Environment and Natural Resources Trust Fund

2022 Request for Proposal

General Information

Proposal ID: 2022-261

Proposal Title: Commercialization Safe, Selective and Low-cost Carp Piscicide

Project Manager Information

Name: Maurice Sadowsky

Organization: MJSTI Corp.

Office Telephone: (302) 559-2998

Email: maurice@carpfree.com

Project Basic Information

Project Summary: The project commercializes a proved-on Koi and patented (US 10,617,119,) a safe (FDA additives), selective by digestion and low-cost piscicide with the goal of controlling invasive carps.

Funds Requested: $200,000

Proposed Project Completion: October 31 2023

LCCMR Funding Category: Small Projects (H)

Secondary Category: Aquatic and Terrestrial Invasive Species (D)

Project Location

What is the best scale for describing where your work will take place?

Region(s): Metro

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Bigheaded and common invasive carps are long life, fecund fish that diminish North American environment. Without control of recruitment, Population Dynamics and carp harvesting history state incomplete adult harvesting increases carp bio-density, the "hydra effect". In a water body above 5,000 acers, it is not possible to remove enough carp to prevent the "hydra effect". The counter intuitive "hydra effect" suggests the way to control these carps is eliminate/reduce recruitment while increasing fish mortality.
Rotenone is the only general use EPA approved piscicide. Rotenone kills all aquatic life and is harmful to mammals. The USGS Asian Carp piscicide program is focused on overnight kill. The USGS proposals lack commercial viability by ignoring the EPA 2007 antimycin A re-registration, lack of supply of antimycin A and beeswax and has no commercial partners. The only 2021 Asian carp Action plan population control is harvesting. Harvesting carp in three non-reproducing pools downstream pools from electric barrier is successful. However, harvesting in the lower Illinois, middle Mississippi and Ohio Rivers and Lake Kentucky has not reduced but increased the bigheaded carp population.
Without carp population control the common carp will inhabit Minnesota Lakes and the Asian carp will invade Minnesota and the Great Lakes.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

MJSTI proved on Koi, common carp that pellets consisting of fat coated water insoluble basic copper carbonate and a slow water-soluble amino acid will kill carp. The carp consumes both beads. In the carp's intestines enzymes strip off the fat and the amino acid instantly makes soluble the copper salt. The fish absorbs the copper ion which causes organ damage. In common carp copper poisoning, the fish converts to anerobic digestion and ceases to eat. Sub-lethal copper carp poisoning will decreases fertility/sterilize both male and female carp and impair the viability of embryos/fry.
Copper is a micro-nutrient required for life, ubiquitous in the environment and ten times more toxic to fish than it is to humans. The MJSTI copper piscicide is likely synergistic with MAISRC Koi herpes virus since both affect the carp's liver.
Common carp uniquely consume corn meal which allows for a selective carp piscicide. The USGS demonstrated bigheaded carp will consume beads confined by a foam ring and fed by an augur.
The limitation of the MJSTI piscicide is low toxicity. Since carp are voracious eaters, the fish selectively endanger themselves. The project goals are maximizing and determining toxicity and start EPA registration.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

The outcomes of this project are optimized and increased toxicity of the MJSTI intestinal soluble copper ion piscicide, preferred formula common carp LD50/LD99, agglomeration of a buoyant preferred bigheaded carp formula bead, agglomerated preferred formula bigheaded carp LD50/LD99 and start the EPA formula and usage registrations.

Activities and Milestones

Activity 1: Common carp experimental design

Activity Budget: $85,000

Activity Description:
The purpose of this step is to determine the ratio optimum ratio of copper salt to amino acid, how concentrated the copper salt can be in the bead and determine if tryptophan can replace fat coated lysine. Tryptophan reduces inactive ingredients by 25%. Dr. Mengetti's fish physiology model should provide potential synergistic agents to increased toxicity. Maurice Sadowsky will make the pellets by drying a cross-linked hydro-colloid gel (process perfected in the patent work). COVE Environmental, an independent aquatic laboratory will conduct the fish tests.

Activity Milestones:

Description	Completion Date
Plan work: EPA Consultant, Dr. Mingetti	August 31 2022
Prepare samples	September 30 2022
Run experimental design	November 30 2022
Determine Common Carp LD50/LD99	December 31 2022

Activity 2: Prepare optimized buoyant fat coated copper/amino acid bead for bigheaded carp test. Determine LD 50/LD99 on bigheaded carp.

Activity Budget: $75,000

Activity Description:
The fat coated basic copper carbonate beads float and are imperious to water. Bigheaded carp need to see the beads, so the beads must break the surface of the water without sinking. The ideal bead is about 200 microns and under 500 microns to limit damage to paddlefish. The plan is to experiment with agglomeration of tryptophan and other water insoluble but miscible materials to allow at least a partial breaking of the water surface. The bead formulation will use the learning from the previous common carp experimental design. COVE is willing to handle bigheaded carp but will need permission from at least Oklahoma government. Dr. Menghetti will advise on design experiments. COVE Environmental will conduct the fish tests.

Activity Milestones:

Description	Completion Date
Determine bead agglomerate process	December 31 2022
Bigheaded carp permission	December 31 2022
Prepare beads	February 28 2023
Determine bigheaded carp LD50/LD99	June 30 2023

Activity 3: Start EPA Regristration

Activity Budget: $40,000

Activity Description:
In 2020 by email an EPA manager stated the approval for the fat coated basic copper carbonate/amino acid piscicide should be for a new application and maybe a new form of the EPA approved copper salt aquatic pesticide ingredient. At the time the registration fee was $20,000 and a six-month review. The EPA manager warned me that non-target species testing is likely to be significantly higher than $20,000. The manufacturer of the copper salt will support the registration.

An EPA consultant is needed guide the process and complete filling forms.. The EPA suggests a pre-filing meeting in which the EPA “recommends” data needed before filing.

Activity Milestones:

Description	Completion Date
EPA consultant prepares filing	July 31 2023
EPA pre-registration meeting	August 31 2023

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?

MJSTI's market estimate for a carp piscicide is $5 to $10 million per year. The EPA may allow limited sales to support registration. Once registered, the plan is for sales to support needed capital. For a ENRTF $200,000 grant, MJSTI is willing to pay a $0.20 per pound royalty for the life of the patent. Once fully commercial, ENRTF should receive 100% of granted funds per year. Maurice Sadowsky invested over $50,000, at least three FTEs and no income. MJSTI owes about $50,000 in success-based debt. The GLFC provided a $11,000 grant.

Project Manager and Organization Qualifications

Project Manager Name: Maurice Sadowsky

Job Title: President

Provide description of the project manager's qualifications to manage the proposed project.

Maurice Sadowsky is MJSTI Corp. Mr. Sadowsky has over 40 years sales, marketing, and business development experience working for Hercules Inc. and then American Ingredients/Caravan Ingredients/Corbion. Using problem solving Mr. Sadowsky increased sales almost 1,000 over 13 years, turned around a $20 million product from a loss to $2.3 million profit and know for market research. Mr. Sadowsky was a problem solver, listening to customers, researching technologies and self-learning accounting and business skills. Mr. Sadowsky used Dr. Porter's Five Forces for market research and Dr. Cooper's Stage-Gate for Business Development.

In 2012 Mr. Sadowsky started market and technology research on the Asian carp problem and determined that the USGS piscicide program lacked commercial viability. Mr. Sadowsky recognized the potential market is small, too small for pesticide companies or private investors. After several false starts in 2017 Mr. Sadowsky purchased a hand-held hot melt sprayer allowing the micro encapsulation of ingredients. Mr. Sadowsky built and operated a fish aquatic laboratory. The development of the soluble copper in the carp's intestine came from two years of spray and fish testing and literature research. In 2019 the Great Lakes Fishery Commission funded the commercial production of the fat coated basic copper carbonate bead at the Aveka Group, Woodbury, MN. Mr. Sadowsky retained 80 pounds of the trial products. An anonymous laboratory conducted bigheaded carp testing. The laboratory work was sloppy and lacked controls. The recommendation from the laboratory was copper bead needs to be buoyant (vs. floating) and increased toxicity. Both recommendations are in this proposal. The US patent office granted MJSTI US 10,617,119, April 14, 2020, Piscicide Composition. Mr. Sadowsky gave four papers at Midwest Fish and Wildlife and ICAIS conferences and applied for 14 grants.

https://www.linkedin.com/in/mauricesadowsky/

Organization: MJSTI Corp.

Organization Description:

MJSTI is a sub chapter S Delaware corporation whose only employee is Maurice Sadowsky. In addition to the piscicide development, MJSTI completed several market research projects and acted as a manufacturer representative. COVE Environmental LLC is a woman owned small business (SBC_001695079) focused on aquatic toxicity. COVE uses the Ecological Test Guidelines OCSPP 850.1075 for freshwater and salt water fish acute toxicity test. Dr.. Matteo Minghetti, Assistant Professor, Oklahoma State University will see the project to ensure proper protcols are used by both Maurice Sadowsky and COVE Environmental. Dr. Minghetti is a fish physiologist whose active work includes fish physiology modeling. Dr. Minghettie' doctoral studies focused on both food borne and waterborne copper toxicity in fish. Web

sites: www.carpfree.com, https://covesciences.com/, https://integrativebiology.okstate.edu/people/faculty/367-matteo-minghetti

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Maurice Sadowsky		Project Manager, Prepare samples			0%	1.3		-
							Sub Total	**-**
Contracts and Services								
COVE Enviromental, LLC	Sub award	COVE Environmental will conduct the common and bighead carp toxicity testing. In 2020, COVE estimated the cost is $1,500 per test.				0.3		$70,000
Dr. Matteo Minghettie, Oklahoma State Univeristy	Professional or Technical Service Contract	Dr. Matteo Minghetti, Assistant Professor, Oklahoma State University will ensure proper protocols are used by both Maurice Sadowsky and COVE Environmental. Dr. Minghetti is a fish physiologist whose active work includes fish physiology modeling. Dr. Minghettie' doctoral studies focused on both food borne and waterborne copper toxicity in fish				0.25		$60,000
Not choosen	Professional or Technical Service Contract	An EPA Consultant is required to complete submission paper work and guide the process. The consultant will have two functions in the process. An initial consultation to ensure the tests completed by COVE Environmental meet EPA standards. The second is to complete the EPA submission request and attend the EPA				0.1		$25,000
							Sub Total	**$155,000**
Equipment, Tools, and Supplies								
	Tools and Supplies	Tryptophan, other chemicals	Materials used to make beads and pellets					$1,000
							Sub Total	**$1,000**
Capital Expenditures								
		Pellitizer, Pan sprayer	Equipment to make pellets and beads					$19,000

							Sub Total	**$19,000**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
							Sub Total	**-**
Travel Outside Minnesota								
	Miles/ Meals/ Lodging	0 to 2 trips to Stillwater, OK; 1-2 trips to EPA Washington, DC; est. 3,000 to 6,000 miles	Maurice Sadowsky to visit Stillwater, OK if necessary and Maurice Sadowsky and EPA consulant to visit EPA in Washington, DC.	X				$5,000
							Sub Total	**$5,000**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
		EPA Filling Fee	To file for EPA regristation of a new application for copper salt as a piscicide					$20,000
							Sub Total	**$20,000**
							Grand Total	**$200,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Travel Outside Minnesota	Miles/Meals/Lodging	0 to 2 trips to Stillwater, OK; 1-2 trips to EPA Washington, DC; est. 3,000 to 6,000 miles	Meeting in Stillwater to review laboratory and discuss experimental plans. Meeting in Washington DC for pre-filing meeting to discuss the issues of the MJSTI piscicide with EPA before filing for registration.

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
In-Kind	MJSTI Corp., product made at Aveka Group, Woodbury, MN	Approximately 80 pounds of 14%, 24% and 32% basic copper carbonate coated with fully hydrogenated soybean oil.	Secured	$10,000
			State Sub Total	**$10,000**
Non-State				
In-Kind	Maurice Sadowsky	Maurice Sadowsky will manage the project with no income and prepare samples at no income.	Secured	$75,000
In-Kind	MJSTI technology	MJSTI invested over $50.0000, has approximately $50,000 in debt based on success and at least three man years of research. Maurice Sadowsky experience includes what makes a product carp will consume, the understanding of raw materials supply and cost, process to make the products as well as the limits of the optimum technology. The investment total is on the order of $500,000.	Secured	$500,000
			Non State Sub Total	**$575,000**
			Funds Total	**$585,000**

Attachments

Required Attachments

Visual Component

File: e53880cc-7b6.docx

Alternate Text for Visual Component

Bigheaded Carp Population Control, April 2021 is a report by Maurice Sadowsky that reviews the Asian carp problem, the Federal response and Population Control options. The 2021 report is not complete but includes a section on Population Dynamics. Although 21 pages long, the report is full of graphics and has three pages of graphics....

Optional Attachments

Support Letter or Other

Title	File
KS Letter of Support	733a8dd5-9bc.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have potential for royalties, copyrights, patents, or sale of products and assets?

Yes

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

Yes

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

No

Does your project include original, hypothesis-driven research?

No

Does the organization have a fiscal agent for this project?

No

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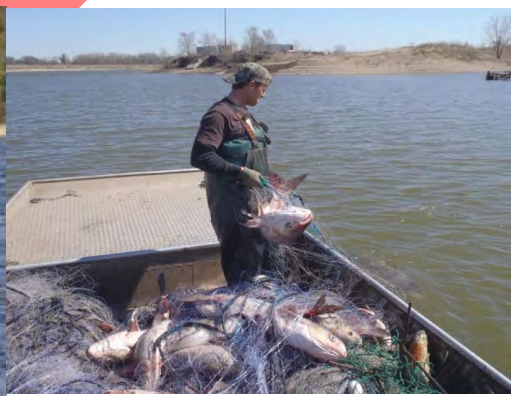
Safe. Selective. Low-cost.

April 2021

Bigheaded Carp Population Control

A REVIEW OF THE BIGHEAD AND SILVER CARPS CHALLENGE, PROGRAMS, SCIENCE AND ANALYSIS OF POPULATION CONTROL MEDTHODS.

MAURICE SADOWSKY, MJSTI CORP.



To understand the issues involved in controlling an invasive species consider the invasion curve. As time passes the invasive species population grows, the higher the costs and the lower the potential to eradicate the species. The best method is prevention. To prevent, eradicate and control an invasive species the managers need to accomplish programs that include public education, enforcement, early detection, barriers and population control.

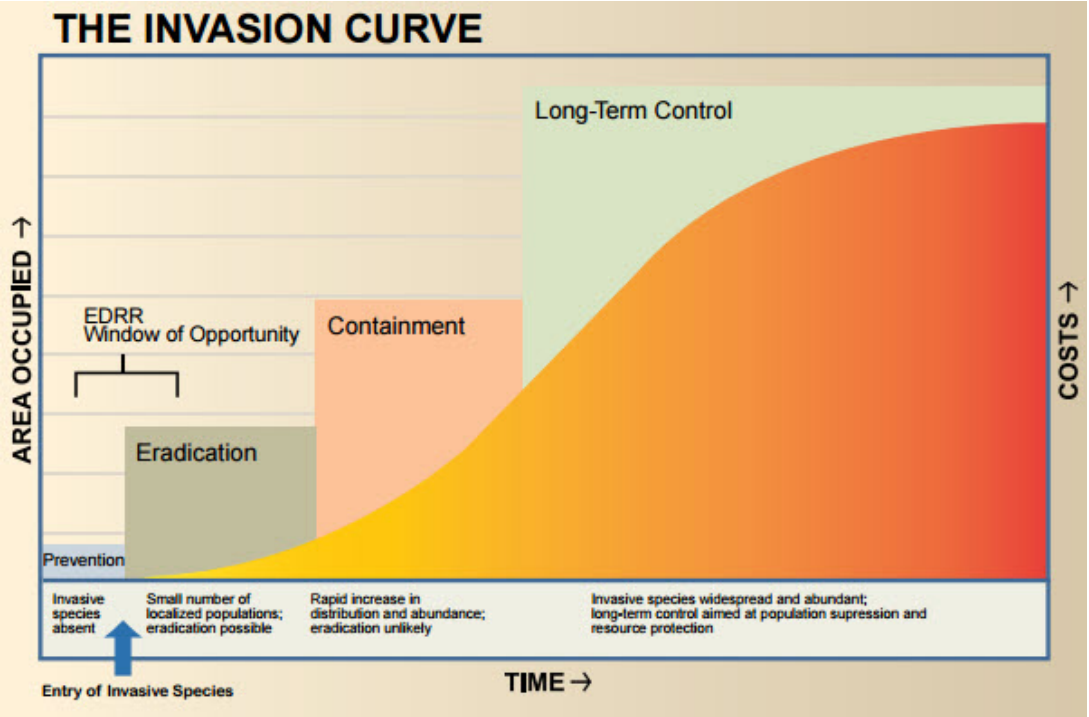


Figure 1 The Invasion Curve (Eckles)

The four Asian carp are the black (*Mylopharyngodon piceus*), grass (*Ctenopharyngodon idella*), bighead (*Hypophthalmichthys nobilis*) and silver (*Hypophthalmichthys molitrix*). The latter two carp species are called bigheaded (BHC) and are the most prolific and threatening.

The bigheaded carp life span/maturity, high fecundity and efficient feeding allow these fish to quickly dominate a habitat. Although the BHC have high annual mortality, some estimates as high as 30%, the fish can live 25 years and achieve a weight of 75+ pounds. The fish grow so fast that in a couple of years they cease to be prey for most predators. The bigheaded carp can start reproduction within their third year. Scientist dissected a large silver carp with over 2 million eggs. It does not matter that 99% of the fry do not reach maturity. Bigheaded carp highly efficient gill rackers out-compete native filter feeding fish and change the plankton composition, limiting competitive species' ability to eat. The bigheaded carp soon become a dominate species, changing the environment and threatening native fish. (Garvey).

The bigheaded carp escaped from aquaculture in a 1970's flood. From a few thousand fish by 2015, the BHC invaded 6,400+ river miles of the Mississippi Basin and MJSTI

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estimates their population exploded to between 30 and 90 million. Every year the BHC expand their territory, and increase their fish bio-density and population.

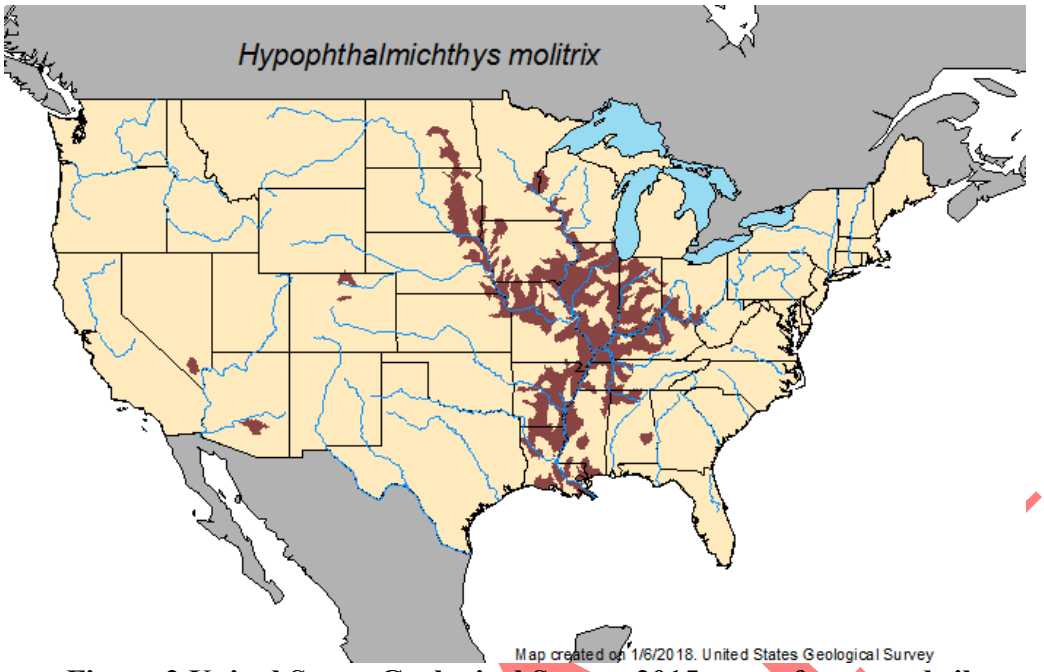

Figure 2 United States Geological Survey 2015 map of captured silver carp, *Hypophthalmichthys molitrix* (USGS Factsheet)

Since 2000, the Federal government responded to the Asian carp invasion of Mississippi Basin invasion by providing over $800 million. In 2011 the Asian Carp Regional Coordinating Committee (ACRCC) was formed in to integrate Federal, State, and Provinces programs. The program plans are published in an annual report. MJSTI analysis of the projects from 2011 to 2021 divides the funding into three groups: education/enforcement/early detection/management (E3), population control and barriers (Sadowsky):

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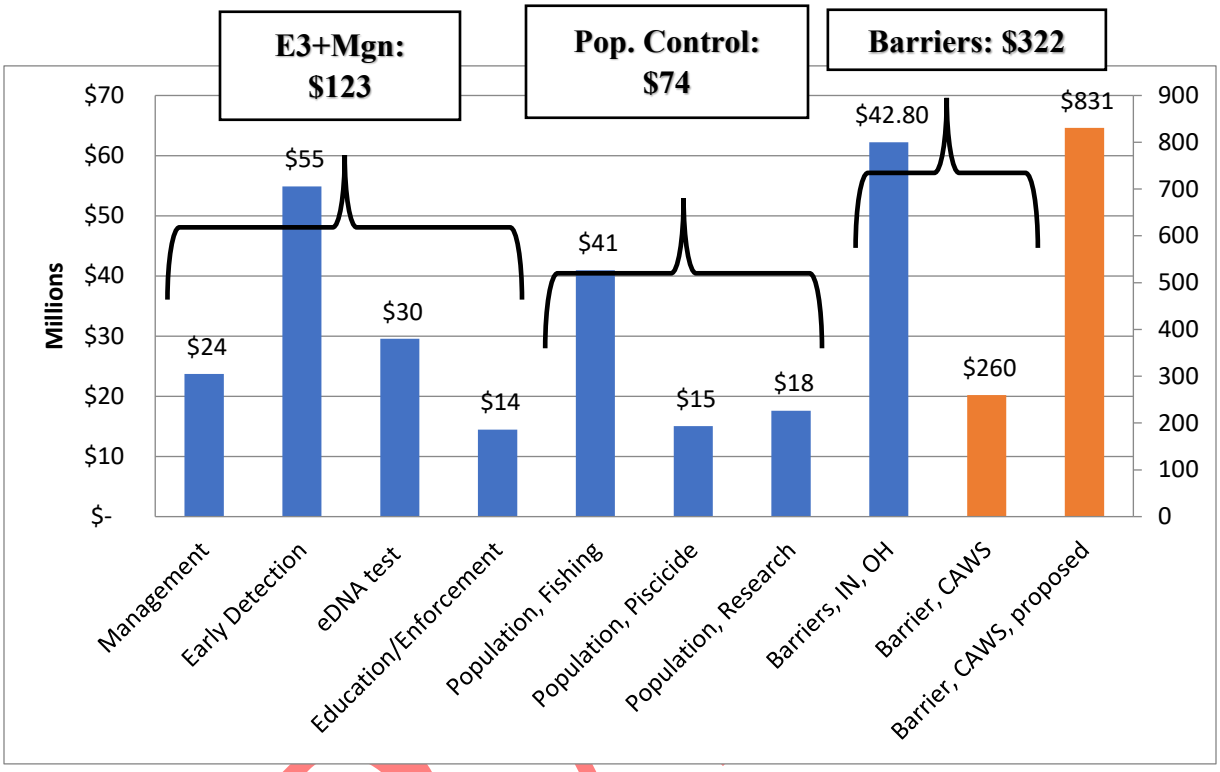
Chart will be updated for 2021 plan

Chart 1: Federal Asian Carp Budget 2011 to 2020, ~$518 million



Barriers

The Army Corps of Engineers (ACE) is responsible for managing navigable waterways and leads the Great Lakes Mississippi River Interbasin Study (GLMRIS). The GLMRIS study found 19 likely crossing points between 1,500-mile divide of the two Basins. The Chicago Area Waterway System (CAWS) is the only water connection between the two Basins. The other eighteen locations are crossing points in floods. The bigheaded carp migration is stopped only by a fifteen-plus-foot, water fall or dam.

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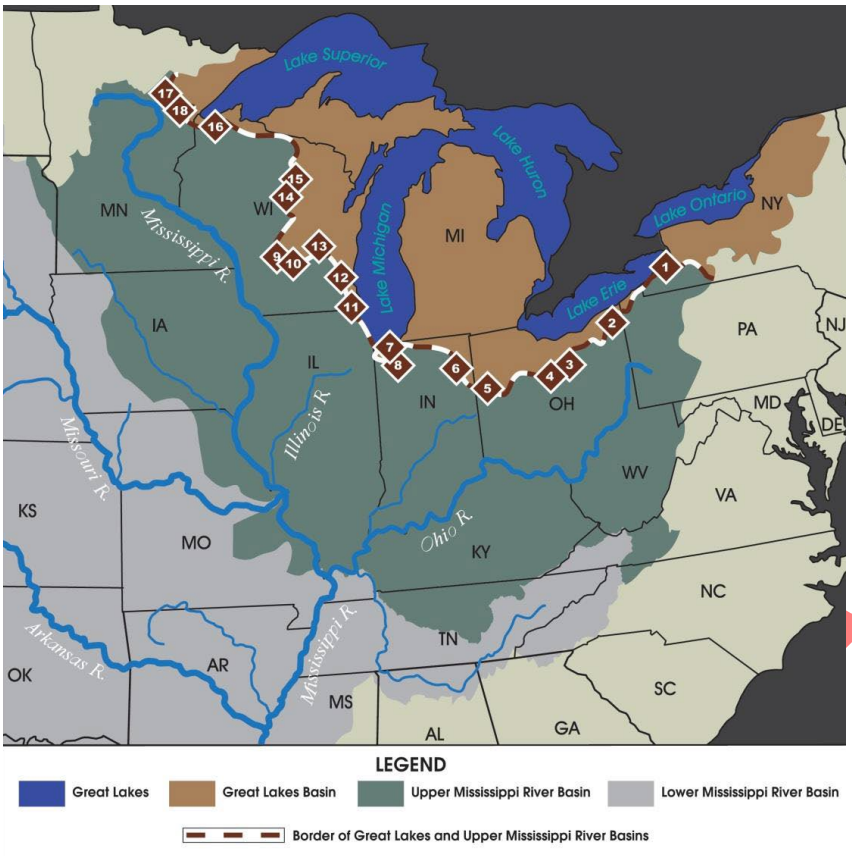

Figure 3, Great Lakes and Mississippi Basin:
the squares are the likely crossing points (ACE, GLMRIS)

Consistent with *The Invasion Curve*, the largest Federal budgeted expense is barriers to prevent the fish from entering the Great Lakes. The barriers include The Chicago Area Waterway System (CAWS) electric fences; land fence and berm in place at Eagle Marsh, south Fort Wayne, IN and Cook County Forests near Chicago Il; and the closing of the St. Anthony Falls lock in Minneapolis, MN.

Water barriers are expensive, starting around $5 million for a bio-acoustic light barrier to over $200 million to install three electric fences in the CAWS (chart costs include operations and maintenance). Three fences provide redundancy eliminating any fish migration and allowing for maintenance while keeping the barrier active. The cost exception is closing a recreational use lock, like St. Anthony in Minneapolis. Land barrier are significantly lower cost; about $15 million for large barriers like Eagle Marsh and Little Killbuck Creek to a few million for regrading, coverts and fencing. Hydrologic separation in the CAWS, not allowing the two basins' waters to exchange, is not economically or practically possible. The initial estimates were $7.8 to $18+ billion.

In response to bigheaded carp population expanding in the Ohio River Basin and protecting Lake Erie, the Army Corps of Engineers just completed land barriers at the headwaters of Tuscarawas River. A second land barrier is under development between the Little Killbuck Creek barrier and Black River, a Lake Erie Tributary.

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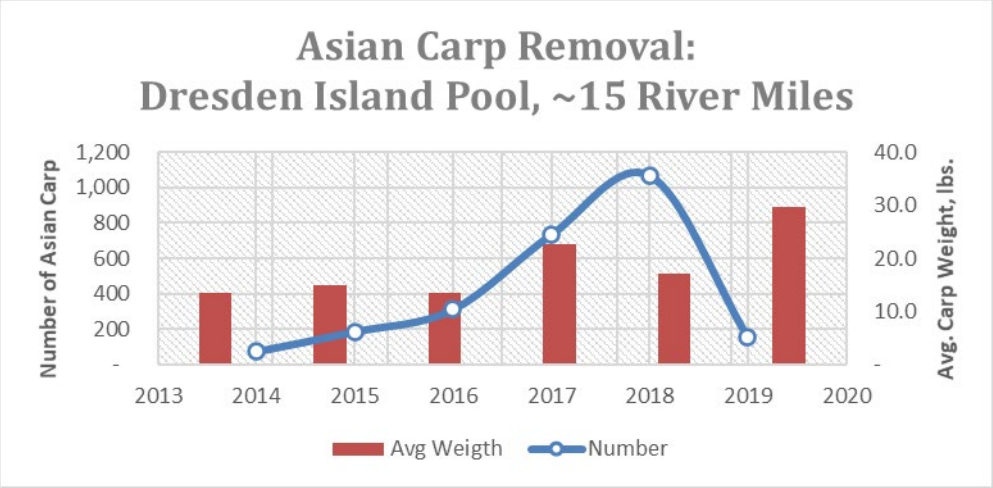
Of the 162 BHC inhabited locks, most are not high enough to be barriers. The few that are offer the opportunity to partition the Asian carp into areas that are easier to control/eradicate these carp or prevent invasion up river. Carbon dioxide, noise, air bubbles, light, water jets and/or electricity may prevent fish from passing through locks. The smaller the inhabited area, the greater the potential for containment and hopefully eradication. ACE has installed two different barriers: Federally developed technology at Lock and Dam 19 on the Mississippi River (near Keokuk, IA) and Fish Guidance Systems' Bio Acoustic Fish Fence (BAFF) at Barkley Lake lock and dam in Kentucky

The CAWS barrier includes removing carp from the three Pools downstream from the electric fence. A Pool is the water above dam. Illinois DNR removed 96% of the Asian carp population (2012 to 2019) from the Asian carp non-reproducing Dresden Island Pool. Since at least 2014 harvesters have not captured any BHC between the Brandon lock and below the electric barrier. In the last 10 years harvesters caught only two bigheaded carp past the CAWS electric fence. The first a bighead carp in 2010 before the third barrier was complete and eight years after the demonstration barrier began operations. The 2018 silver carp either used barge traffic, barrier maintenance and/or luck or someone placed it past the barrier. If the first, the event is so unlikely that if it occurred, would not lead to a reproducing silver carp population past the CAWS electric barrier. The carp's large size and life history suggest the latter event. The silver carp was captured about two months after President Trump suggested ending at least part of Asian carp funding and had only been in the Des Plains River for a couple months.



As the carp population decreases, the food supply increases and the carp gain weight.

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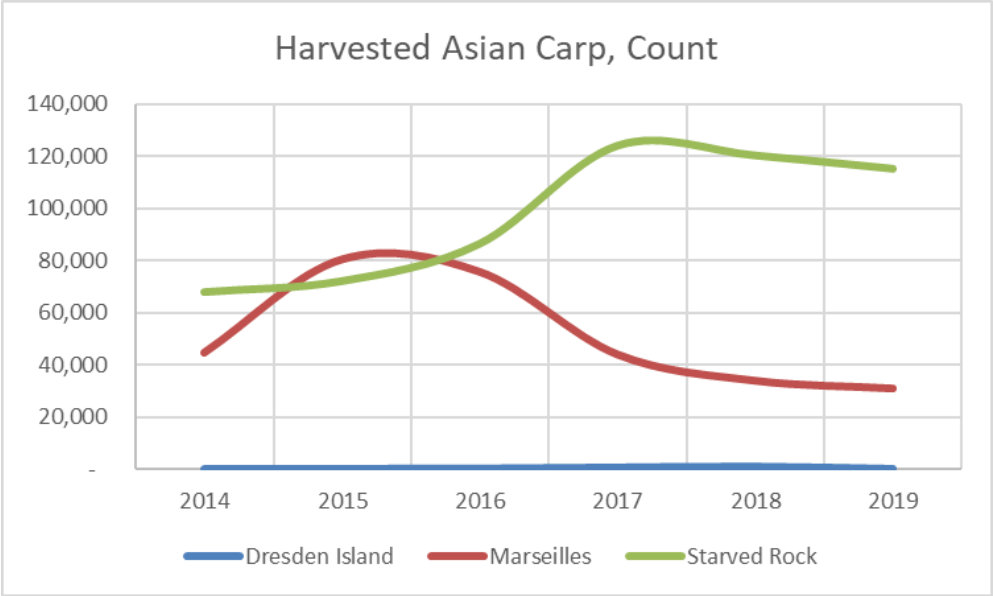

By removing the Asian carp in the three pools downstream from CAWS electric barrier, the barrier is reinforced. In 2020 the IL DNR received funds to harvest from the pool downstream from the Starved Rock Pool, the Peoria Pool. Source of data, IL DNR

The CAWS barrier success makes the proposed $832 million Brandon Lock project controversial. In 2021 ACE started a fourth more powerful electric barrier in the CAWS. The proposed Brandon Lock barrier does not stop any aquatic species moving from the Great Lakes to the Mississippi Basin. The cost is higher than the 20-year Federal Asian carp budget and will impact funding for other environmental projects including Asian carp programs. Paraphrasing one government scientist “Brandon Lock project is a big experiment to determine what ideas work the best in controlling fish migration through locks.” (IL DNR, silver carp analysis, ACRCC Action Plan 2020)

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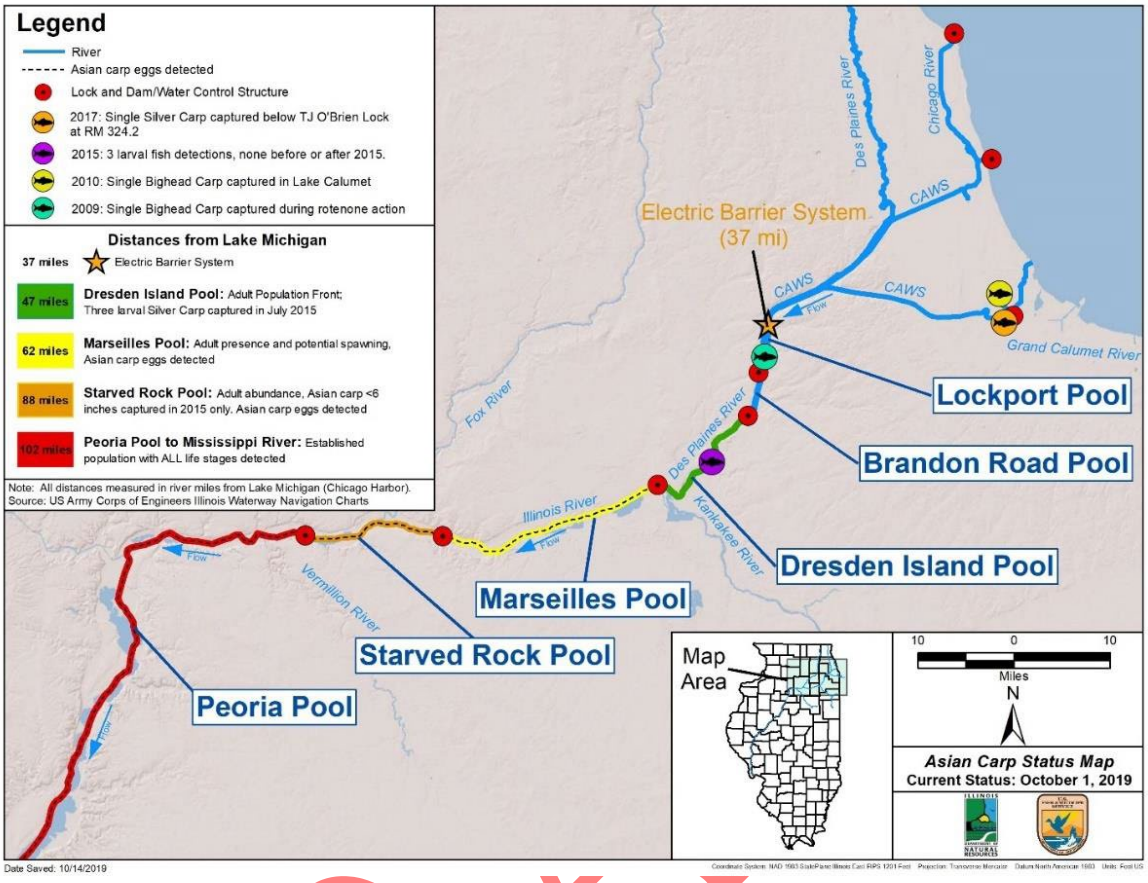

Figure 4: Chicago Area Water Ways System and Upper Illinois River

The ACRCC has keep the bigheaded carp out of the Great Lakes and is developing lock barriers to divide populations of Asian carp.

Education/Enforcement/Early Detection (E3) plus Management

All Mississippi Basin and Great Lakes states have laws against possessing Asian carp with the exception of grass carp. These state conservation agencies teach the public how to identify and dispose of the Asian carp including destroying unused bait fish. State agencies monitor bait, ethnic fish markets and aquaculture. State and Canadian authorities have made arrests.

Fish have excellent senses: vision, hearing, vibrations, and chemicals. At least salmon have infra vision. Fish use those senses to avoid people, nets, sounds, light, vibrations, hazardous chemicals and electricity. BHC are shoal fish, learn from other species about danger. Water systems have currents, change dimensions, and lack clarity. Fish migrate and hide. All of these above factors making surveying fish species and populations extremely difficult.

Scientist use hoop nets, harvesting and electrofishing to survey fish populations. Th U.S. Fish and Wildlife Service developed improved electrofishing boats: Paupier Net and Dozer Trawl. All these methods have their advantages and disadvantages and give

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different results. Fish surveys and populations estimates come with large ranges. For example, a 2015 Asian carp population in the Illinois River was 10 to 30 million fish.

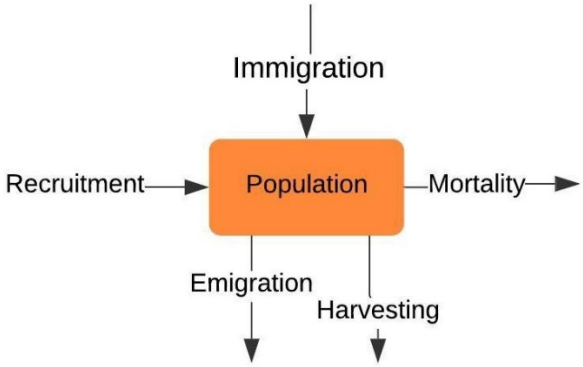
Notre Dame University and improvements by Federal agencies developed eDNA for Asian carp. The method is qualitative not quantitative. Potential false positive causes for positive Asian carp eDNA include but not limited to bird feces, sewer overflow, nets and watercraft. The eDNA test is a good, fast, early detection method to survey uninhabited species in large water bodies.

The Asian carp program established laws, enforcement, education and improved fish detection and surveying methods. (ACRCC, Control Strategy Framework and Action Plans)

Dr. Peter Abrams, U of Toronto, will try and review this section, Dr. Abrams researches fish population dynamics

Population Control

Population dynamics conceptually is relatively simple: the population of the species is the sum of current members plus new members by recruitment or immigration less members that die or emigration.



Applying population dynamics to a simple system is straight forward. Complicated systems where information is limited or unknown, the calculation becomes an estimate. For the bigheaded carp understanding not only fish's life cycle but food, competing, predators and synergistic species, pollution, ever changing Mississippi Basin, and other factors. Increasing the complexity of the bigheaded carp model is as the carp become more dominate the BHC change the plankton composition, native filter fish become scarce or are eliminated, predator species decline with the loss of native filter feeding fish. Finally, irregular nature events such as floods and droughts affect at least the recruitment of BHC. (ACRCC, 2020 Asian Carp Monitoring and Response Plan)

The BHC Mississippi Basin territory contains at least 162 BHC inhabited locks and dams and numerous other dams above the 162 locks and dams. Man affects the water flow and levels below and above the dam for preventing downstream urban flooding, maintaining navigation and recreation. Dam water release of water could affect BHC recruitment and migration.

Fish including BHC emit chemical signals for warnings, recruitment and other communications. Finally, natural selection and or cross breeding could develop a

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Mississippi Basin BHC. Modeling of the bigheaded carp population dynamics is important but will contain certain errors due to inputs and assumed relationships.

Recruitment: In the 1970's the BHC escaped from aquaculture to probably the Arkansas River. In 40 years, probably few thousand BHC exploded to as many as 90 million fish (M. Sadowsky estimate, Struck) in the 6,400+ Mississippi Basin river miles. The BHC successful recruitment is due to their high fecundity, invading new waters, sexually maturity in three years and long life. Flooding is an important factor in BHC recruitment as flood year class sizes are multiple times larger than non-flood years.

Migration: Like all cyprinids, BHC do not have functioning stomachs which limits the size of a meal. To overcome the inability to have one large meal, the fish are constantly foraging for food which explains at least part of the BHC strong instinct to invade new waters. Telemetry studies demonstrate BHC migrate with temperature and have access to most of the Mississippi Basin. One tagged BH released in the Northern Illinois River was captured in New Orleans six months later. Another radio tagged BHC upper Illinois River released tagged BHC migrated to the Ohio River in two weeks and in another two weeks was in Lake Kentucky. Although the BHC need a strong current for successful recruitment, the carp seek out calmer areas of rivers and lakes.

Mortality: Although BHC can live past 20 years, few do. The annual mortality of adult is estimated to be as high as 30%. Common carp intestines are about 1X body length, bigheaded carp 5 to 7X body length and silver carp 11X body length. The longer the intestines, the thinner and more prone to puncture. This is a potential problem for the indiscriminate feeding BHC. Decreasing the annual mortality of BHC is their fast-growing rate, achieving 10 pounds in 2 to 4 years. At that size, the BHC are prey only to large blue catfish.

Food: A BHC competitive advantage is their very fine gill rackers which allows these carp to out compete native filter feeding fish. When invading new rivers and lakes, the BHC consume small and large plankton and change the plankton composition. Large plankton feeders like bigmouth buffalo and paddlefish suffer as the BHC consume the zooplankton before plankton before the species can grow.

A system's "carrying capacity, resources such as food and oxygen, are limited. Lack of resources will hinder growth and recruitments and increase emigration and mortality. The weakest are jeopardized. In the BHC system the weakest are native filter feeding fish and the young. The former competitive disadvantage is described above. In a USGS piscicide filed test, large silver carp pushed aside smaller fish to dominate the feeding. (OpenStax)

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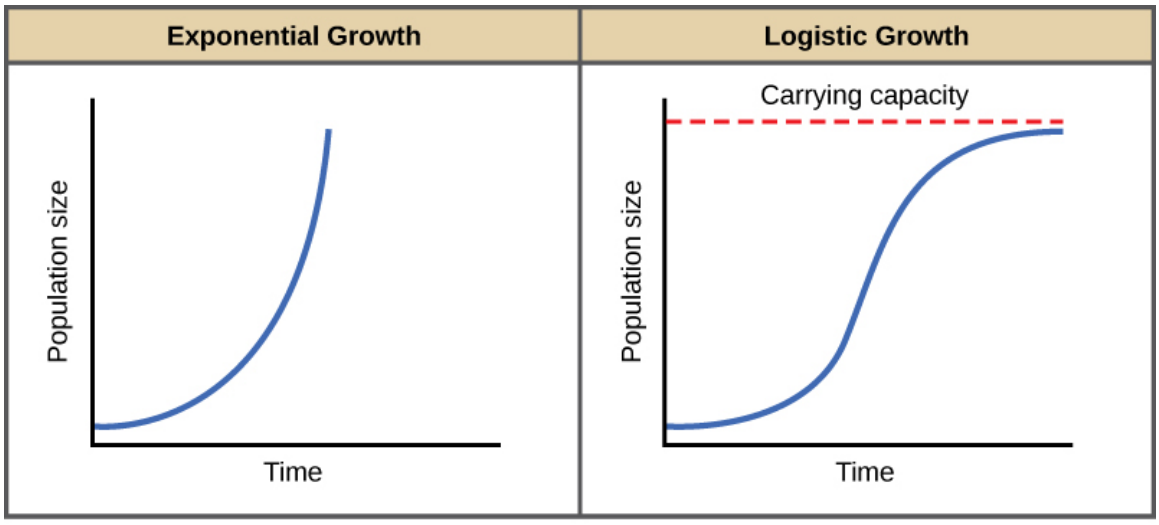

Bigheaded Carp Mississippi Basin examples

1. The expansion of the BHC from few thousand in early the 1970's to probably 90 million in 6,400 Mississippi Basin River miles represents the exponential growth of a species with no carrying capacity.
2. In a flood BHC and common carp invade the 200-to-300-acre Lakes Yankton, Nebraska and Creve Coeur, Missouri. Since at least the BHC cannot recruit, the carp become large and consume all or nearly all the lakes resources causing native fish populations to crash. In a few years the carps become at least 70% if not 90%. of the bio-mass. The use of rotenone at Lake Yankton and Unified Harvesting Method at Creve Coeur removes 100% and 90+% of the carp.
3. Eight years of harvesting of the four pools downriver from the CAWS electric barrier reduced the Dresden Island pool BHC population by 96%. The BHC do not recruit in the four pools. Dresden Island pool immigration and emigration are limited to the downstream pools or the Kankakee River. Immigration from the lower downstream pools is limited by focused harvesting. As the BHC bio-density decreases, food competition decreases and the average weight of the harvested carp increases. Finally, BHC in the Des Plains River of the Dresden Island pool physiologically challenged by pollution from partially treated Chicagoland wastewater (reference).
4. For at least ten years commercial fishers removed Asian carp from the Illinois and Mississippi Rivers. The BHC freely immigrate and emigrate from these rivers to other parts of the Mississippi Basin and successful recruit in both rivers. "Silver carp recruitment was most stable in the Illinois where commercial harvest is the highest" (Sullivan). Silver carp now 90% of BHC, the BHC size is declining and native filter feeding fish are threatened (Irons, Update on Illinois). The goal of the Peoria Pool harvest is 8 million pounds between 16 to 40% of the potential pool harvest and 6.5% of the Illinois Basin Asian carp population. ACRCC, 2020 Action Plan, Irons, private conversation). Using Fish Population Dynamics, Peoria Pool commercial harvesting is increasing the BHC bio-density.

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Fishers harvest all fish including BHC in the Yangtze River, China declined from nearly 400,000 tonnes in the early 1950s to 180,000 tonnes in 2000. The lower to middle river catch of Asian carp as a percentage of the total catch has declined from approximately 85% in pre-modernization China to 5 to 37% around 2000. Over the last 60 years China has drained over 7,000 flood plains and constructed dams, the largest is the Three River Gorges dam. Flooding and backwater habitat are critical to Asian carp recruitment. In 2000 21 cities discharged 14,2 billion tonnes of waste at 2,000 sites. Pollution deteriorates especially filter feeding fish like the BHC. By decreasing recruitment and increasing mortality Asian carp including BHC can be overfished. (Chen)

For the first time in 2010, a 350,000+ shoal of BHC fry appears in the Kansas River. The shoals since then are all smaller. The BHC in the Kansas River are a stable, dominate species limited by a dam at Lawrence, KS. Cat fishing boats collecting silver carp that jump into the fishers' boat is the only harvesting. Blue catfish like silver carp bait. Why did the shoal population decline? After spawning do BHC swim downstream and cannibalize their zooplankton eggs? If so by harvesting adults, man is increasing the number of BHC in the middle Mississippi, Ohio and especially Illinois Rivers and Lake Kentucky. The Aquatic Nuisance Taskforce newsletter of March 22, 2021 highlights Grosholz et. al. paper on the hydrilla effect and aquatic animals. (Grozhlz, ANT)

Harvesting common carp above the number of carp needed to recruit has a history of increasing the common carp bio-density. Common carp like BHC are long life, f fecundity and habitat changing Cyprinidae (USGS Factsheets)

Carp	Common	Silver	Bighead
Adult diet	benthic organisms, vegetation, detritus and plankton	Filter feeding; Plankton, primarily phytoplankton	Filter Feeding; Plankton, prefer zooplankton
Spawning	Lay eggs typically early spring in lake shallow	Broadcast spawn in river of 100km and a current speed of 70cm/s; 40 to 60 hours buoyancy	
Fecundity (potential lifetime reproduction)	300,000 per spawn fertility 1 million eggs/year	1 million; A female found with 5 million eggs	N. American 4,792-1.6 million eggs
Typical weight (lbs.)	4.5 to 31	2.2 to 60	Up to 88
Potential Age, years	20	20	25?

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Water Body	Species	Acers/ Miles	Key Methods	Control	Repro-ducing	Cost
Lachian River, Australia	Common Carp	890 Miles	Harvesting	No	Yes	
Herman, Madison & Brandt Lakes, SD	Common Carp	5,240 Acres	Harvesting	No	Yes	
Clear Lake, IA	Common Carp	3,684 Acres	Harvesting	No	Yes	
Lost Island, IA	Common Carp	1,200 Acres	Harvesting/ Predator Fish	Yes	Yes	~
Lockport and Brandon Road Pools, IL	Asian Carp	10 Miles	Harvesting/ Lock & Elec Barrier	Yes	No	$1.2 to $1.5 M/yr. 2012-2020; $3.8 M 2011
Dresden Island Pool, IL	Asian Carp	15 Miles	Harvesting/ Lock	Yes	No	
Marseilles & Starved Rock Pools, IL	Asian Carp	40 Miles	Harvesting/ Lock	No	Yes	
Creve Coeur Lake, MO	Carp	320 Acres	Harvesting (Unified)	Yes	No/CC Yes?	
Lake Yankton, NE	Carp	250 Acres	Pesticide	Yes	No/CC Yes?	$1.5 M?

Harvesting common carp in the Lachian River, Australia; Herman, Madison and Brandt Lakes, SD and Clear Lake, IA caused the carp population to increase. Netting Asian carp from Dresden Island and Creve Coeur Lake, MO and common carp from Lost Island Lake, IA were successful in removing 90+% of the carp. The difference was that the former bodies of water connected open systems ranging from 3,700 acres to 890 river miles while the later isolated around 1,000 acres lakes and at least the Asian carp were not reproducing. (Brown, Lowell, Bauer, Zarlenga).

Great Lakes Fishery Commission control of the sea lamprey demonstrates that using fish population dynamic and fish life cycle an invasive species can be controlled in the 94,000 square miles Great Lakes. Barriers and selective lampricide treatments, recruitment of adult sea lamprey is reduced by 95+%. Since adult lamprey live only one year, nature resolves the mortality issue. The annual program cost is approximately $30 million. (GLFC)

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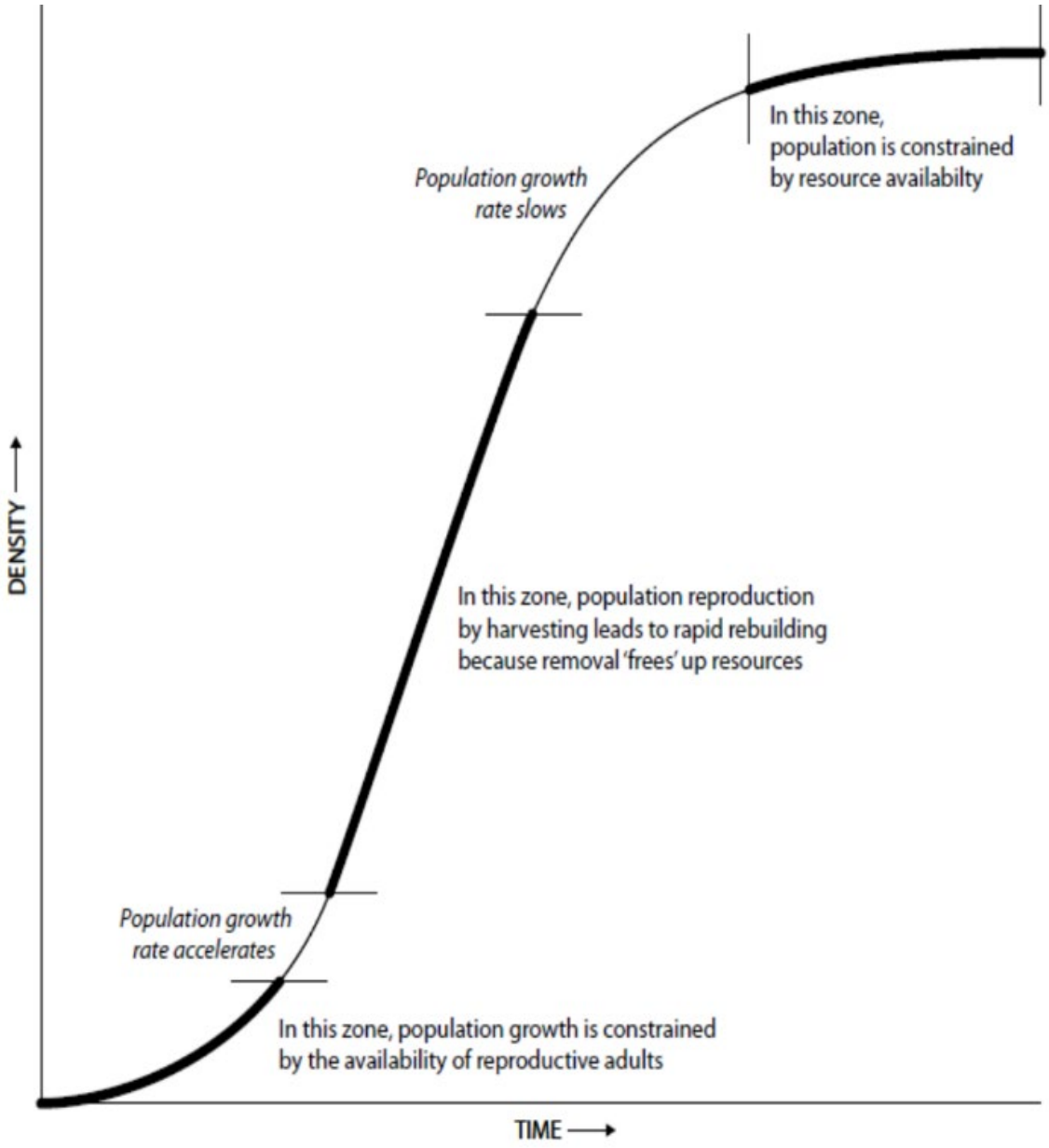

Figure 5: Idealized Food versus Population Chart

Removing adults of a high fecund species is not enough, recruitment must be controlled. The "hydra effect" that prey species overcompensates to predation causing a dramatic increase in the prey species, is documented in the literature (Sieber). By controlling recruitment, even a dominate species in a continental system can be controlled.

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Population control methods

Harvesting is dangerous, expensive and ineffective.

The most dangerous 2017 OHSA occupation is fish harvesting and processing. Two fishermen drowned harvesting Asian carp in January 2018. Harvesting is hard physical work that takes place on rivers with no protection for weather events.

Using contract fishers, the IL DNR reduced the Asian carp by 96% in the Dresden Island Pool and the next two downstream pools. The three pools are about 55 river miles. The cost was $1.1 to $1.5 million per year since at least 2010. Part of the ten years was learning where the fish live and developing new techniques. As Open water harvesting expense is prohibitive. To reduce costs, the ACRCC is subsiding commercial harvesting.

Commercial harvesting is an economic not an environmental activity. The capital required for commercial harvesting is $150,000+ (reference). The Mississippi Basin fishing industry is vanishing due to aging fishers not being replaced by young people.

The three largest Asian carp processors, Schaffer, Two Rivers and Stoller, can process several million pounds each, maybe 20 or 30 million pounds total, around five million fish. The total of all other producers is likely insignificant. The Mississippi Basin fish processor bankruptcies of American Heartland (2014), Moon River (2018) and probably Riverine Fisheries International LLC (2018) demonstrate that Asian carp process is a marginal business. (A to Z database)

BHC are bony and have a gamey flavor red mussel. Both reduce the US market fillet yield by 25%. BHC are worldwide the largest freshwater aquaculture fish which sets the price of carp products as a low-priced commodity (reference).

Commercial fishers typically use gill nets which catch fish of a particular size +/- 20%. Smaller fish swim through the nets while larger fish bounce off the net. Trammel nets, three different size gill nets, significantly increases size range of captured fish but cost three times as much. Fishers set their net size by optimizing profitable catch. In 2018 processors would only pay for BHC that were at least six pounds.

Using sound, light, and electricity to herd carp, Federal agencies improved harvesting yields. The government also developed carp baits. However, carp avoid people, nets, sounds, light, vibrations, and electricity. The carp jump over nets and hide. The BHC range from a few ounces to over fifty pounds. The difficulty of open water harvesting is demonstrated in catfish aquaculture. Skilled aquaculture workers remove 49,000 of the same size fish, in a flat bottom, rectangle three-acre pond leaving 500 to 1,000 uncaptured.

Although harvesting may make the public feel good, the key to managing if not eliminating the BHC is controlling recruitment and then increasing mortality. Ignoring "Fish Population Dynnamics" is just bad science. Commercial harvesting perpetuates the

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Asian carp. Even with improved methods how is it possible to harvest enough BHC to affect recruitment in the Mississippi Basin. At least one a piscicide is required

Piscicides, fish pesticides: By law, the EPA regulates the ingredients, formula, manufacture, application, and usage of "any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest." (EPA). The EPA process is expensive, continuous and requires scientific data. Not all pesticides are highly toxic; salt and vinegar are registered EPA pesticides.

The ideal pesticide controls only the target species, is safe to handle, has limited chemical stability in the environment, is low total cost and is non-toxic to humans and endangered species. Aquatic pesticides are difficult to gain EPA registration because currents disperse the toxin.

A digestive pesticide limits non-target species harm. However, toxins are less harmful digested versus inhaled. If an animal's ability to breath is harmed, death can come in minutes. In contrast fish can last for weeks without eating. The pesticide that decreases fecundity/recruitment or impairs the fish's ability to swim has value.

The BHC non-target species of concern are gizzard shad, bigmouth buffalo, carpsucker and maybe paddlefish. Paddlefish typically consume materials that are 800+ microns which should limit their consuming of the 200-micron bigheaded piscicide.

There are four piscicide programs: USGS antimycin A, USGS eleven other pesticides, USGS RNA and MJSTI Corp.'s intestine forming soluble copper. All four psicicides are digestive.

	MJSTI, Intine Soluble Cu	USGS Antimycin A/Beeswax	USGS 11 other materials	USGS RNA
Status	Raising Capital	In registration?	Development	Development
Killing time	3 to 6 days	Overnight	Overnight?	Development
Aquatic EPA ingredient(s)	Yes	No	No	No
Availability of Raw Materials	Readily available	Not available	Not defined	Custom fermentation
Commercial Time	1 year	Several years	Several years	5 to 10 years

The USGS programs emphasis is killing fish fast, ideally overnight. The USGS program has ignored commercial realities: for example, the antimycin A manufacturer stopped production around 2006 (discovered around 2014) and the EPA delisted antimycin A in 2017 (learned in 2018). In contrast the MJSTI program focused on using available, manufactured supported, EPA registered aquatic pesticide ingredients that are FDA

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additives and accepting a lower rate and longer kill time. The USGS RNA program is in basic research and is probably ten years away from commercialization.

Conclusion: will be rewritten when edits to body complete

To control the BHC population, managers must remove enough reproducing carp effect recruitment. If recruitment is not impaired the BHC bio-density increases. The Australian National Carp Control plan estimates at least 80% of common carp must be removed every year. The population reduction to affect BHC reproduction may be greater than 80%. Dr. Mason estimates as few as 20 sliver carp could become 30% of the Lake Erie fish bio density in 20 years.

The $750 million Federal Asian carp program successes start with keeping the bigheaded and black carp out of the Great lakes. Innovations include the world's largest electric fish barrier, eDNA test, improved fish surveying and harvesting methods. The GLMRIS identified eighteen other potential crossing points between the two barriers and the ACRCC has built barriers to prevent carp migration. The ACRCC team successfully implemented state laws to minimize Asian carp transport, enforced the laws, implemented, education programs and developed early detection and response protocols.

The ACRCC record on population control is wanting. Commercial harvesting is an economic not environmental activity. History, statistics and the Asian carp experience demonstrate harvesting is expensive, dangerous and ineffective. The USGS pesticide program lack commercial viability. MJSTI pesticide program is stopped for lack of funds.

When money is involved science can be ignored. The public hysteria initially over CAWS hydrologic separation followed by Brandon lock project ignores the success of the CAWS electric barrier, economic realities and the science. Similarly, the idea that harvesting is misguided and ignores the statistics and failure of past carp harvesting efforts.

Asian carp is just one of hundreds of invasive species changing our environment. If the Asian carp invade the Great Lakes, will the public ever believe conservation agencies, organizations and lobbyist ability to solve an invasive species problem?

No barrier is perfect. Without Asian carp population control, it is when not if the Asian carp invade the Great Lakes followed by Canada and East Coast rivers and lakes.

Maurice Sadowsky is President of MJSTI Corp. Mr. Sadowsky proved safe, selective, and low-cost carp piscicide. The formula needs optimization followed by EPA registration. MJSTI submitted two grants in July 2020, nine previous grants were rejected. In 2019 the Great Lakes Fishery Commission generous funded the commercial production of the fat coated water insoluble copper salt. www.carpfree.com, maurice@carpfree.com

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Appendix I: Justification

By harming boating and sport fishing, the bigheaded carp threaten, at least in part, the almost $25 billion tourism and water recreation in the Upper Mississippi Basin[1], $5 billion in commercial and sport fishing, total recreational economic activity of $52 billion in the Great Lakes[2],[3] and $1.9 billion economic value in Kentucky lakes[4]. For example, one third of boats registered in the US are registered in the Great Lakes Basin. What fraction of the basin recreation is jeopardized by bigheaded carp can be debated but the impact is a significant economic drag and growing economic threat.

[1] http://www.umrba.org/umr-econ-profile.pdf
[2] https://www.glerl.noaa.gov/education/ourlakes/economy.html
[3] https://www.glc.org/wp-content/uploads/2017/03/GLC-LegPri-2017-FINAL-web.pdf
[4] https://www.tva.gov/Newsroom/Valley-Lakes-Worth-Billions

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