

# Overview of Natural Resource Values Potentially at Risk from Consequences of Net-Pen Aquaculture

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## Introduction

The Great Lakes are ecologically important and an economically-valuable natural asset that affect the quality of life of people in Michigan, the Great Lakes region, and beyond. The purpose of this brief overview is to outline some of the evidence supporting the fact that these natural resources are valuable, with a focus on values at some potential risk of being affected by net-pen aquaculture. While there is evidence that net-pen aquaculture can contribute to nutrient pollution (Clerk et al. 2004), the exact ecological risks of net-pen aquaculture are not known to the author. Thus, this overview demonstrates that many studies support the fact that there are significant economic values for these natural resources, even though the amount those values would be affected, if any, is not known at this time. Put differently, these can be thought of as values at risk, without having quantified the risk.

This overview will discuss two distinct economic concepts that relate to the issue of net-pen aquaculture in the Great Lakes: (1) economic impacts and (2) economic values. Economic impacts measure changes in regional economic activity such as economic output (e.g., sales), incomes, and jobs (Watson et al., 2007). Economic values measure changes in people's and businesses' well-being net of their costs. Notably, the two types of economic values are not always directly comparable (i.e., caution and care is required if both types of measures are to be used in a benefit-cost analysis conducted following economic standards). Although this overview focusses on economic values, it also provides information on economic impacts where available.

This overview has two parts. The first addresses economic values for the services provided by the Great Lakes and tributaries. The second offers additional context and information on a separate economic impact analysis of the effect two new caged-pen operations could have on the economy.

## **Part I. The Great Lakes are a Natural Asset that provide Economic Value**

The Great Lakes have direct effects on people's well-being and welfare through their provision of recreational opportunities and aesthetic values, and through the affect they have on the economy and economic activities (Austin et al, 2007). Broadly speaking, the Great Lakes are a form of natural capital (Kareiva et al. 2011), which provide an array of economically valuable ecosystem services to people, both through markets and outside of markets. Moreover, many areas of the Great Lakes, including many on Lake Huron, are highly stressed ecologically in areas that coincide with highly valued ecosystem services (Allan et al. 2013). Some studies have attempted to compile economic values for the ecosystem services of the Great Lakes (Krantzberg et al. 2008), though substantial uncertainty surrounds such efforts. Regardless, there are numerous economic studies documenting the economic values for a range of ecosystem services of the Great Lakes potentially at risk from cage-pen aquaculture. Even though some of the recreational and aesthetic values provided by the Great Lakes are not provided through market activity, by using non-market valuation methods, economists can and have quantified some of these values.<sup>1</sup> Moreover, the Great Lakes contribute to a variety of commercial activities that affect the economy, and hence people's well-being.

### **Tourism**

Tourism has long been a major sector of the Michigan economy (Spotts 1986). By some estimates, visitors to Michigan spent over \$20 billion and generated an economic impact of about \$37 billion in 2014 (Tourism Economics 2014). Other estimates differ, but regardless, tourism is a substantial part of Michigan's economy. The Great Lakes are a cornerstone of Michigan's tourism industry. Key parts of this industry are tied to Great Lakes water and water quality. For example, boating, beach uses, and fishing can be affected by water quality, including problems related to nutrient enrichment such as algal growth and turbidity, and problems resulting from invasive species and diseases. Specific recreation activities such as boating, beach use, and fishing are discussed in later sections of this overview.

### **Property values**

The value of coastal property is clearly linked to the amenity services of the Great Lakes. Studies have shown the substantial effect proximity and views of the Great

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<sup>1</sup> Accounting for nonmarket values, and the well-developed methods for doing so, is routinely done in state and federal Natural Resource Damage Assessments and under benefit-cost analyses adhering to OMB guidelines.

Lakes can have on property values (Seiler et al. 2001; Bond et al 2002; Krause 2014). Similarly, the literature on factors affecting property values routinely demonstrates the increased property values associated with proximity to lakes and rivers (Olmstead 2010; Muller 2009). The relationship between property values and water quality has also been widely documented (Leggett & Bockstael 2000; Michael et al, 2000), including for water quality and coastal properties in the Great Lakes (Aha et al., 2006). Similarly, studies in other locations consistently link waterfront property values to effects from invasive species (Olden and Tamayo 2014; Horsh and Lewis 2009; Halstead et al. 2003), suggesting similar relationships would hold for property values along the Great Lakes and tributaries that could face increased invasive species risk.

### **Recreational Fisheries**

Studies show recreational fishing in Michigan waters of the GLs is valuable to anglers (Melstrom and Lupi 2013; Lupi et al. 2003 & 2001; Jones and Lupi 2000). These fishery values are directly tied to the abundance of sport fish, so any impacts via nutrients, invasive species, diseases, or others that would adversely affect the fishery would result in economic losses to sport anglers. Some of these same studies and others (Melstrom et al. 2015) also demonstrate substantial economic values for Michigan's river fisheries, and many of these river fisheries would be affected by risks to the Great Lakes due to hydrological connections, species migrations, and movement of angler boats and gear across waterbodies. These studies of recreational fishing, along with a recent summary report (Poe et al. 2012), show economic values for recreational fishing in the range of \$20-\$75 per trip – these are net economic values to the anglers (i.e., value above and beyond what they spend).

In addition to economic values that accrue to anglers, the spending associated with recreational angling trips is well-documented and provides significant economic impacts (Southwick, 2007). Table 1 summarizes the economic impacts of Great Lakes fishing expenditures in Michigan, as measured in 2006. The overall impact on economic output is about \$1 billion dollars a year, some portion of which is at risk if caged-pen facilities adversely affect fishing.

**Table 1:** Economic Impact of Great Lakes Fishing in Michigan in 2006\*

*(Table 1 is found on next page.)*

Retail Sales	Total Multiplier or Ripple Effect	Salaries, Wages, and Business Earnings	Jobs	State and Local Tax Revenues
\$563,000,000	\$1,002,000,000	\$312,000,000	8,283	\$58,000,000

\* Table 1 is reproduced from Southwick (2007, p.10); dollars rounded to nearest million; no adjustment for inflation.

### Charter fishing

Fishing on charter boats is also an important activity in the Great Lakes, with charter trips averaging about 17,000 per year from 1990 to 2009, with a declining trend over time (O’Keefe and Miller 2011). In Lake Huron, charter trips declined overall with the alewife collapse, but charter trips in Saginaw Bay have increased (O’Keefe and Miller 2011). The economic impacts of charter fishing in 2009 are summarized in Table 2 below. It is important to note that there is likely overlap in these estimated impacts with those reported above for recreational fishing in general. Also note the estimates are only for local spending by out-of-town visitors (since the local spending by locals would likely occur anyway).

**Table 2:** Economic Impacts of Great Lakes Charter Fishing in Michigan based on Local Spending by Non-Locals in 2009\*

Location	Expenditures	Output with Multiplier or Ripple Effect	Incomes	Employment Hours
Lake Huron	\$1,365,000	\$1,564,000	\$574,000	50,000
All MI Great Lakes	\$11,677,000	\$14,875,000	\$6,206,000	344,000

\* Table 2 is reproduced from Table 12 of O’Keefe and Miller (2011); rounded to nearest thousand; no adjustment for inflation.

## Commercial fisheries

The Great Lakes support commercial fisheries for state-licensed and tribal fisherman. In 2013, state-licensed and tribal commercial fisheries in Michigan's waters of the Great Lakes harvested about 8.8 million pounds of fish (mostly whitefish), with a dockside value of just over \$14 million (DNR 2015). About 40% of this harvest was from state-licensed operators. For state-licensed operators in Lake Huron, the data for 2013 show that about 1.5 million pounds of fish was harvested with a dockside value of about \$2.8 million dollars (DNR 2015).

## Recreational boating and marinas

Available data suggests that people with boats registered in Michigan spend almost 6 million days a year boating on the Great Lakes (ACOE 2008). Clearly this will generate substantial value to the boaters. Although several studies of the economic impact of recreational boating to the economy have been conducted in the Great Lakes, a recent review by Poe et al. (2012) noted the dearth of studies on the economic values that accrue to boaters themselves. Poe et al. adjust results of Connelly (2007) for party size, and they conclude that a rough estimate of net economic value per person per day is about \$29. This value for boaters is in-line with findings of other boating studies (Sierelis et al. 1995) and related activities such as fishing. Note too the potential overlap with the data above for recreational fishing, since about half of boating trips in Michigan include fishing.

Turning to the economic impacts of Great Lakes boating, a study by the U.S. Army Corp of Engineers (ACOE 2008) provides a thorough analysis of economic impacts. The impacts of trip-related spending are reported for Michigan in Table 3. The ACOE report provides broader impacts that account for boat purchasing as well as the trip expenditures, but boat purchasing is unlikely to be affected by the risks of Great Lakes aquaculture, so they are not reported in Table 3.

**Table 3:** Economic Impacts of Recreational Boats using Great Lakes for Boats Registered in Michigan\*

<b>Sales (\$ Millions)</b>	<b>Jobs</b>	<b>Incomes (\$ Millions)</b>	<b>Value Added (\$ Millions)</b>
\$934	13,473	\$316	\$386

\* Table 3 is reproduced from Table 19 of ACOE (2008); craft expenditures not included;

no adjustment for inflation.

## **Beaches**

Great Lakes beaches provide a wealth of recreational opportunities to Michigan residents and out-of-state tourists. Surveys indicate about 30% of the nation's adults annually participate in some form of coastal recreation (Leeworthy 2001). Research by Chen (2013) shows that Michigan residents living in the Lower Peninsula take about 21 million day trips to public Great Lakes beaches (excluding Lake Superior) each summer. A full accounting of beach uses would yield a much larger visitation number (by factoring in trips that are more than one day, including all beaches, and adding in non-residents). Chen (2013) has developed models to estimate the net economic value to resident beach-goers of Michigan's Great Lake beaches and finds that economic values to beachgoers are about \$20 per day for single day trips and about \$50 per day for multiple day trips. Combining Chen's findings with those of Weicksel (2012) shows that these economic values are significantly reduced by degraded beach quality due to beach closures from bacterial pollution and by the amount of algae present in the water and on the shore. Furthermore, another Great Lakes study also shows that economic values accruing to beachgoers are negatively affected by bacterial pollution as well as by invasive species (Murry et al. 2001).

In addition to providing economic values to the visitors, beachgoers spending also contributes to the economy. Significant economic impacts from beachgoer's spending have been demonstrated for coastal areas of the nation. At California beaches, some research shows visitor spending per-person per-trip to be \$73 (Dwight et al. 2012) and \$104 (King 2002) depending on the location, whereas King (1999) reports residents spending \$24 on day trips and \$120 for overnight trips (all dollars adjusted to 2015). Nevertheless, very few economic impact studies have specifically focused on Great Lakes beaches. One exception includes Murray et al. (2000) that found single day visitors spent \$18.01 each in the local area in 1998. A Michigan example is provided by Cook (2009) who estimated total direct spending of visitors to the Sleeping Bear Dunes National Lakeshore in the region within a one-hour drive of the park was just over \$100 million supporting over 1,200 jobs. Finally, a small pilot study of 140 people randomly chosen at Michigan beaches found that average spending for day trip visitors was about \$16 per person but that average spending for visitors on multiple day trips was about \$270 per person (Cheng 2015). Given the large number of visits to Michigan's Great Lakes beaches, a full accounting of the economic impacts of this spending would produce impacts well in excess of one billion dollars a year.

## **Other Economic Values**

**Municipal and Industrial Water:** Water quality problems related to excess nutrients and some invasive species are known to increase operating and maintenance costs for water treatment and other industrial water users (Renzetti 1999; Dodds et al., 2009; Oreska and Aldridge 2011).

**Non-use Values:** In economics, the notion of economic value is broad and refers to anything for which some people are willing to give up scarce resources. Often these economic values are expressed through market exchanges or by observing people's use of resources. However, people can and do have economic values that are unrelated to their use of resources. These are referred to as nonuse values (Freeman et al. 2014). For example, for issues affecting the quality of the Great Lakes, potential nonuse values could exist for those who neither recreate on the lakes nor own coastal property. Nonuse values for those who prefer to protect Great Lakes water quality could exist across a broad swath of the region, hinting that modest values could translate to large regional benefits.

Nonuse values for changes in water quality are well established in the economics literature (Von Houtven et al. 2014; Griffith et al. 2012; Johnston, Besedin, and Wardwell 2003). In light of the sense of place the Great Lakes provide, as well as the high degree of interest that the people of Michigan have for the Great Lakes, it is likely that there are also nonuse values for protecting the quality of the Great Lakes, though examples of nonuse valuation in the Great Lakes is largely limited to studies of willingness to pay for cleaning up contaminated sites (Lichtkoppler and Blaine 1999; Azevedo et al. 2012).

**Regional Economic Growth and Health Great Lakes:** Studies have discussed the potential for healthy Great Lakes to serve as a driver of regional economic growth and vitality (Austin et al. 2008; Vaccaro 2011; Campbell et al. 2015). Clean and healthy Great Lakes have the potential to draw and attract amenity-led economic growth, particularly in attracting individuals with high levels of human capital (Stevens and Partridge 2015).

## **Part II. Comments on Economic Impact Study of Net-Pen Operations**

This section provides the author's perspective on the analysis that examined the economic impact that would likely occur with the addition of some caged-pen

aquaculture facilities on Lake Huron (Miller et al. Unpublished). That analysis focused on the impact of adding the businesses to the economy and was not tasked with addressing possible impacts resulting from diminution of ecosystem services.

A few issues are raised for consideration of those impacts:

- Actual data on caged-pen aquaculture investment costs, operating costs, and current product prices was not readily available, so budgets that were developed for the aquaculture industry's strategic plan were used to supply the necessary assumptions for the data. Those budgets were developed with some knowledge of the industry and were put together by economists with budgeting experience, but the numbers themselves reflect best professional judgements.
- The price that was used for trout sales in that analysis was \$2.75. This price exceeds the average national average prices for rainbow trout, which are \$1.08 in 2003 and \$1.63 in the 2013 as reported by the agricultural census (NASS 2015). However, the NASS database also reports a lone price of \$3.39 specific to Michigan for 2013. It is possible that Michigan prices in NASS reflect niche markets (otherwise they would likely converge on the national price levels) and because the 2013 NASS data indicate only 13 producers reporting sales of trout for food fish (171,000 pounds were reported sold by Michigan producers out of about 58 million pounds nationally). It is unclear how a price of \$2.75 can be achieved with a larger scale of production in Michigan.
- Given the trends in consumer preferences for local foods, there is the possibility of capturing a price premium for being locally grown, but there could be risks to this branding and pricing strategy if Great Lakes harms developed due to the operations.
- One recent published study shows limited retailer willingness to pay any price premium for Midwestern (fresh on ice) fish, further suggesting the market may not support a price above the national average. The study found 57% of retailers would not pay a price premium for fresh trout and the resulting overall mean price premium was \$0.29 for fresh trout. The study concludes there "is no room" to capture price premiums from retailers for fresh trout from Midwestern producers (Gvillo et al. 2013).
- Caged-pen aquaculture in the Great Lakes entails some production risks (e.g., yield losses, storm damages, failures, etc.) that can impose large losses that are not factored into the budgets. These risks likely vary by the locations. For example, near shore facilities may have less risk of wave damages but could be

more prone to ice damage.

- The above points, taken together, highlight some uncertainties and likely reduce the potential beneficial economic impacts of caged-pen aquaculture in the Great Lakes.

### **III. Conclusions**

The literature supports the claim that the Great Lakes are an economically-valuable natural asset affecting the quality of life of people in Michigan, the Great Lakes region, and beyond. Evidence was provided to show that some key sources of value accruing from these assets can be affected by issues that relate to the unknown risks of net-pen aquaculture in the Great Lakes. Although the examples are not exhaustive, this overview demonstrates the potential for economic values at risk. That risk, if any, was not quantified, but as noted in Part II of the overview, there are uncertainties on the business side as well.

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