EVALUATION OF ECONOMIC BENEFITS AND IMPACTS OF THE PROPOSED REMOVAL OF THE MARION DAM IN OSCEOLA COUNTY MICHIGAN

By

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ABSTRACT

EVALUATION OF ECONOMIC BENEFITS AND IMPACTS OF THE PROPOSED REMOVAL OF THE MARION DAM IN OSCEOLA COUNTY MICHIGAN

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In recent years the removal of dams that pose environmental hazards has been seen as a river restoration and management tool. The ecological benefits of removing dams, such as the restoration of water temperatures and fish passage, have been well documented. However, fewer studies have evaluated the economic benefits and impacts of removing dams.

This study uses the proposed removal of the Marion Dam in Osceola County Michigan as a case study to evaluate recreational fishing benefits and economic impacts associated with removing the dam. The major objective of this research study was to estimate the recreational fishing benefits and economic impacts of removing the Marion Dam and restoring the Middle Branch River (MBR) and Marion Mill Pond (MMP). Both recreational fishing benefits and economic impacts were evaluated at the county (Osceola), Muskegon River Watershed (MRW) and the state of Michigan regional levels. Recreational fishing benefits were estimated using the Michigan Angling Demand Model (MADM). Economic impacts were evaluated using IMPLAN an input-output modeling software.

The MADM predicted an increase in recreational fishing trips to Osceola County and the MRW of 2,051 and 1,390 total user days respectively. Analysis of a 16 mile

change in the MBR from secondary quality to top quality resulted in a statewide increase in welfare of about $39,124 per year. However, the Net Present Value (NPV) of the recreational fishing benefits was estimated to be negative when the dam removal cost estimated at $4,287,500 was factored in. Although the dam removal cost outweighed the estimated recreational fishing benefits, this does not imply that the project is economically unjustifiable because recreational fishing benefits are only one of the many benefits associated with removing the dam. Other benefits such as enhanced property values, potential improvements in boating, swimming and non-use benefits were not estimated.

Impact analysis using IMPLAN showed a minor ongoing increase in the total industry income and output to Osceola County and the MRW as a result of increased recreational fishing trip expenditures. When recreational fishing expenditures go up the most impacted industry sectors were shown to be *Eating and Drinking*, *General Merchandise Stores* and *Domestic Trade*.

One time economic impacts of the proposed Marion dam removal and restoration of the MBR and MMP were estimated to result in some increases employment, value addition and output to the three regional economies. In particular, the project was estimated to create 55 annual part time and full time jobs, with 21 jobs coming from the MRW, 5 from Osceola County and the rest coming from outside the watershed. Some of the most impacted industry sectors due to the dam removal, river and pond restoration project were found to be *Domestic Trade*; *New Utility Structures* and *Engineering-Architectural Services*. Although the impact analysis results may predict increases in employment and income, it is important to note that such gains are usually offset by reductions elsewhere in the economy. Reductions and increases in employment and income are usually transfers in economic activity at the national level.

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To my family, for being there for me.

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ABBREVIATIONS

BCA	Benefit Cost Analysis
CVM	Contingent Valuation Method
FERC	Federal Energy Regulatory Commission
HVM	Hedonic Valuation Method
I-O	Input-Output
MADM	Michigan Angling Demand Model
MBR	Middle Branch River
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resource
MMP	Marion Mill Pond
MRW	Muskegon River Watershed
MSU`	Michigan State University
NPV	Net Present Value
NSFHWAR	National Survey of Fishing, Hunting and Wildlife Associated Recreation
PAE	Progressive Architectural Engineering
PV	Present Value
REIS	Regional Economic Information System
RPC	Regional Purchase Coefficients
RUM	Random Utility Model
TCM	Travel Cost Model
WTA	Willingness to Accept
WTP	Willingness to Pay

CHAPTER 1

INTRODUCTION AND RESEARCH CONTEXT

1. INTRODUCTION

The twentieth century saw the rise in dam construction the world over. Dams have provided a means of socio-economic development and today nearly half of the world's rivers have at least one large dam (World Commission on Dams 2000). During the last century the United States (U.S.) has also seen an increasing number of dam constructions, with the greatest dam of it's time, the 725-feet-high Hoover Dam being completed in 1936 on the Colorado River (Gore and Petts 1989). The Army Corps of Engineers estimates that at least 75, 000 dams above 6 feet tall, and tens of thousands smaller dams (less than 6 feet tall) block rivers across the country. Rivers and streams have been impounded for irrigation, flood control, navigation, water supply, recreation, and hydroelectricity generation. Despite such benefits to human society, recent studies have shown that dams can negatively impact the river ecosystem, especially in the impounded areas (Gore and Petts 1989).

Recent studies demonstrate that dams can block upstream and downstream fish passage, increase water temperatures in the impoundment area and downstream of the impoundment (Trout Unlimited 2002). Power generating turbines have contributed to thousands of fish kills yearly (Alexander 1999). Dams have also been shown to decrease water oxygen levels and to obstruct sediment and nutrient movement along streams (Kanehl et al 1997, Bednarek 2001).

New and improved dam regulatory requirements by federal regulatory agencies can be attributed to improved knowledge and awareness of the impacts of dams.

Regulation and maintenance of dams across the country is generally carried out by federal, state and local government agencies. In the last few decades, the U.S. congress enacted several statutes such as the Clean Water Act (1972), and the Reclamation Safety of Dams Act (1978) to protect the environment and guide management decisions regarding dams. Of all the dams in the country, government agencies and public utility companies own 27%, whilst the majority, 58% are privately owned. Ownership of the remaining 15% of the dams remains unclear (American Rivers et al 1999). Over 2,400 of the dams in the country that are privately owned are regulated by the Federal Energy Regulatory Commission (FERC), (American Rivers et al 1999).

The FERC is the agency responsible for overseeing how most non-federal hydroelectric dams are operated. The FERC has a relicensing program for hydroelectric operations that examines environmental impacts of dams. The program requires dam owners to justify whether dam operation is still in the interest of the public. The FERC issues 30 to 50 year licenses to dams owned by non-federal entities like utility companies and municipalities (Bednarek 2001). Through the relicensing program, FERC has mandated new operating measures such as, increased minimum flows, improved fish ladders, and protection of riparian land. Bednarek (2001) notes that mitigation tools have not always been sufficient in remedying the ecological impacts of dams. For example with the Edward's Dam of Maine, the FERC ordered the dam to be removed in July of 1999, after researchers established that fish ladders would not significantly improve fish populations (Bednarek 2001).

The average life expectancy of a dam is 50 years, but a quarter of the U.S. dams are over 50 years old (American Rivers et al 1999). A lot of these dams, particularly those built for hydroelectricity generation and logging, have outlived their purposes, e.g. the Big Rapids Dam (remnant) on the Muskegon River in Michigan had to be removed for this reason and that it had become structurally unsafe. The state of Wisconsin with over 3,600 dams has the most experience with dam removal, as evidenced by 37 dams that have been removed since 1990 (American Rivers et al 1999). Based on information obtained from 43 states, American Rivers et al (1999) established that a total of 465 dams with an average height of 21 feet have been removed across the county since 1912, but the number is likely to be higher as some agencies have not kept dam removal records.

Improved understanding of river ecosystems and how dams impact them has brought about a movement where removal of dams that have outlived their purpose and pose environmental hazards has become a river restoration and management tool (Born et al 1998; American Rivers et al 1999; Bednarek 2001). Although dam removal has been seen as a way of dealing with obsolete, abandoned and unsafe dams, recently it has emerged as a means of reviving the river ecosystem. The new perception can be attributed to more balanced evaluations that not only look at the benefits of having dams but also at their negative ecological impacts.

1.1 Problem Statement

Removing dams has been shown to have both positive and negative ecological impacts on the river ecosystem (Born et al 1998; American Rivers et al 1999; Alexander 1999; and Bednarek 2001). Although dam removal studies have mostly been ecological and descriptive, a study by Born et al (1998) looked at the socioeconomic and institutional dimensions in dam removal as these factors play an important role in the dam removal decision making process. Whilst there has been increased attention and study given to the ecological impact of dam removals, fewer studies have evaluated the economic benefits, costs and impacts of removing dams. Here, economic impacts refer to the effects a dam removal project can have on the local economy's total industry output, income and employment. To better inform parties involved in the dam-removal decision-making process of not only the ecological benefits and costs of removing dams, but also of the potential economic benefits, costs and impacts of removing dams on the local economy there is need for evaluation of benefits, costs and economic impacts of removing dams. Such information can go a long way in helping local planners make economically sound decisions regarding dam removal.

To conduct the analysis, the proposed removal of the Marion Dam on the Middle Branch River in Osceola County, Michigan is used as a case study. The Marion Dam is a former hydroelectric facility that was built for the logging industry operating in the area during the 1800s. The Michigan Department of Natural Resources (MDNR) has earmarked the dam for removal after ecological studies found it negatively impacts the river ecosystem.

Although a Benefit Cost Analysis (BCA) would be a complete policy analysis tool for such a project, working towards a BCA requires estimation of all the benefits involved. This study therefore addresses a component of the benefits estimation that such an analysis would consider: the recreational fishing benefits of dam removal and river restoration. The study also estimates the economic impacts associated with the dam removal project. Removal of the Marion Dam is part of larger integrated project to manage the Muskegon River Watershed in Michigan initiated by the Muskegon River Watershed Assembly (MRWA).

1.2 Research Objectives

With the above context, the general objective of this study is to estimate the recreational fishing benefits and economic impacts of removing the Marion Dam and restoring the Middle Branch River. Specific objectives of this study are:

1. To estimate recreational fishing benefits of removing the Marion Dam and restoring the Middle Branch River (MBR).
2. To estimate how the number of recreational fishing trips to Osceola County, the Muskegon River Watershed (MRW) and the state of Michigan change with removal of the Marion Dam and restoration of the MBR.
3. To estimate the economic impacts associated with the change in recreational fishing trips to Osceola County, and the MRW.
4. To estimate the economic impacts of removing the Marion Dam and restoring the MBR and Marion Mill Pond (MMP) on the local economies of Osceola County, the MRW and the state of Michigan.

1.3 Significance of Study

Economic considerations are often a significant factor in the decision to remove a dam. Regular dam operation and maintenance costs are likely to increase as the dam ages. Dam removals can involve substantial investments in removing the existing structures, managing accumulated sediment behind the dam and restoring the river ecosystem.

Although dam removals can be expensive ventures, in some cases repair costs have outweighed removal costs. For example, a study by Born et al (1998) found that on average the costs associated with removal of 14 Wisconsin dams to be significantly lower than costs to repair the dams. There is evidence to show that removal of dams that threaten the river ecosystem and have outlived their purpose can restore the river ecosystem (American Rivers et al 1999). As dam removal cost estimations normally involve millions of dollars, it is imperative to provide information on the economic benefits in order for decision makers to make informed public decisions. Knowledge of economic benefits can be useful to agencies and planners concerned with socio-economic development and providing outdoor opportunities to the local economy. Information on local economic impacts can also be quite useful to decision makers and public officials in informing them on whether local economic effects e.g. generation of tax dollars are important in choosing among policy alternatives.

1.4 Methodology

Although there are several economic benefits associated with removing dams, this study will only value one such benefit, the value of recreational fishing associated with removing the Marion Dam. Economic recreational fishing benefits of removing the Marion Dam are estimated using the Michigan Angling Demand Model (MADM). Researchers at Michigan State University (MSU) developed the MADM to economically value recreational angling in Michigan. The MADM will be used to value potential benefits to anglers of the proposed removal of the Marion Dam and restoration of 16 miles of the MBR to a cold water trout stream. The MADM will also be used to estimate how the number of recreational trips to Osceola County, MRW and the state of Michigan change with the removal of the dam.

To estimate the local economic impacts of removing the Marion Dam, IMPLAN, a regional impact analysis modeling software is used. IMPLAN is a software that uses input-output modeling to analyze economic relationships among sectors of the economy. Input-output models are the standard economic tool to analyze complex economic interdependencies among sectors of the economy. In this study IMPLAN is used to estimate impacts of removing the Marion Dam on the local economy's (Osceola County and MRW and the state of Michigan) total industry output, income and employment. IMPLAN will also be used to estimate the economic impacts associated with the change in recreational trip expenditures to Osceola County and the MRW.

1.5 Background on Study Area

The state of Michigan has over 2,000 dams on its waterways. Most of the dams were built for recreational purposes. State and federal agencies in Michigan regulate all dams that are at least 6 feet high and create reservoirs of at least 5 acres. The Marion Dam is one of the 95 dams found along the MRW. The MRW is shown in Fig 1.1.

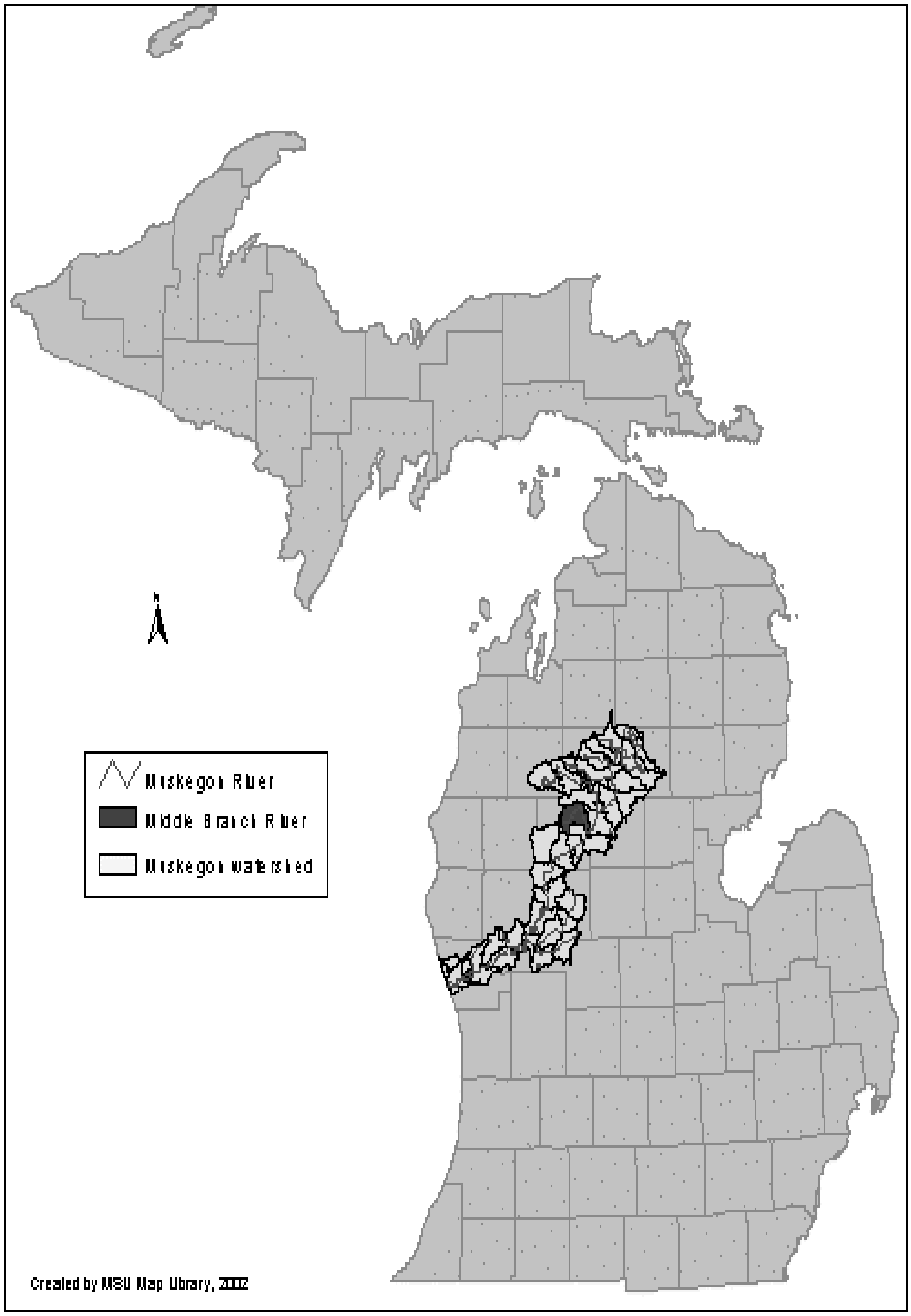

Fig 1.1 State of Michigan map showing location of the Muskegon River Watershed

A fourth of the dams in the watershed are now more than 50 years old, have become obsolete and violate environmental laws (Alexander 1999). Several dams in Muskegon River Watershed including the Marion Dam violate Michigan's Surface Water Quality Standards of increasing water temperatures by more than 2 degrees Fahrenheit (O'Neil 1997). State biologists with the Michigan Department of Natural Resources (MDNR) have suggested addition of fish ladders and removal of dams to improve water quality in Michigan's rivers.

1.5.1 Study Area

The Middle Branch River is a 33-mile long tributary of the Muskegon River in Osceola County Michigan (see Fig 1.2, and Fig 1.3). The Middle Branch River runs through the village of Marion and was first impounded in 1893 to generate hydroelectricity for the logging industry that was in the area. The impoundment of the river- the Marion Mill Pond is 26 acres and is found almost halfway between the headwaters of the Middle Branch River and its confluence with the Muskegon River. The difference in elevation between upstream and downstream of the dam is approximately 8 feet. The Middle Branch River is designated a coldwater trout stream by the MDNR (O'Neal 1997). The river enters the pond from the northeast and flows for about 2100 feet towards the dam spillway (see Appendix 1). Next to the spillway is a 3-4 foot-wide fish ladder. There are also two other water outlets from the pond, but only one of these can be used to regulate pond water levels.

The dam and the pond have been the center of recreational activity ever since the logging industry ceased operating. The Michigan Department of Environmental Quality (MDEQ) has classified the Marion dam as presenting a significant hazard potential[1]

[1] "Significant hazard potential dam means a dam located in an area where its failure may cause damage limited to isolated inhabited homes, agricultural buildings, structures, secondary highways, short line railroads, or public utilities, where environmental degradation may be significant, or where danger to individuals exists"- Michigan Department of Environmental Quality.

Fig 1.2 Osceola County Michigan

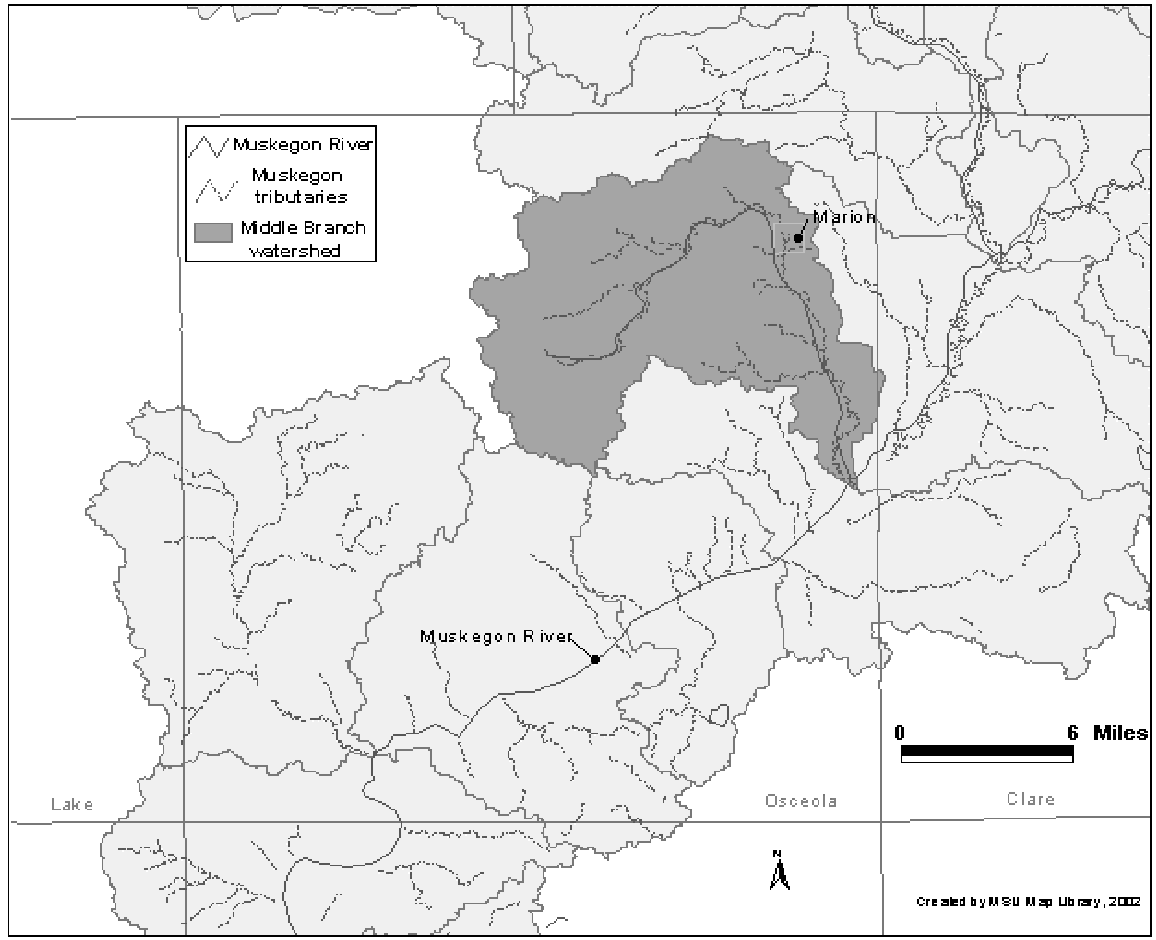

Fig 1.3 Middle Branch River Watershed, Osceola County Michigan

1.5.1.1 Ecological Condition of the Middle Branch River

Based on sensitivity to temperature, conductivity and trout densities the Middle Branch River is said to be in a critical condition according to the MDNR. Thermal pollution is a major threat posed by the Marion Dam. Ideal temperatures for fisheries in cold water streams range from 46^0 to 60^0 Fahrenheit (F). Temperatures beyond 69 degrees F can have dire consequences for cold water species (Allan 1995). Michigan's Surface Water Quality Standard for the MBR is 68 degrees F. Mean summer temperature downstream of the MBR has been shown to be approximately 7^0 Fahrenheit (F) higher than above the impoundment upstream temperature (Lessard 2000). Water temperatures downstream of the Marion dam have also been shown to violate Michigan's Surface Water Quality Standards of exceeding 2 degrees Fahrenheit. Table 1.1 showing mean summer temperature in the MBR over the course of 4 years. It shows how water temperatures are generally higher below the impoundment than upstream of the impoundment.

Table 1.1 Mean Water Temperature of the Middle Branch River

Location	**Year**	**Mean Water Temperature (degrees F)**
Upstream	1998	60.7
Downstream	1998	68.3
Upstream	1999	59.3
Downstream	1999	65.2
Upstream	2000	57.7
Downstream	2000	64.8
Upstream	2001	61.2
Downstream	2001	68.1

Source: O'Neal, 2002

Coldwater fish densities for brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), and slimy sculpin (*Cottus cognatus*) have been found to be much lower downstream than upstream due to increased water temperatures below the impoundment (Lessard 2000). At present there are minimal recreational activities taking place along the river and in the pond due to sediment accumulation in the pond. Progressive Architectural Engineering (PAE) (2001), found the mill pond to be shallow with and average depth of 3 feet from the surface to the top of soft sediment, and hence does not support viable fish populations.

1.5.2. Project Description

As part of restoring the Middle Branch River to its free-flowing status, removing the Marion dam has been proposed by MDNR. The restoration proposal includes, constructing an earthen dike that separates the river from the pond, and deepening the mill pond. After the dam is removed, it is proposed to line the river with stone to create white water conditions and decrease erosion at the current site of the dam. It has also been proposed to build a small bridge at the present location of the dam to provide fishing platform and passage. To prevent sediment transportation downstream when the dam is removed, two sediment traps will be constructed downstream of the impoundment.

In order to increase fisheries and recreational opportunities, the pond will be dredged to a depth of about 25 feet. As separating the pond from the river means that the pond will not have a fresh water supply, a gravity flow system that would channel water from the river to the pond has also been proposed. The restoration proposal is not only to improve coldwater fisheries along the stream but also to create a warm water fishery in the pond and to improve other recreational opportunities such as swimming, and boating. Cost estimations for the restoration project put together by PAE are in Appendix 2.

1.6 Organization of Paper

Chapter two highlights the benefits and costs associated with dam removals and show the link between ecological benefits and services that are economically valuable. Two methods that can be used to value recreational fishing benefits will be discussed in chapter two. A distinction between economic impacts and benefits will also be made in the chapter. Chapter three gives an overview of the structure and use of the MADM and how it is applied to the case study to obtain benefits associated with removing the Marion Dam and restoring the MBR and MMP. Chapter four will discuss input-output models and show how IMPLAN is applied to the case study to determine the economic impacts of the project on three regional economies. Finally, chapter five summarizes the results and significance of the study.

CHAPTER 2

BENEFITS AND COSTS OF REMOVING DAMS AND VALUATION METHODS

2. INTRODUCTION

Removal of dams has been shown to restore rivers to their natural free flowing state. A free flowing river will allow fish passage upstream and downstream, allow adult fish migration to upstream spawning areas, facilitate sediment and nutrient transport upstream and downstream. The removal of the Woolen Mills Dam on the Milwaukee river in Wisconsin led to an improved habitat quality, increased smallmouth bass (*Micropterus dolomieu*) populations (cool water species), and a decrease in common carp populations (Kanehl et al 1997). Common carp (*Cyprinus carpio*) is undesirable for many anglers and is tolerant of warm water habitats.

American Rivers et al (1999) give a review of some of the successful dam removal projects in the country such as the 1997 removal of the Waterworks Dam on the Baraboo River in Wisconsin, which led to increased sport fishery and restoration of the river habitat. Since not all dam removals are success stories, American Rivers et al (1999) also cite the not so successful removals such as the Fort Edward Dam on the Hudson River in New York, where removal of the dam in 1973 resulted in the release of toxic sediment. This demonstrated the need for sediment testing and analysis before removing a dam. Similarly, contaminated sediment found behind the Hersey Dam on the Hersey River in Osceola County Michigan necessitated sediment clean up before work on removing the dam began. Management of sediment before and after dam removals is rather critical, as poor management can lead to movement of toxic sediment downstream which can lead to lawsuits by property owners downstream.

Although the ecological benefits and costs of removing dams have been largely documented (American Rivers et al 1999, Alexander 1999; Bednarek 2001), there is also need to determine whether these benefits and costs influence human welfare such that people can value them. Benefits have economic value only when they help support service flows that matter to people (Freeman 1998). Economic value has to do with economic well being of the individual(s) or the extent to which people benefit from a good or service (Freeman 1998). This section will therefore highlight the economic benefits and costs of removing dams in the context mentioned above.

2.1 Economic Benefits of Removing Dams

In coming up with economic benefits associated with removing dams, it is important to determine the possible linkages between ecological benefits and how they enhance human welfare such that they can be valued. For example, when a dam is removed the natural flow regime of a river can be restored (Kondolf 1997), only when this affects service flows that matter to people can the impact be valued. When a river returns to its natural free flowing self, this can lead to habitat restoration, which in turn improves spawning habitat for fish and can lead to higher fish populations. Higher fish populations lead to an increase in fish catch rates[2] and subsequently an increase in recreational fishing. Determining these linkages requires both biologists and economists to work together (Loomis and Helfand 2001). An example of an ecosystem service flows to establish the link between ecological benefits and economically valuable goods and services associated with dam removals can be represented as:

[2] Catch rate refers to the number of fish caught in given time period.

- Natural flow restored→River habitat restored→ Improved spawning habitat for fish→Increase in fish populations→ Increased catch rates→**Improved recreational fishing**

Economists can then estimate the value of recreational fishing as a consequence of changes in fishing success or in catch rates (Freeman 1998). Some economic benefits of removing dams are shown in Table 2.1.

Table 2.1 Economically Valuable Benefits of Removing Dams

BENEFITS*	**ECONOMICALLY VALUABLE GOOD OR SERVICE**
Reestablishment of natural flow regimes	Improved recreational fishing swimming, boating
Sediment release and transport	Improved recreational fishing
Restored river habitat	Improved recreational fishing
Improved water quality	Improved recreational fishing swimming, boating
Reestablished fish passage upstream and downstream	Improved recreational fishing
Improved river aesthetics	Improved recreational swimming ,boating, fishing
Nutrient flow	Improved recreational fishing
Water temperatures and oxygen levels restored	Improved recreational fishing
Dam safety risks and associated liability costs reduced/avoided	Avoided costs/savings
Maintenance costs avoided	Avoided costs/savings

** Benefits are mostly ecological*

Sometimes the connection between an ecological benefit and an economically valuable service flow maybe quite direct, e.g. increased water quality can be valued if it directly increases swimming or fishing activities. In some instances, the connection can be indirect and subtle. For example, if a dam removal results in lower temperatures that are favorable for trout and salmon, first lower temperatures will enable an improved fishery habitat for cold water species. An improved fishery habitat will lead to larger fish populations, which translates to higher fish catch rates and increased recreational fishing which can be valued. Hence, in economic valuation there is need to trace out the ecosystem service flows to people or economic goods that can be valued. Here ecosystem goods and services are defined as:

"Flows of materials, energy and information from natural capital stocks which combine with manufactured and human capital services to produce human welfare." (Constanza et al 1998).

2.3 Costs of Removing Dams

The main cost component in dam removals is the cost of breaching the dam. As dams trap sediment, removing dams can lead to increased sediment release that can cause abrasion of the riverine habitat (Bednarek 2001), or lead to lawsuits by property owners downstream. Restoring damaged riverine habitats is an additional cost associated with removing dams. At times released sediment can be toxic which could imply higher sediment treatment costs. Other costs associated with removing dams are the loss in services that the dam provided, e.g. electricity generation, transport opportunities. After the dam is removed, benefits associated with having dams can be seen as opportunity costs of not having the dam anymore. Economic concerns in dam removal decisions include long-term operation and maintenance costs of dam and impoundment versus removal and financial liability considerations (Born et al 1998). Potential liability can be a serious concern as dam failure can result in dam owners being liable for personal injury to visitors, potential environmental and property damages. Another economic consideration would be the potential decrease in property values to individual riparian property owners resulting from dam removal (Born et al 1998). In the case of the Marion Dam removal, the Marion Mill pond will be retained; hence there is no anticipated loss to riparian property owners.

Table 2.2 Costs of Removing Dams

COSTS	ECONOMICALLY VALUABLE GOOD OR SERVICE
Emissions from dam demolition	Clean up cost
Certain aquatic species can be negatively impacted by dam removal	Reduced aquatic species
Loss of hydroelectricity, irrigation, flood control purpose	Opportunity cost
Loss in shipping and transportation opportunities	Opportunity cost
Emissions due to replacement power generation	Clean up cost
Deconstruction costs	Cost of deconstruction
Toxic Sediment release downstream	Clean up costs, lawsuits by property owners downstream
Restoration, and improvements	Cost of restoration and improvements

2.4 Valuation Methods for Estimating Benefits of Dam Removal

Just like with most environmental policy issues most of the benefits in dam removals are likely to be non-market benefits. Costs are usually fairly obvious and easily quantified (Loomis and Helfand 2001). Most benefits associated with dam removals are non-market benefits that are recreational, and non-use in nature. The most commonly used method to value non-use or passive values is the Contingent Valuation Method (CVM), whilst recreational benefits are usually valued using the Travel Cost Method (TCM). This section will briefly discuss these two valuation methods.

2.4.1 Travel Cost Method

A major benefit that can be associated with dam removals is improved recreational fishing. The benefits of recreational fishing can be quantified using the Travel Cost Method (TCM). The TCM is based on the notion that visitors to a recreational amenity site incur costs in order to experience the recreational service and that the costs can be used to infer value placed by visitors on the recreational services (Perman, et al 1999). The differences in travel costs and number of trips made by visitors can be used to trace out the demand curve for a recreation site. With a demand curve, the benefit of the recreational amenity can be calculated. Information on trips and travel costs can be obtained through surveys. Using travel cost demand models, Loomis (1999) estimated recreational use benefits of removing four dams on the Lower Snake River. As natural conditions did not exist on the Lower Snake River, an approach that describes the new recreation conditions and asks anglers whether they would visit a site along the river, the number of times they would visit, the distance and time it takes to visit was used. Using only visitation rates of anglers that would definitely visit after the dams were removed, recreational benefits were estimated to increase by $108 million whilst angler days increased by 1.4 million days (Loomis 1999).

2.4.2 Contingent Valuation Method

Another way of evaluating the benefits of dam removal and an improved river ecosystem is the Contingent Valuation Method (CVM). The CVM creates a hypothetical market through the use of questionnaire that respondents reveal their Willingness to Pay (WTP) (Carson 1989; Loomis 2000). Respondents are presented with a payment vehicle through which they would pay for the improved conditions, e.g. through higher taxes, or water bill. Respondents would then indicate their WTP for the proposed changes by giving a dollar amount. Loomis (1996) used a contingent valuation survey to measure recreation benefits of removing two dams on the Elwha River (Washington State) and restoring the river. In the same study non-use values of removing the two dams and restoring the river were also estimated. The total non-market economic value (recreation and non-use) for restoring the Elwha River and its fisheries to residents of Clallam County (the county where the Elwha River is located) were found to be a mean annual value per household of $ 59.

2.4.3 Evaluation of Recreational Fishing Benefits in the Case Study Area

Due to the prohibitively high cost and time consuming nature of economic valuation studies such as the TCM and CVM, for purposes of this study the Michigan Angling Demand Model (MADM) is used. From Table 2.1 it is clear that recreational fishing is one of the main benefits associated with removing dams and restoring rivers to their free flowing status. Removal of the Marion Dam is expected to lower water temperatures and make the stream downstream suitable for trout fishing. Other economic benefits anticipated with removal of the Marion Dam are improved swimming conditions in the lake (impoundment); boating; enhanced property values; and non-use values. For purposes of this study, only recreational fishing benefits are estimated.

Researchers at Michigan State University (MSU) developed the MADM to economically value recreational angling in Michigan. The Travel Cost Demand model was employed in developing the MADM. One of the major objectives of the model was to determine how the values for recreational angling are affected by changes in water quality and other measures of fishing quality. An attractive feature of the model is its ability to provide estimates of changes in the demand for fishing as site characteristics change (Lupi 1996). Therefore in this study, the MADM is applied as a form of policy analysis, to evaluate a policy that affects a site quality characteristic used in the model. In particular the MADM will be used to value the benefits to anglers of removing the Marion Dam to restore the Middle Branch River's ecosystem. The MADM will also be used to predict the changes in the total fishing trips in Osceola County of Michigan. The model is convenient in the sense that it meets the requirements of the study without having to carry out full-fledged Travel Cost and or Contingent Valuation techniques.

2.5 Economic Impacts versus Economic Benefits

After the link between an ecological benefit and an economically valuable good or service that matters to people is established, the next step is to estimate people's willingness to pay (WTP) or willingness to accept compensation (WTA) in relation to the good or service in question. Economic value theory begins with the notion of choice and trade-offs, that is, something must be given up to obtain something else. There are two main ways in which choice situations arise (Hoehn et al 1996). One is when people give up something to obtain a good/service of choice (WTP), or they receive compensation in return for giving up a good/service of choice (WTA). There are direct and indirect methods of measuring WTP and WTA. For example, the Travel Cost Method (TCM) and Hedonic Valuation Method (HVM) deduce non market value indirectly from the value of related market goods and services, whilst Contingent Valuation Method (CVM) involves asking people directly how much a specific environmental good is worth to them.

The TCM reflects the number of trips taken to a recreational angling site at a given price. It shows how much an angler is willing to pay (WTP) to make a visit to a site. The demand curve for recreational fishing shows the relationship between the number of recreation trips and price paid for the trip. The cost of the trip can be used a proxy for the travel costs incurred in visiting the site. Below in Fig 2.1 is an example of a Hicksian recreational demand curve[3]. The horizontal axis shows the number of trips taken whilst the travel costs per trip are shown on the vertical axis.

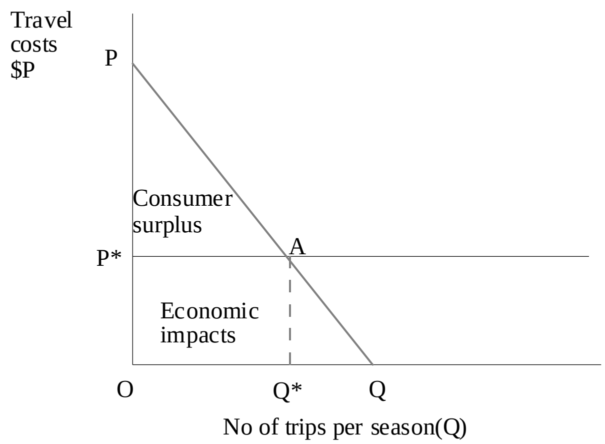

Fig 2.1 Travel cost demand curve

Figure 2.1 shows that as the travel cost per trip increase the number of trips taken decline. Apart from travel costs the position of the demand curve can be influenced by prices of other goods/services and by the quality of the recreational site. The term *consumer surplus* is used to describe welfare gains or loses resulting from changes that affect quantity of trips demanded. Consumer surplus is a measure of value for any good for which a demand curve can be estimated. WTP and WTA are two ways of assessing

[3] Hicksian demand curve shows the relationship between quantity demanded and price of the good or service holding prices of all other goods or services and utility constant.

economic value (Hoehn et al 1996). The WTP for Q* trips in Fig 2.1 is given by the area OPAQ*. Amount spent on Q* trips is given by the area OP*AQ*. Consumer surplus is the excess of the WTP given by triangle P*PA. Consumer surplus gives a measure of economic value of the economic benefit which can go into a BCA as part of the benefits stream. Actual expenditures incurred are given by OP*AQ*. Economic impacts are related to the expenditures and are shown by the area OP^*AQ^*.

Losses and gains in economic benefits are given by the change in consumer surplus. The change in economic benefits is calculated by subtracting the total amount spent making a trip (OP*AQ*) from the total value of the trip given by the area OPAQ*. Travel expenditures do not reflect changes in economic value because they reflect money that has been diverted from elsewhere in the economy to be spent on recreational trips, hence they are just transfers. Only consumer surplus (area P*PA) represents the value of recreational fishing trips and WTP and WTA are measured by consumer surplus.

Often decision makers are not only interested in measures of economic benefits: consumer surplus but they are also interested in economic impacts of a change in policy or management decision. Economic impacts refer to effects of a policy change or management decision on a local economy's total industry output, income and employment. Economic impacts are related to the expenditure portion of Fig 2.1 shown by the area OP*AQ*. Using information on travel expenditures, input-output analysis methods are used to estimate economic impacts[4].

Information on economic impacts is useful as it informs decision makers if a particular policy alternative affects local economic activity (Loomis and Helfand 2001).

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[4] Input-output analysis will be revisited in more detail in chapter 4.

Economic impact analysis can provide information on whether the scale of a change in economic activity is relatively small or large compared to the scale of the local economy. Impact analysis also provides information on which sectors of the economy are impacted most following a policy change, in terms of employment, income and total industry output. It is important for decision makers to note that local gains and losses in employment are nearly always transfers of economic activity at the national level, therefore should not be included in a national BCA (Loomis and Helfand 2001)[5].

Value estimates are therefore based on changes in consumer surplus. Information on changes in economic benefits can be used in a BCA. Hence, for this study any changes in recreational fishing benefits estimated using the MADM can go into a BCA. The next chapter will explain in more detail the structure and use of the MADM and how it is applied to the case study to obtain benefits associated with removing the Marion Dam and restoring the MBR and MMP.

[5] Unless there is no full-employment can gains in employment and income in a local area be considered to be benefits. The unemployment rate has to be substantial and persistent. In the U.S., substantial and persistent unemployment is when unemployment in the local area of concern was 6% or greater, or was 75% above the national average for one of the previous 2 years; or 50% above the national average for 3 of the previous 4 years, or 100% above the national average for 1 of the previous 2 years .

CHAPTER 3

MICHIGAN ANGLING DEMAND MODEL AND APPLICATION

3. INTRODUCTION

3.1 Overview of Model

To estimate the benefits of removing the Marion Dam and restoring the MBR and the MMP, the Michigan Angling Demand Model (MADM) is used. The MADM, developed by Hoehn et al (1996), estimates the demand for recreational fishing in Michigan. The basis of the MADM is the Travel Cost Method (TCM). Travel cost models are based on the notion that visitors to an environmental amenity site incur economic costs in the form of time and travel expenses, and that these costs can be used to infer economic values placed on these amenities by visitors to the site (Perman, et al 1996). The two main types of travel cost models are single site and multiple site models (Lupi, et al 1997). The single site TCM only measures the value of recreational fishing to a single site. Multiple site travel cost models take into account the idea of how visitors can choose to visit alternative recreational sites. To make estimation of parameters used in the MADM possible behavioral data on angler's fishing trips, and data on recreational site characteristics was required. Behavioral data used in the model was obtained through a survey of Michigan residents identified to be potential anglers (Hoehn, et al, 1996). Data on site characteristics was obtained from creel surveys conducted by the MDNR. Site characteristic variables used in the model include, catch rates (used only for the warm and cold water Great Lakes fisheries), stream miles by quality class for both warm and cold rivers/streams, and lake acreage for warm and cold lakes. The MADM uses a multiple site model that employs a nested statistical model referred to as the Random Utility Model (RUM). The RUM estimates the choice of visiting one given recreational site from a set of alternative recreational sites.

3.1.2 Model Structure

The next two sections will explain what nesting and RUM models mean. The Michigan Angling Demand Model incorporates different types of fishing opportunities available in the state of Michigan. The nesting nature of the model divides alternative choices into groups that are similar with alternatives in the same group than with alternatives in different groups (Hoehn, et al 1996). That is, if one decides to go fishing at a Great Lakes site, it makes sense to substitute a Great Lakes site for another Great Lakes site than for another fishery type like Inland Lake. First, the model determines whether anglers choose to go fishing or not. The decision to go fishing is distinguished by whether anglers make a single day trip or a multiple day trip. Within either single day trips or multiple day trips are the different types of product lines. Product line refers to the type of water body[6] and target species[7] they choose. Within each product line are the sites that support the product lines. The MADM is therefore nested at four stages, the participation stage (to go fishing or not), the trip duration (single day versus multiple day trips), the product line stage (the types of water body and fish species) and the site stage (county level). A diagrammatic presentation of the nesting structure is shown in Fig 3.1.

[6] Water Body refers to the Great Lakes, inland lakes, inland streams and rivers, and anadromous runs.
[7] Target species refers to whether anglers go for warm water fish species such as perch, and walleye, or cold-water species such as salmon and trout.

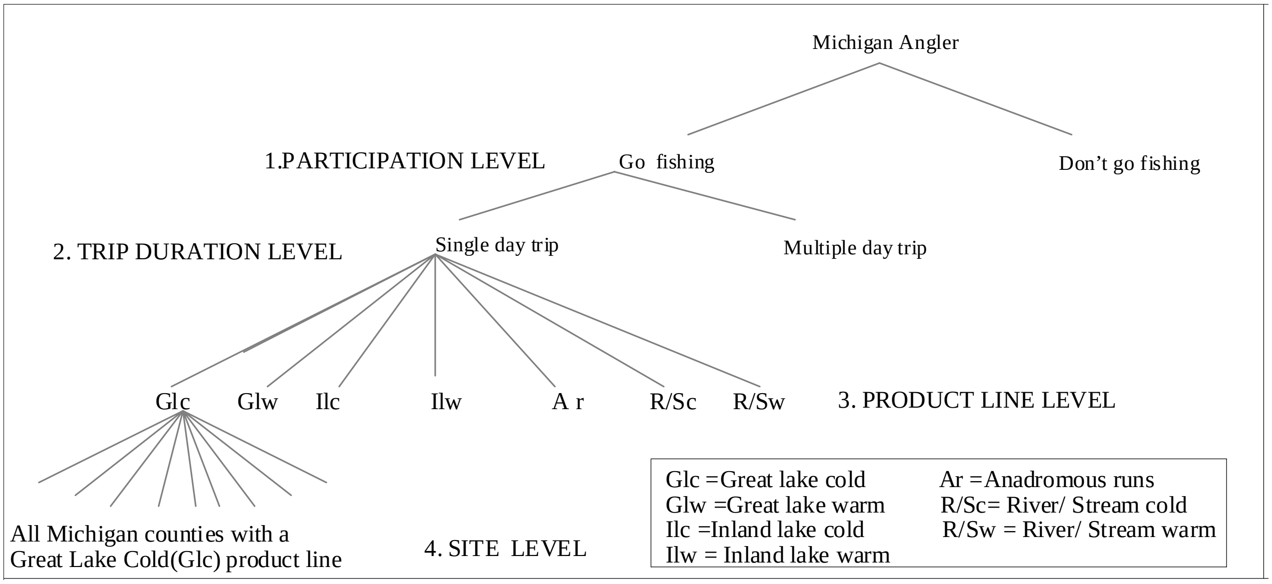

Figure 3.1 Four-stage nesting in the Michigan Angling Demand Model *(source: Hoehn et al 1996)*

3.2 Uses of the MADM

Since the MADM relates the value of recreational fishing to fishing and site characteristics, the model can be used to predict how the value of recreational fishing varies with changes in site characteristics. Therefore the model can be directly used to evaluate policies that affect site characteristics used in the model (Jones and Sung 1993, Hoehn et al, 1996). The model can give a measure of economic value (welfare) for a change in a site characteristic, which is an appropriate measure of benefits that can go into a BCA. Further still the model can be used to predict changes in fishing trips by product line, county level or the state level resulting from quality changes at fishing sites. In conducting policy analysis using the MADM, one would need to first determine the impact of the policy on the variables describing fishing quality in the model. The second step would be to alter the data for the relevant variables for each of the applicable product lines in the county or counties of interest and lastly to run the computer programs for the policy evaluation portions of the model (Hoehn, et al, 1996).

3.4 Application of the Model

For the rivers and streams product lines, both warm water and cold water quality variables in the MADM are miles of streams in the county that are of top quality and secondary quality. Top quality streams are those that support good self-sustaining stocks of desirable fish, whilst in secondary quality streams game fish is limited by factors like pollution, and competition (Hoehn, et al 1996). Quality designations were assigned by MDNR, and do not include a broad definition of quality in terms of scenic beauty and accessibility.

3.4.1 Middle Branch River Miles

The Middle Branch River, which is about 33 miles in length, has approximately 16 miles downstream of Marion (O'Neal, 2002). Removing the Marion Dam is expected to lower water temperatures downstream to levels conducive for cold water fisheries. The river is therefore expected to gain in fish species such as trout[8] downstream. This impact is evaluated by increasing the number of miles of cold river water by 16 miles in the relevant quality categories in the model for the impacted county- Osceola. There are no changes anticipated in warm water fisheries downstream of the river. After the dam is removed and the MBR and MMP are restored, the quality of the river is expected to improve and hence adding to the miles of top quality tributary stream in the model.

3.4.2 Marion Mill Pond

Warm water fisheries are expected to improve in the impoundment- Marion Mill Pond. Part of the proposed restoration project is to retain the Mill Pond, and separate it from the river by a 2,100 feet earthen dike and restore the pond through dredging it to a depth of 25 feet. After restoring the pond warm water fisheries are expected to improve within the impoundment.

For inland lake product lines, total surface area of warm and cold water lakes in acres is used in the model. As "total lake surface area" does not reflect the quality of the lake, the model does not have a quality variable for lakes and impoundments. At present the pond has a surface area of about 26 acres, and after the earthen dike separating river from the pond is put in place, only 20 acres of the pond will be retained. Although the pond acreage drops by 6 acres, this by no means reflects the expected quality improvements of the pond to warm water fisheries in the pond. Hence, for this reason and that acreage does not reflect quality, the lake acreage variable was not altered in the analysis.

Therefore the MADM is only used to estimate the economic value of a 16 mile improvement in cold water stream quality, and estimate how visitor days to Osceola County; the Muskegon River Watershed (MRW) and the state of Michigan change if the 16 miles downstream become top quality like upstream of the river. This was done by increasing the number of miles of coldwater stream product line in Osceola County by 16 followed by running a computer program to evaluate the change.

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[8]Common trout species to the MBR are brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*).

3.5 Empirical Results and Discussion

It is important to note that the MADM only focuses on recreational fishing benefits for Michigan anglers. Welfare effects of individuals who reside outside Michigan are not accounted for by the MADM (Hoehn et al 1996). Welfare estimates are also not only to Osceola County anglers but to all Michigan anglers. The analysis of a change in 16 miles of the MBR from secondary quality to top quality for one open water season results in an estimated statewide increase in welfare of about $39,124 per year[9]. Interpreted differently, this is the willingness to pay of a certain stratum of the general public: potential anglers in Michigan to have 16 miles of the MBR change from secondary quality to top quality stream miles.

Using a discount a discount rate used by federal water resources agencies of 7%, Present Value (PV) of a constant stream of this benefit ($ 39,124) infinite years from now is worth $ 558,914 (Table 3.1). [10] Federal water resources agencies, such as the Bureau of Reclamation have used a discount rate in the mid 7% range during the 1990's that reflects the interest rate cost to the federal government of borrowing money (Loomis and Helfand 2001).

[9] Welfare estimates are in 2002 dollars. Model estimates in 1994 dollars were converted to 2002 dollars using annual average Consumer Price Index (CPI), with base year 1982-1984 =100. A conversion factor of 1.21 was used.

[10] Present Value (PV) refers to the present value of recreational fishing benefits from now into the future indefinitely.

Table 3.1 Discounted Infinite Stream of Benefits of a Change in 16 miles of the MBR from Secondary Quality to Top Quality

Federal Agency	Discount Rate	Present Value Of Benefits	Net Present Value
Federal water resources agencies- OMB	7%	$ 558,914	$ (3,728,586)
Department of Interior	4%	$ 978,100	$ (3,309,400)
National Oceanic and Atmospheric Administration (NOAA)	3%	$ 1,304,133	$ (2,983,367)
Congressional Budget Office	2%	$ 1,956,200	$ (2,331,300)

(Negative figures in brackets)

Project Cost = $ 4, 287, 500

With a discount rate of 3% such as that used by the National Oceanic and Atmospheric Administration (NOAA) the PV of an infinite stream of benefit is $1,304,133. According to the NOAA, 3% is the best estimate of the social time preference of consumers (Loomis and Helfand 2001). Table 3.1 shows the present values of the benefits associated with the improvement of 16 miles of the MBR estimated using discount rates used by different federal agencies. The Net Present Value (NPV) (difference between PV of benefits and project costs) of the benefits of recreational fishing is negative using various discount rates (Table 3.1). As recreational fishing is only one of the benefits associated with the project, it would be inaccurate to conclude that the project suggests inefficient use of resources. Other benefits, such as recreational boating, enhanced property values, and non-use benefits were not estimated, hence recreational fishing benefits are only a portion of the total economic benefits associated with the project. The estimated per trip value of the quality change is about $43.40.

Changes in fishing trips that occur as a result of a 16-mile improvement in quality of the MBR are presented in Table 3.2, Table 3.3 and Table 3.4. The tables show statewide, watershed and county predictions of both single day and multiple day trips for each product line. The last columns in the tables show the change in total recreational fishing user days by product line. The average length of a multiple day trip was estimated to be 3.85 days; therefore the change in total user days was calculated by multiplying the change in multiple day trips with 3.85 and adding them to the change in single day trips.

3.5.1 State of Michigan

Improvement in quality of 16 miles of the MBR in Osceola County will increase the number of fishing trips to river/ stream cold water fisheries by 417 (0.2% change) single day trips (Table 3.2). Although there is a statewide increase in single fishing day trips to cold water rivers/streams, this change is negated by subsequent decreases that occur in other product lines. Trips drawn from anadromous runs, river/stream warm product line and both cold and warm water inland lake product lines account for 0.04% of that decrease in total single day trips. Loss in trips to the great lakes is almost negligible. Hence, overall change in single day trips for all product lines when 16 miles of the MBR become top quality stream miles is a statewide drop in 4 single fishing day trips.

From Table 3.2 statewide multiple day trips go up by 3 for all product lines. Improved quality of 16 miles of the MBR results in a 255 increase in multiple day trips to river/stream cold water fisheries within the state. This increase will be off set by decreases in other product lines in the state. Overall change in total user days is a statewide increase of 8 trip days. Thus for both single and multiple day trip lengths, the model predicts a negligible statewide change in recreational fishing trips.

Table 3.2. Statewide Changes in Fishing Trips and User Days for a Change in 16 Miles of the Middle Branch River from Secondary Quality to Top Quality by Product Line

	Single Day Trips				**Multiple Day Trips**				**Change in Total**
Product Line	Before 16 mile Change	After 16 mile Change	Change	% Change	Before 16 mile Change	After 16 mile Change	Change	% Change	**User Days***
Great Lakes warm	2,082,173	2,082,134	(39)	(0.00)	180,248	180,213	(35)	(0.02)	(174)
Great Lakes cold	299,861	299,851	(10)	(0.00)	161,687	161,653	(34)	(0.02)	(141)
Inland lake warm	3,091,489	3,091,227	(262)	(0.01)	628,930	628,796	(134)	(0.02)	(778)
Inland lake cold	113,042	113,028	(14)	(0.01)	21,958	21,951	(7)	(0.03)	(41)
River Stream warm	971,609	971,537	(72)	(0.01)	124,625	124,600	(25)	(0.02)	(168)
River Stream cold	224,997	225,414	417	0.19	94,245	94,500	255	0.27	1,399
Anadromous runs	278,482	278,458	(24)	(0.01)	99,768	99,751	(17)	(0.02)	(89)
Totals	**7,061,653**	**7,061,649**	**(4)**	**0.14**	**1,311,461**	**1,311,464**	**3**	**0.14**	**8**

Negative figures in brackets

*User days are defined by multiplying multiple day trips by 3.85 and adding single day trips, 3.85 is the average length of a multiple day trip.

3.5.2 Muskegon River Watershed

The Muskegon River Watershed (MRW) stretches over about 13 Michigan counties including Osceola County (Fig 3.4). An improvement in 16 miles of the MBR results in an increase of 432 single day trips to river/stream cold product lines and a substantial substitution of inland lake warm water trips (184) within the watershed. Within these 13 counties, this is not surprising considering Roscommon County receives the most warm inland lake single day trips in the watershed. The net increase of 432 single day trips in cold river/stream product lines in the watershed is less than the increase of 474 at Osceola County shown in table 3.4. This is due to substitution effects were some of the trips made to Osceola County are a result of a loss in trips to other cold river/stream product line sites within the watershed.

Based on the MADM trip prediction results, most counties in the watershed receive less than 0.5% (less than 35,000 single day trips) of the total predicted single day trips in Michigan (Hoehn et al 1996). Unlike for single day trips, all counties in the watershed receive more than 0.5% of the total predicted state multiple day trips. Therefore, the watershed-wide increase in 313 multiple day trips, compared to the 185 increase in single day trips to all product lines can be explained by the fact that counties in the watershed are more likely to receive multiple day trips than single day trips.

Roscommon, Lake and Muskegon counties receive greater than 1.5% of the predicted multiple day trips. As expected, there is substitution of warm inland lake product lines (27) at counties close to Osceola like Roscommon that have a lot of inland warm fisheries. Change in total user days to the watershed is an increase of 1,390 recreational fishing user days when 16 miles of the MBR become top quality.

Table 3.3. Changes in Fishing Trips and User Days for a Change in 16 Miles of the Middle Branch River from Secondary Quality to Top Quality by Product Line to 13 Muskegon Watershed Counties

	Single Day Trips				**Multiple Day Trips**				**Change in Total User Days***
Product Line	Before 16 mile Change	After 16 mile Change	Change	% Change	Before 16 mile Change	After 16 mile Change	Change	% Change	
Great Lakes warm	48,064	48,061	(3)	(0.01)	5,664	5,663	(1)	(0.02)	(7)
Great Lakes cold	20,492	20,491	(1)	(0.00)	8,863	8,861	(2)	(0.02)	(9)
Inland lake warm	413,795	413,611	(184)	(0.04)	111,638	111,611	(27)	(0.02)	(288)
Inland lake cold	18,755	18,749	(6)	(0.03)	3,997	3,995	(2)	(0.05)	(14)
River Stream warm	84,279	84,240	(39)	(0.05)	13,962	13,960	(2)	(0.01)	(47)
River Stream cold	48,051	48,483	432	0.90	28,755	29,106	351	1.22	1,783
Anadromous runs	59,210	59,196	(14)	(0.02)	21,133	21,129	(4)	(0.02)	(29)
Totals	**692,646**	**692,831**	**185**	**0.74**	**194,012**	**194,325**	**313**	**1.07**	**1,390**

Negative figures in brackets

*User days are defined by multiplying multiple day trips by 3.85 and adding single day trips, 3.85 is the average length of a multiple day trip.

3.5.3 Osceola County

As shown in Table 3.4 there is a substantial increase in single day trips to cold water river/stream product lines in Osceola County as a result of the quality improvement associated with the proposed project. The model predicts that river/stream cold single day trips increase by 474 (28% change) at Osceola County. Substitution of inland lake warm, inland lake cold, and river/stream warm product lines in Osceola County for cold water river/stream fishing trips accounts for a decrease of about 0.7% in fishing trips to the product lines. Hence the overall change in single day recreational trips to Osceola County is a 27% (434) increase in single day trips. Since the increase in cold river/stream total single day trips to Osceola County (474) is greater than the increase for the state (417) and watershed (432), the difference comes not only from substitution at different product lines but also at other cold water river/streams within the river/stream cold water product lines in the state and the watershed.

It is important to note that substitution does not only occur at the product line level but also at the site level. Appendix 3 shows predicted changes in single day and multiple day trips in Muskegon River Watershed counties following a 16-mile quality improvement of the MBR. This clearly shows that the predicted increase in single day trips to Osceola County is offset by reductions in single day trips to other counties (sites) within the watershed.

From Table 3.4 total multiple day trips to Osceola County go up by 27% for all product lines. In particular, river/steam cold water multiple day trips to Osceola County are predicted to go up by 427 trip days. Although there is no change to cold water inland lake trips, trips to warm water inland lakes, and warm rivers/streams trips are substituted by cold river/stream fishing trips. There is also a substantial increase in the change in total user days to Osceola County of 2,051 for all the product lines. Osceola County does not have any Great Lake and Anadromous run fisheries.

Table 3.4. Changes in Fishing Trips and User Days for a Change in 16 Miles of the Middle Branch River from Secondary Quality to Top Quality by Product Line to Osceola County

	Single Day Trips				**Multiple Day Trips**				**Change in Total User Days***
Product Line	Before 16 mile Change	After 16 mile Change	Change	% Change	Before 16 mile Change	After 16 mile Change	Change	% Change	
Great Lakes warm	-	-	-	-	-	-	-	-	-
Great Lakes cold	-	-	-	-	-	-	-	-	-
Inland lake warm	12,655	12,626	(29)	(0.23)	5,192	5,186	(6)	(0.12)	(52)
Inland lake cold	795	793	(2)	(0.25)	278	278	-	-	(2)
River Stream warm	3,924	3,915	(9)	(0.23)	1,002	1,001	(1)	(0.10)	(13)
River Stream cold	1,724	2,198	474	27.49	1,583	2,010	427	26.97	2,118
Anadromous runs	-	-	-	-	-	-	-	-	-
Totals	**19,098**	**19,532**	**434**	**26.78**	**8,055**	**8,475**	**420**	**26.76**	**2,051**

Negative figures in brackets

*User days are defined by multiplying multiple day trips by 3.85 and adding single day trips, 3.85 is the average length of a multiple day trip.

Great Lake and Anadromous run product lines are not present in County.

3.6 Summary and Conclusions

The study found that a 16-mile quality improvement of the Middle Branch River from secondary quality to top quality when the Marion Dam is removed, results in an overall increase in total user days of 2,051; 1,390 and 8 to Osceola County, MRW and the state of Michigan respectively. Michigan anglers are predicted to make more fishing trips to Osceola County and the MRW with the quality improvement of the Middle Branch River. Statewide changes were negligible (8 user days). Statewide benefits of recreational fishing were estimated to increase by $39,124 per year. The results showed that with a 16-mile quality improvement of the MBR there is substantial substitution at the product line and site levels. The increase in trips has the potential of increasing economic activity in Osceola County and the MRW as anglers incur expenditures when they make fishing trips.

Although the PV of recreational fishing benefits associated with the dam removal and river/mill pond restoration project was less than the projected cost of dam removal and restoration project of $ 4,287,500, it would be premature to suggest that the project is economically unprofitable. This is because the benefit estimate is only for recreational fishing, other benefits such as enhanced property values, potential improvements in boating, swimming and non-use benefits (existence and bequest) were not taken into account. Benefits associated with improved warm water recreational fishing in the impoundment were also not estimated. Since, the amount of these benefits is unknown; it is not possible to make any conclusions regarding economic profitability of the project.

3.6.1 Research Limitations

This section discusses limitations associated with using the Michigan Angling Demand Model (MADM).

1. For inland lake product lines (including impoundments), the MADM only has one policy variable: total lake acreage per county. As this variable has little to do with quality of the lake or impoundment, it could not be used in the study to evaluate expected benefits from improvement of the Marion Mill Pond (MMP), although warm water fisheries are expected to improve after the pond is restored. Hence, benefits of recreational fishing in the pond were not estimated.
2. It is not certain that removing the Marion Dam and restoring the MBR will restore 16 miles of the MBR.
3. The MADM only estimates recreational fishing benefits to Michigan resident anglers therefore leaving out benefits to non-residents that might be fishing at Michigan recreational fishing sites.
4. The MADM is only a model, hence it may or may not fit the site well. It is important to note that the model is subject to all the factors that affect travel cost models.

CHAPTER 4

INPUT-OUTPUT ANALYSIS AND APPLICATION

4. INTRODUCTION

Economic impacts of the proposed dam removal and river restoration project will be estimated using input-output analysis. Economic impacts of the expenditures associated with increased recreational fishing trips observed in chapter 3 will also be estimated using input-output analysis. Input-output analysis is an accounting and modeling technique that represents economic interdependencies of the economy. It is a means of showing the relationships among industrial sectors and among industrial sectors with final consumers. Input-output models date back to the work of Professor Wassily Leontief in the late 1930's. Professor Leontief was mostly interested in showing the interdependencies among industries in the American Economy. An input –output model can be constructed from observed data for almost any economic area such as a nation, state, county and zip code area (Miller and Blair, 1985). The information contained in input-output models are the monetary flows of products from each industrial sector that is considered a producer to another industrial sector considered the consumer. The basic information from which an input-output model is constructed is contained in an inter-industry transaction table. Input-output rows describe the distribution of a producer's output throughout the economy, whilst the columns describe the composition of inputs needed by industries to produce output (Table 4.1). In output-input tables there is a column called *Final Demand,* which shows the sales by each sector to final demand sectors such as net exports, personal consumption and government purchases. There is also an additional row, for *Value Added*. In engaging in production, purchasing sectors use inputs to production such as labor. Elements of *Final Demand* column and the *Value Added* row each add up to give the Gross National Product (GNP) of an economy.

Table 4.1 Example of an Input-Output Transactions Table

	Agriculture	Mining	Construction	Manufacturing	Transportation	Services	**Final Demand**
Agriculture							
Mining							
Construction							
Manufacturing							
Transportation							
Services							
Value Added							

The next section (4.1) will explain the fundamental structure of input-output models. Thereafter, the need for regional input-output models and multipliers in input-output modeling is discussed. Sections 4.6 and 4.7 will analyze the economic impacts of increased recreational fishing expenditures and of the proposed restoration project on the local economy using an input-output modeling software-IMPLAN.

4.1 Input-Output Notation[11]

Suppose an economy consists of n sectors, the total output of sector i produced can be denoted by X_i, and total final demand for sector i can be represented by Y_i. The exchanges of goods between or among sectors are ultimately, sales and purchases of physical goods, and the observed monetary value of flow from sector i to sector j can be represented by z_{ij}. The z terms are inter-industry sales of sector i to sector j. This

[11] Notation similar to that used by Miller and Blair, 1985 is used for the rest of this chapter.

relationship between total output and inter-industry sales can be represented in the form of an equation as follows:

$$X_i = z_{i1} + z_{i2} + z_{i3} \ldots\ldots\ldots z_{ii} + \ldots\ldots\ldots z_{in} + Y_i \qquad (4\text{-}1)$$

X_i = total output for sector i

Zs = inter-industry sales or intermediate demand (inputs)

Y_i = final demand for sector i

Each of the n sectors can be represented by an equation similar to equation (4-1) as follows:

$$\begin{aligned}
X_1 &= z_{11} + z_{12} + \ldots\ldots\ldots z_{1i} + \ldots\ldots\ldots z_{1n} + Y_1 \\
X_2 &= z_{21} + z_{22} + \ldots\ldots\ldots z_{2i} + \ldots\ldots\ldots z_{2i} + Y_2 \\
&\vdots \\
X_i &= z_{i1} + z_{i2} + \ldots\ldots\ldots z_{ii} + \ldots\ldots\ldots z_{in} + Y_i \qquad (4\text{-}2) \\
&\vdots \\
X_n &= z_{n1} + z_{n2} + \ldots\ldots\ldots z_{ni} + \ldots\ldots\ldots z_{nn} + Y_n
\end{aligned}$$

The ratio of the input to output, z_{ij}/X_j can be represented by a_{ij}. This ratio shows the dollar value of purchases from sector i that must be made by sector j in order to produce a dollar's worth of output. This ratio a_{ij} is called a technical coefficient or direct input coefficient and is fixed in the sense that it represents a fixed relationship between a sector's output and input. Thus Input-output modeling works under constant returns to scale. Substituting the z's by $a_{ij}X_j$ the total output of n sectors, can be written as:

$$
\begin{aligned}
X_1 &= a_{11}X_1 + a_{12}X_2 + \dots\dots\dots a_{1i}X_i + \dots\dots\dots a_{1n}X_n + Y_1 \\
X_2 &= a_{21}X_2 + a_{22}X_2 + \dots\dots\dots a_{2i}X_i + \dots\dots\dots a_{2n}X_n + Y_2 \\
&\vdots \\
X_i &= a_{i1}X_1 + a_{i2}X_2 + \dots\dots\dots a_{ii}X_i + \dots\dots\dots a_{in}X_n + Y_i \\
&\vdots \\
X_n &= a_{n1}X_1 + a_{n2}X_2 + \dots\dots\dots a_{ni}X_i + \dots\dots\dots a_{nn}X_n + Y_n
\end{aligned}
\qquad (4\text{-}3)
$$

When demand from the *Final Demand* sectors (*Y*'s) together with the technical coefficients are known, the necessary output needed to meet the final demand for sectors *i* to *n* can be calculated using matrix algebra. In general matrix form the above system of equations (4-3) can be written in the form *A*, *X* and *Y* defined as:

$$
A = \begin{bmatrix} a_{11}a_{12}\dots\dots\dots a_{1i}\dots\dots\dots a_{1n} \\ a_{21}a_{22}\dots\dots\dots a_{2i}\dots\dots\dots a_{2n} \\ \vdots \\ a_{n1}a_{n2}\dots\dots\dots a_{ni}\dots\dots\dots a_{nn} \end{bmatrix}, \; X = \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix}, \; Y = \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix}
$$

Therefore the systems of equations (4-3) can be written as:

$$X = AX + Y \qquad (4\text{-}4)$$

Collecting like terms: $X - AX = Y$ solving for X gives:

$$X = (I - A)^{-1}Y \qquad (4\text{-}5)$$

I is the identity matrix. If the final demand (exogenous) sectors are known and given the technical coefficients (*a's*) the required output from the *n* sectors can be calculated using the above equation (4-5).

4.2 Closed and Open Models With Respect to Households

Input-output models can be open or closed with respect to households depending on whether the household consumption expenditure part of the final demand sector is treated as an exogenous sector or not. The model that has been discussed so far is an open model, in the sense that the final demand sector is treated as an exogenous sector, i.e. not part of the intermediate demand sectors. Consumption expenditures by households, a component of final demand depends on the labor inputs required by the production sectors. This is because an increase in labor inputs leads to an increase in output produced, which in turn entails more purchases, made by households (Miller and Blair, 1985). As there is a direct relationship between output and household expenditures, the household sector part of the exogenous final demand column can be moved inside the model to be part of the intermediate endogenous sectors- hence closing the model with respect to households. Adding the rows and columns for the new household sector *(n+1)* the system of equations can be denoted by:

$$
\begin{aligned}
X_1 &= z_{11} + z_{12} + \ldots\ldots\ldots z_{1i} + \ldots\ldots\ldots z_{1n} + z_{1,n+1} + Y_1^* \\
X_2 &= z_{21} + z_{22} + \ldots\ldots\ldots z_{2i} + \ldots\ldots\ldots z_{2n} + z_{2,n+1} + Y_2^* \\
&\vdots \\
X_i &= z_{i1} + z_{i2} + \ldots\ldots\ldots z_{ii} + \ldots\ldots\ldots z_{in} + z_{i,n+1} + Y_i^* \qquad (4\text{-}6) \\
&\vdots \\
X_n &= z_{n1} + z_{n2} + \ldots\ldots\ldots z_{ni} + \ldots\ldots\ldots z_{nn} + z_{n,n+1} + Y_n^* \\
X_{n+1} &= z_{n+1,1} + z_{n+1,2} + \ldots\ldots\ldots z_{n+1,i} + \ldots\ldots\ldots + z_{n+1,n} + z_{n+1,n+1} + Y_{n+1}
\end{aligned}
$$

The *n+1* row shows how labor services (inputs) are used by various sectors. The final column shows the purchases of goods from *n* sectors, $(z_{i,n+1})$ made by households.

Alternatively, the $z_{n+1,n+1}$ column represents labor service purchases by households. The remaining final demand after moving household purchases is represented by Y_i^*. Household input coefficients are given by $a_{n+1,j} = z_{n+1,j} / X_j$, that is the value of sector *j's* purchases of labor inputs- $z_{n+1,j}$ are divided by total output for sector *j* to get the value of household labor services used per dollar worth of *j's* output (Miller and Blair 1985). Similarly, household consumption coefficients are given by $a_{i,n+1} = z_{i,n+1} / X_{n+1}$. It shows sector *i's* sales of inputs to the household sector.

4.3 Regional Input-Output Models

Although input-output modeling started off at the national level, over the years as interest shifted to regional economic impact analysis, adjustments to the national input-output models have been made to reflect regional characteristics. Adjustments are necessary as regions can be quite distinct in the mix of inputs they use to produce outputs. Another reason for modification of national input-output models is that on average, smaller regions are likely to be dependent more on outside purchases than a large region. The main goal of regional input-output analysis is to evaluate the economic impacts on producing sectors in a region that are caused by new final demand for products in the region (Miller and Blair 1985). Coming up with regional coefficients can involve conducting surveys of firms to come up with survey based regional input-output tables. Information can also be collected from secondary sources. Therefore regional technical coefficients will be derived as:

Letting *L* be the superscript for a region in question, *M* the superscript for the rest of the nation. Then z_{ij}^{LL} refers to the dollar flow of goods from sector *i* in region *L* to sector j in region L. If information on all the z_{ij}^{LL} is available for all the sectors in the regional economy together with data on gross output of each sector in the region, then a set of input coefficients can be found:

$$a_{ij}^{LL} = \frac{z_{ij}^{LL}}{X_j^L} \qquad (4\text{-}7)$$

Likewise if one has complete information on z_{ij}^{ML}, then z_{ij}^{ML} / X_j^L gives the trade coefficients that show the dollar's worth of input i produced by firms in region M that is used per dollar's worth of output of sector j in region L.

$$a_{ij}^{ML} = \frac{z_{ij}^{ML}}{X_j^L} \qquad (4\text{-}8)$$

The overall monetary flows of inputs from a particular sector to sector j in region *(L)* can be found by summing the monetary flows from within the region with those from outside the region i.e., $z_{ij}^{*L} = z_{ij}^{LL} + z_{ij}^{ML}$, hence the regional technical coefficients can be defined as:

$$a_{ij}^{*L} = \frac{z_{ij}^{*L}}{X_j^L} \qquad (4\text{-}9)$$

In this study, economic impacts will be determined at three levels, Osceola County Muskegon River Watershed, and the state of Michigan. Hence, regional coefficients are employed in the input-output modeling used in the analysis.

4.4 Multipliers in Input-Output Models

To determine the total impact of a change in exogenous final demand the notion of multipliers is used. Multipliers express the total change in output in all sectors resulting from a dollar change in final demand in one sector. With an inverse Leontief model $(I\text{-}A)^{-1}$that is closed with respect to households; total effects or impacts can be given as direct, indirect and induced effects. Whereas with an open inverse Leontief model with respect to households, total effects are only given as direct and indirect effects.

Direct effects are only those changes to the industrial sectors to which a change in final demand occurred. Indirect effects are inter-industry purchase changes in response to the new demands of the directly affected industries, (IMPLAN 1999). Finally, induced effects are changes in household spending as incomes change due to changes in production, (IMPLAN 1999).

4.4.1 Output Multipliers

The output multiplier for sector *j* is the total value of production of all sectors required to meet a dollar worth of change in final demand for sector *j's* output. Assuming a two sector economy, if we represent the change in final demand, an additional dollars worth for sector *j's* output by $(\Delta Y) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$, denoting the $(I - A)^{-1}$ by $\begin{bmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{bmatrix}$, and finding the total effect on the two sector economy is given by $(I - A)^{-1} \Delta Y$ yielding $\begin{bmatrix} \alpha_{11} \\ \alpha_{21} \end{bmatrix}$. Sector *j's* output multiplier *(M_j)* is the sum of the elements in the $(I - A)^{-1} \Delta Y$ column vector divided by a \$1. The dollar in the denominator represents the initial change in sector *j's* output. Therefore the output multiplier for sector *j* is given by: $M_j = \sum_{i=1}^{n} \alpha_{ij}$. Output multipliers for a closed model with respect to households are given by: $\bar{M}_j = \sum_{i=1}^{n+1} \bar{\alpha}_{ij}$, where *n+1* represents the additional endogenous household sector. The bars show that the matrix elements change slightly due to the addition of a new endogenous sector.

4.4.2 Income Multipliers

Income multipliers reflect a change in income received by households resulting from a dollars worth of change in final demand spending. Income multipliers are found by multiplying elements of the Leontief inverse $(I\text{-}A)^{-1}$ by the household input coefficients, $a_{n+1,i}$. For an open model with respect to household, sector *j's* household income multipliers will be given by:

$$H_j = \sum_{i=1}^{n} a_{n+1,i}\alpha_{ij} \qquad (4\text{-}10)$$

For an open model the income multiplier reflects the direct an indirect effects of changes in final demand on households' income. With closed models with respect to households, household multipliers are obtained by converting elements of the matrix $(I - \bar{A})^{-1}$ by the household input coefficients. Using the former Leontief inverse matrix gives the direct, indirect and induced effects household income effects resulting from changes in final demand spending. Therefore household income effects are given by:

$$\bar{H}_j = \sum_{i=1}^{n+1} a_{n+1,i}\,\bar{\alpha}_{ij} \qquad (4\text{-}11)$$

4.4.3 Employment Multipliers

Employment multipliers show the household employment (physical labor) effect of a dollar's worth of change in final demand spending. Suppose e_i is the number of employees in sector *i* and that X_i is the total output of sector *i*, the labor input coefficients can be found by $w_{n+1,i}= e_i/X_i$. Similar to coming up with income multipliers employment multipliers are derived by multiplying elements of the Leontief inverse matrix with the labor input coefficients. Whether effects are direct and indirect or direct, indirect and induce will depend on if the Leontief inverse is closed or open with respect to households.

4.4.4 Sources of Input Output Modeling

In the U.S. a major source of input-output modeling is the U.S. Department of Commerce's Bureau of Economic Analysis (BEA). The BEA produces input-output models of the US economy every five years, broken down by states and regions within states (Jones, 1997). Using Regional Economic Information System (REIS) and other sources the department estimates income and employment multipliers for counties throughout the U.S. Many states have also developed their own primary data input-output models. A commercial group, IMPLAN (IMpact Analysis for PLANing) in Minnesota is also another source of input-output modeling. IMPLAN's data and accounts closely follow accounting conventions used by the Bureau of Economic Analysis and the rectangular tabulation recommended by the United Nations (IMPLAN Pro, User's Guide 1999). IMPLAN develops regional models through a series of adjustment to the national input-output model using local economic information, (Jones 1997). Information is available by state, counties and zip codes within counties, such that input-output models can be constructed for any region.

4.5 IMPLAN

In order to estimate the economic impacts associated with the increase in recreational fishing trip expenditures and the economic impacts of the dam removal and restoration project on the local economies of three regions Osceola County, Muskegon Watershed, and the state of Michigan, IMPLAN software is used. IMPLAN is a computer program that uses input-output modeling to analyze impacts of a given change in an activity level. Any economic impact starts with an event or a direct purchase or initial change. A closed input-output regional model with respect to households is used to perform impact analysis. Total economic impacts are therefore separated into direct, indirect and induced effects.

Sectors developed for the IMPLAN model are based on the Standard Industrial Classification (SIC) code system and the Bureau of Economic Analysis' Input-Output (I-O) sectoring system. IMPLAN has data files for 528 sectors, with information for more than 3000 U.S. counties. IMPLAN data files are available at the national, state, county and zip code levels. Each year the Minnesota IMPLAN Group (MIG) collects secondary data at the national level and converts it to IMPLAN data formats to derive new national I-O matrices, margins, deflators and Regional Purchase Coefficients (RPC). Deflators account for relative price changes during different time periods. IMPLAN like other I-O models has all expenditures in producer prices, such that when purchase price data is used margins are necessary to convert purchase prices to producer prices and vise versa.

RPC represent the proportion of the total demand for a commodity that is supplied by the region itself. As IMPLAN is based on a national non-survey I-O model RPC are also important to capture the regional differences.

For the proposed dam removal and restoration project impact analysis is carried out at the state of Michigan, MRW, and Osceola County regional levels, whilst for impacts associated with the increase in recreational fishing expenditures, analysis is carried out at two regional levels: Osceola County and the MRW. The Muskegon Watershed stretches over a total of seventy-eight zip codes areas spread over thirteen counties namely, Muskegon, Newaygo, Montcalm, Mecosta, Clare, Osceola, Wexford, Missaukee, Lake, Kalkaska, Kent, Crawford, and Roscommon. Zip codes data files for the seventy-eight areas were aggregated to develop a watershed data file.

4.6 Impact Analysis of Increased Recreational Fishing Trip Expenditures in Osceola County and the Muskegon River Watershed

The following section explains how impact analysis is carried out at two regional levels to determine the impacts associated with increased recreational fishing trip expenditures. It was established in chapter three that an improvement in 16 miles of the MBR has a substantial increase in recreational fishing trips (user days) to Osceola County and the Muskegon River Watershed with the exception of the state of Michigan. That is, the quality improvement is likely to have more impact in the area where the improvement takes place i.e. Osceola County, and in surrounding counties in the MRW, than at the state level. Hence impact analysis is only carried out at two regional levels.

Estimation of economic impacts associated with increased recreational spending, requires information on how much anglers spend per fishing trip to Osceola County and MRW. In this study expenditure information was obtained from the U.S. Department of Interior's 1996 National Survey of Fishing, Hunting and Wildlife Associated Recreation (NSFHWAR)[12]. The U.S. Department of Interior collects angler trip and expenditure data every five years. Table 4.2 shows angler expenditures per trip to freshwater fisheries by Michigan residents. Freshwater angler expenditure data was used because it excludes expenditures made to Great Lake fisheries. Expenditures per trip were found by dividing the amounts spent on different trip items e.g. food by the number of freshwater trips made by state residents. Per trip expenditures were multiplied by the increase in recreational fishing trips to find the total expenditures associated with the increase in fishing trips (Table 4.2). An assumption made in the analysis is that all cost items: food, lodging, transport and other trip costs were made in the impact areas, Osceola County and the MRW[13].

[12] Expenditure information came from Table 23 of the U.S. Department of Interior's 1996 National Survey of Fishing, Hunting and Wildlife Associated Recreation (NSFHWAR).
[13] As expenditures on fishing equipment are more likely to be incurred at the point of departure, equipment costs are not included in the analysis.

Table 4.2 User Days, Freshwater Per Trip Expenditures and Total User Day Expenditures

	Increase in User Days	Amount per Trip (1996 $)	Total Recreational Expenditures
Osceola County			
Food	2,051	$4.25	$ 8,717
Lodging	2,051	$4.25	$ 8,717
Transport	2,051	$5.04	$10,329
Other trip Costs	2,051	$7.44	$15,265
Total		$20.98	$ 43,028
Muskegon River Watershed			
Food	1,390	$4.25	$ 5,908
Lodging	1,390	$4.25	$ 5,908
Transport	1,390	$5.04	$ 7,000
Other trip Costs	1,390	$7.44	$ 10,345
Total		$20.98	$ 29,161

The three cost items, food, lodging; transport and "other trip costs" were then matched with appropriate IMPLAN sectors as shown in Table 4.3. The item "other trip costs", which is likely to include costs of bait and ice, was matched with IMPLAN sector 449, *General Merchandise Stores*. Since the survey data reports food and lodging as one item, for purposes of impact analysis it was assumed that 50% of this cost component falls under the *Eating and Drinking* sector, whilst the other 50% falls into the *Hotels and Lodging* sector (Table 4.3). Using the expenditures in Table 4.2 as new demand in the four sectors, IMPLAN was used to estimate the direct, indirect and induced effects associated with the increase in recreational fishing trip expenditures.

Table 4.3 Fishing Cost Items by IMPLAN Industry Sector

IMLAN Sector		Items
No	**Name**	
454	Eating and Drinking	Food
210	Petroleum Refining	Transport
463	Hotels and Lodging Places	Lodging
449	General Merchandise Stores	Other trip Costs

4.6.1 Empirical Results and Discussion

In analyzing the impact of increased recreational trip expenditures in Osceola County and the MRW, IMPLAN measures the impacts on the basis of changes in employment, income (value added), and total industry output. Employment includes both total wage and salary employees plus self employed jobs in a region[14]. It also encompasses both full time and part time workers and is measured in annual average jobs. Value added consists of employee compensation, proprietor income, other property income and indirect business taxes. Value added shows the payments made by each industry to workers, taxes, interests, profits and other income.

4.6.1.1 Osceola County

Impact analysis was carried out to examine the direct, indirect, induced and total economic impacts associated with the change in recreational spending in Osceola County. From Table 4.4, an increase of $43,028 in recreational spending is estimated to increase total industry output by $50,574 in Osceola County. Total income through direct effects and multiplier effects is estimated to increase by $5,284. Multiplier effects include "indirect" effects and "induced" effects. Employment effects associated with the increase

[14] Impact definitions are derived from IMPLAN Professional Version 2.0 User's Guide.

in spending and user days are negligible because the expenditures associated with the increase in user days are not large enough to have sizeable employment effects. Economic impacts for Osceola County are shown in Table 4.4.

Table 4.4 Economic Impacts of Increased Recreational Fishing Trip Expenditures to Osceola County

Regional Level	**Direct Effects**	**Indirect Effects**	**Induced Effects**	**Total Economic Effects**
Osceola County				
Employment	0.3	0	0	0.3
Value Added:	$4,114	$655	$514	$5,284
Output	$48,390	$1,309	$875	$50,574

In terms of total industry output, the top five most impacted industries in Osceola County are shown in Table 4.5. In Osceola County, *Domestic Trade* between the county and the rest of the U.S. makes up 74% of the increase in total industry output due to increased recreational spending (Table 4.5). The *Eating and Drinking* sector contributes 12.8%, whilst *Foreign Trade* contributes 4% of the total industry output due to increased spending. Considering that total output in *Eating and Drinking* was worth $11,654,000 in 1997 (IMPLAN data files, 1997), the proportion of the increase in output to overall sector output is very minimal.

Table 4.5 Five Most Impacted Industry Sectors due to Increased Visitor Spending In Osceola County by Output

IMPLAN Sector		**Total Industry Output**	**Proportion of Increase in Total Industry Output**
No	**Name**		
28001	Domestic Trade	$37,630	74.4%
454	Eating and Drinking	$6,477	12.8%
25001	Foreign Trade	$1,909	3.8%
449	General Merchandise Stores	$1,381	2.7%
463	Hotels and Lodging Places	$1,114	2.2%

Table 4.6 shows the top five industries with the highest proportion of value added. The *Eating and Drinking* sector has the highest proportion of value added, about 50% of the total value added associated with the impact. This attests to the labor-intensive nature of the sector, hence more payments are made to workers in wages and salaries.

Table 4.6 Five Most Impacted Industry Sectors due to Increased Visitor Spending In Osceola County by Value Added

IMPLAN Sector		**Value Added**	**Proportion of Increase in Total Industry Value Added**
No	**Name**		
454	Eating and Drinking	$2,640	50.0%
449	General Merchandise	$1,019	19.3%
463	Hotels and Lodging Places	$506	9.6%
462	Real Estate	$115	2.2%
456	Banking	$103	1.9%

4.6.1.2 Muskegon River Watershed

Recreational fishing trip expenditures in the Muskegon River Watershed are estimated to increase by $29,161 when 16 miles of the MBR improve from secondary quality to top quality. Economic impacts associated with this change in spending are shown in Table 4.7. Total industry output of the sectors that are impacted by the increase in expenditures due to increased user days is $40,020. It is less than value of output to Osceola County by more than $10,000. This can be explained by the fact that Osceola County receives more recreational fishing trips with the quality improvement. Total income to the watershed is estimated to go up by $ 18,654. Again, employment effects are quite negligible.

Table 4.7 Economic Impacts of Increased Recreational Fishing Trips to Muskegon River Watershed

Regional Level	**Direct Effects**	**Indirect Effects**	**Induced Effects**	**Total Economic Effects**
Muskegon River Watershed				
Employment	0.5	0	0.1	0.6
Value Added:	$13,637	$2,172	$2,845	$18,654
Output	$31,723	$3,783	$4,514	$40,020

The five most impacted industries in the watershed as a result of increased visitor spending are shown in Table 4.8. Increased spending due to an increase in recreational fishing trips to the watershed results in the *General Merchandise Stores* sector producing the most output of $10,145. *Domestic Trade* was the second most impacted industry, showing the importance of trade to the watershed's economy when there is increased recreational spending.

Table 4.8. Five Most Impacted Industry Sectors due to Increased Visitor Spending In the Muskegon River Watershed by Total Industry Output

IMPLAN Sector		Total Industry Output	Proportion of Increase in Total Industry Output
No	**Name**		
449	General Merchandise Stores	$11,333	28.3%
28001	Domestic Trade	$8,803	22.0%
454	Eating and Drinking Places	$6,421	16.0%
463	Hotels and Lodging Places	$4,761	11.9%
25001	Foreign Trade	$1,105	2.8%

From Table 4.9 the *General Merchandise Stores* sector has the highest value added ($8,360) associated with the increase in spending. The *Eating and Drinking* sector makes up about 7.5% of the total value added from all industries.

Table 4.9. Five Most Impacted Industry Sectors due to Increased Visitor Spending In the Muskegon River Watershed by Value Added

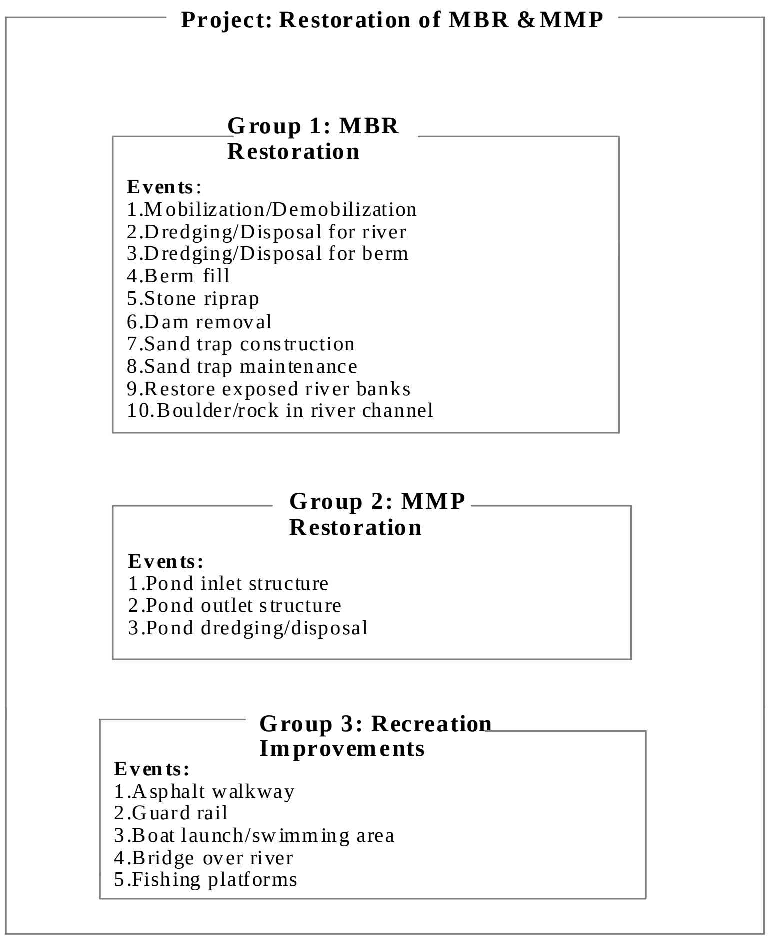
IMPLAN Sector		Value Added	Proportion of Increase in Total Industry Value Added
No	**Name**		
449	General Merchandise Stores	$8,360	44.8%
454	Eating and Drinking Places	$3,001	16.1%
463	Hotels and Lodging Places	$2,654	14.2%
461	Owner-occupied Dwellings	$478	2.6%
462	Real Estate	$366	2.0%

4.7 Impact Analysis of the Proposed Dam Removal, Restoration of Marion Mill Pond and Middle Branch River

The input to an IMPLAN I-O model is a project. An organizational view of the events associated with the dam removal and restoration project is shown in Fig 4.2. The project consists of three stages or sub-projects, namely the restoration of the Middle Branch River (MBR), which includes removal of the dam, restoration of the Marion Mill

Pond (MMP), and lastly recreational improvements. Within each sub-project there are several events as shown in Fig 4.2.

Events in each group were broken down by the cost of materials and labor required (see Appendix 2 for project cost estimation). The different types of materials required by each event were matched with appropriate IMPLAN industry sectors, shown in Table 4.10. For example, as dredging requires rental or purchase of equipment from a contractor it is put in IMPLAN's *Equipment Rental And Leasing* sector, 473.



MBR- Middle Branch River MMP- Marion Mill Pond

Fig 4.2 Project Components

Table 4.10 Material Source Breakdown by Industry Sector

IMPLAN Sector		**Items**	**Material Source**	**Amount**
Number	**Name**			
50	New Utility Structures	Mobilization/Demobilization	100% general overhead	$6,250
		Contingencies	10% of construction	$343,000
				$349,250
473	Equipment Rental	Dredging/Disposal for river	100% equip purchase, rental	$75,000
	And Leasing	Dredging/Disposal for river	100% equip purchase, rental	$61,500
		Berm Fill	20% equip purchase, rental	$36,582
		Stone Riprap	20% equip purchase, rental	$71,000
		Dam Removal	100% contractor equip purchase, rental	$20,000
		Sand Trap construction	100% contractor equip purchase, rental	$2,000
		Sand trap maintenance	100% contractor equip purchase, rental	$3,000
		Restore exposed river bank/bottom	20% equip rental	$1,200
		Boulder/Rock in river channel	20% equip purchase, rental	$4,800
		Pond inlet structure	15% equip rental	$2,250
		Pond outlet structure	15% equip rental	$1,688
		Pond Dredging-Disposal	100% contractor equip purchase, rental	$496,000
		Asphalt Walkway	20% equip rental, purchase	$2,880
		Guard Rail	20% equip rental, purchase	$16,800
		Boat Launch/swimming area	20% contractor equip purchase, rental	$2,010
		Bridge over river	20% contractor equip purchase, rental	$4,020
		Fishing platforms	20% contractor equip purchase, rental	$4,020
				$804,750
41	Sand & Gravel	Berm Fill	80% gravel, rock	$146,328
		Boulder/Rock in River Channel	80% gravel, rock	$19,200
				$165,528

Table 4.10 (cont'd)

IMPLAN Sector		Items	Material Source	Amount
Number	**Name**			
40	Dimension Stone	Stone Riprap	80% stone rip/rap& erosion control supplier	**$284,000**
243	Concrete Products, N.E.C	Pond inlet structure	75% concrete, sand & gravel supplier	$11,250
		Pond outlet structure	75% concrete, sand & gravel supplier	$8,438
				$19,688
254	Blast Furnaces	Pond inlet structure	10% steel supplier	$1,500
	& Steel Mills	Pond outlet structure	10% steel supplier	$1,125
				$2,625
211	Paving Mixtures & Blocks	Asphalt Walkway	80% asphalt, gravel & sand supplier	**$11,520**
244	Ready-Mixed Concrete	Restore exposed river bank/bottom	80% concrete, gravel, rock	$4,800
		Boat Launch/swimming area	80% concrete, gravel rock	$8,040
		Fishing platform	80% concrete, gravel rock	$16,080
				$28,920
258	Steel Pipe & Tubes	Guard Rail	80% guard rail supplier	**$67,200**
140	Structural Wood Members, N.E.C	Bridge over river	80% bridge supplier	**$16,080**
506	Engineering, Architectural Services	Engineering, Permits, Legal & Adm	15% of Construction	**$514,500**
5001	Employee Compensation	Project Labor Costs		**$2,023,440**
			Total Project Costs	**$4,287,500**

As shown in section 4.5 impact analysis of the proposed dam removal restoration project, is not only carried out at Osceola County and the MRW regional levels but also for the state of Michigan.

4.7.1 Regional Purchase Coefficients for Labor

IMPLAN modeling assigns default regional purchase coefficients to the different industry sectors. However, IMPLAN does not have RPC for the "Employee Compensation" sector, hence it was necessary to determine how much of the labor costs are incurred locally in Osceola County, Muskegon Watershed, and the state of Michigan. Labor costs for the project were matched with IMPLAN sector 5001 – *Employee Compensation*. According to Progressive Architectural Engineering (PAE), dredging operations will require specialized labor from outside Osceola County and the MRW. Using labor costs in Appendix 2, unspecialized labor costs incurred in the watershed were found to be 38.7% of the total labor costs. Unspecialized costs are all other costs besides dredging costs. As IMPLAN does not have default RPC for employee compensation, 38.7% was used as the RPC for the sector at the watershed level. According to PAE, approximately 25% of the unspecialized labor costs come from within Osceola County. Therefore, 25% is used as the proportion of unspecialized labor cost that comes from Osceola County.

4.7.2 Empirical Results and Discussion

Removing the Marion Dam, restoring the Middle Branch River and the Marion Mill Pond will require or will create a demand for labor, materials and services (see Appendix 2). Direct effects are the changes in the industrial sectors affected by the change in final demand. Backward linkages create indirect effects. Backward linked industries are the industries that provide inputs to the sectors in Table 4.10. Finally changes in regional households' spending due to direct and indirect effects constitute induced effects. The sum of the direct, indirect and induced effects gives the total economic impacts in the region.

4.7.2.1 Direct Employment Effect of the Project

To determine the direct employment effect of the project, IMPLAN (1997) study area information for the three impact study levels was used to calculate the number of jobs. Since the restoration project is a form of a construction project, annual wage in the construction sector (*New Utility Structures* –50) was calculated in order to determine the number of jobs that would be created by the project. With total employment and employee compensation in sector 50, annual wage rate for the three impact levels was calculated. Details of the calculation are shown in appendix 4. Using IMPLAN's study area information for the state of Michigan it was estimated that the project will employ 55 people for annual full-time and part time jobs, with 21 employees coming from within the MRW (38.7% of 55) and 5 people will be Osceola County residents (25% of 21). Hence, employees from outside the watershed would take the remaining 29 annual full time jobs.

4.7.2.2 Osceola County

IMPLAN was used to estimate the economic impacts in Osceola County from the proposed removal of the Marion Dam and restoration of the MBR and MMP. In addition to the 5 jobs created in Osceola County directly from the project, direct employment, income and total output impact of the project in Osceola County is shown in Table 4.11.

Table 4.11 Economic Impacts of Marion Dam Removal & Restoration of the Middle Branch River & Marion Mill Pond

Regional Level	**Direct Effects**	**Indirect Effects**	**Induced Effects**	**Total Economic Effects**
Osceola County				
Employment	11.0	1.0	1.3	13.3
Value Added	$253,384	$32,566	$40,714	$326,663
Output	$2,455,974	$57,874	$69,269	$2,583,118

The analysis assumed that 25% of unspecialized labor costs are incurred in Osceola County hence, in addition to the gain in 5 direct jobs from the project, direct part time and full time jobs in Osceola County go up by 11. The other 6 direct jobs are created through direct effects in sectors impacted by the project. Total output for all industry sectors impacted by the project goes up by $ $2,583,118 whilst local income increases by about $326,663.

From Table 4.12, in terms of industry output *Domestic Trade* would be the most impacted industry by the proposed dam removal river/mill pond restoration project (64%). This can be explained by the fact that Osceola County does not locally produce most of the materials required for the project, as six sectors: *Dimension Stone; Paving Mixtures; Concrete Products; Blast Furnace and Steel Mills; Equipment Rental and Purchase; and Steel Pipes and Tubes* are not found in the county. This shows the importance of domestic trade between Osceola County and the rest of the U.S. *The New Utility Structures* sector would be the second most impacted industry with 13.5% of the total output due to the restoration project. This is particularly significant when one considers that this gain of $349,033 in total output is about 11% of the total output in the New Utility Structures sector in 1997.

Table 4.12 Five Most Impacted Industry Sectors by the Dam Removal and Restoration Project in Osceola County by Output

IMPLAN Sector		**Industry Output**	**Proportion of Increase in Total Industry Output**
No	**Name**		
28001	Domestic Trade	$1,651,488	63.9%
50	New Utility Structures	$349,033	13.5%
506	Engineering-Architectural Services	$117,250	4.5%
11001	Federal Government Non Defense	$56,399	2.2%
25001	Foreign Trade	$21,272	0.8%
492	Hospitals	$15,781	0.6%

In terms of value added, the *New Utility Structures* sector has the greatest increase in value added of about 53% of the total value added due the proposed project (Table 4.13). The increase in value added to the sector is quite significant as this is about 11% of the total value added in the New Utility Structures sector in 1997. The *Engineering – Architectural Services* and *Hospitals* sectors each have a proportion of 16.5% and 3% of the increase in total industry output respectively. The *New utility Structures* sector also has experience the highest increase in employment of 4 annual year jobs.

Table 4.13. Five Most Impacted Industry Sectors by the Dam Removal and Restoration Project in Osceola County by Value Added

IMPLAN Sector		Value Added	Proportion of Increase in Total Industry Value Added
No	**Name**		
50	New Utility Structures	$172,519	52.8%
506	Engineering-Architectural Services	$53,891	16.5%
492	Hospitals	$8,734	2.7%
461	Owner occupied Dwellings	$8,161	2.5%
455	Miscellaneous Retail	$8,082	2.5%

4.7.2.3. Muskegon River Watershed

The Muskegon River Watershed spreads across 13 Michigan counties. Impact analysis for the watershed shows that in addition to the 21 annual full time and part time jobs (watershed employees) resulting from the project, there is a direct increase of 16 more full time and part time jobs. Hence, including employment multiplier effects, total employment gain goes up by 45 jobs at the watershed level. Total output in the Muskegon Watershed is expected to go up by approximately $3,480,872 whilst income would goes up by $1,107,807. Direct economic impacts lead to multiplier effects that include “indirect” and “induced” effects. Indirect effects occur because the direct inputs needed by an industry to produce its output and sales, require additional inputs (i.e. indirect) to produce. Impact analysis results for the watershed are shown in Table 4.14.

Table 4.14 Economic Impacts of Marion Dam Removal & Restoration of the Middle Branch River and Marion Mill Pond

Regional Level	Direct Effects	Indirect Effects	Induced Effects	Total Economic Effects
Muskegon River Watershed				
Employment	37.4	3.6	4.3	45.3
Value Added:	$758,386	$158,003	$191,419	$1,107,807
Output	$2,902,012	$275,197	$303,663	$3,480,872

Impact analysis for the MRW, estimated the largest increase in industry output to be in the *Domestic Trade* sector. From Table 4.15 *Domestic Trade* makes up about 30% of the increase in trade to the watershed associated with the restoration project. *Equipment Rental and Leasing*; and the *New Utility Structures* sectors make up approximately 18% and 9% of the increase in total industry output respectively. *The Equipment Rental and Leasing* sector also experiences the most gain in jobs of 6 whilst jobs in the *New Utility Structures* go up by 3.

Table 4.15. Five Most Impacted Industry Sectors by the Dam Removal and Restoration Project in the MRW by Output

IMPLAN Sector		Industry Output	Proportion of Increase In Total Industry Output
No	**Name**		
28001	Domestic Trade	$1,044,086	30.0%
473	Equipment Rental and Leasing	$610,202	17.5%
50	New Utility Structures	$323,725	9.3%
506	Engineering-Architectural Services	$232,537	6.7%
11001	Federal Government Non Defense	$221,273	6.4%

From Table 4.16 the *Equipment Rental and Leasing* sector has the highest increase in value added, 30% of the total increase industry value added. The *New Utility Structures, Engineering-Architectural Services, Owner Occupied Dwellings and Hospitals* are among the top five sectors to have the most increase in value added.

Table 4.16. Five Most Impacted Industry Sectors by the Dam Removal and Restoration Project in the MRW by Value Added

IMPLAN Sector		Value Added	Proportion of Increase in Total Industry Value Added
No	**Name**		
473	Equipment Rental and Leasing	$291,666	26.3%
50	New Utility Structures	$155,534	14.0%
506	Engineering-Architectural Services	$116,794	10.5%
461	Owner occupied Dwellings	$71,516	6.5%
492	Hospitals	$33,472	3.0%

4.7.2.4 State of Michigan

Specialized labor for the project will come from outside the watershed, such that labor costs for the state are comprised of both specialized and unspecialized labor costs. From Table 4.17 it can be seen that for the state of Michigan number of jobs will go up by 100 including the 55 direct jobs from the dam removal and restoration project. Total industry output is expected to increase by $6,294,041 million whilst income will go up by approximately $2,255,094.

Table 4.17 Economic Impacts of Marion Dam Removal & Restoration of the Middle Branch River and Marion Mill Pond

Regional Level	Direct Effects	Indirect Effects	Induced Effects	Total Economic Effects
State of Michigan				
Employment	81.3	9	10	100.3
Value Added:	$1,304,447	$467,990	$482,657	$2,255,094
Output	$4,245,957	$774,205	$776,534	$6,294,041

Table 4.18 shows that *Domestic Trade* similar to Osceola County and the MRW has the highest increase in total industry output. The high output in *Domestic Trade* can be explained by the fact that in five industries: *Dimension Stone; Sand and Gravel;*

Concrete Products; Ready-Mixed Concrete and Steel Pipes and Tubes, the state supplies itself with less than 10% of materials needed in the dam removal and restoration project.

Table 4.18. Five Most Impacted Industry Sectors by the Dam Removal and Restoration Project in Michigan State by Output

IMPLAN Sector		**Industry Output**	**Proportion of Increase in Total Industry Output**
No	**Name**		
28001	Domestic Trade	$1,327,497	21.1%
11001	Federal Government Non Defense	$583,393	9.3%
473	Equipment Rental and Leasing	$553,169	8.8%
506	Engineering-Architectural Services	$479,178	7.6%
50	New Utility Structures	$349,033	5.5%

In terms of value added, the *Equipment Rental and Leasing; and Engineering-Architectural Services* sectors both have about 12% of the total increase in value added to the state associated dam removal and restoration project (Table 4.19). Industry sectors that experience the most increase in employment are: *Engineering-Architectural Services* with 5 jobs; *Equipment Rental and Leasing* also with 5 jobs and the *New Utility Structures* with 4 jobs.

Table 4.19. Five Most Impacted Industry Sectors by the Dam Removal and Restoration Project in Michigan State by Value Added

IMPLAN Sector		**Value Added**	**Proportion of Increase in Total Industry Value Added**
No	**Name**		
473	Equipment Rental and Leasing	$273,093	12.1%
506	Engineering-Architectural Services	$260,006	11.5%
50	New Utility Structures	$172,172	7.6%
461	Owner occupied Dwellings	$165,622	7.3%
462	Real Estate	$99,031	4.4%

4.8 Summary and Conclusions

An improvement of 16 miles of the Middle Branch River was estimated to have a substantial increase in recreational fishing trips to Osceola County and the MRW of 2051 and 1390 user days respectively. Impact analysis of increased visitor spending showed that total industry output and income (value added) in the two regions increased (Tables 4.4 and Table 4.7). Although there is an increase in output and income, it is quite an insignificant proportion of the local areas' total industry output and value addition. Nonetheless, the economic impacts do stimulate economic activity in the region, Osceola County and the MRW. Impact analysis also showed which industries are impacted the most. For example, *Domestic Trade* and the *General Merchandise Stores* sectors had the highest increase in total industry output in Osceola County and the MRW respectively. This shows where strong inter-industry linkages exist and where there are opportunities for economic growth when recreational fishing trips and the subsequent spending associated with the trips increase.

Impact analysis of the dam removal and restoration of the MBR and MMP also showed increases in total industry output, income (value added) and employment in Osceola County, the MRW and the state of Michigan. The Project was estimated create about 55 annual part time and full time jobs, of which 21 were estimated to come from within the MRW, whilst 5 come from Osceola County and rest, 29 employees come from outside the watershed.

The *Domestic Trade* sector was found to have the highest proportion of output in the three regional economies. This showed the importance of trade in the three regions. This can be attributed to the absence of some sectors that would supply necessary inputs to the dam removal and restoration project. For example, 50% of the industries that would supply materials for the project are not present in Osceola County. In other instances, although certain sectors were present in the regions the proportion of local supply of materials needed in the project was less that 10%. For the state of Michigan five industries: *Dimension Stone; Sand and Gravel; Concrete Products; Ready-Mixed Concrete and Steel Pipes and Tubes,* supplied the state with less than 10 % of materials needed in the dam removal and restoration project. Impact analysis also showed which industries are impacted the most, hence showing where strong inter-industry linkages exist and where there are opportunities for economic growth if the dam removal and river restoration project becomes a reality.

While from a regional economic viewpoint it is useful to understand how a policy action affects local income and employment, it is also important for decision makers to keep in mind that these are just local effects. This is because gains of employment in Osceola County, the MRW and the state of Michigan are usually offset by reductions of employment elsewhere in regions outside the impact area, which possibly could lead to no overall net change in employment at the national level.

4.8.1 Research Limitations

This section explores potential shortcomings of the data sources and assumptions used in the study.

Impact Analysis of Increased Recreational Fishing Trip Expenditures:

1. Impact analysis of the increased spending due to increased user days to Osceola County and the MRW, used expenditure data from the U.S. Department of Interior's 1996 NSFHWAR. Using this data, average trip expenditure to freshwater fisheries was found to be $20.98. Lupi (1994), using unadjusted raw data estimated Michigan angler expenditures per trip to be approximately $41.14. This estimate is about 50% higher than the NSFHWAR estimate. Hence, this leaves some uncertainty as to which expenditure estimate is more reliable. The estimates from Lupi (1994) were not used in the study as they were based on several assumptions, a small sample and unadjusted raw data.
2. It is also possible that there might be an error in the predicted change in trips since the MADM is only a model which may or may not fit the site well.
3. A major assumption made in the analysis was that all trip costs were incurred in the study areas i.e. Osceola County and the MRW. Only the cost of lodging is likely to be incurred in the impact areas unlike food and transport costs. Visitors are likely to take food with them and fill up their cars with gas before embarking on a recreational fishing trip.
4. Since NSFHWAR does not breakdown the "*Food and Lodging*" into separate cost items, for simplification purposes this cost was broken down into two so that half the costs were matched with the IMPLAN "*Eating and Drinking*" sector whilst

the other half was put in the "*Hotels and Lodging*" sector. Therefore it is important to recognize that this might not represent the actual proportions of the two cost items.

Impact analysis of the proposed dam removal and restoration project:

1. Impact analysis of the dam removal and restoration project used cost estimations put together by PAE. It important to note that the projected costs might turn out to be higher than the actual cost of removing the Marion Dam, restoring the MMP and the MBR as contractors tend to hike the cost of mobilization so as to get some cash flow at the start of a project.

Input-output models are able to represent the interrelationships among sectors of the economy because of some basic simplifying assumptions.

Assumptions of Input-Output Models-IMPLAN:

1. Constant returns to scale

There is a fixed relationship between inputs used and output produced. That is, doubling inputs results in the doubling of output, as the production mix translates inputs into output by exactly the same proportion. Hence, industry production is a linear process. This assumption is likely to be plausible in the short run where certain factors of production such as capital are fixed Loomis and Helfand 2001. Constant returns to scale rules out any economies or diseconomies of scale when large amounts of output are produced to meet increases in final demand.

2. Single industry, one commodity

The traditional I-O models assume that each industry creates one commodity or a group of commodities, and that each firm in the industry produces only one output. More recent I-O models allow for multi-product industries.

Input-output models also assume a fixed and known process produces each product. That is, firms producing the same product use the same mix of inputs to produce output. When the industry is narrowly defined the higher the chances are that some firms will also produce other related goods, and use production technologies that are somewhat different from one another (Loomis and Helfand, 2001).

3. No supply constraints

Input-output models assume that firms or an industry do not face any supply constraints in expanding output to meet increased demand. Firms do not encounter any constraints in terms of land, labor and capital in expanding their output. Prices changes do not affect the proportion of inputs used, only changes in final demand is changes the level of inputs into production.

CHAPTER 5

SUMMARY OF RESEARCH FINDINGS AND POLICY IMPLICATIONS

5.1 ESTIMATION OF RECREATIONAL FISHING BENEFITS

The MADM was used to estimate recreational fishing benefits associated with the proposed removal of the Marion Dam and improvements in the MBR. The model was also used to predict changes in single and multiple day trips to Osceola County, the MRW and the state of Michigan. Analysis of a 16 mile change of the MBR from a secondary quality stream to a top quality stream results in an estimated statewide increase in welfare of about $39,124 per year. The value for each trip associated with the quality change in the MBR was estimated to be $43.40 per trip. Deepening of the MMP is expected to result in improvements in warm water fisheries, but the benefits were not estimated due to limitations associated with the MADM discussed in Chapter 3. For both single day and multiple day trips, changes in recreational fishing trips were found to be negligible at the state level, with a change in total user days of 8. Single day trips to the MRW were predicted to increase by 185 recreational fishing trips (0.7% change), whilst multiple day trips are estimated to increase by 313 (1% change). Overall change in user days to the watershed was an increase of 1,390 days. Substantial changes in fishing trips and user days were estimated for Osceola County. With four product lines (inland lake warm, inland lake cold, river/stream warm, and river/stream cold present in the county), single day trips to the county were predicted to increase by 434 (26.8% change), whilst multiple day trips increased by 420 (26.8% change). Overall change in recreational user days to the county increased by 2,051 days.

In terms of using these results for policy formulation it is important to note that a county's population is expected to influence the proportion of trips made to the county. Osceola County with a population of 23,365 people has less than 0.5% of the state of Michigan's population of 9,990,817. As shown in Fig 5.1, the majority of the state's population is located in the bottom half of the Lower Peninsula, with a substantial concentration around Detroit metropolitan area in Wayne County. The MADM predicts that counties with higher proportions of the state's population are more likely to receive single day trips. Cheboygan County located at the tip of the Lower Peninsula with a population of 26,960 receives the most multiple day trips in the state. Therefore, changes in single day trips, unlike multiple day trips are more likely to be associated with a county's proportion of the state's population, whereas changes in multiple day trips are more diffuse (Hoehn, et al 1996). In the case of Osceola County it can be concluded that changes that occur in single day trips are relatively in proportion with the county's population. Single day trip changes could have very well been more had the improvement occurred in a populous county like Wayne.

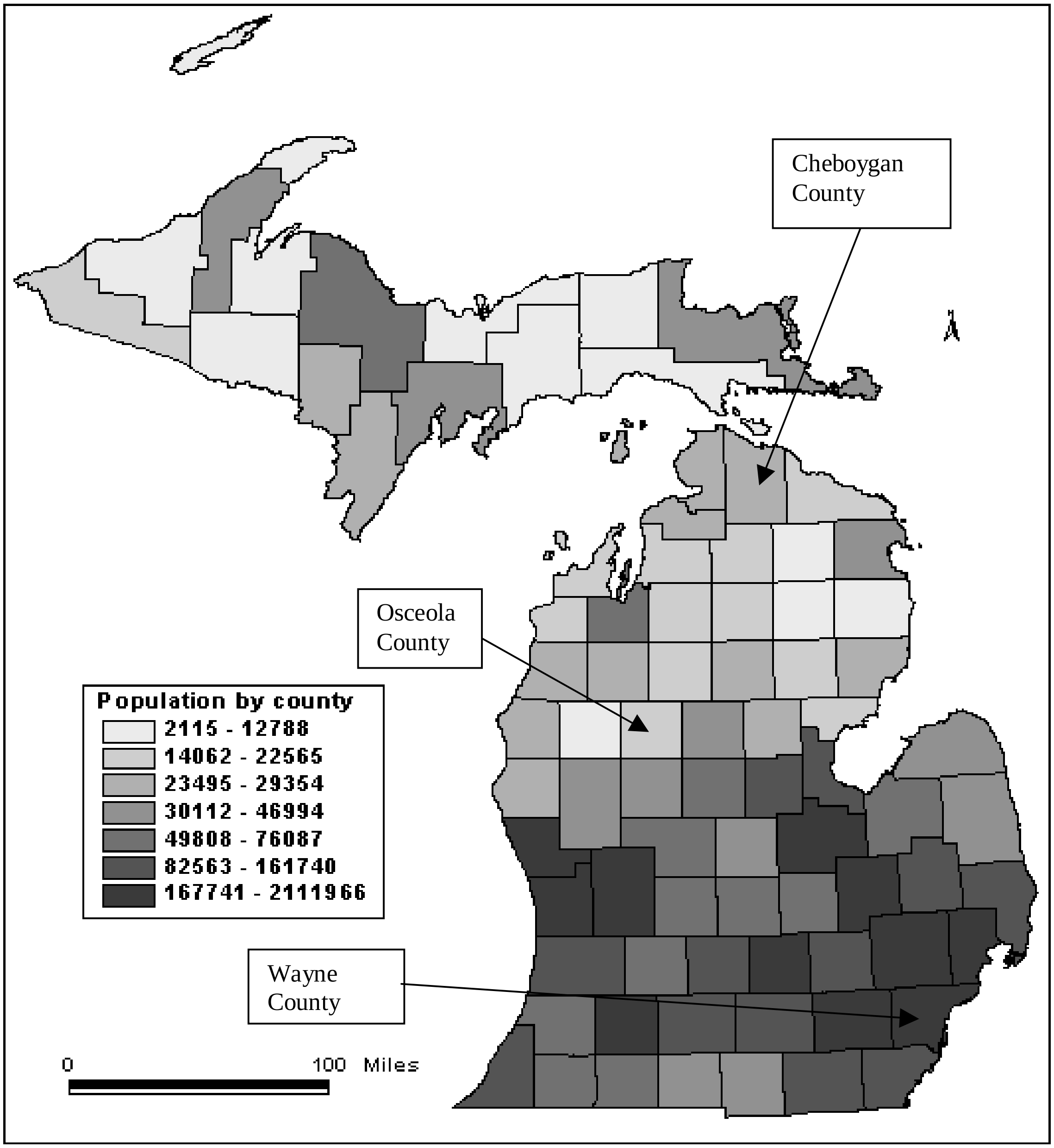


Figure 5.1 Proportion of state of Michigan's population by county

Similarly, because of the "travel cost" variable in the model, and that anglers are treated equally in the aggregation of benefits, changes in river quality in Osceola County generate benefits proportional to how far the county is from larger population areas. For example, an equivalent quality increase to sites near Detroit metro area would generate more benefits than those generated in Osceola County. Benefits are also related to the probability that a site gets visited. That is, benefits estimated for Osceola County are related to the probability that the site, Osceola County is visited. Hence, had a similar change (16-mile improvement) occurred in a site with higher probability of being visited, benefits could have been higher.

The benefits of recreational fishing estimated by the study can go into a benefit cost analysis as one component of the benefits stream. Given the projected cost of the dam removal of $4,287,500 the NPV of a constant stream of the estimated recreational fishing benefits was found to be negative using various discounts rates used by federal agencies. Table 3.1 in chapter 3 shows the NPV of recreational fishing benefits associated with the change in 16 miles of the MBR from secondary quality to top quality. A complete BCA would consider all the benefits and cost streams involved. The benefits estimate from the study mainly informs decision makers of the magnitude of recreational fishing benefits associated with quality improvements in the MBR. The magnitude of other potential benefits is unknown, hence it cannot be concluded that the project costs outweigh the cost of the project. Below is a table showing possible benefits and costs that would go into a complete BCA for the project.

Table 5.1 Benefit and Cost Stream for the Proposed Dam Removal, and Restoration of the MBR and the MMP

Benefit	Estimated	Cost	Estimated
Use Values			
Recreational fishing in the Middle Branch River	Yes	Dam removal, MBR and MMP restoration	Yes
Recreational fishing in Marion Mill Pond	No	Clean up costs after deconstruction	No
Enhanced lake front property values	No		
Improved recreational swimming	No		
Improved recreational boating, kayaking, canoeing	No		
Hiking	No		
Wildlife	No		
Non-use values			
Bequest value	No		
Existence value	No		

From table 5.1 it is apparent that recreational fishing in the MBR is only one of the many benefits estimated in the study. It is important to note that the estimated recreational fishing benefits are not only benefits to Osceola County residents but to all Michigan anglers. They are benefits to the state of Michigan’s angler population when the Marion Dam is removed and the MBR restored. The question of who will bear the cost of the removal and restoration of the project has important policy implications. If the state of Michigan pays for the project then a BCA can be carried out at the state level where not only benefits are to the state anglers but the cost of removal is also incurred by the state. Its not yet clear where funds for the project will come from but potential grant sources for the project are likely to be state government agencies and other non profit organizations.

5.2 ESTIMATION OF ECONOMIC IMPACTS

Information on economic impacts is useful as it informs decision makers if a particular policy alternative affects local economic activity. Economic impact analysis can provide information on whether the scale of a change in economic activity is relatively small or large compared to the scale of the local economy. Impact analysis also provides information on which sectors of the economy are impacted most following a policy change, in terms of employment, income and total industry output.

Impact analysis was carried out in the study as it is important to know the effects of a policy on a local economy's industry output, income and employment. Impact analysis was carried out at the state, county and watershed levels. Economic impacts are related to the expenditure portion of the project. IMPLAN was first used to estimate the economic impacts associated with increased recreational fishing trip expenditures resulting from the increase in user days to Osceola County and MRW. IMPLAN was also used to estimate economic impacts associated with the cost of the dam removal and river restoration project. It is important to note that the economic impacts associated with the dam removal and river restoration project are one time (one year) impacts, whereas economic impacts associated with recreational fishing trip expenditures are expected to occur every year after the dam has been removed and the river has been restored. Impact analysis for the increase in recreational fishing trip expenditures was carried out at the watershed and county level only since the change in user days at the state level was very minimal. The results showed that increased recreational fishing trip expenditures are expected to increase total industry output and income in Osceola County and the MRW. The analysis did not predict any increase in employment as a result of more recreational fishing expenditures in the two regions. Impact analysis showed *Domestic Trade*; *Eating and Drinking*; and *General Merchandise Stores* industrial sectors to experience the most increases in total output and total income due to an additional recreational fishing expenditures. IMPLAN analysis also estimated increases in total output and income in the state of Michigan, the MRW and Osceola County as result of expenditures associated with the dam removal and river restoration (see tables 4.11 – 4.19). The dam removal and river restoration project is also expected to increase employment in all three regional levels. Some of the most impacted industry sectors would be *Domestic Trade*; *New Utility Structures*; *Engineering-Architectural Services* and *Equipment Rental and Leasing*.

When determining whether a particular policy, or in this case the decision to remove the Marion Dam and restore the MBR affects local economy activity it is important to compare the magnitude of the change to the scale of the economy. For example, In Osceola County the *New Utility Structures* sector was estimated to be the most impacted industry sector in terms of output after the dam is removed. This could be considered quite significant when one considers that the gain in output of about $394,000 is about 11% of the total output in the sector for 1997. It is also important to note that gains and losses in local income and employment are usually just local effects. Gains in income in one area usually offset by reductions elsewhere, the same applies with employment when there is full employment. Therefore, reductions and increases in income and employment are nearly always transfers of economic activity at the national level, and should not be included in a national BCA

APPENDICES

Appendix 1: Diagram of Project Restoration

Figure 5. Marion Mill Pond and Middle Branch River Restoration Project Site Plan
Source: Progressive Architectural Engineering, 2001.

Appendix 2. Cost Estimations for the Middle Branch River and Marion Mill Pond Restoration Project and Recreation Elements

No	Events	Total Quantity	Unit	Unit Cost	Cost	Breakdown of costs Labor	Materials
(Group 1) Middle Branch River Restoration Elements							
1	Mobilization/Demobilization	1	LS	$25, 000	$ 25,000	$ 18,750	$ 6,250
2	Dredging/Disposal for River	25,000	CY	$ 6	$ 150,000	$ 75,000	$ 75,000
3	Dredging/Disposal for Berm	20,500	CY	$ 6	$ 123,000	$ 61,500	$ 61,500
4	Berm Fill	27,300	CY	$ 10	$ 273,000	$ 90,090	$ 182,910
5	Stone Riprap w/Fabric on Side Slopes	7,100	CY	$ 100	$ 710,000	$ 355,000	$ 355,000
6	Dam Removal	1	LS	$ 200,000	$ 200,000	$ 180,000	$ 20,000
7	Sand Trap Construction	2	LS	$ 10,000	$ 20,000	$ 18,000	$ 2,000
8	Sand Trap Maintenance	1	LS	$ 30,000	$ 30,000	$ 27,000	$ 3,000
9	Restore exposed River Bank/Bottom	1	LS	$ 30,000	$ 30,000	$ 24,000	$ 6,000
10	Boulder/Rock in River Channel	200	CY	$ 150	$ 30,000	$ 6,000	$ 24,000
	Construction Total				$ 1,591,000		$ 735,660
	Contingencies (10% of Construction)				$ 159,100		$ 159,100
	Engineering, Permits, Legal, & Administrative (15% of Construction)				$ 238,650		$ 238,650
	Total				**$ 1,988,750**	**$ 855,340**	**$ 1,133,410**
(Group 2) Marion Pond Restoration Elements							
1	Pond Inlet Structure	1	LS	$ 20,000	$ 20,000	$ 5,000	$ 15,000
2	Pond Outlet Structure	1	LS	$ 15,000	$ 15,000	$ 3,750	$ 11,250
3	Pond Dredging/ Disposal	400,000	CY	$ 4	$ 1,600,000	$ 1,104,000	$ 496,000
	Construction Total				$ 1,635,000		$ 522,250
	Contingencies (10% of Construction)				$ 163,500		$ 163,500

Appendix 2 (cont'd).

No	Events	Total Quantity	Unit	Unit Cost	Cost	Breakdown of costs Labor	Materials
	Engineering, Permits, Legal, & Administrative (15% of Construction)				$ 245,250		$ 245,250
	Total				**$ 2,043,750**	**$ 1,112,750**	**$ 931,000**
(Group 3) Recreation Elements							
1	Asphalt Walkway	2,400	SY	$ 10	$ 24,000	$ 9,600	$ 14,400
2	Guard Rail	4,200	LF	$ 25	$ 105,000	$ 21,000	$ 84,000
3	Boat Launch/Swimming Area	1	LS	$ 15,000	$ 15,000	$ 4,950	$ 10,050
4	Bridge Over River	1	EA	$ 30,000	$ 30,000	$ 9,900	$ 20,100
5	Fishing Platforms	3	EA	$ 10,000	$ 30,000	$ 9,900	$ 20,100
	Construction Total				$ 204,000		$ 148,650
	Contingencies (10% of Construction)				$ 20,400		$ 20,400
	Engineering, Permits, Legal, & Administrative (15% of Construction)				$ 30,600		$ 30,600
	Total				$ 255,000	**$ 55,350**	**$ 199,650**
					$ 4,287,500		
						$ 2,023,440	**$ 2,264,060**
	Project Total						**$ 4,287,500**

Source: Progressive Architectural Engineering, 2001

Appendix 3: Predicted Trips to the Muskegon River Watershed Counties before and after the 16 mile improvement of the Middle Branch River

Predicted demand for Single Day Trips by MRW counties and by product line for one open water season before quality improvement in 16 miles of the Middle Branch River

County Name	GLW	GLC	ILW	ILC	RSW	RSC	ANAD	TOTAL
CLARE	0	0	16874	942	4544	2072	0	24432
CRAWFORD	0	0	8400	553	2777	2454	0	14184
KALKASKA	0	0	10351	630	2688	1448	0	15118
KENT	0	0	160704	6462	34212	13496	26211	241085
LAKE	0	0	9416	543	2629	3468	4202	20258
MECOSTA	0	0	21263	967	5362	1624	0	29216
MISSAUKE	0	0	7706	0	2562	807	0	11075
MONTCALM	0	0	35654	1682	7582	9148	0	54067
MUSKEGON	48064	20492	22901	3076	9056	4734	12113	120437
NEWAYGO	0	0	37326	1879	4581	5167	16684	65637
OSCEOLA	0	0	12655	795	3924	1724	0	19098
ROSCOMMON	0	0	61242	763	2091	516	0	64612
WEXFORD	0	0	9303	463	2271	1393	0	13429
Totals	48064	20492	413795	18755	84279	48051	59210	692648

Predicted demand for Multiple Day Trips by MRW counties and by product line for one open water season before quality improvement

County	GLW	GLC	ILW	ILC	RSW	RSC	ANAD	TOTAL
CLARE	0	0	6674	321	1114	1891	0	10000
CRAWFORD	0	0	4735	261	1022	2976	0	8993
KALKASKA	0	0	4338	229	753	1402	0	6722
KENT	0	0	8665	325	1106	1743	2455	14294
LAKE	0	0	6150	302	1129	4668	8400	20650
MECOSTA	0	0	8146	336	1499	1517	0	11497
MISSAUKE	0	0	4348	0	1027	1068	0	6443
MONTCALM	0	0	7877	335	999	4804	0	14015
MUSKEGON	5664	8863	8803	508	1565	1603	3486	30491
NEWAYGO	0	0	7752	356	536	2645	6792	18081
OSCEOLA	0	0	5192	278	1002	1583	0	8055
ROSCOMMON	0	0	33769	516	1341	1088	0	36714
WEXFORD	0	0	5189	230	869	1767	0	8055
Totals	5664	8863	111638	3997	13962	28755	21133	194010

Appendix 3 (Cont'd)

Predicted demand for Single Day Trips by MRW counties and by product line for one open water season after quality Improvement in 16 miles of the Middle Branch River

County	GLW	GLC	ILW	ILC	RSW	RSC	ANAD	TOTAL
CLARE	0	0	16854	941	4538	2066	0	24400
CRAWFORD	0	0	8399	553	2776	2453	0	14182
KALKASKA	0	0	10348	630	2688	1447	0	15113
KENT	0	0	160696	6462	34210	13494	26210	241071
LAKE	0	0	9405	543	2626	3459	4197	20230
MECOSTA	0	0	21239	966	5356	1620	0	29180
MISSAUKE	0	0	7696	0	2559	804	0	11059
MONTCALM	0	0	35642	1682	7580	9142	0	54045
MUSKEGON	48061	20491	22899	3076	9056	4734	12112	120428
NEWAYGO	0	0	37307	1878	4578	5162	16677	65603
OSCEOLA	0	0	12626	793	3915	2198	0	19532
ROSCOMMON	0	0	61207	763	2090	515	0	64575
WEXFORD	0	0	9293	462	2268	1389	0	13414
Totals	48061	20491	413611	18749	84240	48483	59196	692832

Predicted demand for Multiple Day Trips by MRW counties and by product line for one open water season after quality improvement of 16 miles of the Middle Branch River

County Name	GLW	GLC	ILW	ILC	RSW	RSC	ANAD	TOTAL
CLARE	0	0	6673	321	1114	1885	0	9993
CRAWFORD	0	0	4734	261	1021	2968	0	8984
KALKASKA	0	0	4337	229	753	1397	0	6716
KENT	0	0	8664	325	1106	1738	2454	14286
LAKE	0	0	6149	302	1129	4656	8399	20634
MECOSTA	0	0	8145	336	1499	1512	0	11491
MISSAUKE	0	0	4347	0	1027	1064	0	6438
MONTCALM	0	0	7875	335	999	4789	0	13998
MUSKEGON	5663	8861	8801	507	1565	1603	3485	30485
NEWAYGO	0	0	7750	355	536	2637	6791	18069
OSCEOLA	0	0	5186	278	1001	2010	0	8475
ROSCOMMON	0	0	33762	516	1341	1085	0	36704
WEXFORD	0	0	5188	230	869	1762	0	8048
Totals	5663	8861	111611	3995	13960	29106	21129	194321

Appendix 4: Employment Calculation

Jobs Created Directly From the Project with employee compensation of $2,023,440

1. Using IMPLAN Study Area Information (Muskegon Watershed Zip file)
Sector 50: (2002 dollars)
Employment = 473
Employee Compensation= $16,183,919.63
Annual wage = 16,183,919.63/473 =$34,215.47
Jobs = 2 023 440/34,215.47=**59 annual jobs**

2. Using IMPLAN Study area Information (state of Michigan)
Sector 50: (2002 dollars)
Employment = 13,043
Employee Compensation = 479,919,630.50
Annual wage = 479,919,630.50/13 043= 36,795.19
Jobs = 2 023 440/36,795.19 = **55 annual jobs (Median)**

3. Using IMPLAN Study Area Information (Osceola County)
Sector 50: (2002 dollars)
Employment = 33
Employee Compensation = 129,9226.79
Annual wage = 1,299,226.79/33= 39,370.50
Jobs = 2 023 440/39,370.50= **51 annual jobs**

LITERATURE CITED

Alexander, J. (1999). The Muskegon River, Unnatural Wonder. The Muskegon Chronicle. Muskegon**:** 1-20.

Allan, J. D. (1995). Stream Ecology: Structure and Function of Running Waters. London, Chapman and Hall.

American Rivers, Friends of the Earth, et al. (1999). Dam Removal Success Stories, American Rivers, Friends of the Earth and Trout Unlimited.

Army Corps of Engineers (2000). An Assessment of the Draft Environmental Impact Statement of the Lower Snake River Dams. Washington D.C., Army Corps of Engineers**:** 1-40.

Bednarek, A. T. (2001). "Undamming Rivers: A Review of the Ecological Impacts of Dam Removal." Environmental Management **27**(6): 803-814.

Born, S. M., K. D. Genskow, et al. (1998). "Socioeconomic and Institutional Dimensions of Dam Removals: The Wisconsin Experience." Environmental Management **22**(3): 359-370.

Carson, R. T. (2000). "Contingent Valuation:A User's Guide." Environmental Science Technology **34**: 1413-1418.

Constanza, R., R. d. Arge, et al. (1998). "The Value of the World's Ecosystem Services And Natural Capital." Ecological Economics **25**: 1-15.

Freeman, A. M. (1998). The Economic Approach to Environmental Policy Selected Essays of A. Myrick Freeman III, Edward Elgar.

Gore, J. A. and G. E. Petts, Eds. (1989). Alternatives in Regulated River Management. Florida, Boca Raton, CRC Press.

Hoehn, J. P., T. Tomasi, et al. (1996). An Economic Model for Valuing Recreational Angling Resources in Michigan, Department of Agricultural Economics, Michigan State University.

IMPLAN (1999). IMPLAN Professional, User's Guide, Analysis Guide and Data Guide. Minnesota, Minnesota IMPLAN Group, Inc.

Jones, C. A. and Y. D. Sung (1993). Valuation of Environmental Quality At Michigan Recreational Fishing Sites: Methodological Issues And Policy Applications, Environmental Protection Agency: Environmental Economics Report Inventory.

Jones, L. L. (1997). Input-Output Modeling And Resource Use Projection. Texas, Department of Agricultural Economics,Texas A&M University.

Kanehl, P. D., J. Lyons, et al. (1997). "Changes in the Habitat and Fish Community of the Milwaukee River, Wisconsin, Following Removal of the Woolen Mills Dam." North American Journal of Fisheries Management **17**: 387-400.

Kondolf, G. M. (1997). "Hungry Water: Effects of Dams and Gravel Mining on River Channels." Environmental Management **21**(4): 533-551.

Layman, C. R., J. R. Boyce, et al. (1996). "Economic Valuation of the Chinook Salmon Sport Fishery of the Gulkana River, Alaska, under Current and Alternate Management Plans." Land Economics **72**(1): 113-128.

Lessard, J. L. (2000). Temperature Effects Of Dams On Coldwater Fish And Macroinvertebrate Communities In Michigan. Fisheries and Wildlife. East Lansing, Michigan State University**:** 130.

Lockwood, R. N. (1997). "Evaluation of Catch Rate Estimators from Michigan Access Point Angler Surveys." North American Journal of Fisheries Management **17**: 611-620.

Loomis, J. (1999). Recreation and Passive Use Values From Removing the Dams on the Lower Snake River to Increase Salmon. Masonville, Colorado, Agricultural Enterprise, Inc**:** 1-51.

Loomis, J. and G. Helfand, Eds. (2001). Environmental Policy Analysis for Decision Making. The Economics of Non-Market Goods and Resources. Dordrecht, Boston, & London, Kluwer Academic Publishers.

Loomis, J., P. Kent, et al. (2000). "Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey." Ecological Economics **33**: 103-117.

Loomis, J. B. (1996). "Measuring the Economic Benefits of Removing Dams and Restoring the Elwha River: Results of a Contingent Valuation Survey." Water Resources Research **32**(2): 441-447.

Lupi, F. (1994). Resident Angler Expenditure for Fishing Trips in Michigan (Unpublished). East Lansing, Michigan State University**:** 1-20.

Lupi, F. (1996). Valuing Nonmarket Environmental Goods and Services. East Lansing, Department of Agricultural Economics, Michigan State University.

Lupi, F. and J. P. Hoehn (2001). Case Study of a Travel Cost Analysis: The Michigan Angling Demand Model. Revealing the Economic Value of Protecting the Great Lakes.

A. Cangelosi, Northeast-Midwest Institute, National Oceanic and Atmospheric Administration**:** 111-120.

Lupi, F., J. P. Hoehn, et al. (1998). The Michigan Recreational Angling Demand Model. East Lansing, Michigan State University**:** 1-39.

Michigan Department of Natural Resources, Fisheries Division. (1997). Removal of the Big Rapids Dam Remnant: An Environmental Assessment. Big Rapids, Ferris State University.

Miller, R. E. and P. D. Blair (1985). Input-Output Analysis: Foundations And Extensions. New Jersey, Prentice-Hall, Inc
Engelwood Cliffs.

O'Neal, R. P. (1997). Muskegon River Watershed Assessment, Michigan Department of Natural Resources Fisheries Division.

O'Neal, R. P. (2002). Ecological Fisheries Evaluations of the Middle Branch River, Osceola County, Michigan Department of Natural Resources, Fisheries Division**:** 1-24.

Perman, R., Y. Ma, et al. (1999). Natural Resource And Environmental Economics. Essex, Pearson Education Limited.

Progressive Architectural Engineering (2001). Marion Mill Pond and Middle Branch River Restoration Project, Preliminary Engineering Feasibility Report. Grand Rapids, Progressive AE**:** 1-17.

Report of the World Commission on Dams (2000). Dams and Development, A New Framework for Decision Making, World on Commission on Dams.

Trout Unlimited (2002). Small Dams Campaign, Trout Unlimited.