Paper 90 – Asian Carp and the Corps of Engineers: Combating Invasive Species within the Inland Navigation System

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ABSTRACT: There is no question that globalization and increased shipping has fostered economic growth and improvements in living standards around the globe. However, increased shipping has resulted in greater opportunities for unwelcomed guests in ballast water which can create ecologic and economic havoc. Over the past several years, the Corps of Engineers has been struggling mightily to prevent Asian carp and other invasive species on the inland river system from reaching the Great Lakes. This paper highlights how quickly invasive species could take hold and potentially impact river traffic along with highlighting the actions the Corps of Engineers has taken to mitigate the problem, as explained in its recent Great Lakes and Interbasin Mississippi River Study (GLMRIS).

1 INTRODUCTION

Globalization and increased shipping has untapped new markets, created millions of waterborne and port-related jobs while connecting the world in ways that could not have been imagined a generation ago. At the same time, the inter-connectedness has created opportunities for unwelcomed stowaways in ballast water and other opportunistic places. Once they debark in a new land, invasive species can quickly outcompete native species and create not just ecological havoc, but economic problems as well.

2 BACKGROUND

During the 1970's, catfish farmers in the Southern United States began importing East Asian carp mainly as a means of controlling algae in their fish ponds (ironically, with the blessing of the Environmental Protection Agency). Significant flooding in the early 1990s along the lower Mississippi River allowed the carp to escape and spread northward, voraciously devouring the food chain along its path. Within a short 10 year-period, the carp had multiplied significantly and spread nearly 1,000 miles, moving into the Illinois and Ohio Rivers (Figure 1). In response, the Corps of Engineers constructed electric barrier systems to deter further migration while the State of Illinois began commercially harvesting the invasive species and applying fish pesticides. Nonetheless, the carp continued to migrate, passing through the barriers and by 2009, was found just 55 miles from Lake Michigan[1]. In December 2009, the State of Michigan filed a lawsuit with the U.S. Supreme Court and demanded the immediate closure of the Chicago Sanitary and Ship Canal to prevent the carp from reaching Lake Michigan and jeopardizing the multi-billion dollar sport and commercial fishery and tourism industries. The State of Illinois along with the Illinois Chamber of Commerce and the American Waterways Operators responded with a counter-suit, arguing that a closure would disrupt the movement of millions of tons of essential coal, grain and other cargo. In 2010, the U.S. Supreme Court rejected the closure. The U.S. Court of Appeals also rejected the preliminary injunction in the following year.

[1] In fact, by 2010 a bighead carp was captured in Lake Calumet, just five miles from Lake Michigan

While Asian carp has been the most publicized, it is not the only invasive species posing a problem to the Great Lakes and Mississippi River Basins. Other recent invasive species include zebra mussels, quagga mussels, Eurasian ruffle and a host of viruses and non-native plants, many of which will not be stopped by the present control measures. It is believed that additional non-native species will be invading in the decades to come, creating legal and potential logistical challenges to the inland river system.

Figure 1: Asian Carp on the Illinois River

2.1 *The Chicago Area Waterway System*

The CAWS is an approximately 130-mile network of canals, locks and channelized rivers that was built in the 1890's and is located in northeastern Illinois and northwestern Indiana (Figure 2). There are five major gateways between the CAWS and Lake Michigan. The Chicago Sanitary and Ship Canal connects the system to the Illinois River and the Mississippi River watershed. The system is used for a variety of purposes including commercial and recreational navigation, sewage treatment, water supply, and flood control.

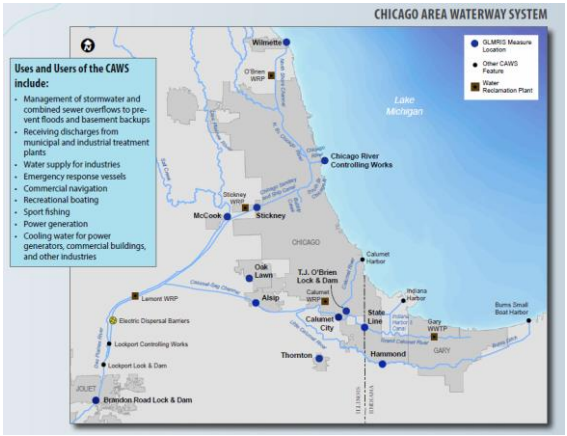

Figure 2: Chicago Area Waterway System

Historically, an average of 23.8 million tons of cargo has moved on the CAWS over the past 15 years with a peak of 28.8 million tons in 2006 and a low of 19.7 million tons in 2010. And while shallow traffic has been declining since 1994, deep draft traffic has increased over that same time period. Coal and coke, petroleum, grains, aggregates, chemicals, ores, iron and steel comprise the largest share of commodities moving on the CAWS. Other users of the CAWS include passenger boats and ferries, non federal government vessels, commercial fishing vessels, federal government vessels, and recreation vessels.

3 GREAT LAKES AND MISSISSIPPI RIVER INTERBASIN STUDY (GLMRIS)

Following a series of reports highlighting the risks and harmful effects of invasive aquatic species, the U.S. Congress in 2007 authorized the Great Lakes and Mississippi River Interbasin Study (GLMRIS) with the goal of providing options that prevent the transfer of invasive aquatic species between the Great Lakes and Mississippi River basins. The Corps of Engineers, with collaboration with other federal agencies, Native American tribes, state and local governments and non-governmental organizations, completed the study in 2014.

With a study area encompassing nearly 1,500 square miles (Figure 3), the inter-agency team first catalogued 254 "aquatic nuisance species" (ANS) to be present in either or both basins. Through extensive literature reviews and stakeholder meetings, the Corps then honed in on the five aquatic waterways specific to the CAWS and identified 13 of the most critical species that would cause medium to high risk of adverse impacts. These species include a virus, algae, plants, mollusks, crustaceans, and fish and were classified by timing of potential impact and extent of effects by their transfer and establishment in the opposite basin (Figure 4). Identifying species and the risk assessment were instrumental to the formulation of project alternatives.

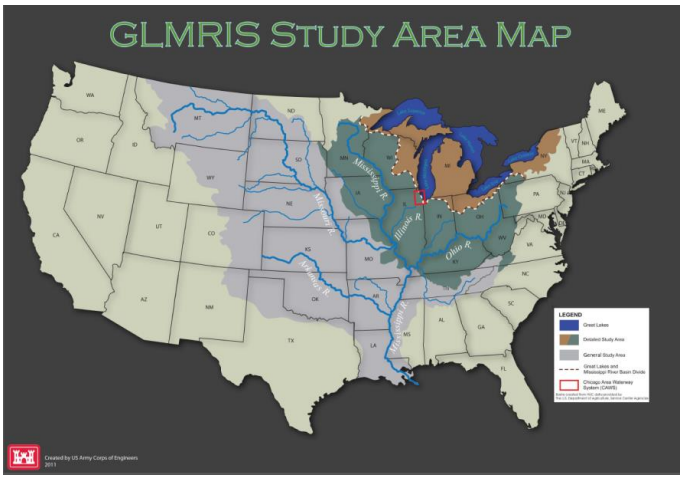

Figure 3: GLMRIS Study Area Map

Taxonomic Category	Common Name	Scientific Name	Basin Currently Inhabited[a]	Risk Level	Time Period to Attain Risk Level[b]
Virus	VHSv (viral hemorrhagic septicemia virus)	*Novirhabdovirus* sp. (Family *Rhabdoviridae*)	GL	Medium	T_{10}
Algae	Grass kelp	*Enteromorpha flexuosa*	GL	Medium	T_{10}
	Red algae	*Bangia atropurpurea*	GL	Medium	T_0
	Diatom	*Stephanodiscus binderanus*	GL	Medium	T_0
Plants	Reed sweetgrass	*Glyceria maxima*	GL	Medium	T_{50}
Crustaceans	Fishhook waterflea	*Cercopagis pengoi*	GL	High	T_{25}
	Bloody red shrimp	*Hemimysis anomala*	GL	High	T_0
	Scud	*Apocorophium lacustre*	MR	Medium	T_0
Fish	Bighead carp	*Hypophthalmichthys nobilis*	MR	Medium	T_{25}
	Silver carp	*Hypophthalmichthys molitrix*	MR	Medium	T_{25}
	Threespine stickleback	*Gasterosteus aculeatus*	GL	Medium	T_0
	Ruffe	*Gymnocephalus cernuus*	GL	Medium	T_{50}
	Tubenose goby	*Proterorhinus semilunaris*	GL	Medium	T_{10}

Figure 4: ANS Posing Medium or High Risks of Adverse Impacts Following Interbasin Transfer through the Chicago Area Waterways System

3.1 *Formulation of Alternatives*

The GLMRIS team formulated eight alternative plans including a No New Federal Action Alternative which simply sustains the present actions in place; e.g., commercial fish harvesting Asian carp, electro-fishing and other monitoring and control methods. This alternative served as the "Without Project Condition" baseline. The team also formulated a more comprehensive non-structural alternative (Alternative 2) involving removal (e.g., netting), chemical control (e.g., herbicides), restricted boat access and new boat cleaning stations, as well as expanded education and awareness programs. Through a collaborative planning charette process, some control measures such as applying lethal temperatures were removed from consideration.

Alternatives 3 through 8 employ various levels of structural control methods such as newly-designed GLMRIS Locks, electric barriers, ANS treatment plants, screened sluice gates, and physical barriers. The new GLMRIS locks will be comprised of gate systems that allow vessel traffic but contain a series of structures and special equipment to control the transfer of ANS. As shown in Figure 6, after a vessel enters and the lock is closed, ANS-treated water will then be pumped into the lock, replacing the water that spilled in with the vessel.

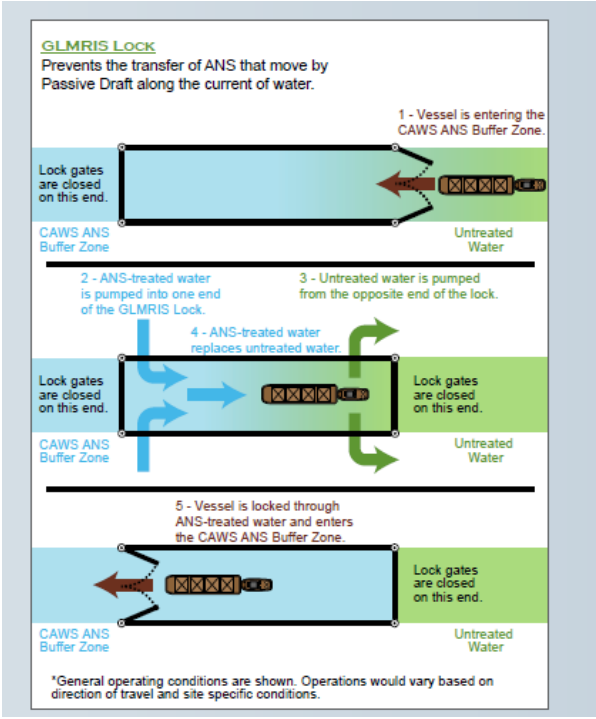

Figure 6: Vessel Passing through GMRIS Lock

To provide even more protection from ANS, the GLMRIS Locks will be designed with electrodes at the bottom of the approach channels and powered by a control house, creating an electric field in the waterway. Fish will then be repelled or stunned by the electricity, which restricts their movement into the GLMRIS Lock (Figure 7).

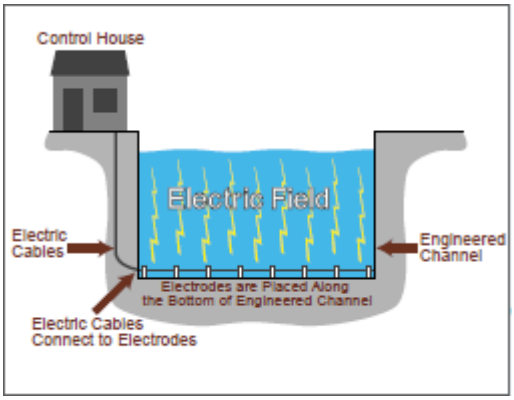

Figure 7: GLMRIS Electric Barrier Layout

Other components include an ANS treatment plant designed to remove ANS from water within the GLMRIS Lock. The process of treating the water includes screening, filtration, and exposure to ultraviolet light (UV) (Figure 8).

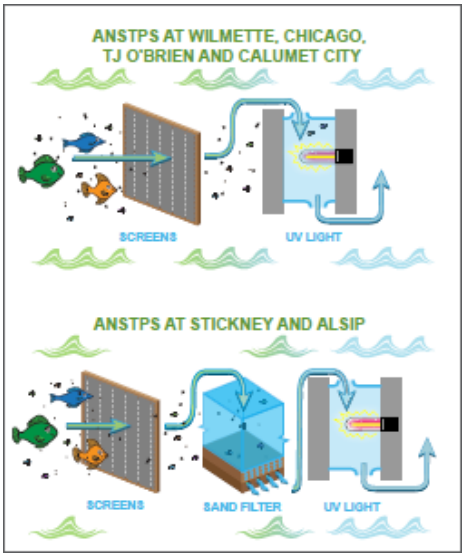

Figure 8: Treatment Plant Process

Screened sluice gates will allow water to pass during significant flood conditions, but restricting fish passage through the structure at the same time (Figure 9).

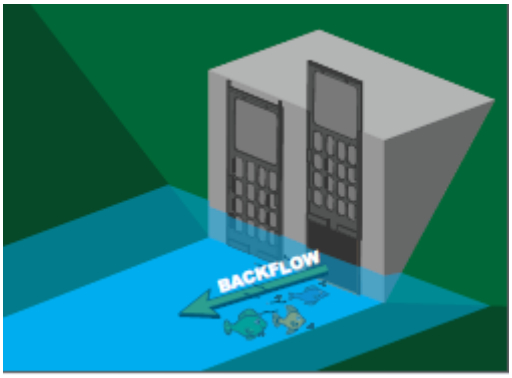

Figure 9: Screened Sluice Gates

The GLMRIS team also proposed several larger structural control measures used to separate one water body from another. Buffer zones will help separate the waterways between upstream and downstream control technologies. Hydrologic separation involves placing physical barriers in waterways to block aquatic connections between basins. Specifically, barriers will be built with concrete and sheet piles but could also be used for park space or pedestrian bridges. Many of the alternatives are hybrids which contain a combination of these separation measures (Figure 10). Additionally, the GLMRIS alternatives involved various levels of mitigation such as water quality improvements to building conveyance tunnels to increased storage for excess storm water and waste water rain events to sediment cleanup.

STRATEGIES USED IN EACH GLMRIS ALTERNATIVE

Alternative Plan	No New Actions	Non-structural Controls	Structural Control Technologies	Buffer Zone	Hydrologic Separation
1	X*				
2		X			
3		X	X		
4		X	X	X	
5		X	X		X
6		X	X		X
7		X	X	X	X
8		X	X	X	X

*Current and previously planned activities sustained

Figure 10: Combinations of Measures used in each GLMRIS Alternative

3.2 *Evaluation of Alternatives*

Without recommending one alternative, the study team evaluated each alternative based on: (1) the perceived effectiveness of each control alternative; (2) its implementability; (3) the frequency of application; (4) public acceptance; and (5) cost of each control measure. They also performed an extensive economic analysis of the without project and with project conditions with respect to commercial, recreation and charter fishing, commercial navigation (both cargo and non-cargo related); changes in flood risk, water quality and hydropower. The report was quite comprehensive and traced the ramifications of each alternative. For example, alternatives containing hydrologic separation would prevent many shallow-draft cargo movements from using the CAWS and so industries would need to switch to truck or rail, find alternative sources for input, sell their output in different markets, or go out of business altogether. Other alternatives calling for additional locks to the system would potentially lengthen lockage times resulting in increased transportation costs.

Finally, the team performed an extensive assessment of the regional economic activity associated with fishing and commercial navigation activities within the Great Lakes, Upper Mississippi River, and Ohio River basins. This evaluation serves as an indicator of what regional economic activity (e.g., sales, income, employment) are at risk in the Without Project and/or With Project conditions.

3.3 *Estimated Project Costs*

The estimated cost of the projects which include mitigation costs, range from $68 million for the Additional Non-Structural Alternative to $18 billion for Lakefront Hydrologic Separation, which entails numerous physical barriers, ANS treatment plants and reservoirs to address induced flooding created by the barriers. Several of the alternatives may take as much as 25 years to become fully operational, while others such as the non-structural controls could be implemented immediately. Follow-up study on specific components of the system such as Brandon Road Lock has recently begun.

4 CONCLUSION

Aquatic invasive species, often a consequence of increased shipping, remains a serious concern with potentially devastating impacts to a region's economy and environment. Invasive species cost the Great Lakes region alone an estimated $200 million annually and the looming threat of Asian carp and others have grown in recent years. Additional information on the GLMRIS can be found at the GLMRIS website: http://glmris.anl.gov/

REFERENCES

U.S. Army Corps of Engineers, Great Lakes and Mississippi River Interbasin Study.

U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center