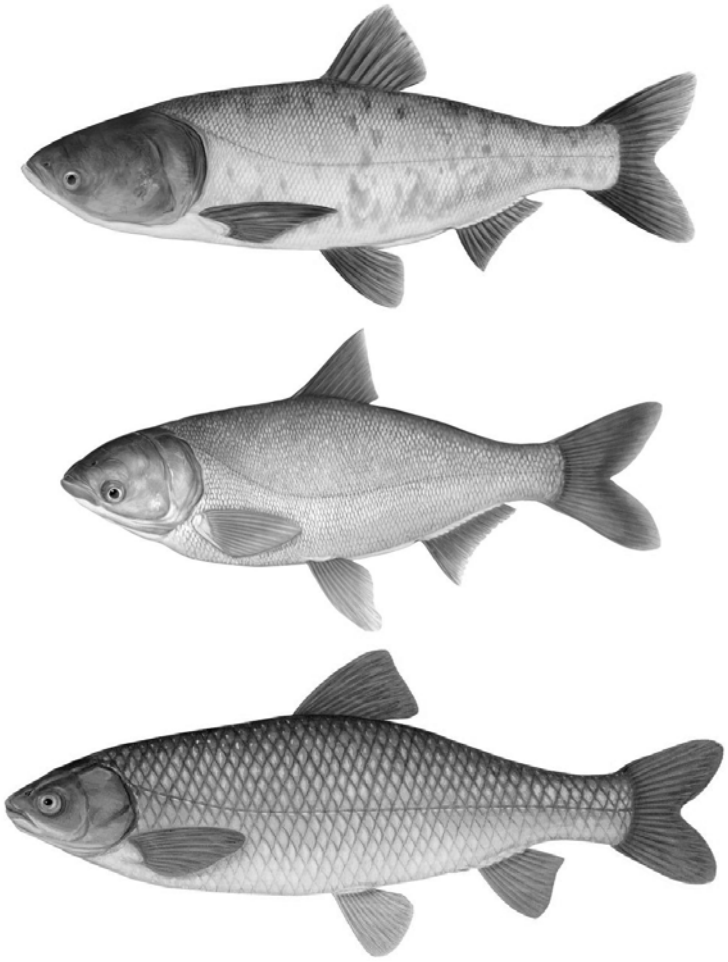
INVASIVE CARP SAMPLING REPORT

JANUARY – DECEMBER 2016

MINNESOTA DEPARTMENT OF NATURAL RESOURCES

DIVISION OF FISH AND WILDLIFE

SECTION OF FISHERIES



UPPER MISSISSIPPI RIVER, POOLS 1-5

LOWER ST. CROIX RIVER, BELOW ST. CROIX FALLS

January 25th, 2017

DEPARTMENT OF NATURAL RESOURCES

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INTRODUCTION

Bighead Carp *Hypophthalmichthys nobilis*, Silver Carp *H. molitrix*, Grass Carp *Ctenopharyngodon idella*, and Black Carp *Mylopharyngodon piceus* (hereafter collectively referred to as Invasive Carps) are invasive species currently found in the United States. These species were introduced into the United States during the early 1970's as aids in fish aquaculture operations (Henderson 1976). Subsequently, large flood events allowed these species to escape into the Mississippi River drainage, where they began reproducing and spreading (Freeze and Henderson 1982). Invasive Carps have migrated up the Mississippi River, and adjoining tributaries, quickly establishing populations in newly invaded areas.

In Minnesota, Silver Carp have been collected on the Mississippi River as far north as Pool 2, near Hastings, MN. Bighead Carp have been collected on the St. Croix River as far north as the Allen S. King plant, near Bayport, MN, and on the Mississippi River as far north as Pool 2, near Hastings, MN before this year (see Results and Discussion section). Grass Carp have been collected on the Mississippi River as far north as Pool 2, near Hastings, MN and on the Minnesota River near New Ulm, MN. Black Carp have never been collected in Minnesota or Wisconsin waters. Currently, there is no evidence of Invasive Carp reproduction in Minnesota waters.

Invasive Carps have the potential to devastate local ecosystems by competing with native planktivores and overcrowding other native species. With high fecundity and the ability to populate new areas quickly, Invasive Carps can reach high abundances, sometimes comprising most of the fish biomass in certain systems (MICRA 2002). Invasive Carps have a voracious appetite, and coupled with their large size (>70 pounds), have the ability to consume large amounts of food by filtering zooplankton, phytoplankton, and organic particles out of the water column (Jennings 1988; Smith 1989; Voros 1997). If Invasive Carp populations establish in

Minnesota, native planktivores such as Paddlefish *Polyodon spathula*, Bigmouth Buffalo *Ictiobus cyprinellus*, Gizzard Shad *Dorosoma cepedianum*, and the larval stages of many other native fishes may be in direct competition with Invasive Carps for food resources. Evidence from the Illinois River suggests that competition with Invasive Carps resulted in reduced condition factors for Bigmouth Buffalo and Gizzard Shad (Irons et al. 2007). Worldwide, introductions of Invasive Carps have led to declines in fish species diversity and abundances of commercially desirable species (Spatura and Gophen 1985; Petr 2002).

With the continuing progression of Invasive Carps up the Mississippi River, Minnesota waters are threatened by a potential invasion. A better understanding of the current status of individual Invasive Carp and populations in Minnesota will allow for more effective efforts to prevent their spread and/or eradicating them if populations do exist. Standard fish sampling assessments have been ongoing in Minnesota's major rivers and have the potential to catch Invasive Carps. However, the gears and methods used in the standard assessments are not the most efficient methods for capturing Invasive Carps. The purpose of this sampling effort is to use gears more specific to Invasive Carps to monitor all life stages of Invasive Carps and associated native fishes in the Mississippi River and the Lower St. Croix River, including contracting commercial fishermen.

OBJECTIVES

- Detect and monitor all life stages of Invasive Carps.
- Monitor native fish species that may be affected by the establishment of Invasive Carps.

SAMPLING SITES

In the Mississippi River, standard Invasive Carp sampling occurred from Navigational Pools 1 through 5, including approximately 89 km of water from St. Anthony Falls Lock and Dam in Minneapolis, MN to Weaver Bottoms in Pool 5 near Weaver, MN. In the St. Croix River, standard effort was focused on an 83 km stretch from the dam near Taylors Falls, MN to the confluence with the Mississippi River near Prescott, WI. Contracted commercial fishermen were hired to use large mesh gillnets and seines to sample in the Mississippi River in Pool 2 and Pool 3 near Red Wing and in the St. Croix River from the dam near Taylors Falls, MN to the confluence with the Mississippi River near Prescott, WI.

SAMPLING METHODS

Gears, methods, and habitats where sampling was focused were derived from a collection of personal communications with biologists who have been sampling Invasive Carps (V. Santucci, Illinois Department of Natural Resources, personal communication; J. Lamer, Western Illinois University, personal communication) and conducting research on the most efficient gears to sample Invasive Carps (M. Diana, Illinois Natural History Survey, personal communication), along with a variety of literature that included sampling techniques and habitat preferences (Lohmeyer and Garvey 2009; Williamson and Garvey 2005; Dettmers et al. 2001; DeGrandchamp et al. 2007; Kolar et al. 2007; DeGrandchamp et al. 2008; Wanner and Klumb 2009; ACRCC 2012). Sampling information for Invasive Carps included in this report took place between January 1, 2016 and December 31, 2016.

Fish Tagging Efforts

Currently several species of fish in the Mississippi River Pool 2 and the St. Croix River are tagged according to study guidelines as part of ongoing tagging studies when encountered. These species included Flathead Catfish *Pylodictis olivaris*, Channel Catfish *Ictalurus punctatus*, Smallmouth Buffalo *Ictiobus bubalus*, and Bigmouth Buffalo in Pool 2. In the St. Croix River, Lake Sturgeon *Acipenser fulvescens*, Muskellunge *Esox masquinongy*, White Bass *Morone chrysops*, Flathead Catfish, and Channel Catfish are being tagged. In both Pool 2 and the St. Croix River, Paddlefish are also tagged.

Gill and Trammel Netting

Gill netting and trammel netting occurred during multiple sampling events on each system. Large mesh gill nets of depths from 8 to 14 feet and lengths of 150 to 300 feet with square mesh sizes of 4 to 6 inches were used to target adult Invasive Carps. Trammel nets with outside wall square mesh sizes of 14 inches and inner square mesh sizes of 4 inches were also used to target adult Invasive Carps. Experimental gill nets 250 feet in length and 6 feet deep consisting of 50 feet complements of net with square mesh sizes 0.75, 1, 1.25, 1.5, 2 inches were used to target juvenile Invasive Carps. Nets were set either short-term or overnight, with short-term sets favored when water temperatures were greater than 60º F. All fish caught were identified and measured.

Commercial Fishing

Commercial fishermen were contracted to target Invasive Carp with gill nets and seines. Minnesota Department of Natural Resources (MN DNR) personnel accompanied contracted commercial fishermen to direct sampling locations and monitor efforts. The number of fish

caught by species was estimated during gill netting operations and total weight harvested was requested from the commercial fishermen for both gill netting and seining operations.

Trap Netting

Trap netting was conducted during one sampling event on the St. Croix River in 2016 using mini-fyke nets. Trap netting was not conducted in the Mississippi River this field season due to high water conditions prevailing most of the field season. The mini-fyke nets consist of a double frame (27 in. x 39 in.), 4 hoops (2 ft.), a single throat, and a 25 ft. lead, with a square mesh size of 0.125 in. throughout. All fish were identified and enumerated in the field.

Electrofishing

Electrofishing occurred in a variety of habitats including backwaters, side channels, main channel borders, and over wing dikes. Sampling locations consisted of 8 standardized sampling locations in Pool 2 (Figure 1) and the St. Croix River (Figure 2 and 3), and all other sampling events occurred at non-standardized locations in the aforementioned habitats at the discretion of the sampler. In 2016, 15 standardized electrofishing sites were sampled for a total of 325 minutes. Standardized sampling locations were selected based on habitats Invasive Carps are likely to occupy and are 1/3 mile (500 meters) in length. At these set sampling locations, all observed fish were collected, identified, measured and weights and aging structures were taken from fish included in the age and growth analysis. If positive identification was not possible, voucher specimens were kept, labeled, and preserved in 90% ethanol for later identification. At non-standardized sampling sites, fish were identified in the water and only fish needed to collect aging structures and Invasive Carps were collected. This reduced unnecessary processing time and allowed for greater sampling effort. Sampling site locations, sampling dates, gear

description, effort, habitat type (main channel border, backwater, wing dike, etc.), water depth, and crew details were recorded for each electrofishing run.

Larval trawling

Larval trawling was conducted in the Mississippi River Pools 2, 3, 4, and 5, and the St. Croix River to target early life stages of Invasive Carps. Eight standardized sites were sampled in Pool 2 (Figure 1), the St. Croix (Figure 2 and 3), and Pool 3 (Figure 4). In addition, non-standardized larval sampling was conducted at four sites in Pool 4 and two sites in Pool 5. A bow mounted icthyoplankton net (0.75 m x 3 m) consisting of 500 um mesh was pushed near the surface into the current so that the velocity of the water entering the net is between 1.0 to 1.5 m/s. At sampling locations where no water current exists (e.g. backwaters), sampling occurred towards a random direction that allowed for a complete sample to be taken in a relatively linear path. A mechanical flow meter was placed in the mouth of the net to determine the volume of water sampled. A total of eight locations were sampled in each standardized system with two, 5-minute pushes conducted at each location. In Pool 2, Pool 3, and the St. Croix River, sampling sites were located in the following macro habitats: 4 main channel, 2 side channel, and 2 backwater locations in each system. For all samples, contents were placed in containers labeled with sample location, name of the water body, and date, and preserved. For preservation, samples were placed into 10% buffered formalin for 24-48 hours and then the formalin was removed and replaced by 90% alcohol. All samples were sifted to remove all excess material, with only eggs and fish kept. Fish and eggs were examined to determine if any Invasive Carp species were collected and to identify specimens to the lowest possible taxonomic level. Samples were also sent to an external researcher for verification and to create a reference collection of the

species caught for future reference. Sampling site locations, sampling dates, gear description, effort, habitat type (main channel border, backwater, wing dike, etc.), water depth, and crew details were recorded for each site.

Age and Growth Analysis

In 2016, age and growth analyses were limited to Smallmouth Buffalo and Bigmouth Buffalo. Bigmouth Buffalo are native planktivores that may be in direct competition with Bighead and Silver Carp. Smallmouth Buffalo, as well as Bigmouth Buffalo, are commercially important and a better understanding of these species will be useful to determine effects from commercial fishing and/or the presence of Invasive Carp. For the previously mentioned species, lengths, weights, and ageing structures were collected as follows: for fish less than 300 mm, up to 5 individuals in each 10 mm length group and for fish 300 mm and greater up to ten individuals in each 25 mm length group. For Smallmouth and Bigmouth Buffalo, pelvic fin rays were extracted and compared. During the 2015 and 2016 field seasons, nearly 3,000 Smallmouth and Bigmouth Buffalo (1,282 Smallmouth Buffalo and 1,566 Bigmouth Buffalo) have been tagged with Floy tags and their pelvic fins were removed for ageing and to validate ageing analyses using re-captured fish in the future as part of another study. Fin rays were dried and cut using a low-speed isomet saw. Two independent readers counted each opaque band as an annulus under a dissecting microscope, using both reflected and transmitted light sources. If counts differed between readers, the readers re-examined the structure independently a second time. If readings differed the second time, the readers conferred until a consensus was reached.

RESULTS AND DISCUSSION

Sampling Results

In total, 73 days were spent sampling between January and December 2016 on the Mississippi River Pool 1, 2, 3, 4, and 5, and the St. Croix River with gears appropriate for sampling Invasive Carps (Table 1). A greater amount of effort was focused on Pool 2 and the St. Croix River (Figure 7), because Invasive Carps were found above Lock and Dam 2 on the Mississippi River in 2014 and due to the finding of Bighead Carp at the Allen S. King Plant discharge on the St. Croix in 2015 and a Grass Carp and a Bighead Carp in the Minnesota River in December 2015 and February 2016, respectively. Determining whether there were individuals or populations of Invasive Carps in Pool 2 and the St. Croix was of high importance. With the results from this sampling effort, it is possible that more Invasive Carp are present in these systems. However, this increased sampling effort decreases the likelihood that populations of Invasive Carps do exist in these systems and reinforces assumptions that Invasive Carps previously caught in the area were only wandering individual adults.

In 2016, a total of 3 Bighead Carp were caught in Minnesota waters and Wisconsin boundary waters (Table 2). One mature male Bighead Carp was collected about 150 miles up the Minnesota River near New Ulm by commercial seine fishermen on February 18, 2016. This represents the furthest upstream this species has ever been observed in the Minnesota River. In addition, one Bighead Carp was collected in Pool 8 near Onalaska, WI by a shore angler on April 12, 2016, and one Bighead Carp was collected in Pool 5A by a bow fisherman on June 11, 2016. The Bighead Carp from the Minnesota River was examined and all samples were sent to biologists from the USGS Columbia Environmental Research Center in Missouri who aged the individual, removed otoliths for microchemistry analysis, examined samples of the reproductive tract for sex and maturity, and stored genetic samples for later analysis. The two Bighead Carp

caught in Wisconsin waters were not able to be recovered by MN DNR staff; however, the Pool 8 fish was collected by U.S. Fish and Wildlife staff and otoliths were removed for microchemistry analysis.

Gill nets and trammel nets set by MN DNR personnel were often used to sample behind wing dikes and in smaller side channel and backwater areas where it wasn't feasible for commercial fishermen to target with their larger operations. In 2016, a total of 12,700 feet of gill and trammel nets were set in Pool 2 and the St. Croix River during 14 days, with most net sets being short-term sets (2-5 hours).

Contracted commercial fishermen set approximately 49,600 feet of gill nets during six days of effort and conducted three seine hauls between January and December 2016. Gill nets were set short term (2-3 hours) and fish were chased towards the net with boats, typically in large backwater areas. In 2016, ten regular commercial fishing operations were also monitored.

Trap netting was conducted using fyke nets for a total of 8 net nights on the upper St. Croix River. All fish were counted and measured in mini fyke nets, except Emerald Shiners *Notropis atherinoides* due large numbers captured. When excluding Emerald Shiners, mini fyke nets caught mostly Bluegill (58.6%), followed by Rock Bass *Ambloplites rupestris* (22.2%), Black Crappie *Pomoxis nigromaculatus* (4.0%), Orange Spotted Sunfish *Lepomis humilis*, Spotfin Shiner *Cyprinella spiloptera*, Spottail Shiner *Notropis hudsonius*, Walleye *Sander vitreus*, Yellow Perch *Perca flavescens* (2.0%), Golden Redhorse *Moxostoma erythrurum*, Green Sunfish *Lepomis cyanellus*, Johnny Darter *Etheostoma nigrum*, Northern Pike *Esox lucius*, Shorthead Redhorse *Moxostoma macrolepidotum* (1.0%).

Both random and standardized electrofishing sampling was conducted on Pools 1 and 2 of the Mississippi and the St. Croix rivers. A total of 1,568 minutes of "on time" over 26 days

were spent electrofishing between January and December 2016. Random electrofishing was used to monitor for Invasive Carp and for collection of individuals for age and growth analyses. Standardized electrofishing sampled a total of 45 species. In Pool 2, 32 species were sampled. The most common species caught were Emerald Shiner (18.3%), followed by Common Carp *Cyprinus carpio* (11.6%), Bluegill (9.8%), Silver Redhorse (8.7%), Largemouth Bass *Micropterus salmoides* (6.9%), Shorthead Redhorse (5.6%), Freshwater Drum (5.6%), and Smallmouth Bass *Micropterus dolomieu* (5.6%), with the other 24 species representing 28.0% of the catch (Figure 5). On the St. Croix River, 42 species were sampled. The most common species were Bluegill (13.3%), followed by Golden Redhorse *Moxostoma erythrurum* (13.0%), Emerald Shiner (12.6%), Silver Redhorse (10.3%), Spotfin Shiner (9.4%), Smallmouth Bass (5.9%), Shorthead Redhorse (4.4%), and Yellow Perch (4.4%), with the other 34 species representing 26.7% of the catch (Figure 6).

Larval trawling was conducted for 156 total trawls during 14 days by the Invasive Carp fisheries personnel. All samples were sifted by Invasive Carp fisheries personnel and all samples with fish larvae or eggs are preserved and have been sent to Colorado State University for expert analysis to determine the species caught and their respective number.

Numerous unique or rare native fishes worth mentioning were encountered during these sampling events. Numerous Blue Suckers *Cycleptus elongatus* and several Goldeyes *Hiodon alosoides*, Mooneyes *H. tergisus*, and Shortnose Gar *Lepisosteus platostomus* were observed in Pool 2. Several Paddlefish, Northern Hogsuckers *Hypentelium nigricans*, Spotted Sucker *Minytrema melanops*, Longnose Gar *Lepisosteus osseus*, River Redhorse *Moxostoma carinatum*, and Greater Redhorse *M. valenciennesi* were observed in the St. Croix River. A complete species

list of species caught and observed on Pool 2 and the St. Croix River from January 2013 through December 2016 has been compiled (Table 3).

RECOMMENDATIONS

Further age and growth analysis as well as population dynamics validation (including fecundity and recruitment) is recommended for commercially valuable Bigmouth and Smallmouth Buffalo, which may be in direct competition for food resources with Invasive Carps. In some states, current Invasive Carp population control efforts include increasing commercial fishing effort to decrease Invasive Carp abundance, although increased commercial effort in Minnesota would potentially negatively affect native species. Resource agencies would benefit from a greater understanding of the population dynamics of our commercially important native fishes. In addition to age and growth analyses, over 3,000 Bigmouth Buffalo and Smallmouth Buffalo have been tagged in Pool 2 during 2015 and 2016 as part of a study investigating movement, exploitation, age and growth, and other key population dynamics of these commercially important species. It is recommended that this tagging project continue to better understand movement patterns and approximate the numbers of individuals present in the Pool 2 of the Mississippi River via mark-recapture techniques.

Paddlefish are another native planktivore that may compete for food resources with Invasive Carps and therefore may be negatively affected. Currently, Paddlefish are a threatened species in Minnesota and populations across their range have suffered due to commercial navigation projects that impede movement and alter habitats, pollution, and overexploitation (Jennings and Zigler 2000). If Invasive Carps become established in Minnesota rivers, local Paddlefish populations would be further stressed. Being a state threatened species, non-lethal means of studying Paddlefish populations are also recommended including continued tagging of

encountered Paddlefish using jaw and acoustic tags. Further effort should also be used to encourage boaters to report any deceased paddlefish for age and growth analysis and other MN DNR offices should collect all deceased Paddlefish for analysis.

REFERENCES

ACRCC (Asian Carp Regional Coordinating Committee). 2012. Monitoring and rapid response plan for Asian carp in the Upper Illinois River and Chicago Area Waterway System. Monitoring and Rapid Response Workgroup, Asian Carp Regional Coordinating Committee, Council on Environmental Quality. Washington. May 2012. <http://asiancarp.us/documents/2011Framework.pdf>

DeGrandchamp, K. L., J. E. Garvey, and L. A. Csoboth. 2007. Linking adult reproduction and larval density of invasive carp in a large river. Transactions of the American Fisheries Society 136:1327-1334.

DeGrandchamp, K. L., J. E. Garvey, and R. E. Colombo. 2008. Movement and Habitat Selection by Invasive Asian Carps in a Large River. Transactions of the American Fisheries Society 137:45-56.

Dettmers, J. H., D. H. Wahl, D. A. Soluk, and S. Gutreuter. 2001. Life in the fast lane: Fish and foodweb structure in the main channel of large rivers. Journal of the North American Benthological Society 20:255-265.

Freeze, M., and S. Henderson. 1982. Distribution and status of the bighead carp and silver carp in Arkansas. North American Journal of Fisheries Management 2:197-200.

Henderson, S. 1976. Observations on the bighead and silver carp and their possible application in pond fish culture. Arkansas Game and Fish Commission, Little Rock.

Hoxmeier, R. J. H., and D. R. DeVries. 1997. Habitat use, diet, and population structure of adult and juvenile paddlefish in the Lower Alabama River. Transactions of the American Fisheries Society 126:288-301.

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 71 (Supplement D):258-273.

Jenning, D. P. 1988. Bighead carp (*Hypophthalmichthys nobilis*): a biological synopsis. U.S. Fish and Wildlife Service, Biology Report 88:1-35.

Jennings, C. A., and S. J. Zigler. 2000. Ecology and biology of paddlefish in North America: historical perspectives, management approaches, and research priorities. Reviews in Fish Biology and Fisheries 10:167–181.

Kolar, C. S., D. C. Chapman, W. R. Courtenay, Jr., C. M. Housel, J. D. Williams, and D. P. Jennings. 2007. Bigheaded carps: a biological synopsis and environmental risk assessment. American Fisheries Society, Special Publication 33, Bethesda, Maryland.

Lohmeyer A. M. and J. E. Garvey. 2009. Placing the North American invasion of Asian carp in a spatially explicit context. Biological Invasions 11:905-916.

MICRA. 2002. Asian carp threat to the Great Lakes. River Crossings: The Newsletter of the Mississippi Interstate Cooperative Resource Association 11:1-2.

Petr, T. 2002. Cold water fish and fisheries in the countries of the high mountain arc of Asia (Hindu Kush-Pamir-Karakoram-Himalayas): a review. *In* Cold Water Fisheries in the Trans-Himalayan Countries, eds. Petr, T. and Swar, D. B., pp. 1-38. FAO Fisheries Technical Paper 431.

Reed, B. C., W. E. Kelso, and D. A. Rutherford. 1992. Growth, fecundity, and mortality of paddlefish in Louisiana. Transactions of the American Fisheries Society 12:378-384.

Smith, D. W. 1989. The feeding selectivity of silver carp, *Hypophthalmichthys molitrix* Val. Journal of Fish Biology 34:819-828.

Spatura, P., and M. Gophen. 1985. Feeding behaviour of silver carp *Hypophthalmichthys molitrix* Val. and its impact on the food web in Lake Kinneret, Israel. Hydrobiologia 120:53-61.

Voros, L. 1997. Size-selective filtration and taxon-specific digestion of plankton and algae by silver carp (*Hypophthalmichthys molitrix* Val.). Hydrobiologia 342:223-228.

Wanner, G. A., and R. A. Klumb. 2009. Asian carp in the Missouri River: Analysis from multiple Missouri River habitat and fisheries programs. National Invasive Species Council materials. Paper 10.

Williamson, C. J., and J. E. Garvey. 2005. Growth, fecundity, and diets of newly established silver carp in the Middle Mississippi River. Transactions of the American Fisheries Society 134:1423-1440.

Table 1. Invasive Carp sampling summary for the Mississippi River Pools 1, 2, 3, 4, 5 and the St. Croix River for January through December 2016. Number of Invasive Carp Captured represents the number of individuals caught by MN DNR, contracted commercial fishermen, or monitored commercial fishing.

Invasive Carp Sampling Summary January – December 2016			**Days**
Random Sampling Effort			
Gill/Trammel Netting	12,700	feet	14
Electrofishing	1,243	minutes	18
Trap Netting	8	net/nights	1
Standardized Sampling Effort			
Electrofishing	325	minutes	8
Larval trawling	156	trawls	14
Targeted Commercial Fishing Effort			
Gill Netting	49,600	feet	6
Seining	3	hauls	3
Monitored Commercial Fishing Effort			
Seining	10	hauls	10
Number of Invasive Carp Captured	0	fish	
Total Number of Days Sampled			73

Table 2. Invasive Carp caught from January through December 2016 in Minnesota and Wisconsin boundary waters.

Date	**Species**	**Water Body**	**Location**	**River Mile**	**Length (mm)**	**Weight (grams)**	**Sex**	**Maturity**	**Capture Method**	**Age**
2/18/2016	Bighead Carp	Minnesota River	Near New Ulm	149.2	974	11700	M	M	Non-monitored Commercial Seine	5
4/12/2016	Bighead Carp	Pool 8	Near Onalaska, WI	703	Unknown	14969	Unknown	Unknown	Shore Angler	Unknown
6/11/2016	Bighead Carp	Pool 5A	Near Fountain City, WI	729.5	1016	12474	Unknown	Unknown	Bow Fisherman	Unknown

Table 3. Species list for the Mississippi River Pool 2 and the St. Croix River from January 2013 through December 2016, including 74 native and invasive species.

Common Name	Genus Species	Pool 2	St. Croix River
American Eel	*Anguilla rostrata*	x	
Bighead Carp	*Hypophthalmichthys nobilis*	x	x
Bigmouth Buffalo	*Ictiobus cyprinellus*	x	x
Black Bullhead	*Ameiurus melas*		x
Black Crappie	*Pomoxis nigromaculatus*	x	x
Blackside Darter	*Percina maculata*	x	x
Blue Sucker	*Cycleptus elongatus*	x	x
Bluegill	*Lepomis macrochirus*	x	x
Bluntnose Minnow	*Pimephales notatus*	x	x
Bowfin	*Amia calva*	x	x
Brook Silverside	*Labidesthes sicculus*	x	
Brook Stickleback	*Culaea inconstans*	x	
Brown Trout	*Salmo trutta*		x
Bullhead Minnow	*Pimephales vigilax*	x	
Burbot	*Lota lota*		x
Channel Catfish	*Ictalurus punctatus*	x	x
Common Carp	*Cyprinus carpio*	x	x
Channel Shiner	*Notropis wickliffi*	x	
Crystal Darter	*Crystallaria asprella*		x
Emerald Shiner	*Notropis atherinoides*	x	x
Fathead Minnow	*Pimephales promelas*	x	
Flathead Catfish	*Pylodictis olivaris*	x	x
Freshwater Drum	*Aplodinotus grunniens*	x	x
Gilt Darter	*Percina evides*		x
Gizzard Shad	*Dorosoma cepedianum*	x	x
Goldeye	*Hiodon alosoides*	x	
Golden Redhorse	*Moxostoma erythrurum*	x	x
Golden Shiner	*Notemigonus crysoleucas*	x	
Grass Carp	*Ctenopharyngodon idella*	x	
Greater Redhorse	*Moxostoma valenciennesi*	x	x
Green Sunfish	*Lepomis cyanellus*	x	x
Hornyhead Chub	*Nocomis biguttatus*	x	
Hybrid Sunfish	*Lepomis microlophus* x *L. cyanellus*	x	x
Iowa Darter	*Etheostoma exile*		x
Johnny Darter	*Etheostoma nigrum*		x
Lake Sturgeon	*Acipenser fulvescens*		x
Largemouth Bass	*Micropterus salmoides*	x	x
Logperch	*Percina caprodes*	x	x
Longnose Gar	*Lepisosteus osseus*	x	x
Mimic Shiner	*Notropis volucellus*	x	x
Mooneye	*Hiodon tergisus*	x	x
Muskellunge	*Esox masquinongy*	x	x
Northern Hogsucker	*Hypentelium nigricans*		x
Northern Pike	*Esox lucius*	x	x
Orangespotted Sunfish	*Lepomis humilis*	x	x
Paddlefish	*Polyodon spathula*	x	x
Pumpkinseed	*Lepomis gibbosus*	x	x
Quillback	*Carpiodes cyprinus*	x	x
River Carpsucker	*Carpiodes carpio*	x	x
River Darter	*Percina shumardi*	x	x
River Redhorse	*Moxostoma carinatum*	x	x
Rock Bass	*Ambloplites rupestris*	x	x
Sand Shiner	*Notropis stramineus*	x	
Sauger	*Sander canadensis*	x	x
Shorthead Redhorse	*Moxostoma macrolepidotum*	x	x
Shortnose Gar	*Lepisosteus platostomus*	x	x
Silver Carp	*Hypophthalmichthys molitrix*	x	
Silver Lamprey	*Ichthyomyzon unicuspis*	x	x
Silver Redhorse	*Moxostoma anisurum*	x	x
Skipjack Herring	*Alosa chrysochloris*	x	
Slenderhead Darter	*Percina phoxocephala*	x	
Smallmouth Bass	*Micropterus dolomieu*	x	x
Smallmouth Buffalo	*Ictiobus bubalus*	x	x

Table 3 (continued). Species list for the Mississippi River Pool 2 and the St. Croix River from January 2013 through December 2015, including 74 native and invasive species.

Common Name	Genus Species	Pool 2	St. Croix River
Spotfin Shiner	*Cyprinella spiloptera*	x	x
Spottail Shiner	*Notropis hudsonius*	x	
Spotted Sucker	*Minytrema melanops*	x	x
Tadpole Madtom	*Noturus gyrinus*	x	
Trout Perch	*Percopsis omiscomaycus*		x
Walleye	*Sander vitreus*	x	x
White Bass	*Morone chrysops*	x	x
White Crappie	*Pomoxis annularis*	x	x
White Sucker	*Catostomus commersonii*	x	x
Yellow Bullhead	*Ameiurus natalis*	x	
Yellow Perch	*Perca flavescens*	x	x

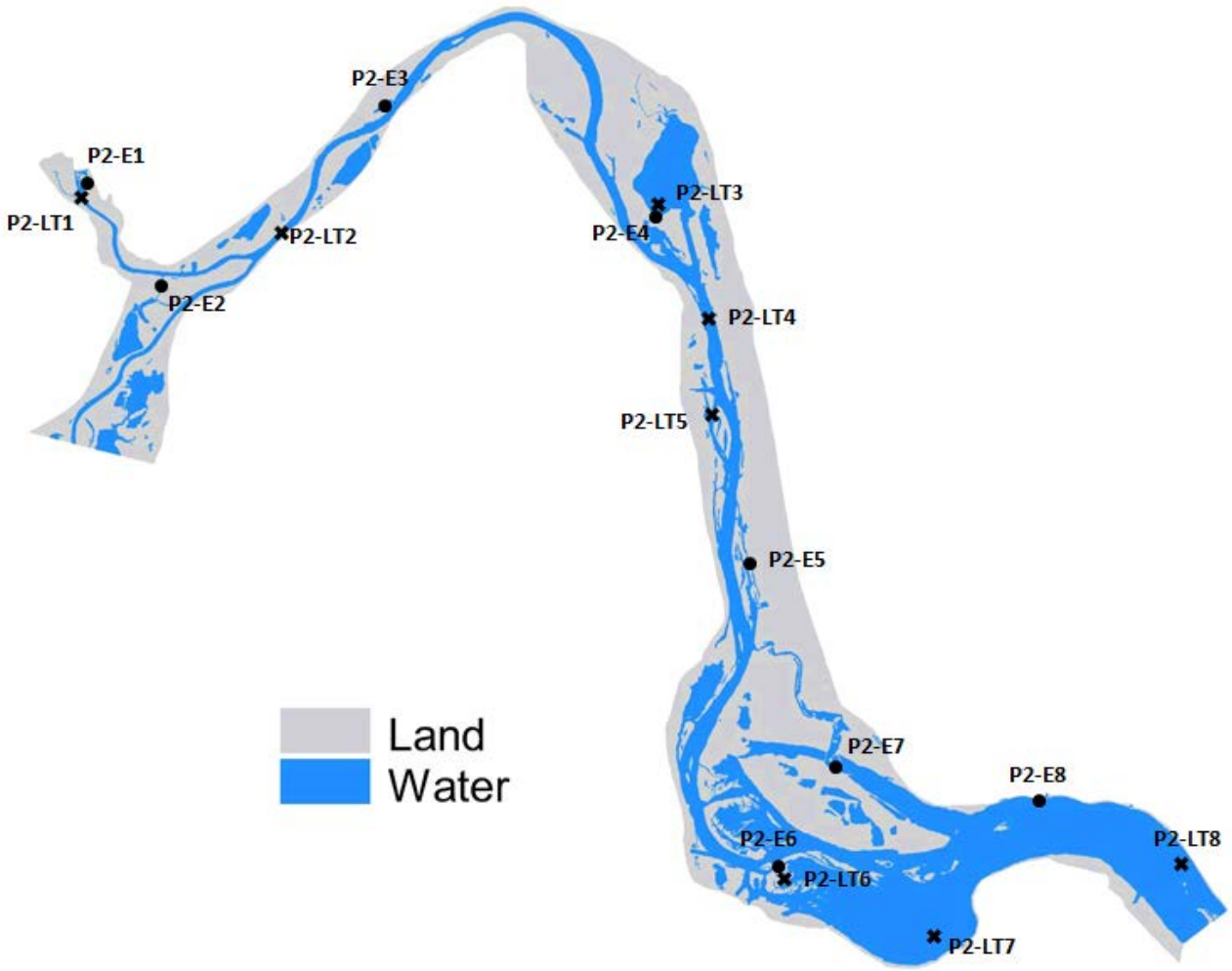

Figure 1. Standardized electrofishing (dark circle, E1 – E8) and larval fish trawling (dark cross, LT1 - LT 8) locations on Pool 2 (P2) of the Mississippi River.

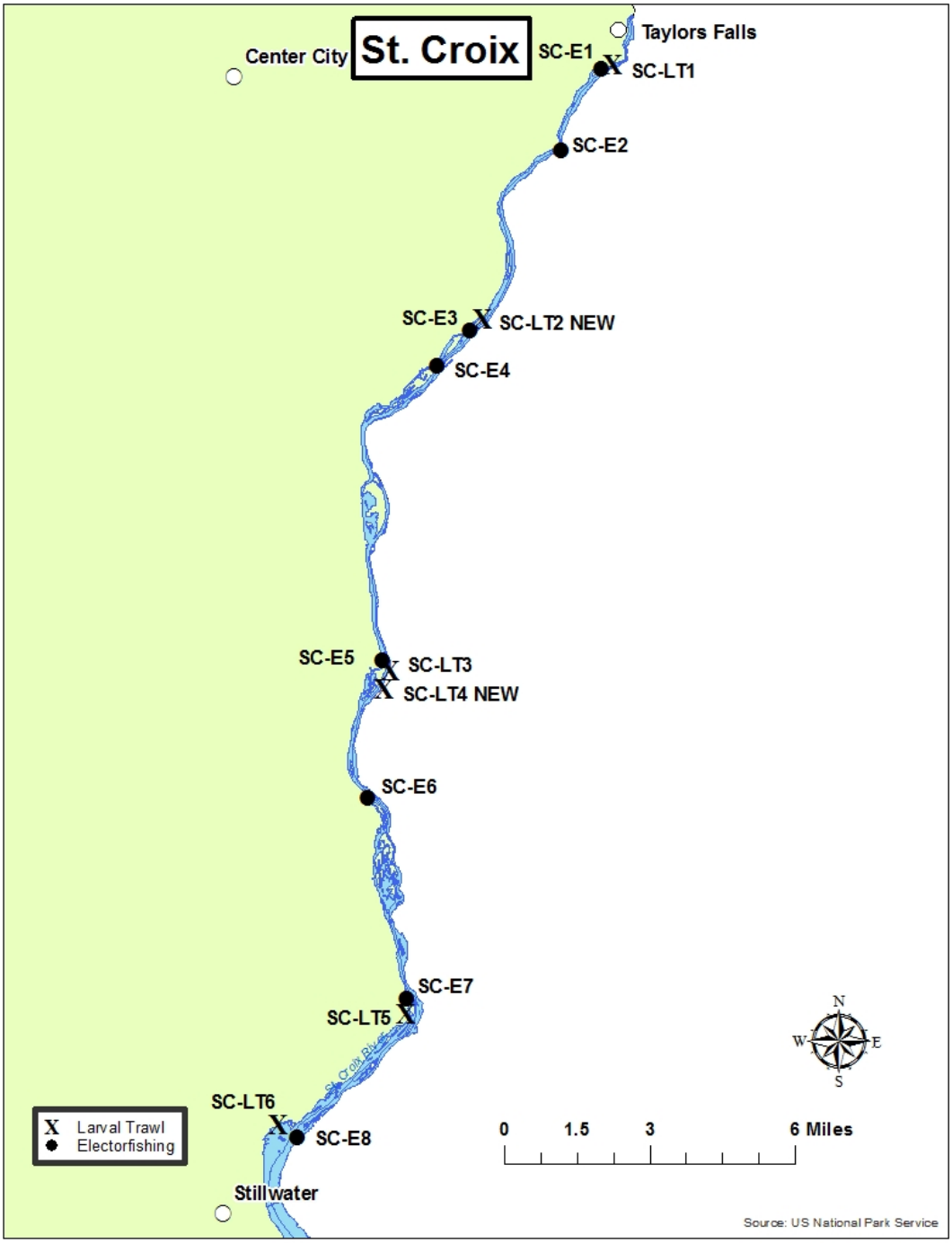

Figure 2. Standardized electrofishing (dark circle, E1 – E8) and larval fish trawling (dark cross, LT1 - LT 6) locations on the St. Croix River (SC). Sites SC-LT2 and SC-LT4 were moved in 2016 due to the site becoming too shallow to trawl.

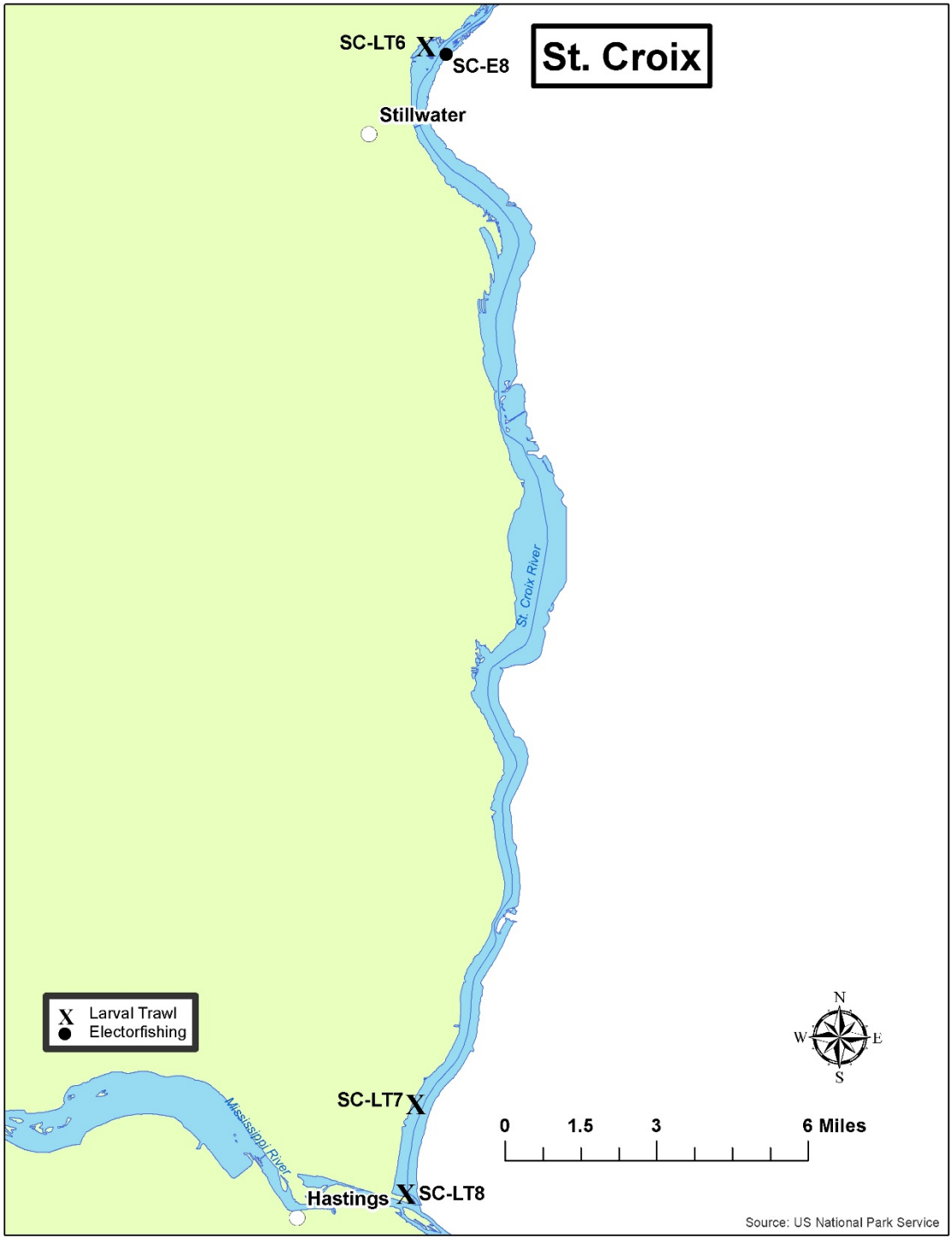

Figure 2 (Continued). Standardized electrofishing (dark circle, E8) and larval fish trawling (dark cross, LT 6 - LT 8) locations on the St. Croix River (SC).

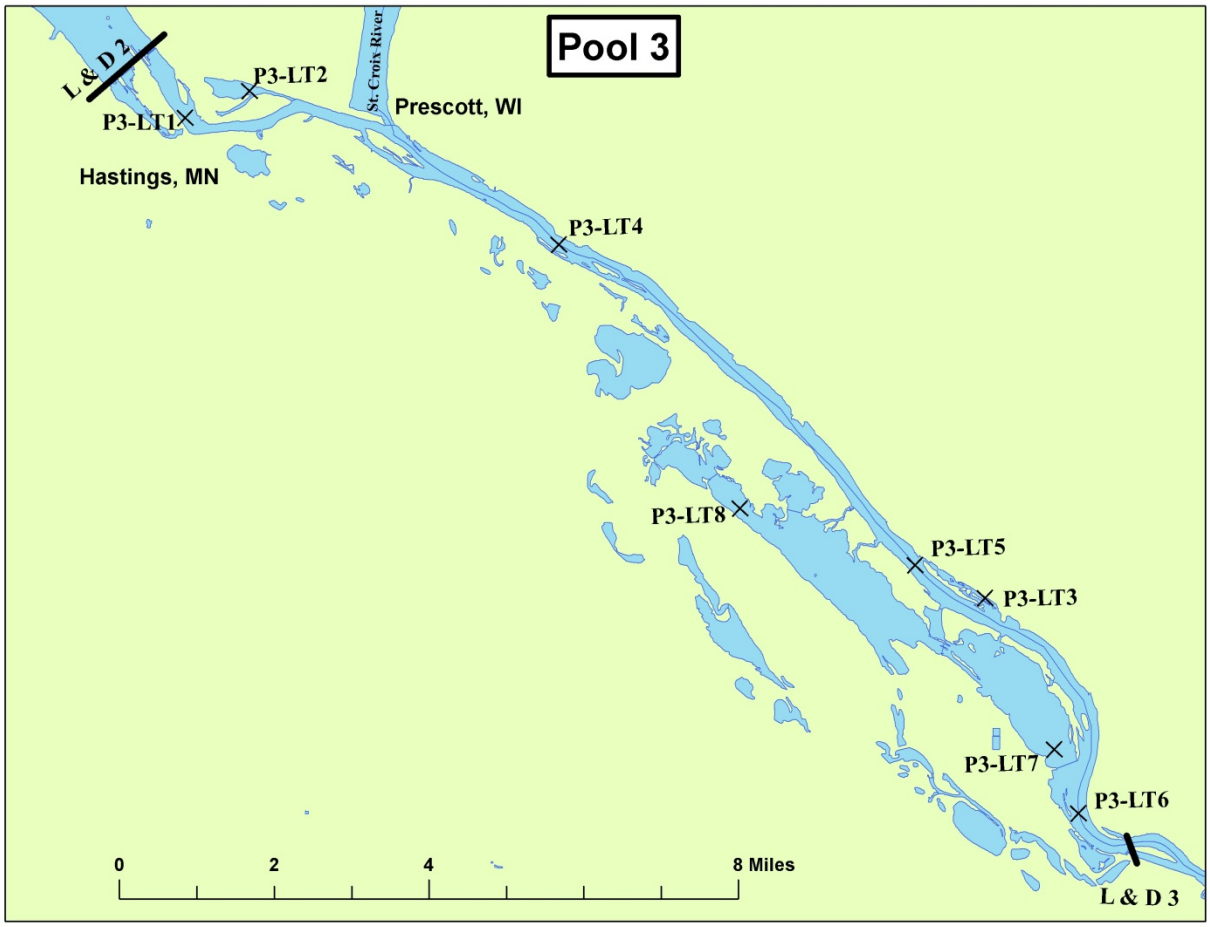

Figure 3. Standardized larval fish trawling (LT1-LT8) locations on Pool 3 (P3). Site P3-LT3 was moved in 2015 due to the site becoming too shallow to trawl.

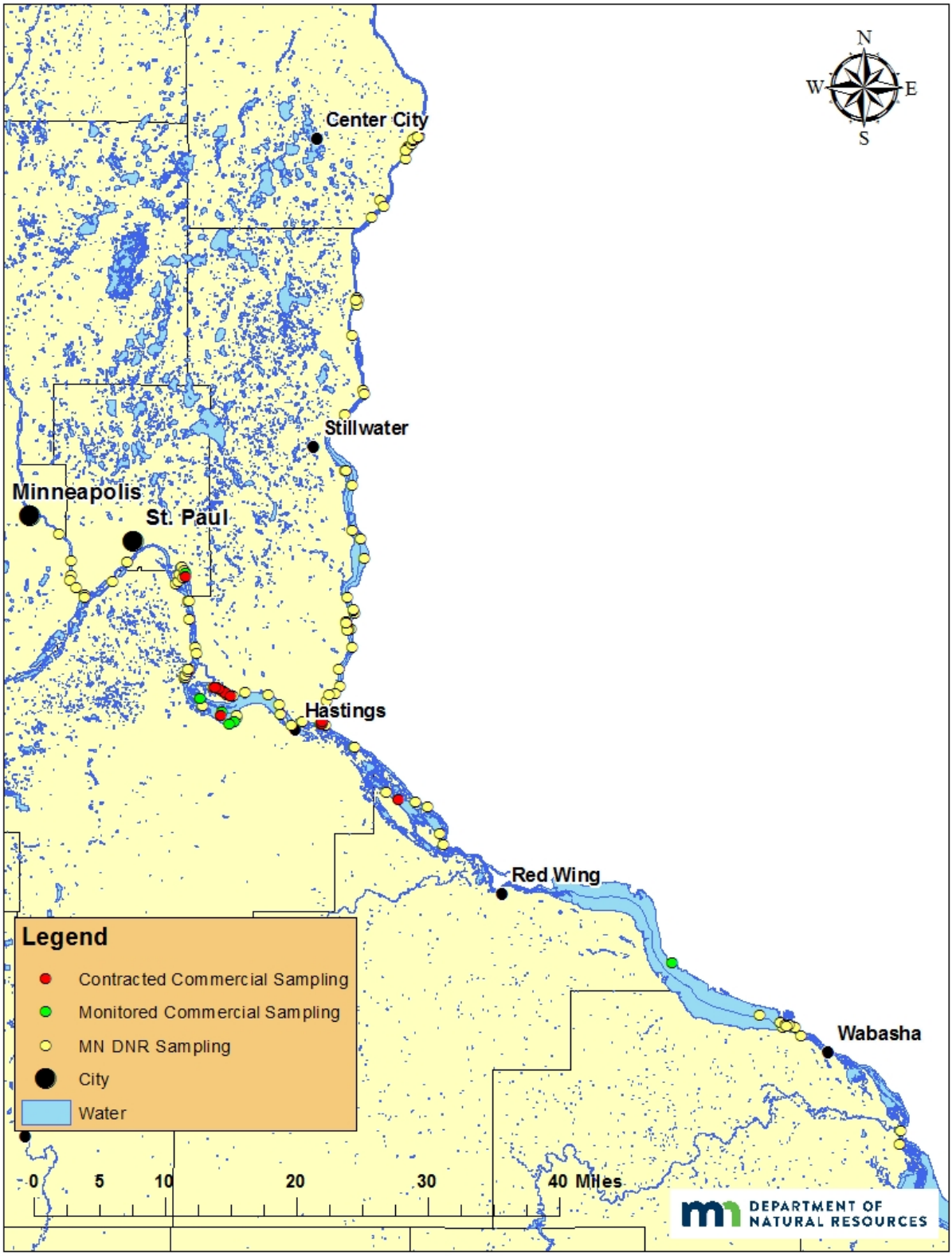

Figure 4. All sampling locations for contracted commercial sampling and MN DNR sampling on the Mississippi River and the St. Croix River during 2016.

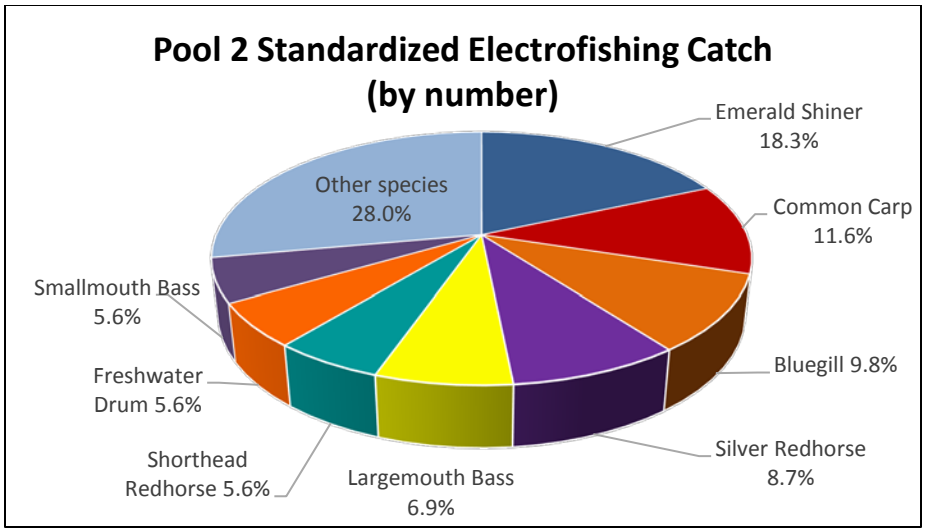

Figure 5. The percent catch by number of fish caught during standardized electrofishing on the Mississippi River Pool 2 during 2016. "Other species" represents 24 species, including: Gizzard Shad, Black Crappie, Channel Catfish, Smallmouth Buffalo,Walleye, Highfin, Quillback, Bigmouth Buffalo, White Bass, River Carpsucker, Spotfin Shiner, Logperch, Greater Redhorse, Northern Pike, Sauger, Golden Redhorse, Hybrid Sunfish, Rock Bass, Slenderhead Darter, White Crappie, and Yellow Perch.

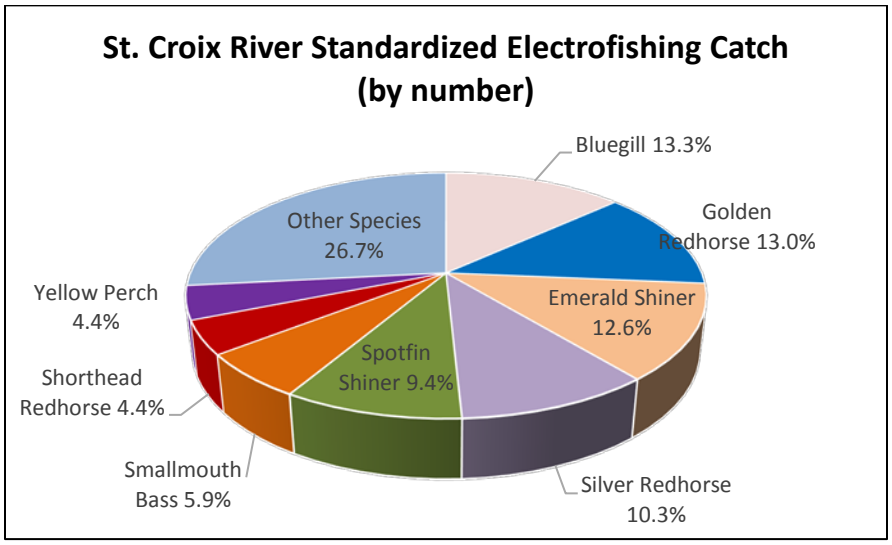

Figure 6. The percent catch by number of fish caught during standardized electrofishing on the St. Croix River during 2016. "Other species" represents 34 species, including: Common Carp, Rock Bass, Largemouth Bass, Spotted Sucker, Freshwater Drum, River Redhorse, White Crappie, Northern Pike, Spottail Shiner, Logperch, Walleye, Quillback, Black Crappie, River Carpsucker, Highfin, Bigmouth Buffalo, Brook Silverside, Bowfin, Smallmouth Buffalo, Channel Catfish, Blackside Darter, Flathead Catfish, Gizzard Shad, Golden Shiner, Johnny Darter, Northern Hogsucker, Mimic Shiner, White Sucker, Blue Sucker, Greater Redhorse, Silver Lamprey, Bluntnose Minnow, Pumpkinseed, and White Bass.