

# Fishing for the Future

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## **Re-imagining the Kalamazoo River to create regional economic development strategies for the City of Plainwell and Allegan County**

Gerald R. Ford School of Public Policy at the University of Michigan-Ann Arbor  
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## **Executive Summary**

The City of Plainwell approached the Gerald R. Ford School of Public Policy at the University of Michigan-Ann Arbor to create an economic development plan to rehabilitate the stretch of the Kalamazoo River running through Allegan County, which includes Plainwell and the adjacent communities of Otsego and Allegan. Plainwell, Otsego, and Allegan hope to restore the fishery along the Kalamazoo River. The restored fishery will create regional tourism opportunities for riverfront communities in Allegan County. Currently, sediment-contaminated dams prevent fish from migrating through the Allegan County stretch of the River beyond Allegan Dam. To allow migratory fish to traverse the River, both the dams and their contaminated sediments must be removed or fish ladders and/or fish channels must be constructed. To address these considerations, the major part of our report is a cost-benefit analysis (CBA) that measures the feasibility of removing the dams or constructing fish ladders in order to restore the fishery. We also conduct a stakeholder analysis that identifies the perspectives of the various interests involved.

Our findings indicate that the most economically beneficial option is to rehabilitate the river as quickly as possible. Given political realities and the complexity of the dam sediment removal process, we recommend proceeding with fish ladders and natural bypasses as an immediate strategy. Even in the event that fish ladders/natural bypasses are constructed at all dams in the short term and then all dams are removed in the long term, our analysis indicates that it still makes economic sense to act quickly to gain first mover advantage and to leverage multiplier effects.

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## Report Objective

This report examines the costs and benefits associated with the various options to restore the Kalamazoo River fishery. We compare the feasibility of dam removal with the construction of fish ladders and the creation of natural bypasses. The results of the CBA are incorporated into an economic development strategy.

## History of the Mid-Kalamazoo River

Throughout the late 19<sup>th</sup> and early- to-mid 20<sup>th</sup> centuries, paper mills situated along the banks of the Kalamazoo River released their industrial waste into the river water. Polychlorinated biphenols (PCBs) comprised one of the major groups of pollutants. These chemicals severely contaminated surface and ground water as well as the sediments in the banks and the beds of the river. These organic contaminants not only polluted the rivers, but also depleted the waters of their dissolved oxygen, causing a large number of fish die-offs.

On October 5, 1953, the Kalamazoo River made national news when Life Magazine<sup>1</sup> published a photograph of a massive fish die off that had occurred in Dumont Creek—a tributary of the river—after organic pollutants released by numerous paper mills along the Kalamazoo River depleted the river’s dissolved oxygen. This contamination forced the fish to move upstream where they became trapped and died. The photograph titled “Four Acres of Carp Corpses on the Kalamazoo” inextricably linked the Kalamazoo River with pollution, an image that half a century later still lingers in local residents’ minds despite recent local, state, and federal clean-up efforts<sup>2</sup>.



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<sup>1</sup> Armstrong, Joe: “Four Acres of Carp on the Kalamazoo.” October 15, 1953. Life Magazine Photo of the Week. Pg 27.

<sup>2</sup> Prichard, James, “Kalamazoo River is Freshening Up,” LA Times: [articles.latimes.com/2004/apr/25/news/adna-Kalamazoo25](http://articles.latimes.com/2004/apr/25/news/adna-Kalamazoo25), April 25, 2004. Accessed 10 Nov 2012.

In 1976, the federal government banned PCBs because of their highly toxic, carcinogenic effects. Although no new PCBs have been released into the Kalamazoo River for more than 35 years, many of the contaminants remain embedded in the sediments throughout the river basin and serve as an ongoing source of contamination to aquatic and terrestrial organisms that live in and around the river. PCBs are highly stable chemicals that do not decompose easily—a feature which made them very useful as an industrial chemical—but also mean that they persist in the environment for long periods of time when released. They are also highly soluble in fats, collecting in the fatty tissues of organisms that are exposed to contaminated sediments or ingest organisms that have been contaminated. Prior to the contamination of the Kalamazoo River, scientists estimate that 89 different fish species were native to the Kalamazoo River Basin. While there are currently 102 different fish species inhabiting the river system today, many of these are the result of accidental and intentional introductions. Many native species populations were largely reduced by a combination of the pollutants released into the waters, as well as by the construction of dams for hydroelectric power and to control the flow of the water.<sup>3</sup>

For example, lake sturgeon, a native fish species that is currently threatened in the Kalamazoo River, was once abundant along the Kalamazoo River in the area between Allegan Lake and Morrow Dam. Dam construction, however, reduced sturgeon spawning habitat from 130 miles to the 26 miles between Lake Michigan and the Lake Allegan dam, severely limiting its migration and reproduction capacity.

Since 1976, as a result of the river contamination and its effects on local fish, state officials have released advisories against eating fish caught in the Kalamazoo River.<sup>4</sup> Studies suggest that fish caught in Portage Creek and the Kalamazoo River contain PCB concentrations in excess of 10mg/kg, far exceeding the 2mg/kg maximum concentration known to cause significant increases in egg and fry mortality in various fish species<sup>5</sup>. PCBs also cause adverse physiological, developmental, reproductive, biochemical, and immunological effects in fish species.

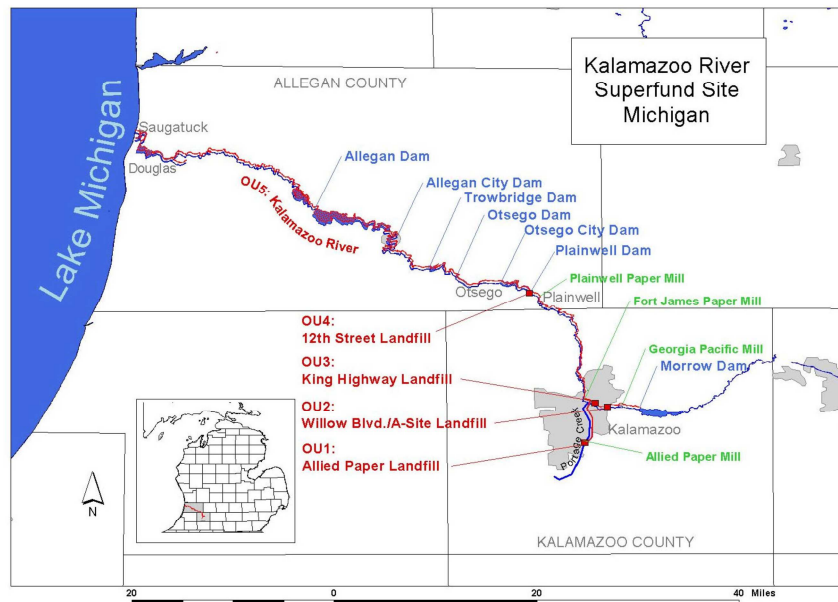
In 1990, the portion of the Kalamazoo River known as the Allied Creek/Portage Creek/Kalamazoo River was declared a Superfund Site under the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). This 80 mile stretch of the Kalamazoo River extends from Portage Creek downstream to the mouth of the Kalamazoo River at Lake Michigan. The area has been divided into five operable units (OUs). Four of the OUs are land-based and are former landfills where the paper mills disposed of their PCB-contaminated waste from the 1950s until the 1970s. The fifth OU is the river itself.

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<sup>3</sup> Wesley, Jay K. "Kalamazoo River Assessment." Michigan Department of Natural Resources. September 2005. [http://www.michigandnr.com/publications/pdfs/IFR/ifrilibra/Special/Reports/sr35/sr35\\_text.pdf](http://www.michigandnr.com/publications/pdfs/IFR/ifrilibra/Special/Reports/sr35/sr35_text.pdf) Accessed 7 Nov 2012.

<sup>4</sup> Prichard, James, "Kalamazoo River is Freshening Up," LA Times: [articles.latimes.com/2004/apr/25/news/adna-kalamazoo25](http://articles.latimes.com/2004/apr/25/news/adna-kalamazoo25), April 25, 2004. Accessed 11/10/2012.

<sup>5</sup> Wesley, Jay K. "Kalamazoo River Assessment." Michigan Department of Natural Resources. September 2005. [http://www.michigandnr.com/publications/pdfs/IFR/ifrilibra/Special/Reports/sr35/sr35\\_text.pdf](http://www.michigandnr.com/publications/pdfs/IFR/ifrilibra/Special/Reports/sr35/sr35_text.pdf) Accessed 7 Nov 2012.



In 2004, the Los Angeles Times published a story on the Kalamazoo River, comparing the river in the 1950s with the early 2000s. The article noted how the Kalamazoo River’s scenic waterways today belie its history. Residents who grew up along the Kalamazoo before 1976 recall the water being a “whitish-brown color.” Nobody dared to eat the bass, carp, or salmon swimming within it. The few residents that chose to canoe along the river took extra precautions to avoid touching the water. According to John Pahl, the official historian of Allegan County, “the fumes from the river and the dead fish, in some cases, peeled the paint right off the houses here.”<sup>6</sup>

Erik Wilson, the City Manager of Plainwell, said that the people’s historical memory of the Kalamazoo River has discouraged development for several generations, despite efforts to clean the river and to combat its negative reputation. Following a critical clean-up in 2009 that removed 130,000 cubic yards of contaminated in-stream and bank sediment from the Plainwell impoundment, efforts to revitalize the river have been revived. In recent years, attitudes of local residents, particularly among younger generations, have also started to change. In addition to the ongoing construction of a riverwalk along the Plainwell portion of the Kalamazoo River, Allegan County officials want to build on the growing momentum to improve the river by pursuing an economic development project that will benefit residents and improve the health of the river and its fisheries.

<sup>6</sup> Prichard, James, “Kalamazoo River is Freshening Up,” LA Times: [articles.latimes.com/2004/apr/25/news/adna-Kalamazoo25](http://articles.latimes.com/2004/apr/25/news/adna-Kalamazoo25), April 25, 2004. Accessed 10 Nov 2012.

## **The Importance of a Healthy Riverine Ecosystem and Associated Benefits**

Robust aquatic ecosystems are resilient to changing environmental conditions. Ecologists often pinpoint species diversity as a major component in determining the resilience of ecosystem structure, because greater species diversity allows more species to occupy different niches in the ecosystem. As communities become less complex, ecosystems become more susceptible to changing conditions that often result in ecosystem collapse. Because the stretch of the Kalamazoo River that traverses Allegan County has lost some of its species complexity due to contamination and river modifications (e.g. dams), the maintenance and rehabilitation of the system should be a top priority.

The maintenance of fishery systems requires slowing or preventing the loss of ecosystem structures and processes, while rehabilitation attempts to restore these structures and processes. Rehabilitation would restore fish migration along the Kalamazoo River to allow migratory fish to regain access to lost spawning habitats, expanding their range upstream and eventually re-bounding their population numbers. The removal of unnecessary dams and the construction of fish ladders or natural bypasses would largely assist in this rehabilitation process. Chinook salmon, lake sturgeon, steelhead, and suckers would all benefit from this approach. Fishery restoration would also allow for the development of a healthy ecosystem, supporting other organisms such as eagles and minks.

In addition to these environmental benefits, a restored Kalamazoo River also has the potential to have a significant regional economic impact. The annual economic value for Michigan's recreational fishery in 2006 was estimated between \$1.67 billion and \$3.69 billion.<sup>7</sup> Michigan was ranked 5th nationally in angler expenditures in 2006 and recreational fishing was responsible for 27,348 jobs.<sup>8</sup> A restored Kalamazoo River has the potential to shift more of this money to Allegan County in the form of revenue derived through the sale of fish licenses and increased tourism. In addition, our cost-benefit analysis, included below, indicates that large increases in property values will accrue to the citizens of Allegan County.

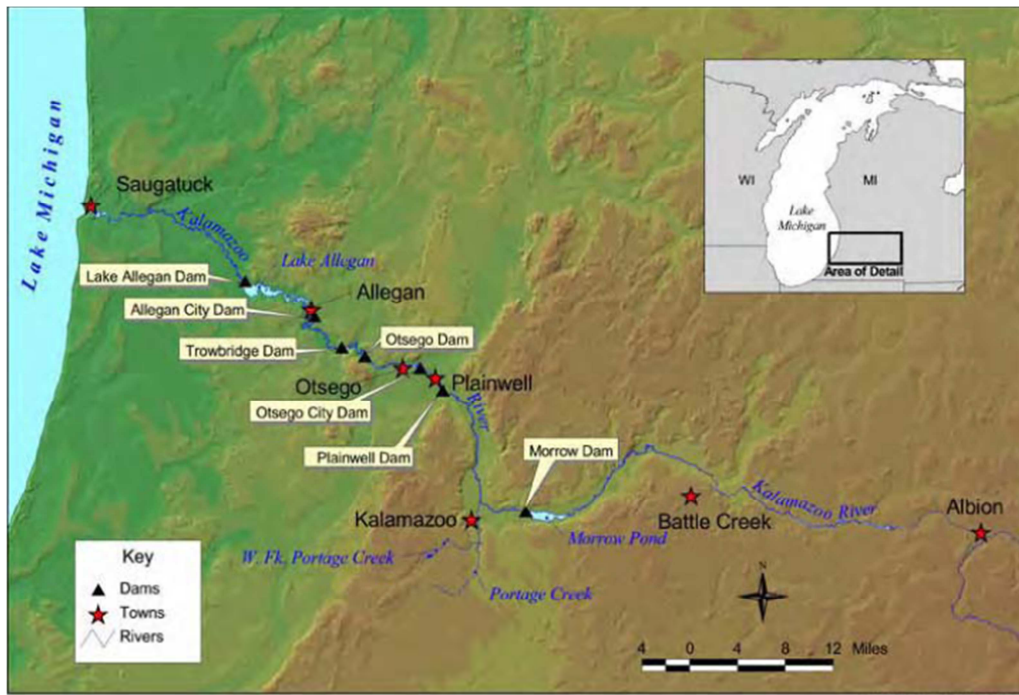
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<sup>7</sup> State of Michigan Department of Natural Resources, Fisheries Division. "2011 Accomplishments Report." [http://www.michigan.gov/documents/dnr/2011\\_FD\\_Accomplishments\\_Report-final\\_377998\\_7.pdf](http://www.michigan.gov/documents/dnr/2011_FD_Accomplishments_Report-final_377998_7.pdf) Accessed 5 Dec 2012.

<sup>8</sup> *ibid*

## Main Obstacles and Potential Solutions

Five contaminated dams between Lake Allegan and Plainwell present the main barriers to the development of a functioning and healthy fishery along the stretch of the Kalamazoo River that traverses through Allegan County. These dams were built to supply hydroelectric power and/or to control water levels. However, they have detrimentally altered the Kalamazoo River's fisheries and ecosystems, contributing to local species extinction while restricting the habitats and ranges of certain fish species to the area between Lake Allegan and Lake Michigan.



Dams affect the flow patterns, temperature, sediments, and flooding of river segments and have detrimentally affected the distribution and abundance of certain fish species, such as smallmouth bass, northern pike, blacknose dace, lake sturgeon, and black crappie in the Kalamazoo River.<sup>9</sup> These four factors are also essential for the creation of specific spawning habitats for fish species, and changes caused by dams can drastically those spawning habitats. Along the Kalamazoo River, only three percent (or 5.5 miles)<sup>10</sup> meet the standard for ideal, productive habitats for fish species. Dams also contribute to the destruction of fish habitats because they cause increased river bank and bed erosion. Furthermore, impoundment areas created by dams raise water temperatures, eliminating certain aquatic species below dams that require lower temperatures<sup>11</sup>.

<sup>9</sup> Wesley, Jay. (2005) Kalamazoo River Assessment. Michigan's Department of Natural Resources, Fisheries Division. Special Report, No. 35. [http://www.dnr.state.mi.us/publications/pdfs/IFR/ifrilibra/Special/Reports/sr35/sr35\\_text.pdf](http://www.dnr.state.mi.us/publications/pdfs/IFR/ifrilibra/Special/Reports/sr35/sr35_text.pdf) Accessed 7 Nov 2012.

<sup>10</sup> ibid

<sup>11</sup> ibid



Although these dams have drastically altered the fisheries and ecosystems within and along the Kalamazoo River, they currently play a critical role in containing the contaminated sediments caused by the Potentially Responsible Parties (PRPs). If the dams are demolished before sediment clean-up, the contaminated soils would flow downriver and further pollute the river system, causing additional damage to the ecosystems and fisheries downstream. Although the PRPs have been found legally liable for cleaning up their toxic mess, they are still negotiating with the EPA on precise damage amounts and the financial distribution process.

Therefore, there are two potential solutions that will create a productive fisheries habitat in the Kalamazoo River. The first is the complete removal of dams coordinated with the removal of contaminated sediments. The second solution is to maintain the dams as they are and construct fish ladders or bypasses at the dams in order to allow for the movement of migratory fish species along the course of the river.

Fish ladders are designed to allow for the passage of migratory fish species up- and down-stream where dams have been constructed. Their construction and design are complicated by the fact that different fish species require different specifications in order to work effectively. Despite this fact, Jay Wesley from the Department of Natural Resources, Fisheries Division, has recommended constructing vertical slot weirs at the majority of dams along the Kalamazoo River because they will allow the majority of fish species to pass.

There are currently no known fish ladders that can effectively allow lake sturgeon to pass upstream. Instead, a natural bypass or channel will have to be constructed to accommodate them. This sort of fish passage system mimics a natural stream or channel and can double in functionality to allow for additional recreational benefits (such as canoeing) depending on specific design details.

## Cost-Benefit Analysis

Interviews with Jay Wesley and other local environmental experts indicate that complete dam removal and contamination clean-up is the optimal solution in terms of environmental and other benefits. The main constraint is the cost of dam removal. While the PRPs are legally required to pay for the sediment removal in the dams and riverbanks, they are not liable for the cost of dam destruction. Beyond the cost of removal, the PRPs and EPA have not come to a consensus on total financial obligations, allocation of funds to specific projects, or a timeline for restoration. Until the cities and townships along the Mid-Kalamazoo River have a firm commitment from the PRPs and EPA on sediment removal, they are understandably hesitant to proceed with any dam removal plans. Moreover, river restoration cannot exist in isolation. Multiple entities, often with overlapping jurisdictions, must be involved in the process. In addition to the concerns highlighted above, any comprehensive dam removal plan must navigate an intricate web of political realities requiring a high degree of cooperation across multiple jurisdictions. Given these concerns, we recognize that full dam removal is likely a longer-term solution.

## Options

The residents along this stretch of the Kalamazoo River have been anticipating full river restoration for decades. The question at hand is whether the cities and townships along this stretch of the river can take independent actions to facilitate the river restoration process. To answer this question and determine the economic viability of such a plan, we conducted a quantitative cost-benefit analysis that examines three distinct scenarios:

- A. Status quo (no dam removal, no fish ladders/natural bypasses)**
- B. Dam removal (for all dams except Lake Allegan Dam)**
- C. Fish ladders/natural bypasses at all dams**

It is unlikely that any one scenario will come to fruition in its entirety. Instead, some combination of these scenarios will likely develop over time. Our goal for this section is to provide a basis for understanding our overall thought process behind calculating the cost benefit analysis and to describe how we derived the figures for each calculation. Full information to calculate the costs and benefits for all three scenarios at each dam under consideration is available in the appendix. Although no projection can perfectly predict true costs and benefits, we believe our conservative analysis captures the worst-case financial scenario at each dam.

## Assumptions and Methodological Approach

1. We recognize that Lake Allegan Dam will not be removed. It is privately owned by Citizens Electric and currently generates electricity for the region. Based on interviews with Jay Wesley, we determined that Lake Allegan Dam requires a natural bypass instead of a fish ladder. The dam currently has a fish ladder that never worked properly. In addition, the dam itself is high, meaning ladder installation would be costly. The state also owns the marshy land adjacent to the dam, making a natural bypass option relatively less expensive than the fish ladder option.
2. Although the City of Allegan recently invested significant money rehabilitating the Allegan City Dam and creating a park space around it, we have included the possibility of removing this dam in our analysis. While the city may object to dam destruction after investing resources in the

dam, and its removal in the short-term may be unlikely, no legal restrictions prohibit its demolition.

3. The calculations for our primary cost-benefit analysis assess total value creation for the entire region, meaning we considered costs and benefits accrued at the federal, state, and local levels. This includes both active (e.g. DNR collecting fishing license fees) and passive (e.g. homeowners receiving a windfall from river restoration) parties. We included a separate analysis for costs and benefits accruing specifically to Plainwell in the appendix. Data in the appendix can be used by other jurisdictions (cities and townships, Michigan’s DNR, etc.) to compile a similar list of costs and benefits accruing to their respective regions.
4. Some costs and benefits, such as a rise in property values, can be apportioned by each municipality based on existing data. Other effects of river restoration, like the environmental benefits accruing to each municipality, are much harder to apportion. In these cases, we multiplied the total cost or benefit by the percentage of river within the appropriate jurisdiction. This technique approximates the proportion of costs/benefits accruing to the jurisdiction in question.
5. Property value calculations assume a nine percent increase in total land value for all land in each jurisdiction along the river. This percentage is based on similar projects in Colorado and Oregon, where the increase in total property values attributable to river restoration averaged between ten and 15 percent. We assumed a nine percent increase for the Kalamazoo to provide a conservative growth estimate.
6. The added benefit of additional property taxes for local municipalities is incorporated into the total rise in property values. Separately calculating this benefit would double count the total value attributable to river restoration efforts.

### Scenario A: Status Quo

This scenario provides a baseline from which to compare the other two options. The only cost is ongoing dam maintenance, estimated at \$40,130 annually for all dams. No additional benefits accrue under this option beyond the current money the DNR collects from selling fishing licenses.

	Dam 1	Dam 2	Dam 3	Dam 4	Dam 5	Dam 6	Total
	Lake Allegan	Allegan City	Trowbridge	Otsego	Otsego City	Plainwell	
<b>Total annual cost</b>	\$3,684	\$3,684	\$12,368	\$12,368	\$8,026	\$0	<b>\$40,130</b>
<b>Total annual benefit</b>	\$157,862	\$78,931	\$39,465	\$39,465	\$39,465	\$79,931	<b>\$434,120</b>

### Scenario B: Dam Removal

Under this scenario, the DNR removes existing dams, eliminating the need for fish ladders and natural bypasses. Any fish ladders constructed under Scenario C (see below) would also be removed. Because dam removal releases all impediments to fish migration, our analysis raises the total number of fish available to anglers over time due to increased reproduction rates. Since increased fish concentration

attracts more anglers, we calculate a similar increase in fishing licenses demanded over time. This option assumes that the PRPs cover the full cost of sediment removal and decontamination.

	Dam 1	Dam 2	Dam 3	Dam 4	Dam 5	Dam 6	Total
	Lake Allegan	Allegan City	Trowbridge	Otsego	Otsego City	Plainwell	
<b>Total one-time cost</b>	\$8,250,000	\$1,000,000	\$1,000,000	\$1,000,000	\$1,000,000	\$0	<b>\$12,250,000</b>
<b>Total annual cost</b>	\$3,684	\$177,338	\$183,301	\$86,827	\$77,179	\$77,179	<b>\$605,508</b>
<b>Total one-time benefit</b>	\$0	\$31,933,548	\$33,770,968	\$15,996,774	\$14,103,355	\$14,219,355	<b>\$110,200,000</b>
<b>Total annual benefit</b>	\$161,132	\$1,450,188	\$1,530,754	\$725,094	\$644,528	\$644,528	<b>\$5,156,225</b>

Total one-time costs for dam removal and building a fish channel at Lake Allegan Dam equal \$12.25 million. Fish stocking costs (coho and chinook salmon, steelhead trout, brown trout, and walleye) total \$600,000 per year. Based on our calculations, one-time benefits would total \$110 million, mostly from the increase in property values and natural environment benefits. Ongoing benefits, including fishing licenses and fishing tourism revenue, total \$5 million per year. Some additional boating revenue might be generated as well, estimated at \$60 per person per day, but the exact amount largely depends on marketing and tourism strategies developed by the State of Michigan and local municipalities along this stretch of the Kalamazoo River. We did not include this potential revenue in our calculations.

### Scenario C: Fish Ladders and Natural Bypasses

Under this scenario, all five dams between Lake Allegan and Plainwell remain intact and the DNR continues with ongoing dam maintenance. DNR installs fish ladders or natural bypasses – depending on dam height and natural topography -- to allow fish migration. Individual municipalities along the river are responsible for establishing local economic infrastructure to encourage fishing-related tourism, such as retail shops, food stands, campgrounds, parking lots, etc.

We estimate the total one-time costs to install the dam detours to be \$17.5 million. Annual costs, consisting of fish re-stocking (coho and chinook salmon, steelhead trout, brown trout, and walleye) and ongoing dam/fish ladder maintenance would be \$650,000 per year.

Based on our calculations one-time benefits would total \$109 million, mostly from the increase in property values and natural environment benefits. Ongoing benefits, including fishing licenses and fishing tourism revenue, total \$5 million per year.

	Dam 1	Dam 2	Dam 3	Dam 4	Dam 5	Dam 6	Total
	Lake Allegan	Allegan City	Trowbridge	Otsego	Otsego City	Plainwell	
<b>Total one-time cost</b>	\$8,250,000	\$3,000,000	\$2,750,000	\$1,250,000	\$2,250,000	\$0	<b>\$17,500,000</b>
<b>Total annual cost</b>	\$8,398	\$179,052	\$197,240	\$99,909	\$86,491	\$77,179	<b>\$648,270</b>
<b>Total one-time benefit</b>	\$0	\$31,732,258	\$33,495,161	\$15,866,129	\$14,103,226	\$14,103,226	<b>\$109,300,000</b>
<b>Total annual benefit</b>	\$157,862	\$1,420,757	\$1,499,688	\$710,379	\$631,448	\$631,448	<b>\$5,051,581</b>

This scenario meets many key goals of the river restoration project. Although sturgeon would be unable to use the fish ladders, salmon, trout, and other fish species would be able to fully traverse the Mid-Kalamazoo. With a larger fish population, cities and townships could create local infrastructure to attract more anglers to the river. Increased angler tourism would increase demand for resident and non-resident fishing licenses. This increase in revenue would help the DNR to sustain the natural fishery in the Kalamazoo River. The dams would still act as a deterrent for boaters in the region, meaning the area would not experience increased growth in boating-related tourism.

### Analysis of Options

Given the data we compiled, from an economic standpoint it is economically viable to proceed with the most expedient option to achieve some degree of river restoration. This is especially true when we consider the City of Plainwell’s unique position: the municipality has already paid for dam removal within its jurisdiction, but can only fully reap the economic benefit of a revitalized river when other cities and townships downstream take similar action. We outline the specific costs and benefits that accrue to Plainwell in the appendix.

For both the region as a whole and Plainwell specifically, the conclusions are largely the same. First, the status quo is not an economically attractive option. In economic terms, the opportunity cost of doing nothing is too high and the region is foregoing potentially significant economic and environmental benefits by not acting. Second, even the worst case scenario from a cost perspective – installing fish ladders/natural bypasses in all dams in the short term and then paying to remove the dams in the longer term – creates more economic benefits than waiting for all dams (except Lake Allegan Dam) to be removed. While this conclusion is contingent on the ultimate timeframe for complete dam removal, even a conservative estimate of 10 years for the removal of the majority of dams suggests that installing fish ladders/natural bypasses in the short term makes good economic sense.

Regardless of standing, the most critical piece of our analysis is the timing of events. In short, a significant first-mover advantage will help to multiply any economic benefits and minimize long-term

costs. The sooner the process of river restoration begins – whether by fish ladder/natural bypass or complete dam removal - the faster these benefits will start to accrue. Compounding and a multiplier effect will enhance benefits over time. Moreover, it takes time for perceptions to change. One of the greatest challenges in reimagining the Kalamazoo River is the process of changing people’s negative perceptions of the water. This process takes time, but the sooner it begins, the sooner people will begin to imagine the River as a regional recreational destination.

## Stakeholder Analysis

As indicated above, unlike many other types of local economic development activities, restoring the Kalamazoo River presents a cross-jurisdictional challenge. We analyzed the effect of each scenario on four primary stakeholder groups:

- Federal government (through the EPA)
- State of Michigan (through the Department of Natural Resources)
- Allegan County and individual municipalities like Plainwell
- Local citizens, business owners, and tourists

## Federal Government

The federal government's interest in restoring the Kalamazoo River is based on the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA), which governs the contamination rehabilitation process.<sup>12</sup> Over the past 20 years, policymakers and litigation have greatly clarified the process through which natural resource damage assessment, calculation, and settlement takes place. Current policies identify three phases of this process:

1. Preliminary Assessment
2. Injury Assessment/Restoration Planning
3. Restoration Implementation

The majority of the Kalamazoo River Superfund Site is currently in the second phase: injury assessment and restoration planning. Given this status, and the government's responsibilities under CERCLA, it would like to see complete river restoration as quickly as possible.<sup>13</sup> As an EPA Superfund Site, the Kalamazoo River is eligible for Natural Resource Damages (NRDs). The overarching goal of the Superfund program is to restore the environment to its natural state prior to degradation. Legislative and judicial rulings have defined two distinct types of restoration regulations: "primary restoration, which includes actions that return the injured natural resources or services to baseline conditions, and compensatory restoration, which is any action taken to compensate for interim losses of natural resources and services until full recovery."<sup>14</sup> The precise definition of these services presents an ongoing dilemma within the natural resource restitution community. Services generally "refer to the functions performed by the resource for the benefit of another natural resource or the public. The value of a natural resource or service includes the value individuals derive from direct use of the natural resource...as well as the value individuals derive from knowing a natural resource will be available for future generations."<sup>15</sup>

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<sup>12</sup> "CERCLA Overview." U.S. Environmental Protection Agency. <http://www.epa.gov/superfund/policy/cercla.htm> Accessed 1 Dec 2012.

<sup>13</sup> *ibid*

<sup>14</sup> Denton, Charles M. and Hupp Craig. (2002). Natural Resources Damage Assessments and Claims in the Great Lakes Basin, Part II: Analysis of NRD Settlements. *Michigan Environmental Law Journal*, 20(1), 3-27. Pg. 12 <http://www.michbar.org/environmental/pdfs/Issue63.pdf> Accessed 16 Nov 2012.

<sup>15</sup> *ibid*

The State of Michigan has appointed a number of trustees to help determine how to distribute NRD credits across the state to address remediation once a final agreement with the PRPs has been reached. These Trustees include the Michigan Department of Environmental Quality, the Michigan Department of Attorney General, the U.S. Fish & Wildlife Service, and the National Oceanic and Atmospheric Administration.<sup>16</sup> As described above, the law and associated regulations leave two issues unresolved: whether rehabilitation must take place at the same site as the environmental harm, and whether environmental repair for nature's sake must be paramount to environmental repair for public use and enjoyment. Answers to these critical questions will help guide the Trustees in determining how to repair the Kalamazoo River. Our cost-benefit analysis finds that river restoration using fish ladders/natural bypasses will produce a one-time benefit to the natural environment valued at \$1.3 million. Complete dam removal for all dams except Lake Allegan Dam will result in an environmental benefit equal to \$2.2 million. These figures were derived using the same formula developed by Ecotrust when evaluating the impact of dam removal on the Klamath River in Oregon.<sup>17</sup>

While the EPA and NRD Trustees clearly want complete river restoration, they are not immune to the complexities of working with multiple organizations and agencies. Based on the history of this project as well as other Superfund sites around the country, it is clear that non time-sensitive restoration efforts are not always at the top of the federal government's lengthy list of priorities. Thus, while the EPA may not want to accept Scenario A, maintaining the status quo, for very long, it may be forced to do so until it eventually reaches an agreement with the PRPs.

### State of Michigan

Through its Department of Natural Resources (DNR), the State of Michigan promotes conservation, protection, management, the utilization of Michigan's natural resources, and the development of recreational activities around them. The DNR's Fisheries Division is responsible for creating, maintaining and improving a sustainable habitat for Michigan's aquatic resources and fisheries. Given these priorities, DNR has a critical role in restoring the Kalamazoo River, developing a thriving habitat for fish, and fostering recreational activities around the river.

While its focus is maintaining the environment for the public good, like all state agencies, the DNR is constrained by limited resources. The DNR is funded by state general fund revenues, federal funds, and a variety of restricted funds.<sup>18</sup> Fishing licenses fund many DNR activities related to the state's rivers and lakes. The sale of fishing license has continuously declined over the past decade. While revenue generated from fishing licenses increased five percent between 2001 and 2010 due to license cost increases, this incremental amount barely keeps pace with inflation. The fisheries division budget has

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<sup>16</sup> *ibid.* Pg. 5.

<sup>17</sup> Kruse, Sarah A. and Astrid J. Scholz. "Preliminary Economic Assessment of Dam Removal: The Klamath River, Ecotrust." January 31, 2006. [http://www.ecotrust.org/workingpapers/WPS2\\_Klamath\\_Dam\\_Assess.pdf](http://www.ecotrust.org/workingpapers/WPS2_Klamath_Dam_Assess.pdf) Accessed 2 Dec 2012.

<sup>18</sup> Alexander, Jeff. "Is State Losing its Love of Fish?" *Bridge: News & Analysis from the Center for Michigan*. October 27, 2011. <http://bridgemi.com/2011/10/is-state-losing-its-love-of-fish/> Accessed 20 Nov 2012.



been cut ten percent over the past five years. The revenue from license sales is not keeping pace with rising employee expenses and the increasing cost of maintaining fish hatcheries, research boats and other essential equipment<sup>19</sup>.

**Table 1: Fishing License Sold in Michigan, 2001-2010**

	Number of License Issued		Cost	
	Resident	Non-Resident	Resident	Non-Resident
2001	1,111,119	304,431	17,604,789	4,559,093
2002	1,092,787	291,005	18,412,671	4,957,807
2003	1,075,725	293,021	18,119,670	4,973,721
2004	1,033,632	283,973	17,467,876	4,851,005
2005	1,018,542	276,305	17,208,229	4,773,840
2006	1,014,946	272,497	17,962,580	4,895,499
2007	1,019,605	270,853	17,951,656	4,894,550
2008	1,010,067	278,869	17,689,470	5,024,594
2009	990,410	271,110	17,258,658	4,936,500
2010	1,029,429	284,256	17,844,745	5,129,515

**Source: Fisheries Division, Michigan Department of Natural Resource, State of Michigan**

Given this trend, the DNR is interested in increasing the revenue it receives from selling fishing licenses. This logic suggests that the DNR would favor a fish ladder/natural bypass solution in the short term to start rebuilding the Mid-Kalamazoo’s brand as a regional fishing destination. At the same time, however, the agency is wary of spending money to install fish ladders or build natural bypasses if it will also be responsible for at least a portion of dam removal costs in the longer term. This tension, the core of the economic debate analyzed in the cost-benefit section above, is valid. Our analysis indicates that the total benefit of moving ahead with fish ladders/natural bypasses in the short term outweighs total costs. However, our analysis does not explicitly break out costs and benefits allocated to the DNR. It is possible that the DNR would not be able to fully recoup its costs if it had to pay for both a fish detour option in the short term and dam removal in the future. Even if this happened, based on our projections, the DNR would sell enough new fishing licenses in the short term to fully cover these additional costs.

### **Allegan County and Local Municipalities**

Each municipality and jurisdiction has its own specific considerations when weighing options to restore the Kalamazoo River. Some cities, like Allegan, have recently spent significant money to repair their dams and to build park space. They may be reluctant to move ahead with dam removal options and would prefer the status quo over dam removal. Other cities, like Plainwell, have already removed their dams and want to realize the full economic potential of a restored river as quickly as possible. Some officials in Allegan County might also worry that the concentration of recreational fishers at Lake Allegan Dam might be in jeopardy if fish no longer gather in the water near the dam. In all cases, however, increasing the number of fish in the river, developing basic infrastructure for recreational fishing-based tourism, and promoting the return of a healthy ecosystem will benefit all municipalities in the region.

<sup>19</sup> ibid

The challenge is working together to find solutions that work for the entire region. Plainwell cannot fully reap the benefits of a restored river system unless the dams downriver allow fish to pass. The lack of truly regional governance structures makes this process more difficult. However, by focusing on the common benefits outlined above, the municipalities along the mid-Kalamazoo River can begin to develop an action plan that promotes sustainable regional economic development. As the primary regional entity, Allegan County can potentially perform a facilitating role in pushing forward an agenda that promotes river restoration.

### **Local Citizens, Tourists, and Business Owners**

The three stakeholders analyzed above -- the federal government, the State of Michigan, and local municipal governments -- each provide goods and services to the general public. To simplify our analysis, we divided the general public as a stakeholder into two subcategories:

- **Local citizens and tourists** – Local citizens are residents of Allegan County and its municipalities. Tourists are potential anglers who might travel to the region for recreational activities along the river.
- **Business owners** -- The proprietors of businesses that might be affected by a cleaner, more widely used Kalamazoo River.

#### **Local Citizens and Tourists**

Although we cannot measure public opinion on river restoration options with certainty, we can use exhibited behavior as a proxy to inform our analysis of public preference. Despite recent attempts to clean up the water, local residents continue to cite pollution and contamination as the most frequent complaint about the river. Since 1976, government officials have posted advisories warning anglers of the health risks associated with consuming fish caught in the Kalamazoo River. A 2001 advisory recommended that anglers eat no more than one fish caught in the Kalamazoo River per week. Although this advice was specifically released for the central and lower regions of the river, it perpetuated the stigma that the Kalamazoo River is unclean and unsafe. These advisories are likely to have depressed property values along the river, reduced the number of visits by current anglers, and discouraged potential anglers from coming to the region for recreational fishing opportunities.

Past studies suggest that most anglers currently prefer the lower end of the Kalamazoo River for fishing.<sup>20</sup> This is unsurprising since Allegan Dam, the dividing line between the central and lower Kalamazoo River, is currently an impassible barrier for anadromous fish species. As a result, many fish cluster in the lower stretch of the river, creating ideal conditions for anglers. A majority of these anglers come from cities or townships within Allegan and Kalamazoo Counties. Smaller numbers also come from adjacent counties.

The challenge is to expand the geography of prime fishing opportunities into the Mid-Kalamazoo region for existing anglers and to introduce sport fishing to new groups of people in the area. A rehabilitated

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<sup>20</sup> State of Michigan Department of Natural Resources. "Existing Uses and Recreational Opportunities: Kalamazoo River" [http://www.michigan.gov/documents/dnr/existing\\_uses\\_rec\\_opps\\_184226\\_7.pdf](http://www.michigan.gov/documents/dnr/existing_uses_rec_opps_184226_7.pdf) Accessed 5 Dec 2012.

Kalamazoo River will accommodate a greater number of these anglers and help to revive interest in the sport. Strategically placed, high-quality fishing opportunities can recruit lapsed anglers back into participation.<sup>21</sup> Evidence suggests that, in the absence of contamination in the Kalamazoo River, the total number of angler-trips would be much higher.<sup>22</sup> Current anglers would likely spend more fishing days at the river, and potential anglers who currently avoid the river due to contamination fears and lack of fish supply would start using it for recreational activities. Based on estimates from similar case studies, we estimate that the number of angler-days on the river would increase by at least five percent after river restoration.<sup>23</sup>

From the perspective of both existing and potential anglers, either the fish ladder/natural bypass option or the dam removal option would achieve the same basic objectives. Likewise, landowners would see a similar rise in property values regardless of which option is selected. Only boaters would have a strong preference of dam removal over detour options. Regardless of the final decision, local citizens and tourists alike will benefit from a coordinated marketing campaign that highlights the fishing opportunities and cleanliness of the Mid-Kalamazoo River.

### **Local Businesses**

While rehabilitating the Kalamazoo River in Allegan County will have many positive benefits for local communities, we have focused primarily on the value of sport fishing/anglers in this report. It is also worthwhile to briefly address a directly related value: the potential for a renewed Kalamazoo River to significantly raise revenues for local businesses. This, in turn, will result in increased sales tax revenues for the state. Opening the waterway to fish migration – either by removing the dams altogether or modifying the dams to allow fish passage – will have a positive benefit on these businesses by increasing the number of local customers and attracting tourists from outside the region.

Few studies have explored the direct effect of river rehabilitation on local businesses in Michigan, partially because a significant portion of the net benefit to small businesses is directly linked to local investment in tourism infrastructure. The available data mostly focuses on revitalizing the broader Great Lakes ecosystem, with a particular emphasis on the Lakes themselves. Because we could not find reliable data for benefits to small business, we did not include them in our cost-benefit analysis. However, a 2007 report by the Council of Great Lakes Industries and the Healing Our Waters Coalition found that “in addition to spending their time fishing, anglers purchase equipment, bait, transportation, lodging, and other goods and services in the Great Lakes states. The most recent estimate available of

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<sup>21</sup> Balsman, Dane M. and Daniel E. Shoup. “Opportunities for Urban Fishing: Developing Urban Fishing Programs to Recruit and Retain Urban Anglers.” *American Fisheries Societies Symposium*, 67:31-40, 2008. <http://nrem.okstate.edu/shouplab/Publications/PDF%20files/Balsman%20and%20Shoup%202008%20Opportunities%20for%20Urban%20fishing%20AFS%20Symp%2067.pdf> Accessed 5 Dec 2012.

<sup>22</sup> Atkin, C. 1995. Data from 1994 Kalamazoo River Anglers Survey. Conducted by Charles Atkin of Michigan State University, Technical Report submitted in 1995 to Blasland, Bouck & Lee.

<sup>23</sup> *ibid*

the volume of these expenditures is \$1.3 billion in 2001.<sup>24</sup> Given inflation rates over the past 11 years, these expenditures equal roughly \$1.5 billion in current dollars. While this study does not separate out individual states or river systems, nor does it provide a quantitative estimate of the economic impact of a revitalized water system on local businesses, it does offer some sense of the economic potential of a thriving sport fishing industry along the Mid-Kalamazoo River.

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<sup>24</sup> Austin, John C., Soren Anderson, Paul N. Courant, and Robert E. Litan. "America's North Coast: A Benefit-Cost Analysis of a Program to Protect and Restore the Great Lakes," *Healthy Lakes, Healthy Lives*. Pg. 33. [http://www.healthylakes.org/site\\_upload/upload/America\\_s\\_North\\_Coast\\_Report\\_07.pdf](http://www.healthylakes.org/site_upload/upload/America_s_North_Coast_Report_07.pdf) Accessed 5 Dec 2012.

## Conclusions and Recommendations

Based on our cost-benefit analysis, we recommend proceeding with the most expedient river rehabilitation option available. Given the complexities of working with the EPA and the PRPs to finalize the process of awarding damages, this means installing fish ladders and natural bypasses throughout the mid-Kalamazoo River. By acting quickly, jurisdictions in the region will be able to recover any additional costs incurred from installing these detours, even if the dams are removed in the future.

We recognize the importance of working together as a region to make meaningful advances in restoring the river. Plainwell has already done its part by removing the dams within its jurisdiction. The city can now take a lead role in driving a broader effort to make river restoration a reality. We also realize that different stakeholders have different concerns in the river restoration process. Our hope is that the supplemental information provided in the Stakeholder Analysis section will help you navigate the complex terrain as you work with these municipalities, agencies, and organizations.

Beyond the politics of river restoration, it is imperative that people's perceptions about the river shift in parallel to changes in the ecosystem. Many of the benefits associated with a restored river can only be enjoyed if people know about the opportunities and choose to take advantage of them. A shift in perception is undoubtedly a long-term endeavor. The positive effect on local businesses is still a longer-term effect. However, we recommend a few intermediate steps that will both help change people's perceptions about the river and offer limited opportunities to gain revenue in the short-term:

- Install boat launches
- Permit and/or create public park facilities (camping, BBQ, etc.)
- Encourage establishment of bait and tackle shops
- Focus on fast food/restaurants/food truck options

The first two options, boat launches and public park facilities, require some minimal municipal investment. The latter two options, attracting bait/tackle shops and focusing on food options, relies mostly on private investment but requires municipal permitting. Although the specific details of these types of options are beyond the scope of this report, we highly encourage Plainwell to invest in increased marketing and infrastructure to create a more hospitable environment for local citizens and tourists to enjoy greater recreational opportunities along the Mid-Kalamazoo River.

## Appendix 1: Dam Overviews

Dam Name	Lake Allegan	Allagan City	Trowbridge	Otsego (rural)	Otsego City	Plainwell	Cost Allocation	
							<u>Regional</u>	<u>Plainwell</u>
Dam Height (feet)	33	12	11	5	9	8	0	0
Dam Ownership	Private	Public	Public	Public	Public	Public	0	0
Dam Risk	Low	Low	High	High	Medium	Removed	0	0
Distance from Previous Dam (miles)	0.00	9.00	9.50	4.50	4.00	4.00	31.00	0.00
Fishing Tourism #ppl/yr	4,326	2,163	1,082	1,082	1,082	2,163	11,820	2,163

## Appendix 2: Scenario A – Status Quo – Detailed Costs and Benefits

	Lake Allegan	Allegan City	Trowbridge	Otsego (rural)	Otsego City	Plainwell	Cost Allocation		Total
							Regional	Plainwell	
<b>Total Annual Cost</b>	<b>\$ 3,684.00</b>	<b>\$ 3,684.00</b>	<b>\$ 12,368.00</b>	<b>\$ 12,368.00</b>	<b>\$ 8,026.00</b>	<b>\$ -</b>	<b>\$ 40,130.00</b>	<b>\$ -</b>	<b>\$ 80,260.00</b>
Dam Maintenance	\$ 3,684.00	\$ 3,684.00	\$ 12,368.00	\$ 12,368.00	\$ 8,026.00	\$ -	\$ 40,130.00	\$ -	\$ 80,260.00
									\$ -
									\$ -
<b>Total Annual Benefit</b>	<b>\$ 157,861.92</b>	<b>\$ 78,930.96</b>	<b>\$ 39,465.48</b>	<b>\$ 39,465.48</b>	<b>\$ 39,465.48</b>	<b>\$ 78,930.96</b>	<b>\$ 434,120.27</b>	<b>\$ 78,930.96</b>	<b>\$ 947,171.49</b>
Fishing Tourism	\$ 127,578.73	\$ 63,789.37	\$ 31,894.68	\$ 31,894.68	\$ 31,894.68	\$ 63,789.37	\$ 350,841.51	\$ 63,789.37	\$ 765,472.38
Fishing Licenses	\$ 30,283.18	\$ 15,141.59	\$ 7,570.80	\$ 7,570.80	\$ 7,570.80	\$ 15,141.59	\$ 83,278.76	\$ 15,141.59	\$ 181,699.11

### Appendix 3: Scenario B – Dam Removal – Detailed Costs and Benefits

	Lake Allegan	Allegan City	Trowbridge	Otsego (rural)	Otsego City	Plainwell	Cost Allocation		
							Regional	Plainwell	Total
<b>One Time Cashflows</b>									
<b>Total Costs</b>	\$ 8,250,000.00	\$ 1,000,000.00	\$ 1,000,000.00	\$ 1,000,000.00	\$ 1,000,000.00		\$ 12,250,000.00		\$ 24,500,000.00
Dam Removal	\$ 8,250,000.00	\$ 1,000,000.00	\$ 1,000,000.00	\$ 1,000,000.00	\$ 1,000,000.00		\$ 12,250,000.00		\$ 24,500,000.00
<b>Total Benefits</b>		\$ 24,154,838.71	\$ 25,496,774.19	\$ 12,077,419.35	\$ 10,735,483.87	\$ 10,735,483.87	\$ 83,200,000.00	\$ 5,367,741.94	\$ 171,767,741.94
Environment		\$ 638,709.68	\$ 674,193.55	\$ 319,354.84	\$ 283,870.97	\$ 283,870.97	\$ 2,200,000.00	\$ 141,935.48	\$ 4,541,935.48
Property Values		\$ 23,516,129.03	\$ 24,822,580.65	\$ 11,758,064.52	\$ 10,451,612.90	\$ 10,451,612.90	\$ 81,000,000.00	\$ 5,225,806.45	\$ 167,225,806.45
<b>Annual Cashflows</b>									
<b>Total Costs</b>	\$ 3,684.00	\$ 177,337.55	\$ 183,300.97	\$ 86,826.77	\$ 77,179.35	\$ 77,179.35	\$ 605,508.00	\$ 38,589.68	\$ 1,249,605.68
Fish Stocking		\$ 173,653.55	\$ 183,300.97	\$ 86,826.77	\$ 77,179.35	\$ 77,179.35	\$ 598,140.00	\$ 38,589.68	\$ 1,234,869.68
Maintenance	\$ 3,684.00	\$ 3,684.00					\$ 7,368.00		\$ 14,736.00
<b>Total Benefits</b>	\$ 157,861.92	\$ 1,420,757.24	\$ 1,499,688.19	\$ 710,378.62	\$ 631,447.66	\$ 631,447.66	\$ 5,051,581.29	\$ 315,723.83	\$ 10,418,886.41
Fishing Tourism	\$ 127,578.73	\$ 1,148,208.58	\$ 1,211,997.94	\$ 574,104.29	\$ 510,314.92	\$ 510,314.92	\$ 4,082,519.38	\$ 255,157.46	\$ 8,420,196.22
Fishing Licenses	\$ 30,283.18	\$ 272,548.66	\$ 287,690.25	\$ 136,274.33	\$ 121,132.74	\$ 121,132.74	\$ 969,061.91	\$ 60,566.37	\$ 1,998,690.18



## Appendix 4: Scenario C – Fish Ladders and Natural Bypasses – Detailed Costs and Benefits

	Lake Allegan	Allegan City	Trowbridge	Otsego (rural)	Otsego City	Plainwell	Cost Allocation		
							Regional	Plainwell	Total
<b>One Time Cashflows</b>									
<b>Total Costs</b>	<b>\$ 8,250,000.00</b>	<b>\$ 3,000,000.00</b>	<b>\$ 2,750,000.00</b>	<b>\$ 1,250,000.00</b>	<b>\$ 2,250,000.00</b>		<b>\$ 17,500,000.00</b>		<b>\$ 35,000,000.00</b>
Fish Bypass/Ladder	\$ 8,250,000.00	\$ 3,000,000.00	\$ 2,750,000.00	\$ 1,250,000.00	\$ 2,250,000.00		\$ 17,500,000.00		\$ 35,000,000.00
<b>Total Benefits</b>		<b>\$ 23,893,548.39</b>	<b>\$ 25,220,967.74</b>	<b>\$ 11,946,774.19</b>	<b>\$ 10,619,354.84</b>	<b>\$ 10,619,354.84</b>	<b>\$ 82,300,000.00</b>	<b>\$ 5,309,677.42</b>	<b>\$ 169,909,677.42</b>
Natural Environment		\$ 377,419.35	\$ 398,387.10	\$ 188,709.68	\$ 167,741.94	\$ 167,741.94	\$ 1,300,000.00	\$ 83,870.97	\$ 2,683,870.97
Property Values		\$ 23,516,129.03	\$ 24,822,580.65	\$ 11,758,064.52	\$ 10,451,612.90	\$ 10,451,612.90	\$ 81,000,000.00	\$ 5,225,806.45	\$ 167,225,806.45
<b>Annual Cashflows</b>									
<b>Total Costs</b>	<b>\$ 8,398.29</b>	<b>\$ 179,051.83</b>	<b>\$ 197,240.40</b>	<b>\$ 99,909.06</b>	<b>\$ 86,491.07</b>	<b>\$ 77,179.35</b>	<b>\$ 648,270.00</b>	<b>\$ 38,589.68</b>	<b>\$ 1,335,129.68</b>
Detour Maintenance	\$ 4,714.29	\$ 1,714.29	\$ 1,571.43	\$ 714.29	\$ 1,285.71		\$ 10,000.00		\$ 20,000.00
Dam Maintenance	\$ 3,684.00	\$ 3,684.00	\$ 12,368.00	\$ 12,368.00	\$ 8,026.00		\$ 40,130.00		\$ 80,260.00
Fish Stocking		\$ 173,653.55	\$ 183,300.97	\$ 86,826.77	\$ 77,179.35	\$ 77,179.35	\$ 598,140.00	\$ 38,589.68	\$ 1,234,869.68
<b>Total Benefits</b>	<b>\$ 157,861.92</b>	<b>\$ 1,420,757.24</b>	<b>\$ 1,499,688.19</b>	<b>\$ 710,378.62</b>	<b>\$ 631,447.66</b>	<b>\$ 631,447.66</b>	<b>\$ 5,051,581.29</b>	<b>\$ 315,723.83</b>	<b>\$ 10,418,886.41</b>
Fishing Tourism	\$ 127,578.73	\$ 1,148,208.58	\$ 1,211,997.94	\$ 574,104.29	\$ 510,314.92	\$ 510,314.92	\$ 4,082,519.38	\$ 255,157.46	\$ 8,420,196.22
Fishing Licenses	\$ 30,283.18	\$ 272,548.66	\$ 287,690.25	\$ 136,274.33	\$ 121,132.74	\$ 121,132.74	\$ 969,061.91	\$ 60,566.37	\$ 1,998,690.18

## Appendix 5: Summary of Three Scenarios

Scenario A: Status Quo									Total
Total Annual Cost	\$ 3,684.00	\$ 3,684.00	\$ 12,368.00	\$ 12,368.00	\$ 8,026.00		\$ 40,130.00		\$ 80,260.00
Total Annual Benefit	\$ 157,861.92	\$ 78,930.96	\$ 39,465.48	\$ 39,465.48	\$ 39,465.48	\$ 78,930.96	\$ 434,120.27	\$ 78,930.96	\$ 947,171.49
Scenario B: Dam Removal									Total
One Time Cashflows									
Total Costs	\$ 8,250,000.00	\$ 1,000,000.00	\$ 1,000,000.00	\$ 1,000,000.00	\$ 1,000,000.00		\$ 12,250,000.00		\$ 24,500,000.00
Total Benefits		\$ 24,154,838.71	\$ 25,496,774.19	\$ 12,077,419.35	\$ 10,735,483.87	\$ 10,735,483.87	\$ 83,200,000.00	\$ 5,367,741.94	\$ 171,767,741.94
Annual Cashflows									
Total Costs	\$ 3,684.00	\$ 177,337.55	\$ 183,300.97	\$ 86,826.77	\$ 77,179.00	\$ 77,179.35	\$ 605,508.00	\$ 38,589.68	\$ 1,249,605.32
Total Benefits	\$ 157,861.92	\$ 1,420,757.24	\$ 1,499,688.19	\$ 710,378.62	\$ 631,447.66	\$ 631,447.66	\$ 5,051,581.29	\$ 315,723.83	\$ 10,418,886.41
Scenario C: Fish Ladders/Natural Bypass									Total
One Time Cashflows									
Total Costs	\$ 8,250,000.00	\$ 3,000,000.00	\$ 2,750,000.00	\$ 1,250,000.00	\$ 2,250,000.00		\$ 17,500,000.00		\$ 35,000,000.00
Total Benefits		\$ 24,154,839.00	\$ 25,496,774.00	\$ 12,077,419.00	\$ 10,735,484.00	\$ 10,735,484.00	\$ 83,200,000.00	\$ 5,367,742.00	\$ 171,767,742.00
Annual Cashflows									
Total Costs	\$ 3,684.00	\$ 177,338.00	\$ 183,301.00	\$ 86,827.00	\$ 77,179.00	\$ 77,179.00	\$ 605,508.00	\$ 38,590.00	\$ 1,249,606.00
Total Benefits	\$ 157,862.00	\$ 1,420,757.00	\$ 1,499,688.00	\$ 710,379.00	\$ 631,448.00	\$ 631,448.00	\$ 5,051,581.00	\$ 315,724.00	\$ 10,418,887.00

## Appendix 6: CBA Data Sources

Allegan County Equalization Department. "ALLEGAN COUNTY 2012 EQUALIZATION REPORT."

[http://www.allegancounty.org/docs/EQ/EQ2012\\_EqualizationReport.pdf](http://www.allegancounty.org/docs/EQ/EQ2012_EqualizationReport.pdf)

Introduction to Michigan Fish Stocking Guidelines. "Michigan Fish Stocking Guidelines II." October 2004.

[http://www.michigandnr.com/publications/pdfs/ifr/ifrlibra/special/abstracts/sr32\\_intro.pdf](http://www.michigandnr.com/publications/pdfs/ifr/ifrlibra/special/abstracts/sr32_intro.pdf)

Loomis, John and Kent, Paula. "Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey."

<https://www.msu.edu/user/lupi/aec829/D.pdf>

Mississippi Department of Environmental Quality Office of Land & Water Resources Dam Safety Division. "Cost Estimates and Other Considerations for Building and Maintaining a Dam."

[http://www.mississippi.org/assets/docs/community/dam\\_cost\\_comp.pdf](http://www.mississippi.org/assets/docs/community/dam_cost_comp.pdf)

NRtoday. "Fish ladder at Soda Springs Dam complete."

<http://www.nrtoday.com/news/ticker/3249869-113/fish-dam-ladder-umpqua>

Wesley, J.K. 2005. "Kalamazoo River Assessment." Michigan Department of Natural Resources, Fisheries Division, Special Report 35, Ann Arbor.