APPENDIX

APPENDIX
Table of Contents

AFFIDAVIT
OF
RICHARD LANYON

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

STATES OF WISCONSIN, MINNESOTA, OHIO, AND PENNSYLVANIA, *Complainants,* *v.* STATE OF ILLINOIS AND THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO, *Defendants,* UNITED STATES OF AMERICA, *Intervenor.*	No. 1 Original
STATE OF MICHIGAN, *Complainant,* *v.* STATE OF ILLINOIS AND THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO, *Defendants,* UNITED STATES OF AMERICA, *Intervenor.*	No. 2 Original
STATE OF NEW YORK, *Complainant,* *v.* STATE OF ILLINOIS AND THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO, *Defendants,* UNITED STATES OF AMERICA, *Intervenor.*	No. 3 Original

AFFIDAVIT OF RICHARD LANYON

1. My name is Richard Lanyon. I make this affidavit based upon my personal knowledge as well as information supplied to me by members of my staff under my supervision and public records, including, but not limited to, information sheets attached to this affidavit as Group Exhibit A. If called upon as a witness, I can testify competently to the contents of this affidavit.

2. I am the Executive Director of the Metropolitan Water Reclamation District of Greater Chicago (District). I have been the Executive Director since June 2, 2006, and I am responsible for the day-to-day operations of the District, overseeing the work of approximately 2,100 employees and the administration of the District's statutory responsibilities and a $1.7 billion budget.

3. Prior to being the Executive Director of the District, I was the Director of Research and Development for seven years. My career at the District began in 1963 and I have served in managerial positions in the Engineering and Maintenance and Operations Departments as well as in Research and Development.

4. I have a Bachelor and Master of Civil Engineering degrees from the University of Illinois at Urbana-Champaign (UIUC). I am a registered Professional Engineer in the State of Illinois under Registration No. 062-24552.

5. I received the American Society of Civil Engineer's National Government Civil Engineer of the Year Award in 1999 and Distinguished Alumnus of the Department of Civil and Environmental Engineering at the UIUC in 2003. I am also a past President of the Illinois Section of the American Society of Civil Engineers (ASCE) and have been involved in a variety of technical activities for ASCE, the Water Environment Federation, the Illinois Association of Wastewater Agencies, and the U.S. Geological Survey.

6. Currently, I serve on the Board of Directors of the National Association of Clean Water Agencies and I am the Chair of the Water Environment Federation's Sustainability Community of Practice.

7. The District's service area encompasses most of Cook County, which includes the City of Chicago and 125 municipalities. The District provides wastewater treatment service to approximately 5 million residents.

8. Within the District's service area is what is known as the Chicago Area Waterway System (CAWS). The CAWS consists of 76.3 miles of canals that traverse Chicago and 31 other communities, and serves the area for commercial and recreational navigation and to drain urban stormwater runoff and treated municipal wastewater effluent from the District's four treatment plants that discharge to the CAWS.

9. The majority of the CAWS was artificially created in the early 1900s to reverse the flow of the Chicago River away from Lake Michigan (Lake) in an effort to keep pollution out of the Lake.

10. The Chicago River, which historically acted as an open sewer receiving the discharge of sewage from city sewers, flowed directly into the Lake.

11. During storms, water from the Chicago River would move further into the Lake near the drinking water intakes for the city, threatening outbreaks of waterborne illnesses.

12. Development and industrialization of the area near the Calumet River lagged downtown Chicago, but in time this river would also contribute pollution to the Lake.

13. Construction of the 28-mile Chicago Sanitary and Ship Canal (CSSC) was completed by the District in 1900, permanently reversing the flow of the Chicago River and South Branch away from the Lake.

14. The original outlet control for the CSSC was the Lockport Controlling Works, consisting of a 160-foot long submersible dam and seven vertical sluice gates.

15. In 1907, a 4-mile extension of the CSSC was completed and included the Powerhouse for hydroelectric generation and a navigation lock. In 1933, the navigation lock was replaced with a much larger lock constructed and operated by the U. S. Army Corps of Engineers (Corps). The District's navigation lock and the submersible dam were decommissioned.

16. The 8-mile North Shore Channel, Wilmette Pumping Station (WPS) and a navigation lock adjacent to the WPS were completed by the District in 1910, through which Lake water was diverted to dilute and flush wastewater downstream through the North Branch of the Chicago River, which was deepened to accommodate the additional flow.

17. The North Shore Channel and North Branch also served as the outlet for sewers, some formerly discharging to the Lake. In 1961, the navigation lock was decommissioned and replaced with a vertical sluice gate to both allow discretionary diversion to be brought into the North Shore Channel and to discharge excess floodwater to the Lake.

18. Prior to the construction of the North Shore Channel, the District constructed a new 2-mile deeper, straighter and wider channel for the North Branch, replacing a meandering sluggish reach. The District also constructed the North Branch Dam to maintain control on the remaining upstream natural channel of the North Branch.

19. The Calumet-Sag Channel was completed in 1922, connecting the Little Calumet River to the CSSC. Upon completion, the Calumet River and a portion of the Little Calumet River was partially reversed to flow away from the Lake.

20. The control on the Calumet-Sag Channel from 1922 to 1965 was a navigation lock named the Calumet-Sag Channel Controlling Works, located at the eastern end of the channel in Blue Island, Illinois. Excess floodwater from the Little Calumet River watershed could flow to the Lake without any restriction until 1965.

21. Throughout this period of canal and waterway control construction, the District also began experimental testing of sewage treatment methods and built several experimental prototype plants before commencing the construction in the 1920s of the major plants that remain in service today.

22. In 1937, as a result of the 1930 U. S. Supreme Court Decree, the District constructed the Chicago River Controlling Works (CRCW) consisting of a navigation lock, eight sluice gates and connecting walls to separate the Chicago River from the Lake.

23. The CRCW provided a positive means to control the flow of water between the Chicago River and the Lake. In 1984, the operation and maintenance of the navigation lock was turned over to the Corps. The Corps operates the sluice gates at the direction of the District.

24. In 1960, the Corps completed construction of the O'Brien Lock and Dam (OL&D) on the Calumet River south of 130th Street in Chicago. This was built as a part of the Corps' Calumet-Sag Channel widening project, a navigation improvement.

25. Due to construction scheduling of this project, the OL&D was not put into operation until 1965, when it became the control on the Calumet branch of the CAWS, replacing the Calumet-Sag Channel Controlling Works, and causing the flow in the Little Calumet River to be permanently reversed away from the Lake.

26. Channel construction and modifications to the CAWS established a navigable connection between the Great Lakes and the Illinois River, making Chicago a commercial center.

27. Constructing channels also allowed for the drainage of sewage before sewage treatment was employed, and ultimately, for the drainage of treated wastewater upon completion of the District's wastewater treatment plants. Most significantly, man-made channels facilitated the reversal of the Chicago and Calumet Rivers, away from the Lake, so that Chicagoans could be provided safe and reliable drinking water.

28. Today, the District controls the water level in the CAWS for navigational purposes, storm relief and maintenance of adequate water quality for aquatic life through its operation of three lakefront structures: the WPS; the sluice gates at the CRCW; and the sluice gates as the OL&D; and two structures downstream on the CSSC: the Lockport Powerhouse and the Lockport Controlling Works.

29. The WPS is located on the Lake at the northern most point of the CAWS and is owned, operated and maintained by the District. The WPS consists of one large sluice gate separating the Lake from the North Shore Channel and one pump capable of pumping water from the Lake to the North Shore Channel for water quality purposes.

30. The pump is used when the Lake is low. When the Lake is high, gravity flow through the sluice gate is used.

31. The average amount of discretionary diversion water taken from the Lake by the District at the WPS is an approximate annual average of 40 cubic feet per second (cfs).

32. The District normally maintains the water level in the North Shore Channel between minus 1 foot Chicago City Datum (CCD) and minus 2 feet CCD.

33. Chicago City Datum is the local reference point for measuring elevations. It provides a consistent starting point to compare flood and ground elevations. Zero in the CCD is 579.48 feet above mean sea level.

34. When the water level in the North Shore Channel rises to an elevation of plus 4.5 feet CCD during severe wet weather, the District will evaluate the conditions and determine whether it may need to open the

sluice gate to release excess floodwater in the North Shore Channel to avoid flooding along the North Shore Channel.

35. The low point in the top of the gate separating the Lake and channel at the WPS is at plus 5.0 feet, CCD. Overflow of floodwater to the Lake will occur regardless of efforts to restrict flow reversals to the Lake once the water rises above plus 5.0 feet CCD.

36. Four miles downstream from the WPS, the District's North Side Water Reclamation Plant (WRP) discharges treated effluent to the North Shore Channel, at an annual average of 375 cfs.

37. Four miles further downstream, the North Branch tributary discharges at the confluence of the North Shore Channel and the North Branch, an annual average of 133 cfs. These flows are the principal sources of flow in the North Shore Channel and North Branch portion of the CAWS.

38. The CRCW was constructed on the Lake in Chicago's downtown area by the District in the late 1930s. The CRCW navigational lock is currently maintained and operated by the U. S. Army Corps of Engineers. In addition to the lock, the District has eight sluice gates at CRCW that it utilizes to reverse the CAWS to the Lake during extreme wet weather events in order to prevent flooding in the Chicago downtown area.

39. Federal Regulations require that the District maintain an elevation in the Chicago River at the west end of the lock at no time higher than minus 0.5 foot CCD, and at no time lower than minus 2.0 feet CCD, except in times of excessive storm run-off into the river or when the Lake is below minus 2 feet CCD.

40. When the water level in the Chicago River rises to an elevation of plus 3.0 feet CCD during severe wet weather, the District will consider whether it may need to open the sluice gates to release excess floodwater in the CAWS to avoid flooding. On three occasions over the past decade, opening the sluice gates was insufficient to control rising water levels and alleviate flooding concerns and the District had to request the Corps to also open the navigational lock.

41. The District also uses the sluice gates at CRCW for diversion of Lake water during dry weather to maintain the CAWS at appropriate levels for navigation and to maintain water quality, taking in an annual

average of 150 cfs. The Lake water from CRCW flows into the main stem of the Chicago River, then into the South Branch of the Chicago River, and into the CSSC.

42. The District has no pumps at CRCW for the intake of discretionary diversion water. Discretionary diversion water from the Lake is the principal flow in the 1.5-mile reach of the main stem of the Chicago River.

43. From the confluence of the North Branch and the main stem, flow in the CAWS proceeds downstream in the South Branch and then in the CSSC. Ten miles downstream from the aforementioned confluence, the District's Stickney WRP discharges treated effluent, at an annual average of 1,200 cfs. The aggregate of the previously enumerated flows are the principal source of flow in the CSSC until the confluence of the Calumet-Sag Channel.

44. The OL&D controls the volume of water diverted from the Lake and the flow in a portion of the Little Calumet River and the Calumet-Sag Channel. The Corps owns, operates and maintains the navigational lock and dam. In addition to the lock, there are also four sluice gates operated by the Corps at the direction of the District for discretionary diversion water from the Lake and release of excess floodwaters to the Lake.

45. The District takes an annual average of 115 cfs discretionary diversion from the Lake at the OL&D. The District uses the sluice gates at the OL&D for discretionary diversion in that the District has no pumps at the OL&D.

46. Federal Regulations require the District to maintain an elevation at the downstream end of the navigation lock no time higher than minus 0.5 foot CCD, and at no time lower than minus 2.0 feet CCD, except in times of excessive storm run-off into the Illinois Waterway, or when the Lake is below minus 2 feet CCD. When the water level in the Calumet-Sag Channel reaches an elevation of plus 3.0 feet CCD, the District will consider whether it may need to open the sluice gates to draw down the CAWS to avoid flooding.

47. Five miles downstream of the OL&D, the District's Calumet WRP discharges treated effluent to the Little Calumet River at an annual average of 380 cfs. Two miles downstream, the Little Calumet River watershed discharges to the CAWS at an annual average of 195 cfs and

the flow in the Calumet-Sag Channel moves downstream into the CSSC.

48. Three miles downstream of the confluence of the CSSC and the Calumet-Sag Channel, the District's Lemont WRP discharges treated effluent to the CSSC at an annual average of 3 cfs.

49. All outflow exits the CAWS at the Lockport Lock and Powerhouse and, on occasion, the Lockport Controlling Works. In addition to two hydroelectric generating units at the Powerhouse, the District operates up to nine sluice gates to control floodwater discharge. The District will use one or more of the seven additional sluice gates two miles upstream of the Lockport Lock and Powerhouse at the Lockport Controlling Works to divert flow to the Des Plaines River under extreme wet weather events.

50. The limiting control of floodwater discharges at Lockport is the capacity of the 160-foot wide CSSC in the 10-mile reach between the Lockport Controlling Works and the confluence of the CSSC and the Calumet-Sag Channel. The capacity is limited to 20,000 cfs.

51. As enumerated above, there are several sources of inflow to the CAWS that pass through the Lockport Lock and Powerhouse. The waters entering the CAWS upstream of Lockport includes treated effluent from water reclamation plants, discretionary diversion from the Lake, water to operate the navigation locks, leakage through control walls, tributary streams, storm runoff, and combined sewer overflows.

52. Over 70 percent of the annual flow in the system is from the discharge of treated municipal wastewater effluent from the Calumet, Lemont, North Side, and Stickney WRPs owned and operated by the District. During dry weather periods, virtually 100 percent of the flow is from these plants and other water reclamation plants on the tributary streams. During wet weather periods, about 50 percent of the flow is from the water reclamation plants.

53. The District has no means in place to prevent fish passage from the CAWS to the Lake when releasing excess floodwaters to the Lake during extreme wet weather events.

54. Discharging hundreds of millions of gallons of water, or over eleven billion gallons as was required in September 2008, make it extremely unlikely that the District could design, install and operate a

mechanical barrier that will prevent fish from exiting the CAWS to the Lake during a release of excess floodwaters of such magnitude.

55. The District has had to request the Corps to open the lock gates at the CRCW on three occasions in the last decade because the sluice gates could not relieve the CAWS of the necessary volume of floodwater in the timeframe required to prevent flooding. In September 2008, the District requested opening the lock at the OL&D due to insufficient capacity of the sluice gates to release excess floodwaters.

56. The locks provide the District with an alternative discharge outlet in the event the District encounters operational problems with the sluice gates. The District needs this operational flexibility in emergency situations to protect the public health and safety and reduce excessive damages due to flooding.

57. The District conducts its operations to ensure that releases of excess floodwaters to the Lake are only done as a matter of last resort when all of the District's facilities are operating at their maximum capacity and the waterways are approaching or exceeding flood stage. The District routinely monitors the level of the CAWS around the clock to ensure they are maintained at the levels within the aforementioned regulations, while also closely watching the latest weather forecasts and monitoring in real-time the rainfall amounts in the Chicago area and water levels in the CAWS. If significant amounts of rainfall are expected, the District will draw down the water level in the CAWS in anticipation of floodwater inflows for additional storage capacity by opening the sluice gates at the Lockport Powerhouse and Lockport Controlling Works and allowing water to drain away from the Lake.

58. When the rain begins to fall and enters the District's intercepting sewers, the District's three largest reclamation plants will treat their maximum practical flow, which can be as great as a combined daily maximum flow of approximately 2.3 billion gallons. In addition, the District utilizes tunnels for storage that have been constructed as part of its Tunnel and Reservoir Plan (TARP).

59. TARP consists of 109 miles of tunnels that were completed in 2006 and have the capacity to hold 2.3 billion gallons of combined sewage and floodwater. The District is in the process of building two large reservoirs for additional storage to reduce the quantity of combined sewage and floodwater discharged to the waterways, one of which will hold 7.8 billion gallons of stormwater and combined sewage upon its

projected completion in 2015 (Thornton Composite Reservoir), while the second reservoir (McCook Reservoir) will be constructed in two stages. Stage I of the McCook Reservoir will hold approximately 3.5 billion gallons and is expected to be completed in 2017, while Stage II will hold an additional 6.5 billion gallons and has an anticipated completion date of 2029.

60. Upon reaching the maximum treatment capacity at its reclamation plants and upon its TARP tunnels reaching maximum capacity, the excess flow will be discharged to the CAWS via one of approximately 300 combined sewer overflows (CSO) outfalls located along the CAWS. The CSO outfalls discharge stormwater combined with sewage. At this point, the stormwater run-off and combined sewage discharging at the numerous outfall locations will cause an increase in the elevation of the CAWS.

61. The maximum amount of water that the District can release downstream at Lockport is approximately 20,000 cfs, which is inadequate to prevent the CAWS from continuing to rise under extreme wet weather conditions. Consequently, even with sluice gates at the Lockport Powerhouse and Lockport Controlling Works allowing the maximum amount of flow to go downstream, the water level in the CAWS will continue to rise.

62. Looking at the particular facts for each segment of the CAWS, including the water levels of the CAWS at various points in the system, the weather forecast, ground conditions, and the status of the water reclamation plants and the tunnels, the District will determine whether a release of excess floodwater to the Lake at one or more of the three lakefront structures is necessary to avoid flooding. The District will do so only after all other options have been exhausted, and only to the extent necessary.

63. If this Court grants Michigan's request to, in effect, cease release of excess floodwaters to the Lake, the District will have no option but to allow the water in the CAWS to rise. The precise extent of the flooding that will result is unknown in that the District has historically released excess floodwaters to the Lake in an effort to prevent such flooding.

64. Based upon the District's more than one hundred years of engineering experience in operating the waterways, its sewer system and treatment facilities, and my personal experience with same, it is my

opinion that if the water in the CAWS is allowed to rise unchecked, flooding will occur in the Chicago area during extreme wet weather events.

65. The extreme flooding will result in the overtopping of banks, the inundation of low-lying property and basement sewer back-ups. Basement sewer back-ups occur when the level of water in the river rises, causing sewer outfall structures to become submerged and reducing or eliminating discharge capacity, thereby forcing flow into basement drains and other low areas, such as railroad underpasses and depressed Interstate routes.

66. When, where and the extent of flooding depends upon various factors, including the area wide extent, intensity and duration of the storm event, the increase in water elevation in the waterways, the geographic location, and the antecedent rainfall conditions.

67. While I am unable to identify the exact scope of flooding that will occur during intense rain events due to many variables involved, I am aware of certain adverse consequences that will occur if the water in the CAWS rises above certain elevations.

68. With respect to the North Shore Channel, once the water level rises to plus 5 feet CCD, the water will overtop the sluice gate separating the Channel from the Lake and render it useless. Effects upstream of the WPS along the Channel itself and on the nearby communities will depend upon the factors described in the preceding paragraph.

69. Even with the ability to release excess floodwaters at the WPS, severe flooding occurred along the North Branch in the Albany Park neighborhood of Chicago as recently as September 2008 due to high water levels. One certain fact is that higher water levels increase the level and severity of flood damages.

70. Similarly, overtopping of the riverbank in downtown Chicago will occur in one or more locations at plus 4.7 feet, CCD. The top of the lock gates at CRCW is at plus 6.0 feet CCD, and as at WPS, excess floodwaters will be released to the Lake regardless of attempts to restrict their release.

71. Lower Wacker Drive, a major underground thoroughfare running along the Chicago River for over 2 miles, is at approximately plus 4.7 feet CCD and risks flooding when the Chicago River nears this

elevation. In addition, based upon prior storm events, as the elevation of the Chicago River rises in the Loop to approximately plus 5 feet CCD, additional structures along the River are placed at risk, including the tracks at Union Station, a major train hub in Chicago's west loop.

72. The counterweight pits of many downtown bascule bridges will also be flooded, rendering these structures inoperable to pass navigation.

73. Also, the top of the lock gates at the OL&D are at elevation plus 6.5 feet CCD, allowing these gates to be overtopped by rising floodwaters, resulting in a discharge to the Lake.

74. Areas in the Little Calumet River watershed are particularly prone to flooding due to the large developed areas at low elevations.

75. Even with the ability to release excess floodwaters at the OL&D, severe flooding was experienced as recently as September 2008 due to high water levels.

76. The examples set forth in the preceding paragraphs are just a handful of known instances of potential flooding. The only way to predict the location and extent of flooding throughout the entire CAWS with any degree of specificity, without allowing it to actually occur, is conducting a study that incorporates sophisticated computer modeling.

77. Floodwaters in an urban area, such as Chicago, include combined sewage, which consists of a combination of stormwater and untreated sewage. Although the sewage portion of the combined flow is highly dilute under storm conditions, it nevertheless will be present in the water that overtops the banks and backs-up into basements in homes and businesses.

78. There will be flooding in certain storm events if the District is unable to discharge to the Lake, and such flooding poses both public health and safety issues as well as economic consequences. The location and extent of where these risks will occur along the CAWS is uncertain due to the fact it is dependent on so many variables.

79. As a result of the tunnel portion of TARP, reversals to the Lake have decreased over the years, water quality in the CAWS has improved drastically, and the number of fish species has increased dramatically. As the Thornton Composite and McCook Reservoirs come on line in the

upcoming years, reversals to the Lake will continue to decline and water quality in the CAWS will continue to improve.

80. The need to continue to relieve the CAWS to the Lake under extreme wet weather events still exists. Even when TARP is fully operational, the need to reverse to the Lake may still exist on rare occasions due to the unpredictability of the weather.

81. Although there have been only ten reversals to the Lake in the last decade, five of the ten reversals occurred in the past 16 months, forcing the District to discharge a combined total of approximately 12 billion gallons to the Lake. Storms in close succession do not allow sufficient time for tunnels and reservoirs to be evacuated before the next storm occurs. Had the District been enjoined from discharging to the Lake, much of this water would have had to find another outlet, such as overtopping the waterways or backing-up in basements and other low-lying areas and structures.

82. The District has spent over $2.5 billion constructing TARP and the Corps has spent an additional $250 million to date to improve water quality and reduce instances of flooding. Prohibiting reversals to the Lake under appropriate circumstances could undo much of the flood control benefits achieved to date through TARP.

83. Although less dire than the flooding concerns, the District's inability to take Lake water via the sluice gates at WPS, CRCW and the OL&D will also impact the CAWS.

84. The District is authorized annually to take up to 35 cfs of Lake water for navigational make-up purposes and up to 270 cfs for discretionary diversion purposes, which is primarily used to maintain water quality in the CAWS generally, and particularly in stagnant reaches.

85. If the District is prohibited from opening its sluice gates at WPS, CRCW and the OL&D, it will be unable to take water from the Lake. The District's inability to do so will result in stagnation in certain reaches of the Chicago River, the Little Calumet River and the North Shore Channel.

86. Stagnation in the waterways will cause the following: (1) stream velocities decrease to near zero; (2) a substantial loss in recreational use; (3) loss of natural re-aeration causing dominance in the oxygen

demand of sediments; (4) loss of dissolved oxygen in the water; and (5) fish avoidance due to low dissolved oxygen.

87. Lack of diversion for navigational purposes will also impact commercial navigation and recreational users of the CAWS. The inability to open sluice gates to maintain proper water levels will result in the water levels to decrease during dry weather and limit the ability of boaters, canoeists and kayakers to utilize the waterways.

88. Low water levels and stagnant conditions will give rise to nuisance odors along the waterways adversely affecting the livability of nearby neighborhoods.

89. Lack of discretionary diversion will also cause higher water temperatures, resulting in lower dissolved oxygen for aquatic health and less capacity for several steam electric generating stations to use canal water for cooling.

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Richard Lanyon

Richard Lanyon
Executive Director
Metropolitan Water Reclamation District
of Greater Chicago

Subscribed and sworn to before me this
4th day of January, 2010

MARGARET T CONWAY
MY COMMISSION EXPIRES:12/13/10

Margaret T. Conway
Notary Public

GROUP EXHIBIT A

Protecting Our Water Environment

Metropolitan Water Reclamation District of Greater Chicago

100 EAST ERIE STREET CHICAGO, ILLINOIS 60611-3154 312·751·5600

DESCRIPTION OF THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO: ITS HISTORY, LOCATION, SIZE, POPULATION, AND TYPE OF GOVERNMENT

District and History

The Metropolitan Water Reclamation District of Greater Chicago (District) is an independent government and taxing body encompassing approximately 91 percent of the land area and 98 percent of the assessed valuation of Cook County, Illinois.

The District is a separate legal entity sharing an overlapping tax base with the City of Chicago, the Chicago Board of Education, the Chicago School Finance Authority, the County of Cook, the Cook County Forest Preserve District, the Chicago Park District, the Chicago Public Building Commission, the Cook County Community College District, and various municipalities and school districts outside the City of Chicago but within the District's boundaries.

The District was originally organized as the Sanitary District of Chicago in 1889 under an act of the Illinois General Assembly which has been modified from time to time to increase the District's authority and jurisdiction. The enabling act in 1889 was in direct response to a long standing problem with contamination of the water supply and nuisance conditions of the rivers. The District reversed the flow of the Chicago and Calumet River Systems to stop the discharge of sewage to Lake Michigan and instead, discharge it to the Des Plaines River, where it could be diluted as it flowed into the Illinois River and eventually the Mississippi River. Prior to the District's construction of a 61.3 mile system of canals and waterway improvements, the Chicago and Calumet River Systems were tributary to Lake Michigan. These river systems are now tributary to the Illinois River system.

From 1955 through 1988, the District was called The Metropolitan Sanitary District of Greater Chicago. In order to provide a more accurate perception of the District's current functions and responsibilities, the name was changed effective, January 1, 1989, to Metropolitan Water Reclamation District of Greater Chicago.

Mission and Responsibilities

The mission of the District is to protect the health and safety of the public in its service area, protect the quality of the water supply source (Lake Michigan), improve the quality of water in watercourses in its service area, protect businesses and homes from flood damages, and manage water as a vital resource for its service area.

The District collects wastewater from municipalities in its service area, conveys it to wastewater reclamation plants, provides full secondary treatment and discharges clean water to local waterways. The District is also responsible for stormwater management for all of Cook County, including areas outside of the District's corporate boundaries for wastewater services.

Services

The District's seven modern water reclamation plants provide excellent treatment for residential and industrial wastewater, meeting permitted discharge limits virtually at all times. The treatment process is protected by a pretreatment program to guard against hazardous substances and toxic chemicals. These are strictly regulated pursuant to federal and state requirements. The District routinely monitors all industries and non-residential sources to assure that wastes are disposed of in an environmentally responsible and lawful manner.

Treated wastewater, along with runoff from rainfall, enters local canals, rivers and streams that serve as headwaters of the Illinois River system. Stormwater in the separate sewered area is controlled to reduce flood damages by a number of stormwater detention reservoirs. In the combined sewer area, the District's tunnel and reservoir project has significantly reduced basement backup and overflows to local waterways.

Flow within the District's waterway system and the Lake Michigan discretionary diversion flow are controlled by three inlet structures on Lake Michigan: Wilmette Pumping Station, Chicago River Controlling Works and O'Brien Lock and Dam. The single outlet control structure is the Lockport Lock and Powerhouse.

While exercising no direct control over wastewater collection systems owned and maintained by cities, villages, sewer districts and utilities, the District does control municipal sewer construction by permits outside the city of Chicago. It also owns a network of intercepting sewers to convey wastewater from the local collection systems to the water reclamation plants.

Facilities

The District is located primarily within the boundaries of Cook County, Illinois. The District serves an area of 883.5 square miles which includes the City of Chicago and 125 suburban communities. The District serves an equivalent population of 10.35 million people; 5.25 million real people, a commercial and industrial equivalent of 4.5 million people, and a combined sewer overflow equivalent of 0.6 million people. The District's 554 miles of intercepting sewers and force mains range in size from 12 inches to 27 feet in diameter, and are fed by approximately 10,000 local sewer system connections.

DESCRIPTION OF THE METROPOLITAN WATER RECLAMATION DISTRICT OF GREATER CHICAGO: ITS HISTORY, LOCATION, SIZE, POPULATION, AND TYPE OF GOVERNMENT

The District's Tunnel and Reservoir Project (TARP) is one of the country's largest public works projects for pollution and flood control. Four tunnel systems total 109.4 miles of tunnels, 9 to 33 feet in diameter and 150 to 300 feet underground. One reservoir is in operation and construction is in progress on the two remaining reservoirs.

The District owns and operates one of the world's largest water reclamation plants, in addition to six other plants and 23 pumping stations. The District treats an average of 1.4 billion gallons of wastewater each day. The District's total wastewater treatment capacity is over 2.0 billion gallons per day.

The District controls 76.1 miles of navigable waterways, which are part of the inland waterway system connecting the Great Lakes with the Gulf of Mexico. It also owns and operates 35 stormwater detention reservoirs to provide regional stormwater flood damage reduction.

In conjunction with its biosolids beneficial utilization and farm land application program, the District recycles all biosolids in land application programs in northeast Illinois, and owns over 13,500 acres of land in Fulton County, Illinois, formerly used for biosolids application.

Governance

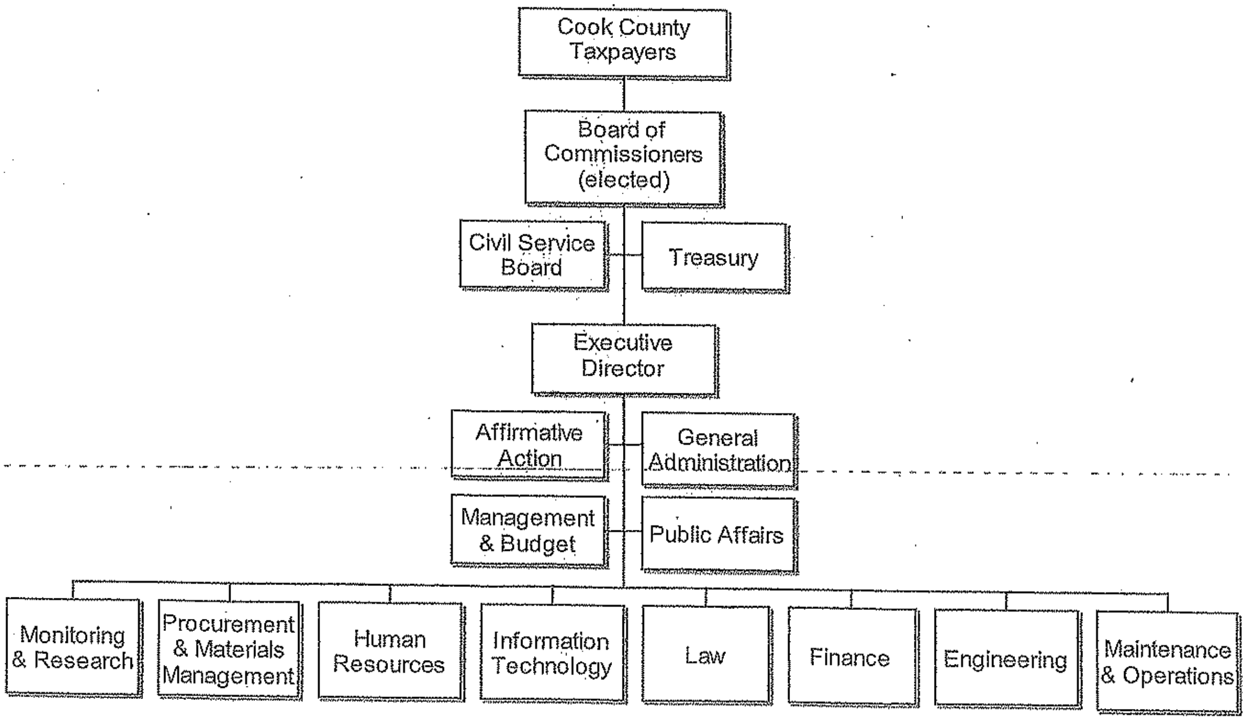
The District is governed by a nine–member Board of Commissioners (Board). Commissioners are elected at large and serve on a salaried basis. Three Commissioners are elected every two years for six–year terms. Biannually, the Board elects from its membership a President, Vice President, and Chairman of the Committee on Finance.

Organization Structure

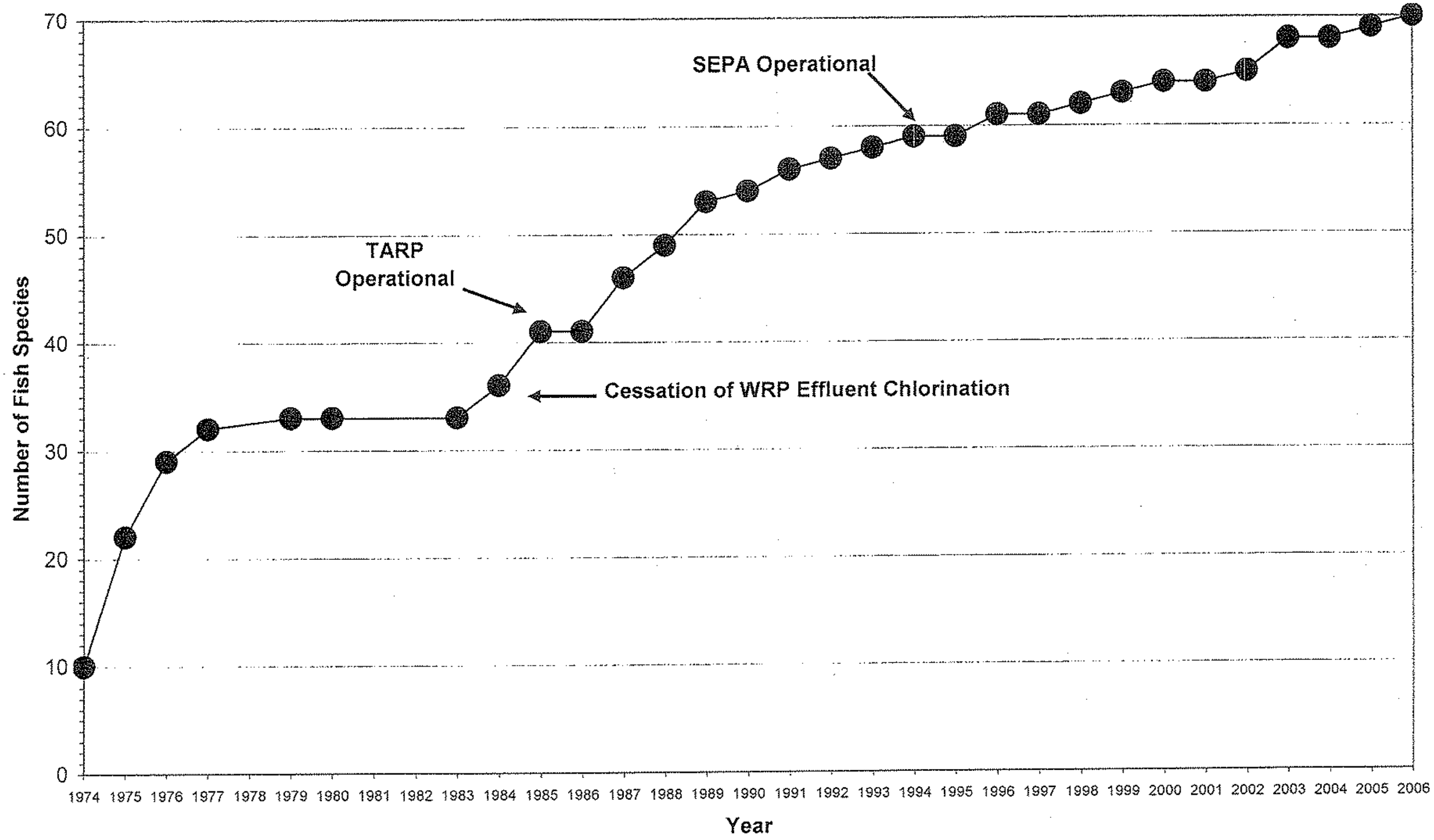
The Executive Director, who reports directly to the Board, manages the District's day-to-day operations. Eight appointed department heads report to the Executive Director.

The Treasurer of the District, its chief financial officer, is appointed by and reports directly to the Board.

General Administration, Management & Budget, Affirmative Action, and Public Affairs are direct staff and support units, reporting to the Executive Director.



CUMULATIVE NUMBER OF FISH SPECIES COLLECTED FROM THE CHICAGO AND CALUMET RIVER SYSTEMS BETWEEN 1974 AND 2006



AFFIDAVIT
OF
SAMUEL DENNISON

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

STATES OF WISCONSIN, MINNESOTA, OHIO, AND PENNSYLVANIA, *Complainants,* *v.* STATE OF ILLINOIS AND THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO, *Defendants,* UNITED STATES OF AMERICA, *Intervenor.*	No. 1 Original
STATE OF MICHIGAN, *Complainant,* *v.* STATE OF ILLINOIS AND THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO, *Defendants,* UNITED STATES OF AMERICA, *Intervenor.*	No. 2 Original
STATE OF NEW YORK, *Complainant,* *v.* STATE OF ILLINOIS AND THE METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO, *Defendants,* UNITED STATES OF AMERICA, *Intervenor.*	No. 3 Original

AFFIDAVIT OF SAMUEL DENNISON

1. My name is Samuel Dennison, PhD. 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 Metropolitan Water Reclamation District of Greater Chicago ("District") as a Supervising Aquatic Biologist in the Aquatic Ecology & Water Section of the Monitoring and Research Department.

3. I received a Bachelor of Arts degree with a major in Biology from Saint Mary's University in Winona, Minnesota, a Master of Science degree in Fisheries Biology from Iowa State University in Ames, Iowa, and a Doctor of Philosophy degree in Biology from the Illinois Institute of Technology in Chicago, Illinois.

4. I am a certified Fisheries Professional with the American Fisheries Society and also a Past President of the Illinois Chapter of the American Fisheries Society

5. I have been employed by the District since 1971. My primary responsibility from 1974 through 2003 was monitoring fish populations in Chicago area waterways.

6. Since 2003, I have served as Head of the Aquatic Ecology and Water Quality Section within the Environmental Monitoring and Research Division, where I supervise a staff of 11 persons.

7. As part of my work for the District, I am familiar with the science relevant to fish monitoring, collection, and analysis in the Chicago Area Waterway System (CAWS).

8. The science of Environmental DNA (eDNA) testing is a newly developed method of monitoring fish. It is my understanding that it was recently developed at the University of Notre Dame and was used for the first time this past summer by the US Army Corps of Engineers to monitor the CAWS for the presence of invasive species of fish, specifically bighead and silver carp, known collectively as Asian carp.

9. To my knowledge, there has been no publication of the laboratory or field procedures relative to the eDNA testing of the CAWS in a peer reviewed scientific journal.

10. Measures of eDNA sample collection and sample analysis error, variability, and detection limits in identifying the DNA of Asian carp would be relevant considerations in testing the usefulness of eDNA monitoring. I am unaware of the publication of this information

11. The District does not employ eDNA monitoring as part of its fish monitoring program.

12. Possible contamination of eDNA samples taken from the waterways must be taken into consideration when determining the reliability of the sample results.

13. The waters of the CAWS can be contaminated with eDNA from downstream waters where Asian carp may actually exist and be transported upstream. One method by which transportation may occur is by adherence to barges and other water craft. And, there are myriad other transportation scenarios. The result of this transportation of carp DNA is a false impression that there is a presence of Asian carp in the upstream waters.

14. I have reviewed the *District's Response to the Motion for Preliminary Injunction* in pertinent part and agree with the statements attributed to the publication *Bigheaded carps: A Biological Synopsis and Environmental Risk Assessment.* American Fisheries Society, Special Publication 33, Bethesda, Maryland relative to the existence of Bighead carp existing in Lake Erie, having been collected in 1995, 2000, 2002 and 2003, but not having established populations in Lake Erie.

15. I have reviewed the research project entitled *Evaluating Asian Carp Colonization Potential and Impact in the Great Lakes,* by the National Sea Grant College Program, Hill and Pegg, which was completed in August 2008 and agree with the statements attributed to that study regarding the inability of Asian carp to colonize on the open water regions within the Great Lakes because of the limited food source (plankton) there.

16. The aforementioned studies support the theory that Asian carp may already exist in the Great Lakes for as long as 15 years without collections having increased and widened over that time because they are unable to survive and propagate in numbers sufficient to overwhelm the existing ecosystem.

17. The District has its own independent fish monitoring program in the CAWS for many years but has never specifically monitored for the existence of Asian carp as part of this program.

18. In the past, the District has assisted the US Fish and Wildlife Service and other agencies, including the US Army Corps of Engineers, with the "Goby Roundup and Carp Corral," and Asian carp monitoring, in the Lockport and Brandon Road navigational pools of the CAWS and Des Plaines River, respectively.

19. The Army Corps of Engineers performs fish monitoring in the CAWS to track Asian carp. As a result, if the District were required to establish its own independent fish monitoring program specifically to track Asian carp, that monitoring would be duplicative of the efforts of the Corps.

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[Signature page to follow]

Samuel G. Dennison

Samuel G. Dennison, PhD
Supervising Aquatic Biologist
Monitoring & Research Dept.
Metropolitan Water Reclamation
District of Greater Chicago

Subscribed and sworn to before me
this 4th day of January, 2010.

Rosalie Bottari
Notary Public

ROSALIE BOTTARI
MY COMMISSION EXPIRES:04/10/10

Excerpts from BIGHEADED CARPS: A BIOLOGICAL SYNOPSIS AND ENVIRONMENTAL RISK ASSESMENT

By C.S. Kolar, D.C. Chapman, W.R. Courtenay Jr., C.M. Housel, J.D. Williams, and D.P. Jennings

Bigheaded Carps
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Contents

Largescale Silver Carp

Hybrids of largescale silver and silver carp were introduced to the mid-Syr Dar'ya River basin in Kazakstan (about 40–42°N) from northern Vietnam in the early to mid-1980s (Payusova and Shubnikova 1986; Salikhov and Kamilov 1995) where they are assumed to be established.

United States Introduced Distribution

Bighead Carp

There are conflicting reports about the first importation of bighead carp into the United States. Cremer and Smitherman (1980) reported a personal communication with J. Malone (Lonoke, Arkansas 1975), that bighead and silver carp were introduced in 1971 from Taiwan for biofiltration of sewage lagoons. Shelton and Smitherman (1984) cited Cremer and Smitherman (1980) and stated that bighead carp were introduced in 1972 into Arkansas and studied at the State Fish Hatchery at Lonoke. McCann et al. (1996) cited Cremer and Smitherman (1980) and reported that bighead carp were introduced in 1972 as a potential food fish. Henderson (1979b) reported that bighead and silver carps were introduced into Arkansas in 1973 as a potential addition to fish production ponds. Shelton and Smitherman (1984) reported that at least one shipment of bighead carp was imported to the United States from Israel and another from Yugoslavia by aquaculturalists.

Regardless of why or when bighead carp were imported into the United States, research on various aspects of the culture and biology of the species quickly ensued in several states. Research began in 1975 to assess the ability of bighead and silver carps to improve water quality at the Benton Services Center, Benton, Arkansas (Henderson 1978, 1979a, 1983). An additional study was also conducted on the use of commonly used chemicals to control bighead and silver carp in aquaculture ponds (Henderson 1976). Young from the stock in Arkansas were received by Auburn University, Alabama, in 1974 for research projects in earthen ponds (Pretto-Malca 1976; Dunseth 1977; Cremer and Smitherman 1980). Bighead carp stock from Arkansas was also shipped to the Sam A. Parr Fisheries Research Center in Illinois for a polyculture study in earthen ponds begun in 1975 (Malecha et al. 1978a,b, 1981). Additional experiments were conducted in tanks and ponds at the Illinois Natural History Survey using grass carp × bighead carp hybrids (Wiley and Wike 1986).

Soon after their initial importation into the United States, bighead carp, usually with silver carp, were stocked into wastewater treatment lagoons and impoundments in several states. The Arkansas Game and Fish Commission stocked bighead and silver carps into an existing wastewater treatment system to study the usefulness of the fishes in improving water quality (1975–1976, Henderson 1978, 1979a; 1977–1980, Henderson 1979b, 1983). Freeze and Henderson (1982) referred to four sites, without providing specific locations, in Arkansas that were stocked with bighead and silver carp. In 1983, hybrid grass × bighead carp were stocked into Lewis Creek Reservoir, a power plant cooling reservoir near Willis, Texas (Bettoli et al. 1985). In 1992, bighead and silver carps were stocked into a pond in Arvada, Colorado, to control nuisance algae (Lieberman 1996). Pantex (1997) reported stocking bighead carp into the plant's wastewater treatment lagoon in Texas.

The first record of bighead carp in natural waters of the United States occurred in 1981 when a single individual was caught at river mile 919 in the Ohio River, below Smithland Dam, Kentucky (Freeze and Henderson 1982; Carter 1983). The specimen was believed to have escaped from a fish farm. The first open water record of this species in Arkansas is based on two specimens taken from the Arkansas River in 1988; however, as of the late 1980s, there was no evidence of natural reproduction in that state (Robison and Buchanan 1988). According to Dill and Cordone (1997),

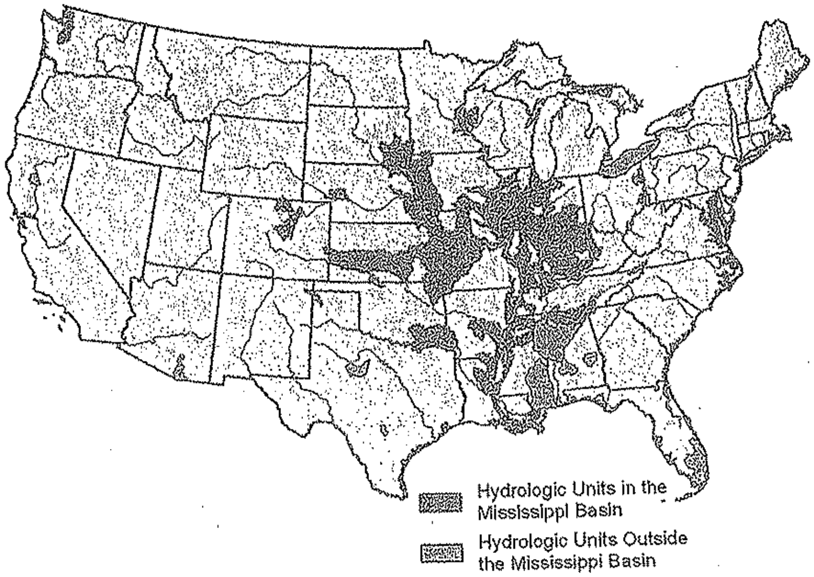

Figure 4.8. Hydrologic Unit Codes (HUC 8) where bighead carp *Hypophthalmichthys nobilis* have been collected in the United States. Bighead carp at the time of this writing (March 2007) are not known to be established outside the Mississippi River basin (hydrologic units in red). Insufficient data exists to be able to determine which parts of the Mississippi River basin have self-sustaining populations of bighead carp. Map developed from U.S. Geological Survey's Nonindigenous Aquatic Species Database. Continuously updated maps may be found at http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=55.1

there is evidence that ponds in California containing bighead carp have spilled since 1989, perhaps giving the species access to the Sacramento River. In the 1990s, 5,000 bighead carp escaped from an aquaculture facility into the Osage River, Missouri (Nico and Fuller 1999), but bighead carp were already found in the Mississippi and Missouri rivers at that time. Another reported escape resulted in bighead carp from Kansas apparently dispersing into Oklahoma (Nico and Fuller 1999). An earlier report of bighead carp from canals in Arizona was of a hybrid with grass carp (Marsh and Minckley 1983).

Bighead carp have now been recorded from waters of 23 states (Figure 4.8) and from the Canadian waters of Lake Erie in Ontario (U.S. Geological Survey 2004; Table 4.3). Pflieger (1997) documented the first evidence of natural reproduction with the capture of young bighead carp in Missouri in 1989. Burr and Warren (1986) reported collection of a postlarval fish in southern Illinois in 1992. Subsequently, Burr et al. (1996) noted that bighead carp seemed to be using the lower reaches of the Big Muddy, Cache, and Kaskaskia rivers in Illinois to spawn. Tucker et al. (1996) also found young-of-year in their 1992 and 1994 collections in the Mississippi River of Illinois and Missouri. In 1997 and 1998, Schrank et al. (2001) documented reproduction of bighead carp in the lower Missouri River (Figure 4.9). The species is thus well established in the Mississippi, Missouri, Ohio, Illinois (Figure 4.10) and Tennessee River basins. By 1998, adult bighead carp ranked fourth in total commercial harvest in the Missouri section of the Missouri River (Robinson 1998). Chick and Pegg (2001) showed that bighead carp seemed to be increasing exponentially in Navigation Pool 26

Figure 4.9. The Missouri River at New Haven, Missouri, looking downriver during a period of moderately low discharge. Note the abundance of wing dikes, rock structures that are designed to focus the river flow and maintain the navigation channel. Such structures provide low velocity habitat used by bigheaded carps. Photograph courtesy of the U.S. Geological Survey.

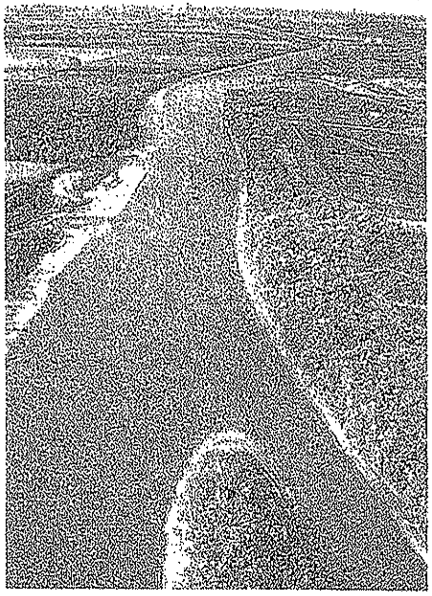

Figure 4.10. South view of Turkey Island and the Mackinaw River from the Illinois River, river mile 148.5. Photograph courtesy of the Illinois Natural History Survey.

of the Mississippi River (near St. Louis, Missouri) from 1992 to 2000. The northernmost records, as of July 2004, are from the Mississippi River in Pool 4, Minnesota/Wisconsin, and the Missouri River, at Gavins Point Dam, southeastern South Dakota. In the Ohio River basin, it has been recorded from a lake on Mill Creek (Mahoning River drainage), Youngstown, Ohio, and from the Ohio River at Moundsville, West Virginia (Table 4.3). In 2005, the Ohio River Valley Water Sanitation Commission (ORSANCO) collected bighead carp at the three lowest dams surveyed in the Ohio River (Markland, J.T. Myers, and Smithland) during a lockchamber survey. At the Markland Dam (river mile 531.5), 179 juveniles were collected, from 18 to 30 cm total length (J. Thomas, ORSANCO, Cincinnati, Ohio, personal communication, 2006).

In addition to large rivers, juvenile bighead carp are known to invade small tributaries, particularly areas below spillways. For example, in July 1998, 877 juvenile bighead carp were collected in one sweep of a seine (18.3 m long x 12.2 m deep with 3.175-mm mesh size) in Cedar Creek, Jackson County, Illinois. The collection site is approximately 19–24 stream km from the confluence of Cedar Creek with the Big Muddy River. Cedar Creek is about 4 m wide where these specimens were collected from a school estimated to be in the tens of thousands (J. Stewart, Southern Illinois University, Carbondale, personal communication, 2004). Populations continue to expand. A hoop net retrieved from the lower Red River, Louisiana, on April 12, 2004, contained nothing but Asian carps, mostly bighead carp and some silver and grass carps. The estimated weight of the net was 408 kg (R. Thomas, Louisiana Department of Wildlife and Fisheries, Baton Rouge, personal communication, 2004).

The major pathway for introduction of bighead carp in the United States has been importation for biological control of plankton in aquaculture ponds and water quality improvement in sewage treatment ponds.

Table 4.3. Records of bighead carp *Hypophthalmichthys nobilis* within the United States and Canada. Where the species has been found multiple times in the same location, only the first collection year is provided. Adapted from the U.S. Geological Survey Nonindigenous Aquatic Species (NAS) Database (http://nas.er.usgs.gov) and recent records. Records entered into the NAS Database as of April 11, 2006 are included here. Blanks indicate that no information was available.

State or province	County	Drainage	Locality	Year
Alabama	Lee	Lower Tallapoosa	Yates Reservoir	1984
Alabama	Tuscaloosa	Upper Black Warrior	Fish ponds	1992
Alabama		Black Warrio	Black Warrior	1996
Alabama		Gulf of Mexico	Central part of state	1998
Alabama	Colbert	Tennessee	Pickwick Lake	1998
Alabama	Lawrence	Tennessee	Wilson Lake below Wheeler Dam	2003
Alabama	Wilcox	Alabama	Millers Ferry Lock	2003
Alabama		Tennessee	In Florence, just below TVA dam	2004
Alabama	Jackson	Tennessee	Unnamed creek near Scottsboro	2004
Arkansas	Saline	Upper Saline	Saline River	1988

Table 4.3. Continued

State or province	County	Drainage	Locality	Year
Arkansas	Jefferson	Lower Arkansas	Arkansas River	1988
Arkansas	Prairie	Lower White	Lower White River	1988
Arkansas	Lonoke	Bayou Meto	Bayou Meto	1988
Arkansas	Craighead	Lower St. Francis	Lower St. Francis River	1988
Arkansas	Dade	Arkansas	Arkansas River	1998
Arkansas	Desha	Lower Arkansas	From Dam #2 downriver to the Mississippi River	2003
Arkansas	Mississippi	Lower Mississippi-Memphis	Mississippi River	2004
Arkansas		Lower White	White River National Wildlife Refuge	2005
California	Tehama	Sacramento	Three ponds in south-eastern part of county	1992
Colorado	Larimer	Cache La Poudre	Power plant reservoir on Rawhide Creek	1980
Colorado	Larimer		East slope water treatment ponds	1996
Colorado	Denver	Upper South Platte	Birdland Creek Reservoir in Denver	2000
Colorado	Arapahoe	Middle South Patte-Cherry	Cherry Creek Reservoir in Denver	2004
Florida	Palm Beach	Everglades	Southeast side of Lake Okeechobee	1989
Florida	Bay	St. Andrew St. Joseph	North Bay (part of St. Andrew Bay) below Deer Point Dam at spillway	1994
Illinois	Hancock	Mississippi	River mile 364, Mississippi River	1986
Illinois	Schuyler	Lower Illinois	Chain Lake at Illinois River river mile 100	1986
Illinois	Schuyler	Lower Illinois	Long Lake	1986
Illinois	Marion	Little Wabash	Research pond	1987
Illinois	Henderson	Flint-Henderson	Mississippi River near Gadstone	1987
Illinois		Upper Mississippi	Mississippi River	1989
Illinois	Kankakee	Illinois	Kankakee River	1990
Illinois	Mason	Mississippi	Illinois River	1990
Illinois	Madison	Upper Mississippi	Mississippi River near Alton	1991
Illinois	Union	Big Muddy	Big Muddy River near Aldridge	1992
Illinois	Jackson	Upper Mississippi	Mississippi River at Rattlesnake Ferry	1992
Illinois	Alexander	Cache	Horseshoe Lake near Miller City	1993
Illinois	Fulton	Mississippi	Illinois River	1993
Illinois	Washington	Middle Kaskaskia	Kaskaskia River near Covington	1994

Table 4.3. Continued

State or province	County	Drainage	Locality	Year
Illinois	Jackson	Big Muddy	Big Muddy River, just south of Murphysboro	1994
Illinois	Alexander	Cache	Lake Creek at spillway	1994
Illinois	Union		Lyerla Lake	1995
Illinois	Jackson	Upper Mississippi-Cape Girardeau	Big Muddy River, one mile west of State Road 3	1996
Illinois	Randolph	Upper Mississippi-Cape Girardeau	Mississippi River at mouth of Kaskaskia River, river mile 117.5	1996
Illinois	Franklin	Mississippi	Big Muddy River	1997
Illinois	Moultrie	Mississippi	Lake Shelbyville, Kaskaskia River	1997
Illinois	Pope	Lower Ohio-Bay	Mouth of Alcorn Creek at Smithland Dam	1997
Illinois	Pope	Lower Ohio-Bay	Ohio River at mouth of Lusk Creek	1997
Illinois	Calhoun	The Sny	Mississippi River at Batchtown Wildlife Management Area, river mile 245.8	1997
Illinois		Peruque-Piasa	Mississippi River near Alton	1998
Illinois	Peoria	Mississippi	Illinois River	1998
Illinois	Gallatin	Wabash	Fehrer Lake	1998
Illinois	Madison	Mississippi	Cahokia Canal	1998
Illinois	La Salle	Mississippi	Illinois River	1998
Illinois	Jackson	Big Muddy	At mouth of ditch below standpipe drain at Cedar Lake Dam, adjacent to Cedar Creek	1998
Illinois	Jackson	Big Muddy	Big Muddy River at mouth of Kincaid Creek	1998
Illinois	Randolph	Upper Mississippi-Cape Girardeau	Kaskaskia River at lock and dam, 6.5 miles north northwest of Chester	1998
Illionis	St. Clair	Cahokia-Joachim	Harding Ditch, Frank Holten State Park	1998
Illinois	Pope	Lower Ohio	Alcorn Creek, 3 miles north	1998
Illinois	Peoria	Lower Illinois	llinois River	1998
Illinois	Crawford	Wabash	Minnow Slough	1999
Illinois		Lower Illinois	Illinois River at river mile 157.8	2000
Illinois	Mason	Illinois	Crane Lake	2000
Illinois	Cass	Illinois	Lily Lake	2000
Illinois	Tazewell	Mississippi	Illinois River	2000
Illinois	Monroe	Cahokia-Joachim	Mississippi River, river mile 146	2000
Illinois	Calhoun	The Sny	Mississippi River at lower Gilead Slough, river mile 250.5	2000
Illinois	Wabash	Lower Wabash	Wabash River, 3 miles southeast of Allendale	2000

Table 4.3. Continued

State or province	County	Drainage	Locality	Year
Illinois	Mason	Lower Illinois	Illinois River, Lake Chautuqua	2000
Illinois	Mason	Lower Illinois	Quiver Lake, Illinois River river mile 123	2000
Illinois	Mason	Lower Illinois	Myers Ditch, Illinois River side channel at river mile 129.3	2000
Illinois	Madison	Peruque-Piasa	Mississippi River, pool 26	2000
Illinois	Brown	Lower Illinois	Illinois River, La Grange Reach	2000
Illinois	Mason	Lower Illinois	Illinois River, La Grange Reach	2000
Illinois	Jackson	Upper Mississippi	Mississippi River at Grand Tower	2000
Illinois	Calhoun	Lower Illinois	Illinois river, near Grafton, river mile 13.6	2001
Illinois	Lawerence	Embarras	Embarrass River, Lawrence, 1500 m downstream of CSX Transportation railroad bridge	2001
Illinois	Fulton	Lower Illinois	Otter Creek at bridge 2.5 miles northeast of Summum	2001
Illinois	Will	Des Plaines	Des Plaines River slightly downstream of Grant Creek, river mile 157.8	2002
Illinois	Jersey	Peruque-Piasa	Mississippi River at Piasa Harbor access, river mile 209.5	2002
Illinois	Tazewell	Lower Illinois	Spring Lake, 4 miles northwest of Manito	2003
Illinois	Rock Island	Copperas-Duck	Lake George, along Mississippi River, 5 miles west of Andalusia	2003
Illinois	Cass	Lower Sangamon	Coon Slough	2003
Illinois	Fulton	Lower Illinois	Big Lake, backwater lake of Illinois River, 8 miles west of Manito	2003
Illinois	Cook	Chicago	McKinley Lagoon in Chicago	2003
Illinois	Iroquois	Kankakee	Iroquois river, near Watseka	2003
Illinois		Cahokia-Joachim	Mississippi River, Lock and Dam 27 downstream to Kaskaskia River	2004
Illinois		Upper Mississippi	Mississippi River from Kaskaskia River downstream to Ohio River	2004
Illinois	Adams	Bear-Wyaconda	Mississippi River vaciwnity of Lock and Dam 20	2004
Illinois		The Sny	Mississippi River, Lock and Dams 25-21	2004
Illinois	Hancock	Flint-Henderson	Mississippi River at Lock and Dam 19	2004
Illinois	Alexander	Upper Mississippi	Picayune Chute (across from the Mississippi River from Cape Girardeau, Missouri)	2004
Illinois	White	Little Wabash	Brashy Slough, near New Haven	2004
Illinois	La Salle	Lower Illinois-Senachwine	Illinois River, up to the Starved Rock Lock and Dam, river mile 231	2004
Illinois	White	Lower Wabash	Wabash River (river mile 23.5)	2004
Illinois	Clark	Middle Wabash-Busseron	Wabash River, river mile 183	2004
Illinois		Lower Ohio	Ohio River	2004
Illinois		Illinois	Hennepin Canal	2004
Illinois		Lower Illinois	Illinois River National Wildlife and Fish Refuges	2005

Table 4.3. Continued

State or province	County	Drainage	Locality	Year
Illinois	Winnebago	Lower Rock	Rock River, just below Fordam Dam in Rockford	2005
Indiana			Unspecified locality	1984
Indiana	Vermillion	Ohio	Ohio	1995
Indiana	Greene	Lower White	White River near Bloomfield	1996
Indiana	Jefferson	Silver-Little Kentucky	Ohio River near Madison	1998
Indiana	Vigo	Wabash	Bryant Creek, Oxendine Bayou	1999
Indiana	Lawrence	White	East fork of the White River at Williams	1999
Indiana	Pike	White	White River	2000
Indiana	Harrison	Blue-Sinking	Ohio River	2004
Indiana	Posey, Warrick, Vanderburgh	Highland-Pigeon	Ohio River	2004
Indiana	Sullivan	Middle Wabash-Busseron	Wabash River (river mile 166)	2004
Indiana	Knox	Middle Wabash-Busseron	Wabash River (river mile 118)	2004
Indiana	Spencer, Warrick, Perry	Lower Ohio-Little Pigeon	Ohio River	2004
Iowa	Woodbury	Missouri	Sergent Bluff	1988
Iowa	Wapello	Lower Des Moines	Ottumwa, below dam, Des Moines River	1990
Iowa	Appanoose	Upper Chariton	Chariton River near Rathbun Lake	1991
Iowa	Monona	Missouri	Louisville Bend	1995
Iowa	Appanoose	Upper Chariton	Rathbun Lake spillway	1996
Iowa	Marion	Des Moines	Red Rock Lake Dam	1996
Iowa	Woodbury	Missouri	Sioux City	1997
Iowa	Harrison	Missouri	Remington Access 1997	
Iowa	Woodbury	Big Sioux	I-29 bridge	1997
Iowa	Van Buren	Des Moines	Des Moines River at Boneporte	1998
Iowa	Wapello	Des Moines	Ottumwa Lagoon and Des Moines River near Ottumwa	2002
Iowa	Johnson	Lower Iowa	Iowa river (river mile 74), 0.5 mile below Burlington Road Dam, Iowa City	
Iowa	Allamakee	Mississippi	Mississippi River (Pool 9)	2003
Iowa	Union	Platte	Summit Lake outlet, east of Creston	2004
Iowa	Davis	Lower Des Moines	Lake Wapello outlet (Pee Dee Creek)	2004
Iowa	Harrison	Big Papillion-Mosquito	Desoto National Wildlife Refuge (along Missouri River, 25 miles north of Omaha)	2005
Kansas	Butler	Upper Walnut	Fish farm near Towanda	1987
Kansas		Missouri	Missouri River just north of Atchinson	1988
Kansas		Kansas	Kansas River at Lawrence	1993
Kansas	Doniphan	Missouri	Missouri River at White Cloud	1997
Kansas		Missouri-Nishnabotna	Missouri River	1998
Kansas		Middle Arkansas	Arkansas River	1998
Kansas		Arkansas	Lower Neosho River	1998
Kansas		Lower Kansas	Kansas River, Lawrence	1998
Kansas		Lower Kansas	Wakarusa River below Clinton Dam	1998
Kansas		Lower Kansas	Lower Kansas River	1998

Table 4.3. Continued

State or province	County	Drainage	Locality	Year
Kansas		Middle Verdigris	River tributary, southeastern Kansas	2000
Kansas		Arkansas	Neosho River	2002
Kansas	Doniphan	Tarkio-Wolf	Missouri River, river mile 483.4, near Iowa Point	2002
Kansas	Atchison	Independence-Sugar	Missouri River, river mile 425.3	2002
Kansas	Kiowa	Upper Salt Fork	A farm pond	2005
Kentucky	Livingston	Ohio	Ohio River at river mile 919	1981
Kentucky			Unspecified locality	1984
Kentucky	Calloway	Kentucky Lake	Kentucky Lake, Blood River Arm	1995
Kentucky	Union	Highland-Pigeon	Ohio River at Uniontown Lock and Dam	1997
Kentucky	Carlisle	Bayou De Chien-Mayfield	Westvaco Wildlife Management Area near Berkley	1998
Kentucky	Franklin	Lower Kentucky	Kentucky River, Pool 3, downstream of Frankfort Lock and Dam #4	2000
Kentucky		Ohio	Green River	2001
Kentucky		Lower Ohio	Ohio River	2004
Kentucky	Ballard	Lower Mississippi-Memphis	Fish Lake	2004
Kentucky	Livingston	Kentucky Lake	Kentucky Lake	2004
Kentucky	Lyon	Lower Cumberland	Lake Barkley	2004
Kentucky	Ballard	Lower Mississ-ippi-Memphis	Ballard Wildlife Management Areas, all lakes	2004
Kentucky	Ballard	Lower Mississ ippi-Memphis	Peal Wildlife Management Area, all lakes	2004
Kentucky	Bullitt	Salt	Salt River, south of Louisville	2004
Kentucky	Ballard	Lower Mississ-ippi-Memphis	Swan Lake Wildlife Management Area, all lakes	2004
Kentucky	Ballard	Lower Mississippi -Memphis	Boatwright Wildlife Management Area, all lakes	2004
Kentucky	Henderson	Highland-Pigeon	Ohio River, river mile 794, across from Evansville, Indiana	2004
Kentucky	Hancock	Lower Ohio-Little Pigeon	Ohio River	2004
Kentucky	Meade	Blue-Sinking	Ohio River	2004
Kentucky	Carroll	Middle Ohio-Laughery	Ohio River at mouth of Kentucky River, Carrollton	2004
Kentucky	Henderson	Lower Green	Green River, Pool 1	2004
Kentucky	Muhlenberg	Middle Green	Green Rhiver, Pool 2, extending to mouth of Mud River	2004
Kentucky	Gallatin	Middle Ohio-Lauhery	Ohio River, river mile 532, Markland Locks and Dam	2005
Louisiana	Franklin	Atchafalaya	Turkey Creek Lake	1985
Louisiana	Monroe	Atchafalaya	Atchafalaya River	1989
Louisiana	Concordia	Bayou Cocodrie	Turkey Creek near Ferriday	1989
Louisiana	Ouachita	Boeuf	Gourd Bayou, 1.3 miles southeast of highway 594 and I-20	1991

Table 4.3. Continued

State or province	County	Drainage	Locality	Year
Louisiana	Richland	Boeuf	Bayou Lafourche, northeast portion of Parish	1997
Louisiana	Ascension	West Central Louisiana Coastal	Mississippi River, Borrow Pit	1997
Louisiana		Caldwell	Lafourche Lake	1993
Louisiana	Union	St. Martin	Henderson Lake	1997
Louisiana	Iberia/St. Martin	Atchafalaya	South Atchafalaya River basin	1998
Louisiana		Lower Red	Red River	1998
Louisiana	Monroe	Atchafalaya	Atchafalaya River	1998
Louisiana		Avoyelles	Spring Bayou	1999
Minnesota	Washington	St. Croix	Downstream of Bayport	1996
Minnesota	Wabasha	Mississippi	Lake Pepin (Pool 4)	2003
Missouri	Miller	Lower Osage	Osage River	1987
Missouri	Buchanan	Independence-Sugar	Missouri River at St. Joseph	1988
Missouri	Carroll	Lower Missouri	Ditch off Missouri River	1989
Missouri	Boone	Lower Missouri	Missouri River tributary	1989
Missouri			Unspecified locality	1992
Missouri	St. Charles	Mississippi	Brickhouse Slough	1993
Missouri		Lower Mississippi	Mississippi River	1994
Missouri		Missouri	Missouri River at Lexington	1997
Missouri	Mississippi	New Madrid-St. Johns	Mud Ditch/Wilkerson Ditch/Ten Mile Pond Ditch off country road 518 bridge	1997
Missouri	New Madrid Ditches	Little River	Dry Run Lake, 1 mile northeast of New Madrid	1997
Missouri		Lower Missouri	Missouri River, river miles 50.0-0.0	1997
Missouri		Lower Missouri-Moreau	Missouri River from Glasgow River to Osage River (river miles 220.-130.4)	1997
Missouri		Chariton	Chariton River	1998
Missouri		Lower Mississippi	Missouri River	1998
Missouri		Osage	Osage River	1998
Missouri		Lamine	Lamine River	1999
Missouri	St. Charles	Peruque-Piasa	Mississippi River Pool 26	2000
Missouri	Perry	Upper Mississippi	Mississippi River at Wilkinson Island	2000
Missouri			Private pond	2000
Missouri	Perry	Upper Mississippi	Mississippi River at first island downstream of Grand Tower, Illinois	2001
Missouri		Lake of the Ozarks	Lake of the Ozarks	2001
Missouri	Cole	Lower Missouri-Moreau	Moniteau Creek, 1 mile northwest of Marion	2003
Missouri		Lower Grand	Grand River	2003
Missouri	Howard	Lower Missouri-Moreau	Moreau River	2003
Missouri	Howard	Lower Missouri-Moreau	Moniteau Creek in Rocheport	2004
Missouri	Howard	Lower Missouri-Moreau	Bonne Femme Creek	2004
Missouri		Upper Mississippi	Mississippi River from Kaskaskia downstream to Ohio River	2004

Table 4.3. Continued

State or province	County	Drainage	Locality	Year
Missouri	Howard	Lower Missouri-Moreau	Moniteau Creek in Rocheport	2004
Missouri	Howard	Lower Missouri-Moreau	Bonne Femme Creek	2004
Missouri		Upper Mississippi	Mississippi River from Kaskaskia River downstream to Ohio River	2004
Missouri		Peruque-Piasa	Mississippi River, near Lock and Dam 26	2004
Missouri		Cahokia-Joachim	Mississippi River, Locka and Dam 27 downstream to Kaskaskia River	2004
Missouri		Flint-Henderson	Mississippi River at Lock and Dam 19	2004
Missouri		The Sny	Mississippi River, Lock and Dams 25-21	2004
Mississippi	Cahoma	Big Sunflower	Mississippi River near Friars Point	1986
Mississippi	Warren	Lower Yazoo	Mississippi River, bayou off river below Vicksburg	1991
Mississippi	Forrest	Pascagoula	Unspecified waterbody in Forrest County	1992
Mississippi	Jackson	Lower Mississippi	Pascagoula River near Pascagoula	1992
Mississippi	Warren	Lower Yazoo	Skillikalia Bayou	1994
Mississippi	Bolivar	Big Sunflower	Black Bayou	1994
Mississippi	Issaquena	Coldwater	Steele Bayou	1994
Mississippi	Washington	Lower Mississippi	Mississippi River near Greenville	1995
Mississippi	Warren	Lower Yazoo	Lower Yazoo near mouth of Pascagoula River	1995
Mississippi	Jackson	Pascagoula	Pascagoula River	1995
Mississippi	Lamar	Black	Near Little Black Creek	1995
Mississippi	Panola	Little Tallahatchie	Lower Sardis Lake (Barrow Lake)	1999
Mississippi	Wilkinson	Lower Mississippi-Nachez	Lake Mary, old Homochitto River bed	2000
Mississippi	Sharkey	Deer-Steele	Little Sunflower River, 7.5 km southeast of Rolling Fork	2003
Mississippi	Leflore	Yalobusha	Six Mile Lake (6 miles north of Greenwood)	2004
Nebraska	Richardson	Tarkio-Wolf	Missouri River, river mile 508.6	1990
Nebraska	Keith	Platte	North Platte River	1995
Nebraska	Nemaha	Tarkio-Wolf	Missouri River	1996
Nebraska		Lancaster Salt	Middle Creek, plune pool below Pawnee Reservoir	1996
Nebraska	Knox	Lewis and Clark Lake	Missouri River	1997
Nebraska	Dixon	Lewis and Clark Lake	Missouri River	1997
Nebraska	Richardson	Tarkio-Wolf	Missouri River, river mile 517	1997
Nebraska	Cass	Keg-Weeping Water	Missouri River, river mile 589, Plattsmouth; Goose Island, river mile 577	1998
Nebraska		Missouri-Nishnabotna	Missouri River	1998
Nebraska		Lower Platte	Platte River	1998

Table 4.3. Continued

State or province	County	Drainage	Locality	Year
Nebraska		Missouri	Unspecified, Missouri River	2000
Nebraska		Missouri	Missouri at Gavins Point Dam	2001
Nebraska	Burt	Blackbird-Soldier	Missouri River	2001
Nebraska		Big Papillion-Mosquito	Missouri River	2001
Nebraska	Otoe	Keg-Weeping Water	Missouri River, river mile 565.0	2002
Nebraska	Cass	Keg-Weeping Water	Missouri River, river mile 595.0	2002
Nebraska	Richardson	Tarkio-Wolf	Missouri River, river mile 491.2	2002
Nebraska	Washington	Big Papillion-Mosquito	Missouri River at Lake De Soto, west of Blair	2002
Nebraska	Cedar	Missouri	Missouri River	2003
Nebraska	Washington	Big Papillion-Mosquito	Boyer Chute National Wildlife Refuge	2005
Ohio	Erie	Lake Erie	Lake Erie at Sandusky	1995
Ohio	Erie	Lake Erie	Lake Erie at Sandusky	2000
Ohio	Jefferson	Upper Ohio-Wheeling	Ohio River at Rayland	2002
Ohio	Mahoning	Mahoning River	Lake Glacier near Youngstown	2003
Oklahoma	Ottawa	Lower Neosho	Neosho (Grand) River near Miami	1992
Oklahoma	Mayes	Lower Neosho	Neosho (Grand) River near Pensacola	1992
Oklahoma	Delaware	Lower Neosho	Grand Lake Reservoir	1996
Oklahoma		Lower Neosho	Neosho River	1996
Oklahoma		Lower Neosho	Ogeechee Bay, upper Grand Lake	1996
Oklahoma		Lower Neosho	Lake Hudson Reservoir	1996
Oklahoma		Arkansas-White-Red	Unspecified waterbody	1998
Ontario, Canada		Lake Erie	Lake Erie near Long Point, Ontario	2000
Ontario, Canada		Lake Erie	Lake Erie off Pelee Island	2002
Ontario, Canada		Lake Erie	Western Lake Erie near St. Louis, Ontario	2002-2003
South Dakota		Lewis and Clark Lake	Missouri River below Gavins Point Dam	1998
South Dakota		Lewis and Clark Lake	Missouri River below Gavins Point Dam	2003
South Dakota		James River	James River	2002-2003
South Dakota		Big Sioux River	Big Sioux River	2002-2003
South Dakota		Vermillion River	Vermillion River	2002-2003
Tennessee	Dyer	Lower Mississippi	Mississippi River	1994
Tennessee	Haywood	Lower Hatchie-Mississippi	Hatchie River near Brownsville	1995
Tennessee	Tipton	Lower Mississippi	Bear Creek, about 10 miles west of Munford	1995
Tennessee	Marion	Middle Tennessee	Nickajack Reservoir near Chattanooga	1999
Tennessee	Marion	Middle Tennessee	Guntersville Reservoir	1999
Tennessee	Stewart	Lower Cumberland	Lake Barkley	2002
Tennessee		Tennessee	Kentucky Lake	2002

Table 4.3. Continued

State or province	County	Drainage	Locality	Year
Tennessee	Lake	Mississippi	Reelfoot Lake	2003
Tennessee	Marion	Middle Tennessee-Chickamauga	Guntersville Lake	2005
Texas	Bexar	Upper San Antonio	Victor Braunig Reservoir	1991
Texas			Fish farms	1992
Texas	Hartley	Rita Blanca	Rita Blanca Lake, just south of Dalhart	1993
Texas		Red	Red River below Lake Texoma	1998
Texas	Jones	Brazos	Phantom Hill Reservoir	1999
Texas	Taylor	Brazos	Lake Kirby	2000
West Virginia	Marshall	Upper Ohio	Ohio River at Moundsville	1997
Wisconsin	St. Croix	St. Croix	Downstream of Bayport, Minnesota	1996
Wisconsin	Dunn	Chippewa	Red Cedar River (observed)	2003
Wisconsin	Crawford	Mississippi	Mississippi River (Pool 9)	2003
Wisconsin	Pepin	Mississippi	Lake Pepin (Pool 4)	2003

Silver Carp

There are conflicting reports about the first importation of silver carp into the United States. Cremer and Smitherman (1980) stated, citing personal communication with J. Malone (Lonoke, Arkansas 1975), that bighead and silver carp were imported in 1971 from Taiwan for biofiltration of sewage lagoons. Shelton and Smitherman (1984) stated that silver carp were introduced in 1972 under an agreement of maintenance with the Arkansas Game and Fish Commission and cited a personal communication with J.M. Malone. Henderson (1979b) reported that bighead and silver carps were introduced into Arkansas in 1973 as a potential addition to fish production ponds. Shelton and Smitherman (1984) reported that silver carp were imported to the United States in at least one other shipment from Yugoslavia by a private fish farmer.

The use of silver carp in research related to sewage treatment facilities (Henderson 1978) has been proposed as an alternative potential source for escapement to the wild, rather than aquaculture facilities. The types of connectivity between the research sites and open waters remains unclear, as does the potential for escape.

Silver carp were also used in research projects soon after importation in many of the same studies as bighead carp. In 1974, the Arkansas Game and Fish Commission began researching the benefits and threats of bighead and silver carps (Henderson 1978, 1979a; Freeze and Henderson 1982). A study was conducted on the utility of commonly used chemicals to control bighead and silver carps in aquaculture ponds (Henderson 1976). Young from the stock in Arkansas were received by Auburn University, Alabama, in 1974 for research projects in earthen ponds with bighead carp (Pretto-Malca 1976; Dunseth 1977; Cremer and Smitherman 1980). Bighead and silver carp stock from Arkansas was also shipped to the Sam A. Parr Fisheries Research Center in Illinois for a polyculture study in earthen ponds for experiments begun in 1975 (Buck et al. 1978 a, b; Malecha et al. 1981). Additional polyculture experiments were conducted in tanks at the Illinois Natural History Survey (Henebry et al. 1988).

Soon after their initial importation into the country, silver carp, usually with bighead carp, were stocked into wastewater treatment lagoons and impoundments in several states. The Arkansas Game and Fish Commission stocked bighead and silver carp into an existing wastewater treatment system to study the usefulness of the fishes in improving water quality (1975–1976, Henderson 1978, 1979a; 1977–1980, Henderson 1979b, 1983). Freeze and Henderson (1982) referred to four sites in Arkansas, without providing specific locations, that were stocked with bighead and silver carps. In 1992, bighead and silver carps were stocked into a pond in Arvada, Colorado, to control nuisance algae (Lieberman 1996). Pantex (1997) reported stocking silver carp into the plant's wastewater treatment lagoon in Texas.

In 1974 or 1975, specimens of silver carp were collected from Bayou Meto and the White River, Arkansas County, Arkansas (U.S. Geological Survey 2004). The report of these captures was filed in a memorandum from the Director, Fish Farming Experimental Station, Stuttgart, Arkansas, to the Director, U.S. Fish and Wildlife Service Region 4, Atlanta, Georgia. In that memorandum, it was stated that the silver carp was a "potential threat to native fish." Silver carp were propagated and distributed by private hatcheries and by the Arkansas Game and Fish Commission (Freeze and Henderson 1982). In January 1980, several silver carp were collected from Crooked Creek, northeastern Arkansas County, that flowed through two private fish hatcheries possessing silver carp (Freeze and Henderson 1982). By 1981, silver carp had been collected from the White, Arkansas, and Mississippi rivers in Arkansas (Robison and Buchanan 1988). From there, they continued to spread through the Mississippi River basin. Silver carp have now been collected from the natural waters of 16 states and Puerto Rico (Table 4.4). Introduction of this species into Puerto Rico resulted from release of fingerlings mixed with a shipment of grass carp from Lonoke, Arkansas (Erdman 1984). Rinne (1995) listed silver carp as introduced to Arizona in 1972 and denoted it as established, however, this seems unlikely given that there are no verifiable collections, and that the date coincides with the earliest importations of silver carp into Arkansas. W. Silvey (Arizona Game and Fish Department, Phoenix, Arizona, personal communication, 1998) indicated that the reference is probably apocryphal.

In the early 1980s commercial fishers in Arkansas caught 166 silver carp from seven sites; but in an intensive 1980–1981 survey to determine the distribution and status of bighead and silver carps in the state, Arkansas Game and Fish Commission personnel could not locate additional specimens (Freeze and Henderson 1982). Although Arkansas state personnel did not find young-of-year fish, several specimens taken by the commercial fishers were sexually mature and exhibited secondary sexual characteristics (Freeze and Henderson 1982). Burr et al. (1996) found young-of-year in a ditch near Horseshoe Lake and reported this as the first evidence of successful spawning of silver carp in Illinois waters and the United States. Douglas et al. (1996) collected more than 1,600 larval bigheaded carp from a backwater outlet of the Black River in Louisiana in 1994. Like bighead carp, silver carp is established throughout in the Mississippi River basin (Figure 4.11), and its range is still expanding . Silver carp

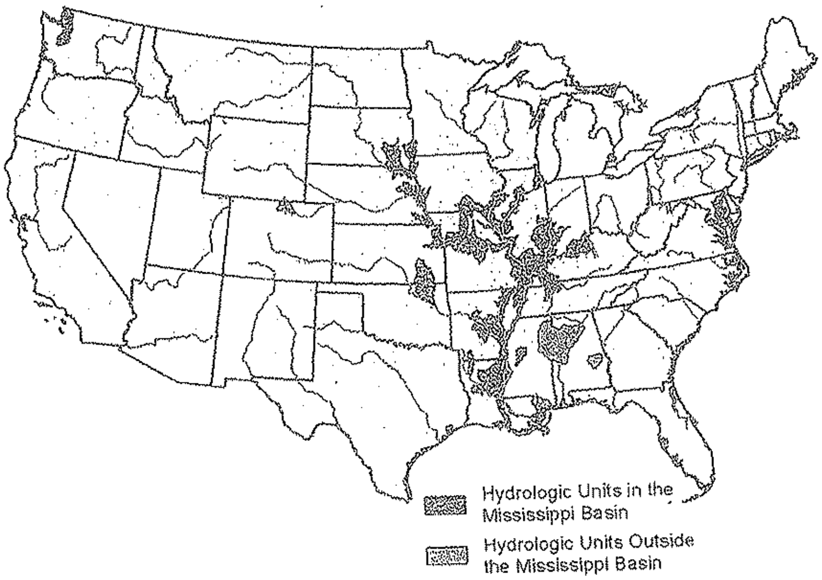

Figure 4.11. Hydrologic Unit Codes (HUC 8) where silver carp *Hypophthalmichthys molitrix* have been collected in the United States. Silver carp at the time of this writing (March 2007) are not known to be established outside the Mississippi River basin (hydrologic units in red). Insufficient data exists to be able to determine which parts of the Mississippi River basin have self-sustaining populations of silver carp. Map developed from U.S. Geological Survey's Nonindigenous Aquatic Species Database. Continuously updated maps may be found at http://nas.er.usgs.

were first collected in the Ohio River drainage in 1986, but began to become abundant and spread more widely during the 1990s (Table 4.4). In 2004, the Ohio River Valley Water Sanitation Commission (ORSANCO) surveyed the Wabash River and collected silver carp throughout their survey (J. Thomas, ORSANCO, Cincinnati, Ohio, personal communication, 2006). In 2005, ORSANCO conducted lock chamber surveys at six dams riverwide (from river mile 31.7 to river mile 918.5). They collected 31 silver carp at the J.T.Myers Dam (river mile 846) and one at the Smithland Dam (river mile 918.5; J. Thomas, personal communication, 2006).

The major pathway for introduction of silver carp in the United States has been importation for biological control of plankton in aquaculture ponds and water quality improvement in sewage treatment ponds.

Largescale Silver Carp

There is no indication that the largescale silver carp has been introduced into the United States or other countries of North America.

Table 4.4. Records of silver carp *Hypophthalmichthys molitrix* within the United States. Where the species has been found multiple times in the same location, only the first collection year is provided. Adapted from the U.S. Geological Survey Nonindigenous Aquatic Species (NAS) Database (http://nas.er.usgs.gov) and recent records. Records entered into the NAS Database as of April 11, 2006 are included here. Blanks indicate that

State or province	County	Drainage	Locality	Year
Alabama	Tallapoosa-Elmore	Lower Tallapoosa	Yates Reservoir (Sougahatchee Creek)	1984
Alabama		Black Warrior-Tombigbee	Black Warrior drainage	1996
Alabama		Gulf of Mexico	Central part of state	1998
Arkansas	Arkansas	Arkansas	White River	1975
Arkansas	Arkansas	Bayou Meto	Bayou Meto	1975
Arkansas	Jefferson	Arkansas	Arkansas River, Pine Bluff, Lock and Dam 4	1981
Arkansas	Arkansas	Bayou Meto	Bayou Meto just below the confluence with Crooked Creek, near Abeles	1981
Arkansas	Lonoke	Bayou Meto	Crooked Creek above confluence with Bayou Meto in southeastern county	1981
Arkansas	Lonoke	Bayou Meto	Bayou Meto, near bridge	1981
Arkansas		Lower Arkansas	Arkansas River (lower section, possibly near Lock and Dam 2)	1981
Arkansas		Lower Red-Ouachita	Oachita River	1981
Arkansas	Prairie	Lower White-Bayou Des Arc	White River near Des Arcs	1981
Arkansas		Mississippi	Mississippi River at river mile 804	1982
Arkansas			Unspecified waterbodies	1986
Arkansas	Dade	Arkansas	Arkansas River	1988
Arkansas		Arkansas-White-Red	White River, Akansas River	1988
Arkansas	Craighead	Cache	Lost Creek	1988

Table 4.4. Continued

State or province	County	Drainage	Locality	Year
Arkansas	Faulkner	Lake Conway-Point Remove	Lake Conway	1988
Arkansas	Pope	Lake Conway-Point Remove	Lake Conway	1988
Arkansas	Mississippi	Little River Ditches	Little River Ditches	1988
Arkansas	Poinsett	Little River Ditches	Little River Ditches	1988
Arkansas	Phillips	Lower White	Lower White River drainage	1988
Arkansas	Jefferson	Lower Arkansas-Maumelle	Lower Arkansas	1988
Arkansas	Pulaski	Lower Arkansas-Maumelle	Arkansas River	1988
Arkansas	Lawrence	Lower Black	Black River	1988
Arkansas	Mississippi	Lower Mississippi-Memphis	Mississippi River	1988
Arkansas	Phillips	Lower White	Lower White	1988
Arkansas	Prairie	Lower White	Lower White	1988
Arkansas	Prairie	Lower White-Bayou Des Arc	White River	1988
Arkansas	Saline	Upper Saline	Saline River	1988
Arkansas	Monroe	Cache	Cache River near confluence with White River (near Clarendon)	2003
Arizona	Maricopa	Middle Gila	Urban lake in Chandler (suburb of Phoenix)	1972
Arizona			Arizona waters-extirpated	1990
Colorado	Larimer	Cache La Poudre	Power plant reservoir on Rawhide Creek	1980
Colorado		More than one	East slope of water treatment ponds	1996
Hawaii		Hawaii	Not specific	1992
Illinois	Jackson	Upper Mississippi-Cape Girardeau	Mississippi River	1983
Illinois	Hancock	Flint-Henderson	Mississippi River, below Lock and Dam 19 (river mile 364), 1 mile south of Hamilton	1986
Illinois	Coles	Embarras	Below Lake Charleston spillway	1987
Illinois	Marion	Little Wabash	Research pond	1987
Illinois	Monroe	Cocokia-Joachim	Mississippi river mile 160 at Merrimac	1990
Illinois	Jackson	Big Muddy	Big Muddy River at Rattlesnake Ferry	1994
Illinois	Alexander	Cache	Horseshoe Lake	1994
Illinois	Alexander	Cache	Ditch at Horseshoe Lake	1995
Illinois	Alexander	Cache	Lake Creek, Horseshoe Lake spillway in floodwaters	1996
Illinois	Jackson	Big Muddy	Kinkaid Creek below spillway of Kinkaid Reservoir	1998
Illinois	Alexander	Cache	Horeshoe Lake, below spillway	1998
Illinois	Massac	Lower Ohio	Ohio River at Fort Massac State Park	1998
Illinois	Massac	Lower Ohio	Ohio River at Cottonwood Bar	1998
Illinois	Pope	Lower Ohio-Bay	Lusk Creek at confluence with Ohio River	1998
Illinois	Madison	Peruque-Piasa	Mississippi River (Pool 26)	1998
Illinois	Randolph	Upper Mississippi-Cape Girardeau	Kaskaskia River at lock and dam, about 105 km north northwest of Chester	1998

Table 4.4. Continued

State or province	County	Drainage	Locality	Year
Illinois	Randolph	Upper Mississippi-Cape Girardeau	River at mouth of Kaskaskia River, just upstream of Fort Kaskaskia state historical site	1998
Illinois	Randolph	Upper Mississippi-Cape Girardeau	Mississippi River, about 3.2 km downstream of Cora, Illinois	1998
Illinois	Alexander	Cache	Horseshoe Lake	1999
Illinois	Alexander	Cache	Lake Creek, Horseshoe Lake spillway	1999
Illinois	Johnson	Lower Ohio	Cache River, Post Creek, 3.2 km south of West Vienna	1999
Illinois	Crawford	Middle-Wabash-Busseron	Minnow Slough	1999
Illinois	Jackson	Big Muddy	Big Muddy River, River Ferry, 6.4 km southeast of Grand Tower	2000
Illinois	Brown	Lower Illinois	Illinois River, La Grange Reach	2000
Illinois	Cass	Lower Illinois	Illinois River	2000
Illinois		Lower Illinois-Lake Chautauqua	Illinois River, river mile 157.8	2000
Illinois	Cass	Lower Illinois-Lake Chautauqua	Muscooten Bay near Beardstown	2000
Illinois	Mason	Lower Illinois-Lake Chautauqua	Illinois River, La Grane Reach	2000
Illinois	Mason	Lower Illinois-Lake Chautauqua	Meyers Ditch, an Illinois River side channel at river mile 129.3	2000
Illinois	Tazwell	Lower Illinois-Lake Chautauqua	Illinois River	2000
Illinois	Madison	Peruque-Piasa	Mississippi River (Pool 26)	2000
Illinois	Gallatin	Saline	Saline River at Route 1, bridge 6.4 km southeast of Equality	2000
Illinois	Massac	Lower Ohio	Ohio River, river mile 950	2000
Illinois	Lawrence	Embarras	Embarras River at Lawrenceville	2001
Illinois	Calhoun	Lower Illinois	Illinois River, river mile 13.6 near Grafton	2001
Illinois	Perry	Upper Mississippi-Cape Girardeau	Mississippi River at first island downstream of Grand Towers	2001
Illinois		Lower Illinois	Illinois River, river mile 157.8	2001
Illinois	Jackson	Big Muddy	Big Muddy River south of Murphysboro	2002
Illinois	Calhoun	The Sny	Mississippi River, Pool 25, near Batchtown	2002
Illinois	Fulton	Lower Illinois-Lake Chautauqua	Spoon River	2003
Illinois	Pulaski	Lower Ohio	Post Creek cutoff about 6.4 km of Grand Chain	2003
Illinois	Clark	Middle Wabash-Busseron	Wabash River at Darwin	2003
Illinois	Adams	Bear-Wyaconda	Mississippi River vicinity of Lock and Dam 20	2004
Illinois		Cahokia-Joachim	Mississippi River, Lock and Dam 27 downstream to Kaskaskia River	2004

Table 4.4. Continued

State or province	County	Drainage	Locality	Year
Illinois	Randolph	Upper Mississippi-Cape Girardeau	River at mouth of Kaskaskia River, just upstream of Fort Kaskaskia	1998
Illinois	Will	Des Plaines	Chicago Sanitary and Ship Canal, around river mile 294, about 3.2 km south of the electric barrier in Romeoville	2004
Illinois	Hancock	Flint-Henderson	Mississippi River at Lock and Dam 19	2004
Illinois	Brown	Lower Illinois	Illinois River, La Grange Reach	2004
Illinois	Mason	Lower Illinois-Lake Chautauqua	Illinois River, La Grange Reach	2004
Illinois	La Salle	Lower Illinois-Senachwine Lake	Illinois River up to Starved Rock Lock and Dam, river mile 231.0	2004
Illinois		Lower Ohio	Ohio River	2004
Illinois		Lower Ohio-Bay	Ohio River	2004
Illinois		Lower Wabash	Wabash River	2004
Illinois		Middle Wabash-Busseron	Wabash River	2004
Illinois		The Sny	Mississippi River, Lock and Dams 25-21	2004
Illinois	Madison	Peruque-Piasa	Mississippi River, near Lock and Dam 26	2004
Illinois		Upper Mississippi-Cape Girardeau	Mississippi River from Kaskaskia River downstream to the Ohio River	2004
Indiana		Ohio	Southeast part of state	1992
Indiana	Greene	Lower Wabash	West fork of White River	2003
Indiana	Gibson	Lower White	White River at Hazelton	2004
Indiana		Lower Wabash	Wabash River	2004
Indiana		Middle Wabash-Busseron	Wabash River	2004
Indiana	Knox	Middle Wabash-Busseron	Wabash River, river miles 117 and 134	2004
Indiana	Sullivan	Middle Wabash-Busseron	Wabash River, river mile 166	2004
Indiana	Posey	Lower Wabash	Wabash River, river mile 23.5	2004
Iowa	Lee	Flint-Henderson	Mississippi River (river mile 364) just below dam at Keokuk	2003
Iowa		Marion	Lower Des Moines Des Moines River below Lake Red Rock	2003
Iowa		Van Buren	Lower Des Moines Des Moines River (river mile 51) at Keosauqua	2003
Iowa		Wapello	Lower Des Moines Des Moines River (river mile 90) at Ottumwa	2003
Iowa		Upper Chariton	Chariton River below Lake Rathbun	2003
Iowa	Des Moines	Flint-Henderson	Mississippi River, Pool 18	2004
Kansas			Unspecified waterbodies	1984
Kansas	Marin	Verdigris	Eastern rivers in Kansas	1998
Kansas		Middle Verdigris	Fixed research site	2001
Kentucky	Union	Highland-Pigeon	Ohio River at Uniontown	1986
Kentucky	Union	Highland-Pigeon	Below Uniontown Lock and Dam	1991
Kentucky	Marshall	Lower Tennessee	Tennessee River, below Kentucky Dam	1995

Table 4.4. Continued

State or province	County	Drainage	Locality	Year
Kentucky	Livingston	Lower Ohio-Bay	Ohio River (river mile 918.5) at Smithland Lock and Dam near Smithland	1999
Kentucky	Jefferson	Silver-Little Kentucky	Ohio River at Louisville (at falls)	1999
Kentucky	McCracken	Lower Ohio	Ohio River, river miles 936, 944.3, and 950.4	2000
Kentucky	Ballard	Lower Ohio	Ohio River, river mile 967.5	2000
Kentucky	Meade	Blue-Sinking	Ohio River about 5 miles west of West Point	2002
Kentucky	Livingston	Lower Ohio	Ohio River, river mile 928.4	2003
Kentucky	Ballard	Lower Ohio	Ohio River, river mile 974.1	
Kentucky	Livingston	Kentucky Lake	Kentucky Lake	2004
Kentucky	Lyon	Lower Cumberland	Lake Barkley	2004
Kentucky	Ballard	Lower Mississippi-Memphis	Fish Lake	2004
Kentucky	Ballard Memphis	Lower Mississippi-	Ballard Wildlife Management Area, all lakes	2004
Kentucky	Ballard	Lower Mississippi-Memphis	Peal Wildlife Management Area, all lakes	2004
Kentucky	Ballard	Lower Mississippi-Memphis	Swan Lake Wildlife Management Area, all lakes	2004
Kentucky	Ballard	Lower Mississippi-Memphis	Boatwright Wildlife Management Area, all lakes	2004
Kentucky	McCracken	Lower Tennessee	Clarks River near Paducah	2004
Kentucky	Bullitt	Salt	Salt River, just south of Louisville	2004
Louisiana		Lower Mississippi	Mississippi River	1983
Louisiana	Franklin	Boeuf	Turkey Creek Lake	1985
Louisiana	Monroe	Atchafalaya	Atchafalaya River	1988
Louisiana	Franklin	Boeuf	Bouef River near Turkey Creek	1988
Louisiana	Franklin	Boeuf	Confluence of Turkey Creek and Caldwell parishes	1988
Louisiana	Maui	Boeuf	Boeuf River, Richland and Caldwell parishes	1988
Louisiana	Richland	Boeuf	LaFourche Canal	1988
Louisiana	Lincoln	Dugdemona	Farm pond; Miller Lake	1988
Louisiana	East Carroll	Lower Mississippi-Greenville	Mississippi River and backwater lake	1988
Louisiana	Concordia	Lower Mississippi-Nachez	Mississippi River and backwater lake	1988
Louisiana	Ouachita	Lower Ouachita	Ouachita Wildlife Management Area, water pumped from La Fourche Canal	1988
Louisiana	Ouachita	Lower Ouachita	Ouachita River	1988
Louisiana	Natchitoches	Lower Red-Lake Iatt	Red River	1988
Louisiana	Catahoula	Tensas	Black River	1988
Louisiana		Little	Little River	1989
Louisiana		Loggy Bayou	Loggy Bayou	1989

Table 4.4. Continued

State or province	County	Drainage	Locality	Year
Louisiana	East Carroll	Lower Mississippi-Greenville	Mississippi River and backwater lake	1989
Louisiana	Monroe	Atchafalaya	Atchafalaya drainage	1998
Louisiana	Point Coupee	Atchafalaya	Atchafalaya River, Mud Hole, old river control structure	1998
Louisiana		Lower Mississippi-Baton Rouge	Mississippi River drainage	1998
Louisiana		Lower Mississippi-Greenville	Mississippi River drainage	1998
Louisiana		Lower Mississippi-Nachez	Mississippi River drainage	1998
Louisiana		Lower Red	Red River drainage	1998
Mississippi	Tunica	Lower Mississippi-Helena	Mississippi River, St. Francis Lake sandbar, river mile 672	2000
Mississippi	Bolivar	Big Sunflower	Mississippi River, gravel bar west of Rosedale	2001
Mississippi	Issaquena	Lower Mississippi-Greenville	Chotard Lake	2002
Mississippi	Yazoo	Yazoo	Yazoo River at Highway 49W	2004
Missouri	New Madrid	Little River Ditches	Dry Run Lake, 1.6 km northeast of New Madrid	1997
Missouri		Lower Missouri	Missouri River	1998
Missouri		Lower Missouri-Blackwater	Missouri River	1998
Missouri	St. Charles	Peruque-Piasa	Mississippi River (Pool 26)	1998
Missouri	Cape Girardeau	Whitewater	Castor River, headwater diversion channel	1998
Missouri	St. Charles	Peruque-Piasa	Mississippi River (Pool 26)	2000
Missouri	Perry	Upper Mississippi-Cape Girardeau	Mississippi River at Wilkinson Island	2000
Missouri	Scott	Upper Mississippi-Cape Girardeau	Mississippi River, 25.7 river km south of Cape Girardeau	2001
Missouri	Cooper	Lamine	Lamine River	2002
Missouri	Lincoln	The Sny	Mississippi River Pool 25, 5.6 km northeast of Foley	2002
Missouri		Lamine	Lamine River	2003
Missouri	Cooper	Lamine	Blackwater River	2003
Missouri		Lower Grand	Grand River	2003
Missouri	Boone	Lower Missouri-Moreau	Missouri River near Hartsburg	2003
Missouri	Callaway	Lower Missouri-Moreau	Cedar Creek near Jefferson City	2003
Missouri	Cole	Lower Missouri-Moreau	Moniteau Creek about 1.6 km northwest of Marion	2003
Missouri	Howard	Lower Missouri-Moreau	Moreau River	2003
Missouri		Lower Osage	Osage River	2003
Missouri		Cahokia-Joachim	Mississippi River, Lock and Dam 27 downstream to Kaskaskia River	2004

Table 4.4. Continued

State or province	County	Drainage	Locality	Year
Missouri		Flint-Henderson	Mississippi River at Lock and Dam 19	2004
Missouri	Chariton	Lower Missouri-Crooked	Palmer Creek	2004
Missouri		Lower Missouri-Moreau	Little Chariton River	2004
Missouri	Boone	Lower Missouri-Moreau	Hart Creek	2004
Missouri	Boone	Lower Missouri-Moreau	Unnamed creek 2.4 km southeast of Hartsburg	2004
Missouri	Callaway	Lower Missouri-Moreau	Auxvasse River	2004
Missouri	Cooper	Lower Missouri-Moreau	Petite Saline Creek	2004
Missouri	Howard	Lower Missouri-Moreau	Moniteau Creek near Rocheport	2004
Missouri	Howard	Lower Missouri-Moreau	Bonne Femme Creek	2004
Missouri	Osage	Lower Missouri-Moreau	Loose Creek	2004
Missouri		Peruque-Piasa	Mississippi River (near Lock and Dam 26)	2004
Missouri		The Sny	Mississippi River, Lock and Dams 25-21	2004
Missouri		Upper Mississippi-Cape Girardeau	Mississippi River from Kaskaskia River downstream to Ohio River	2004
Nebraska		Missouri	Nonspecific (probably Missouri River)	2000
Nebraska	Dodge	Lower Platte	Elkhorn River 4.8 km northwest of Scribner	2003
Nebraska	Dodge	Lower Elkhorn	Elkhorn River, near Crowell	2003
Nebraska	Washington	Big Papillion-Mosquito	Boyer Chute National Wildlife Refuge	2005
Puerto Rico		Eastern Puerto Rico	At Dorado Beach Hotel golf course pond	1972
South Dakota		Lewis and Clark	Missouri River below Gavins Point Dam	2003
South Dakota		Missouri	Missouri River up to Gavins Point Dam	2003
South Dakota	Yankton	Lower James	Mouth of the James River	2003
South Dakota	Lincoln	Lower Big Sioux	Big Sioux River near Canton	2004
Tennessee		Lower Mississippi-Memphis	Mississippi River overflow	1989
Tennessee	Shelby	Lower Mississippi-Memphis	Mississippi River, river mile 743 near Memphis	2000
Tennessee	Shelby	Lower Mississippi-Memphis	McKellar Lake in Memphis	2005

Excerpts from EVALUATING ASIAN CARP COLONIZATION POTENTIAL AND IMPACT IN THE GREAT LAKES, AN AQUATIC INVASIVE SPECIES RESEARCH PROJECT, FINAL REPORT TO ILLINOIS-INDIANA SEA GRANT

By Walter Hill & Mark Pegg

Final Report to Illinois-Indiana Sea Grant

Evaluating Asian Carp Colonization Potential and Impact in the Great Lakes

Completion Date: August 31, 2008

An Aquatic Invasive Species Research Project
National Sea Grant College Program
National Oceanic and Atmospheric Administration

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Abstract

Filter-feeding Asian carp (bighead carp, *Hypophthalmichthys nobilis,* and silver carp, *Hypophthalmichthys molitrix*) threaten to invade Lake Michigan and other Great Lakes through the Chicago Sanitary and Ship Canal and through introductions via bait use or the release of fish from live markets. These carp consume plankton, the base of the pelagic food web, and could disrupt a critical food source for larval and adult fish currently inhabiting the lakes. However, it is not clear that Asian carp, which are usually found in productive habitats, could survive on the relatively sparse plankton typical of most of the Great Lakes. Respirometry, mesocosm growth studies, and bioenergetic models were used in this study to evaluate the potential for growth and successful establishment by Asian carp introduced into the Great Lakes. Respiration, a key component in bioenergetic models, was measured for >130 bighead and silver carp over a range of body sizes and environmental temperatures in both static and flowing-water respirometers. The respiration data were incorporated into standard bioenergetic models that calculated basic energy requirements of the carp. These requirements were then compared to planktonic food resources to predict when and where Asian carp could grow and survive in the Great Lakes. The modeling results and mesocosm growth experiments suggest that filter-feeding Asian carp will be unable to colonize most open water regions within the Great Lakes because of limited plankton availability. Productive embayments and wetlands are more likely to support Asian carp growth, and resource managers should focus monitoring and preventative efforts there.

Introduction

Invasive species have had extensive and well-documented negative effects on Great Lake ecosystems. Two new threats are the Asian carps: the bighead carp *Hypophthalmichthys nobilis* and silver carp *Hypophthalmichthys molitrix*. These fish have strong potential to invade the Great Lakes via an artificial connection between the Great Lakes and Mississippi River drainage basins. The connection between these drainage basins occurs via the Chicago Sanitary and Ship Canal (CSSC). Improvements in surface water quality during the late 20th century have recently transformed the man-made CSSC into a gateway for the transfer of invasive fishes between the Mississippi River and Great Lakes drainage basins. Bighead carp have moved up the Illinois River and are now within about 50 river miles of Lake Michigan. Bighead and silver carps migrate upstream to spawn (Verigin et al. 1978), so it is very probable that these fishes could naturally invade Lake Michigan through the CSSC if nothing were done to slow their advance upstream. An electric dispersal barrier currently operates in the CSSC about 22 miles below the Chicago River Lock in Chicago, but there is no guarantee that the barrier will be 100% effective at repelling fish under all conditions. Furthermore, although the CSSC is the most prominent invasion pathway, it is not the only one. Other pathways for introduction of the Asian carps into the Great Lakes remain. These pathways include the introduction of carp through the use of live bait or through illegal trade in live fish.

Both bighead and silver carp are planktivores, capable of consuming the phytoplankton and zooplankton that form the base of the pelagic food web in the Great Lakes. The ability of these filter-feeding carps to reduce plankton densities and potentially compete with native planktivores is of special concern in the Great Lakes. Zooplankton reductions mediated by zebra mussel colonizations have already been linked to reduced recruitment success of an important sport fish, the yellow perch, in Lake Michigan (Dettmers et al. 2003; Janssen and Luebke 2004). Furthermore, recent declines in alewife condition may also be related to reduced zooplankton and *Diporeia* availability since the zebra mussel invasion (Madenjian et al. 2002). If efficient planktivores like the bighead and silver carp establish themselves in the Great Lakes, populations of important native or naturalized fishes that rely on planktonic food sources, including yellow perch, rainbow smelt *Osmerus mordax*, and alewife, may be even further depressed. A reduction of the forage base could jeopardize the multi-billion dollar sport fishery for salmonines, as well as further complicate lake trout restoration efforts across the basin.

The potential impacts of bighead and silver carp to the aquatic fauna of the Great Lakes raise serious concern about these two invaders in the basin. Therefore, it is important to first understand whether these fish can survive and flourish in the Great Lakes. Not only will such information provide a critical first look at the potential for these invaders to establish large populations, but it also will be useful ecological information if these invaders do become established and decisions are made to attempt to control these carps.

A tacit assumption made in identifying Asian carp as significant threats to Great Lake ecosystems is that they will be able to grow on the relatively dilute plankton that occurs in large portions of the Great Lakes. Flourishing populations of filter-feeding Asian carp are historically associated with eutrophic conditions that feature abundant phytoplankton and zooplankton. Most areas of the Great Lakes are oligotrophic to slightly mesotrophic, and feature relatively low abundances of phytoplankton and zooplankton, especially since the arrival of zebra mussels. For example, mean chlorophyll *a* values in Lake Michigan and Lake Superior are <1 µg/L (EPA GLNPO Open Water Surveillance Program data), whereas mean chlorophyll a values in areas of the Mississippi River where Asian carp now thrive are >20 µg/L (J. Chick, INHS, personal communication). The ability of Asian carp to successfully exploit the relatively sparse food environment of the Great Lakes may be limited, particularly since these filter-feeding fish are likely to devote a substantial portion of their energy budget to swimming expenditures.

Our overarching objective was to provide solid scientific information on the likelihood that Asian carp will be able to colonize and impact the plankton of the Great Lakes. This information was intended to be used by resource managers and decision makers in prioritizing invasive threats and developing prevention and management strategies. Our specific objectives were to: (1) develop a predictive model of Asian carp consumption and growth in the Great Lakes using a bioenergetics approach; (2) test model predictions with growth and consumption experiments in mesocosms; (3) predict where in the Great Lakes Asian carp are likely to survive by feeding on plankton; and (4) provide initial estimates of the potential impact of Asian carp on Great Lake plankton communities.

The research described in this report was broken into several different components. First, we describe extensive respirometry measurements needed to provide data on carp respiration critical to the construction of bioenergetics models. This research was performed at the University of Nebraska and the Illinois Natural History Survey's Illinois River Biological Station, and it formed the basis of Jen Hogue's Masters's thesis. Second, we describe mesocosm growth experiments performed at the Jake Wolf fish hatchery along the Illinois River. These experiments measured the growth response of bighead carp to different plankton densities (including a density similar to that found in Lake Michigan) and also examined the effect of carp on zooplankton species composition. Third, we examined the combined effect of food quality and food quantity on the growth of bighead carp in mesocosm experiments performed at the University of Illinois to explore the possibility that the nitrogen or phosphorus content of Great Lakes plankton could limit carp growth in the Great Lakes. Fourth, we modeled potential carp growth with bioenergetic models that employed respiration coefficients obtained as part of this project, and compared the bioenergetics demands of growth to the energy available in plankton in various parts of the Great Lakes. We conclude from these studies that filter-feeding Asian carp are unlikely to colonize most open-water habitats in the Great Lakes because of food scarcity, but the carp may be able to persist in productive near-shore habitats if they are able to reach them.

Narrative

1. Respirometry

The objective of this part of the project was to measure oxygen consumption (respiration) rates for bighead carp and silver carp in relation to water temperature, swimming speed, and life-stage. These data were subsequently incorporated into bioenergetics models that predicted potential growth and food consumption rates of bighead and silver carp in Lake Michigan and other Great Lakes (see Narrative part 4 [below] for a description of the modeling results). The methods and results of the respiration measurements are presented in full detail in Hogue (2008) and Hogue and Pegg (submitted), and only the major points will be described here. Briefly, oxygen consumption was measured in both static and flowing-water respirometers. Respiratory rates were measured on >130 individuals that included juvenile and adult fish of both species. Established respirometry methods were employed to measure respiration over a range of water temperatures (5, 10, 15, 20, and 25°C), different life stages (juvenile fish < 50-cm, and adult fish >50-cm), and different activity levels (0.0-m/s, 0.3-m/s, and 0.6-m/s). Trials were conducted over one hour using a static respirometer to measure resting respiration rates and a swim chamber to conduct active trials.

Respiration was influenced by fish size, temperature, and activity. Figure 1 illustrates the overall relationship between oxygen consumption rate (OCR) and fish size, which was allometric.

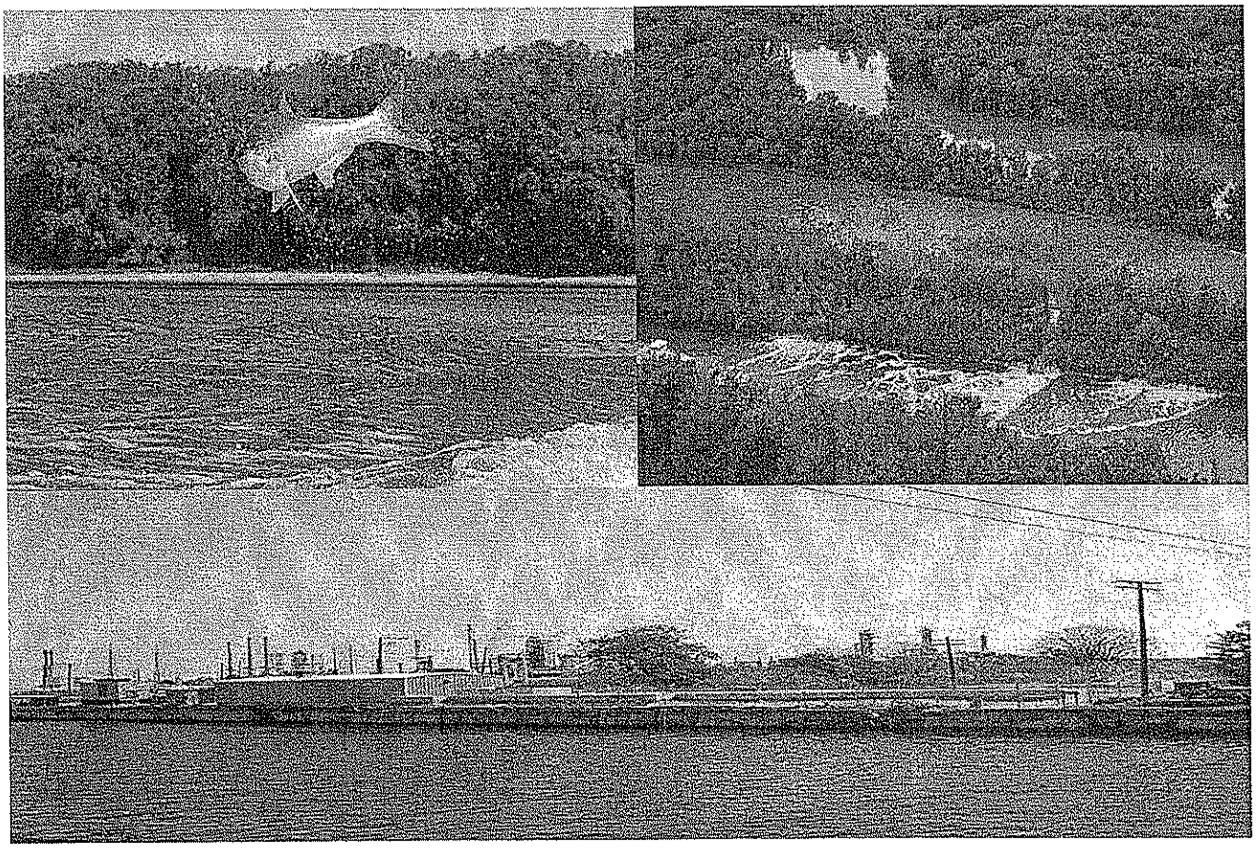
Excerpts from DISPERSAL BARRIER EFFICACY STUDY,

INTERIM I – DISPERSAL BARRIER BYPASS RISK REDUCTION STUDY & INTEGRATED ENVIRONMENTAL ASSESSMENT, DECEMBER 2009 DRAFT REPORT

By U.S. Army Corps of Engineers
Chicago District

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

Executive Summary

The fish electrical dispersal barrier system (Barriers I, IIA, & IIB) is a unique project that significantly reduces the risk of an inter-basin transfer of Aquatic Nuisance Species (ANS) fish between the Mississippi River and Great Lakes basins via the Chicago Sanitary and Ship Canal (CSSC). The project authority was clarified and expanded in WRDA 2007, Section 3061 (b)(1)(D) and directed the US Army Corps of Engineers (USACE) to conduct a study of a range of options and technologies for reducing impacts of hazards that may reduce the efficacy of the barriers. USACE divided the focus of investigations into four major areas: ANS Barrier Bypasses, Optimal Operating Parameters of the Barriers, ANS Human Transfer and ANS Abundance Reduction.

In the summer of 2009, USACE began employing a new monitoring method, Environmental-DNA (eDNA), which identified potential locations of Asian carps much further upstream in the CSSC than previously thought. In response to eDNA testing results that indicate Asian carps may potentially be one mile south of the barrier system within the CSSC and located in both the Des Plaines River and Illinois & Michigan (I&M) Canal, Congress included a new authority within the Section 126 of the Energy and Water Development Appropriations Act of 2010, P.L. 111-85. This new authority directs the Secretary of the Army to implement measures recommended in the efficacy study, or provided in interim reports, authorized under section 3061 of the Water Resources Development Act of 2007 (121 Stat. 1121), with such modifications or emergency measures as the Secretary of the Army determines to be appropriate, to prevent aquatic nuisance species from bypassing the Chicago Sanitary and Ship Canal Dispersal Barrier Project referred to in that section and to prevent aquatic nuisance species from dispersing into the Great Lakes.

Interim I study 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 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. These discussions are located in Appendix E.

An Interim report will document investigations into optimal parameters for operating the electric field of the Dispersal Barriers and will recommend the best settings to deter both adult and juvenile Asian carps. The District will implement the recommended operating parameter as part of the Barrier Project's operation and maintenance in the near term

Another Interim Report will include a recommendation for a permanent solution to Dispersal Barrier bypass. The implementation of additional dispersal barriers or other physical features to further reduce the risk associated with physical bypass will be a focus of this efficacy study, which will require Congressional authorization and appropriations for implementation. This report will provide a summary of all interim reports completed to date and recommend a long-term, multi-agency comprehensive strategy for improving the efficacy of the dispersal barriers and reducing the population effects of Asian carps within the Illinois River system. The long-term strategy will be coordinated with other agencies and concerned stakeholders that can contribute to efforts related to the reduction of Asian carps in the Illinois River System and CSSC. Additional studies may be undertaken in the future as technologies to address ANS species evolve, to ensure that the Barriers project continues to function to keep ANS fish species from entering the Great Lakes basin.

Interim Risk Reduction Emergency Measures Considered

A USACE Project Delivery Team (PDT) evaluated risk reduction measures that could serve as a physical barrier to the passage of ANS fish, specifically Asian carps from the Des Plaines River overland to the Chicago Sanitary and Ship Canal. Due to the high levels of concern of fish bypass during wet weather the team considered measures traditionally employed for advance flood-fighting, as well as non-traditional measures that would serve as an effective barrier to minimize the risk of carp movement via the Des Plaines bypass. The measures considered, are as follows:

1. No Action – Maintains the status quo and would most likely allow for the Asian carps to bypass the barrier system.

2. Gabion Baskets – Stacked Gabion baskets made of galvanized wire mesh and filled with stone could be utilized. Typical dimensions of a single basket are 3'x3'x6' with 3"x3" openings in the wire mesh. They can be constructed at the project site and stacked as necessary to the desired height. The current estimate assumes the gabion baskets would be filled with rip rap. The topsoil will be stripped and a 6" layer of compacted gravel will be placed prior to placement. This option likely has the longest installation time of the all the barrier options. The gabion baskets would become impermeable over time as they filled with silt, debris and vegetation.

3. Concrete Barricades – Precast concrete barricades are an impermeable barrier. Typical dimensions are 2'-3" tall x 12'-6" long with a 1'-7 5/8" base width and 8" top width. Concrete barricades will be precast and delivered to the site. Barricades are available with male-female ends so that they can be fitted together to minimize flow between the barricades. The topsoil will be stripped and a 6" layer of compacted gravel will be placed prior to placement. Installation time is minimal, although lead time may be required. Placement of compacted gravel and fitted ends will minimize need for sandbags and plastic sheeting.

4. Rapid Deployment Flood Walls (RDFW's) – A RDFW is a modular, collapsible plastic grid that serves as a direct replacement for sandbag walls, which forms an impermeable barrier. Typical dimensions are 8" tall x 3'-6" long x 3'-6" wide. They are assembled in place to the desired height and then filled with sand. It can be assembled with minimal labor and filled with a loader. The topsoil will be stripped and a 6" layer of compacted gravel will be placed prior to placement. Although this feature is typically dismantled after the flood risk is gone, in this application, the RDFW would remain in place until a permanent solution to fish bypass is implemented.

5. Concrete Blocks – Concrete blocks are an impermeable barrier. Typical dimensions vary depending on the height. Concrete blocks will be precast and delivered to the site. The topsoil will be stripped and a 6" layer of compacted gravel will be placed prior to placement. Installation time is minimal, although lead time may be required.

6. Chain Link Fencing – Chain link fence is a permeable barrier. Typical dimensions of a section of fence are 6′ long by either 4′, 6′ or 8′ tall. It would consist of 6 gauge galvanized wire steel mesh with 1/4″ openings. Fence posts will be four inches in diameter galvanized steel and will be set four feet into the ground into a twelve inch diameter concrete post hole. The posts will be spaced six feet on center. In areas where bedrock exists at the surface, the bedrock will be drilled to accommodate the post holes. The 6′ & 8′ tall fence will have three rails (top, middle, bottom) horizontally between the fence posts and the 4′ tall fence will only have two (top & bottom). Rails will be 1 5/8″ diameter galvanized steel pipe. This is not a tried and true method for excluding fish, but theoretically it can stop the dispersal of Asian carps as long as the structural integrity of the fence is maintained. An angled non-barbed wire extension will be placed atop of the fence to thwart leaping silver carp. Issues that may arise from using the fence include vandalism and breakage, clogging with riverine debris and scouring at the base. Continual maintenance would need to be performed to remove clogs and to ensure that if fence cutting occurs, it is quickly mended. Installation time is long and lead time will be necessary because the current robust design of the fence requires materials in massive quantities that will not be found in stock. Riprap will be placed along the bottom fence rail in areas where scour could be an issue during a major flood event.

7. Culvert Blocking – The recommended near term solution for the I&M Canal potential bypass, after preliminary H&H analysis, is to block off the I&M Canal at Cico Road and slip line (reduce the roughness of the pipe by inserting a PVC pipe in the existing culvert) and add inlet transitions to the International-Matex Tank Terminals (IMTT) culverts. The hydrologic flow divide is located just east of Cico Road, so placing a barrier here would not affect stormwater flows or induce flooding. Inclusion of additional freeboard will be evaluated during detailed design and floodway permit process.

8. Chain Link Fence & Concrete Barricade Combo / Block I&M Canal – Optimized combination of concrete barricade and chain link fence with ¼″ openings for the Des Plaines bypass, and culvert blocking to address the I&M Canal bypass.

Preferred Risk Reduction Measure

It is the Interim I Report's recommendation to implement the optimized interim risk reduction measure as a temporary and emergency solution. The preferred risk reduction measure is to place 34,600-feet of Concrete Barricades and 33,400-feet of Chain Link Fence with ¼″ openings. The total project cost of this IRRM is currently estimated to be [redacted]. The implementation of this measure would protect 68,000-feet (~13-miles) of flood prone area along the CSSC upstream of the Dispersal Barriers. Also, the two culverts under Cico Road in the I&M Canal will be disabled and the flow capacity increased at the IMTT culverts.