

**Preventing Silver-Carp Devastation
of
Upper Tennessee & Cumberland River Basins
(Plan of Action)**

Report to:

**Tennessee Valley Authority (TVA)
U.S. Fish and Wildlife Service (USFWS)
Tennessee Wildlife Resources Agency (TWRA)
Asian Carp Advisory Commission
U.S. Army Corps of Engineers (USACE)
Tennessee Wildlife Federation (TWF)
U.S. Geological Survey (USGS)**

By

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PREFACE

Over the past decades millions of dollars have been spent addressing the Asian carp invasion in the United States. The four Asian carp species (grass, bighead, silver and black) impact nearly every aspect of an aquatic ecosystem. The grass carp impacts aquatic vegetation, the bighead and silver impact plankton populations, and the black impacts mollusks and crustaceans, all foods and sources of cover for native fish. These four invasive species have essentially taken over most of the Ohio, Mississippi, Missouri, and Tennessee Rivers and their tributaries. But of the four, the silver carp has had by far the greatest impact on ecosystems and recreation because of the sheer size of their population numbers and their jumping habit. Silver carp plankton consumption takes away the food of the larvae of most other fish species and aquatic organisms, and their jumping habit significantly impacts recreational uses of any water body. Preventing a silver carp invasion of the Upper Tennessee River watershed is thus of paramount importance. Though this document specifically addresses the Upper TN River Basin, it applies equally to the Upper Cumberland River Basin.

The millions spent thus far have not prevented Asian carp from invading uninfected ecosystems. The silver carp have severely impacted the recreation industry and lowered lake and river property values. The battle against these invasive fish continues with states, counties, agencies, and organizations vying for state and federal money to help prevent and control the ecological and economic devastation that these fish inflict.

Heretofore, the allocations of funds were managed by committee and/or through joint meetings with organizations such as the Tennessee Wildlife Federation, U.S. Fish and Wildlife Service, United States Geological Service, United States Army Corps of Engineers, and state agencies. The millions of dollars have been spent on too many projects to list, and a great deal of information and scientific data have been collected.

Most recently \$25 million in federal funding has been allocated by Congress to address the Asian carp issue, and it is expected that more dollars will be realized in the future. Although this amount of money is significant, the number of organizations and projects that will be seeking funding will far exceed the allocation, resulting in a huge funding shortage. This funding deficiency is largely due to the enormous geographical area impacted by the Asian carp invasions.

This document was prepared for the Watts Bar Ecology and Fisheries Council (WBEFC) to address the common funding problem: how allocated funds can best be used to achieve the greatest value for the dollar. When dollars are limited, it is crucial all allocations represent the absolute best use of public money. Every project funded must be defensible and shown to be superior to other options/projects seeking funds. Foremost, the **long-term** benefits, cost, and risk must take precedence over short-term consequences, positive or negative.

WBEFC REPORT GUIDANCE

The formal education (PhD in Fisheries Biology) and 50 years of laboratory, field, research, and project management experience in carrying out hundreds of environmental endeavors throughout the country, confirmed to the author of this report, the need to always use science as the primary basis for forming environmental recommendations and decisions, over beliefs, speculation, or feelings. Most importantly it confirms that the key in reaching the best possible outcome is to look to experts to obtain needed expertise, and to look closely at past experiences, projects, and historical facts. This was done in compiling this report.

The lead national management authority in environmental matters is the U.S. Fish and Wildlife Service (USFWS). Their stated mission is “*To work with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American People.*” They are on the front lines, and are the principal federal agency leading the battle against the Asian carp crisis.

The USFWS established an impressive and highly accomplished Asian Carp Working Group with over 30-professionals representing state and federal agencies, universities, associations, councils, and others. In 2007, they submitted their report: *Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States*, to U.S. Fish and Wildlife Service Region-3 Fisheries Program and the Aquatic Nuisance Species Task Force.^[1]^[SEP]The WBEFC concurs fully with their findings, and their advice and guidance forms the foundation for this report.

The USFWS recognized the complexity of the situation, and that the magnitude of the problems was such that all stakeholders (i.e., private and public-sector fisheries professionals, aqua-culturists, aquatic ecologists, and the public) must be involved in the development of an appropriate management plan. They stated; “*Implementation should begin immediately to prevent further introduction and to stop the spread of Asian carps into uninvaded waters throughout the United States.*”

Following are the unaltered, only shortened goals stated in the USFWS publication (Underline is for emphasis):

Goal 1: Prevent accidental and deliberate unauthorized introductions of bighead, black, grass, and silver carps in the United States. Active control measures are needed to prevent introductions or range extensions; however, consideration must be given to the risks and costs/benefits to determine when actions are warranted.

This goal is extremely pertinent. The most efficient, proven “active control” is an electric barrier. This goal states that it is paramount to “prevent” range extensions of the Asian carp. This is precisely what the WBEFC plan of action does—it “prevents” range extensions.

Our plan of action also quantifies the “cost/benefit” of not preventing the carp from moving into the Upper TN River Basins. The USFWS specifically identifies the need to identify “risk” in this goal. The risk to the Upper TN River Basin is factual: the four lakes **will** feel the same economic and environmental devastation as The Land Between the Lake if the fish reach the lakes. Leaving Watts Bar lock open while further discussions take place is a “Risk” that is **unwarranted** and can be easily eliminated. The USFWS clearly states that such risk must be considered when making decisions and plans. To date, only the WBEFC has quantified the

economic risk to this region. Decision makers MUST weigh the risk of the fish reaching our four lakes, against the cost of stopping them by closing the lock and constructing an electric barrier.

Goal 2: *Contain and control the expansion of feral populations of bighead, black, grass, and silver carps in the United States. A long term, cooperative national effort between federal, state, tribal and private stakeholders is required to contain existing populations and prevent their spread. . . . Monitoring programs are paramount in the timely detection and effective utilization of Rapid Response Plans to prevent range expansions and eradicate new introductions. Due consideration should be given to the effects of containment actions on the long-term ecological sustainability of native aquatic resources.*

The WBEFC plan of action was developed to Contain and control the expansion of these invasive species in order to prevent their spread. Our plan is indeed a Rapid Response Plan to prevent range expansions, for it calls for immediate temporary closure of the Watts Bar Lock. This rapid response is the only way to ensure that the silver carp does not expand their range into the Upper TN River Basin. Our plan focuses on the long-term ecological sustainability, rather than the short-term minor economic and inconvenience impact on river transportation.

Goal 5: *Provide information to the public, commercial entities, and government agencies to improve effective management and control of bighead, black, grass, and silver carps in the United States.*

This WBEFC report and plan of action was written to inform the public, commercial entities, and government agencies. It has been placed on our website: <http://wbefc.org/>

Goal 6: *Conduct research to provide accurate and scientifically valid information necessary for the effective management and control of bighead, black, grass, and silver carps in the United States.*

It is essential that all recommendations and decision be based on accurate and scientifically valid information, rather than beliefs, speculation or what someone “thinks.” This document is based entirely on basic fisheries biology, aquatic ecology, limnology, existing silver carp advancement upstream in the Tennessee River, and the decades old history of the silver carp range expansion.

Goal 7: *Effectively plan, implement, and evaluate management and control efforts for bighead, black, grass, and silver carps in the United States. Bighead, grass, and silver carps have established feral populations over a wide geographic range in the United States; therefore, a nationally coordinated approach is needed to successfully implement an effective integrated management plan. Implementation of an effective plan to address such a complex issue over such a wide geographic area will require a sophisticated management structure and significant funding. Efficient use of this funding will require that recommendations be strategically prioritized and properly sequenced. Formal institutional arrangements, including a process for conflict resolution, will also be required between partners to facilitate plan implementation.*

This USFWS goal is critical to accomplishing their goal “**to stop the spread of Asian carps into uninvaded waters throughout the United States.**” Yes, a “sophisticated management structure” is needed to accomplish this, and indeed recommendations must be strategically prioritized and properly sequenced. This is why the WBEFC recommends the use of a third-party consulting firm for management and plan design as well as the use of formal decision analysis. The USFWS understands how complex and multifaceted the silver carp crisis is and recognizes the need to “Prioritize” and properly “Sequence” actions.

The USFWS goals recognize that preventing Asian carp from expanding their range is the highest priority and to accomplish this, actions must be properly sequenced. This WBEFC

document was written to do just that. The WBEFC is a stakeholder, and our efforts over the past five-years have followed the USFWS goals precisely. Our Plan of Action in this document echo's the USFWS foremost goal: "*to prevent further introduction and to stop the spread of Asian carp into uninvaded waters throughout the United States.*"

This report is based on: fisheries biology, aquatic ecology, silver-carp invasion history in other basins, Smith and Root (electric barrier contractor) communications, economics from TVA and UT, past use of decision analysis tools, and additional data/information from other sources.

The purpose of this report is three-fold:

1. To demonstrate that an experienced and professional management structure and the use of formal decision analysis should be utilized to establish a plan of action to achieve the greatest environmental and economic value in the allocation of Asian carp funding resources.
2. To show clearly that "**preventing**" these invasive species from reaching Asian carp free lakes represents the best use of funds and therefore embodies the top priority in funding allocation.
3. To provide a science-based *plan of action* to prevent the silver carp from advancing into and taking over the Upper TN and Cumberland River Basins.

INTRODUCTION

The urgency and need for the information in this report is critical for decision makers to make the best possible decisions in allocating funds in the fight against the silver carp. Clearly, when funds are limited, every dollar spent must yield the greatest possible value and be justified as such. The only way to achieve the greatest value in funding is to compare the value gained by each allocation potential against all the others. This is not difficult to do, for formal and informal decision analysis has been in use for many decades, especially concerning environmental projects (see Appendix-1). It can be a standalone effort, and is often utilized in the NEPA process depending on the nature of the program.

Every decision maker has a responsibility to make the best possible decision he/she can—this is clear. More often than not, environmental decisions are made by selecting a number of individuals and experts to work together to assess a problem and formulate a solution. A typical committee, commission, or workgroup of individuals will generally include professionals with significant expertise, formal education, or experience in related environmental fields, and often include others with management experience or political affiliations. More often than not, a large budget will be divided equally among those seeking funding, with little or no weight placed on the true over-arching value to be gained by the individual projects undertaken. This piecemeal approach only thwarts prioritized and holistic solutions, which can be derived from a sequenced, balanced and comprehensive approach to the problem(s).

The concern with asking an assemblage of individuals to address an environmental problem and render recommendations is individual bias. Everyone has bias in the form of preferences, beliefs, background, education, goals, etc. This bias is exaggerated when the grouping of individuals is from a wide geographical area undergoing the same environmental problem/concern and vying for funds to eliminate or reduce the environmental threat/problem. This is especially apparent in dealing with the silver carps issues. Many regions, lakes,

ecosystems, and economies have been seriously impacted by the silver carp, for they have taken over nearly every ecosystem in the Ohio, Mississippi, Missouri, Cumberland and Tennessee river basins.

Because of this wide geographical area of silver carp devastation, there simply is not enough money available to address or reduce the negative ecosystem and economic impacts these fish have triggered in every area. This is precisely why it is essential that the money spent results in the highest possible environmental/economic value. Since all regions and all impacted areas cannot possibly be adequately funded, priorities must be established. Decisions made using decision analysis are prioritized and fully justified, easily explained, and are supported by science and sound reasoning.

DECISION ANALYSIS

Decisions to be made regarding environmental degradation call for not only the best science has to offer, but also for the right choice of tools to make decisions. At this juncture, good intent and good science can still lead to bad decisions. Decision making tools are available and must be used. Without their use, decisions are reduced to individual judgement with little or no scientific basis, significant uncertainty, speculation, and often under stress. Using this tool moves the decision makers (government agencies, industry, local organizations, and other stakeholders) from qualitative judging to value-focused thinking. It builds a framework for a thought process that charts the decision situation in detail. Priorities, objectives, attributes, and properties are developed and fine-tuned. Then a model is built for quantifying and properly weighing values.

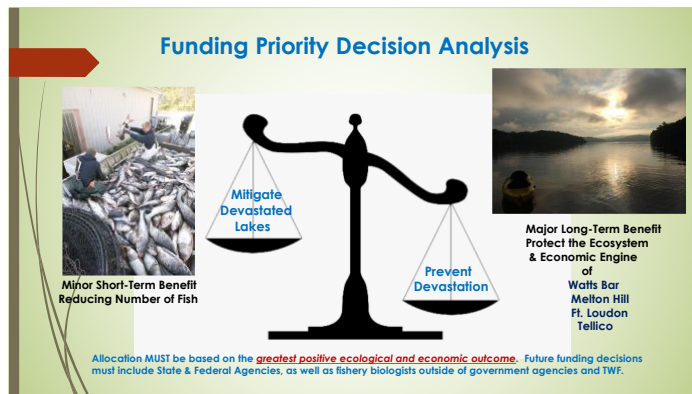
Environmental degradation issues are emotional, whether they be real or potential, and science can aid in understanding an issue and arriving at the best decisions. But environmental science has many tools, and thus the selection of the proper scientific tool is critical. In other words, highly quantitative and accurate investigations may produce good science but with no utilitarian value. For example, in addressing the silver carp crisis, one may want to spend \$200,000 to determine the speed, direction, rate of advancement, and environmental factors that pertain to silver carp movement in a typical river/lake. The data gained would be sound, valuable, and relative to silver carp movement, and thus good information to predict when the fish would likely reach another lake. However, using the decision process/equation, it would show that the information would have little utilitarian value regarding whether or not the upstream lake would eventually be occupied, because fisheries biology and factual history in other basins tells us the fish will eventually reach the other lakes. It would only allow us to predict when they might arrive there. The question then is, should the money be spent to obtain that data or would spending it on another project yield a greater value?

It is essential in making funding decisions to fully comprehend the true value to be gained (economic/environmental benefit). When good scientists, good government, and good intent lead to a study that results in no utilitarian value, a bad decision has been made. The "bad" isn't the result of the study; it is the decision to undertake the study, for it contributed nothing to prevent silver carp devastation. Selecting where money is spent represents a true dilemma and challenge, and that is why the proper tools should be incorporated.

Making informed decisions up front will save years and millions of dollars from being wasted, and will go a long way toward freeing the decision maker of criticism or blame. Most important, this kind of decision making assesses whether a solution can be found, how much of

the problem can be addressed, and how best to do so. Decision analysis is a science and a pivotal assessment tool. Decision making should never be reduced to a concerned response, a belief, a vote, politics, or what appears to be a fair distribution of funds.

The figure below is but one simplified example of using decision analysis. The question is: What is the best use of dollars if there is enough money to **either** mitigate devastated lakes by reducing the population of silver carp, or *stop the spread into uninvaded waters* (you can't do both for there is not enough money)? Decision analysis will weigh both options for the decision makers by evaluating short-term and long-term economic and ecosystem benefit and costs. The ecological and economic benefits of both options will be quantified, these facts will show clearly the greatest use of the funds.



Every decision maker has the responsibility to the public to make the best possible decision based on science and economics without personal bias. The WBEFC is asking the Asian Carp Commission, and individuals in agencies and organizations tasked with allocating the Asian carp fund, to ensure rigorous decision analysis to the allocation of the \$25 million. This will yield the greatest possible long-term ecological and economic value/benefit. The cost to do so

should come from the Federal funds. The use of this scientific tool is the way to ensure allocation of funds achieves the greatest value without question. Too, it will eliminate any criticism, for each decision can be explained and justified. Every decision maker should welcome this.

Appendix-1, is a publication in **The Journal of Environmental Health-- Utilitarian Decisions in the Environmental Health Sciences**. It explains how the author of this report used formal decision analysis to allocate a \$12 million environmental budget. The dilemma was very similar to the allocation of a \$25 million budget. In using this tool, each allocation was easily defensible and elucidated, and no one questioned the results. Use of this scientific tool will render the best decisions and recommendations possible, without question.

ECONOMIC IMPACTS

The economic impacts of the invasive silver carp have been widespread and severe. They include major tourism reduction, losses to marinas and many small businesses, reduced recreation, and the need for continuing funds to reduce their abundance by commercial fishing. Fishing tournaments have slowly disappeared, for the population and health of game fish are eventually severely reduced. Property values have dropped significantly, along with property tax revenues to the counties and states. These losses amount to hundreds of millions of dollars every year.

More than a year ago, Tennessee Wildlife Federation CEO Michael Butler said. *“If these fish get to Gunter’sville and Nickajack, they’re going to get into Chickamauga. That riverfront in East Tennessee is worth billions and billions of dollars. The financial risk is huge. TVA says the river is worth \$100 million per year. That’s a really huge concern. These fish get in, and they not only compete for base food resources but they just by volume replace native species and move*

them out." He is accurate on all accounts. However, since his statement, the fish have been reported in all three of those lakes.

On January 15, 2020, at the Senate Energy, Agriculture and Natural Resources Committee meeting in Nashville, the author of this report provided expert testimony on the ecosystem and economic impacts the silver carp will have on the four carp free lakes in the Upper TN River Basin if they are not stopped. Following my presentation, Senator Bill Powers of Tennessee, a committee member, made this statement: *"The economic impact (to the four lakes in the Upper TN River Basin) will be devastating. I live in Clarksville and go to Kentucky Lake and Lake Barkley. In fact, I have Stewart County and its part of Lake Barkley. Their fishing tournaments where they used to have 200 boats plus, is now 50 boats. I have two professional fishermen that I work with, they said half of the 50 boats did not get a fish this year. That's how bad it's become in and of itself, but the real estate values that are on the lake are dropping. The guides that have been on this lake for years and years are moving to Center Hill Lake and the ancillary things that go with this, the restaurants, bait shops, and marina owners, they are going too. The impact of this is devastating and it is going on today in The Land Between the Lakes where I'm from. Even though it is too late for me, I would encourage everyone to get on board with Dr. Joseph. The problem is real, and it is a devastating occurrence."* Senator Powers understood fully, if the carp reach our four lakes (Watts Bar, Melton Hill, Fort Loudon, and Tellico Lakes), the same economic and ecological devastation **will** take place.

Agreeing with Senator Powers, personal communications with the Director of Tourism for the nine-county region in North West Tennessee, Mr. Gary Mason said the recreation industry is down 40-50% in the past few years. He said fishing guide services and tournaments have been hit extremely hard. He mentioned that likely due to the intense commercial fishing and removal of many thousands of pounds of carp, it appears that the crappie fishing is beginning to recover a bit. In addition, personal communications with Sam Lashlee, a seasoned professional fisherman and guide confirmed the negative impact to fishing guides and tournaments. He averaged 275 trips/year before the carp took over but could no longer make a living there. He left his successful professional fisherman career in 2019 after more than 15-years due to the invasive Asian carp. He now works in auto sales in Knoxville TN.

In 2017 the University of Tennessee Institute of Agriculture completed a detailed study that found "that recreational visitors to the TVA reservoir system generate an average annual economic impact of \$11.9 billion as well as more than 130,000 local jobs, \$4.45 billion in labor income and \$916 million in state and local taxes." (The quote is from Burton English of the UTIA). This study show that the TVA system of lakes produces nearly 12-billion dollars a year from tourism and the many lake recreational activities found on and around the reservoirs. Professional and non-professional fishing tournaments on the four lakes in the Upper TN River Basin are popular activities. These activities 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 as well as kids and adults being pulled on tubes, wake boards, and skis, and individuals on jet skis. Jumping silver carp have broken jaws, fractured skulls and knocked people out of boats. Silver carp will place significant stress on all native game fish, as well as forage fish populations, and all will suffer in number and the health of individual fish. They will significantly alter the natural species diversity and seriously impact the natural ecosystem. These impacts cannot be reversed as long as the silver-carp are present.

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, lake cabin and boat rentals, fishing camps, and even boat sales. These are nearly all family owned and operated businesses whose entire income and livelihood is related to recreation. Unfortunately, many of these businesses will not survive. As well, tackle and bait shops and small fishing camps and sporting goods outlets will face closure.

Using information from TVA and UT publications, table-1 below shows the recreation related revenues by lake and associated counties in the four-lake region of the Upper TN River Basin. Table-2 shows the total income revenue for each county.

Table-1
Annual Revenue Income from Recreation by Lake and County

Body of Water	Total Annual Est. Revenues (\$millions)	Shoreline County	Estimated percentage of shoreline in county*	Estimated annual Revenue to county
Watts Bar	\$752			
		Roane	50	\$376
		Rhea	25	\$188
		Meigs	15	\$112
		Loudon	10	\$ 76
Melton Hill	\$199			
		Anderson	70	\$139
		Roane	5	\$ 10
		Loudon	5	\$ 10
		Knox	20	\$40
Fort Loudon	\$361			
		Loudon	15	\$54
		Knox	55	\$199
		Blount	30	\$108
Tellico	\$344			
		Loudon	50	\$172
		Monroe	50	\$172
Total	\$1656			

* Est. shoreline per county error +/- 10 %. Revisions/additions made 9/22/2019

Table-2
Total Income Revenue by County

County	Revenue Estimates per lake (\$-millions)	Total Revenue per County (\$-millions)
Rhea	203+188	\$391
Meigs	202+112	\$314
Roane	376+10	\$386
Anderson	139	\$139
Loudon	765+45+172+10	\$312
Monroe	172	\$172
Knox	40+199	\$239
Blount	108	\$108
Total		\$2061

It is estimated that economic downturn to the lake recreation industries at The Land Between the Lakes due to the silver carp invasion has approached 50% and is increasing. If the silver carp reach the four-lake region of the Upper TN River Basin, there is no question that this region will feel the same economic impacts. This 50% hit will amount to an **annual loss** of revenue of over a Billion Dollars. Since eradication is impossible, the region will not be able to recover, and the loss would increase annually. Presently this region is experiencing an increase in this industry as well as new businesses being added. This trend will reverse when the first silver carp is seen jumping out of the water and the sighting is publicized in the media.

It is clear that **preventing** these fish from reaching the Upper TN River Basin must be recognized as the highest priority by state and federal agencies and all organizations involved in decision making. **Prevention** of a major permanent economic downturn to a huge four lake region, is far more valuable than slightly reducing the economic impact in already impacted lakes. Yes, those lakes deserve consideration and efforts to reduce impacts, but not at the cost of allowing other carp-free lakes to then undergo the same devastation they are experiencing. If allocating funds to slightly mitigate the impact in one region means there is not enough money to prevent the same impact to another region, the allocation should not be made.

It may seem to make sense and be fair to give a little money to all the impacted areas. But at what cost to those areas which are not yet impacted? Is it “fair” to allow four silver carp free lakes to undergo devastation so that some funds can be allocated to reducing the number of fish in a carp infested lake? If unlimited funds were available, then that question wouldn’t arise. But funds are limited, and thus the need to prioritize spending is absolutely critical.

SILVER CARP BARRIERS

Though different barriers have been mentioned, it is apparent the TWRA and others are focused primarily on the bioacoustics fish fence (BAFF). The WBEFC fully supports their use. This barrier is new thus only laboratory data is available as to their ability to stop silver carp. The research being conducted on the BAFF at Barkley Lock will provide field results in the next year or two.

Laboratory research shows that the BAFF can be from 73 – 97% effective. (Bioacoustic Deterrence of Invasive Bigheaded Carp, Murchy, Kelsie (2016): Dennis, C.E., Zielinski, D. & Sorensen, P.W. *Biol Invasions* **21**, 2837–2855 (2019). Laboratory studies use flumes fitted with the bioacoustics components. A flume is a very small/restricted channel and cannot duplicate the depth, width, or actual conditions at a large lock. It is generally expected that an efficient bioacoustics barrier would be 95% effective.

Considering that the abundance of silver carp at a dam can be in the hundreds of thousands, 5% passing the barrier amounts to a large number of individual fish. If 100,000 silver carp reach a barrier in a single week, 5,000 individuals would likely make it past the barrier. This could happen week after week. It would have prevented thousands of fish from passing through the lock, but the number of fish entering would continually increase. A BAFF would significantly reduce recruitment into the lake, and represents a valuable and important means of lowering the number of fish. But for a lake that has no silver carp, this number of fish is too high.

Completely preventing silver carp from moving into an ecosystem free of the fish demands the best technology available if the ecosystem is to remain silver carp free. The best and proven technology today is the electric barrier. It is possible to prevent migration of these fish upstream by installing an electric barrier. They have been installed in over 50 locations in the U.S. and Europe, and have been in use since the 1950s. To see the many barriers constructed, visit: <https://www.smith-root.com/barriers/sites/>

There is no danger of electrocution if someone fell in the water, because the pulsed DC voltage is very low .2 to 1.2 Volts with the current of about 0.005 amps. The person would feel a tingle and it would be uncomfortable, but it would not be lethal or do harm. Smith and Root

explain barrier safety as follows: *There are two areas of concern for electrical safety. Smith-Root electrical barrier systems are designed with careful attention to all national safety codes. Nevertheless, we require barriers to be fenced and warning signs also be posted. In the water, the water acts as a conductor in the circuit. The voltage is dissipated over the length of the field so that the voltage gradient over any small length of the field is much less than the total voltage applied.*

Electric Barriers Prevent Movement Upstream

Repelling the Invaders
 Has the barrier placed on the bottom of a lock or lake — adjacent to a dam or existing barrier — been designed?
 A. First electrode array and second to the bottom of the channel.
 B. The electrodes are connected to a control building. Equipment in the control building generates a direct current pulse through the electrodes, creating an electric field in the water column.
 C. The migration of electrically sensitive fish, called "barbaric fish," causes them to stop from moving beyond the barrier area.
 D. The voltage is low enough that fish are not killed, though the electrical current will harm to some extent. Larger fish are more affected than smaller fish. (Note: smaller fish are more affected.)

Gradua 3-Field Fish Barrier (GFB)

Voltage	Current
1.2 V/cm	0.005 A/cm
1.0 V/cm	0.005 A/cm
0.8 V/cm	0.005 A/cm
0.6 V/cm	0.005 A/cm
0.4 V/cm	0.005 A/cm
0.2 V/cm	0.005 A/cm

NO POSSIBILITY OF ELECTROCUTION—Far Below Defibrillation Voltage (200–1,000v):
 People have swam through these electric barriers without any injury. They said they can feel it — it's like a tingle — but it's not anything that impairs their ability to swim or move.

Smith-Root barrier and behavioral guidance systems are designed to be non-lethal and to use only low-frequency pulsed direct current (DC) to create electric fields. Humans are three times more likely to be harmed by alternating current (AC) than by DC current, and it has been shown repeatedly in the scientific literature that use of AC can injure fish. Pulse frequency (especially) and duration and current can all contribute to potential damage; thus Smith-Root sets these values well below the electrocution threshold of a typical ground fault interrupter. Pulse frequencies for barriers are much lower than those used in traditional electrofishing. Our interest for most barriers is in changing fish behavior, not achieving galvanotaxis, tetany or anesthesia. Vessels can safely pass through our electrical fields. Metal-hulled vessels create

local short-circuits (requiring longer fields to ensure that fish do not find a pathway through); there are no potential differences within a hull. Hulls of insulating materials merely distort the field by displacing the conductive water. As occurs in the Chicago Sanitary and Ship Canal multiple times per hour, metal-hulled barges traverse our series of electric barriers for Asian carp control with no effects to vessels or occupants. Smith- Root systems are safe to operate when done so in accordance with the design criteria specified for each unique situation. (<https://www.smith-root.com/barriers>) 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>

Electric barriers can be up to 100% effective in stopping silver carp as discussed in the following journal publications: *Parker, A.D., et al., Direct observations of fish incapacitation rates at a large electrical fish barrier in the Chicago Sanitary and Ship Canal, J. Great Lakes Res. (2015) U.S. Fish and Wildlife Service, Carterville Fish and Wildlife Conservation Office, 9053 Route 148, Marion, IL 62959, USA; Michigan Department of Environmental Quality, Surface Water Assessment Section, 525 W Allegan Street, Lansing, MI 48909, USA; Aquatic Ecology Laboratory, The Ohio State University, 1314 Kinnear Road, Columbus, OH 43212, USA*

Even if the electric barrier is not 100% effective, the few fish entering a lake may not find the ideal conditions for reproduction. If they are small fish, they may be eaten as forage fish before they reach maturity to reproduce (3-4 years), and larger fish may be injured and die. Even if a small number spawn, that spawn may not have the required conditions to allow the eggs to survive, and if a few eggs hatch, the tiny fry take 30-60 days to reach a fingerling stage and stand a good chance of being consumed. So, even if a few fish make it through, the lake could always remain silver carp free. If the carp are allowed to continue unimpeded, they will eventually take over the entire ecosystems.

To ensure that the entire Upper TN River Basin of four beautiful lakes remains silver carp free, a bioacoustics barrier should be placed in front of the electric barrier. The relatively low cost of this barrier would result in a significant reduction in the number of silver carp reaching the electric barrier. Together, both barriers would most assuredly result in the region remaining silver carp free.

Smith and Root gathered the technical data needed to estimate the cost of design and construction of an electric barrier on Watts Bar lock. The Cost would be between \$50-75 Million, and would take 4-5 years to complete. Adding a bioacoustics barrier in front of the electric barrier would add approximately \$5-7 million.

The greater goal must be considered when deciding the best alternative. If it's to reduce recruitment into a lake with silver carp, a less expensive bioacoustics barrier would do that. If it is *to prevent further introduction and to stop the spread of Asian carps into uninvaded waters* as stated by the USFWS, an electric barrier is the far more efficient solution. Too, when considering an electric barrier, though they are far more expensive, one must weigh the cost of the barrier against the long-term economic impact of the silver carp takeover on the region. Though silver carp takeover doesn't happen quickly, one absolutely must look at the *long-term* consequence. History of the devastation throughout the entire Midwest and the economic and ecosystem cost is clear. It may take a decade or more to feel the full impact of the silver carp if they reach the Upper TN and Cumberland River basins, but it **will** happen; history substantiates this **fact**. The carp-free lakes will mirror the devastation at The Land Between the Lakes. This not "speculation" it is fact based on both fisheries science and the history of silver carp advance and subsequent devastation.

TVA aquatic zoologist Dennis Baxter said, "*Our goal is to stop the upward migration of Asian carp in the Tennessee and Cumberland river systems. We're hoping to get ahead of this problem.*" The WBEFC has had meetings with TVA staff and management, discussed our program goals, and were met with understanding and support. WBEFC and TVA have the same goal. TVA is in the process of writing National Environmental Policy Act (NEPA) documentation at this time.

TWRA stated, "*Protecting the upper river reservoirs continues to be a primary goal as we evaluate strategies. Completely stopping carp is a goal we would like to meet, but that technology have not been demonstrated for our navigation locks.*" The technology has not been demonstrated because only a single pilot barrier has been built and the results won't be available for a year or two. TWRA also stated, "*there is no expectation that any existing barrier options would be 100% effective. Due to this limitation, they do not think that one barrier at Watts Bar will save Watts Bar and reservoirs above.*" As explained above, a barrier does not have to be 100% effective to keep a lake carp free. The premise that a barrier won't save our lakes is speculation. The TWRA told the *Chattanooga Times Free Press* that "*barriers to stop the fish do work, and they are the block-and-tackle.*" We agree with this, and knowing the efficiency of electric barriers, we are confident the Upper TN River Basin can remain carp free.

TWRA further stated, "*It seems more important to reduce carp abundance and movement at downstream locks, otherwise those populations will step from one lake to the next and eventually pass a barrier at Watts Bar Lock. We still have an opportunity to protect those lakes that are not occupied by large numbers of carp. Should those fish spawn successfully then our strategy would need to change.* First: the fish will eventually spawn, fact. They have reproduced in every river basin they occupied. To "think" they won't spawn, is contrary to fisheries science. Second: reducing recruitment does not protect a lake. It *may* lengthen the time before the fish overtake the ecosystem, but it may not even do that, for it would only take one or two ideal spawns. Either way, they will eventually spawn and overtake a lake (history has proven this). The silver carp are in Chickamauga. Thus, as TWRA suggested, it's time they change their strategy to comply with USFWS guidance, "*to stop the spread of Asian carps into uninvaded waters.*"

Future actions or inactions must not be based on what "seems" important. All actions must be based entirely on sound fisheries biology and aquatic ecology, along with formal risk assessment. WBEFC agrees that reducing recruitment downstream is very important, but it is more important to eliminate recruitment altogether. It bears repeating that reducing recruitment upstream will indeed slow the population increase of carp, but it allows the fish to continually invade new waters and eventually take over. The only way to prevent occupation is to stop them from migrating, not just slow them down.

ST. ANTHONY FALLS LOCK CLOSURE

In 2011, eDNA in water samples from the St. Croix River near St. Croix Falls Wisconsin tested positive for silver carp and raised the alarm and urgency that the carp were on the move toward Minnesota and ultimately the Great Lakes. Action was needed. An *Ad Hoc Asian Carp Task Force* was formed. This task force included the National Park Service, Minnesota Department of Natural Resources, U.S. Fish and Wildlife Service), University of Minnesota, U.S. Army Corps of Engineers, Friends of the Mississippi, and Upper Mississippi River Waterways Association. The task force issued their Asian Carp Action Plan to assess the threat

posed by Asian carp and propose actions needed to minimize their impact in Minnesota. The elements of this plan included: 1) early detection and response; 2) prevention and deterrence; 3) mitigation and control, and 4) outreach and communication.

The Minnesota DNR facilitated an update to this plan and a draft was provided in 2014. Soon after, the *Stop Carp Coalition* was formed. This coalition included over twenty organizations including the National Wildlife Federation, Friends of the Mississippi River, Midwest Marina Association, and the Central Minnesota Audubon Society representing thousands of members in Minnesota, and others. Belden Russonello was retained to conduct a survey of Minnesota voters. Their Report showed that 93% were concerned about the carp, and 63% favored closing the lock.

August 2013, a silver carp was found in the Mississippi River north of Winona Wisconsin which is about 120 miles from Minneapolis/St. Paul. This heightened the urgency for action. Gov. Mark Dayton convened four carp summits. From available literature, the outcome of these summits did not present adequate proactive actions to control the carp. On March 2014 carp eggs were found in samples from the Mississippi River near Lynxville Wisconsin which is approximately 200 miles south of Minneapolis/St. Paul. This provided a heightened urgency in Minnesota since it meant the fish were spawning and not just migrating through.

In a 2014 report, (Congress poised to close Upper St. Anthony Falls Lock to hold off Asian Carp), Cory Mitchell reported that Minnesota DNR officials have been battling the spread of the Asian carp since the early 2000's. He further stated that some river industry groups opposed closure saying it could hurt the region's economy doing little to stop the migration of the carp. A metropolitan council report said closing would eliminate 72 jobs and negatively impact economic output by more than \$40M. Proponents countered that this paled in comparison to the negative impact to the multi-billion-dollar tourism industry. A Stop The Carp Coalition information sheet stated that fishing alone supports 43,000 Minnesota jobs, generates \$2.8B in direct annual revenues and contributes \$640M a year in federal, state, and local tax revenues. Corey Mitchell reported that the Minnesota congressional delegation played a major role in crafting agreements and provisions for legislation. This included Sen. Amy Klobuchar (also participated in Gov. Dayton's summits) and U.S. Rep. Keith Ellison, with support from Sen. Al Franken, and Reps. Rick Nolan, Erik Paulson, and Tim Walz. Bottom line is Minnesota congressional delegates were instrumental in accomplishing closure of the lock.

The lock closed on 6/10/2014 in the Water Resources Reform and Development Act (WRDA) signed by President Obama. This was the first time a navigable waterway was closed to quell the invasion of an invasive species. This ended the reign of Minneapolis as the head of navigation on the Mississippi river. (Ref. 1: Lager, 6/8/2015 Upper St. Anthony Lock closing after half a century; blame the carp, MPR news).

It took a concerted effort by many organizations to close the St. Anthony Falls Lock. The active involvement and leadership of members of Minnesota's legislature delegation led by Minnesota Sen. Amy Klobuchar was instrumental in making this happen. The Governor of Tennessee must take the initiative and work with the Tennessee Department of Environment and Conservation, U.S. Army Corps of Engineers, TVA and our congressional representatives to pass legislation to close Watts Bar Lock until a barrier is constructed there. This will prevent an environmental, economic, and ecological emergency in our state.

St. Anthony's lock was "Permanently" closed. The Watts Bar Lock would only be closed for the time it takes to construct a barrier. TVA has had many extended lock closure periods for maintenance, channel siltation, damage, and repairs. Temporary closure of a lock for an extended

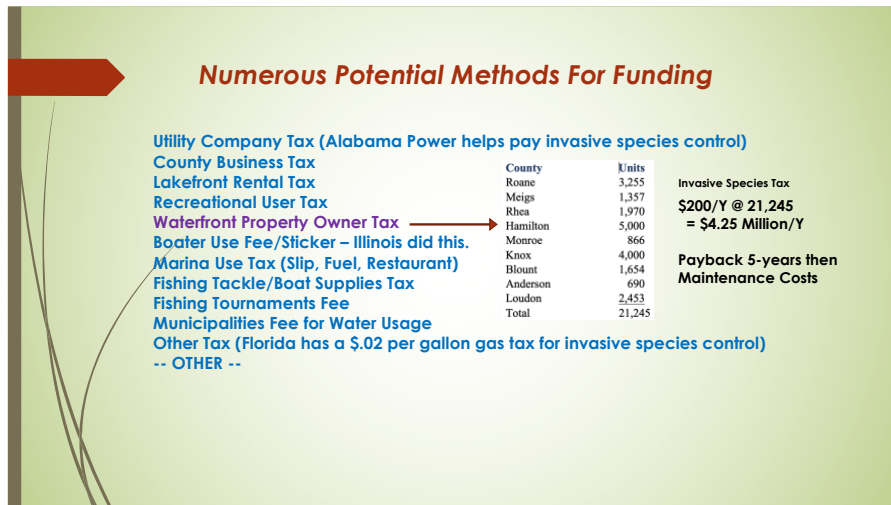
period, should not require congressional approval, because the closure would not be permanent. It would be an emergency extended temporary closure to prevent an environmental and economic disaster. Preventing and ecological and economic devastation of four lakes certainly represents an emergency.

SHORT-TERM ECONOMIC IMPACT OF LOCK CLOSURE

Closure of the Watts Bar Lock will have a temporary negative impact on the river transportation industry and recreational boaters. At the same time, it will have a positive impact on rail and truck transportation. As well, consumers of the transported goods will be paying more due to the increased cost of land vs. river transportation. This is unfortunate, but these impacts will be temporary, lasting only while the lock is closed. The few million-dollar *temporary* annual loss, compared to the > \$1-Billion *permanent* annual lost revenue to the four-lake region is clearly an acceptable temporary impact.

It must be understood, that the economic loss to the region that “will” take place when/if the silver carp pass through Watts Bar Lock will never be recoverable, and will continue to worsen. As well, tax money will be needed every year to supplement commercial fishing to reduce the number of silver carp in the lakes (as is presently an ongoing challenge at The Land Between the Lakes). While at the same time the economic downturn will be reduced tax revenues. This can all be prevented, by accepting a short-term negative impact on the river transportation industry.

FUNDING FOR BARRIER CONSTRUCTION AND OPERATION



This figure shows a short-list of ways to pay for the construction and operation of an electric barrier. Many of the methods listed have been successfully implemented in other regions. Thus, the higher cost of electric barriers must not prevent it from being considered. Not only could it pay for the construction and operation, it could support

mitigation activities in other regions/lakes.

One taxation method alone would possibly be enough. There are over 21,000 waterfront property owners on the four lakes. If each was assessed an invasive species tax of \$200/year, this would provide \$4.25 Million/Year to pay off the electric barrier. Note, this is a tax ONLY on those with property on the water. The vast majority of these property owners can easily afford the added property tax. It is doubtful that property owners on the lake would object to this cost, for it would keep their lake carp-free, lake recreation high quality, and their property value increasing instead of decreasing. In addition, most of these property owners are avid users of the

lake and realize that they would continue to enjoy the fishing, boating, skiing, jet skis, and pulling their families on tubes and wakeboard without risk of serious injury.

Numerous other taxes and fees can easily be implemented, and the additional funds would allow continued funding for the operation and maintenance of the barrier, and excess funds could then be used in other regions to reduce the numbers of carp in their lakes as well as fund other impact reducing projects. This would allow a continued funding source for those lakes while protecting the four lakes in the Upper TN River Basin. This is a win-win situation. The only downside is that the funding wouldn't be immediate.

The State of Tennessee could fund the electric barrier with a *Federal Loan Guarantee* to be paid back later. This is not speculation, it's a very real funding source. The author of this report was the environmental manager for the \$1.8 Billion federal loan guarantee to construct the \$2.02 Billion Great Plains Synfuels Plant. If a loan guarantee can be attained for \$1.8 Billion to build a plant, the state of Tennessee could easily acquire one for the cost of an electric barrier to prevent a \$1-Billion annual economic regional loss and protect 4-lake ecosystems from devastation. It only takes the management effort to do so.

EXTENT OF SILVER CARP RANGE

TWRA confirmed a report on Jan. 10 that a silver carp was captured on Chickamauga Lake in October. The angler, Dustin Hinkle, said the invasive fish "jumped into the boat as I deployed my trolling motor." Hinkle encountered the fish near the Sequoyah Nuclear Plant, and stated he "saw 15-20 more fish near the surface" exhibiting a feeding behavior. Since he reported 15-20 fish were near the surface, there is no doubt that the true number of silver carp likely far exceed twenty fish. A group of 15-20 fish represents the size of a "breeding group" according to silver carp experts.

TWRA confirms invasive Silver carp captured in Chickamauga Lake

by WTVC | Friday, January 10th 2020



The Tennessee Wildlife Resources received a report on Jan. 10 that a silver carp was captured on Chickamauga Lake in October. (Image: TWRA)

Following the sighting, TWRA sampled the lake specifically for Asian carp but was unable to find any. Cole Harty, the Aquatic Nuisance Species Coordinator for TWRA said, *"I am not surprised that there have been no additional confirmed sightings or collections. Indications are that any Asian carp present in the upper Tennessee River are very few in number. The scarcity of fish that may be in these reaches, combined with the size of our reservoirs and ability of Asian carp to avoid sampling gears, makes likelihood of detection low."*

Basic fisheries science, and the history of silver carp movement, makes it clear, that to prevent the silver carp from reaching the remaining four lakes

in the Upper TN River Basin, two actions are essential.

1. The lock at Watts Bar dam must remain closed until a barrier is installed.
2. An electric barrier should be constructed and put in operation as soon as possible (4-5 years)

3. A bioacoustics barrier could be constructed first (8-10 months to construct), to allow reopening the lock earlier. Short-term closures would be used to then construct the ele. barrier.

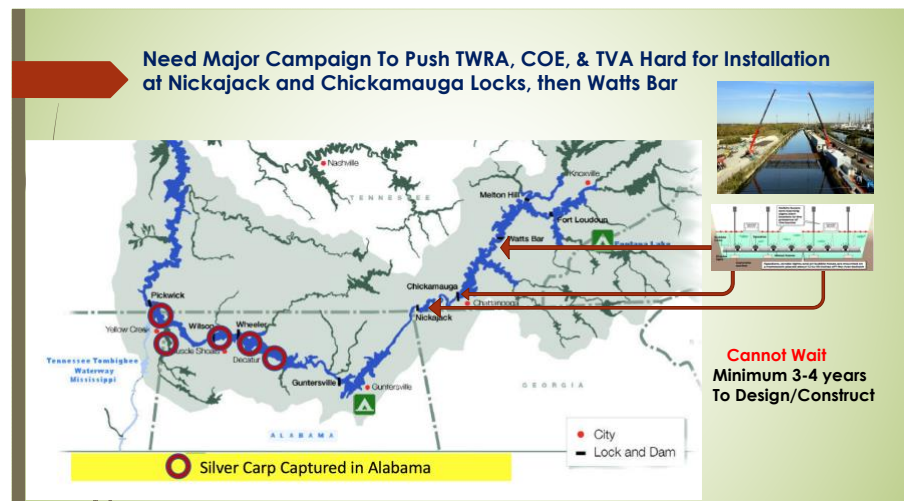
The silver carp are in Chickamauga. The numbers are very low at this date; however, we know two facts. Fisheries biology and the history of the silver carp taking over the entire Ohio, Missouri, Mississippi and nearly the entire Tennessee river basins, confirms that the fish will eventually increase in number, due in part to migration from downstream, and successful reproduction. Thus, immediate action must be taken to keep them from occupying Watts Bar Lake.

History has proven beyond any doubt; the silver carp continually move upstream. To ignore this fact, or believe that they may not pass through the lock, is to disregard both historical fact and basic fisheries science—they **will** advance past the Watts Bar Lock. Even if one believes it just “*might*” take longer, that belief, when proven incorrect, it will be too late. Thus, the only reasonable decision is to err on the side of sound fisheries science and history, rather than ‘speculation’ or what someone may ‘think.’ The risk it too great to act on speculation.

Yes, it may be easy to ignore these facts and the reality that four lakes will be devastated, and thus not even address lock closure because it would mean a negative economic impact on the barge industry and an inconvenience on recreational boaters. But to do so is nailing the coffin closed on those beautiful lakes. In a decade or two when the enormous economic downturn is upon those lakes and lake recreation risks include fractured skulls, broken jaws (which have occurred) or worse, a child’s broken neck, what will then be said about what should have been done? Decision makers must ask themselves this question and do what is right, without worry about what is a bit controversial. Too, they should remember, the minor economic impact to the barge industry will be “short-term” while the economic impact of the silver carp to the four-lake region (>\$1 Billion annually) will be “long-term” and only increase year by year. One should also realize that a short-term economic decline in the barge industry will result in a short-term economic benefit to the rail and truck transportation industries.

WBEFC RECOMMENDED PLAN

Before we discuss the present WBEFC recommended plan of action, it is important that we first explain our earlier recommendation. Why? Because our earlier plan is no longer valid resulting in modifying our recommendations. It also demonstrates clearly that our present plan is not too conservative, as was expressed by the TWRA. As you can see, our initial PowerPoint presentation (and numerous technical reports and communications), WBEFC recommended barrier placement be at Nickajack and Chickamauga locks.



At that time, the silver carp were in Wheeler, and WBEFC reports stated that because they had been in Wheeler for years, we were *certain* they had migrated into Guntersville, even though the TWRA had not found them and didn't believe there were in the lake. Thus, to prevent further migration, WBEFC recommended a barrier be placed in front of the carp at Nickajack and/or Chickamauga to offer the best protection.

Immediately everything changed when the TWRA press release showed that silver carp were found in Chickamauga. Not only had they made their way to Guntersville, as WBEFC suspected, they had also passed through the Nickajack and Chickamauga locks as well. We were incorrect thinking they had only advanced to Guntersville. This necessitated we change the WBEFC recommended plan of action, and we identified this to the TWRA in meetings and reports. The purpose of clarifying this is to emphasize that TWRA must *also* change their recommended plan based on the silver carp being found in Chickamauga.

Just looking at the historical advance of the silver carp, without any knowledge of fisheries biology, it is clear they are advancing into the Upper TN River Basin far more quickly than the TWRA "thought." Regarding the spawning in these lakes, TWRA recently told the *Chattanooga Times Free Press*, "*We're kind of getting a break here in that they are not spawning every year readily, and maybe they don't have the conditions they need in some of these systems. If they did have what they need everywhere there'd be no hope of controlling them. It gives me hope that they don't have what they need everywhere. They're not finding what they need, and they need warm water, and they get that every summer, and they need water that's moving enough that it carries their eggs up out of the sediment.*" TWRA is correct, given the proper spawning conditions, there would be no hope in controlling the silver carp.

But to "hope" that the fish don't find conditions needed to spawn, is not what decisions should be based on. Optimum spawning temperature for silver carp is between 71 – 83 degrees Fahrenheit. This is the typical range in the Upper TN River Basin. Also, the eggs must remain suspended in the water column, and a constant flow will do that. The TN River always has a flow, and the rate varies with rainfall and power generation. The ideal conditions for successful spawn *will* occur. How often is unknown, but migration history throughout the entire Midwest substantiates without question, they *will* spawn.

Since we do not know the number of fish in Guntersville, Nickajack, or Chickamauga, there is no way to predict how quickly or slowly they will populate the ecosystem. If a small pod of silver carp finds the proper spawning conditions, knowing a single adult female can produce 2-4 million eggs, a successful spawn of a small pod can lead to a rapid population growth, regardless of recruitment from downstream. This is fact, not speculation. Reducing recruitment will not stop the advancement, and may not even slow it.

Following USFWS guidance, the WBEFC stands firm that the highest priority for funding must go to **prevent** silver carp-free lakes from being occupied. What could be more important than to maintain four healthy ecosystems and preventing a Billion Dollar **annual** recreation economic loss to the region? There are only a few silver carp-free lakes remaining, and everything should be done to keep these ecosystems carp-free at **all cost**.

However, due to: 1) the demands on the existing funding to mitigate carp infested lakes; 2) the wide geographical extent of their devastation, and; 3) the politics of allocating funds with an underlying wish to be fair and thus divide the existing funding among the many requesting funds, it is likely decisions makers will feel obligated to "spread the wealth" even knowing in doing so the Upper TN River Basin of four carp-free lakes will eventually feel the same devastation as all the rest.

Too, it is unlikely anyone will have to answer for allowing these ecosystems to be destroyed, for decisions will be made by committee rather than a single individual or agency. The fact remains that four beautiful lakes can be saved. However, to do so will require decision makers to agree upon a focused effort to prevent the carp from reaching this region. This would require that allocation of funding be prioritized to the Upper TN River and Cumberland River Basins. This would mean less mitigation in other lakes, and thus decision makers are not likely to forgo mitigating their regions to protect another region. The WBEFC is providing to the decision makers recommendations, which if implemented, would allow Watts Bar, Melton Hill, Fort Loudon, and Tellico Lakes to retain their healthy ecosystem and economy with a high probability they would remain silver carp free.

WBEFC RECOMMENDATIONS:

Recommendation-1: Immediately close Watts Bar lock. Protect what is still pristine while discussions and decisions are made regarding barrier configuration.

Recommendation-2: Early 2022, all state and federal agency decision makers, the Asian Carp Commission, and political leaders who will allocate funding, should undertake a formal decision analysis process carried out by a third-party firm or university. This process will accomplish the following:

1. *Decision made will be based on a sound process involving science, historical facts, and the greatest economic values gained in allocating the funds.*
2. *Bias, judgement, and personal beliefs will be reduced or eliminated.*
3. *Recommended funding allocations will be fully defensible and understandable. All allocations can be elucidated in detail. This will free decision makers from criticism.*

Recommendation-3: Place preventing the silver carp from reaching the Upper TN River Basin and the Upper Cumberland River Basin as the #1 top-priority. This would mean that the \$25 million Asian carp fund would be spent first to prevent the fish from moving upstream, before funds were allocated for other purposes.

Recommendation-4: Establish that the first barrier be placed in front of the silver carp to prevent their movement upstream, before any consideration is given for barriers to be placed behind them to reduce recruitment into lakes presently occupied by the fish. For the TN River Basin, this would place the first barrier at Watts Bar Lock.

Recommendation-5: Immediately work with the Governor of Tennessee, TVA and the US Army Corps of Engineers, and request an environmental and economic emergency be enacted to allow a “temporary” closure of Watts Bar Lock. If it must go through Congress, begin the process immediately, but close the lock.

Recommendation-6: Contact Smith and Root and begin an engineering design for an electric barrier at Watts Bar Lock. Contact Fish Guidance Systems (U.K. Company) for engineering design for a BAFF, and have them work with Smith and Root, so that together they could develop a single engineering design package. This is what is being done in Michigan.

Recommendation-7: Work with the contractor that built the bioacoustics barrier at Barkley lake and have them work with Smith and Root to incorporate a bioacoustics barrier into a single engineering design to be placed in front of the electric barrier. This is being done in Michigan.

Recommendation-8: Begin construction of an electric barrier at Watts Bar Lock as soon as possible, and if possible construct a bioacoustics fish fence (BAFF) in front of the electric barrier.

Recommendation-9: Establish a committee to write legislation to implement an invasive species tax that would be charged to all property owners on the water and all private and commercial vessels registered in the four-lake region, implement the tax, and establish other taxation and recreation fees to apply to the four lakes. The same should take place in the Upper Cumberland River Basin.

Recommendation-10: Establish a committee to write an inclusive/detailed Asian Carp Management Plan to provide the technical information and justification for the actions needed to prevent the silver carp from reaching the Upper TN and Cumberland River Basins. This document would be for public consumption.

Recommendation-11: Contract with an environmental consulting firm to accomplish the recommendations above. Funds should come from the \$25 million federal funding.

SUMMARY AND CONCLUSIONS

The WBEFC asks that this report be seriously considered and addressed by the Tennessee Asian Carp Advisory Commission, TWRA, TWF, TVA, USACE, and those political leaders involved with the silver carp issue. The WBEFC has worked tirelessly over the past several years to keep the Upper TN River Basin free of this invasive species. The recommendations presented herein, if implemented, would result in the Upper TN River Basin remaining silver carp free. This would protect four magnificent lake ecosystems and prevent a >\$1-Billion annual regional lake recreation economic loss. It would allow property values to continually increase, and foster new recreation, boating, fishing, and marina industries.

If the carp are not prevented from reaching this region, they will eventually take over Watts Bar, Melton Hill, Fort Loudon, and Tellico Lakes. The opportunity exists to save these last magnificent ecosystems. The cost to protect our lakes can be paid for by incorporating a few taxation measures, and will represent a minimal burden to any one individual, and few would protest. It is time we recognize that these lakes can be saved, and every action to do so is not only the right thing to do, but those that make this happen will share a rare legacy—saving the entire Upper TN River Basin.

The decision makers can set aside this reality of saving our region, or they can take action to make it happen. Yes, it will take significant effort and dedication, but clearly it is worth it. The WBEFC offers its education, expertise, and project management experience to assist in this endeavor. The Board of Directors have over a hundred years of combined experience managing environmental projects around the country and abroad, ranging from a few hundred-thousand to a Billion dollars.

The Council also realizes our recommendations will require a great deal of effort, money, dedication and determination, as well as a collaborative and detailed plan of action. This is not likely to result from Commission meetings, discussions, and the final decisions from all the agencies and individuals responsible for making the decisions. This is not a criticism of the Commission or agencies, but a realization of the effort required. However, it can be accomplished by using an environmental consulting firm. Thus, WBEFC considers Recommendation-11 to be imperative.

Saving the Upper TN River Basin will take a determined effort on the part of many agencies and organizations as well as individuals. However, nothing in this *plan of action* is unique or has not been accomplished before. The WBEFC plan of action is a credible and unfailing way the magnificent Upper TN River Basin can remain magnificent. Time is the friend of the silver carp and the enemy of environmental health. These four beautiful lakes and those in the Upper Cumberland River Basin cannot be replaced. They can and must remain free of the silver carp and all costs, costs that can be paid for by lake property owners and users.

WBEFC reminds decision makers that the **USFWS** clearly says that preventing the fish from reaching unaffected ecosystems is top priority. They understand the need to reduce populations in ecosystems occupied by the silver carp, but they place “Preventing” them from reaching new lakes as the top priority. Decision makers must follow the USFWS recommendation to stop them first, and mitigate second. Especially when the budget is limited. If this recommendation is not followed, then every single ecosystem/lake will forever be silver carp dominated, at the expense of everything good.

This report provides the details of how the carp-free lakes can be saved. Not only can they be saved, but it bears repeating, the high cost to do so can be entirely paid for by imposing a small tax only on the users of the lake. This has been done before in many places. There is nothing unique in this report for everything recommended has been accomplished before—it only takes effort and time. Thus, to say “The cost is too high” is simply invalid. Saving our lakes will take considerable leadership to prevent our region from following in the footsteps of The Land Between the Lakes. It is our hope that decision makers will closely and deliberately weigh the economics, science, risk, and immense value of the Upper TN River Basin, and take the needed steps and actions to save our magnificent four-lake region.

Decision makers must ask themselves this critical question: “What is the worst possible outcome?” The answer to that question is: the silver carp invade the remaining carp-free lakes. Working backwards from the worst possible outcome, decision makers can then develop the strategy needed to ensure that the worst possible outcome does not happen. This document presents such a strategy to save our lakes.

To do so would decree to these decision makers a *profound* legacy. Will they choose a legacy of saving Watts Bar, Melton Hill, Fort Loudon, and Tellico Lakes, or the legacy of allowing the carp to inflict the disastrous economic, ecological, and recreational impacts?

Timothy Joseph, PhD

Fisheries Biologist

Chairman: Watts Bar Ecology and Fisheries Council



APPENDIX

Utilitarian Decisions in the Environmental Health Sciences

Author: Joseph PhD, Timothy W.
Publication: Journal of Environmental Health
Date: Oct 1, 1999
Words: 3240

ABSTRACT

Environmental health professionals, who must identify, evaluate, and arrive a solution to the myriad ecological and human health issues facing the public, must choose their tools from among a labyrinthine array of complex sciences. Although these tools represent worthy instruments and are in themselves valuable as pure sciences, using them can present a serious dilemma. Human health and environmental degradation call not only for the best a science has to offer, but also for the right choice of tools. At this juncture, good intent and good science can lead to bad decisions. Decision making is a science, yet it if often reduced to judgement under stress. Knowing what the issues are, understanding the limits of science, and involving the public in the decision-making process is the right way to solve the complex health and environmental issues surrounding us.

Introduction

The ways in which the federal government uses the environmental health sciences as assessment tools are examined in this paper from two perspectives:

1. the perspective of the government scientist/project director, whose objective is quality science with value, and
2. the perspective of the government manager who must deal with budget and politics, who is responsible for addressing stakeholder concerns, and who must spend taxpayer money wisely.

The scientist is a health risk professional eager to establish and maintain an objective, accurate, provable hypothesis. The manager wants to provide answers and solutions that are understood and accepted by stakeholders (especially those certain that they have been affected).

Often in government work, one individual is both scientist and manager. This dual role is indeed a challenge, because science and politics may have different destinations. Science wants to prove that a correlation does or does not exist. Politics wants to solve the problem. These goals aren't the same. People who are convinced that they, or the environment, have been harmed, would like science to show proof for that harm. When science is unable to prove a correlation, it can only conclude that a correlation could exist. Unfortunately, "could" quickly advances to "does" in the mind of the concerned individual. This is understandable. Then the press (totally ignorant but declaring by inference total accuracy) turns the negative into an absolute and convinces the rest of us. The question then becomes "Can science be properly managed by the federal government in a public arena saturated with conflicting agendas and predetermined ideas about outcomes?"

Human health issues are emotional. Contamination implies environmental degradation, health threat, sickness, and death. Risk generates fear, and fear calls for the strongest force to eliminate the risk. Sciences such as dose reconstruction, risk assessment, health studies, the study of carcinogenicity, consequence assessment, epidemiology, and toxicity may be appropriate to the type of analysis required, but they can't always provide definitive conclusions. In other words, highly quantitative and accurate investigations may produce good science with no utilitarian value.

A utilitarian perspective means applying characteristics sorely needed in environmental and human health sciences work - namely, efficacy, functionality, and substantive value. Yet it is difficult to maintain a utilitarian perspective in the face of fear generated by thoughts of pollution, toxins, ecological risk, cancer, birth defects, and death.

Data and the Scientist

Public concern is often the fuel for science, and science has a way of stretching to meet those concerns; an important goal of science is its own advancement. When data are limited, good science is unable to reconstruct dose or assess risk. Because the public has a valid concern, however, the manager may ask the scientist to reach into the toolbox and grab a complex instrument - often without weighing the likelihood of solving the problem. Even when the scientist recognizes up front that a successful study will not change health risk or ecological threat, stakeholder concern alone may authorize the study. Often, a lengthy and expensive project will conclude that further study is needed only because a conclusive determination could not be made. That same conclusion often can be drawn before the study is begun, and the need should be addressed at that time.

New firms with catchy names are continually being spawned by the "new science" seed. The inherent difficulty of these sciences has been acknowledged by the development of another new science called uncertainty analysis. Uncertainty analysis is the science of measuring how ambiguous the results of the other sciences are. Thus, science, which sets out to be as exact as possible, finds itself pursuing the exactness of inexactness. Will the next new science be "certainology," the certainty of uncertainty? Or will we realize it's time to take account of what we should expect of science?

Adding to the problem is that scientists, managers, and politicians tend to work in isolation from each other. When they do pull together, the question is often "How can we satisfy the public outcry?" and the easy answer is "Grab the best tool we have and carry out a study." The question should be "How can we best understand the stakeholders' concern?" The answer should be "Let's work with them to clarify the problem and develop a meaningful plan of action that will answer their concern." Notice that the plan of action isn't to "address or solve," the concern. A concern can be addressed and studied for years with millions of dollars but never solved. Concerns can, however, be answered. The answer may be that a multimillion dollar study will likely provide a definitive cause and effect, and that the study, though expensive, has value. Or, the answer may be that the use of this tool will only bring us a little closer to understanding the complexity of the problem because the tool simply can't yield conclusive results either way. Thus, the benefit does not justify the cost of this particular study.

The Public and the Scientist

The scientist and the public are often seen as oil and water simply because they are wrongly stereotyped: The public's intelligence is overlooked, and the scientists are overlooked as stakeholders. The average person is intelligent, although he or she may not understand isotopic ratios and picocuries. Scientists are not remote entities with their heads stuck in a cloud. One reason for misunderstandings is that amongst the public, scientists experience the apple barrel effect. The scientist dips into the barrel, encounters imprudence, and considers the entire barrel a roadblock to understanding. In addition, the intellect in the barrel can be obscured by the loudness of the imprudence that tries to speak for the entire barrel. Many of the healthy apples hide at the bottom of the barrel to avoid getting bruised or abused.

The ensuing confusion overwhelms the scientist, frustrates the public, puts the manager in a defensive posture, and ends the rationality of the system. Consequently, the public assumes the scientist doesn't understand the public; the scientist assumes the public can't be reached because it doesn't align with or care about the science; and the manager becomes a "big-brother bad guy" accused of skirting the facts and hiding behind excuses. Add the hype-fueled reporter and a press with no concept of factual investigation, and you have chaos.

Budget and the Manager

In the confusion, the benefit-cost ratio may be obscured just when a government manager needs it most. The manager may be asked or forced to fund grants defined according to a scientist's or politician's interpretation of public need. Once funds are allocated, little accountability remains with the manager; with the grant goes the responsibility. When the grant project is underway, its direction is unlikely to change - even if the need for such a change becomes obvious. In the meantime, the public continues to ask for what it wants and fairly criticizes the study it didn't ask for.

One common approach is to form a committee or panel of experts and make them accountable. This approach can backfire. Although a committee may have a name, it often has no face. Chair and members come

and go, and a member may see the "committee" as responsible, rather than the individual, thus deflating or destroying accountability altogether. The committee may become so wrapped up in science and politics that the objective of the study is lost; it's not unusual for science to default to politics. Also, once the committee gets rolling, it may be impossible to change the direction or scope of the study. Good science may produce no conclusive answers, and the committee may try to skirt criticism with a recommendation for additional study. One may look back on a completed study and wonder who was in charge and what the public purchased.

Trust, or lack thereof, plays a role. The public seems unable to look beyond past government errors and to trust government scientists or managers. It's a sad and costly state of affairs when the word government is synonymous with distrust. In an attempt to regain trust, the government can find itself spending money on science to solve a public perception problem that has no scientific resolution. Good intent and good science unfortunately can go awry and foster more distrust.

Because the public is not satisfied that its concerns are being adequately addressed even when more studies are funded, the scientists and managers view the public as unreasonable. The public condemns the government for wasting money and not answering its concern. In the interim, the situation escalates, amplitude overrules sensible science, and more projects that should never have been funded are approved. Such studies not only waste money and fail to solve the problem, but also divert funds from other needy areas, especially research. The scientist, the manager, and the public all get lost in a forest of confusion, false assumptions, politics, and unsupported decisions. The product may be good science, but it probably will sit on a shelf to be read only by other scientists.

Data and the Accountable Public Servant

As public servants, people in government are accountable to the public - but accountable for what? Too often, a complex health or environmental problem has no easy solution. This situation poses an ethical dilemma. It may be responsive on the part of the government official to attend to the demands of the stakeholder even though the official is certain no solution will be reached, but is it responsible? By contrast, if the public servant turns down a study because the study won't solve the problem, does the public consider the public servant to be accountable or unresponsive? What should be the role of the public servant?

Funding studies of questionable value can place the scientist and the manager at odds. It can also place scientists at odds with each other. Good scientists want to advance science and, when asked to assess a broad public concern, will offer the best they have. Because the scientist has been brought in to address a problem, not to understand the issues, the most sophisticated tool is "the best" simply by default. Other scientists may be left questioning the choice of tool but hesitant to suggest that little will be gained except advancement of the tool. Scientists will readily identify the limitations of a study if they understand what the real issue and goal are. This type of preemptive thinking, responsible as it is, may be irrelevant when government managers are in the throes of responding to public and political pressure.

When a study concludes that more study is needed, the concerned are still concerned, but also upset because time and money have been wasted. The situation arises because the concerned public, the agency with the funds, and the scientists never got together to evaluate what the problem is and what the tools can accomplish. Acting out of good intentions just is not enough anymore. The most important effort of responsibility is needed up front.

The Public, the Problem, and the Scientist

Scientists usually are not involved in the decision-making process, have no clue what the real concern is, and are not asked if a successful study will provide a solution. Would wisdom not suggest a peek at the likelihood of finding an answer before committing millions of dollars of public funds to collect good data that are useless? We should expect the scientist to understand the stakeholders' concerns before trying to solve them, and we should ask scientists to explain the limitations of the tools to the stakeholders. Individually, neither the scientist, the manager, nor the stakeholder has the answer, but together they probably do.

Decision Analysis, the Value Solution

When good scientists, good government, and good intent lead to a study that results in good science of no utilitarian value, a bad decision has been made. The "bad" isn't the result of the study; it is the decision to undertake the study.

Is there a solution to this dilemma? Yes, if one is willing to understand, accept, and combine a few basic principles of politics and science, divorce bureaucracy, and perhaps even incorporate another science to a greater or lesser degree. Making informed decisions up front can save years and millions of dollars from being wasted, and it can go a long way toward freeing the decision maker of criticism or blame. Most important, this kind of decision making assesses whether a solution can be found, how much of the problem can be addressed, and how best to do so.

Decision analysis is a science and a pivotal assessment tool, yet decision making is too often reduced to a concerned response - and sometimes to ego. Whether formally or informally, decision analysis needs to come into play. It is the best way to put a problem into context with its genesis and solution. In analyzing a decision, dissecting its parts, and understanding what's needed to make a good decision, one is forced to think backwards and answer questions about motive, success, and value. The more the parts of a decision are dissected, the easier it becomes to quantify the value of those pieces. This process develops and clarifies the attributes of the decision and then asks the decision makers to weigh and compare the value of each attribute relative to the study. Decision making can draw on the intelligence, views, and opinion of all those involved (e.g., managers, scientists, those concerned about the issue, other stakeholders). It is blind to politics, outcry, pressure, and emotion - or at least it will identify those components so that they can be weighed properly. Looking into a kind of crystal ball at success or failure forces the decision maker to address and incorporate a full complement of facts. Decision analysis doesn't allow one to skip any issue out of fear or in the interests of convenience.

This decision-making tool has been around for a long time. Ten years ago, the author was responsible for the allocation of a \$12 million federal budget slated to address environmental concerns relative to a new commercial industry (coal gasification). When a number of studies were proposed, whose cost totaled more than \$75 million, he had a dilemma. True, he had the authority to select a research portfolio, but his goals were

- * to get the most value for the taxpayer dollar,
- * to be able to justify his decision, and
- * to win acceptance of the portfolio, especially by those who were not funded.

A formal decision analysis framework was used to quantify the value of each study and rank it for funding. The proposer of each study went through a rigorous step-by-step evaluation. Value comparisons were made among all proposed studies with the assumption that each study would reach its goal; the likelihood of success was assessed as well. Each proposer was involved in the decision process. In the end, the proposers understood why their studies - and all others - were or were not funded. The final selection was never questioned because it was clear to all involved. Most important, the return on the research dollar investment was maximized (1).

Decision analysis is the opposite of uncertainty analysis because it seeks certainty in choice. Specificity and quantifying logic are maximized, and qualitative judgement and uncertainty are minimized. The process is nearly immune to the squeaky wheel and provides a logical, systematic, traceable, understandable, quantifiable, and defensible decision that is easily reiterated. It moves the decision makers (government agencies, industry, local organizations, and other stakeholders) from qualitative judging to value-focused thinking.

Decision analysis builds a framework for a thought process that charts the decision situation in detail. Objectives, attributes, and properties are developed and fine-tuned. Then a model is built for quantifying values that are ordinarily thought to be unquantifiable. Hidden objectives also are uncovered. Most important, this process maps the decision equation so that it can be understood by all participants and explained to anyone. The process is described in detail in Ralph Keeney's Value-Focused Thinking (2).

The government finally is beginning to shed the old paradigm in which simply spending money to satisfy an outcry is considered responsive. Stakeholders are being recognized as positive forces and integral to the process of decision making. It's not enough, however, simply to involve stakeholders through a forum for addressing concerns. Stakeholder organizations are effective and meaningful when their contribution is quantifiable in terms of perceived value rather than in terms of the weight of an outcry. Formal decision analysts sort this out, giving stakeholders an equal share in the decision process, as well as credit for the solution.

Conclusion

A decision always has a solid foundation when the government and the public join together and use the proper scientific tools to make value-focused decisions instead of exercising judgement under stress in response to outcry, amplitude, or politics. Does this mean the government should listen less or ignore the outcry? On the contrary, it means the government must listen more closely, understand in great depth what is being asked, and, when possible, bring the outcry into its team. The government must ignore politics and image, solicit the intellect of the stakeholders as well as of the scientists, and use only facts and science to arrive at decisions. In an unpatronizing way, issues, values, and science must be explained throughout the process - not only at the end.

One must accept, however, that when all is done, solving the problem may not always solve the controversy. Belief can be far stronger than reason or proof. Decision analysis won't eliminate the dissatisfaction of opposition members who are blind to decision-making tools or are motivated only by their own agendas and opinions, but it will answer them with reason, values, and facts that others can understand.

Finally, it's time we as scientists, managers, and public servants forget what self-proclaimed experts tell us about needing to explain science at the sixth-grade level so that the public will understand. Even individuals with advanced degrees don't always understand complex sciences. The information should be comprehensible to everyone. This is called intelligibility in composition, not sixth-grade writing. Anything less is irresponsible. Furthermore, we must continue to give members of the public the credit they deserve, treat them as partners in the process, and use their intelligence. The public must be allowed to see the process and, if possible, to participate in it. If they cannot do so in a rational and professional manner, they should be excused and told why.

The satchels of environmental health professionals are filled with wonderful scientific tools. We have a responsibility to understand those tools and use them wisely in consultation with the patient. We need to replace politics with science, emotion with facts, guesswork with decision analysis, and image with value; we need to continue moving toward trust. Perhaps we could even add a genuine smile.

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