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RUST BELT INDUSTRY AND THE GREAT LAKES WATER AGREEMENT ACT (GLWQA): AN ASSESSMENT OF THEIR COLLABORATIVE ANIMOSITY

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ABSTRACT

The Great Lakes supply 95% of the freshwater used for drinking in the United States and 21% of the earth's entire freshwater supply. They are also the source of more than 40 million gallons of water each day for use in American industrial power production. As a geopolitical lynchpin and a regional Global Hydro-Hub, the American Midwest has built up its industrial strength through usage of water from the Great Lakes. However, this usage has also brought unanticipated negative consequences, as nearby industry has been found to be the largest source of chloride and other pollutants in the Great Lakes such as garbage disposal waste, sewer runoff, and water softening products, thereby achieving geopolitical stature at the cost of water quality. The demand for water governance from various climate change actors over several generations has given rise to the Great Lakes Water Agreement Act (GLWQA), binational legislation agreed upon by the US and Canada. In this study, quantitative tests including the Welch Test and the Mann-Whitney U test were performed using datasets of water pollution records of Midwest industrialists from the US Environmental Protection Agency as well as industrial output from the North American Industry Classification System. Based on the results of this output, this study will measure the revenue of industrial production in light of the associated water pollution for this region's American states in order to determine whether Midwest industrialists' productivity is counterbalanced by the newest amendments of the GLWQA.

KEYWORDS: water governance, water-related markets, geo-political incentives, policy research, GLWQA

INTRODUCTION

The Great Lakes of North America are a vital natural resource for the region. They contain 21% of the earth's entire freshwater supply and 84% of North America's surface fresh water (The 71percent, 2020). Of the 40 million gallons of freshwater consumed daily from the Great Lakes, more than half is utilized for industrial power production (Environmental Law and Policy Center, 2019). However, over the decades, the region's industrial output has had negative unintended consequences, including degraded water quality. This study will address this dilemma by assessing industrial production against the water pollution records for this region's American states vis-à-vis various enforcement eras of the Great Lakes Water Agreement Act (GLWQA).

LITERATURE REVIEW

The Great Lakes, consisting of Lake Superior, Lake Michigan, Lake Huron, Lake Erie, and Lake Ontario, are the largest group of freshwater lakes on earth. Freedman and Monson (1989) labeled the Great Lakes "unquestionably a unique national and global resource" (p. 285).

The Great Lakes region has been economically strong ever since it was first widely settled, and today the region by itself comprises the world's fourth-largest economy (Shin, 2013). Martin (1999) stated that the Great Lakes include "one of the world's largest concentrations of industrial" output (p. 15). The Environmental Law and Policy Center (2019) noted that "agriculture, industrial manufacturing, fishing, and recreation together form an economic engine" (p. 1) of commerce in the region.

The Great Lakes have contributed mightily to the economic prowess of the Rust Belt, also referred to as the Manufacturing Belt, a region consisting of Midwest American states, generally south, west, and east of the Great Lakes. The Rust Belt's rise in economic strength during the late nineteenth and early twentieth centuries is attributed to the coinciding rise of the manufacturing sector (Stiglitz, 2017), particularly organizations powered by the fossil-fuel industry that were built up during the peak of American industry in the late 1800s and early to mid-1900s (Cooke, 2006; Biggers, 2014).

This manufacturing-led economic prowess has come with unanticipated consequences for the region. During the past several decades, the decline of US manufacturing has been specifically intertwined with job loss attributed to plant closings (Deakin & Edwards, 1993; Chase, 2003; Brown et al., 2008; Bernero & Peduto, 2016). Many consider burdensome industrial regulations as a culprit that has inhibited the region's industrial effectiveness. Reksulak et al. (2013) found that Rust Belt states bear comparatively higher industrial costs associated with regulations compared to other regions of the country, and corporations in the region have often blamed government regulations for the many factory closings (Isenberg, 2017). Cooke (2006) and Biggers (2014) stated that since the Rust Belt is generally powered by the coal industry, anti-coal regulations in particular have negatively affected these economies the most (Cooke, 2006; Biggers, 2014). As such, the Rust Belt has been generally opposed to federal regulations in the manufacturing sector.

Ardent opposition to federal industrial regulations centered in the Rust Belt has grown in recent decades, and local politicians from both parties have sought to protect "their constituents from economic loss rather than protecting them from pollution" (Schoenbrod, 2008, p. 216). Even union leaders, who historically have constituted a political stronghold, have split with historical party stances and have vehemently opposed regulations in the politically powerful Rust Belt steel industry (Lopez, 2004; Goldsmith, 2016).

Climate change has been negatively affecting the Great Lakes ecosystem (Spring, 2001; Egan, 2017; Dempsey, 2019; Environmental Law and Policy Center, 2019). The Rust Belt's and Great Lakes' high concentrations of population density and industrial output have particularly contributed to the degradation of the quality of the freshwater supply over recent generations, leading to more specific federal regulations to limit water pollution. Manufacturing organizations are the largest offenders in terms of water pollution, pouring chloride sources and other pollutants such as garbage disposal waste, sewer runoff, and water softening products into the Great Lakes, dwarfing other sources including chemical, steel, and food manufacturers (Sonzogni et al., 1983). As a response to water pollution, the binational Great Lakes Water Agreement (GLWQA) was enacted in 1972 by the US and Canada. Swain (1981) surmised, "Both the United States and Canada have long recognized the importance of their boundary waters, and the need to preserve them as a priceless international resource and heritage" (p. 447)., and the agreement began as a means of implementing goals and actions for improving water quality in the Great Lakes. It was subsequently amended in 1983, 1987, and 2012. Private industry has been part of the guidance and writing process throughout the history of the legislation, particularly in the leadup to the GLWQA (Martin, 1999).

While industry has been involved in the past development of the agreement (Freedman & Monson, 1989), an amendment called the Great Lakes Water Quality Initiative of 1990 involved more federal regulatory agencies and oversight (including the EPA) and less input from Rust Belt industry (National Water Quality Inventory Report to Congress, 1994). The resulting legislation was seen as "stringent" and "requiring the states to adopt strict standards for waste disposal and discharge into the lakes" (Cox, 2013, p. 122). Today, the US Environmental Protection Agency (EPA) coordinates the American responsibilities in the GLWQA.

In 2001, the Great Lakes Charter Annex (GLCA), a handshake agreement addressing the regional water ecosystem between the governors of Rust Belt states and the premiers of Canadian provinces, was formed to better coordinate the management of the Great Lakes water supply. Opposition to this agreement from Rust Belt industry has been increasingly harsh (Inside Washington Publishers, 2004), as companies felt that it would thwart their ability to produce goods efficiently. The GLCA went through binational reviews over the years and by 2012 Canada and the US amended the agreement to add nine objectives along with ten annexes to form the Great Lakes Water Quality Agreement (GLWQA). This new agreement kept the provisions of the original GLCA in-tact, but the new programs were designed to address the "chemical, physical, and biological integrity" of the ecosystem, including toxic chemicals such as vessel pollution, in order to stem overall habitat degradation (EPA-GLWQA, 2021, para. 2). By 2017, the International Joint

Commission (IJC), a Canadian/American bi-national border association addressing GLWQA water issues, released its first triennial progress report (International Joint Commission Final Report, 2017), finding “remarkable progress” while stating that it “salutes the parties for these achievements” (p. 11). However, the Commission concluded that for the parties involved including Rust Belt industry, “accountability would be further improved… with the addition of clear, specific, time-bound commitments” (p. 35) and requested a progress report in several years.

Nevertheless, fallout from continued water pollution issues in the Great Lakes has affected local citizens and received nationwide attention. In 2014, the city of Toledo, Ohio, issued a “do not drink/do not boil” water order for its citizens because an algae that produced harmful toxins was found growing in Lake Erie (Daley, 2020). In 2016, the governor of Michigan declared a state of emergency in Flint, Michigan, because its drinking water, sourced from Lake Huron, contained high levels of lead.

In 2017, The IJC noted that the efforts to clean up the Great Lakes over the past 25 years have been “a mix of achievements and challenges” (McCartney, 2017, p. 1). Some critics say that regulations enacted on manufacturers in the Great Lakes need to go further to keep these water crises from occurring more often and claim that negative effects of climate change will affect Great Lakes manufacturers in the future more than increased regulations in the present (Shin, 2013; Annin, 2018). However, others say that regulations have gone too far and have inhibited efficient models of production. As such, this study will compare industrial production against the water pollution records in these Rust Belt states during various eras of the GLWQA. The effects of adding stricter amendments to the GLWQA will be described.

Methodology/Results

Some states that border the Great Lakes are not generally considered to be part of the Rust Belt, including New York to the east and Minnesota to the west. Data from these states will not be included for the purposes of this study. In addition, several Rust Belt states with comparatively smaller Great Lakes coastlines, including Indiana (45 miles) and Illinois (63 miles), were not included. As such, those states (Minnesota, Illinois, Indiana, and New York) were omitted from the sample set of other US states, as was Iowa, a Rust Belt state with no coastline. That left Ohio (312 miles), Wisconsin (820 miles), Michigan (3,224 miles), and Pennsylvania (140 miles) as a sample set of Rust Belt states, with particular focus on Michigan due to its extensive coastline (Office for Coastal Management, 2020).

This study used a cross-sectional analysis to assess water pollution resulting from industrial productivity/output in terms of several different GLWQA milestones. Therefore, this study focused on datasets during the first and subsequent years in which various water pollution regulations were enforced, including 2002 (one year after the GLCA was enacted), 2014 (the first year in which the GLWQA was fully enforced and implemented), and 2018 (one year after the IJC's progress report and edicts). The total on-site and off-site disposal or releases of chemicals (total pollution) was used from the US Environmental Protection Agency's (EPA) Toxic Release Inventory (TRI) from the most recent year (2020) (EnviroEPA, 2021). The composite pollution rates were extracted from the TRI, a publicly-available EPA database containing information on the release of toxic chemicals (Antisdel, 2017). In order to assess economic data specific to industrial output, statistics from the US Bureau of Economic Analysis (BEA), a federal database, were used to ascertain annual state GDP specifically related to the manufacturing process, or "Annual Gross Domestic GDP by state, GDP current dollars" (Bureau of Economic Analysis, 2021).

To obtain a comparable method for assessing pollution related to manufacturing output, or a pollution efficiency index (PEI), variables for both pollution and productivity must be included. A larger PEI would indicate a more efficient manufacturing process in terms of pollution. Before extremes were removed, the PEIs of the non-Rust Belt states were much higher than those of the Rust Belt states, especially in 2014 and 2018, when non-Rust Belt states had a whopping 52.2 and 69.5 times the PEI of the Rust Belt states (see below) during those years (see table 1 below). Extreme values were omitted because there were outliers for the PEI in the first two sample sets (the following states were removed whose PEI was larger than 2,000,000 in at least one year: Arizona, Massachusetts, New Hampshire, Rhode Island).

When omitting the outlier states in the non-Rust Belt sample set, the Rust Belt states were actually producing more efficiently in terms of pollution for 2002 (33,060.3 PEI versus 14,941.8 PEI) but by 2018, they were producing 3.77 times less efficiently (19,970.9 versus 75,349.9) compared to the rest of the country, and by 2018 the Rust Belt's production efficiency was similar to that of 2014 (27,564.6 versus 74,673.7, or 3.71 times more efficient).

Table 1. Average PEIs of Non-Rust Belt/Rust Belt

	2002	2014	2018
with Extremes: Non-Rust Belt PEIs vs Rust Belt PEI's	4.11	52.21	69.49
No Extremes: Non-Rust Belt PEIs vs Rust Belt PEI's	.45	3.77	3.71

The quantitative tests of significance utilized include the Welch Test, f-test, and Mann-Whitney U test (see below). From the f-test's output, it was determined that the variances of the Rust Belt versus non-Rust Belt sample sets were different; the p-value for the f-test was less than 0.05, the level of significance (see below).

Additional tests were performed to assess if the sample sets had normal distributions. The Mann-Whitney

U test, a nonparametric test of the null hypothesis utilized for randomly selected values x and y from two different populations, found that these groups showed normal distribution among the non-Rust Belt states, partially because of the larger sample set of 41 states. For this test, if the p-value is larger than 0.05, it can be claimed that the distributions of two groups are roughly equal. Since the p-values were larger than 0.05, it can be stated that there is no significant difference between the two groups. Subsequently, if the p-value for the Welch test is larger than 0.05, we can claim that there is no significant difference between the means of two groups. This was the case, thus confirming the results of the Mann-Whitney U test. As such, we can state that there were not significant differences between the sample sets.

Table 2. PEI means of both sample sets: P-value for various tests of significance

Year	*f*-test	Welch test	Mann–Whitney U test
2002	0.05494	0.2041	0.1514
2014	<<0.01	0.2357	0.1729
2018	<<0.01	0.06307	0.5669

Future Studies

Since Rust Belt producers were polluting at extremely efficient rates in 2002 but not in 2014, one could infer that since the 2012 GLWQA became fully enforced by 2014, further analysis from prior years should be conducted to ascertain what factors led to this shift. Whatever the turning point, similar PEI means within the sample sets of Rust Belt and non-Rust Belt states in 2014 and 2018 provide a glimpse of the consistency in production efficiency during this era. Whatever changes were made in the production process as it relates to air pollution had become widespread.

Since the state of Michigan merited additional analysis, it should be noted that it had a massive 9.6 times the average PEI of the other three Rust-Belt states in the sample set in 2002, but that dwindled to 2.8 times the average PEI in 2014 and 1.6 in 2018. Further analysis should focus on the relative production efficiency of Michigan and what changes prompted it to produce so efficiently in terms of pollution in 2002 and to continue to do so but to a lesser extent today.

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Appendix A.

Histogram of average PEI of Rust Belt versus non-Rust Belt for the three years in the sample sets (extremes removed)

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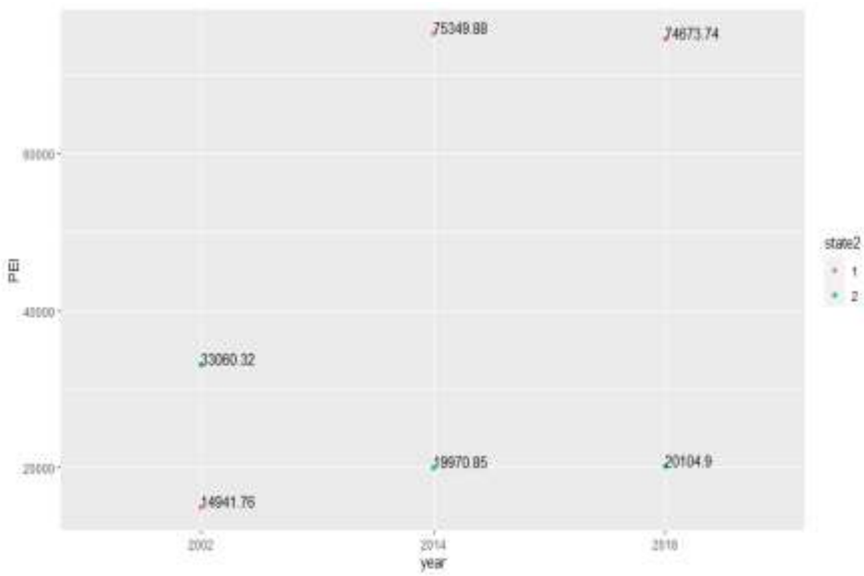
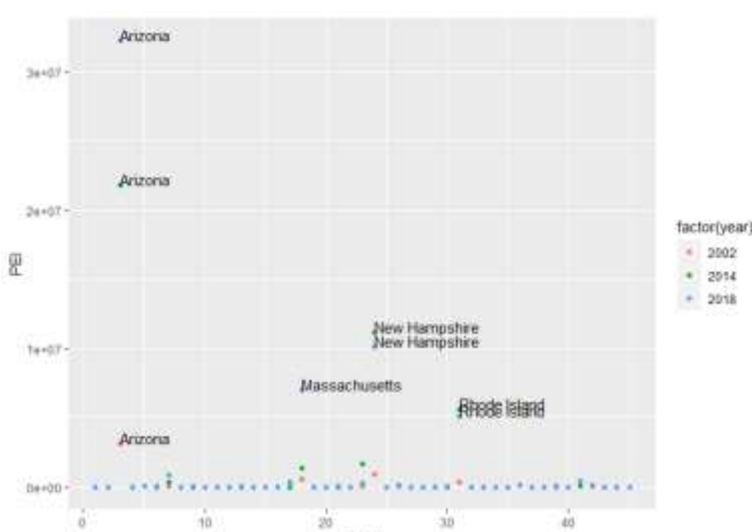


Appendix B.

Histogram of individual state PEI for the three years in the sample sets (extremes not removed)



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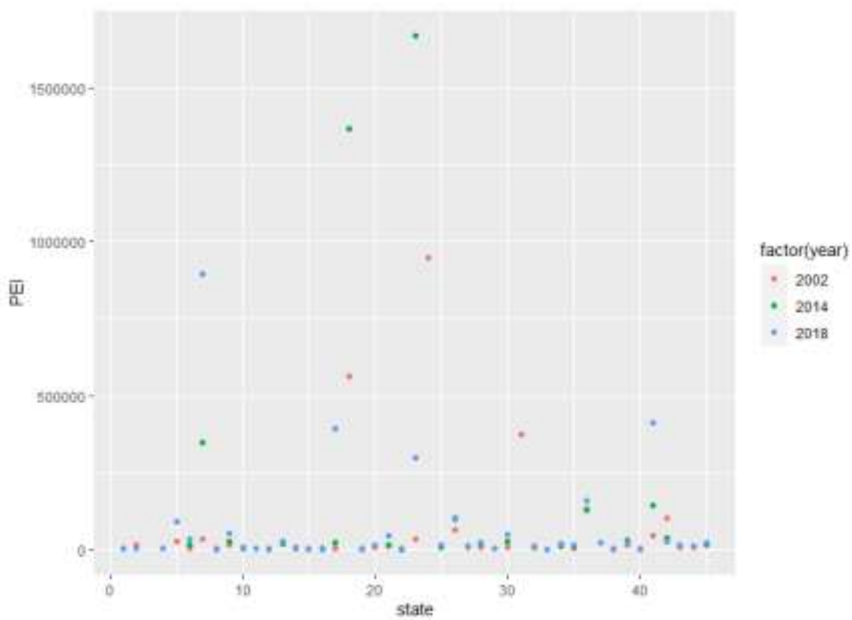
Appendix C.
Histogram of individual state PEI for the three years in the sample sets with extremes (PEI>2000000) removed



Appendix D.
Histogram of individual state PEI for the three years in the sample sets with extremes (PEI>2000000) removed

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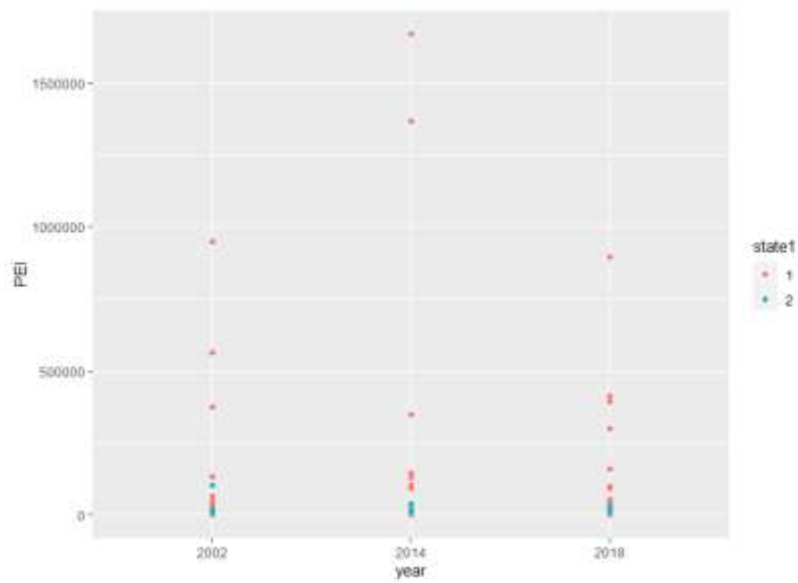

Appendix E.

Statistics used for the 2002 sample set

	Water Pollution 2002 (millions of lbs)	GNP 2002 (related to manufacturing: millions of USD)
Alabama	7.2	21,249.6
Alaska	.0665	918.6
Arizona	.0071	22,328.7
Arkansas	3.5	14,711.1
California	5.8	162,315.4
Colorado	5.0	14,876.6
Connecticut	.7495	25,948.8
Delaware	.9288	3,352.4
Florida	2.3	30,935.4
Georgia	10.5	44,628.1
Hawaii	.4546	979.6
Idaho	5.3	5,266.5
Kansas	.7216	15,032.2
Kentucky	3.0	25,013.5
Louisiana	11.6	21,226.3
Maine	3.6	4,500.3
Maryland	3.2	15,434.6
Massachusetts	.0658	36,977.7
Mississippi	8.8	10,828.0
Missouri	4.4	29,758.0

Montana	.1031	1,270.2
Nebraska	13.1	7,394.8
Nevada	.0929	3,157.1
New Hampshire	.0069	6,542.9
New Jersey	4.8	44,999.4
New Mexico	.0688	4,522.4
North Carolina	8.8	69,174.9
North Dakota	.1974	1,758.9
Oklahoma	3.1	11,562.0
Oregon	2.6	20,655.7
Rhode Island	.0124	4,647.7
South Carolina	3.0	26,114.0
South Dakota	2.4	3,683.3
Tennessee	3.0	35,047.2
Texas	30.0	105,120.4
Utah	.0632	8,427.4
Vermont	.1192	2,906.0
Virginia	18.0	34,504.1
Washington	2.2	31,866.4
West Virginia	4.3	5,557.4
Wyoming	.021	955.6
Michigan	.8341	84,070.9
Ohio	8.9	83,777.7
Pennsylvania	9.7	74,670.1
Wisconsin	3.0	43,013.3

Source: EPA Fact Sheet
Source: BEA

Appendix F.
Statistics used for the 2014 sample set

	Water Pollution 2014 (millions of lbs)	GNP 2014 (related to manufacturing: millions of USD)
Alabama	14.2	33,282.3
Alaska	.7965	1,589.4
Arizona	.0011	24,016.5
Arkansas	4.6	17,638.4
California	2.9	264,400.1
Colorado	1.5	22,293.7
Connecticut	.0848	29,319.7
Delaware	2.9	4,021.6
Florida	1.6	42,820.0
Georgia	16.0	52,572.2
Hawaii	.5341	1,671.2
Idaho	2.8	7,264.3

Kansas	1.2	21,811.9
Kentucky	6.9	34,759.1
Louisiana	13.3	49,488.5
Maine	2.8	5,518.8
Maryland	.8183	19,450.3
Massachusetts	.0357	48,745.0
Mississippi	7.6	16,165.4
Missouri	2.2	36,468.2
Montana	.2257	3,021.6
Nebraska	11.6	12,926.6
Nevada	.0037	6,174.5
New Hampshire	.000663	7,399.3
New Jersey	5.3	46,036.3
New Mexico	.0356	3,671.2
North Carolina	8.6	90,974.8
North Dakota	.2024	3,665.0
Oklahoma	3.7	18,053.3
Oregon	1.1	28,355.8
Rhode Island	.000769	4,306.6
South Carolina	3.3	31,181.5
South Dakota	2.8	4,174.1
Tennessee	4.2	47,177.1
Texas	16.7	202,207.5
Utah	.1262	16,272.8
Vermont	.1248	2,742.6
Virginia	11.1	40,223.7
Washington	2.2	62,620.4
West Virginia	2.0	7,177.8
Wyoming	.0121	1,744.0
Michigan	2.2	86,085.2
Ohio	6.9	104,944.1
Pennsylvania	8.2	86,730.0
Wisconsin	3.8	56,877.1

Source: EPA Fact Sheet
Source: BEA

Appendix G.
Statistics used for the 2018 sample set

	Water Pollution 2018 (millions of lbs)	GNP 2018 (related to manufacturing: millions of USD)
Alabama	11.0	37,617.1
Alaska	.5281	1,842.6
Arizona	.000897	28,943.5
Arkansas	5.7	19,323.8
California	3.5	320,738.6
Colorado	.768	25,750.7

Connecticut	.0331	29,658.9
Delaware	5.4	4,802.3
Florida	1.1	56,186.9
Georgia	7.4	63,316.8
Hawaii	.7499	1,999.5
Idaho	2.8	8,607.4
Kansas	.9888	27,574.4
Kentucky	6.0	37,745.2
Louisiana	14.3	52,248.1
Maine	5.2	6,169.5
Maryland	.0624	24,449.8
Massachusetts	.0075	52,613.6
Mississippi	8.4	18,773.9
Missouri	2.7	39,006.6
Montana	.0747	3,320.0
Nebraska	3.7	13,538.2
Nevada	.0265	7,919.2
New Hampshire	.000956	9,693.0
New Jersey	3.7	52,261.8
New Mexico	.0421	4,177.6
North Carolina	7.8	100,739.6
North Dakota	.1731	3,989.5
Oklahoma	3.6	18,465.1
Oregon	.7025	34,053.9
Rhode Island	.000999	5,094.4
South Carolina	3.6	38,389.7
South Dakota	2.9	5,134.8
Tennessee	3.2	54,969.3
Texas	17.8	237,661.6
Utah	.1233	19,581.7
Vermont	.1284	3,106.1
Virginia	9.1	45,274.5
Washington	2.9	64,551.8
West Virginia	2.2	8,085.3
Wyoming	.0055	2,259.9
Michigan	3.6	99,232.7
Ohio	6.8	111,490.6
Pennsylvania	7.5	91,486.9
Wisconsin	2.6	63,078.7

Source: EPA Fact Sheet
Source: BEA