

# THE DYNAMIC GREAT LAKES ECONOMY

## EMPLOYMENT TRENDS from 2009 to 2018



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# INTRODUCTION

Analysis of 2018 economic data shows that more than 1.3 million jobs are directly connected to the Great Lakes states, generating \$82 billion in wages; 139,490 jobs have been added since 2009.

The Great Lakes are a vital natural resource to the eight states (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin) that border the inland seas. Their abundant freshwater provides a backbone for the region's economy and has shaped the culture and history of communities. People are attracted to live and visit in this region because of the growing innovation in industries and diverse recreational opportunities.

It has been nine years since the original report, *Vital to Our Nation's Economy: Great Lakes Jobs*, was published. Great Lakes state

**More than 1.3 million jobs are directly connected to the Great Lakes, generating \$82 billion in wages.**

leaders and communities have used this analysis of Great Lakes jobs to emphasize the importance of protecting the region's most valuable asset, which provides a competitive advantage for businesses, such as tourism and shipping. To capture the ever-changing, dynamic blue economy, Michigan Sea Grant has provided an updated summary of Great Lakes employment data that shows job trends over the past decade, in addition to possible explanations of why these trends occurred for each business sector. The report analyzes the status and trends for all Great Lakes-related sectors between 2009 and 2018 across the 83 coastal counties in the eight states.

The analysis is based on employment data from the Bureau of Labor Statistics and represents a conservative estimate of employment related to the Great Lakes in the following sectors: manufacturing; tourism and recreation; transportation and warehousing; agriculture, fishing, and food production; science and engineering; utilities; and mining. It covers the rebound in jobs after the 2008 Recession by looking at the changes in employment between 2009 and 2018. The report does not include changes in employment due to the COVID-19 pandemic starting in 2020.

**Nearly 140,000 jobs have been added to the Great Lakes region since 2009.**



# GOALS

The goal of this report is to provide a conservative estimate of the number of United States jobs for Great Lakes connected sectors. This report provides a summary of the total 2018 direct employment data for sectors in coastal counties and compares these totals with

2009 and provides analysis and insights related to these trends. Similar to the 2011 report, the authors defined Great Lakes-related jobs as employment in industries that rely upon the Great Lakes for key inputs (e.g., water, fish) or economic viability (e.g., inexpensive transportation that provides an economic advantage),

or are significantly influenced by the Great Lakes (e.g., by attracting visitors or climate moderation). The industries used for this report would either not exist or not have developed to the extent that they have reached today without reliance upon the Great Lakes resources.



## RESULTS

Employment summaries were estimated using 2018 data from the Bureau of Labor Statistics' (BLS) Quarterly Census of Employment and Wages (QCEW) and its Occupational Employment Statistics (OES) program. For all eight states, only jobs in the specific sectors in the 83 coastal counties bordering the Great Lakes were included (see Figure 1, map of the Great Lakes states' coastal counties). For more information on the source data and justification for chosen methods for calculations, see the Methods section of this publication in the Appendix.

Great Lakes Coastal Counties

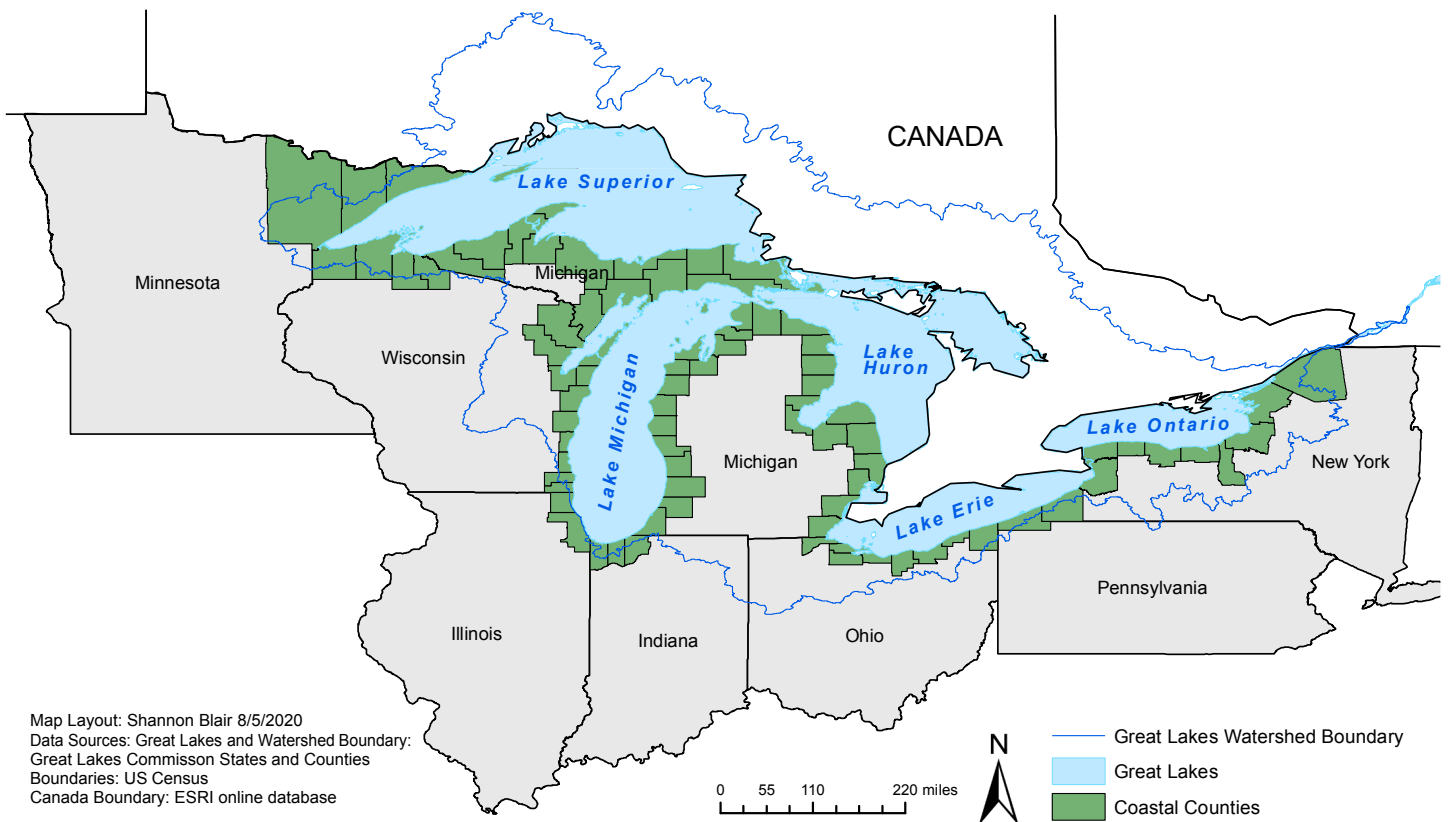


Figure 1. The 83 highlighted coastal counties were used to collect employment data for seven sectors.



## MANUFACTURING

**STATUS:** 823,735 Great Lakes Jobs

Accessibility to efficient transportation and an abundance of freshwater attracted manufacturing companies to the Great Lakes. For example, steel mills and mineral processing companies rely on the Great Lakes to transport iron ore and finished products to customers at cost-effective shipping rates. Paper, chemical, and pharmaceutical companies rely on fresh and abundant Great Lakes water to make their products.

**TRENDS ANALYSIS:** +8%, +65,765 Great Lakes Jobs

The economic recovery after the 2008 Recession resulted in an increase in manufacturing employment, primarily in lower-wage jobs. Michigan had a revival in the auto industry, with a 23% increase in jobs from 2009 to 2014.<sup>1</sup> Abundant freshwater, cost-effective transportation, and high quality of life for company employees are factors that contributed to this increase in employment in the region.

Sector	2009	2018	Percent Change	Gain/Loss
Manufacturing	757,970	823,735	+8%	+65,765
Tourism and Recreation	217,635	240,864	+10%	+23,229
Transportation and Warehousing	118,550	153,060	+23%	+34,510
Agriculture, Fishing, and Food Production	118,430	133,352	+11%	+14,922
Science and Engineering	25,489	26,326	+3%	+837
Utilities	10,980	10,803	-2%	-177
Mining	5,012	5,416	+7%	+404
<b>Total</b>	<b>1,254,066</b>	<b>1,393,556</b>	<b>+10%</b>	<b>+139,490</b>

Table 1. Change in the number of coastal county jobs connected to the Great Lakes by sector from 2009 to 2018. All employment data from QCEW and OES.

## TOURISM AND RECREATION

**STATUS:** 240,864 Great Lakes Jobs

The Great Lakes are a freshwater resource that attracts visitors from around the world. The beaches, trail systems, open water, parks, and natural protected areas support a tourism and recreation sector that provides economic sustainability and growth to coastal communities. For example, tens of thousands of people from inside and outside of the region take advantage of the local, state, and federal trail systems every year.

**Almost 115 million people visited Michigan in 2014, spending over \$22 billion in local economies.**

The three national parks and three national lakeshores located in coastal counties attracted approximately 6.5 million visitors in 2018.<sup>2</sup> Over 1.8 million recreational anglers enjoyed fishing the Great Lakes and spent nearly \$2.2 billion on trip and equipment expenditures in 2016.<sup>3</sup> In 2018, there were more than 4 million registered recreation vessels and 3.8 million paddlesports participants in the region.<sup>4,5</sup> Great Lakes tourists are primarily domestic, and 75% of them take day trips for particular activities, such as festivals and outdoor recreation.<sup>6</sup>

**TREND ANALYSIS:** +10%, +23,229 Great Lakes Jobs

Employment in this sector has continued to grow since the 1950s. The increase in tourism

## 2018 Great Lakes Jobs by State

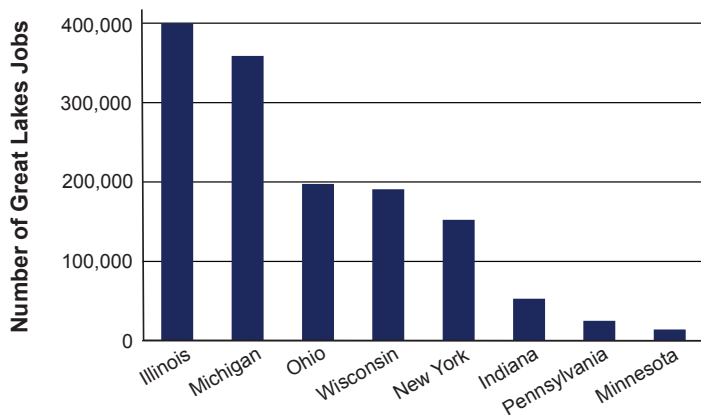


Figure 2. The number of jobs that are connected to the Great Lakes in each state's coastal counties (2018).

enhances Great Lakes states' economies. For example, Michigan had 113.4 million visitors that spent over \$22 billion in 2014. Of the \$22 billion, visitors spent \$13 billion in Michigan's coastal counties.<sup>7</sup> The increase in demand caused by more tourists visiting the Great Lakes can have a positive impact on jobs. The eight states had a total of over one billion visitors in 2014. Ohio had 139.5 million visitors and 354 thousand jobs, and Minnesota had 71.2 million visitors and 186 thousand tourism jobs in 2014.<sup>6</sup>

Trail systems in the region have a meaningful impact on economic activity with the increase in the number of visitors, money spent, and tourism businesses in the area. In Michigan, the Detroit RiverWalk, a 3.5-mile paved waterfront path connecting downtown Detroit and multiple green spaces, is at the center of riverfront activities in the city. A 2013 economic impact study

found that approximately 3 million people visited the riverfront each year for annual festivals, weekly events, and casual trips and spent nearly \$16.7 million on directly related riverfront activities.<sup>8</sup> The creation of the RiverWalk also sparked new recreational opportunities for kayak, paddleboard, and bike rentals, and tours along the Detroit River. Detroit River Sports, which opened its doors in 2012, has seen its business double from 2015 to 2018.<sup>9</sup>

The Great Lakes Restoration Initiative (GLRI) is an environmental restoration program administered by the U.S. Environmental Protection Agency (EPA) that protects and restores ecosystems by cleaning up degraded sites, improving water quality, and enhancing coastal habitats. These restoration projects improve the quality of recreation experiences along the Great Lakes, which benefits the economic vitality and quality of life of communities. The GLRI has provided funding for over 5,300 projects across the eight Great Lakes states that target the biggest ecosystem threats, such as contaminated sediments, harmful algal blooms, and loss of fish and wildlife habitat. A 2018 economic study shows that every dollar of GLRI spending from 2010 through 2016 will generate \$1.62 of economic value in tourism industries through 2036.<sup>10</sup>

The GLRI has also led to a resurgence in water-based recreation and waterfront development and the creation of new tourism-related jobs. For example, the GLRI has funded projects in the "Twin Ports" cities of Superior, WI, and Duluth, WI, and the western Lake Michigan city of Sheboygan, WI, that cleaned up contaminated sediment and restored wildlife habitat resulting in numerous positive economic outcomes.

## 2018 Great Lakes Jobs by Sector

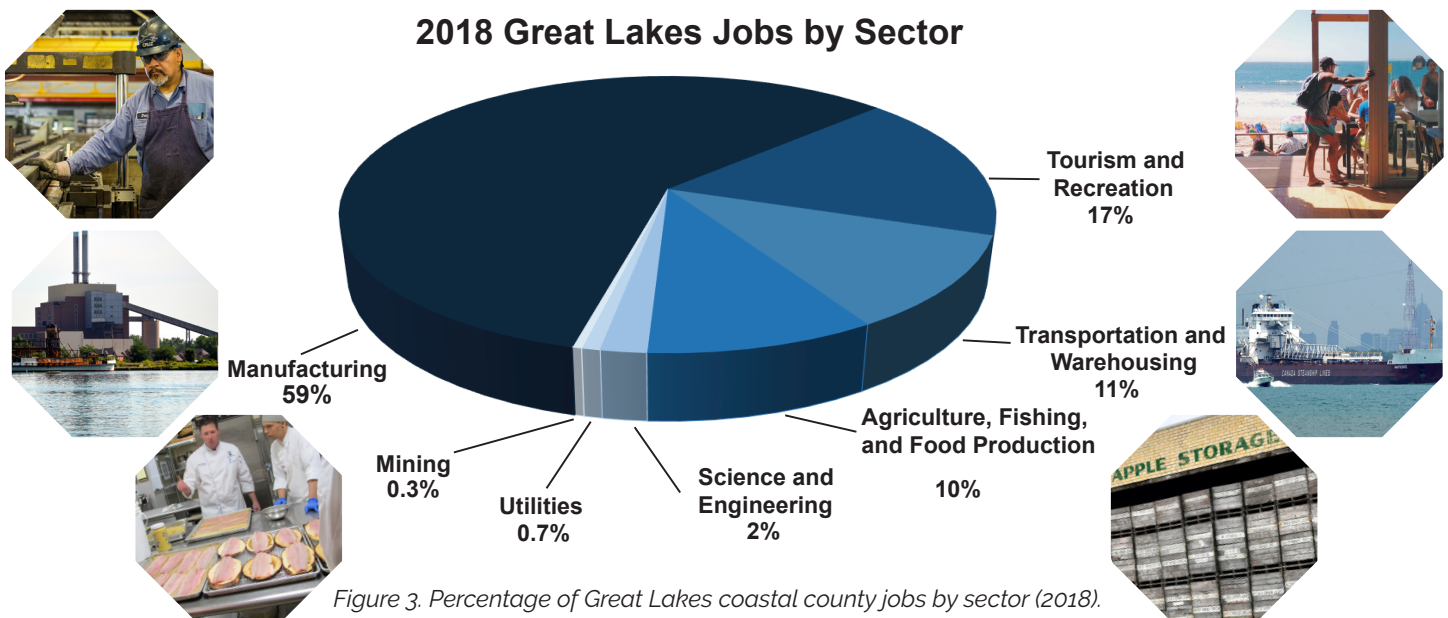


Figure 3. Percentage of Great Lakes coastal county jobs by sector (2018).

The waterfront improvements in the Twin Ports have drawn in hotel developments along the waterways that increased the number of hotel rooms by 10% between 2006 and 2016, which gave rise to an increase in tourism employment.<sup>11</sup> Sheboygan has seen a renewed interest in boating with a 41% increase in transient boater revenue for the city's Harbor Centre Marina since 2014.<sup>12</sup>



## TRANSPORTATION AND WAREHOUSING

**STATUS:** 153,060 Great Lakes Jobs

The regional transportation system includes an extensive network of highways, railroads, and shipping ports that boost the economy by supporting trade, functional supply chains, goods-producing industries, and associated jobs.<sup>13</sup> United States vessels on the Great Lakes transport an average of 87 million tons of dry-bulk cargo each year.<sup>14</sup> The whole fleet can move its cargo 11% farther than rail and 592% farther than trucks for the same cost, making shipping on the Lakes an economical option for businesses.<sup>15</sup> Warehouses in this multimodal system store goods and provide logistic services for the distribution of goods. There were 909 warehousing and storage establishments in the eight states' coastal counties in 2018.<sup>16</sup>

**TREND ANALYSIS:** +23%, +34,510 Great Lakes Jobs

The maritime industry has a significant influence on employment for the region because it is a reliable and cost-competitive way to transport cargo. Without the Great Lakes, the maritime industry would not be as big of an asset to the region's transportation system as it is today. From 2009 to 2013, the United States invested \$903 million into Great Lakes vessels, ports,

and water infrastructure with a commitment of \$568 million for ports, terminals, and water infrastructure post-2013.<sup>17</sup> This investment maintains the reliable and cost-effective maritime industry and helps the industry create jobs for new development, maintenance, and port and vessels crews.

Section 27 of the Merchant Marine Act of 1920, also known as the Jones Act, supports maritime jobs within the Great Lakes states by requiring all cargo moving between the United States ports to be on vessels that are crewed, built by, and owned by businesses in the United States. This requirement plays a crucial role in supporting shipbuilding and maintenance at the major ports along the Lakes. The region has 123,670 Jones Act-related jobs or 20% of the national total.<sup>18</sup> That is more jobs than the 37,590 Jones Act-related jobs in the Pacific Northwest region and 70,780 related jobs in Louisiana, which has the most per capita maritime jobs in the country.<sup>19,20</sup>

Warehousing and truck transportation make up 94% of jobs within this sector. Great Lakes shipping ports are hubs where vessels unload and other forms of transportation take over, so an increase in vessel transportation activities can benefit warehousing and trucking. Additionally, the rising demand for e-commerce may contribute to the growth of jobs for warehousing and truck transportation in the region.<sup>21</sup>

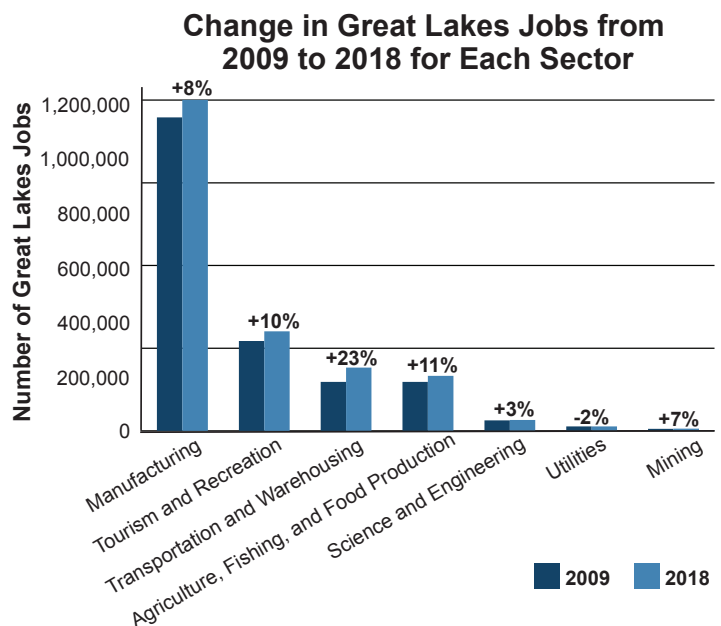


Figure 4. Great Lakes coastal county jobs by sector in 2009 and 2018. The percent change between the two time periods is listed above the bar graph.



## AGRICULTURE, FISHING, AND FOOD PRODUCTION

**STATUS:** 133,352 Great Lakes Jobs

The Great Lakes support a variety of fish species that sustain tribal and state-licensed commercial fisheries. State-licensed commercial fishing operations catch fish to sell fresh and frozen or as value-added products, such as breaded or canned products, at restaurants, farmer's markets, grocery stores, or their own retail fish houses. Over 5 million pounds of lake whitefish were harvested from the Great Lakes in 2017, with most coming from Michigan and Wisconsin.<sup>22</sup>

Tribal communities support commercial fishing operations, including retail businesses and some processing facilities that are protected by three treaties that reserve tribal nations' fishing rights in the ceded territories of the Great Lakes. For example, five U.S. Native American tribal nations under the 1836 fishing treaty harvested 1.6 million pounds of whitefish from Lakes Superior, Michigan, and Huron in 2018.<sup>23</sup>

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**Michigan farmers produced 201 million pounds of cherries and 15 million pounds of wine grapes in 2018.**

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In addition to fisheries, the Great Lakes provide ideal soil and climate conditions and water in coastal areas to grow specialty crops such as cherries and wine grapes. In Michigan, 201 million pounds of cherries and 15 million pounds of wine grapes were produced by farmers in 2018.<sup>24,25</sup> These specialty crops have inspired the creation of culinary festivals and beverage products that enhance tourism.

**TREND ANALYSIS:** +11%, +14,922 Great Lakes Jobs

Commercial fisheries contribute a small number of jobs to the agriculture, fishing, and food production sector. These businesses are typically small operations made up of five to ten people but could be larger if they added new services, such as fish processing, or created value-added products. Even though they are small, each job produced can have a significant impact on the local economies. A vast reduction of commercial fisheries occurred after the industries' collapse in the 1940s, 50s, and 60s due to the decline in Great Lakes fish populations. Today there are a small number of commercial fishing licenses that operate under state regulations governing where they can fish, what they can catch, and what equipment they can use. Michigan has the most commercial fishing licenses out of all the eight states with around 50, but only a portion of them harvest fish each year.<sup>26</sup>

Similar to commercial fisheries, tribal fisheries contribute a small number of jobs to the sector but can have a significant impact on the local economies. Native American tribal nations have treaty reserved fishing rights that allocate tribal fish harvest. From 2000 through 2005, there were 237 fishing licenses for the U.S. Native American tribal nations to harvest lake whitefish and 127 state commercial licenses.<sup>27</sup> Even though these operations are small, they do have large average catches. The average catch over the last five years was around 400,000 pounds of lake whitefish for the Keweenaw Bay Indian Community in Michigan and the Bad River and Red Cliff bands of Lake Superior Chippewa in Wisconsin that fish the Michigan and Wisconsin waters of Lake Superior under the 1842 and 1854 treaties.<sup>23</sup>

Crop production and food manufacturing provide food to local, regional, and international markets. The coastal counties have ideal soil and climate conditions along with reliable water irrigation that supports farms and orchards as well as processing facilities to turn those crops into food products. However, there has been a continuous decline in the number of farms across the entirety of each Great Lakes state. Between 2011 and 2018, there was a loss of 47,600 farms, from 520,200 in 2011 to 474,900 in 2018.<sup>28,29</sup> This decreasing trend occurred on a smaller scale within the coastal counties, which resulted in the elimination of some jobs and consolidation of others into larger farm operations. Food manufacturing employment represents the majority of the increase in jobs in this sector. The employment data analyzed here likely

includes some businesses in this industry that may not be specifically related to the Great Lakes, such as processing operations for grains and meat products.

**Since the 1980s, the number of wineries in Michigan increased from 12 to 130.**

The region's wine industry has been growing with new vineyards and winery establishments each year. This growth is due in part to the effects of the Great Lakes on coastal climate and growing conditions that support both difficult-to-grow wine grapes and landscapes that attract visitors to tour wineries. Tourism interest in wine tasting and the large out-of-state markets created a demand that has influenced the growth in the number of acres used for farming wine grapes. Wineries and vineyards attract both in- and out-of-state visitors that go to other tourist destinations along the Great Lakes. Since the 1980s, the number of wineries in Michigan increased from 12 to 130, with the majority of new establishments occurring in the last decade.<sup>30</sup> A study estimated that nearly 1.78 million people visited Wisconsin winery tasting rooms in 2015. These visitors directly spent an estimated \$152.6 million.<sup>31</sup>



## SCIENCE AND ENGINEERING

**STATUS:** 26,326 Great Lakes Jobs

These numbers include nineteen occupations in science, engineering, and conservation, including environmental scientists and those tied to Great Lakes industries, such as food scientists and nuclear engineers. Employers range from universities and non-profit organizations to private businesses.

**TREND ANALYSIS:** +3%, +837 Great Lakes Jobs

Great Lakes-related employment in the science and engineering sector has remained relatively constant. Jobs in science and technology contribute to resource sustainability, regional economies, and quality of life in coastal economies. Many of these organizations bring money into the Great Lakes states through external funding for innovative research, resource restoration, and community enhancement projects (e.g., the GLRI funding mentioned above). This funding can also help create jobs within these organizations.



## UTILITIES

**STATUS:** 10,803 Great Lakes Jobs

Power-production depends on the surface waters throughout the region. Nuclear, coal, and natural gas power plants are often located on the coasts to facilitate access to water for facility cooling. Coal power plants also benefit from the easy access to Great Lakes vessels transporting coal. Additionally, hydro-electric production occurs in Sault Ste. Marie, Niagara Falls, and the Upper St. Lawrence River as well as on many Great Lakes tributaries.

**TREND ANALYSIS:** -2%, -177 Great Lakes Jobs

Numerous coal-powered plants have closed over the past decade because of high operating and maintenance costs, while natural gas power plants have become more competitive because of low natural gas prices.<sup>32</sup> Since 2009, 25 coal-powered plants have been retired within the Great Lakes coastal counties — 62 are still operational.<sup>33</sup> Retirement of these plants can result in a loss of jobs or the transfer of workers to a natural gas power plant. This sector only experienced a 2% job loss since 2008, a loss that was



likely ameliorated by transferring jobs within the utility sector, including in the renewable energy industry.

In the United States, utilities employment for renewable energy, such as wind and solar, makes up a small percentage of jobs associated with electric generation. Wind and solar electric generation had 4.1% and 0.7% of United States jobs in utilities for 2017.<sup>34</sup> Additional renewable energy jobs in construction and manufacturing are not included in this report because these jobs are typically not found within the Great Lakes coastal counties. The renewable energy industry could have employment growth in the future as the region adapts to climate-related changes to the energy sector.



## MINING

**STATUS:** 5,416 Great Lakes Jobs

The abundance of metals, minerals, sand, and gravel deposits that formed in the Great Lakes region and a consistent regional market for the material has sustained mining operations since the mid-1840s.<sup>35</sup> Additionally, vessel transportation reduces the overall costs of the extracted minerals by moving large amounts of cargo at lower costs than land-based transportation. It takes one 1,000-foot vessel to move 62,000 tons of cargo, compared to 2,430 trucks or 564 railcars.<sup>15</sup>

**TREND ANALYSIS:** +7%, +404 Great Lakes Jobs

Metal extraction in the Lake Superior region of Michigan, Minnesota, and Wisconsin has occurred since the mid-1840s to meet the historical and current demands for development. Metals are in high demand for the manufacturing of products such as stainless steel appliances and solar panels. Mining for limestone,

salt, gypsum, and sand and gravel also occurs throughout the region most prominently in Michigan.

Iron ore is one of the most valuable non-fuel mined commodities in the Great Lakes region. Taconite is a low-grade iron ore mined from the Mesabi Iron Range in Minnesota and the Marquette Range in Michigan and then shipped on Great Lakes vessels to steel production facilities across the region. The steel production facilities' reliance on iron ore mining solidifies employment in the mining industry of Minnesota and Michigan.

Employment in the mining industry has been tumultuous over the past few decades because it is closely related to the performance of the economy overall. For example, mining employment dropped during the early 2000s and 2008 Recessions, was on the rise after the 2008 Recession, but then took a hit in 2015-2016 due to the low foreign steel prices. Iron mining started to ramp up activity in 2016 once the federal government began to create policies to protect the domestic steel industry.<sup>36</sup>

## CONCLUSION

The Great Lakes are the backbone of the region's economy and have shaped the culture and history of local communities. Without the Great Lakes' influence, there would be no 1,000-foot freighters shipping cargo, magnificent beaches for recreation, industrial use of water to produce food and create products, or an emerging water technology market. Protecting the health of the Great Lakes not only sustains critical jobs; it also makes the region desirable for new businesses and families. The coastal counties of the eight Great Lakes states produce 21% of the GDP in the region and 5.8% of the United States GDP.<sup>37,38</sup> The majority of positive trends in employment for all seven sectors further illustrates the influence of the Great Lakes on the region's economy and highlights the importance of protecting them for future growth.

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**The coastal counties of the eight Great Lakes states produce 21% of the GDP in the region and 5.8% of the U.S. GDP.**

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By 2040, six of the Great Lakes states (Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin) are projected to have a combined population growth of

about 3.2 million, but there would also be slow to zero growth in the labor force because of the out-migration of people in their 30s and 40s and early retirements. However, young people entering the labor force could offset this slow to zero growth.<sup>1</sup> The region has the capacity to increase the labor force by creating more innovation centers and tourism opportunities, along with increasing technical training and education in water-related industries. Locally trained and educated young people in water-related industries could provide a stable workforce in the region. For example, the Great Lakes Boat Building School in Cedarville, Michigan, trains students to be craftsmen and technicians in the maritime industry. Additionally, the region provides recreational opportunities, lower costs of living, and family-oriented communities that can attract out-of-state businesses and individuals to help offset the predicted slow growth over the next two decades.

The region and the nation recognize the need to protect and wisely manage this valuable freshwater resource to develop a sustainable blue economy and support vibrant coastal communities. The federally funded GLRI provides funds for projects that directly restore degraded freshwater ecosystems and indirectly improve economies and quality of life in Great Lakes communities. These investments reached a peak of over \$500 million invested in 2015 and have generated new economic activity in the region each year since 2010.<sup>10</sup> An analysis of this program estimates that for every federal dollar spent, there will be an additional \$3.35 of economic activity through 2035.<sup>10</sup> Added benefits of new businesses, increased home values, more jobs, and more water-based recreation will contribute to economic growth and improve the quality of life of residents. The Great Lakes region has proven it can bounce back after years of environmental degradation and the 2008 Recession and will continue to be resilient through the COVID-19 pandemic and future changes to the economy and ecosystem.

## MICHIGAN STATEWIDE VS. COASTAL COUNTIES PERCENT CHANGE IN JOBS BETWEEN 2009 AND 2018

The 2011 Great Lakes Jobs report evaluated Michigan statewide employment totals for manufacturing, mining, and science and engineering to account for the historical influence of the lakes on these industries and because the entire state is within the region. Below are the job total percent changes between 2009 and 2018 for Michigan statewide and coastal counties for these three sectors. The percent changes suggests that Michigan coastal counties had a greater increase in jobs from 2009 to 2018 compared with statewide, indicating a better recovery from the 2008 Recession.

### MINING

**+5%**  
Statewide

**+18%**  
Coastal Counties

### SCIENCE AND ENGINEERING

**+2%**  
Statewide

**+34%**  
Coastal Counties

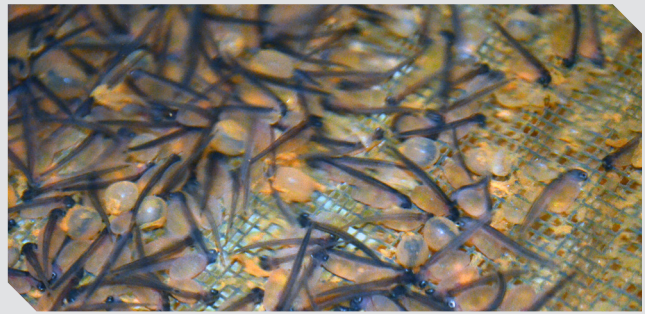
### MANUFACTURING

**+37%**  
Statewide

**+40%**  
Coastal Counties

## AQUACULTURE: EMERGING INDUSTRY IN THE GREAT LAKES REGION

The aquaculture industry currently has minimal employment within the Great Lakes region, but there is the possibility to expand from small-scale operations towards larger and more productive operations. As reported by the USDA 2018 Census of Aquaculture, there are nearly 310 aquaculture operations across the eight Great Lakes states.<sup>39</sup> Recent openings include companies like Superior Fresh in Wisconsin that produces 200,000 pounds of Atlantic salmon and steelhead annually, and AquaBounty in Indiana that increased their production of Atlantic salmon to 200,000 pounds per month in 2020. This indicates an industry on the verge of expansion across the region and into the coastal counties.<sup>40, 41</sup>



The Great Lakes have the potential to support this emerging industry, given the basin's abundant freshwater, the demand for baitfish by Great Lakes anglers, and existing stocking operations in the Lakes. However, there are concerns over water pollution, fish disease, unintended introduction of non-native species, and effects on wild species. The Great Lakes states have a focus on land aquaculture operations and not cage culture operations in the Great Lakes.<sup>42</sup>

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# APPENDIX

## METHODS USED TO CALCULATE THE NUMBER OF GREAT LAKES-RELATED JOBS

In 2011, Michigan Sea Grant published *Vital to Our Nation's Economy: Great Lakes Jobs* (2011, Michigan Sea Grant) to estimate the number of Great Lakes-related jobs for all eight Great Lakes states (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin). This 2020 report summarizes the employment data for 2018 using the same data sources as the 2011 report and similar assumptions, with one exception. This report only used coastal data for all Great Lakes-related sectors, whereas the previous report used Michigan statewide data for the manufacturing, mining, and science and engineering sectors in addition to the coastal data for all the other sectors in Michigan and states. The 2009 employment totals for Michigan manufacturing, mining, and science and engineering were updated to reflect this change.

## DATA SOURCES

Data used for this study came from two programs within the U.S. Bureau of Labor Statistics:

**QUARTERLY CENSUS OF EMPLOYMENT AND WAGES (QCEW)** program publishes a quarterly count of employment and wages reported by employers. Data are available at the county or state level within detailed industry categories. The categories were developed from the North American Industry Classification System (NAICS) 2012 codes. The NAICS is made up of 3-digit, 4-digit, 5-digit, and 6-digit industry codes. 3-digit codes represent a generalized industry (e.g., 482- Rail Transportation), and 6-digit codes represent a specialized industry (e.g., 441222- Boat Dealers). Federal statistical agencies use this standard when classifying businesses to collect, analyze, and publish statistical data related to the United States business economy. These data include all part-time and full-time workers covered by state unemployment insurance laws and federal workers covered by the Unemployment Compensation for Federal Employees program. Annual employment data are released approximately 6 months after the end of the year.

The QCEW data set excludes members of the armed forces, elected and judicial officials, the self-employed,

proprietors, domestic workers, unpaid family workers, and railroad workers covered by the railroad unemployment insurance system. The program provides employment data within detailed industry categories; however, data are suppressed for any industry classification when necessary to protect the identity of cooperating employers. For example, data suppression often happens in rural counties because there may be only one or two employers within a given industry, making them easy to identify. The QCEW data set provides a conservative estimate regarding employment in rural counties and in fields with a larger percentage of self-employed or informal workers, such as anglers, wildlife guides, and farmers.

**OCCUPATIONAL EMPLOYMENT STATISTICS (OES)** program conducts a semi-annual survey that covers all full-time and part-time wage and salary workers in nonfarm industries. The OES data set provides detailed information about 800 occupations for states or metropolitan statistical areas (MSAs), but not counties. The survey does not cover the self-employed, owners, and partners in unincorporated firms, household workers, or unpaid family workers. This data set was used only to identify specific technical jobs not intuitively connected to the lakes, such as fisheries biologists working for an engineering firm, agency, or university. Data are issued approximately one year after the reference period.

## ASSUMPTIONS

Both QCEW and OES programs release annual employment data approximately 6-12 months after the end of the year. Therefore, this report uses 2018 employment data that summarized the period from January 2018 to December 2018. The report also used 2009 employment data that summarized the period from January 2009 and December 2009 to change the Michigan manufacturing, mining, and science and engineering employment from statewide to coastal county totals. The entire data set was downloaded as text files to Microsoft Excel and filtered based on geographic and industry criteria. Job totals for each sector include Great Lakes-related industries and occupations. The list of industry and occupation codes are in Appendix Table 2. Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin have a geographic range of coastal counties bordering the Great Lakes for jobs in all of the sectors (Figure 1).

## JOBS IN SCIENCE AND ENGINEERING

Great Lake-influenced technical jobs include scientific and engineering occupations connected directly to the natural environment, such as nautical engineers or environmental scientists, and occupations tied directly to an industry influenced by the Great Lakes, such as food scientists (agriculture, food processing) and nuclear engineers (utilities). This limited sub-set of technical professions represents less than 5% of all engineering and scientific jobs in the region.

The OES was used to select 17 specific science and engineering professions (Appendix: Table 2). All of the states in the region used the following coastal Metropolitan Statistical Areas: Chicago-Naperville-Elgin, IL; Michigan City-La Porte, IN; Bay City, MI; Detroit-Warren-Dearborn, MI; Duluth, MN; Buffalo-Cheektowaga-Niagara Falls, NY; Rochester, NY; Syracuse, NY; Cleveland-Elyria, OH; Toledo, OH; Erie, PA; Green Bay, WI; Milwaukee-Waukesha-West Allis, WI. These MSAs, except the two for Michigan, are the same ones used in the 2011 report but have slightly different names due to changes over the years. The two Michigan MSAs are new because of the decision to gather 2009 and 2018 employment data for the coastal counties. Two other industries from the QCEW were included in this sector: conservation organizations and administration of environmental programs.

## JOBS IN THE SIX OTHER SECTORS

Jobs in these six sectors were estimated based on QCEW data. For all states, Great Lakes-related jobs only included coastal counties.

### MANUFACTURING

The Great Lakes provide efficient transportation for iron ore and finished goods, which sustains steel production and manufacturing. The region's clean and abundant water attracts chemical and pharmaceutical companies. Historically, access to the Lakes resulted in a concentration of educational, transportation, and manufacturing infrastructure and technical skills, which continues to drive manufacturing and innovation in the region. We considered all manufacturing industries, except printing and petroleum product manufacturing, to be Great Lakes jobs.

## TOURISM AND RECREATION

Great Lake beaches, trails, resort communities, and natural areas support a vibrant recreation and tourism industry that includes boating, bird watching, hiking, fishing, swimming, and camping that were captured by 12 industry categories (Table 2). We excluded food service, gas stations, and air transportation from Great Lakes-related jobs because it was difficult to isolate employment from these business sectors related to leisure travel.



## TRANSPORTATION AND WAREHOUSING

Transporting by vessel is more efficient and cost-effective than by train and truck, giving mining, manufacturing, and agriculture a competitive edge. Many of the region's transportation routes are multi-modal and involve transfers among lake-bound and international vessels, trains, and trucks. We considered water, rail, and road transport and excluded air, passenger ground, and pipeline transport from Great Lakes jobs. We included sightseeing transport in the tourism and recreation sector.



## AGRICULTURE, FISHING, AND FOOD PRODUCTION

Over geologic time, the Great Lakes created unique soil conditions and produced topography along the coast, such as muck soils and sandy hills where fruit, vegetable, and ornamental plants flourish. The Great Lakes moderate the climate of coastal areas, improving production and creating microclimates that are ideal for specialty crops. Additionally, the Lakes support a wide variety of fish to sustain the tribal and state-licensed commercial fisheries. We considered all crop production, food and beverage production (including seafood processing and fermentation), and fishing and hunting in coastal counties and excluded animal production from Great Lakes-related jobs. The QCEW program counts very few hunting and fishing jobs because it excludes self-employed people and proprietors.

## UTILITIES

Nuclear, coal, and natural gas power plants are the largest users of surface water in the region because of the ready access to water along the coast for facility cooling. The Great Lakes also have hydroelectricity production in Sault Ste. Marie, Niagara Falls, and the Upper St. Lawrence River. We included water and sewerage systems as Great Lakes jobs but excluded natural gas distribution.

## MINING

The abundance of minerals, sand, and gravel deposits that formed over a vast expanse of geologic time and a consistent regional market for the materials has sustained mining operations. Great Lakes shipping reduces the overall costs of the extracted minerals by moving large amounts of cargo at lower costs than land-based transportation. We consider all mining jobs, except oil and gas extraction, to be Great Lakes jobs.



The mining sector codes used for the 2009 jobs total for Michigan are updated. The 2011 report used Code 22 Mining, Quarrying, and Oil and Gas Extraction instead of the four codes (212, 213113, 213114, 213115) mentioned in Appendix Table 2. Code 22 was removed from this report and replaced by the four codes for the 2009 and 2018 coastal counties mining jobs total.

For the 2009 Minnesota mining jobs total, Code 22 Mining, Quarrying, and Oil and Gas Extraction was used instead of the four codes (212, 213113, 213114, 213115) mentioned in Appendix Table 2. Code 22 was used instead because the four codes have suppressed data, resulting in the mining jobs total for 2009 to be zero. Minnesota has a large mining industry in the coastal counties due to the Mesabi Iron Range, so having zero jobs for 2009 does not accurately represent this industry's impact on employment. The four codes were used for the 2018 Minnesota mining jobs totals because data suppression did not occur.



## ADDITIONAL CONSIDERATIONS

The data sources and methodology used to estimate the number of Great Lakes jobs could potentially result in an overestimation or underestimation of employment in some industries. We identified the following factors as possible biases to employment estimates: overestimation of jobs from all crop production in coastal counties and underestimation of jobs from the exclusion of specific types of employment and data suppression.

## FACTORS LEADING TO AN OVERESTIMATION OF EMPLOYMENT CONNECTED TO THE GREAT LAKES

A factor leading to an overestimation of employment is the consideration of all crop production in coastal counties to be Great Lakes-related. The Lakes make the coastal area better suited for high-value crops (e.g., fruit, greenhouse operations); however, some types of agriculture would occur without the presence of the Lakes, such as row crops (e.g., corn and soybeans). Also, the source data for this analysis counts part-time and full-time employment as equivalent.



## FACTORS LEADING TO AN UNDERESTIMATION OF EMPLOYMENT CONNECTED TO THE GREAT LAKES

Factors leading to an underestimation of employment are the exclusion of specific types of jobs and the suppression of source data. This analysis only examines direct employment in industries connected to the Great Lakes and does not include indirect and induced. The sum of all three types of employment (direct, indirect, and induced) is a measurement often used for the total economic impact. For example, we included the jobs of people working in maritime transportation, such as longshoreman (direct employment), but not jobs in industries that supply maritime transport companies (indirect employment), or the jobs created when maritime transport employees spend their salaries on groceries, auto fuel, or clothing (induced employment).

The source data from the Bureau of Labor Statistics does not cover certain types of employment, including the self-employed, proprietors, railroad workers, and members of the military. This likely leads to an underestimation of employment in some Great Lakes-dependent industries, such as fishing, outdoor guiding, and shipping, as well as jobs within the U.S. Army Corps of Engineers and the Coast Guard.

The Bureau of Labor Statistics is required to suppress any data that could be connected to a specific business when there are only one or two establishments in a particular industry and county. As a result, employment data in narrow industry categories, such as aquaculture or boat dealers, or from rural counties with limited industries, are underestimated in this analysis.



Table 2. Bureau of Labor Statistic Industries and Occupations that are Considered Connected to the Great Lakes, by Sector

Sector	Code	Industry or Occupation Designation
<b>AGRICULTURE, FISHING AND FOOD PRODUCTION</b> <i>Data Source: QCEW</i> <i>Geographic Range: Coastal counties</i> <i>Exclusions: Animal production, forestry</i>	111	Crop production
	1125	Aquaculture
	114	Fishing, hunting and trapping
	1151	Support activities for crop production
	311	Food manufacturing
	312	Beverage and tobacco product manufacturing
<b>MANUFACTURING</b> <i>Data Source: QCEW</i> <i>Geographic Range: Coastal counties</i> <i>Exclusions: Printing, petroleum products manufacturing</i>	313	Textile mills
	314	Textile product mills
	315	Apparel manufacturing
	316	Leather and allied product manufacturing
	321	Wood product manufacturing
	322	Paper manufacturing
	325	Chemical manufacturing
	326	Plastics and rubber products manufacturing
	327	Nonmetallic mineral product manufacturing
	331	Primary metal manufacturing
	332	Fabricated metal product manufacturing
	333	Machinery manufacturing
	334	Computer and electronic product manufacturing
	335	Electrical equipment and appliance mfg.
	336	Transportation equipment manufacturing
	337	Furniture and related product manufacturing
339	Miscellaneous manufacturing	
<b>SCIENCE AND ENGINEERING</b> <i>Data Source: OES</i> <i>Geographic Range: Coastal Metropolitan Statistical Areas</i> <i>Exclusions: Most general engineering and science occupations</i>	17-2081	Environmental engineers
	17-2151	Mining and geological engineers, including mining safety engineers
	17-2161	Nuclear engineers
	17-3025	Environmental engineering technicians
	19-1012	Food scientists and technologists
	19-1013	Soil and plant scientists
	19-1023	Zoologists and wildlife biologists
	19-1031	Conservation scientists
	19-2021	Atmospheric and space scientists
	19-2041	Environmental scientists and specialists, including health
	19-2042	Geoscientist, except hydrologist and geographer
	19-2043	Hydrologists
	19-4011	Agricultural and food science technicians
	19-4041	Geological and petroleum technicians
	19-4051	Nuclear technicians
	19-4091	Environmental science and protection technicians, including health
	19-4093	Forest and conservation technicians

Table 2 (continued). Bureau of Labor Statistic Industries and Occupations that are Considered Connected to the Great Lakes, by Sector

Sector	Code	Industry or Occupation Designation
<b>SCIENCE AND ENGINEERING</b> <i>Data Source: QCEW</i> <i>Geographic Range: Coastal counties</i> <i>Exclusions: All other public administration and services</i>	813312	Environment and conservation organizations
	924	Administration of environmental programs
<b>MINING</b> <i>Data Source: QCEW</i> <i>Geographic Range: Coastal counties</i> <i>Exclusions: Oil and gas extraction</i>	212	Mining, except oil and gas
	213113	Support activities for coal mining
	213114	Support activities for metal mining
	213115	Support activities for nonmetallic minerals
<b>TOURISM AND RECREATION</b> <i>Data Source: QCEW</i> <i>Geographic Range: Coastal counties</i> <i>Exclusions: Food service, gas stations, air transport</i>	441222	Boat dealers
	45111	Sporting goods stores
	4853	Taxi and limousine service
	4855	Charter bus industry
	487	Scenic and sightseeing transportation
	532111	Passenger car rental
	5615	Travel arrangement and reservation services
	712	Museums, historical sites, zoos, and parks
	713	Amusements, gambling, and recreation
	71393	Marinas
	7211	Traveler accommodation
	7212	RV parks and recreational camps
<b>TRANSPORTATION AND WAREHOUSING</b> <i>Data Source: QCEW</i> <i>Geographic Range: Coastal counties</i> <i>Exclusions: Air transport, transit and ground passenger transport, pipeline transport, sightseeing transport</i>	482	Rail transportation
	483	Water transportation
	484	Truck transportation
	4882	Support activities for rail transportation
	4883	Support activities for water transportation
	4884	Support activities for road transportation
	493	Warehousing and storage
<b>UTILITIES</b> <i>Data Source: QCEW</i> <i>Geographic Range: Coastal counties</i> <i>Exclusions: Natural gas distribution</i>	2211	Power generation and supply
	2213	Water, sewerage and other systems



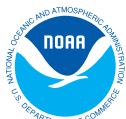
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Michigan Sea Grant helps to foster economic growth and protect Michigan’s coastal, Great Lakes resources through education, research, and outreach. A collaborative effort of the University of Michigan and Michigan State University and its MSU Extension, Michigan Sea Grant is part of the NOAA-National Sea Grant network of 34 university-based programs.

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