 km (312 mi) of shoreline, and all associated Ohio tributaries. However, due to the inter-jurisdictional nature of Lake Erie fisheries, they are managed cooperatively by Michigan, Ohio, New York, Pennsylvania, and the Province of Ontario under auspices of the Joint Strategic Plan for Management of Great Lakes Fisheries (GLFC 2007) through the LEC of the GLFC. All jurisdictions manage the fishery resources cooperatively through consensus-based decision making while still maintaining management authority within their waters

Ohio's Lake Erie recreational fisheries are economically important. Each year anglers expend nearly 4 million hours of effort to harvest 2.7 million kg (6 million lbs.) of fish, generating over $760 million in economic revenue for the region (Southwick Associates 2012). The total number of anglers using Lake Erie fisheries is unknown, but information from Ohio fishing license sales, the USFWS (U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau 2012), and Southwick Associates (2012) suggests that more than 332,000 anglers fish Lake Erie each year. These anglers provide more than $486 million in direct retail sales and support over 7,000 jobs. Included among these is the Ohio charter boat fleet, the largest jurisdictional fleet on any Great Lake, which routinely exceeds 700 licensed guides (ODNR 2020; Lucente et al. 2013). Ohio's recreational fisheries target a host of species including Walleye *Stizostedion vitreus*, Yellow Perch *Perca flavescens*, Smallmouth Bass *Micropterus dolomieu*, Largemouth Bass *Micropterus salmoides*, White Bass *Morone chrysops*, and Steelhead *Oncorhynchus mykiss*. Walleye is the most sought-after species, with Yellow Perch traditionally being second.

Ohio's portion of Lake Erie also supports a commercial fishery that routinely lands over 1.8 million kg (4 million lbs.) of fish annually, with a landed value of over $4 million (ODNR 2020). This fishery consists of 18 commercial trapnet licenses and 25 commercial seine licenses (11 of the 25 seine licenses were active in 2020). Commercial trapnets harvest Yellow Perch for the wholesale fresh and frozen fish markets. Commercial seines harvest for both the fresh and frozen markets, live fish supply markets in large metropolitan areas, and private pay lakes in Ohio and Indiana. Over 60% of the commercial harvest poundage from Lake Erie consists of fishes that are underutilized by the recreational fishery (e.g., White Bass, White Perch *Morone americana*, Freshwater Drum *Aplodinotus grunniens*, and Channel Catfish Ictalurus punctatus); however, Yellow Perch represent over 70% of the total landed value of the commercial catch. Ohio's annual commercial harvest of Yellow Perch averages 635,029 kg (1.4 million lbs.).

Lake Erie also supports several threatened and endangered species, and species of special concern including Ciscoes *Coregonus artedi*, Lake Sturgeon *Acipenser fulvescens*, and Lake Whitefish *Coregonus clupeaformis* which were all historically important in commercial fisheries.

Lake Whitefish currently supports a limited commercial fishery in Lake Erie, while Lake Sturgeon and Ciscoes are restricted from both recreational and commercial harvest. Other species, including Pugnose Shiner *Notropis anogenus*, Longnose Sucker *Notropis longirostris*, Burbot *Lota lota*, Lake Trout *Salvelinus namaycush*, and Channel Darter *Percina copelandi* are listed as threatened, endangered, or of special concern and contribute to the biodiversity of the Lake Erie fish community. For more information on Ohio's listed species, visit:(https://ohiodnr.gov/static/documents/wildlife/state-listed-species/Ohio's%20Listed%20Species%20pub356.pdf

Lake Erie has been the recipient of many AIS over the past century (Mills et al. 1994). Most of the major introductions prior to 1980 were fishes that entered the lake through the Welland Shipping Canal, including Sea Lamprey *Petromyzon marinus*, Alewife *Alosa pseudoharengus*, and White Perch. Other non-native fishes, including Rainbow Smelt *Osmerus mordax* and Common Carp, were intentionally introduced. All these species have naturalized, reproducing populations in Lake Erie at present, and Common Carp, Rainbow Smelt, and White Perch provide fishery benefits, but at a much lower value than native species. After 1980, the most important source of introductions to Lake Erie has been through ballast water discharge from commercial freighters. Species introduced through this vector include Zebra Mussels *Dreissena polymorpha* and Quagga Mussels *Dreissena rostriformis bugensis*, Round Goby *Neogobius melanostomus*, Spiny Water Flea *Bythotrephes longimanus* and Fishhook Water Flea *Cercopagis pengoi* and the Bloody Red Shrimp *Hemimysis anomala*. The long-term effects of invasive species on the native fauna of Lake Erie and its fisheries are uncertain but are clearly not beneficial. Institutional programs have been implemented only for Sea Lamprey, costing approximately $20 million per year to administer (http://www.glfc.org/sea-lamprey.php). Preventing the establishment of reproducing populations of invasive species in Lake Erie is, by far, the most cost-effective measure. Once established the only effective means of addressing them is to consider what compensatory actions might be necessary and available to mitigate the negative effects on the native fish community.

Bighead Carp and Silver Carp

History in Lake Erie: There have been three documented occurrences of Bighead Carp in Lake Erie, with all occurring in the late 1990s and early 2000s (Morrison et al. 2004). The first documented occurrence was a Bighead Carp captured in a commercial trapnet in Ohio waters off Cedar Point, Sandusky Bay, Ohio during May 1995. The fish measured 606 mm and is archived at the Ohio State University Museum of Biological Diversity. Growth chronology analysis suggested that the fish was approximately six years old and growth checks suggested that the fish may have entered the Lake Erie environment during 1993 or 1994. The second documented occurrence was a Bighead Carp captured by a commercial seine in Sandusky Bay during June 2000. This fish measured 900 mm. No growth analysis was conducted on this individual and the specimen was not archived. The third documented occurrence was a Bighead Carp captured in a commercial trapnet in Ontario waters just west of Point Pelee during October 2000. This fish was a mature female measuring 937 mm and is archived at the Royal Ontario Museum. Growth chronology analysis on this fish suggested that it was 8 to 10 years old at capture and may have been introduced into the Lake Erie environment during the same period as

the 1995 capture (Morrison et al. 2004). There have been no other captures of Bighead Carp in Lake Erie since 2000 and no documented occurrences of Silver Carp in Lake Erie to date.

Environmental DNA Sampling: Environmental DNA (eDNA; DNA associated with shed or sloughed microscopic tissue fragments in the water column) is a tool for the early detection and surveillance of invasive species such as Bighead Carp and Silver Carp (Jerde et al. 2011). Beginning in August 2011, efforts began to collect eDNA samples from Lake Erie embayments and tributaries as a surveillance method for Bighead Carp and Silver Carp, and later for Grass Carp (Table 1). In many cases eDNA sampling was accompanied by targeted sampling using gill nets, electrofishing, commercial seines, and other fisheries assessment gear. Despite the increased surveillance and targeted effort since 2011 no Bighead or Silver carp have been captured in Lake Erie during targeted efforts or as bycatch during fisheries management assessments or commercial fishing (LEC Invasive Carp Fact Sheet). It is important to note that the positive eDNA sample results in Table 1 do not necessarily indicate the presence of a live fish because there are other sources of eDNA that could account for a positive sample result, consequently, these results should be viewed with caution.

Table 1. Environmental DNA (eDNA) sampling for invasive carps in Ohio waters of Lake Erie and tributaries, 2011-2019.

Year	Month	Location	# Samples	Positive Detections	
				Bighead	Silver
2011	August	Maumee & Sandusky Bay; Lorain Harbor	417	4	2
2013	June	Maumee & Sandusky River	325	0	1
2014	April-June	Black, Cuyahoga, Grand, Huron, Maumee, Ottawa, Portage, Sandusky, and Vermilion Rivers; Conneaut Creek	1275	0	0
2015	April-June	Black, Cuyahoga, Grand, Huron, Maumee, Ottawa, Portage, and Sandusky Rivers	1713	0	0
2016	April-June	Cuyahoga, Grand Maumee, and Sandusky Rivers	1378	0	0
2017	April-June	Cuyahoga, Grand, Maumee, and Sandusky Rivers	2323	0	0
2018	April-June	Cuyahoga, Grand, Maumee, and Sandusky Rivers	2320	0	0
2019*	April/May, Sept., Nov.	Maumee and Sandusky Rivers	1954	0	1

Several conclusions can be drawn from the results of the extensive eDNA and traditional sampling that has occurred in the Lake Erie watershed since 2011. First, if Bighead Carp or Silver Carp are present in the Lake Erie system, they are likely in relatively low abundance. There is currently no evidence that Bighead Carp or Silver Carp have established reproducing, self-sustaining populations in Lake Erie. Bighead Carp have been documented in the system; however, individuals have not been captured and reported to DOW in more than two decades. Considering the extent of agency fisheries assessment surveys, commercial seine and trap net effort, and the amount of recreational angling in Ohio waters of Lake Erie, the lack of Bighead Carp and Silver Carp bycatch indicates extremely low numbers or complete absence.

Second, eDNA sampling techniques have been in development since 2009. The use of eDNA as an early detection tool presents enormous opportunities for AIS detection and control; however, there remain uncertainties associated with interpretation of eDNA results. Positive eDNA results could be interpreted several ways, particularly when live specimens are not collected in conjunction with these results. Besides live specimens of Bighead Carp and Silver Carp, other sources of eDNA in the Lake Erie environment could include commercial live haul water, bait transportation water, bird feces, or dead (market) fish (USACE 2012b). False positive results are also possible, and the false positive rates are not well understood (Qian et al. 2020). Therefore, additional research is needed on calibration of eDNA results, as well as persistence of eDNA in the environment, to assist management agencies in interpretation of eDNA results.

The LEC established a position statement for Lake Erie fisheries management agencies that outlines strategies each agency should undertake to minimize the risk of establishment of Bighead Carp and Silver Carp in the Lake Erie ecosystem within Michigan, Ohio, New York, Pennsylvania, and Ontario (http://glfc.org/pubs/clc/CLC%20position%20statement%20about%20Asian%20carps_FINAL.pdf). Those strategies include: 1) a recognition that unified decision-making by the GLFC LEC is imperative to minimize risk of introduction; 2) state and provincial agencies should work to identify potential sources and vectors for introduction of Bighead Carp and Silver Carp into Lake Erie and minimize those risks; 3) state and provincial agencies should work to minimize the risk of introductions of Bighead Carp and Silver Carp through physical connections; 4) coordinated actions by state, provincial, and federal partners will be necessary; and 5) additional research is imperative to understand the tools available for detection, strategies for prevention and control, or mitigation of effects.

Issue: Bighead Carp and Silver Carp are present in the Ohio River watershed but have yet to be found in the Lake Erie watershed. Bighead Carp and Silver Carp must be prevented from becoming established in Lake Erie. If these fishes become established in Lake Erie, they are expected to negatively affect foodwebs that are critical to supporting native species that allow for economically important sport and commercial fisheries.

Outcome 1: Bighead Carp and Silver Carp are prevented from becoming established in Lake Erie.

Objective 1.1: Create permanent separation of Ohio's critical AIS pathways at Little Killbuck Creek by 2024 and Grand Lake St Marys by 2022 and provide long-term maintenance at the connection at Ohio Erie Canal that was closed in 2020.

Problems:

- Three critical hydrologic pathways have been identified in Ohio as potential sources of Bighead Carp and Silver Carp introduction from the Mississippi River watershed (USACE 2012a). The connection at Little Killbuck Creek is considered medium risk and the connection at Grand Lake St. Marys is considered low risk.
- Creating permanent separation of critical pathways requires funding, private-public partnerships, inter-agency cooperation, and can involve extensive engineering plans, design, and construction.

Strategies:

- Leverage Great Lakes Restoration Initiative (GLRI) funds to address critical pathway closures to the greatest extent possible at Little Killbuck Creek.
- Work with private landowners to facilitate closure of the Little Killbuck Creek pathway.
- In partnership with the Division of Parks and Watercraft, provide long-term maintenance of the AIS closure measures implemented by the USACE at the Ohio Erie Canal pathway.
- Work with the Division of Parks and Watercraft to close the pathway at Grand Lake St. Marys and provide long-term maintenance of the closure measures.

Supporting Actions:

- FCGX05: Aquatic Invasive Species – Early Detection and Rapid Response
- FCGX06: Closure of the Little Killbuck Creek GLMRIS Connection
- FCGX07: Closure of the Grand Lake St Marys GLMRIS Connection
- FCGX08: Closure of the Ohio Erie Canal GLMRIS Connection

Objective 1.2: Collaborate with partners to support permanent hydrologic separation of the Mississippi River and Great Lakes basins at the Chicago Area Waterway System (CAWS) so that a strategy for separation is identified as soon as possible.

Problems:

- The CAWS provides the single greatest risk of Bighead Carp and Silver Carp invasion to the Great Lakes (ACRCC 2010; USACE 2012a; GLC 2012).
- A series of electric barriers are currently the only obstacle between Illinois River populations of Bighead Carp and Silver Carp and Lake Michigan.
- Progress in planning and implementing permanent separation of the Illinois River and Lake Michigan is logistically complex and therefore, slow.
- Measures at the Brandon Road Lock and Dam have a long timeline with significant costs that require a state match.

Strategies:

- Participate in ACRCC meetings and communications.
- Provide support for the proposed deterrent measures for Bighead Carp and Silver Carp at Brandon Road Lock and Dam.
- Work with other Great Lakes partners to support permanent separation of the basins at the CAWS.

Supporting Actions:

- FCGX05: Aquatic Invasive Species – Early Detection and Rapid Response
- FFDX02: Lake Erie Fisheries Management

Objective 1.3: Use fish sampling and fishery harvest assessment to annually monitor for the presence of Bighead Carp and Silver Carp in Lake Erie.

Problems:

- Monitoring for an invasive species in low density with traditional fishing gear and angler assessments is difficult.
- Three adult Bighead Carp have been caught in Lake Erie, one in 1995 and two in 2000.
- Four positive eDNA results for both Bighead Carp and Silver Carp have been detected in Sandusky Bay and Maumee Bay.
- Potential sources of Bighead Carp and Silver Carp' eDNA in Lake Erie are unclear and interpretation of eDNA results are difficult. Such low positive rates with high testing numbers could very well be caused by false positives.

Strategies:

- Use nearshore targeted sampling with electrofishing gear to monitor for Bighead Carp and Silver Carp
- Monitor commercial catches as a means of Bighead Carp and Silver Carp' surveillance.
- Record bycatches of Bighead Carp and Silver Carp during routine fish sampling as a means of surveillance.
- Share results of sampling among agencies and jurisdictions to communicate lake-wide surveillance efforts on an annual basis through the annual LEC/STC update.
- Encourage anglers to report Bighead Carp and Silver Carp when caught or found through the ODNE website at https://ohiodnr.gov/wps/portal/gov/odnr/discover-and-learn/safety-conservation/fish-management/aquatic-invasive-species/reporting-aquatic-invasives

Supporting Actions:

- FCGX05: Aquatic Invasive Species – Early Detection and Rapid Response
- FSNS01: Lake Erie Commercial Fisheries Management
- FSDS01: Lake Erie Fisheries Assessment
- FFDX02: Lake Erie Fisheries Management

Objective 1.4: Facilitate USFWS eDNA sampling efforts in tributaries, bays, and main lake.

Problems:

- Early invasion of Lake Erie by Bighead Carp and Silver Carp may be difficult to detect with standard fisheries surveys and commercial catch monitoring.
- Collection of sufficient numbers of samples of eDNA is challenging in a waterbody the size of Lake Erie.
- Positive results from eDNA sampling are difficult to interpret due to multiple potential sources of DNA introduction (e.g., contaminated water, equipment, bird feces, as well as unknown false

positive rates) in a waterbody and strategies to address them are limited in open waters of the Great Lakes.

Strategies:

- Facilitate collection of eDNA samples in Lake Erie by the USFWS to the extent possible.
- Work with partner agencies and organizations to better understand and interpret results and understand potential sources of eDNA.
- Monitor current research and development of emerging eDNA technology.

Supporting Actions:

- FCGX05: Aquatic Invasive Species – Early Detection and Rapid Response

Objective 1.5: Minimize the potential for accidental importation of juvenile Bighead Carp and Silver Carp via bait dealers and fish transporters through annual monitoring during March to November.

Problems:

- Transportation of live fishes can be a significant vector for the introduction of invasive or undesirable fishes.
- Positive Bighead Carp and Silver Carp eDNA has been detected during some bait shop testing.
- Bait dealers and fish haulers may not be aware of concerns regarding Bighead Carp and Silver Carp.
- Suppliers of bait may originate from aquaculture facilities in the southern United States that contain Bighead Carp and Silver Carp.
- Due to the USDA-APHIS Federal Order for VHS, risks of importation of bait from waters infested with Bighead Carp and Silver Carp may have increased.

Strategies:

- Partner with the DOW Law Enforcement to inspect bait outlets for high risk AIS.
- Revise ORC and OAC to allow DOW staff to track positive eDNA more effectively or other occurrences.
- Partner with other agencies (USFWS and Ohio Department of Agriculture (ODA)) to conduct inspections and track permits.
- Partner with the United States Department of Agriculture-Animal and Plant Health Inspection Service (USDA-APHIS) and ODA to address state and federal restrictions on bait movement within the Lake Erie drainage basin to minimize risks associated with VHS spread and Bighead Carp and Silver Carp introduction.

Supporting Actions:

- FCGX05: Aquatic Invasive Species – Early Detection and Rapid Response
- LANX16: Wildlife Permitting
- LANX01: Rule Promulgation

Objective 1.6: Minimize the potential for deliberate sales or releases of live adult Bighead Carp and Silver Carp via fish transporters and fish markets through annual notifications to fish haulers and fish markets and inspections of each.

Problems:

- Transportation of live fishes can be a significant vector for the introduction of invasive or undesirable fishes.
- As few as 10 released adult Bighead Carp or Silver Carp in proximity may establish a population based on DFO risk assessment (Cudmore et al. 2012).
- Fish haulers and fish markets may not be aware of concerns regarding Bighead Carp and Silver Carp.

Strategies:

- Conduct annual inspections of loads from fish haulers and investigate illegal sales at fish markets.

Supporting Actions:

- FCGX05: Aquatic Invasive Species – Early Detection and Rapid Response
- LANX24: Wildlife Permitting

Grass Carp

Grass Carp are herbivorous and, at high densities, have the potential to negatively impact native fish communities in the Great Lakes through reduction of aquatic vegetated habitats (DFO 2017). Grass Carp were imported into Alabama and Arkansas aquaculture facilities in 1963 to control vegetation in rearing ponds (Mitchell and Kelly 2006). They were used in aquaculture facilities and widely stocked in private and public waters, and range expansion resulted from intentional and escapes of stocked fish. Escapes of captive fish and the intentional stocking of diploid fish promoted their spread across the US (Guillory and Gasaway 1978), and feral populations became established in the White River, Arkansas and Mississippi River, Illinois. Concern over potential ecological consequences of feral fish led to the development of a sterile, non-reproductive form (triploid) used for vegetation control (Mitchel and Kelly 2006). Today, more than 400,000 triploid Grass Carp are sold per year in at least 30 states. Importation of triploid Grass Carp from private aquaculture facilities is permitted by the USFWS to track shipments and sophisticated ploidy testing is routine at production facilities.

Ohio Administrative Code (OAC) does not permit importation of diploid Grass Carp (OAC 1501:31-19-01); however, importation of certified triploid Grass Carp (OAC 1501:31-19-01), incapable of reproduction, has been legal since 1988. OAC stipulates that individuals who import or sell Grass Carp can only sell fish that are certified as triploid by the USFWS. Triploid Grass Carp offer a biological control for vegetation that is cost-effective and reduces the need for chemical control measures. Legalization of triploid Grass Carp minimized concerns about their ecological impact should they escape from where they are stocked and has likely reduced the illegal sale of diploid fish. Presently, Grass Carp stocking is prohibited or restricted to triploid fish in US states and Canadian provinces bordering the

Great Lakes; however, some central and southern states continue to allow the stocking of the diploid fish (Conover et al. 2007).

Triploid Grass Carp are commonly used to control vegetation in small farm ponds and small private or public lakes. A total of 19 different aquaculture facilities imported 45,149 triploid Grass Carp into Ohio in 2019 and 52,832 fish in 2020, which likely represents typical annual sales in Ohio. All these fish came from one of three aquaculture facilities in Arkansas: Keo Fish Farms; J.M. Malone and Sons; and Hopper-Stephens Hatcheries, Inc. During 2020, the DOW stocked 837 triploid Grass Carp in three small public lakes or wildlife area ponds to control vegetation.

Illegal diploid Grass Carp could put Ohio waters at risk by damaging habitats and altering fish communities given the documented reproduction of Grass Carp in large rivers. Grass Carp could potentially decimate submerged aquatic vegetation that is critical to migrating waterfowl and other water birds. The first documented occurrence of Grass Carp in Lake Erie proper occurred in 1984 (Roger Knight, personal communication). Since then, the DOW has confirmed Grass Carp in the waters of Lake Erie proper, as well as in harbors and tributaries to Lake Erie.

In the last decade, evidence from ploidy testing, fish size and age, and otolith microchemistry have shown that Grass Carp are successfully reproducing in two Ohio Lake Erie tributaries, the Maumee and Sandusky rivers (Chapman et al 2013; Embke et al. 2016; Patrick Kocovsky, USGS, personal communication). Grass Carp have been observed in the Ohio waters of Lake Erie since 1984; therefore, it is possible that diploid Grass Carp have been in Lake Erie for decades. It is also possible that diploid Grass Carp could have escaped from a neighboring state or province as they were available within the Great Lakes Basin as recently as 2005 (DFO 2005). An episodic flooding event, like that which occurred in the Lake Erie Western Basin watershed during 2011, may have established conditions suitable for reproduction. Diploid Grass Carp are not unique to the Ohio portion of Lake Erie or the Great Lakes. They have also been documented in the Michigan portion of Lake Erie near the ”hot ponds” of the Detroit Edison Monroe Power Plant, in the Tittabawassee River (Lake Huron watershed), and several locations in Lake Calumet and tributaries of Lake Michigan (Marion Wittmann, UND, personal communication).

Grass Carp Ploidy Testing: Grass Carp have been incidentally captured by commercial netters in the lower Sandusky River, downstream of Fremont, Ohio for over a decade. Historic captures within the Great Lakes basin were believed to be escaped triploid stockings, posing little threat to native ecosystems. The collection of 4 relatively small-bodied (450-550 mm TL) Grass Carp by a commercial seine operator in 2012 suggested the possibility of reproduction in the Sandusky River (Chapman et al. 2013), and stimulated efforts to understand the status of Grass Carp and their potential for reproduction in Lake Erie tributaries. Ploidy testing since 2012 has determined that a high proportion of Grass Carp in the system are diploid and capable of reproduction (Chapman et al. 2013; Wieringa et al. 2016), leading to regional concern (Table 2).

Table 2. Grass Carp captures and ploidy testing results from Ohio waters of Lake Erie and tributaries 2012-2019.

Year	# Grass Carp Caught	# Ploidy Tested	% Diploid
2012	6	4	75
2013	3	3	33
2014	6	6	83
2015	16	4	100
2016	5	4	100
2017[a]	26	22	100
2018	42	39	68
2019[b]	175	139	47[c]
2020[d]	114	85	73

[a]Captures prior to 2017 were incidental commercial or agency captures; 2017 marks the first year of targeted sampling in Ohio waters.
[b]First year of dedicated Grass Carp removal teams in Ohio.
[c]75 Grass Carp were removed from the Cuyahoga River (1st year sampled), and only 12% were diploid.
[d]First year with 4 Grass Carp removal teams in Ohio; start of sampling delayed due to COVID-19 restrictions.

In 2012, the DOW began testing ploidy status of individual fish captured during agency fish surveys and by commercial netters. All samples collected have been tested for ploidy by the USGS National Wetlands Research Center in Lafayette, Louisiana, or the USFWS Whitney Genetics Laboratory in La Crosse, Wisconsin. Ploidy status of individual Grass Carp was determined using flow cytometry technology as established in Jenkins and Thomas (2007). For determining ploidy of feral Grass Carp, cells from the vitreous humor (fluid taken from the eye) or blood samples are used, and sample collection and preparation followed the standard operating procedure supplied by USGS National Wetlands Research Center. In 2012, 10 Grass Carp collected from Lake Erie and the Sandusky River in commercial trap nets and seines were tested. Of these, five were confirmed as diploid, two were confirmed triploid, one was undetermined, and two were not tested due to equipment malfunctions.

Beginning in 2013, DOW staff initiated statewide ploidy testing of Grass Carp incidentally captured during standard fish surveys and commercial fishing operations in waters where triploid fish were not stocked for vegetation control. All samples were tested using flow cytometry at the USFWS Whitney Genetics Laboratory. Additionally, fin clips and otoliths were analyzed to identify origins of wild-caught Grass Carp. To further these efforts, the DOW updated Lake Erie commercial fishery catch reporting software to include grid-specific reporting on Grass Carp landed and added Grass Carp to the list of species that can be commercially harvested.

Grass Carp Early Life History Research and Seasonal Movement: In 2015, seven Grass Carp eggs were collected in the Sandusky River during or immediately-after high-flow events (Embke et al. 2016). In 2017, seven adult Grass Carp implanted with acoustic transmitters were detected on a real-time

hydrophone operated by the US Geological Survey (USGS) during a high-flow event May 29-June 1, 2017, and subsequent sampling resulted in collection of several hundred Grass Carp eggs at multiple locations between Brady's Island near Fremont and Wightman's Grove. A single adult Grass Carp was detected during a secondary flow event on July 8-9, 2017 and eggs also were collected during a flow event on July 12. These results indicate that Grass Carp are using the Sandusky River to spawn during high flows, but it is unclear if these spawning events are resulting in successful recruitment to the population. As of 2020 no larval Grass Carp have been captured in the Sandusky River during ichthyoplankton sampling with nets or light traps. Subsequent flow modeling suggests that Grass Carp spawning in the Sandusky River occurs between Brady's Island and the former site of the Ballville Dam located in Fremont, Ohio.

On June 13 and 26, 2018, six Grass Carp larvae were collected from the Maumee River in Toledo, Ohio near the I-280 bridge during high water flow events typical of spawning conditions for Grass Carp. These fish represent the first Grass Carp collected in the larval stage from within the Great Lakes watershed, confirming that all Grass Carp life stages have been documented in the Western Basin of Lake Erie (i.e., eggs, larvae, juveniles, and adults).

Grass Carp life history and movement has been monitored through sampling for Grass Carp eggs and larvae in Lake Erie tributaries in the western basin to determine the extent and location of spawning to allow for more efficient removal. Also, fifty wild-caught Grass Carp were implanted with ultrasonic coded acoustic tags and their movements are being monitored by both fixed and real-time receivers. Due to the loss of previously tagged Grass Carp, additional fish will be implanted with tags and released to maintain a tagged population of 50 fish.

These efforts will provide a better understanding of their spawning locations and movement to allow for more efficient removal by having real-time information on locations and a record of seasonal tributary use thus revealing where they are most susceptible to standard fishing gear.

In 2020 and 2021, Grass Carp sampling will be focusing efforts on other Lake Erie tributaries (i.e., Cuyahoga, Huron, Portage, Black, rivers) in Ohio to determine whether Grass Carp are spawning in these systems. Identifying additional locations where spawning is occurring will be vital to focus removal efforts on the future. To date, only the Sandusky and Maumee Rivers have shown to have spawning Grass Carp. Also, the DOW will continue to work with partner agencies using acoustic telemetry to facilitate grass carp removal efforts.

Grass Carp Removal Efforts 2017-2020: In summer of 2017, DOW fisheries staff began implementing targeted efforts to remove Grass Carp from Lake Erie tributaries (Table 2). These early efforts focused on using single- or tandem-boat electrofishing in areas of the Sandusky River where incidental commercial seine catches had been made, or in areas suspected (through egg sampling or telemetry data) of supporting Grass Carp spawning. These initial efforts resulted in the observation of two fish but no captures. The need to refine sampling techniques was identified, and planning began for two multi-agency actions to address this need.

During August 28 –31, 2017, multiple agencies and organizations participated in planned actions that were successful in removal of Grass Carp and informing research about movement and habitat use. In 2017, 19.6 hours of gill netting, 13.9 hours of trammel netting, 25.6 hours of electrofishing, and 96 hours of mini fyke netting in the lower 12 km of the Sandusky River resulted in the capture of eight Grass Carp with combined net and electrofishing methods where fish were chased into nets. Electrofishing around shorelines enclosed with trammel nets was found to be the most effective way to capture Grass Carp when river discharges are relatively low.

In June 12–14, 2018, 70.5 hours of electrofishing and 63.7 hours of trammel net effort in the Sandusky and Maumee Rivers resulted in the capture of 31 Grass Carp, 21 of which were removed (20 from the Sandusky and one from the Maumee), one recaptured fish (tagged in 2016 near Maumee Bay and captured/released in the Sandusky) that was returned for continued tracking, and nine fish implanted with transmitters (seven in the Sandusky and two in the Maumee) for tracking as part of continued efforts to understand movement and inform long-term removal efforts. High river discharges during the 2018 action significantly limited the effectiveness of trammel nets; however, information from telemetry, early life history sampling, and FluEgg modeling was used to re-distribute electrofishing effort to likely spawning habitat, where most of the fish were collected using coordinated multi-boat electrofishing.

The Sandusky River Grass Carp planned actions had multiple desired outcomes. Overall, these collaborative multi-agency approaches helped assess Grass Carp removal methodologies, increased staff preparedness and familiarity with sampling methodologies, and increased information about population demographics in the Sandusky River and western Lake Erie. Specifically, this allowed us to: 1) evaluate the utility of various gears for targeted collections in the Sandusky River; 2) increase proficiency with multiple gears in lotic habitats; 3) increase demographic information on distribution, size composition, age, ploidy, and relative abundance of Grass Carp in the Sandusky River and western Lake Erie; and 4) remove Grass Carp from the Sandusky River.

Starting in 2019, DOW began the deployment of Grass Carp Strike Teams in partnership with University of Toledo (UT) and the GLFC. These teams are dedicated to Grass Carp removal efforts and work with similar teams from Michigan DNR and USFWS. A single team was formed in 2019 and was comprised of a UT lead worker and three seasonal staff from DOW. This team was responsible for the direct capture of 50 Grass Carp in 2019. In 2020 the number of Strike Teams was expanded from one to four.

Two major removal events occurred in 2019. The first was a multi-agency field exercise on the Sandusky River on June 4-6. The plan was to test alternative methods of setting trammel nets in high current areas (as opposed to shorelines and side channels with low current); however, this exercise coincided with a high flow event and resulted in the capture of 20 Grass Carp using both nets and electrofishing. The second removal event built on exploratory work by USFWS in the Cuyahoga River, which led to some multi-agency removal work during the fall of 2019. In total, 75 Grass Carp were removed over the course of several weeks; however, subsequent ploidy testing indicated that 88% of captured fish from the Cuyahoga River were triploid (non-reproducing). Until evidence of natural reproduction in the Cuyahoga River is found, additional removal efforts will focus on the Sandusky and Maumee Rivers where spawning has been documented and the proportion of diploid fish is higher. Exploratory sampling in additional tributaries will begin in 2021 but remain limited in nature and primarily informed by early life history research.

Grass Carp Supply Chain Monitoring: Diploid Grass Carp could be transported and sold as triploids , or mixed with triploids, and could escape from the waters where they are stocked and establish reproducing populations. To assess the Grass Carp supply chain in Ohio, a 2-year undercover operation was undertaken in 2015 and 2016. A total of 1,200 Grass Carp were covertly purchased from selected suppliers in Ohio and tested for ploidy by the USGS National Wetlands Research Center in Lafayette, Louisiana (Kinter et al. 2018). All fish tested were triploid which indicates that the Ohio supply chain was secure during the project period. Monitoring of imported Grass Carp through a permit process and testing of ploidy status of imported fish will be continued to maintain supply chain security.

Structured Decision-Making (SDM) Process: The DOW worked in cooperation with partners to conduct a facilitated Structured Decision-Making Process among agencies in 2018. Facilitation was provided by the Michigan State University Quantitative Fisheries Center and funding was supported by the ACRCC. The goal of the Grass Carp SDM was to collaboratively develop an adaptive management strategy to control or eradicate the Grass Carp population in Lake Erie, with the flexibility to update management actions with increasing knowledge about the system. Through this process, we have been able to address areas of uncertainty in the decision-making process by using a variety of gear types to evaluate Grass Carp catchability while conducting targeted removal efforts. The SDM process helps collaboratively identify an efficient, collaborative management strategy while taking into consideration the agency and university stakeholder values in the process, ultimately aiding in cohesive implementation. Through the adaptive management process, control efforts also provide essential information about Grass Carp abundance, movement, and catchability that can be used to inform future management decisions.

An additional action from the SDM process was to determine the feasibility of a barrier on the Sandusky River to disrupt Grass Carp spawning. The preliminary study prepared by AECOM – Kleinschmidt looked at the feasibility of a structural or behavioral barrier on the Sandusky River and it was determined that a seasonal behavioral barrier using sound and air bubbles could effectively disrupt Grass Carp spawning. Further assessment of this technology will take place and funding identified for implementation.

Lake Erie Grass Carp Response Strategy (2019-2023): The *Lake Erie Grass Carp Response Strategy: 2019 – 2023* (Appendix B) describes the DOW strategy to prevent Grass Carp expansion beyond western Lake Erie. This plan was developed to provide a foundation for on-the-ground efforts to address Grass Carp reproduction in the Sandusky and Maumee Rivers and prevent population expansion in Lake Erie. It is adaptive and informed by current and emerging science; therefore, it will be revised, as necessary. Response actions include two outcomes (goals) with supporting objectives and strategies:

- Outcome 1: The introduction and expansion of reproductively viable (diploid) Grass Carp is prevented beyond western Lake Erie and the Maumee and Sandusky rivers.
- Outcome 2: Strategies are implemented by the DOW and partners to prevent Grass Carp populations in Ohio waters from reaching levels that compromise aquatic communities.

The Great Lakes Restoration Initiative (GLRI) is the anticipated source of funding for this strategy.

Issue: Diploid Grass Carp have been found in the Western Basin of Lake Erie and reproduction has been documented in the Maumee and Sandusky rivers. Diploid Grass Carp must be prevented from

becoming established in Lake Erie. If these fish successfully reproduce in Ohio, feral populations could negatively affect native habitats, ecosystem integrity, and sport fisheries.

Outcome 2: Populations of feral Grass Carp are prevented from becoming established in Lake Erie, or, at a minimum, Lake Erie does not become a source of reproducing Grass Carp in the Great Lakes.

Objective 2.1: Continue annual surveillance via testing ploidy status of Grass Carp caught in the Lake Erie watershed to determine the extent of the Grass Carps population's reproductive capacity.

Problems:

- Diploid Grass Carp have been found in public waters (Lake Erie; Sandusky, Maumee, Cuyahoga rivers).
- Fish haulers could potentially mix batches of triploid and diploid Grass Carp by mistake or to increase profits.
- Grass Carp may escape from waters where they are stocked.

Strategies:

- Use the Lake Erie commercial fishery and fisheries assessment projects in both Lake Erie and inland waters to collect wild Grass Carp.
- Use microchemistry to determine the natal source of select diploid Grass Carp collected in the Lake Erie watershed
- Monitor the frequency of diploid and triploid Grass Carp collected from those waters where Grass Carp have not been intentionally stocked.
- Support research into Grass Carp movement, habitat use, and control efficiencies using acoustic telemetry.
- Except for fish used in acoustic telemetry, ensure a "no live release" of Grass Carp captured through agency assessments (mandate) or by commercial fishers (purchase).
- Actively engage in discussions with the ACRCC, USFWS, USGS, Great Lakes states and Canada about next actions to address knowledge gaps about Grass Carp population status in the Great Lakes, evaluate risk from this species, and potential development of integrated pest management strategies to control impacts of feral, naturally reproducing Grass Carp.

Supporting Actions:

- FCGX09: Development of Capabilities and Response Methods to Effectively Respond to Detection of Grass Carp
- FSNS01: Lake Erie Commercial Fisheries Management (secondary objective)
- FSDS01: Lake Erie Fisheries Assessment (secondary objective)
- FIDS01: Inland Fisheries Assessment (secondary objective)
- FIDS01: Ohio River Fisheries Assessment (secondary objective)

Objective 2.2: Annually verify compliance with the USFWS ploidy certification program by randomly inspecting shipments of Grass Carp delivered in Ohio and prosecute violators who illegally import diploid Grass Carp.

Problems:

- Diploid Grass Carp are legal for sale in other states and potentially could be mixed with loads of triploid Grass Carp.
- Loads of Grass Carp imported into Ohio are not routinely monitored.
- Risk of mixing diploid and triploid Grass Carp in single loads is minimal to fish haulers.

Strategies:

- Develop a procedure to verify use of the USFWS ploidy certification program for accuracy and compliance.
- Continue to covertly purchase Grass Carp for ploidy testing.
- Establish a schedule for the random inspection of loads of Grass Carp and increase legal consequences for illegal importation of diploid fish.
- Work with the GLFC, Association of Fish and Wildlife Agencies (AFWA) and others to eliminate the use of diploid Grass Carp in the United States.

Supporting Actions:

- FCGX09: Development of Capabilities and Response Methods to Effectively Respond to Detection of Grass Carp
- LANX16: Wildlife Permitting

Objective 2.3: Work with the Aquatic Nuisance Species Task Force (ANSTF), GLP and the MRBP to prohibit the trade of diploid Grass Carp in the United States by 2023.

Problems:

- Diploid Grass Carp are legal to stock in some states.
- Availability of diploid Grass Carp creates an opportunity for illegal sales of diploid Grass Carp in states where only triploid Grass Carp are legal.

Strategies:

- Continue regional discussion of diploid Grass Carp use and potential threats.

Supporting Actions:

- FCGX09: Development of Capabilities and Response Methods to Effectively Respond to Detection of Grass Carp

Objective 2.4: Remove Grass Carp from Ohio waters of Lake Erie and tributaries through targeted strike teams.

Problems:

- Diploid Grass Carp are spawning in the Sandusky and Maumee rivers, and have been captured in other Lake Erie tributaries .
- Grass Carp are in low abundance and are difficult to capture efficiently.
- Research into Grass Carp movement, habitat use, and spawning behavior has improved removal efforts, but additional work is necessary.
- Grass Carp removal is very expensive.

Strategies:

- Support targeted removal through the deployment of dedicated Ohio Grass Carp Strike Teams in collaboration with UT and GLFC.
- Support continued research into Grass Carp capture methods, movement, habitat use, spawning behavior, natal origin, and early life history to improve removal efficiency. Prioritize efforts in the Sandusky and Maumee rivers where Grass Carp are known to spawn.
- Continued collaboration with Grass Carp removal teams from USFWS and Michigan DNR.
- Conduct exploratory sampling in other Lake Erie tributaries to identify all potential Grass Carp sources.

Supporting Actions:

- FCGX09: Development of Capabilities and Response Methods to Effectively Respond to Detection of Grass Carp

Objective 2.5: Implement a behavioral barrier on the Sandusky River to reduce Grass Carp access to spawning areas by 2024.

Problems:

- Diploid Grass Carp are reproducing in the Sandusky River and may be a source of fish in other tributaries.
- Early life history research has identified that spawning is occurring in an area in the Sandusky River near Fremont, OH.
- Grass Carp removal is very expensive.
- Constructing a permanent barrier to prevent Grass Carp from accessing spawning areas is not realistic due to human health and safety concerns and impacts to native, migratory fishes.

Strategies:

- Continue to work with partners from Michigan DNR, USGS, and the GLFC to finalize a feasibility study for a seasonal barrier to Grass Carp movement that will reduce 75% of Grass Carp access to spawning areas.

Supporting Actions:

- FCGX09: Development of Capabilities and Response Methods to Effectively Respond to Detection of Grass Carp

V. Ohio River Watershed

Background and Situation Analysis

The Ohio River watershed is a sub-basin within the Mississippi River basin that includes portions of 11 states and comprises 20 percent of the Mississippi River basin. Nearly 10 percent of the United States population lives in the 530,244 km^2 (203,940 mi^2) Ohio River sub-basin. The Ohio River is formed in Pittsburgh, Pennsylvania by the confluence of the Allegheny and Monongahela rivers and flows 1,582 km (981 mi) to Cairo, Illinois where it enters the Mississippi River, and 835 km (451 mi) forms the southern border of Ohio. A total of 69 tributaries with drainages greater than 2,600 km^2 (1,000 mi^2)

enter the Ohio River as it flows through Pennsylvania, West Virginia, Ohio, Kentucky, Indiana, and Illinois. The Tennessee, Wabash, and Cumberland rivers are the largest tributaries, and account for approximately 20, 16 and 9 percent of the watershed, respectively (www.orsanco.org). The Ohio River is an important source of water supply, commercial navigation, power generation, and recreation. Three million people currently use the Ohio River as a source of potable drinking water. Twenty navigational dams are operated and provide a 2.7 m (9 ft) minimum depth for commercial and recreational navigation. Over 207 metric tonnes (230 English tons) of cargo is transported on the river annually, composed primarily of coal and other energy products. Forty-nine power-generating facilities operate on the Ohio River and the combined capacity of these facilities exceeds 6% of the total generating capacity in the United States. Recreational fishing and boating also represents a significant portion of river use and these activities contribute to local and regional economies (Shell et al. 1996; Responsive Management 2009; Sindt 2013; Singh et al. 2014; Pritt 2018).

Approximately 159 fish species are found within the Ohio River and 285 are found within the basin (Wallus et al. 1990). Species composition and abundance have changed dramatically during the past century because of dam construction, pollution, and pollution abatement (Pearson and Krumholz 1984). The Ohio River contains 25 sport fishes, and no fishes are federally listed as endangered, threatened, or candidate species.

Within the Ohio portion of the Ohio River watershed, the DOW has the responsibility and authority to manage public fisheries within six major watersheds, the Great Miami, Little Miami, Scioto, Hocking, Muskingum, and Mahoning, representing 13.1 million ha (32 million acres) of drainage. Among these are 77 major streams that total 7,649 km (4,130 mi) and are associated with 1,856 named streams (Sanders 2002). Many of these rivers and streams provide valuable sport fisheries throughout the state.

In total, Ohio is estimated to have 2,293 lakes and reservoirs > 2 ha (5 acre), totaling 57,468 ha (142,006 acre) (ODNR 1980) and over two-thirds of Ohio's public fishing reservoirs fall within the Ohio River watershed. Considering smaller waters, the U.S. Environmental Protection Agency (USEPA) estimated that Ohio has 5,130 lakes, reservoirs and ponds totaling 76,267 ha (188,461 acre), whereas the ODNR estimated over 50,000 water bodies totaling 80,937 ha (200,000 acre) during this same time. Numerous small ponds counted by the ODNR were not identified by the USEPA due to differences in methods (Davic et al. 1996). The most recent estimate of all inland lentic waters, regardless of size, is over 52,000 ponds, lakes, and reservoirs statewide (Miami University 2005).

Ohio inland sport fisheries, including the Ohio River, rivers and streams, and lakes and reservoirs contribute $2.1 billion annually to the economy (Southwick Associates 2012). These fisheries provide 14 million days of fishing for Ohio's 1.3 million anglers, and through this participation, support $1.4 billion in retail sales and more than 18,000 jobs (Southwick Associates 2012). Approximately 17 percent of Ohio anglers fish the Ohio River (Zajac et al. 2011; Singh et al. 2014). Results from recent creel survey of the Ohio River waters bordering Ohio, Kentucky, and West Virginia (Sindt 2013; Pritt 2018) indicated that fishing effort differed among species sought by anglers in pools and tailwaters. In pools, effort was greatest for Black Bass (45%), Catfishes (27%), "anything" (18%), Walleye and Sauger *Sander canadensis* (4%), and Morone spp. (primarily White Bass and Hybrid Striped Bass *Morone*

saxatilis X *M. chrysops* (2%). In tailwaters, effort was greatest for "anything" (42%), followed by Morone spp. (24%), Walleye and Sauger (13%), Catfishes (13%), and Black Bass (3%). Only 27 percent of interviewed anglers indicated that they harvested fish from the Ohio River, but they average approximately 35 days fishing the river each year during 2011.

Although the DOW is responsible for managing the fisheries resources in public waters, controlling authorities vary among lakes and reservoirs statewide, shore access can be limited along rivers and streams, and shared jurisdiction with neighboring states along the Ohio River are among the major challenges the DOW faces. This is relevant in addressing all AIS, but particularly Bighead Carp and Silver Carp. Similarly, watershed health directly influences the success of sport fishes in all public waters, yet the DOW has little influence or statutory authority to address negative effects of poor land management or use on water quality, making good inter-agency cooperation imperative and effective partnerships important. In addressing AIS, such as Bighead Carp and Silver Carp, effective partnerships, good public communication, and public education are essential.

Bighead Carp and Silver Carp

The southern two-thirds of Ohio are within the Ohio River watershed where adult Bighead Carp are found in low numbers throughout Ohio's portion of the Ohio River and Silver Carp are found in low numbers up to the R.C. Byrd Pool of the Ohio River below Gallipolis, Ohio (Figures 1, 2 and 6).

The DOW works closely on Ohio River issues with natural resource management agencies in Pennsylvania, West Virginia, Kentucky, Indiana, and Illinois through the Ohio River Fisheries Management Team (ORFMT) which was formed in 1990 to develop an inter-jurisdictional perspective to management of Ohio River fisheries. The ORFMT developed *the Ohio River Basin Asian Carp Control Strategy Framework* (2014) to minimize the social, ecological, and economic impacts of these invasive fishes. The coordinated strategies outlined in this document directly meet the goals, as specified by the United States Congress in Section 1039 (b) of the Water Resources Reform and Development Act of 2014 (WRRDA), of controlling the spread of Invasive Carp in the Upper Mississippi and Ohio River basins and tributaries by carrying out activities designed to slow and eventually eliminate the threat posed by these species. Coordination of Invasive Carp activities in the Ohio River Basin are coordinated by the Ohio River Asian Carp Partnership which facilitates funding through the USFWS, which engaged stakeholders to participate in development of the Ohio River Sub-basin Invasive Carp Action Plan.

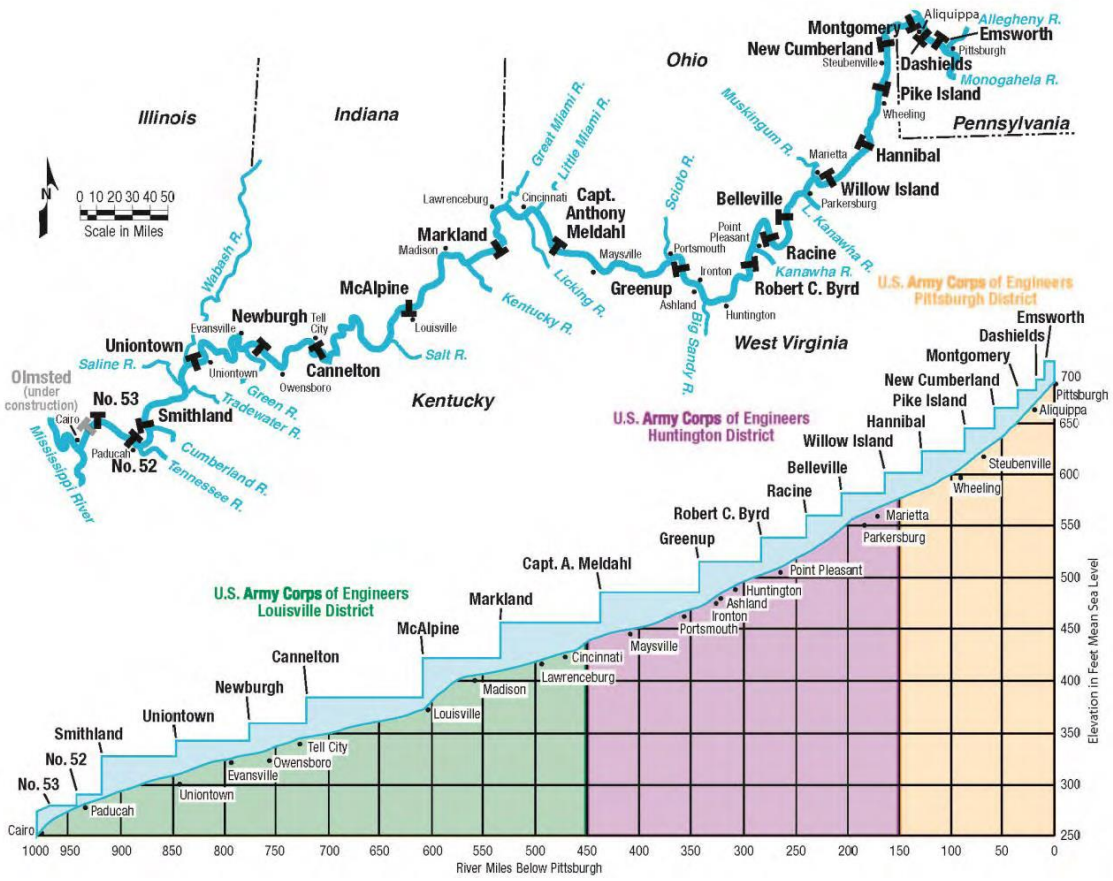


Figure 6. U.S. Army Corps of Engineers lock and dam projects on the Ohio River (courtesy of the US Army Corps of Engineers).

Issue: Bighead Carp and Silver Carp are abundant in the Ohio River downstream of McAlpine Dam and are progressing upstream. Ohio River locks and dams do not prevent upstream movement of Bighead Carp and Silver Carp and these fishes are likely to populate unobstructed rivers and tributaries connected to the Ohio River if habitat is sufficient and suitable for reproduction. Expansion of Bighead Carp and Silver Carp' distributions in the Ohio River watershed should be prevented to the greatest extent possible. Whereas eliminating expansion within open systems is not currently feasible, preventing introductions of these fishes to closed systems or those with barriers to upstream migration (tributary impoundments) is possible and important. If found in impounded waters (ponds, canal lakes, upground reservoirs, tributary reservoirs), damage to sport fisheries may be rather limited because reproduction is not anticipated due to limited spawning habitat and flow conditions for Bighead Carp and Silver Carp. However, fish at large increase risk of additional transfers to rivers and streams and Lake Erie, where natural reproduction of these fishes is likely and significant negative effects are anticipated.

Outcome 3: Introduction of Bighead Carp and Silver Carp is prevented from waters within the Ohio River watershed that are closed systems or have pre-existing barriers to natural immigration through tributaries.

Objective 3.1: Prevent accidental importation of juvenile Bighead Carp and Silver Carp through annual monitoring of bait dealers and live fish transporters.

Problems:

- Transportation of live fishes can be a significant vector for the introduction of invasive or undesirable fishes.
- eDNA testing from some bait stores has returned positive detections of Bighead Carp and Silver Carp .
- Bait dealers and fish haulers may not be aware of concerns regarding Bighead Carp and Silver Carp.
- Bait may originate from aquaculture facilities in the southern United States where Bighead Carp and Silver Carp are abundant.

Strategies:

- Conduct inspections of bait dealers and fish transporters and track permits to ensure that Bighead Carp and Silver Carp are not being transported.

Supporting Actions:

- FCGX02: Statewide Management of Aquatic Invasive Species
- LANX16: Wildlife Permitting
- LANX01: Rule Promulgation

Objective 3.2: Prevent deliberate sales or releases of live adult Bighead Carp and Silver Carp via fish transporters and fish markets through annual inspections of fish haulers and fish markets.

Problems:

- Transportation of live fishes can be a significant vector for the introduction of invasive or undesirable fishes.
- As few as 10 adult Bighead Carp or Silver carp may establish a population based on DFO risk assessment for the Great Lakes. Establishment is more likely in small waters with suitable habitat.
- Fish haulers and fish markets may not be aware of concerns regarding Bighead Carp and Silver Carp.

Strategies:

- Inspect loads from fish haulers and investigate illegal sales at fish markets.

Supporting Actions:

- FCGX02: Statewide Management of Aquatic Invasive Species
- LANX16: Wildlife Permitting LANX01 Rule Promulgation
- LANX24: Commercial Fish

Objective 3.3: Use annual agency fish sampling in reservoirs, inter-agency fish sampling on the Ohio River, and angler reporting to monitor Bighead Carp and Silver Carp distribution, rates of introduction, and expansion.

Problems:

- Bighead Carp and Silver Carp are abundant in the lower Ohio River and expanding upstream.
- The distribution and abundance of Bighead Carp and Silver Carp is not well understood in the middle and upper reaches of the Ohio River.

Strategies:

- Conduct standard Inland Management System surveys for sport fishes in lakes and reservoirs and the Ohio River and record all observations of Bighead Carp and Silver Carp.
- Share results of fish sampling on the Ohio River with the ORFMT.
- Encourage anglers to report Bighead Carp and Silver Carp when caught or found through the ODNE website at https://ohiodnr.gov/wps/portal/gov/odnr/discover-and-learn/safety-conservation/fish-management/aquatic-invasive-species/reporting-aquatic-invasives

Supporting Actions:

- FCGX02: Statewide Management of Aquatic Invasive Species
- FIDS01: Inland Fisheries Assessment
- FIDS02: Ohio River Fisheries Assessment)

Objective 3.4: Cooperate with the USFWS and ORFMT states to quantify Bighead Carp and Silver Carp distribution and movement in the Ohio River and major tributaries during 2021-2030.

Problems:

- Distribution, rates of movement, environmental cues to movement, and habitat use of Bighead Carp and Silver Carp in the Ohio River are not well understood, even in the lower reaches where fish are abundant.
- Movement studies of Bighead Carp and Silver Carp in the Mississippi and Illinois rivers suggest that lock and dam structures are not significant obstacles to inter-pool movement.
- The Muskingum River is Ohio's largest watershed within the Ohio River drainage and has 10 on-stream impoundments that provide over 16,000 acres of high-quality fishing and is associated with two medium risk critical pathways for potential movement of Bighead Carp and Silver Carp into the Great Lakes drainage.
- Positive results from eDNA sampling are difficult to interpret due to multiple potential sources of DNA introduction in a waterbody and limited strategies to address them in flowing, open systems.

Strategies:

- Provide intellectual, technical, and field support to the USFWS and ORFMT states for the Bighead Carp and Silver Carp distribution and movement study.

- Work with partners to track Bighead Carp and Silver Carp on the Ohio River and tributaries, including the Muskingum River, using eDNA and telemetry.
- Work with partner agencies to interpret results and better understand potential sources of eDNA and monitor current research and development of emerging eDNA technology.

Supporting Actions:

- FCGX02: Statewide Management of Aquatic Invasive Species.

Grass Carp

Background information on Grass Carp distribution, use in the control of aquatic vegetation, and threat to aquatic habitat and native species is provided in the Lake Erie Grass Carp section above. The difference between the Lake Erie and Ohio River watersheds is in how they are managed. Because the Lake Erie Grass Carp spawning is confined to the Sandusky and Maumee Rivers in the western basin, there is the potential to control and possibly eradicate this population through targeted removal and the possible use of a behavioral barrier to disrupt spawning. This is not the case in the Ohio River watershed where Grass Carp are limited in number, widely distributed, with no evidence of reproduction. Also, there is not a focal population where a control action could be implemented in the Ohio River watershed, consequently, preventative measures will be the focus.

Issue: Diploid Grass Carp have been found in Ohio. Diploid Grass Carp must be prevented from becoming established in Ohio. If these fish successfully reproduce in Ohio, feral populations could negatively affect native habitats, ecosystem integrity, and sport fisheries.

Outcome 4: Populations of Grass Carp are prevented from further establishment in Ohio waters.

Objective 4.1: Annually verify compliance with the USFWS ploidy certification program, randomly inspect shipments of Grass Carp delivered in Ohio and prosecute violators who illegally import diploid Grass Carp.

Problems:

- Diploid Grass Carp are legal for sale in other states and potentially could be mixed with loads of triploid Grass Carp imported into Ohio.
- Imported Grass Carp are not routinely monitored.
- Risk to fish haulers of mixing diploid and triploid Grass Carp in single loads is minimal.

Strategies:

- Develop a procedure to verify compliance with the USFWS ploidy certification program for accuracy and compliance.
- Covertly purchase Grass Carp for ploidy testing.
- Establish a schedule for random inspections of imported fish. Increase legal consequences for illegal importation of diploid Grass Carp.
- Work with the GLFC, AFWA and other partner agencies to prohibit the sale of diploid Grass Carp.

Supporting Actions:

- FCGX02: Statewide Management of Aquatic Invasive Species
- LANX16: Wildlife Permitting
- LANX24: Commercial Fishing

Objective 4.2: Work with the ANSTF, GLP and MRBP to urge the prohibition of diploid Grass Carp in the United States.

Problems:

- Diploid Grass Carp are legal to stock in some states.
- Availability of diploid Grass Carp creates an opportunity for illegal sales of diploid Grass Carp in states where only triploid Grass Carp are legal.

Strategies:

- Continue regional discussion of Grass Carp use and potential threats of diploid Grass Carp.

Supporting Actions:

- FCGX02: Statewide Management of Aquatic Invasive Species

VI. Response and Communication

Actions of the DOW are part of a coordinated national response to the Invasive Carp invasion. Issues related to AIS transcend the responsibility and authority of a single jurisdiction or agency. Therefore, the DOW must effectively respond to changes in the Bighead, Silver, Grass, and Black carps that require action and communicate internally and externally through prescribed strategies to share new information, clarify rationale for necessary actions or responses, and address emerging concerns. This is best accomplished through existing response guidelines and communication frameworks. Well-coordinated agency response and communication are necessary to establish and maintain support for large-scale efforts that require work across jurisdictions and federal support. However, it is essential to appreciate that when new information emerges that there are strong jurisdictional responsibilities and considerations.

Ohio anglers view helping control the spread of exotic species as one of the DOW's most important stewardship issues (Zajac et al. 2011). However, the public may not be familiar with the importance of this issue to Ohio and the limited number of strategies available to minimize risk of AIS introductions. Using established response guidelines to address changes in the Invasive Carp landscape and providing accurate and current information regarding Bighead, Silver, Grass, and Black carps risks posed to Ohio waters, strategies for minimizing that risk, and their potential negative effects is essential to preventing further spread of these fishes. The public must also be aware that strategies to prevent AIS introduction may affect individual recreational angler behavior and experiences and the recreation industry. Businesses may resist implementation of measures to minimize risk of AIS introductions because of cost or other effects to their operations.

Discovery of Silver Carp in the Ohio River reports of positive eDNA results from Lake Erie, and discovery of reproducing Grass Carp in Lake Erie have created a great deal of interest and concern by the public and media. Reports of Bighead Carp and Silver Carp by anglers fishing the Ohio River have become commonplace. However, anglers are often uncertain regarding the identification of these fish, unaware of the DOW website for reporting fish that they have caught or found dead, and unfamiliar with what they can do to prevent the spread of Bighead Carp and Silver Carp to other waters. Education and outreach are necessary to close gaps in familiarity with the Bighead Carp and Silver Carp' problem.

Finally, the public must understand that Bighead, Silver, Grass, and Black carps, like other AIS, are undesirable and have negative consequences to sport fisheries, aquatic communities, or the economy. It must be clear that if established, AIS become a tax on the public, natural resource agencies, and the resources themselves; therefore, it is imperative that the public understand that the most effective means to manage AIS is to prevent their introduction.

Issue: Effective response to the changing Invasive Carp landscape and effective communication is paramount for implementing cooperative intra- and inter-agency management strategies and securing public support through understanding and appreciation of the Invasive Carp issue.

Outcome 5: A formal DOW response and communication strategy is in place to address new or emerging Invasive Carp information or emerging issues.

Objective 5.1: Use the ODNR Division of Wildlife Invasive Carp Response Guidelines (Appendix C) to address new information or emerging issues related specifically to Invasive Carp.

Problems:

- Lacking a formal response strategy to respond to new information on Invasive Carp will result in an inefficient response.

Strategies:

- Maintain updated contingency response plans in the event of unexpected findings of Bighead, Silver, Black, and Grass carps in either watershed.

Supporting Actions:

- FCGX02: Statewide Management of Aquatic Invasive Species
- FCGX05: Aquatic Invasive Species – Early Detection and Rapid Response
- FCGX09: Development of Capabilities and Response Methods to Effectively Respond to Detection of Grass Carp

Objective 5.2: Use the Council of Great Lakes Fisheries Agencies Invasive Fishes Communications Protocol to communicate information related to Invasive Carp (Appendix D).

Problems:

- Lacking a communications plan, sufficient time may not be available upon receiving positive results to develop of messaging to partners and the public.
- Lacking a communications plan increases complexity and decreases efficiency when working with other agencies or jurisdictions and communicating with the public.

Strategies:

- Communicate a response strategy with the ODNR, partner state and federal agencies, universities, and non-governmental organizations.
- Ensure that the DOW communications strategy is consistent with existing USFWS Invasive Carp communication protocols.

Supporting Actions:

- FCGX02: Statewide Management of Aquatic Invasive Species
- FCGX05: Aquatic Invasive Species – Early Detection and Rapid Response
- FCGX09: Development of Capabilities and Response Methods to Effectively Respond to Detection of Grass Carp

Objective 5.3: When needed, communicate plans, findings, and responses with partner agencies through existing organizational structures.

Problems:

- An extensive network of individuals within a variety of organizations and agencies is currently working on the Invasive Carp issue and communication among them can be challenging due to the volume of information at large.

Strategies:

- Follow a tiered approach to communication among partners and stakeholders that facilitates cooperation and communication.

Supporting Actions:

- FCGX02: Statewide Management of Aquatic Invasive Species
- FCGX05: Aquatic Invasive Species – Early Detection and Rapid Response
- FCGX09: Development of Capabilities and Response Methods to Effectively Respond to Detection of Grass Carp

Objective 5.4: Annually provide outreach material via the DOW website, signage, handouts, and presentations to increase public awareness of the risks associated with populations of Invasive Carp becoming established in Ohio.

Problems:

- The public may be unaware of the economic costs and ecological risks associated with established populations of Bighead Carp and Silver Carp.
- The public may be unaware of how they can help prevent the spread of Bighead Carp and Silver Carp.

- The public may not be able to identify Bighead Carp and Silver Carp and may not understand the importance of reporting these fish when encountered.
- State and federal agencies do not have the capacity to monitor all waters for Bighead Carp and Silver Carp.
- The public may not be aware of the action line for reporting Bighead Carp and Silver Carp.
- State and federal agencies have a limited number of strategies for minimizing the risk of establishment of Bighead, Silver, and Grass carps in Ohio.
- Strategies available for minimizing the risks of establishment of Bighead, Silver, and Grass carps could have effects on recreational behavior and experiences and businesses.
- The public may be unaware of measures necessary to prevent introduction of Bighead Carp and Silver Carp in waters without established populations.

Strategies:

- Maintain current information about Bighead Carp and Silver Carp on the DOW website.
- Provide sufficient signage at boat ramps, bait and tackle stores, and other outlets to alert the public to threats from Bighead Carp and Silver Carp.
- Create an awareness of the DOW website, e-newsletter, and signage used for outreach.
- Create an awareness of the strategies available for minimizing the risks of establishment of Bighead, Silver, and Grass carps in Ohio.
- Work with recreational, aquaculture, bait, and live-haul industries to develop an understanding of consequences Invasive Carp establishment and development of solutions that minimize effect on recreational experiences and commercial business operations, while reducing the risk of establishment of Bighead, Silver, and Grass carps in Ohio.
- Continue the "Trash Unused Bait" campaign with Wildlife Forever to encourage anglers to properly dispose of unused bait.
- Continue to distribute and promote the *Ohio Field Guide to Aquatic Invasive Species* available at: https://ohiodnr.gov/static/documents/wildlife/fish-management/OSU_AIS_FieldGuide_Web.pdf
- Work with partners (ex. Ohio Sea Grant, ODNR Division of Watercraft, and The Ohio State University) to provide public communication.

Supporting Actions:

- FCGX02: Statewide Management of Aquatic Invasive Species
- FCGX05: Aquatic Invasive Species – Early Detection and Rapid Response
- FCGX09: Development of Capabilities and Response Methods to Effectively Respond to Detection of Grass Carp

VII. References

Asian Carp Regional Coordinating Committee. 2010. 2011 Asian carp control strategy framework. U.S. Army Corps of Engineers, Chicago.

Asian Carp Regional Coordinating Committee. 2012. Monitoring and rapid response plan for Asian carp in the upper Illinois River and Chicago Area Waterway System. Asian Carp Regional Coordinating Committee, Monitoring and Rapid Response Workgroup. U.S. Army Corps of Engineers, Chicago.

Chapman, D.C., J.J. Davis, J.A. Jenkins, P.M. Kocovsky, J.G. Miner, J. Farver, and P.R. Jackson. 2013. First of grass carp recruitment in the Great Lakes basin. Journal of Great Lakes Research 39

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

Conover, G. 2013. Ohio River Sub-basin Asian carp action plan. Ohio River Fisheries Management Team technical report, Frankfort.

Cooke, S.L., and W.R. Hill. 2010. Can filter-feeding Asian carp invade the Laurentian Great Lakes? A bioenergetics modeling exercise. Freshwater Biology 55:2138-2152.

CMS Steering Committee. 2011. Comprehensive Management System: Operations manual. Ohio Department of Natural Resources, Division of Wildlife, Columbus.

Cudmore, B., N.E. Mandrak, J.M. Dettmers, D.C. Chapman, and C.S. Kolar. 2012. Binational ecological risk assessment of bigheaded carp. DFO Canadian Science Advisory Secretariat, Research Document 2011/114.

Davic, R.D., E. Eicher, and J. DeShon. 1996. Ohio water resources inventory volume 3: Ohio's public lakes, ponds, and reservoirs. Ohio Environmental Protection Agency, Columbus.

DFO, 2005. Carp Status Report. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2005/001.

Embke, H.S., Kocovsky, P.M., Richter, C.A., Pritt, J.J.,Mayer, C.M., Qian, S.S., 2016. First direct confirmation of grass carp spawning in a Great Lakes tributary. J. Great Lakes Res. 42, 899–903.

Garcia et al. 2013. Development of a Fluvial Egg Drift Simulator to evaluate the transportand dispersion of Asian carp eggs in rivers. Ecological Modeling. 263: 211 – 222.

Great Lakes Commission. 2012. Restoring the natural divide: separating the Great Lakes and the Mississippi River basins in the Chicago Area Waterway System. Great Lakes Commission and St. Lawrence Cities Initiative (see: http://www.glc.org/caws/).

Great Lakes Fishery Commission. 2007. A joint strategic plan for the management of Great Lakes Fisheries (adopted in 1997 and supersedes 1981 original). Great Lakes Fishery Commission miscellaneous publications 2007-01.

Hale, S., K. Cunningham, and R. Zweifel. 2006. Reservoir tactical plan. Ohio Department of Natural Resources, Division of Wildlife, Columbus.

Hale, S., J. Tyson, J. Navarro, and T. Parrett. 2013. Fisheries tactical plan: 2011-2020, update 2. Ohio Department of Natural Resources, Division of Wildlife, Columbus.

Herborg, L.M., N.E. Mandrak, B. Cudmore, and H.J. MacIssac. 2007. Comparative distribution and invasion risk of snakehead and Asian carp species in North America. Canadian Journal of Fisheries and Aquatic Sciences 64:1723-1735.

Irons, K. S., G. G. Sass, M. A. McClelland, and J. D. Stafford. 2007. Reduced condition factor of two native fish species coincident with invasion of non-native Asian carps in the Illinois River, U.S.A. Is this evidence for competition and reduced fitness? Journal of Fish Biology, 258–273.

Jenkins, J.A., and R.G. Thomas. 2007. Use of eyeballs for establishing ploidy of Asian carp. North American Journal of Fisheries Management 27:1195-1202.

Jerde, C.L., A.R. Mahon, W.L. Chadderton, and D.M. Lodge. 2011. "Sight-unseen" detection of rare aquatic species using environmental DNA. Conservation Letters 2011:1-8.

KDFWR. 2013. Ohio River Asian carp leading edge report. Kentucky Department of Fish and Wildlife Resources, inter-agency communication, Frankfort.

Kinter, B.T., et al., 2018. Assessing the risk of diploid grass carp Ctenopharyngodon idella in the certified triploid supply chain in Ohio, J. Great Lakes Res. https://doi.org/10.1016/j.jglr.2018.07.004

Kocovsky, P.M., D.C. Chapman, and J.E. McKenna. 2012. Thermal and hydrologic suitability of Lake Erie and its major tributaries for spawning of Asian carp. Journal of Great Lakes Research 38(1):159-166.

Kolar, C.S., D.C. Chapman, W.R. Courtenay, C.M. Housel, J.D. Williams, and D.P. Jennings. 2005. Asian carp of the genus Hypophthalmichthys (Picses, Cyprindidae): a biological synopsis and environmental risk assessment. U.S. Fish and Wildlife Service Report 94400-3-0128, Washington, D.C.

Lake Erie Committee. Lake Erie Grass Carp Adaptive Response Strategy 2019-2023.

Lucente, J.E., T. Gabriel, G. Davis, C. Wellington, and F. Lichtkoppler. 2013. Ohio's 2010 Lake Erie charter fishing industry. Fisheries 37:532-541.

Miami University. 2005. Ponds often little but have big impact. The Miami University Report 25:10, Oxford, Ohio.

Michigan Sea Grant. 2020. The Dynamic Great Lakes Economy: employment trends from 2009-2018

Mills, E.L., J.H. Leach, J.T. Carlton, and C.L. Secor. 1994. Exotic species and the integrity of the Great Lakes. BioScience 44:666-676.

Morrison, B.J., J.C. Casselman, T.B. Johnson, and D.L. Noakes. 2004. New Asian carp genus (Hypophthalmichthys) in Lake Erie. Fisheries 29:6-8.

ODNR. 2013. State management plan for aquatic invasive species. Ohio Department of Natural Resources, Division of Wildlife, final report R03/27/2013, Columbus.

ODNR. 1980. Inventory of Ohio's lakes. Ohio Department of Natural Resources, Division of Water, Ohio water inventory report 26, Columbus.

ODNR. 2019. Lake Erie Grass Carp Response Strategy. Ohio Department of Natural Resources, Division of Wildlife, Columbus

ODNR. 2020. Ohio's Lake Erie Fisheries, 2019. Annual status report. Federal Aid in Fish Restoration Project F-69-P. Ohio Department of Natural Resources, Division of Wildlife, Lake Erie Fisheries Units, Fairport Harbor and Sandusky. 125 pp.

Pearson, W.D. and L.A. Krumholz. 1984. Distribution and status of Ohio River fishes. University of Louisville, Water Resources Laboratory. U.S. Department of Energy, Final Report ORNL/EPA V-9, Oak Ridge.

Pritt, J. 2018. 2017 Ohio River Creel Survey Report. Ohio Department of Natural Resources, Division of Wildlife, Hebron, Ohio.

Qian, S.S., Refsnider, J.M., Moore, J.A., Kramer, G.A., and Streby, H.M. 2020. All tests are imperfect: Accounting for false positives and false negatives using Bayesian statistics. Heliyon, 6(3): e03571).

Responsive Management. 2009. Ohio River Valley residents' river-based recreation and consumption of freshwater fish. Responsive Management, Harrisonburg.

Rosaen, A.L., E.A. Grover, C.W. Spencer, and P.L. Anderson. 2012. The cost of aquatic invasive species to Great Lakes states. Anderson Economic Group LLC, East Lansing.

Sampson, S. J, C. S. Guy, and J. F. Fairchild. 2003. Competitive Interactions between Age-0 Bighead Carp and Paddlefish. Transactions of the American Fisheries Society 132:1222–1228.

Sanders, R.E. 2002. A guide to Ohio Streams. Ohio Chapter of the American Fisheries Society, Columbus, Ohio.

Schell, S.A., D.J. Bright, and J.A. Marshall. 1996. Ohio River recreational use survey 1992-1993. Ohio Department of Natural Resources, Division of Wildlife, Final Report F4DR03, Columbus.

Schuyler J. S., J. H. Chick, and M. A. Pegg. 2009. Diet overlap among two Asian carp and three native fishes in backwater lakes on the Illinois and Mississippi rivers. Biological Invasions 11:483–496

Singh, A.S., Bruskotter, J.T. and Walpole, H.D. (2014) Fishing Activities and Stewardship on the Ohio River. The Ohio State University, School of Environment and Natural Resources, and the Ohio Department of Natural Resources, Division of Wildlife.

Sindt, A. 2013. 2012 Ohio River Creel Survey Report. Ohio Department of Natural Resources, Division of Wildlife, Hebron, Ohio.

Southwick and Associates. 2012. Sportfishing in America: An economic force for conservation. American Sportfishing Association, Alexandria.

Stewart, J. 2013. Ohio river Asian carp monitoring and assessment. Unpublished project narrative. U.S. Fish and Wildlife Service, Cartersville.

U.S. Army Corps of Engineers. 2012a. GLMRIS focus area 2 aquatic pathways assessment summary report. U.S. Army Corps of Engineers (see: http://glmris.anl.gov/documents/index.cfm), Chicago.

U.S. Army Corps of Engineers. 2012b. Environmental DNA calibration study. U.S. Army Corps of Engineers, interim review report, Chicago.

U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2012. 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, U.S. Census Bureau, final report, Washington, D.C.

U.S. Fish and Wildlife Service. 1994. Great Lakes fishery resources restoration study: report to congress (draft report). ANS Digest: volume 1, number 1. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.

Wallus, R., T.P. Simon, and B.L. Yeager. 1990. Reproductive biology and early life history of fishes within the Ohio River drainage. Volume 1: Acipenseridae through Esocidae. Tennessee Valley Authority, Chattanooga.

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

Zajac, R. M., Eilers, E. M., Bruskotter, J. T. & Toman, E. (2011). Fishing Ohio: A Survey of Ohio Anglers. The Ohio State University, School of Environment and Natural Resources, and the Ohio Department of Natural Resources, Division of Wildlife.

Appendix A

The Planning Environment

The DOW operates under an organizational approach referred to as a Comprehensive Management System, or CMS (CMS Steering Committee 2011), a process for agency function that includes four key components: 1) inventory and survey; 2) strategic (long-term) and tactical (10 years or less) planning; 3) operational planning (annual); and 4) evaluation. This approach is supported by the USFWS through guidance provided by the Comprehensive Management System Grant: Chapter 4. The CMS is a process that allows for continual improvement of our agency and the management of fish and wildlife resources in Ohio through adaptive adjustments in mission, vision, direction, planning, and operations.

The ODNR-DOW Strategic Plan is the part of the CMS that provides broad, long-range direction for fish and wildlife conservation in Ohio. DOW tactical and operational plans represent additional components of the CMS that provide greater detail and are subject to routine updating as needed during the longer Strategic Plan time horizon. The Invasive Carp Tactical Plan provides specific direction for addressing these invasive species in Ohio during 2021-2030. This plan identifies issues and desired outcomes (goals), each with specific objectives, problems, and strategies or needs to be addressed during the next 10 years. Issues and desired outcomes requiring attention in each watershed directly support one or more strategic actions and identify specific milestones to be accomplished by implementing one or more activities conducted though the annual Operational Plan via operational projects.

Division of Wildlife Tactical Plans has the following elements:

Background and Situation Analysis: This section presents a brief history, overview, and status or issues associated with each subproject or area of interest. It often provides insights regarding situational strengths, weaknesses, opportunities or threats through a survey and inventory of the management, research, and conservation environment. While it may reflect on the past, it may also include current data and projections related to the future.

Issues: Issues flow from the background and situation analysis, survey and inventory, and expert knowledge of the resource. These are big picture topics that require attention for conservation actions to move forward in a particular resource area of interest. There may be one or more issues that are prioritized to address during the life of the plan.

Outcomes (Goals): Stated end points, benefits, results, or targets to be achieved, from which the quality, effectiveness, or success of work can be determined and the result or effect of having met the objectives. In Ohio, these outcomes are essentially goals that are associated with important issues or high priority management levers and are stated as the desired future condition. Outcomes are linked to the DOW Strategic Plan via “Supporting Strategic Actions” associated with the Fundamental Principles of Stewardship, Opportunities, Connections, Engagement, and Excellence.

Objectives: Concise, specific statements of what exactly will be accomplished. These accomplishments may be expressed as a quantity, a deadline, and/or the required quality of the accomplishment. Objectives should be quantifiable and measurable to facilitate evaluation and support, and flow from outcome statements to achieve the desired condition. Objectives are linked to the annual DOW Operational Plan via “Supporting Actions”, which provide specific operational project numbers and titles when available.

Problems: A specific factor that may limit the agency's ability to achieve goals and objectives. These should be concise but descriptive statements about factors that may prevent or limit progress toward achieving an objective and its associated outcome.

Strategies/Needs: Methods or approaches for achieving goals and/or objectives. The USFWS also identifies these as "needs," which are defined as whatever is or may be required to overcome problems. These may be viewed as actions or tools that must be applied to make significant progress toward the objective and associated outcome. These will generally be less specific and detailed than problem statements and objectives and can be viewed as foundations for operational planning.

The Invasive Carp Tactical Plan is:

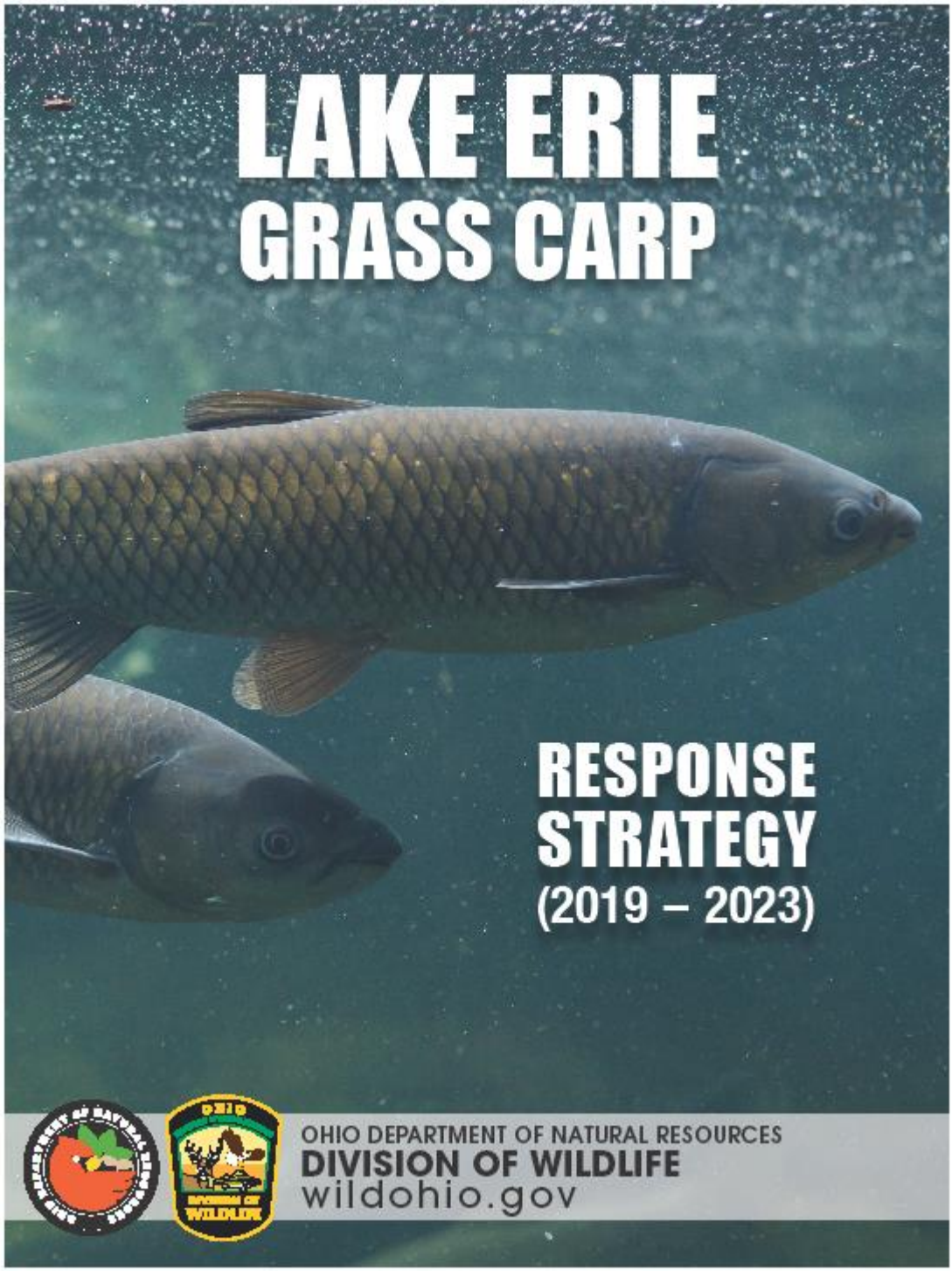
- **Available to the public:** The plan is intended to keep the DOW Fish Management and Research Group on track in addressing the highest priority issues related to Invasive Carp in Ohio during the next 10 years. Although the plan is written as a technical document it is available to all stakeholders and the public.
- **Only effective if routinely evaluated:** The plan will require a 5-year (mid-cycle) evaluation to make major adjustments in plan elements or operational projects that may be necessary; however, in the spirit of adaptive management, annual use, review, and adjustment of this plan is anticipated. Annual performance reports from operational projects related to this plan should allow fine-scale adjustments in budgeting personnel and non-personnel costs of activities and facilitate achieving tactical outcomes and objectives.

The Invasive Carp Tactical Plan is not:

- **All encompassing:** The plan does not address every issue related to Invasive Carp in Ohio; rather, it represents the highest priority outcomes and objectives identified at this time, many of which may be accomplished during 2021-2030. During this period, additions or deletions of outcomes and objectives, or their priority among resource management may change as needs change. Some overlapping material can be found in the DOW Fisheries Tactical Plan, Aquatic Stewardship Chapter.
- **Restrictive:** The plan is not intended to be restrictive. Important opportunities or issues not included in this plan are likely to arise during the next 10 years and we would be remiss not to respond with revisions of tactical direction. The plan is not intended to prevent taking advantage of opportunities or restrict responses to emerging concerns.
- **An endpoint:** Completion of this plan is not considered an endpoint; rather, a guide to address the challenges outlined in this document and a continuation of the CMS cycle.

Implementation of the Invasive Carp Tactical Plan begins May 2021. The structure of this plan is important for successful implementation of both tactical and operational activities given the CMS. Tasks and timelines should be established to address specific objectives. Many of the outcomes and objectives can be addressed through coordinating efforts within the Fish Management and Research Group. However, cooperation with anglers, other DOW groups, ODNR Divisions, university research partners, neighboring state and provincial agencies, non-governmental organizations and other external entities will also be important. The 2021-2030 Invasive Carp Tactical Plan provides a foundation for not only on-the-ground work conducted by the DOW during the next 10 years, but future planning activities as well. Experience gained from plan development and implementation should ensure progress and continual improvement well into the future.

Appendix B


LAKE ERIE
GRASS CARP
RESPONSE
STRATEGY
(2019 – 2023)
OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE
wildohio.gov

Mission Statement:

The mission of the Ohio Department of Natural Resources (ODNR) Division of Wildlife is to conserve and improve fish and wildlife resources and their habitats for sustainable use and appreciation by all.

Acknowledgements:

- Scott Hale, ODNR Division of Wildlife
- John Navarro, ODNR Division of Wildlife
- Travis Hartman, ODNR Division of Wildlife
- Eric Weimer, ODNR Division of Wildlife
- Janice Kerns, ODNR Division of Wildlife
- Rich Carter, ODNR Division of Wildlife
- Roger Knight, Great Lakes Fishery Commission
- Jim Francis, Michigan DNR

Recommended Citation:

ODNR Division of Wildlife. 2019. Lake Erie Grass Carp Response Strategy: 2019-2023. Ohio Department of Natural Resources, Division of Wildlife. Columbus, Ohio.

Table of Contents Page

Executive Summary

The *Lake Erie Grass Carp Response Strategy: 2019 – 2023*, describes the Ohio Department of Natural Resources, Division of Wildlife (DOW) strategy to prevent Grass Carp expansion beyond western Lake Erie, the Maumee and Sandusky rivers. Grass Carp are herbivorous and exist in Ohio in two forms. Diploid Grass Carp can reproduce, are illegal to possess in Ohio, and are undesirable due to their potential to damage habitats, alter fish communities and degrade ecosystems. Triploid Grass Carp are genetically altered, cannot reproduce, and are routinely, and legally, used in small lakes and ponds to control aquatic vegetation as an alternative to chemical methods. Recent findings of diploid Grass Carp in western Lake Erie and the Maumee and Sandusky rivers pose a serious threat to Lake Erie and the Great Lakes. Documentation of diploid Grass Carp in Lake Erie and successful reproduction in the Sandusky and Maumee rivers is an immediate concern. This plan was developed to provide a foundation for on-the-ground efforts to address Grass Carp reproduction in these rivers and population expansion in Lake Erie. It is adaptive and informed by current and emerging science; therefore, it will be revised, as necessary. Response actions include two outcomes (goals) with supporting objectives and strategies.

Outcome 1: The introduction and expansion of reproductively viable (diploid) Grass Carp is prevented beyond western Lake Erie and the Maumee and Sandusky rivers. Objectives include:

- **Objective 1.1** – Secure the aquaculture supply chain through routine annual inspections to ensure that only triploid (sterile) fish are available.
- **Objective 1.2** – Ensure a secure bait trade through annual surveillance of the bait industry and outreach to reduce the risk of Grass Carp being inadvertently released into the wild.
- **Objective 1.3** – Close knowledge gaps and better understand the life history of Grass Carp by annually monitoring their presence, refining strategies to minimize expansion, and identifying effective approaches to reduce populations.

Outcome 2: Strategies are implemented by the DOW and partners to prevent Grass Carp populations in Ohio waters from reaching levels that compromise aquatic communities as informed through a Structured Decision-Making (SDM) process and ongoing science. The Objectives include:

- **Objective 2.1** – Work with partners to implement annual removal of 390 Grass Carp from Lake Erie to suppress range expansion, as recommended by the SDM process.
- **Objective 2.2 –** Enlist the aid of commercial fishers to annually monitor abundance, distribution and assist in achieving annual objectives for removal of Grass Carp.
- **Objective 2.3** – Complete an evaluation of potential barriers to limit reproduction and recruitment in the Sandusky and Maumee rivers.

The Great Lakes Restoration Initiative is the anticipated source of funding for this strategy.

Introduction

The term “Invasive Carp” commonly refers to a select group of cyprinid fishes (minnow family) that are native to Asia. The United States Fish and Wildlife Service (USFWS) specifically use “Invasive Carp” to refer to Bighead Carp *Hypophthalmichthys nobilis*, Silver Carp *Hypophthalmichthys molitrix*, Black Carp *Mylopharyngodon piceus* and Grass Carp (also known as White Amur) *Ctenopharyngodon idella*. Each was intentionally introduced into the United States as a biological control. All potentially threaten Ohio’s fisheries and aquatic ecosystems. Bighead Carp and Silver Carp are increasingly present in the

Ohio River, with the greatest populations in the westernmost reaches. Grass Carp have been found throughout Ohio; however, findings of diploid Grass Carp capable of reproducing have been rare and limited to western Lake Erie, the Maumee and Sandusky rivers.

Grass Carp were imported into Alabama and Arkansas aquaculture facilities in 1963 to control vegetation in rearing ponds (Mitchell and Kelly 2006). They were widely stocked, and range expansion resulted from intentional and accidental releases. Escapes of captive fish and the intentional stocking of diploid fish promoted their spread across the US (Guillory and Gasaway 1978). Concern over potential ecological consequences led to the development of a sterile, non-reproductive form (triploid) used for vegetation control (Mitchel and Kelly 2006). Shortly thereafter, a commercial hatchery in Arkansas developed a commercially viable process for creating triploid Grass Carp that has led to sales of over 400,000 triploid Grass Carp per year in at least 30 states (Conover et al. 2007). Importation of triploid Grass Carp is permitted by the USFWS to track shipments and sophisticated ploidy testing is routine at production facilities.

Ohio law established in Ohio Administrative Code (OAC) does not permit importation of diploid Grass Carp (OAC 1501:31-19-01); however, importation of certified triploid Grass Carp (OAC 1501:31-19-01), incapable of reproduction, to control vegetation has been legal since 1988. OAC stipulates that individuals who import or sell triploid Grass Carp can only sell fish that are certified as triploid by the USFWS. Triploid Grass Carp offer a biological control for vegetation that is cost-effective and reduces the need for chemical vegetation control measures. Legalization of triploid Grass Carp minimized concerns about their ecological impact should they escape containment where they are stocked and has likely reduced the illegal importation of diploid fish. Presently, Grass Carp stocking is prohibited or restricted to triploid fish in US states and Canadian provinces bordering the Great Lakes; however, some central and southern U.S. states continue to allow the stocking of the diploid fish (Conover et al. 2007).

Grass Carp are herbivorous and have the potential to negatively impact native fish communities in the Great Lakes through habitat destruction when abundant (DFO 2017). Given the documented reproduction of Grass Carp in large rivers, they could compromise aquatic ecosystems in Ohio rivers, streams, and Lake Erie migrating waterfowl and other water birds that rely on submersed aquatic vegetation.

Grass Carp were detected in Lake Erie as early as the mid-1980s, but since some jurisdictions allow the stocking of triploid (sterile) Grass Carp it was assumed that these intermittent captures were escaped sterile fish. Concerns associated with Grass Carp were elevated in Michigan and Ohio in 2012 when feral fish tested were found to be diploid. Between 2013 and 2017, a joint effort with commercial fishers resulted in the capture of 83 grass carp in western Lake Erie which were found to be of multiple size classes, indicative of multiple stocking events or natural recruitment. These results were later corroborated by research conducted by Central Michigan University and USGS which determined that greater than 80% of grass carp captured in Lake Erie were fertile and that spawning had occurred in the Sandusky River.

These findings resulted in the need for cooperative, deliberate, and planned actions. The potential expansion of diploid Grass Carp poses adverse impacts to native habitats, ecosystem integrity and ultimately sport fisheries and commercial fisheries, water birds and waterfowl. Actions described in this plan are intended to prevent Grass Carp expansion and population growth through science-based adaptive management.

II. History of Grass Carp and Response Actions in Ohio Waters

Grass Carp have been incidentally captured by commercial netters in the lower Sandusky River, downstream of Fremont, Ohio for over a decade. Historic captures within the Great Lakes basin were believed to be escaped triploid stockings, posing little threat to native ecosystems. However, ploidy testing since 2012 has determined that a high proportion of Grass Carp in the system are diploid and capable of reproduction (Chapman et al. 2013; Wieringa et al. 2016), leading to regional concern.

In 2012, the DOW began testing ploidy status of individual fish captured during agency fish surveys and by commercial netters. All samples collected have been tested for ploidy by the USGS National Wetlands Research Center in Lafayette, Louisiana, or the USFWS Whitney Genetics Laboratory in La Crosse, Wisconsin. Ploidy status of individual Grass Carp was determined using flow cytometry technology as established in Jenkins and Thomas (2007). For determining ploidy of feral Grass Carp, cells from the vitreous humor (fluid taken from the eye) are used and sample collection and preparation followed the standard operating procedure supplied by USGS National Wetlands Research Center. In 2012, 10 Grass Carp collected from Lake Erie and the Sandusky River in commercial trap nets and seines where tested; five were confirmed as diploid, two were confirmed triploid, one was undetermined, and two were not tested due to equipment malfunctions.

Beginning in 2013, DOW staff initiated statewide ploidy testing of Grass Carp incidentally captured during standard fish surveys and commercial fishing operations in waters where triploid fish were not stocked for vegetation control. All samples were tested using flow cytometry at the USFWS Whitney Genetics Laboratory. Additionally, fin clips and otoliths were analyzed to understand origins of wild-caught Grass Carp. To further these efforts, the DOW updated Lake Erie commercial fishery catch reporting software to include grid-specific reporting on Grass Carp landed and added Grass Carp to the list of species that can be commercially harvested.

Evidence, including ploidy testing, fish size and age, and otolith microchemistry suggest that Grass Carp collected in the Sandusky River during 2012 resulted from successful reproduction (Chapman et al 2013). Although the first indication of natural reproduction of Grass Carp in Ohio, evaluation of fertility through ploidy testing did not begin until 2012. Grass Carp have been observed in the Ohio portion of Lake Erie since 1984; therefore, it is possible that diploid Grass Carp have been in Lake Erie for decades. An episodic flooding event, like that in the Western Basin of Lake Erie during 2011, may have established conditions suitable for reproduction.

In 2015, researchers began collecting ichthyoplankton in the Sandusky River and observed seven eggs during or immediately-after high-flow events (Embke et al. 2016). In 2017, seven Grass Carp implanted with acoustic transmitters were detected on a real-time hydrophone operated by the US Geological Survey (USGS) during a high-flow event May 29-June 1. Subsequent sampling resulted in collection of several hundred Grass Carp eggs at multiple locations between Brady's Island near Fremont and Wightman's Grove. A single adult Grass Carp was detected during a secondary flow event on July 8-9 and eggs also were collected during a flow event on July 12. These results indicate that Grass Carp are using the Sandusky River to spawn, but it is unclear if they are successfully recruiting to the population. Subsequent flow modeling suggests that Grass Carp spawning in the Sandusky River occurs between Brady's Island and the former site of the Ballville Dam located in Fremont, Ohio. Diploid Grass Carp are not unique to the Ohio portion of Lake Erie or the Great Lakes. They have also been documented in the

Michigan portion of Lake Erie near the Detroit Edison Monroe Power Plant and several locations in Lake Calumet and tributaries of Lake Michigan (Marion Wittmann, UND, personal communication).

On June 13 and 26, 2018, a sampling crew from The University of Toledo (UT) collaborating with USGS, collected six Grass Carp from the Maumee River in Toledo, Ohio. The larval Grass Carp were collected near the I-280 bridge during high water flow events typical of spawning conditions for Grass Carp. These young fish were the first Grass Carp collected in their larval stage from within the Great Lakes watershed and now confirms that all Grass Carp life stages have been documented in the Western Basin of Lake Erie (eggs, larvae, juveniles, and adults).

The DOW has also participated in efforts by USGS, UT, and Michigan Department of Natural Resources (MDNR) to learn more about Grass Carp life history and movement. Efforts by USGS and UT include sampling for Grass Carp eggs and larvae in Lake Erie tributaries in the western basin to determine the extent and location of spawning. Through a collaboration with MDNR and USGS, 50 wild-caught Grass Carp were implanted with acoustic tags and their movements are being monitored by both fixed and real-time receivers. Due to the loss of previously tagged Grass Carp, additional fish will be implanted with tags and released to maintain a tagged population at 50 fish. All these efforts will allow the DOW and partner agencies to better understand management options by having real-time information on Grass Carp locations and when they are in tributaries where they are susceptible to standard fishing gear.

Grass Carp Supply Chain Monitoring. An issue regarding Grass Carp in Ohio is that fish transported and sold as triploids could be diploids, or mixed with diploids, and could escape waters where they were stocked and establish reproducing populations. To assess the Grass Carp supply chain in Ohio, a 2-year undercover operation was undertaken in 2015 and 2016. A total of 1,200 Grass Carp were covertly purchased for selected suppliers in Ohio and tested for ploidy by the USGS National Wetlands Research Center in Lafayette, Louisiana (Kinter et al. 2018). All fish tested were triploid which indicates that the Ohio supply chain was secure during the project period. Continued monitoring of imported Grass Carp through a permit process and testing of ploidy status of imported fish, along with testing of Lake Erie watershed wild-caught fish, will continue as described in this document.

Sandusky River Grass Carp Planned Action: 2017, 2018, and 2019. During August 28 –31, 2017 and June 12–14, 2018, multiple agencies and organizations participated in planned actions that were successful in removal of Grass Carp and informing research about movement and habitat use.

In 2017, 19.6 hours of gill netting, 13.9 hours of trammel netting, 25.6 hours of electrofishing, and 96 hours of mini fyke netting in the Sandusky River resulted in the capture of eight Grass Carp with combined net and electrofishing methods where fish were chased into nets.

In 2018, 70.5 hours of electrofishing and 63.7 hours of trammel net effort in the Sandusky and Maumee Rivers resulted in the capture of 31 grass carp; 21 of which were removed (20 from the Sandusky and one from the Maumee), one recaptured fish (tagged in 2016 near Maumee Bay and captured/released in the Sandusky) that was returned for continued tracking, and nine fish implanted with transmitters (seven in the Sandusky and two in the Maumee) for tracking as part of continued efforts to understand movement and inform long-term removal efforts. Due to high flows limiting the effectiveness of trammel nets, most the fish were collected using multiple electrofishing boats.

The Sandusky River Grass Carp Planned Actions had multiple desired outcomes. Overall, these collaborative multi-agency approaches helped assess Grass Carp sampling (removal) methodologies, increased staff preparedness and familiarity with sampling methodologies, and increased information about population demographics in the Sandusky River and western Lake Erie (Weimer 2018). Specifically, this allowed us to: 1) evaluate the utility of various gears for targeted collections in the Sandusky River; 2) increase proficiency with multiple gears in lotic habitats; 3) increase demographic information on distribution, size composition, ploidy, and relative abundance of Grass Carp in the Sandusky River and western Lake Erie; and 4) remove Grass Carp from the Sandusky River.

Starting in 2019, DOW will transition from planned actions to the deployment of a dedicated Grass Carp Strike Team in partnership with UT. This team will be comprised of a UT lead worker and three seasonal staff from DOW. This team will be dedicated to Grass Carp removal efforts and will work with similar teams from MDNR and USFWS.

Structured Decision-Making (SDM) Process. The goal of the Grass Carp SDM was to collaboratively develop an adaptive management strategy to control/eradicate the Grass Carp population in Lake Erie, with the flexibility to update management actions with increasing knowledge about the system. Through this process, we will be able to address areas of uncertainty in the decision-making process by using a variety of gear types to evaluate Grass Carp catchability while conducting targeted removal efforts.

The SDM process will help collaboratively identify a management strategy while taking into consideration the stakeholders (i.e., agencies and universities) values in the process, ultimately aiding in cohesive implementation. Through the adaptive management process, control efforts will also provide essential information about Grass Carp abundance, movement, and catchability that can be used to inform future management decisions.

III. Outcomes, Objectives and Strategies

It is critical that the DOW response to Grass Carp be adaptive, consistent with agency authority and responsibility, and sustainable. Completion of adaptive response actions described in this section are contingent upon identification of and successful award of funding. The current funding source for actions is the Great Lakes Restoration Initiative.

Adaptive approaches are essential to capitalize on new information or perspectives, whether derived from lessons learned through experimental management, collaborative insights, closing knowledge gaps, research, or discovery. Agency authority and responsibility identified in Ohio Revised Code (ORC) and OAC present legal sideboards associated with laws, regulations, and authority that must be considered. Sustainable, cost-effective approaches are essential because Grass Carp present a long-term threat to many Ohio water bodies that the DOW manages. Therefore, tactical responses must be prudent and cannot tax agency resources to an extent that compromises the agency's mission and core responsibilities to manage fish and wildlife. Collaboration with partner agencies, federal support, and benefits from existing agency and partner work is critical to ensuring that an effective and meaningful response to Grass Carp in Ohio is possible and sustainable.

This plan addresses currently identified issues caused by Grass Carp. This Response Strategy plan has two outcomes, six objectives, and 13 strategies.

Issue: ***Diploid Grass Carp are reproducing in Lake Erie.*** Actions outlined in this section are intended to prevent diploid Grass Carp from becoming established in Lake Erie and its tributaries, as continued reproductive success may allow feral populations to become abundant and negatively affect native habitats, ecosystem integrity, and sport and commercial fisheries. Our intent is to prevent Grass Carp from attaining densities that cause adverse impacts by a science-based, adaptive management approach to guide decision-making.

- **Outcome 1: The introduction and expansion of reproductively viable (diploid) Grass Carp is prevented beyond western Lake Erie and the Maumee and Sandusky rivers.**

  - **Objective 1.1 - Secure the aquaculture supply chain through routine annual inspections to ensure that only triploid (sterile) fish are available:** There is the potential for diploid (fertile) Grass Carp to be in the commerce supply chain and there is a risk of these fish being inadvertently released into the wild. To reduce this risk, DOW Law Enforcement and Fish Management Sections will monitor the supply chain for ploidy status of Grass Carp available for sale in Ohio to ensure that only triploid (sterile) fish are available.
    - **Strategy 1.1.1 – Conduct Random Sampling of Supply Chain:** Build upon earlier efforts to randomly sample sales during April through October to covertly test ploidy status of Grass Carp from 10 Grass Carp facilities annually (10 fish per sample, 100 fish total).

  - **Objective 1.2 - Ensure a secure bait trade through annual surveillance of the bait industry and outreach to reduce the risk of Grass Carp being inadvertently released into the wild:** There is the potential for diploid Grass Carp (as well as other AIS) to be in the bait trade and there is a risk of these fish being inadvertently released into the wild. To reduce this risk, routine surveillance of the bait industry will be implemented, and outreach efforts will be implemented.
    - **Strategy 1.2.1 – Bait Trade Surveillance:** Continue annual surveillance of bait outlets through our Law Enforcement Section to screen for potential invasive aquatic species including Grass Carp through annual inspection of 25 percent of the bait outlets with every outlet having a mandatory inspection once every four years.
    - **Strategy 1.2.2 – Bait Trade Outreach:** Continue to provide outreach material to bait outlets to assist with self-monitoring of AIS, including Grass Carp.
    - **Strategy 1.2.3 – Angler Outreach:** Continue annual partnership with Wildlife Forever on the "Trash Unused Bait" campaign to provide funding for six billboards along the Lake Erie coastline and half-page ads in the Ohio Outdoor News from April through October.

  - **Objective 1.3 – Close knowledge gaps and better understand the life history of Grass Carp by annually monitoring their presence, refining strategies to minimize expansion, and identifying effective approaches to reduce populations:** The number, spatial distribution, preferred habitats, and biology of Grass Carp in Lake Erie is unknown; consequently, there is a need to monitor their presence and possible population expansion to help focus eradication and population reduction strategies.
    - **Strategy 1.3.1 – Monitor Populations:** Monitor Grass Carp presence through: 1) routine fisheries surveys, 2) targeted sampling in locations of likely aggregations at appropriate times, and 3) monitoring commercial netters to better inform estimates of Grass Carp population size and distribution.

- **Strategy 1.3.2 – Monitor Movement:** Continue to collaborate with MDNR to radio tag Grass Carp to monitor their movement in Lake Erie (and the Great Lakes) and selected tributaries through the GLATOS system and through real-time receivers. Deploy additional receivers to provide finer-scale resolution on Grass Carp movements / locations and to track real-time movements in the Sandusky River, Maumee River, and other selected tributaries; and investigate the use of mobile tracking.
- **Strategy 1.3.3 – Determine Detection Probability:** To assist with our efforts to collect Grass Carp, we will initiate a two-year study with UT to develop a model to accurately estimate the detection probability of Grass Carp. This model will help refine eradication and control efforts and provide a better estimate of population size.
- **Strategy 1.3.4 – Assess Reproduction:** Continue to collaborate with UT and USGS to monitor for Grass Carp reproduction in the Sandusky River, Maumee River, and other selected tributaries by sampling for eggs and larvae as determined by habitat and flow characteristics.

- **Outcome 2: Strategies are implemented by the DOW and partners to prevent Grass Carp populations in Ohio waters from reaching levels that compromise aquatic communities as informed through a SDM process and ongoing science.**

  - **Objective 2.1 – Work with partners to implement annual removal of 390 Grass Carp from Lake Erie to suppress range expansion, as recommended by the SDM process:** The SDM process suggested that annual removal of 390 Grass Carp could suppress range expansion. We will work with our partners to better understand our ability to remove this number annually from Lake Erie and this estimate will be adjusted as new information updates the model.
    - **Strategy 2.1.1 – Develop Sustainable, Cost-Effective, Long-Term Removal Program:** Using the information learned from Ohio's planned actions in 2017 and 2018, develop a long-term Grass Carp removal strategy through the development of a Grass Carp Strike Team through a partnership with the UT to focus on future Grass Carp control activities. The Ohio team will work closely with similar teams housed within the MDNR and USFWS.

  - **Objective 2.2 – Enlist the aid of commercial fish netters to annually monitor abundance, distribution and assist in achieving annual objectives for removal of Grass Carp:** Commercial netters have provided an important indicator of Grass Carp abundance and distribution, and further utilization of the fishery will be considered.
    - **Strategy 2.2.1:** Partner with commercial fishers to strengthen Grass Carp reporting by incentivizing individuals turned in to the DOW.

  - **Objective 2.3 – Complete an evaluation of potential barriers to limit reproduction and recruitment in the Sandusky and Maumee Rivers:** There may be an opportunity to prevent Grass Carp from reaching suitable spawning areas using physical and behavioral barriers, or to remove fish using a selective fish passage system.
    - **Strategy 2.3.1: Conduct a Barrier Feasibility Study** - Identify a suitable entity to conduct a study to evaluate existing conditions on the Sandusky and Maumee Rivers to determine the feasibility of a temporary or permanent barrier in these rivers. The study will evaluate potential barrier types and determine how and where they might be used to block movements of Grass Carp and/or support population reduction actions.

- **Strategy 2.3.2: Develop a Barrier Design** – If the study identified above concludes that a barrier system is workable, cost-effective, and sustainable; then a qualified engineer will develop a barrier design. Funding and construction of a barrier would be considered in 2021.
- **Strategy 2.3.3: Consider New Technologies for Implementation** - Evaluate control technologies being developed by the USGS for use on Grass Carp in Lake Erie. Deploy as deemed necessary, relevant, and appropriate based on economic feasibility, ease of implementation, and available funding. Implementation could potentially occur within the bounds of this plan, pending identification of a funding source.

IV. Communication, Coordination and Cooperation

Actions of the DOW are part of a coordinated national response to the Invasive Carp invasion. Issues related to AIS transcend the responsibility and authority of a single authority or agency. Therefore, the DOW will effectively communicate internally and externally through prescribed strategies to share new information, clarify rationale for necessary actions or responses, and address emerging concerns. This will be accomplished through existing organizations with established communication frameworks.

Grass Carp in the Western Basin of Lake Erie is a multi-jurisdictional issue; therefore, good communication, coordination and cooperation between state, provincial and federal agencies, universities, and other partners is essential. Fluid dialog, planning, strategy sessions, joint exercises, face-to-face meetings, conference calls and routine correspondence via e-mail and phone are vital as information continues to emerge, management approaches adapt, and resources are sought to address Grass Carp issues. A focus on applied science that promote strategies in this plan is of great importance to the DOW and synergy between managers (DOW, MDNR, USFWS, Ontario Ministry of Natural Resources, and the Department of Fisheries and Oceans Canada) and researchers (USGS and universities) should facilitate such efforts.

V. References

Chapman, D.C., J.J. Davis, J.A. Jenkins, P.M. Kocovsky, J.G. Miner, J. Farver, and P.R. Jackson. 2013. First evidence of grass carp recruitment in the Great Lakes basin. Journal of Great Lakes Research 39:547-554.

Conover, G., Simmonds, R., and Whalen, M., 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. 223 pp.

DFO. 2017. Ecological Risk Assessment of Grass Carp (Ctenopharyngodon idella) for Great Lakes Basin. DFO Can. Sci. Advis. Sec. Sci. Re. 2016/057.

Embke, H. S., Kocovsky, P. M., Richter, C. A., Pritt, J. J., Mayer, C. M., and Qian, S. S. 2016. First direct confirmation of grass carp spawning in a Great Lakes tributary. Journal of Great Lakes Research, 42: 899-903.

Guillory, V. and Gassaway, R. D. 1978. Zoogeography of the grass carp in the United States. Transactions of the American Fisheries Society, 107(1): 105-112.

Kinter, B.T, Jenkins, J.A., and Tyson, J.T. 2018. Assessing the risk of diploid grass carp *Ctenopharyngodon idella* in the certified triploid supply chain in Ohio. Journal of Great Lakes Research, JGLR-01365; No. of pages: 7; 4C.

Mitchell, A. J., and Kelly, A. M. 2006. The public sector role in the establishment of grass carp in the United States. Fisheries, 31(3): 113-121.

Weimer, E. 2018. Ohio Department of Natural Resources, Division of Wildlife, Sandusky River Grass Carp Planned Action 2018 Work Plan, Personal Communication.

Wieringa, J. G., Herbst, S. J., and Mahon, A. R. 2016. The reproductive viability of grass carp (Ctenopharyngodon idella) in the western basin of Lake Erie. Journal of Great Lakes Research, 43: 405-409.

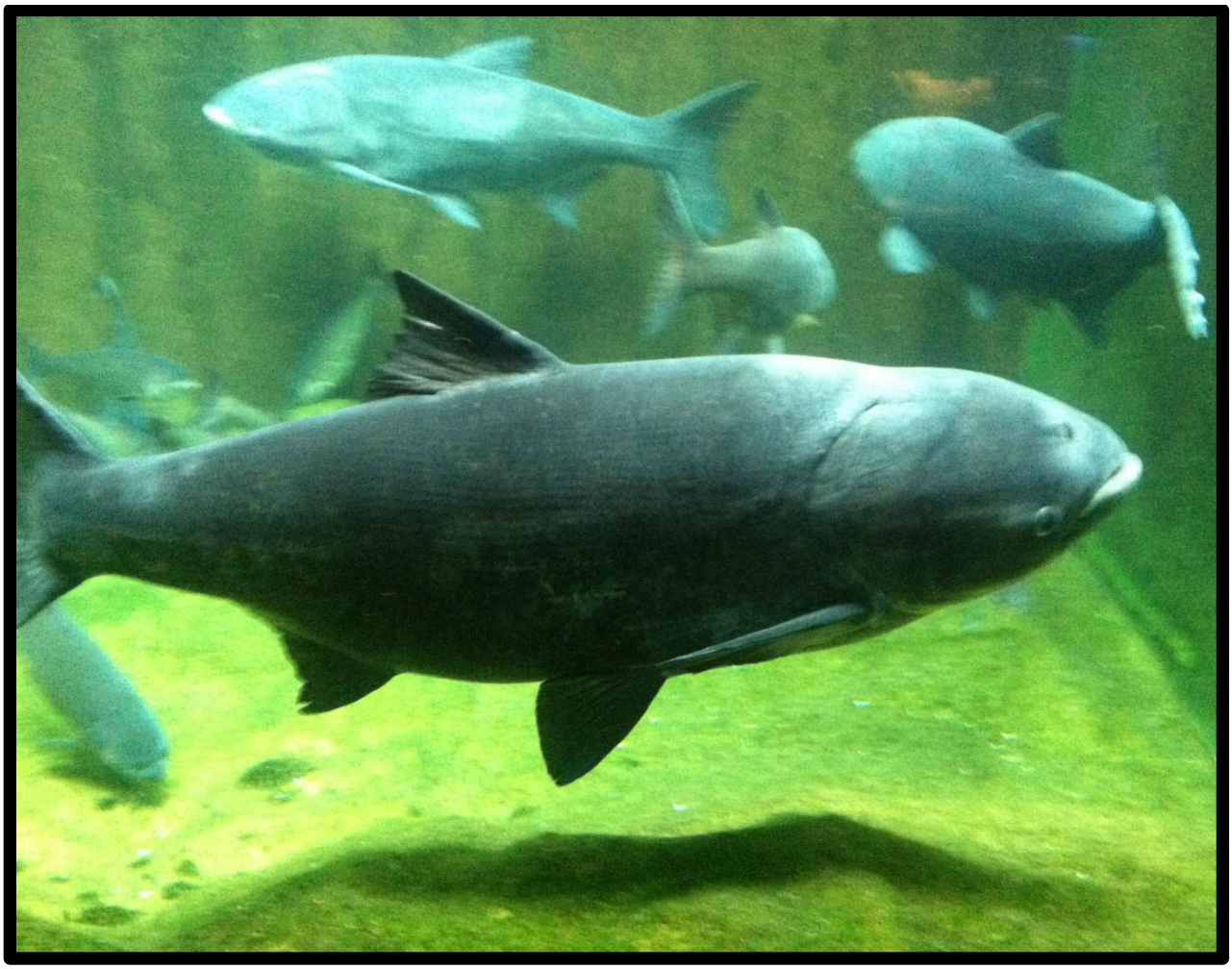
Appendix C

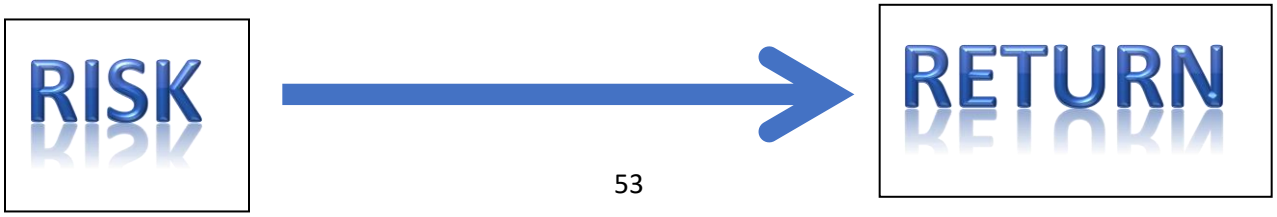
Invasive Carp Response Guidelines

Ohio Department of Natural Resources

Division of Wildlife

April, 2021





Mission Statement:

The mission of the Ohio Department of Natural Resources (ODNR) Division of Wildlife is to conserve and improve fish and wildlife resources and their habitats for sustainable use and appreciation by all.

Acknowledgements:

- Scott Hale, Executive Administrator, Fish Management and Research
- John Navarro, Aquatic Stewardship Program Administrator
- Travis Hartman, Lake Erie Fisheries Program Administrator
- Rich Zweifel, Inland Fisheries Program Administrator
- Eric Weimer, Supervisor, Sandusky Fisheries Research Unit

Recommended Citation:

ODNR Division of Wildlife. 2021. Invasive Carp Response Guidelines: 2021. Ohio Department of Natural Resources, Division of Wildlife. Columbus, Ohio.

TABLE OF CONTENTS

Executive Summary

These guidelines provide a strategy to address new information or emerging issues related specifically to Invasive Carp (Bighead, Silver, Grass, and Black Carp) through explicit responses to predicted scenarios that can readily be communicated to the public and supported with risk and return based rationale. The guidelines provide consistent responses to new information based on the threat Invasive Carp pose in specific waters and the ability of the agency and its partners to eliminate the risk. Planned responses promote the implementation of actions that are commensurate with the level of risk and facilitate communication of the agency's response to the public. Responses are guided by information flow charts and a decision matrix based on the relative risks of new findings and return on planned responses.

New Invasive Carp reports will be assessed to determine the risk to the resource and the likelihood that a response action will be successful. The Invasive Carp Risk-Return Matrix provides an assessment of scenarios that are based on location and the action to be taken.

The Ohio Department of Natural Resources Division of Wildlife (ODNR DOW) will take specific action to include one or more of the following specific actions in response to information received:

- **Report:** Information will be reported within ODNR DOW and to the US Geological Survey Non-Indigenous Aquatic Species Database.
- **Communicate:** Information will be communicated as necessary and appropriate to partner organizations and to the public through a media news release.
- **Planned Response:** Additional environmental DNA (eDNA) sampling in response to positive eDNA results or the deployment of traditional fishing gear (electrofishing and nets) in response to a live fish capture or successive positive eDNA detections.
- **Eradication:** In specific circumstances actions can be taken to eliminate the risk of Invasive Carp.
- **Monitor:** Continue to assess conditions if eradication is not feasible as determined by relative risk and potential return.

I. Introduction

The ODNR DOW *Invasive Carp Tactical Plan 2021 - 2030* (ODNR 2021) addresses the threat of Invasive Carp to Ohio's fisheries and aquatic resources. An important objective of this plan is to develop a response strategy to address new information or emerging issues related specifically to four species of Invasive Carp: Bighead, Silver, Grass, and Black Carp. These guidelines provide a strategy for explicit responses to predicted scenarios that can readily be communicated with the public and supported with risk and return based rationale, such as positive findings from environmental DNA (eDNA) or reports of Invasive Carp in previously unreported waters.

With limited funding available to address this issue, it is prudent to allocate resources efficiently and effectively. The intent of these response guidelines is to provide consistent responses to new information based on the threat they pose in specific waters and the ability of the agency and its partners to eliminate the risk. Planned responses will promote the implementation of actions that are commensurate with the level of the risk and facilitate communication of the agency's response to the public. To accomplish this,

the ODNR DOW developed information flow charts to guide responses and a decision matrix based on the relative risks of new findings and return on planned responses.

Ohio is part of two major watersheds and the threat from Bighead, Silver Grass, and Black Carp are unique to each. The northern third of Ohio is within the Lake Erie watershed and currently does not have Bighead, Silver, or Black Carp. There have been fertile (diploid) Grass Carp collected in the Lake Erie watershed, and spawning has been documented in the Sandusky and Maumee Rivers and current actions are being taken to prevent establishment. The southern two-thirds of Ohio are within the Ohio River watershed. Adult Bighead Carp and Silver Carp are now present in low numbers in Ohio's portion of the Ohio River mainstem and both Bighead Carp and Silver Carp are abundant in the lower Ohio River (near Louisville, Kentucky) and its major tributaries. Grass Carp are widely distributed in low numbers throughout the Ohio River watershed and Black Carp are not yet found in Ohio but are present in the lower reached of the Ohio River. Response guidelines for Bighead, Silver, Grass, and Black Carp differ depending upon species, type of new information, and location.

II. Parameters Used in Consideration of Response

Potential Data Considered in Detection:

- **Environmental DNA:** Positive findings may indicate the presence of Invasive Carp through analysis of their genetic information shed into the water from mucus, scales, or feces, but do not confirm presence of a live fish. This technology is still evolving, and results are viewed as insightful, but not absolute regarding the presence of a live fish.
- **Adult:** Findings of adult fish are significant, depending upon where they are reported, but are not indicative of reproduction or established populations since these fish move extensively in unobstructed waters.
- **Juvenile:** Findings of juvenile fishes strongly suggest that natural reproduction has taken place where they are observed.
- **Eggs:** Findings of eggs is an indication of successful reproduction but does not necessarily result in recruitment to the population.

Locations of Observance and Implications:

- **Ohio River watershed mainstem and tributaries:**
    - Bighead Carp and Silver Carp are present in the mainstem and the lower portions of its tributaries and will likely become established as environmental conditions and habitat permit.
    - Grass Carp are found throughout the watershed, but captures have been isolated adults.
    - Black Carp are not present, but this will likely change as fish move up the river from the lower reaches.
- **Reservoirs:**
    - Bighead Carp and Silver Carp are not present in reservoirs and populations are unlikely to establish due to the small size of Ohio reservoirs and the lack of spawning habitat.
    - Grass Carp captures have been isolated adults and are unlikely to establish due to the small size of Ohio reservoirs and the lack of spawning habitat.

- Black Carp are not present in Ohio Reservoirs.

- **Muskingum River:**
  - This large Ohio River tributary has two direct water connections in Lodi and Akron, Ohio that could facilitate movement of Invasive Carp into Lake Erie.
  - Bighead Carp eDNA was detected in the Muskingum River in 2013 but intensive sampling in 2014 did not find any live Bighead Carp. Follow-up eDNA sampling by the USFWS indicates that no Bighead Carp or Silver Carp are present in the river.
  - Grass Carp captures have been isolated adults and no reproduction is evident.
  - Black Carp are not present, but this will likely change as fish move up the river from the lower reaches.
- **Lake Erie open lake and tributaries:**
  - Bighead Carp and Silver Carp eDNA has been detected in the Western Basin of Lake Erie but follow-up sampling and monitoring has not found any live fish.
  - There have been fertile (diploid) Grass Carp collected in the Lake Erie and reproduction has been documented in the Sandusky and Maumee Rivers and efforts are underway to control and eradicate this population.
  - Black Carp are not present in the Lake Erie watershed.

Response Actions: In response to information received regarding a positive eDNA report or confirmed live fish or eggs, the ODNR DOW will take one or more of the following specific actions:

- **Report:** Information will be reported within ODNR DOW and to the US Geological Survey Non-Indigenous Aquatic Species Database.
- **Communicate:** Information will be communicated as necessary and appropriate to partner organizations and to the public through a media news release.
- **Planned Response:** This will entail additional eDNA sampling in response to positive eDNA results or the deployment of traditional fishing gear (electrofishing and nets) in response to repeated positive eDNA results or a live fish capture.
- **Eradication:** In specific circumstances, actions can be taken to eliminate the risk of Invasive Carp.
- **Monitor:** If an eradication effort does not take place because it is not feasible then we will continue to assess the situation to monitor conditions for change.

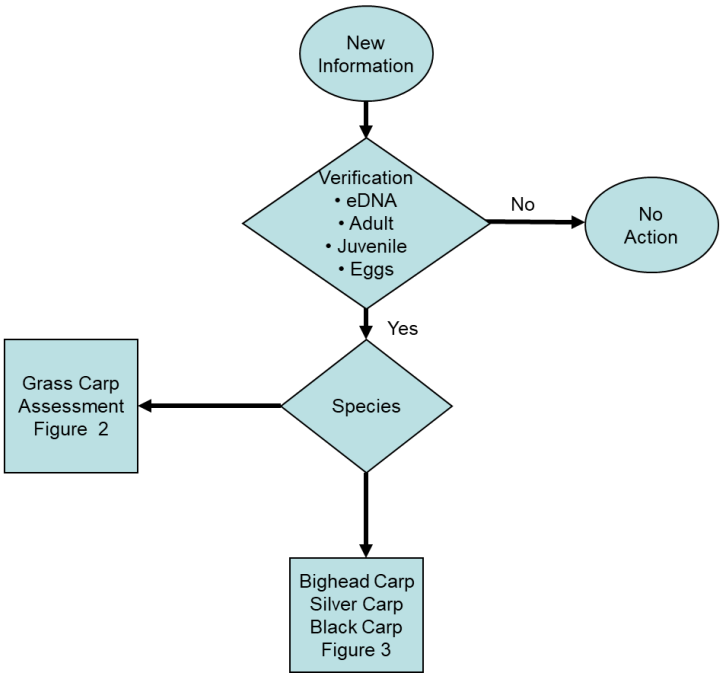
III. Invasive Carp Information Assessment

As new information is received concerning Invasive Carp, decisions will be considered as outlined below and in flow charts presented in Figures 1-3. An important component of the information assessment in these flow charts is the assessment of risk and return. The Invasive Carp Risk – Return Matrix and discussed in Section IV of this document details how new Invasive Carp reports are assessed to determine the risk to the resource and the return in terms of the likelihood that a response action will be successful.

Invasive Carp Information Assessment Flow Chart: The Invasive Carp Information Flow Chart (Figure 1) outlines the initial steps taken with respect to new information for Invasive Carp. When new information concerning Invasive Carp is reported in Ohio, the ODNR DOW will first verify that the report is credible. This will be accomplished through vetting the source and our ability to confirm the identification. Once

the report is confirmed as credible, the action taken will be based on the type of information reported (eDNA, adult, juvenile, or eggs) and the species reported (Bighead, Silver, Grass, and Black Carp).

Figure 1: Asian Carp Information Flow Chart (2021)

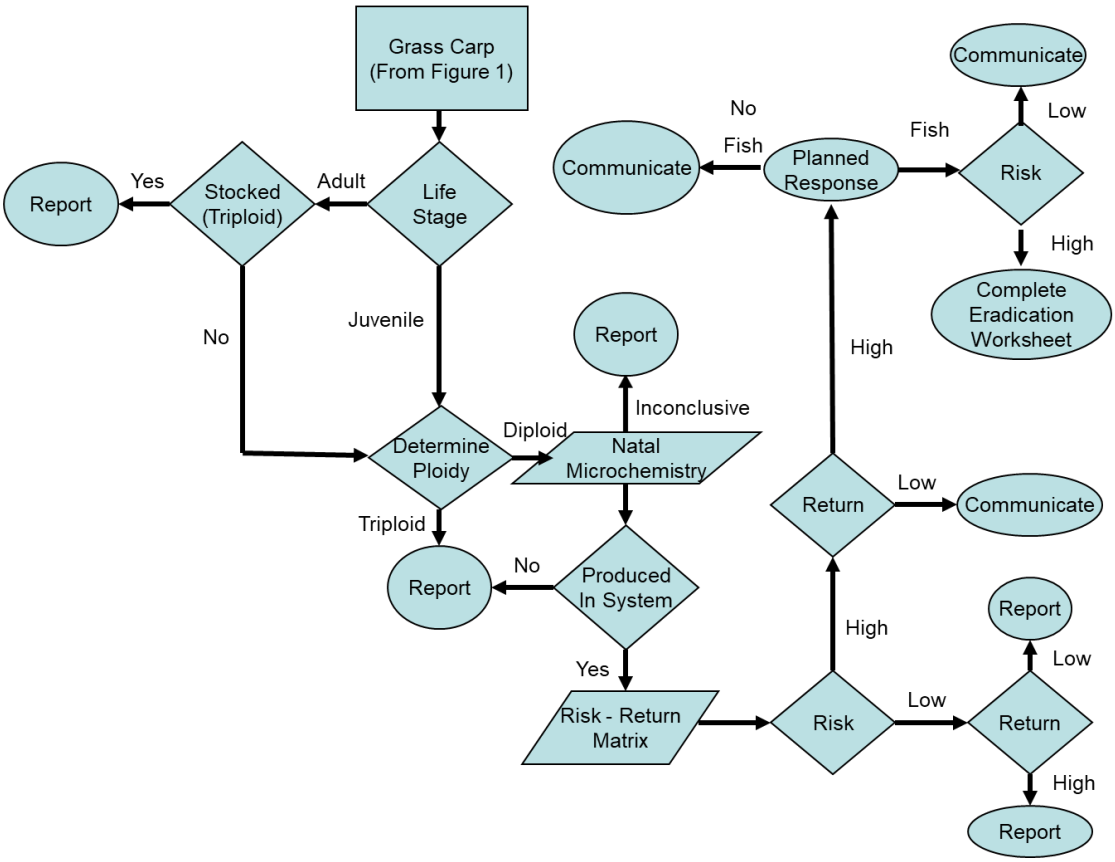


Grass Carp Information Assessment Flow Chart (Figure 2): Verified Grass Carp reports will be assessed based on life stage:

- Adult fish from waters known to be stocked with triploid Grass Carp (sterile) will be **reported**.
- Adult Grass Carp from the wild or juvenile Grass Carp will be assessed to determine if they are stocked triploid (sterile) or diploid (fertile) fish. Triploid Grass Carp will be **reported**.
- Diploid Grass Carp will be tested using natal microchemistry to determine if the fish was produced locally through natural reproduction (e.g., within the river system or close geographic proximity) or if it was produced elsewhere (e.g., southern aquaculture facility) and stocked locally. Grass Carp that were produced elsewhere are an indication that they were not from local reproduction and will be **reported**.
- Grass Carp that were spawned locally are an indication that there may be a reproducing population and the ODNR DOW will conduct a **risk assessment** as outlined in Section IV. If the Grass Carp is from the Ohio River watershed, where they are widespread, then the risk is low, and the information will be **reported**.
- If the Grass Carp is produced locally in the Lake Erie watershed, where they are not yet established, then ODNR DOW will determine if the **return** of an action would have a high likelihood of success. If the return success is determined to be low, then ODNR DOW will **communicate** the information.

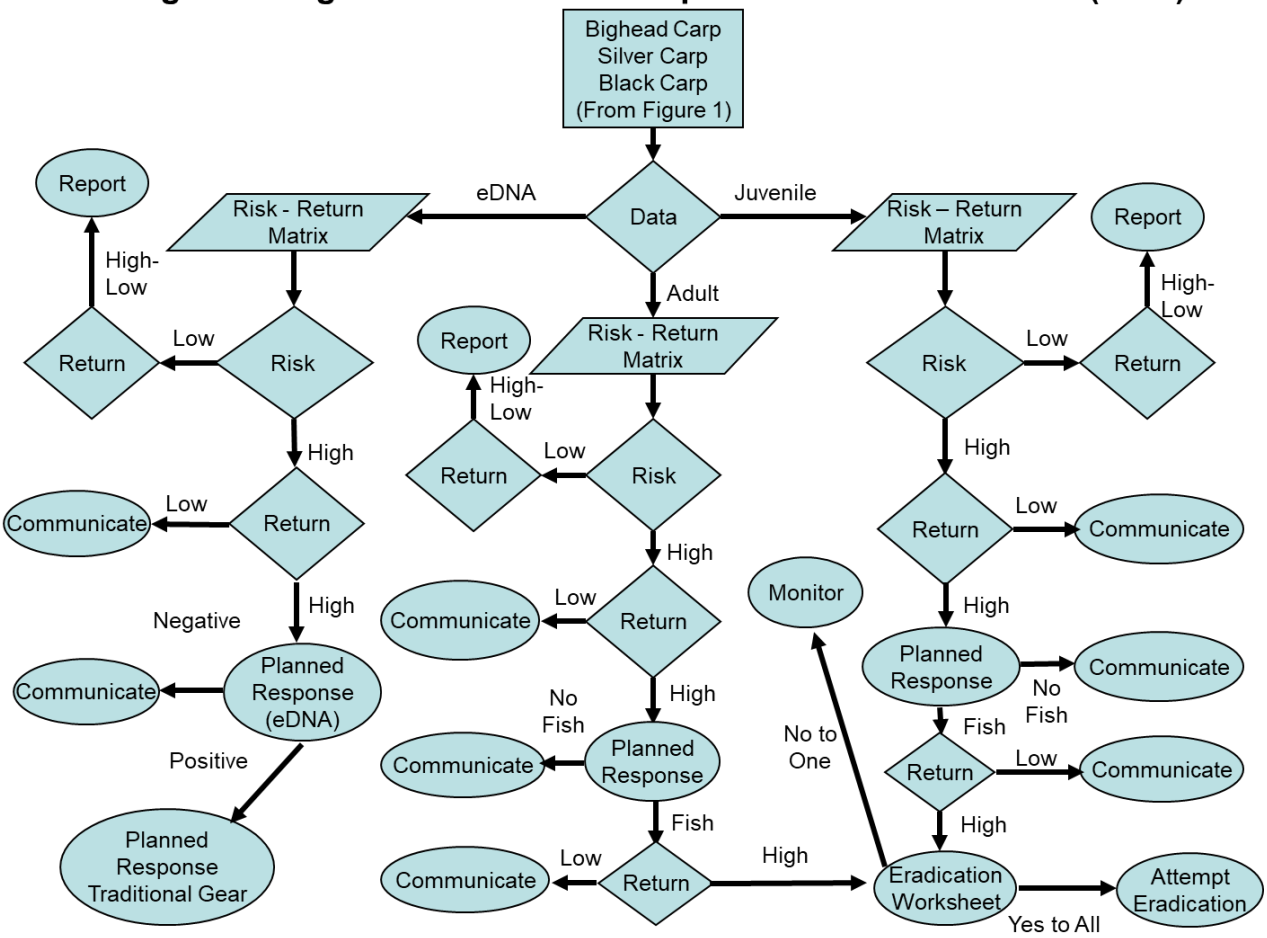
- If the **return** on an action will have a high likelihood of success, then ODNR DOW will conduct a **planned response** with traditional gear (electrofishing and/or nets) to determine the scale of the problem. If no fish are captured, then ODNR DOW will **communicate** the information.
- If additional diploid Grass Carp are collected then ODNR DOW will assess the **risk.** If the risk is determined to be low, then ODNR DOW will **communicate** the information.
- If additional diploid Grass Carp are collected and the **risk** is determined to be high, then an **eradication** effort will be attempted following the details in Section IV.

Figure 2: Grass Carp Information Flow Chart (2021)



Bighead, Silver, and Black Carp Information Assessment Flow Chart (Figure 3): Verified Bighead, Silver, or Black Carp reports will be assessed based on the type of *Data* collected: 1) eDNA, 2) adult fish, 3) juvenile fish.

Figure 3: Bighead/Silver/Black Carp Information Flow Chart (2021)



Report of eDNA: Environmental DNA refers to a process where water samples are analyzed for the presence of a species' genetic material. This technique has been used to detect the presence of aquatic animals in a water body; however, genetic material can come from sources other than a live fish, consequently, eDNA should not be solely used to determine the presence of live Invasive Carp. The response to a positive detection of Bighead, Silver, or Black Carp eDNA is as follows:

- A **risk assessment,** as outlined in Section IV, will be conducted to determine the threat to the system. If Bighead, Silver, or Black Carp eDNA is detected in the Ohio River watershed, where they are widespread or reservoirs where they will not likely establish due to lack of spawning habitat and conditions, the risk will be considered low and it will be **reported**.
- If Bighead, Silver, or Black Carp eDNA is detected in Lake Erie, its tributaries, or in the Muskingum River where the risk is considered high, then ODNR DOW will determine whether the **return** of an action would have a high likelihood of success. If the return is determined to be low, then ODNR DOW will **communicate** the information.
- If the **return** has a high likelihood of success, then ODNR DOW will conduct a **planned response** to collect additional water samples for eDNA analysis to better define the potential location of fish. If no further positive eDNA is collected, ODNR DOW will **communicate** the information.

- If additional positive eDNA is collected, then ODNR DOW will conduct a **planned response** using traditional fish sampling gear. If fish are collected, then ODNR DOW will move to the next phase of the assessment as presented below.

Confirmation of Adult Fish: The response to a verified report of a live adult Bighead, Silver, or Black Carp is as follows:

- A **risk assessment**, as outlined in Section IV, will be conducted to determine the threat to the system. If adult Bighead, Silver, or Black Carp are detected in the Ohio River watershed where they are widely distributed or reservoirs where they will not likely establish due to lack of spawning habitat, then the risk will be considered low and it will be **reported**.
- If adult Bighead, Silver, or Black Carp are confirmed in Lake Erie, its tributaries, or in the Muskingum River where the risk is considered high, then ODNR DOW will determine if the **return** of an action would have a high likelihood of success. If the return is determined to be low, then ODNR DOW will **communicate**.
- If the **return** has a high likelihood of success, then ODNR DOW will conduct a **planned response** with traditional sampling gear to better define the potential location of fish. If no additional fish are collected, then ODNR DOW will **communicate** the information.
- If additional fish are collected, ODNR DOW will determine if the **return** of an action would have a high likelihood of success. If the return is determined to be low then ODNR DOW will **communicate** the information.
- If the **return** of an action has a high likelihood of success, then an **eradication** effort will be attempted following the details in Section IV.

Confirmation of Juvenile Fish or Eggs: The response to a verified report of a live juvenile Bighead, Silver, or Black Carp or their eggs is as follows:

- A **risk assessment**, as outlined in Section IV, will be conducted to determine the threat to the system. If juvenile Bighead, Silver, or Black Carp or their eggs are detected in the Ohio River watershed where they are widely distributed or reservoirs where they will not likely establish due to lack of spawning habitat, then the risk will be considered low and it will be **reported**.
- If juvenile Bighead, Silver, or Black Carp or their eggs are confirmed in Lake Erie, its tributaries, or in the Muskingum River where the risk is considered high, then ODNR DOW will determine if the **return** of an action would have a high likelihood of success. If the return is determined to be low, then ODNR DOW will **communicate** the information.
- If the **return** has a high likelihood of success, then ODNR DOW will conduct a **planned response** with traditional sampling gear to better define the potential location of fish. If no further fish are collected, then ODNR DOW will **communicate** the information.
- If additional fish are collected, then ODNR DOW will determine if the **return** of an action would have a high likelihood of success. If the return is determined to be low, then ODNR DOW will **communicate** the information.

- If the **return** of an action would have a high likelihood of success, then an **eradication** effort will be attempted following the details in Section IV.

IV. Risk-Return Matrix

Risk-Return Assessment: Information on a new Invasive Carp report will be assessed to determine the risk to the resource and the return in terms of the likelihood that a response action will be successful. The Invasive Carp Risk-Return Matrix (Table 1) provides a matrix of risk-return assessment scenarios that are based on location and the action to be taken.

Low Risk Scenarios:

- Locations where Invasive Carp are widespread or will likely become established (e.g., the Ohio River and its tributaries).
- Locations where Invasive Carp are not likely to become established due to lack of spawning habitat and conditions (e.g., ponds or reservoirs).
- Locations where findings are based on eDNA, which detects the presence of genetic material but is not a confirmation of a live fish.

High Risk Scenarios:

- Locations where Invasive Carp are not yet established (e.g., Lake Erie tributaries and Lake Erie).
- Locations in the Muskingum River which has two direct water connections that could facilitate Bighead, Silver, Grass, and Black Carp movement into the Lake Erie watershed where they are not present.

Low Return Scenarios:

- Locations where Invasive Carp are widespread or will likely become established (e.g., the Ohio River and its tributaries).
- Locations in large systems where an action is not practical (e.g., open waters of Lake Erie).

High Return Scenarios:

- Locations in tributaries where there may be spawning activity and where an action could be successful in preventing range expansion.

Action Taken: The ODNR DOW will take the following actions based on risk and return.

- All low-risk scenarios: **Report** the information.
- High risk scenarios that have a low probability of a successful action: **Communicate** the information.
- High risk scenarios that have a high likelihood of a successful return: Conduct a **planned response**.
- If after the **planned response** the risk is determined to be high, an **eradication** effort will be attempted if the answers to all the questions in the Invasive Carp Eradication Assessment Worksheet (Table 2) are answered with a “yes”.
- If at least one of the answers to the questions in the Invasive Carp Eradication Assessment Worksheet (Table 2) is a “no”, then we will **monitor** the situation in case the situation changes.

Table 1: Invasive Carp Risk-Return Matrix (2021)					
Habitat	Risk		Return		Action Taken
	Low	High	Low	High	
Grass Carp - Diploid					
Ohio River Watershed					
Mainstem	X		X		Report
Tributaries	X			X	Report
Reservoirs	X		X		Report
Muskingum River*		X		X	Planned Response
Lake Erie Watershed					
Open Lake		X	X		Communicate
Tributaries		X		X	Planned Response
Reservoirs	X		X		Report
Bighead/Silver/Black Carp					
Ohio River Watershed					
eDNA					
Mainstem	X		X		Report
Tributaries	X		X		Report
Reservoirs	X		X		Report
Muskingum River*		X		X	Planned Response
Adult					
Mainstem	X		X		Report
Tributaries	X		X		Report
Reservoirs	X		X		Report
Muskingum River*		X		X	Planned Response
Juvenile/Egg					
Mainstem	X		X		Report
Tributaries	X		X		Report
Reservoirs	X		X		Report
Muskingum River*		X		X	Planned Response
* Past upper most lock & dam					
Lake Erie Watershed					
eDNA					
Open Lake		X	X		Communicate
Tributaries		X		X	Planned Response

Reservoirs	X		X		Report
Adult					
Open Lake		X	X		Communicate
Tributaries		X		X	Planned Response
Reservoirs	X		X		Report
Juvenile/Egg					
Open Lake		X	X		Communicate
Tributaries		X		X	Planned Response
Reservoirs	X		X		Report

Table 2: Invasive Carp Eradication Assessment Worksheet
1) Is the species a new invasion to the state or to a geographic location with the state? • Yes/No:
2) Is the species known to cause significant impacts in its native range and/or is the species known to be invasive outside of its native range? • Yes/No:
3) Is there knowledge of the source of introduction and risk of reintroduction or further spread? • Yes/No:
4) Was the invasion detected early? • Yes/No:
5) Is the infestation small and localized? • Yes/No:
6) Can the species be quarantined/contained while control measures are planned and implemented? • Yes/No:
7) Is there acceptance that not responding will have serious impacts? • Yes/No:
8) Is the location public or directly connected to public resources (i.e., public land or water)? • Yes/No:

Appendix D

Invasive Fishes Communications Protocol

Council of Great Lakes Fisheries Agencies

DRAFT v7 - December 2020

Executive Summary

Timely and accurate sharing of information is essential for addressing risks from invasive fishes to Great Lakes fisheries. Consistent with its prescribed role under *A Joint Strategic Plan for the Management of Great Lakes Fisheries*, the Council of Great Lakes Fisheries Agencies (Council) has developed this protocol to guide interagency communication of new information involving invasive fishes in the Great Lakes. The specific deliverables are (1) a set of "talking points" that clearly and succinctly describe new "events" related to invasive fishes in the Great Lakes, as delivered by a "responsible" management or science agency with jurisdiction over that information, and (2) a clear process to follow for communications related to new invasive fishes. Events encompass all types of information, from unexpected discoveries to results from planned management or research projects. A standard "Event Description Form" will be used to capture key details and draft talking points for all events and will identify the responsible agency and contact person. The protocol calls for consultation to occur between a responsible agency and an appropriate lake committee, with additional input from the Council of Lake Committees and the Council, before establishing final talking points for an event. The protocol also recognizes three levels (urgent, important, routine) of response times (within 24 hours, 5 business days, 10 business days, respectively) for developing final talking points, depending on the type of event. Roles and responsibilities of all participants are also specified, along with a flow diagram to guide application of the protocol. The protocol is a working document, to be revised as necessary following application.

Background

Since the 1800s, non-native fishes have entered the Great Lakes through various pathways and some have established naturalized (self-sustaining) populations that negatively affect lake ecosystems, fish communities, and associated fisheries. Examples of adverse impacts include habitat degradation (common carp), predation (sea lamprey, rainbow smelt, alewife, white perch, round goby), and competition for food and habitat resources (virtually all but sea lamprey). Reducing the risk of harmful impacts from invasive fishes on fish communities and fisheries remains important for the achievement of fish community objectives (FCOs) throughout the Great Lakes. Fishery managers have few options to control established populations of invasive fishes. Other than sea lamprey control, manipulation of alewife biomass through salmonid stocking, commercial fishery exploitation on some species (rainbow smelt, common carp, and white perch), and denying fish access to riverine and wetland habitats with barriers, fishery managers are largely powerless to affect the population trajectory of established invasive fishes. Consequently, prevention of the introduction and establishment of invasive fishes in the Great Lakes remains a high priority of fisheries managers. Other management needs include targeted monitoring to detect invasive fishes and assess their population status, as well as research to develop improved control methods and to understand the effects of their impacts on fish communities and fisheries.

Inter-agency coordination is paramount to ensure that the efforts of management and science agencies align across the basin for acceptable levels of risk management involving invasive fishes. The formal adoption and implementation of *A Joint Strategic Plan for the Management of Great Lakes Fisheries* (the Plan) in 1981 (with revision in 1997), has been pivotal in coordinating management and research efforts of four federal, one provincial, eight state, and three tribal signatory agencies in the basin, as facilitated by the Great Lakes Fishery Commission (GLFC). The Plan provides a time-tested flexible framework, ideal for addressing issues associated with invasive fishes, by accommodating the varying roles of all agencies for implementation.

A primary responsibility of the Council of Great Lakes Fisheries Agencies (Council) is to guide and support the process of implementing the Plan, in part by ensuring mutual accountability among all Parties through strategic communications involving the Council, lake committees, the Council of Lake Committees (CLC), and CLC subcommittees for Great Lakes law enforcement and fish health. On behalf of all signatory agencies to the Plan, the Council herein embraces a leading role in coordinating inter-jurisdictional communication associated with risk management and associated science for invasive fishes in the Great Lakes Basin.

Purpose

This document prescribes a protocol under which signatory agencies shall communicate new information about invasive fishes within the Council and from the Council to other audiences.

Principles

1. The protocol applies to new information from signatory agencies about invasive fishes, accommodating new arrivals and species already present in the Great Lakes for which ***events*** have occurred relative to their ***population status*** and ***impacts*** on lake ecosystems and fisheries, and to associated ***management*** and ***research***. Definitions for these high-lighted terms are listed in the next section.
2. The protocol is intended to enable proactive communication that is clear, timely, and consistent with expectations described herein, allowing all member agencies of the Council to understand the new information in relation to the status and nature of a potential threat, available management options, research that is underway or planned, and desired/expected outcomes from a decision or action by a ***responsible agency***.
3. The protocol shall focus on the development of a formal set of key elements ("talking points") that describe an event, as approved by the responsible agency, and provide the basis for all subsequent communications associated with that event.
4. The protocol encompasses communication of research or actions undertaken by academic institutions, non-governmental organizations, or non-signatory agencies to the Plan only through their voluntary or mandated connections to signatory agencies, who then become the responsible agency on their behalf.
5. The protocol should allow the Council to communicate with all other non-agency audiences effectively and consistently, as warranted and approved by a responsible agency.

6. The protocol will not supersede or constrain internal communication protocols or consultation processes of any signatory agency.
7. The protocol will accommodate strategies and procedures of the Plan, the Council's Communication Framework for the Joint Strategic Plan (1998), and the Council's Decision Support Protocol for Barrier/Dam Modification and Removal (2013)
8. To the extent possible, this protocol will align with responsibilities (e.g., terms of reference, www.glfc.org) of the Council, the Council of Lake Committees, lake committees, the Great Lakes Fish Health Committee, and the Great Lakes Law Enforcement Committee
9. To the extent possible, this protocol will align with other related initiatives, including:
    a. the Aquatic Invasive Species Task Force and mutual aid agreement (MAA) for combating aquatic invasive species threats in the Great Lakes- St. Lawrence river basin (2014); administered by the Conference of Great Lakes and St. Lawrence Governors and Premiers
    b. the Great Lakes Panel on Aquatic Nuisance Species, under the Great Lakes Commission; and
    c. the Asian Carp Regional Coordinating Committee (ACRCC) and its sub-committees.
10. All draft information pertaining to any event and associated communications among signatory agencies and groups shall be kept confidential and is not to be distributed in any way contrary to this protocol.
11. The protocol is a working document, to be adapted as necessary following future application, to fulfill its intended purpose.

Terminology/Definitions

1. ***Event*** - any new information that signifies a change in previous knowledge or a condition relative to ***population status***, ***impacts, management,*** or ***research,*** involving an invasive fish in the Great Lakes Basin, as determined by a ***responsible agency***. See Table 1 for examples of events.
2. ***Population status*** - the stage of invasion, adapted from Cudmore at al. (2017):
    a. ***Pre-arrival-*** no evidence that a species is present in a Great Lake or its watershed
    b. ***Arrival -*** verified record (e.g., fish in hand) of initial occurrence for a species in a new lake by a qualified professional.
    c. ***Survival***- verified existence of a species beyond its first winter in a Great Lake
    d. ***Reproduction***- verified evidence of egg, larvae, or juvenile production by an invasive species
    e. ***Establishment-*** a population that has become self-sustaining, defined as occurring when individuals spawned within the Great Lakes basin have subsequently successfully reproduced.
    f. ***Spread-*** expansion of a population already present in the Great Lakes, as opposed to new arrivals from outside the basin, into new lakes, as designated by a lake committee.
    g. ***Consequences-*** invasive species have attained densities enough to affect
        i. ***ecology-*** ecosystem structure or function, as designated by a lake committee
        ii. ***fishery -*** performance (e.g., catch, effort, species/size composition, catchability, spatial-temporal dynamics, economic value), as designated by a lake committee
3. ***Impacts-*** outcomes from invasive fish effects on the ecosystem and/or fisheries performance.
4. ***Management*** - deliberate efforts to address threats or impacts from invasive fishes

a. ***Prevention-*** impede the arrival of a new species or impede its successful reproduction and/or establishment
b. ***Surveillance-*** determine population status, including early detection and pre-arrival
c. ***Response-*** impede transition along the invasion pathway (e.g., sequential phases of population status); eradication is the ultimate response but may not be achievable
d. ***Suppression***- reduce an established population to minimize consequences.
e. ***Control***- reduce an established population to a pre-defined "target" level

5. ***Research*** - scientific investigations testing hypotheses to enhance understanding of population status and impacts, and to assess/improve effectiveness of management
6. ***Responsible Agency*** - a signatory agency of the Plan with jurisdiction over an event.
7. ***Management Agency -*** an agency with statutory authority and mandate to manage natural resources or invasive species where an event occurs.

<u>Communication Elements</u>

1. Outputs
    a. The focus of this protocol is to guide a responsible agency in distributing formal talking points regarding an event that can be applied by any group to a variety of audiences, following notification of the relevant management agency (or other agencies) and consultation with groups of the Plan (lake committees, the CLC and Council), as facilitated by the GLFC.
    b. Adherence to the formal talking points distributed by a responsible agency will allow communication departments of signatory agencies and the GLFC to develop documents (news releases, power-point files, briefing items, etc.) that do not require formal approval from the responsible agency prior to release.
    c. Although formal approval of documents is not required, the responsible agency will be informed of all applications of the talking points and offered an opportunity to review and comment on all documents at their discretion, within a defined period.
2. Roles and Responsibilities
    a. <u>*Decision authority:*</u> a responsible agency determines final content and delivery of all talking points involving events that occur within its area and discipline of jurisdiction.
        ~~i.~~ For events involving management actions in response to changes in population status or impacts, decision authority resides with the management agency.
        ii. For events involving scientific monitoring and research, decision authority resides with the agency that conducted the investigation, although conceivable management implications should be part of the consultation with management agencies and affected lake committees.
        iii. Examples:
            1. ODNR is the responsible agency for communications involving a cooperative interagency response to target removal of Grass Carp in Sandusky Bay (Ohio)
            2. USGS is the responsible agency for communications involving their research on Grass Carp spawning behavior.

3. USFWS or DFO would be the responsible agency for communications involving a discovery of a new invasive species during their detection surveys.

b. *Notification*: early communication (phone, email) from a responsible agency to another agency to indicate that an event has occurred, providing awareness and an opportunity for input prior to the release of a draft event description.
    i. In accordance with timing and principles provided in this protocol, a responsible agency will notify a management agency (if not already the responsible agency) and the GLFC when an event has occurred, pending internal approval by the responsible agency before any information is released.
    ii. At their discretion, a responsible agency may notify any other agency prior to the release of any communication associated with an event.

c. *Consultation*: ideally, consultation will lead to the collaborative development of common talking points, guided initially by a draft event description, which should consist of proposed talking points that clearly state the change in knowledge or condition and the importance of the event.
    i. In accordance with timing and principles provided in this protocol and roles described below, a responsible agency will consult with a relevant lake committee via the GLFC contact, who will coordinate communications among the lake committee, CLC, and Council (as warranted) to receive input or recommendations before finalizing talking points for the event.
    ii. Roles and process:
        1. Responsible agency: provide draft event description to the GLFC contact for consultation with groups of the Plan; consult with management agency or any other agency (as desired); consider input from agencies when developing final talking points.
        2. Lake committee: review draft event description from the responsible agency, as provided by the GLFC contact; provide comments on proposed talking points from a FCOs and cooperative fisheries management-based perspective to the responsible agency via the GLFC contact.
        3. CLC: as warranted (see Section 3), review lake committee comments on proposed talking points and provide additional comments from an inter-lake perspective to the GLFC contact, consulting Law Enforcement Committee and Fish Health Committee as appropriate.
        4. Council: as warranted (see Section 3), review lake committee and CLC comments on the proposed talking points and provide comments relevant to consistency with tenets of the Plan to the GLFC contact.
        5. GLFC role: provide lake committee, CLC, and Council comments on proposed talking points to the responsible agency; facilitate communications among all groups to address areas of concern and tension; encourage collaborative development of talking points and ensure consistency with the Plan and this protocol; GLFC fishery management program director to lead inter-group communications with assistance from GLFC communications director.

3. Timing
    a. Communication of events should be commensurate with the need to rapidly disseminate information.
    b. Unless otherwise stipulated by a responsible agency, the time lapse between the distribution of draft (e.g., consultation) and final talking points by a responsible agency should occur as follows:
        i. URGENT- within 24 hours
            1. example: unexpected changes in population status involving new or extant invasive fish species (see Table 1).
        ii. Important- within 5 business days
            1. examples: research findings, management actions/outcomes (see Table 1)
        iii. Routine- within 10 business days
            1. examples: planned research or management projects (see Table 1)
    c. The GLFC will coordinate the consultation process through a lake committee, involving the CLC/Council as warranted, to facilitate timely consideration of any comments by a responsible agency in final talking points.
    d. Consultation of URGENT events will be expedited through simultaneous distribution of draft talking points to a lake committee, CLC, and Council by the GLFC.
    e. Consultation of Important or Routine events will occur through a lake committee with GLFC assistance to determine if CLC and Council engagement is warranted.
4. Event description: for each event, a standardized form (end of document; also see example scenarios in Appendix A) should be used with the following fields to be completed by the responsible agency
    a. Draft or Final (e.g., pre-, or post-consultation talking points)
    a. URGENT, Important, or Routine (see Timing, section 3)
    b. Species: common and scientific names for invasive fish species of interest
    c. Location: area within a Great Lake or its watershed
    d. Event time/duration: date or range of dates
    e. Responsible agency: management or science agency name
    f. Contact: identify communications person, email, telephone number
    g. Type:
        a. unexpected discovery, outside the scope of a planned AIS project or activity (example: new species captured by a fisherman or in routine population sampling)
        b. planned AIS-related project or activity by a signatory agency or lake committee (examples: monitoring, research, policy, or position statement, etc.)
    h. Information category: population status or impacts
    i. Activity: management or research
        i. management- prevention, monitoring, response, suppression, control
        ii. research- population status, ecological or fishery impacts, tools/techniques, other
    j. Talking Points: ***brief*** bulleted items that integrate all available information and allow any audience to understand
        i. what the event entails or entailed (planned/unexpected, activity, etc.)
        ii. where the event occurred, or will occur
        iii. what was discovered, learned, or is anticipated

iv. why the event matters (tie to information category and risk management)
v. when the event occurred, or will occur
vi. who is leading the way (responsible agency contact)
vii. next steps

k. Supporting information: non-specified, see Appendix B for additional resources, examples:
i. source of information
ii. confirmed/unconfirmed (verification)
iii. quantity of information (N sufficiency, replicates, many sources consistent result)
iv. accuracy/precision of metrics
v. level of uncertainty/knowledge gaps
vi. link to position statements, fact sheets, species management plans, risk assessment plans, action, or background documents
vii. extant criteria that trigger an expected management response if any

5. Method
a. Each signatory agency shall designate a contact person (or position or office; see Appendix C) for communications involving event descriptions and notify the GLFC contact of any changes to their designated contact.
b. Responsible agencies may select an alternate to their designated contact for any event via the event description form; alternates will be considered temporary (e.g., for that event only).
c. Distribution of confidential information should occur among designated contacts of each agency by face-to-face, telephone, or webinar communication and email that includes, but is not limited to, a standardized event description form.
d. Responses and talking points shall be expressed via email unless otherwise prescribed in formal consultation processes of affected agencies.
e. Final talking points from a Responsible Agency shall be distributed via a revised event description form or in an alternate format of their preference.
f. For efficiency, communications between a responsible agency and any group of the Plan (lake committee, CLC, Council), or among groups of the Plan, should occur through the GLFC agency contact.

6. Flow (Fig. 1)
a. Step 1: Unexpected or planned event occurs
b. Step 2: Preparation and internal approval of event description by responsible agency
i. Appendix A provides example scenarios
ii. Appendix B provides additional resources
iii. Appendix C provides agency contacts
c. Step 3: Consultation initiated
1. GLFC contact (Appendix C) receives draft event description from responsible agency, distributes to lake committee (all events)
2. For URGENT events, GLFC simultaneously distributes draft event description to CLC and Council, in addition to the lake committee
3. Lake committee reviews event description, with FCOs/fisheries emphasis, provides comments to GLFC contact; may request GLFC to solicit CLC and/or Council review of Important and Routine events

4. CLC reviews event description from inter-lake management perspective, provides comments to GLFC contact
5. Council reviews event description and communications with CLC and lake committee from consistency with tenets of the Plan perspective, provides comments to GLFC contact.

d. Step 4: GLFC contact provides to responsible agency any comments on proposed talking points provided by lake committee, CLC, and Council.
e. Step 5: Responsible agency distributes final talking points to all agency contacts (Appendix C), including the GLFC for distribution to the lake committee, CLC, and Council.

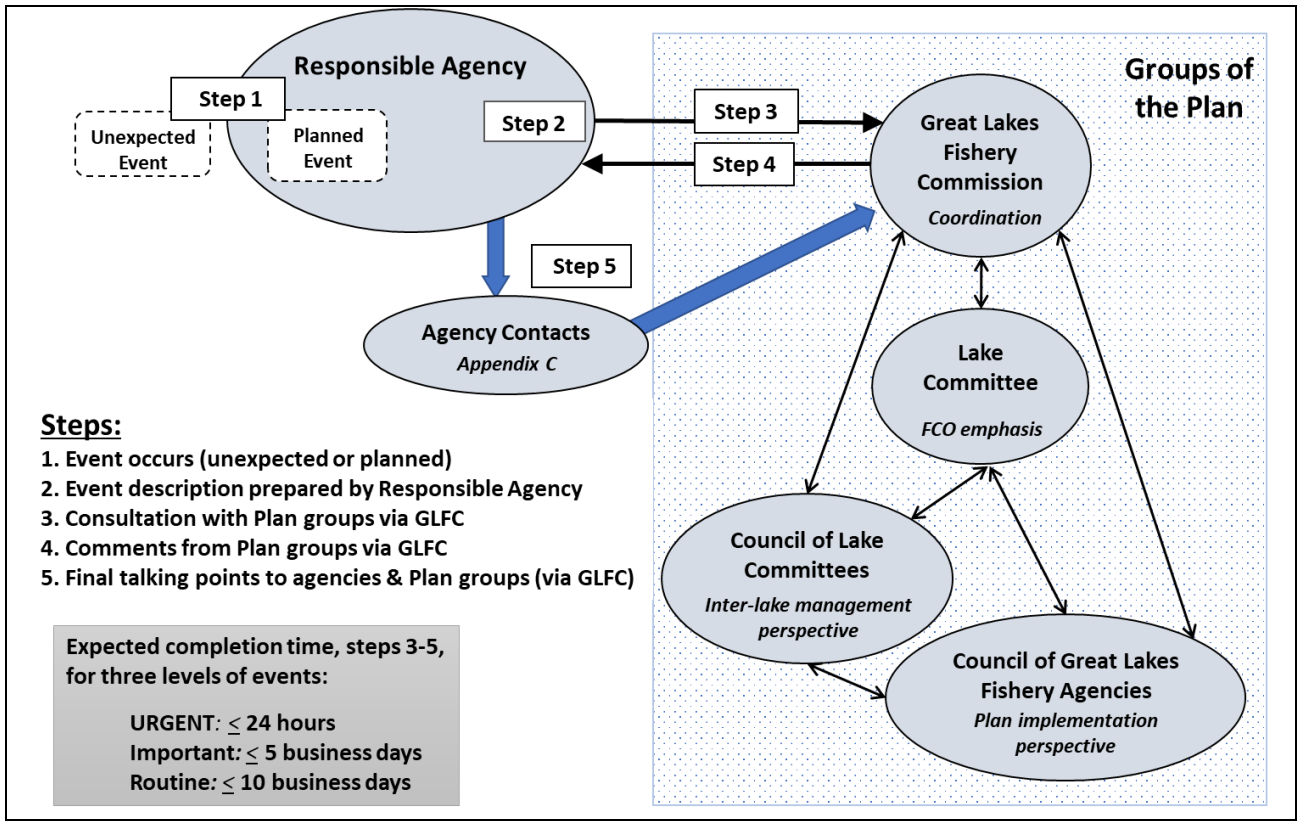


Figure 1. Flow chain for communication of events involving invasive fishes among agencies and groups specified under A Joint Strategic Plan for the Management of Great Lakes Fisheries (Plan). See "Communication Elements", item 6, for additional details.

7. Additional description of roles
    a. Responsible agency
        i. determines that an event has occurred,
        ii. notifies or consults management agency and GLFC through agency contacts and other agencies as warranted
        iii. compiles event description

iv. obtains internal agency approval of event description for confidential distribution to the GLFC contact for distribution to a lake committee and, for URGENT events only, to the CLC and Council.
v. consults directly with the GLFC to receive comments about proposed talking points from a lake committee, which may also incorporate comments from the CLC and/or Council.
vi. drafts talking points for specified audiences (as necessary); requests additional feedback from any group, as warranted,
vii. releases final talking points to agency contacts (Appendix C), including the GLFC for distribution to the lake committee, CLC, and Council

b. Lake committee
   i. reviews event description with proposed talking points from the responsible agency via the GLFC contact
   ii. consults responsible agency via GLFC contact for clarification, additional information
   iii. as warranted, consults CLC and/or Council via the GLFC contact when developing comments on draft talking points
   iv. provides comments about proposed talking points from a FCOs- and fishery management-based perspective to the responsible agency via the GLFC contact.

c. CLC
   i. reviews requests from lake committee via the GLFC contact to review draft talking points
   ii. consults GLFC to seek clarification, additional information
   iii. consults Law Enforcement Committee and Fish Health Committee as appropriate
   iv. as warranted, provides additional comments from an inter-lake fishery management perspective to the lake committee via the GLFC contact

d. Council
   i. reviews requests from lake committee via the GLFC contact to review draft talking points
   ii. consults GLFC to seek clarification, additional information
   iii. as warranted, provides additional comments from a consistency with tenets of the Plan perspective to the lake committee via the GLFC contact.

e. GLFC
   i. receives draft event description from responsible agency
   ii. orchestrates consultation process involving groups of the Plan
   iii. receives comments from the lake committee; consults lake committee and/or responsible agency for clarification, additional information
   iv. facilitates interactions among the lake committee, CLC, and Council, and involving the responsible agency, as necessary
   v. provides comments from lake committee, CLC, and Council to responsible agency
   vi. distributes final talking points from responsible agency to lake committee, CLC, and Council

Implementation considerations

1. Signatory agencies may wish to develop/reinforce connections to selected non-signatory groups (e.g., universities, Sea Grant programs, conservation, or watershed coalitions, etc.) and encourage their support for implementing the protocol.
2. Signatory agencies may wish to consider how the roles of communications specialists and managers may vary among types of events and prepare accordingly.
3. Signatory agencies and the GLFC should explore tactics to ensure efficient communication flow within and among all agencies and Plan groups to achieve targeted response times. For example, email subject lines could include key timing words (e.g., Urgent, Important, Routine) to facilitate timely communication of events.

References

Cudmore, B., Jones, L.A., Mandrak, N.E., Dettmers, J.M., Chapman, D.C., Kolar, C.S, and Conover, G. 2017. Ecological Risk Assessment of Grass Carp (*Ctenopharyngodon idella*) for the Great Lakes Basin. DFO Can. Sci. Advis. Sec. Res. Doc. 2016/118. vi + 115 p.

Event Description Form

NOTE: This information is confidential, not for distribution or use beyond intended audiences.

☐ **Draft** ☐ **Final**

☐ **URGENT** ☐ **Important** ☐ **Routine**

Species: _____

Location: _____

Event time/duration: _____

Responsible agency: _____

Contact person/e-mail: _____

Type: ☐ **Unexpected** ☐ **Planned**

Information category: ☐ **Population status** ☐ **Impacts**

Activity: ☐ **Management** ☐ **Research**

☐ prevention	☐ population status
☐ surveillance	☐ ecological impacts
☐ response	☐ fishery impacts
☐ suppression	☐ tools/techniques
☐ control	☐ other

Talking Points (bullets):

Supporting information: (attach additional files or links as necessary)