

THE SILVER CARP THREAT

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Silver Carp: Hypophthalmichthys molitrix

HISTORY

In the 1970's nearsighted state biologists, natural resource managers, sewage treatment facility operators, and others made appalling errors in judgement by thinking introducing nonnative species would be a good thing. Those decisions resulted in dreadful and devastating ecological consequences we face today both in the terrestrial environment (Kudzu) and aquatic ecosystems (Asian Carp). Most biologists were against such introductions for they knew it would be very difficult if not impossible to ensure none were ever release into the natural environment. As well, they stood by their belief that a natural ecosystem should never be altered by changing the species diversity. Simply put, nothing can improve on a natural ecosystem. Yet nonnative invasive species still were imported.



Nonnative organisms often have a devastating impact on natural resources, human health, and the economy. In a natural ecosystem, organisms evolve together into a native community with checks and balances that determine population growth and species diversity. A complex web of interactions is established by primary producers, predators, herbivores, bacteria/disease, parasites, and a multitude of other organisms forming an important and complex ecological balance. An introduced species won't have the evolutionary barriers or limits and their population can explode disrupting the natural communities and ecological process. They can outcompete and even eliminate native organisms making the ecosystem less diverse which leaves it even more susceptible to further devastation including disease, habitat alteration, and critical habitat elimination.

Introduction of the Asian Carp is one of those grievous decisions that has had devastating consequences. There are four species now in the United States (Grass, Bighead, Silver and Black). All are from China. They were introduced for various aquaculture purposes and then escaped from confined production ponds and unintentionally introduced into natural waterways during extreme floods on the Mississippi River. Their relentless invasion quickly increased their distribution and abundance. All four Asian carp species are now abundant in the Mississippi River Basin, and have migrated into Tennessee waters via locks at Kentucky and Barkley dams and have entered Reelfoot Lake during high flows through its spillway.

BIOLOGY

The silver carp has a deeply keeled body with tiny scales but no scales on the head or gill covers. They mature in 2-3 years and can live 20 years or more. They have a large mouth with no teeth in the jaw, with eyes forward and turned slightly downward. They can grow to over 4 ft. and 75 lbs. They rapidly reproduce and devastate an ecosystem due primarily to two factors which give them a great advantage. First, a large mature female can lay 4-5 million eggs each year. Secondly, they do not require nesting habitat as most fish do; they spawn in the water column. The slow current keeps the eggs suspended until they hatch and begin feeding.

Silver Carp are planktivorous filter feeders, meaning they merely swim with their mouths



Figure 1: Silver Carp

open and consume whatever is floating in the water column, primarily phytoplankton and zooplankton. They can filter out 20-40% of their body weight each day which represents millions of planktonic organisms. They are so efficient they have been used in sewage treatment ponds to reduce and remove algal blooms.

The Silver Carp is considered by many to be a fine food fish due to its good flavor, texture, and appearance. Live fish can even be found in some high-end food stores.

Because it feeds only on plankton and not benthic organisms or other fish, the flesh is free of toxins like PCBs and Mercury when the toxins are present in the environment. Commercial fishing for this fish is being done in some states as a measure to reduce their numbers and is highly recommended and sponsored by the State of Tennessee.

The abundance of Asian carp has attracted more commercial fishing. This can remove millions of pounds of carp annually. At the recommendation of the Tennessee General Assembly's Asian Carp Task Force, Tennessee Wildlife Resources Agency (TWRA) funded a \$75,000 grant in 2017 to the Paris Henry County Industrial Committee to develop local commercial fishing businesses for carp. As a result, recipient businesses have increased their interest in harvest of carp. TWRA is currently drafting another plan to provide even more incentives to commercial fishers and wholesale fish dealers. During May of 2018 the Tennessee Fish and Wildlife Commission approved a \$500,000 budget request to provide incentives for the commercial harvest in Kentucky, Barkley, Cheatham, and Old Hickory Lakes.

DISTRIBUTION

Figure-2 below shows the distribution within the U.S. A major portion of the Mississippi River drainage basin has been taken over. Silver carp are making their way upstream and will take over the entire Tennessee River ecosystem and its tributaries unless a major effort to prevent migration is implemented at Tennessee River locks “**Immediately.**” Time is the best friend of the Silver Carp and the worst enemy of the TVA system of lakes and reservoirs.

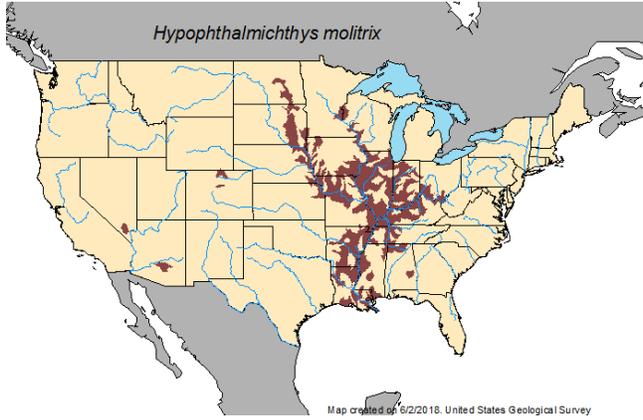


Figure 1: U.S. Distribution of Asian Carp

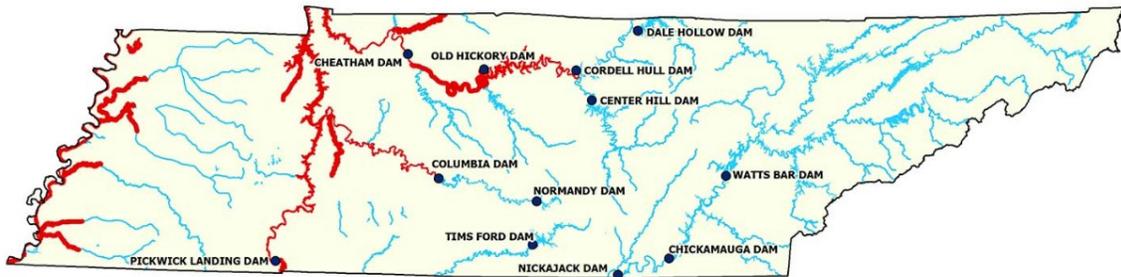


Figure 3: Distribution in Tennessee

The figure above shows the distribution in Tennessee, but is likely to be out of date. The fish will effectively move upstream to every river system and tributary unless there is no lock at a dam. Without effective control measures, nearly the entire map above will be red.



Figure 4: Alabama Presence of Silver Carp

Figure-4 shows where Silver Carp have been found and captured in the Alabama portion of the TVA system of reservoirs. What is unknown is the population abundance. Their mere presence in Wheeler Reservoir tells me they are very likely to be present throughout the lake and could very well be at the Guntersville lock and dam. If indeed they are at the lock, they will quickly enter Guntersville Lake.

ECOLOGICAL IMPACTS

Due to the extremely high fecundity (up to 5 million eggs/mature individual), Silver Carp can quickly take over and outcompete native species causing enormous damage to the entire ecosystem. There is abundant literature showing that their numbers alone will quickly alter the trophic levels of the native fish communities. This is due to the extreme number of individuals each consuming up to 10 - 40% of their body weight in phytoplankton and zooplankton every day. This can quickly reduce the food availability for juvenile fish, forage fish, native filter-feeding fish (shad), mussels, insects, and other organisms that completely rely on phytoplankton and zooplankton as their only food source.



Figure 5: Pontoon Boat Amidst Jumping Silver Carp

Carrying capacity refers to the maximum population size of a species that the aquatic ecosystem can sustain indefinitely and is based on the food, habitat, water quality and other

requirement available in the environment. In a balanced system all species are below, near, or at carrying capacity and doing well. The phytoplankton and zooplankton are the primary producers, the bottom of the food-pyramid, and represent the food source for juvenile fish and the wealth of benthic fauna which are also a major food source. Altering the bottom of the food-pyramid will quickly change the biodiversity of the ecosystem. This is a devastating ecological impact, for the entire ecosystem is out of balance. When the bottom of the aquatic food-web is severely reduced, it can quickly result in the loss of native forage fish and game fish due to lack of abundant food sources and the resulting stress. This will eventually lead to a lake so out of balance that for all practical purposes it would be a fisheries *monoculture* of Silver Carp. Other fish species would struggle to maintain presence, but their numbers would be low, highly stressed, leading ultimately to possible elimination of species from the ecosystem.

I feel it necessary to restate the critical importance the foundation for a healthy aquatic ecosystem--the primary producers at the bottom of the food-web. Every living organism in the ecosystem is tied to the health of that foundation and cannot survive long without them. The Silver Carp feeds ravenously on that very foundation, and their ability to multiply in extremely high numbers can quickly overwhelm and destroy that foundation. By devastating the population of phytoplankton and zooplankton in a lake, they are destroying the food source of all other organisms. As they continue to devour the plankton, even the Silver Carp population itself will become stressed, for their carrying capacity also depends on the abundance of phytoplankton and zooplankton which they are rapidly destroying. They will reach and exceed their carrying capacity which would ultimately lead to fish-kills/die-off of the Silver Carp. Silver Carp are the cancer cells of an aquatic ecosystem. Just like cancer cells in the human body, the fish multiply until they kill the host and thus themselves.

An unbalanced aquatic ecosystem would never completely recover. These fish would continue to repopulate to their carrying capacity at the expense of all other organisms maintaining the imbalance year after year. Their relentless attack on the primary producers in the food-web could never be stopped except by completely eliminating the silver carp, which would be impossible. All attempts to reduce their numbers through commercial fishing or other harvesting measures would not significantly alter the negative impacts of this fish, their rate of reproduction is simply too great.

RECREATIONAL IMPACTS

The Silver Carp not only destroy a lake's ecosystem, they also impact recreation in a major way. When the fish are startled by a passing boat, they panic and jump out of the water. They can jump as high as 6 – 10 feet. This makes waterskiing, wakeboarding, tubing, jet skiing, and boating extremely dangerous. Even at a slow speed, getting hit by a fish, particularly a large one, can result in serious injury, especially when struck in the face. A 19-year old was tubing when struck in the face by a Silver Carp. It broke his nose and fractured his skull/forehead. The only safe boating would be in a large vessel or one with an enclosed cockpit, for unprotected occupants would be in great danger. One can only imagine a lake where taking a ride on your jet

ski or in your boat poses grave risk, but this is precisely the case when Silver Carp are present. The chances of not getting hit would be remote, the only question is how damaging it would be.

ECONOMIC IMPACTS

University of Tennessee studies show that the TVA system of lakes bring in nearly 12-billion dollars a year from tourism and the many recreational activities found on and around the reservoirs. Tourism will be severely impacted resulting in a huge revenue loss to cities, counties, marinas, and the many small businesses associated with lake recreation.

Fishing tournaments are a popular activity on most reservoirs. This activity will suffer greatly and likely disappear due to the Silver Carp impact on game fish populations as well as the serious danger to the fishermen who typically move at a high rate of speed between fishing locations. Silver Carp will place significant stress on all Game fish as well as forage fish, populations, and both will suffer greatly in number and health of individual fish, slowly eliminating fishing tournaments.

The lake property real-estate market will suffer and property values will drop significantly. This will bring about an economic decline in many aspects of lake-home ownership, including property tax rate and county income from taxes being lost to the county.

There are thousands of small businesses directly and indirectly related to lake recreation. None are immune to economic loss if the Silver Carp reach the area. Hit particularly hard will be marinas, associated restaurants, and lake cabin and boat rentals. These are nearly all family owned and operated businesses whose entire income and livelihood is related to recreation. Almost assuredly some of these will not survive. As well, tackle and bait shops and small fishing camps and outlets will face closure.

Clearly, the economic impact from the loss of recreational and tourism industries will be in the hundreds of millions of dollars every year, along with a continual decline in small-business operations. Presently we are seeing an increase in the success of these businesses as well as new businesses being added. This trend will reverse when the first Silver Carp is seen jumping out of the water.

WHAT CAN BE DONE TO PREVENT MIGRATION?

There are existing methods which have been implemented to slow or stop migration, and a significant effort is being done by states researching other possibilities. The most proven method is electric barriers. Another promising barrier is the bio-acoustic fish fence.

Bio-Acoustic Fish Fence (BAFF)

A bio-acoustic fish fence is the combination of a bubble wall and a sound barrier. A bubble wall alone will not keep fish from entering a lock. It very well could be a deterrent, but bubbles alone will not be intimidating enough to ensure no fish will swim through it, especially if the fish is startled or being chased by a predator.

Research is presently being done regarding sound barriers to deter fish movement. It has been shown that high-frequency sound will deter Silver Carp. However there has not been enough research to conclusively answer what the optimal sound frequencies might be or what sound pressure levels would be needed to optimize repulsion of the fish. However, the combination of the bubble net and sound are a promising deterrent.

Electric Barriers

Electric barriers have been in use since the 1950's. This is a proven technology, and over the years major improvements have been made. Numerous configurations of electric barriers have been used to effectively restrict fish movement. Each system generally consists of a type of electrode (chains, weighted cables, metal bars dangling in the water column, or electrodes placed on the bottom often in groves in a concrete sill and/or up the sides of the channel. A pulsed Direct Current (DC) field is the preferred choice. The electric barrier uses a low-frequency pulsed DC current to create the barrier field. The current is set below the electrocution threshold of a typical home ground-fault-interrupter and is designed to be non-lethal. Fish would become quite uncomfortable in a weak field and turn quickly away, for fish are extremely sensitive to any electric field.

A DC electric barrier uses a graduated voltage gradient electrical field to deter upstream migration of fish. The voltage gradient is strongest at the electrode and as the distance from the electrode increased, the gradient gets steadily lower. A pulsed current affects the muscular control of the fish as well as sensory organs. The pulsed DC electrical field can be mathematically modeled depending on depth, water quality, and other factors to produce the necessary field strength. A fish will feel the electric field as it approaches when the field is quite low. As they get closer, the current and voltage of the field will get stronger and stronger. The fish will turn away quickly, and if it doesn't and continues toward the stronger current at the electrodes, its muscles will constrict and remain constricted rendering the fish unable to swim until it is carried downstream with the water flow and out of the electric field, where it would recover completely. For a complete discussion and technical information about electric barriers see the online PDF:

<https://www.smith-root.com/images/smith-root/downloads/57/09446.005-barrier-book.pdf>

WHAT IS CURRENTLY BEING DONE?

A great deal of research is underway by numerous agencies and states to prevent the spread of Asian Carp. Likewise, some measures have been implemented, and a huge regional effort is underway to further address this problem.



The Kentucky Department of Fish and Wildlife Resources (KDFWR) is a leader in the deterrent and control of Asian Carp. You can view this information on their web site: <https://fw.ky.gov/Fish/Pages/Asian-Carp-Information.aspx>

To get an idea of the effort and money being spent to address this invasion, see the "[KDFWR Plan of Action and Partners](#)" and "[Current Projects](#)" below. Here is the information presented:

[What Can You Do?](#)

[Asian Carp Identification](#)

[Distribution](#)

[Impacts](#)

[Laws and Regulations](#)

[KDFWR Plan of Action and Partners](#)

[Current Projects](#)

[Publicity](#)

[Recreation Opportunities](#)

[Preparing and Cooking](#)

You can find a wealth of additional information online and see how millions of dollars are being spent to try and gain some bit of control over these invasive Asian Carp. This paper is not meant to bring light to those efforts. As worthy as they are, the information and research will not stop any Asian Carp advance unless they are constructed, implemented, and maintained before the carp arrive.

WHAT MUST BE DONE?

As I mentioned, since we know the Silver Carp are present in Wheeler Lake, there is a good possibility/likelihood they are already at the upstream Guntersville Lock. Fish can and do move quickly within a lake and tend to move upstream. Filter-feeding fish will use a slow current to their advantage by swimming into the flow with their mouths open. This brings a greater volume of water through their gill-rakers with less effort. By design, Silver Carp are continually on the move, thus, I am confident they are near or currently at the lock.

This being said, there is simply no time to wait. These invaders aren't going to wait around. We presently have methods that work and are being utilized elsewhere. There is no question that the method of choice is electric barriers. They should be installed **as soon as possible** at the Guntersville Lock, Nickajack Lock, and Chickamauga Lock. When complete, installation at the Watts Bar Lock and Loudon Lock should be done. The process must start immediately as it will take many months to design the specific configuration for a lock, obtain the permits, and initiate construction. It is essential an interagency team be established which includes US Fish and Wildlife, Secretary of the Interior, State of Tennessee, TVA, TWRA, Corps of Engineers, and the contractor. The Watts Bar Ecology and Fishery Council (wbefc.org), and the Stop-the-Carp organization (stopthecarp.org) offer our assistance in any way possible, including significant funding potential from Stop-the-Carp.

COST TO CONSTRUCT

In conversations with Smith and Root, the leading U.S company that designs, manufactures, and builds electric barriers, the estimated cost to outfit a typical TVA lock with an electric barrier is between \$500K-700K with control/telemetry equipment an additional 30K-40K. Even if we

assume \$1-million per lock, this is pocket change when compared to the *enormous* revenue loss each year to the local and state economy if the Silver Carp reach our lakes.

The time to design such a barrier is estimated to take 17-months with construction needing about 7-months. This gives the carp plenty of time to move upstream, which they will. Because of the uncertainty of their presence, and another 2-years to migrate, it only makes sense to stop migration in the most certain place possible. I have little doubt they will be in Guntersville in two years. Thus, any barrier at the lock into Guntersville Lake from Wheeler Lake will be too late. Ideally, Nickajack Lock and Chickamauga Lock would be outfitted at the same time, and Watts Bar Lock next. It is essential for TWRA to continually perform populations studies in Guntersville, Chickamauga, and Nickajack to confirm presence or absence of the carp. This is necessary to determine which lock(s) are outfitted. Only in this way can we be certain migration is stopped.



Figure 6: Barrier Construction and Control Room--Photos by Smith Root

If full funding is not immediately available, an LLC should be formed to obtain loans and/or government loan guarantees, while corporate, government, small-business, and private/individual funding is being raised. Millions of dollars can be obtained if simply every property owner, business owner, and other stakeholders on the lakes would make a tax-free donation of merely \$100 or more. I believe very few stakeholders would be unwilling to donate such a small amount to protect such a wondrous resource. There are numerous other ways to help fund this effort. The STC organization has already acquired funding and is actively advancing their search for additional funding sources.

We must bite the financial bullet and strike back at the Asian Carp attack if we have any chance of saving our lakes. We must begin with the immediate installation of electric barriers at a minimum of two locks. I also believe the bio-acoustic fish fence should be installed in front of the electric barrier as an added barrier. The electric barriers may not be foolproof and could go down; thus, the extra effort would add a bit more likelihood of migration prevention.

THE TIME IS NOW

Time is of critical importance. As an experienced fishery biologist, my fear is the Silver Carp are presently throughout Wheeler Lake as I have stated they may have already entered Guntersville Lake. I hope this is not true, but if only a few individuals entered, it may be sometime before they are captured, but one cannot forget that a **single** mature female fish can spawn several times during the summer laying 4 – 5 million eggs. One only need do the math to appreciate how rapidly a few fish can lead to a lake overrun with invasive fish in a few short years.

The ecology of our lakes is under attack in a very real way. When University of Tennessee studies show that our lakes are responsible for “Billions” of dollars of revenue to the region, and that every mile of shoreline brings in about a Million-Dollars, how can one possibly put aside protecting that wealth. Fact: that wealth will be lost if we do nothing. Whether it takes 2, 4, or 6 years to destroy our lakes is not the question—they will be devastated unless we act “Now” to protect what remains of the TVA system presently free of Asian Carp. There is no question whatsoever that the amazing wealth brought about by a healthy lake ecosystem will be gone along with the ecosystem itself. This is not supposition, it is not a mere threat, it is not fear mongering, it is ecological reality in every sense of the word.



One only need look at the ecosystem devastation, recreational, and economic impacts that have already occurred throughout the Mississippi Basin: one only has to look at the forecasts of the billions of dollars of revenue loss predicted to occur if they Asian Carp reaches the Great Lakes; one only has to put themselves in boat motoring through a wall of airborne fish to fully appreciate what the future holds if these fish reach our lakes.

Remembering simply that each mile of our shoreline is valued at a million dollars to the local economy makes the cost to implement control measures at the locks insignificant. You cannot put a dollar value on a huge, healthy, aquatic ecosystem. Pay a little now or suffer huge economic and environmental consequences later seems like a very easy choice to make. Money spent today will be orders-of-magnitude less than if we are challenged with the problems of dealing with them if they reach our beautiful lakes. There will be “No” possibility of recovering from an invasion, it **MUST** be prevented.



NEXT STEPS

The entire process from approval to engineering to construction and operation is lengthy. I cannot overstate the need to work all aspects of this process in the most expedited manner possible, simply because as I have stated, the Silver Carp move rapidly and reproduce in incredible numbers. The urgency of beginning the process can likewise not be overstated.

If it takes two years to complete construction, then it must begin at Nickajack and Chickamauga, for without a doubt, the fish will have occupied Guntersville Lake by that time. And if possible, Watts Bar Lock construction should also be started. But as stated, this determination should be based on TWRA population surveys. Yes, protection from migration of the Silver Carp is a moving target because they are moving. Bottom-line, we cannot wait to begin.

The most immediate need is to bring together TVA, TWRA and the COE and work toward completing the necessary approvals. This process alone can be lengthy, but it can also be expedited—it must be expedited. The first action should be to select an experienced manager

from each agency with one delegated as chairman for this group. Using experienced staff from each, a formal project team should be established and immediately generate an organization chart, develop a work breakdown structure, divide the workload, establish an expedited schedule, and initiate contact with appropriate companies to begin design effort.

Initial contracts should be established and funding provided so that design can begin, products manufactured, and schedules for construction set. This process must be multitasked and move quickly, for the carp are indeed moving quickly to ravage and devastate our lakes. We simply cannot afford to take our time or allow agency red-tape to slow this process. All three agencies need to step up to the plate, form this coalition, and move together to make this happen: "It can, if they do."

Only in this manner can we save the remaining Silver Carp free TVA aquatic ecosystems from being destroyed. The process to protect our lakes must begin in earnest immediately. I stand ready to assist in any way I can.

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