# APPENDIX

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**1967 Decree with**
**1980 Amendments**

IT IS ORDERED, ADJUDGED, AND DECREED that:

1. The State of Illinois and its municipalities, political subdivisions, agencies, and instrumentalities, including, among others, the cities of Chicago, Evanston, Highland Park, Highwood and Lake Forest, the villages of Wilmette, Kenilworth, Winnetka, and Glencoe, the Elmhurst-Villa Park-Lombard Water Commission, the Chicago Park District and the Metropolitan Sanitary District of Greater Chicago, their employees and agents and all persons assuming to act under their authority, are hereby enjoined from diverting any of the waters of Lake Michigan or its watershed into the Illinois waterway, whether by way of domestic pumpage from the lake the sewage effluent derived from which reaches the Illinois waterway, or by way of storm run-off from the Lake Michigan watershed which is diverted into the Sanitary and Ship Canal, or by way of direct diversion from the lake into the canal, in excess of an average for all of them combined of 3,200 cubic feet per second. "Domestic pumpage," as used in this decree, includes water supplied to commercial and industrial establishments and "domestic use" includes use by such establishments. The water permitted by this decree to be diverted from Lake Michigan and its watershed may be apportioned by the State of Illinois among its municipalities, political subdivisions, agencies, and instrumentalities for domestic use or for direct diversion into the Sanitary and Ship Canal to maintain it in a reasonably

satisfactory sanitary condition, in such manner and amounts and by and through such instrumentalities as the State may deem proper, subject to any regulations imposed by Congress in the interests of navigation or pollution control.

2. The amount of water diverted into the Sanitary and Ship Canal directly from Lake Michigan and as storm runoff from the Lake Michigan watershed shall be determined by deducting from the total flow in the canal at Lockport (a) the total amount of domestic pumpage from Lake Michigan and from ground sources in the Lake Michigan watershed, except to the extent that any such ground sources are supplied by infiltration from Lake Michigan, by the State of Illinois and its municipalities, political subdivisions, agencies, and instrumentalities the sewage effluent derived from which reaches the canal, (b) the total amount of domestic pumpage from ground and surface sources outside the Lake Michigan watershed the sewage effluent derived from which reaches the canal, (c) the total estimated storm runoff from the upper Illinois River watershed reaching the canal, (d) the total amount of domestic pumpage from all sources by municipalities and political subdivisions of the States of Indiana and Wisconsin the sewage effluent derived from which reaches the canal, and (e) any water diverted by Illinois, with the consent of the United States, into Lake Michigan from any source outside the Lake Michigan watershed.

3. For the purpose of determining whether the total amount of water diverted from Lake Michigan by the State of Illinois and its municipalities, political sub-divisions, agencies and instrumentalities is not in excess of the maximum amount permitted by this

decree, the amounts of domestic pumpage from the lake by the State and its municipalities, political subdivisions, agencies and instrumentalities the sewage and sewage effluent derived from which reaches the Illinois waterway, either above or below Lockport, shall be added to the amount of direct diversion into the canal from the lake and storm runoff reaching the canal from the Lake Michigan watershed computed as provided in Paragraph 2 of this decree. The annual accounting period shall consist of twelve months terminating on the last day of September. A period of forty (40) years, consisting of the current annual accounting period and the previous thirty-nine (39) such periods (all after the effective date of this decree), shall be permitted, when necessary, for achieving an average diversion which is not in excess of the maximum permitted amount; provided, however, that the average diversion in any annual accounting period shall not exceed 3680 cubic feet per second, except that in any two (2) annual accounting periods within a forty (40) year period, the average annual diversion may not exceed 3840 cubic feet per second as a result of extreme hydrologic conditions; and, that for the first thirty-nine (39) years the cumulative algebraic sum of each annual accounting period's average diversion minus 3200 cubic feet per second shall not exceed 2000 cubic feet per second-years. All measurements and computations required by this decree shall be made by the appropriate officers, agencies or instrumentalities of the State of Illinois, or the Corps of Engineers of the United States Army subject to agreement with and cost-sharing by the State of Illinois for all reasonable costs including equipment, using the best current engineering practice and scientific knowledge. If made by the State of Illinois,

the measurements and computations shall be conducted under the continuous supervision and direction of the Corps of Engineers of the United States Army in cooperation and consultation with the United States Geological Survey, including but not limited to periodic field investigation of measuring device calibration and data gathering. All measurements and computations made by the State of Illinois shall be subject to periodic audit by the Corps of Engineers. An annual report on the measurements and computations required by this decree shall be issued by the Corps of Engineers. Best current engineering practice and scientific knowledge shall be determined within six (6) months after implementation of the decree based upon a recommendation from a majority of the members of a three-member committee. The members of this committee shall be appointed by the Chief of Engineers of the United States Army Corps of Engineers. The members shall be selected on the basis of recognized experience and technical expertise in flow measurement or hydrology. None of the committee members shall be employees of the Corps of Engineers or employees or paid consultants of any of the parties to these proceedings other than the United States. The Corps of Engineers shall convene such a committee upon implementation of this decree and at least each five (5) years after implementation of this decree to review and report to the Corps of Engineers and the parties on the method of accounting and the operation of the accounting procedure. Reasonable notice of these meetings must be given to each of the parties. Each party to these proceedings shall have the right to attend committee meetings, inspect any and all measurement facilities

and structures, have access to any data and reports and be permitted to take its own measurements.

4. The State of Illinois may make application for a modification of this decree so as to permit the diversion of additional water from Lake Michigan for domestic use when and if it appears that the reasonable needs of the Northeastern Illinois Metropolitan Region (comprising Cook, Du Page, Kane, Lake, McHenry, and Will Counties) for water for such use cannot be met from the water resources available to the region, including both ground and surface water and the water permitted by this decree to be diverted from Lake Michigan, and if it further appears that all feasible means reasonably available to the State of Illinois and its municipalities, political subdivisions, agencies, and instrumentalities have been employed to improve the water quality of the Sanitary and Ship Canal and to conserve and manage the water resources of the region and the use of water therein in accordance with the best modern scientific knowledge and engineering practice.

5. This decree shall become effective on March 1, 1970, and shall thereupon supersede the decree entered by this Court in Nos. 1, 2, and 3, Original Docket, on April 21, 1930, as enlarged May 22, 1933, provided that for the period between January 1, 1970, and March 1, 1970, the amount of water diverted by Illinois into the Sanitary and Ship Canal (determined in accordance with paragraph 2 of this decree) shall not exceed an average of 1,500 cubic feet per second. The amendment to Paragraph 3 of this decree shall take effect on the first day of October following the passage into law by the General Assembly of the State of Illinois of an amendment to the Level of Lake

Michigan Act providing that the amount used for dilution in the Sanitary and Ship Canal for water quality purposes shall not be increased above three hundred twenty (320) cubic feet per second, and that in allocations to new users of Lake Michigan water, allocations for domestic purposes be given priority and to the extent practicable allocations to new users of Lake Michigan water shall be made with the goal of reducing withdrawals from the Cambrian-Ordovician aquifer.

6. The complaint of the State of Illinois in No. 11, Original Docket, on behalf of its instrumentality, the Elmhurst-Villa Park-Lombard Water Commission, is hereby dismissed, without prejudice to that Commission sharing in the water permitted by this decree to be diverted from Lake Michigan.

7. Any of the parties hereto may apply at the foot of this decree for any other or further action or relief, and this Court retains jurisdiction of the suits in Nos. 1, 2, and 3, Original Docket, for the purpose of making any order or direction, or modification of this decree, or any supplemental decree, which it may deem at any time to
be proper in relation to the subject matter in controversy.

8. All the parties to these proceedings shall bear their own costs. The costs and expenses of the Special Master shall be equally divided between the plaintiffs as a group and the defendants as a group in Nos. 1, 2, and 3, Original Docket. The costs and expenses thus imposed upon the plaintiffs and defendants shall be borne by the individual plaintiffs and defendants, respectively, in equal shares.

**In the Supreme Court of the United States**
OCTOBER TERM, 1978

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No. 1, Original
STATES OF WISCONSIN, MINNESOTA, OHIO AND PENNSYLVANIA, COMPLAINANTS
v.

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No. 2, Original
STATE OF MICHIGAN, COMPLAINANT
v.
STATE OF ILLINOIS AND THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO, DEFENDANTS,
UNITED STATES OF AMERICA, INTERVENOR

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No. 3, Original
STATE OF NEW YORK, COMPLAINANT
v.
STATE OF ILLINOIS AND THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO, DEFENDANTS,
UNITED STATES OF AMERICA, INTERVENOR

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*ON MOTION FOR LEAVE TO FILE PETITION FOR MODIFICATION OF DECREE*

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MEMORANDUM FOR THE UNITED STATES

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The history of this litigation is sufficiently recited in Illinois' motion (at 15-21). As there indicated, the United States has been an active participant in these cases for many years, first as an *amicus curiae (e* g, 352 U.S. 983, 984; 359 U.S. 963; 360 U.S. 712, 713, 714), later as an intervenor (361 U.S. 956), and we contributed to the formulation of the proposed decree that the Court entered on June 12, 1967. 388 U.S. 426. The potentially affected interests of the United States are many. Those concerns include navigation in the Great Lakes, the St. Lawrence Seaway and the Illinois Waterway, hydroelectric power development on the Niagara and St. Lawrence Rivers, pollution and other threats to public health in and around the Great Lakes, the national interest in the Great Lakes-St Lawrence system as a unique natural resource, and, finally, the maintenance of friendly relations with Canada. It is accordingly with special caution that we approach any proposal for change.

1. Procedurally, we agree with Illinois that the Court has retained jurisdiction to entertain the present petition for modification. On several previous occasions, the original decree was reopened, in major or minor respects. See, *e* g, 289 U.S. 395; 311 U.S. 107, 352 U.S. 945; 360 U.S. 712; 388 U.S. 426. Those precedents are persuasive here. Moreover, the 1967 decree which is sought to be changed expressly permits "[a]ny of the parties * * * [to] apply" in future "for any other or further action or relief," and provides that jurisdiction is retained "for the purpose of making any *** modification of [the] decree." Para.

3

7, 388 U.S. at 430. In our view, these words fully authorize the pending application.

2. On its merits, the modification sought by Illinois seems to us unobjectionable. The objective is to permit the State to make more efficient use of the water it diverts from Lake Michigan and this would be accomplished by a new method of accounting. Specifically, Illinois proposes (a) that the diversion measurement points be moved from Lockport on the Illinois Waterway to three lakefront intake points; (b) that a fixed value for stormwater runoff of 550 cubic feet per second be used for accounting purposes; and (c) that the accounting year for computing the diversion be changed to begin on October 1 and end on September 30.

Since the proposal was filed, we have consulted the Corps of Engineers and the Environmental Protection Agency, and are advised that no adverse effects are anticipated from the proposed modification. The Department of State has also consulted with the Government of Canada, whose representatives have voiced no objection. We have accordingly no reason to oppose entry of the modified decree.

It is not possible, however, fully to assess the impact of the changed accounting system until actual experience has demonstrated the exact effects. For this reason, it has been suggested that the decree require Illinois to file a detailed report in due course, and the State has agreed to do so "within five years." We believe that is not sufficient. Our own suggestion is that Illinois be required to submit to all parties an



*annual* progress report on the actual experience under the new accounting system.

Accordingly, we do not oppose the granting of the pending motion or the entry of the proposed modified

decree, subject only to the inclusion of an annual reporting requirement.

Respectfully submitted.

WADE H. McCiis, JR.
*Solicitor General*

DECEMBER 1978

# ECONOMICS OF GREAT LAKES FISHERIES: A 1985 ASSESSMENT

**by**

DANIEL R. TALHELM
Department of Park & Recreation Resources
Michigan State University
East Lansing, MI 48824

TECHNICAL REPORT No. 54

Great Lakes Fishery Commission
145 1 Green Road
Ann Arbor, Michigan 48105-2898

November 1988

The total economic impact of the Great Lakes sport and food fishery on the regional economy is $2.3 to $4.3 billion (U.S. dollars). This means that if this fishery were stopped, and anglers and food fish consumers reallocated their $1.1to $2.1 billion direct expenditures to other purposes, up to $4.3 billion in sales would be shifted from present businesses and individuals, to other businesses and individuals in the region or in other regions. About 35 percent of that would be personal income, shifted to other persons. [Page 3]

**U.S. Fish & Wildlife Service**

**Asian Carp -An Aquatic Nuisance Species**

Region 3-Great Lakes/Big Rivers

*Leadership in Conserving, Enhancing, and Restoring Aquatic Ecosystems*

## Asian Carp: Huge Fish with Huge Impacts

### *Pathways and Introductions into the United States*

Bighead, silver, grass, and black carp are native to Asia. Grass carp were first introduced into the United States in 1963, whereas bighead, silver, and black carp arrived in the 1970s. All four species escaped into the Mississippi River Basin, and all but the black carp are known to have developed self-sustaining populations. Bighead and grass carp were captured in the Great Lakes Basin, but there is no evidence of reproduction to date.

### *Biology and Ecology*

Bighead carp grow to a maximum of about 60 inches and 110 pounds. Silver carp also grow very fast compared to most native fishes in the United States. In aquaculture facilities, silver carp have grown to 12 pounds in one year, and may grow to a maximum of 39 inches and 60 pounds. Grass carp can eat up to 40% of their body weight per day, and grow to a maximum of 59 inches, 99 pounds, and live up to 21 years. Black carp can grow to a maximum of 48 inches, and 71 pounds, on a diet composed almost exclusively of snails, mussels, and other invertebrates.

***Distribution and Abundance***

Grass carp inhabit waters within and bordering 45 states, whereas bighead carp have been collected from 18 states, silver carp from 12 states, and black carp from only Illinois (some escaped from an aquaculture facility in Missouri). . . .

Data from the Illinois Natural History Survey indicates that bighead carp abundance has been increasing exponentially in a portion of the Upper Mississippi River. The population has tended to double there every year. Bighead carp populations may be increasing at equally fast rates on portions of the Illinois and Missouri Rivers, while silver carp
abundance may be increasing at similar rates in all of those rivers.

***Ecological Risks and Impacts***

Detailed ecological risk assessments are being completed for bighead, silver, and black carp. Known risks include rapid range expansion and population increase which could decrease abundance of native mussels, other invertebrates, and fishes. Grass carp can eliminate vast areas of aquatic plants that are important as fish food and spawning and nursery habitats. Losses of those habitats can potentially reduce recruitment and abundance of native fishes. Black carp could reduce abundance of already rare snails, mussels, and other invertebrates. Silver carp can jump at least 10 feet out of the water and that behavior has resulted in injuries to boaters. Collisions between boaters and jumping silver carp have the potential to cause human fatalities.
(see . . . video at: http://www.protectyourwaters.netl)

***Threats to the Great Lakes Basin***

Bighead and silver carp are in the Illinois River, which is connected to the Great Lakes via the Chicago Sanitary and Ship Canal. Asian carp pose the greatest immediate threat to the Great Lakes ecosystem. An electrical barrier designed to repel fish was placed in the waterway. It is experimental and may not be 100% effective but remains the only defense against the upstream movement of bighead and silver carp from the Illinois River into the Great Lakes. Bighead and silver carp could colonize all of the Great Lakes and sustain high-density populations. High densities would likely result in declines in abundance of many native fishes. Presently, bighead and silver carp are known to be within 22 miles of the electric barrier which is about 25 miles from Lake Michigan. Both species could reach the Great Lakes by swimming through the electrical barrier, or by release of bait fish or fish sold live for food.

Great Lakes sport and commercial fisheries are valued at $4.5 billion dollars annually, without including the indirect economic impact of those industries. Degradation of those fisheries would have severe economic impacts on Great Lakes communities that benefit from the fisheries. Waterfowl production areas are also at risk from Asian carp. Hunters spend more than $2.6 billion annually on their sport in the Great Lakes, so reduction of waterfowl populations there would decrease the economic value to communities that benefit from hunting. The effects of Asian carp on wetlands in the Prairie Pothole Region would have an even greater effect on hunting and the economies it supports.

U.S. Fish & Wildlife Service
1800/344 WILD
http://www.fws.gov

U.S. Fish & Wildlife Service
Bishop Henry Whipple Federal Building
1 Federal Drive
Ft. Snelling, MN 55111

For more information please contact:
Mike Hoff, Aquatic Nuisance Species Coordinator
612/713-5114 or visit our website at:
http://midwest.fws.gov/Fisheries/

March 2004

**DEPARTMENT OF THE INTERIOR**

**Fish and Wildlife Service**

**50 CFR Part 16**
**RIN 1018-AT29**

**Injurious Wildlife Species; Silver Carp (Hypophthalmichthys molitrix) and Largescale Silver Carp (Hypophthalmichthys harmandi)**

**AGENCY:** Fish and Wildlife Service, Interior.

**ACTION:** Final rule.

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**SUMMARY:** The U.S. Fish and Wildlife Service (Service or we) adds all forms of live silver carp *(Hypophthalmichthys molitrix)*, gametes, viable eggs, and hybrids; and all forms of live largescale silver carp *(Hypophthalmichthys harmandi)*, gametes, viable eggs, and hybrids to the list of injurious fish, mollusks, and crustaceans under the Lacey Act. The best available information indicates that this action is necessary to protect the interests of human beings, and wildlife and wildlife resources, from the purposeful or accidental introduction, and subsequent establishment, of silver carp and largescale silver carp populations in ecosystems of the United States. Live silver carp and largescale silver carp, gametes, viable eggs, and hybrids can be imported only by permit for scientific, medical, educational, or zoological purposes, or without a permit by Federal agencies solely for their own use; permits will also be required for the interstate transportation of live silver or largescale silver carp,

gametes, viable eggs, or hybrids currently within the United States. Interstate transportation permits may be issued for scientific, medical, educational, or zoological purposes.

**DATES:** This rule is effective August 9, 2007.

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**Biology**

The commonly named silver carp belongs to the family Cyprinidae, with the species name of *Hypophthalmichthys molitrix*. Silver carp are native to Asia (China and Eastern Siberia), from about 54 °N southward to 21 °N. Silver carp are primarily phytoplanktivores, but are highly opportunistic, eating phytoplankton, zooplankton, bacteria, and detritus. Silver carp are well established throughout much of the Mississippi River Basin, and its range is expanding in that basis.

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**Factors That Contribute to Injuriousness for Silver Carp**

*Introduction and Spread*

The major pathway for introduction of silver carp in the United States was importation for biological control of plankton in aquaculture ponds and sewage lagoons. The pathway that led to the presence of this species in open waters of the United States was likely escape from these facilities. Subsequent escapes and the mixture of silver carp

with other species that were stocked likely contributed to the expansion of the species' range, along with natural reproduction.

Other probable pathways that may aid the spread of existing populations of silver carp include connected waterways, contamination of pond-grown bait fishes with silver carp, ballast water release, release or escape from livehaulers that support commercial fisheries, or spread by commercial fishers themselves.

***

Silver carp have survived, have become established in river systems, and have been reproducing in natural waters of the United States since at least 1995. Because silver carp can occupy lakes, there is serious concern that this species will further expand its range beyond riverine environments and into lake environments including the Great Lakes. If introduced, it is highly likely that silver carp will establish reproducing populations in other major river systems, such as the Potomac/Chesapeake, Columbia, and Sacramento/San Joaquin Delta. In their native range, juveniles and adults are also found in lakes, reservoirs, and canals where they grow well, but probably cannot spawn and recruit without access to an appropriate riverine habitat.

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*Potential Effects on Native Species*

Silver carps' food consumption rate is high, but widely variable. Fry at the smallest size class consumed up to 140% of their body weight daily; 63 mg fingerlings consumed just more than 30% and 70-166 mg fingerlings consumed 63% of their body weight. Adult silver carp have been shown to consume 8.8 kilograms (kg) of food per year, with 90% of the consumption occurring during the three warmest months of the year.

Silver carp are quite tolerant of broad water temperatures from 4 °C to 40 °C. Silver carp can grow quickly (20 to 30 kg in 5 to 8 years), and large adults can reach over 1.2 meters in length and 50 kg in weight. Silver carp are difficult to age, but have been reported to live 15-20+ years.

The reproductive potential of silver carp is high and increases with body size. It has been estimated that silver carp weighing 3.18 to 12.1 kg can produce 145,000-5,400,000 eggs. Silver carp mature anywhere from 3-8 years, and males usually mature one year earlier than females. The same female may spawn twice during one growing season. Silver carp exhibit a prolonged spawning period, into late summer or early fall, in the United States.

Due to the large size, fast growth rate, high food consumption rate and high reproductive potential of silver carp, competition for food and habitat with native planktivorous fishes and with post-larvae and early juveniles of most native fishes is likely high. Since nearly all larvae and juvenile fishes are planktivorous and based on other demonstrated impacts, it is highly likely that silver carp are adversely affecting many native fishes in the

Mississippi River Basin, particularly in waters where food may become limited, though long-term studies have not yet been conducted. Affected native species include paddlefish *(Polyodon spathula)*, bigmouth buffalo *(Ictiobus cyprinellus)*, gizzard shad *(Dorosoma cepedianum)*, emerald shiner *(Notropis atherinoides)*, and threadfin shad *(Dorosoma petenens)*. It is highly likely silver carp would adversely affect fishes in the Great Lakes basin or other watersheds if they establish.

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Because silver carp are likely to negatively affect important planktivorous forage fishes such as the gizzard shad and emerald shiner, scientists have indicated that fishes and birds that prey on these species would likely also be negatively affected. Adult silver carp are too large to be preyed on by almost any native predator. Young silver carp have likely been incorporated into the diets of piscivorous birds and fishes to some degree, but the extent of this predation is not known. Ecosystem balance is likely to be modified if silver carp populations become large enough to dominate other planktivorous fish species. The most likely negative effect would be an alteration of fish community structure through competition for food.

***

Adverse effects of silver carp on some threatened and endangered freshwater mussels and fishes are likely to be moderate to high. There are currently 116 fishes and 70 mussels on the Federal List of Endangered and Threatened Wildlife.

Because silver carp have the same habitat requirements as approximately 40 fishes and 25 mussels currently on the endangered or threatened species list, these listed species will likely be impacted by competition for food and habitat by the introduction and establishment of silver carp.

Habitat requirements, springs and small streams, of the remaining listed fishes and mussels would probably preclude any detectable effects as it is unlikely that silver carp could survive in such small bodies of water.

Adverse effects of established populations of silver carp on endangered and threatened fishes would most likely be through direct competition for food resources, particularly phytoplankton and, to a lesser extent, zooplankton, in the water column during the larval stage. Potential for direct predation and injury of drifting fertilized eggs and larvae of native fishes also exists. The fact that silver carp can become extremely abundant and reach a very large size (> 1 m in length) in rivers, lakes, and reservoirs increases the probability of a negative impact on aquatic ecosystems they invade as high densities of silver carp decrease food availability for native species....

*Habitat Degradation*

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However, due to the impacts listed above, it is highly likely that silver carp would have adverse effects on designated critical habitats of threatened and endangered species. There are currently 60 species of fishes and 18 mussels with designated critical habitat. Of those, at least 26 inhabit lakes or reaches of streams large enough to support silver carp. Therefore, dense populations of silver carp are likely to affect the critical habitats upon which the threatened and endangered species depend.

***

*Impacts to Humans*

Silver carp in the United States cause substantial impacts to the health and welfare of human beings who use waterways infested with silver carp. There are numerous reports of injuries to humans and damage to boats and boating equipment because of the jumping habits of silver carp in the vicinity of moving motorized watercraft. Some reported injuries include cuts from fins, black eyes, broken bones, back injuries, and concussions. Silver carp also cause property damage including broken radios, depth finders, fishing equipment, and antennae. Some vessels have been retrofitted with a Plexiglas pilot's cab as protection against jumping silver carp.

**Factors That Reduce or Remove Injuriousness for Silver Carp**

*Detection and Response*

If silver carp were introduced or spread into new U.S. waters, it is unlikely that the introduction would be discovered until the numbers were high enough to impact wildlife and wildlife resources. Widespread surveys of waterways are not conducted to establish species' presence lists. Delay in discovery would limit the ability and effectiveness to rapidly respond to the introduction and prevent establishment of new populations. It is unlikely that silver carp could be eradicated from U.S. waterways unless they are found in unconnected waterbodies.

*Potential Control*

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Due to the extensive established range of silver carp in the Mississippi River Basin, conventional control methods are not feasible to reduce established populations. Massive fishing efforts utilizing netting and electrofishing may be effective in reducing populations, but many non-target fish species would also be killed. Justifying the expense of such efforts would require a large commercial demand, which does not currently exist, nor is likely given the jumping behavior of silver carp that makes fishing difficult. Selective removal of silver carp is possible given their location in the water column, but water trawling could also remove other non-target fish such as paddlefish.

The large and growing range of silver carp in U.S. waterways makes chemical control of

established populations highly unlikely, both physically and fiscally. Use of chemical treatments, such as rotenone, would be expensive, only locally effective, and would negatively affect all fishes and invertebrates, not just the target carp. At present, there is no method known to substantially reduce established populations of silver carp. Eradication is not possible with presently available technology.

Conclusion

In summary, the Service finds all forms of live silver carp, including gametes, viable eggs and hybrids, to be injurious to wildlife and wildlife resources of the United States and to the interests of human beings because:

- Silver carp are highly likely to spread from their current established range to new waterbodies in the United States;

- Silver carp are highly likely to compete with native species, including threatened and endangered species, for food and habitat;

- Silver carp have the potential to carry pathogens and transfer them to native fish;

- Silver carp are likely to develop dense populations that will likely affect critical habitat for threatened and endangered species and could further imperil other native fishes and mussels;

- Silver carp are negatively impacting humans;

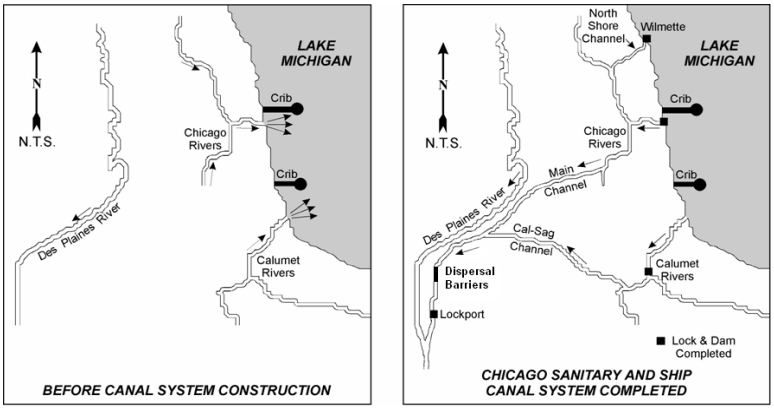
- It would be difficult to eradicate or reduce large populations of silver carp, or recover ecosystems disturbed by the species; and

- There are no potential ecological benefits for U.S. waters from the introduction of silver carp.

**Chicago Sanitary and Ship Canal Aquatic Nuisance Species Dispersal Barriers**
**Project Manager:** Shea, Chuck

**Introduction:**

The Chicago Sanitary and Ship Canal (CSSC) is a man-made waterway that provides a direct hydraulic connection between Lake Michigan and the Mississippi River Basin. As non-indigenous aquatic species

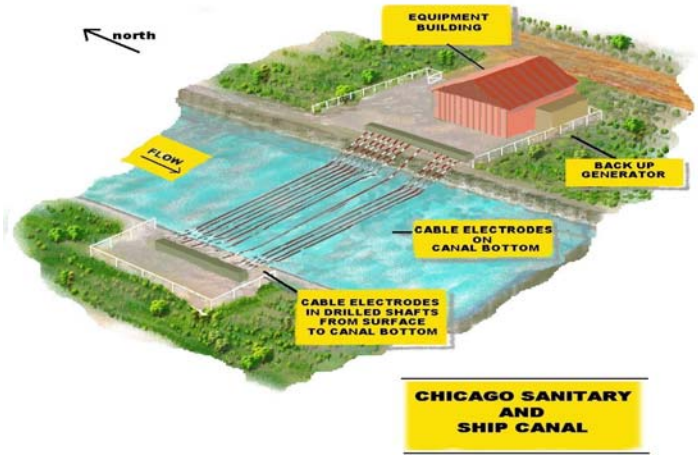



use the CSSC to move between the two basins, they prey on native species and compete for food, living space and spawning areas. Currently the greatest concern is the potential movement of Asian carp into the Great lakes.

| **Mississippi Basin** | **Great Lakes Basin** |
|---|---|
| Bighead Carp | Round Goby |
| Silver Carp | Ruffe |
| Black Carp | White Perch |

The Corps was authorized to conduct a demonstration project to identify an environmentally

sound method for preventing the dispersal of aquatic nuisance species through the CSSC. The Corps formed an Advisory Panel, including other agencies and stakeholders, to evaluate potential methods.



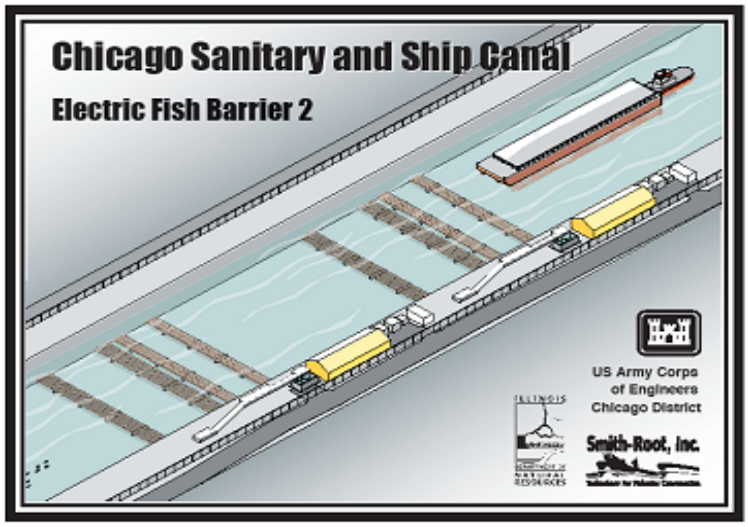

**Project Description**:

An electric barrier was selected because it is a non-lethal deterrent that does not interfere with water flow or navigation in the canal. The Demonstration Barrier (Barrier I) is formed of steel cables that are secured to the bottom of the canal. A low-voltage, pulsing DC current is sent through the cables, creating an electric field in the water. The electric field is uncomfortable for the fish and they do not swim across it.

Based on the effectiveness of Barrier I, a second more permanent barrier (Barrier II) was authorized. Barrier II is a similar electric field barrier, that covers a larger area within the CSSC, has a longer

service life and includes design improvements identified during monitoring and testing of Barrier I. Barrier II consists of two sets of electrical arrays and control houses, known as Barriers IIA and IIB. Each control house and set of arrays can be operated independently, but the ultimate goal is to operate both at the same time.

Barrier I is located at River Mile 296.5 in the CSSC. Barrier II is located 800 to 1,500 feet downstream of Barrier I. Both barriers have been designed and constructed by Smith-Root, Inc. of Vancouver, WA under contract to the Corps of Engineers.



**Project History:**

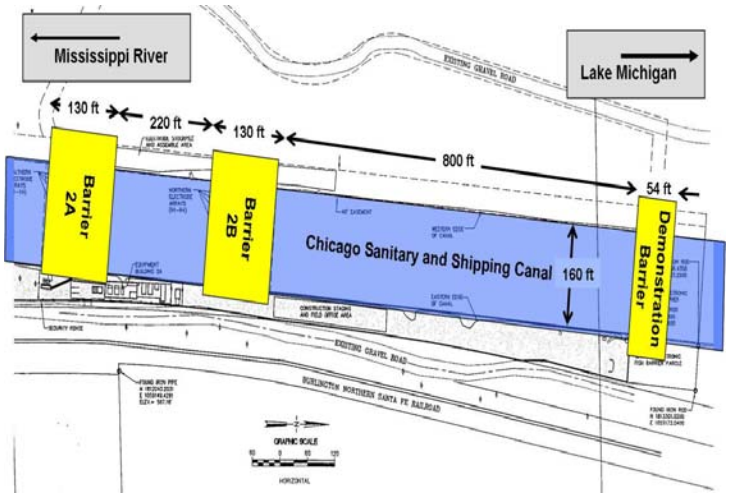
In April 2002, the Corps of Engineers began operation of the first barrier (Barrier I) as a demonstration of a new technology for preventing the spread of aquatic nuisance species. Barrier I, which is located at river mile 296.5 in Romeoville, IL, is formed of steel cables (see diagram below right) that are secured to the bottom of the canal. A low-voltage, pulsing DC current is sent through the cables, creating an electric field in the water. The electric field is uncomfortable for fish and they do not swim across it. Since Barrier I was originally built as a demonstration, it was not intended to be operated for more than a few years. In 2004, the Corps initiated construction of a permanent barrier (Barrier II) to prevent the migration of fish, including Asian carp, between the watersheds. Barrier II, which is located 800 to 1,300 feet downstream of Barrier I, also uses a pulsed electric field, but includes several design improvements identified during monitoring and testing of Barrier I. Barrier II is able to generate a more powerful electric field over a larger area and consists of two sets of electrical arrays and control houses, known as Barriers IIA and IIB. Each control house and set of arrays can be operated independently, but the ultimate goal is to operate both at the same time. In 2007, Congress authorized the Corps to complete Barrier II, to upgrade Barrier I and make it permanent, and to operate the barrier system at full federal cost.

**Current Status:**

Barrier I and Barrier IIA are operating continuously. Barrier IIB is partially constructed. Due to its

original demonstration status, Barrier I was designed and built with materials that were not intended for long-term use. It was taken off-line for approximately a month in September-October 2008 for significant repairs. These repairs were successfully completed and will allow Barrier I to remain in service for several more years until Barriers IIA and IIB are completed and fully functional. Once Barrier II is fully operational, Barrier I will be taken off line and replaced with a more permanent facility.

Construction of Barrier IIA was completed in 2006 and, after completion of extensive operational and safety testing, Barrier IIA was continuously in operation at a maximum in-water field strength of 1 volt/inch during the 2008 repairs to Barrier I. This is the same electrical field strength that Barrier I has operated at since it was activated. After a final period of maintenance and repairs, Barrier IIA was




activated for long-term continuous operation in April 2009 at a maximum in-water electric field strength of 1 volt/inch.

Preliminary results of a new monitoring method called eDNA indicate that Asian carp may be closer than pervious thought. After extensive collaboration with partner agencies, the Corps increased the operating parameters of the barrier to a setting of two volts per inch, 15 Hertz frequency and 6.5 milliseconds duration, which is the combination of voltage, frequency an pulse rate that research to date has shown to be most effective in deterring Asian Carp.

Most fish are repelled by an electric field operating at a maximum in-water field strength of 1 volt/inch. However, an independent study has indicated that higher voltages may be necessary to deter smaller fish. Barrier IIA has the capability of operating at higher voltages, but such operation will increase public safety risks. The Corps is conducting ongoing research to verify the optimal operating parameters for deterring fish of all sizes. Based on new monitoring results indicating that the Asian carp have moved within approximately five miles of the barriers, the Corps is currently preparing for operations at the optimum operating parameters identified to date. Additional safety tests will be completed for these new operating parameters.

Preliminary results of a new monitoring method called eDNA indicate that Asian carp may be closer than previously thought. After extensive collaboration with partner agencies, the Corps increased the operating parameters of the barrier to a setting of two volts per inch, 15 Hertz frequency and 6.5 milliseconds pulse rate, which is the combination of voltage, frequency and pulse rate research has

shown to be effective in deterring both adult and juvenile Asian carp.

Final design of Barrier IIB will not be completed until research on optimal operating parameters is fully completed and operational and safety testing at Barrier IIA is completed. Construction of Barrier IIB is expected to begin in fall 2009 and will be completed in 2010.

**Costs:**

Barrier I is 100% Federally funded. Through Fiscal Year 2007, approximately $4 million has been spent on the demonstration project for planning, design, construction, and ongoing operation and maintenance. The demonstration project has no funding ceiling. Operation can continue as long as Congress continues to appropriate funds to the project.

Barrier II is 75% Federally funded. The Illinois Department of Natural Resources (IDNR) is the non-Federal sponsor and, with some assistance from other Great Lakes states, is providing the remaining 25% of the project cost. Through Fiscal Year 2007, approximately $8.5 million has been spent on planning, design, and construction.

Barrier II is authorized for a total project cost of $9.1 million. However, the estimated total project cost for completion of both Barrier IIA and Barrier IIB is now $16 million. Additional laws must be passed to increase or waive the $9.1 million funding ceiling and appropriate further funds to the Barrier II project or Barrier IIB can not be completed.

**Authorizations:**

Demonstration Barrier: Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPACA) of 1990 (P.L. 101-636, as amended in 1996) and Section 2309 of P.L. 109-234, Emergency Supplemental Appropriations Act. Permanent Barrier: Section 1135, WRDA 1986 and Section 345 of PL. 108-335, District of Columbia Appropriations Act, 2005.

**Page Last Updated:** 27 Aug 2009

Center for Aquatic Conservation, Department of Biological Sciences, University of Notre Dame, Notre Dame, IN 46556




**Risk Reduction Study Fact Sheet**
**Environmental DNA (eDNA)**

**Chicago Sanitary and Ship Canal – Aquatic Nuisance Species Dispersal Barrier**

**Contacts:**
**David M. Lodge,** Professor, Director of the Center for Aquatic Conservation, Univ. of Notre Dame; Ph. (574) 631-6094/2849, dlodge@nd.edu

**Andrew R. Mahon,** Postdoctoral Research Associate, Univ. of Notre Dame

**Christopher L. Jerde,** Postdoctoral Research Associate, Univ. of Notre Dame

**W. Lindsay Chadderton,** Director of Aquatic Invasive
Species, Great Lakes Project, The Nature Conservancy

**Overview:** Fishes, including Asian carp, release DNA into the environment in the form of mucoidal secretions, feces, and urine. DNA degrades in the environment, but this process is not instantaneous,

and DNA can be held in suspension and transported. The presence of species can be detected by filtering water samples, and then extracting and amplifying short fragments of the shed DNA. In contrast to other surveillance methods, the environmental DNA (eDNA) method does not rely on direct observation of Asian carp to evaluate presence.

**Scope:** Laboratory and field studies using eDNA methods confirm that Asian carps can be detected in 2 liter water samples from sites that electrofishing indicates have high, moderate, and low densities of carp. Water samples are collected in the field and filtered in the lab. DNA is extracted from the filtrate, and any DNA from bighead and silver carp is amplified with PCR using genetic markers that are unique to bighead and silver carp. The eDNA approach uses standard genetic identification methods in a novel application – the extraction of low concentrations of DNA from water sampled in the field that allows for species-specific detection (Plate 1).

The objectives of this study are to locate the invasion front using the eDNA and provide an early detection tool to inform rapid responses and other management. We will complete a longitudinal study of CSSC, sampling both the main-stem and different microhabitats where eDNA may accumulate, resulting in an increased probability of detection. From this information, locations above the current detection front, at the electric barrier, and above the electric barrier, that are identified as optimal eDNA detection sites, will be targeted for continual surveillance.

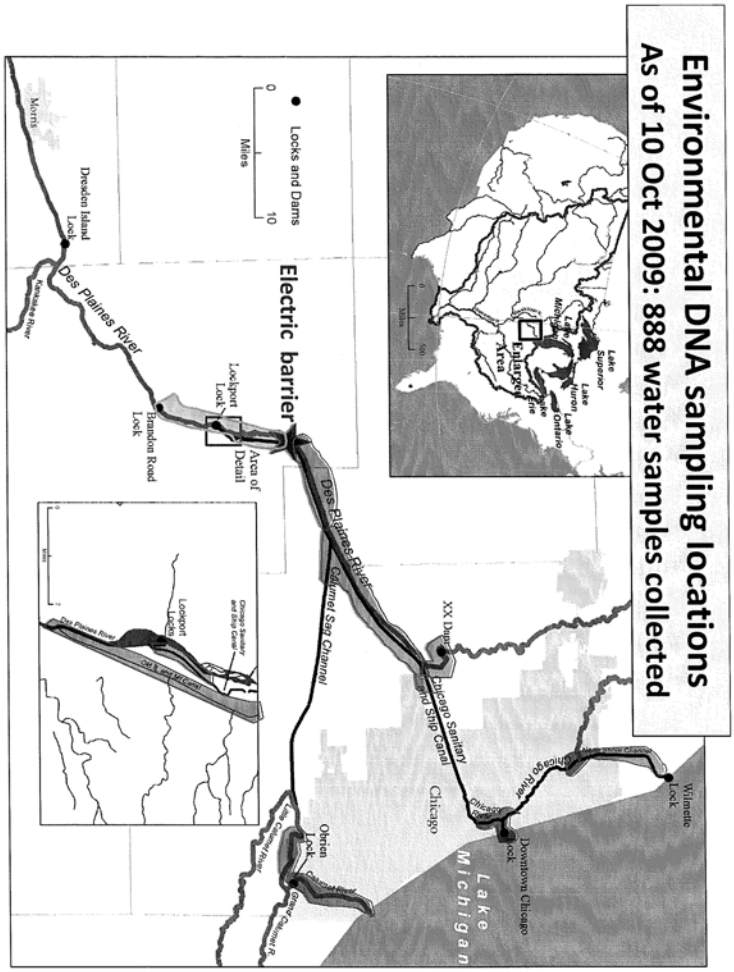
**How will this improve our current monitoring?** The eDNA approach to surveillance will allow greater geographiccoverage throughout the CSSC and connected waterways, and is more sensitive at detecting low abundance of fish than the methods currently employed. Adult and juvenile eDNA can be detected using this technique, and while the former is more likely, themethod does not allow size or sex of fish to be differentiated. Water sample collection can be accomplished from boats, bridges, shorelines, and in habitats that are difficult to sample with the current approaches (such as shallow channels of the Des Plaines River or deep sections of the CSSC where electrofishing can be ineffective and where high boater traffic precludes the application of nets).

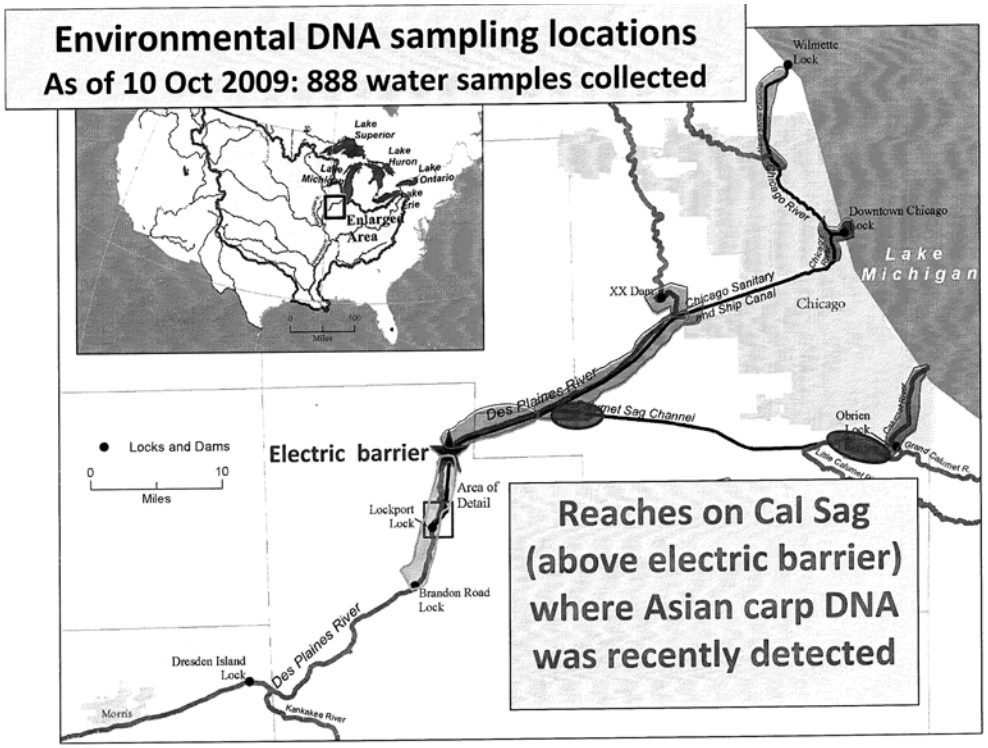
**Current Results:** As of 17 September 2009, the eDNA method has detected silver carp DNA approximately 1 mile south of the electric barrier. All analyzed CSSC samples above the electric barrier have been negative for silver carp eDNA. Testing for bighead eDNA in the Lockport pool is underway.

**Authority:** The Water Resources Development Act of 2007, Section 3061, Chicago Sanitary and Ship Canal Dispersal Barriers Project, Illinois, and a Cooperative Ecosystems Study Unit (CESU) with the Engineer Research Development Center (ERDC), authorized this project.

The current budgetary support covers eDNA surveillance methods as part of a larger and ongoing CESU agreement through June 2010.


For additional project information please visit our websites
**http://www.nd.edu/~lodgelab/**
**http://aquacon.nd.edu/**


Environmental DNA sampling locations
As of 10 Oct 2009: 888 water samples collected
Locks and Dams
Miles
Electric barrier
Area of Detail
Lockport Lock
Brandon Road Lock
Dresden Island Lock
Des Plaines River
Morris
Kankakee River
Calumet Sag Channel
Chicago Sanitary and Ship Canal
Chicago
Lake Michigan
Wilmette Lock
Downtown Chicago Lock
O'Brien Lock
Calumet River
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
Enlarged Area


Environmental DNA sampling locations
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Wilmette Lock
Chicago River
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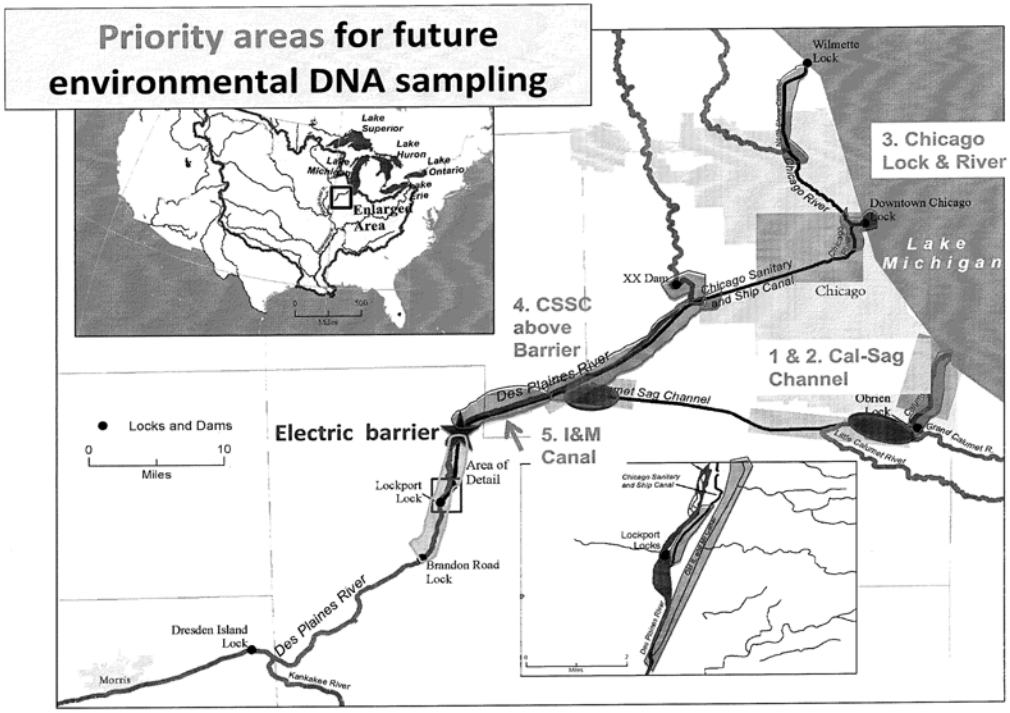
Lake Michigan
Chicago Sanitary and Ship Canal
Chicago
Des Plaines River
Calumet Sag Channel
Obrien Lock
Grand Calumet R.
Locks and Dams
Electric barrier
Area of Detail
Lockport Lock
Brandon Road Lock
Des Plaines River
Dresden Island Lock
Kankakee River
Morris
Reaches on Cal Sag (above electric barrier) where Asian carp DNA was recently detected

**Close-up of reach of Cal-sag near O'Brien lock where DNA for Asian carp was recently detected**

**Detail of reach of Cal-Sag near confluence with CSSC where DNA for Asian carp was recently detected**


Priority areas for future environmental DNA sampling
Lake Superior
Lake Huron
Lake Michigan
Lake Ontario
Lake Erie
Enlarged Area
Wilmette Lock
3. Chicago Lock & River
Chicago River
Downtown Chicago Lock
Lake Michigan
XX Dam
Chicago Sanitary and Ship Canal
Chicago
4. CSSC above Barrier
1 & 2. Cal-Sag Channel
Des Plaines River
Cal-Sag Channel
O'brien Lock
Grand Calumet R.
Little Calumet River
Locks and Dams
0
10
Miles
Electric barrier
5. I&M Canal
Area of Detail
Lockport Lock
Brandon Road Lock
Des Plaines River
Dresden Island Lock
Morris
Kankakee River
Chicago Sanitary and Ship Canal
Lockport Locks
Old Channel
Old Channel Barrier
Des Plaines River

**Illinois Department of Natural Resources**

Asian Carp FAQs

November 13, 2009

**What are Asian carp?**
There are three species of Asian carp that are considered invasive and a threat to the Great Lakes, the bighead, silver and black carp. Silver and bighead carp are filter-feeding fish and consume plant and animal plankton at an alarming rate. Bighead carp can grow to very large sizes of over five feet in length and can weigh 100 pounds or more. Black carp differ in that they consume primarily mollusks, and threaten native mussel and sturgeon populations. They can grow to seven feet in length and 150 pounds.

**Where did Asian carp come from?**
Asian carp were originally imported to the southern United States in the 1970s to help aquaculture and wastewater treatment facilities keep retention ponds clean. Flooding throughout the 1990's allowed these fish to escape into the Mississippi and migrate into the Missouri and Illinois rivers.

**Why are they a problem in Illinois?**
Asian carp are a problem because of their feeding and spawning habits. Bighead carp are capable of consuming 40% of their own body weight in food each day. Silver carp are smaller, but pose a greater danger to recreational users because of their tendency to jump out of the water when disturbed by boat motors. They have severely impacted fishing and recreation on the Illinois River. They can spawn

multiple times during each season and quickly out-compete native species by disrupting the food chain everywhere they go.

**Click the link to see how they have devastated the Illinois River.**

http://www.youtube.com/watch?v=yS7zkTnQVaM

**What happens if Asian carp enter the Great Lakes?**

Asian carp could have a devastating effect on the Great Lakes ecosystem and a significant economic impact on the $7 billion fishery. Once in Lake Michigan, this invasive species could access many new tributaries connected to the Great Lakes. These fish aggressively compete with native commercial and sport fish for food. They are well suited to the water temperature, food supply, and lack of predators of the Great Lakes and could quickly become the dominant species. Once in the lake, it would be very difficult to control them.

**Where are the Asian carp now?**

During 2002 monitoring efforts, Asian carp were detected in the upper Illinois River, just 60 miles from Lake Michigan. In 2009, by using a new method called eDNA testing, silver carp were detected considerably closer, within the Lockport Pool (Des Plaines River, and I&M Canal).

**What is eDNA testing/How does it work?**

Environmental DNA testing (eDNA) was developed at the University of Notre Dame to improve monitoring of invasive species. All fish, including Asian carp, release DNA into the environment. The presence of individual species can be detected by filtering water samples, and then extracting and

amplifying short fragments of the shed DNA. The objective is to use eDNA testing as an early detection tool to identify Asian carp locations. For more information on eDNA testing click the link below.
http://www.lrc.usace.army.mil/pao/eDNA_FactSheet_20090918.pdf.

**Why have no actual Asian carp been found in the areas where eDNA testing has identified them?**

Asian carp are still below a threshold of detection using traditional fishing gear. Electro- fishing is successful in detecting bighead and silver carp when they are in high abundance. The Chicago Sanitary and Ship Canal is, in some places, nearly 30 feet deep, which is another disadvantage to using traditional sampling methods. In the early spring and late fall, the water is cooler and produces less algae (a main food source of bighead and silver carp diets), and the fish tend to reside a bit deeper than they would during warmer months. With decreased metabolism (not as much food), they are also less active and therefore harder to detect.

**How would the fish enter Lake Michigan?**

The Chicago Sanitary and Ship Canal (CSSC) is a manmade waterway that provides a direct connection between the Mississippi River system and Lake Michigan. eDNA sampling suggests that the carp are already about a mile from the electric barrier located within the CSSC that is designed to deter them from advancing through the canal to Lake Michigan.

**Are there other navigation points for fish to swim around the electric barrier?**

Other points of possible entry to the CSSC above the electric barrier are the low lying areas of land positioned between the Des Plaines River, the Illinois and Michigan (I&M) Canal and the Chicago Sanitary and Ship Canal. During heavy rainfall events, these areas are prone to flooding. A significant rain could flood the banks, joining the Des Plaines with the CSSC or the I & M canal with the CSSC, and allowing these fish to bypass the barrier and advance toward Lake Michigan. The U.S. Army Corps of Engineers and others are currently investigating potential solutions to these bypass issues.

Invasive Species Great Lakes US EPA

http://www.epa.gov/glnpo/invasive/asiancarp/
Last updated on Wednesday, November 25th, 2009

Photo courtesy of US Fish and Wildlife Service

**Asian Carp and the Great Lakes**

Asian carp have been found in the Illinois River, which connects the Mississippi River to Lake Michigan. Due to their large size and rapid rate of reproduction, these fish could pose a significant risk to the Great Lakes Ecosystem.

* * *

**How did Asian carp get so close to the Great Lakes?**

Two species of Asian carp -- the bighead and silver -- were imported by catfish farmers in the 1970's to remove algae and suspended matter out of their ponds. During large floods in the early 1990s, many of the catfish farm ponds overflowed their banks, and the Asian carp were released into local waterways in the Mississippi River basin.

The carp have steadily made their way northward up the Mississippi, becoming the most abundant species in some areas of the River.

The Chicago Sanitary and Ship Canal, where the barrier is being constructed, connects the Mississippi River to the Great Lakes via the Illinois River.

**What effects might Asian carp have on the Great Lakes?**

Asian Carp are a significant threat to the Great Lakes because they are large, extremely prolific, and consume vast amounts of food. They can weigh up to 100 pounds, and can grow to a length of more than four feet. They are well-suited to the climate of the Great Lakes region, which is similar to their native Asian habitats.

Researchers expect that Asian carp would disrupt the food chain that supports the native fish of the Great Lakes. Due to their large size, ravenous appetites, and rapid rate of reproduction, these fish could pose a significant risk to the Great Lakes Ecosystem.

12/4/2009

**Dispersal Barrier Efficacy Study**

**INTERIM I – Dispersal Barrier Bypass Risk Reduction Study & Integrated Environmental Assessment**

**December 2009 Draft Report**

US Army Corps of Engineers
Chicago District

**1.1 – Dispersal Barrier Efficacy Study**

The fish dispersal barrier project represents a unique, but temporary solution to an imminent threat: the risk of an inter-basin transfer of fish between the Mississippi River and Great Lakes basins. The dispersal barriers were designed and constructed to reduce this risk of inter-basin transfer of fish via the Chicago Sanitary and Ship Canal (CSSC).

Although the dispersal barriers were designed to prevent the movement of any Aquatic Nuisance Species (ANS) fish species in either direction through the canal, the current species of concern are the Asian carp (Cypriniformes: Cyprinidae). Asian carp have the potential to damage the Great Lakes and confluent large riverine ecosystems by disrupting the complex food web of the system and causing damage to the sport fishing industry. Two species of Asian carp, bighead carp *(Hypophthalmichthys nobilis)* and silver carp *(H. molitrix)*, have become well established in the Mississippi and Illinois River systems exhibiting exponential population growth in recent years. Certain life history traits have enabled bighead and silver carp to achieve massive population numbers soon after establishing. Currently, the Illinois River is estimated to have the largest population of bighead and silver carp in the world. The prevention of an interbasin transfer of bighead and silver carp from the Illinois River to Lake Michigan is paramount in avoiding ecologic and economic disaster.

This Interim Report (Interim I- Dispersal Barrier Bypass Risk Reduction Study & Integrated

Environmental Assessment) investigates emergency measures (various structures and no action) that reduces risk of the Asian carps bypassing the Dispersal Barrier vis-à-vis overland
flow from the Des Plaines River to the CSSC and flow through culverts in the Illinois and Michigan (I&M) Canal to the CSSC. The emergency measures would need to be implemented as soon as possible, but no later than 28 October 2010, based on the project authorization. In
addition, preliminary discussions are included on the possibilities of transfer via ballast water of navigational vessels that traverse through the dispersal barrier and Asian carps abundance reduction. These additional areas of study will be further expanded upon in subsequent Interim Reports. [Page 7]

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**1.3 – Study Background**

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[T]he I&M Canal gave way to a much larger Sanitary and Ship Canal started in 1892 that connected Lake Michigan with the Illinois Waterway. The permanent connection between the Lake Michigan and the Mississippi drainage was finalized with the completion of the Sanitary and Ship Canal in 1900. On the Calumet River, the Corps of Engineers removed sandbars and built piers at the mouth during 1870-1882; between 1888-1896 the river between Lake Michigan and Lake
Calumet was straightened; between 1899 and 1916 the Calumet River was dredged to a depth of 16 feet; between 1911-1922 the Calumet Feeder Canal was

obliterated by the construction of the Cal-Sag Channel, which was incised through a vast and unique dolomite prairie, formerly the Saganashkee marshland. With the completion of joining the Cal-Sag Channel with the Calumet River, the Calumet Region's drainage was chiefly reversed; and in 1965 the Calumet River was completely reversed by the construction of the O'Brien lock and dam near the original confluence with Lake Michigan. The I&M Canal is no longer in operation. Since the creation of the canal system, poorly treated wastewater, low dissolved oxygen concentrations, high ammonia concentrations and other contaminants formed an effective "barrier" not only to colonization of the canal by native pioneer species, but to introduced species as well. Significant improvements in water quality over the last two decades have allowed the aquatic conditions in the canal to become accommodating for native and introduced species of the tolerant sort, which both share pioneering attributes. [Page 9]

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**1.4 – Study Purpose**

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The failure of the barriers to prevent the spread of the Asian carps to the Great Lakes could be catastrophic to its ecosystem and the planktonic-fisheries interactions. The rapid implementation of measures to ensure the Efficacy of the Dispersal Barrier project is critical. The design analyses contained in this report address the potential for bypass of the Barriers via:

1) overland flow from the Des Plaines River to the CSSC, 2) bypass through culverts via the I&M canal, and 3) ballast water transfer. The potential Des Plaines River and I&M Canal bypasses are located upstream of the Barriers. The intent of this report is consistent with the national plan for managing and controlling Asian carps, which was developed by the Asian Carp Working Group, Aquatic Nuisance Species Task Force. Strategy 3.2.2.1 of the National Plan states: (To) Develop and implement redundant barrier systems within the CSSC to limit the unrestricted access of Asian carp to Lake Michigan. [Page 11]

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**CHAPTER 4 – INTERIM RISK REDUCTION**

The purpose of the Efficacy Interim I report is to quickly determine the best way to keep Asian carps from bypassing the barrier project in the CSSC and dispersing into the Great Lakes. Based upon environmental DNA tests the silver carp are upstream of the dispersal barrier system in the Des Plaines River and the next flood on the Des Plaines could allow silver carp to bypass the barrier. A flood in the Des Plaines River determined to be a 125-year event occurred in September 2008. Another flood could occur at any time but are usually in the spring. If the Asian carps bypass the barrier they could ultimately disperse into the Great Lakes via one or more of the 5 possible points of entry into Lake Michigan, the other Great Lakes and a significant number of the Great Lakes tributaries. The economic impact of Asian carps establishing in the Great Lakes is estimated by others to be between $4 billion and $6 billion annually. Further ecological disruption in the

Great Lakes food web would have dire consequences for planktivorous fishes and mussels. The emergency nature of this threat requires expedited development of a USACE project, including an abbreviated planning process, review and approval. [Page 32]

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[A] primary level of protection was achieved when the electrical CSSC Dispersal Barrier was constructed and place in operation in the CSSC which is the main artery of dispersal for invasive fishes from the Mississippi River system to the Great Lakes and vice versa. More in-depth study of the project area and a tell-tale September 2008 flood have revealed that there are secondary intermittent hydraulic connections that could allow invasive species to disperse around the existing electric barrier system. These secondary intermittent hydraulic connections need to be addressed quickly to prevent or slow the invasive Asian carps from entering the Great Lakes basin. The electric barrier system is considered experimental and temporary fix to this problem of aquatic nuisance species dispersal, with fish being the first target. New measures must be implemented to control the movement of other non-native biological organisms such as plants, plankton, and mussels. Additional study is being undertaken to remedy the unnatural connection between basins, but until a permanent solution is recognized and agreed upon, it is anticipated temporary solutions will continue to be implemented and changed as needed.

Without immediate implementation of emergency measures to prevent Asian carp dispersal around the barrier system via the Des Plaines Rive and/or I&M

Canal, there is a high level of certainty that Asian carp will gain access to the Great Lakes. The efficacy of the in place electric barriers is quite dependent upon all other routes of dispersal being sealed off. Only adult through juvenile fish are of concern with this issue. Eggs and larvae that get swept over these points would quickly be washed back down stream since they do not have swimming capability. Taking no action would allow Asian carp to disperse to the Great Lakes basin thereby making the placement of an electrical barrier system in the canal useless. [Page 34]

**Asian Carp Management**
**Invasive Species Coordination Web Site**

## The Threat to the Great Lakes

The presence of Asian carps in the Great Lakes could cause catastrophic declines in abundances of native fish species, cause economic impacts to sport and commercial fisheries, and result in injuries to boaters.

**The presence of Asian carp in the Great Lakes could cause declines in abundances of native fish species.**

- Asian carps can consume 40 percent of their body weight in food daily. Great abundance of Asian carps will result in competition for food with native species including cisco, bloater, yellow perch, which are fed on by predator species including lake trout and walleye.

- Under the conditions found in the Great Lakes such as water temperature, food abundance, Asian carps could outnumber all other native species, as is happening in parts of Illinois, Mississippi and Missouri Rivers.

- The Great Lakes are home to federally and/or state listed threatened or endangered fish, mollusks, plants, mammals, insects, and reptiles. Other Great Lakes invasives have been implicated in adverse effects upon up to 46% of the local federally listed endangered plant and animal species. Introduction of

Asian carp to the region could further harm these organisms and perhaps lead to their disappearance from the Great Lakes.

**The establishment of Asian carps could cause great economic impact to the Great Lakes commercial, and sport fisheries collectively valued at more than $7 billion annually.**

**2006 National Survey of Fishing, Hunting, and Wildlife Associated Recreation**

- Reduced abundance of native fishes will result in reduced harvest by sport and commercial fishers. Reduced harvest will cause reduction in angling quality, and economic impact to those whose livelihood depends on sport and commercial fisheries.

- The potential impact of Asian carps on the Great Lakes sport and commercial fishing industry can be seen now along the Mississippi River basin—where in just a few short years following introduction of Asian carp into an area, many commercial fishing locations have been abandoned, as native fish have nearly disappeared from the catch, replaced by Asian carp.

- In 2002, a workshop convened by the Great Lakes Protection Fund predicted that introduction of Asian carps into the Great Lakes would threaten the sport and commercial fisheries, and could result in ecological and economic damages far exceeding those caused by the sea lamprey and zebra mussel invasions.

**The presence of Asian carps could result in injuries to boaters and other waterway users.**

- Silver carp are often referred to as “flying fish” because when they are disturbed by boat motors, silver carps will jump from the water up to 6 feet.

- These jumping silver carps are causing injuries to boaters in the Illinois, Mississippi and Missouri Rivers. If silver carp become abundant in the Great Lakes, then that species will cause injuries to boaters and other waterway users there.

- Such injuries will result in reduced pleasure boating and other recreational activities in the Great Lakes, which will cause economic impacts to those whose livelihoods are supported by recreational boating.

Development of this web site is supported by the U.S. Fish & Wildlife Service through a partnership with the University of Texas - Arlington and contains information and resources derived from a variety of other partners and sources. Materials on this web site are free for public use and are not intended to be used for profit.

**Illinois Department of Natural Resources**

**FOR IMMEDIATE RELEASE**
December 3, 2009

**Bighead Asian Carp Found in Chicago Sanitary and Ship Canal**

**LOCKPORT, IL** – The Asian Carp Rapid Response Workgroup announced Thursday evening that a bighead Asian carp was found in the Chicago Sanitary and Ship Canal (CSSC) just above the Lockport Lock and Dam. This is the first physical specimen that has been found in the CSSC since eDNA testing earlier this year suggested the presence of Asian carp in the area.

"This is clearly a significant find in this operation that validates why it is so important for this work to be done," said Illinois Department of Natural Resources Assistant Director John Rogner. "We will continue to work with the U.S. Army Corps of Engineers and our partners on maintaining the integrity of the area around the barrier."

Concentrations of Asian carp in the Lockport Pool are expected to be low compared to total biomass collected.

The bighead carp was found 500 feet above the Lockport Lock and Dam near the west bank by a U.S. Fish and Wildlife Service Assistant Project Leader from the Carterville, Illinois office. The fish is 21 and 7/8 inches long.

Biologists working with the Asian Carp Rapid Response Workgroup began applying Rotenone Wednesday evening on a 5.7-mile stretch of the canal. Rotenone application was chosen as the best option of keeping Asian carp from breaching the electric barrier while it is taken down for scheduled routine maintenance. The application went as planned and clean-up efforts began around 8am this morning. The discovery of the bighead was found during those efforts.

Clean-up operations ended at sundown Thursday evening and resumed at 7a.m. Friday. More than 350 people have contributed to the efforts on the ground during this week's operation.

The media access area on the canal will be open to media at 8am Friday morning.

**Illinois Department of Natural Resources**

**FOR IMMEDIATE RELEASE**
December 6, 2009

## Asian Carp Rapid Response Workgroup wraps up main operation on Chicago Sanitary Ship Canal

### *Scheduled routine electric barrier maintenance complete*

**CHICAGO** – The Asian Carp Rapid Response Workgroup is closing out main project operations on a 5.7-mile stretch of the Chicago Sanitary and Ship Canal (CSSC) that began on December 2.

Maintenance on the electric barrier, IIA, was completed and the barrier was returned to operation at 10 p.m. on Friday, December 4.

"This has been a tremendous cooperative undertaking. Thanks to the outstanding efforts of our partner agencies from the U.S. and Canada, the Corps team was able to successfully complete this necessary maintenance and to do so ahead of schedule," said Col. Vincent Quarles, Commander of the U.S. Army Corps of Engineers, Chicago District.

"We appreciate the understanding and support of the navigation industry during this important maintenance operation. The Army Corps of Engineers is fully aware of both the economic and environmental importance of the area waterways," Quarles said.

The U.S Coast Guard (USCG) began enforcing a safety zone on the CSSC on December 2 in support of Asian Carp Rapid Response Operations. USCG has already restored access to parts of the canal and will continue to reduce the safety zone as the workgroup completes final phases of the operation.

In support of scheduled routine barrier maintenance, biologists working with the Asian Carp Rapid Response Workgroup began applying Rotenone, a fish toxicant, on Wednesday, December 2 on a 5.7-mile stretch of the canal.

"I want to thank each and every person and organization who put forth an extreme amount of time, energy and resources to make this project a success," said Illinois Department of Natural Resources Assistant Director John Rogner. "The eDNA testing worked to give us an early warning. We took it seriously and we took action. The alternative was to do nothing and that would have been a mistake."

Rotenone application was chosen as the best option for keeping Asian carp from breaching the lower voltage demonstration barrier while the more powerful Barrier IIA was taken down for scheduled routine maintenance. The application of rotenone and a detoxifying agent was successful and the clean-up of visible dead fish are complete at this time.

One Bighead Asian carp was discovered nearly 500 feet above the Lockport Lock on Thursday afternoon, December 3. Biologists with the workgroup believe there is a high probability that additional Asian carp

were killed during the toxicant application but may not be found.

"The cold water temperatures on the canal this week means far more fish are sinking to the bottom of the waterway than will float to the top. Over the next several weeks and months, some fish may float to the surface but the majority of fish will break down naturally below the surface," said Illinois Department of Natural Resources Fisheries Chief Steve Pallo.

The workgroup has collected thousands of fish, mostly common carp, from the canal since cleanup efforts began on December 3. Those fish are being disposed of properly in a landfill.

The public should be advised that dead fish may be observed from time to time over the next several weeks as some fish may rise to the surface. Public health officials always caution against eating dead or dying fish in any instance that have not been caught alive.

The workgroup is now focused on efforts above the electrical barrier system near T.J. Obrien Lock in an attempt to find Asian carp in areas where positive eDNA tests have been found. Positive Asian carp DNA evidence exists over nearly 10 miles of the Cal-Sag Channel and Sanitary and Ship Canal above the barrier.

The workgroup is using commercial fishermen, augmented with state and federal fisheries personnel, to deploy commercial fishing gear in a 5.5-mile stretch of the Cal-Sag Channel. Fishing operations

are using nearly 2,000 yards of fishing nets deployed for two overnight periods. Nets have been deployed over portions of the reach since Dec. 1 and have been highly successful in collecting fish, although no Asian carp have been collected.

While the workgroup considered additional Rotenone application in specific areas above the barrier as a sampling option, there is no evidence to suggest Asian carp might be concentrated in any specific part of the 10-mile stretch of the canal where eDNA tests have been positive.

Water temperatures above the barrier are much colder than downstream where Rotenone was applied for the main project in support of scheduled barrier maintenance. At these temperatures, dead fish would likely never surface to be identified. Without identification, Rotenone would be ineffective as a sampling tool.

In contrast, fishing nets would effectively sample the entire reach and provide the best evidence of the potential presence and relative abundance of Asian carp in this stretch of channel. It would also confirm the exact location of any fish collected. Any Asian carp collected will be removed from the system, thereby providing a measure of population reduction.

"The effort near the O'Brien Lock is fundamentally different from the action below the barrier. The purpose of applying Rotenone below the barrier was to ensure no Asian carp advanced up the channel while the barrier was powered down. In addition, Rotenone would provide us little if any information about the presence and abundance of carp in this

reach upstream," said IDNR Assistant Director John Rogner.

The Asian Carp Rapid Response Workgroup and its partners are committed to remaining vigilant in the future and to explore all options available to prevent the spread of Asian carp to the Great Lakes.

The Asian CarpRapid Response Workgroup includes the Illinois Department of Natural Resources, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, U.S. Coast Guard, USDA Animal and Plant Health Inspection Service, Chicago Department of Environment, Metropolitan Water Reclamation District of Greater Chicago, Midwest Generation, Great Lakes Commission, Great Lakes Fishery Commission, International Joint Commission, and Wisconsin Sea Grant. Fisheries management agencies from Indiana, Wisconsin, Michigan, Minnesota, Ohio, Pennsylvania, New York and Canada have also provided support to the operation.

For more information about Asian carp and the Rapid Response operations on the CSSC, the public and media are encouraged to log on to www.asiancarp.org/rapidresponse.

**Illinois Department of Natural Resources**

**FOR IMMEDIATE RELEASE**
December 8, 2009

## Asian Carp Rapid Response Workgroup finishes operation on Cal-Sag Channel

### *No Asian carp collected above electrical barrier; safety zone rescinded*

CHICAGO – The Asian Carp Rapid Response Workgroup has completed fishing operations near the T.J. O'Brien Lock in an attempt to locate Asian carp after eDNA sampling in the area tested positive for the invasive species. The Workgroup used commercial fishermen and federal fisheries personnel to deploy nearly 3,000 yards of fishing nets along a 5.5-mile stretch of the Cal-Sag Channel. While the nets were successful in collecting more than 800 fish, no Asian carp were found. The catch included more than 700 common carp and 10 other species.

The fishing operations that began on Dec. 1, wrapped up late yesterday, Dec. 7. On Monday evening, the U.S. Coast Guard reopened the Cal-Sag Channel and Little Calumet River to vessel traffic.

While the fishing operations and the Chicago Sanitary and Ship Canal rotenone application have thus far confirmed just one Bighead Asian carp, the Workgroup expects their work to continue for some time.

eDNA is serving its purpose as an early warning system and suggests that Asian carp may have

reached the Cal-Sag Channel. Based on recent sampling and the fish collection efforts there, the Workgroup believes that if Asian carp are present, their numbers are likely very small. The Workgroup and its partners are committed to remaining vigilant in the future and exploring all options available to prevent the spread of Asian carp to the Great Lakes.

Among the next steps already underway to prevent the spread of the destructive fish to the Great Lakes:

- Illinois Department of Natural Resources and other partners will evaluate the week's efforts and develop options for additional carp population assessment and control in the Cal-Sag Channel and Chicago Sanitary and Ship Canal

- U.S. Army Corps of Engineers will continue their eDNA sampling effort with the University of Notre Dame

- U.S. Army Corps of Engineers are focused on addressing potential bypass issues (along the Des Plaines River, I&M Canal, Grand Calumet and Little Calumet River), the interbasin study and expedited construction of barrier IIB

- The Rapid Response Workgroup partners are evaluating a range of additional options and consequences for Asian carp prevention management strategies in the waterways—and potentially, further into the Great Lakes

The Asian Carp Rapid Response Workgroup includes the Illinois Department of Natural Resources, U.S. Army Corps of Engineers, U.S. Environmental

Protection Agency, U.S. Fish and Wildlife Service, U.S. Coast Guard, U.S. Department of Agriculture Animal and Plant Health Inspection Service, Chicago Department of Environment, Metropolitan Water Reclamation District of Greater Chicago, Midwest Generation, Great Lakes Commission, Great Lakes Fishery, Commission, International Joint Commission, and Wisconsin Sea Grant.

Fisheries management agencies from Indiana, Wisconsin, Michigan, Minnesota, Ohio, Pennsylvania, New York and Canada have also provided support to the operation.

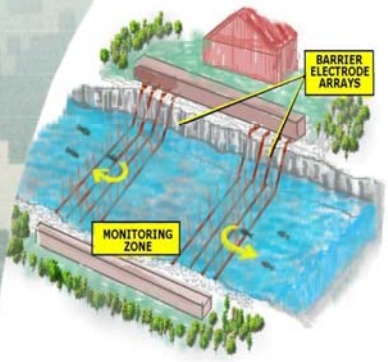
For more information about Asian carp and the Rapid Response operations, see www.asiancarp.org/rapidresponse.

# Fish Barrier Update

MG John Peabody

Commander

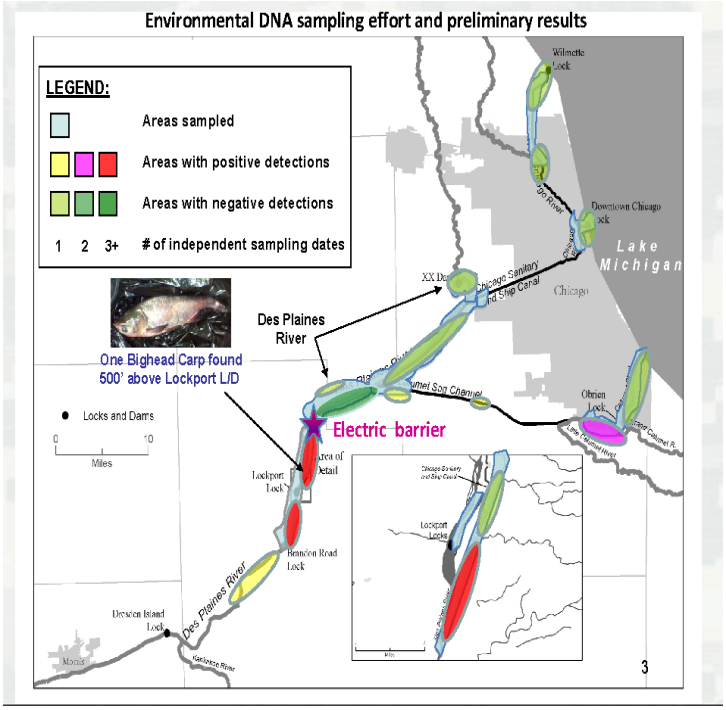
Great Lakes and Ohio River Division


US Army Corps of Engineers

BUILDING STRONG®


Addressing Asian Carp Migration
WILMETTE PUMPING STATION
RIVER ENTRANCES TO LAKE MICHIGAN
CHICAGO LOCK
Cook
DuPage
City of Chicago
CALUMET HARBOR
INDIANA HARBOR
O'BRIEN LOCK AND DAM
BURNS HARBOR
ELECTRIC BARRIERS
Positive eDNA Detections above barriers
LOCKPORT LOCK
Will
Lake
Porter
2
BUILDING STRONG®


Environmental DNA sampling effort and preliminary results
LEGEND:
Areas sampled
Areas with positive detections
Areas with negative detections
1 2 3+ # of independent sampling dates
One Bighead Carp found 500' above Lockport L/D
Des Plaines River
Electric barrier
Locks and Dams
Miles
Lockport Lock
Area of Detail
Brandon Road Lock
Dresden Island Lock
Des Plaines River
Kankakee River
Wilmette Lock
Downtown Chicago Lock
Lake Michigan
Chicago
Chicago Sanitary and Ship Canal
Calumet Sag Channel
O'Brien Lock
Lockport Locks
3

In The
# Supreme Court of the United States
October Term, 1966

| | |
|---|---|
| STATES OF WISCONSIN, MINNESOTA, OHIO, AND ENNSYLVANIA,<br><br>*Complainants*,<br>*v.*<br>STATE OF ILLINOIS AND THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO,<br><br>*Defendants,*<br>UNITED STATES OF AMERICA,<br><br>*Intervenor*. | No. 1 Original |
| STATE OF MICHIGAN,<br><br>*Complainant,*<br>*v.*<br>STATE OF ILLINOIS AND THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO,<br><br>*Defendants,*<br>UNITED STATES OF AMERICA,<br><br>*Intervenor*. | No. 2 Original |

| | |
|---|---|
| STATE OF NEW YORK,<br><br>*Complainant*,<br>*v.*<br>STATE OF ILLINOIS AND THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO,<br><br>*Defendants*,<br>UNITED STATES OF AMERICA,<br><br>*Intervenor*. | No. 3 Original |

AFFIDAVIT OF THOMAS E. KNUEVE

1. My name is Thomas E. Knueve. I make this affidavit based upon my personal knowledge. If called upon as a witness, I can testify competently to the contents of this affidavit.

2. I am employed by the State of Michigan as an Environmental Engineer in the Permits Section, Water Bureau (WB), Department of Environmental Quality (DEQ). I have worked in the capacity of an Environmental Engineer for 31 years. Prior to that time period, I worked in the Municipal Consulting Engineering field as a Civil Engineer for 6 years.

3. I have a Bachelor's of Science Degree in Civil Engineering from Michigan State University. I am a registered Professional Engineer with the State of Michigan under Registration No. 26132.

4. I am the statewide specialist for the planning, design, and construction of Combined Sewer Overflow (CSO) systems, Sanitary Sewer Overflow (SSO) systems, and wastewater transportation systems.

5. I have reviewed publicly available information regarding the Chicago Sanitary and Ship Canal and its associated waterways. Specifically, I reviewed the Great Lakes Fishery Commission 2008 Project Completion Report, entitled "Preliminary Feasibility of Ecological Separation of the Mississippi River and the Great Lakes to Prevent the Transfer of Aquatic Invasive Species," by Joel Brammeier, Irwin Polls, and Scudder Mackey, published November 2008 (relevant portions excerpted and attached as Exhibit A). I also reviewed the Dispersal Barrier Efficacy Study, entitled "Interim I – Dispersal Barrier Bypass Risk Reduction Study & Integrated Environmental Assessment, December 2009 Draft Report," published by the United States Army Corps of Engineers, Chicago District.

6. The Chicago Waterway System includes the Chicago Sanitary and Ship Canal, the Chicago River (which is connected to Lake Michigan via the North Shore Channel), and the Calumet River (which is connected to the Chicago Sanitary and Ship Canal via the Calumet-Sag Channel). (Exhibit A at 3-4.)

7. The Chicago Sanitary and Ship Canal, North Shore Channel, and Calumet-Sag Channel were created as part of a diversion project, wherein water was diverted from Lake Michigan into the Chicago Waterway System in order to wash sewage away from the Chicago River and Lake Michigan (the

source of Chicago's drinking water supply). (Exhibit A at 11 and 20-21.)

8. There are three navigational locks in the Chicago Waterway System: the Lockport Powerhouse and Lock, the Thomas J. O'Brien Lock and Dam, and the Chicago Lock (which is part of the Chicago River Controlling Works). (Exhibit A at 22-23 and 26.)

9. The Lockport Powerhouse and Lock are located in the Chicago Sanitary and Ship Canal, approximately one mile north of the junction of the Canal and the Des Plaines River. The lock is operated by the United States Army Corps of Engineers (Corps), while the Powerhouse is operated by the Metropolitan Water Reclamation District of Greater Chicago (District). (Exhibit A at 26.)

10. The O'Brien Lock and Dam are located on the Calumet River near where it connects to Lake Michigan. The Lock and Dam are operated by the Corps. There are also sluice gates at this location to control water intake from Lake Michigan and, in rare situations, to reverse the flow back to Lake Michigan in flood conditions. Sluice gates are movable devices within a dam or control structure that vary the size of openings through which water flows. The sluice gates are operated by the District. (Exhibit A at 23.)

11. The Chicago Controlling Works are located in downtown Chicago where the Chicago River connects to Lake Michigan. The Controlling Works include a concrete wall separating the Chicago River from Lake Michigan, sluice gates, and a navigational lock. The lock is operated by the Corps, while the remainder of

the structure and the sluice gates are operated by the District. (Exhibit A at 22-23.)

12. Vessel traffic passes both ways through each of the locks. All three locks provide conduits through which fish, including Asian carp, may pass. The Chicago Lock and the O'Brien Lock provide direct connections from the Chicago Waterway System to Lake Michigan. (Exhibit A at 50-55.)

13. All three locks exist for the purpose of navigation. The locks open and close to allow ships to pass. Most of the traffic passing through the Lockport and O'Brien Lock consists of barges hauling commercial goods, and barge tows. The Chicago Lock is primarily used by recreational and commercial passenger vessels. Because the locks are frequently closed, the operation of the locks accounts for very little of the allowable diversion of water from Lake Michigan under the 1967 Decree entered in this case. Therefore, closing the locks will not have a detrimental effect on stormwater or wastewater management. (Exhibit A at 50-55.)

14. In addition to the Chicago Lock and the O'Brien Lock, there are three other direct connections between the Chicago Waterway System and Lake Michigan. They are the Wilmette Pumping Station (where the North Shore Channel connects the Chicago River to Lake Michigan), the Grand Calumet River (which connects to the Chicago Sanitary and Ship Canal via the Calumet-Sag Channel and the Calumet River, then flows into Indiana where it connects with Lake Michigan), and the Little Calumet River (which flows from the Calumet-Sag

Channel into Indiana, where it connects to Lake Michigan via Burns Ditch). (Exhibit A at 4.)

15. The Wilmette Pumping Station uses pumps and sluice gates to control water intake from Lake Michigan, and to reverse water flow back into Lake Michigan under flood conditions during large, widespread, wet weather events. (Exhibit A at 21.)

16. There are currently no permanent control structures in either the Grand Calumet River or the Little Calumet River that could prevent the passage of fish from the Chicago Waterway System into Lake Michigan. However, the United States Environmental Protection Agency has informed the Michigan Department of Environmental Quality that temporary sheet piling has been installed in West Branch Grand Calumet River near the Illinois-Indiana state line as part of an ongoing environmental cleanup project at Grand Calumet Area of Concern.

17. According to a Combined Sewer Overflow report obtained from the Metropolitan Water Reclamation District of Greater Chicago website (available at http://www.mwrd.org/irj/go/km/docs/documents/MWRD/internet/protecting%20the%20environment/Combined%20Sewer%20Overflows/htmls/Reversals.xls and attached as Exhibit B), storm events that have required that the flow of water be reversed back into Lake Michigan have occurred only rarely since 1985. On the rare occasions that these reversals have occurred, the reversals have been done primarily at the Wilmette Pumping Station. Since 1985, these reversals have occurred a total of nine times at the

Chicago and O'Brien Locks, with only four of those reversals at the O'Brien Locks. (Exhibit B.)

18. Through the operation of the sluice gates, the Chicago Waterway System can be drawn down in anticipation of storm events. This increases its capacity to contain runoff waters, and thus reduces the potential for flooding and the need to reverse water flow from the system back into Lake Michigan. (Exhibit A at 20-25.)

19. All five connections between the Chicago Waterway System and Lake Michigan (the O'Brien Lock, the Chicago Lock, the Wilmette Pumping Station, the Grand Calumet River, and the Little Calumet River) provide potential conduits for Asian carp to reach the Great Lakes. (Exhibit A at 4.)

20. Were it not for the diversion project and the associated infrastructure created, operated, and maintained by the State of Illinois, the Corps, and the District, there would be no connection between the Chicago Waterway System and Lake Michigan. (Exhibit A at 20-28.)

21. I make this affidavit based upon personal knowledge of these facts, and, if called as a witness, I am competent to so testify.

Thomas E. Knueve
Environmental Engineer
Permits Section
Water Bureau
Department of Environmental Quality

Subscribed and sworn to before me this
17th day of December, 2009.

Nancy E. Hart, Notary Public
Ingham County, Michigan
Acting in Ingham County, Michigan
My Commission Expires: 7/10/12

(Exhibit A)

GREAT LAKES FISHERY COMMISSION

2008 Project Completion Report[1]

# PRELIMINARY FEASIBILITY OF ECOLOGICAL SEPARATION OF THE MISSISSIPPI RIVER AND THE GREAT LAKES TO PREVENT THE TRANSFER OF AQUATIC INVASIVE SPECIES

by:

**Joel Brammeier[2], Irwin Polls[3], Scudder Mackey[4]**

**November 2008**

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[1] Project completion reports of Commission-sponsored research axe made available to the Commission's Cooperators in the interest of rapid dissemination of information that may be useful in Great Lakes fishery management, research, or administration. The reader should be aware that project completion reports have not been through a peer-review process and that sponsorship of the project by the Commission does not necessarily imply that the findings or conclusions are endorsed by the Commission. Do not cite findings without permission of the author.

[2] Alliance for the Great Lakes, 17 N. State Street, Chicago, IL 60602

[3] Ecological Monitoring and Assessment, 3206 Mapleleaf Drive, Glenview, IL 60026

[4] Habitat Solutions, 37045 N. Ganster Road, Beach Park, IL 60087

## Chapter 1 – Chicago Waterway System Summary

### Study Area

While the Chicago Waterway System and the Chicago and Calumet Waterways are highly visible and used by a broad range of stakeholders, the structure and function of the systems are generally poorly understood outside of a small community of scientific and navigation professionals. A summary of the functions of chemical, biological and physical integrity, hydrology, ownership and commercial and recreational navigation is the critical foundation to decision-making regarding the system's future.

The Chicago and Calumet Waterways (CCW) are located in northeastern Illinois and northwest Indiana (Figure 1) and include the Chicago Waterway System (CWS). The CWS is a subset of the less commonly known CCW. Chapter 1 refers to the CCW with the exception of the section on navigation, which defines and refers to the reaches of the CWS. Subsequent chapters refer to the more commonly known CWS.

The CCW include seven modified rivers (North Branch of the Chicago River, Chicago River, South Branch of the Chicago River, South Fork of the South Branch of the Chicago River, Calumet River, Grand Calumet River, and the Little Calumet River) and three artificial or manmade channels and canal (Chicago Sanitary and Ship Canal, North Shore Channel, and the Calumet-Sag Channel).

The approximately 740 square mile watershed contains the Great Lakes region's largest city, Chicago. The eastern boundary of the watershed is Lake Michigan, and the southern boundary is defined by the junction of the Chicago Sanitary and Ship Canal and the Des Plaines River in Joliet, Illinois. Located within Cook, Lake, and Will County, Illinois and Lake County, Indiana, the Cook County portion of the watershed is approximately 35 miles long and 20 miles wide at its widest point. The CCW are dominated by an urban landscape. However, concentrations of nondeveloped land (principally forest preserves) are found throughout the watershed and in particular border the waterways.

-3-

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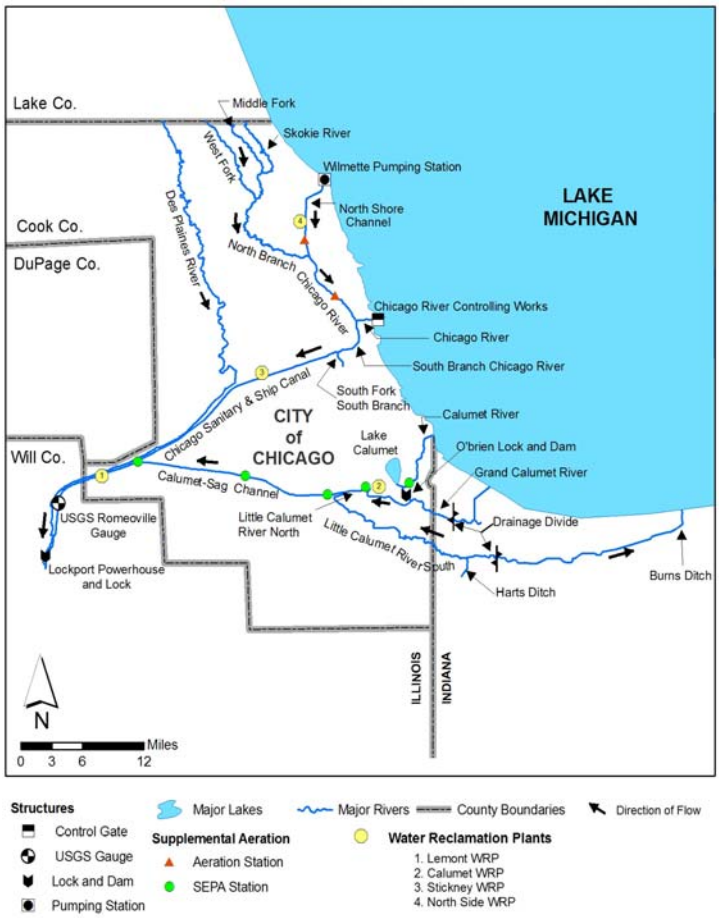
**Figure 1. Map of the Chicago and Calumet Waterways**

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In order to protect the area's primary water supply, Lake Michigan, the Illinois General Assembly adopted the Sanitary District of Chicago Enabling Act in 1889. The legislation led to the creation of the Sanitary District of Chicago, the predecessor of the

Metropolitan Water Reclamation District of Greater Chicago (MWRDGC).

Soon after the Sanitary District of Chicago was established, its board of trustees, subscribing to the popular belief that "dilution was the solution to pollution," implemented a long-term plan to permanently reverse the flows of the North and South Branches of the Chicago Rivers and the Calumet River away from Lake Michigan, and to divert the contaminated river water downstream where it could be diluted as it flowed into the Des Plaines River, and eventually to the Illinois and Mississippi Rivers.

By 1900, a man-made canal, the Chicago Sanitary and Ship Canal, connected the South Branch of the Chicago River with the Des Plaines River in Joliet. The artificial North Shore and Calumet-Sag Channels were completed in 1910 and 1922, respectively. Following completion of the three man-made waterways, Chicago's raw sewage, industrial wastes, and urban storm water were directed away from the Great Lakes watershed into the Des Plaines, Illinois, and Mississippi Rivers (Figure 4), thereby providing a constant and unimpeded aquatic connection between the Great Lakes and Mississippi River watersheds.

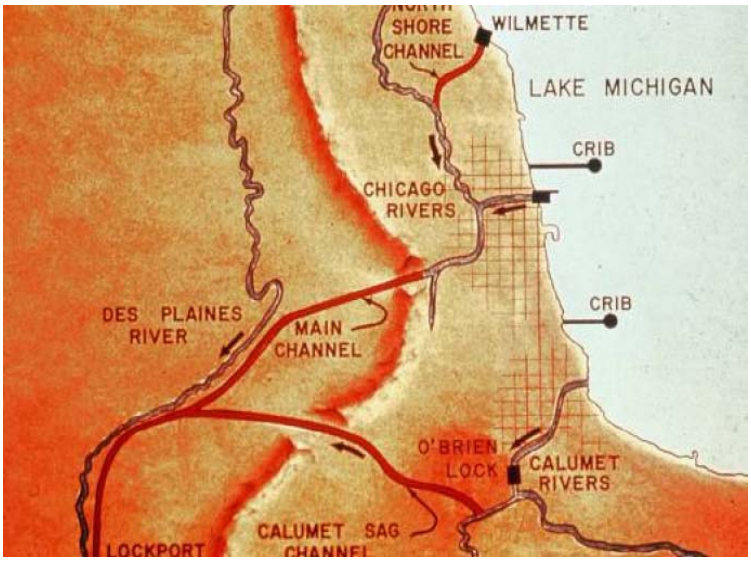


**Figure** 4. Map Showing Reversal of CCW upon completion of Cal-Sag Channel.



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**Table 3.** Characteristics of North Side, Calumet, Stickney, and Lemont Water Reclamation Plants

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**Table 3**. Characteristics of North Side, Calumet, Stickney, and Lemont Water Reclamation Plants

| Water Reclamation Plant | Receiving Waterbody | Mean Design Flow ($ft^3/s$) | Maximum Design Flow ($ft^3/s$) | 2001 Mean Flow ($ft^3/s$) |
|---|---|---|---|---|
| North Side | North Shore Channel | 516 | 698 | 415 |
| Calumet | Little Calumet River | 549 | 667 | 398 |
| Stickney | Chicago Sanitary & Ship Canal | 1,860 | 2,232 | 1,159 |
| Lemont | Chicago Sanitary & Ship Canal | 5 | 6 | 3 |

**Figure** 5. Stickney Water Reclamation Plant

*Lake Michigan Diversion Flows.* Before 1939, water from Lake Michigan flowed unregulated and unimpeded into the Chicago River. In 1901, the United States Secretary of War issued a provisional permit to the Sanitary District of Chicago limiting the inflow (diversion) of water from Lake Michigan into Chicago area waterways to 4,167 cfs. By 1908, the Sanitary MWRDGC exceeded the diversion limit for Lake Michigan water (Changnon and Changnon 1996) and in 1930 the U.S. Supreme Court ordered that after December of 1938 the total Lake



Michigan diversion at Chicago should be reduced to 1,500 cfs plus additional water for domestic supply. A total Lake Michigan diversion of 3,200 cfs was reaffirmed in 1967 and again in 1980 by the U.S. Supreme Court. Currently, the Lake Michigan diversion accountable to the state of Illinois is limited to 3,200 cfs over a forty-year averaging period.

The measurement of the quantity of Lake Michigan diversion water and the method for accounting are specified in the U.S. Supreme Court Decree and in a 1996 Memo of Understanding (MOU) between the U.S. Department of Justice and eight states bordering the Great Lakes. The Illinois Department of Natural Resources (IDNR) controls and regulates Lake Michigan diversion water. The USACE is responsible for computing the annual Illinois Lake Michigan diversion and preparing an annual diversion report for IDNR.

***Direct Diversion.*** Water directly diverted from Lake Michigan into the CCW is used for improvement and maintenance of instream water quality, lockage, leakage, and navigational makeup. Direct diversion of water from Lake Michigan into the CCW occurs at three lakefront locations: Wilmette Pumping Station, Chicago River Controlling Works, and the O'Brien Lock and Dam (Figure 1).

The Wilmette Pumping Station is located in Wilmette, Illinois under the Sheridan Road Bridge where the North Shore Channel intersects Lake Michigan (Figure 6). The MWRDGC built the Wilmette Pumping Station in 1910. The pumping station controls the flow of water between Lake Michigan and the North Shore Channel. Lake Michigan water is diverted into the North Shore Channel for augmenting low flows, diluting pollution and achieving water quality standards.

**Figure 6.** Lakefront Diversion Location at Wilmette Pumping Station

The pumping station at Wilmette includes four screw pumps and a concrete channel and sluice gate (32 ft X 16 ft). Each screw pump is rated at 250 $ft^3/s$. For a number of years, the screw pumps were not in operation. To reduce leakage from Lake Michigan, the pump bays at the Wilmette Pumping Station were sealed in 1993. During that period, water was diverted into the North Shore Channel by raising the sluice gate. Because of non-operation of the screw pumps, five temporary portable pumps (50 $ft^3/s$) were placed in operation in 2000. Since the temporary pumps provided insufficient capacity for maintaining water quality in the North Shore Channel, one of the original screw pumps was rehabilitated in 2002 The

MWRDGC is responsible for the operation and maintenance of the Wilmette Pumping Station.

The Chicago River Controlling Works is located in Chicago, Illinois just south of Navy Pier, where the Chicago River joins with Lake Michigan (Figure 1). The controlling works were built by the MWRDGC in 1938 to prevent uncontrolled Lake Michigan water from draining into the Chicago River. The control structure includes concrete walls separating the Chicago River from Lake Michigan, a navigation lock, two sets of sluice gates, and a pumping station. The USACE is responsible for maintenance and operation of the lock. The lock is 80 ft wide and 600 ft long, with a lift of two feet. Water is diverted from Lake Michigan into the Chicago River through openings in the sluice gates, The two sets of underwater sluice gates consist of eight openings measuring 10 ft X 10 ft. The MWRDGC is responsible for the operation and maintenance of the



two sluice gates. A pumping station was built by IDNR for the purpose of returning excess leakage and lockage water in the Chicago River back to Lake Michigan.

The Thomas J. O'Brien Lock and Dam are located in Chicago, Illinois at River Mile 326.5 on the Calumet River (Figure 1). The control structure was built by the USACE in 1959 to control the flow of water between Lake Michigan and the Little Calumet River. The lock is 110 ft wide and 1000 ft long, with a lift of two feet. Water is diverted from the Calumet River through four submerged sluice gates, each 10 ft X 10 ft in size. The lock and dam are operated and

maintained by the USACE. However, the four sluice gates are operated by the MWRDGC.

During WY 2001, the estimated total Lake Michigan diversion accountable to the state of Illinois was 2,767 *ft³/s* (USACE 2001). The Illinois Lake Michigan diversion allocations for WY 2001 are as follows: (1) l,54,6 ft³/s (55.9%) for water supply, which is the sum of water supply for all communities in Illinois receiving water directly from Lake Michigan; (2) approximately 871.5 ft³/s *(31.5%)* for storm water runoff diverted from Lake Michigan; (3) 260.5 ft³/s (94%) for discretionary diversion (improving and maintaining water quality); (4) 27,0 ft³/s (1.0%) for lockage, locking vessels to and from the lake; (5) 17,3 ft³/s (0.6%) for leakage, water estimated to pass in an uncontrolled manner through or around the three lakefront intake structures; and (6) 45.4 ft³/s (1.6%) for navigational makeup, water used during drawdown periods to maintain sufficient navigation depths.

*Discretionary Diversion.* Through 2014, the MWRDGC's allocation of Lake Michigan diversion water for the improvement and maintenance of water quality in the CCW is for an annual mean of 270 ft³/s. After 2014, the discretionary diversion is scheduled to be reduced to 101 ft³/s. A reduction in Lake Michigan discretionary diversion was agreed upon because over time water quality in the CCW will improve (fewer overflows from combined sewers). Discretionary diversion principally occurs during the months of May through October. Generally, higher direct diversion flows occur during the warmer, summer months. Some flow is diverted into the North Shore Channel throughout the year because of low

dissolved oxygen during the winter months. During WY 2001, it is estimated that 9.4% (260.5 *ft³/s)* of the Lake Michigan diversion by the state of Illinois was for improving and maintaining water quality in the CCW. The mean annual direct diversion of Lake Michigan water for water quality improvement into the North Shore Channel at Wilmette, Chicago River at the Chicago River Controlling Works, and Little Calumet



River at the O'Brien Lock and Dam during WY 2001 was estimated at 29 ft³/s, 125 *ft³/s,* and 107 *ft³/s,* respectively.

Between water years 1985 and 2005, the total amount of water diverted from Lake Michigan fbi improving and maintaining water quality in the CCW has gradually decreased (Figure 7). The decrease in discretionary diversion over the 20-year period can be directly attributed to improved water quality in the waterways.

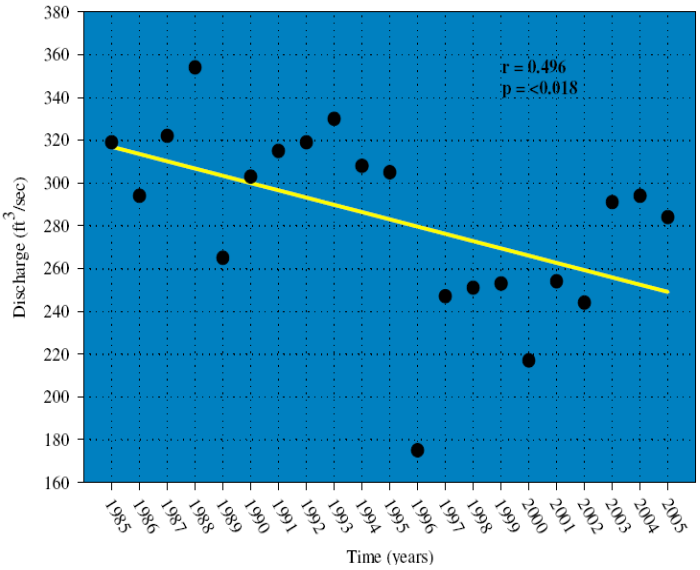


**Figure 7**. Total Annual Mean Discretionary Diversion at Wilmette Pumping Station, Chicago River Controlling Works, and O'Brien Lock and Dam plotted Against Time (1985-2005).

*Tributary Flows.* Approximately 10% of the flow in the CCW originates from three major tributaries (North Branch of the Chicago River, Grand Calumet River, and the Little Calumet River) (USACE, 2001). During WY 2001, the estimated mean annual tributary flows from the North Branch of the Chicago River, Grand Calumet River, and the Little Calumet River were l36, 11.8, and 160,2 $ft^3/s$, respectively.



*Operation of Storm Flows.* In order to prevent or minimize localized flooding from anticipated storm events, the M\VRDGC lowers the water level in the CCW by increasing the discharge at the Lockport

powerhouse. The process of lowering the water level allows for additional water storage in the waterways. During large, widespread, wet weather events, the subsequent runoff may raise levels in the waterways, necessitating control of water levels by releasing flood waters at one or more of the three lakefront diversion structures back into Lake Michigan. Since 1985, 8 reversals or back flows to the Lake have occurred. The majority of the reversals back to the Lake have occurred at the Wilmette Pumping Station. The August 2007 reversal was the first since a series in September 2002.

*Combined Sewer Overflows (CSOs).* Overflows from combined sewers are discharges to receiving water bodies from a wastewater collection system conveying both sanitary sewage and storm water. Several hundred combined sewers are located on the CCW. Historically, the capacities of combined sewers often were exceeded during some wet weather events, resulting in the release of untreated sewage to area waterways. In 1975, the **MWRDGC** began construction of drop shafts and tunnels (Figure 8) designed to capture overflows from combined sewers and convey the storm water and untreated wastewater to open surface reservoirs rather than overflowing to area waterways. Following storage of CSOs, the water is pumped to a water reclamation plant for treatment. The structural flood control and water quality improvement system is called the Tunnel and Reservoir Plan (TARP). To date, 109 miles of tunnels have been built and are fully operational. Two large storage reservoirs (Thornton Composite and McCook) are currently under construction. Both storage reservoirs are scheduled to be operational by 2014, although completion

schedules have varied during the 3-decade-plus life of the project. According to the USACE, both reservoirs are designed to capture up to a 20-year storm event (Lanyon, personal communication). It is estimated that since the first tunnels became operational in 1985, more than 850 billion gallons of CSOs have been captured and conveyed to MWRDGC water reclamation plants for treatment.



**Figure 8.** Construction of Conveyance Tunnels for Tunnel and Reservoir Plan (TARP)

Outlet Flows

All outlet flow exits the CCW at the Lockport Powerhouse and Lock and the Lockport Controlling Works (Figure 1). During dry weather, water is released from the waterways through one hydroelectric generating unit and the navigation lock at the Lockport Powerhouse and Lock.

*Lockport Powerhouse and Lock.* The Lockport Powerhouse and Lock are located in Lockport, Illinois on the Chicago Sanitary and Ship Canal one mile upstream from the junction with the Des Plaines River (Figure 9). Two hydroelectric generating units at Lockport have a combined capacity of 5,000 $ft^3/s$. During storm conditions, water is diverted from the Chicago Sanitary and Ship Canal through nine submerged sluice gates (9 ft X 14 ft). Each sluice gate is capable of a maximum discharge of 2,500 $ft^3/s$. The powerhouse is operated by the MWRDGC, and the navigational lock is operated by the USACE. The Lockport lock is 110 feet wide and 600 feet long, with a lift of 37 feet.



**Figure 9.** Lockport Powerhouse (left) and Lock (center) on the Chicago Sanitary & Ship Canal

***Lockport Controlling Works.*** The Lockport Controlling Works operated by the MWRDGC is located on the Chicago Sanitary and Ship Canal two miles upstream from the Lockport Powerhouse. The outlet structure operates periodically during storms when discharge above the capacity of the Lockport Powerhouse is required. Flood waters from the Chicago Sanitary and Ship Canal are discharged directly to the Des Plaines River through seven sluice gates (30 ft X 20 ft).

***Flow at Romeoville.*** Until ***2005,*** the total flow from the CCW was determined by the USGS at Romeoville Road located on the Chicago Sanitary and Ship Canal near the terminus of the water shed, 6.1 miles above the junction of the canal and the Des Plaines River (Figure 1). In 2005, the stream gauge was relocated upstream to River Mile 3020. During WY 2001, the estimated mean annual flow at Romeoville was 2,710 $ft^3/s$. The principal components of the discharge at Romeoville include treated wastewater from four MWRDGC treatment plants, direct diversion of water from Lake Michigan, tributary flows from the North



Branch of the Chicago River, Little Calumet River, and the Grand Calumet River, combined sewer overflows, and direct runoff from urban storm water It should be noted that there is a general bias for measured and estimated inflows to the CCW to exceed the outflow measured at Romeoville on the Chicago Sanitary and Ship Canal (Institute for Urban Environmental Risk Management 2003).

The minimum and maximum daily mean discharge during WY 2001 was 1,192 $ft^3/s$ (Jan 11, 2001) and

11,087 $ft^3/s$ (August 2,2001), respectively. Since 1986, the minimum and maximum water year mean annual discharges were 2,660 $ft^3/s$ and 4,319 $ft^3/s$, respectively. The highest maximum instantaneous flow during the 17-year period was 19,466 $ft^3/s$ in February 1997. Generally, the highest mean monthly stream flows measured at Romeoville occurred during July, August, and September and the lowest mean monthly discharges occurred during December and January.

Overall, the **CCW** have experienced a significant decrease in flow over the past 20 years (measured at Romeoville) throughout the range of flow conditions (Figure 10). During the period 1985-2005, the estimated annual mean discharge at Romeoville was 3,299 $ft^3/s$ compared with 2,725 $ft^3/s$ for WY 2005. The decrease in flow in the CCW can be attributed to climatic variability, a decrease in discretionary diversion and leakage at the three lakefront locations, and additional water conservation measures implemented by the city of Chicago.



***

**Navigation**[5]

Under Corps nomenclature, the Chicago Waterway System (CWS) is divided into six distinct segments: the Main and North Branch Chicago River, the South Branch Chicago River, the Chicago Sanitary and Ship Canal, the Calumet River, Lake Calumet and the Calumet-Sag Channel. For navigation purposes, the sum of these segments is called "Port of Chicago." The use of this term is distinct from that employed by the Illinois International Port District (IIPD), which uses "Port of Chicago" to describe its deep-draft operations on the southeast side of Chicago. For this report, "Port of Chicago" will mean the six segments comprising the CWS as described by the Corps.

With substantial variability, approximately 25 million tons of commodities move on the CWS each year. Movement centers on bulk commodities including coal (30%), building materials such as sand and gravel (40%), iron ore and steel products (20%) and a variety of other small-quantity commodities (10%). Commodity movement has not been a growth industry but has remained relatively flat from year to year since the early 1990s.

There are 13 miles of deep-draft segments on the southeast side of Chicago in the Calumet River/Lake

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[5] All data on navigation are published by the U.S Army Corps of Engineers Waterborne Commerce Statistics Center. Data were extracted and organized from Corps databases via a proprietary program written by Scudder Mackey and are available from the authors upon request Original databases are available for public download at http://www.iwr.usace.army.mil/ndc/wcsc/wcsc.htm.

Calumet and in the Chicago River and contiguous sections of its north and south branches. The remaining 58 miles of the CWS are maintained for barge traffic at a 9 foot depth. There are 3 locks: the lock at the Chicago River Controlling Works ("Chicago Lock") in downtown Chicago, the O'Brien Lock in the southeast part of the system, and the Lockport Lock which functions as the sole downstream access point.

In addition to barge movements the CWS is subject to significant recreational pressure. Over the last 10 years, the three CWS locks handled anywhere from 45,000-65,000 recreational vessel movements per year. There are numerous recreational marinas on the CWS as well as boat storage facilities.

These commonly-cited numbers provide only a superficial understanding of commercial navigation pressures on the CWS. Commodity movements tend to congregate along specific



segments while being nearly absent from others. Likewise, pressure from recreational uses is clustered at certain locks and segments.

A review of lockage data reveals that movement of commodities between the Chicago River and Lake Michigan is minimal (Figure 12). Fewer than 100 loaded barges per year transit the Chicago Lock, and this number has been dropping steadily since 2000. Transit of commodity-laden barges is much higher at the CWS's other two locks. Lockport accommodates anywhere from 9,000- 12000 loaded barge movements annually (Figure 13), while O'Brien accommodates

4,000-8,000 (Figure 14). These barges bring with them corresponding movements from commercial vessels (barge tows). In each case, movements peaked in the mid-1990s and have dropped off but stayed steady at the lower end of the ranges since 2000.



Figure 12 Annual Vessel Lockages
Chicago River Lock and Dam

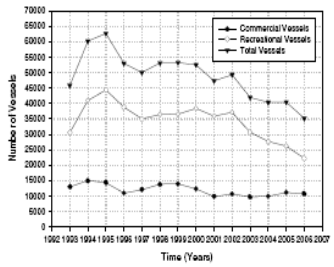
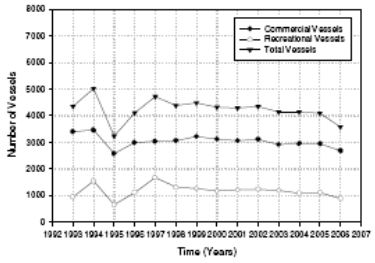
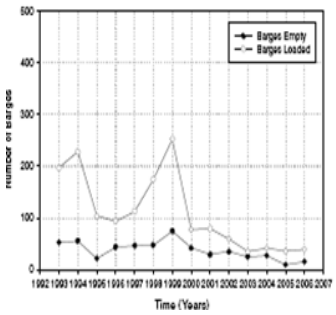


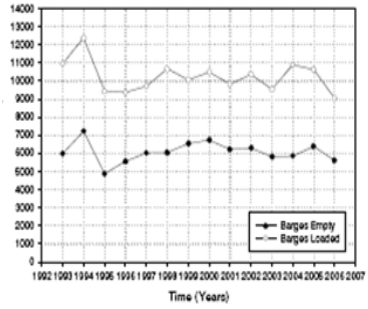

Figure 13 Annual Vessel Lockages
Lockport Lock and Dam




Number of Barges Empty and Loaded
Chicago River Lock and Dam



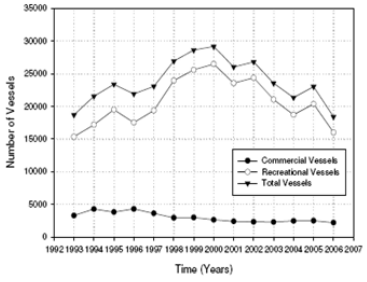

Number of Barges Empty and Loaded
Lockport Lock and Dam



While elucidating CWS pressure points, lockage data does not provide directional information. To better understand the direction and destination of cargo on CWS segments, it is essential to define navigation terminology.

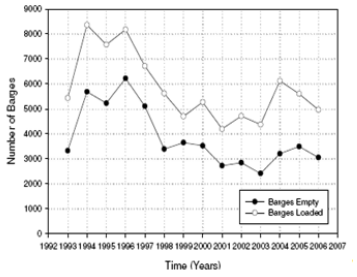
*Canadian* traffic, for the purposes of this report, moves between the CWS and Great Lakes ports in Canada. *Lakewise* traffic moves between U.S. ports on the Great Lakes, while *internal* traffic is commodity movement that is entirely within an inland waterway such as the CWS. Internal traffic includes commodities that are carried between Lake Michigan and the CWS on barges.

**Figure 14** Annual Vessel Lockages
O'Brien Lock and Dam




Number of Barges Empty and Loaded
O'Brien Lock and Dam

Number of Barges Empty and Loaded
O'Brien Lock and Dam




*Inbound* vessels are entering a segment and delivering cargo on that segment, while *outbound* vessels are leaving a segment to deliver cargo on another. *Upbound* traffic is moving in the upstream direction while *downbound* traffic moves in the downstream direction. *Through* traffic moves through a segment without delivering or taking on cargo (USACE).

Each of these definitions should be considered relevant to a given internal and domestic system *segment*, e.g. the Chicago Sanitary and Ship Canal (CSSC). A vessel entering the CSSC at Lockport lock with a destination on the CSSC would be said to be inbound and upbound. A vessel moving from the North Branch of the Chicago River into the South Branch then on to deliver cargo along the CSSC would be downbound through relative to the South Branch but downbound inbound relative to the CSSC.

An example of lakewise traffic would be a deep-draft vessel entering the Calumet River and dropping off cargo from another Great Lakes port. Although this cargo has moved on both the Great Lakes and inland waterways, its destination port being the deep-draft Great Lakes port at Chicago makes it lakewise traffic.

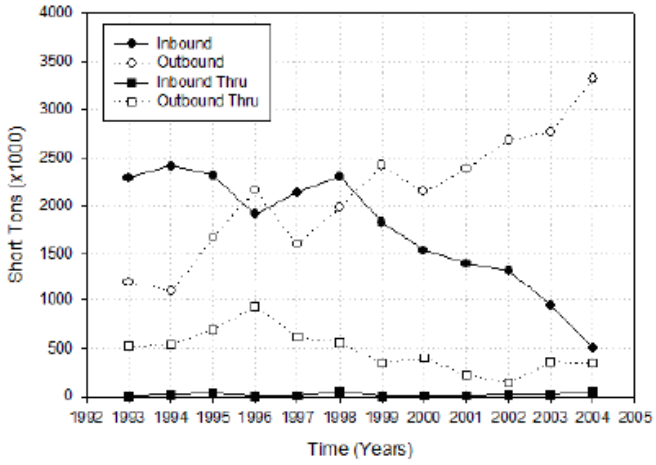
Lake Traffic

All non-Canadian foreign, Canadian, and domestic lakewise traffic requires access to a deep-draft port and includes movement between the CWS and Lake Michigan. Following is a brief summary of 2004 data as representative of current commodity traffic.

Non-Canadian foreign imports comprised approximately 1.2% of total tonnage in the Port of Chicago in 2004. This was made up nearly entirely of 300,000 short tons of steel products. There were no foreign exports from the CWS. Meanwhile, the U.S. imported nearly 2 million tons of building materials and other minerals from Canada while exporting 835,000 tons of coal and 373,000 tons of petroleum products. Canadian imports and exports provide

about 13% of CWS traffic by tonnage: over 10 times that provided by foreign movements.

**Figure 15** Lakewise Tonnages Inbound and Outbound Calumet Harbor and River (3741)




Domestic lakewise inbound traffic has steadily decreased since 1993 while shipments from the port of Chicago have skyrocketed (Figure 15). Lake vessels took on over 3 million tons of coal in the Port of Chicago in 2004, along with small volumes of petroleum products and building materials. The port received over 800,000 tons of building materials including sand, gravel,



manufactured cement and steel from these vessels. Lakewise traffic accounts for another 15% of traffic on the CWS.

Taken in sum, the vast majority of cargo entering the CWS from other Great Lakes ports is building materials, and the vast majority leaving for other Great Lakes ports is coal. Commodity shipment to Great Lakes ports from the Port of Chicago has

climbed in the last decade while receipts have plummeted. Together, lake, Canadian and foreign vessels account for nearly 30% of CWS tonnage. Foreign imports, while of a higher value per ton than raw commodities moved by Canadian and domestic lakewise traffic, are a small portion of this percentage.

**(Exhibit B)**

**Reversals to Lake Michigan (1985 - Present)**

**Million Gallons**

| | Date | O'Brien Lock | CRCW | Wilmette | Total Volume |
|---|---|---|---|---|---|
| 2009 | 6/19/2009 | | | 191.6 | 191.6 |
| 2009 | 3/8/2009 | | | 143.1 | 143.1 |
| 2009 | 2/26-27/09 | | | 78.9 | 78.9 |
| 2008 | 12/27-28/08 | | | 480.8 | 480.8 |
| 2008 | 9/13-16/08 | 2669.2 | 5438.2 | 2941.7 | 11049.1 |
| 2007 | 8/23-24/07 | | | 224.0 | 224.0 |
| 2006 | None | | | | 0.0 |
| 2005 | None | | | | 0.0 |
| 2004 | None | | | | 0.0 |
| 2003 | None | | | | 0.0 |
| 2002 | 8/22/2002 | | 1296.4 | 455.4 | 1751.8 |
| 2001 | 10/13/2001 | | | 90.7 | 90.7 |
| | 8/31/2001 | | | 75.3 | 75.3 |
| | 8/2/2001 | | 883.1 | 139.9 | 1023.0 |
| 2000 | None | | | | 0.0 |
| 1999 | 6/13/1999 | | | 9.7 | 9.7 |
| 1998 | None | | | | 0.0 |
| 1997 | 8/16-8/17/97 | | 402.0 | 157.0 | 559.0 |
| | 2/20-2/22/97 | 1458.0 | 1947.0 | 774.0 | 4179.0 |
| 1996 | 7/17-7/18/96 | 1032.0 | 519.0 | | 1551.0 |
| 1995 | None | | | | 0.0 |
| 1994 | None | | | | 0.0 |
| 1993 | None | | | | 0.0 |
| 1992 | None | | | | 0.0 |
| 1991 | None | | | | 0.0 |

| | Date | O'Brien Lock | CRCW | Wilmette | Total Volume |
|---|---|---|---|---|---|
| 1990 | 11/27-11/28/90 | 224.0 | 86.0 | 154.0 | 464.0 |
| | 8/17-8/18/90 | | | 9.5 | 9.5 |
| | 5/9-5/10/90 | | 208.0 | 289.0 | 497.0 |
| 1989 | 8/3-8/4/89 | | | 52.0 | 52.0 |
| 1988 | None | | | | 0.0 |
| 1987 | 8/25-8/26/87 | | | 18.0 | 18.0 |
| | 8/13-8/14/87 | | 986.0 | 971.0 | 1957.0 |
| 1986 | 10/3/1986 | | | 53.0 | 53.0 |
| 1985 | 8/6/1985 | | | 58.0 | 58.0 |
| | 3/4/1985 | | | 153.3 | 153.3 |

In The
# Supreme Court of the United States
October Term, 1966

| | |
|---|---|
| STATES OF WISCONSIN, MINNESOTA, OHIO, AND ENNSYLVANIA,<br><br>*Complainants*,<br>*v.*<br>STATE OF ILLINOIS AND THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO,<br><br>*Defendants,*<br>UNITED STATES OF AMERICA,<br><br>*Intervenor*. | No. 1 Original |
| STATE OF MICHIGAN,<br><br>*Complainant,*<br>*v.*<br>STATE OF ILLINOIS AND THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO,<br><br>*Defendants,*<br>UNITED STATES OF AMERICA,<br><br>*Intervenor*. | No. 2 Original |

| | |
|---|---|
| STATE OF NEW YORK,<br><br>*Complainant*,<br>*v.*<br>STATE OF ILLINOIS AND THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO,<br><br>*Defendants*,<br>UNITED STATES OF AMERICA,<br><br>*Intervenor*. | No. 3 Original |

AFFIDAVIT OF TAMMY J. NEWCOMB, PH.D.

Tammy J. Newcomb, being first duly sworn, states as follows:

1. I am employed by the Michigan Department of Natural Resources (MDNR), Fisheries Division, as a State Administrative Manager in the Fisheries Research Program.

2. I received a B.S. degree in Fisheries and Wildlife from Michigan State University in 1990, a M.S. degree in Forestry, concentration in Fisheries Management, from West Virginia University in 1992 and a Ph.D. in Fisheries and Wildlife from Michigan State University in 1998.

3. I have worked for the MDNR as a State Administrative Manager since 2002. A copy of my curriculum vitae is attached as Exhibit A.

4. My professional duties include management of the Fisheries Program for the MDNR. I review and oversee the fisheries science program statewide, including both Great Lakes and inland waters.

5. I have reviewed academic literature, research and studies concerning Asian carp.

6. As a result of that review I have determined that Asian carp, in particular the silver carp and the bighead carp pose a significant risk to the ecosystem of the Great Lakes should even a relatively small number of these fish enter the Great Lakes system and begin reproducing.

7. My conclusions and the support for those conclusions are discussed in more detail in the following paragraphs of this affidavit.

**The severity of the potential threat to fisheries resources in the Great Lakes Basin if silver and bighead carp enter and become established in some areas of the Lakes and connecting rivers and streams**.

8. The potential threat to Great Lakes fisheries resources if bighead and silver carp enter the lakes and become established as reproducing populations is both biologically and economically severe and likely irreversible.

9. The threat from silver and bighead carp is well documented in the scientific literature (e.g., see Kolar

et al. 2005; Asian Carp Working Group 2007; Brammeier et al. 2008)[1], and is founded on known aspects of the biology of the these carp as well as the invasion experienced in the Mississippi River Basin. The Great Lakes and its tributaries provide desirable physical and thermal habitat, and the two species have high reproductive capabilities, fast growth rates, and their diets overlap at certain times and certain life stages with key commercial and recreational fish species.

10. In general, silver carp prefer standing waters or slow flowing waters, including backwater areas of flowing river systems. They feed on a combination of items, primary of which is phytoplankton, but they will also consume zooplankton, invertebrates, detritus, and bacteria when phytoplankton is not in great supply. Bighead carp have a preferred habitat of lowland river systems, but have been introduced into ponds, lakes and reservoirs where they exist and grow well. This species of carp feeds primarily on plankton, but will also consume algae and insects. The silver and bighead carp have the potential to disperse widely in open systems, and both species reproduce in rivers.

**The Great Lakes, including their bays, tributaries, and drowned river mouths, and inland waters may provide desirable habitat for silver and bighead carp**.

11. Silver and bighead carp have the potential to disperse widely in open systems, with observations of

[1] A bibliography with full citations to all noted literature is attached as Exhibit B to this affidavit.

movements up to 14.3 km/d (8.89 miles/day) in the Illinois River (Peters et al. 2006). In Missouri, the majority of silver carp were observed in water around 1 m (3.28 feet) deep while a large portion of bighead carp were observed in waters deeper than 3 m (9.84 feet) (Kolar et al. 2005).

12. In Michigan's waters of the Great Lakes and their tributaries, examples of areas conducive to survival of silver and bighead carp include Saginaw Bay, the Muskegon River, Bays de Noc, Grand Traverse Bay, and any drowned river mouth with an embayment at its confluence with the Great Lakes. Furthermore, both species of carp grow and persist in water bodies from the size of ponds to large lakes. It is to be expected, therefore, that silver and bighead carp could inhabit inland lakes and reservoirs (Kolar et al. 2005).

**Wide thermal tolerance, high reproductive rates, and fast growth will provide the potential for expansion by silver and bighead carp and competition with native species of fish.**

13. Silver and bighead carp have wider temperature niches (10-35°C; 50-95°F) than many species of fish that are native to the Great Lakes, although the optimum temperature for these carp is close to 30°C (86°F) (Kolar et al. 2005). Additionally, silver and bighead carp are known to persist in very cold environments where air temperatures reach -30°C (-22°F). Silver and bighead carp can also persist in water temperatures as high as 38-40°C (100.4-103.4°F) (Kolar et al. 2005).

14. Silver and bighead carp have high fecundity given the large numbers of eggs produced per female, which ranges from 280,000 eggs in smaller, younger females to more than a million eggs in older, larger fish (Kolar et al. 2005). In the Missouri River, fecundity averaged 226,213 eggs, ranging from 57,283 to 328,538 eggs (Kolar et al. 2005). However, the population of silver and bighead carp in the Missouri River is generally new and therefore young. Thus, the average number of eggs per female is expected to be less at this point in their colonization of the river than that observed for silver and bighead carp in their home range. It is important to note that silver and bighead carp are as fecund as alewife, another invasive species that in the course of a decade reproduced to noxious nuisance levels in the Great Lakes.

15. In temperate regions, silver and bighead carp are known to begin spawning at age 6, however in the Missouri River they have been observed to begin spawning at age 2 (Kolar et al 2005).

16. Silver and bighead carp migrate up rivers and spawn in waters that have velocities of 0.6 to 2.3 m/s (1.97 to 8.86 feet/second), a temperature range of 18-30°C (64.4-86.0°F), that are turbid and include areas of mixing such as the confluence of rivers, among rocks and rapids, or behind sandbars, stonebeds, or islands. They have been found to be flexible in their requirements for spawning when introduced to new areas. For example, silver and bighead carp are known to spawn in man-made canals (Kolar et al. 2005).

17. Potential changes in reproductive ecology of silver and bighead carp in North America are unpredictable, but it is certain that they are plastic enough in their behavior to exploit new areas. For example, a prolonged reproductive season with multiple times of spawning has been observed only rarely in Asia. In the Missouri River, however, bighead carp were reported to have a very protracted spawning period with spawning occurring multiple times from early spring through fall (Schrank and Guy 2002; Papoulias et al. 2006). Thus, Asian carp can adapt and modify their behavior to benefit from environments as they invade new waters.

18. Early risk assessment studies suggested that, based on perceived alkalinity requirements, the probability was high for silver and bighead carp to successfully invade and become established in the Pere Marquette, St. Joseph, Ontonagon, Big Cedar, Ford, Rifle, Saginaw, Black, Belle, and Raisin rivers in Michigan, (Kolar et al. 2005). A more recent review and understanding of the alkalinity level issue suggests that silver and bighead carp may also successfully spawn in numerous other rivers and streams in Michigan, and those additional areas should be considered as potential invasion sites (Chapman and Deters 2009).

19. Growth rates of bighead and silver carp are high and thus their young will quickly outgrow a size that could be preyed upon by other species of fish. In general, the adult size of these carp is similar to or larger than what has been observed for Chinook salmon and lake trout in the Great Lakes Basin.

**Key species of fish in the Great Lakes, which are targeted by recreational anglers and commercial operations, could decline because of direct competition with silver and bighead carp for food.**

20. Silver and bighead carp are filter feeders and have a feeding capacity that greatly exceeds that observed for alewives (Smith 1989; Ke et al. 2007). Zooplankton is often the primary diet item for both silver carp and bighead carp (Xu and Xie 2004; Zhou et al. 2009), although both of these species of carp are capable of feeding on phytoplankton (Dong and Li 1994; Xie and Liu 1994). Silver carp can effectively forage on smaller items than bighead carp and will feed primarily on phytoplankton, but silver carp will also consume zooplankton when phytoplankton levels are low (Kolar et al. 2005). These two species of Asian carp consume large amounts of zooplankton and phytoplankton and excrete their body weight in feces in as few as 10 days (Kolar et al. 2005).

21. Silver and bighead carp can have substantial effects on recruitment of native species of fish by reducing the abundance of zooplankton, since zooplankton comprise the critical food source for larval life stages of almost all species of fish in the Great Lakes Basin. Based on their feeding habits, silver and bighead carp have the potential to compete with species such as alewife, lake whitefish, emerald shiner, lake herring, and bigmouth buffalo. It is also believed that these carp may negatively affect the survival of larval walleye, yellow perch, and other species of fish that spawn in nearshore waters of the Great Lakes by outcompeting these species for the plankton that both need to survive.

22. When silver and bighead carp alter the plankton communities of the Great Lakes, this alteration will likely lead to disruption of the food web and, ultimately to negative consequences for species of fish like Chinook salmon, lake trout, and steelhead. This occurs when Asian carp outcompete forage fish species for the plankton they need to survive, which in turn deprives larger predator fish such as Chinook salmon, lake trout and steelhead of their primary food source, i.e., the forage fish.

23. For these reasons, if silver and bighead carp successfully invade and become established in the Great Lakes, then some of the current fish communities and species of fish in the lakes may be extirpated (Kolar et al 2005). Significant changes in the composition of the fish communities in the Mississippi River Basin have already occurred in less than two decades where silver and bighead carp have become naturalized.

24. Not only will this have a devastating effect on Michigan's sport fishery, silver and bighead carp also have the very real potential to disrupt and adversely affect commercial fisheries in the Great Lakes. For example, commercial fisheries in the Mississippi River Basin have been significantly altered due to the invasion of Asian carp and the subsequent loss of the species of fish targeted by commercial operations (Asian Carp Working Group 2007). The currently accepted value of recreational and commercial fishing on the Great Lakes is estimated at nearly $7 billion per year. This value is based on a 1985 estimate by Dr. Daniel Talhelm of Michigan State University that

has subsequently been adjusted for inflation (Talhelm 1988).

**The severity of the adverse impacts on other natural resources and the Great Lakes ecosystem as a whole if silver and bighead carp enter the Great Lakes.**

25. All natural resource management agencies and partners in the Great Lakes Basin have expressed concern about the potential ecological and economic effect of silver and bighead carp on the Basin. The life history traits of silver and bighead carp suggest there is a high probability that they will cause negative ecological and economic effects wherever they become established. Silver and bighead carp can reproduce multiple times per year, can attain very high densities, are long-lived, are very mobile, have a high tolerance for poor water quality, and have voracious feeding habits.

26. Once established, control of silver and bighead carp is believed to be nearly impossible. If those carp become established in the Great Lakes Basin, it will certainly be difficult and costly to deal with the negative ecological and economic effects caused by Asian carp and those effects will likely be, as a practical matter, permanent.

**Specific abatement and control measures that are needed both near term and long term.**

27. Chicago area waterways (Chicago waterways) where silver and bighead carp are an issue consist of the Chicago Sanitary and Ship Canal, the Calumet-Sag Channel, the Chicago River, the Calumet River,

Grand Calumet River and the Little Calumet River. The United States Army Corps of Engineers (Corps) has acknowledged that these waterways all provide a direct connection to Lake Michigan and a potential pathway for silver and bighead carp to enter the Great Lakes. (App. 78a)

28. There are control structures in the Chicago Sanitary and Ship Canal, the Calumet–Sag Channel and the Chicago River: the O'Brien Locks and Dam, the Chicago Controlling Works and the Wilmette Pumping Station, that could act as barriers to prevent migration of silver and bighead carp from the Chicago waterways to Lake Michigan if such structures are operated to prevent that migration.

29. The Grand Calumet River and the Little Calumet River/Burns Ditch provide outlets to Lake Michigan that are not controlled by any permanent barrier. In these cases, the only way to ensure the risk of invasion by silver and bighead carp into Lake Michigan is fully mitigated is to physically prevent passage down these waterways to Lake Michigan.

30. The U.S. Army Corps of Engineers (Corps) operates an electric fish dispersal barrier in the southwest end of the Chicago Sanitary and Ship Canal near the Lockport Lock. This barrier is intended to keep Asian carp out of the Chicago waterways, and out of the Great Lakes. There are two segments of the barrier currently operating, although the most recent section put into operation is not operating at full design capacity. A third electric barrier is under construction.

31. Fully functioning electrical barriers may decrease the risk that silver and bighead carp can invade Lake Michigan, even though it is not yet known if the barriers will be completely effective at repelling all sizes of these carp. Such barriers are necessary interim measures in conjunction with other mitigating actions because recent experience teaches that none of the other potential remedies either individually or collectively are foolproof, short of complete and permanent physical separation of the Mississippi River Basin from Lake Michigan. Of immediate concern is whether the U.S. Coast Guard (USCG) will allow the full electrical capacity, for which the existing barrier near Lockport was designed, to be used to repel silver and bighead carp. Finally, the backup electrical barrier must be completed posthaste.

32. There also remains the possibility that silver and bighead carp can move between the Chicago Sanitary and Ship Canal, the Des Plaines River, Deer Run Creek and the Illinois and Michigan Canal during flood events (USACE 2009). Such an occurrence would bypass any protection provided by the full use of the electrical barriers. Therefore, a solution to prevent this potential exchange of silver and bighead carp between these water bodies must be designed and constructed immediately before the potential for flooding in spring of 2010.

33. The Corps recently issued data indicating that its environmental DNA (eDNA) testing program had found evidence of silver and/or bighead carp in the Calumet-Sag Channel, in an area upstream of the electric barrier and downstream of the O'Brien Locks ("Target Area.") (App. 67a) This area is only a few

miles from Lake Michigan, and the only barrier between this area and Lake Michigan is the O'Brien Locks and dam.

34. While the Illinois Department of Natural Resources (IDNR) did attempt to find and net Asian carp in the Target Area after eDNA testing, the effort was unsuccessful, based on information published by the IDNR and the Corps concerning this activity. I believe that the effort could not have captured 100% of the fish in the Target Area, and that Asian carp could in fact be in this area as indicated by the Corps' eDNA testing. Given the size of the area, approximately 5.5 miles of river, it seems unlikely that there would have been only a total of 800 fish of all species in this stretch of river. Yet this is apparently the number of fish captured by the IDNR's nets. Furthermore, in general, nets target specific sizes and some species better than others. Although exact specifics are unknown regarding the sampling effort, given the amount of gear reportedly deployed, it is unlikely that thorough coverage of the entire 5.5 mile stretch in question was accomplished.

35. Given the evidence from USACE's eDNA testing in the Target Area, and based on the general knowledge that the O'Brien Lock, the lock at the Chicago Controlling Works, the Wilmette Pumping Station, the Grand Calumet River and the Little Calumet River/Burns Ditch provide a direct connection to Lake Michigan, the most effective and immediate remedies to stop the movement of Asian carp into Lake Michigan include all of the following actions:

A) Do not open the O'Brien Lock and the lock at the Chicago Controlling Works.

B) Operate all other structures, including sluice gates, only in a manner that assures that silver and bighead carp cannot enter the lake.

C) Physically prevent passage from the Grand Calumet River and the Little Calumet River/Burns Ditch into Lake Michigan.

D) Use the existing electrical barrier at the highest voltage for which it was designed, and complete the construction of the backup barrier.

E) Construct a physical barrier between the Des Plaines River and the Chicago Sanitary and Ship Canal to prevent the transfer of silver and bighead carp between these water bodies during floods.

F) Undertake continuous and regular monitoring for silver and bighead carp above the electrical barriers and in other strategic locations throughout the Chicago Waterway System.

36. The best, long-term solution to ensure silver and bighead carp are not transferred between the Mississippi River Basin and Lake Michigan is to eliminate any physical connection between the two water bodies. To eliminate the immediate and irreversible risk of damage to the Great Lakes posed by the invasion of Asian carp through the Chicago Waterway System and into Lake Michigan, the study of permanently separating the Mississippi River and Great Lakes basins should be completed as quickly as practicable. Subsequent to a final report, actions

required to achieve the goal of permanent separation should commence immediately.

37. Effective management to prevent silver and bighead carp from entering Lake Michigan through the Chicago Waterway System requires reliable estimates of the locations and abundance of the carp throughout the System. Given the complexity of the Chicago Waterway System and the efficacy of various monitoring methods, a robust monitoring program should be developed and implemented on a continuous basis at strategic points throughout the Chicago Waterway System. The program should include netting, electro-shocking as appropriate, eDNA testing, and any other method that is deemed suitable for detecting Asian carp in the Chicago Waterway System.

38. Unless otherwise indicated, the matters asserted in this affidavit are based on my own first-hand knowledge and if called upon to testify concerning these matters, I would so testify.

Tammy J. Newcomb, Ph.D.

Subscribed and sworn to before me this
17th day of December, 2009.

Nancy E. Hart, Notary Public
Ingham County, Michigan
Acting in Ingham County, Michigan
My Commission Expires: 7/10/12

**(Exhibit A)**

**Tammy J. Newcomb, Ph.D.**

**Research Program Manager**
**MDNR Fisheries Division**
**530 W. Allegan Street**
**POBox30446**
**Lansing, MI 48909-7946**
**(517)373-3960**

**5419 E. Sherwood Rd**
**Webberville, MI 48892**
**(517) 468-3250**
**newcombt@michigan.gov**

**EDUCATION**

**Ph.D. 1998** Fisheries Management, Department of Fisheries and Wildlife, Michigan State University,East Lansing
*Dissertation title*: "Juvenile Steelhead Production in the Betsie River Watershed"
*Research Emphasis*: Juvenile salmonid smolt production and monitoring, population dynamics of juvenile steelhead in relation to environmental effects, watershed temperature modeling, spatial and temporal variation in stream fish communities

**M.S. 1992** Wildlife Management, Forestry Department, West Virginia University, Morgantown
*Thesis Title*: "Smallmouth Bass Microhabitat Use in Three West Virginia Streams"
*Research Emphasis*: fish habitat use, alternatives in development of habitat suitability criteria, transferability testing of habitat suitability criteria

**B.S. 1990** Fisheries & Wildlife Management, Department of Fisheries and Wildlife, Michigan State University, East Lansing

**PROFESSIONAL EXPERIENCE**

**Research Program Manager, Michigan Department of Natural Resources, Fisheries Division, Lansing, MI 48910**

- June 2008 – present
- Member of Fisheries Division Management Team
- Supervise operations of 6 research stations, 4 Great Lakes vessels,
- Direct reports include 6 station managers, 1 administrative assistant, 1 program support staff
- Responsible for budget exceeding $2 million
- Coordinate Federal Aid funding program
- Manage and coordinate Partnership for Ecosystem Research Program with 6 faculty appointments
- Represent Division on Department ecosystem management and planning team
- Oversee operations for research and monitoring projects in the Great Lakes, status and trends program for inland lakes and rivers, creel program, and marking and tagging program
- Manage the Division's request for proposals process for funding external research
- Act on behalf of the Chief as requested

Lake Huron Basin Coordinator, Michigan Department of Natural Resources, Fisheries Division, Lansing, MI 48910

- September 2002 – December 2004; January 2006 to June 2008
- Member of Fisheries Division Management Team
- Coordinated Fisheries Division activities, including work and budget planning processes within
  the Lake Huron Basin (supervise 19 employees; approximately $765,000 budget)
- Represent Division on Department ecosystem management and planning team
- Organize and facilitate Lake Huron Basin Citizen Fishery Advisory Committee
- Assisted Unit Managers in development of collaborative work between Fisheries Division and other groups and agencies, lead Lake Huron Basin Team working group
- Represent Division on Great Lakes Fishery Commission (GFLC), Council of Lake Committees
- Serve as member of the GLFC, Lake Huron Committee
- Funded Research: *Adaptive Integrated Framework (AIF): a new methodology for managing impacts of multiple stressors in coastal ecosystems,* C. A. Stow, S. B. Brandt, T. E. Croley II, J. Dyble, G. L. Fahnestiel, T. F. Nalepa, S. A. Pothoven, H. A. Vanderploeg (NOAA Great Lakes Environmental Research Laboratories), S. D. Peacor, M. D. Kaplowitz, F. Lupi (Michigan State University), T. O. Hook, D. Beletsky, C. De Marchi, T. H. Johengen, D. R. Kashian (University of Michigan), P. J. Vavrentyev (University of Akron), J. V. Depinto (Limno-Tech, Inc), C. He (Western Michigan University), T. J. Newcomb (MDNR Fisheries Division), J. H. Bredin (MDEQ, Office of the Great Lakes, NOAA Funding, $3.8 million, 2008-2012.

**Acting Assistant Chief, Michigan Department of Natural Resources, Fisheries Division, Lansing, MI 48910**

- December 2004 to December 2005
- Served in Chief capacity December 2004 through March 2005
- Supervised Hatchery Section, Research Section, Aquatic and Regulatory Affairs Unit, Habitat Management Unit, Heavy Equipment Unit, and Tribal Coordination Unit
- Work with Director's office to secure funding and develop budget reduction plans
- Provided testimony at State Senate and House hearings
- Worked on interdisciplinary council to implement ecosystem management in Michigan

**Adjunct Faculty, Michigan State University, Department of Fisheries and Wildlife, East Lansing, MI (October 2003 – present)**

- Co-Advisor for M.S. student. Ania, A. 2007. *Application of a science-based, multi-scaled approach to watershed protection and rehabilitation in the Rifle River Watershed, Michigan*.
  Michigan State University, M. S. Thesis.
- Numerous (>12) guest lectures at Michigan State University on fisheries management, stream habitat management, and Great Lakes ecology and management (2002-present)

**Assistant Professor, Virginia Polytechnic and State University, Department of Fisheries and Wildlife Sciences, 100 Cheatham Hall, Blacksburg,**
**Virginia 24061-0321 (*also* Adjunct Faculty October 2002 – present)**

- February 1999-August 2002, 50% research, 50% teaching appointment
- Instructed the following courses: Principles of Fisheries & Wildlife Management, Stream Habitat
  Assessment and Management, Introduction to Renewable Natural Resources, and Ichthyology
- Mentored 6 graduate students through research programs and career development
- Sought external funding for research program focusing on stream fish and watershed management issues
- Served on undergraduate and outreach Department committees and Faculty Senate
- Advised 15-20 undergraduates annually on academic programs and career options
- Active in the Minority Academic Opportunities Program
- Funded Research (10 projects; $1.3 million dollars) –

*Evaluation of Stream Habitat Preferences of Adult Mussels for Tailwater Introduction*, R. J. Neves and T. J. Newcomb, Tennessee Valley Authority, $50,000 (2002-2004)

*The Uptake of Mercury and Relationship to Food Habits of Selected Fish Species in the South River and South Fork Shenandoah River, Virginia*, T.J. Newcomb and D. J. Orth, DuPont, $127,567 (2002-2004)

*Hydroacoustic and Acoustic Doppler Technology for Characterizing Aquatic Habita,* Aspires Grant, VPI & SU, T. J. Newcomb, D. C. Novinger, and P. Diplas, $24,161 (2000-2001)

*Anadromous and Catadromous Fish Survey of Selected Streams in North Carolina and South Carolina*, Duke Power, T. J. Newcomb, $15,000 (2000)

*Transformation of FiW 2114, Principles of Fisheries and Wildlife Management into an On-line Course*, Center for Innovation in Learning, VPI & SU, T. J. Newcomb and B. R. Murphy, $23,000 (2000-2001)

*Identification of Host Fishes and Propagation of Juvenile Mussels at White Sulphur Springs National Fish Hatchery, West, Virginia*, U.S. Fish and Wildlife Service, R. J. Neves and T. J. Newcomb, $50,000, (1999-2001)

*Options for Modeling and Managing Stream Temperature in the Face of Increasing Water Demands and Minimum Instream Flows*, Virginia Water Resources Research Center, T. J. Newcomb and D. J. Orth, $50,000, (1999-2001)

*Influences of Fluctuating Releases on Stream Fishes and Habitat in the Smith River below Philpott Dam*, Virginia Dept. Game & Inland Fisheries, D. J. Orth, T. J. Newcomb, P. Diplas, C. A. Dolloff, $569,200, (1999-2004)

*Stream Habitat Modeling to Support Water Management Decisions, North Fork Shenandoah, Lord Fairfax Planning District*, D. J. Orth and T. J. Newcomb, $350,200, (1999-2003)

*Erosion Processes and Prediction on the Fort Pickett Military Reservation*, Virginia Military Affairs, T. J. Newcomb and J. Waldon, $40,000, (2000-2001)

**Visiting Assistant Professor, Virginia Polytechnic and State University, Department of Fisheries and Wildlife Sciences, 100 Cheatham Hall, Blacksburg, Virginia 24061-0321**

**Visiting Assistant Professor, Michigan State University, Department of Fisheries & Wildlife, Room 13 Natural Resources Bldg, East Lansing, Michigan 48824-1222**

**Fisheries Biologist, U. S. Fish and Wildlife Service, Ecological Services, 911 N.E. 11th Avenue, Portland, Oregon 97232-4181**

**Graduate Research Assistant, Michigan State University, Department of Fisheries & Wildlife, Room 13 Natural Resources Bldg, East Lansing, Michigan 48824-1222**

**Fisheries Biologist, Cooperative Education Program, U.S. Fish and Wildlife Service National Ecology Research Center, 4512 McMurry Avenue, Fort Collins, Colorado 80525 (6/92-11/92), Ecological Services, 2651 Coolidge Rd, East Lansing, Michigan 48823 (11/92-4/93)**

**Graduate Research Assistant, West Virginia Cooperative Fish and Wildlife Research Unit, Box 6125 Percival Hall, Morgantown, West Virginia 26506**

**PEER REVIEWED PUBLICATIONS**

Newcomb, T. J., D. J. Orth, and D. F. Stauffer. 2007. Habitat Evaluation. Chapter 16 *in* C. S. Guy and M. L. Brown, Analysis and Interpretation of Freshwater Fisheries Data. American Fisheries Society, Bethesda, MD.

Murphy, G. W., T. J. Newcomb, and D. J. Orth. 2007. Sexual and seasonal variations of mercury in smallmouth bass. Journal of Freshwater Ecology 22: 135-144.

Mummert, A. K., T. J. Newcomb, R. J. Neves, and B. Parker. 2006. Evaluation of a recirculating pond system for rearing juvenile freshwater mussels at White Sulphur Springs National Fish Hatchery, West Virginia, USA. *American Malacological Bulletin 21:1-10*.

Krause, C. W., T. J. Newcomb, and D. J. Orth. 2005. Thermal habitat assessment of alternative flow scenarios in a tailwater fishery. *River Research and Applications* 21:1-13.

Krause, C.W., B. Lockard, T. J. Newcomb, D. Kibler, V. Lohani, and D. J. Orth. 2004. Predicting influences of
urban development on thermal habitat in a warm water Stream. *Journal of the American Water Resources Association* 40:1645-1658.

Persinger, J.W., D. W. Orth, and T. J. Newcomb. 2004. A comparison of snorkeling versus throwable anode
electrofishing for evaluating stream fish habitat use. *Journal of Freshwater Ecology* 19:547-557.

National Research Council. 2004. Managing the Columbia River: Instream Flows, Water Withdrawals, and Salmon Survival. Water Science Technology Board, Board on Environmental Studies and Toxicology. National Academies Press. (Responsible for contributions to 2 chapters).

National Research Council. 2004. Endangered and Threatened Fishes in the Klamath River Basin: Causes of Decline, Strategies for Recovery. Board of Environmental Studies and Toxicology. National Academies Press (Responsible for contributions to 3 chapters).

Mummert, A. K., R. J. Neves, T. J. Newcomb, and D. S. Cherry. 2003. Sensitivity of juvenile freshwater mussels to total and unionized ammonia. *Journal of Environmental Toxicology and Chemistry* 22: 2545-2553.

Newcomb, T. J. K. A. Hanna, and M. R. Anderson. 2001. Macroinvertebrate forage in the Smith River tailwater. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 55: 116-125.

Orth, D. J. and T. J. Newcomb. 2002. Certainties and uncertainties in defining essential habitats for riverine smallmouth bass. Black Bass 2000. Special Proceedings of the American Fisheries Society. Pages 251-264 *in* D. P. Philipp and M. S. Ridgway, *editors*. Black bass: ecology, conservation, and management. American Fisheries Society, Symposium 31, Bethesda, Maryland.

Newcomb, T. J. and T. G. Coon. 2001. Evaluation of alternate methods for estimating numbers of emigrating steelhead smolts. *North American Journal of Fisheries Management* 21:548-560.

Newcomb, T. J., S. A. Perry, and W. B. Perry. 1995. Development and comparison of habitat suitability criteria for smallmouth bass in three West Virginia rivers. *Rivers* 5(3):170-183.

Bovee, K. D., T. Newcomb, and T. G. Coon. 1994. Relations between habitat variability and population dynamics of bass in the Huron River, Michigan. U.S. Department of the Interior, National Biological Survey, Washington D. C., Biological Report 21.

**OTHER PUBLICATIONS AND REPORTS**

Mass Marking Task Group. 2005. Recommendations for mass marking hatchery-reared trout and salmon stocked into the Great Lakes basin. Great Lakes Fishery Commission, Ann Arbor, Michigan (Served as one of the principle authors for the report).

Orth, D. J., A. W. Averett, J. Persinger, M. Chan, J. L. Lozinski, and T. J. 2004. Stream habitat modeling to support water management decisions for the North Fork Shenandoah River, Virginia. Final Report.

Orth, D. J., T. J. Newcomb, C. A. Dolloff, P. Diplas, C. W. Krause, D. A. Novinger, M. Anderson, M. Buyhoff, A.
Hunter, and Y. Shen. 2004. Influences of fluctuating releases on stream habitats for brown trout in the Smith River below Philpott Dam. Final Report.

Krause, C. W., T. J. Newcomb, D. J. Orth. 2003. Modeling Optimum Growth Temperatures for Trout in a Tailwater Fishery. Proceedings for the American Society of Civil Engineers Conference on Water Resources Planning and Management, Roanoke, Virginia.

Coon, T. G. and T. J. Newcomb. 1998. Fish briefs and buckets of fish: Conforming ichthyology to needs of
tudents with natural resource career paths. Pages 32-36 in Proceedings of the Second Biennial Conference
on University Education in Natural Resources, March 7-10, Utah State University, Logan.

Zedonis, P. A. and T. J. Newcomb. 1998. An evaluation of flow and water temperatures for protection of spring
salmon and steelhead smolts in the Trinity River, California. U.S. Fish and Wildlife Service, Coastal California Fish and Wildlife Office, Arcata, California. 24p.

Newcomb, T. J., and T. G. Coon. 1997. Evaluation of alternate methods for estimating numbers of outmigrating steelhead smolts. Michigan Department of Natural Resources, Fisheries Research Report 2045, Ann Arbor.

Newcomb, T. J., and T. G. Coon. 1997. Environmental variability and survival of steelhead parr in a thermally diverse watershed. Michigan Department of Natural Resources, Fisheries Research Report 2046, Ann Arbor.

Newcomb, T. J., and T. G. Coon. 1997. Assessment of management alternatives for altering the thermal regime of the Betsie River, Michigan. Michigan Department of Natural Resources, Fisheries Research Report 2047, Ann Arbor.

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Cindy S. Kolar et al., United States Fish and Wildlife Service, Asian Carps of the Genus Hypophthalmichthys (Pisces, Cyprinidae) – A Biological Synopsis and Environmental Risk Assessment (2005)

Joel Brammeier et al., Great Lakes Fishery Commission, Preliminary Feasibility of Ecological Separation of the Mississippi River and the Great Lakes to Prevent the Transfer of Aquatic Invasive Species (2008)

Lindsay M. Peters et al., Movements of Adult Radio-Tagged Bighead Carp in the Illinois River, 135 Transactions of the American Fisheries Society 1205 (2006)

Duane C. Chapman et al., Effect of Water Hardness and Dissolved-Solid Concentration on Hatching Success and Egg Size in Bighead Carp, 138 Transactions of American Fisheries Society 1226 (2009)

Sally J. Schrank et al., Age, growth, and gonadal characteristics of adult bighead carp, Hypophthalmicthys nobilis, in the lower Missouri River, 64 Environmental Biology of Fishes 443 (2002)

D.M. Papoulias et al., Reproductive condition and occurrence of intersex in bighead carp and silver carp in the Missouri River, 571 Hydrobiologia 355 (2006)

Zhixin Ke et al., In situ study on the control of toxic Microcystis blooms using phytoplanktivorous fish in

the subtropical Lake Taihu of China: A large fish pen experiment, 265 Aquaculture 127 (2007)

Jun Xu et al., Studies on the Food Web Structure of Lake Donghu Using Stable Carbon and Nitrogen Isotope Ratios, 19 Journal of Freshwater Ecology 4, at 645 (2004)

Qiong Zhou et al., Seasonabl variations in stable isotope ratios of two biomanipulation fishes and seston in a large pen culture in hyperpeutrophic Meiliang Bay, Lake Taihu, 35 Ecological Engineering 1603 (2009)

Daniel R. Talhelm, Great Lakes Fishery Commission, Economics of Great Lakes Fisheries: a 1985 Assessment (1988)

United States Army Corps of Engineers, Dispersal Barrier Efficacy Study (2009)

Injurious Wildlife Species; Silver Carp and Largescale Carp, 72 Fed. Reg. 37,459 (2007)

United States Department of the Interior, National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (2006)

P. Xie et al., Phytoplankton, especially diatoms, in the gut contents and feces of two planktivorous cyprinids – silver carp and bighead carp, 12 Chinese Journal of Oceanology and Liminology 308 (1994)

D.W. Smith, The feeding selectivity of silver carp, Hyphphtrhalmichthys molitrix Val., 34 Journal of Fish Biology 817 (1989)

S. Dong et al., Comparative studies on the feeding selectivity of silver carp Hypophthalmichthys molitrix and bighead carp Aristichthys nobilis, 44 Journal of Fish Biology 621 (1994)