



Business Success Center

# **The Economic Impact of the Fox Locks**

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## Executive Summary

This report explores the economic impact of the Fox Locks system. Stretching from Menasha to DePere, the Fox Locks represents a system of 17 locks on the Fox River. Beginning in 2005, the Fox River Navigational System Authority (FRSNA) was authorized to begin a \$14.5 million project to renovate the lock system. This report first evaluates the economic contribution of the completed work since 2005. Next, the report estimates the future economic impact of the locks under four different scenarios: (i) Menasha and Rapid Croche locks are closed (ii) Rapid Croche opens, Menasha is closed (iii) Rapid Croche is closed, Menasha opens, and (iv) All locks are fully operational. Summarizing the main findings:

- The work to date restoring the locks has contributed the following to the Fox Valley Regional economy from 2005-2015 (Menasha is closed Scenario):
  - \$64.4 million in total output
  - \$39.2 million in labor income
  - 1458 jobs
  - \$22 million in business investment
- The **additional** economic impact of opening each of Menasha and Rapide Croche accumulated over a 10 year period starting in 2018:
  1. Menasha is opened, Rapide Croche is closed:
    - \$42.9 million in *additional* total output accumulated over 10 years
    - \$26 million in *additional* labor income accumulated over 10 years

- 939 *additional* jobs accumulated over 10 years
  - \$14.6 million in *additional* business investment accumulated over 10 years
2. Menasha is opened, Rapide Croche receives boat transfer station:
    - \$210 million in *additional* total output accumulated over 10 years
    - \$127.7 million in *additional* labor income accumulated over 10 years
    - 4,595 *additional* jobs accumulated over 10 years
    - \$71.8 million in *additional* business investment accumulated over 10 years
  3. Rapide Croche receives boat transfer station, Menasha is closed:
    - \$167.7 million in *additional* total output accumulated over 10 years
    - \$102 million in *additional* labor income accumulated over 10 years
    - 3,669 *additional* jobs accumulated over 10 years
    - \$57.3 million in *additional* business investment accumulated over 10 years
- Over the next 10 years, the proposed Visitors’ Center has a potential economic impact of:
    - \$79.7 million in *additional* total output accumulated over 10 years
    - \$48.5 million in *additional* labor income accumulated over 10 years
    - 1,744 *additional* jobs accumulated over 10 years
    - \$27.2 million in *additional* business investment accumulated over 10 years
  - In total, a fully functioning Lock system, including the visitors’ center has a 10 year potential economic impact of:
    - \$290 million in *additional* total output accumulated over 10 years
    - \$176 million in *additional* labor income accumulated over 10 years
    - 6,339 *additional* jobs accumulated over 10 years
    - \$99 million in *additional* business investment accumulated over 10 years

# 1 Introduction and Overview

Stretching from Menasha to DePere, the Fox Locks represents a system of 17 locks on the Fox River. Figure 1 provides a map of the Lock system. Beginning in 2005, the Fox River Navigational System Authority (FRNSA) was authorized to begin a \$14.5 million project to renovate the lock system. Currently, 16 of the 17 locks have been restored and are potentially fully operational; however, due to concerns regarding an aquatic invasive species (AIS), the Menasha lock is closed (it was open from 2005-2015 and was closed in September of 2015). Similarly, the lock at Rapid Croche is closed, although the FRNSA has a proposed plan to make the lock operational via a boat transfer and cleaning station.

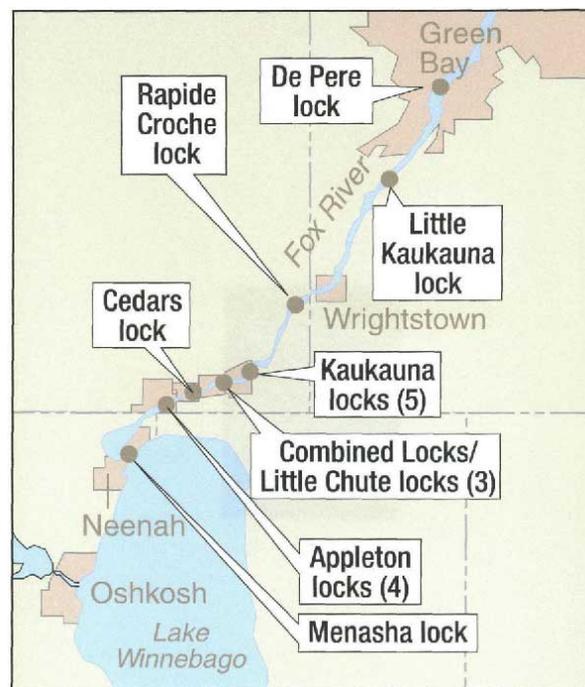


Figure 1: Map of Lock System

This report has two primary objectives: 1) Evaluate the economic impact of the locks and their restoration work, and 2) evaluate the future economic impact of differing levels of lock functionality, depending on what combinations of locks currently closed are opened and usable. While the details are described below in Section 2, the amount and timing of restorations and maintenance to the Locks represents the key starting point for the analysis.

Since 2005, restoration on the existing locks occurred at the following dates:<sup>1</sup>

- 2005: Little Chute
- 2006: Appleton 1-4
- 2007: Cedars
- 2008: Little Chute
- 2009: Combined Locks
- 2011: Kaukauna 4
- 2012: Kaukauna 3 and 5
- 2013: Kaukauna 2
- 2014: DePere, Kaukauna 1, and Menasha

Over this period of time, \$14.5 million was invested in the Fox Valley Regional economy. Section 3 of this economic impact analysis examines the contribution of this previous work. In Section 4, the potential future impact of the Locks system is evaluated under several different scenarios. As discussed above, two locks are currently closed. The lock at Rapide Croche is closed indefinitely to help prevent transmission of aquatic invasive species (AIS) from the Great Lakes to Lake Winnebago. Similarly, the Menasha lock is closed since September 2015 due to AIS concerns (round goby). Thus, there exist four different scenarios to analyze:

1. Current system, Menasha and Rapide Croche stay closed
2. Menasha lock re-opened, Rapide Croche stays closed
3. Rapide Croche opened, Menasha stays closed
4. Both Rapide Croche and Menasha open

Water sports and related activities represent an important component of the Wisconsin economy, and this is especially true of the Fox Valley Region. With two large lakes, the Fox River, and access to Lake Michigan, the water sport possibilities are significant. Indeed boating, fishing, and other related water activities have a large economic impact on the Fox Valley Regional economy. According to data from the National Marine Manufacturers Association (NMMA), in 2015 recreational boating had an estimated total economic impact of \$603.5 million and \$742.8 million in Congressional Districts 6 and 8, respectively (which

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<sup>1</sup>See <http://www.foxlocks.org/the-locks/lock-system-overview/>

includes the region defined for the Locks contribution).<sup>2</sup> Thus, recreational boating contributes \$1.3 billion annually to the Fox Valley Regional economy, representing nearly 12% of total output (GDP) in the Fox Valley Regional economy. Similarly, a 2006 Economic Impact analysis of fishing activities on Lake Winnebago found a total economic impact of \$234 million annually. Adjusted for inflation, this is equivalent to an annual economic impact of \$275 million in 2016.

These studies show the importance of water-sports and activities to the Fox Valley Regional economy. Although these previous studies are not used in the analysis below, they are presented here simply to show the importance of water-sports and related activities to the local economy. The Locks represent a key component of the interconnected waterways supporting this economic activity. The goal of this analysis is to estimate the past and potential future impact of the Locks on the Fox Valley Regional economy.

It is also worth noting that the analysis in this report characterizes the potential gains from different levels of functionality of the Locks, assuming the necessary AIS protections are in place. In this regard, this report focuses only on characterizing the potential economic gains; as a result, it is not a cost-benefit analysis. A full cost-benefit analysis would require estimating models to quantify the varying probabilities of AIS issues potentially propagated by the Locks, as well as estimating their potential economic costs. While AIS protections may be utilized, as with all bodies of water, there exists some risk of potential AIS issues. The economic impact numbers presented in this report should be considered relative to these potential future costs.

Within each combination of lock openings/closures, different scenarios are analyzed to estimate the future impact of the Locks on the Fox Valley Regional economy over the next 10 years. The next section describes the details of the approach taken in this study, along with the data and methodology.

## 2 Methodology, Approach, and Data

The Locks have several ways to contribute to the Fox Valley Regional economy. Most immediately, the \$14.5 million spent on lock repairs and renovations directly contributes. Many industries are supported in this process. Of course, the impact stretches beyond the immediate impact of \$14.5 million. Specifically, there exist two other possibilities for evaluating the total economic impact.

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<sup>2</sup>See <https://www.nmma.org/statistics/publications/economic-impact-infographics>

First, one could examine the additional spending created by a functioning Lock system. Since 2005, over 30,000 people and more than 6,000 boats have travelled through the locks system. When recreational boaters and other water craft (e.g. kayaks) use the locks, they spend money in the local economy. For example, on a trip through the locks, a group of 4 people in a boat eat lunch, purchase gasoline and other supplies for the boat, and may shop at local stores along the way. Traditional economic impact analyses (using an input-output model) focus on this injection of spending. This is referred to as an increase in final demand. To meet this increase in demand, local business produce more goods and services from other local businesses, causing the total impact to be a multiple of the initial injection of spending.

There are two reasons why examining additional spending by lock boaters is inappropriate to judge the economic impact of the Locks. First, to be valid, the spending by boaters would have to be from visitors to the area; that is, it must be truly *new* spending to the area. While indeed some users of the locks come from out of the area, many others do not. Lacking consistent data on the residence of Lock users, the spending approach becomes infeasible. Moreover, this approach requires one to estimate the number of additional visitors that can be directly attributable to the opening of the Locks, which again is difficult given currently available data.

Second, the economic impact of the Locks is potentially well beyond the additional spending by lock users. Specifically, a functioning lock system provides opportunities for expansion of local businesses. If lock users dock boats and explore local surroundings, the value of investing in expansions and new businesses increases. In addition, the Locks provide various educational opportunities for users and visitors of the locks. Indeed, the planned Visitor's Center in Appleton is intended to highlight and expand these educational opportunities. Viewed in this light, the lock restorations function similarly to investments in education. This second effect is not well captured, if at all, by a traditional input-output model based economic impact study.

## 2.1 Approach

To begin, consider how any additional spending or business investment affects a local economy. To understand this question, we must first break down how an economy operates. An economy produces goods/services that are referred to as **output**. To produce output, an economy needs three key ingredients: (i) Capital, (ii) Labor, and (iii) Infrastructure. Capital refers to the buildings, factories, machines, equipment, etc. that a business uses to produce its products/services. Labor refers to the workers a business employs, and infrastructure refers

to **Public Capital**, which is roads, bridges, power supplies, schools, etc. that facilitate business activity.

For example, consider a restaurant. To produce meals for customers, the restaurant needs a building and cooking equipment (ovens, refrigerators, etc.). This represents the restaurant's Capital. In addition, the restaurant will need employees to operate the equipment, prepare the food, and serve customers. This represents the restaurant's Labor. Finally, the restaurant needs functioning roads/railways/waterways to transport the raw materials it uses and to allow customers and workers to access their establishments, as well as a school system to educate its owners and workers. This represents the Infrastructure.

The value of infrastructure, or public capital, on economic activity has been well established in existing research.<sup>3</sup> Consider the restaurant example. Suppose that initially access to the restaurant's location was somewhat restricted. If the area invests in infrastructure improvements that increase access to the restaurant, the restaurant becomes more productive. They will produce more meals and services, and hire more workers. The restaurant will likely also have to purchase additional capital, referred to as business investment. Moreover, with improved access and expansion of this particular restaurant, and as the increased incomes of employees leads to more spending in the area, other businesses may decide to locate nearby. Thus, the initial increase in infrastructure investment increases overall economic activity by a multiple of the initial investment.

A similar scenario is true with respect to the Locks. Functioning locks increase the infrastructure value of the Fox river and nearby lakes. For example, consider the recent riverfront development in Appleton. Local housing, a coffee shop (Temptest), restaurant (Mr. Brews Taphouse), and hotel (Marriot) have all been built along the waterfront. Indeed, the water access represents a key component of the profitability of these investments for local businesses. While the functioning locks that increase access to this area do not represent the sole reason for this increased economic activity, it does represent a crucial improvement/investment in the infrastructure that supports this economic activity. The analysis presented in this report estimates the economic impact of the Lock system via its value as infrastructure.

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<sup>3</sup>See for example [Glomm and Ravikumar \(1997\)](#) and [Seung and Kraybill \(2001\)](#) among many others.

## 2.2 Methodology

Defining the relevant local economies potentially impacted represents an important first step in the analysis. Again, the economic impact of the Locks stems from its value as infrastructure for local economies; therefore, the lakes and waterways used by the locks, or accessible via the locks, represent areas of potential impact. Given this, the Fox Valley Regional economy is defined from Green Bay to Fond du Lac. This represents Brown, Calumet, Outagamie, Winnebago, and Fond du Lac counties.

To estimate the economic impact of the infrastructure investments represented by the Locks, a model of the local economy is developed. Estimating the relationship between output, labor, capital, and infrastructure in the local economy represents a key foundation. Towards this end, a *production function* must be estimated for the Fox Valley Regional economy. An attached Technical Appendix describes the details of the specification of this production function and its estimation.

Having estimated a production function, with data on actual output, employment, capital, and public capital (infrastructure), a model is specified that describes local business investment decisions (how much capital to use) and employment decisions (how much labor to hire and at what wages), taking as given the level of infrastructure. This model is then fitted to existing data on the Fox Valley Regional economy as a benchmark. From this benchmark, the desired “experiments” are conducted, varying the available infrastructure based on different levels of Locks functionality.

## 2.3 Data

As discussed above, estimating a production function and fitting the model require data for the Fox Valley Regional economy. Regional economic data is available from the U.S. Department of Commerce via the Bureau of Economic Analysis (BEA).<sup>4</sup> For some necessary data series, regional availability is given by Metropolitan Statistical Areas (MSA). Given the aforementioned definition of the Fox Valley Regional economy, the appropriate MSAs are: Green Bay, Appleton, Oshkosh-Neenah, and Fond du Lac.<sup>5</sup>

To estimate the model, data on Real GDP (Gross Domestic Product), Employment, and Public Capital (Infrastructure) is needed. Real GDP and Employment data were obtained from the BEA. Data on Public Capital is not readily available and thus must be constructed.

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<sup>4</sup>This data was obtained at <https://www.bea.gov/regional/index.htm>.

<sup>5</sup>MSAs are defined and determined by the Office of Management and Budget, <https://www.whitehouse.gov/omb>.

In this study, estimates of public capital for the State of Wisconsin were obtained from two sources, [Holtz-Eakin \(1993\)](#) and [Fisher and Wassmer \(2013\)](#). From these sources, the stock of public capital is estimated at 2.89% of real GDP and is nearly constant across the relevant years. Thus, the stock of public capital is calculated based on this fraction of Real GDP for the Fox Valley Regional economy. The remaining details of the estimating procedure and data benchmarks is discussed in the Technical Appendix.

### 3 Economic Impact of the Locks: 2005-2015

The analysis begins by estimating the total economic impact of the Locks over the course of their renovations and repairs, namely from 2005-2015. This is accomplished by using the model of the Fox Valley Regional economy to predict what *would* have occurred had none of the Locks been restored. That is, decrease the actual stock of public capital in a particular year by the amount of work done on Locks in that year. Given this counterfactual level of infrastructure, what would GDP, employment, investment, and wages be? The difference between the actual data and this counterfactual outcome gives the economic impact of the Locks renovations.

Table 1: Economic Impact of Locks: 2005-2015

Variable	Contribution of Locks
GDP	\$64,421,074
Labor Income	\$39,168,013
Investment	\$22,047,490
Employment	1,458

Table 1 displays the cumulative economic impact of the Locks from 2005-2015. In terms of total output, the Locks contributed \$64.4 million in additional GDP to the Fox Valley Regional economy. The Locks also contributed an additional \$39 million in Labor Income, stemming in part from the additional 1,458 jobs attributable to the Locks, and from an increase in wages paid by firms. Wages increase primarily due to the increase in the capital stock attributable to the Locks. When capital increases, workers become more productive and earn higher wages. Combined with the increase in employment, total Labor Income increased. Finally, investment increased by a cumulative sum of \$22,047,490, which is calculated as the difference in capital income in the baseline case (data) and the counterfactual economy (with no Locks renovations).

In Table 1, the results apply only to the direct impact of the Locks renovations. That is, in each year a lock is renovated, the appropriate amount of infrastructure is removed from the economy in that specific period; however, the cumulative effect of removing the infrastructure is not calculated. To examine the full impact of the renovations, one must consider the cumulative effect of removing the infrastructure. Consider the following example.

Suppose that each lock involves an infrastructure investment of \$1 million. In year 1 one lock is renovated, 1 is renovated in year 2, and 3 are renovated in year 3. This implies a total investment of 5 locks or \$5 million. In Table 1, the observed stock of public capital is reduced by \$1 million in year 1, \$1 million, year 2, and then \$3 million in year 3. This gives the economic impact of each lock individually, but does not cumulate the total impact of having none of the locks renovated. The total cumulative impact is represented by reducing the stock of public capital by \$1 million in year 1, \$2 million in year 2, and then \$5 million in year 3. The total cumulative impact of the Locks on the Fox Valley Regional economy is presented in Table 2.

Table 2: Total Cumulative Impact of the Locks: 2005-2015

Year	Real GDP (\$'s)	Labor Income (\$'s)	Employment	Investment (\$'s)
2005	2,541,511	1,545,239	-	870,596
2006	13,121,962	7,978,153	18	4,489,106
2007	17,343,479	10,544,835	109	5,932,899
2008	21,739,819	13,217,810	216	7,436,369
2009	26,616,553	16,182,865	341	9,104,207
2010	29,312,554	17,822,033	486	10,026,271
2011	34,571,717	21,019,604	630	11,824,942
2012	42,748,471	25,991,070	790	14,621,411
2013	48,447,602	29,456,142	985	16,570,465
2014	60,567,592	36,825,096	1,203	20,715,558
2015	65,925,986	40,083,000	1,474	22,548,198
Total	362,937,247	220,665,846	6,252	124,140,021

Imagine the following counterfactual: none of the Locks were renovated, and thus none are usable. Taking the difference between predictions with no locks and what actually occurred calculates the value of the entire lock system. Table 2 presents these results. From 2005-2015 the Lock system contributed a total of nearly \$363 million in real GDP (output), \$220.7 million in labor income, 6, 252 additional jobs, and \$124 million in capital investments. This amounts to an average of \$33 million each year from 2005-2015 in total additional economic activity. This cumulative look at the value of the Locks further underscores its importance

to the Fox Valley Regional economy. If the locks are all closed at some point in the future, the last row of Table 2 displays what impact this would have on the local economy over a 10 year period.

## 4 Economic Impact of Rapide Croche and Menasha Locks

This section analyzes the economic value of both the Menasha and Rapide Croche locks. As both locks currently are closed, a baseline predicted path for the economy must be established. The projected future path of the key economic variables for the Fox Valley Regional economy are first estimated using a linear time-trend specification. Having estimated a specification for each of real GDP, employment, and population growth, the remaining variables can similarly be computed/imputed from the model economy. This exercise then predicts levels for real GDP, employment, labor income, and investment for the next 10 years.<sup>6</sup> Once the benchmark future economy is established, the counterfactual cases may be analyzed. Each case is now discussed.

### 4.1 Menasha is opened and Rapide Croche is closed

If the Menasha lock is opened, this increases the value of existing infrastructure. The lock has already been restored and had been operational, so opening the lock also restores the infrastructure value. If the Rapide Croche lock remains closed, however, there is no change to the baseline level of public capital. Thus, the first experiment increases infrastructure by the value of the Menasha lock, and recomputes the levels for real GDP, employment, labor income, and investment for the next 10 years. The value of the Menasha lock is assumed as a baseline to be equal to the average infrastructure value of 1 lock, which is equivalent to distributing the \$14.5 million investment equally across the locks repaired. This assumption almost certainly understates the full impact of the Menasha lock, as this lock was the most used in the system, acting as a gateway to Lake Winnebago; as a result, Menasha is likely significantly more valuable than average.

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<sup>6</sup>The levels predicted for the baseline economy do not affect the results presented here. Since the production function exhibits constant returns to scale (i.e. homogeneous of degree 1), any level changes in real GDP result in proportionate changes in capital, labor, and public capital. Assuming that real GDP grows somewhere approximately close to trend in the future, the estimates presented here will not vary significantly if real GDP varies mildly from its predicted value.

Table 3: Economic Impact of Menasha Lock over 10 years

Year	Real GDP (\$'s)	Labor Income (\$'s)	Employment	Investment (\$'s)
1	2,865,331	1,742,121	18	978,447
2	3,187,099	1,937,756	35	1,088,479
3	3,507,351	2,132,469	52	1,197,992
4	3,825,816	2,326,096	70	1,306,893
5	4,142,230	2,518,476	86	1,415,093
6	4,456,328	2,709,448	103	1,522,502
7	4,767,856	2,898,856	120	1,629,031
8	5,076,560	3,086,548	136	1,734,594
9	5,382,194	3,272,374	152	1,839,108
10	5,684,518	3,456,187	167	1,942,489
Total	42,895,282	26,080,332	939	14,654,628

Table 3 displays the effect of opening the Menasha lock over the next 10 years. In total over the next 10 years, the Menasha lock has the potential to bring an additional \$43 million in total output, \$26 million in labor income, and additional 939 jobs, and increases capital investment by a total of \$14.6 million. In addition, notice that the annual impact of opening the Menasha lock, *adjusted for inflation*, grows each year. This occurs as the additional infrastructure generates more investment, increasing the capital stock, and generating more employment. These affects accumulate over time. This represents the economic growth potential of the infrastructure value of the Locks.<sup>7</sup>

Table 4: Economic Impact of Opening Both Menasha and Rapide Croche

Year	Real GDP (\$'s)	Labor Income (\$'s)	Employment	Investment (\$'s)
1	14,030,819	8,530,738	86	4,797,044
2	15,607,474	9,489,344	172	5,336,247
3	17,176,710	10,443,440	257	5,872,912
4	18,737,205	11,392,221	340	6,406,588
5	20,287,655	12,334,895	423	6,936,829
6	21,826,781	13,270,683	505	7,463,197
7	23,353,325	14,198,822	585	7,985,261
8	24,866,054	15,118,561	665	8,502,601
9	26,363,764	16,029,169	743	9,014,805
10	27,845,279	16,929,930	820	9,521,469
Total	210,095,067	127,737,801	4,595	71,836,954

<sup>7</sup>See Glomm and Ravikumar (1997), Rioja (2003), Gibson and Rioja (2017), among others for discussion of the economic growth potential on infrastructure investments.

## 4.2 Menasha is opened, Rapide Croche receives boat transfer station

In this scenario, in addition to the infrastructure impact of the Menasha lock described in Section 4.1, the planned boat transfer and cleaning facility is completed at Rapide Croche, making this lock also fully operational. The boat transfer and cleaning facility is estimated to cost \$3.8 million and would be potentially operational by 2018 (the start date does not impact the estimated economic impact). Based on these scenarios, Table 4 shows the economic impact on Real GDP, Labor Income, Employment, and Investment over the next 10 years. In total, over the next 10 years a fully functional lock system has the potential to add an additional \$210 million in output, \$127.7 million in labor income, nearly 5,000 jobs, and an additional \$71.8 million in capital investments. On average, this represents an additional \$21 million annually to the Fox Valley Regional economy.

## 4.3 Rapide Croche receives boat transfer station, Menasha Lock is closed

Assuming Rapide Croche receives the boat transfer and cleaning station while Menasha is closed represents the final Lock scenario to analyze. As discussed above, the proposed boat transfer and cleaning facility is estimated to cost \$3.8 million. Table 5 displays the 10 year impact of increasing the level of infrastructure in the Fox Valley Regional economy by this amount.

Table 5: Economic Impact of Rapid Croche Boat Transfer, Menasha is closed

Year	Real GDP (\$'s)	Labor Income (\$'s)	Employment	Investment (\$'s)
1	11,202,308	6,811,003	69	3,829,694
2	12,460,889	7,576,220	137	4,260,115
3	13,713,542	8,337,833	205	4,688,509
4	14,959,212	9,095,201	272	5,114,515
5	16,196,858	9,847,690	338	5,537,776
6	17,425,458	10,594,679	403	5,957,944
7	18,644,008	11,335,557	467	6,374,675
8	19,851,523	12,069,726	531	6,787,632
9	21,047,042	12,796,601	593	7,196,486
10	22,229,624	13,515,611	655	7,600,915
Total	167,730,464	101,980,122	3,669	57,348,260

From Table 5, in total, a functional lock at Rapide Croche has a potential economic impact of \$167.7 million of additional output, \$101.9 million in labor income, and additional 3,700 jobs, and an additional \$57.3 million in capital investments. Annualized this is equivalent to an additional \$16.7 million of total economic activity per year.

#### 4.4 Appleton Visitors' Center

Finally, this section examines the potential economic impact of completing the proposed Appleton Visitors' Center. As discussed above, the proposal is for a \$1.8 million Visitor's Center located at Appleton Lock 3 (see <http://foxlocks.org/visitor-center/> for more details).

Table 6: Economic Impact of Appleton Visitors' Center over 10 years

Year	Real GDP (\$'s)	Labor Income (\$'s)	Employment	Investment (\$'s)
1	5,324,628	3,237,374	33	1,819,527
2	5,922,633	3,600,961	65	2,024,031
3	6,517,818	3,962,834	97	2,227,571
4	7,109,683	4,322,687	129	2,429,976
5	7,697,731	4,680,220	161	2,631,075
6	8,281,476	5,035,137	192	2,830,702
7	8,860,441	5,387,148	222	3,028,695
8	9,434,157	5,735,968	252	3,224,892
9	10,002,168	6,081,318	282	3,419,139
10	10,564,027	6,422,928	311	3,611,281
Total	79,714,760	48,466,574	1,744	27,246,889

Table 6 displays the potential economic impact each year over the next 10 years. As previously discussed, the potential economic impact of the Visitors' Center is significant as it may be viewed similarly to an investment in education. Indeed, Table 6 confirms this, showing a total potential impact of an additional \$79.7 million of output, \$48.5 million in labor income, 1,744 additional jobs, and \$27.2 million in additional capital investments. On average, this represents a potential \$7.9 million per year of additional economic activity. As with the other cases examined, the economic impact of the visitors' center increases over time (after adjusting for inflation), reflecting the economic growth potential of such investments in the infrastructure in the Fox Valley Regional economy.

## 5 Total Potential Impact of the Locks and the Economic Impact of Related Activities

This section cumulates the total impact of the Locks under each scenario above. To begin, first combine the future potential impact of each lock opening/closing scenario with the economic impact of the Visitors' Center, which occurs in each scenario. Table 7 presents the total 10 year impact on the relevant economic variables, and Table 8 displays the average annual contribution in each variable under each scenario. From Table 8, on average, having both the Menasha and Rapide Croche locks open has the potential to contribute \$29 million in total output, \$17.6 million in additional Labor Income, \$634 additional jobs, and \$99 million in additional capital investment, *each year* for the next 10 years.

As a matter of comparison, consider the economic impact of the EAA AirVenture event on the Fox Valley Regional Economy. Based on a recent study of its economic impact, in 2017 it contributed a total of \$170 million in additional economic activity, including around 2,000 additional jobs.<sup>8</sup> Thus, the potential contribution of the Locks represents on average about 20% of the total contribution of AirVenture to the Fox Valley Regional economy.

Next, consider the total 20 year impact of each Lock opening scenario. In this case, we want to include the 2005-2015 impact of the Locks, and add to it the potential additional future impact. To do so, one adds the impact of the appropriate variable from Table 1 to the same variable under each scenario in Table 7. Table 9 displays this total economic impact.

Finally, again considering the full 20 year impact, Table 10 adds the cumulative contribution of the Locks from 2005-2015 to the appropriate variable under each scenario in Table 7, giving the full cumulative impact of the Locks over a 20 year period. Table 11 presents the average annual impacts of this case.

Table 7: Total 10 year Impact including Visitors' Center

Scenario	Real GDP (\$'s)	Labor Income (\$'s)	Employment	Investment (\$'s)
Menasha Open	122,610,042	74,546,906	2,683	41,901,517
Rapide Croche Open	247,445,224	150,446,696	5,413	84,595,149
Both Open	289,809,827	176,204,375	6,339	99,083,844

<sup>8</sup><https://www.eaa.org/en/eea/eea-news-and-aviation-news/news/09-21-2017-airventure-contributes-more-t>

Table 8: Average annual impact of Table 7 scenarios

Scenario	Real GDP (\$'s)	Labor Income (\$'s)	Employment	Investment (\$'s)
Menasha Open	12,261,004	7,454,691	268	4,190,152
Rapide Croche Open	24,744,522	15,044,670	541	8,459,515
Both Open	28,980,983	17,620,437	634	9,908,384

Table 9: Total Impact of Each Scenario, Including 2005-2015 Individual Impacts

Scenario	Real GDP (\$'s)	Labor Income (\$'s)	Employment	Investment (\$'s)
Menasha Open	187,031,116	113,714,919	4,141	63,949,007
Rapide Croche Open	311,866,298	189,614,709	6,871	106,642,639
Both Open	354,230,901	215,372,388	7,797	121,131,334

## 6 Conclusion

The analysis presented above estimates the economic impact of the Locks system on the Fox Valley Regional economy. To date the Locks have already had a significant economic impact on the Fox Valley Regional economy. Including the visitors' center, having a fully functioning lock system has the potential to generate an additional \$290 million in economic activity over the next 10 years, supporting over 6,300 additional jobs. This underscores the great value the Locks add to the Fox River in an area where water sports and related activities represent a key part of the economy.

Table 10: Total Impact of Each Scenario, Including 2005-2015 Cumulative Impact

Scenario	Real GDP (\$'s)	Labor Income (\$'s)	Employment	Investment (\$'s)
Menasha Open	528,442,571	321,293,083	9,874	180,696,166
Rapide Croche Open	610,382,471	371,112,542	11,665	208,735,170
Both Open	652,747,074	396,870,221	12,591	223,223,864

Table 11: Average Annual Impact of Scenarios from Table 10

Scenario	Real GDP (\$'s)	Labor Income (\$'s)	Employment	Investment (\$'s)
Menasha Open	25,163,932	15,299,671	470	8,604,579
Rapide Croche Open	29,065,832	17,672,026	555	9,939,770
Both Open	31,083,194	18,898,582	600	10,629,708

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## A Model of the Local Economy

This technical appendix describes the model used in the analysis above. Towards this end, the production function describing the relationship between the capital stock, labor stock, and public capital stock to total output (real GDP) must be specified. Following [Glomm and Ravikumar \(1997\)](#) and [Seung and Kraybill \(2001\)](#), a constant returns to scale production function in the Cobb-Douglas class is specified. The production function for the Fox Valley Regional economy is:

$$Y_t = z_t K_t^{\alpha(1-\varepsilon)} L_t^{(1-\alpha)(1-\varepsilon)} G_t^\varepsilon \quad (1)$$

where  $Y_t$ ,  $K_t$ ,  $L_t$ , and  $G_t$  represent output, capital stock, labor stock, and public capital stock in period  $t$ , respectively. The parameters  $z_t$ ,  $\alpha$ , and  $\varepsilon$  must be determined based on existing data, which is described below.

This function describes how the economy combines the inputs of capital, labor, and infrastructure and produces output. We assume that firms in the economy operate under perfect competition and make decisions to maximize profits. Under these assumptions, the market prices for capital and labor are determined by:

$$w_t = \frac{\partial Y_t}{\partial L_t} = (1 - \alpha)(1 - \varepsilon) z_t K_t^{\alpha(1-\varepsilon)} L_t^{(1-\alpha)(1-\varepsilon)-1} G_t^\varepsilon \quad (2)$$

$$r_t = \frac{\partial Y_t}{\partial K_t} = \alpha(1 - \varepsilon) z_t K_t^{\alpha(1-\varepsilon)-1} L_t^{(1-\alpha)(1-\varepsilon)} G_t^\varepsilon \quad (3)$$

where  $w_t$  represents the real wage in period  $t$ , and  $r_t$  is the return to capital in period  $t$ . Thus, the price of labor,  $w_t$ , and capital,  $r_t$ , are determined by their respective marginal products.

### A.1 Determination of Employment and Investment

Workers are assumed to supply labor inelastically. The stock of potential labor is taken as the current level of employment. Then, employment evolves as workers either migrate to the Fox Valley Region, or current workers exit (either to work in another location, to enter unemployment, or if they leave the labor force). Specifically, following, employment evolves according to:

$$L_t = L_{t-1}(1 + g) + M_{t-1} \quad (4)$$

where  $L_t$  is the employment level in period  $t$ ,  $g$  is the population growth rate, and  $M_t$  is the net-migration of workers to the Fox Valley Region. Following [Seung and Kraybill \(2001\)](#) net migration is determined by:

$$M_t = L_t \left[ \left( \frac{w_t}{\bar{w}_t} \right)^\mu - 1 \right] \quad (5)$$

where  $\bar{w}_t$  represents the ROW (rest of world wage), or the outside option for a worker employed in the region in period  $t$ . From Equation (5), workers in-migrate to the region if wages are higher than the outside option, and out-migrate if the ROW wage remains higher. The parameter  $\mu$  measures the elasticity of labor migration with respect to this relative wage.

Investment depends on two factors: (i) depreciation and (ii) expected future profitability of capital. Letting  $\delta_k$  denote the depreciation rate of capital, capital evolves according to:

$$K_t = (1 - \delta)K_{t-1} + I_t \quad (6)$$

where  $K_t$  is the capital stock in period  $t$  and  $I_t$  denotes investment in new capital. To determine the level of investment, I set  $K_t = K_t^*$ , where  $K_t^d$  represents capital demand and is given by solving Equation (3) for  $K_t$ :

$$K_t^d = \left[ \frac{r_t}{\alpha(1 - \varepsilon)z_t(L_t)^{(1-\alpha)(1-\varepsilon)}G_t^\varepsilon} \right]^{\frac{1}{\alpha(1-\varepsilon)-1}} \quad (7)$$

Thus, we have

$$I_t = K_t^d - (1 - \delta)K_{t-1} \quad (8)$$

## B Calibration and Simulation of Counterfactuals

This section describes the calibration of the baseline model and simulation of the counterfactual cases. To begin, several of the baseline parameters are readily available in the existing literature. Table 12 lists these parameters, their values, and the source of the data/values. Capital share of income is determined by  $\alpha$  (see Equation (1)), which is set at the standard value determined by the NIPA (National Income and Product Accounts). The depreciation rate of capital is set to 0.04, following [Seung and Kraybill \(2001\)](#), while  $\mu$ , the elasticity of labor mobility is set to 0.137 according to [Plaut \(1981\)](#). Finally, the elasticity of output with respect to public capital,  $\varepsilon$  is set to 0.05, following [Costa, Ellson, and Martin \(1987\)](#). This value represents the lowest value found in the existing literature. [Garcia-Mila, McGuire, and](#)

Porter (1996) finds a value of 0.20, and Seung and Kraybill (2001) use a value of 0.10 as a baseline. Generally, the higher the value of  $\varepsilon$ , the stronger the effect of the locks estimated above will become; as a result, it was prudent to error on the side of underestimating the impact by using the lowest estimated value of  $\varepsilon$ .

Table 12: Parameterization from existing estimates

Variable	Description	Value	Source
$\alpha$	Capital Share	0.36	NIPA
$\varepsilon$	Elasticity of public capital	0.05	Costa, Ellson, and Martin (1987)
$\delta_k$	Depreciation rate, Capital	0.04	Seung and Kraybill (2001)
$\mu$	Elasticity of Labor Mobility	0.137	Plaut (1981)

Given the parameters in Table 12, the remaining parameters are estimated to fit the model's predictions to existing data from the 2005-2016 time period. The data utilized are as follows. First, output in the model is estimated to match total Real GDP in the Fox Valley Regional Economy. The Fox Valley Regional economy is defined as Brown, Calumet, Outagamie, Winnebago, and Fond du Lac counties. Data on Real GDP was obtained from the Bureau of Economic Analysis (BEA) for the metropolitan areas of Green Bay, Appleton, Oshkosh-Neenah, and Fond du Lac (which comprises the aforementioned counties; see the definitions of these MSAs). Similarly, both employment and population data was obtained from the same source.

Once the model is estimated and fitted to the 2005-2016 period, the counterfactual experiments are performed. For the future 10 year predictions, the baseline levels must be established. The model then predicts the additional economic activity based on different scenarios. For the future 10 year levels, time trend models were estimated on each of the aforementioned data series. Although forecasting at longer horizons involves increasingly large confidence intervals, the ability of these time trend models to predict does not affect the estimated impact of the Locks. The impact of the Locks is *relative* to current GDP, employment, and investment; the time trend predictions simply provide the most informed estimate of the baseline scenario in the future.